The Weather Guide

A Weather Information Companion for the forecast area of the National Weather Service in San Diego

6th Edition
2012

National Weather Service, San Diego

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Introduction

This weather guide is designed primarily for those who routinely use National Weather Service (NWS) forecasts and products. An electronic copy can be found on our web page at:
www.wrh.noaa.gov/sgx/document/The_Weather_Guide.pdf.
The purpose of the Weather Guide is to:

- Provide answers to common questions
- Describe the organization, the people, and functions of the NWS - San Diego
- Explain NWS products
- Describe specific challenges local NWS forecasters face in producing accurate forecasts
- Create a better general understanding of the particular weather and climate of our region
- Provide numerous resources for additional information

The desired effect of this guide is to help the general public and journalism community gain a greater understanding of our local weather and the functions of the National Weather Service. We hope to improve relationships among members of the local media, emergency management, and other agencies with responsibility to the public. With a spirit of greater cooperation, we can together provide better services and understanding to our residents and visitors.

The National Weather Service in San Diego invites anyone with any interest to our office for a free and informal tour. We especially encourage members of the weather community or meteorology students to take advantage of this nearby resource and become familiar with the science, our work, and the local weather. We have various training and educational resources for those pursuing a career in meteorology or for those seeking a greater understanding of the science and its local applications.

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The National Weather Service

Mission

The National Weather Service (NWS) provides forecasts and warnings for weather, hydrologic, and climate needs for the United States, its territories, adjacent waters and ocean areas. The mission is to **protect of life and property and enhance the national economy**. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community.

This mission is accomplished by providing warnings and forecasts of hazardous weather, including thunderstorms, flooding, hurricanes, tornadoes, winter weather, tsunamis, and climate events. The NWS is the **sole United States official voice** for issuing warnings during life-threatening weather situations.

Brief History

The National Weather Service was created as a branch of the Signal Service, later the Signal Corps of the Army, by a Joint Congressional Resolution in 1870. It provided "for taking meteorological observations at the military stations in the...United States, and for giving notice...of the approach and force of storms."

The benefits of the weather service were soon recognized by business industries, the general public, and farmers who demanded special forecasts and warnings applicable to their needs. This led to the creation of a new organization with a more scientific status. Congress transferred the weather service of the Army to the Department of Agriculture in 1891 and named it the U.S. Weather Bureau.

Before World War II, technology and communications improved slowly, but the war accelerated the need for aviation forecasts, and an increase in technology and participation by all sectors of society, including women. More employees, training and resources were poured into the war effort. Advances in satellite and radar technology soon followed. During the 1950s and 1960s organizational changes took place, including the distribution of local forecast offices across the country. In addition, numerous national centers were established to provide support for numerical weather prediction, research, climate archives, climate prediction, hydrology, aviation weather, marine weather, severe storms and hurricanes. In 1970 the Weather Bureau changed its name to the National Weather Service (NWS) and became part of the newly formed National Oceanic and Atmospheric Administration (NOAA).

Since then many more advances have taken place in computer technology, allowing for greater power in producing numerical model guidance used by meteorologists. Satellites have become more sophisticated in the weather features they can detect. In the 1990s a "Modernization and Restructuring" effort was realized. Doppler Weather Radars were installed nationwide, representing a vast improvement over the old radars. New Advanced Weather Interactive Processing Systems (AWIPS) were installed nationwide in 1999. These workstations provide meteorological data, model guidance, satellite imagery and radar data with great flexibility in data manipulation and analysis. In 2000 a massive computer upgrade was made to allow greater speed and stability in generating numerical model guidance. In 2004 the NWS changed the forecast landscape with new digital forecasts designed to offer more spatial and temporal detail and to adapt to emerging digital technology. As the capacity of technology and understanding increases, forecasts become more accurate and extend further into the future. The NWS is the world leader for all operational weather forecasting and provides its basic infrastructure. For more history and stories, click on: **www.history.noaa.gov**.

The Role

The National Weather Service is part of NOAA, the National Oceanic and Atmospheric Administration, which is part of the Department of Commerce (DOC) in the U.S. Government. As noted in the mission statement, the entire weather database and infrastructure in this country (i.e. satellites, radars, weather monitoring stations, model guidance, etc.), is provided and maintained by the NWS. Private weather companies, consultants, media outlets, and research organizations all depend on this infrastructure.

It is easy to see why the NWS is part of the Department of Commerce. Numerous professions are directly impacted by the weather and countless decisions are made in response to weather forecasts. For example, anybody who works outdoors such as construction crews must monitor the forecast and make cost-saving decisions. Industries of transportation, agriculture and recreation depend heavily on weather information. Indirectly, some industries like the stock market may be impacted as entire local economies can be affected by flood, drought, freezes, or damaging weather. In fact, it is hard to find a profession not in some way affected by the weather.

The global economy is also increasingly dependent on weather forecasts. As much as one-third of the U.S. gross domestic product—three trillion dollars' worth of goods and services—is at least partially dependent on weather, according to estimates. Obvious examples include road, sea, and air transportation. Less obvious, perhaps, are power companies, which depend on temperature forecasts to anticipate consumer demand, and school systems.

Most Americans get weather information from media sources, such as television and radio, the Internet, smart phone applications and newspapers. These media sources are in effect weather retailers, selling weather information to customers through advertising money or subscriptions to services. But there is yet another layer in the process. For example, let’s say a local newspaper features a weather page. To prepare this page and to do it every day, the newspaper employs a private weather company. The newspaper gives the company its requirements for their weather page. The company fulfills the requirements at the appointed times and sends the bill to the newspaper. This works in a similar way for television and radio. The daily temperatures and rainfall amounts you see on the evening news were probably first collected and disseminated by the NWS, then gathered by the private weather company, then included in their weather package delivered to the paying television station. The private company may have some weather infrastructure of their own, but largely their data and guidance are provided as public access by the NWS, namely satellite and radar data, and weather model guidance. In this way the NWS serves as a sort of giant wholesale weather warehouse, where the weather retailers can shop for free to produce their products and services specific to their customers’ needs.

The Organization

The NWS is organized into headquarters, national centers, regional offices, and various field offices. See **www.weather.gov/organization.php**. The headquarters offices are located in Maryland (metro Washington DC) which oversee and administrate the entire agency. Nine national centers provide guidance to offices in the field scattered across the country, comprising the National Centers for

Environmental Prediction (NCEP), most of which are also located in Maryland. They include:

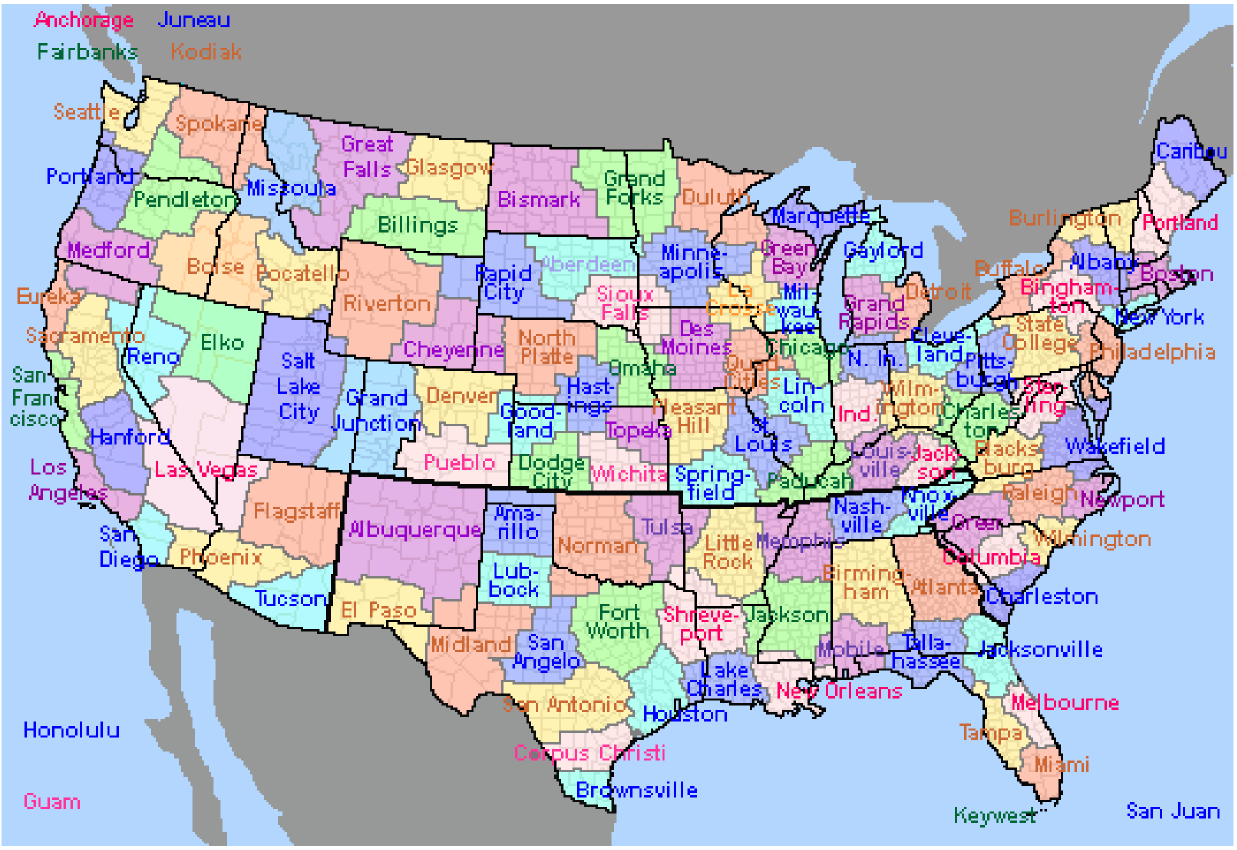
- **Aviation Weather Center (AWC)** provides aviation warnings and forecasts of hazardous flight conditions at all levels within domestic and international air space. The center is located in Kansas City, MO. See **aviationweather.gov**.
- **Climate Prediction Center (CPC)** monitors and forecasts short-term climate fluctuations and provides information on the effects climate patterns can have on the nation. They provide the official monthly and seasonal outlooks. They are the official experts on climate altering mechanisms such as El Niño and La Niña. See **www.cpc.ncep.noaa.gov**.
- **Environmental Modeling Center (EMC)** develops and improves numerical weather, climate, hydrological and ocean prediction through a broad program in partnership with the research community. See **www.emc.ncep.noaa.gov**.
- **Hydrometeorological Prediction Center (HPC)** provides nationwide analysis and forecast guidance products out through seven days, including the official daily weather map analyses. They compute quantitative precipitation guidance. See **www.hpc.ncep.noaa.gov**.
- **NCEP Central Operations (NCO)** sustains and executes the operational suite of numerical analyses and forecast models and prepares NCEP products for dissemination as guidance essential for weather prediction by each Weather Forecast Office (WFO). See **www.nco.ncep.noaa.gov**.
- **Ocean Prediction Center (OPC)** issues weather warnings and forecasts out to five days for the Atlantic and Pacific Oceans north of 30 degrees North latitude. See **www.opc.ncep.noaa.gov**.
- **Space Weather Prediction Center (SWPC)** provides space weather alerts and warnings for disturbances that can affect people and equipment working in space and on earth. The Center is located in Boulder, CO. See **www.swpc.noaa.gov**.
- **Storm Prediction Center (SPC)** provides tornado and severe weather watches for the contiguous United States along with a suite of hazardous weather forecasts. The Center is located in Norman, OK. See **www.spc.noaa.gov**.
- **National Hurricane Center (NHC)** includes the and provides forecasts of the movement and strength of tropical weather systems and issues watches and warnings for the U.S. and surrounding areas. The Center is located in Miami, FL. See **www.nhc.noaa.gov**.

Other specialized support centers, not part of NCEP include:

- National Severe Storms Laboratory (NSSL)
- Spaceflight Meteorology Group (SMG)
- Climate Diagnostics Center (CDC)
- Hydrologic Research Laboratory (HRL)
- National Climatic Data Center (NCDC)
- Pacific Tsunami Warning Center (PTWC)
- Central Pacific Hurricane Center (CPHC)
- West Coast/Alaska Tsunami Warning Center (WC/ATWC)

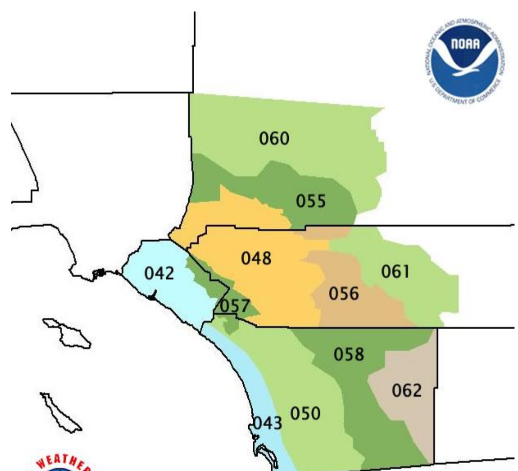
For hydrologic support, there are 13 River Forecast Centers (RFCs) across the country. For aviation support, there are 22 Center Weather Service Units (CWSUs) across the country, co-located with Air Route Traffic Control Centers. The country is divided into 122 forecast areas, also known as County Warning Areas (CWAs), each serviced by the local Weather Forecast Office (WFO) (see map below).

Regional offices in the Eastern, Central, Southern, Western, Alaskan and Pacific regions oversee these field offices within their region of the country. The Western Region Headquarters directs NWS operations in the western states from its office in Salt Lake City, Utah. This includes 24 WFOs, including the office in San Diego, three RFCs, and four CWSUs.



The NWS in San Diego

The San Diego Forecast Office prepares forecasts and any necessary warnings for a sizable area of Southern California, which is called a County Warning Forecast Area (CWFA or CWA). The San Diego CWA comprises all of Orange and San Diego Counties, western Riverside County, southwestern San Bernardino County and adjacent coastal waters off San Diego County. The CWA is divided into forecast zones, each containing roughly similar climates. A zone forecast is routinely made for each zone, the text of which is generated from a highly detailed graphical database. Forecast operations run continuously 24 hours a day, 365 days a year, providing its citizens a constant monitoring of the weather and protection of life and property in the form of timely warnings. In this way the NWS is the "weather police." The San Diego Forecast Office meteorologists are the experts of local weather and climate. They keep informed of research developments and the latest discoveries and news that impact the weather, such as El Niño and climate prediction, but do not conduct the research themselves and therefore are not experts in those research fields.



A History of the NWS in San Diego

"A very great gale blew from the southwest; the port being good, we felt nothing," commented Juan Rodriguez Cabrillo in 1542, upon sailing into what is now San Diego Bay. It was probably the first

documented weather observation in California.

Officially, weather observations were first taken in San Diego from 1849 to 1871 at the San Diego Mission de Alcalá and at Ft. Stockton, now part of Presidio Park, by the Medical Corps of the Army. When the Army's Signal Service assumed the task in 1871, the weather observing station was moved downtown to Horton Square at present day Broadway between 3rd and 4th Avenues. In 1909 a city ordinance allowed the U.S. Weather Bureau to install a weather kiosk to be placed in the San Diego Plaza containing weather instruments, posted forecasts, and weather charts. It is not known when the kiosk was discontinued. The official station moved around the Horton Square area several times from 1871 until 1940, but always remained within a stone's throw of present day Horton Plaza. In 1890 the first Weather Bureau Office was located on 5th Avenue between E and F streets. In 1930 the office and a second weather observing station were relocated to the Lindbergh Municipal Airport 1 ½ miles northwest of the city office, but observations were continued downtown. In 1940 observations became official at Lindbergh Field. This new site was considered close enough and sufficiently similar in climate to the downtown location that the climate record was continued uninterrupted rather than starting a new separate record for the new location. In 1969 the weather equipment was moved to its current location at the General Aviation Building at Lindbergh Field, now San Diego's International Airport. A history of the early observations in San Diego has been published and can be found at: **www.wrh.noaa.gov/sgx/cpm/SanDiegoHistory.pdf**.

In 1970 the Lindbergh Field office became a National Weather Service Office with limited forecasting responsibility. The NWS office in Los Angeles provided the general forecasts for all of Southern California. The San Diego office adapted these forecasts for local use and issued warnings for San Diego County in addition to the regular duties of taking weather observations at Lindbergh Field. In October 1995, the office at Lindbergh Field moved to Rancho Bernardo in the northern reaches of the city and discontinued taking the weather observations, but still maintained the climate record at Lindbergh with the help of automated equipment and contract observers installed in 1996. In 1997 the San Diego Office made a gradual transition to full forecast office capacity. Orange, western Riverside, and southwestern San Bernardino Counties were added to San Diego County. Since 1997 all forecasts and warnings for our area originate from the office in Rancho Bernardo. Marine forecast and warning responsibility for adjacent coastal waters were added in 1999. In late 2002, the Interactive Forecast Preparation System (IFPS) was implemented. This bold new forecasting system provides NWS forecasts in a graphical format and with a great amount of detail. In January 2003, the office assumed fire weather forecast responsibility in an area with virtually a year-round fire season. In November 2004, the northern borders of the CWA were adjusted. The community of Yucca Valley joined Twentynine Palms and other Morongo Basin communities as part of the Las Vegas area of responsibility. In exchange, the San Diego Forecast Office added an area north of Victorville almost to Barstow, including the city of Helendale.

The function, purpose and importance of the NWS were stated eloquently by Ford A. Carpenter in *The Climate and Weather of San Diego* California, published in 1913. "A few years ago a member of the French Academy of Science visited the San Diego Weather Bureau office, and having being shown the

meteorological apparatus and informed as to the application of the data to the everyday needs of commerce and agriculture, exclaimed, “You Americans are a wonderful people. You not only equal the French in the use of delicate instruments from which theories are evolved, but you excel us in making the results worth dollars and cents.”
Carpenter also observed, “An article in the *Century* magazine a few years ago stated that the Weather Bureau costs the United States a million and a half dollars a year, but that a conservative insurance company figured that on an average the people of the United States saved annually $30,000,000 because of their weather service, and this in addition to thousands of lives.”

The People of the NWS in San Diego

The staff at the NWS in San Diego consists of around 25 employees. Five managers and one assistant (three of which are degreed meteorologists) direct the work activities and administrative duties of the office. An Information Technology Officer maintains computer systems. Ten to 12 forecasters (all of whom are degreed meteorologists) prepare and disseminate forecasts and warnings, and attend to focal point duties and other projects. A combination of hydrometeorological technicians (HMTs) and meteorologist interns form the Public Service Unit. They collect and disseminate data, operate the NOAA Weather Radio, manage the climate observer program, and answer phone calls from the public and media. The interns (who are degreed meteorologists) also perform forecaster duties occasionally.

The Meteorologist-in-Charge (MIC) is Roger Pierce. He ultimately oversees all operations and work in the office and implements changes in policy or practices when needed. Questions about policy, funding, employment, technology, and the future are best directed to the MIC.

Alex Tardy is the Warning Coordination Meteorologist (WCM). He maintains relationships with our partners in service, i.e., emergency management within cities and counties, agencies of flood control and law enforcement, fire departments, and the media. He keeps the staff current and proficient in correct warning practices, completes verification studies, and conducts a variety of outreach activities.

Ivory Small is the Science and Operations Officer (SOO). He ensures that good forecasting techniques and good science are used by meteorologists through training and development. He implements the latest technology and meteorological theory from the research community and produces some of the research himself. He can answer questions regarding student volunteer and employment programs. He is the best resource for questions about the meteorology behind the weather.

Noel Isla is the Observing Program Leader (OPL). He oversees surface weather observations, such as those supporting aviation, marine, cooperative climate programs. He also oversees the responsibilities of the public service unit.

Mike Lauderdale is the Electronic Systems Analyst (ESA). He and his staff of electronic technicians maintain and repair all electronic equipment in our region. This includes observational equipment, the two Doppler Radars, and NOAA All-Hazards Radio.

The first line of phone communication is usually with the Public Service Unit, which will be staffed by a hydrometeorological technician (HMT) or Meteorologist Intern. They answer general questions about the weather, climate, or forecast, or can point you in the right direction for the answer. Forecasters on duty can provide greater detail about the reasons behind the current weather or forecast. Many questions of this nature can be answered by consulting the latest Area Forecast Discussion, updated at least four times a day.

When not working basic operations directly, each member of the staff completes focal point duties. These include directing local programs, conducting special projects or overseeing other areas of responsibility. A list of the entire staff and the numerous duties they perform in addition to operational duties can be found on our staff web page: **weather.gov/sandiego/office/staff.php?wfo=sgx**.

Communications and Product Dissemination

Text products and information disseminated from the NWS are transmitted in a coded format. Each product name is identified, for Weather Wire and EMWIN (Emergency Manager's source) purposes, by its code containing nine letters. The code formula is cccNNNxxx, where ccc is the regional node, NNN is the product identifier, and xxx is normally the code of the originating forecast office. For example, LAXZFPSGX indicates Los Angeles (LAX) is the regional node, the Zone Forecast Product (ZFP) is the name of the product, and San Diego-Rancho Bernardo (SGX) is the originating office. When a product is sent from the office, it goes to Gateway, the communications center for the NWS. From there, the products are disseminated to the world. Subscribing news services and private weather information companies then pick up these products and send them to users. The NWS maintains the largest meteorological telecommunications switching center in the world, sending and receiving nearly half a million meteorological bulletins each day.

The NWS relies heavily on its partners in emergency management and the media to keep communities safe and well informed. Emergency managers and the media have timely access to severe weather information through a number of systems and services listed below. For information on how to set up a service to receive real-time weather information, contact our Warning Coordination Meteorologist, Alex Tardy, at 858-675-8700 ext. 223.

There are many ways to get NWS information. iNWS is a great way to be notified whenever watches, warnings and/or advisories are issued. You choose which products and from which offices you get the products. See **inws.wrh.noaa.gov**

The **Family of Services** includes the NOAA Weather Wire Service, NOAAPort and news agencies such as AP, UPI and City News Service. These systems provide paying subscribers consistent and timely weather information in real time. For more information, visit: **www.csc.com/public_sector/ds/27517-nwws** and **www.meteostar.com**.

Private commercial information vendors supply numerous paying customers with weather information packages tailored to their needs. These are easily found on the Internet by doing a search for weather software.

Emergency management and flood control agencies in California can receive timely information through the **California Law Enforcement Telecom System** (CLETS). This originates from the State Office of Emergency Services in Sacramento.

You can always consult the NWS web page (**www.weather.gov)** for up to date information from a national perspective. However, it is subject to limitations inherent to the Internet.

Weather information can also be obtained from the National Weather Service anywhere and anytime using a wireless device. All you need is a wireless device that can surf the Internet along with a wireless Internet service provider. For more details, visit **www.srh.noaa.gov/cte.htm**. RSS feeds and podcasts are also available, see **www.nws.noaa.gov/rss**.

Local Programs

The **Aviation** program encompasses the preparation, transmission and verification of Terminal Aerodrome Forecasts (TAFs). TAFs are coded 24-hour forecasts updated at least every six hours. TAFs give detailed weather conditions expected at six area airports: San Diego-Lindbergh Field (SAN), McClellan-Palomar Airport (CRQ), Orange County-John Wayne (SNA), Ontario (ONT), Palm Springs (PSP), and Thermal (TRM). Soaring forecasts are also generated daily. Airport weather warnings are issued when severe weather threatens Lindbergh Field. Aircraft accident reports are issued for fatal accidents.

The **Cooperative Observer Program** is a vast network of thousands of weather stations across the nation. Local volunteers keep a daily climate record with data collected from equipment provided and maintained by the NWS. San Diego's Cooperative Program Manager directs this work at more than 90 official weather stations in our region. Data from some of the stations are used for hydrology and forecasting purposes. Climate data are forwarded to the National Climatic Data Center and become part of the official climate record.

The **San Diego Mesonet** is a network of public and private providers of weather data. Using existing weather stations, providers can transmit data from their own weather stations to the NWS in real-time. See **www.wrh.noaa.gov/sgx/cpm/sdm.php?wfo=sgx**.

Fire Weather forecasts are essential for fire fighting efforts by a number of agencies. Routine Fire Weather Forecasts are issued detailing sky condition, winds, relative humidity, and lightning potential. Specific spot forecasts are given by request for particular fire fighting or controlled burn situations, and also for hazardous material incidents. Fire Weather Watches and Red Flag Warnings are issued when dangerous fire potential exists.

The **Hydrology** program provides guidance and data for forecasting rainfall amounts and flooding. The hydrology focal point works closely with flood control agencies, NWS hydrologists and River Forecast Centers to ensure data that is correct, useful and timely gets into the hands of forecasters during possible flooding events. Networks of instrumentation such as rain gauges and stream gauges are maintained to monitor rapidly changing hydrological events.

Computer models and software are developed and maintained to enable accurate and timely issuance of hydrological products such as flash flood warnings.

The **Marine** program oversees the quality preparation of marine forecasts. The Coastal Waters Forecast describes wind and sea conditions out to five days; the Surf Forecast provides details about the next day's surf. Relationships with the marine community are maintained, along with a network of coastal observation equipment for frequent observational data. Warning systems are ready to be used in the event of large surf, coastal flooding, tidal overflow, tsunamis, or severe weather of any kind over the coastal waters.

NOAA All-Hazards Radio continuously broadcasts a cycle of warnings, forecasts and current conditions on six separate frequencies on the VHF band, originating from the San Diego office. Specially designed receivers have the capability to alarm and play a warning at the moment it is issued. This is possible due to ever-improving computer-synthesized voice technology. A Spanish language transmitter was installed in June 2004 in the Coachella Valley and provides Spanish broadcast of all products. It is the first transmitter of its kind in the west. The following table includes transmitter locations, names, and frequencies:

San Diego (east of Poway)	KEC-62	162.40 MHz
Santa Ana Mountains (south of Corona)	WWG-21	162.45 MHz
Coachella Valley (east of Indio)	KIG-78	162.40 MHz
Strawberry Peak (south of Lake Arrowhead)	WXM-66	162.50 MHz
Mt. Soledad Marine (La Jolla)	WNG-637	162.425 MHz
Coachella Valley Spanish (east of Indio)	WNG-712	162.525 MHz

The **Public Forecast Program** is a suite of forecasts and warnings designed for the entire public community. The traditional flagship product of the NWS has been the Zone Forecast, the routine forecast issued at least twice daily. The forecast is text generated from our digital forecast database. Forecasts of sky condition, temperatures, precipitation and significant winds are included in the forecast which extends to seven days. Area Forecast Discussions are issued at least four times a day. They give the current reasoning behind the forecast and explain any additional action taken. Quantitative Precipitation Forecasts are issued during the wet season and as needed during the dry season to indicate expected rainfall amounts. Hazardous Weather Outlooks are issued when any hazardous weather is expected for the upcoming week and contain flash flood potential indices during the monsoon season. Any necessary watches, warnings, advisories, and other statements are issued under the direction of the Public Forecaster on duty.

The **Weather Spotter Program** is a network of volunteers. A weather spotter is a person who observes significant weather and relays the information to the NWS. With this information, forecasters can issue warnings and update forecasts if necessary in a more accurate and timely manner. Around 1400 weather spotters are keeping an eye to the sky in our forecast area. Information about the program, including the quarterly newsletter can be found at: **www.wrh.noaa.gov/sgx/spotter/spotter.php**.

Skywarn is a more proactive spotter network involving ham radio communications to relay weather information during active weather events. When forecasters deem appropriate, Skywarn is "activated" and a Skywarn member operates radio communications from the San Diego office. Reports of significant weather or damage are actively solicited from the Skywarn community. The reports are then immediately forwarded to the forecasters on duty to aid in the forecast and warning process. For more information on the local Skywarn organization, visit **www.swskywarn.org**.

Spotter and Skywarn training presentations are held occasionally to recruit and train weather spotters.

Products and Services Offered by the NWS in San Diego

The NWS prepares a large number of various products that provide specific information. Each product name is identified by its code containing nine letters. The code formula is explained under "Communications and Product Dissemination" above. For a listing of NWS products, see Appendix A. The products are organized and described in the following categories. Note: All products originating from San Diego begin with the LAX identifier. For simplicity, the products below will be identified only by the following six letter code.

Climate - click on "Climate - Local" on our homepage for more information.

The **Daily Temperature and Precipitation Summary** (RTPSGX) reports the daily maximum and minimum temperatures and precipitation for numerous cities in our forecast area from a variety of weather stations, such as airports, cooperative observers, and remote weather systems. The RTP is issued at 430 am/pm and again at 530 pm largely to provide the data to local news media for early morning and late afternoon broadcasts. Updates may occur during the evening if and when additional data arrives. Note that these temperatures are the 24 hour high and low, which may not necessarily agree with the calendar day because thermometers are reset at the time of the 4 pm observation. This can lead to a problem. For example, let's say the high in Anaheim was 80 degrees one day. The 4 pm report gave the high of 80 and the current temperature of 77. The next day is much cooler; Fullerton and Santa Ana each report a high of 65 degrees. The report from Anaheim is a high of 77. Clearly, this is what we call a "carry-over". The high of 77 occurred at the time the thermometer was reset around 4 pm the previous day. Stations that report once daily are susceptible to carry-overs when the following day is cooler. Other problems are more rare, but also possible. An observer may not have reported for multiple days for a variety of reasons and the thermometer would not have been reset. The data given may then be the highest and lowest temperatures for the period, not the current day. Also, the high temperature may actually occur after the 4 pm observation. Please take special note of the disclaimer on the product and understand that some highs that appear abnormally high may be carried over from the previous day.

The **Climate Report** (CLIxxx) shows the updated climate values for the day for a number of cities in our area. Daily climate reports are prepared for many sites with automated weather equipment. In the product's header, xxx represents the three-letter identifier, normally an airport. Each CLI product is a daily almanac of temperature, precipitation, and several other weather conditions displayed with daily normal values, updated totals and records. These products are updated twice daily early in the morning and in the afternoon.

The **Local Climatological Data (CF6)** chart is a look at the current month of daily records. This is not an issued product, but is available on our web site. These are prepared for all cities for which there is a

climate report (CLIxxx).
The **Monthly Weather Summary** (CLMSAN) is updated on the 1st day of each month, detailing the previous month's statistics for these same cities/airports that have a CLI report. This product summarizes the weather of the previous month.
The **Record Report** (RERSGX) is a report of daily record temperatures or rainfall amounts met or exceeded at many cities in the area. This product is automatically headlined on the home page. Only some of the cities that report daily on the RTPSGX keep a history of daily records. Some of these cities have a short history dating back only to the 1970s. This makes the records easier to reach, and therefore less than remarkable. San Diego, Santa Ana, and Riverside are three stations with a much longer climate record.

Current Observations - click on "Current Conditions - Observations" on our homepage for more information.

The **Regional Weather Roundup** (RWRSGX) is a collective of current automated observations in the region including sky condition, temperature, dew point, relative humidity, wind speed and direction, barometric pressure and trends. When applicable, the remarks column shows very low visibilities, heat index or wind chill index values.
The **Coastal Weather Observations** (CGRSGX) product lists the current weather and sea conditions at several coastal stations, and is updated every three hours, but is very limited overnight.

Public Forecasts

The **Zone Forecast Product** (ZFPSGX) has traditionally been the flagship forecast product we issue. It is issued at 330 am and 230 pm every day and as necessary (when the forecast does not match current or expected conditions, or when updates are made to non-routine products). It is generated from a digital database maintained and updated by forecasters. Graphical digital forecasts are also available providing spatial and temporal detail not previously available with text products, see Graphical Forecasts on the home page.
The **Hazardous Weather Outlook** (HWOSGX) is a product issued when any expected weather in the following week may need the issuance of an advisory or a warning. It is issued by 6 am on days when these expected conditions exist, and updated as necessary. The outlook also presents a flash flood potential rating during the monsoon season in each mountain and desert zone as none, low, moderate or high.
The **Short Term Forecast** (NOWSGX), also called the "nowcast", is a brief detailed forecast usually covering two hours, but no more than six hours. These forecasts are issued to add beneficial detail, for example, describing location, movement, and possible impact of thunderstorms.
The **Area Forecast Discussion** (AFDSGX) is a discussion of the reasoning and thinking behind the forecast. A simple explanation of the general weather pattern for the coming week is given in the synopsis. The discussion portion contains a wealth of information about the current and future weather developments and the particular challenges involved in the current forecast. It is routinely updated four times daily, at 330 am, 930 am, 230 pm, 930 pm and other times when needed. The discussion on the web contains links that go to the non-routine products in effect and links that explain some of the more complex meteorological terms that may be used.
The **Tabular State Forecast for California** (SFTSGX) and the **Point Forecast Matrix** (PFMSGX) are part of the digital suite of products generated by the gridded digital database. The SFTSGX is a forecast of specific temperatures and chances of precipitation for selected cities across Southern California. The PFMSGX is a highly detailed forecast of numerous weather parameters in three hour increments for the next two days for a select few cities. Both these products are issued at least twice daily by 330 am and

230 pm.
The **Quantitative Precipitation Statement** (QPSSGX) is a routine forecast of rainfall amounts during the wet season, roughly November through April, but also during other times of the year when a significant precipitation event is expected. The product shows in table format expected rainfall amounts in 6-hour intervals for the coming three days for numerous locations in the forecast area. This product is issued twice daily by 4 am/pm.

Non-routine Products

A **Watch** is issued well in advance when conditions are favorable for a weather event to occur that can threaten life and/or property in the watch area.

A **Warning** is issued when a weather event that can threaten life and/or property is imminent or already occurring in the warned area. Emergency Alert Systems (**EAS**) are activated for short-fused warnings, such as a Severe Thunderstorm Warning.

An **Advisory** is issued when serious conditions are present and cause significant inconvenience. It may lead to a watch or warning.

Warning and Advisory criteria are found in Appendix D.

Verification

Observed weather conditions are essential to help the NWS determine which non-routine products to issue. When warnings are issued, weather reports are collected to verify the warning. A collection of these reports will be issued as a **Local Storm Report** (LSRSGX). With the verification data, studies can be made to learn how well the forecast team warns correctly or creates a false alarm. In this way the NWS takes responsibility for its warnings. Verification is an important part of the ongoing improvement of the warning process.

Hydrology – Flash Floods and Floods

Flash floods are defined as a rapid rise in water flooding a local area, followed by a rapid drop in water level. Any small stream, creek, arroyo, wash or paved urban areas can be briefly inundated by a flash flood. Flash floods should be water flowing rapidly at least six inches deep. Dam breaks or breaches cause flash flooding downstream. When any of these are expected a **Flash Flood Watch** (FFASGX) and subsequently a **Flash Flood Warning** (FFWSGX) are issued. A **Flood Advisory for Urban and Small Stream Flooding** (FLSSGX) informs of inundation conditions not threatening life and property, but can be dangerous if not taken seriously. Examples of advisory conditions include a flooded intersection or onramp to a freeway that is blocked by water and disrupting traffic flow. The **Flash Flood Statement** (FFSSGX) is issued to update or cancel Flash Flood Warnings (FFWSGX).

A **Flood Watch** (FFASGX) and subsequently a **Flood Warning** (FLWSGX) are issued when a mainstem river is expected to overflow its banks. A **Flood Statement** (FLSSGX) updates a warning and may update and summarize more than one warning. The NWS defines a flood as a normally dry area inundated with water along an established watercourse such as a mainstem river. In San Diego's forecast area, there are four rivers that qualify as such watercourses: The San Diego River at Fashion Valley, the San Luis Rey River at Oceanside, the Santa Margarita River at Ysidora, and the Mojave River at Victorville (Mojave Narrows). The **River Statement** (RVSSGX) provides specific forecast levels at these flood gages during flooding events.

Winter Weather

All of the following winter weather watches, warnings and advisories come under the product header WSWSGX. The **Winter Storm Watch** and **Winter Storm Warning** are issued when a significant winter storm will impact the region. These detail the adverse impacts caused by heavy snowfall combined with strong winds. When snowfall and strong winds combine to create white-out conditions and near zero visibilities over several hours, a **Blizzard Warning** is issued. Although unheard of in Southern California, ice storms or freezing rain events would be covered by an **Ice Storm Warning** and a **Freezing Rain (or Drizzle) Advisory**, respectively. Several different winter weather hazards can be in effect at once under one WSWSGX product.

Severe Weather

Severe weather is associated with thunderstorms, which can bring any combination of deadly lightning, tornadoes, large hail, heavy rain (with associated flooding), and any other strong damaging winds. When conditions are favorable for severe thunderstorms or tornadoes, the Storm Prediction Center issues a **Severe Local Statement** (SLSCA). This becomes a **Severe Weather Watch** for Southern California in a redefining statement issued by the Oxnard office. A **Severe Thunderstorm Warning** (SVRSGX) is issued when severe thunderstorm warning criteria are met or are imminent. It is not mandatory that a local statement or a watch be in effect before a warning is issued (in fact, it is rare). When a tornado is detected by weather spotters or Doppler Weather Radar, or the forecaster strongly believes a tornado is about to develop, a **Tornado Warning** (TORSGX) is issued. Updates are made to either or both of these warnings with a **Severe Weather Statement** (SVSSGX). Flash floods occurring with severe thunderstorms are detailed in their own separate **Flash Flood Warning** (FFWSGX). Severe weather over coastal waters is covered by a **Special Marine Warning** (SMWSGX), which warns of waterspouts and other severe and hazardous boating weather. Severe weather is often extremely localized in time and space. Accordingly, these products are very short-fused and cover a small area.

Weather without Precipitation

A Non-Precipitation Weather product (NPWSGX) covers a great variety of weather events that do not include precipitation. This product can be an advisory, a watch or a warning. A **High Wind Watch** and subsequently a **High Wind Warning** are issued when strong winds causing potential damage are expected. A **Wind Advisory** is issued when strong winds are expected, but fall below warning criteria. A **Wind Chill Warning** or a **Wind Chill Advisory** is issued when strong winds combine with very low temperatures. Blowing dust and/or sand that reduce visibility may prompt a **Blowing Dust/Sand Advisory**. When dense fog develops in more than just a localized sense, a **Dense Fog Advisory** is issued. Extremes in temperature are also covered by the product. High temperatures and humidity may warrant an **Excessive Heat Warning** when the Heat Index becomes dangerous. A **Freeze Warning** is issued when freezing temperatures present a serious threat to crops. A **Frost Advisory** is issued when a freeze is less serious.

Marine Forecasts and Warnings

The **Coastal Waters Forecast** (CWFSGX) is a routine forecast of winds and sea state on the coastal waters out to five days. It is issued four times daily by 230 and 830 am/pm PST and 330 and 930 am/pm PDT. The forecast covers the coastal waters from the San Diego County shore out to 60 nautical miles (about five nm beyond San Clemente Island). The area is divided into two zones by a line 30 nautical miles off the coast parallel to the coast. Within the body of the forecast a **Small Craft Advisory** may be headlined when winds and/or seas begin to present a hazard for small vessels. If seas are especially hazardous, it will be specified as a **Small Craft Advisory for Hazardous Seas**. The following rare warnings, **Gale**, **Storm**, **Tropical Storm,** or **Hurricane,** may be headlined when very strong winds and/or stormy seas are expected. The **Surf Zone Forecast** (SRFSGX) is issued twice daily by 2 am/pm and contains surf and rip current risk information for the beaches of Orange and San Diego Counties. A **Marine Weather Statement** (MWSSGX) describes potentially dangerous boating conditions such as waterspouts or non-severe thunderstorms on the open water. A **High Surf Advisory** (CFWSGX) is issued when large and dangerous surf is widespread along the coast or when minor tidal overflow occurs. When the weather over the water becomes severe with strong thunderstorms, a **Special Marine Warning** (SMWSGX) is issued. Coastal flooding caused by very high tides and/or large surf is covered by a **Coastal Flood Watch** and subsequently a **Coastal Flood Warning** (CFWSGX). If an earthquake occurs along the Pacific Rim that will generate a tsunami along the coast, a **Tsunami Warning** (TSUWCA) will be issued by the West Coast and Alaska Tsunami Warning Center. A **Tsunami watch**, **Tsunami Advisory**, or **Tsunami Information Statement** (TIBWCA) may be issued. If Southern California impacts are expected, these products are reissued with more local details by the San Diego Forecast Office.

Aviation Products

Aviation products are coded and disseminated to the aviation community, not through the standard media to the public, but are available on our web site. A **Terminal Aerodrome Forecast** (TAF) provides detailed changes in wind speed and direction, visibility, cloud coverage, cloud ceiling height and precipitation for local airports out to 24 hours. These airports include San Diego-Lindbergh Field (TAFSAN), McClellan-Palomar in Carlsbad (TAFCRQ), Orange County-John Wayne in Santa Ana (TAFSNA), Ontario (TAFONT), Palm Springs (TAFPSP), and Thermal (TAFTRM).

Fire Weather

A **Fire Weather Planning Forecast** (FWFSGX) is similar to the public zone forecast, but gives more detail regarding relative humidity, winds and lightning potential. A **Fire Weather Watch** and subsequently a **Red Flag Warning** (both RFWSGX) are issued when dangerous wildfire potential exists, i.e., when strong winds combine with low relative humidity and low fuel moisture. Spot weather forecasts, which are site specific for wildfires, controlled prescribed burns, hazardous material spills, or for any other public agency support, are issued upon request.

News Products

A **Special Weather Statement** (SPSSGX) is a description of an upcoming significant weather event, such as a winter storm. It is usually allowed to expire once the weather event is occurring and is covered by a warning or advisory, such as a Winter Storm Warning. The **Rainfall Storm Total Summary** (RRMSGX) is a periodic update to storm precipitation totals during or after a given storm. This product is automatically headlined on our home page. The **Local Storm Report** (LSRSGX) is issued during and after an intense weather event, documenting the impact of heavy rain, hail, flooding or severe weather of any kind. Several reports may be issued during the event as information becomes available. A summary report is issued at the end of the event. A **Public Information Statement** (PNSSGX) is a multi-purpose news product. Its information can range from a summary of a weather event, an update to new technology, a change in the format of a product, a change in local policy, or other purposes.

Weather Safety and Preparedness – Click on "Preparedness" on our homepage for more information.

The primary mission and responsibility of the National Weather Service is to protect life and property. The goal is to warn for all potentially dangerous weather events with sufficient lead time so emergency personnel and the public can take action to eliminate or minimize the loss of life and/or property. However, for many reasons a dangerous weather event may strike without a warning being issued, or the public may not be otherwise prepared. Weather awareness and preparedness are vitally important especially in our region where residents can become complacent because dangerous weather is relatively infrequent and the population is dense.

Upon the initial issuance of a short-fused warning, the **Emergency Alert System (EAS)** is activated. Local news radio stations with this responsibility receive this alert of three tone bursts and proceed to broadcast the warning over their station, in accordance with regulations of the Federal Communications Commission (FCC). On television the warning message scrolls across the top or bottom of the screen. NOAA weather radios broadcast the warning direct from the NWS office (specially designed receivers kick on automatically when a warning is issued). The NWS – San Diego web site will indicate the warning on a color coded map. Sadly, these efforts are sometimes not sufficient to inform all endangered parties in a timely fashion. We encourage all residents and visitors to become aware of the potential weather dangers associated with the area in which the live, work, and visit, and the means to receive these warnings, and to prepare accordingly.

Two programs of the NWS help communities to better prepare themselves for disasters. **Stormready** communities are better prepared to save lives from the onslaught of severe weather through better planning, education, and awareness. The **TsunamiReady** program is designed to help coastal communities reduce the potential for disastrous tsunami-related consequences. For more information about how to become involved, see **www.stormready.noaa.gov** and **www.tsunamiready.noaa.gov**. See Appendix E for weather safety information.

Behind The Forecasts

Terminology and Forecast Language

The NWS has a unique way of describing expected weather. Some of the terms used to describe time periods and weather conditions may seem arbitrary, but there are rather specific meanings attached to them.

Forecast Time Periods

Time Period	Definition
today	sunrise to sunset
tonight	sunset to sunrise
morning or in the morning	sunrise to noon
afternoon or in the afternoon	noon to around 6 pm
evening or in the evening	from 6 pm to midnight

In the forecast the days are divided into both day and night periods. A night period crosses over midnight as outlined above. For example, "Sunday night" means from sunset Sunday evening until sunrise Monday morning. Low temperatures for Sunday night most of the time would technically occur early Monday morning around sunrise, but are mentioned in the Sunday night period.

Sky Conditions

Sky conditions are described depending on how many tenths of the sky is covered by opaque clouds (clouds that completely block the sun).

clear or sunny	less than 1/10 opaque clouds
mostly clear or mostly sunny	1/10 to 2/10 opaque clouds
partly cloudy	3/10 to 6/10 opaque clouds
mostly cloudy	7/10 to 8/10 opaque clouds
cloudy	9/10 to 10/10 opaque clouds

High cirrus clouds are often somewhat transparent, so even if the sky is full of them the term mostly clear or partly cloudy may be used. In contrast, a small patch of fog can entirely obscure the sky from an observer's point of view. It may be cloudy or foggy at that point, but only a mile or two away the skies are completely clear. That patch of fog is so low it is below the horizon from an outside observer's perspective. This is often the case with varying terrain, a shallow marine layer, and dense fog. Fog may persist at the beaches while only a quarter mile inland it is clear. Forecasters attempt to include language to specify the range of possibilities, but cannot describe every possibility without becoming entirely too wordy. A mostly sunny forecast may be a bad forecast to the few people underneath a tiny isolated patch of fog, but a correct forecast to the other 99% of the population. By contrast, high clouds can be seen hundreds of horizontal miles away.

Winds

Wind direction is described as the direction **from** which the wind is blowing (e.g., a northwest wind is a wind coming from the northwest). Wind speeds are given in miles per hour (note: wind speeds are given in knots on marine products). Terms that may be used to describe wind speeds are defined in the following table.

Since winds are highly variable in time and space, usually the strongest winds expected anywhere in the zone are mentioned. For people in areas normally protected from the wind, this understanding is important. “Local” is a term often used to imply that indicated winds will not blow over the entire area, but at some unspecified locations that may differ in time and space. Often, winds are influenced by terrain creating a predictable wind pattern. If there is enough confidence about exactly where and when the winds will take place, a better description is given. For example, phrases such as “below passes and canyons in the morning” are often included to add beneficial detail.

Temperatures

Temperatures are given in simple numerical ranges such as “lows 42 to 50”. In many weather situations temperature ranges can be very large; a forecast of the entire range would not be useful, and a detailed description would be too wordy. In these cases, extreme temperature outliers are simply left out of the range and the forecast is made for the majority of the area. For example, on a clear morning in the San Bernardino Mountains low temperatures may range from 29 degrees in a high mountain valley to 51 degrees on a foothill slope. A forecast covering that entire range (28 to 52 for example) is not very useful, so a judgment is made that most lows within that zone will be 33 to 47. Observers over time will come to know where their local temperatures fit with respect to the standard forecast ranges. The details can still be found using the point-specific digital forecast, however.

Precipitation

The idea to use probabilities for whether it was going to rain began with the National Weather Service in 1965. The original concept was to provide a risk-benefit assessment for people to whom the occurrence of rain was critical. For example, a contractor might decide to pour concrete if the chance of rain is only 30 percent, but might decide not to pour if it's 60 percent. **Probability of Precipitation (PoP)** is the likelihood (expressed as a percent) of measurable liquid precipitation (or the water equivalent of frozen precipitation) during a specified period of time for any point in the forecast zone. **Measurable precipitation is defined as 0.01 inch or more.** PoPs accompany **expressions of uncertainty** or **areal qualifiers** within the forecast narrative. For example, a slight chance of rain (20%) is an expression of uncertainty that means at least one location in a zone should receive measurable precipitation 2 out of 10 times (20%) given a similar weather situation. Or, to state the converse, rain is NOT expected 8 out of 10 times. The probability has nothing to do with the amount,

duration, or the percentage of the area that will get rain. When showers are mentioned in a forecast, there is a high likelihood of them occurring somewhere in the area, and thus the probability refers to the amount of the area in the forecast that will receive measurable rain, and receive an areal qualifier. “Scattered showers” means that 30 to 50 percent of the zone’s area gets hit by at least one shower and receives measurable precipitation. Below is a table of these two descriptive methods and their relationship to PoPs.

PoP Percent	Expression of Uncertainty	Equivalent Area Qualifiers
10-20 percent	slight chance	isolated
30-40-50 percent	chance	scattered
60-70 percent	likely	numerous (or none used)
80-90-100 percent	(none used)	(none used)

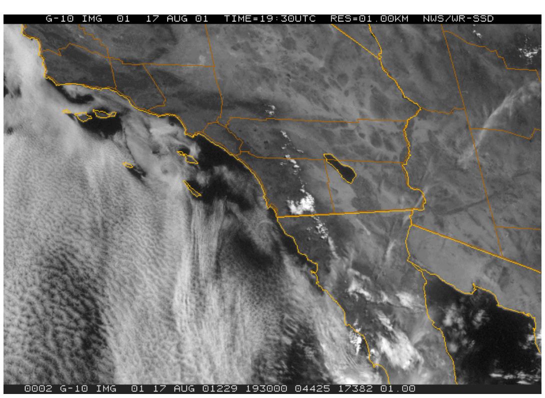
For trace events (precipitation of less than 0.01 inch), the terms “drizzle,” “light rain” or “sprinkles” will be used, often with a PoP of less than 15%. Our marine environment can bring dense fog (which can be very misty), heavy condensation, and drizzle. Many times these marine layer precipitation events result in a trace, even when road surfaces become completely wet. For more on the philosophy of probabilities, see the Uncertainty section under Forecast Challenges below.

Forecast Tools

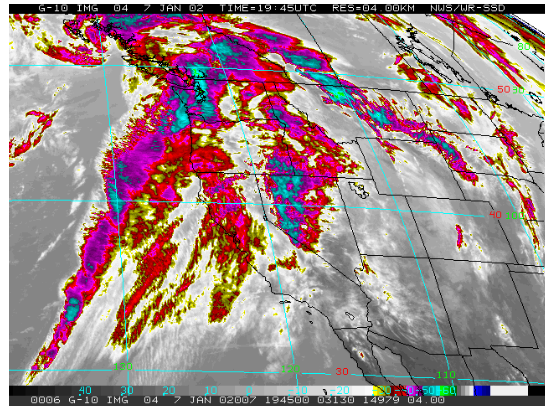
Today’s forecaster has a large variety of tools available. Many advances in technology and the understanding of meteorological principles in recent decades have added a great deal to the science. Seven day forecasts today are about as accurate as three day forecasts were back in the 1980s. Meteorologists blend their own knowledge and experience with the data provided by these tools to make a forecast.

Satellite

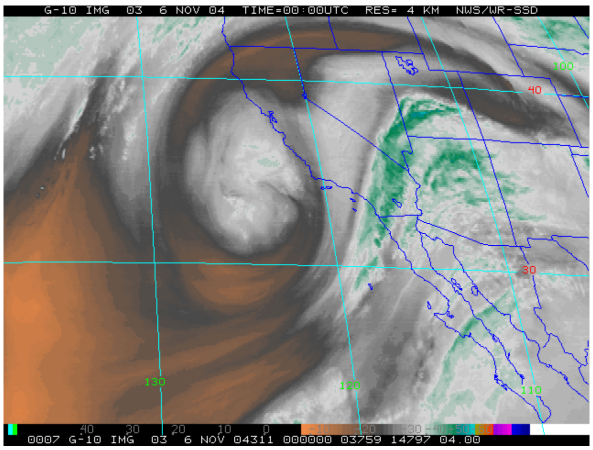
Satellite data is one of the more essential forecasting tools. The satellite in use over the western U.S. is the GOES - West Satellite. This satellite is geostationary, meaning that it rotates along with the earth so that it is always over the same place on the earth. Three basic images are generated from this satellite: visible, infrared and water vapor imagery. Polar-orbiting satellite data are also used. These orbit the earth crossing the poles. Several additional specialized images are also available.



Visible imagery is like a camera snapshot from space, recording reflected visible light from the earth’s surface. All clouds are white. The image goes black as the sun sets. Since all clouds are white, it is sometimes difficult to tell at what levels these clouds exist.



Infrared images are actually measurements of temperature, rather than reflected light as in visible satellite images. Warmer objects appear darker than colder objects. Cloud temperatures are related to cloud height, and relative cloud height can be readily inferred. The color spectrum on the gray scale is converted to colors to more easily discern the temperature differences.



Water vapor images are useful for identifying regions of moist and dry air. Dark colors such as black and dark grey indicate dry air while bright colors such as white or light grey indicate moist air. Swirling wind patterns in low pressure systems and jet streams are easily identified. Colors have also been added to these images to more easily discern the moisture differences. Other derived satellite products have been developed, such as the **fog** product. In San Diego this is commonly used at night to easily detect the low clouds and fog common to our region. For more background on satellite imagery, click on: **www.srh.weather.gov/jetstream/remote/satellite.htm**.

Radar

Doppler Weather Radars were installed during the early 1990s and marked the beginning of a new era in detecting and forecasting weather. The official name is **NEXRAD WSR-88D**, meaning NEXt Generation Weather Service RADar-1988 Doppler. Technicians at the San Diego office maintain two Doppler radars: one east of Scripps Ranch in San Diego, and one in the Santa Ana Mountains south of Corona. While some media outlets claim ownership of WSR-88D Doppler Radars, only the National Weather Service owns and maintains weather radars in our area. In addition to detecting areas of precipitation called **echoes**, the Doppler Radar also detects movement and intensity of the precipitation. The radar also detects wind velocity and direction, useful for detecting rapid shifts in wind direction, including tornadoes. These data alert forecasters to the possible need of warnings or advisories.

How does it work? The radar sends out a beam of energy that strikes an object. Some of that energy is reflected back to the radar. The velocity of the object can be derived from the phase change of the beam’s wavelength as it returns to the radar. The radar has many limitations. Due to occasional atmospheric conditions, the beam is bent toward the ground and detects ground effects (hills, trees, structures) called "clutter." The beam scans the atmosphere in slices, one angle at a time. As the beam angles upward, the beam may be over 20,000 feet high at a distance beyond 100 miles. Significant weather can occur below the beam completely undetected. In addition to raindrops and ground effects, the radar can detect birds, insects, dust, etc. Military operations often include spreading **chaff** (tiny, fine metal strips) into the atmosphere. Chaff is a very good reflector for the radar beam and shows up on the radar display as an intense radar echo. Often, a quick look at the satellite image can help verify that this is not precipitation. Echo signatures of chaff look quite different in appearance than actual precipitation and can be easily identified by the trained eye, but it becomes more difficult when echoes of legitimate precipitation are also present. For more information about Doppler Radar, click on: **www.srh.weather.gov/jetstream/doppler/doppler_intro.htm**.

In 2012, Dual Polarization Radar technology was installed at the Doppler radars across the country. Dual-Polarization technology takes each sweep of the radar from 2-D, to 3-D. Before Dual-Pol, a radar beam was transmitted only in the horizontal plane, so the beam could only receive data about falling precipitation in one direction. With this 2012 upgrade, forecasters can get information about precipitation not only in the horizontal but in the vertical as well, telling us much more about what we are looking at.

Observations

Surface observations are current weather conditions measured at a point on the earth's surface. The most reliable and accurate source of hourly weather observations are automated surface observation systems, called **ASOS** stations, a network of standardized equipment funded and maintained by the NWS. This equipment, usually located at airports, transmits at least one hourly observation called a **METAR** (METeorological Aviation Routine weather report). METARs are written in METAR code, an international weather descriptive code.

A network of **ALERT** (Automated Local Evaluation in Real Time) equipment is used primarily for hydrological purposes, measuring rainfall and river levels, but also temperature and wind in some cases. This equipment is maintained by flood control agencies in cooperation with the NWS.

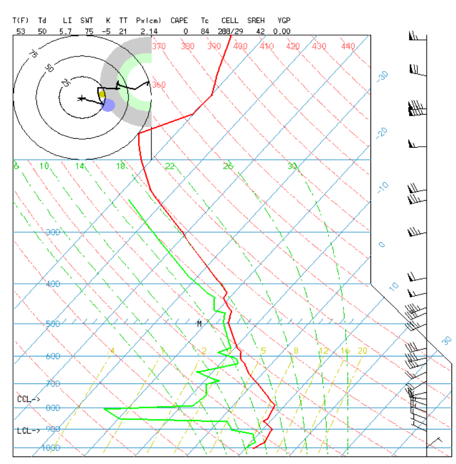
Another network of weather instrumentation is **RAWS** (Remote Automated Weather Station) data, used primarily for fire weather forecasting support. The network is maintained by several other federal and state agencies, such as the California Department of Forestry (CALFIRE), the Forest Service (USFS) and the Bureau of Land Management (BLM).

The **San Diego Mesonet** is a network comprising private citizens or external agencies providing real-time data to the NWS in San Diego from their own privately funded equipment. Participants collect their data on a data logger installed on their computer. Using high speed Internet and the ftp process, the data is transmitted automatically to workstations at the NWS in San Diego. The siting, placement, and accuracy of the equipment of these sites have been verified and approved by NWS personnel, so forecasters can trust the data that comes from them. For more information, click on "Other Useful Links, then San Diego Mesonet" on our home page. The **Mesowest** is a collective of numerous observational data maintained by the University of Utah. It is a useful tool used by NWS forecasters to monitor all observational data at once.

A large variety of **other weather data** sources are available, mainly on the Internet. These include school networks, resorts, businesses and private citizens with weather equipment. We use these sources only as a last resort and with caution due to their occasional low levels of accuracy and reliability. On occasion we invite these providers to join the San Diego Mesonet.

Upper Air Observations provide valuable data for a lot of reasons. Forecasters need to know the behavior of the atmosphere in three dimensions, not just at the earth's surface. Observations of the upper air are taken by weather balloons with an attached radiosonde, a small packet of weather instruments. As the radiosonde rises, it sends a constant stream of data, which is crucial for understanding the current state of the atmosphere. The data is collected by radio receivers on the ground and plotted as a vertical trace called a **sounding**, on a thermodynamic diagram called a "Skew-T." This snapshot of temperature, dew point and winds in the atmospheric column is a most valuable set of data. A forecaster can identify temperature inversions common to our region, levels of instability and moisture, changes in wind speed and direction, and infer many other atmospheric behaviors. More than 2,000 of these balloons are launched around the world at 00z and 12z universal "zulu" time (locally 4 am/pm PST and 5 am/pm PDT). In this way the world is synchronized with an accurate three dimensional picture of the weather conditions twice a day. These data are among the most important input to computerized numerical weather models. It's only by getting a complete picture of what the weather is doing now that forecasters can hope to say what it will do next. Unfortunately, the sounding network is rather sparse and soundings are taken only twice a day. Locally, soundings are taken at Miramar MCAS (pictured at right, below). Around the region, other soundings are taken at Vandenberg AFB, Oakland, and occasionally at Edwards AFB, Yuma, Arizona, and Guaymas, Mexico.

The typical weather balloon is about six feet in diameter (two meters) and is filled with either helium or hydrogen. It carries a one-pound (half a kilogram) package of weather instruments and transmitters. Flights may last over two hours, reaching altitudes of 22 miles (35 kilometers), where the temperature drops to minus 130 degrees F (minus 90 degrees C). At that height the balloon, having swollen to about 20 feet (six meters) in diameter due to the low air pressure, tends to pop, cutting short the flight. The one-pound radiosondes do not hurtle to the ground, however—little parachutes bring them back down safely, complete with mailing instructions. Returned instrument packages can be retooled and reused. But even now, with GPS tracking, the NWS



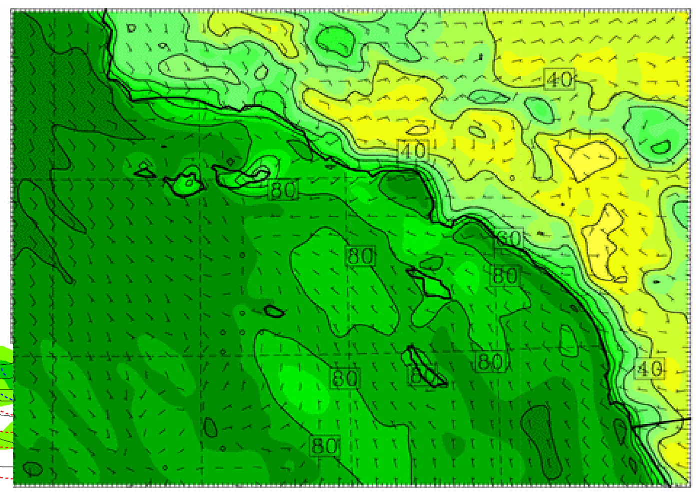
recovers only about 15 percent of the radiosondes.

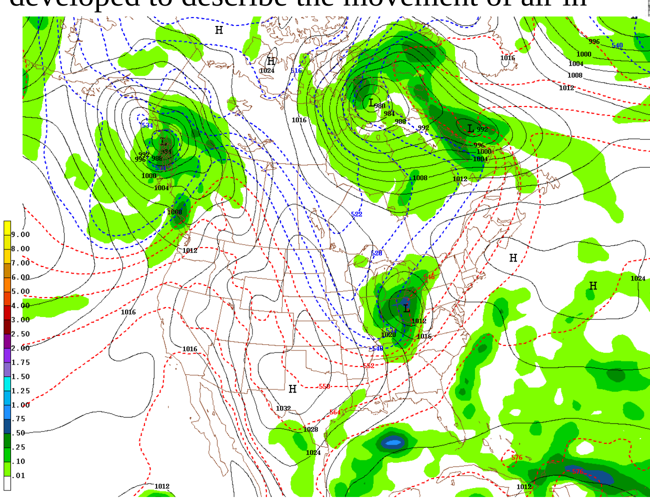
Satellite Sounders are becoming more adept at correctly inferring temperatures and winds at all levels of the atmosphere from GOES Satellites. Satellites have equipment that will acquire profiles of temperature and moisture for clear or partly clear fields of view. In addition, cloud tracking allows for the measurement of wind in the atmosphere. This information is used for input to the weather models which result in improved weather analysis and forecasting.

Wind Profilers are surface based instrument grids that detect winds and temperatures in the atmospheric column. Most of these are maintained by the military, universities, or other research institutions.

ACARS (Aircraft Communication Addressing and Reporting System) data are vertical traces of weather data taken by commercial airliners during ascents out of and descents into major airports. The frequent upper air observations are valuable because they often fill in the gaps of time and space between weather balloon soundings.

Forecast Models - Numerical Model Guidance





Once meteorologists have an accurate picture of the current atmosphere, the process of forecasting can begin. Scientists through the ages have come to understand some of the movements of the atmosphere through the study of physics, fluid dynamics, and thermodynamics. Mathematical equations called equations of motion have been developed to describe the movement of air in the atmosphere. By modifying these equations, removing the less important components, and inserting the weather data into the equations, a solution can be calculated for a future time. For example, if we know the temperature for a certain place at midnight, we can enter that value into the equation to get the temperature for that place at noon. This can be done for many time steps (i.e. 24, 36, 48 hours) into the future and for numerous points on the map. These equations of motion are non-linear, meaning they cannot be solved by hand in a timely fashion; if we attempted to solve the equation by hand, the weather event would occur before we could produce a forecast for it! This is why powerful computers are essential. The computer can make iterations, a long sequence of approximations which increasingly get closer to the solution. After numerous iterations, an acceptable solution arrives. The process is repeated for every weather parameter and for every grid point on the map. The plotted values can then be connected by interpolating values between the points, like connecting the dots. The whole process works like baking bread as follows:

Data is collected: upper air, satellite, radar, surface observations, buoys, etc.	*Ingredients are gathered.*
Data is input into mathematical equations of motion to be solved by powerful computers.	*Ingredients are mixed and put in the oven.*
The computer generates a numerical solution in future time steps.	*The bread is baked.*
The solutions are checked for quality and plotted graphically on maps.	*The warm bread is sliced and served.*

In its finished form, the numerical model guidance arrives at each forecast office a few hours after the "run time": 00z, 06z, 12z, and 18z universal time (a few models are run more frequently, but do not extend very far into the future). The main supercomputer in use by the NWS is named Blue and is located at an IBM facility in Gaithersburg, Maryland. Weather data arrives from an array of sources, including observation stations, ocean buoys, and global weather balloons. Some aircraft even carry sampling instruments. But satellites increasingly provide extensive coverage that can penetrate and monitor different layers of the atmosphere. The number of daily weather observations crunched by NOAA's supercomputers is around 200 million. After the guidance is computed and post-processed, it is sent to each forecast office where the data is ingested by AWIPS equipment. The guidance packages are then available to the forecaster to analyze and formulate a forecast. It comes in graphical format or statistically generated text format. Just like bread, the model guidance package becomes stale with time, and obsolete with the arrival of the new model guidance run.

Some guidance is received from national or regional centers regarding rainfall amounts, flooding and flash flooding potential, severe thunderstorms, hurricanes, hazardous fire weather, etc. For example, if a big storm is coming and forecasters need to figure out how much rainfall is coming, the San Diego office will receive guidance from the Hydrometeorological Prediction Center (HPC) in Maryland and the River Forecast Center (RFC) in Sacramento. They will provide valuable input for deciding how much precipitation will fall and what flooding impacts may occur. The Storm Prediction Center (SPC) in Oklahoma provides guidance on the probability of severe thunderstorms. The National Hurricane Center (NHC) in Miami projects tropical cyclone tracks and intensities in the Atlantic and eastern Pacific Oceans. In the end, final decisions regarding local warnings and forecasts rest with the forecasters in the San Diego office.

Advanced Weather Information Processing System (AWIPS)

AWIPS is a workstation that provides one-stop shopping for weather data and guidance used by the forecaster. Numerical model guidance, satellite imagery, radar data, and analyses can be viewed graphically. AWIPS offers the capability of viewing the model guidance in a variety of

ways to get a four-dimensional understanding of the atmosphere's behavior. NWS alphanumeric guidance, observations, and text products nationwide are also available.
Interactive Forecast Preparation System (IFPS)

IFPS is the system that forecasters use for preparing and issuing forecasts. With this system, located in AWIPS, forecasters manipulate a high-resolution digital database that represents the expected weather, rather than writing text. Forecasters edit grids of numerous weather parameters, such as maximum and minimum temperatures, hourly temperatures and dew points, three-hourly winds, chances of precipitation, sky cloud cover, and so on. IFPS then generates a suite of graphical and text forecasts from the digital database. The resulting digital forecasts offer a much higher degree of temporal and spatial detail, with additional weather elements not available previously, such as relative humidity and rainfall amounts. Now you can literally get a forecast specific to your neighborhood and see how the weather will change during the day. Explore the available information by clicking "Graphical Forecasts" on our home page.

The grids generated by each local NWS forecast is collected and merged into one seamless **National Digital Forecast Database (NDFD)**. To ensure consistency and quality along forecast office boundaries, weather elements are coordinated between offices. The NDFD database is made available to all customers and partners (public and private) who can then create a wide range of text, graphic, and image products of their own. Any individual user with a computer and access to the internet can download information from the NDFD to suit his or her needs.

Forecast Challenges

Regarding Southern California weather, some observers may joke, "What weather?" Our climate and our profession have often been the target of jokes (e.g., "why don't you get a real job?!", "if I were wrong as often as you are, I'd be fired!" or "isn't this where they send the junior meteorologists?"). It is true that our climate does not suffer the extremes of temperature, wind, and precipitation that many other climates do. The challenge of predicting our weather lies in the uncertainties, subtleties, and relatively infrequent extremes, not often in the severity. Our enormous population base is largely unfamiliar with severe life-threatening weather is less prepared for it when it comes, and that presents a new risk. For these reasons Southern California is prone to low-probability yet high-impact weather events. Dense fog, drizzle, or light rainfall can be a killer. Compare traffic accident reports in Southern California when it rains with those reports when it does not rain, then look at the same figures for Seattle. Additionally, expectations differ with professions. A surgeon is expected to be perfect or very near perfect all the time, but baseball players are considered successful when they get a hit in only one third of their attempts. Stock market analysts are much less accurate and far more ambiguous than are weather forecasters.

Despite popular belief, forecasting the weather in our region is not as easy at it seems. "You guys have it easy, it's always nice here" is an often heard comment. A common misconception is that difficulty to forecast corresponds to severity of the weather, and conversely, it is easy to forecast for benign weather. For example, it is very difficult to forecast tornadoes and hurricanes and easy to forecast coastal fog. Understandably, more research has been conducted on severe life-threatening weather (because that's where the funding goes) and better model guidance has come from it. Much less model improvement has been made for coastal fog, Santa Ana winds, and terrain issues common to our region. Therefore, forecasting for weather that is not severe can often be more difficult, but is overlooked because the weather remains benign and low impact. However, when active weather occurs very locally, but in a very sensitive area, it can be catastrophic. For example, only one hour of strong wind on only one hillside can make a wildfire explode. Advances in the science have led to greater forecast accuracy, and that has increased the public's expectations of weather forecasters to get the forecast right. While forecasters may claim and promise greater forecast accuracy, the weather is still the weather: chaotic, complex, and inherently unpredictable.

There are a number of questions to answer and puzzles to solve each day. These puzzles may be as innocuous as determining when the coastal clouds will clear or what the high temperature will be, but most of the time there are more significant issues. These issues are mentioned in the **forecast discussion**. Reasons, opinions, clarifications, and expressions of model performance and preference are included in the discussion. Formerly, discussions were meant only for coordination purposes within the NWS meteorology community and transmitted through equipment that required extreme brevity. For these reasons, many complex meteorological terms, abbreviations, contractions, and jargon were used. In recent years discussions have become much more public (and posted on the Internet) and have become much more readable for non-meteorologists. One who reads the discussions day after day will quickly gain an understanding of the particular challenges the forecasters are facing, even when the weather is benign. A glossary is linked to select terms often used in the discussion, providing explanations of these complex terms. Click on "Discussion" on our home page for the latest update.

Uncertainty

"To the often-heard question, 'Why can't we make better weather forecasts?' I have been tempted to reply, 'Well, why should we be able to make any forecasts at all?'"
- Edward N. Lorenz, MIT researcher, in *The Essence of Chaos*.

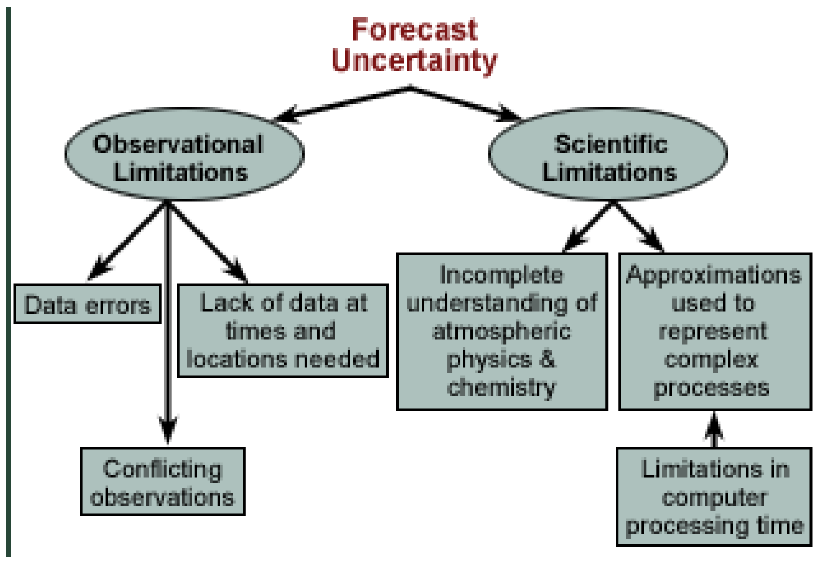
Chaos Theory is very real in meteorology. The tiniest errors in the initial conditions become very large errors in the solution. If a computer model does not initialize well, it is like a golf club swinging through the ball at an angle only slightly off perfection. The result, as many golfers know, is a large error in where the ball ends up.

Some uncertainties in our forecasts arise because of the lack of essential information. With our current knowledge and technology, it is impossible to account for all the possible variables that impact the weather. Our data networks may not be dense enough to detect some significant local effect. The leading researchers in the field may not have discovered the meteorological theory behind an event and forecasters may not even understand everything that is actually taking place. The forecaster may not be fully aware of the situation or sufficiently experienced to detect something important. Sometimes the weather simply defies explanation, or at least an explanation that forecasters can come up with. For example, if we look at two identical low pressure systems with the same dynamics, moisture, temperature profile, structure, etc., we often see different results, like rain with one system, but not with the other. We often ask how and why. After the event forecasters can speculate on why it rained or didn't rain, and even come up with an acceptable explanation, but that's after the fact. Forecasters keep that in their records and in their brains for future reference. If the event is rather significant, forecasters may even collect the data surrounding the event, analyze and study it in depth, and write and publish a paper as a case study.

Our climate and global position add to the uncertainty in our forecasts. San Diego is located just far enough south to be on the southern edge of the normal winter storm track. We may be on the edge of the area of expected rain. Promising weather systems may not maintain strength as they approach us. The weather system may bring local showers where some spots measure rain while the rest of the area remains dry.

Comparisons of satellite data to model guidance can be done on AWIPS to determine the quality of the guidance. This is called model initialization. For example, if the model guidance at 00z does not match closely to the observed atmosphere (model data and observations can be overlaid on a satellite image) at 00z, then the initialization was not good. The forecaster may conclude that since this particular model did not initialize well (does not have a good handle on the current weather pattern), there is no way its prognoses will have a good handle on it for future time periods; the forecaster will then discount or ignore its solutions. The model guidance may give us different solutions with each new model run, or the models' solutions differ from one model to another. When the models seem to disagree from run to run and/or with each other, forecaster confidence lowers. At times with a particular feature such as a storm, the models are very tardy to come into agreement, perhaps less than one day before the storm. When the confidence is low, the forecaster relies more on experience and the observed weather data than the guidance, and as a result the forecast may become less specific.

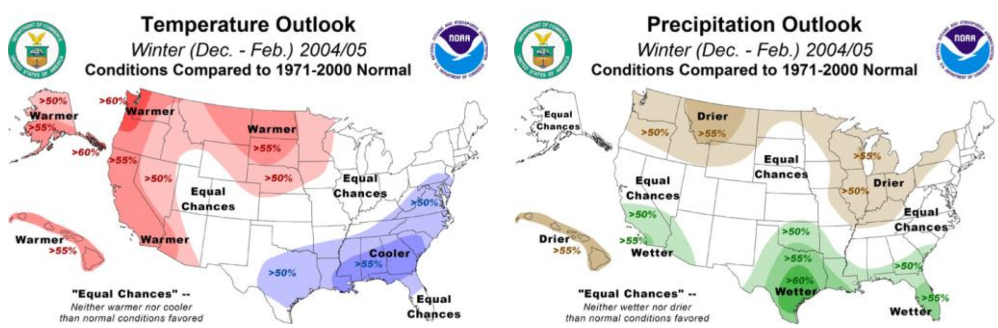
In contrast to our challenges, the Seattle forecaster has it relatively simple: A storm approaches, forecast rain. It is only a question of when and how much. Many local folks demand that forecasters could be so certain: "Just tell us, is it going to rain or not?" The science of meteorology is young. Many discoveries in meteorology theory and improvements in numerical model guidance are taking place, but there are still numerous hidden variables or nuances that can go undetected and change the weather. Our efforts to correctly define atmospheric motion in real time are clumsy at best. The NWS prefers to avoid giving an irresponsible and possibly misleading forecast of certainty when no such certainty exists. This is why forecasters use terms of probability. The following true example is illustrative. One day the NWS issued a forecast with a 40% chance of rain for the next day. When the next day arrived, a radio personality reported rain where he was and questioned on the air: "Does this mean that the chance of rain was really 100%?" No. If we were to flip a coin, we know the chance of it coming up heads is 50%. If it comes up heads, it does not mean the chance of coming up heads before the coin flip should have been 100%. The chance is again 50% before the next coin flip. Failure of the broadcast media to grasp the probability concept can unintentionally change the meaning of the forecast that much of the public receives. Broadcasters are often heard to report a chance of rain, or even a slight chance, as "rain in the forecast," significantly altering the meaning. It is human nature to add certainty where there is little.



Forecasts can be misinterpreted or trusted too much. "A chance of showers" would have been a good forecast if only some areas get measurable rain (in the radio personality example above, the shower he experienced may have been the only one in the area). "Mostly sunny" is a good forecast if most coastal areas are sunny, even if a few beaches experience fog all day. "Locally windy" is a good forecast if a few spots are windy, even if most areas are not. Conditions change in both time and space. “Partly cloudy” may mean mostly cloudy at times or mostly sunny at times during the day, but for brevity’s sake the forecaster chose to simplify the wording. With the common low clouds, it may be completely cloudy in some spots and completely sunny in other spots, then the reverse occurs, all within the same zone; for this, “partly cloudy” might be appropriate forecast wording as well. It should also be remembered that forecasts are refreshed often. A forecast is routinely issued every 12 hours. Often, the forecast is updated between those routine issuances. By the time the morning newspaper reaches your door, there may already be two or three updates made to the forecast you are reading.

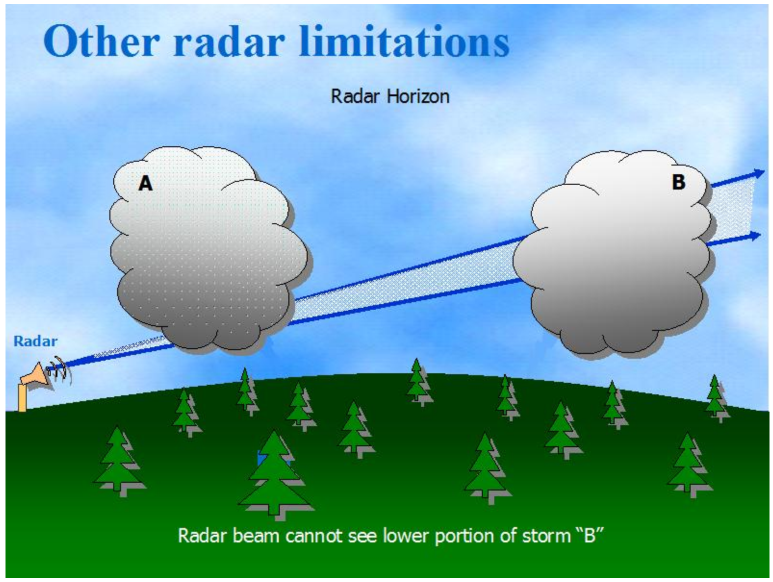
Forecasts for future time periods become more and more uncertain with each future forecast day. The NWS issues seven-day forecasts as part of the routine public forecasts. On average, NWS forecasters accurately predict the next day’s weather 90% of the time. Today's four-day forecast is as accurate as the two-day forecast was in 1985. The accuracy deteriorates as the forecast goes further out; the day seven forecast is just over 50% accurate. Beyond seven days, let’s be frank, the forecast is a flip of the coin, but some extended models can indicate which way to lean, warm or cool, wet or dry. Actually, the climatological normals become the best forecast much beyond about ten days. When someone calls requesting a forecast for an outdoor wedding two months away, we give them the climatological normal high, low, and chance of rainfall for the date.

Long Term Prediction is fraught with uncertainty, but significant advances have been made in understanding the global climate and today there are more data available for analysis. In recent decades the climate altering mechanism **El Niño** has been a catalyst for these advances (for more on El Niño, see “The Weather of Southwest California - A Climate Overview”). The **Climate Prediction Center** (CPC) is a national agency and world leader in climate studies and long term predictions. They produce monthly and seasonal outlooks for the entire country. The outlooks are not exactly forecasts, but graphical outlooks of whether temperature and precipitation will be above normal, near normal, or below normal. Sophisticated climate models take into account all important effects on global weather such as sea surface temperatures, pressure patterns, upper level winds, and solar radiation. Occasional press releases on outlooks of significance are one way the CPC informs us of the weather trends in the weeks and months ahead. Many of these press releases are headlined on our home page when they occur.



Scarce Data on the Edge

To the west and south of California lies the vast, open Pacific Ocean. There are a few buoys and ship reports, but it is largely devoid of data. To the south and east is Mexico with very few reliable data sources. Because some of our weather comes from the west or south, it is difficult to know what kind of weather is headed our way with any detail. By contrast, most of the country has the advantage of looking west (where most of their weather comes from) to learn exactly what kind of weather is headed their way. An old axiom states that if you want to know what weather to expect in New York City tomorrow, just look at the weather in Pittsburgh today. The lack of upstream observations hurt California forecasters in another way. Numerical model guidance depends on initial data to get a correct start on the forecast. With very few data points over the ocean, the model has only a vague idea of the weather conditions before they reach land. Accordingly, the model often has trouble ascertaining the strength, position and/or timing of approaching weather systems. Yet another problem arises. Several model domains (areas covered by the model) have a western boundary not far out to sea. So these models do not “see” a weather system before it enters the domain. Once it sees the system, it may struggle to correctly represent and define it before it reaches land.



Even in our highly populated area with numerous data points, there never seem to be enough data points when they are most needed. That is because many weather phenomena are highly localized and very brief. California tornadoes provide a good example. It is nearly impossible to forecast a Southern California tornado before it touches down. The Doppler Radar scans a slice of the atmosphere every six minutes at each beam angle. A tornado can touch down, do its damage and lift back into the cloud in much less time than the six minutes between radar scans. Additionally, a tornado may be distant from the radar, occur below the beam, and go undetected. Doppler Radars were built and tested for the severe weather of the plain states and are more attuned to detecting those larger scale severe storms. Luckily, California tornadoes are usually not as severe or damaging as those in the Midwest. In an effort to better detect these localized weather phenomena, we have around 1300 volunteer weather spotters across the region that help fill in the gaps in data. We also appreciate it when our partners in the media and public agencies pass along a significant report to us.

Microclimates

Microclimates are very small scale climate zones. Southern California’s highly complex terrain and proximity to the ocean create a variety of microclimates. The weather can be very different between canyons and mesas, beaches and inland areas, mountain tops, slopes and valleys, urban and rural areas. On a clear night, overnight low temperatures may be 15 degrees lower in a canyon compared to a neighboring mesa. High temperatures at a foggy beach may be 15 degrees lower compared to the temperature under the sun only a mile inland. Winds may be strong through certain corridors, while neighboring areas are nearly calm.

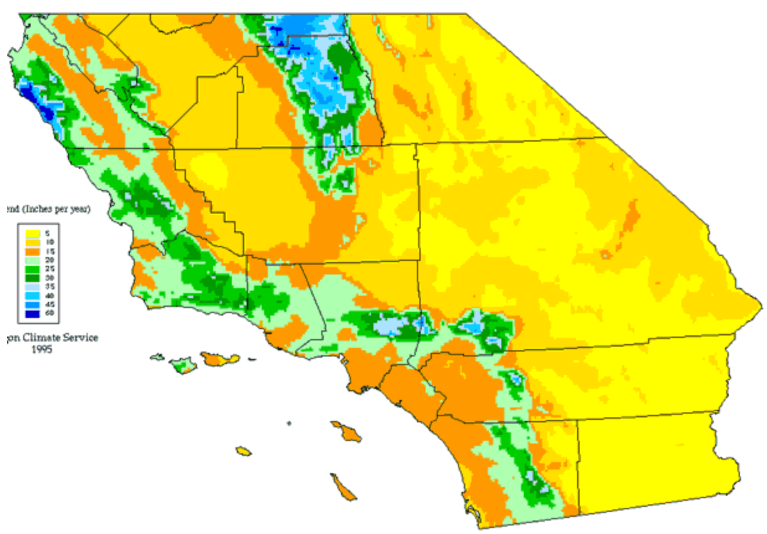
The graphical forecasts generated by the IFPS (Interactive Forecast Preparation System) are our way to provide this kind of microclimate (2.5 km resolution) detail to our users. With a growing data network, we are able to provide this kind of microclimate forecasting with better detail than ever before.

The Weather of Southwest California: A Climate Overview

Climate Zones

"In enumerating the peculiar advantages of San Diego, there seems to be one which is of very great importance. Perhaps, as a scientific man, I may lay more stress upon it than is necessary, but I hardly think it possible; I have seen many parts of the world, and have made some study of this subject. It is the question of the climate of your latitude that I refer to. You have a great capital in your climate. It will be worth millions to you. This is one of the favored spots of the earth, and people will come to you from all quarters to live in your genial and healthful climate, a climate that has no equal." – Alexander Agassiz, 1872.

The agreeable coastal California climate is the stuff of legend and lore. It has inspired artists and writers. Most people visualize the mild coastal climate when asked about the climate of Southern California, forgetting for a moment that there are coastal, inland, mountain and desert climate zones that are highly distinct and very close together. These climate zones are determined by several factors: proximity to the ocean, terrain, elevation and latitude. Using the Koppen climate classification system, the metropolitan areas of Southern California have a Mediterranean climate, characterized by mild, sometimes wet winters and warm, very dry summers. The climate types in the mountains range from Mediterranean, to Subtropical Steppe (not as mild as Mediterranean with more precipitation in all seasons) to Highland (more extreme and variable due to elevation). Desert climate types include Mid-latitude Desert, a dry climate with hot summers and cool winters, and Subtropical Desert, relatively hotter and drier. The Mediterranean climate includes all coastal areas, valleys and foothills. Subtropical Steppe climates would include the mountains between the foothills and the higher peaks. Highland climates would encompass the mountain tops, probably above 7,000 or 8,000 feet. Mid-latitude Deserts include the Mojave Desert, at elevations above 2,000 feet. Subtropical Deserts include the Colorado Desert, at elevations below 2,000 feet.



Annual Average Precipitation (Inches),

Annual precipitation amounts increase gradually from the coast to the mountain crests, then drop dramatically into the deserts.

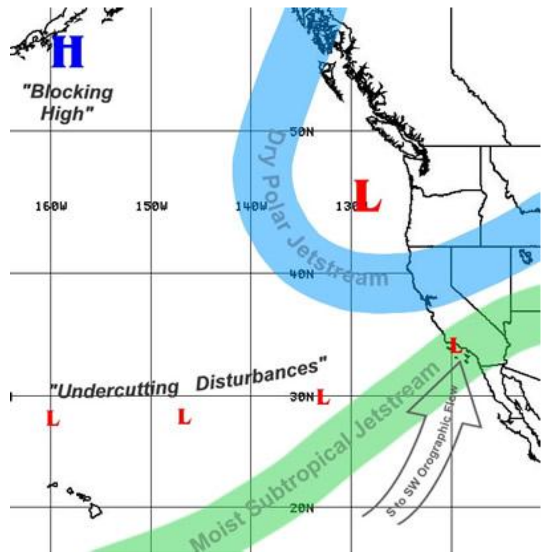
California owes its agreeable climate to a semi-permanent high pressure area located over the eastern Pacific Ocean, which deflects storms northward and secures fair weather for the region. During the winter months, this high breaks down allowing the jet stream to steer mid-latitude weather systems along a more southern track of the prevailing westerly winds. For this reason, the vast majority of precipitation comes from winter storms between November and March.

"The American public is familiar on all sides with elaborate and detailed statements of the weather at a

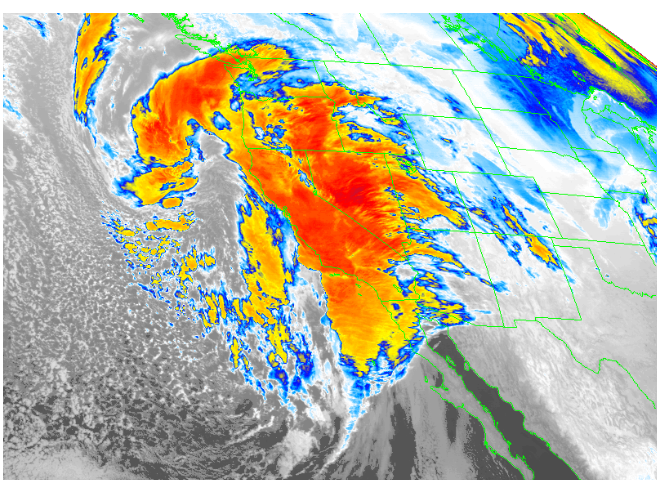
thousand and one resorts. If we may believe all we read in such reports, the temperature never reaches the eighties, the sky is flecked with just enough of cloud to perfect the landscape, the breezes are always balmy, and the nights ever cool. There is possibly one place in the United States where such conditions obtain, a bit of country of about forty square miles at the extreme southwestern part of the United States, in which San Diego is situated; but even here, perhaps, once in two or three years, the sultry blasts of the Mojave Desert pass over the low mountain range and parch this favored district." - General Greely, Chief Signal Officer of the United States, in an exhaustive article on summer climates appearing in the magazine *Scribners* in April, 1888.

Winter Storms

"The wind [the southeaster] is the bane of the coast of California. Between the months of November and April, including a part of each (which is the rainy season in this latitude), you are never safe from it; and accordingly, in the ports which are open to it, vessels are obliged during these months to lie at anchor at a distance of three miles from the shore, with slip-ropes on their cables, ready to slip and go to sea at a moment's warning. The only ports that are safe from this wind are San Francisco and Monterey in the north and San Diego in the south." – Richard Henry Dana in *Two Years Before the Mast*, 1835.



Winter storms bring a great variety of weather phenomena: strong winds, flooding rains, heavy snows, large surf, and thunderstorms with their damaging lightning, hail, winds and the occasional tornado. In Southern California, cold fronts arrive with little resemblance to those described by weather textbooks. The cold air associated with deep troughs of low pressure becomes modified by the mild ocean waters and the front becomes less distinct. Winter storms often have a leading band of rain ahead of the colder air of the system. With the warmer storms, the majority of the rainfall occurs in these initial bands. Cold storms bring a pool of cold unstable air aloft that follows behind the initial rain band, bringing showers and/or



thunderstorms. In these colder storms the majority of precipitation often falls from the showers and thunderstorms rather than the initial band of rain. At times there is a high variability of rainfall distribution. For example, a big winter storm may bring three inches of rainfall to Anaheim, but less than an inch to San Diego. In showery situations, one thunderstorm can drop over an inch of rainfall over one neighborhood, leaving the rest of the area dry. The direction of flow of the lower level winds can indicate favorable areas for more rain than others. If the flow is from the south or southwest, we expect relatively greater rainfall in Orange County, the northern Inland Empire and especially the San Gabriel Mountains and the San Bernardino Mountains. West or northwest flow will bring relatively greater rainfall to San Diego County.

The mountains usually receive more rainfall than the lowlands because of the **orographic effect**. This effect is when the air directed at a mountain is forced upward, enhancing the upward motion already within the low pressure system. More moisture is able to condense and grow into raindrops. For this reason San Diego area beaches annually receive around 10 inches of precipitation, while Palomar Mountain receives annually over 40 inches.

On rare occasions, the subtropical jet stream can direct warm, moist air into California originating from the central Pacific. This stream of moist air is sometimes called the Pineapple Connection or Pineapple Express, because the track often comes from the direction of Hawaii. The air has greater available moisture than the air contained in colder storms, so they tend to bring heavy rain, but little if any snow. When the long wave pattern, or general global circulation, steers this moisture into our region, a wet pattern develops and there can be many days of rainfall. Once the soil becomes saturated, most of the rainfall immediately becomes runoff, which causes flooding and flash flooding. If the rainfall is intense enough, such as in heavy prolonged thunderstorms, the soil need not be saturated, as the water will run off regardless and produce flash floods. This is a serious problem in California. The state ranks second (behind only Texas) in the number of flood related fatalities in the last 40 years. During roughly the same period of time, California also ranks second (behind only Pennsylvania) in the costs of flood related damage.

Southern California's wildfires create burn areas that are ill-suited to absorbing rainfall for a number of reasons. Vegetation helps mitigate flash flooding in two ways. Leaves and branches intercept and absorb some of the rain falling before reaching the ground. Root systems absorb some of that water as it percolates below the surface. If the vegetation is destroyed by a fire, the important component of vegetation in reducing some of the runoff is taken away. Southern California's soils contain a high content of clay, a soil type that is very slow to absorb water. It also dries into a hard packed surface resembling concrete. The soils dry out and compact even further from the heat of a fire. As a result, a high percentage of the rainfall becomes runoff; therefore, much less rain is needed to produce a flash flood. Rain falling on these burn areas can gather mud, ash, and debris (trees, rocks) on its way downhill. These **debris flows** can be very dangerous and damaging, like an extra thick flash flood with the additional mass of the debris within the channel.

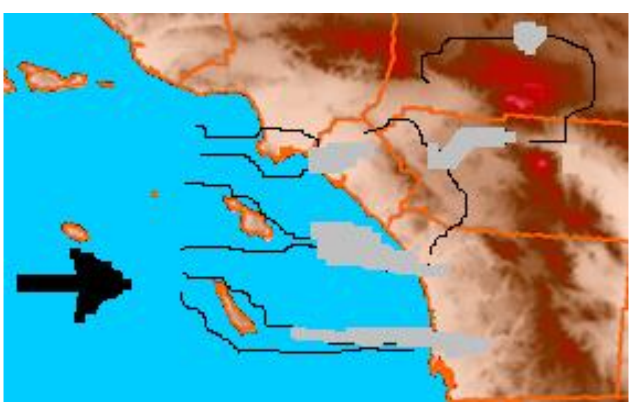
Strong winds accompany especially strong winter storms and can cause damage particularly along the coast and in the mountains. At the coast the wind can move across the water with little friction to drag the wind down. In the mountains, the terrain rises up into the stronger winds aloft. As the winds smash into the mountains, lee side waves form and often surface in the deserts, which can cause strong damaging winds there as well.

The phenomenon of **El Niño** makes its presence known during winter by altering the traditional path of the jet streams and directing frequent storms into California. Occasionally, the polar jet stream brings a cold front that coincides with the subtropical jet stream and produces massive amounts of rain. Any strong individual storm during the wet season can bring disaster, but the real problem with El Niño comes from the *frequent arrival* of strong storms. They simply continue to exacerbate the problems left by the previous storm(s) and do not allow enough time for people or the environment to recover. See *El Niño and La Niña* later in this chapter.

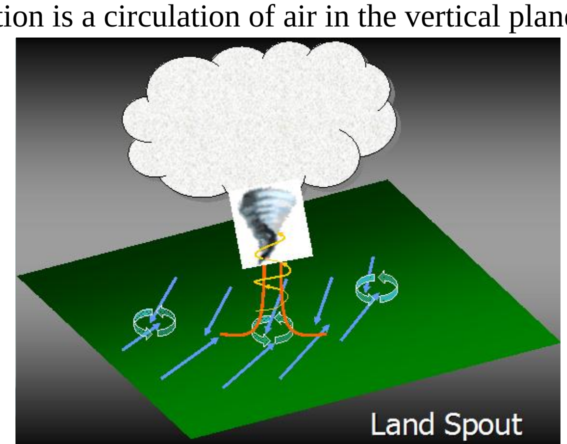
A storm originating from the Gulf of Alaska or Canada obviously will have much more cold air associated with it than a storm from farther south. Cold air aloft contributes to instability, a strong decrease between temperatures at the surface and temperatures aloft. If instability is great, thunderstorms develop. On occasion these thunderstorms are severe, meaning there is some combination of intense flooding rain, large damaging hail, and/or strong damaging wind.

Thunderstorms pose a number of problems. They bring intense rain, which can cause flash flooding. They contain lightning, hail, and very strong wind gusts, which can kill or injure people and damage property and crops. Thunderstorms also develop in warm air masses when tropical moisture is introduced from the southwest monsoon or a decaying tropical cyclone. A thunderstorm is considered severe when winds are strong enough and hail is big enough to produce damage.

Winter storms also bring snow mainly to the mountains. One strong storm can bring a few feet of new snow to the higher mountains. While most Southern California residents do not have to worry about snow at home, we do often have to drive through winter conditions to leave the region. On very rare occasions, an especially cold storm can drop the snow levels to some of the densely populated lower elevations.



When the atmosphere is moist and unstable, convergence of the air at lower levels can produce lines of rising motion called **convection**. This convection is a circulation of air in the vertical plane and can



produce showers and thunderstorms. Topographical barriers such as islands or mountains can induce these convective lines in the proper conditions. Low level winds flow around surface barriers, such as islands or mountains, and converge on the lee side in the same fashion that water in a stream flows around rocks and converges on the opposite side. As the air converges, eddies form and the air is forced upward because it cannot sink into the ocean or the ground. The result is a line of convection containing showers and/or thunderstorms parallel to the mean flow extending downwind. We call this lee side convergence. For example, westerly winds flowing around the Palos Verdes peninsula can produce a line of convection from Long Beach into northern Orange County. This area is also Southern California's "tornado alley." In fact, the area of southern LA County and northern Orange County receives a greater frequency of tornadoes per unit area than does Oklahoma. Luckily most of these California tornadoes are not as violent. Winds flowing around the Santa Ana Mountains form the "Elsinore Convergence" from Lake Elsinore to Hemet. Smaller similar convergence zones can develop on the north and east sides of all the mountains from Victorville to Mexico.

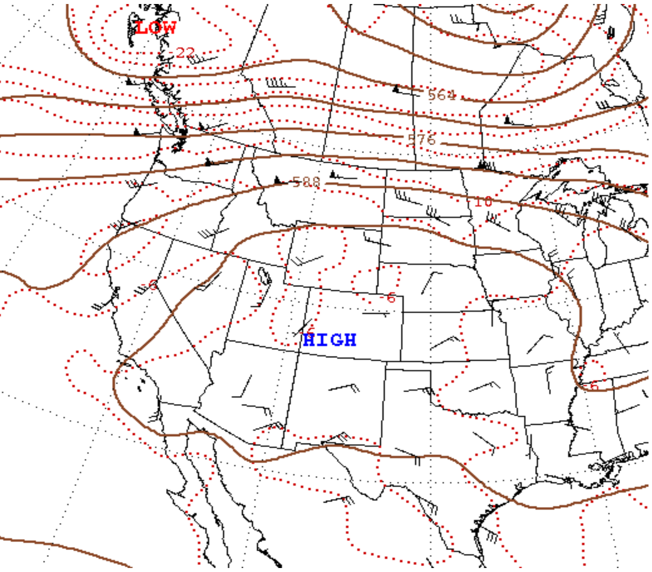
In addition to showers and thunderstorms, waterspouts and **landspouts** can result. These are small scale weak tornadoes, not caused by supercell thunderstorms like their powerful Texas relatives, but by low level wind shear as winds from opposite directions collide and form tightly wound eddies in these convergence zones. Waterspouts and landspouts can cause damage, but are always identified among the weak tornado class (EF-0 or EF-1 on the Enhanced Fujita Scale). Indeed, most California tornadoes on record have probably actually been tornadoes of the landspout variety. There are supercell thunderstorms each year in Southern California that produce the classic style tornadoes, but they are relatively few.

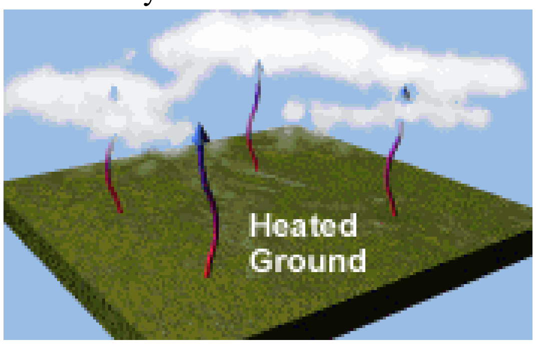
Winter storms also bring large ocean swell, which translates into large surf at the beaches. Large swell is generated by strong persistent winds that blow across a long swath of ocean surface called a fetch. Large swells result and propagate toward the shore. Large scale winter storms bring Southern California the largest swell and surf. In addition to the obvious dangers for beach visitors and water sports enthusiasts, tidal overflow and erosion of sand and coastal bluffs present many more dangers to life and property.

The Summer Monsoon

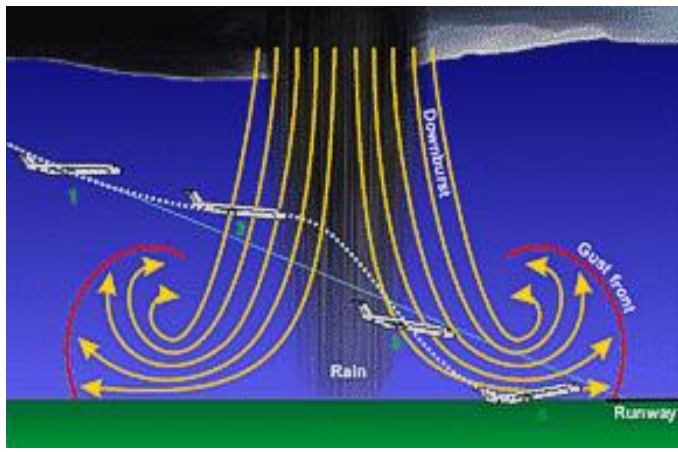
The Southwest Monsoon season occurs from July through September over the southwestern U.S., generally more prominent from Arizona eastward. Occasionally, episodes of monsoonal flow reach Southern California during late summer and bring thunderstorms (sometimes called "Sonoran" storms) mainly to the mountains and deserts.

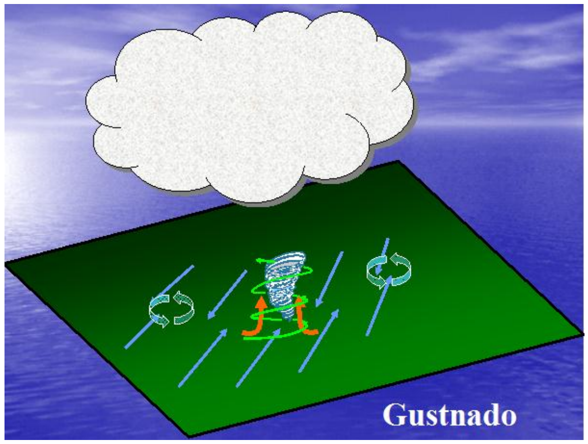
The monsoonal flow develops as a strong upper ridge builds over the four corners region or the Great Basin. The resulting easterly or southeasterly flow on the south side of this high draws warm moist air from Mexico into the Southwest U.S. Perturbations or disturbances in this flow such as an **easterly wave** trigger **convection** and thunderstorms. An easterly wave is an inverted low pressure trough within the monsoonal flow that moves from Arizona or Sonora westward into California. At times moist air flows northward from the Gulf of California (Sea of Cortez) further destabilizing the atmosphere. This is called a **gulf surge**. At times, even when the monsoon is absent, the moist air layer of the gulf surge is rather shallow and does not produce thunderstorms; it becomes a sort of hot, humid, desert marine layer. For thunderstorms to develop, the moist air moving into the region needs to be rather deep in the atmospheric column. The heating of the earth's surface further destabilizes the atmosphere and convection results; columns of locally heated bubbles of air (thermals) rise in the moist atmosphere and grow into towering cumulonimbus clouds and thunderstorms. Sometimes the monsoonal flow spreads a shield of opaque cloudiness over the region. When this happens, convection may be inhibited because the sun is not able to effectively heat the earth's surface, creating the instability sufficient to produce these rising thermals.





In the mountains and deserts, the air from the surface to the cloud level is usually very dry. As the thunderstorm produces rain, the drops fall into this drier layer and may completely evaporate (if falling rain does not reach the ground, it is called **virga**). This evaporation cools the column of air. Because cool air is heavier than warm air, the cool air in the warm environment will sink and accelerate as it descends. This **downburst** of air can reach the ground with damaging force. A highly localized downburst (covering less than 2.5 miles) is called a **microburst**. Upon impact with the ground, the winds rapidly spread across the earth's surface as a **gust front**. Some gust fronts, or outflow boundaries, can converge with neighboring thunderstorm outflows. These colliding gust fronts, often called outflow boundaries, can create new lines of convection. When a strong outflow meets with relatively calm air or with other outflows, tightly spinning eddies of wind called **gustnadoes** can result and can cause damage.



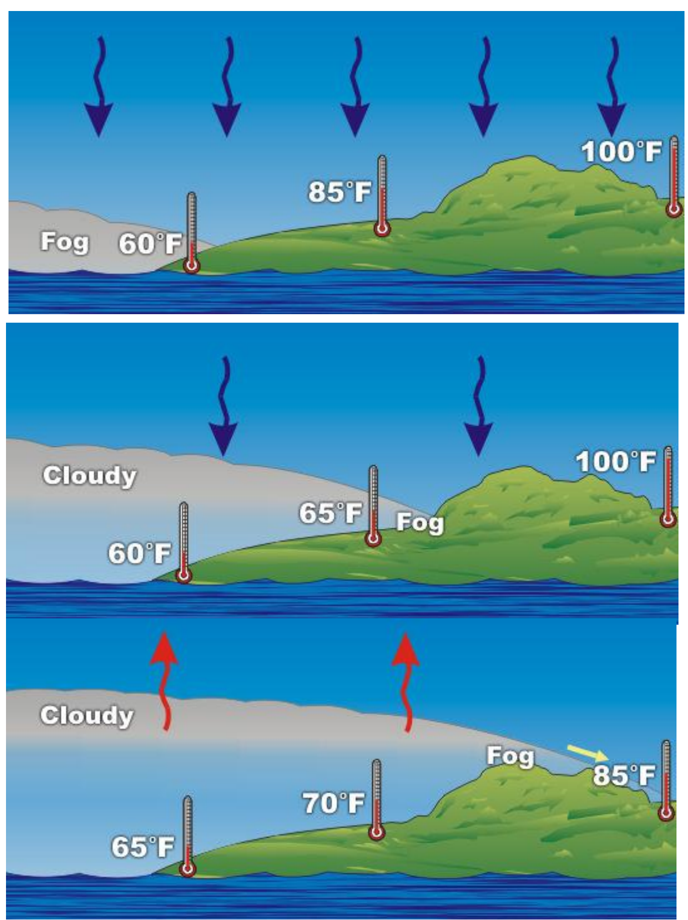


Flash flooding in rough terrain can be very deceptive. A mountain thunderstorm can flood desert areas with water, mud and rock, even if no rain falls in the desert. Flash floods in areas of steep terrain, impenetrable rocky soil, and little vegetation are the most volatile.

Normally, monsoon thunderstorms are relatively rare west of the mountains, but can occur under the right conditions. If the winds from the mountain top level upward are rather strong from the east or southeast, thunderstorms can drift from the mountains to the valleys, and even to the coast.

The Marine Layer

The marine layer is perhaps coastal California’s most dominating weather feature. It all starts with the semi-permanent high pressure over the eastern Pacific Ocean, which produces persistent northwest winds that parallel the west coast. These winds pull cool waters from the Gulf of Alaska southeast along the west coast, producing the ocean current called the California Current. In addition, the Coriolis force pushes surface waters away from the coast, allowing cooler waters from the ocean depths to surface. This is called upwelling. The cool current and upwelling combine to provide consistently cool waters along the west coast. When the air well above the water is warmer than the water, as it is normally for all seasons except winter but most common in late spring and early summer, a temperature **inversion** develops. Instead of the air *cooling* with increasing elevation the air actually *increases* in temperature with height, the *inverse* of the standard atmosphere. The cooler air below the inversion is called the **marine layer** and is cooled by conduction to the point that condensation occurs and stratus clouds form. Because of its persistence in late spring and early summer, we often refer to it as the “May Gray” or “June Gloom”.



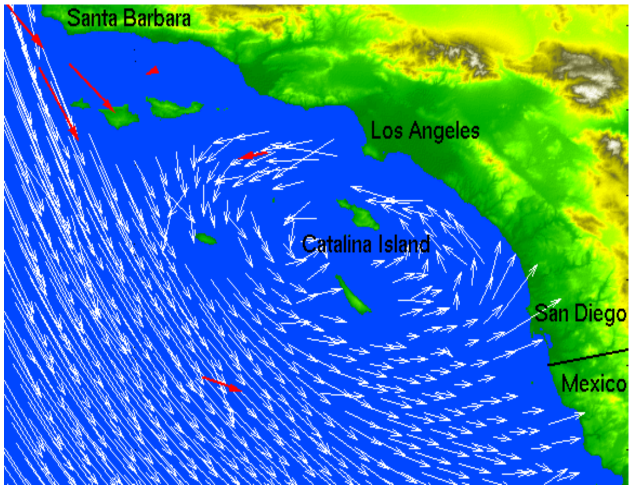
The downward force of air under very strong high pressure aloft presses down on the marine layer keeping it confined near the coast where very cool, foggy weather is typical. Inland, temperatures rise under the same high pressure. We often call this a shallow marine layer, squished by high pressure aloft.

As high pressure aloft decreases in strength, the downward force decreases allowing the marine layer to penetrate farther inland. The clouds are located near the top of the marine layer so at the beach the fog lifts to a lower cloud deck. Further inland, fog is located at the leading edge of the inland push of the cooler air.

Low pressure aloft allows the marine layer to deepen to as much as 6,000 feet (2000 meters). The fog is confined to the mountain tops and passes. In the lower elevations, the marine air begins to warm as it is modified by the heat rising from the ground. The cooler air moves over the coastal mountains and through the passes into the interior valleys.

However, if the low pressure has enough cold air aloft, it can wipe out the inversion; the cold air replaces the warm air above the marine layer. This "busts up" the marine layer, the warm dry layer and the cool moist layer mix, and the low clouds clear. When the inversion is very strong and relatively shallow, the coastal clouds can stick to the beaches all day, which occasionally happens during June and July, just when schools get out and locals and tourists hit the beaches.

The common cloudiness near the coast occurs mainly during the night and early morning, and then evaporates during the day. The clouds normally clear during the morning as a progression from inland areas to the coast. As the sun begins to warm the land surface (even through the cloud layer), the cloud layer begins to evaporate from the ground upward until the clouds completely evaporate. At dusk, the sun has set and the evaporation slows, so the onshore flow can move the clouds over land without evaporating. Very little mixing takes place between the cool moist marine layer and the warm dry layer above it due to stability. Cold air is denser than warm air and finds stability or equilibrium at lower levels. As an analogy, the cool marine air is like water in a bathtub, content to stay at the bottom and not mix with the air above it. The clouds will not rise over the mountains without evaporating. If you hike in the sunny dry foothills early on a summer morning you can see an "undercast" sky condition, a solid cloud layer below.



A **coastal eddy** is a counter clockwise circulation of low level winds in the California Bight (the California Bight is comprised of the ocean waters fronted by the concave Southern California coastline). Because these coastal eddy circulations are often centered near Santa Catalina Island, it is often called a **Catalina Eddy**. It forms when the air flow aloft becomes cyclonic (counter-clockwise) and when strong northwest winds blow off Point Conception. Those winds continue blowing toward the southeast and naturally curve into the bight. Imagine a pinwheel in the vicinity of Catalina Island. The stronger winds over the outer waters would spin that pinwheel counter clockwise because the winds in the inner waters are weaker. Eddy formation is characterized by a southerly shift in coastal winds, a rapid increase in the depth of the marine layer, a thickening of the stratus cloud layer, and often some drizzle. The marine layer can deepen to 6,000 feet and extend well inland along the slopes of Southern California's larger mountains and even through the lower passes into the deserts near Hesperia and Palm Springs. These occasions are almost always accompanied by drizzle or even light rain. Because the cloud layer is thick and the circulation produces more clouds, it takes much longer to evaporate the cloud layer. Over land the cloudiness can persist into the afternoon or even all day near the coast. Coastal eddies occur predominantly during the “stratus season” – late spring and early summer.

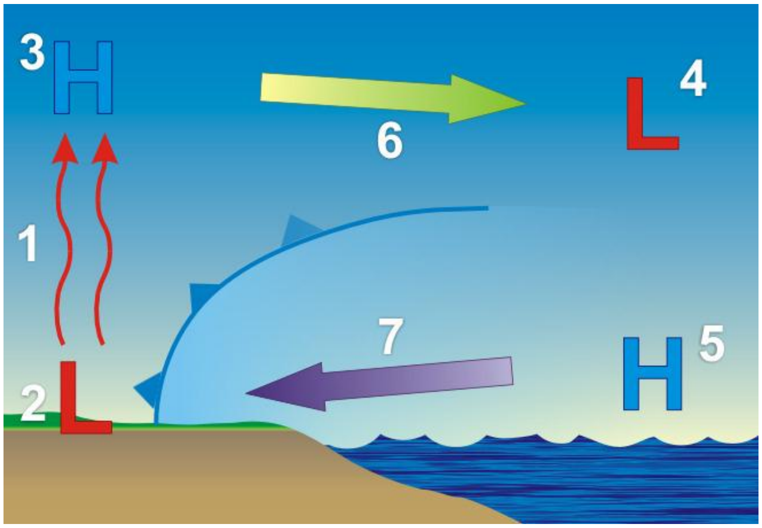
At times with a deep marine layer, probably at least 2000 feet deep, the atmosphere below the inversion can become unstable as the sun warms the land surface. The initial stratus clouds clear, but the warm and moist surface air rises to produce shallow convection and cloud development capped by the inversion. Meanwhile, at the beaches the sea breeze is drawing cool surface air onshore, which stabilizes the atmosphere. In these situations, the coast clears while clouds continuously redevelop inland. This is what we call “reverse clearing” because clearing occurs from the beaches toward inland areas, the reverse of the standard clearing pattern.

Dense Fog can form when the stratus cloud layer comes in contact with the ground, usually along the inland edge of the cloud deck. When the marine layer is deep, dense fog will develop in the mountains and foothills. Fog can also develop as air ascends a mountain slope and condenses. When the marine layer is shallow, the clouds will not penetrate very far inland, staying near the coast. In these cases lower elevations may get dense fog. This kind of fog is called **advection fog** because the fog advects, or moves horizontally from one location to another.

Radiation fog, also called ground fog, is not usually related to the marine layer. It can develop on clear, cold, and calm nights when the air near the surface is moist, such as after a rainstorm. The moist air has a high dew point temperature, the temperature at which the air becomes saturated. As the ambient temperature falls in the evening, it will reach the dew point and fog can develop. This is more common in inland valleys because they are sheltered from the modifying effect of the mild ocean.

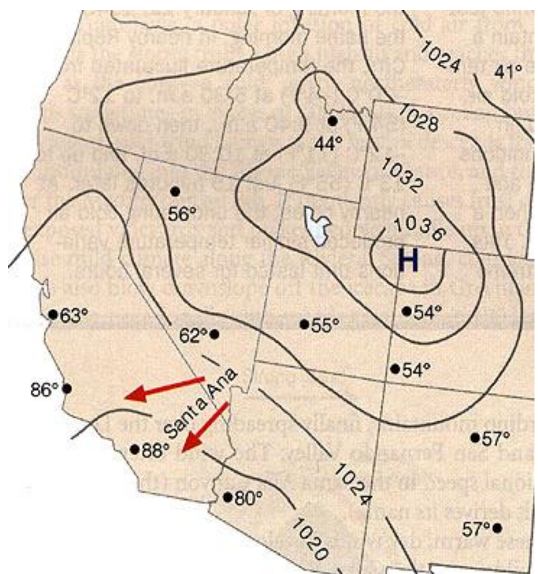
The Sea Breeze

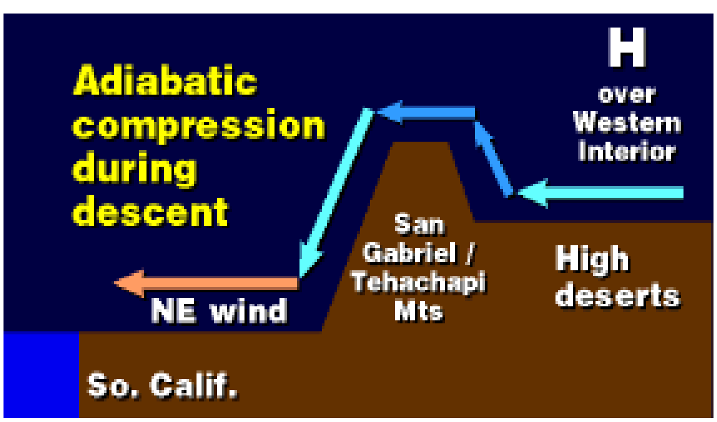
At the surface, the sun warms both the ground and ocean at the same rate. However, since the heat in the ground is not absorbed well it returns heat to warm the air. The warmed air, with its decreased density, begins to rise (1, see diagram). The rising air creates a weak low pressure area (called a thermal low) due to a decrease in air mass at the surface (2). Typically, from 3,000 to 5,000 feet above this low pressure, as the air cools, it begins to collect resulting in an increase in pressure, creating a "high" (3). These differences in pressures over land, both at the surface and aloft are greater than the differences in pressures over water at the same elevations (4 and 5). Therefore, as the atmosphere seeks to reestablish the equal pressure both on land and on the sea, two airflows from high pressure to low pressure develop; the offshore flow aloft (6) and the onshore flow at the surface, called the **sea breeze** (7). The prevailing wind flow with a present marine layer is from the ocean to the land, or **onshore flow**. The strength of the onshore flow is determined and measured by pressure differences (gradients) between higher pressure over the ocean and lower pressure over the desert. If the gradient is steep, the onshore flow is strong, and vice versa. In our forecast discussions we often refer to the pressure gradient between Lindbergh Field (SAN) and the Imperial Airport near El Centro (IPL) as a local benchmark.



Santa Ana Winds and Hot Weather

Santa Ana winds are strong, dry offshore winds that blow from the east or northeast. These winds are strongest below passes and canyons of the coastal ranges of Southern California. The name is derived from the Santa Ana Canyon, which is susceptible to these winds. The complex topography of Southern California along with various atmospheric conditions create numerous scenarios that may cause widespread or isolated Santa Ana events. Santa Ana winds develop when a region of high pressure builds over the Great Basin (the plateau east of the Sierra Nevada and west of the Rocky Mountains including Nevada and western Utah). Air moves from high pressure to low pressure; in this case, from the Great Basin to the coast. This pressure pattern often follows the passage of an upper low through the interior west. If the upper low moves into northern Mexico or Arizona, the upper level winds will be from





northeast, and enhance the northeast surface flow. The cold air associated with the upper low forms a dry front coming from the northeast. As the northeast winds encounter the mountain barriers of Southern California, a lee side turbulent mountain wave results (imagine a flag waving in a horizontal orientation). Strong subsidence, associated with the cold air following these fronts, forces these strong mountain waves downward to the surface.

On rare occasions, there may be precipitation with the system and a "wet Santa Ana" results, but most of the time a Santa Ana event brings clear skies and warm weather. Clockwise circulation around this high pressure area and subsidence (sinking motion) forces air down the mountain slopes from the higher plateau. As the air descends, the higher pressure at lower elevations compresses the air, like a bicycle pump warms the compressed air. The dry warm air accelerates as it descends toward the coast. When the temperature gradients or winds aloft do not provide the upper support to push the winds, the pressure gradient by itself can drive them. These "gradient driven" winds are often quite localized, narrow corridors or rivers of winds and are channeled mainly through topographical breaks like canyons and passes. Without the upper support, they also are not as strong.

Santa Ana winds occur mainly during fall and winter and are most common during December. Summer events are rare. A reasonably strong event can produce sustained wind speeds of 30 to 40 mph with gusts over 60 mph. During exceptional events the top gusts can exceed 100 mph. The strongest winds usually occur during the night and morning due to the absence of a competing sea breeze.

The impacts of these winds are numerous. There is always a high fire danger during these events. Trees and power lines are toppled, leading to property damage and power outages. High profile vehicles are at risk of being blown over. Turbulence and low level wind shear adversely affect aircraft, while strong winds and associated waves can present great danger to boaters.

Fall events can bring hot weather as well as strong winds. Most high temperature records in coastal California have occurred during a hot Santa Ana. Legend and lore have sprung from these uncomfortable conditions. Some have called it "Devil's Breath". Early Mexican residents called them *los vientos del diablo* - the devil winds. It is a strange time for residents near the coast because their mild climate turns into the Sahara for a time. Fires increase, crime seems to go up, and numerous health conditions worsen, such as allergies. Some claim earthquakes are more likely during this "earthquake weather." Like the time during a full moon, it just seems that more weird things happen.

Hot weather is relative in our region of wide variations. In the lower deserts it is a staple of life. Near the coast it is a rather rare occurrence. **Extreme heat** most often comes when strong high pressure aloft is present over the region. This produces an atmosphere that is generally subsiding, or sinking. As the air subsides, it compresses and warms as the pressure increases near the surface. When the monsoon flow over the desert southwest sends moisture into our region, this added humidity compounds the danger of the heat. Years ago, the National Weather Service developed the Heat Index to properly account for the body's reaction to the combined effects of heat and humidity. See appendix H for the Heat Index Table.

Dust devils are products of a heated land surface and do not need extreme heat to develop. On sunny days, the ground heats up in a non-uniform way producing rising pockets of air called thermals. In strong thermals, the rising air develops a spin and the result is a dust devil, a narrow rotating column of air that can sometimes reach several hundred feet into the sky. Dust devils are usually not dangerous, but some can cause minor property damage. They are not associated with tornadoes, since tornadoes only develop from strong thunderstorms. They are most common in the inland valleys and deserts of our region.

Tropical Connections: Hurricanes and Their Remnants

Hurricanes need warm ocean waters to survive and grow; as a general rule, the sea surface temperature should be above 80 degrees. Below that temperature, the hurricane will lose its energy and die. The California Current is a cool ocean current that parallels the California coast, maintaining the sea surface temperatures safely below 80 degrees. This is why hurricanes normally do not strike the California coast.

However, on October 2, 1858, a category 1 hurricane did indeed strike San Diego. This is documented by leading hurricane researchers and published by the American Meteorological Society. You can find the article on their website **www.ametsoc.org**. On two other occasions in recorded history has a tropical storm hit Southern California. Since a legitimate hurricane has struck our coast, that means it can in the future, with a similar likelihood as a major earthquake or tsunami. It may not happen in our lifetimes, but we should think about hurricane preparedness in the same way we think about preparedness for major earthquakes and tsunamis.

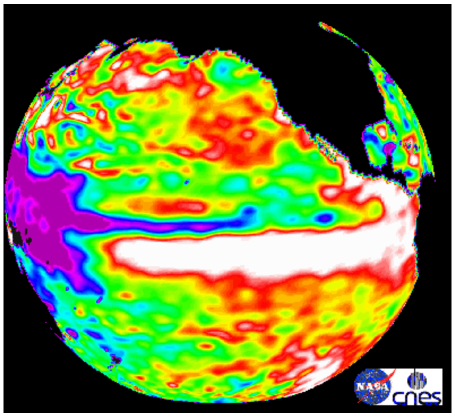
The eastern Pacific hurricane season runs generally from June through October, officially from May 15 to November 30. Hurricanes or tropical storms moving into the cooler waters will decay, but on occasion are strong enough to come very close to California at tropical storm strength and produce a wild, off-season rainfall event with widespread flash flood damage. Some of Southern California's heaviest rainfall events have been the result.

More likely, only the remnants of these storms will provide a source of warm, moist and unstable air off the coast of Mexico. If the upper level flow is from the south, this unstable air is brought into the region. There is very little rising motion associated with these moist air masses, but the great amount of moisture is sufficient to produce showers. Some local effects can enhance the precipitation. The ocean waters are warmest during late summer, so the stabilizing effect of the normally cool ocean waters is reduced. As these unstable tropical remnants move into Southern California, the orographic (mountain) effect and surface heating provide additional uplift necessary to produce the showers and thunderstorms.

Tropical cyclones can generate large swell. If the track and speed of the cyclone are just right, and it moves through a narrow window of area off the coast of Mexico, the hurricane can send these large swell to Southern California beaches and the result is large surf, particularly on south-facing beaches.

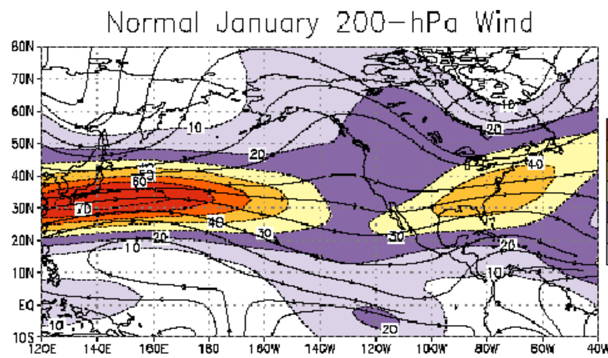
El Niño and La Niña

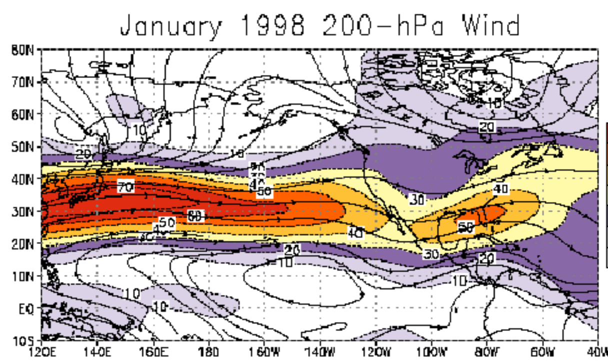
The term El Niño (Spanish for the "Christ child") was originally used by fishermen along the coasts of Ecuador and Peru to refer to a warm ocean current that typically appears around the Christmas season. The term El Niño has come to be used for these exceptionally strong warm intervals that not only disrupt the fishing industry but also bring heavy rains to the normally dry region. La Niña (El Niño's sister) is the opposite of El Niño, where equatorial Pacific Ocean waters are cooler than normal.



Normally in the tropical Pacific Ocean, the trade winds are persistent winds that blow westward from a region of higher pressure over the eastern Pacific toward a region of lower pressure centered over Indonesia. During El Niño years, this atmospheric pressure pattern breaks down. Air pressure rises over the western Pacific and lowers over the eastern Pacific. This change weakens or even reverses the trade winds. This fluctuation in pressure across the Pacific Ocean is called the Southern Oscillation. The normally strong coastal upwelling of ocean waters along the west coast of South America is decreased or stopped by the weakened trade winds and this allows warmer surface waters from the western Pacific to surge eastward toward South America. Because these pressure reversals and ocean warming are concurrent, it is referred to as the El Niño - Southern Oscillation, or ENSO.

The oceans and the atmosphere greatly influence each other. During normal years, the eastern Pacific waters cool the air above them. Cool dense air does not easily form clouds and rain, so the coasts of Peru and northern Chile receive very little rain. When the ocean warms, the moist warm air above it becomes buoyant enough to produce rain. This shift in major rain zones has a ripple effect on wind patterns and climatic conditions all over the globe. With the presence of a strong El Niño, the subtropical jet stream becomes oriented over California, carrying large amounts of warm moist air into the region. The upper figure on the previous page shows a normal January jet stream weakening before reaching California. The lower figure shows the strong jet stream during the strong El Niño of January 1998 actually reaching California.





The impacts of El Niño and La Niña show up most clearly during the northern winter. El Niño winters are milder over Canada and the northern United States, while cooler and wetter than normal winters are experienced in the southern U.S. During La Niña years, winters are warmer in the upper Midwest and cooler in the Southeast and Southwest. It is wetter than normal in the Northwest and drier than normal in the southern third of the U.S. For more information about El Niño and La Niña, click on: **www.cpc.noaa.gov/products/precip/CWlink/MJO/enso.shtml**.

Climate Change

In recent decades it has been observed that the average temperature of the earth is rising. The numerous effects of this rise in temperature can greatly impact global climates and human life. This has produced cause for concern well beyond the scientific community. At the NWS in San Diego, no direct research or study of global warming or climate change is performed. For more information on the subject, click on: **www.climate.gov**.

Sun, Earth, Sea, Space, and Optical Phenomena

The sun, earth, sea and sky produce naturally occurring phenomena that generate questions directed to the NWS for explanation. These may include solar and lunar phenomena, optics, astronomy, space weather such as aurora borealis or solar flares, ocean behaviors beyond sea state, earthquakes, volcanoes, and geology. These phenomena do not fall under the expertise of meteorologists at the NWS. Meteorologists may have some knowledge about these phenomena and may offer it, but the knowledge or opinion is not qualified professionally, only possibly from a personal interest or hobby.

A History of Significant Weather Events in Southern California
Organized by Weather Type

Updated February 2012

The following weather events occurred in or near the forecast area of the National Weather Service in San Diego, which includes Orange and San Diego Counties, southwestern San Bernardino County, and western Riverside County. Some events from Los Angeles and surrounding areas are included. Events were included based on infrequency, severity, and impact.

Note: This listing is not comprehensive.

Heavy Rain: Flooding and Flash Flooding, Mud Slides, Debris Flows, Landslides

Date(s)	**Weather**	**Adverse Impacts**
1770, 1772, 1780, 1810, 1815, 1821, 1822, 1825, 1839, 1840, 1841,1842		Various reports from missions indicate significant flooding along the Los Angeles, Santa Ana and San Diego Rivers, often changing the entire courses.
2.1850		"Moderate floods occurring in the Santa Ana River Basin."
2.1852		"Moderate flood resulted from unprecedented rain in the mountains. A severe flood year in Southern California".
10.2.1858	Category 1 hurricane hits San Diego, the only actual hurricane on record to strike the U.S. West Coast. Implied winds of 75 mph.	Extensive wind damage to property (F2). Streets swept clean by heavy rains.
12.24.1861-1.23.1862	Epic floods termed the "Noachian Deluge of California". It rained 30 days in succession, beginning 12.24.1861 to 1.23.1862. 35" fell in LA. In San Diego over 7" fell in January alone.	The Santa Ana River in Anaheim ran 4' deep and spread in an unbroken sheet to Coyote Hills, 3 miles beyond (present Fullerton). The LA River mouth shifted from Venice to Wilmington. The worst flooding in San Diego County occurred after six weeks of rain. All of Mission Valley was underwater, Old Town was evacuated. The tide backed its waters into the San Diego River and cut a new channel into the bay. 20 died in Orange County.
3.30.1867	Heavy rains hit San Bernardino County.	Flooded barley fields. Several homes were destroyed or damaged. Lumber mills in Mill Creek and Santa Ana canyons were destroyed.
4.1867	A thunderstorm over Cajon Pass dropped heavy rain for 30 minutes.	Flash flooding and debris flows four feet deep rushed down the canyon and destroyed a road leading to mountain mills.

12.1867	Torrential rains hit the San Bernardino Mountains. Lytle Creek and Cajon Creek united to form a river 180 feet wide in places, and 15 to 20 feet deep. Warm Creek and City Creek united and was half a mile wide. The Santa Ana was raging.	Farm lands, orchards, vineyards and buildings were destroyed.
8.11-12.1873	1.95" fell in San Diego from a tropical storm. 1.80" fell on 8.12, the wettest calendar day in August on record. 1.72" fell in Paradise Valley (SE San Diego). Nearly 3" fell in "Cajon Ranch". This was called the greatest summer rainfall in history. The previous daily August rainfall record was 0.31" in 1867.	1' of water was reported on the ground at "Cajon Ranch".
12.4.1873	2.52" of rain fell in San Diego, the ninth wettest calendar day on record and the third wettest December day.	
1.1876	Heavy rains.	A great flood occurred inundating wide areas between Anaheim and Westminster.
11.9.1879	2.68" of rain fell in San Diego, the fifth wettest calendar day on record and the wettest November day.	
12.29-30.1879	4.23" fell in San Diego in 48 hours, the heaviest storm in 30 years.	
12.18.1880	Heavy rains.	San Diego streets flooded.
1.12.1882	2.49" of rain fell in San Diego, the tenth wettest calendar day on record and the second wettest January day. 4.75" fell in Poway.	

2.14-20.1884	5+" of rain falls in Spring Valley. Fallbrook gets heavy rain (more than 15" in the month). Rains continued all during the spring with disastrous results. This helped produce the wettest February in San Diego history (9.05"). It is the third wettest month on record (wettest: 9.26" in 12.1921). The 1883-84 season ended as the wettest in San Diego history with 25.97".	Flooding and damage to crops, livestock and railroads in the area, including Temecula Canyon. San Diego River "booming" through Mission Valley on 3.10.1884. The Santa Ana River cut a new channel to the sea three miles southeast.
7.1884	A heavy thunderstorm struck the Cajon Pass area.	Flash flood waters rose to 50 feet deep. Severe erosion occurred ripping out an orchard, railroad lines and roads.
11.21.1884	A heavy winter storm brought four inches of rain to LA, and six inches to Cajon Pass.	Newly laid railroad track was washed out. Numerous mud slides.
7.14.1886	LA records its greatest 24 hr rainfall amount for July: 0.24".	
12.1886-1.1887	Heavy winter rains inundate western San Bernardino. One night in 1.1887 11 inches of rain fell in Cajon Pass.	A blocked culvert swamps entire San Bernardino neighborhoods. Railroads were buried in mud in Cajon Pass.
8.31.1889	LA records its greatest 24 hr rainfall amount for August: 0.61".	
10.12.1889	A monsoon-type thunderstorm brought 7.58" to Encinitas in 8 hrs. 0.44" fell in San Diego.	
2.19-23.1891	33" of rain was reported in Descanso in a 60 hour period. 2.56" in San Diego. From 2.16 to 2.25, a total of 4.69" fell in San Diego. Reverend Father Ubach of St. Joseph's had prayed for rain on 2.2.1891. Rain fell on snow in the San Bernardino Mountains. 4.53" fell in San Bernardino on 2.23.	Heavy damage and losses to homes, land, livestock, transportation and power throughout the Tijuana and San Diego River Basins. The worst was flooding along the Tijuana River where all structures were swept away and a man was killed. Three prospectors died at Table Mountain in Baja California. San Bernardino and Riverside became isolated as all railroad and highway bridges were out for two to three weeks. Lake Elsinore overflowed.

8.11.1891	Thunderstorms above Redlands and Rialto dropped intense rain.	Flash floods in the Zanja drainage crossed a street at ten feet deep. Some squatters and Indians were drowned and their tents and belongings were washed into Redlands. Rialto and San Bernardino also reported debris flows.
8.12.1891	Two thunderstorm cells merge. 16.10" at Campo; 11.50" in 80 minutes, a record 80 minute rainfall for the state (and at one time the record 80 minute rainfall for the nation).	
3.23.1893	Heavy rain around San Bernardino.	Railroads were washed out as was a bridge in town.
12.1894	Heavy rain.	A flood took out a trestle between Rialto and San Bernardino. Mill Creek and the Santa Ana River also flooded.
12.9.1898	Heavy rain.	Railroad washed out and ½ mile covered in mud in Rose Canyon, near Pacific Beach. A trestle in Chollas was washed out. "Several hundred dollars" in damage.
7.20-21.1902	A dying tropical cyclone brought 2" of rain to the mountains and deserts of Southern California during a very strong El Niño event of 1901-02.	
7.25.1902	0.83 inch of rain fell in San Diego, the wettest calendar day in July on record.	
4.1.1903	At least 3.06 inches of rain fell in San Bernardino. Rain fell on snow in the high country.	Bridges and roads were washed out. A man using a cable car fell into the Santa Ana River and drowned.

1905-1907	Heavy rainfall in 1905 in the Colorado River basin.	The Colorado River swells and eventually breaches an Imperial Valley dike. It took nearly two years to finally control the River's flow into the Salton Basin and stop the flooding. The result of the sudden influx of water and the lack of natural drainage from the basin resulted in the formation of the Salton Sea.
2.4-6.1905	Heavy rains caused the San Diego River to run for the first time in six years. 4.23" fell in San Diego in 43 hours.	
3.15.1905	0.94" fell in San Diego in 30 minutes, the greatest 30 minute rainfall on record.	
3.24-25.1906	2.36" of rain fell in San Diego on 3.24, the wettest calendar day in March on record. Almost 1" in three hours. 5.10" at Cuyamaca, 4" at Escondido, Oceanside and Ramona, 3" in El Cajon and Lakeside. Storm totals: 6.41" in Oceanside, 6.30" in Escondido, and 2.78" in San Diego.	Widespread flooding in Fallbrook. Streets flooded and roads washed out in the San Diego Metro area.
8.18-19.1906	A tropical storm came up into the Gulf of California and the southwestern United States, giving the mountains and deserts heavy rainfall. Needles received 5.66" of rain, twice the normal of seasonal rainfall. This occurred during the El Niño of 1905-06.	
12.1906	A heavy storm dropped 2.5 inches on San Bernardino in 24 hours.	Runoff flooded San Bernardino. A railroad was washed out between Highland and Redlands.
1.10.1907	A warm rain fell on snow.	Flood around San Bernardino.

1.21-22.1909	4.53 inches of rain fell in San Bernardino. At Pine Crest (Crestline) 7.00 inches fell in 24 hours. At Waterman Canyon 4.11” in 24 hours.	Lytle Creek, Waterman Canyon and the Santa Ana River all flooded. Railroad damage occurred in Mill Creek and Colton.
8.30.1909	Heavy thunderstorm in the San Bernardino Mountains.	Flood waters damaged businesses in San Bernardino.
12.31.1909-1.1.1910	Heavy rain storm. 4.23” of rain fell in San Bernardino.	Lytle Creek and the Santa Ana River flooded at its highest stage in 20 years. Railroads were severely damaged. Colton was isolated. Damage in San Bernardino was the “worst in history” and homes in the west of the city were flooded. Highways, water supplies and other utilities were damaged. A train from LA plunged into the Santa Ana River in Colton.
1.18.1914	Heavy rain storm. Almost 9 inches of rain fell at Lytle Creek, 0.64 inch in San Bernardino. (Flooding rains continued through 2.21).	Colton was flooded and isolated. Orchards, highways and railroads damaged all over the northern Inland Empire. One was killed.
8.26.1915	The remnants of a tropical cyclone moved northward across northern Baja California into the deserts of southern California with rainfall of 1 inch at Riverside. This occurred during the strong El Niño of 1914-15.	
1.14-21.1916	Widespread heavy rains in Southern California. 8.5” fell during this period in San Bernardino. 16.71” in 24 hours at Squirrel Inn (near Lake Arrowhead) during 1.16 and 1.17, a record 24 hour rainfall for California until 1943. 12.73” fell in the Morena neighborhood of San Diego from 1.10-1.13. More than 9” fell in two storms in the Coachella Valley. Previous storms had deposited deep snow in the mountains, adding to the runoff.	Widespread flooding. At least 22 dead. Roofs in Chula Vista, poultry farm in Vista, boats in Coronado and Newport damaged. Most cities completely inundated. Pine trees from Palomar Mountain floating down San Luis Rey River through Oceanside. The cities of Indio, Coachella and Mecca underwater. Ontario and Redlands were isolated and roads, railroads and bridges were washed out.

1.25-30.1916	Heavy rain exacerbates the flooding earlier in the month. Monthly rainfall totals for 1.1916 ranged from 7.56" at San Diego to 57.91" at Dorman's Ranch (in San Bernardino Mtns., 2,500' elev.) 5" fell in less than 12 hours in San Diego.	Most extensive flooding in Southern California to date and resulted in 28 total deaths in the region, 22 in San Diego County. This is the most destructive and deadly weather event in San Diego County History. The Lower Otay dam broke sending a 40' wall of water downstream, killing 15. A few others drowned in Mission Valley and in the San Luis Rey River. The Sweetwater Dam also broke. Every large bridge in San Diego County but one was seriously damaged or destroyed. Four drowned in Orange County, two in a cottage floating down the Santa Ana River. Two drowned in San Bernardino County. Total damage was nearly $8 million (1916 dollars).
8.20-21.1921	The remnants of a tropical cyclone tracked northward into western Arizona from central Baja California generating rainfall of up to 2" in the deserts and southern mountains of southern California. This occurred during the La Niña of 1920-21.	
9.30.1921	4" of rain fell on the deserts of Southern California as a result of a dying tropical cyclone that crossed Baja California and moved into southwestern Arizona. 1.23" of rain fell in San Diego, the wettest calendar day in September on record.	
12.24-26.1921	Heavy storm. 6.76" in LA. On 12.26 2.10" fell in Redlands, 1.71" in San Bernardino. From 12.17 to 12.27, 30.64" fell at Squirrel Inn at Lake Arrowhead.	Flooded roads, bridges, railroads. Lake Arrowhead rose seven feet.
1.1-2.1922	Heavy rains. 2.5 inches fell in San Bernardino.	Flooded roads, bridges, railroads. Santa Ana River rose three feet.

7.18.1922	7.10” of rain fell in Campo.	Probably some flash flooding.
10.4.1925	2.95” fell at San Diego, the second wettest calendar day on record and the wettest in October.	
4.5.1926	3.23” at San Diego, the wettest calendar day on record. Other short-period rainfall records broken: 0.28” in five minutes, 0.75” in 30 minutes, 1.16” in one hour, and 2.09” in 2 hours. 0.65” fell in one minute at Opid’s Camp in the San Gabriel Mountains, the greatest one minute rainfall in state history. 3.85” fell in San Bernardino, 3.07” in Riverside, which was the greatest April rainfall in 45 years.	Floodwaters and mud up to 4’ deep inundated the eastern part of downtown San Diego. Flooding displaced 150 families here and in National City. Flood waters damaged and closed all highways in the San Gabriel and San Bernardino Mountains.
2.11-17.1927	Continual rain for 6 days. 25.38” fell at Henshaw Dam (14.18” on 2.16), 21.86” at Cuyamaca, 13.10” at El Capitan, 10.70” at El Cajon, 9.54” at La Mesa and 6.33” at San Diego. 8.30” fell in San Bernardino and 5.60” in Riverside. On 2.17, 12.81” at Cuyamaca, 2.65” at El Capitan, 2.20” at El Cajon, 1.47 at La Mesa. On 2.14 at midday, San Diego received 0.80” in 45 minutes, and 0.25” in 5 minutes. Heavy warm rains melted mountain snows. Snow Creek recorded 7” of rain in one day.	Unprecedented flow of the Whitewater River. Floods washed out roads and bridges in Thousand Palms and Palm Desert. Levees broken, Thermal inundated. Several San Diego County dams overtopped, causing widespread flooding downstream. Bridges and roads were washed out in east San Diego metro area. In San Diego’s north county, roads and bridges were wiped out, stranding residents for days. The San Dieguito River washed out a section of hwy. 101. San Diego and Tijuana were isolated for several days. Crops were carried out to sea. In Solana Beach Children rowed down Cedros Ave in makeshift canoes. Large areas of Long Beach, Fullerton and Anaheim inundated.

9.18.1929	A tropical cyclone moved north northwest just off the west coast of Baja California, dissipating off the coast of northern Baja California. Rainfall of up to 4” occurred in the southern mountains and deserts of southern California on 9.18.	
5.1930	Three inches of rain fell from a single cloudburst in the Encinitas – Olivenhain area.	A haystack was washed to the ocean.
12.29.1931	Heavy rains hit the San Bernardino Mountains.	Waterman and East Twin Creeks were raging torrents, causing several mudslides and washing several cabins from their foundations. Thirteen mudslides along Rim of the World Drive.
2.9.1932	A heavy rainstorm hit San Diego’s north county and the Inland Empire.	2.5 feet of water spilled over Hodges Dam, flooding the San Dieguito Valley. All roads were impassable and so was the railroad at Sorrento Valley. One woman drowned in Loma Linda when her bus was caught in floodwaters. Some highways and bridges were closed. The Santa Ana River ran 500 feet wide at Riverside.
9.28-10.1.1932	Four days of heavy rains from a dying tropical cyclone brought flooding to parts of the mountains and deserts of southern California. Rainfall of 4.38” fell at Tehachapi in 7 hours on 9.30 and four day storm total was 7.10”. This occurred during the El Niño year of 1932-33.	Flooding to parts of the mountains and deserts. Floods on Agua Caliente and Tehachapi Creeks around Tehachapi resulted in 15 deaths.

12.30-1.1.1934	A major storm. 7.36" in 24 hrs at LA (8.26" storm total since 12.30.1933). Storm totals in southern slopes of mountains topped 12" (heaviest: 16.29" in Azusa). Daily totals on 1.1: 6.21" at Fullerton, 6.90" Placentia, 5.16" Yorba Linda, 4.69" Buena Park, 5.04" Anaheim, 5.38" Orange , 4.81" Garden Grove, 3.24" Newport Beach, 2.96" Laguna Beach, 3.55" San Juan Cap., 3" San Clemente, 2.65" Redlands, 2.68" Oceanside, 1.56" Carlsbad, 2.44" Escondido, 0.67" San Diego , 0.48" Victorville.	45 die all over Southern California in floods. Walls of water and debris up to 10' high were noted in some canyon areas.
8.25.1935	A tropical cyclone tracked northward across southern and central Baja California. The remnants spread into Arizona generating rainfall of up to 2" in the southern valleys, mountains, and deserts.	
8.9.1936	A tropical cyclone tracked north northwestward across the Gulf of California with the remnants tracking northward into western Arizona. Locally heavy rainfall occurred in the mountains surrounding LA.	
2.4-7.1937	2.71" of rain fell in San Diego on 2.6, the third wettest calendar day and the wettest February day on record. 2.60" fell in 12 hours. For the storm, 8.20" fell in Descanso, 5.70" in Escondido. 4.25" fell in Long Beach, a 24-hr record.	Flooding kills several. LA basin flooded in many communities. Hodges Dam overtopped. Mountain snowmelt added to the flooding.

2.27-3.4.1938	Storm of tropical origin. 11.06” at LA. More than 30” at several mountain stations of San Gabriel and San Bernardino Mountains (32.2” at Kelly’s Kamp 8,300’ elev.). More than 22” in the Santa Ana River headwaters. Considerable snow was melted, adding to the runoff. This led to unprecedented flood control efforts, including a network of dams and canals and concrete channels. On 3.3 2.80” fell at Descanso, 2.47” at Escondido, where the storm total was 6.95”.	210 reported dead or missing in flooding across Southern California. 45 in Orange County, of which 43 perished in Mexican-American Atwood from an 8 ft. wall of water. Hundreds injured. Santa Ana River floods, inundates nearly all of northern Orange County. Catastrophic damage to more than 1,500 residences. 400 cabins and buildings washed away in and around San Antonio Canyon. Whitewater River floods, isolates Palm Springs.
7.27-28.1939	A severe thunderstorm hit Needles with 1.46” in nine hours from 6 pm to 3 am.	Flash floods and debris flows damaged homes and businesses.
9.4-6.1939	The remnants of a hurricane tracked northeastward across northern Baja California into southwest Arizona generating rainfall of up to 7” on the mountains and deserts. Blythe received more rain than would normally fall in 1 year and Imperial received more rain than would normally fall in 2 years. Four tropical cyclones would impact Southern California during the month of September 1939, an unprecedented occurrence. 1.21” fell in San Diego.	Floods through eastern canyons inundate Thermal with 3’ of water. Extensive damage in Mecca.
9.8.1939	A thunderstorm dropped 2.70” of rain on Needles. This was the first in a series of storms to hit Needles with 8.50” this month, almost double the entire seasonal average.	Flash floods and debris flows washed through city streets and washed out railroads and highways. Several residences and a few businesses were damaged.
9.11-12.1939	4” of rain fell across the deserts and mountains as a dying tropical cyclone moved across Baja California into southwestern Arizona. This was the second tropical cyclone to affect California during the busy month of September 1939. A strong El Niño contributed to the activity.	

9.19-21.1939	A tropical cyclone moving northwestward, just off the west coast of Mexico, moved into southern Baja California and dissipated. The moisture from this tropical cyclone generated rainfall of up to 3" in the deserts and mountains.	
9.24-26.1939	"El Cordonazo" or "The Lash of St. Francis" a tropical storm hits Southern California and causes the greatest September rainfall ever. The storm lost hurricane status shortly before moving onshore at San Pedro at tropical storm strength. Torrential rains: LA 5.42" in 24 hours, Mt. Wilson 11.60" (also records for the month of September). Nearly 7" in three hours at Indio from one thunderstorm. 9.65" at Raywood Flat, 3.62" Needles, 1.51" Palm Springs. A thunderstorm preceding the tropical storm dropped 6.45" in 6 hours at Indio on 9.24. Needles measured 8.50" this month, about double the seasonal average.	45 killed in floods all over Southern California, and 48 more at sea. $2 million damage to structures along the coast and to crops. Eastern Coachella Valley under 2' of water. Californians were generally unprepared and were alerted to their vulnerability to tropical storms. In response, the weather bureau established a forecast office for southern California, which began operations in February of 1940.
11.27.1939	0.65" rain fell in San Diego in 15 minutes, the greatest 15 minute rainfall on record.	
12.23-24 .1940	3.62" at San Diego, the greatest 24 hour rainfall on record.	Heavy rains loosened soil in Del Mar that led to a landslide along a train track, derailing the train and killing three.
3.12-14.1941	A heavy storm hit the San Gabriel Mountains and Mojave Desert. Victorville received 1.78".	The Mojave River flooded homes in the Oro Grande Wash. In Wrightwood three houses were destroyed from a mudslide in Heath Canyon. Mud and debris 6' deep covered Lone Pine Road.
8.9.1941	A heavy thunderstorm struck Needles.	Flash floods and debris flows damaged streets and highways. Several motorists were stranded, but no one was hurt.

8.10.1941	Thunderstorms in eastern Coachella Valley.	Buildings damaged. Water 30" deep in Mecca.
10.13.1942	A midnight thunderstorm hit Upland with 2.25" of rain in just over one hour.	Mud and debris washed down Euclid Avenue and flooded at least one home. Four calves at an Ontario dairy were washed away.
1.23-24.1943	26.12" fell in 24 hours at Hoegees Camp in the San Gabriel Mountains, setting the state 24 hour precipitation record. More than 28" fell for the storm at Camp Baldy, 14.28" in Upland, 7.23" in San Bernardino, 4.56" at Palm Springs, and about 3" in Victorville.	Lytle Creek flooded, killing one and forcing 150 families in San Bernardino and Colton to evacuate. Other roads and bridges in this area were damaged or undermined. All highways surrounding Victorville were blocked.
2.21-24.1943	Heavy rainstorms hit the San Bernardino Mountains and Inland Empire. Over four days Lake Arrowhead received 13.36" and Perris 4.87".	Damage was light because of recent work done on flood channels.
3.3-5.1943	A major storm struck the San Bernardino Mountains and nearby areas. During one eleven hour period, 5.25" of rain fell in Crestline. Victorville had a storm total of 1.82".	Only minor flood damage and closed roads around Fontana.
10.9.1943	An incredible thunderstorm complex brought 3.90" of rain to Twentynine Palms in about three hours.	Flash floods and debris flows blocked roadways and trapped vehicles. One house was seriously damaged.
12.10.1943	2.56" of rain fell at San Diego, the eighth wettest day on record and the second wettest December day.	
2.21.1944	A heavy storm struck San Bernardino County.	Minor flooding problems around Lytle Creek. A few bridges were washed out around Victorville.
8.18.1945	Remnants of a hurricane produced thunderstorms in eastern Coachella Valley.	Extensive damage at Oasis. Water 18" deep in Mecca.
9.2.1945	A heavy thunderstorm hit Wrightwood.	One residence was destroyed and debris covered Lone Pine Road.

9.9-10.1945	A tropical cyclone moving north northwestward just off the west coast of Baja California dissipated off the coast of northern Baja California. Showers produced rainfall up to 2” in the mountains.	
12.22.1945	2.60” of rain fell in San Diego, the sixth wettest calendar day and the wettest December day on record.	Minor flooding closed some roads and bridges around San Bernardino.
7.30.1946	A heavy thunderstorm struck Twentynine Palms.	One house was destroyed by a wall of water. The garage and car in it were carried a half mile away.
9.29-10.1.1946	A tropical storm moved northward into northern Baja California and dissipated with rainfall of up to 4” in the mountains on 9.30 and exceeding 4” in the mountains on 10.1. This occurred during the El Niño of 1946-47. On 9.29 a particular cloudburst dropped 3” of rain in 30 minutes in San Bernardino.	On 9.29 around San Bernardino, farmlands, orchards and vineyards were eroded and some roads were damaged. Many homes were flooded.
8.8.1947	A heavy thunderstorm struck Needles.	Serious damage done to highways and railroads, including highway 66.
2.5.1948	Steady rain and mountain snow hit Southern California after a long dry spell. San Bernardino recorded 2.14” from this storm. Only 5.75” was recorded before this storm in the previous year.	
6.2.1948	An unseasonal thunderstorm brought heavy rain to San Bernardino.	Streets in northern San Bernardino flooded.
7.23.1948	Thunderstorms in Palm Desert and La Quinta.	Homes flooded. Erosion damage to roads and canals.
2.6.1950	Heavy rain.	Chino Creek inundates Hwy 71 from Corona to Ontario.
7.6.1950	A heavy thunderstorm erupted over the Yucaipa Ridge area.	The rain fell on denuded slopes from a 640 acre wildfire on 6.30 in Oak Glen. Mud and debris flowed into Yucaipa.

8.27-29.1951	A hurricane moving north northwestward just off the west coast of Baja California moved northeastward into northern Baja California and dissipated. Moisture from this tropical cyclone resulted in rainfall of 2 to 5” in the mountains and deserts. Many roads were washed out in the Imperial Valley, but otherwise no major damage occurred in southern California. This occurred during the El Niño of 1951-52.	
1.13-18.1952	Heavy rain hits Southern California in a few waves of storms. 5.52” fell in San Bernardino over the six days. On 1.18 3.17” fell in LA in 24 hours.	At least 8 died in flooded LA. Other flooding was reported in Upland and Ontario.
9.19-21.1952	A west-northwestward moving tropical storm southwest of Baja California dissipated. Moisture from this storm resulted in rainfall of up to 2” in the mountains and deserts, with most falling on 9.19. This occurred during the El Niño of 1951-52.	
11.30.1952	Heavy rain dropped almost one inch in Upland.	Flooding was reported in Upland and homes were flooded in Ontario.
1.18-19.1954	Heavy rain “averaged” about 3 inches around Upland and Rancho Cucamonga and more than 4 inches in the mountains.	Floods and debris flows struck these communities and blocked or damaged roads. Debris flows at least 10’ deep in Arcadia nearly killed people. Large boulders smashed into homes. These debris flows followed wildfires in the San Gabriel Mountains.
1.24-25.1954	A second heavy rain storm in a week struck Southern California.	Flood waters came down San Antonio Canyon into Upland and Rancho Cucamonga. A rescue was made of a couple. Debris flows up to two feet deep and flooding struck these communities. Rock slides closed Rim of the World Highway and City Creek Canyon.

7.12.1954	Heavy thunderstorms struck the Morongo Basin.	Flash floods hit Morongo Valley, Yucca Valley, and Twentynine Palms. Numerous roads were severely damaged and closed. Some roads were left covered in sand and mud.
7.16-19.1954	A northward moving hurricane made landfall in central Baja California with the remnants moving into Arizona. Rainfall of up to 2" occurred in the mountains and deserts. This occurred during the El Niño of 1953-54.	On 7.16 a severe thunderstorm struck the Daggett area east of Barstow. Eight miles of Hwy. 66 were flooded. The highway was also flooded near Hinkley with 18" of water.
11.10.1954	A heavy storm dumped 2" of rain on San Bernardino and up to 6" in the nearby mountains.	Flash floods and debris flows covered the mountains. Floodwaters inundated many parts of San Bernardino and mud slides blocked and damaged mountain roads.
7.19.1955	Heavy thunderstorms struck desert areas of Twentynine Palms and Barstow. One cloudburst hit Cherry Valley with 3" of rain in 30 minutes.	A 75' stream of water crossed Hwy. 66 at Hodge, southwest of Barstow. Washouts were also reported around Twentynine Palms.
7.28.1955	A heavy thunderstorm dropped more than 2" of rain in Needles.	Flooding at a railroad underpass 10' deep made a small lake. Rushing water a quarter mile wide trapped a car, but occupants were rescued.
8.4.1955	Thunderstorms strike Barton Flats and Needles.	Flash floods washed out a road and caused minor slides around Barton Flats. In Needles, flash floods washed out Hwy. 66 and damaged railroads. 100 people were made homeless as many washes turned into raging torrents.
8.14.1955	Heavy thunderstorms struck Forest Home (now Forest Falls) and Barstow.	Torrents of water up to 6' deep swept down Mill Creek Canyon leaving up to 5' of sand and rocks on the road. Huge boulders rolled onto the roadways.
8.23.1955	Heavy thunderstorms hit the San Bernardino Mountains and deserts.	Highways 66 and 91 were blocked by "wide rivers" of flash flood waters. Rocks and mud covered roadways west of Barstow and in Forest Home (Forest Falls).

1.25-27.1956	A heavy storm in Southern California dropped 13.74" in Lake Arrowhead, 7.97" in LA, 7.27" in Santa Ana, 7.06" in San Bernardino, 4.00" in Riverside, 1.14" in San Diego, and 0.74" in Palm Springs.	Around San Bernardino, local floods filled streets and channels, and blocked many roadways. Mud and rocks covered some roads, causing damage. This damage occurred after fires denuded nearby mountain slopes.
4.18.1956	Heavy thunderstorms struck Barstow and Victorville with an estimated 1.25" of rain. One quarter inch hail was also reported covering the ground.	A wall of water two feet deep damaged 40 homes in west Barstow.
7.23-28.1956	Strong monsoon flow hit the region with thunderstorms each day, even west of the mountains. On 7.24 an evening thunderstorm hit Barstow with an estimated one inch of rain in 30 minutes. Heavy rain also hit Joshua Tree city. On 7.25 1.26" fell in Riverside, 1.05" Yucaipa, 1.01" Lytle Creek, 1.15" Upland. Almost 0.5" in five minutes at Glendora.	On 7.23 water two feet deep covered spots in Apple Valley. Many dry desert lakes were filled. On 7.24 roads were washed out in Joshua Tree city. On 7.25 flash flooding hit San Bernardino, Riverside and Ontario. In Apple Valley, floodwaters reached depths of 2-3'. On 7.26 through 7.28 successive thunderstorms brought flash floods and mudslides to the Barton Flats area, damaging and closing roads.
2.27.1957	A heavy rainstorm drenched the Southland.	Burn areas from fires the previous November in the San Bernardino foothills led to severe debris flows and flash floods into Highland. A block of homes were inundated as well as most of a school grounds. City Creek ran black from ash and soot.
7.12.1957	A heavy thunderstorm struck Redlands at 235 pm with 1" of rainfall in 30 minutes. Lightning, hail and "winds, which blew alternately from every point of the compass" accompanied the storm. Just after 3 pm the sun was out and streets were dry.	Within 10 minutes streets were flooded in Redlands. One girl drowned while swept nearly a mile down a storm drain.

10.11.1957	Heavy rain hit San Bernardino. Rainfall of 0.5" hit during 10 minutes at Del Rosa Ranger Station (a 40 year occurrence). Total was 1.37" at the site from 10.11 to 10.14.	The rains eased the fire threat. But burn areas from fires the previous August led to debris flows into the northern San Bernardino area. Tons of mud and debris were deposited in dozens of homes and yards from Little Mountain to Del Rosa.
2.3-4.1958	A heavy rain storm drenched San Bernardino with nearly four inches. Almost two inches fell in Redlands.	Warm Creek overflowed with ash blackened water near Tippencoe Av. More debris washed into the Del Rosa area. A bad flood occurred in Fontana.
4.2-3.1958	A heavy rainstorm struck the northern Inland Empire. 2.80" fell in San Bernardino, 2.25" in Redlands.	Heavy runoff caused flooding in San Bernardino, Fontana and in Hesperia. Creeks exceeded banks and numerous roads were blocked by water, mud and boulders.
7.28-30.1958	Moisture from a west northwestward moving tropical storm which dissipated west of central Baja California generated up to 2" of rainfall in the deserts and mountains. This occurred during the El Niño of 1957-58. On 7.29 a thunderstorm hit the Barton Flats and Forest Home (now Forest Falls) area with 2" of rain. On 7.30 a severe thunderstorm brought heavy rain and large hail to Barstow. It was called "the worst storm in 60 years". Another thunderstorm struck Twentynine Palms on 7.30.	On 7.29 several walls of mud rolled off fire-denuded hills onto the road in several places along the highway in Barton Flats and Forest Home. 5 cars were trapped. A flash flood struck Barstow on 7.30 and actually moved a house off its foundation. Residents had to escape through windows from flooded houses in Lenwood. Tons of mud engulfed hwy 66. In Twentynine Palms floodwaters and mud flowed through the streets and into a few buildings.
8.15.1958	A severe thunderstorm dropped heavy rain and large hail in the Oak Glen area.	Tons of mud flowed from a burn area from a fire one month previous. The mud covered orchards, Oak Glen road and left mud up to three feet deep across a 500 foot length below Ford Canyon.

9.5.1958	A heavy thunderstorm struck the Lucerne Valley area.	Floodwaters covered Rabbit Springs Rd. up to one foot deep for over a mile.
1.4-5.1959	Big winter storm.	Roof damage and animals killed at San Diego. Considerable property damage from flooding and mud slides. Rattlesnake Creek in Poway inundates the city.
2.14-16.1959	Heavy rain.	Flooding in San Diego.
8.5.1959	A heavy thunderstorm dropped 0.63 inch in Needles.	Flash floods damaged desert highways east of Needles. A car and trailer were swept away without a trace, but occupants were saved.
8.17.1959	A heavy thunderstorm dropped 1.5 inches in Needles and 1 inch at the Needles airport.	One died and three were missing in disastrous flooding. Bridges, highways and railroads were washed out across a wide area. Cars were swept away. Waves up to 22 feet were observed coming down Sacramento Wash. This was considered the greatest runoff of record from any desert watershed in San Bernardino County history.
9.13.1959	An intense thunderstorm hit east of Joshua Tree City between noon and 1 pm.	Heavy debris flows came from the canyons and damaged numerous homes. Sand more than three feet deep covered some properties.
4.27-28.1960	Heavy rain.	1 drowning death and 3 traffic deaths. Flooding and closed highways.
7.22.1960	A thunderstorm strikes Forest Home (now Forest Falls).	A debris flow blocked the road and trapped one car.
9.1.1960	A noon thunderstorm hit the Barstow area.	Flash floods damaged highways around Lenwood. Mud and debris were deposited on Barstow streets.

9.2.1960	A thunderstorm dropped more than two inches of rain on San Bernardino. Other thunderstorms struck Twentynine Palms.	Homes and businesses were flooded in east San Bernardino and Loma Linda. Streets and highways were washed out in Twentynine Palms.
9.9-11.1960	North northwestward moving Hurricane Estelle dissipated west of the central Baja California coast. The heaviest rains were over the San Diego County Mountains with 3.40" recorded at Julian on 9.9 and 9.10. On 9.10 a thunderstorm hit Forest Home (now Forest Falls) with 1.08 inches of rain in three hours, but was harder nearby. A severe thunderstorm struck Redlands. On 9.11 a thunderstorm hit the area east of Lucerne Valley.	Debris blocked the highway in Forest Home. Streets and lawns were flooded in Redlands. Flash flooding four feet deep washed out a section of road and stranded several vehicles east of Lucerne Valley.
11.5.1960	Heavy rain, mainly from Orange County northward.	1 drowning death, 2 injuries. Flooding, mud slides, and property damage. Power outages.
8.4.1961	Heavy thunderstorm near El Capitan Reservoir: 1.75" in 90 minutes. Another heavy thunderstorm hit south of Yucca Valley.	Los Coches and Quail Creeks flood Lakeside. Flash floods hit the area south of Yucca Valley and also blocked Hwy. 62 with mud and debris up to two feet deep.
8.15.1961	An early morning thunderstorm struck the entire Morongo Basin with up to 2.23 inches of rain between 1 and 3 am.	Extensive flash flooding washed out roads, isolating Joshua Tree National Monument. Ten homes in southeast Joshua Tree were flooded.
8.19.1961	Thunderstorms hit Barstow, Redlands and Calimesa.	Roads and highways were eroded. A few homes in Redlands were sitting in two to three feet of water.
8.23.1961	Thunderstorms hit Angelus Oaks and Forest Home (now Forest Falls), and across the high desert including Victorville and Lucerne Valley.	Roads were closed because of water and mud, up to five feet deep at the "Y" between Forest Home and Camp Angelus. One family was trapped in mud attempting to drive through it. Homes around Bell Mountain northeast of Victorville were smothered in mud. Water rose to 12 feet deep in this area.

11.20.1961	A heavy rain fell in the mountains above San Bernardino.	Waters and rocky debris came down the canyons into orange groves and Patton Hospital grounds, causing damage to fences and trees.
12.2.1961	A heavy rain fell in Fontana and Rialto.	Floodwaters rushed down Lytle Creek Wash and into some homes in San Bernardino and Fontana. Many streets closed because of flooding.
1.21-22.1962	The heaviest winter storm in 13 years struck the San Bernardino area with 2.93 inches in Ontario and about two inches in San Bernardino.	Minor flooding of streets and neighborhoods.
2.7-26.1962	A very wet period for Southern California. 20”+ in wettest mountain locations.	20 killed, 15 injured in flooding, mud slides. Property damage, trees down, boats damaged. On 2.19 flooding was reported in Montclair, Ontario and San Bernardino.
8.20.1962	A heavy thunderstorm struck Twentynine Palms.	Highway 62 was flooded.
9.24.1962	Thunderstorms hit the San Bernardino Mountains and high desert around Barstow.	Flash flooding occurred east of Barstow.
9.25.1962	Scattered thunderstorms around Needles.	Flash flooding closed several highways around Needles.
2.9-11.1963	A strong winter storm hit the region with heavy rain.	Many homes and highways were flooded. Slides blocked all mountain highways, some with large boulders.
8.7.1963	Thunderstorms struck Newberry, Yucca Valley and Twentynine Palms.	Floods coming off lava beds south of Newberry put 10 inches of mud in the homes of 30 families. Widespread losses were also felt by livestock and agriculture. A lumber yard was buried in mud.
8.8.1963	A heavy thunderstorm struck Victorville - Desert Knolls with 1.67” in two hours and Victorville with 0.81”.	No deaths or injuries occurred in the flash floods, but there were rescues of motorists. Some flooding was three feet deep in Apple Valley, four to five feet deep on Old Woman Springs Road.

8.10.1963	A heavy thunderstorm struck Lenwood and Barstow.	In Lenwood a boy was swept 200 feet by a flash flood before clinging to a telephone pole. The same flash flood carried a loaded trailer 150 feet off the highway.
8.14.1963	A terrible thunderstorm hit Oak Glen with about two inches of rain within three hours. The thunderstorm was heavier to the north along Yucaipa Ridge.	Disastrous debris flows damaged numerous homes, farms, roads, and a church. Two boys were rescued from the flooding creek.
8.17.1963	A heavy thunderstorm hit the tiny town of Rice (east of Joshua Tree NM)	The flash flood washed out roads and railroads.
9.17-19.1963	Northeastward moving Tropical Storm Katherine made landfall in northern Baja California with rainfall of up to 6.50" in the mountains. 3.86" fell in San Bernardino, 3.44" in Riverside, 2.66" in Victorville and Cuyamaca, 1.90" in San Diego, 1.88" in Indio, and 1.62" in Santa Ana.	Disastrous flooding and erosion hit a northern San Bernardino neighborhood.
10.18.1963	Strong thunderstorms hit the Twentynine Palms area.	Flash floods and debris flows moved into several homes and yards. Roads were left impassable.
11.19-20.1963	Heavy rains hit Southern California with 1.5 to 3 inches.	6 injured in local flooding and numerous traffic accidents.
1.21-22.1964	A strong winter storm dropped 1.5 inches of rain on San Bernardino and Redlands and up to 5 inches in Lake Arrowhead.	A flash flood in Upland damaged a road.
12.1964		40 dead from flooding in LA and Orange Counties.
4.8-10.1965	A heavy rain storm dropped 1.5 to 2 inches across the coastal basin, but up to 8 inches in the San Bernardino Mountains.	Flash floods caused damage in Yucaipa.
8.8.1965	A sudden thunderstorm dropped "several inches of rain" on the foothills south of Lucerne Valley.	A flash flood covered a 50 foot wide canyon floor with four feet of water. 21 members of a Riverside jeep club were stranded. Three jeeps were demolished, one being swept 300 feet down the canyon.

8.11.1965	A heavy thunderstorm struck Redlands.	Flash floods went into some homes and businesses in Redlands. Two youths were rescued after being swept nearly two miles down a storm drain system.
8.14.1965	A heavy thunderstorm struck Yucaipa.	A flash flood came down Wildwood Canyon for an hour, washing out some roads and flooding streets. A pickup truck driver was swept about 1200 feet, but climbed out unhurt.
8.16.1965	Thunderstorms hit the mountains and deserts.	A flash flood four feet deep damaged highway 138 near Wrightwood.
11.22-25.1965	Heavy storms drawing tropical moisture in the mountains and desert. Storm totals: 20” at Mt. San Gorgonio, 16” at Mt. San Jacinto, 9.59” at Cuyamaca, 6-9” at Banning-Cabezon, over 4” at Palm Springs, less than 1” near the Salton Sea. One day total over 9” at Snow Creek.	15 died all over Southern California. The entire region was hit hard with severe flooding, including road and bridge washouts and debris flows. Santee was inundated. Two drowned attempting to cross the Whitewater River. Five died in Tijuana. One died in Rancho Cucamonga, another drowned in San Bernardino and three drowned in Lytle Creek flooding. Record flood levels on Tahquitz Creek. Largest flood on Whitewater River since 1938. Spring Valley Creek floods in southeast San Diego. The Sweetwater River floods parts of National City and Chula Vista.
12.10.1965	1.36” fell in San Diego in one hour, the greatest one hour rainfall on record.	
12.29-31.1965	A warm storm of torrential rains melted mountain snow. One report said more than 13” fell in 24 hours at Mt. Baldy. Nearly 9” did fall in Lake Arrowhead. 1.5 to 3” fell in the coastal lowlands.	One drowned in Lytle Creek. Disastrous flooding and debris flows occurred in the Lytle Creek and Scotland communities, Baldy Village, and in Waterman Canyon. Two boys were rescued from the Santa Ana River in Colton. Numerous roads were washed out in the high desert and the mountains.

12.2-7.1966	Heavy rain. On 12.5 6.66” fell at Idyllwild. On 12.6 9.42” fell at Big Bear Lake. Storm totals for the period: 27.79” in Lake Arrowhead (believed to be a 100 year rainfall), 23.73” in Palomar Mountain, 18.72” in Big Bear Lake, 17.85” in Idyllwild, 9.14” in San Bernardino, 7.63” in Redlands, 6.21” in Santa Ana, 5.19” in Riverside, 2.99” in San Diego, 2.73” in Palm Springs, but only 0.66” in Victorville and 0.28” in Barstow!	At least two homes were destroyed by floods and debris flows in Mill Creek Canyon. Debris flows and floods damaged homes and roads in Wrightwood and Lytle Creek. Homes and businesses were flooded in Redlands and Palm Springs. Many roads across the region were flooded and washed out. Scuba divers could not recover a Montclair man believed drowned in floodwaters.
1.21-25.1967	Two back to back storms brought 9.24” of precipitation to Lake Arrowhead, 5.46” to Palomar Mountain, 4.86” to Big Bear Lake, 4.24” of rain to San Bernardino, 4.04” to Idyllwild, 2.81” to Santa Ana, and 2.13” to San Diego.	Several roads were flooded and closed for a time.
3.11-14.1967	A series of storms brought heavy rain of 8.52” to Lake Arrowhead and 8.06” to Lytle Creek. Only about one inch fell in the San Bernardino area during this time, and none in Victorville.	The Mojave River flooded a couple of roads and washed out construction sites in the desert.
7.5.1967	A heavy thunderstorm produced a rainfall of 1.25 inches in one hour at Twentynine Palms.	Highway 62 was washed out and closed east of town.
7.13.1967	Thunderstorms hit the high desert and parts of the San Bernardino Mountains. 0.29” fell in Victorville.	Flash floods filled streets in Victorville and the Oro Grande Wash overflowed, flooding at least two homes. A debris flow resulted on Highway 38 in Barton Flats.
7.14.1967	Heavy thunderstorms struck the high desert for the second day in a row.	Major highways were flooded and washed out west of Victorville.
8.16-17.1967	Thunderstorms in the lower desert. 2.5” in 1.5 hours at Cathedral City, 0.75” at Indio.	
8.23.1967	Numerous thunderstorms hit southwest San Bernardino County.	Flash floods swept through Yucaipa, Redlands, Wrightwood, Lucerne Valley and Adelanto. In Yucaipa huge chunks of pavement were washed into homes, causing damage.

8.30-31.1967	Hurricane Katrina crossed the southern tip of Baja California, then traversed almost the entire length of the Gulf of California before making landfall again and rapidly weakening. 2”+ of rain fell on parts of the lower desert. 2” at La Quinta on 8.30.	La Quinta cut off for several hours. 150 homes damaged by floods in Palm Desert and Indian Wells. Numerous roads washed out in Coachella Valley. The Fort Irwin road north of Barstow was flooded, isolating the army base.
9.6.1967	A heavy thunderstorm struck the west Barstow area.	Flash floods hit a neighborhood in west Barstow. Some homes and yards were filled with up to three feet of mud.
11.18-21.1967	A moist subtropical storm system produced 14”+ in mountains above LA, 7.96” in LA. Called “worst since 1934.” On 11.19 1.87” fell in one hour in LA, the greatest one hour rainfall on record. On 11.21 0.51” in San Diego in 10 minutes, the greatest 10 minute rainfall on record.	2 killed. Flash flooding and mud slides. 400 stranded in mountains due to closed highways.
12.12-15.1967	Heavy rain.	2 drowning deaths in San Diego County.
3.6-8.1968	Heavy rain.	1 drowning death. Local flooding. Damage to buildings, homes, and schools, including homes in Ontario and Chino on 3.7. Debris flows closed several highways.
6.7.1968	Heavy thunderstorms struck the high desert.	Flash flooding closed several roads in the Barstow and Yermo areas.
7.22.1968	A heavy thunderstorm struck Needles with 1.50 inches of rain.	Flash flooding damaged numerous buildings, streets and highways.

1.18-28.1969	Heavy rains of tropical origin hit in two waves, one beginning 1.18 and the other 1.23. The totals: as much as 50” of rain at 7,700’ elev., 37.5” at Lake Arrowhead, 31” of rain on south slopes of Mt. San Gorgonio, 15.5” at San Jacinto Peak, 13.4” in LA, ~10” at Banning, less than 1” from Indio southeast. 11.72” at Forest Falls on 1.25.	87 reported dead from flooding and mud slides all over California. Scores dead in traffic accidents. Hundreds of homes and buildings destroyed in slides, including 14 destroyed and 11 damaged homes in Mt. Baldy Village. 50 homes near Forest Home (Forest Falls) were damaged by flooding. Highways and railroads washed out. Power outages. Cucamonga Creek itself caused $10 million in damage. The Mojave River took out numerous bridges and flooded farmlands in the upper desert.
2.16-26.1969	Heavy rain continued. Up to 30” of rain on south slopes of Mt. San Gorgonio, 13” northwest of Mt. San Jacinto, ~10” at Banning, less than 1” in eastern Coachella Valley. 5-15” of rain in the lowlands from 2.22 to 2.25. 9.25” at Forest Falls on 2.24.	The death and destruction continued from the previous month. 21dead from flooding and mud slides all over California. An entire family was killed in Mt. Baldy Village when a mud slide hit their home. Extensive damage to crops, farmland and livestock. Creeks around Yucaipa all left their banks and substantial flooding occurred to residences and businesses. In the upper desert farmlands became lakes and more than 100 homes along the Mojave River were damaged. Roads and bridges recently repaired from previous month’s damage either washed out or were destroyed again.
6.15.1969	Strong thunderstorms struck the San Bernardino and San Gabriel Mountains.	Flash floods washed out and closed several highways on the north slopes and in the desert, including Hwy. 138 in Pinon Hills.
7.27.1969	A heavy thunderstorm hit Lucerne Valley.	Flash floods and debris flows moved several cars of f the highway and caused damage to some homes. A three foot wall of water ripped out three miles of highway.

9.16.1969	A heavy thunderstorm hit Barstow.	Flash flooding flowed through the streets of Barstow. Water washed into 40 homes.
3.1-2.1970	A strong storm hit the region. 5.22” fell in Lytle Creek, 3.12” in Lake Arrowhead, 2.60” in Redlands, 1.87” in San Bernardino, 1.79” in Riverside, 1.66” in Palm Springs, and 1.35” in Santa Ana.	One died in floodwaters in Chino. Extensive flooding occurred all over the northern Inland Empire.
8.15.1970	Heavy thunderstorms hit the desert.	Flash flooding wiped out highway 95 north and south of Needles, as well as highway 66 in Helendale.
11.25-30.1970	A series of storms struck the region following large destructive wildfires in the San Bernardino and San Gabriel Mountains earlier in the fall. 9.17” of precipitation fell in Lake Arrowhead, 7.22” in Lytle Creek, 5.11” in Big Bear Lake, 5.02” in Palomar Mountain, 3.56” in San Bernardino, 2.63” in Redlands, 2.51” in Santa Ana, 2.05” in San Diego.	Flooding inundated streets and highways in the Rancho Cucamonga area. At least 60 homes were damaged by floods and debris flows.
12.17-22.1970	A series of storms brought heavy rains to the region. 7.03” was recorded in Palomar Mountain, 6.93” in Lytle Creek, 6.35” in Lake Arrowhead, 5.38” in Idyllwild, 4.72” in Big Bear Lake, 2.81” in San Bernardino, 2.67” in Santa Ana, 2.27” in Riverside, and 1.84” in San Diego.	Several roads were flooded and washed out in the northern Inland Empire, exacerbated by the extensive burn areas from earlier in the fall.
3.14.1971	A thunderstorm brought 1.11” of rain to San Bernardino in a short time.	No flooding damage resulted.
9.30-10.1.1971	Caribbean Sea Hurricane Irene crossed Nicaragua and reformed in the eastern Pacific as Hurricane Olivia. Olivia recurved to the northeast and made landfall in central Baja California with rainfall of up to one inch in the southern deserts. This occurred during the La Niña of 1970-71.	
11.16.1971		Poway Creek floods Poway.

12.22-28.1971	A series of wet storms hit the region during this week. 19.44” fell in Lake Arrowhead, 15.26” in Lytle Creek, 12.31” in Big Bear Lake, 7.49” in Palomar Mountain, 5.45” in San Bernardino, 4.98” in Santa Ana, 3.92” in Redlands, 3.04” in Riverside, 2.28” in San Diego, 1.24” in Palm Springs, and 1.02” in Victorville,	Extensive street flooding occurred across the region.
6.7.1972	Thunderstorms struck the Barstow and Helendale area with about 0.5” of rainfall in a short time.	Several structures and many streets and yards were inundated with water and debris.
8.2.1972	Thunderstorms hit San Bernardino County.	Flash floods covered portions of highways with mud, including a stretch of Interstate 15 between Barstow and Baker for eight hours. Highway 95 near Needles was also closed by flash flooding.
8.12.1972	Tropical Storm Diane sent moisture into the region which produced thunderstorms across Southern California. 2.1 inches of rain fell in Lucerne Valley in less than one hour. 0.38” fell in Riverside, and 0.31” in Big Bear Lake.	Flash floods left a foot of silt on downtown Lucerne Valley and closed several highways, including Interstate 15 northeast of Barstow.
8.13.1972	Tropical Storm Diane sent moisture into the region which produced a thunderstorm in the Afton area, about 40 miles northeast of Barstow. Visibility was reduced to near zero.	Flash floods covered Interstate 15 and closed it for half a day. Other roads and railroads were washed out.
8.29-9.6.1972	Hurricane Hyacinth moved as far west as 125 West before recurving to the northeast. The remnants made landfall between Los Angeles and San Diego on the 9.3 with winds of 25 mph and rainfall of up to one inch in the mountains. This tropical cyclone holds the distinction of traveling the farthest west before recurving and making landfall in Southern California. This occurred during the El Niño of 1972-73. 0.44” measured in San Diego.	Flash flooding on 9.3 resulted in closing Interstate 40 at Ludlow, east of Barstow, for two hours. Railroads were damaged as well.

10.6.1972	Hurricane Joanne recurved making landfall in northern Baja California, maintaining tropical storm strength into Arizona and generating rainfall up to 2” in the southeast deserts. This occurred during the strong El Niño of 1972-73.	
10.19.1972	A violent thunderstorm struck Redlands with two hours of heavy rain and hail. Officially at the Redlands gauge, 0.55 inch fell.	Intersections in Redlands were flooded.
1.16-18.1973	Local amounts up to 3” on 1.16 and an additional 3” on 1.18.	Local flooding, mud slides, power outages.
2.10-11.1973	1-2” at coast, 3-7” coastal valleys, up to 12” at Mts. Wilson and Baldy. 6” in 6 hours at Mt. Wilson on 2.11.	Flooding and mud slides closed many roads.
1.3-5.1974	Heavy rain.	1 drowning death near Temecula. Many highways closed due to flooding and mud slides.
12.3-4.1974	Heavy rain.	Considerable flooding of low lying areas of Orange County. Forester Creek in El Cajon floods.
2.4-10.1976	Heavy rain period. 4.30” at San Diego.	
9.9-12.1976	Record rains, flooding from Tropical Storm Kathleen (a 160+ year event). 14.76” on south slopes of Mt. San Gorgonio, 8” Mt. San Jacinto, 10.13” Mt. Laguna, 4+” in Little San Bernardino Mountains, 1.8”-2.8” in the Coachella Valley. Deep Canyon (above La Quinta) recorded 2.96” in 3 hours on 9.10. Rainfall in the Santa Rosa Mountains above the Coachella Valley called “heaviest in recorded history.” 1” in San Diego. On 9.10 2.8” fell in 3 hrs in Borrego Valley and 1.74” fell this day in LA, a daily record. This occurred during the El Niño of 1976-77.	6 buried and killed in sand in Ocotillo. Much of the Imperial Valley flooded. I-8 and other highways ripped out in several locations in the mountains and desert. Floods of record attained at numerous streams above the Coachella Valley. Widespread property damage on the eastern slopes of the peninsular range and the adjacent deserts.

9.23.1976	A thunderstorm dropped 4” of rain in 3 hrs in Borrego Valley. Only 1.2” fell at the Anza Borrego Desert Park headquarters.	Damage and erosion to fields, property and the airport.
10.22.1976	An isolated and powerful thunderstorm dropped torrential rain on Jamul. 3.84 inches was recorded in four hours from 2 to 6 pm, 1.85 of which occurred between 3 and 4 pm.	High runoff produced local flooding.
5.8.1977	1.49” of rain fell in San Diego, the wettest calendar day in May on record.	
8.15-17.1977	Hurricane Doreen tracked north northwestward along the west coast of Baja California, dissipating over the coastal waters. Most areas received at least 2” of rainfall with up to 8” in the mountains. This occurred during the El Niño of 1977-78. Heavy rainfall included 4.9” Mt. Laguna, 4.5” Borrego Palm Canyon, 4.0” Palomar Mtn. and Lake Henshaw, 3.26” Borrego Springs (2.53” in 6 hrs on 8.16, a 100 year event), 2”+ Palm Springs, 4.5” Salton Sea in several hours. 2.13” at San Diego for the period, 1.44” on 8.16. On 8.17 2.06” fell in LA, the wettest August day on record.	4 dead and $25 million in damage in Southern California. Debris flows and flooding from Henderson Canyon into Borrego Springs De Anza neighborhood, damaging 100 homes. Mud flows up to 5’ deep. Flooded roads in desert areas. Floods and crop damage at the Salton Sea.
9.10.1977	Heavy rains in Little San Bernardino Mountains (Joshua Tree NP) produced a rainfall of nearly 5” fell in 1 hour above the Thousand Palms Wash.	Floods down Thousand Palms Wash caused extensive damage to Thousand Palms area, nearly destroying the oasis in the valley. The California Aqueduct that runs just north of the preserve was clogged with debris, resulting in the flood of nearly a billion gallons of water through this area.

10.6-7.1977	Hurricane Heather recurved with the remnants tracking across northern Baja California into Arizona. There was rainfall up to 2” in the southern mountains and deserts. This occurred during the El Niño of 1977-78.	
12.27.1977	Heavy rain.	Mud slide in mountains northeast of Redlands buries a car killing 1 and injuring 3.
1.16.1978	A Pacific storm brought heavy rains.	Flooding killed 2 people and damaged roads, car lots and hotels in Mission Valley. De Luz became isolated. A mobile home park in Chula Vista was evacuated by motorboat.
2.8-10.1978	Heavy rain: 16.4” at Lytle Creek, 13.64” Lake Arrowhead, 11.97” Wrightwood, 11.15” Devore, 10.4” Santiago Peak, 8.5” Crestline, 5” Ontario, 4.79” Big Bear Lake, 3.83” Santa Ana.	20 killed all over Southern California, 13 of them in Hidden Springs in the San Gabriel Mountains. Widespread flooding, flash flooding, and mud slides. Numerous homes washed away.
3.4-5.1978	Heavy rain.	20 deaths from flooding and mudslides in LA area. 3 drowning deaths and disastrous flooding in Lakeside. 26 dead and 600 left homeless in Tijuana and Ensenada.
9.5-6.1978	Hurricane Norman recurved with the remnants tracking into southern California from the south southwest. Rainfall exceeded 3” in the mountains. This occurred during the El Niño of 1977-78.	
1.30-31.1979	2-4” rainfall in 24 hours over much of coastal Southern California. 2.57” of rain fell in San Diego on 1.31, the seventh wettest calendar day and the wettest January day on record. 4.82” fell in National City, 4.25” in La Mesa, 3.30” at SDSU, 3.78” in El Cajon.	Flooding along Silver Strand highway, in Fashion Valley, also in Spring Valley, Lemon Grove, Lakeside and Carlsbad. Lake Hodges overflowed.

7.20.1979	Big thunderstorm in Palm Desert and Rancho Mirage.	Debris flow killed one and caused $7 million damage. Flash flooding hit hundreds of homes in Rancho Mirage, Palm Desert and La Quinta. Some residents swept out of their homes at night.
2.13-21.1980	Six storms hit Southern California. 31.69" in Mt. Wilson, 25.56" in Palomar Mtn., 24.34" in Cuyamaca, 20.65" in Julian, 18.27" in Mt. Laguna, 12.88" in Ramona, 12.75" in LA, 10.09" in Escondido, 6.80" in La Mesa, 4.47" in San Diego.	30 killed in widespread floods and mud slides. Post-fire flooding overwhelmed a basin below Harrison Canyon in north San Bernardino four times. Forty homes were damaged or destroyed there. Roads and hundreds of homes destroyed or damaged. Mission Valley completely inundated between Friars Rd. and I-8.
3.1-3.1981	3" along coast and 5-6" in local mountains.	Widespread street flooding and mud slides. Power outages.
11.27-28.1981	Nearly 2" in LA area.	Highway deaths.
3.16-18.1982	2-4" in San Diego County. 2.13" of rain fell in 24 hours in Pt. Loma from 3.17-3.18.	Local flooding closed many streets.
9.17-18.1982	The remnants of Hurricane Norman tracked northeastward across northern Baja California into Arizona with scattered rainfall amounts up to 1 inch in the southern mountains and deserts. This occurred during the strong El Niño of 1982-83.	
9.24-26.1982	The remnants of Hurricane Olivia recurved northeastward across Southern California with rainfall up to 4" in the mountains. This occurred during the strong El Niño of 1982-83.	
12.8-9.1982	Heavy rain in eastern San Diego County.	Flooding; disastrous flooding in Ocotillo.
2.24-28.1983	Heavy rain.	Extensive street flooding. Damage to 30 cars and an apartment building in Anaheim.

3.1-3.1983	Heavy rain. Up to 18” precipitation from Santa Barbara to LA. On 3.1 0.33” fell in 5 minutes in San Diego, the greatest 5 minute rainfall on record.	
4.17-20.1983	Heavy rain.	Street flooding and mud slides.
9.20-21.1983	Northward moving Hurricane Manuel dissipated off the west coast of northern Baja California with up to 3” of rainfall in the southern mountains and deserts. This occurred during the strong El Niño of 1982-83.	
2.18-19.1984	Heavy rain.	Mud slides in Orange County up to 2' deep.
11.11-13.1985	Heavy rain from a cold, slow-moving storm with embedded thunderstorms produced 4.25” in Julian, 3.42” in La Mesa, 2.63” in SDSU, 2.44” in Vista, 2.40” in Lemon Grove, 2.39” in Alpine, 2.19” in Poway, 2.13” in Chula Vista, and 1.84” in San Diego	Flooding in Spring Valley, Mission Valley. Erosion damage in La Mesa.
11.24-26.1985	A slow moving low grabbing moisture from Hawaii dropped 2.57” in San Diego, 3.49” at Cuyamaca, 2.68” in Escondido, 2.62” in Julian, 2.49” in Pt. Loma and 2.48” in Santee.	Numerous areas were flooded and power outages were common. Especially hard hit was Mission Valley.
2.14-17.1986	Heavy rain.	1 death from flash flooding.
3.15-16.1986	Heavy rain in Orange County.	Mud slides along the coast.
9.24-25.1986	Unseasonable rainfall hit San Diego County: 1.04” at San Diego, 5.14” in Palomar Mountain, 2.07” in Julian, 1.88” in Mt. Laguna, 1.61” in Lemon Grove, 1.58” in Pt. Loma, 1.57” in Vista, 1.47” in SDSU.	Flooding occurred in low roadways in Mission Valley.

10.2.1986	A band of fast moving thunderstorms raced across the LA basin, through the San Bernardino Mountains and into the upper desert. 1.50" fell in Pasadena along with 3" of accumulated hail. 1.02" in LA, a daily record, 1.01" fell in one hour. San Diego County was largely spared, with only 0.22" at Palomar Mountain.	
10.9-10.1986	Thunderstorms dropped 2.40" at Mt. Laguna, 2.10" at Campo, 2.03" at Julian, 1.90" at El Cajon, 1.50" at Alpine, 1.39" at San Diego, 0.41" at Miramar. Most of these became daily rainfall records. Hail the size of marbles was reported in San Diego's east county.	Rainwater flooded through a leaky roof at downtown San Diego police headquarters. Numerous streets flooded in south and east parts of San Diego County. Power outages occurred from lightning strikes.
11.17-18.1986	Early season storm brought 1.16" to San Diego, more rain that falls in than a normal November. Montgomery Field 1.49", 1.21" at Mt. Laguna, 1.07" at Miramar, 1.03" in Oceanside and 0.41" in Chula Vista.	Numerous traffic accidents, a few power outages. The San Diego River flooded causing many road closures in Mission Valley. Street flooding occurred in North Park and Midway areas and in Encinitas. A mudslide blocked Malibu Canyon road. A traffic accident claimed two lives in LA.
12.20.1986	Thunderstorm and heavy rain for two hours. 0.70" Oceanside, >0.5" Alpine, 0.32" in San Diego.	Power outages occurred from lightning strikes and power lines blown down.

1.4-5.1987	Heavy rain and snow from powerful Pacific storm: 1-2”+ in the northern Inland Empire, 2.20” at Chino. 1.68” at San Diego, Cuyamaca Park 2.73”, Julian 2.59”, Lemon Grove 1.52”, National City 1.40”, El Cajon 1.34”, Escondido 1.30”, Coronado 0.95” and Del Mar 0.80”.	Two died on slick roads in San Diego County. The San Diego River flooded Mission Valley, stranding cars and closing roads, including Friars Rd. Lots of street flooding in Pacific Beach, Sorrento Valley and Spring Valley near the Sweetwater River. Sewage spilled into Mission Bay. Road washouts in the high desert. Scattered power outages. Mud slides occurred on the Sunrise Highway. A mud slide in Pomona blocked traffic on the 60 freeway.
5.15.1987	The monsoon made a very early visit. Thunderstorms arrived in the mountains and deserts. 0.20 inch fell in Mt. Laguna.	
6.5-6.1987	Unseasonable thunderstorms hit LA County, mostly the Antelope Valley.	Flash flooding, power outages and lightning caused fires were the result. More than 500,000 were without power.
9.22-23.1987	Thunderstorms developed on this day and on 9.23 from San Diego to El Cajon from the remnants of Hurricane Norma. Rainfall was 0.55 inch in two hours at Lemon Grove and 0.97 inch total. 0.70 inch fell at Lindbergh Field, a record for the date.	Very frequent lightning caused numerous power outages and property damage, and ignited small fires. Lots of street flooding. Road washouts in the high desert.
10.5-12.1987	Heavy rain from Hurricane Ramon: 0.75” at coast, 2” in mountains, 2.14” at Camp Pendleton, 2.08” in Fallbrook, 0.69” at Lindbergh Field.	Scattered flooding and power outages. A Palomar Mountain fire was extinguished.
10.22.1987	Heavy rain with amounts ranging up to 5” at Blue Jay. Heavy rain also in northern San Diego County: 0.95” in Palomar Mountain.	Flash flooding resulted in 2 deaths, 10 injuries, and more than a million dollars damage in Blue Jay. Flash flooding and debris/mud flows in Pauma Valley (exacerbated by a previous fire on southwest slopes of Palomar Mountain). A building destroyed, 4 homes evacuated.

10.31.1987	Heavy rain. Mt. Wilson received 3.14" of rain in 24 hours. 2.34" in Mt. Laguna, 1.1" in El Cajon.	Numerous mudslides. 3 die and 25 are injured in weather-related auto accidents. Sewage spills closed an 80-mile stretch of beaches in LA.
11.4-5.1987	Low pressure of the California coast produces heavy rain and thunderstorms. 2.02" fell in Palomar Mountain and 1.16" in San Diego.	Numerous flooded roadways and intersections around San Diego. A roof collapsed in San Diego. Minor mud slides on I-8 at SDSU, Mission Valley and near Temecula. Flash flooding stranded 8,000 in Death Valley.
12.4-5.1987	A cold front crossing the Pacific Coast brought heavy rain. Mt. Wilson was drenched with 2.17" in 6 hours. 1.02" fell at LA between 5 and 7 pm and rain rates of 1" per hour were reported for a time at John Wayne Airport, and 0.61" fell in 30 minutes in San Diego all on 12.4. Storm totals: 1.5" in San Diego, 1.05" in Montgomery Field, 0.89" in La Mesa, 0.82" San Diego State Univ, Miramar 0.75", Chula Vista 0.32".	Flooding in downtown LA prompted some evacuations. Flooded intersections, power outages, tree damage, numerous traffic accidents. Flooding, including water into some houses, was reported in Fallbrook. More flooding was reported all across San Diego County, including downtown San Diego, where numerous motorists were trapped in their vehicles. A mudslide closed Valley Center Road and Lake Wohlford Road.
12.16-17.1987	A heavy rain storm hit San Diego County. 2.01" in Oceanside, 2" in El Cajon and La Mesa, 1.97" National City, 1.85" Poway, 1.73" Montgomery Field.	Minor flooding in Mission Valley.
2.2.1988	A dying subtropical system drops 4" in the mountains of San Diego County. More than 4" fell in Imperial Beach in 24 hours and 3.71" in 8 hrs. 1.5" fell in Chula Vista. 1.25" fell in San Diego and less than an inch fell in other parts of San Diego County.	Standing water 5' deep in some intersections. 50 homes in Imperial Beach flooded. Some homes flooded with 3-6' of water. $0.5 million in damage. 30 families displaced by flooded homes. Power outages, road closures.
4.15.1988	1.53" of rain in 24 hrs. at Death Valley. Normal for the season is 2.33" (1971-2000 normal). April average is only 0.12".	

4.19-23.1988	Heavy rain. 4.15” of rain fell in 24 hours at Mt. Wilson. 1.75” fell at Cuyamaca Rancho State Park on from 2.22 to 2.23. 0.79” at San Diego.	Flooding, mud slides, and numerous traffic accidents. 26 injured in major collision around LA. Flooding of intersections and several road closures occurred all over San Diego, Orange and LA Counties. A Mission Valley hotel was flooded. Los Penasquitos Creek flooded a portion of Poway. Street flooding occurred in southern San Diego County along with downed trees, power outages, and overflowed sewer lines. 3 straight Dodgers games rained out (only 12 rainouts in previous 26 years). Trees fell on power lines causing power outages.
12.16.1988	Strong Pacific storm. 2” in 6 hours during the early morning at Mt. Wilson and a storm total of more than 3.5”.	
8.7-11.1989	One of the most severe convective outbreaks of record in Southern California climaxed on 8.11.	
2.4.1990	Heavy rain in the San Bernardino area.	1 death from flooding.
6.9-10.1990	Rain and thunderstorms from Hurricane Boris. 0.37” at San Diego in 30 minutes, 1.41” Mt. Laguna, 0.98” Escondido, 0.87” Fallbrook. 0.49” fell in San Diego on 6.10, the wettest calendar day in June on record.	
2.27-3.1.1991	Series of storms produced 3-6” at lower elevations, 11-14” in the mountains. 9.58” at Palomar Mountain.	2 dead, 6 injured. Urban flooding, mud slides, and road washouts. Flood waters 5' deep at Desert Hot Springs.

3.17-22.1991	A vigorous storm produced 1-8” in lower elevations, up to 14” in the mountains. 4” fell in Santa Barbara. On 3.19 1.58” at Lindbergh Field in 24 hours. More than 1” in Poway, Alpine, Julian, Campo and Ramona. On 3.21 1.98” fell in La Mesa, 0.81” at Lindbergh Field.	Local flooding and mud slides. Mud and rock slides along Del Dios highway on 3.19. On 3.20 Hwy. 78 was closed for a long time due to flooding. Streets in Mission Valley flooded. On 3.21 mud slides, road washouts and power outages were reported at Rincon Indian Res.
3.26-27.1991	A strong winter storm produced 1.80” in 24 hours in Escondido, 1.71” in Poway, 1.56” in Fallbrook, 1.55” in La Mesa, 1.52” in Ramona, 1.48” in El Cajon, 1.09” in San Diego.	Golf courses and shopping centers flooded by the San Diego River in Mission Valley. Flooding damaged apartments in North Park. Flooding damaged Highway 78 east of the San Diego Wild Animal Park.
7.30-31.1991	Monsoon flow spawned thunderstorms that drenched the region. On 7.30, 0.77” fell in La Mesa, 0.58” in El Cajon, 0.56” in Santee, 0.33” in Balboa Park, 0.23” in San Diego Mission Valley and Lindbergh Field. On 7.31 Ocotillo was hit with 6” rain in two hours.	Part of a store and a house were flooded and buried in mud and sand. Imperial highway was washed out. On 7.30 Mobile homes were flooded in La Mesa and homes and streets were flooded in East City Heights and Mission Gorge. Trees downed, power outages.
12.27-29.1991	Back to back storms dropped 2-7” at lower elevations.	Flooding of low lying areas, mud slides, and closed highways.
1.5-7.1992	1-2” at lower elevations.	Flooding and mud slides.
2.5-16.1992	A series of many intense storms brought heavy rain. A total of 20”+ in the mountains and 8-16”+ at lower elevations.	2 killed in avalanche at Mt. Baldy. Flash flooding, mud slides, and road closures.
3.1-7.1992	A series of storms brings 1-4”.	Local flooding.
3.20-23.1992	A series of storms brings 1-5”.	Local flooding.
4.1.1992	Heavy rain from thunderstorms. 3” in less than 1 hour at Escondido.	Flash flooding.

8.13.1992	Massive outbreak of tropical moisture created thunderstorms with some of the heaviest rainfall rates in history. 6.5” in 90 minutes at Palomar Mountain, 4” in 2 hours at Mt. Laguna.	
12.4-7.1992	Big storm produces 0.5-6” from the coast to the mountains.	Local flooding. Mud slides, standing water, and road closures.
1.1993	Subtropical moisture joined a strong upper level low in the Pacific. A series of storms produced 20-50” of precipitation in the mountains and up to 12” at lower elevations over a two week period (1.6-1.18). One of the longest periods of consecutive days of rain on record (13) and measurable rain fell nearly every day from 1.2 to 1.19.	Flooding and flash flooding, mud slides, etc.
1.5-10.1993	14+” of rain fell in Cuyamaca and Palomar Mountain. 6+” in Escondido.	The State declared San Diego County a disaster area.
1.12-18.1993	A second stormy period in the month dropped 18+” at Palomar Mountain, 12+” at Cuyamaca and De Luz. 11.62” fell at De Luz in 48 hours on 1.16-1.17.	Heavy flooding occurred on the Santa Margarita and San Luis Rey Rivers. Hwy. 76 was washed out near I-15. The airports at Camp Pendleton and Oceanside sustained flood damage. In Tijuana, homes and streets were flooded along the Tijuana River. 5 died and 139 people were caught in floodwaters, 600 were evacuated.
2.7-10.1993	1-5” near the coast, up to 10” in the mountains, 0.5-1.5” in the deserts.	Widespread flooding.
2.18-20.1993	Heavy rain: 9” at Palomar Mountain, 6+” at Cuyamaca, 1-3” at the coastal areas and valleys of San Diego County.	Flooding from Oceanside to Encinitas. Homes damaged along Mojave River in Hesperia.
3.25-26.1993	Heavy rain.	Local flooding, mud, debris, and road closures in Orange County.

6.5.1993	A strong, late season spring storm moved into California. The 0.76” of rain at LA set a new daily rainfall record for June. Lake Gregory was deluged with 3.24” of rain. 1” in Palomar Mountain.	
8.25-26.1993	Rain and thunderstorms from Hurricane Hilary. 3-4” in two hours from heavy thunderstorms in the San Bernardino Mountains, Morongo Valley, and Desert Hot Springs.	Flash flooding in Yucaipa and Morongo Valley.
1.3-4.1995	Heavy rain.	Flash flooding in Seal Beach, Norco, and Oceanside.
1.10-11.1995	Heavy rain.	Extensive flooding in Orange County.
1.14.1995	8-9” in northern Inland Empire.	Extensive flooding in Yucaipa. Many roads closed.
2.14.1995	3” of rain fell in San Diego County.	The San Diego River overflowed onto adjacent streets in Santee, forcing some residents to evacuate their homes. In eastern San Diego, heavy rains flooded some homes. One woman drowned in her basement when it became submerged with 5’ of water.
3.4.1995		The La Conchita mud slide (near Santa Barbara) destroyed nine houses within a few seconds.
3.5-6.1995	6” in 24 hours, 10.34” in 48 hours at Idyllwild. 8.57” in 24 hours and 14.58” in 48 hours at Palomar Mountain.	Floodwaters washed out a stretch of I-5, closing it for over a week. The overall toll from a series of Pacific storms: 27 killed, $3 billion in damage. 10,000 homes were damaged.
3.11.1995	3.07” at Banning - Beaumont, 2.75” at Murrieta, 2.10” at Moreno Valley, 1.23” at Riverside, 0.84” at Palm Springs, 7.73” at Wrightwood in 48 hours.	Section of I-5 washed out, lots of local flooding.

2.25-28.1996	0.5-1.5” in coastal areas.	
12.21-22.1996	2” in coastal areas, 2-5” in inland valleys and foothills.	
1.12-13.1997	1-3” in coastal areas and valleys.	
2.23-24.1997	Heavy rain.	Widespread flooding in coastal cities and Inland Empire. Homes stranded in De Luz. Cliff erosion in Del Mar and Solana Beach.
9.2.1997	Thunderstorm at Pine Cove drops 3.7” in one hour.	
9.4.1997	Hurricane Linda became the strongest storm recorded in the eastern Pacific with winds estimated at 180 mph and gusts to 218 mph. For a time it threatened to come ashore in California as a tropical storm, but the storm turned away, affecting the region with added moisture for showers and thunderstorms. This occurred during the strong El Niño of 1997-98. 2.5” per hour rain rates were recorded at Forest Falls.	Disastrous flooding and debris flows at Forest Falls: $3.2 million damage, 2 houses destroyed, 77 damaged, car-size boulders, wall of mud 150' wide and 15' tall. Flooding damage also at Oak Glen.
9.24-26.1997	Heavy rain and thunderstorms from Hurricane Nora. 5.50” at Mt. San Jacinto, 4.70” Mt. Laguna, 4.41” Mt. San Gorgonio, 3-4” at several locations in mountains, 3.07” Twentynine Palms, 1.5-2” at Coachella and Borrego Valleys, 2.88” Hemet, 1-2” in many inland areas.	Flooding in Palm Springs, Borrego Springs and Spring Valley. Traffic deaths.
10.7.1997	Heavy rain in Inland Empire. Storm was of 100 year intensity. 1.65” in 1 hour and 15 minutes, 0.31” in 3 minutes at Hemet.	Floods and debris flows. $2.5 million damage. Large trees, mud and boulders swept down canyons. Homes, apartments flooded at north San Bernardino and Highland.

12.6-8.1997	Heavy rains of 4-8" across Orange County, heaviest in 70 years. 10" at Mission Viejo, over 4" Corona. Heavy downpours in Victor Valley.	Widespread flooding in Orange County. Mud slides and coastal erosion. Flooding in Corona and several communities of Victor Valley. Mud flow through Adelanto.
1.8-10.1998	Heavy rain of 2".	Floods and mud in Del Dios (near Escondido).
2.3-4.1998	Heavy rain of 3".	Flooding, mud slides, power outages.
2.6-9.1998	Heavy rain. Up to 3" rainfall over all of Southern California.	Catastrophic and widespread flooding, especially in Newport Beach and Irvine. Lots of property damage in southern Orange County. Evacuations and swift water rescues. Landslides, mud slides, and sink holes. Roads, bridges, and railroads damaged.
2.14-15.1998	1-2" in coastal areas, 3-5" in valleys and foothills.	Flooding and mud slides.
2.23-24.1998	Heavy rain. 2-5" rainfall over all of Southern California.	2 dead, 2 injured. $100 million estimated damage. Power outages. Catastrophic and widespread flooding. Hundreds of homes damaged. Numerous evacuations and swift water rescues. Landslides, mud slides, and sink holes. Roads, bridges, and railroads damaged. Livestock and crop loss.
3.25.1998	3.5" in 4 hours at San Clemente.	Flooding.
5.12.1998	Rain in San Diego.	First rain-out of a San Diego Padres game in Mission Valley in over 15 years.
7.20.1998	Heavy thunderstorms. 1.11" fell at Cuyamaca.	Flooding at Mission Beach and Barton Flats in San Bernardino Mountains.
8.12-14.1998	Strong thunderstorms in Apple Valley.	Flash flooding.

8.29-31.1998	Strong thunderstorms. 0.77" in 45 minutes at Wrightwood, 1.5" at Apple Valley, 0.68" in 30 minutes at Forest Falls.	Flash flooding in Hemet. Homes and roads flooded with 4 to 6" of water in Hesperia and Apple Valley. Rock slides in Mill Creek. Flooding of roads in Sugarloaf and Forest Falls.
7.8.1999	Heavy thunderstorms.	Flooding in San Jacinto, Palm Springs, Cathedral City, and Palm Desert.
7.11-13.1999	Heavy thunderstorms in and around the higher mountains. 1.65" in less than 30 minutes at Lake Henshaw, 1.57" in 20 minutes at Big Bear City, 1.40" in 30 minutes at Sugarloaf, 1.6" in 85 minutes at Forest Falls, 1" in 1 hour at Pine Cove, 1" in 25 minutes at Shelter Valley. 1" per hour rain rate at Phelan. 1.8" in 25 minutes at Forest Falls again on 7.13.	2 dead, dozens injured, 6 homes destroyed, many more damaged, 20' high wall of water moving at 45 mph moving 70-ton boulders at Forest Falls. Buildings washed away at Jenks Lake. Disastrous flooding and mud slides at Oak Glen, Big Bear City, and Apple Valley. Flooding in Yucca Valley area, Beaumont area and Palm Springs. Roadways closed due to flash flooding.
7.21.1999	Heavy thunderstorms near Borrego Springs.	Flash flooding damage at Borrego Springs and Ocotillo Wells.
2.10.2000	Heavy rain.	3 killed, 8 injured from flooding and mud slides.
2.21-23.2000	Heavy rain.	Lots of flooding, mud slides. Roads washed out in Hemet.
4.17-18.2000	Up to 2" at lower elevations.	
6.21.2000	Heavy rains (about one inch) at La Jolla Indian Reservation near Palomar Mountain on a recently burned area.	Flooding and mudslides along Hwy. 76. 200' of highway covered by up to 18" of mud.
8.24.2000	Thunderstorm drops 0.76" at Palomar Mountain.	Mudslide closes Highway 76.
8.29.2000	Desert thunderstorms: 1.5" in 45 minutes at Borrego Springs.	Flash flooding, mud in homes, roads damaged in Borrego Springs area. Flash floods, mud, and debris covered roads from Yucca Valley to Palm Springs and Oasis.

9.7.2000	Heavy thunderstorm in Morongo Valley.	Flash flooding.
1.10-11.2001	Heavy winter storm. Two to four" of rain. 1.74" of precipitation (some snow) at Phelan.	Flash flooding from Seal Beach to Garden Grove to Costa Mesa. Several mud slides in San Diego County
2.11-13.2001	Heavy winter storm. 2-5" at Orange County and the western Inland Empire. 1-2" over the rest of the lowlands.	Extensive urban flooding and mud slides. Trees and power lines knocked down.
7.6.2001	Strong thunderstorms in eastern Coachella Valley.	Roads inundated. Damage and erosion around Oasis.
7.7.2001	Strong thunderstorms in Victor and Lucerne Valleys. 0.25" in five minutes at Lucerne Valley.	Roads closed due to flash flooding, mud slides.
9.2-3.2001	Thunderstorms generated from remnants of Hurricane Flossie. 2.1" in 1 hour at Lake Cuyamaca.	Flash floods and mud slides in the San Bernardino Mountains and Lake Cuyamaca.
9.30-10.1.2001	Thunderstorms in mountains and inland valleys.	Flooding in Beaumont.
2.11-14.2003	Heavy rain: 10.15" at Forest Falls, 9.75" Lytle Creek, 8.47" Lake Arrowhead, 7.60" Santiago Peak, 6.86" Mira Loma, 5.15" Wrightwood, 3.95" Hesperia, 3.87" Lake Elsinore, 3" Lindbergh Field.	Localized flooding.
8.1.2003	Thunderstorms in Borrego Valley. Estimated 2.5-3" rain in 2 hours.	Flash flooding: 4 ft of water running in San Felipe Wash. 1 car and family stranded in Borrego Palm Canyon. Half of Ocotillo Wells Airport runway inundated, debris on Hwy. 78.
8.20.2003	Thunderstorms. 3" at Yucca Valley, 2.63" in 1 hr, 7 min. at San Felipe Valley, 1.92" in 2 hours at Ocotillo Wells.	Flash Flooding. 5 residences flooded in Yucca Valley. 3 dead and 2 swift water rescues from trapped vehicles in 29 Palms. Numerous washes flooded. Hwy. S2 near Warner Springs closed to flooding.

8.24.2003	Thunderstorms. 2” at Pine Valley in 35 min.	Flash Flooding east of Alpine and in Pine Valley.
8.25-27.2003	Thunderstorms in the mountains.	Flooding closes Hwy. 38 in Big Bear City, roads near Guatay, routes S2 and S22 near Ranchita, Hwy. 78 east of Julian (rock and mud slides), streets in Borrego Springs and Campo.
9.2-3.2003	Thunderstorms in mountains and deserts. Rain rates over 1 inch per hour with many of them.	Flash flooding and roadways flooded in Lake Henshaw area, Palm Canyon near Palm Springs, Yucca Valley, Idyllwild, Santa Ysabel, Mt. Laguna and Borrego Springs.
11.13.2003	A thunderstorm dropped 5.3 inches of rain and hail in the Watts, Compton and South Gate area of Los Angeles. The hail accumulated more than a foot deep in spots.	Flooding damaged dozens of homes, schools and hospitals and some roofs collapsed under the hail. Hundreds of motorists were stranded and power was knocked out to more than 100,000 homes and businesses. Residents shoveled hail and slush from streets.
12.25.2003	Heavy rain. 8.58” at Lytle Creek, 5.79” Devore, 5.59” Santiago Peak, 5.40” Forest Falls, 3.94” Volcan Mountain. 0.35”-2.5” fell at lower elevations.	15 dead in mudslides in areas burned by wildfires in Oct 2003: 13 in a church camp in Waterman Canyon north of San Bernardino, 2 in a campground in Devore.
8.13-14.2004	Monsoon thunderstorms produced 0.71” in 30 minutes in Phelan, 0.63” in 8 minutes at Volcan Mountain (north of Julian), 0.66” in 11 minutes in San Felipe Valley (south of Borrego Springs).	Flash flooding. On 8.13 flash floods in Wildomar, Sage, and La Quinta. Hwy. 78 near Yaqui Pass closed. On 8.14 severe flash flooding of homes in Spring Valley Lake (Victorville) and Hesperia. Vehicles trapped in 5’ water. Water 8’ deep inundated a railroad causing major delays (a 60 train backup extending to Cajon Pass).

8.15.2004	A thunderstorm dropped 1-2" of rain on Death Valley in a short time.	Flash flooding and debris flows along Hwy 190 killed 2 in a pickup truck that was washed off the highway. About 3 miles of road was totally washed away and the National Park was closed for 10 days. 13 miles of Hwy 190 was closed nearly 9 months for repairs to 13 miles of damaged roads.
9.10-11.2004	Thunderstorms in Borrego Palm Canyon produced a wall of mud 8-10' high and 150 yards wide. Training thunderstorms over Johnson Valley.	Severe flash flooding. In Borrego Springs 70-90 homes damaged, a campground was washed out and major damage occurred at a golf course. In Johnson Valley, Hwy. 247 was washed out in numerous sections. Minor damage to homes.
10.20,27.2004	Monthly record rainfall received in one day, and in 6 hours in many locations of Orange Co. Totals for last two weeks of Oct: 4-8" in lower elevations, up to 14" at Lake Arrowhead. 2.70" fell at Lindbergh Field, the fourth most on a calendar day on record.	On 10.20: Widespread flooding. Bridge washed out near Wrightwood. One killed in floodwaters near Lytle Creek. Many mountain roads impassable with mud and rockslides. Railroad tracks washed out, derailing train. Horses neck deep in flood waters. Golf course rescue. 10.27: 7 rescued from vehicles in flooded intersection in Sun City. 12 vehicles trapped in mud at Scissors Crossing (east of Julian). Homeless man rescued in San Diego River. Several vehicles stuck in San Jacinto River floodwaters near Perris.
12.28-29.2004	Heavy rain from a big storm. 1.10 in 40 minutes at San Diego Country Estates (east of Ramona).	Flash flooding in Waterman Canyon and other mountain areas. Debris flow in San Diego Country Estates. Flooding on Lytle Creek road and Hesperia.
12.31.2004	Mud slides occurred on Hwy. 138 and on Hwy. 18 in the San Bernardino Mountains.	Hwy. 138 closed for three days.

1.7-11.2005	Five consecutive days of heavy precipitation all over Southern California. More than 30” of precipitation in the San Bernardino Mountains. 4-10” at lower elevations. 31.75” of precipitation fell at Lake Arrowhead, 29.70” at Lytle Creek, 19.86” at Devore, and 15.09” at Palomar Mountain. This followed heavy storms in late Dec and early Jan.	Widespread and catastrophic flooding and damage totaling $100 million. A mountain slope failed on top of La Conchita. Damage to crops, golf courses, and there were sewage spillages. A state of emergency was declared for all four counties. On 1.10 a woman and her unborn child were swept away by City Creek in Highland and killed. Debris flows in City Creek. Lytle Creek grew to 200’ wide and flooded homes. 350 homes were flooded in Placentia. Numerous rescues needed across the region. Debris flows across I 215 in Devore. In Big Bear City, 111 homes, schools and businesses were flooded. On 1.9 mudslides destroyed three homes, damaged 7 others in Lake Arrowhead area. Mudslides in Anaheim caused damage. I-15 in Temecula damaged and closed by mudslides and flooding. Ortega Highway closed. Homes were flooded in southern Inland Empire and Valley Center. San Luis Rey River flooded and washed out Pacific St. in Oceanside, cresting above flood stage twice, peaking at 20.7’ on 1.11. On 1.11 a hotel in Crestline was destroyed by mudslide. A tree killed one in San Diego. Felled trees caused extensive damage in San Diego County. By 1.11 numerous highways in the San Bernardino Mountains were closed. The Mojave River flooded 3 homes and other structures, and caused extensive damage in Hesperia and Oro Grande. On 1.14 a forced release of water at Prado Dam flooded the Santa Ana River valley and damaged the Corona Airport.

2.18-23.2005	Heavy storm rains dumped 3-6" near the coast and valleys, 6-12" in the mountains, more than 2" in the deserts. 18.79" fell at Lytle Creek, 12.33" at Lake Arrowhead and 6.80" at Fullerton.	Dairy Farm losses in the northern Inland Empire. Most back roads damaged in the San Bernardino Mountains beyond use. Lake Hodges, which was only 17% of capacity in October, began to spill. San Diego River flooded, killing one. On 2.21 an earthen dam near Wrightwood gave way, flooding and causing extensive damage downstream. Numerous mudslides across the region damaged many homes. A landslide sent boulders into a home in Silverado Canyon and killed one.
6.1.2005	An enormous landslide occurred in Laguna Beach. Caused by saturated soils from the previous winter's epic rains.	15 homes were destroyed or severely damaged. Minor injuries. $27 million estimated damage.
7.23.2005	Thunderstorms produced rain rates in Hemet of 1.5" in 30 minutes, and 1 inch in 15 minutes.	Flash flooding in Hemet area. Residences and businesses were flooded.
7.24.2005	Heavy thunderstorms hit the mountains and deserts. 2.30" fell in Mt. Laguna in 40 minutes. 0.72" fell in Cuyamaca in 36 minutes. 5.58" fell in 12 hours in Victorville.	Flash floods hit Lucerne Valley and highway 247. Vehicles swept off roads and rescues needed. Roads washed out in Apple Valley. Three major mud slides hit Forest Falls. Flash flooding also in Phelan, Hemet, and east of Julian.
7.29.2005	Intense rain from thunderstorms hit the mountains and deserts. 0.91" hit Mt. Laguna in 28 minutes, 0.63 in 14 minutes. 0.5" hit San Felipe Wash in 10 minutes.	Flash flooding was reported in the Mt. San Jacinto Wilderness, also in Ranchita and Warner Springs.
7.30.2005	Intense thunderstorms hit the mountains and deserts.	Flash flooding in the wilderness area of Mt. San Gorgonio, Barton Flats, Lucerne Valley and Idyllwild. The Banning airport was flooded.

7.31.2005	Thunderstorms produced 0.52” in 13 minutes fell at Lake Morena. 0.75” fell in 22 minutes at Yucaipa Ridge.	Flash flooding occurred in Big Bear City, Anza, and south of Warner Springs.
6.28.2006	A heavy thunderstorm produced 1.25” in 15 minutes at Loma Tova, just south of the border east of Tecate.	Visibility was reduced to near zero in the heavy rain along Interstate 8.
7.7.2006	Thunderstorms dropped 0.75” in 15 minutes and 1.22” in 40 minutes at Yucaipa Ridge.	Flooding occurred along some Mill Creek tributaries. Mud and rock debris covered parts of Valley of the Falls Drive.
9.2.2006	A thunderstorm near Pinyon Pines dropped 1.14” in 30 minutes.	Flash flooding occurred in Pinyon Flats, eroding roads. Mudslides trapped several vehicles on Hwy. 74.
9.3.2006	A microburst hit northeast of Sun City.	Power lines and poles were knocked down. Power outages resulted.
9.4.2006	A thunderstorm dropped heavy rain along the Elsinore Convergence Zone.	Significant mudslides (debris flows) occurred in north San Jacinto, trapping 19 vehicles. A few homes and businesses were damaged.
9.6.2006	Heavy thunderstorms occurred along the Elsinore Convergence Zone near Hemet.	Flash floods closed roads in Hemet, cars were stalled, a mudslide along Hwy. 74.
10.13.2006	A thunderstorm dropped 0.51” in 5 minutes and 1.81” in 30 minutes in San Bernardino.	18 homes and businesses and two vehicles were damaged by flooding. Big sinkholes were left in a road. One swift water rescue. Mud and debris were left on roads.
3.22.2007	A strong thunderstorm caused erratic winds over Lake Henshaw.	Three elderly fisherman lost their lives on a boat in Lake Henshaw.
7.25.2007	A late night thunderstorm dropped heavy rain in Indio Hills.	A flash flood damaged Dillon Rd. A family of seven needed a rescue.

8.26.2007	Remnants of Hurricane Dean produced thunderstorms and heavy rain in the morning, then again in the afternoon. In Escondido nearly 2 inches fell in less than 90 minutes in the morning.	Flash flooding occurred near Borrego Springs and Ocotillo Wells, rendering several roads impassable. Several park visitors were trapped near the Borrego Badlands.
11.30-12.1-2007	Heavy rain from cutoff low with a tropical connection. Up to six inches of rain fell on Palomar Mountain and Forest Falls.	A debris flow (including large trees) over the Poomacha Burn area buried a house in mud, caused serious damage to several vehicles and highway 76. The flow was estimated at 15 feet high, 150-200 feet wide.
1.27.2008	Heavy rain hits the region.	Several debris flows were triggered in the Poomacha and Witch Creek burn areas. Portions of highways 78 and 76 were closed.
5.22.2008	Heavy rain from thunderstorms was produced by a very cold and unstable storm from the north.	Several debris flows occurred. In the Santiago burn area of eastern Orange County, damage was done to homes and businesses. 28 residences were flooded and damaged in northeast Moreno Valley. Minor damage occurred in the Witch Creek burn area around Ramona.
7.20.2008	A rare early morning thunderstorm hit the Coachella Valley. On the edge of the storm in Cathedral City, 1.25” in 30 minutes fell.	15 to 20 businesses and several homes were damaged at a trailer home park. Highway 111 was closed because of mud and rocks.
8.30.2008	Heavy thunderstorms struck the San Jacinto Mountains and near Forest Falls.	Flash floods up to 3’ deep carried rocks and mud and covered many roads in Idyllwild-Fern Valley.
2.5-10.2009	A strong cold front produced heavy rain across Southern California. 2 inches fell near the coast and up to 6 inches fell in the foothills.	On 2.5, flash flooding occurred near La Habra Heights. One foot of water flooded Highway 60 near the Hacienda exit.

9.2.2009	A strong thunderstorm produced 0.55 inch of rain in 24 minutes in Moreno Valley. Heavy thunderstorms moved through northern San Diego County, with over an inch reported in Ramona and San Diego Country Estates.	Minor flash flooding resulted in Moreno Valley. Four inches of mud and water was reported on Highway 78 near Witch Creek.
9.5.2009	A nearly stationary thunderstorm with heavy rain and strong winds occurred near the town of Ocotillo Wells. A dew point of 75 was observed with a temperature of 105. According to radar data, storm tops exceeded 60 thousand feet and golf ball size hail was possible. This massive desert storm could be easily seen from the coast.	Flash flooding near Ocotillo Wells along Fish Creek Wash and Split Mountain Road. 16 downed power poles along Split Mountain Road.
1.18-22.2010	A very wet and dynamic series of storms dropped two to four inches of rainfall in the deserts, to four to eight inches west of the mountains, to six to 12 inches on the coastal slopes.	Widespread flooding resulted across the region. Some of the worst flash flooding occurred in the high desert on the 1.21 due to the prolonged heavy rainfall. Scores of homes and several schools sustained damage, and many roads were washed out in Hesperia, Apple Valley, Victorville and Adelanto. Numerous swift water rescues were needed, one of which likely saved four teens trapped in a storm water drain. Two deaths in Tijuana were attributed to the flooding.
8.25.2010	Powerful thunderstorms hit Forest Falls and Hemet with heavy rain.	Flash floods resulted.
8.26.2010	Powerful thunderstorms hit Wrightwood and Warner Springs with heavy rain.	Flash floods resulted.

12.17-22.2010	A very wet period developed as strong westerly flow across the Pacific tapped a pool of deep subtropical moisture near Hawaii, resulting in days of moderate to heavy rainfall. Four to 12 inches of rain fell in the coastal and valley areas over six days, 12 to 28 inches in the mountains, up to 9 inches in the high desert and less than 4 inches in the lower desert.	Major landslides and flash flooding impacted the communities of Laguna Beach, Apple Valley, along the Whitewater Channel in the Coachella Valley near Palm Springs, Highland, Corona, Loma Linda, La Jolla, and the city of San Diego from 12.21 to this day. Qualcomm Stadium was flooded, but was miraculously drained and prepared for the Poinsettia Bowl held there on 12.23.

Heavy Snow, Rare Snow at Low Elevations

Date(s)	Weather	Adverse Impacts
12.1847	Light snow in hills above Old Town San Diego. Greater amounts to the east.	
1848	Snow fell “to the depth of several feet, and covered the plains for a long time.” (referring to the San Bernardino Valley).	“Several thousand head of cattle were destroyed.”
1.30-2.3.1873	44” snow fell in Grass Valley (Lake Arrowhead).	Residents quickly made snowshoes.
1.12-14.1882	15” at San Bernardino. 3' in Campo over four days producing 8’ drifts. 25” in outlying San Diego, including: 4” along Poway Grade, 3” at El Cajon, 1” Poway (disappearing in a few hours). The foothills above Poway stayed white for 2 or 3 days. Light snow in Del Mar. 5” in Riverside. 20” in Campo on 1.13. Snow flakes, but not sticking at San Diego.	Birds and livestock killed, telegraph lines down. Citrus damage.
2.28.1891	18” at Big Bear Lake.	
2.1901	A blizzard dumped 6’ of snow and piled up drifts 8’ deep in Campo.	
1.10.1907	A warm rain fell on deep snow at Big Bear Lake. Four feet of snow remained and then froze again.	Trees were loaded with ice, snapping in the wind. Large Oaks and Cedars were downed. Telephone lines broke at every span.
4.21-22.1908	0.6” fell in Santa Ana, the greatest snowfall on record.	
11.27.1919	Snow brought a white mantle to area hills and valleys around San Diego. 8” in Morena 8”, 5” at Carrizo Gorge, and 4” at Warner Springs.	
1.11.1930	2” at Palm Springs.	

1.15.1932	Up to 2" snow all over the LA Basin (called the heaviest on record). 1" at LA Civic Center and beaches at Santa Monica whitened. 18" in Julian, 17" at Mt. Laguna, 14" at Cuyamaca, and 6" at Descanso.	
1.21.1937	Snow flurries at San Diego. Trace amounts stuck to northern and eastern parts of the city.	
2.21.1944	A heavy snowstorm struck the San Bernardino Mountains.	Several snow slides, some 50 to 60 feet high, obliterated parts of the Rim of the World Highway.
2.11.1946	Snow flurries in many parts of San Diego.	
1.9-11.1949	Snow in lowlands: 14" Woodland Hills, 8" La Canada and Catalina Island (2,100'), 6" Altadena, 5" Burbank, 4" Pasadena, 1" Laguna Beach and Long Beach.. A trace in San Diego, the only time since 1882. 3' Mt. Laguna, 18" Cuyamaca, 1' Julian, 4-8" as low as 1000' elevation. A light covering in La Jolla, Point Loma, Miramar, Escondido, Spring Valley, and other outlying San Diego areas, even El Centro.	Snarled all kinds of transportation. Power outages and emergencies. Plane crash kills 5 and injures 1 near Julian. Camping group stranded at Cuyamaca.
1.13-18.1952	Heavy snow in several waves hit the San Bernardino Mountains. 40" fell in Lake Arrowhead (with a snow depth of 46"), 37" in Big Bear Lake.	All mountain roads were blocked and closed because of snow slides.
4.13.1956	A cold snowstorm brought 1' to Mt. Laguna, at least 6" at Palomar Mountain, 1.5" at Julian.	
1.29.1957	24" at Mt. Laguna, 21" at Palomar Mtn., 20" at Lake Cuyamaca, 12" at Julian, 10" at Mesa Grande, 6" at Lake Henshaw.	The snowstorm stranded 200 people north of LA.

1.20-22.1962	A big snow storm extended to lower elevations, producing two inches in Victorville, Barstow and Yucaipa. 27 inches fell in Big Bear Lake and 24 inches in Lake Arrowhead.	Highways closed.
12.9.1963	Heavy snow in the mountains.	5 killed, 6 injured. Highways blocked.
1.20-21.1964	17 inches of snow fell in Big Bear Lake and Idyllwild.	Heavy snows closed schools and roads.
3.22-24.1964	Big snow storm. Totals: 29" in Idyllwild (22" on 3.24), 26" at Lake Arrowhead, 23" at Palomar Mtn., 18" at Big Bear Lake.	
4.7-11.1965	A strong late-season storm dropped heavy snow in the mountains, including 50 inches in Lake Arrowhead, 24 inches in Idyllwild, and 13 inches in Palomar Mountain.	Mountain roads were closed.
1.21-25.1967	Two back to back storms brought 24" at Big Bear Lake, 20" at Lake Arrowhead, and 8" at Idyllwild and Palomar Mountain.	Roads were closed for a time.
3.11-14.1967	Heavy snow in the mountains, up to two feet fell in Big Bear Lake. But only one inch at Lake Arrowhead and Idyllwild.	Highways closed.
12.13-19.1967	50" at Mt. Laguna in 24 hours on 12.18 and 12.19, 38" Idyllwild, 2' Palomar Mountain, 12-18" in higher elevations. 6" Temecula, 5" Fallbrook, 4.5" Anza Borrego State Park, 3" Borrego Springs, 2" Carlsbad on 12.13. Light covering over many San Diego mesas. Mt. Laguna recorded an 8 day total of 96.5".	1 freezing death. Numerous schools and highways closed. Transportation disrupted and chains were required on Hwy. 395 just north of Mission Valley. Power outages.
2.20-25.1969	Heavy snow in mountains approach greatest depths on record.	
11.25-30.1970	A series of storms dropped up to 18" in the San Bernardino Mountains.	

12.17-22.1970	A series of storms dropped heavy snow in the San Bernardino Mountains. 32" fell in Idyllwild, 28" in Big Bear Lake, 26" in Palomar Mountain, and 24" in Lake Arrowhead.	
12.26-28.1971	A series of heavy storms started out warm on previous days, but then turned colder to produce up to two feet of snow at Lake Arrowhead, 20" at Palomar Mountain, 15" at Big Bear Lake, 13" at Idyllwild, and 6" at Cuyamaca.	Snow closed the Morongo Pass at Yucca Valley for a time.
3.11.1973	8" fell at Mt. Laguna and 4" at Palomar Mountain.	
1.3-5.1974	Over 18" in San Bernardino Mountains. 17" fell in Victorville on 1.5, the greatest daily amount on record. On 1.4, flurries were reported in Palm Springs.	Structures and a few roofs collapse due to weight of snow. Power lines and trees snapped.
11.28-29.1975	First winter storm of season was heavy. Up to 2' in San Bernardino Mountains, 16" at Big Bear Lake.	20 stranded campers rescued after a few days.
3.2-4.1976	20" at Running Springs.	
1.30-2.2.1979	Widespread snow. 2" at Palm Springs. 56" fell in Big Bear Lake, the greatest snowfall on record. On 1.31, snow fell heavily in Palm Springs and 8" fell at Lancaster. Snow and rain mix at Borrego Springs. Mt. Laguna 2' and Julian 1'.	On 1.31, all major interstates into LA (I-5, I-15, and I-10) were closed. Snow drifts shut down Interstate 10 on both sides of Palm Springs, isolating the city. Schools were closed and hundreds of cars were abandoned.
11.27-28.1981	3' at Big Bear Lake.	
3.18.1982	25" at Palomar Mountain.	
2.18-19.1984	Up to 16" in the mountains.	
12.18-19.1984	A major snowstorm brings up to 16" to the mountains and upper deserts, including 13" to Lancaster.	Edwards AFB and Interstate 5 (from Castaic to the San Joaquin Valley) were both closed.
12.28.1984	A rain and snow mix fell in Borrego Springs.	

2.2.1985	Up to 2” snow in Palm Springs.	
3.2.1985	Snow fell briefly in Escondido. Ice pellets fell in Poway, Coronado, La Mesa, and Escondido, with hail in Linda Vista and downtown San Diego.	
11.11-13.1985	A cold, slow-moving storm dropped 14” in Mt. Laguna, 5” in Julian and through the San Gabriel Mountains, and snow fell as low as Alpine (1800’).	Interstates were closed for a time.
12.10-11.1985	A cold storm brought heavy snow to the mountains and light snow to lower elevations. 17” in Mt. Laguna, 15” in Julian, 12” in Palomar Mountain, and up to 4” in Victorville and Warner Springs.	Highways and schools were closed in the mountains and in parts of the upper desert.
3.15-16.1986	3' in the San Bernardino Mountains.	
10.3.1986	Rain and thunderstorms hit LA area. 1.50” in Pasadena, 1.02” in LA. 3” of hail piled up in Pasadena.	Classes were cancelled at CSU-Northridge because of hail. Several serious traffic accidents in Pasadena.
1.4.1987	A ski resort in Big Bear received up to 2’ of snow at the higher lifts. Up to 15” occurred elsewhere in the San Bernardino Mountains. 9” in Mt. Laguna, 4” in Cuyamaca Park and a few inches in Julian.	
2.22-25.1987	24” at Mt. Laguna, 22” at Cuyamaca, 12-17” in the San Bernardino Mountains (17” at Big Bear Lake), 6” Pine Valley, 3” Lake Morena. 4” fell in one hour at Lake Hughes. Snow pellets to coastal areas: 2-3” at Huntington Beach, measurable sleet and hail at San Diego Bay front. On 2.25 light snow was recorded in Tarzana, Northridge, Torrance, Fontana and Redlands.	Roads and schools were closed in mountain areas. An aircraft accident in a snow squall near Anza killed four.

12.16-17.1987	Snow fell for two minutes at Malibu Beach on 12.16. A foot of snow fell in the mountains north and east of LA. 24” of snow fell in Julian. 9” of snow fell at Mt. Laguna on 12.17.	Disneyland was closed due to the weather for only the second time in 24 years. Other theme parks and I-5 and I-15 were closed on stretches through the mountains stranding motorists in the Southland. Numerous accidents killed some motorists. Snow cancelled all schools in the mountains of San Diego County and sent 16,000 students home in the Santa Clarita Valley.
12.24.1987	Snow flurries over the entire San Diego metro area, but not a flake officially at San Diego. Heavy snow in the Laguna Mountains.	
1.17-18.1988	14” at Mt. Laguna.	
2.7-9.1989	Snow at the beaches in LA to the desert in Palm Springs. 15” in the mountains. 3” at Palmdale.	Major road closures. Numerous traffic accidents.
1.16-17.1990	Snow flurries within San Diego city limits. None officially at San Diego. 14” at Mt. Laguna. 10-16” in mountains.	
2.4.1990	10-13” in the mountains.	
2.14.1990	Snowflakes reported all over the San Diego metro area.	
2.16-18.1990	3-4' in the mountains. 48” at Green Valley and 46” at Big Bear Lake.	Avalanche at Wrightwood buries 10 hikers, injuring 1.
2.27-3.1.1991	Back to back storms dump 2-3' in the Big Bear area, up to 2' elsewhere in the mountains.	Highways closed.
3.17-20.1991	2-5' in the mountains. On 3.19 1’ of snow fell at Mt. Laguna, 6” at Palomar Mountain and Cuyamaca.	Schools and roads closed in the mountains, including I-8 from Alpine to Imperial County. Downed trees and power outages.

3.26-27.1991	36” at Lake Arrowhead, 27” Big Bear Lake, and 18.5” Idyllwild. 18” fell at Mt. Laguna.	An avalanche of snow isolated 100 people in Big Bear Lake by blocking Highway 18.
1.5-7.1992	6-20” in the mountains, 2-8” in foothills and high desert floors.	
12.4-7.1992	6” to 2' in the mountains.	
2.7-10.1993	8-18” in the mountains.	
1.3-4.1995	6-12” in the mountains. Snow in the high desert: 2” of heavy, wet snow at 2300'.	
3.11.1995	Over 20” at Bear Mountain.	
12.23.1995	12” in the San Bernardino Mountains, 8” on the high desert floors.	
1.22-23.1996	12” above 4000'.	
2.25-28.1996	10” at Idyllwild, 2” Yucaipa, a dusting at Hemet and Corona. 1-2' in mountains, up to 6” in high desert.	
3.12-13.1996	8-12” in the San Bernardino Mountains.	
1.12-15.1997	18” at Mt. Laguna. 18”-3' snow above 2500'. Ski resort at Snow Valley open until 5.18, the latest in 78 year history.	13 illegal immigrants die near Pine Valley.
2.23-24.1998	1-2' above 6000', 3-4' above 7000'.	Trees and power lines down.
3.28-29.1998	Coldest storm of the year. 1-3' above 5000', 4-8” above 3000'. Ice pellets and hail 1” deep in some coastal and foothill areas.	Considerable damage to crops. Serious traffic accidents.
4.1.1998	Up to 3' of powder at ski resorts. 18” at Pine Cove.	
1.26.1999	22” over a large area around Running Springs, 18” at Angelus Oaks.	Road closures.

4.1-2.1999	18” in 12 hours at Mt. Laguna. 7-9” at Pine Valley and Descanso, 2” at Boulevard, “heavy snow” reported at Cherry Valley (3000'), 1” at Homeland (1,700').	8 illegal immigrants found dead near Descanso, 2 just over the border. 50 survived wearing only light clothing and tennis shoes and had never experienced snow; they had been on foot for 3 days.
6.2-3.1999	Latest measurable snow on record for area mountains. 3” at Mt. Laguna, 1” Wrightwood.	
2.21-23.2000	18” at Forest Falls.	
3.4-6.2000	Up to 17” in 24 hours in the mountains. 14” at Forest Falls.	3 illegal immigrants dead south of Mt. Laguna.
4.17-18.2000	Late winter storm: 18” at Wrightwood.	
1.10-11.2001	13-18” in Idyllwild area. 3” in Phelan.	
2.6-14.2001	Over a week of heavy snow called “most in a decade”: 5' at Blue Jay and Mountain High, 2' Snow Summit, 5-12” at Apple Valley. Mountain High reports 12” on 2.6, 10” on 2.11, 36” on 2.12, 30” on 2.13, 8” on 2.14.	Roof of ice rink caves in at Blue Jay.
2.28.2001	32” at Mountain High.	
1.28-29.2002	Light snow in southern Inland Empire.	
3.18.2002	3” in Apple Valley, the greatest daily snow amount for March. 1” in Hesperia.	
10.27.2004	2’ in Big Bear, most of which fell in 12 hour period.	A few local ski resorts opened on the earliest date in their history.

11.20-22.2004	Thundersnow started in the upper desert late on 11.20 and snow continued at times for two days. Widespread reports of 2’ with drifts to 3’ at Wrightwood, Lake Arrowhead, Big Bear and Palm Springs Tramway. Snow level as low as 1,000’. 18-20” in foothills south of Yucca Valley, 14” in Phelan, 9-12” in Hesperia and Apple Valley, 9” in Yucaipa and Calimesa, up to 3” throughout southern Inland Empire.	Tree damage in lower elevations caused house damage and power outages. Snow lined I-10 near Calimesa for a few days.
1.3-4.2005	Heavy snow fell as low as 2500’. Up to 1’ at higher elevations, up to 10” in the San Diego County mountains. Big Bear Lake completely froze over by 1.5.	
1.7-8.2005	Heavy snow up to several feet fell in the mountains.	200 motorists were rescued on Hwy. 18 west of Big Bear Lake.
2.19-23.2005	A strong winter storm brought 4-8’ to Mt. Baldy and Mountain High ski resorts. Reports of 10’ on the highest peaks. Only 1-2’ of new snow at Big Bear ski resorts. Big Bear Lake only measured 9”.	Lift chairs and shacks had to be dug out of the snow at Mountain High.
3.10-11.2006	Snow fell as low as 1500’. 36” fell at All the mountain highways were Big Bear Lake, Lake Arrowhead and closed the Palm Springs Tram. 27” at Pine Cove and Idyllwild, 25” at Cuyamaca, 13” in Warner Springs, 12” in Pine Valley.	One immigrant was killed and seven injured near Pine Valley. Roof damage in Guatay.
1.12-13.2007	3” in Yucaipa. 1” snow in Highland, and Redlands on 1.12. Trace amounts of snow as low as 500’ in elevation in the Inland Empire. On 1.13 a trace of snow was reported in Rancho Bernardo, Escondido, Chula Vista, El Cajon and La Mesa. Wrightwood received 24-38”.	I-15 and Hwy. 138 were closed. A few people were killed in avalanches at Mountain High Ski Resort.

2.14.2008	Heavy snow struck mainly San Diego County, including the inland valleys. Snow fell as low as 1000 feet elevation. 8” fell in the mountains of the county. Up to 4” fell in the higher inland valleys.	Highways were closed at higher elevations. Hundreds of motorists were stranded overnight because of closed highways.
5.22.2008	A very late season snowstorm dropped several inches of snow in the mountains, and as low as 5000 feet elevation.	
12.15-17.2008	A snowstorm of a magnitude that hasn't occurred since 1979 descended on the mountains and high deserts. Impressive snow totals include 54” at Big Bear, almost 36” at Wrightwood, 20” at Pinon Hills, and 16” at Hesperia, Idyllwild and Julian.	Interstate 15 was closed from San Bernardino to the Nevada state line for many hours.
2.16.2009	A snowstorm brought amounts of up to 18 inches in the mountains, bringing the snow depth in Big Bear City to 45 inches.	Several highways in the mountains, including I-15 through the Cajon Pass, were closed due to snow.
1.18-22.2010	A series of storms brought snowfall of 40 to 60 inches to the higher resorts, with up to seven feet at the highest ski resorts.	
12.17-22.2010	Heavy wet snow accumulated above 6500 feet with amounts over 6 inches and as much as 2 feet above 7500 feet.	
2.26.2011	Heavy snow in the mountains. 20 inches fell in Wrightwood and Big Bear Lake, and 18 inches in Palomar Mountain. Light snow stuck to the ground as low as 1000 feet elevation in Ramona and Jamul.	

Severe Thunderstorms: Large Hail, Strong Thunderstorm Winds, and Killer Lightning (See flash flooding in heavy rain section)

Date(s)	**Weather**	**Adverse Impacts**
3.21.1912	A heavy hail storm in San Diego put hail on the ground that remained there 3 hours.	
2.28-3.3.1938	Thunderstorms.	1 killed by lightning in Corona.
7.27.1939	A severe thunderstorm dropped hail greater than one inch in diameter in Needles.	
9.20.1939	Lightning struck two street cars and other structures.	Several small fires started in the city. Damage to structures.
12.2.1944	A heavy hail storm hit east San Diego and Linda Vista.	
7.27.1946	Hail piled up to 1.5" between Wrightwood and Big Pines.	Some property damage was caused by the heavy rain and hail.
6.2.1948	Two lightning bolts struck northern San Bernardino during a rare June thunderstorm.	
7.16.1954	A severe thunderstorm struck the Daggett area east of Barstow.	In addition to the heavy rains and flooding, this storm produced damaging winds. These "gales" knocked down several power poles and were "hurled across the highway". A mobile home was overturned and "ripped to pieces".
7.24.1956	A severe thunderstorm dropped hail "almost the size of baseballs" and very strong winds at Joshua Tree National Monument.	A Marine Corps party was pelted.
10.20-21.1957	Widespread thunderstorms. Hail drifted to 18" in East LA.	
7.30.1958	A severe thunderstorm struck Barstow with hail greater than one inch in diameter.	The hail damaged roofs, cars and windows.
8.15.1958	A severe thunderstorm struck Oak Glen with hail two inches in diameter.	Damage to the apple crop was extensive.

7.21.1960	A thunderstorm struck the San Bernardino Mountains.	Lightning sparked 24 fires.
9.2.1960	Golf ball size and baseball size hail at Boulevard area. 2-3” precipitation. Hail diameter measured at 2.75” and weighed over 1 lb., some stones estimated larger. 2.75” hail also in Riverside County. This is the largest known hail to hit Southern California. A severe thunderstorm also hit San Bernardino.	Considerable damage to houses. Winds in San Bernardino blew roofs off houses, smashed windows and blew down dozens of power poles.
9.10.1960	A severe thunderstorm struck Redlands at 3 pm with strong winds.	Trees were uprooted.
10.8.1961	Hail up to 2” deep covered Mt. Helix area.	
8.20.1962	A severe thunderstorm struck Twentynine Palms.	Trees were blown down and winds broke windows.
12.12.1965	Hail up to 4” deep covered Pt. Loma.	
7.13.1967	A strong thunderstorm produced damaging winds in the high desert.	Telephone and power poles were knocked down, causing widespread power outages.
12.13.1967	Marble size hail hit Palomar Mountain from thunderstorms preceding a major snow storm.	
3.7.1968	Lightning struck southwest San Bernardino County.	Three citrus trees were struck.
9.16.1969	Several lightning storms struck the San Bernardino area.	Lightning strikes caused power failures. Power poles were set on fire. Several forest fires were also set, but quickly contained.
3.14.1971	A thunderstorm contained many cloud to ground lightning strikes.	Lightning strikes caused power outages.
8.15.1971	Heavy thunderstorms strike the Joshua Tree region.	Flash flooding put debris and mud up to three feet deep on several highways around and west of Joshua Tree city.
8.21.1971	A heavy thunderstorm hit Needles with nearly two inches of rainfall.	Flash flooding and debris flows wiped out several roads and swept several vehicles off roads.

10.24.1971	Isolated and briefly heavy thunderstorms struck the region. 1.58" fell in San Bernardino, 0.12" in Riverside, nothing in Redlands. Some places reported drifts of hail.	Streets flooded with up to two feet of water and/or became slippery with hail. Numerous traffic accidents resulted.
12.22-28.1971	A series of storms hit the region over one week. 19.44" of precipitation fell in Lake Arrowhead, 15.26" in Lytle Creek, 5.45" in San Bernardino, 4.98" in Santa Ana, 3.92" in Redlands, 3.04" in Riverside, and 2.28" in San Diego.	Flooding of highways and streets, including debris flows in the mountains.
8.12.1972	Lightning struck the Riverside and Norco area.	One boy was killed. Several power outages occurred.
1.30-31.1979	Golf ball size hail.	
3.12.1982	A thunderstorm produced lightning strikes and hail that piled up in La Mesa and along I-8 near Pine Valley.	Lightning smashed a huge hole in a La Mesa home, throwing a resident, breaking a window and burning carpet. Another bolt struck a nearby flagpole. Other strikes started a small fire in Alpine. Hail caused accidents along I-8 in Pine Valley.
4.1.1982	Strong storm winds hit Encinitas – Leucadia.	Trees were downed, greenhouses destroyed.
8.12.1986	A severe thunderstorm struck Needles.	Streets were flooded and stranded motorists. Winds blew out windows of several businesses and ripped off a roof of an apartment building.
10.2.1986	Rain and thunderstorms hit LA area. 1.50" in Pasadena (in a little more than 1 hour), 1.02" in LA (in less than 1 hour), nearly 1" in Lake Arrowhead in 40 minutes, and 0.77" in Monrovia. 3" of hail piled up in Pasadena. Wind gusts to 35 mph. Hail nearly ½" in diameter in Westwood. In Blythe, winds gusted over 50 mph and 0.79" fell in 30 minutes. San Diego County was largely missed, with only 0.22" reported at Palomar Mountain.	Classes were cancelled at CSU-Northridge from power outages and several serious traffic accidents resulted in Pasadena because of hail. Minor flooding.
10.10.1986	Hail the size of marbles was reported during a Pacific storm with thunderstorms embedded in San Diego's east county.	

2.23.1987	Thunderstorms with hail and lightning hit San Diego, Coronado and Encinitas.	2" of sleet and hail piled up in downtown San Diego (a snowman was built at Seaport Village). Lightning struck a transformer in Logan Heights, knocking out power.
6.6.1987	Rare June thunderstorms hit the LA region and Mojave Desert. A severe thunderstorm hit Palmdale and Lancaster. 1" diameter hail at Mt. Pinos in northern LA County, ¾" hail at Palmdale, 1/2" hail hit Pine Mountain near the LA-Kern county line. Lightning struck the Santa Monica Bay.	Power was knocked out. Lightning sparked small fires. In Lancaster, mobile homes were damaged by strong winds (possible tornado?) and lightning. Two-by-fours were driven into the roofs of mobile homes. Utility poles were uprooted and broken in half.
9.1-2.1987	Remnants of tropical storm Lidia brought thunderstorms to the San Diego Valleys with lightning and strong damaging winds (possibly a tornado). 35 mph winds were reported at Pt. Loma.	On 9.1 lightning struck a power pole in El Cajon, which ruptured gas lines. Another bolt started a house fire. Lightning caused several small fires. What was reported as a dust devil was probably a microburst or a tornado damaged awnings and other items to mobile homes near Lake Jennings. In El Cajon a tree with an 8-inch trunk was snapped in half. On 9.2 a woman was struck by lightning near Lake Henshaw. Ten fires were started by lightning in the mountains of San Diego County.
9.22-23.1987	Frequent lightning and thunderstorms from Hurricane Norma in the San Diego area. Numerous lightning strikes in Escondido. 0.55" in two hours at Lemon Grove, 0.97" total. 0.68" at Lindbergh Field.	Numerous power outages, property damage from lightning strikes, and small fires ignited.

12.4.1987	Thunderstorm winds gusted to 60 mph in Westminster and 55 mph at Newport Beach.	In Westminster winds damaged 40 mobile homes, 9 of which were ripped out of the ground, leaving 24 people homeless. Winds knocked down power lines in Newport Beach. Lightning struck a radio tower in Newport Beach, knocking the station off the air, and knocked out power to the area.
4.23.1988	An intense winter-like storm brought thunderstorms.	9 girls at Tustin were injured (burned and thrown to the ground) when lightning struck the tree under which their softball team had taken shelter from the rain.
3.20.1991	Lightning struck North Park – San Diego. Hail reported in El Cajon, Miramar and University City.	Power knocked out by lightning struck transformer. A house fire was started.
7.30.1991	Lightning struck San Diego in City Heights.	Several grass fires were started. A big power outage occurred.
9.4.1991	A thunderstorm complex produced golf ball sized hail across parts of the San Bernardino Mountains. The Big Bear Lake area reported hail up to 2.5” deep.	
4.26.1994	Large hail up to 0.75” from San Dimas to Ontario.	Section of I-215 closed.
5.24.1996	A cold storm system came from the north and produced thunderstorms. Streets were buried in pea-size hail in Fallbrook. “Ping pong size” hail also fell there. Lightning strikes were common.	Crop damage around Fallbrook from the hail. Lightning struck two palm trees in Oceanside and burned like torches. Power was knocked out.
7.10.1996	Lightning hit the San Diego region.	Power was knocked out in central San Diego, the zoo and other metro areas.
1.12-13.1997	Dime size hail up to 1' deep over a small area in Buena Park and Cypress.	
2.17.1997	Marble size hail at Yucaipa.	

5.18.1997	Wet microburst in Apple Valley (in addition to two tornadoes).	Building and structure damage. Power lines arcing down and producing fires.
8.3.1997	Dime size hail at Campo.	
9.1-2.1997	Strong thunderstorm winds: three gusts to 104 mph at Twentynine Palms. Apple Valley gust 62 mph.	Large tree blown down in Apple Valley.
9.4.1997	Thunderstorms from Hurricane Linda: golf ball size hail in Forest Falls area.	
3.28.1998	Microburst in Lake Elsinore.	Tree uprooted, extensive roof damage.
4.1.1998	Grape size hail piled up 2” deep at Laguna Niguel.	
7.20.1998	Thunderstorms erupted near the coast and in the mountains.	Lightning sparked at least five fires in San Diego County. Strikes also hit a Clairemont home, and two trees in Pacific Beach. Lightning also caused a few power outages.
8.12-14.1998	Downburst in Hemet with winds 70 mph and 0.75” hail. Strong winds in Apple Valley. Golf ball size hail at Cajon Pass. 1.6” rain in 30 minutes at Boulevard.	Buildings damaged, trees and power lines down in Hemet.
8.29-31.1998	Severe thunderstorms. Wind gust of 86 mph at Sage (south of Hemet), gust 50 Rialto, 45 San Marcos.	Downed trees and power lines. Fires started by lightning near Barona Ranch.
9.2.1998	Severe thunderstorms at Hemet and San Marcos from Hurricane Isis. Strong winds from thunderstorms in Orange County with gusts to 40 mph.	Large fires in Orange County.
12.6.1998	Thunderstorm in Los Alamitos and Garden Grove: gusts 50-60 mph called “almost a tornado.”	
7.13.1999	0.75” hail at Forest Falls.	

3.5-6.2000	Golf ball size hail at Garden Grove, Santa Ana, and Running Springs. Strong thunderstorm winds at the coast: gust 60 mph at Huntington Beach.	Property damage and trees downed along the coast from Huntington Beach to Sunset Cliffs.
4.18.2000	A severe thunderstorm brought downburst winds estimated at 80 to 100 mph from Bellflower to Diamond Bar. 0.75" hail was reported in Downey.	Severe damage to factories and mobile home parks in Paramount (one mobile home was blown over). Wind damage was done to trees, power lines and numerous buildings along the entire path. In Norwalk, a large Eucalyptus fell onto I-5, closing the freeway for 3 hours, backing up traffic 17 miles.
8.1.2000	0.5" hail at Lake Arrowhead.	
8.29.2000	Thunderstorm wind gust to 61 mph at Borrego Springs.	
9.7.2000	"Big" hail strikes Forest Falls. Lightning strikes Oceanside High School.	
2.13.2001	Thunderstorm gust to 89 mph in east Orange.	
2.27.2001	Dime size hail in Mira Mesa, and 8" of graupel (soft hail) pile up on I-15.	Traffic delays.
7.3.2001	A microburst hit Hesperia creating a wall of sand and dust and a moaning sound.	A radio tower was toppled and other property was damaged.
8.8.2001	Strong thunderstorm in Twentynine Palms.	Damages.
9.2-3.2001	Strong thunderstorms from Hurricane Flossie. Hail up to 0.5" in Pine Valley.	1 boy killed by lightning in Apple Valley. 1 man killed and 1 boy injured by lightning at Cuyamaca Rancho State Park. Trees fell on a house in Beaumont.
9.30-10.1.2001	Thunderstorms in mountains and inland valleys.	1 killed by lightning at Cuyamaca Rancho State Park.

8.24.2003	Thunderstorms produce nickel size hail in Pine Valley, strong winds at Lake Henshaw.	Major tree damage at Lake Henshaw.
8.25.2003	0.75” hail at Big Bear City.	
9.2.2003	1.25” hail at Descanso.	
9.4.2003	1.75” hail in Joshua Tree and 29 Palms. 0.75” hail in Julian area.	
11.13.2003	A thunderstorm dropped 5.3 inches of rain and hail in the Watts, Compton and South Gate area of Los Angeles. The hail accumulated more than a foot deep in spots.	Flooding damaged dozens of homes, schools and hospitals and some roofs collapsed under the hail. Hundreds of motorists were stranded and power was knocked out to more than 100,000 homes and businesses. Residents shoveled hail and slush from streets.
8.13-14.2004	Monsoon thunderstorms in the valleys, mountains and deserts. Lightning struck a house in Murrieta. Lightning struck a tree in Victorville. Golf ball size (1.75”) hail in Yucca Valley. Nickel size (0.88”) hail in Phelan.	Lightning in Murrieta ignited house fire. Hail dented cars in Yucca Valley. Lightning in Victorville struck a tree and it fell over onto a limousine, trapping 15 occupants.
1.3.2004	Numerous lightning strikes from Norco to Devore.	1 injured in Fontana from flying glass when a 100’ tree was struck and fell on a house.
9.11.2004	1” hail in Borrego Springs, accompanied by 60 mph gust in Borrego Springs. This could have been stronger, but the anemometer was destroyed. Strong winds in La Quinta.	Window broken by hail. Strong winds knocked down six power poles. In La Quinta: 138 trees knocked down at one golf course with building damage, more trees down at other golf courses. Roof tiles blown off. Damage to power poles and transformers.
2.19.2005	¾” hail reported in Anaheim. In Laguna Hills thunderstorm winds had estimated gusts of 81 mph.	Winds blew down fences and trees and damaged a mobile home in Laguna Hills.
2.22.2005	Thunderstorm wind gusts to 68 mph in Newport Beach. 1” hail hit Costa Mesa.	

2.24.2005	Numerous thunderstorms in the Inland Empire.	Lightning struck a girl in Moreno Valley.
4.28.2005	A squall line raced ashore in Orange County with 70 mph winds.	Homes and businesses damaged in Dana Point, San Clemente and San Juan Capistrano. Numerous trees felled.
7.22-23.2005	Lightning strikes. Thunderstorms reaching the coast in San Diego County. Hail to the size of nickels (0.88") fell in Hemet. 60-70 mph winds hit the Hemet and Menifee region.	Lightning sparked fires near Big Bear Lake on 7.22 and 15 fires in San Diego County, including Vista on 7.23, burning 150 acres and causing power outages. The winds in Hemet and Menifee downed trees and flung lawn furniture.
7.24.2005	Thunderstorm winds were estimated to 60 mph at Canyon Lake.	A fence was blown over.
7.29.2005	Nickel size (0.88") hail hit Buckman Springs, ¾" hail hit Big Bear Lake, Ranchita, and the Boulevard-Jacumba area along I-8. Multiple reports of 60 mph wind gusts in Ranchita.	
7.30.2005	1.5" hail hit Forest Falls and ¾" hail hit Big Bear City.	
9.20.2005	Numerous thunderstorms hit northern San Diego County.	Lightning was the big problem, knocking out power, starting a number of tree fires from Carlsbad to Escondido, and producing damage to a school in Valley Center.
3.10-11.2006	Large hail fell with a big winter storm. On 1.10 1" hail fell in Escondido. Hail was widespread throughout San Diego county and even accumulated. On 1.11 a supercell thunderstorm went through northern San Diego County leaving 1" hail again in Escondido, and 0.5" hail accumulated to 1" deep from Carlsbad to Escondido.	

4.5.2006	0.75" hail fell in Corona.	Lightning caused damage to two homes in Rialto. Thunderstorm winds blew down trees in Mira Loma.
7.9.2006	Lightning sparked the Sawtooth and Millard Wildfires near Morongo Valley and Banning.	The Sawtooth burned 62,000 acres, caused considerable damage in Pioneertown and killed a man. The Millard Fire burned 24,000 acres.
7.5.2006	A thunderstorm produced one inch hail and 40-50 mph winds near Boulevard and Tierra del Sol.	
7.22.2006	Strong thunderstorm winds hit Lake Elsinore.	A 40' tree was blown over.
7.23.2006	Strong thunderstorm winds hit Menifee. Lightning sparked the Coyote Fire southeast of Anza.	Numerous trees were blown down, some of which fell on homes. The Coyote Fire burned 460 acres.
7.26.2006	A thunderstorm produced one inch hail southeast of Julian.	
9.2.2006	Thunderstorm winds were estimated at 58 mph in the Coachella Valley. Nickel size hail fell near Campo. Lightning sparked two fires near Warner Springs.	In the Coachella Valley damage was done to trees, power lines and street signs.
9.6.2006	Strong thunderstorms produced strong winds estimated at 70 mph.	Damage to trees, buildings, power lines occurred from San Jacinto to Temecula. Extensive damage to wineries.
3.27.2007	A microburst hit the Fullerton Airport. Top recorded winds were only 30 mph, but spotters estimated winds of at least 45 mph. Another thunderstorm wind hit Encinitas.	A roof of an aviation building was lost. In Encinitas a large Eucalyptus tree fell onto three cars in Encinitas, causing two injuries.
8.31.2007	A severe thunderstorm in Lake Elsinore produced severe winds. Another heavy thunderstorm hit Wrightwood. Other thunderstorms dropped a blanket of hail over vast areas between Big Bear and San Gorgonio.	In Lake Elsinore, the thunderstorm winds downed trees, power lines and caused roof damage. In Wrightwood, a debris flow damage roads along Sheep Creek, trapping motorists. A big accumulation of small hail was seen for many days at the top of Mt. San Gorgonio.

9.1.2007	Severe thunderstorms struck from Lake Henshaw to Oak Grove.	Severe winds broke off large oak branches. Damage to vehicles. Debris on the highway caused an accident.
9.2.2007	A severe microburst struck downtown Ramona.	Numerous trees and power poles were blown over. A few outbuildings, fences, signs, etc., were damaged or destroyed.
5.22.2008	Thunderstorms deposited several inches of hail from Redlands to Perris. Several reports of nickel size hail in Moreno Valley and dime size hail in Murrieta.	Snowplows were called to clear the hail. Awnings, trees and vehicles were damaged.
8.4.2008	A severe thunderstorm produced dime to nickel sized hail in La Quinta, as well as a 63 mph wind gust.	
8.25.2008	A severe thunderstorm developed over Baja California and produced damaging microbursts as it moved north over Campo. Measured wind speeds were 52 mph, but estimated winds were at least 58 mph. Nickel sized hail fell just northwest of Ranchita.	Trees were downed in Campo.
8.30.2008	A severe thunderstorm developed over Idyllwild-Fern Valley and dropped hailstones in size from marbles to walnuts (1.5” diameter).	Hail injured two during an already progressing search and rescue operation at Suicide Rock. These are the only documented injuries resulting from direct hail impact in California history. Also, a helicopter made an emergency landing.
9.11.2008	A thunderstorm produced strong outflow measured at 67 mph in La Quinta. Another thunderstorm produced golf ball sized hail in Ranchita.	
5.29.2009	Strong thunderstorms produced a microburst or gustnado in Hesperia.	The winds damaged four horse shelter roofs in Hesperia. One roof was completely removed from the shelter. Winds also knocked over power lines in Hesperia and Victorville. Lightning from the thunderstorm also began a small brush fire near Yucca Valley.

6.3.2009	Low pressure off the central California coast triggered bands of convection and numerous thunderstorms that produced over 1500 cloud to ground lightning strikes, gusty winds, and a few hail storms over Southern California. Hail up to one inch in diameter fell in Carmel Valley. Rainfall was very light in all areas.	Strong winds felled a tree onto a passing vehicle in Big Bear Lake, crushing the car and killing the driver. Lightning struck and killed a woman in Fontana. Six were severely burned and injured when lightning struck a fence next to them in San Bernardino. Lightning struck a palm tree in San Marcos, which critically injured a man underneath. Apartments in Riverside were struck by lightning, starting a fire. About 70 small brush fires were started by lightning across the region.
7.19.2009	Severe thunderstorm winds struck La Quinta foothills with gusts measuring 61 mph.	
8.25.2010	Strong thunderstorm winds estimated at 60 mph struck Lake Elsinore.	Power poles were knocked down, trampolines were thrown. Live power lines trapped a bus full of people.
8.26.2010	One inch diameter hail struck Sunshine Summit near Warner Springs.	
10.19.2010	Lightning struck a home in Riverside.	A six inch hole resulted in the roof.

Tornadoes, Funnel Clouds, Waterspouts, and Damaging Dust Devils

Date(s)	Weather	Adverse Impacts
12.9.1898	A waterspout was observed off Mt. Soledad – La Jolla and Pt. Loma for 10 minutes. This was considered the first such thing in history on this stretch of coast. It was reported to move ashore a few thousand yards.	Vegetation was washed out, leaving bare rock exposed in considerable areas on the south slope of Mt. Soledad.
3.11.1909	Two waterspouts observed several miles off Pt. Loma for 20 minutes.	
4.5.1926	A waterspout comes ashore to become a tornado in National City resulting in the most damaging tornado on record in San Diego County.	8 injured. Two homes were totally destroyed. Roofs were torn off homes and numerous roofs were damaged. One shingle was driven into the side of a building "as if it had been shot from a gun." Trees were downed and power was knocked out.
4.27.1931	A waterspout and two funnel clouds were sited off the coast of San Diego during the morning.	
9.20.1939	Two tornadoes reported in San Diego.	Damage to garage. Debris.
3.16.1952	Tornado in Santa Monica.	3 dead in storm; damage.
6.25.1954	Tornado northeast of Victorville.	
4.6.1955	Tornado north of Moreno Valley.	
4.13.1956	Strong storm winds hit Chula Vista. Counted officially as a tornado (one witness, a Texas native, claimed it was).	Roof damage done to 60 homes and extensively to a school. Two injured by flying glass. Trees uprooted, TV antennas toppled and windows shattered. 10 fish were sucked out of San Diego Bay and deposited on the ground one mile inland.
1.29.1957	Waterspout off Ocean Beach. Two funnel clouds observed over North Island (possibly the waterspout) and Mt. Soledad – La Jolla.	

6.18.1957	A "twister" struck La Mesa, occurring during a very hot Santa Ana event. Without a thunderstorm present, this was most likely a strong dust devil.	A boat was knocked its trailer, and damage was done to two roofs.
10.20-21.1957	Waterspouts were sighted off Point Mugu and Oceanside.	
4.1.1958	Tornado in Laguna Beach.	
4.2.1958	Tornado in San Bernardino.	A roof was ripped off a garage at Baseline and Sterling.
5.3.1959	A tornado hit North Island Naval Air Station.	Metal shelter was picked up. Power lines and trees down, debris scattered.
10.8.1961	At least 10 waterspouts were observed between Del Mar and Oceanside. A waterspout moved ashore to become a tornado in Carlsbad. Three of the waterspouts were observed off Del Mar.	Roof ripped off, trees felled, fences downed in Carlsbad and Oceanside. Three injured from flying objects. Boats torn from moorings in Oceanside. Damage to Carlsbad SDG&E electric generator plant.
2.19.1962	Tornado in Irvine.	Trees were uprooted and power poles were toppled.
3.7.1964	Two waterspouts were observed, one off Oceanside and one off La Jolla.	
12.13.1965	Waterspout observed around 1 pm. Location unknown.	
4.8.1965	Tornado in Costa Mesa.	
11.7.1966	Tornadoes in Newport Beach and Costa Mesa.	Property Damage.
7.22.1966	Tornado in Victorville.	
11.30.1970	A waterspout and three small funnel clouds reported six miles west of San Diego.	
2.23.1971	A tornado 10 miles east of Brown Field, Otay Mesa, near Mt. San Miguel. At least six funnel clouds in Chula Vista, Brown Field, and San Ysidro. A waterspout off Imperial Beach.	No damage reported.

10.17.1971	Waterspout observed for 10 minutes just west of Pt. Loma.	
2.23.1973	Tornado near San Diego.	
7.20.1974	Tornado in Hemet.	Property damage.
10.22.1974	Tornado in Yucca Valley.	Property damage.
10.29.1974	Tornado in Encinitas.	
9.4-6.1976	Six tornadoes. 5 around El Mirage, west of Adelanto, one near Mt. Baldy.	Property damage.
3.16.1977	Tornado skipped from Fullerton to Brea.	4 injured. Damage to 80 homes.
1.5.1978	Tornado in Costa Mesa at 9 pm.	Trees fell and caused roof damage. Roof damage, power lines down.
1.11.1978	Two waterspouts and several waterspouts were reported off the coast of La Jolla.	
2.9.1978	Tornado in Irvine.	
2.10.1978	Tornadoes in El Segundo and in Huntington Beach.	In El Segundo, trees were hurled onto parked cars. Power poles were knocked down along a one mile path. In Huntington Beach 6 injured; $3 million property damage.
3.5.1978	A funnel cloud was reported from the El Toro Marine Base.	
12.19.1978	Tornado in Oceanside.	3 injured. $15,000 damage to vehicles and structures.
1.5.1979	A waterspout came ashore and became a tornado at Mission Beach.	Several boats were tossed and damaged. A catamaran was tossed 50’ on to the boardwalk, damaging it.

1.18.1979	Tornadoes in Tierrasanta and Midway - San Diego. The same tornado or other tornadoes may have hit Mission Hills and Encanto.	Ripped up signs, sidings, street lights, etc., and dropping debris in traffic in Midway. Lots of property damage in Midway, Encanto and Mission Hills. Property damage in Tierrasanta.
1.31.1979	Tornado in Santa Ana, possibly elsewhere.	Numerous power outages.
2.17.1980	Waterspout off Camp Pendleton.	
2.20.1980	Tornado in Clairemont - San Diego.	Considerable property damage.
3.21.1980	Funnel cloud observed south of San Diego.	
1.20.1982	Tornado in Riverside.	
3.17-18.1982	Tornado at Lindbergh Field - San Diego and at Loma Portal – Pt. Loma.	
9.7.1982	Tornado in Landers.	Property damage.
11.9.1982	Seven tornadoes touched down in the LA Basin. Three of the tornadoes began as waterspouts at Pt. Mugu, Malibu and Long Beach. The Long Beach waterspout moved ten miles inland, becoming an F2 tornado. Another tornado reached F2 strength in Van Nuys. Two other tornadoes were in Garden Grove and Mission Viejo.	Property damage, especially with the Long Beach waterspout/tornado.
3.1.1983	Two tornadoes around LA, an F2 and an F0.	In all, 30 people were injured and 100 homes were damaged. At 8 pm one F2 tornado damaged seven businesses and 50 homes in South Central LA, caused 30 injuries and lifted about one mile before reaching the civic center. The F0 tornado injured a motorist when his Cadillac was lifted 15’ and carried across a highway in San Marino.
8.1.1983	Tornado in Landers.	Property damage.

9.28.1983	Six funnel clouds sited off the coast of San Diego.	
1.13.1984	Tornado in Huntington Beach.	Property damage.
1.27.1985	Funnel cloud west of Lindbergh Field.	
2.3-4.1985	Tornado in Tierrasanta and Allied Gardens - San Diego. Funnel clouds at Brown Field.	Eight mobile homes damaged. Roofs torn off. Other property damage.
9.18.1985	Tornado around the north shore of the Salton Sea.	
11.12.1985	Waterspout came ashore in Encinitas, becoming a tornado.	$250,000 in damage. Forty greenhouses damaged or destroyed, roof flung on car, destroying it. Trees down. Other property damage.
11.25.1985	Funnel cloud sited at Imperial Beach.	
2.25.1986	Waterspout reported 5 miles west of Lindbergh Field – San Diego and reported from Silver Strand. 2 funnel clouds were reported near Pacific Beach.	
3.16.1986	Tornado in Anaheim 0.5 mile northeast of Disneyland struck at 530 am and was determined F1 strength. Its track was 1.25 miles in length and was 20-40 yards wide.	Property damage of shattered windows and torn roofs.
2.22-24.1987	Tornadoes and waterspouts in the Huntington Beach area.	
2.25.1987	Several funnel clouds and waterspouts around San Diego County. One waterspout was 7 miles west of Crystal Pier in Pacific Beach, another 7 miles west of the San Diego River channel. A funnel cloud was observed off Imperial Beach.	Waterspouts damaged many boats in Coronado harbors. A waterspout picked up a dropped a 30’, 5-ton cabin cruiser. A dinghy was also tossed and reported to have been in the air for 15-20 seconds.
7.27.1987	Tornado in Twentynine Palms.	

9.1.1987	Thunderstorms hit San Diego Valleys with lightning and strong damaging winds (possibly a tornado).	What was reported as a dust devil was probably a microburst or a tornado damaged awnings and other items to mobile homes near Lake Jennings. In El Cajon a tree with an 8-inch trunk was snapped in half.
9.24.1987	Two funnel clouds were reported around Earp (on Colorado River).	
1.18.1988	Tornadoes in Mission Viejo and San Clemente.	Property damage. A baseball dugout was blown 150 yards into the middle of a city street.
1.14.1990	Tornado in East City Heights - San Diego. A waterspout turned tornado hit Shelter Island – San Diego.	Property damage. Boats tossed in Shelter Island.
3.12.1990	A funnel cloud was observed 5 miles south of Lindbergh Field.	
3.19.1990	A funnel cloud was observed over the San Diego neighborhood of San Carlos.	
3.25.1990	A waterspout was observed off the coast of Oceanside.	
2.28.1991	Tornado in Tustin. A waterspout observed off La Jolla.	
3.19-20.1991	Tornadoes in East City Heights and San Carlos areas of San Diego on 3.19. Tornadoes in Riverside and Muscoy (near San Bernardino) on 3.20. Also on 3.20 a waterspout came ashore to become a tornado at Camp Pendleton. Two other waterspouts were seen off the coast there.	Property damage in San Diego. In San Carlos pines were ripped out by roots, palm and cottonwood trees snapped in half. Cars were smashed by falling objects, debris and patio furniture was strewn throughout the neighborhood, including a refrigerator. A car was moved 60’ by a falling palm.
3.26-27.1991	On 3.26 tornado at Vandenberg AFB. On 3.27 Tornadoes in Huntington Beach and rural San Marcos. The tornado in Huntington Beach cut a five-mile swath.	In Huntington Beach the roofs were taken off of six homes. Dozens of other homes were damaged and 50 mobile homes were severely damaged.

2.15.1992	Tornado in Camp Pendleton.	Property damage.
12.7.1992	Tornadoes in Anaheim, Westminster, and Carlsbad. Waterspout 8 miles off San Diego coast. Another one 11.5 miles off Mission Beach.	Property damage. Three carports and two mobile homes damaged in Carlsbad.
12.29.1992	Tornado in San Clemente.	Property damage.
1.18.1993	Tornado in Orange County. Funnel cloud in Hemet.	Property damage.
1.30.1993	Funnel cloud observed over Mission Bay.	
2.8.1993	Tornado in Brea.	Property damage.
3.26-28.1993	Funnel clouds near Temecula and a funnel cloud in Moreno Valley.	
11.11.1993	Tornado in Portola Hills (near Tustin).	2 injuries; property damage.
2.7.1994	Tornado from Newport Beach to Tustin.	Roof and window damage. Trees blown down.
4.26.1994	Waterspout 11 miles southwest of Camp Pendleton.	
8.12.1994	Tornado in Valle Vista (east of Hemet) and several funnel clouds in Hemet.	Trees uprooted. Power poles blown over. A home damaged and a trailer destroyed.
12.13.1994	Two waterspouts about 0.5 mile off Newport Beach.	
12.13.1995	Funnel cloud near Fullerton airport.	
3.13.1996	Funnel cloud in Irvine, two southwest of Moreno Valley, and one northwest of Hemet.	
5.25.1996	Funnel cloud 10 miles west of Lindbergh Field - San Diego.	
12.22.1996	Tornado in Cabazon.	Threw a 5 ton mobile home 30’. Minor damage to six other mobile homes.

1.12.1997	A waterspout 2 miles southwest of Lindbergh Field - San Diego came ashore at Shelter Island.	Damage to resort.
2.28.1997	Funnel cloud in Kearny Mesa - San Diego.	
4.2.1997	Funnel cloud 5 miles west of Lindbergh Field - San Diego.	
5.11.1997	Tornado in Apple Valley.	Catastrophic damage to buildings, structures, trees, power lines.
5.18.1997	Two tornadoes in Apple Valley and a wet microburst. Estimated 130-140 mph winds.	Building and structure damage. Power lines arcing down and producing fires.
5.20.1997	Tornado 7 miles east of Borrego Springs.	
6.6.1997	Tornado in Hesperia.	Destroyed a large fountain.
6.13.1997	Funnel cloud 2 miles northwest of Lindbergh Field - San Diego.	
8.6.1997	Funnel cloud in Pine Valley.	
11.10-11.1997	A waterspout came ashore at Newport Pier 11.10 and quickly dissipated over western Costa Mesa. Winds were estimated at 60 to 70 mph. Tornado in Irvine 11.11, and another funnel developed.	Minor power outages. Little damage. A fisherman was blown from one end of the Newport pier to another. Property and vehicle damage in Irvine from flying debris. Ten cars were thrown a few feet.
11.30.1997	Waterspout 6 miles south of Newport Beach.	
12.8.1997	Funnel cloud in Del Mar.	
12.21.1997	Waterspout and tornado in Huntington Beach developed from a supercell thunderstorm.	Considerable damage to boats, houses, and city property.
1.2.1998	Funnel cloud southwest of Chula Vista.	
1.9.1998	Waterspout 3 miles off Laguna Beach. Tornado at Long Beach	Property damage in Long Beach.

1.29.1998	Waterspout moves ashore on Moonlight Beach and becomes a tornado at Encinitas	Property damage.
2.9.1998	Tornado in Cardiff - Encinitas and Rancho Santa Fe.	Minor damage.
2.17.1998	Waterspout off Point Loma.	
2.24.1998	Tornado in Huntington Beach. Waterspout off Mission Beach.	Property damage, power outage. Roof travels 1/4 mile.
3.13-14.1998	Numerous waterspouts between Long Beach, Huntington Beach and Catalina. Funnel clouds in Phelan and Hesperia.	
3.28.1998	Funnel cloud in Dulzura.	
3.31-4.1.1998	Numerous funnel clouds reported near Orange and San Diego County coasts, two of which became waterspouts off Orange County. One waterspout briefly hit the coast south of the Huntington Beach Pier.	
5.5.1998	“Apparent” tornado in San Bernardino and Rialto	Shredded metal siding in Rialto.
5.6.1998	Waterspout 1 mile west of North Island.	
5.13.1998	Tornado in Homeland. Funnel clouds in Homeland and Moreno Valley.	Damage to mobile homes in Homeland.
6.6.1998	Two funnel clouds off Dana Point.	
9.2.1998	Funnel cloud in Pomona.	
9.27.1998	Funnel cloud over Mission Beach.	
12.5.1998	Funnel cloud 2 miles southwest of Imperial Beach.	
1.25.1999	Funnel cloud 1 mile off Costa Mesa coast.	

4.1-3.1999	Waterspout 6 miles off Newport Beach on 4.1. Funnel cloud 3 miles west of La Jolla on 4.2. Waterspout 3 miles southwest of Oceanside on 4.3.	
4.7.1999	Funnel cloud 2 miles west of La Jolla.	
4.12.1999	Funnel cloud northeast of Temecula.	
6.3-4.1999	Funnel cloud 1 mile off San Clemente. Waterspout off Laguna Beach.	
7.10.1999	Funnel cloud in Hesperia.	
7.12.1999	Tornado 6 miles east of Julian. Recorded wind speeds 43 mph.	Building and structure damage. Trees uprooted and knocked over.
7.21.1999	Tornado in Shelter Valley.	Property damage.
12.31.1999	Funnel clouds in Santa Ana and Oceanside. Waterspout off Costa Mesa coast.	
2.21.2000	Tornado at Anaheim Hills.	Property damage.
3.3.2000	Waterspout 3 miles west of La Jolla.	
3.7.2000	Waterspout 10 Miles West of San Clemente. Funnel cloud 2 miles west of La Jolla.	
6.14.2000	Funnel cloud in Phelan.	
6.23.2000	Two funnel clouds around Hesperia.	
6.25.2000	Funnel cloud 12 miles west of Ocean Beach.	
8.25.2000	Funnel cloud came within 200' of the ground in Jacumba.	
9.7.2000	Funnel cloud over Carlsbad.	
10.28.2000	Funnel clouds around Newport Beach and Costa Mesa.	
11.10.2000	Tornado in southeast Poway.	Damage to 8 houses, trees uprooted and knocked down, vehicles moved.

1.10-12.2001	Funnel cloud at Orange County Airport, Newport Beach on 1.10, and Kearny Mesa - San Diego on 1.11. Waterspout 3 miles west of Chula Vista on 1.11 and 12 miles west of Mission Beach on 1.12.	
2.10-11.2001	Waterspout 2 miles west of La Jolla and a funnel cloud 3 miles northwest of La Jolla on 2.10.Waterspout 3 miles off Laguna Beach and two waterspouts 1 mile west of Ocean Beach on 2.11.	
2.13-14.2001	Funnel clouds in Palm Desert on 2.13 and 9 miles west of Oceanside on 2.14.	
2.24.2001	Tornado in Orange.	Damage to a warehouse, 6 structures, fences, and telephone wires.
2.27.2001	Several funnel clouds in Escondido. A waterspout 10 miles west of San Diego - Lindbergh Field.	
3.6.2001	Funnel cloud in Yorba Linda.	
4.9.2001	Two funnel clouds 4 miles southwest of San Diego - Lindbergh Field.	
5.28.2001	Two brief waterspouts 5 miles west of Laguna Beach.	
7.3.2001	Dust devil in Hesperia (may be a microburst or other thunderstorm wind).	Blows off roof.
7.7.2001	Tornado at Twentynine Palms and Joshua Tree.	Minor damage to homes and businesses in Joshua Tree.
8.15.2001	Dust devil in Menifee.	Damage to shed.
8.17.2001	Funnel cloud in Dulzura.	
2.17.2002	Two funnel clouds around Carlsbad.	
3.24.2002	Two funnel clouds around Carlsbad.	

5.20.2002	Three funnel clouds and one waterspout off the coast near Dana Point.	
10.26.2002	Funnel cloud 5 miles northeast of Borrego Springs.	
5.27.2003	Dust devil in Sugarloaf.	Damage to three vehicles.
9.4.2003	Tornado in Joshua Tree - Yucca Valley.	Extensive damage ($25K) to one residence. Minor damage to 11 other residences. No injuries.
11.1.2003	Large waterspout between Laguna Beach and Catalina Island.	
4.17.2004	Several funnel clouds were spotted off San Clemente.	
8.14.2004	Tornadoes hit Yucca Valley and Phelan.	
9.5.2004	A strong dust devil hit Vista.	Ripped a sign off a fence and threw it 40' away over a house.
10.17.2004	A tornado hit Oceanside. It was a waterspout that came ashore. Funnel cloud occurred at Encinitas' Moonlight Beach.	Damage to structures, trees, windows, etc.
10.20.2004	Several funnel clouds offshore from San Clemente.	
10.21.2004	A waterspout was 2 miles southwest of North Island.	
12.4.2004	A funnel cloud, possibly a waterspout, was observed off San Clemente.	
12.28.2004	Tornadoes in Long Beach, Inglewood and Whittier. A funnel cloud was reported in Fullerton. A waterspout was reported 10 miles west of Oceanside Harbor.	The tornadoes caused minor damage to trees and roofs.

1.2-4.2005	On 1.2: Funnel clouds were reported 10 miles west of Huntington Beach pier, off Dana Point and northwest of San Diego Bay. On 1.3: Funnel clouds were reported in Fullerton and Huntington Beach. On 1.4: A funnel cloud was reported in Costa Mesa.	
1.9.2005	A tornado hit Hemet. A funnel cloud was reported in Mira Loma.	The tornado picked up a storage shed in Diamond Valley and threw it into a power pole.
2.19.2005	A waterspout moved ashore (within 100 yards of the pier) and became a tornado in Huntington Beach. Multiple waterspouts were reported. A super cell thunderstorm moved ashore in Oceanside and spawned an F1 tornado that moved through Fallbrook, Rainbow and Temecula.	The tornado in Huntington Beach damaged and downed trees and power poles. Extensive damage to cars, trees, roofs, fences, etc. in Fallbrook, Rainbow and Temecula.
2.22-23.2005	On 2.23 A tornado hit Chula Vista. On 2.22 funnel clouds were reported in San Diego – Clairemont, Dana Point, north of Victorville, and Mira Loma. On 2.23 funnel clouds were reported in La Jolla and Spring Valley.	The tornado stopped traffic on the 805 freeway.
2.26.2005	A landspout-tornado hit Lake Elsinore, lasting about 5 minutes.	
3.4.2005	A tornado hit Fontana. A funnel cloud was reported in Carmel Valley – Del Mar.	The tornado felled several trees and power lines. Roof damage to three homes. Roof taken off of building.
4.28.2005	Funnel clouds were reported in Hemet and in Carlsbad.	
5.6.2005	A waterspout was spotted off Imperial Beach. A funnel cloud was reported near Tustin.	
7.23.2005	A tornado struck Hemet.	Trees downed.
7.29-30.2005	Thunderstorms produced funnel clouds in Mt. Laguna on 7.29 and in the San Gorgonio Wilderness on 7.30.	

11.27.2005	A funnel cloud was observed from Dana Point.	
2.18.2006	A waterspout was observed 6 nautical miles off Dana Point.	
3.10-11.2006	On 3.10 a waterspout came ashore in Encinitas (becoming a tornado). On 3.11 a supercell thunderstorm produced a waterspout off south Carlsbad. A tornado was later reported in north Ramona from this storm.	In Encinitas a tree fell over a railroad track and halted traffic. In Ramona trees were downed and some property damage was incurred.
4.5.2006	A funnel cloud was spotted in Riverside near Highway 60 and I-215.	
4.14.2006	A funnel cloud was observed over Del Mar.	
10.13.2006	Several funnel clouds and waterspouts were observed off the coast of Catalina Island.	
3.27.2007	A funnel cloud was spotted off the La Jolla coast.	
9.22.2007	As many as eight waterspouts and countless more funnel clouds were seen in one hour along the coast of Orange and San Diego Counties.	Two waterspouts came ashore. One at Cardiff blew over tents. Another came ashore at Newport Beach.
3.15.2008	Funnel cloud southwest of Balboa Park.	
4.26.2008	A strong dust devil developed in Montclair.	Damage was done to several large tents at Montara Elementary School. 14 were injured.
5.22.2008	Four tornadoes touched down near Moreno Valley. One was rated EF-2, which was the strongest California tornado since the Sunnyvale tornado in 1998, and was on the ground for an exceptional 21 minutes.	9 railroad cars were derailed. A semi truck was lifted 30-40 feet in the air and severely injured the driver. Damage to roofs, trailers and sheds.
9.17.2008	A tornado was observed in Johnson Valley, but no damage was reported.	

2.7.2009	Three waterspouts were reported eight miles south of San Pedro. Another waterspout was spotted about 20 miles west of Encinitas.	
11.28.2009	A waterspout was observed off Moonlight Beach in Encinitas.	
1.19.2010	A tornado went through Seal Beach and Huntington Beach causing, and wind gusts reached 60 mph in San Clemente. Several waterspouts and very strong winds of 93 mph were also reported in Newport Beach and Huntington Beach.	Local damage including boats in Huntington Harbor.
2.9.2010	A waterspout was observed south of Coronado.	
3.6.2010	Two funnel clouds were observed by the John Wayne Airport. Five funnel clouds were observed by a police helicopter off the coast of Crystal Cove.	
12.12.2011	A waterspout was seen off La Jolla.	

Strong winds (for thunderstorm related winds, see severe thunderstorms)

Date(s)	**Weather**	**Adverse Impacts**
10.2.1858	Category 1 hurricane hits San Diego. Implied winds of 75 mph.	Extensive wind damage to property (F2).
8.11-12.1873	A tropical storm hit San Diego with winds that "stiffened up to quite a gale".	Damage to roof tops and felled trees.
11.13.1880	Severe Santa Ana winds and sandstorms in Southern California.	Extensive damage.
2.24.1891	Strong and continuous storm winds blew at 40 mph.	Boats were smashed on shore. A roof was taken off a warehouse.
1.27.1916	All wind velocity records were broken in San Diego. Peak wind 54 mph, with a max gust to 62 mph. Average speed for the day was 26.2 mph.	
1.10.1918	Strong offshore winds. Peak wind at San Diego was north at 31 mph at 6:38 am.	Skies were full of dust with 300 yards visibility. At noon visibility was only a few miles.
11.25.1918	Strong windstorm produced a wind gust of 96 mph at Mt. Wilson.	
5.23.1932	Strong winds and low humidity.	12 serious brush fires resulted, blackening nearly 2000 acres in San Diego County. The biggest fire was in Spring Valley.
3.5.1933	Strong east winds.	A fire in De Luz area spread rapidly westward and scorched more than 800 acres.
9.24-25.1939	Tropical storm lost hurricane status shortly before moving onshore at San Pedro. Sustained winds of 50 mph.	48 dead from sinking boats.
2.11.1946	Icy cold winds in mountains of San Diego County with gust 72 mph.	

1.10.1949	Cold winter storm. Gust to 75 mph in the mountains of San Diego County, gust to 40 mph in San Diego.	Plane crash kills 5 and injures 1 near Julian.
4.13.1956	Strong storm winds hit Chula Vista. Possible tornado (one witness, a Texas native, claimed it was).	Roof damage done to 60 homes and extensively to a school. Two injured by flying glass. Trees uprooted, TV antennas toppled and windows shattered. 10 fish were sucked out of San Diego Bay and deposited on the ground.
11.19-29.1956	A strong and prolonged Santa Ana wind event started on 11.19 and ended on 11.29. On 11.20 a 100 mph gust was recorded at a forest lookout near Saugus.	A fire north of Descanso started on 11.19, killed 11 and burned 44,000 acres. Two wooden bridges and a power plant were destroyed.
11.21-22.1957	Extremely destructive Santa Ana winds.	Winds produced a 28,000 acre brush fire on a 40-mile front west of Crystal Lake. People were ordered off streets in some areas due to flying debris. 12 of 33 passengers on an airplane over Ontario were hurt by a downdraft in extreme turbulence. Paint was completely stripped off of windward sides of 4 cars stalled in a Fontana sandstorm.
11.5-6.1961	Strong Santa Ana winds fanned fires in Bel Air and Brentwood. 74° at 10 pm at LA, 5° dew point. 3% relative humidity in Burbank on 11.6.	Fire in Topanga Canyon. 103 injured firemen, $100 million economic losses including 484 buildings (mostly residential) and 6,090 acres destroyed.
9.26.1963	Santa Ana winds. Gusts over 50 mph in the mountains of San Diego County.	Hottest heat wave west of mountains in the county on record.
11.19-20.1963	Strong storm winds.	Hundreds of trees downed. Power lines downed.
12.2-3.1966	Strong storm winds.	Power outages.
1.18-28.1969	Strong storm winds.	4 dead from falling trees. Power outages.

2.20-25.1969	Strong storm winds.	Telephone, power, and gas outages.
9.26-29.1970	Gusts to 60 mph at Cuyamaca Rancho State Park.	The Laguna Fire. 8 killed, 400 homes destroyed, 185,000 acres burned as of 9.28 from Cuyamaca to Alpine.
2.10-11.1973	Strong storm winds. 57 mph at Riverside, 46 Newport Beach.	Some 200 trees uprooted in Pacific Beach alone.
3.25.1975	Wind gust of 101 mph at Sandberg, a California record.	
2.4-10.1976	Strong storm winds: 64 mph at Palmdale.	
9.10.1976	Hurricane Kathleen brought the southwest the highest sustained winds ever associated with an eastern Pacific tropical cyclone with sustained winds of 57 mph at Yuma.	
12.20.1977	Very strong Santa Ana winds gusted to 90 mph in the mountains of San Diego County.	A truck driver was killed on I-8. A girl in La Mesa was injured when a tree fell on her. Some brush fires were fanned. Widespread crop damage was suffered in northern San Diego County to avocados, strawberries, etc. Numerous trees and power poles were knocked down. In Ramona entire barns were destroyed.
10.9.1982	Santa Ana winds gusted to 60 mph.	A major wildfire moved across the Santa Monica Mountains.
11.30-12.1.1982	Widespread strong wind with a big storm.	Power out to 1.6 million homes.
3.1.1985	Strong storm winds struck San Diego County.	Trees and antennas were toppled, causing numerous power outages.
3.26.1984	Ferocious winds strafed the Mojave Desert with winds of 60-90 mph. Peak wind at Mojave 103 mph, Daggett 66 mph.	Power outages, road closures. A CHP officer reported a car door ripped off and hit by a sizable rock near Indio and another car had its windows blown out.

11.12.1985	Strong storm winds gusted to nearly 80 mph along the San Diego County coast.	Lots of tree damage, power outages and roof damage in La Jolla. One tree fell on two cars in Hillcrest. Winds capsized a sailboat off Carlsbad, killing one.
12.9.1985	Strong storm winds of at least 35 mph along the San Diego County coast.	Several boats in Mission Bay were capsized. Numerous trees down causing power outages, one on a car on Hwy. 163, another on a parked car in Coronado.
11.23.1986	Strong Santa Ana winds hit LA and mountain foothills. Gusts to 54 mph were recorded, but estimated gusts were 70 mph. Only 30-40 mph gusts were estimated at Mt. Laguna.	An unfinished house in Glendale was blown to bits. Numerous beach rescues were needed for sailors and windsurfers. Two sailboat masts were snapped in a boat race at Channel Islands.
1.20.1987	Wind gusts to 80 mph below Cajon Pass, 70 mph in San Bernardino, 60 mph at Mt. Laguna and 40 mph in El Toro.	Thick dust clouds. Trucks blown over. Trees down. A hundred power poles were down in the Inland Empire. Numerous power outages. Schools closed in Fontana as a result of power outages. A mobile classroom was knocked over. Brush fires were started.
2.6-7.1987	Santa Ana winds: Gusts up to 75 mph Cuyamaca and Palomar Mountain areas. Gusts to 60 mph hit Brown Field and Warner Springs, 40 mph in Julian and Valley Center. 35 mph at San Diego.	Plane flipped over at Brown Field. Winds forced a sailboat into the rocks at Pt. Loma. I-8 was closed for two hours in eastern San Diego County. Trees, power lines and fences were downed, causing damage and power outages. A highway sign fell on cars.
2.23-24.1987	Storm winds were clocked at 50 mph in Mt. Laguna. Gusts reached 34 mph at San Diego.	

3.15.1987	Widespread strong storm winds. Gusts to 40 mph at San Diego with sustained winds 25-35 mph all day.	Power outages all over San Diego metro area. Motor homes toppled in the desert. A light standard fell over onto cars in Coronado. Boats flipped over in harbors. A 22’ boat turned over at Mission Beach jetty. Catalina cruise ships were delayed, stranding 1,200 tourists there.
11.18.1987	Santa Ana winds buffeted the mountains and valleys.	
12.4-5.1987	Strong Pacific storm brought gale force winds along the coast exceeding 40 mph.	Trees down, power outages.
12.12-13.1987	Strong Santa Ana winds in San Bernardino, with gusts to 60 mph. Gusts up to 80 mph around San Bernardino. Strong damaging winds in San Diego County. 38 mph recorded at San Diego.	80 power poles were blown down within a ½ mile stretch in Fontana and Rancho Cucamonga. One was injured when a tree fell on a truck. Downed tree limbs damaged cars, homes and gardens. Power poles and freeway signs were damaged. A parked helicopter was blown down a hillside in Altadena. Trees blown down and power outages in San Diego County. One was killed by a Eucalyptus tree falling on a truck in Spring Valley.
12.15.1987	Strong storm winds of 100 mph at Wheeler Ridge in the Tehachapi Mountains. 80 mph in San Bernardino Co. Up to 70 mph gusts at Pt. Arguello and gusts up to 60 mph gusts were clocked in Orange Co. and the San Gabriel Mountains.	One truck overturned.
12.17.1987	A strong Alaskan storm brought strong winds.	Boats broke free of moorings at Shelter Island, San Diego.

1.17.1988	Major Pacific storm produced a gust to 64 mph from the west at San Diego - Lindbergh Field, highest wind on record.	Trees uprooted in the San Diego area. Boats in San Diego harbor damaged intensively. Apartment windows were ripped out in Imperial Beach, where damage estimated $1 million. Trees were knocked down and debris was strewn all around San Diego and the zoo. Zoo was closed for the first time in 72 years to remove damage. Kelp beds were damaged.
1.21-22.1988	Strong offshore winds following a major Pacific storm. Gusts to 80 mph at the Grapevine and gusts to 60 mph at Ontario on the night of 1.21. Gusts were reported up to 80 mph in San Diego County on 1.22.	Power poles, road signs big rigs knocked down in the Inland Empire. In San Diego County, 6 were injured, roofs were blown off houses, trees were toppled and crops destroyed. A barn was demolished and a garage crushed by a giant tree in Pine Valley. 20 buildings were destroyed or damaged at Viejas. Avocado and flower crops were destroyed in Fallbrook and Encinitas, respectively. Five greenhouses were destroyed in Encinitas.

2.16-19.1988	Very strong Santa Ana winds: Gusts of 90 mph at Newport Beach, 70+ mph in the San Gabriel Mountain foothills on 2.17. Gusts to 76 mph at Monument Peak - Mt. Laguna on 2.18. Gust 63 at Ontario on 2.17, gust 50 at Rancho Cucamonga on 2.16.	Numerous trees and power lines downed and power outages all near the foothills of the San Gabriel and San Bernardino Mountains. On 2.19 in Pauma Valley a mobile home was overturned and shingles were torn off roofs. Fontana schools were closed due to wind damage at schools. Three were killed when a big rig truck overturned and burned, one was killed having stepped on a downed power line). Power outages hit 200,000 customers in LA and Orange counties. Minor structural damage occurred to signs, etc. Grass fires resulted. Roof damage was widespread in communities around Glendale and Pasadena. Planes flipped in Burbank and at John Wayne airports. Boats were torn from moorings in Newport Harbor.
5.29.1988	Gale force winds hit the coast. Gusts to 60 mph in the mountains, 45 mph at LAX. Gusts to 40 mph at San Diego.	Hang glider crashed and died. Power went out. Brush fires started.
11.30.1988	Santa An winds gusted to 75 mph at Laguna Peak (Ventura Co.).	
12.8.1988	Strong Santa Ana winds across Southern California. Gust 92 mph at Laguna Peak (Ventura Co.).	Winds fanned several major fires. Buildings unroofed, trees and power lines brought down. Estimated damage $20 million.
11.28.1989	Strong Santa Ana winds. Gusts to 70 mph at the Rialto Airport.	Several tractor- trailer trucks were overturned east of Los Angeles.
12.11.1989	Strong Santa Ana winds. Gusts to 100 mph near the Grapevine.	Winds reduced visibilities to near zero in the desert areas, and closed major interstate highways east of Ontario.

3.18-19.1991	Storm winds gusted to 125 mph on Laguna Peak (Ventura Co.). Winds of 60 mph in San Carlos area of San Diego, probably a tornado.	Extensive damage in San Carlos area of San Diego.
12.19-21.1991	Strong northerly winds resulted from a deep low pressure system over Arizona. Top gusts reached 63 mph in the Santa Monica Mountains, 52 mph in Van Nuys, and 36 mph at LAX airport.	
2.28.1991	Strong storm winds hit the San Diego area.	Boats were torn from moorings at Harbor Island, San Diego Bay, and extensive roof damage was done to the San Diego Convention Center.
10.26-27.1993	Santa Ana winds: gust 62 mph at Ontario.	Twenty fires ravaged Southern California including in Laguna Hills. 4 dead, 162 injured, $1 billion economic losses in property alone and 194,000 acres were destroyed.
11.2-4.1993	Santa Ana winds gusted to over 60 mph.	The Old Topanga fire burned from Calabasas to the ocean consuming hundreds of homes.
12.24.1993	Santa Ana winds: gust 75 mph at Ontario.	
12.14.1996	Santa Ana winds: gust 111 mph at Fremont Canyon, gust 92 Rialto.	2 killed from flying debris.
12.21-22.1996	Storm winds 40-50 mph.	
1.5-6.1997	Storm winds: gust 99 mph at Fremont Canyon, 58 mph elsewhere.	
1.29.1997	Santa Ana winds: gust 100 mph at Fremont Canyon, 87 Rialto.	Big rigs blown over.
8.20.1997	The remnants of Tropical Storm Ignacio tracked northward moving inland in central California with gale force winds over portions of the Southern California coastal waters. This occurred during the strong El Niño of 1997-98.	

10.14.1997	Santa Ana winds: gusts 87 mph in central Orange County.	Large fire in Orange County.
12.10-12 .1997	Santa Ana winds: gust 96 mph (unofficial) at Pine Valley, 87 Upland.	2 killed from flying debris. Property damage in Sun City. Crop damage. Boats damaged and sunk at Coronado and Avalon.
12.18-22 .1997	Gusts 60 mph at Rialto. Gusts 67 mph at Idyllwild and below Cajon Pass.	1 killed. Fire, trees down, and widespread wind damage.
12.29 .1997	Gusts 60+ mph at Santa Ana.	
2.3-4.1998	Strong storm winds: gust 60 mph at Newport Harbor, 51 San Clemente.	
2.23-24.1998	Strong widespread storm winds 40-60 mph.	Trees and power lines knocked down. Damage.
3.28-29.1998	Strong storm winds in Orange County: sustained 30-40 mph. Gust 70 mph at Newport Beach, gust 60 Huntington Beach. Gusts to 60 mph in the mountains.	Trees down, power out, and damage across Orange and San Diego Counties. 1 illegal immigrant dead in Jamul.
12.9-10.1998	Santa Ana winds: gust 101 mph at Modjeska Canyon, gust 93 Fremont Canyon, 52 Santa Ana, 83 Ontario.	Trees and power lines down. Overturned vehicles. Property damage.
1.21.1999	Gust 80 mph in the Salton Sea area. Gusts up to 70 mph in the Coachella Valley, 47 Palm Springs, 36 Thermal.	
2.10-12.1999	Santa Ana winds: gust 85 mph at Rialto, gusts to 80 mph reported from I-8.	I-8 closed.
5.13.1999	Strong winds: sustained 61 mph at Borrego Springs.	Roof and tree damage.
11.22.1999	Gust 80 mph at Highland.	
12.3.1999	Santa Ana winds: gust 90 mph at San Bernardino, 68 Fontana.	
12.10-11.1999	Gust 60 mph at Palm Springs.	

12.21-22.1999	Santa Ana winds: gust 68 mph at Campo, 53 Huntington Beach, 44 Orange.	House and tree damage in Hemet.
1.5-6.2000	Santa Ana winds: gust 93 mph at Fremont Canyon, 60 Ontario, 58 Devore.	I-15 closed.
2.19.2000	Santa Ana winds: gust 92 mph at Fremont Canyon.	
2.21-23.2000	Winter storm winds: gust 75 mph along Highway 91.	Trees down at Lake Arrowhead.
4.1.2000	Santa Ana winds: gust 93 mph at Mission Viejo, 67 Anaheim Hills.	
4.17-18.2000	Late winter storm: gust 68 mph in the mountains of San Diego County.	
11.7.2000	Santa Ana winds: gust 82 mph at Fremont Canyon.	
12.25-26.2000	Santa Ana winds: gust 87 mph at Fremont Canyon.	Damage and injuries in Mira Loma, and Orange and Riverside Counties.
1.2-3.2001	Santa Ana winds: gust 52 mph at Ontario, 60 Rialto.	Viejas Fire. 5,500 acres burned. Trees and power lines down.
1.10-11.2001	Winter storm: gust 71 mph at Phelan.	
2.7.2001	Winter storm: gusts 50 mph at Palm Springs and Thermal, 54 Fish Creek.	
11.27.2001	Strong Santa Ana winds extend offshore from the coast.	Damage. A boat accident off Newport Beach.
12.7-8.2001	Santa Ana winds: gust 87 mph at Fremont Canyon.	Potrero Fire.
1.24.2002	Santa Ana winds.	
2.8-10.2002	Santa Ana winds: gust 80 mph at Descanso, 78 Fremont Canyon, 76 San Bernardino.	Fire in Fallbrook area.

1.6-7.2003	Very widespread Santa Ana winds: gust 100 mph at Fremont Canyon, 90 Ontario, 80 Upland, 72 Trabuco Canyon, 70 Riverside, 58 Miramar.	2 dead, 11 injured. Widespread property damage, road closures, power outages, trees down, wildfires, crop damage.
10.25-27.2003	Santa Ana Winds: gust 56 mph at Descanso, 46 Anza, 45 Ontario, 43 Fremont Canyon, 41 Beaumont, 40 Campo.	Unprecedented wildfires consumed hundreds of thousands of acres, killed over 20 people, caused over one billion dollars in damage.
10.20.2004	A storm wind of 39 mph was measured at Lindbergh Field from the south, the strongest October wind on record.	
11.21.2004	A cold storm brought wind gusts to 84 mph to Fremont Canyon.	
12.16.2004	Santa Ana winds sustained 51 mph with gusts to 78 mph at Fremont Canyon. Gusts to 69 mph northwest of San Bernardino and 66 mph near Pine Valley.	Big rigs blown over, closing a freeway for a short time. Other damage.
12.29.2004	A storm wind of 58 mph was measured at Lindbergh Field on 12.29 from the south, the strongest December wind on record. Wind gusts to 69 mph at Julian, 60-65 mph gusts in the Inland Empire and 60 mph at Alpine.	Widespread wind damage across the coasts and valleys.
2.3.2005	Strong storm winds of 70 mph hit the region.	Homes in Idyllwild were damaged by felled trees. Downed power lines in the Inland Empire. Big rig overturned on I-8.
4.7.2005	Strong winds in the Coachella Valley. Gust of 52 mph at Thermal, but likely stronger in the region.	Reduced visibility in La Quinta led to a 12 car pileup accident.
1.2.2006	Post frontal winds more than 50 mph widespread across the region.	The “M” above Moreno Valley was demolished. Trees were downed, power lines, power poles, on to houses and cars. In Crestline there were 20 homes left uninhabitable. In San Diego Bay boats broke loose from their moorings.

1.22-24.2006	Santa Ana wind event. Peak winds occurred on 1.24 at Fremont Canyon at 71 mph. During these days, wind gusts exceeded 60 mph on 19 hourly observations.	7 big rigs overturned in Fontana. Downed power lines and trees caused power outages and property damage. Roof of a car port torn off in Hemet. Dust storm closed Ramona Expressway.
2.6-7.2006	Santa Ana winds blew.	The Sierra Fire east of Orange burned nearly 11,000 acres. Eight minor injuries.
10.26.2006	Offshore winds blew to 40 mph in the Banning Pass.	The Esperanza Fire was started by an arsonist. It burned 40,200 acres from Cabazon to San Jacinto. It destroyed 34 homes and killed 5 firefighters.
11.29.2006	Offshore winds gusted to 73 mph at Fremont Canyon (sustained 54 mph), 58 mph at Ontario.	Widespread property damage and power outages as a result of downed power lines, poles and trees.
12.3.2006	Offshore winds gusted to 92 mph with seven gusts over 75 mph in northwest San Bernardino. Gusts to 75 mph at Fremont Canyon.	Downed power lines sparked a small fire in the Inland Empire. 16 power poles were downed in Valley Center.
12.27.2006	Strong storm winds hit the coast. Gusts hit 54 mph at La Jolla, 52 mph at Torrey Pines and San Clemente Island, 51 mph at Pt. Loma, 49 mph at Huntington Beach, 46 mph at North Island and 40 mph at San Diego Lindbergh Field.	Numerous trees were downed, damaging several vehicles.
1.5-8.2007	Offshore winds: Gusts to 84 mph at Fremont Canyon, 64 mph at Rancho Cucamonga, 63 mph at El Cariso, 62 mph at Rialto and 55 mph at Ontario.	Downed power poles, tree limbs. Trees fell on to homes and cars in Lake Arrowhead.

10.21-23.2007	Very strong Santa Ana winds. A gust of 85 mph was recorded at Fremont Canyon, 79 mph at San Bernardino, 75 mph at Descanso and Mira Loma, 74 mph at Fallbrook and Rancho Cucamonga. Some locations experienced tropical storm force winds (or greater) for more than 36 consecutive hours.	Winds caused at least $60 million in damage and destruction to buildings, fences, vehicles, etc. The devastating wildfires of 2007 were fanned by these winds. These fires caused the largest mass evacuation in California history.
11.15-19.2008	Santa Ana winds gusted over 70 mph in the Santa Ana mountains and over 60 mph in the northern Inland Empire.	Freeway Complex Fire from Corona through Chino Hills and Yorba Linda burned more than 30,000 acres.
1.9.2009	Santa Ana wind gusts of up to 83 mph at Fremont Canyon.	Winds downed trees and power lines, overturned semi-trucks, and damaged roofs.
3.22.2009	Strong onshore winds in the mountains and deserts with gusts 73 mph at Burns Canyon.	Winds knocked down trees, freeway signs, and power lines in the mountains and deserts. Two fires were reported in La Quinta, which caused damage to structures and trees.
4.3.2009	Strong onshore winds produced a gust of over 70 mph in Lucerne Valley.	The high winds resulted in downed power lines and minor roof damage. A 50 acre brush fire in Palm Springs damaged two homes and led to the evacuation of 50 other homes. The fire began in the late afternoon, burning desert scrub near a residential neighborhood and was contained later that evening.
1.19.2010	Strong storm winds struck the region. Wind gusts reached 60 mph in San Clemente. Several waterspouts and very strong winds of 93 mph were also reported in Newport Beach and Huntington Beach. A tornado occurred in Seal Beach and Huntington Beach.	A tree fell onto a mobile home in Lakeside, causing one fatality. Local damage including boats in Huntington Harbor.

Extreme Heat

Date(s)	**Weather**	**Adverse Impacts**
6.17.1859	133° in Santa Barbara from hot offshore (sundowner) winds. Accuracy discredited as temperature sensor was in full sun.	Roasted fruit on one side.
6.11.1877	112° observed in LA. It would be the all-time record, but official records didn't begin until 20 days later.	
3.28-29.1879	95° on 3.28 and 99° on 3.29 at San Diego. 99° in LA on 3.29.	
7.25.1891	109° in LA.	
5.27.1896	124° at Salton (City), the national maximum temperature for May.	
4.25.1898	118° at Volcano Springs (east side of Salton Sea, before the sea), the national maximum temperature for April. It was 117° at Salton (on the west side of the "sea").	
6.23.1902	129° at Volcano Springs (east side of Salton Sea, before the sea), the national maximum temperature for June. It was 127° at Salton (on the west side of the "sea").	
11.12.1906	105° at Craftonville (now Crafton Hills, near Redlands), the national maximum temperature for November.	
9.16.1909	100° in San Diego, the hottest day since 9.22.1883 (26 years). It occurred at 9 am.	
4.23.1910	100° in LA, a record for April.	

7.10.1913	134° at Death Valley, the hottest reading on record for the Western Hemisphere. And the nation's highest temperature on record for July. Sandstorm conditions accompanied the heat.	
9.17.1913	110° at San Diego**,** the highest temperature on record until 9.26.1963. Santa Ana conditions. An unofficial report of 127° came from San Bernardino.	One died, a carpenter working outside. A few small fires occurred, including one downtown that destroyed one house.
6.16.1917	124° at Mecca climaxes the most destructive heat wave of record in California history.	
7.6-8.17.1917	A prolonged hot spell hit Death Valley with 43 consecutive days of temperatures 120° or higher.	
2.25.1921	92° in LA, the hottest ever in February.	
9.16-17.1929	A hot spell hits San Diego. 111° in the coastal valleys. A reading of 94° was at San Diego at 4 am on 9.17.	
12.8.1938	100° at La Mesa, the national maximum temperature for December.	
9.18-22.1939	95+° records at San Diego each day, highest of 106° on 9.21. LA reaches 100° for seven consecutive days, peaking at 107° on 9.20. On 9.20 it was 107° in Escondido and 104° in the San Diego - College area. On 9.22 the low temperature in LA was 84°, the highest minimum on record.	Eight heat-related deaths in LA.
7.10.1940	97° at Santa Ana, 96° Laguna Beach.	
9.2.1950	126° at Mecca, the national maximum temperature for September.	
8.31-9.7.1955	Heat wave. On 9.1 it was 110° in LA, an all time record, and 104° in San Diego.	
7.17.1960	101° at Idyllwild.	

10.14.1961	Hot Santa Ana winds drove the temperature to 110° in Long Beach, the hottest in the nation, 107° in San Diego, 105° in LA, and over 100° in many coastal and inland locations. It was 88° at San Nicolas Island.	
9.26.1963	113° at El Toro, the hot spot in the nation for the date. 111° at Lindbergh Field, highest temperature on record (95° at 8 am). 112° at El Cajon, 109° at Imperial Beach, 108° at Carlsbad, Oceanside, Santee and Chula Vista, 107° at SDSU, Lemon Grove, La Mesa and Escondido, (only) 96° at Coronado.	Crop damage and animals killed. Schools dismissed, workers sent home, etc. Surf temperature dropped from 70° to 64° in one day due to the increased upwelling caused by offshore winds.
10.22.1964	Santa Ana conditions produced a high temperature of 104° at San Diego.	
10.20-29.1965	A very long heat wave. A peak of 104° at San Diego on 10.22. LA had 10 consecutive days with afternoon highs reaching 100 degrees.	
11.1.1966	101° at LA airport, 100° at LA, the all time November high, 97° at San Diego.	Santa Ana winds fan fires, which killed 16 fire fighters.
8.22.1969	110° at Cuyamaca.	
9.25-30.1970	Drought in southern California came to a climax. Hot Santa Ana winds sent the temperature soaring to 105° at LA and 97° at San Diego on 9.25.	The Laguna Fire consumed whole communities of interior San Diego County were. Half a million acres were burned, and the fires caused fifty million dollars damage.
8.11-13.1971	100° at Palomar Mountain.	
9.12.1971	103° in LA.	
10.6.1971	Santa Ana conditions produced a high of 101° at San Diego. It was 103° in La Mesa, 101° in National City, but only 84° at Imperial Beach!	A fire of 1000 acres burned southeast of Poway.
7.28-30.1972	100° at Palomar Mountain.	

11.12.1974	Santa Ana conditions warmed up Imperial Beach to 96°, the hottest in the nation that day. It was 91° at San Diego.	
6.9-13.1979	Five consecutive days of 90+° at San Diego, peaking with 101° on 6.10. Minima between 69° and 72°.	
7.10.1979	123° at Palm Springs.	
9.4-19.1984	Tropical air from weakening hurricane Marie brought hot conditions to the region. Record minima set each day except one at San Diego, ranging from 73° to the highest minimum of all time of 78° on 9.9. 100° maximum on 9.8. On 9.9 San Diego reached 100°, the hottest day since 9.15.1979.	Poor air quality and high humidity caused numerous health problems.
6.30.1985	100+° in parts of the city of San Diego.	Fire in Normal Heights - San Diego.
2.6.1987	A Santa Ana event brought warm weather to the coast: 82° at San Diego, 84° at Oceanside.	
4.21-22.1987	A rare springtime weak Santa Ana event brought 90°+ temperatures. 97° in El Cajon, 95° in Spring Valley, 94° in Santee, 93° at SDSU, Miramar, La Mesa, LA and Borrego Springs. It was 91° in Poway, Escondido and Fallbrook, and 87° in San Diego.	Numerous small brush fires erupted in the San Diego valleys.
9.1.1987	A tropical air mass (remnants of tropical storm Lidia) brought heat to the region: 109° at the Wild Animal Park, 106° in El Cajon, 105° in Escondido and Santee, 99° at SDSU, 89° in National City and 83° at San Diego.	
10.3-4.1987	108° in LA on both days, a record for October. It was 109° in El Cajon, 106° in Chula Vista, Fallbrook and Santee, and 104° in San Diego on 10.3.	Dry weather and winds fuel the Palomar Mountain fire.

2.10-11.1988	Record heat from Santa Ana conditions: On 2.10: 92° at San Juan Capistrano, the nation's high, 90° at Lemon Grove, 88° at Los Angeles and Escondido. On 2.11: 83° in San Diego, 87° in many locations around San Diego.	
3.25-26.1988	Santa Ana conditions brought temps in the 90s all over the region and record heat: 102° in Santee on 3.25, 97° throughout the San Diego Valleys, 95° in LA and Santa Maria, 90° in San Diego.	Several brush fires resulted.
4.6-7.1989	Daily high temperature records broken at ALL recording stations in Southern California. Many monthly record high temperatures set for April: Some highlights: 112° Palm Springs, 106° LA, 104° Riverside, 103° Escondido, 101° Tustin, 98° San Diego, 95° Victorville, 76° Big Bear Lake. Part of major heat wave from late March into mid April.	
7.4.1989	115° at Dulzura.	
5.5.1990	The high of 101° in downtown LA was 8 degrees higher than their previous record for the date.	
7.28.1991	120° in Borrego Springs, 100° in Campo.	
8.12.1991	Tropical storm Hilda sent hot humid air into the region. 94° at San Diego.	
8.17.1992	Tropical air brought high temperatures and heat index values to LA for a week. On this day it was 99° with a heat index of 110°.	
8.1.1993	123° at Palm Springs.	
2.20.1995	95° in LA, the highest temperature on record for February.	

7.27-29.1995	Heat wave: 123° at Palm Springs on 7.28-29. 120° at Coachella, 113° San Jacinto, 112° Riverside, 111° Banning, Moreno Valley, and Sun City. 110° at Yucaipa on 7.27.	
8.2-7.1997	Heat wave: 121° at Thermal, 113° Brea, 110° Riverside and Ontario, 101° Julian. Low of 93° at Palm Springs on 8.5.	5 deaths.
7.16.1998	120° at Palm Springs, 118° Borrego Springs (127° Death Valley).	
7.27.1998	123° at Thermal, 119° at Borrego Springs, 118° Palm Springs.	
8.29-31.1998	Record heat near coast. 112° at Yorba Linda and the Wild Animal Park, 110° at El Cajon, Hemet and Riverside, 108° at Ramona, 106° in Vista and Escondido, over 100° in most of Orange County. 114° at Dulzura on 8.29.	Firefighters were slowed while battling blazes at Lake Jennings and Camp Pendleton.
5.7-9.2001	Heat wave. 109° at Palm Springs, Thermal, and Borrego Springs, 103° at Hemet, 102° San Bernardino.	
9.1.2002	Tropical heat wave: 118° at Dulzura, 113° Temecula, 112° Riverside and Menifee. Sharp temperature gradients: 77° at Newport Beach to 107° Santa Ana (10 miles), 72° Oceanside Harbor to 87° Oceanside Airport (2 miles), 81° Sea World to 91° San Diego - Lindbergh Field (3 miles).	
4.26-27.2004	Record highs for April were set. On 4.26: 103° at Wild Animal Park, 100° at Yorba Linda. On 4.27 it was 85° at Idyllwild.	

7.10-20.2005	Strong high pressure brought a lengthy heat wave to the region. 121° in Thermal, 120° in Palm Springs and Borrego Springs, 116° in Hesperia. Big Bear Lake tied their all-time record at 94° on 7.18. 98° at Idyllwild. Low temperature at Indio was 90° on 7.13.	One death in the Anza Borrego Desert. Near record power consumption.
7.22.2006	A major heat wave with humidity, in some ways unprecedented, hit Southern California. 121° in Palm Springs, 120° at Indio and Thermal, 114° at Ontario and the Wild Animal Park, 113° at El Cajon. It was 112° at Escondido and 109° in La Mesa (both highest all time). Record minimum temperatures were recorded in most places. Desert locations reported the all-time warmest month on record. Sea temperatures hit 80°.	16 were killed from the heat, and many more were treated. Some power outages occurred.
7.3-6.2007	A major heat wave struck the mountains and deserts. A strong persistent marine layer precluded the heat wave from impacting the coasts and valleys. 119° in Ocotillo Wells, 116° in Palm Springs and Indio, 115° in Anza Borrego, 107° in Julian, 103° at Lake Cuyamaca, 100° at Idyllwild, 97° at Palomar Mountain, 94° at Big Bear Lake (ties all time high) and Mt. Laguna.	Some heat illnesses, poorly documented.
9.1-3.2007	A heat wave with a monsoon flavor. Temperatures exceeded 95° in the coasts and the mountains, 105° in the valleys, 110° in the Inland Empire and high deserts, and 115° in the lower deserts.	At least six deaths from heat related illnesses.

1.13.2009	The minimum temperature at Santa Ana of 73° not only set a record high minimum temperature for the date and month, but also for the entire winter season. Incredibly, the minimum is tied for the 23rd highest minimum temperature on record (and this was in January!). Persistent Santa Ana winds and strong high pressure were the causes.	
9.27.2010	Strong high pressure and offshore flow led to record high temperatures for many stations. Los Angeles reached their all-time high temperature of 113°. Santa Ana's 112° just missed the all-time mark by one degree. Numerous high temperature records for the month of September were broken. This fall heat followed the coolest summer since 1933.	
11.3-4.2010	Strong high pressure and offshore flow led to all-time November record high temperatures. At San Diego it reached 100° on 11.4, the highest temperature on record in November, and the only time it has reached the century mark in November. This was also the first time a 100 degree reading was reached in more than 21 years. In Riverside, the temperature of 99° on 11.3 tied and the 101° reading on 11.4 broke all time November records. On 11.3 it was 101° in Santa Ana, equaling the highest November temperature on record. And it was 96° in Laguna Beach, the second highest November temperature on record.	

Extreme Cold

Date(s)	Weather	Adverse Impacts
1.9.1888	Cold wave. Freezing temperatures in citrus growing areas.	Loss of citrus crop.
12.23-30.1891	Cold wave.	0.5” thick ice in San Diego pools, 1” thick ice on oranges on trees in Mission Valley.
12.17.1897	26° at Riverside.	
1.6-7.1913	25° at San Diego on 1.7, the lowest temperature on record. 28° on 1.6 with a high temperature of only 45°, the lowest maximum temperature on record. Also on 1.7: 4° at Campo, 9° Cuyamaca, 13° Alpine , 15° Julian and Lakeside, 20° El Cajon, 22° Lemon Grove, 24° La Mesa, and 26° Chula Vista.	Killing freeze all over San Diego County and many crops and fruit lost. Water pipes frozen, trolley lines disrupted, fishing nets unusable. Ice skating in a San Diego fountain on ice 0.75” thick. Extreme damage to citrus crop all over California. This directly led to the establishment of the U.S. Weather Bureau’s Fruit Frost forecast program.
12.14.1920	Frost was observed at the bay side in San Diego.	
1.22.1937	19° at Palm Springs.	
11.12.1938	24° in Escondido, 14° at Descanso, and 10° at both Palomar Mountain and Cameron (near Mt. Laguna).	
1.4.1949	8° at Palomar Mountain.	
1.25.1949	-4° at Cuyamaca.	The lowest temperature ever recorded in San Diego County.
1.4-5.1971	On 1.4: 29° at Pt. Loma and Chula Vista, 28° in La Mesa, 26° in El Cajon, 24° in Lakeside, 8° at Mt. Laguna, and 5° at Palomar Mountain. On 1.5, 1° at Idyllwild.	Ice skating was done on Lake Cuyamaca.
1.29.1979	-25° in Big Bear Lake.	The lowest temperature ever recorded in Southern California.

1.16-18.1987	A very cold air mass remained over the region. It was 10° at Mt. Laguna, 17° at Bonsall, 22° at Valley Center, 24° in Poway, 26° in El Cajon, 31° in Chula Vista and 36° at San Diego. On 1.17 it was 24° in Fallbrook, 28° in Del Mar.	Substantial avocado crop loss in the millions of dollars. Two homeless died of hypothermia on 1.17.
2.22-25.1987	Lows below 40° at Lindbergh for three consecutive days (coldest stretch since 1978).	
12.14-15.1987	13° in Mt. Laguna, 18° in Campo, 23° in Valley Center, 24° in Escondido, 28° in El Cajon, 31° in Del Mar, 32° in Imperial Beach, 33° in Chula Vista.	Minor damage to crops.
12.25-26.1987	9° at Mt. Laguna and 22° in Valley Center on 12.25. On 12.26: 15° in Julian and Mt. Laguna, 16° in Campo, 22° in Poway, 26° in El Cajon, 30° in Del Mar, 37° at San Diego.	Extensive damage to avocado and citrus crop.
12.24-30.1988	A week of subfreezing temperatures in Southern California.	5 people died as a result of the cold.
2.14.1990	A wind chill of -25° was reported at Mt. Laguna. High temperature was 52° at San Diego – Lindbergh Field.	
12.21-23.1990	An arctic air mass produced record cold and a low temperature of 29° at Redondo Beach on 12.22.	
6.3.1999	The high temperature of 38° at Mt. Wilson became the lowest high temperature on record for June.	
12.26.1997	0° at Big Bear Lake, 4° Big Bear Airport.	
12.7.1998	30° at Capistrano Beach and Dana Point, 29° at Mission Viejo and San Clemente.	

6.3.1999	Unseasonably cold air mass brings record cold so late in the season. Highs of 42° at Palomar Mountain and Mt. Laguna.	
2.14.2001	0° at Wrightwood.	
1.30-31.2002	13° at Shelter Valley, 17° Campo, 22° Ramona, 28° Escondido.	Crops damaged in northern San Diego County.
12.1-3.2004	30s at the coast, 20s in inland valleys and deserts, teens and single digits in the mountains. 8° on all three mornings at Big Bear. Wrightwood dipped to 9°.	Crops were damaged.
1.12-18.2007	A cold snap peaked on 1.15. -7° at Fawnskin, -2° at Big Bear Lake and Wrightwood, 5° at Hesperia, 6° at Mt. Laguna, 10° at Borrego Airport, 12° at Campo, 16° at Ramona, 18° at Thermal, 19° in Hemet, 20° at Camp Pendleton.	$114.7 million in crop damage in San Diego Co. $86 million in Riverside Co. $11.1 in San Bernardino Co. $600 thousand damage from broken pipes in San Bernardino Co. All 3 counties declared disaster areas.

High Surf, Stormy Seas, Tsunamis, Coastal Flooding and Erosion

Date(s)	Weather	Adverse Impacts
7.10.1855	An earthquake in LA causes two large swell to hit Dana Point.	
8.23.1856	A 7.8 magnitude earthquake in Japan. San Diego Bay rises 12' over the high water mark.	
5.27.1862	A 5.9 magnitude earthquake causes landslides into San Diego Bay and 3-4' wave runup.	
8.13.1868	Two earthquakes near 8.5 magnitude off Chile produce 2.64' wave height in San Diego.	
8.7.1906	Tsunami in San Diego from local sea quake.	
5.5.1918	Strong rip currents hit Ocean Beach.	13 men, including 11 servicemen, drown. More than 60 are rescued by lifeguards.
1927	A tsunami hit Southern California, raising the ocean by 6'.	
8.21.1934	Tsunami in San Diego with 20' maximum amplitude from local sea quake.	
12.12.1937	High surf.	Three piers ripped out from LA to Santa Barbara.
9.24.1939	Tropical storm. 50 mph winds. Extremely large waves.	48 dead from sinking boats. Harbors damaged.
4.1.1946	An 7.8 magnitude earthquake hits the Aleutian Islands. Newport Harbor shows a 5' drop in tide. San Pedro shows a 2.5' jump in tide.	
1.4-5.1959	High surf from a big storm.	Coastal damage in San Diego and Orange Counties. Boats and harbors damaged.

5.22-24.1960	An 8.5 magnitude earthquake hits Chile. Waves 8' above normal hit San Diego. Tide currents estimated at 2025 kts.	On 5.23 docks near Pt. Loma were destroyed. A barge broke in half in Quivira Basin of Mission Bay. Extensive damage to docks throughout the harbor. Ferry service to Coronado was disrupted. In LA: a scuba diver drowned, major damage to small craft, $1 million damage.
2.9-11.1963	High surf from a big storm.	Damage to coastal homes and structures.
3.28.1964	An 8.4 magnitude earthquake hits Alaska. Tsunami reaches all of California. 2' maximum amplitude in San Diego, 6.4' rise in 10 minutes.	Damage.
11.29.1975	A 7.2 magnitude earthquake hits Hawaii. Tsunami hits Catalina. 2.4' maximum amplitude in San Diego.	Damage.
2.13-21.1980	Large waves hit coast. Coastal flooding at Mission Beach; water over boardwalk and into houses.	
1.22-29.1983	A series of storms produces surf up to 20’ high. High tides and surf produce the peak of the damage on 1.26.	On 1.26 several piers were heavily damaged in Santa Monica, Seal Beach and Crystal Pier in Pacific Beach. Flooding damage to numerous businesses and homes in Malibu, Venice, Redondo Beach. Residents were evacuated from Seal Beach and Sunset Beach. Several injuries to people swept off rocks.
3.2-3.1983	Waves 15-20’ hit the coast around LA.	
2.14-17.1986	High surf from a big storm.	2 drowning deaths.
12.1-2.1986	High tides of 7.7’ at San Diego.	Minor flooding at La Jolla Shores’ parking lot. A few beach closures. On 12.1 minor flooding (4” of sea water) along Pacific Coast Hwy. in Huntington Beach from rising tides prompted lane closures.

12.31.1986	High tide in San Diego 7.8'. In Eureka the tide was 9.1', thought to be the highest in a century.	Luckily the weather was fine and surf was small. Minor flooding at coastal low spots on Mission Beach and Ocean Beach. Water lapping at the curbs of streets in Balboa Island, Newport Beach.
1.12.1987	Waves of 6-9' with sets up to 12' hit the coast.	One suspected drowning. 11' boat swamped.
2.2-4.1987	On 2.2 5-6' waves hit the coast.	Large surf inundated Seacoast Dr. in Imperial Beach. A man and his son were swept off Sunset Cliffs and died.
2.6.1987	A 20' rogue wave capsized a sportfishing boat off San Quintin, Baja.	10 of 12 boaters died.
12.16.1987	Stormy seas resulted from a strong Alaskan storm.	6 were rescued and 3 feared dead in a sinking of a fishing boat near Santa Barbara Island. A barge and fishing boat uprooted moorings and smashed into a wharf, and three sailboats were thrown onto the beach in Santa Barbara.
1.18-19.1988	Surf rose to 20' along beaches, some breakers to 25'.	8 killed, 3 reported missing all over Southern California. More than $68 million damage caused by surf. Boulders protecting Mission Bay were washed away. Asphalt and dunes were washed out in Coronado. Mission Beach condos flooded by ocean water and kelp; 3' of kelp landed in a front yard and more kelp went through a garage window! A boat was capsized. 7 beach swimmers were missing and 4 presumed drowned on 1.21.
4.30.1988	An earthquake 46 miles west of San Diego generates large surf of 14' with sets to 20'.	

5.29.1988	Gale force winds cause stormy seas.	Avalon Harbor was closed after several boats were driven ashore or scattered. One boater presumed dead. In Mission Bay one was injured when a catamaran was capsized. Piers were closed and surf claimed part of a restaurant in Redondo Beach. Boats were capsized around San Pedro. Two boaters died. Several boats were smashed against the rocks in Avalon Harbor.
3.19.1991	Strong storm winds created large waves and surf.	A 33' sailboat was blown aground and destroyed at Pt. Loma.
7.24-26.1996	7-10' surf with sets to 12' generated by an intense South Pacific storm south of Tahiti.	500+ rescues made at Southern CA beaches.
8.17-19.1997	Tropical storm Ignacio produces 18' waves in Orange County.	
9.14.1997	Hurricane Linda became the strongest storm recorded in the eastern Pacific with winds estimated at 180 mph and gusts to 218 mph. For a time it threatened to come ashore in California as a tropical storm, but the storm turned away, affecting the state with high surf: 15-18' waves at the Wedge at Newport Beach.	5 people were swept off a jetty at the Wedge and carried 300 yards out to sea before they were rescued by a passing boat.
9.25-26.1997	Hurricane Nora produces waves 20'+ at Seal Beach.	Tidal flooding over a 14 block stretch in Seal Beach.
12.7-8.1997	Coastal erosion in Laguna Beach.	
1.30.1998	High surf.	Coastal damage.

2.23-28.1998	High surf from a big storm combined with high tides.	Coastal damage and flooding (damage to Ocean Beach Pier). Several homes destroyed in San Diego County. Rocks were on highway 101 in Cardiff. Parking lots of restaurant row were littered with rocks and debris up to 1’ deep. Restaurants forced to cover windows with plywood.
10.27.2000	Heavy rain and very high tides.	Coastal inundation and flooding at Sunset Beach (Seal Beach).
1.9.2001	Very high tide, but only 4' surf.	Surfside in Seal Beach flooded.
11.27.2001	Strong winds off the coast.	Boat accident off Newport Beach.
9.5-6.2004	Large surf from Hurricane Howard. Waves 6-12’ throughout Orange County. Water temperature 72°.	More than 1,000 rescues during the hottest day of the year at the beach. Estimated 575,000 beach visitors.
1.8.2005	Large waves on top of very high tides greater than 7’.	Coastal flooding of PCH and boardwalk at Seal Beach.
12.21.2005	A powerful storm in the east Pacific generated large surf with sets of 20’.	Broken surfboards, rescues, beach erosion. All piers were shut down. Surf flooded a parking lot in Carlsbad and floated several cars. Boardwalk damage in Dana Point. Tow-in surfing occurred 1.5 miles off Seal Beach.
12.27.2006	Strong storm winds generated large surf. Highest sets were 10-16’. Surf was reported at 10-12’ with a 3 second period at Newport Beach.	
2.24-25.2008	High surf of 15’ struck the beaches.	Damage was done at the Ocean Beach pier.
7.24-26.2009	A long period four foot south swell generated high surf and strong rip currents. Eight to ten foot surf with sets to twelve feet were observed at many south facing beaches, and sets up to twenty feet reported in the most favorable locations. The high surf also generated strong rip currents, which were responsible for hundreds, perhaps even thousands, of rescues throughout Southern California.	Structural damage and one death occurred.

2.27.2010	A tsunami was generated from a Chile earthquake of 8.8.	Sections of a Shelter Island dock were damaged. Several vessels broke moorings in San Diego Bay.

Miscellaneous: Dense fog, barometric pressure, dry spells, etc.

Date(s)	Weather	Adverse Impacts
2.17.1883	Highest barometric pressure at San Diego: 30.53”.	
8.16.1909	A dry spell began in Bagdad, central San Bernardino County, lasted until 5.6.1912, a stretch of 994 days! (Southern Pacific RR employees kept this debated record).	
5.6.1912	It rained in Bagdad, ending a national record dry stretch of 994 consecutive days that began on 8.16.1909. (Southern Pacific RR employees kept this debated record).	
10.3.1912	A dry spell began in Bagdad, CA, lasting 767 days and ended on 11.9.1914. (Southern Pacific RR employees kept this debated record).	
11.9.1914	In Bagdad, rain finally fell ending an incredible dry spell at 767 days that started on 10.3.1912. (Southern Pacific RR employees kept this debated record).	
12.31.1929	Greenland Ranch, in Death Valley, California, went the entire year without measurable precipitation.	
8.1939	Sea surface temperatures off the Southern California coast are in the upper 70s during August, with some reports of 80° near San Diego.	
3.3.1983	Lowest barometric pressure at San Diego: 29.37”. This lasted until 1.21.2010 when the pressure fell to 29.15”.	
12.15.1969	Dense fog in Orange County.	100+ vehicle pile-up on I-5.

11.10.1980	Dense fog in San Bernardino.	24 vehicle pile-up on I-15. 7 dead, 17 injured.
2.21.1985	A sticky white rain fell across Southern California. Apparently, strong winds blew dust from the dry Owens and China Lakes and mixed with rain clouds.	Everything was covered with fine white grit, slightly alkaline, but non-toxic.
1.17.1988	Lowest barometric pressure at Los Angeles: 29.25”. This lasted until 1.21.2010 when the pressure dropped to 29.07”.	
12.31.1989	Santa Maria reported their driest year of record with just 3.3”of precipitation.	
2.14.2000	Dense fog at Cajon Pass.	71 vehicle pile-up on I-15. 22 injured. I-15 closed for 4 hours.
12.3.2000	Dense fog caused several fatal car accidents in San Diego County.	One man involved in the accidents jumped over a guard rail to escape traffic. Unaware he was on a bridge, he fell 70 feet to the road below.
10.24.2001	Dense fog in Inland Empire.	39 vehicles pile up in 13 separate accidents on I-215 in Perris. 8 injured.
11.3.2002	Dense fog in south LA.	194 vehicles were involved on two pileups on the 710 freeway. 0 deaths and 41 injuries.
7.28.2006	The ocean temperatures off San Diego County were well above normal during July. Normal temps are around 70°, but Del Mar sea temps averaged over 72° for the month. On 7.28 the reading was 81.1°.	Lifeguards broadcast the high sea temp reading to the people on the beach, who applauded “…like they had won a sweepstakes.”
6.11.2009	Dense fog in the mountains near San Bernardino.	Two multiple-car pileups occurred in the Cajon Pass on I-15. At least 30 vehicles were involved, and 15 injuries were reported. Along Highway 18, two related accidents occurred in the dense fog, resulting in one indirect death.

1.21.2010	The lowest barometric pressure readings in history in LA and San Diego. In LA pressure fell to 29.07”, breaking the record of 29.25” on 1.17.1988. In San Diego the pressure fell to 29.15”, breaking the record of 29.37” set on 3.3.1983.	

Appendix B - Weather Glossary

Acid Rain: Cloud or rain droplets containing pollutants, such as oxides of sulfur and nitrogen, to make them acidic (eg. pH <7.0). < 7.0)

ACCAS: An acronym for Altocumulus Castellanus.

Adiabatic Process: The change of temperature of air without transferring heat. In an adiabatic process compression results in warming, and expansion results in cooling.

Advanced Weather Information Processing System (AWIPS): NWS computer workstations that integrate graphics, including computer models, satellite and radar imagery.

Advection: The horizontal transport of air or atmospheric properties. Commonly used with temperatures, i.e., “warm air advection”.

Advection Fog: Fog that forms as warmer, moist air moves over a cold surface. The air is cooled to saturation by the loss of heat to the cold surface.

Advisory: Advisories are issued for weather situations that cause significant inconveniences but do not meet warning criteria and, if caution is not exercised, could lead to life-threatening situations. Advisories are issued for significant events that are occurring, are imminent, or have a very high probability of occurrence.

Air Mass: A large body of air having similar horizontal temperature and moisture characteristics.

Air Mass Thunderstorm: Generally, a thunderstorm not associated with a front or other type of synoptic-scale forcing mechanism. Air mass thunderstorms typically are associated with warm, humid air in the summer months; they develop during the afternoon in response to insolation, and dissipate rather quickly after sunset. They generally are less likely to be severe than other types of thunderstorms, but they still are capable of producing downbursts, brief heavy rain, and (in extreme cases) hail over 0.75” in diameter. Also, see Pulse Thunderstorm, Popcorn Convection and Single Cell Thunderstorm.

AIRMET (AIRman's METeorological Information): This NWS aviation product advises of weather that maybe hazardous, other than convective activity, to single engine, other light aircraft, and Visual Flight Rule (VFR) pilots. However, operators of large aircraft may also be concerned with these phenomena.

Air Parcel: An imaginary small body of air that is used to explain the behavior of air. A parcel is large enough to contain a very great number of molecules, but small enough so that the properties assigned to it are approximately uniform throughout.

Air Pressure: The force exerted on a surface by the weight of the air above it. The internationally recognized unit for measuring this pressure is the kilopascal.

Air Stagnation: A meteorological situation in which there is a major buildup of air pollution in the atmosphere. This usually occurs when the same air mass is parked over the same area for several days. During this time, the light winds cannot "cleanse" the buildup of smoke, dust, gases, and other industrial air pollution.

Air Transportatable Mobile Unit (ATMU): A modularized transportable unit containing communications and observational equipment necessary to support a meteorologist preparing on-site forecasts at a wildfire or other incident.

Albedo: The percentage of incoming radiation reflected by a surface.

ALERT Flood Warning System: A cooperative, community-operated flood warning system; the acronym stands for Automated Local Evaluation (in) Real Time. See also Automated Local Evaluation in Real Time (ALERT).

Aleutian Low: A semi-permanent, subpolar area of low pressure located in the Gulf of Alaska near the Aleutian Islands. It is a generating area for storms and migratory lows often reach maximum intensity in this area. It is most active during the late fall to late spring. During the summer, it is weaker, retreating towards the North Pole and becoming almost nonexistent. During this time, the North Pacific High pressure system dominates.

Algorithm: A computer program (or set of programs) which is designed to systematically solve a certain kind of problem. Numerical Prediction models have algorithms programmed into them to determine derived fields, such as precipitation or rising motion. WSR-88D radars (NEXRAD) employ algorithms to analyze radar data and automatically determine storm motion, probability of hail, VIL, accumulated rainfall, and several other parameters.

Altimeter: An instrument that indicates the altitude of an object above a fixed level. Pressure altimeters use an aneroid barometer with a scale graduated in altitude instead of pressure.

Altimeter Setting: That pressure value to which an aircraft altimeter scale is set so that it will indicate the altitude above mean sea-level of an aircraft on the ground at the location for which the value was determined.

Altitude: Height expressed as the distance above a reference point, which is normally sea level or ground level.

Altocumulus (Ac): These clouds are composed of mainly water. They appear as white or gray colored roll like elements or bands. The individual elements are large and darker than in cirrocumulus clouds. These clouds form between 6,500 and 23,000 feet.

Altocumulus Castellanus (ACCAS): They are middle level convective clouds and possibly they should be classified as clouds with extensive vertical development. They are composed of mainly water vapor. They are characterized by their billowing tops and comparatively high bases. These clouds form between 6,500 and 23,000 feet. These clouds are a sign of instability aloft, and may precede the rapid development of thunderstorms.

Altocumulus Standing Lenticular (ACSL): These clouds are formed on the crests of waves crested by barriers in the wind flow, such as mountains. The clouds show little movement and have the shape of a lens, hence the name standing lenticular. Wind, however, can be quite strong blowing through the cloud. They are characterized by their smooth, polished edges and may look like a stack of pancakes or a UFO. These may also form on wave crests. They are composed of mainly water vapor and form between 6,500 and 23,000 feet.

Altostratus (As): It is a bluish veil or layer of clouds having a fibrous appearance. The outline of the sun may show dimly as through frosted glass. It often merges gradually into cirrostratus. As with cirrostratus, it often is part of a cloud shield associated with a front. This type of cloud is composed of mainly water vapor and result from lifting a layer. These clouds form between 6,500 and 23,000 feet.

Anabatic Wind: A wind which blows up a steep slope or mountain side. It is also known as an upslope flow. These winds typically occur during the daytime in calm sunny weather. A hill or mountain top will be radiatively warmed by the sun which in turn heats the air just above it. See Katabatic Wind.

Anemometer: An instrument that measures wind speed.

Aneroid Barometer: An instrument designed to measure atmospheric pressure. It contains no mercury (Hg).

Anticyclone: An area of high pressure around which the wind blows clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. At the center of the circulation, there is sinking air. Generally, this sinking air provides clear skies.

Anvil: The flat, spreading top of a Cumulonimbus Cloud (Cb). Thunderstorm anvils may spread hundreds of miles downwind from the thunderstorm itself, and sometimes may spread upwind.

Apparent Temperature: A measure of human discomfort due to combined heat and humidity. It measures the increased physiological heat stress and discomfort associated with higher than comfortable humidity. The apparent temperature is less than the actual air temperature when the humidity is relatively low and that the apparent temperature indicates the reduced stress and increased comfort associated with the higher rate of evaporative cooling of the skin.

Arctic Air: A mass of very cold, dry air that usually originates over the Arctic Ocean north of Canada and Alaska.

Arctic High: A very cold high pressure that originates over the Arctic Ocean.

Area Forecast Discussion (AFD): This NWS product is intended to provide a well-reasoned discussion of the meteorological thinking which went into the preparation of the Zone Forecast Product. The forecaster will try to focus on the most particular challenges of the forecast. At the end of the discussion, there will be a list of all advisories, watches and warnings that are not short-fused (lasting less than 6 hours).

Arid: An adjunctive applied to regions where precipitation is so deficient in quantity, or occurs at such times, that agriculture is impracticable without irrigation.

Arroyo: A water-carved channel or gully in arid country, usually rather small with steep banks, dry most of the time, due to infrequent rainfall and the shallowness of the cut which does not penetrate below the level of permanent ground water.

ASOS: An acronym for **A**utomated **S**urface **O**bserving **S**ystem.

Atmosphere: The gaseous envelope surrounding the earth, composed primarily of nitrogen and oxygen.

Atmospheric Pressure: The pressure asserted by the mass of the column of air directly above any specific point (also called air pressure or barometric pressure).

Atmospheric Stability: An indication of how easily a parcel of air is lifted. If the air is very stable it is difficult to make the parcel rise. If the air is very unstable the parcel may rise on its own once started.

Aurora: A glowing light display in the nighttime sky cause by excited gases in the upper atmosphere giving off light. In the Northern Hemisphere, it is called the aurora borealis (northern lights). In the Southern Hemisphere, it is called aurora australis (southern lights).

Automated Local Evaluation in Real Time (ALERT): A local flood warning system where river and rainfall data area collected via radio signals in real-time at an ALERT base station.

Automated Surface Observing System: ASOS serves as the nation's primary surface weather observing network. It is designed to support weather forecast activities and aviation operations and, at the same time, support the needs of the meteorological, hydrological, and climatological research communities.

Avalanche: A mass of snow, rock, and/or ice falling down a mountain or incline. In practice, it usually refers to the snow avalanche. In the United States, the term snow slide is commonly used to mean a snow avalanche.

Aviation Area Forecast (FA): This NWS aviation product is a forecast of clouds and weather conditions over an area as large as the size of several states. It must be used in conjunction with Airmet bulletins for the same area in order to get a complete picture of the weather. The area forecast together with the Airmet Sierra bulletin are used to determine forecast enroute weather and to interpolate conditions at airports which do not have terminal forecasts (FT's) issued.

Aviation Weather Center (AWC): One of the National Centers for Environmental Prediction. The Aviation Weather Center (AWC), located in Kansas City, Mo., enhances aviation safety by issuing accurate warnings, forecasts and analyses of hazardous weather for aviation interests. The Center identifies existing or imminent weather hazards to aircraft in flight and creates warnings for transmission to the aviation community. The Center also originates operational forecasts of weather conditions that will affect domestic and international aviation interests.

AWIPS: Advanced Weather Information Processing System. NWS computer workstations that integrate graphics, including computer models, satellite and radar imagery.

Back-Building Thunderstorm: A thunderstorm in which new development takes place on the upwind side (usually the west or southwest side), such that the storm seems to remain stationary or propagate in a backward direction.

Back Door Cold Front: A cold front moving south or southwest, the opposite of typical cold fronts which move eastward.

Backing: A counterclockwise change in wind direction with increasing height in the atmosphere. For example, the wind direction would change from the north at the ground to the northwest aloft. This is indicative of the airmass cooling or cold air advection (CAA).

Bar: An obstacle formed at the shallow entrance to the mouth of a river or bay.

Baroclinic Zone: A region in which a temperature gradient exists on a constant pressure surface. Baroclinic zones are favored areas for strengthening and weakening systems; barotropic systems, on the other hand, do not exhibit significant changes in intensity. Also, wind shear is characteristic of a baroclinic zone. See Barotropic System.

Barometer: An instrument for measuring atmospheric pressure. The two most common types are the mercury barometer and the aneroid barometer.

Barometric Pressure: The actual pressure value indicated by a pressure sensor.

Barotropic System: A weather system in which temperature and pressure surfaces are coincident, i.e., temperature is uniform (no temperature gradient) on a constant pressure surface. Barotropic systems are characterized by a lack of wind shear. See Baroclinic Zone.

Base Reflectivity (R): This WSR-88D radar product depicts a full 360° sweep of echo intensity data. It is available for every elevation angle that is sampled in a volume scan. It is used to observe precipitation intensity and movement; determine storm structure; estimate hail potential; locate boundaries (cold front, outflow, sea breeze, etc.); identify cloud layers; and detect light snow, drizzle, birds, insects, and smoke plumes.

Base Velocity (V): This WSR-88D radar product depicts a full 360° sweep of radial velocity data. It is available for every elevation angle that is sampled in a volume scan. It is used to estimate wind speed and direction; determine regions of significant shear (convergence, etc.); locate boundaries (cold front, outflow, sea breeze, etc.); identify areas of circulation; and determine storm structure.

Beach Erosion: The carrying away of beach materials by wave action, currents, tides, or wind.

Bermuda High: A semi-permanent, subtropical area of high pressure in the North Atlantic Ocean off the East Coast of North America that migrates east and west with varying central pressure. Depending on the season, it has different names. When it is displaced westward, during the Northern Hemispheric summer and fall, the center is located in the western North Atlantic, near Bermuda. In the winter and early spring, it is primarily centered near the Azores in the eastern part of the North Atlantic. Then it may be referred to as the Azores High.

Best Track: A subjectively smoothed path, versus a precise and very erratic fix-to-fix path, used to represent tropical cyclone movement. It is based on an assessment of all available data.

Black Ice: Thin, new ice on fresh or saltwater, appearing dark in color because of its transparency; also popularly applied to thin hazardous ice coverings on roads.

Blizzard: A winter storm which produces the following conditions for at least 3 hours:

* Sustained winds or frequent gusts to 35 miles per hour or greater, and
* Considerable falling and/or blowing snow reducing visibility to less than 1/4 mile.

Blizzard Warning: This product is issued by the NWS when blizzard conditions are life threatening. The criteria for this warning varies from state to state.

Blocking High: The development of a warm ridge or cutoff high aloft at high latitudes which becomes associated with a cold high at the surface, causing a split in the westerly winds. Such a high will move very slowly, tending to move west during intensification and east during dissipation. It prevents the movement of migratory cyclones across its latitudes. Two examples are a cut-off high and an Omega block.

Blowing: A descriptor used to amplify observed weather phenomena (dust, sand, snow, and spray) whenever the phenomena are raised to a height of 6 feet or more above the ground and reduces horizontal visibility to less than 7 statue miles.

Blowing Dust (BLDU): Wind-driven dust that significantly reduces surface visibility to less than 7 miles.

Blowing Snow (BLSA): Wind-driven sand that significantly reduces surface visibility to less than 7 miles.

Blowing Snow (BLSN): Wind-driven snow that significantly reduces surface visibility to less than 7 miles. BLIZZARD: Snow with winds in excess of 35 mph and visibilities of 1/4 mile or less, for an extended period of time (e.g. > 3 hours).

Boundary Layer: In general, a layer of air adjacent to a bounding surface. Specifically, the term most often refers to the planetary boundary layer, which is the layer within which the effects of friction are significant. For the earth, this layer is considered to be roughly the lowest one or two kilometers of the atmosphere. It is within this layer that temperatures are most strongly affected by daytime insolation and nighttime radiational cooling, and winds are affected by friction with the earth's surface. The effects of friction die out gradually with height, so the “top” of this layer cannot be defined exactly.

Broken (BKN): An official sky cover classification for aviation weather observations, descriptive of a sky cover of 5/8 to 7/8.

CAA: An acronym for Cold air advection.

Cap or Cap Strength: It measures the ability of stable air aloft (a layer of relatively warm air) to inhibit low-level parcel ascent. Empirical studies show that a cap greater than 2°C often precludes thunderstorms in the absence of a strong dynamical or forced lift. This occurs even when the instability is excessive. A strong cap prevents widespread convection from occurring. Also called a lid.

Calm: A condition when *no* air motion is detected.

CAPE: An acronym for Convective Available Potential Energy.

Categorical: An NWS precipitation descriptor for a 80%, 90%, or 100% chance of measurable precipitation (0.01"). See Precipitation Probability (PoP).

Cb: An acronym for cumulonimbus.

Ceiling: The height of the lowest layer of clouds, when the sky is broken or overcast.

Ceilometer: A device used to evaluate the height of clouds or the vertical visibility into a surface-based obscuration.

Cell: Convection in the form of a single updraft, downdraft, or updraft/downdraft couplet, typically seen as a vertical dome or tower as in a cumulus or towering cumulus cloud. Some thunderstorms consist of several cells (see multi-cellular thunderstorm).

Celsius: A temperature scale in which 0° is the freezing point of water and 100° is the boiling point.

Chaff: Small strips of metal foil usually dropped in large quantities from aircraft or balloons. Chaff typically produces a radar echo which closely resembles precipitation. Chaff drops once were conducted by the military in order to confuse enemy radar, but now are conducted mainly for radar testing and calibration purposes.

Chance: An NWS precipitation descriptor for 30%, 40%, or 50% chance of measurable precipitation (0.01"). When the precipitation is convective in nature, the term scattered is used. See Precipitation Probability (PoP).

Chinook Wind: A warm, dry foehn wind that descends the eastern slope of the Rocky Mountains. The warmth and dryness of this wind can quickly melt and evaporate snowcover. Another kind of foehn wind is the Santa Ana.

Cirriform: High altitude ice clouds with a very thin wispy appearance.

Cirrocumulus(Cc): They are thin clouds, the individual elements which appear as small white flakes or patches of cotton, usually showing brilliant and glittering quality suggestive of ice crystals. They form at altitudes between 16,500 to 45,000 feet above ground.

Cirrocumulus Standing Leticular (CCSL): These clouds are formed on the crests of waves crested by barriers in the wind flow. The clouds show little movement hence the name standing. Wind, however, can be quite strong blowing through the cloud. They are characterized by their smooth, polished edges. They may also form on wave crests. They are ice crystal clouds and generally are whiter than ACSL. These clouds from between 16,500 and 45,000 feet.

Cirrostratus (Cs): They are thin, whitish cloud layers appearing like a sheet or veil. They are diffuse, sometimes partially striated or fibrous. Due to their ice crystal makeup, these clouds are associated with halos - large, luminous circles or arcs of circles surrounding the sun or moon. The layer frequently is the edge of a frontal shield. They form at altitudes between 16,500 to 45,000 feet above ground.

Cirrus (Ci): They are thin, feather like clouds composed entirely of ice crystals. They form at altitudes between 16,500 to 45,000 feet above ground. Thunderstorm anvils are a form of cirrus cloud, but most cirrus clouds are not associated with thunderstorms.

Civil Emergency Message (CEM): These NWS statements are issued when a local or state official wants a warning disseminated regarding nuclear accidents, spills of toxic material, and other similar situations.

Clear: Sky condition of less than 1/10 cloud coverage.

Climate: The historical record of average daily and seasonal weather events.

Climatological Data (CD): This National Climatic Data Center (NCDC) publication, also produced monthly and annually, contains daily temperature and precipitation data for over 8,000 locations.

Climate Diagnostics Center (CDC): The CDC is part of the National Oceanic & Atmospheric Administration (NOAA). Their mission is to identify the nature and causes of climate variations on time scales ranging from a month to centuries. The goal of this work is to develop the ability to predict important climate variations on these time scales.

Climate Prediction Center (CPC): The CPC is one of nine national centers that comprises the National Centers for Environmental Prediction (NCEP). Their mission is to maintain a continuous watch on short-term climate fluctuations and to diagnose and predict them. These efforts are designed to assist agencies both inside and outside the federal government in coping with such climate related problems as food supply, energy allocation, and water resources.

Closed Low: A low pressure area with a distinct center of cyclonic circulation which can be completely encircled by one or more isobars or height contour lines. The term usually is used to distinguish a low pressure area aloft from a low-pressure trough. Closed lows aloft typically are partially or completely detached from the main westerly current or jet stream, and thus move relatively slowly and erratically. See Cutoff Low.

Cloud: A visible aggregate of minute water droplets or ice particles in the atmosphere above the Earth's surface.

Cloud Height: The height of the base of a cloud or cloud layer above the surface of the earth.

Cloud Layer: An array of clouds whose bases are at approximately the same level.

Cloud Seeding: An experimental process used to weaken hurricanes or enhance rainfall in dry areas.

Cloud Streets: Rows of cumulus or cumulus-type clouds aligned parallel to the low-level flow. Cloud streets sometimes can be seen from the ground, but are seen best on satellite photographs.

Cloudy: When the predominant/average sky condition is covered completely by opaque (not transparent) clouds.

Clutter: Radar echoes that interfere with observation of desired signals on the radar display.

Coalescence: The process by which water droplets in a cloud collide and come together to form raindrops.

Coastal Convergence: The convergence or running together of land and sea winds, creating a stronger band of wind near the shore. Factors such as the shape of the shoreline and the angle between the wind and the shore determine the severity of this effect. See also Island Effect and Convergence Zone.

Coastal Flood Statement: This NWS product keeps the public and cooperating agencies informed of the status of existing coastal flood watches and warnings as well as provides an update on local conditions. It is also used to cancel a Coastal Flood Watch or a Coastal Flood Warning.

Coastal Flood Warning: This NWS product alerts residents along the Atlantic, Pacific, and Gulf Coasts that coastal flooding is either imminent or occurring.

Coastal Flood Watch: This NWS product alerts residents along the Atlantic, Pacific, and Gulf Coasts to the possibility of coastal flooding.

Coastal Flooding: Flooding that occurs where water is driven onto land from an adjacent body of water, usually caused by a combination of high surf and high tides. The high surf can come from strong winter storms or tropical cyclones.

Coastal Waters Forecast (CWF): A forecast of wind, wave and weather conditions between the coastline and 60 miles offshore.

Cold Air Advection: Transport of cold air into a region by horizontal winds.

Cold Core Low: A low pressure area which is colder at its center than at its periphery. Mid-latitude cyclones exhibit this temperature pattern. They usually produce much of their cloud cover and precipitation during the daytime when the instability is the greatest. At night, the clouds and precipitation usually diminishes significantly.

Cold Front: The leading edge of a relatively colder airmass which separates two air masses in which the gradients of temperature and moisture are maximized. In the northern hemisphere winds ahead of the front will be typically southwest and shift into the northwest with frontal passage.

Cold Pool: A region of relatively cold air, represented on a weather map analysis as a relative minimum in temperature surrounded by closed isotherms. Cold pools aloft represent regions of relatively low stability, while surface-based cold pools are regions of relatively stable air.

Combined Seas: Generally referred to as "Seas". It is used to describe the combination or interaction of wind waves and swells. In some prediction techniques, its height is the square root of the sum of the squares of the wind wave and swell heights. It is generally equal to the height of the swell plus 1/3 the height of the wind waves.

Comma Cloud: A synoptic scale cloud pattern with a characteristic comma-like shape, often seen on satellite photographs associated with large and intense low-pressure systems.

Composite Reflectivity(CR): This WSR-88D radar product displays the maximum reflectivities for each resolution grid box for all elevation angles in a volume scan. Available with combined attribute table which provides valuable information concerning storm characteristics, such as storm tops, maximum radial velocity and reflectivity, and possible existence of hail and mesocyclones. It is used to observe the highest reflectivities in a storm from any scanned elevation angle; determine intensity trends; and generate cross section through maximum reflectivity.

Condensation: The process of gas or vapor changing to liquid.

Condensation Funnel: A funnel-shaped cloud associated with rotation and consisting of condensed water droplets (as opposed to smoke, dust, debris, etc.). Compare with debris cloud.

Continental Air Mass: A dry air mass originating over a large land area.

CONUS: An acroynm for Continental United States.

Convection: Generally, transport of heat and moisture by the movement of a fluid. In meteorology, the term is used specifically to describe vertical transport of heat and moisture, especially by updrafts and downdrafts in an unstable atmosphere. The terms "convection" and "thunderstorms" often are used interchangeably, although thunderstorms are only one form of convection. Cumulonibus (Cb), towering cumulus clouds, and Altocumulus Castellanus (ACCAS) clouds all are visible forms of convection. However, convection is not always made visible by clouds. Convection which occurs without cloud formation is called dry convection, while the visible convection processes referred to above are forms of moist convection.

Convective Available Potential Energy (CAPE): It defines the vertically integrated positive buoyancy of an adiabatically rising air parcel on a sounding. This is proportional to the amount kinetic energy that the air parcel gains while it is warmer that the surrounding environment. As a result, CAPE provides the best measure of the potential instability available in the atmosphere. Increasing values of CAPE generally lead to progressively vigorous convection. However, severe thunderstorms can form in environments showing weak to moderate CAPE, especially if the Storm Relative Helicity values are high.

Convective Clouds: The vertically developed family of cumulus and cumulonimbus clouds. The height of their bases range from as low as 1,000 feet to a bit more than 10,000 feet. Clouds with extensive vertical development are positive indications of unstable air. Strong upward currents in vertically developed clouds can carry high concentrations of supercooled water to high levels where temperatures are quite cold. Upper portions of these clouds may be composed of water and ice.

Convective Outlook (SWO): A forecast containing the area(s) of expected thunderstorm occurrence and expected severity over the contiguous United States, issued several times daily by the SPC in Norman, Oklahoma. They are sent out as both a narrative and a graphic covering a period of up to 52 hours in advance. This product serves as guidance to the local NWS Office for use in the preparation of forecast products issued; to advise the public, media, and other interests of the possibility of severe weather; and to assist with preliminary staffing should severe weather be anticipated. The terms approaching, slight risk, moderate risk, and high risk are used to describe severe thunderstorm potential.

Convective Rain: Rain associated with convective or cumuliform clouds characterized by vertical development in the form of rising mounds, domes, or towers.

Convective SIGMETs: These NWS aviation products are issued in the conterminous U.S. for any of the following. Severe thunderstorm due to: surface winds greater than or equal to 50 knots, hail at the surface greater than or equal to 0.75" in diameter, tornadoes, embedded thunderstorms, line of thunderstorms, or thunderstorms greater than or equal to VIP level 4 affecting 40% or more of an area at least 3000 square miles. Any Convective SIGMET implies severe or greater turbulence, severe icing, and low level wind shear.

Convergence: A contraction of a vector field; the opposite of divergence. Convergence in a horizontal wind field indicates that more air is entering a given area than is leaving at that level. To compensate for the resulting "excess," vertical motion may result: upward forcing if convergence is at low levels, or downward forcing (subsidence) if convergence is at high levels. Upward forcing from low-level convergence increases the potential for thunderstorm development (when other factors, such as instability, are favorable).

Convergence Line or Zone: A horizontal line or zone along which horizontal convergence of the airflow is occurring. Common forms of convergence lines are sea-breeze fronts, cold-air outflow from thunderstorms, and synoptic fronts. In areas of complex terrain, these are often produced by air moving around terrain features. The effect is rising air motion along a line of convergence in the lee of the features, causing convective showers, thunderstorms, waterspouts or funnel clouds. See also Island Effect.

Cooling Degree Day: see Degree Day.

Cooperative Observer: An individual (or institution) who takes precipitation and temperature observations-and in some cases other observations such as river stage, soil temperature, and evaporation-at or near their home, or place of business. Many observers transmit their reports by touch-tone telephone to an NWS computer, and nearly all observers mail monthly reports to the National Climatic Data Center to be archived and published.

Coriolis Effect: The effect caused by the Earth's rotation which deflects air moving between two places. It causes an object to move to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

County Warning Area (CWA): The area assigned to a specific NWS Forecast Office for the purpose of warnings issuance and hazard awareness responsibility.

Creek: A small stream of water which serves as the natural drainage course for a small drainage basin.

CU: An acronym for cumulus.

Cumuliform: Descriptive of all clouds with vertical development in the form of rising mounds, domes, or towers.

Cumulonimbus Cloud (Cb): They are the ultimate manifestation of instability. They are vertically developed clouds of large dimensions with dense "boiling" tops often crowned with thick veils of dense cirrus (anvil). This is also called a "thunderstorm cloud". It can produce very heavy precipitation, lightning, large hail (greater than 0.75"), damaging winds, and tornadoes.

Cumulonimbus Mammatus Cloud (CBMAM): It is associated with a cumulonimbus cloud. It indicates extreme instability. This cloud is characterized by hanging festoons or protuberances underneath the anvil of the Cumulonimbus Cloud (Cb). The festoons may be at any level of the cloud from the underside of the anvil to the base of the cloud.

Cumulus Cloud (Cu): These clouds form in convective currents and are characterized by relatively flat bases and dome-shaped tops. Fair weather cumulus do not show extensive "towers" or vertical development and do not produce precipitation. A cumulus may, however, be an early stage in the development of towering cumulus or cumulonimbus. More often fair weather cumulus indicate a relatively shallow layer of instability.
Cumulus Congestus: Same as towering cumulus. Sometimes referred to just as congestus.

Cutoff Low: A closed low which has become completely displaced (cut off) from basic westerly current (such as the jet stream), and moves independently of that current. Cutoff lows may remain nearly stationary for days, or on occasion may move westward opposite to the prevailing flow aloft (i.e., retrogression), or erratically. “Cutoff low” and “closed low” often are used interchangeably to describe low pressure centers aloft. However, not all closed lows are completely removed from the influence of the basic westerlies. Therefore, the recommended usage of the terms is to reserve the use of “cutoff low” only to those closed lows which clearly are detached completely from the westerlies. See also Closed Low.

Cyclone: An area of low atmospheric pressure that has a closed circulation. Cyclones (or more commonly called “low pressure areas”) rotate counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. They often bring about clouds and precipitation. Also the term used for a hurricane in Australia and the Indian Ocean.

Cyclonic Circulation (or Cyclonic Rotation): Circulation (or rotation) which is in the same sense as the Earth's rotation, i.e., counterclockwise (in the Northern Hemisphere) as would be seen from above. Nearly all mesocyclones and strong or violent tornadoes exhibit cyclonic rotation, but some smaller vortices, such as gustnadoes, occasionally rotate anticyclonically (clockwise). Compare with anticyclonic rotation.

Daily Climate Report: As the name indicates, this tabular climatological product is issued daily by each NWS office. It is organized so that similar items are grouped together (i.e., temperature, precipitation, wind, sunrise and sunset times, etc.).

dBZ: A logarithmic expression for reflectivity factor, referenced to (1 mm^6 / 1 m^3). dBZ = 10 log (z / 1 mm^6 m^3). See decibel.

Dead Fuel Moisture: Dead fuel moisture responds solely to ambient environmental conditions and is critical in determining fire potential. Dead fuel moistures are classed by time lag. Dead fuels in NFDRS have four classes. 1-hr fuels are fine flashy fuels, less than 0.25” diameter, that respond quickly to weather changes and are computed from observation time temperature, humidity and cloudiness. 10-hr fuels are 0.25” to 1” in diameters and are computed from observation time temperature, humidity, and cloudiness, or may be a standard set of “10-Hr Fuel Sticks” that are weighed as part of the fire weather observation. 100-hr fuels are 1” to 3” in diameter and computed from 24 hour average boundary condition composed of day length, hours of rain, and daily temperature/humidity ranges. 1000-hr fuels are 3” to 6” in diameter and computed from a 7-day average boundary condition composed of day length, hours of rain, and daily temperature/humidity ranges.

Debris Cloud: A rotating “cloud” of dust or debris, near or on the ground, often appearing beneath a condensation funnel and surrounding the base of a tornado. Note that a debris cloud appearing beneath a thunderstorm will confirm the presence of a tornado, even in the absence of a condensation funnel.

Decibel (dB): This is a logarithmic expression comparing the energy that the radar emits (Z_1) to the energy that radar receives back from a radar target (Z_2). It is expressed mathematically as Z (dBZ) = 10 log (Z_1/Z_2) The solution to this equation lets the radar operator know the strength of a target. The value of Z is a function of the amount of radar beam energy that is back scattered by a target and detected as a signal (or echo). Higher values of Z (and dBZ) thus indicate more energy being back scattered by a target. See also dBZ.

Decouple: The tendency for the surface wind to become much lighter than wind above it at night when the surface temperature cools.

Degree Day: It gauges the amount of heating or cooling needed for a building using 65°F as a baseline. To compute heating/cooling degree-days, take the average temperature for a day and subtract the reference temperature of 65°F. If the difference is positive, it is called a *Cooling Degree Days*. If the difference is negative, it is called a *Heating Degree Days*. The magnitude of the difference is the number of days. For example, if your average temperature is 50°F for a day in December, the difference of the average temperature for that day and the reference temperature of 65°F would yield a minus 15°. Therefore, you know that you are going to have 15 Heating Degree Days that day. Electrical, natural gas, power, and heating, and air conditioning industries utilize heating and cooling degree information to calculate their needs.

Dense Fog: A fog in which the visibility is <¼ mile.

Dense Fog Advisory: This product is issued by the NWS when widespread fog reduces visibility to less than or equal to ¼ mile.

Dew: Water droplets that form upon surfaces on or near the ground when air is cooled toward its dew point.

Dew Point (Dew-Point Temperature): A measure of atmospheric moisture. The temperature to which air must be cooled, at constant pressure and moisture content, in order for saturation to occur. The higher the dew point, the greater amount of water vapor in the air mass.

Directional Shear: The component of wind shear which is due to a change in wind direction with height, e.g., southeasterly winds at the surface and southwesterly winds aloft. A veering wind with height in the lower part of the atmosphere is a type of directional shear often considered important for tornado development.

Dirty Ridge: Most of the time, upper-level ridges bring fairly clear weather as the storms are steered around the ridge. Sometimes, however, strong storms undercut the ridge and create precipitation. Ridges that experience this undercutting by storms are known as dirty ridges because of the unusual occurrence of precipitation.

Diurnal: Daily; related to actions which are completed in the course of a calendar day, and which typically recur every calendar day (e.g., diurnal temperature rises during the day, and diurnal falls at night).

Divergence: A measure of the expansion or spreading out of a vector field; usually said of horizontal winds. It is the opposite of convergence. Divergence at upper levels of the atmosphere enhances upward motion, and hence the potential for thunderstorm development (if other factors also are favorable).

Doppler Radar: A **W**eather **S**urveillance **R**adar (WSR-88D) system developed in 1988. About 120 systems were installed at Weather Forecast Offices. An additional 24 systems were installed at Department of Defense (Air Force Bases) sites. This powerful and sensitive Doppler system generates many useful products for meteorologists, among them: standard reflectivity echoes, wind velocity or atmospheric air motion pictures, and areal 1-hour, 3-hour, or storm-total precipitation images. This radar can also measure radial velocity, the instantaneous component of motion parallel to the radar beam (i.e., toward or away from the radar antenna).

Doppler Shift: The change in observed frequency of wave energy due to the relative motion of the observer and wave source. For example, as a train approaches your location, you hear a higher pitch sound. After the train has passed your location, you will hear a lower pitch sound. The Doppler radar uses this change in frequency to determine the velocity and direction of the wind.

Downburst: A strong down draft, initiated by a thunderstorm, that induces an outburst of damaging straight line winds on or near the ground. Downburst winds can produce damage similar to a strong tornado. The damage from aloft often looks like a star with debris spreading out from the center in straight lines. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder. Downbursts come in the following to 2 categories: microburst and macroburst.

Downdraft: A small-scale column of air that rapidly sinks toward the ground as in a shower or thunderstorm. A downburst is the result of a strong downdraft.

Downslope Flow: Air that descends down a mountain chain or over sloping terrain (pressurized air moving from high pressure to low pressure), resulting in subsequent drying, and in some cases, dramatic warming of air that can quickly melt a snowcover. Local names for downslope winds or “foehn winds” in the western United States are Chinook Winds, East Winds, North Winds, Mono Winds and Santa Ana Winds. Usually associated with little or no clouds.

Drainage Basin or Area: A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

Drizzle (DZ): Fairly uniform precipitation composed exclusively of fine drops with diameters less than 0.02” (0.5 mm) which are very close together. Drizzle appears to float while following air currents, although unlike fog droplets, it falls to the ground. The intensity of drizzle is based solely on visibility.

Drought: A period of abnormally dry weather sufficiently prolonged from the lack of precipitation to cause a serious hydrologic imbalance.

Drought Index: Computed value which is related to some of the cumulative effects of a prolonged and abnormal moisture deficiency. (An index of hydrological drought corresponding to levels below the mean in streams, lakes, and reservoirs.).

Dryline: A boundary separating moist and dry air masses and an important factor in severe weather frequency in the Great Plains. It typically lies north-south across the central and southern high Plains states during the spring and early summer, where it separates moist air from the Gulf of Mexico (to the east) and dry desert air from the southwestern states (to the west).

Dry Microburst: A microburst with little or no precipitation reaching the ground, most common in semi-arid regions. They may or may not produce lightning. Dry microbursts may develop in an otherwise fair-weather pattern; visible signs may include a cumulus cloud or small Cb with a high base and high-level virga, or perhaps only an orphan anvil from a dying rain shower. At the ground, the only visible sign might be a dust plume or a ring of blowing dust beneath a local area of virga. Compare with wet microburst.

Dry Slot: A zone of dry (and relatively cloud-free) air which wraps east or northeast into the southern and eastern parts of a large or small scale low pressure system. A dry slot generally is seen best on satellite photographs.

Dust Devil: A small, vigorous whirlwind, usually of short duration, rendered visible by dust, sand, and debris picked up from the ground. They range from 10 feet to greater than 100 feet in diameter, and can extend up to 1000 feet above the ground. They are caused by intense surface heating. This heating causes the air to rapidly rise and thus, a mini low pressure system is formed. They are usually found in desert or dry climatic regions where dust and dirt can be easily lifted. Only rarely do they cause any damage. Wind speeds can reach 30 to 60 mph.

Dynamics: Generally, any forces that produce motion or effect change. In operational meteorology, dynamics usually refer specifically to those forces that produce vertical motion in the atmosphere.

Easterly Wave: A wavelike disturbance in the tropical easterly winds that usually moves from east to west. Such waves can grow into tropical depressions.

Ebb Current: A receding tidal current that moves water away from shore or down a tidal river or estuary.

Echo: Energy back scattered from a target (precipitation, clouds, etc.) and received by and displayed on a radar screen.

ECMWF: An acronym for European Centre for Medium-Range Weather Forecasting model. See European Model.

Eddy: A small rotating area of water.

EF Scale: See Enhanced Fujita Scale (EF-scale).

El Niño: The warm phase of the Southern Oscillation (SO). Characterized by the warming of the sea surface temperatures (SST) in the central and eastern equatorial Pacific Ocean, beginning at about Christmas time (hence the name "El Niño", which is Spanish for "Christ child"). This causes the sardine population to die off the Peru coast. The anomalously warm water also causes the deep convection to shift from its normal position near Indonesia to the east. This is also preceded and accompanied by anomalous westerly wind at low levels. During the warm phase of the SO severe drought occurs over Indonesia and Australia. The warming of the ocean in the tropical Pacific increases the strength of the Hadley circulation (a global wind pattern) and causes the entire tropics to warm. The strengthened hemispheric north-south temperature gradient adds energy to the atmosphere. In particular, the subtropical jet is stronger and its maximum wind extends farther to the east than is normal. This is often related to the deeper than normal Aleutian low, a split jet-level flow over the western U.S. and a trough in the southeastern U.S.. This pattern is called the "Pacific North American Teleconnection pattern". When established, it leads to warm, dry conditions over the northern U.S., particularly the Northwest, and to unusually wet conditions over the southern U.S.. The El Niño typically lasts from 12 to 18 months. See Southern Oscillation, ENSO, and La Niña.

El Niño Southern Oscillation (ENSO): An acronym designed to stress the special importance of the warm phase (El Niño) of the Southern Oscillation. See El Niño and Southern Oscillation.

Emergency Managers Weather Information Network (EMWIN): A means of providing the emergency management community with access to a set of NWS warnings, watches, forecasts, and other products at no recurring cost. EMWIN is a suite of data access methods which make available a live stream of weather and other critical emergency information, including: 1. Radio - Digital weather information is transmitted using inexpensive radio broadcast and personal computer (PC) technologies. 2. Internet - The Interactive Weather Information Network (IWIN) page uses HTML formatting and additional hyperlinks to an EMWIN server that ingests the data. 3. Satellite - Satellite broadcast makes the datastream available nationwide, but not to provide detailed support (i.e. funding, manpower, or equipment) for state and local efforts to redistribute the datastream after downlink. The NWS broadcasts EMWIN on GOES 10 and GOES 12 satellites. Note: The above methods are intended to provide data to users at little or no cost. There are other methods available, at higher cost to the end-user, including various commercial weather distribution systems. EMWIN is a supplement to other NWS dissemination services, which include: NOAA Weather Radio (NWR), NOAA Weather Wire System (NWWS), Family of Services (FOS), NOAAPORT, and NEXRAD Information Dissemination Service (NIDS).

Enhanced Fujita Scale (EF-scale): A system originally developed as the Fujita Scale by Dr. Theodore Fujita of the University of Chicago to classify tornadoes based on wind damage. The Enhanced Fujita Scale is an adaptation implemented by the NWS in 2007 to more accurately rate tornadoes from EF0 for weakest to EF5 for strongest tornadoes. See also Fujita F Scale.

Environmental Modeling Center (EMC): This is one of 9 centers that comprises the National Centers for Environmental Prediction (NCEP). This center improves numerical weather, marine and climate predictions, through a broad program of research in data assimilation and modeling. In support of the NCEP operational forecasting mission, the EMC develops, improves and monitors data assimilation systems and models of the atmosphere, ocean and coupled system, using advanced methods developed internally as well as cooperatively with scientists from Universities, NOAA Laboratories and other government agencies, and the international scientific community.

European Model: One of medium-range (3 to 7 days) forecast models that forecasters use to write their extended forecasts. It has a resolution of 75 kilometers and covers the entire northern hemisphere. This model comes from European Centre for Medium-Range Weather Forecasts

(ECMWF) which is an international organization supported by 18 European Member States. See GFS and UKMET.

Evaporation: A process by which liquid changes into a gas or vapor.

Evapotranspiration: Combination of evaporation from free water surfaces and transpiration of water from plant surfaces to the atmosphere.

Excessive Heat Warning: This product is issued by the NWS when excessive heat is life threatening. The criteria for this warning varies from state to state.

Extratropical: A term used in advisories and tropical summaries to indicate that a tropical cyclone has lost its “tropical” characteristics. The term implies both poleward displacement of the cyclone and the conversion of the cyclone's primary energy source from the release of latent heat of condensation to baroclinic (the temperature contrast between warm and cold air masses) processes. It is important to note that cyclones can become extratropical and still retain winds of hurricane or tropical storm force.

Eye: The relatively calm center in a hurricane that is more than one half surrounded by wall cloud. The winds are light, the skies are partly cloudy or even clear (the skies are usually free of rain) and radar depicts it as an echo-free area within the eye wall. The hurricane eye typically forms when the maximum sustained tangential wind speeds exceeds about 78 miles an hour. The eye diameter, as depicted by radar, ranges typically from as small as 5 to 10 miles upwards to about 100 miles. The average hurricane eye diameter is a little over 20 miles. When the eye is shrinking in size, the hurricane is intensifying.

F Scale: See Fujita Scale.

Fahrenheit (F): The standard scale used to measure temperature in the United States, in which the freezing point of water is 32° and the boiling point is 212°.

Fair: It is usually used at night to describe less than 3/8 opaque clouds, no precipitation, no extremes of visibility, temperature or winds. It describes generally pleasant weather conditions.

Fetch: The area in which ocean waves are generated by the wind. Also refers to the length of the fetch area, measured in the direction of the wind.

Few (FEW): An official sky cover classification for aviation weather observations, descriptive of a sky cover of 1/8 to 2/8. This is applied only when obscuring phenomenon aloft are present--that is, not when obscuring phenomenon are surface-based, such as fog. Also, an NWS convective precipitation descriptor for a 10% chance of measurable precipitation (0.01”). Few is used interchangeably with isolated. See Precipitation Probability (PoP).

Fire Behavior: A complex chain-reaction process that describes the ignition, buildup, propagation, and decline of any fire in wildland fuels.

Fire Danger: The result of both constant factors (fuels) and variable factors (primarily weather), which affects the ignition, spread, and difficulty of control of fires and the damage they cause.

Fire Danger Rating: A fire control management system that integrates the effects of selected fire danger factors into one or more qualitative or numerical indices from which ease of ignition and probable fire behavior may be estimated.

Fire Weather Services: Routine daily forecasts; spot forecasts; prescribed burn forecasts; smoke management forecasts and information, advisories, observations, summaries, and briefings produced in and by an NWS office during normal working hours, plus warnings of critical weather conditions. Generally, these basic services are tailored to meet the specific needs of user agencies.

Fire Weather Watch: A product issued by the NWS when fuel conditions and weather portray a high or extreme fire danger, usually when very low humidity and strong winds are forecast. This is usually followed by a Red Flag Warning.

Flash Flood: A flood which follows within a few hours (usually less than 6 hours) of heavy or excessive rainfall, or dam or levee failure. This is a dangerous situation that threatens lives and property.

Flash Flood Statement (FFS): This product is issued after either a Flash Flood Watch or a Flash Flood Warning has been issued by a local NWS Forecast Office. It will provide the latest information on the flash flooding situation or event. It will also be used to remove parts of the geographical area covered by the original watch or warning when the flash flooding event is no longer a threat or has ended in a certain area. Finally, this statement can be used to terminate the original watch or warning when it is no longer valid.

Flash Flood Warning (FFW): This warning signifies a short duration of intense flooding of communities, streams, or urban areas with high peak rate of flow. Flash floods may result from such things as torrential downpours or dam and levee breaks. They are issued by the local NWS Office for 4 hours or less. \

Flash Flood Watch (FFA): This product is issued by the local NWS office for events that have the potential for short duration (usually less than 6 hours) intense flooding of communities, streams or areas for which the occurrence is neither certain nor imminent. This watch indicates that flash flooding is a possibility in or close to the watch area. Those in the affected area are urged to be ready to take action if a Flash Flood Warning is issued or flooding is observed. A Flash Flood Watch may be issued for potential flooding from eitherdam breaks, or torrential downpours.

Flood: The inundation of a normally dry area caused by high flow, or overflow of water in an established watercourse, such as a river or stream. This is a duration type event with a slower onset than flash flooding, normally greater than 6 hours.

Flood Stage: A gage height at which a watercouse overtops its banks and begins to cause damage to any portion of the defined reach.

Flood Statement (FLS): This product is issued after either a Flash Flood Watch or a Flash Flood Warning has been issued by a local NWS Forecast Office. It will provide the latest information on the flash flooding situation or event. It will also be used to remove parts of the geographical area covered by the original watch or warning when the flash flooding event is no longer a threat or has ended in a certain area. Finally, this statement can be used to terminate the original watch or warning when it is no longer valid.

Flood Warning (FLW): This warning signifies a longer duration and more gradual flooding of communities, streams, or urban areas. Floods usually begin after 6 hours of excessive rainfall.

Flood Watch (FLA): This watch is issued by a local NWS Office to indicate that there is a potential of flooding in or close to the watch area. Those in the affected area are urged to be ready to take action if a flood warning is issued or flooding is observed. In flooding, the onset of flooding take place much slower (usually greater than 6 hours) than a flash flood.

Flow: 1. The general movement of air, either in the upper or lower atmosphere, e.g. “onshore flow” is air moving from the ocean to land. 2. Volume of water in a river or stream, passing a specific observation site, during a specific time period. It is typically expressed in units of cubic feet per second.

Flurries: Light snowfall that generally does not produce a measurable accumulation.

Fog (FG): A visible aggregate of minute water particle (droplets) which are based at the Earth's surface and reduces horizontal visibility to less than 5/8 statue mile, and unlike drizzle, it does not fall to the ground. It occurs most frequently in coastal regions because of the great water vapor content of the air. However, it can occur anywhere. The rapidity with which fog can form makes it especially hazardous. It forms by any atmospheric process that does one of the following: Cools the air to its dew point, or raises the dew point to the air temperature. Names given to fog types identify their methods of formation. The principle types are radiation fog, ice fog, advection fog, upslope fog, rain induced fog, and steam fog. These types of fog are called “dense” when the surface visibility is equal to or less than 1/4 mile. A Dense Fog Advisory will be issued when the dense fog becomes widespread.

Foëhn: A warm dry wind on the lee side of a mountain range. The heating and drying are due to adiabatic compression as the winds descend downslope. Foëhn winds are Mistrals in France, Sciroccos in North Africa, Chinooks in the northern plains of the U.S., Mono Winds in Northern California, Diablo Winds in the San Francisco Bay Area, and Santa Ana Winds in Southern California.

Forecast Models: Forecasters use numerical weather models to make their forecasts. These numerical models are classified into four main classes. The first is global models, which focus on the entire northern hemisphere. The second is national models, which focus on the USA. The third is regional models. These regional models have a finer grid than national models and are run out for smaller periods of time. The final class of models is relocatable models, which do not focus on any permanent geographical location. Relocatable models are very limited on the size of the geographical area for which they can forecast, but these models have very high resolutions, or very small forecast grid boxes.

Freeze: It is when the surface air temperature is expected to be 32°F or below over a widespread area for a climatologically significant period of time. Use of the term is usually restricted to advective situations or to occasions when wind or other conditions prevent frost. Adjectives such as “killing”, “severe”, or “hard” will be used when appropriate. “Killing” may be used during the growing season when the temperature is expected to be low enough for a sufficient duration to kill all but the hardiest herbaceous crops or plants.

Freezing Level: The lowest altitude in the atmosphere, or a given location, at which the air temperature is 32°F.

Freezing Rain or Drizzle: This occurs when rain or drizzle freezes on surfaces (such as the ground, trees, power lines, motor vehicles, streets, highways, etc.) that have a temperature of 32°F or below. Small accumulations of ice can cause driving and walking difficulties. Meanwhile, heavy accumulations of ice can pull down trees and utility lines. In this situation, it would be called an Ice Storm.

Front: A boundary or transition zone between two air masses of different density, and thus (usually) of different temperature. A moving front is named according to the advancing air mass, e.g., cold front if colder air is advancing. See cold front, occluded front, stationary front, and warm front.

Frost: The formation of ice crystals on the ground or other surfaces in the form of scales, needles, feathers, or fans. Frost develops under conditions similar to dew, except the temperatures of the Earth's surface and earthbound objects fall below 32°F. As with the term “freeze”, this condition is primarily significant during the growing season. If a frost period is sufficiently severe to end the growing season or delay its beginning, it is commonly referred to as a “killing frost”. Some objects cool more efficiently than the air, and can cause frost to form on objects, even when air temperatures are well above freezing.

Frost/Freeze Advisory: This product is issued by the NWS when freezing temperatures or conditions conducive to the formation of frost occur during the growing season.

Frost Point: Dew point below freezing.

Fractus: Ragged, detached cloud fragments; same as scud.

Fuel Moisture: The water content of fuel particle expressed as a percent of the oven dried weight of the fuel particle. Fuel moisture observations are generally for the 10-hour time lag fuels (medium-sized roundwood 0.25” to 1” in diameter).

Fujita Scale (F-scale): A scale used to classify the strength of a tornado. It was devised by Dr. Theodore Fujita from the University of Chicago. The F-scale gives tornadoes a numerical rating from F0 to F5 based on wind damage. This system was adjusted by the NWS as the Enhanced Fujita Scale and implemented in 2007.

Funnel Cloud (FC): A condensation funnel extending from the base of a towering cumulus or Cb, associated with a rotating column of air that is not in contact with the ground (and hence different from a tornado). A condensation funnel is a tornado, not a funnel cloud, if either it is in contact with the ground, or a debris cloud or dust whirl is visible beneath it.

Gale: Wind speeds from 39 to 54 mph (34 to 47 knots).

Gale Warning: The NWS will issue marine warnings for 1-minute sustained winds between 34 (39 mph) and 47 knots (54 mph) are expected in coastal waters.

Geostationary Satellite: Satellites orbiting at 22,370 miles above the Earth's surface with the same rotational velocity as the Earth; therefore, the satellite remains over the same location on the Earth 24 hours a day.

GFS: An acronym for Global Forecast System.

Glaze: Ice formed by freezing precipitation covering the ground or exposed objects.

Global Forecast System (GFS): The MRF and AVN forecast models from NCEP were combined into a single system and renamed the Global Forecast System (GFS). The GFS produces forecasts out to 16 days, four times per day.

Global Warming: An overall increase in world temperatures which may be caused by additional heat being trapped by greenhouse gases.

GOES: **G**eostationary **O**perational **E**nvironmental **S**atellite.

Gradient: The time rate or spatial rate of change of an atmospheric property.

Graupel: Small pellets of ice created when supercooled water droplets coat, or rime, a snowflake. The pellets are cloudy or white, not clear like sleet, and often are mistaken for hail. Also called soft hail, snow pellets, or tapioca snow.

Gravity Wave: A wave disturbance in which buoyancy acts as the restoring force on parcels displaced from hydrostatic equilibrium. Waves on the ocean are examples of gravity waves.

Greenhouse Effect: The heating effect caused by gases in the atmosphere absorbing heat (solar radiation) instead of letting it escape back into space. There are 2 types: **Natural** - It is what keeps the Earth's average temperature at 59°F instead of 0°F. In this case, the most abundant greenhouse gas is water vapor. **Anthropogenic** - Additional warming caused by having too much carbon dioxide (CO_2).

Ground Clutter: A pattern of radar echoes from fixed ground targets (buildings, hills, etc.) near the radar. Ground clutter may hide or confuse precipitation echoes near the radar antenna. It is usually more noticeable at night when the radar beam is encountering superrefractive conditions.

Ground Fog: Fog produced over the land by the cooling of the lower atmosphere as it comes in contact with the ground. Also known as radiation fog, and in Central California as tule fog. Groung fog has little vertical extent (usually 20 feet or less).

Gust: A brief sudden increase in wind speed. Generally the duration is less than 20 seconds and the fluctuation greater than 10 mph.

Gust Front: Formed when the down draft and rain-cooled air of a thunderstorm reach the ground, and then spread out along the ground. Usually marked by a sudden wind shift, sharply falling temperatures, and possibly heavy downpours and/or hail. If two or more of these gust fronts intersect each other, a new thunderstorm could possibly develop. Sometimes it is associated with a shelf cloud or roll cloud. Also, see downburst, gustnado, and outflow boundary. .

Gustnado: Slang for a gust front tornado. A small tornado, usually weak and short-lived, that occurs along the gust front of a thunderstorm. Often it is visible only as a debris cloud or dust whirl near the ground. Gustnadoes are not associated with storm-scale rotation (i.e. mesocyclones).

Gyre: A circular or spiral motion, primarily referring to water currents.

Hail (GR): Precipitation in the form of balls or lumps usually consisting of concentric layers of ice. A thunderstorm is classified as severe when it produces hail 0.75" or larger in diameter.

Haines Index: This is also called the Lower Atmosphere Stability Index. It is computed from the morning (12Z) soundings from RAOB stations across North America. The index is composed of a stability term and a moisture term. The stability term is derived from the temperature difference at two atmosphere levels. The moisture term is derived from the dew point depression at a single atmosphere level. This index has been shown to be correlated with large fire growth on initiating and existing fires where surface winds do not dominate fire behavior. The Haines Indexes range from 2 to 6 for indicating potential for large fire growth: 2 – Very Low Potential (Moist Stable Lower Atmosphere), 3 – Very Low Potential, 4 – Low Potential, 5 – Moderate Potential, 6 – High Potential (Dry unstable lower atmosphere.

Halos: Rings or arcs that seem to encircle the sun or moon. They are caused by the refraction of light through the ice crystals in cirrus clouds.

Haze (HZ): A concentration of salt particles or other dry particles not readily classified as dust or other phenomenon. Occurs in stable air usually only a few thousand feet thick, but may extend as high as 15,000 feet. Haze layers often have definite tops above which the visibilities are good. However, the visibility in the haze layer can be very poor.

Heat Advisory: This product is issued by the NWS when excessive heat may pose a hazard or is life threatening if action is not taken. The criteria for this advisory varies from state to state.

Heating Degree Day: see Degree Day.

Heat Index: The Heat Index (HI) or the "Apparent Temperature" is an accurate measure of how hot it really feels when the Relative Humidity (RH) is added to the actual air temperature. As an example, if the air temperature is 90°F and the Relative Humidity (RH) is 70%, the Heat Index (HI)--or how hot it actually feels--is 106°F. This index was devised for shady, light wind conditions. Exposure to full sunshine can increase Heat Index (HI) values by up to 15°F. Also strong winds, particularly with very hot, dry air, can be extremely dangerous. Any value Heat Index (HI) greater than 105°F is in the Danger Category. When the Heat Index is between 105-115°F for 3 hours or more, a Heat Advisory will be issued by the local NWS Forecast Office. See also Apparent Temperature.

Heat Island: A dome of elevated temperatures over an urban area caused by the heat absorbed by structures and pavement.

Heat Lightning: Lightning that occurs at a distance such that thunder is no longer audible.

Heavy Snow: Depending on the region of the USA, this generally means that four or more inches of snow has accumulated in 12 hours, or six or more inches of snow in 24 hours.

Height: The altitude above sea level at which a specified pressure is present, e.g. a 500 millibar height may be 5640 meters in altitude. Lower values indicate an upper trough of low pressure while higher values indicate an upper ridge of high pressure.

Helicity: A property of a moving fluid which represents the potential for helical flow (i.e. flow which follows the pattern of a corkscrew) to evolve. Helicity is proportional to the strength of the flow, the amount of vertical wind shear, and the amount of turning in the flow (i.e. vorticity). Atmospheric helicity is computed from the vertical wind profile in the lower part of the atmosphere (usually from the surface up to 3 km), and is measured relative to storm motion. This value allows the forecaster to determine the rotational tendency of a thunderstorm. Higher values of helicity (generally, around 150 m2/s2 or more) favor the development of mid-level rotation (i.e. mesocyclones). Extreme values can exceed 600 m2/s2. It is dependent on the local environmental wind profile in which a thunderstorm develops and the thunderstorm motion.

High: A region of high pressure, marked as a blue “H” on a weather map. A high is usually associated with fair weather. See anticyclone.

High Clouds: These clouds have bases between 16,500 and 45,000 feet in the mid latitudes. At this level they are composed of primarily of ice crystals. Some clouds at this level are cirrus, cirrocumulus, and cirrostratus.

High Wind Advisory: This product is issued by local NWS Forecast Offices when high wind speeds may pose a hazard. The criteria for this advisory varies from state to state.

High Wind Watch: This product is issued by local NWS Forecast Offices when there is the potential of high wind speeds developing that may pose a hazard or is life threatening.

High Wind Warning: This product is issued by local NWS Forecast Offices when high wind speeds may pose a hazard or is life threatening. The criteria for this warning varies from state to state.

Hook or Hook Echo: A pendant or hook on the right rear of a radar echo that often identifies mesocyclones on the radar display. The hook is caused by precipitation drawn into a cyclonic spiral by the winds, and the associated notch in the echo is caused by precipitation-free, warm, moist air flowing into the storm. A hook often is associated with a mesocyclone, and indicates favorable conditions for tornado development.

HMT (Hydrometeorological Technicians): Individuals who, at the technical level, have knowledge in meteorology and hydrology. Among their duties are data collection, quality control, gage network maintenance, as well as the gathering and disseminating of data and products.

HP (High Precipitation) Storm or HP (High Precipitation) Supercell: A supercell thunderstorm in which heavy precipitation (often including hail) falls on the trailing side of the mesocyclone. Precipitation often totally envelops the region of rotation, making visual identification of any embedded tornadoes difficult and very dangerous. HP storms often produce extreme and prolonged downburst events, serious flash flooding, and very large damaging hail events.

HPC: An acronym for the Hydrometeorological Prediction Center.

Humidity: Generally, a measure of the water vapor content of the air. Popularly, it is used synonymously with relative humidity.

Hurricane: A warm-core tropical cyclone in which the maximum sustained surface wind (using the U.S. 1-minute average) is 64 kt (74 mph or 119 kph) or more. The term hurricane is used for Northern Hemisphere cyclones east of the International Dateline to the Greenwich Meridian. It has a diameter of 250 to 500 miles and a cyclonic circulation typically extending to near 50,000 feet. It is called a Typhoon in the western Pacific north of the Equator and west of the International Dateline, a Cyclone in the Indian Ocean, and Baguio in the Philippines area. See Saffir-Simpson Hurricane Intensity Scale.

Hurricane Local Statement (HLS): This product is issued by a local NWS office when it is in or near an area threatened by a tropical storm or a hurricane. This statement will take the place of Special (SPS) and Severe (SVS) Statements, Flash Flood/Flood (FFS) Statements, Coastal Flood Statements, and Marine Weather (MWS) Statements. This statement does not replace the tropical storm or hurricane advisory from a hurricane center; rather, it complements the advisory with crucial local information. Inland offices close to the coast may use HLSs if tropical storm or hurricane conditions are forecasted or observed.

Hurricane Season: The portion of the year having a relatively high incidence of hurricanes. The hurricane season in the Atlantic, Caribbean, and Gulf of Mexico runs from June 1 to November 30. The hurricane season in the Eastern Pacific basin runs from May 15 to November 30. The hurricane season in the Central Pacific basin runs from June 1 to November 30.

Hurricane Warning: A warning that sustained winds 64 kt (74 mph or 119 kph) or higher associated with a hurricane are expected in a specified coastal area in 24 hours or less. A hurricane warning can remain in effect when dangerously high water or a combination of dangerously high water and exceptionally high waves continue, even though winds may be less than hurricane force.

Hurricane Watch: An announcement of specific coastal areas that a hurricane or an incipient hurricane condition poses a possible threat, generally within 36 hours.

Hydrologic Cycle: The constant movement of water above, on, and below the Earth's surface. Processes such as precipitation, evaporation, condensation, infiltration, and runoff comprise the cycle. Within the cycle, water changes forms in response to the Earth's climatic conditions.

Hydrologic Services: A general term referring to the operations, products, verbal communications, and related forms of support provided by the NWS for the Nation's streams, reservoirs, and other areas affected by surface water.

Hydrology: The applied science concerned with the waters of the earth, their occurrences, distribution, and circulation through the unending hydrologic cycle of: Precipitation, consequent runoff, infiltration, and storage; eventual evaporation; and so forth. It is concerned with the physical and chemical reaction of water with the rest of the earth, and its relation to the life of the earth.

Hydrometeor: A particle of condensed water (liquid, snow, ice, graupel, hail) in the atmosphere.

Hydrometeorological Prediction Center (HPC): This is one of 9 centers that comprises the National Centers for Environmental Prediction (NCEP). This national center provides basic hydrometeorological analysis and forecasts for NWS Field Offices and the entire meteorological community. HPC meteorologists serve as experts in quantitative precipitation forecasting and numerical model interpretation. Products provided by the HPC include surface analyses, outlooks for heavy rain and snow, as well as guidance weather forecasts through five days.

Hydrometeorologists: Individuals who have the combined knowledge in the fields of both meteorology and hydrology which enables them to study and solve hydrologic problems where meteorology is a factor.

Hydrometeorology: The interdisciplinary science involving the study and analysis of the interrelation between the atmospheric and land phases of water as it moves through the hydrologic cycle.

Hygrometer: An instrument which measures the humidity of the air.

Ice Crystals (IC): A fall of unbranched (snow crystals are branched) ice crystals in the form of needles, columns, or plates. They are also referred to as *Diamond Dust*.

Ice Fog: Occurs when the temperature is much below freezing and water vapor condenses directly as ice crystals (sublimation). It is a radiational fog and the conditions for its formation are the same as for radiational fog except that the temperature must be cold. It occurs mostly in Arctic regions, but it is not unknown in middle latitudes during the cold season.

Ice Pellets (PL): Precipitation of transparent and translucent pellets of ice, which are round or irregular, rarely conical, and which have a diameter of 0.2” (5 mm), or less. Ice Pellets bounce when they make contact with the ground. It is sometimes called “Sleet”. There are two main types: 1 – Hard grains of ice consisting of frozen raindrops, or largely melted and refrozen snowflakes. 2 – Pellets of snow encased in a thin layer of ice which have formed from the freezing, either of droplets intercepted by the pellets, or of water resulting from the partial melting of the pellets.

Ice Storm: Occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in the loss of power and communications. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulation are accumulations of 0.25” or greater.

Ice Storm Warning: This product is issued by the NWS when freezing rain produces a significant and possibly damaging accumulation of ice. The criteria for this warning varies from state to state.

Impulse: See upper level system.

Indian Summer: An unseasonably warm and calm period near the middle of autumn, usually following a substantial period of cool weather. Usually referred to in northern climates.

Infrared (IR) Satellite Imagery: This satellite imagery senses surface and cloud top temperatures by measuring the wavelength of electromagnetic radiation emitted from these objects. This energy is called “infrared”. High clouds are very cold, so they appear white. Mid-level clouds are somewhat warmer, so they will be a light gray shade. Low clouds are warmer still, so they appear as a dark shade of gray or black. Often, low clouds are the same temperature as the surrounding terrain and cannot be distinguished at all. This imagery can be used both during the day and night.

Insolation: Incoming solar radiation. Solar heating; sunshine.

Instability (Unstable Air): A state of atmosphere in which the vertical distribution of temperature allows rising, warm air to continue to rise and accelerate. This kind of motion is conducive for thunderstorm development. Instability is a prerequisite for severe weather - the greater the instability, the greater the potential for severe thunderstorms. See lifted index and sounding.

Intertropical Convergence Zone (ITCZ): The boundary zone separating the northeast trade winds of the Northern Hemisphere from the southeast trade winds of the Southern Hemisphere. This region often contains convection along the zone.

Inversion: Generally, a departure from the usual increase or decrease in an atmospheric property with altitude. Specifically it almost always refers to a temperature inversion, i.e., an increase in temperature with height, or to the layer within which such an increase occurs. This occurs when warm air sits over cold air, possibly trapping moisture and pollutants in the surface air layer. An inversion is present at the top of the marine layer and in the lower part of a cap.

IR: An acronym for Infrared. See Infrared Satellite Imagery.

Iridescent Clouds: Clouds that exhibit brilliant bright spots, bands, or borders of colors, usually red and green, observed up to about 30 degrees from the sun. The coloration is due to the diffraction with small cloud particles producing the effect. It is usually seen in thin cirrostratus, cirrocumulus, and altocumulus clouds.

Island Effect (Bands): The effect that produces lines of convection in the lee of islands. As winds are forced around the islands, they collide on the lee side and air is forced upward. In an unstable air mass, this can produce convective showers, thunderstorms, waterspouts and funnel clouds. See also Convergence Zone.

Isobar: A line of equal barometric pressure on a weather map.

Isolated: An NWS convective precipitation descriptor for a 10% chance of measurable precipitation (0.01”). Isolated is used interchangeably with few. See Precipitation Probability (PoP).

Isolated Storm: An individual cell or a group of cells that are identifiable and separate from other cells in a geographic area.

Isotach: A line on a weather map connecting points of equal wind speed.

Isotherm: A line on a weather map connecting points of equal temperature.

Isothermal: Of equal or constant temperature with respect to either space or time.

Isothermal Atmosphere: An atmosphere in hydrostatic equilibrium in which the temperature is constant with altitude and in which, the pressure decreases exponentially upward.

Isothermal Layer: Any layer where the temperature is constant with altitude, such that the temperature lapse rate is zero. Specifically, the approximately isothermal region of the atmosphere immediately above the tropopause.

ITCZ: Acronym for Inter-tropical Convergence Zone.

Jet Max (or Speed Max, Jet Streak): A point or area of relative maximum wind speeds within a jet stream.

Jet Streak: A concentrated region within the jet stream where the wind speeds are the strongest. It sets up unique wind currents in its vicinity which either enhance or diminish the likelihood of clouds and precipitation. It will propagate downstream along the jet stream axis.

Jet Stream: A narrow band of strong winds in the atmosphere that controls the movement of high and low pressure systems and associated fronts. Jet Streams meander from time to time. Wind speeds can reach 200 mph or higher in certain cases. It is usually found at 30,000 to 40,000 feet above the earth's surface. It owes its existence to the large temperature contrast between the polar and equatorial regions. The position and orientation of jet streams vary from day to day. General weather patterns (hot/cold, wet/dry) are related closely to the position, strength and orientation of the jet stream (or jet streams).

Jetty: A structure (e.g.; a pier, or mole of wood or stone) extending into a sea, lake, or river to influence the current or tide or to protect a harbor.

Katabatic Wind: A wind that blows down a topographic incline such as a hill, mountain, or glacier as a result of cold, dense air flowing downhill.

Knot: Unit of speed used in aviation and marine activities which is equal to 1 nautical mile per hour or about 1.15 statue miles an hour.

Land Breeze: A wind that blows from the land towards a body of water and caused by the difference in surface temperature (heating) of the land and water. Also known as an offshore breeze.

Landspout: Slang for a tornado that does not arise from organized storm-scale rotation and therefore is not associated with a wall cloud (visually) or a mesocyclone (on radar). Landspouts typically are observed beneath Cbs or towering cumulus clouds (often as no more than a dust whirl), and essentially are the land-based equivalents of waterspouts. It is believed that most California tornadoes are of the landspout variety.

La Niña: The cool phase of the Southern Oscillation (SO), or the opposite of El Niño. Characterized by the cooling of the sea surface temperatures (SST) in the central and eastern equatorial Pacific Ocean. See El Niño, Southern Oscillation and ENSO.

Lapse Rate: The rate of change of an atmospheric variable, usually temperature, with height. A steep lapse rate implies a rapid decrease in temperature with height (a sign of instability) and a steepening lapse rate implies that destabilization is occurring.

Large-scale: See synoptic-scale.

Lee Effect: The effect of topography on winds to the lee (downwind) side of an obstacle such as a steep island, cliff, or mountain range.

Leeside: The downwind side of a mountain chain.

Leeside Low: Extratropical cyclones that form on the downwind (lee) side of a mountain chain. In the United States, they frequently form on the eastern side of the Rockies and Sierra Nevada.

Left Front Quadrant: The area downstream from and to the left of an upper-level jet max (as would be viewed looking along the direction of flow). Upward motion and severe thunderstorm potential sometimes are increased in this area relative to the wind speed maximum. Also, see right rear quadrant.

Lightning: A sudden visible flash of energy and light caused by electrical discharges from thunderstorms.

Lightning Flash: The total luminous phenomenon accompanying a lightning discharge. It may be composed of one to a few tens of strokes that use essentially the same channel to ground.

Lightning Stroke: Any of a series of repeated electrical discharges comprising a single lightning discharge (strike). Specifically, in the case of a cloud-to-ground discharge, a leader plus its subsequent return streamer.

Likely: An NWS precipitation descriptor for a 60% or 70% chance of measurable precipitation (0.01”). When the precipitation is showery or convective in nature, the term numerous will occasionally be used. See Precipitation Probability (PoP).

Loaded Gun (Sounding): Slang for a sounding characterized by extreme instability but containing a cap, such that explosive thunderstorm development can be expected if the cap can be weakened or the air below it heated sufficiently to overcome it.

Local Flooding: Flooding conditions over a relatively limited (localized) area.

Local Storm Report (LSR): A product issued by local NWS offices to inform users of reports of severe and/or significant weather-related events.

Longwave Trough: A trough in the prevailing westerly flow aloft which is characterized by large length and (usually) long duration. Generally, there are no more than about five longwave troughs around the Northern Hemisphere at any given time. Their position and intensity govern general weather patterns (e.g., hot/cold, wet/dry) over periods of days, weeks, or months. Smaller disturbances (e.g., shortwave troughs) typically move more rapidly through the broader flow of a longwave trough, producing weather changes over shorter time periods (a day or less).

Low: A region of low pressure, marked as “L” on a weather map. A low center is usually accompanied by precipitation, extensive cloudiness, and moderate winds. See cyclone.

Low Clouds: The bases of these clouds range from near the surface to about 6,500 feet in middle latitudes. These clouds are almost entirely of water, but the water may be supercooled at sub-freezing temperatures. Low clouds at sub-freezing temperatures can also contain snow and ice particles. The two most common members of this family are stratus and stratocumulus.

Macroburst: One of 2 categories of downbursts (the other category is called a microburst). This Downburst has an affected outflow area of at least 2.5 miles wide and peak winds lasting between 5 and 20 minutes. Intense macrobursts may cause tornado-force damage up to F-3.

Main Stem: The reach of a river/stream formed by the tributaries that flow into it.

Major Flooding: A general term including extensive inundation and property damage. (Usually characterized by the evacuation of people and livestock and the closure of both primary and secondary roads.)

Mammatus Clouds: Rounded, smooth, sack-like protrusions hanging from the underside of a cloud (usually a thunderstorm anvil). Mammatus clouds often accompany severe thunderstorms, but do not produce severe weather; they may accompany non-severe storms as well.

Marine Inversion: A temperature inversion created by the cooling of a warm air mass from below by the cooler ocean.

Marine Weather Statement: The NWS will issue this statement: 1. To provide follow-up information on Special Marine Warnings and to cancel all or part of a warning. 2. To describe short duration, non-severe, but potentially hazardous conditions which sustained winds or frequent gusts are less than 34 knots for 2 hours or less. Short-lived increases in winds, although below threshold for Special Marine Warnings, that may make small craft handling difficult especially for inexperienced boaters. 3. To provide information for a variety of conditions not covered by warnings or routine forecasts (e.g., low water conditions, dense fog, etc.). 4. To discuss increasing or decreasing winds and to convey details on possible later warnings.

Maritime Air Mass: A moist air mass originating over the ocean.

MB: An acronym for millibars.

Mean Low Water (MLW): The average height of the daily low tides recorded over a 19-year period at a specific location.

Mean Lower Low Water (MLLW): The average height of the lower of the two low tides occurring during a tidal cycle recorded over a 19-year period at a particular location.

Mean Sea Level (MSL): The average height of the surface of the sea at a particular location for all stages of the tide over a 19-year period. This is usually determined from the hourly height readings of the tide gage at that site.

Mean Temperature: The average of a series of temperatures taken over a period of time, such as a day or a month.

Measurable: Precipitation of 0.01” or more.

Medium Range: In forecasting, (generally) three to seven days in advance.

Melting Level: The altitude which ice crystals and snowflakes melt as they descend through the atmosphere.

Meniscus: The curved surface of the liquid at the open end of a capillary column, as in a rain gage.

Meridional Flow: Large-scale atmospheric flow in which the north-south component (i.e., longitudinal, or along a meridian) is pronounced. The accompanying zonal (east-west) component often is weaker than normal. Compare with zonal flow.

Mesocyclone (MESO): A storm-scale region of rotation, typically around 2-6 miles in diameter and often found in the right rear flank of a supercell (or often on the eastern, or front, flank of an HP storm). The circulation of a mesocyclone covers an area much larger than the tornado that may develop within it. Properly used, mesocyclone is a radar term; it is defined as a rotation signature appearing on Doppler radar that meets specific criteria for magnitude, vertical depth, and duration.

Mesonet: A regional network of observing stations (usually surface stations) designed to diagnose mesoscale weather features and their associated processes.

Mesoscale: Size scale referring to weather systems smaller than synoptic-scale systems but larger than storm-scale systems. Horizontal dimensions generally range from around 50 miles to several hundred miles. Squall lines and large thunderstorm complexes are examples of mesoscale weather systems.

METAR: A weather observation near ground level. It may include date and time, wind, visibility, weather and obstructions to vision, sky condition, temperature and dew point, sea level pressure, precipitation amount and other data used for aircraft operations.

Meteorology: The study of the atmosphere and atmospheric phenomena.

Microburst: One of 2 categories of downbursts (the other category is called a macroburst). This downburst has an affected outflow area of less than 2.5 miles wide and peak winds lasting less than 5 minutes. They may induce dangerous horizontal/vertical wind shears, which can adversely affect aircraft performance and cause property damage. They can be sub-classified into either dry or wet microburst depending on how much (or little) rain accompanies the microburst when it reaches the ground. Most microbursts are rather short-lived (5 minutes or so), but on rare occasions they have been known to last up to 6 times that long.

Middle Clouds: In the middle family are the altostratus, altocumulus, and nimbostratus clouds. The height of the bases of these clouds ranges from 6,500 to 23,000 feet in middle latitudes. These clouds are primarily water; however, much of the water may be supercooled and the clouds can contain some ice crystals.

Mid-Latitude Areas: Areas between 30° and 60° north and south of the Equator.

Millibar (mb): Unit of atmospheric pressure. It is equal to 0.03" of mercury and 100 Pa (pascal). One thousand millibars equals 29.55" of mercury on a barometer. Normal surface pressure is approximately 1013 millibars.

Minor Flooding: A general term indicating minimal or no property damage but possibly some public inconvenience.

Minor Tidal Overflow: Minor flooding caused by high tides, which results in little if any damage.

Mist (BR): A visible aggregate of minute water particles suspended in the atmosphere that reduces visibility to less than 7 statue miles, but greater than or equal to 5/8 statue miles.

Mixing: Air movements (usually vertical) that make the properties of a parcel of air homogeneous. It may result in a lapse rate approaching the moist or dry adiabatic rate.

Model: A mathematical representation of a process, system, or object developed to understand its behavior or to make predictions. The representation always involves certain simplifications and assumptions. Models are one of the primary forecasting tools used in the NWS.

Model Output Statistics (MOS): A set of statistical equations that use model output to forecast the probability of precipitation, high and low temperature, cloud cover, and precipitation amount for many cities across the USA. The statistical equations were specifically tailored for each location, taking into account factors such as each location's climate.

Monsoon: A persistent seasonal wind, often responsible for seasonal precipitation regime or a wind which blows from opposite directions between winter and summer. Usually the wind blows from land to sea in winter and from sea to land in summer. In the Southwest U.S. the "Southwest Monsoon" occurs during late summer, producing usually diurnal thunderstorms. For many desert locations, this is the cause of the majority of the annual rainfall.

MOS: An acronym for Model Output Statistics.

Mostly Clear:When the predominant/average sky condition is covered 1/8 to 2/8 with opaque (not transparent) clouds. Sometime called Mostly Sunny if it is during the day.

Mostly Cloudy: When the predominant/average sky condition is covered by more than half, but not completely covered by opaque (not transparent) clouds. In other words, 5/8 to 7/8 of the sky is covered by opaque clouds.

Mostly Sunny: When the predominant/average daytime sky condition is covered 1/8 to 2/8 with opaque (not transparent) clouds. Same as mostly clear.

MRF - Medium-Range Forecast model: The MRF was one of the main models forecasters use for the medium range time period beyond 48 hours into the future. It is has been replaced by the Global Forecast System (GFS).

MSLP: Acronym for Mean sea level pressure.

Muggy: Colloquially descriptive of warm and especially humid weather.

Multicell Thunderstorms: These thunderstorms are organized in clusters of at least 2-4 short-lived cells. Each cell generates a cold air outflow and these individual outflows combine to form a large gust front. Convergence along the gust front causes new cells to develop every 5 to 15 minutes. The cells move roughly with the mean wind.

NAM: An acronym for the North American model. generated every 6 hours by NCEP.

National Environmental Satellite, Data, and Information Service (NESDIS): NESDIS collects, processes, stores, analyzes, and disseminates various types of hydrologic, meteorologic, and oceanic data. NESDIS is also responsible for the development of analytical and descriptive products so as to meet the needs of its users.

National Oceanographic and Atmospheric Administration (NOAA): A branch of the US Department of Commerce, NOAA is the parent organization of the NWS. Other agencies within NOAA include: National Environmental Satellite, Data, and Information Service, the National Marine Fisheries Service, and the National Ocean Service.

National Centers for Environmental Prediction (NCEP): The National Oceanic and Atmospheric Administration created the National Centers for Environmental Prediction (NCEP) to take advantage of improving technology and better serve the public and modernized NWS. The NCEP's goal is to protect life and property, as well as mitigate economic loss, by providing accurate forecasts and forecast guidance products to weather service field offices. The NCEP prepares and makes available national forecasts and outlooks of weather and climate. Meteorologists currently generate weather forecasts to seven days. Climate predictions are made for two weeks out to a year. Nine national centers comprise the NCEP: Aviation Weather Center, Climate Prediction Center, Environmental Modeling Center, Hydrometeorological Prediction Center, NCEP Central Operations, Ocean Prediction Center, Space Environmental Center, Storm Prediction Center, and Tropical Prediction Center.

National Climatic Data Center (NCDC): Located in Asheville, North Carolina, the agency that archives and distributes climatic and forecast data.

National Fire Danger Rating System (NFDRS): A system that directly integrates the effects of fuels, topography, and weather into components that associates with occurrence and fire behavior potential. The system uses the components to derive indices that indicate the number of fires, difficulty of containment, and finally, the total fire control job in a rating area. The system is intended to provide guidance for short-range planning by evaluating the near upper limits of the behavior of fires that might occur in an area during the rating period. It is not designed to serve as a direct fire behavior forecast.

National Hurricane Center (NHC): This center maintains a continuous watch on tropical cyclones over the Atlantic, Caribbean, Gulf of Mexico, and the Eastern Pacific from 15 May through November 30. The Center prepares and distributes hurricane watches and warnings. During the “off-season” NHC provides training for U.S. emergency managers and representatives from many other countries that are affected by tropical cyclones. NHC also conducts applied research to evaluate and improve hurricane forecasting techniques, and is involved in public awareness programs.

National Weather Service (NWS): The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community. This mission is accomplished by providing warnings and forecasts of hazardous weather, including thunderstorms, flooding, hurricanes, tornadoes, winter weather, tsunamis, and climate events. The NWS is the sole United States *officia*l voice for issuing warnings during life-threatening weather situations.

Neap Tide: A minimum tide occurring at the first and third quarters of the moon.

Negative-Tilt Trough: An upper level system which is tilted to the west with increasing latitude (i.e., with an axis from southeast to northwest). A negative-tilt trough often is a sign of a developing or intensifying system.

Negative Vorticity Advection (NVA): A region of negative vorticity usually several hundred of kilometers wide on a upper level chart that moves with the general wind flow. It aids in weather prediction by showing where regions of sinking air. This is typically associated with clear skies.

NESDIS: An acronym for National Environmental Satellite, Data, and Information Service.

NEXRAD: An acronym that stands for **NEX**t generation of weather **RAD**ar. It is a technologically-advanced weather radar. NEXRAD is a high-resolution Doppler radar with increased emphasis on automation, including use of algorithms and automated volume scans. NEXRAD units are known as WSR-88D.

Nimbostratus (Ns): A dark, gray cloud characterized by more or less continuously falling precipitation. It is not accompanied by lightning, thunder, or hail. They normally occur between 6,500 and 23,000 feet above the ground.

NOAA: An acronym for National Oceanographic and Atmospheric Administration.

NOAAPORT Broadcast System: This provides a one-way broadcast communication of NOAA environmental data and information in near-real time to NOAA and external users. This broadcast service is implemented by a commercial provider of satellite communications utilizing C-band. Weather data is collected by GOES satellite environmental sensors and NWS observing systems, and processed to create products. The products are fed to the AWIPS Network Control Facility (NCF) which routes the products to the appropriate NOAAPORT channel for uplink and broadcast.

NOAA All-Hazards Radio: It is the voice of the NWS. NOAA All-Hazards Radio broadcasts NWS warnings, watches, forecasts and other hazard information from other government agencies 24 hours a day. It is provided as a public service by the Department of Commerce's National Oceanic and Atmospheric Administration. The NOAA All-Hazards Radio network has more than 700 stations.

NOAA Weather Wire Service (NWWS): The NOAA Weather Wire Service is the primary telecommunications network for NWS forecasts, warnings and other products to the mass media (newspapers, radio stations, TV, etc.) and emergency management agencies. The NWWS is a satellite communications system that transmits NWS products directly from NWS offices to external users. The NWWS satellite communications system is operated by GTE Corp., under contract to the NWS. The system uses satellite transmitting (i.e. “uplink”) equipment at more than 58 major NWS forecast offices.

Noctilucent Clouds: Wavy, thin, bluish-white clouds that are best seen at twilight in polar latitudes. They form at altitudes about 80 to 90 km above the Earth's surface.

North American Model (NAM): The North American model, which is generated every 6 hours by NCEP. This model is more regional in nature and contains a higher spatial resolution than the more global GFS model.

Normal: The long-term average value of a meteorological element for a certain area. For example, “temperatures are normal for this time of year”. Usually averaged over 30 years.

Nowcast: A weather forecast, generally out to six hours or less. This is also called a Short Term Forecast.

NVA: An acronym for Negative Vorticity Advection.

NSSL (National Severe Storms Laboratory): NSSL is one of NOAA's internationally known Environmental Research Laboratories, leading the way in investigations of all aspects of severe weather. Headquartered in Norman OK with staff in Colorado, Nevada, Washington, Utah, and Wisconsin, the people of NSSL, in partnership with the NWS, are dedicated to improving severe weather warnings and forecasts in order to save lives and reduce property damage.

Nucleus: A particle of any nature upon which molecules of water or ice accumulate.

Numerical Weather Prediction (NWP): Forecasting weather by the use of numerical models, run on high speed computers. Most of the NWP for the NWS is done at the National Centers for Environmental Prediction (NCEP).

Numerous: An NWS convective precipitation descriptor for a 60% or 70% chance of measurable precipitation (0.01”). See Precipitation Probability (PoP).

NWP: An acronym for Numerical Weather Prediction.

NWS: An acronym for the National Weather Service.

Occluded Front (Occlusion): A complex frontal system that ideally forms when a cold front overtakes a warm front. When the air is colder than the air ahead of it, the front is called a *cold occlusion*. When the air behind the front is milder than the air ahead of it, it is called a *warm occlusion.* These processes lead to the dissipation of the front in which there is no gradient in temperature and moisture.

Ocean Prediction Center (OPC): This is one of 9 centers that comprise the National Centers for Environmental Prediction (NCEP). The Ocean Prediction Center (OPC) is an integral component of NCEP. OPC is located at the NOAA Science Center in Camp Springs, MD. The primary responsibility is the issuance of marine warnings, forecasts, and guidance in text and graphical format for maritime users. Also, the OPC quality controls marine observations globally from ship, buoy, and automated marine observations for gross errors prior to being assimilated into computer model guidance. In addition OPC coordinates with the National Hurricane Center (NHC) with forecast points for tropical cyclones in the Atlantic Ocean E of 65°W.

Offshore Flow: Air movement from the interior toward the ocean, usually associated with dry weather. Can be caused by any combination of offshore pressure gradients (higher pressure over the interior and lower pressure off the coast), temperature gradients (colder air over the interior and warmer air off the coast), and/or northeast winds aloft that transfer to the surface. See Foehn and Santa Ana.

Offshore Forecast (OFF): This marine forecast is designed to serve users who operate beyond the coastal waters where it usually requires more than a day or more of sailing to and from port (from 60 to 250 nautical miles). These users are mainly commercial fishermen and merchant shipping and, to a lesser extent, government and research vessels and large recreational craft.

Omega: A term used to describe vertical motion in the atmosphere. Omega is determined by the amount of spin (or large scale rotation) and warm (or cold) advection present in the atmosphere. On a weather forecast chart, high values of omega (or a strong omega field) relate to upward vertical motion in the atmosphere. If this upward vertical motion is strong enough and in a sufficiently moist air mass, precipitation results.

Omega High: A blocking ridge of high pressure that forms in the middle or upper troposphere. It looks like the Greek letter omega (**Ω**).

Onshore Flow: Air movement from the ocean across land. A sea breeze is indicative of onshore flow. It usually indicates an increase in moisture. Can be caused by onshore pressure gradients (higher pressure over the ocean and lower pressure over land).

Orographic: Related to, or caused by, physical geography (such as mountains or sloping terrain).

Orographic Lifting (Upslope Flow): Occurs when air is forced to rise and cool due to terrain features such as hills or mountains. If the cooling is sufficient, water vapor condenses into clouds. Additional cooling results in rain or snow. It can cause extensive cloudiness and increased amounts of precipitation in higher terrain.

Orographic Precipitation: Precipitation which is caused by hills or mountain ranges deflecting the moisture-laden air masses upward, causing them to cool and precipitate their moisture.

Orphan Anvil: Slang for an anvil from a dissipated thunderstorm, below which no other clouds remain.

Outflow Boundary: A storm-scale or mesoscale boundary separating thunderstorm-cooled air (outflow) from the surrounding air; similar in effect to a cold front, with passage marked by a wind shift and usually a drop in temperature. Outflow boundaries may persist for 24 hours or more after the thunderstorms that generated them dissipate, and may travel hundreds of miles from their area of origin. New thunderstorms often develop along outflow boundaries, especially near the point of intersection with another boundary (cold front, dry line, another outflow boundary, etc.)

Overcast (OVC): An official sky cover classification for aviation weather observations, when the sky is completely covered by an obscuring phenomenon. This is applied only when obscuring phenomenon aloft are present--that is, not when obscuring phenomenon are surface-based, such as fog.

Overrunning: A weather pattern in which a relatively warm air mass is in motion above another air mass of greater density at the surface. Embedded thunderstorms sometimes develop in such a pattern; severe thunderstorms (mainly with large hail) can occur, but tornadoes are unlikely. Overrunning often is applied to the case of warm air riding up over a retreating layer of colder air, as along the sloping surface of a warm front. Such use of the term technically is incorrect, but in general it refers to a pattern characterized by widespread clouds and steady precipitation on the cool side of a front or other boundary.

Overshooting: The failure of the radar to detect a target due to the radar beam passing above the target.

Overshooting Top (or Penetrating Top): A dome-like protrusion above a thunderstorm anvil, representing a very strong updraft and hence a higher potential for severe weather with that storm. A persistent and/or large overshooting top (anvil dome) often is present on a supercell. A short-lived overshooting top, or one that forms and dissipates in cycles, may indicate the presence of a pulse storm or a cyclic storm.

Ozone: A nearly colorless (but faintly blue) gaseous form of oxygen, with a characteristic odor like that of weak chlorine. Its chemical formula is O_3. It is usually found in trace amounts in the atmosphere, but it is primarily found at 30,000 to 150,000 feet above the ground. Its production results from photochemical process involving ultraviolet radiation. Because it absorbs harmful radiation at those heights, it is a very beneficial gas. However, photochemical processes involving industrial/vehicle emissions can produce ozone near the ground. In this case, it can be harmful to people with respiratory or heart problems.

Pacific High: A semipermanent anticyclone located in the Eastern North Pacific.

Palmer Drought Severity Index: An index whereby excesses or deficiencies of precipitation are determined in relation to average climate values. The index takes in to account precipitation, potential and actual evapotranspiration, infiltration of water into the soil, and runoff.

Partly Cloudy: When the predominant/average sky condition is covered 3/8 to 4/8 with opaque (not transparent) clouds. Same as Partly Sunny.

Partly Sunny: When the predominant/average sky condition is covered 3/8 to 4/8 with opaque (not transparent) clouds. Same as Partly Cloudy.

Patchy or **Patches of**: Used with fog to denote random occurrence over relatively small areas.

Peak Wind Speed: The maximum instantaneous wind speed since the last observation that exceeded 25 knots.

Pineapple Connection or **Pineapple Express**: Slang for a water vapor plume from the tropics. Usually used on the West Coast describing a plume of water vapor extending from Hawaii.

Polar Front: A semipermanent, semicontinuous front that separates tropical air masses from polar air masses.

Polar Jet Stream: A jet stream that is associated with the polar front in the middle and high latitudes. It is usually located at altitudes between 9,000 and 12,000 km.

Polar Orbiting Satellite: A weather satellite which travels over both poles each time it orbits the Earth. It orbits about 530 miles (850 km) above the Earth's surface.

Ponding: In flat areas, runoff collects, or ponds in depression and cannot drain out. Flood waters must infiltrate slowly into the soil, evaporate, or be pumped out.

Popcorn Convection: Slang for showers and thunderstorms that form on a scattered basis with little or no apparent organization, usually during the afternoon in response to diurnal heating. Individual thunderstorms typically are of the type sometimes referred to as air-mass thunderstorms. These thunderstorms are small, short-lived, very rarely severe, and they almost always dissipate near or just after sunset. See Pulse Thunderstorm, Air Mass Thunderstorm and Single Cell Thunderstorm.

Pops: An acronym for **P**robability **o**f **P**recipitation or **P**recipitation **P**robabilities.

Positive-Tilt Trough: An upper level system which is tilted to the east with increasing latitude (i.e., from southwest to northeast). A positive-tilt trough often is a sign of a weakening weather system, and generally is less likely to result in severe weather than a negative-tilt trough if all other factors are equal.

Positive Vorticity Advection (PVA): A region of positive vorticity usually several hundred of kilometers wide on an upper level chart that moves with the general wind flow. It aids in weather prediction by showing where regions of rising air occur. This usually results in clouds and precipitation.

Precipitable Water (PW): It measures the depth of liquid water at the surface that would result after precipitating all of the water vapor in a vertical column usually extending from the surface to 300 mb.

Precipitation: 1. The process where water vapor condenses in the atmosphere to form water droplets that fall to the Earth as rain, sleet, snow, hail, etc. 2. As used in hydrology, precipitation is the discharge of water, in a liquid or solid state, out of the atmosphere, generally onto a land or water surface. It is the common process by which atmospheric water becomes surface, or subsurface water. The term "precipitation" is also commonly used to designate the quantity of water that is precipitated. Precipitation includes rainfall, snow, hail, and sleet, and is therefore a more general term than rainfall.

Prescribed Burn: Fire applied to wildland fuels, in a definite place for a specific purpose under exacting weather and fuel conditions (the prescription), to achieve a specific objective of resource management.

Present Movement: The best estimate of the movement of the center of a tropical cyclone at a given time and given position. This estimate does not reflect the short-period, small scale oscillations of the cyclone center.

Pressure: The force exerted by the weight of the atmosphere, also known as atmospheric pressure. When measured on a barometer, it is referred to as barometric pressure and it is expressed in inches of mercury, millibars, or kiloPascals.

Pressure Gradient: The amount of pressure change occurring over a given distance.

Pressure Gradient Force: A three-dimensional force vector operating in the atmosphere that accelerates air parcels away from regions of high pressure and toward regions of low pressure in response to an air pressure gradient. Usually resolved into vertical and horizontal components.

Pressure Tendency: The character and amount of atmospheric pressure change during a specified period of time, usually 3-hour period preceding an observation.

Prevailing Visibility: The visibility that is considered representative of conditions at the station; the greatest distance that can be seen throughout at least half the horizon circle, not necessarily continuous.

Prevailing Westerlies: Winds in the middle latitudes (approximately 30° to 60° N/S) that generally blow from west to east.

Prevailing Wind: A wind that consistently blows from one direction more than from any other.

Precipitation Probabilities (PoP): It is defined as the likelihood of occurrence (expressed as a percent) of a measurable amount of liquid precipitation (or the water equivalent of frozen precipitation) during a specified period of time at any given point in the forecast area. Measurable precipitation is defined as equal to or greater than 0.01" or 0.2 mm. Normally, the period of time is 12 hours, unless specified otherwise.

Profiler: An instrument designed to measure horizontal winds directly above its location, and thus measure the vertical wind profile. Profilers operate on the same principles as Doppler radar.

Psychrometer: An instrument used to measure the water vapor content of the air. It consists of two thermometers, one of which is an ordinary glass thermometer, while the other has its bulb covered with a jacket of clean muslin which is saturated with distilled water prior to use. After whirling the instrument, the dew point and relative humidity can be obtained with the aid of tables.

Public Information Statement (PNS): This narrative statement can be used for a current or expected nonhazardous event of general interest to the public that can usually be covered with a single message. This may include: Unusual atmospheric phenomena such as sun dogs, halos, rainbows, aurora borealis, lenticular clouds, and stories about a long-term dry/cold/wet/warm spell; public educational information and activities, such as storm safety rules, awareness activities, storm drills, etc, or information regarding service changes, service limitations, interruptions due to reduced or lost power or equipment outages, or special information clarifying interpretation of NWS data. For example, this product may be used to inform users of radar equipment outages or special information clarifying interpretation of radar data originating from an unusual source which may be mistaken for precipitation (such as chaff drops, smoke plumes, etc., that produces echoes on the radar display.

Pulse Thunderstorm: A thunderstorm within which a brief period (pulse) of strong updraft occurs, during and immediately after which the storm produces a short episode of severe weather. These storms generally are not tornado producers, but often produce large hail and/or damaging winds. Also, see Air Mass Thunderstorm, Popcorn Convection and Single Cell Thunderstorm.

PVA: An acronym for Positive Vorticity Advection.

QPF (Quantitative Precipitation Forecast): A spatial and temporal precipitation forecast that will predict the potential amount of future precipitation for a specified region, or area.

RADAR: An instrument used to detect precipitation by measuring the strength of the electromagnetic signal reflected back. (RADAR= **Ra**dio **D**etection **a**nd **R**anging)

Radar Beam: The straight line that a radar pulse travels along. As the radar beam gets further away from the radar, it gets wider and wider. In order for a precipitation target to be detected by the radar, it must fill the entire radar beam; therefore, the radar will have a difficult time detecting small showers and thunderstorms at a great distance from the radar.

Radar Reflectivity: The sum of all backscattering cross-sections (e.g., precipitation particles) in a pulse resolution volume divided by that volume.

Radiation: Energy emitted in the form of electromagnetic waves. Radiation has differing characteristics depending upon the wavelength. Radiation from the sun has a short wavelength (ultra-violet) while energy re-radiated from the Earth's surface and the atmosphere has a long wavelength (infra-red).

Radiation Fog: Fog produced from the air near the ground being cooled to saturation by contact with the cold ground. The cooling of the ground results from night time loss of heat from the Earth to space (terrestrial radiation). Favorable conditions for radiation fog are clear sky, little or no wind, and high relative humidity. It occurs in stable air and is primarily a night time or early morning phenomenon. As the Earth and the lower layers of the atmosphere warm during the day, air that was stable during the early morning hours may become unstable - at least in the lower levels. For this reason visibility usually improves as the temperature rises during the day. Mixing in the lower levels disperses the fog into a thicker layer, and eventually it evaporates into the warmer air. When cloud layers form aloft over a radiation fog and retard heating from the sun, visibility improvement is very slow. It is also known as Ground Fog and Valley Fog, and in Central California as tule fog.

Radiation Inversion: It is a thermally produced, surface-based inversion formed by rapid radiational cooling of the Earth's surface at night. It does not usually extend above the lower few hundred feet. Conditions which are favorable for this type of inversion are: long nights, clear skies, dry air, little or no wind, and a cold or snow covered surface.

Radiational Cooling: The cooling of the Earth's surface. At night, the Earth suffers a net heat loss to space due to terrestrial cooling. This is more pronounced when you have a clear sky.

Radiosonde: An instrument attached to a weather balloon that transmits pressure, humidity, temperature, and wind data to a ground-based receiving station as it ascends.

Rain (RA): Precipitation, either in the form of drops larger than 0.02” (0.5 mm), or smaller drops, which in contrast to drizzle, are widely separated.

Rain Shadow: Areas of the leeward side of a mountain or mountain range which often receive much less rain than the windward side.

Rainbow: An arc that exhibits in concentric bands the colors of the spectrum and is formed opposite the sun by refraction and reflection of the sun's rays in rain drops.

RAOB: An acronym for Radiosonde Observation. See Radiosonde.

Record Report: This non-routine narrative product is issued by the NWS to report meteorological and hydrological events that equal or exceed existing records.

Red Flag: This a fire weather program which highlights the onset of critical weather conditions conducive to extensive wildfire occurrences.

Red Flag Warning: A term used by fire-weather forecasters to call attention to weather conditions that may result in extreme burning conditions. It is issued when it is an on-going event or the fire weather forecaster has a high degree of confidence that Red Flag criteria will occur within 24 hours of issuance. Red Flag criteria occurs whenever the following forecast weather parameters are forecasted to met: 1. A sustained wind average 15 mph or greater, 2. Relative humidity less than or equal to 25%, and when dry lightning is expected.

Reflectivity: A radar product designed to determine the strength or the intensity of a precipitation target. In order for the radar to calculate the reflectivity, it sends out a small burst of energy. This energy strikes the small water particles located in the precipitation target. The more of these particles located in the precipitation target, the greater the return of energy returned back to the radar. One will see a greater reflectivity return from heavy rain than light rain. Reflectivity is expressed in the units of dBZ where dB stands for decibels and the Z stands for reflectivity. See dBZ.

Relative Humidity: A dimensionless ratio, expressed in percent, of the amount of atmospheric moisture present relative to the amount that would be present if the air were saturated. Since the latter amount is dependent on temperature, relative humidity is a function of both moisture content and temperature. As such, relative humidity by itself does not directly indicate the actual amount of atmospheric moisture present. See dew point.

Retrogression (or Retrograde Motion): Movement of a weather system in a direction opposite to that of the basic flow in which it is embedded, usually referring to a closed low or a longwave trough which moves westward.

Return Flow: South winds on the back (west) side of an eastward-moving surface high pressure system.

Rex Block: A blocking pattern where there is an upper level high located directly north of a closed low.

RFC (River Forecast Center): Centers that serve groups of Weather Service Forecast offices in providing hydrologic guidance and is the first echelon office for the preparation of river and flood forecasts and warnings.

Ridge: An elongated area of high pressure in the atmosphere. Opposite of trough.

Right Rear Quadrant: The area upstream from and to the right of an upper-level jet max (as would be viewed looking along the direction of flow). Upward motion and severe thunderstorm potential sometimes are increased in this area relative to the wind speed maximum. Also, see left front quadrant.

Rip Current: A strong, narrow current of surface water that flows seaward through the surf into deeper water. Waves approaching the shoreline create a water buildup which results in a return flow. This return flow (rip current) transports the excess water into deeper waters. Bubbles and debris usually float on the surface of the rip current. Although this current is extremely localized, they result in numerous deaths every year. These deaths are contributed to swimmers becoming exhausted by trying to swim against the rip current. If you are a swimmer caught in a rip current, wade sideways parallel to the beach until you are out of its pull. Another means of escape for those who are good swimmers is to ride the current out beyond the surf zone where the rip current dissipates then swim to shore outside the effects of the narrow current. This phenomenon is sometimes mistakenly called a “rip tide” or an “undertow”.

River Basin: Drainage area of a river and its tributaries.

River Flood Statement (FLS): This product is used by the local NWS to update and expand the information in the River Flood Warning. This statement may be used in lieu of a warning if flooding is forecasted, imminent, or existing and it presents no threat to life or property. The statement will also be used to terminate a River Flood Warning.

River Flood Warning (FLW): This is product is issued by the local NWS when forecast points (those that have formal gaging sites and established flood stages) at specific communities or areas along rivers where flooding has been forecasted, is imminent, or is in progress. Flooding is defined as the inundation of normally dry areas as a result of increased water levels in an established water course. The flood warning normally specifies crest information. It usually occurs 6 hours or later after the causative event and it is usually associated with widespread heavy rain and/or snow melt or ice jams.

River Flooding: The rise of a river to an elevation such that the river overflows its natural banks causing or threatening damage.

River Gage: A device for measuring the river stage.

Roll Cloud: A low, horizontal tube-shaped cloud associated with a thunderstorm gust front (or sometimes with a cold front). Roll clouds are relatively rare; they are completely detached from the thunderstorm base or other cloud features, thus differentiating them from the more familiar shelf clouds. Roll clouds usually appear to be "rolling" about a horizontal axis, but should not be confused with funnel clouds.

Rope (or Rope Funnel): A narrow, often contorted condensation funnel usually associated with the decaying stage of a tornado. See rope stage.

Rope Cloud: In satellite meteorology, a narrow, rope-like band of clouds sometimes seen on satellite images along a front or other boundary. The term sometimes is used synonymously with rope or rope funnel.

Rope Stage: The dissipating stage of a tornado, characterized by thinning and shrinking of the condensation funnel into a rope (or rope funnel). Damage still is possible during this stage.

Rotor Cloud: A turbulent cloud formation found in the lee of some large mountain barriers. The air in the cloud rotates around an axis parallel to the mountain range.

RUC - Rapid Update Cycle: A numerical model run at NCEP that focuses on short-term (up to 12 hours) forecasts and small-scale weather features. Forecasts are prepared every 3 hours.

Runoff: That part of precipitation that flows toward streams on the surface of the ground or within the ground. Runoff is composed of base flow and surface runoff.

Saffir-Simpson Hurricane Intensity Scale: This scale was developed in an effort to estimate the possible damage a hurricane's sustained winds and storm surge could do to a coastal area. The scale of numbers is based on actual conditions at some time during the life of the storm. As the hurricane intensifies or weakens, the scale number is reassessed accordingly.

Sandstorm (SS): Particles of sand carried aloft by strong wind. The sand particles are mostly confined to the lowest ten feet, and rarely rise more than fifty feet above the ground.

Santa Ana Wind: A strong, hot, dry foehn-like wind that blows from the north, northeast, or east into Southern California. Occasionally, the term is used even if the temperatures are low. The winds are generated by surface high pressure (an anticyclone) located over the high deserts of the Great Basin (Nevada) and produce warmth and dryness from compressional heating as the air descends to lower elevations near the coast.

Scattered (SCT): 1. An official sky cover classification for aviation weather observations, descriptive of a sky cover of 3/8 to 4/8. This is applied only when obscuring phenomenon aloft are present--that is, not when obscuring phenomenon are surface-based, such as fog. 2. A NWS convective precipitation descriptor for a 30%, 40%, and 50% chance of measurable precipitation (> Trace). See Probability of Precipitation (PoP).

Scud (or Fractus): Small, ragged, low cloud fragments that are unattached to a larger cloud base and often seen with and behind cold fronts and thunderstorm gust fronts. Such clouds generally are associated with cool moist air, such as thunderstorm outflow.

Sea Breeze: A wind that blows from a sea or ocean towards a land mass as a result of temperature and pressure gradients along the coastal interface. Also known as an onshore breeze.

Seas: This term is used in NWS Marine Forecasts to describe the combination or interaction of wind waves and swells (combined seas) in which the separate components are not distinguished. This includes the case when swells are negligible or are not considered in describing sea state.

Sea Level Pressure: The pressure value obtained by the theoretical reduction or increase of barometric pressure to sea-level.

Sea Surface Temperature (SST): Surface temperature of ocean water. This data is collected using IR satellite imagery, buoy and ship data.

Severe Thunderstorm: A strong thunderstorm with a tornado, wind gusts in excess of 58 mph (50 knots), and/or hail with a diameter of 0.75" or more.

Severe Thunderstorm Warning (SVR): This is issued when either a severe thunderstorm is indicated by the WSR-88D radar or a spotter reports a thunderstorm producing a hail 0.75" or larger in diameter and/or winds equal or exceed 50 kts (58 mph); therefore, people in the affected area should seek safe shelter immediately.

Severe Thunderstorm Watch (WWA): This is issued by the NWS when conditions are favorable for the development of severe thunderstorms in and close to the watch area. The size of the watch can vary depending on the weather situation. They are usually issued for a duration of 4 to 8 hours. They are normally issued well in advance of the actual occurrence of severe weather. During the watch, people should review severe thunderstorm safety rules and be prepared to move a place of safety if threatening weather approaches. The Watch is issued by the Storm Prediction Center in Norman, Oklahoma. Prior to the issuance, SPC will usually contact the affected local NWS Forecast Office and they will discuss what their current thinking is on the weather situation. Afterwards, SPC will issue a preliminary Severe Thunderstorm Watch and then the affected NWFO will then adjust the watch (adding or eliminating counties) and issue it to the public by way of a Watch Redefining Statement. During the watch, the local forecast office will keep the you informed on what is happening in the watch area and also let the you know when the watch has expired or been cancelled.

Severe Weather Statement (SVS): An NWS product which provides follow up information on severe weather conditions (severe thunderstorm or tornadoes) which have occurred or are currently occurring.

Shear: Variation in wind speed (speed shear) and/or direction (directional shear) over a short distance. Shear usually refers to vertical wind shear, i.e., the change in wind with height.

Sheet Flow: Water flow that occurs overland in places where there are no defined channels; the flood water spreads out over a large area at a uniform depth.

Shelf Cloud: A low, horizontal wedge-shaped arcus cloud, associated with a thunderstorm gust front (or occasionally with a cold front, even in the absence of thunderstorms). Unlike the roll cloud, the shelf cloud is attached to the base of the parent cloud above it (usually a thunderstorm). Rising cloud motion often can be seen in the leading (outer) part of the shelf cloud, while the underside often appears turbulent, boiling, and wind-torn. It is accompanied by gusty, straight-line winds and is followed by precipitation.

Shoaling: The process whereby waves coming into shallow waters are slowed by bottom friction and become closer together and steeper.

Short-Fuse Warning: A warning issued by the NWS for a local weather hazard of relatively short duration. Short-fuse warnings include tornado warnings, severe thunderstorm warnings, and flash flood warnings. Tornado and severe thunderstorm warnings typically are issued for periods of an hour or less, flash flood warnings typically for three hours or less.

Short Term Forecast: This NWS narrative summary describes the weather in the local area and includes a short-range forecast (not more than 6 hours). This product will be updated more frequently when it is used during active weather. This product is also sometimes referred to as a nowcast.

Shortwave (or Shortwave Trough): A disturbance in the mid or upper part of the atmosphere which induces upward motion ahead of it. If other conditions are favorable, the upward motion can contribute to thunderstorm development ahead of a shortwave.

Shower (SH): It implies short duration, intermittent, and scattered precipitation (rain, snow, ice pellet) of a more unstable, convective nature.

SIGMET (SIGnificant METeorlogical Information): This NWS aviation product advises of weather potentially hazardous to all aircraft other than convective activity. In the conterminous U.S., SIGMETS covered are severe icing, severe or extreme turbulence, duststorms and sandstorms lowering visibilities to less that three (3) miles, and/or volcanic ash.

Significant Wave Height: The average height (trough to crest distance) of the one-third highest waves. An experienced observer will most frequently report heights equivalent to the average of the highest one-third of all waves observed.

Single Cell Thunderstorm: Generally, a thunderstorm not associated with a front or other type of synoptic-scale forcing mechanism. Air mass thunderstorms typically are associated with warm, humid air in the summer months; they develop during the afternoon in response to insolation, and dissipate rather quickly after sunset. They generally are less likely to be severe than other types of thunderstorms, but they still are capable of producing downbursts, brief heavy rain, and (in extreme cases) hail over 0.75" in diameter. Also, see Air Mass Thunderstorm, Popcorn Convection and Pulse Thunderstorm.

Sky Condition: Used in a forecast to describe the predominant/average sky condition based upon octants (eighths) of the sky covered by opaque (not transparent) clouds. The usual descriptors are: clear or sunny, 0/8, mostly clear or mostly sunny, 1/8 to 2/8, partly cloudy or partly sunny, 3/8 to 4/8, mostly cloudy, 5/8 to 7/8, and cloudy, 8/8.

Sleet (PL): Describes solid grains of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. These grains usually bounce upon impact with the ground or pavement. Heavy sleet is a relatively rare event defined as an accumulation of ice pellets covering the ground to a depth of 0.5" or more. See Ice Pellets.

Slight Chance: An NWS precipitation descriptor for a 20 percent chance of measurable precipitation (0.01"). When the precipitation is convective in nature, the term widely scattered or isolated is used. See Precipitation Probability (PoP).

Small Craft Advisory: This is issued by the NWS to alert small boats to sustained (more than 2 hours) hazardous weather or sea conditions. These conditions may be either present or forecasted. Winds in excess of 22 knots (25 mph), and less than 34 knots (39 mph), that may cause hazardous conditions for operators of small vessels. The advisory may be issued for winds, hazardous seas, or both.

Small Stream Flooding: Flooding of small creeks and streams.

Smog: Originally smog meant a mixture of smoke and fog. Now, it means air that has restricted visibility due to pollution or pollution formed in the presence of sunlight--photochemical smog.

Smoke (FU): A suspension in the air of small particles produced by combustion. A transition to haze may occur when smoke particles have traveled a great distance (25 to 100 miles or more) and when the larger particles have settled out and the remaining particles have become widely scattered through the atmosphere.

Snow (SN): Precipitation of frozen crystals, mostly branched in the form of six-pointed stars. It usually falls steadily for several hours or more. Like drizzle, its intensity is based on visibility. The amount of snow that falls is highly dependent upon temperature. For example, at 10°F, one inch of precipitation will produce 30" of snow. At 20°F, one inch of precipitation will produce

20” of snow. At 30°F, one inch of precipitation produces 10” of snow. At freezing, one inch precipitation will produce approximately 6” of snow.

Snow Advisory: This product is issued by the NWS when a low pressure system produces snow that may cause significant inconvenience, but do not meet warning criteria and if caution is not exercised could lead to life threatening situations. The advisory criteria vary from area to area.

Snow and Blowing Snow Advisory: This product is issued by the NWS during situations that cause significant inconvenience, but do not meet warning criteria and if caution is not exercised could lead to life threatening situations. The warning criteria in this definition vary from area to area.

Snow Depth: The combined total depth of both the old and new snow on the ground.

Snow Flurries: Intermittent light snowfalls of short duration (generally light snow showers) with no measurable accumulation.

Snow Grains (SG): Precipitation of very small, white, and opaque grains of ice. They can be distinguished from ice pellets, because ice pellets bounce and snow grains do not bounce at all.

Snow Pack: The combined layers of snow and ice on the ground at any one time. It is also called snowcover.

Snow Pellets (GS): Precipitation of white, opaque grains of ice. The grains are round or sometimes conical. Diameters range from about 0.08” to 0.2” (2mm to 5 mm).

Snow Shower (SHSN): It is a moderate snowfall of short duration. Some accumulation is possible.

Sounding: A plot of the vertical profile of temperature and dew point (and often winds) above a fixed location. Soundings are used extensively in weather forecasting, e.g., to determine instability, locate temperature inversions, measure the strength of the cap, obtain the convective temperature, measure the depth of the marine layer, etc.

Southern Oscillation (SO): A “see-saw” in surface pressure in the tropical Pacific characterized by simultaneously opposite sea level pressure anomalies at Tahiti, in the eastern tropical Pacific and Darwin, on the northwest coast of Australia. The SO was discovered by Sir Gilbert Walker in the early 1920s. Later, the three-dimensional east-west circulation related to the SO was discovered and named the “Walker Circulation”. The SO oscillates with a period of 2-5 years. During one phase, when the sea level pressure is low at Tahiti and High at Darwin, the El Niño occurs. The cold phase of the SO, called La Niña, is characterized by high pressure in the eastern equatorial Pacific, low in the west, and by anomalously low sea surface temperature (SST) in the central and eastern Pacific. This is called El Niño Southern Oscillation or ENSO.

Space Environment Center (SEC): This center provides real-time monitoring and forecasting of solar and geophysical events, conducts research in solar-terrestrial physics, and develops techniques for forecasting solar and geophysical disturbances. SEC's Space Weather Operations is jointly operated by NOAA and the U.S. Air Force and is the national and world warning center for disturbances that can affect people and equipment working in the space environment.

SPC: An acronym for the Storm Prediction Center.

Special Marine Warning (SMW): This is issued by the NWS for hazardous weather conditions over water (thunderstorms, funnel clouds, or waterspouts) usually of short duration (2 hours or less) and producing sustained winds or frequent gusts of 34 knots or more.
These are tone alerted on NOAA All-Hazards Radio. Boaters can also get this information by tuning into Coast Guard and commercial radio stations that transmit marine weather information.

Special Weather Statement (SPS): This is issued by the NWS to provide additional information about expected or ongoing significant weather changes not covered in other statements. This would include non-severe convective, winter weather, and non-precipitation events.

Specific Humidity: In a system of moist air, the ratio of the mass of water vapor to the total mass of the system.

Speed Shear: The component of wind shear which is due to a change in wind speed with height, e.g., southwesterly winds of 20 mph at 10,000 feet increasing to 50 mph at 20,000 feet. Speed shear is an important factor in severe weather development, especially in the middle and upper levels of the atmosphere.

Spot Forecasts: These are NWS site-specific fire weather forecasts. They are issued upon request of User Agencies for wildfires, prescribed burns, hazardous material incidents, or special projects.

Spray (PY): An ensemble of water droplets torn by the wind from the surface of the of an extensive body of water, generally from crests of waves, and carried a short distance into the air.

Spring Tide: A tide higher than normal which occurs around the time of the new and full moon.

Squall (SQ): A strong wind characterized by a sudden onset in which the wind speed increases at least 16 knots and is sustained more than 22 knots or more for at least one minute.

Squall Line: A line or narrow band of active thunderstorms. The line may extend across several hundred miles. It forms along and ahead of an advancing cold front.

Stable: An atmospheric state with warm air above cold air which inhibits the vertical movement of air.

Stable Air: Air with little or no tendency to rise.

Station Pressure: The pressure that is read from a barometer but is not adjusted to sea level.

Stationary Front: A front that barely moves with winds blowing in almost parallel, but in opposite directions on each side of the front. Occasionally, these fronts can cause widespread flooding, because showers and thunderstorms moving along them will continue to move across the same area. This weather situation is called “train echoing”.

Steam Fog: It forms as cold air moves over warm water. Water evaporates from the warm water surface and immediately condenses in the cold air above. Heat from the water warms the lower levels of the air creating a shallow layer of instability. It rises like smoke from the warm surface. The low level convection can become quite turbulent. Steam fog is most common in Arctic regions where it is called “Arctic Sea Smoke”, but it can and does occur occasionally at all latitudes.

Steering Winds (or Steering Currents): A prevailing synoptic scale flow which governs the movement of smaller features embedded within it.

Storm: Any disturbed state of the atmosphere, especially affecting the Earth's surface, and strongly implying destructive and otherwise unpleasant weather. Storms range in scale from tornadoes and thunderstorms through tropical cyclones to widespread extratropical cyclones. In marine usage, winds 48 knots (55 mph) or greater.

Storm Motion: The speed and direction at which a thunderstorm travels.

Storm Prediction Center (SPC): A national forecast center in Norman, Oklahoma, which is part of NCEP. The SPC is responsible for providing short-term forecast guidance for severe convection, excessive rainfall (flash flooding), and severe winter weather over the contiguous United States. This includes the issuance of Tornado and Severe Thunderstorm Watches.

Storm Relative: Measured relative to a moving thunderstorm, usually referring to winds, wind shear, or helicity.

Storm Surge: A rise above the normal water level along a shore caused by strong onshore winds and/or reduced atmospheric pressure. The surge height is the difference of the observed water level minus the predicted tide. Most hurricane deaths are caused by the storm surge. It can be 50 or more miles wide and sweeps across the coastline around where the hurricane makes landfall. The maximum rises in sea-level move from under the storm to the right of the storm's track, reaching a maximum amplitude of 10 to 30 feet at the coast. The storm surge may even double or more in height when the hurricane's track causes it to funnel water into a bay. The storm surge increases substantially as it approaches the land because the normal water depth decreases rapidly as it approaches the beaches. The moving water contains the same amount of energy; thus, resulting in an increase of storm surge. Typically, the stronger the hurricane, the greater the storm surge.

Storm Tide: The actual sea level resulting from astronomical tide combined with the storm surge. This term is used interchangeably with *“hurricane tide”*.

Storm Track: The path that a low pressure area follows.

Storm Warning: A marine warning of sustained surface winds of 48 kt (55 mph or 88 kph) or greater, either predicted or occurring, not directly associated with tropical cyclones.

Straight Line Winds: Generally, any wind that is not associated with rotation, used mainly to differentiate them from tornadic winds.

Stratiform: Descriptive of clouds of extensive horizontal development, as contrasted to the more narrow and vertically developed cumuliform type. Stratiform clouds cover large areas but show relatively little vertical development. Stratiform precipitation, in general, is relatively continuous and uniform in intensity (i.e., steady rain versus rain showers).

Stratiform Rain: Horizontally widespread rain, uniform in character, typically associated with macroscale fronts and pressure systems.

Stratocumulus (Sc): It has globular masses or rolls unlike the flat, sometimes definite, base of stratus. This cloud often forms from stratus as the stratus is breaking up or from spreading out of cumulus clouds. They usually consist of mainly water vapor and are located between the ground and 6,500 feet. Stratocumulus often reveals the depth of the moist air at low levels, while the speed of the cloud elements can reveal the strength of the low-level jet.

Stratosphere: The layer of the atmosphere above the troposphere, where temperature increases with height.

Stratus (St): It is a low, uniform sheet-like cloud. Stratus may appear in the form of ragged patches, but otherwise does not exhibit individual cloud elements as do cumulus and stratocumulus clouds. It usually is located between the ground and 6,500 feet. It usually consists of mainly water vapor. Fog is a stratus cloud with its base located at the ground.

Stream Gage: A site along a stream where the stage (water level) is read either by eye or measured with recording equipment.

Sublimation: The change from ice (a solid) directly to water vapor (a gas) without going through the liquid water phase. It is the opposite of Deposition.

Subrefraction: The bending of the radar beam in the vertical which is less than under standard refractive conditions. This causes the beam to be higher than indicated, and lead to the underestimation of cloud heights.

Subsidence: The slow sinking of air usually associated with high pressure areas. It is usually over a broad area and is associated with warming air and little if any cloud formation.

Subsidence Inversion: It is produced by adiabatic heating of air as it sinks and is associated with anticyclones (high pressure) and/or stable air masses. These inversions form between sinking heated air and air below and they are characterized by temperature increase with height through the inversion, while above the inversion, the temperature cools. The dew point temperature, relative humidity, and mixing ratio values all decrease with height through the inversion.

Subtropical Jet: This branch of the jet stream is usually found between 20° and 30° latitude at altitudes between 12 and 14 km.

Supercell: A thunderstorm with a persistent rotating updraft. Supercells are responsible for a remarkably high percentage of severe weather events - especially tornadoes, extremely large hail and damaging straight-line winds. They frequently travel to the right of the main environmental winds (i.e., they are right movers). Visual characteristics often include a rain-free base (with or without a wall cloud), tail cloud, flanking line, overshooting top, and back-sheared anvil, all of which normally are observed in or near the right rear or southwest part of the storm. Storms exhibiting these characteristics often are called classic supercells; however HP storms and LP storms also are supercell varieties.

Supercooled Liquid Water: In the atmosphere, liquid water can survive at temperatures lower than 0°C (32°F); many vigorous storms contain large amounts of supercooled liquid water at low temperatures. Important in the formation of graupel and hail.

Supersaturation: The condition which occurs in the atmosphere when the relative humidity is greater than 100%.

Superrefraction: Bending of the radar beam in the vertical which is greater than sub-standard refractive conditions. This causes the beam to be lower than indicated, and often results in extensive ground clutter as well as an overestimation of cloud top heights.

Surface Pressure: The pressure that is read from a barometer but is not adjusted to sea level.

Surface Runoff: The part of runoff, caused by precipitation and/or snowmelt, that moves over the soil surface to the nearest stream channel. Rain that falls on the stream channel is often lumped with this quantity.

Sunny: When there are no opaque (not transparent) clouds. Same as clear.

Swell: Wind-generated waves that have traveled out of their generating area. Swells characteristically exhibit smoother, more regular and uniform crests and a longer period than wind waves.

Synoptic Chart: Chart showing meteorological conditions over a region at a given time; a weather map.

Synoptic Scale (or Large Scale): The typical weather map scale that shows features such as high and low pressure areas and fronts over a distance spanning a continent. Compare with mesoscale and storm-scale.

TAF: An acronym for Terminal Aerodrome Forecast

TCU: An acronym for Towering Cumulus.

T. D.: An acronym for Tropical Depression.

Teleconnection: A strong statistical relationship between weather in different parts of the globe.

For example, there appears to be a teleconnection between the tropics and North America during El Niño.

Temperature: A measure of the warmth of the ambient air measured by a suitable instrument such as a thermometer.

Terminal Aerodrome Forecast (TAF): This NWS aviation product is a concise statement of the expected meteorological conditions at an airport during a specified period (usually 24 hours). TAFs use the same weather code found in METAR weather reports.

Thermal: A relatively small-scale, rising air current produced when the Earth's surface is heated. Thermals are a common source of low level turbulence for aircraft.

Thermal Highs: Areas of high pressure that are shallow in vertical extent and are produced primarily by very low surface temperatures.

Thermal Lows: Areas of low pressure that are shallow in vertical extent and are produced primarily by high surface temperatures.

Thermodynamic Chart (or Thermodynamic Diagram): A chart containing contours of pressure, temperature, moisture, and potential temperature, all drawn relative to each other such that basic thermodynamic laws are satisfied. Such a chart typically is used to plot atmospheric soundings, and to estimate potential changes in temperature, moisture, etc. if air were displaced vertically from a given level. A thermodynamic chart thus is a useful tool in diagnosing atmospheric stability.

Thermodynamics: In general, the relationships between heat and other properties (such as temperature, pressure, density, etc.) In forecast discussions, thermodynamics usually refers to the distribution of temperature and moisture (both vertical and horizontal) as related to the diagnosis of atmospheric instability.

Thermometer: An instrument for measuring temperature.

Thunder: The sound emitted by the rapidly expanding gases along the channel of a lightning discharge. Thunder is seldom heard farther than about 15 miles from the lightning discharge, with 25 miles an approximate upper limit and 10 miles a typical value.

Thunderstorm (TS): A local storm produced by cumulonimbus clouds. It is always accompanied by lightning and thunder. It is estimated that nearly 2,000 thunderstorms occur simultaneously around the Earth at any given instant. There are 3 types of thunderstorms:
1. Single Cell Thunderstorms, 2. Multicell Thunderstorms, and 3. Supercell Thunderstorm.

Tides: They are the periodic (occurring at regular intervals) variations in the surface water level of the oceans, bays, gulfs, and inlets. Tides are the result of the gravitational attraction of the sun and the moon on the earth, but mostly from the moon. Every 27.3 days, the earth and the moon revolve around a common point. This means that the oceans and other water bodies which are affected by the earth-moon system experience a new tidal cycle every 27.3 days. Because of the physical processes which occur to produce the tidal system, there are two high tides and two low tides each day. Because of the angle of the moon with respect to the earth, the two high tides and the two low tides each day do not have to be of equal height. Tides also differ in height on a daily basis, due to the changing distance between the earth and the moon. Scientists use measurements of the height of the water level to examine tides and the various phenomena which influence tides, such as hurricanes and winter storms.

Tilted Storm or Tilted Updraft: A thunderstorm or cloud tower which is not purely vertical but instead exhibits a slanted or tilted character. It is a sign of vertical wind shear, a favorable condition for severe storm development.

Tipping-Bucket Rain Gage: A precipitation gage where collected water is funneled into a two compartment bucket; 0.01", 0.1 mm, or some other designed quantity of rain will fill one compartment and overbalance the bucket so that it tips, emptying into a reservoir and moving the second compartment into place beneath the funnel. As the bucket is tipped, it actuates an electric circuit, recording the rainfall.

Tornado (+FC): A violently rotating column of air in contact with the ground and extending from the base of a thunderstorm. A condensation funnel does not need to reach to the ground for a tornado to be present; a debris cloud beneath a thunderstorm is all that is needed to confirm the presence of a tornado, even in the total absence of a condensation funnel. It nearly always starts as a funnel cloud and may be accompanied by a loud roaring noise. Tornadoes are classified by the amount of damage that they cause. See Fujita Scale and Enhanced Fujita Scale.

Tornado Alley: The area of the United States in which tornadoes are most frequent. It encompasses the great lowland areas of the Mississippi, the Ohio, and lower Missouri River Valleys. Although no state is entirely free of tornadoes, they are most frequent in the Plains area between the Rocky Mountains and Appalachians.

Tornado Warning (TOR): This is issued when a tornado is indicated by the WSR-88D radar or sighted by spotters; therefore, people in the affected area should seek safe shelter immediately. They can be issued without a Tornado Watch being already in effect. They are usually issued for a duration of around 30 minutes. A Tornado Warning is issued by the local NWS office. It will include where the tornado was located and what towns will be in its path. After it has been issued, it will be followed up by periodic Severe Weather Statements. These statements will contain updated information on the tornado and they will also let the public know when warning is no longer in effect.

Tornado Watch (SEL): This is issued by the NWS when conditions are favorable for the development of tornadoes in and close to the watch area. The watch is in a form of a rectangle whose size and orientation varies depending on the weather situation. They are usually issued for a duration of 4 to 8 hours. They normally are issued well in advance of the actual occurrence of severe weather. During the watch, people should review tornado safety rules and be prepared to move a place of safety if threatening weather approaches.

Tower: Short for towering cumulus.

Towering Cumulus (TCU): It signifies a relatively deep layer of unstable air. The bases are flat and usually appear darker than the bases of fair weather cumulus. They show considerable vertical development and have billowing "cauliflower" tops. Showers can result from these clouds. Same as cumulus congestus.

TPC: An acronym for the Tropical Prediction Center.

Trace: A rainfall amount less than 0.01".

Track: The path that a storm or weather system follows.

Trade Winds: The winds that occupy most of the tropics and blow from subtropical highs to the equatorial low.

Transcribed WEather Broadcasts (TWEBs): This NWS aviation product is similar to the Area Forecast (FA) except information is contained in a route format. Forecast sky cover (height and amount of cloud bases), cloud tops, visibility (including vertical visibility), weather, and obstructions to vision are described for a corridor 25 miles either side of the route.

Transpiration: Water discharged into the atmosphere from plant surfaces.

Tropical Cyclone: It is a warm-core low pressure system which is non-frontal. It originates over tropical and subtropical waters and a has an organized cyclonic (counter-clockwise) surface wind circulation.

Tropical Depression: Cyclones that have maximum sustained winds of surface wind speed (using the U.S. 1-minute average) is 33 kt (38 mph or 62 kph) or less. They are either located in the tropics or subtropics. They characteristically have one or more closed isobars. They usually intensify slowly and may dissipate before reaching Tropical Storm intensity.

Tropical Disturbance: A discrete tropical weather system of apparently organized convection--generally 100 to 300 nautical miles in diameter---originating in the tropics or subtropics, having a nonfrontal migratory character, and maintaining its identity for 24 hours or more. It may or may not be associated with a detectable perturbation of the wind field. In successive stages of intensification, it may be subsequently classified as a tropical wave, tropical depression, tropical storm, or hurricane.

Tropical Prediction Center (TPC): One of NOAA's 9 National Centers for Environmental Prediction (NCEP). The mission of the Tropical Prediction Center (TPC) is to save lives and protect property by issuing watches, warnings, forecasts, and analyses of hazardous weather conditions in the tropics. TPC products are generated for use in both the domestic and international communities. To fulfill its mission, the TPC is comprised of the following branches: The National Hurricane Center, Tropical Analysis and Forecast Branch (TAFB), and the Technical Support Branch (TSB).

Tropical Storm: It is a warm-core tropical cyclone that has maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 kt (39 mph or 63 kph) to 63 kt (73 mph or 118 kph).

Tropical Storm Warning: A warning for tropical storm conditions including sustained winds within the range of 34 to 63 kt (39 to 73 mph or 63 to 118 kph) that are expected in a specified coastal area within 24 hours or less.

Tropical Storm Watch: An announcement that a tropical storm poses or tropical storm conditions pose a threat to coastal areas generally within 36 hours. A tropical storm watch should normally not be issued if the system is forecast to attain hurricane strength.

Tropical Wave: A trough or cyclonic curvature maximum in the trade wind easterlies and it is not classified as a tropical cyclone. The wave may reach maximum amplitude in the lower middle troposphere.

Tropics: Areas of the Earth within 20°North/South of the Equator.

Tropopause: The upper boundary of the troposphere, usually characterized by an abrupt change in lapse rate from positive (decreasing temperature with height) to neutral or negative (temperature constant or increasing with height). It is also the boundary between the troposphere and the stratosphere.

Troposphere: The layer of the atmosphere from the earth's surface up to the tropopause, characterized by decreasing temperature with height (except, perhaps, in thin layers - see inversion, cap), vertical wind motion, appreciable water vapor content, and sensible weather (clouds, rain, etc.).

Trough: An elongated area of relatively low atmospheric pressure, usually not associated with a closed circulation, and thus used to distinguish from a closed low. The opposite of ridge.

T.S.: An abbreviation for Tropical Storm.

Tsunami: An ocean wave produced by a sub-marine earthquake, landslide, or volcanic eruption. These waves may reach enormous dimensions and have sufficient energy to travel across entire oceans. (Sometimes referred to incorrectly as a tidal wave).

Tule Fog: Radiation fog in California’s Central Valley. It forms during night and morning hours in late fall and winter months following rainfall. A leading cause of weather related casualties in California.

Turbulence: Disrupted flow in the atmosphere that produces gusts and eddies.

Turkey Tower: Slang for a narrow, individual cloud tower that develops and falls apart rapidly. The sudden development of turkey towers from small cumulus clouds may signify the breaking of a cap.

TWEB: Accronym for Transcribed WEather Broadcast.

Twister: In the United States, a colloquial term for a tornado.

Typhoon: A tropical cyclone of hurricane strength in the Western Pacific Ocean (west of the international dateline).

UKMET: A medium-range (3 to 7 day) numerical weather prediction model operated by the United Kingdom METeorological Agency. It has a resolution of 75 kilometers and covers the entire northern hemisphere. Forecasters use this model along with the ***European*** and ***GFS*** in making their extended forecasts (3 to 7 days).

Ultraviolet Radiation: The energy range just beyond the violet end of the visible spectrum. Although ultraviolet radiation constitutes only about 5 percent of the total energy emitted from the sun, it is the major energy source for the stratosphere and mesosphere, playing a dominant role in both energy balance and chemical composition.

Unstable Air: An atmospheric state of warm air below cold air. Since warm air naturally rises above cold air (due to warm air being less dense than cold air), vertical movement and mixing of air layers can occur.

Updraft: Current(s) of air with marked vertical upward motion. If the air is sufficiently moist, then the moisture condenses to become a cumulus cloud or an individual tower of a towering cumulus or cumulonimbus.

Upper-Level Disturbance: A disturbance in the upper atmospheric flow pattern which is usually associated with clouds and precipitation. This disturbance is characterized by distinct cyclonic flow, a pocket of cold air, and sometimes a jet streak. These features make the air aloft more unstable and conducive to clouds and precipitation.

Upper Level System: A general term for any large-scale or mesoscale disturbance capable of producing upward motion (lift) in the middle or upper parts of the atmosphere. This term sometimes is used interchangeably with impulse or shortwave.

Upslope Flow: Air that flows toward higher terrain, and hence is forced to rise. The added lift often results in widespread low cloudiness and stratiform precipitation if the air is stable, or an increased chance of thunderstorm development if the air is unstable.

Upwelling: The process by which cold waters from the depths of a lake or ocean rise to the surface. This often occurs along the California coast during the summer and is an important component in the development of coastal stratus clouds.

Urban & Small Stream Flood Advisory (FLS): This advisory alerts the public to flooding which is generally only an inconvenience (not life-threatening) to those living in the affected area. Issued when heavy rain will cause flooding of streets and low-lying places in urban areas. Also used if small rural or urban streams are expected to reach or exceed bankfull. Some damage to homes or roads could occur.

Urban Flooding: Flooding of streets, underpasses, low lying areas, or storm drains. This type of flooding is mainly an inconvenience and is generally not life threatening.

Urban Heat Island: The increased air temperatures in urban areas in contrast to cooler surrounding rural areas due to the increased heat retention properties of concrete and pavement.

UTC: Coordinated Universal Time. The time in the zero degree meridian time zone.

UV (Ultraviolet) Index: This index provides important information to help you prevent overexposure to the sun's rays. It was designed by the National Weather Service and the Environmental Protection Agency (EPA). It is computed using forecasted ozone levels, a computer model that relates ozone levels to UV incidence on the ground, forecasted cloud amounts, and the elevation of the forecast cities.

Valley Winds: The tendency of wind to funnel down a pronounced valley. Also the movement of air down the slopes of a valley at night (katabatic winds) or up the slopes of valley during the day (anabatic winds).

Veering Wind: Wind which changes in a clockwise direction with time at a given location (e.g., from southerly to westerly), or which change direction in a clockwise sense with height (e.g., southeasterly at the surface turning to southwesterly aloft). Veering winds with height are indicative of warm air advection (WAA).

Vertical Wind Shear: The rate of change of wind speed or direction, with a given change in height. This is a critical factor in determining whether severe thunderstorms will develop.

Vertically Stacked System: A low-pressure system, usually a closed low or cutoff low, which is not tilted with height, i.e., located similarly at all levels of the atmosphere. Such systems typically are weakening and are slow-moving, and are less likely to produce severe weather than tilted systems. However, cold pools aloft associated with vertically-stacked systems may enhance instability enough to produce severe weather.

Virga: Precipitation that evaporates before it reaches the ground. It appears as wisps or streaks of rain or snow falling out of a cloud. As the precipitation evaporates, it cools the air and starts a down draft. In certain cases, shafts of virga may precede a microburst.

Visible (VIS) Satellite Imagery: This type of satellite imagery uses reflected sunlight (this is actually reflected solar radiation) to see things in the atmosphere and on the Earth's surface. Clouds and fresh snow are excellent reflectors, so they appear white on the imagery. Clouds can be distinguished from snow, because clouds move and snow does not move. Meanwhile, the ground reflects less sunlight, so it appears black on the imagery. The satellite uses its 0.55 to 0.75 micrometer (um) channel to detect this reflected sunlight. Since this imagery relies on reflected imagery, it cannot be used during night.

Visibility: The greatest distance an observer can see and identify prominent objects.

Visual Flight Rules (VFR): Refers to the general weather conditions pilots can expect at the surface. VFR is ceiling greater than or equal to 1,000 feet and visibility greater than or equal to 3 miles. Marginal VFR (MVFR) is a sub-category of VFR (ceiling 1,000 - 3,000 feet and/or visibility 3 to 5 miles).

Vort Max: This short for vorticity maximum. It is a center, or maximum, in the vorticity field of a fluid.

Vortex: In its most general use, any flow possessing vorticity. More often the term refers to a flow with closed streamlines.

Vorticity: A vector measure of the local rotation in a fluid flow. In weather analysis and forecasting, it usually refers to the vertical component of rotation (i.e., rotation about a vertical axis) and is used most often in reference to synoptic scale or mesoscale weather systems. By convention, positive values indicate cyclonic rotation.

WAA: An acronym for Warm Air Advection.

Wall Cloud: It is formed in a supercell thunderstorm. A localized, persistent, often abrupt lowering from a rain-free base. Wall clouds can range from a fraction of a mile up to nearly five miles in diameter, and normally are found on the south or southwest (inflow) side of the thunderstorm, attached to the rain free cloud base, and marks the strongest updraft in the thunderstorm. Eventually, this updraft will pull air from the rain cooled area of the thunderstorm. Since the rain cooled air is very humid, it will quickly condense in the updraft at a lower altitude than the rain free cloud base. When seen from within several miles, many wall clouds exhibit rapid upward motion and cyclonic rotation. However, not all wall clouds rotate. Rotating wall clouds usually develop before strong or violent tornadoes, by anywhere from a few minutes up to nearly an hour. Wall clouds should be monitored visually for signs of persistent, sustained rotation and/or rapid vertical motion.

Warm Air Advection: Transport of warm air into an area by horizontal winds.

Warm Core Low: A low pressure area which is warmer at its center than at its periphery. Tropical cyclones exhibit this temperature pattern. Unlike cold core lows, these lows produce much of their cloud cover and precipitation during the nighttime.

Warm Front: A front that moves in such a way that warm air replaces cold air.

Warning: A type of product issued by NWS offices indicating that a particular weather hazard is either imminent or has been reported. A warning indicates the need to take action to protect life and property. The type of hazard is reflected in the type of warning (e.g., tornado warning, blizzard warning). See short-fuse warning.

Warning Stage: The level of a river or stream which begins to cause flooding, and at which concerned interests should take action.

Watch: A type of NWS product indicating that a particular hazard is possible, i.e., that conditions are more favorable than usual for its occurrence. A watch is a recommendation for planning, preparation, and increased awareness (i.e., to be alert for changing weather, listen for further information, and think about what to do if the danger materializes).

Watch Redefining Statement (SLS): This product tells the public which areas are included in the watch and is issued by the local NWS Forecast Office.

Water Equivalent: The liquid content of solid precipitation that has accumulated on the ground (snow depth). The accumulation may consist of snow, ice formed by freezing precipitation, freezing liquid precipitation, or ice formed by the refreezing of melted snow.

Watershed: The total area drained by a river and its tributaries. Sometimes called a basin.

Water Vapor (WV) Satellite Imagery: This satellite imagery uses that detects moisture between 700 and 200 mb; therefore, it is good for determining mid and upper level moisture in the atmosphere. Abundant water vapor appears white in this imagery. Meanwhile, dry air appears black in this satellite imagery. This satellite imagery can be used both day and night.

Water Vapor Plume: This appears in the water vapor satellite imagery. It is a plume-like object that extends from the Intertropical Convergence Zone (ITCZ) northward or southward into the higher latitudes and is a favored region for very heavy rain. It is thought that the ice crystals located in this plume help thunderstorms to become highly efficient rainfall producers. In North America, this is sometimes called the “Mexican Connection” for moisture moving into the southwestern US from Mexico or the “Pineapple Connection” for moisture moving into the west coast from the tropics.

Waterspout: A violently rotating column of air, usually a pendant to a cumulus or cumulonimbus cloud, over a body of water with its circulation reaching the water. Waterspouts can be generated by thunderstorms, or can be cold air funnels, being generated by a cold air mass passing over much warmer waters. Such waterspouts are generally much less intense than tornadoes.

Wave: An identifiable, periodic disturbance or motion in a medium that shows displacement. The most commonly referred medium is water, followed by the atmosphere. The forecasted heights of waves in the oceans are those heights expected at the end of the fetch for that body of water.

Weather Forecast Office (WFO): This National Weather Service office is responsible for issuing advisories, warnings, statements, and short term forecasts for its county warning area. There are 122 WFOs that cover the entire U.S. and its territories.

Weather balloon: Large balloon filled with helium or hydrogen that carries a radiosonde (weather instrument) aloft to measure temperature pressure and humidity as the balloon rises through the air. It is attached to a small parachute so that when the balloon inevitably breaks, the radiosonde doesn't hurtle back to earth dangerously quickly.

Weather synopsis: A description of weather patterns affecting a large area.

West Coast and Alaska Tsunami Warning Center (WCATWC): The WCATWC provides tsunami warning guidance for all U.S. coastal states (except Hawaii), and the Canadian coastal provinces. It is located in Palmer, AK. A tsunami warning for California will come from this center and will be relayed by the local NWS office.

Wet-Bulb Temperature: The lowest temperature that can be obtained by evaporating water into air.

Wet-Bulb Zero (WBZ): The height where the wet-bulb temperature goes below 0°F. WBZ heights between 7000 ft and 10,500 ft (above ground level) correlate well with large hail at the surface when storms develop in an air mass primed for strong convection. It is also a good indicator of the elevation of snowfall.

Wet Microburst: A microburst accompanied by heavy precipitation at the surface. A rain foot may be a visible sign of a wet microburst. See dry microburst.

WFO: A National Weather Service Weather Forecast Office.

Whirlwind: A small, rotating column of air; may be visible as a dust devil.

Wildfire: Any free burning uncontainable wildland fire not prescribed for the area which consumes the natural fuels and spreads in response to its environment.

Willy-Willy: A tropical cyclone of hurricane strength near Australia.

Wind: The horizontal motion of the air past a given point. Winds begin with differences in air pressures. Pressure that's higher at one place than another sets up a force pushing from the high toward the low pressure. The greater the difference in pressures, the stronger the force. The distance between the area of high pressure and the area of low pressure also determines how fast the moving air is accelerated. Meteorologists refer to the force that starts the wind flowing as the pressure gradient force. High and low pressure are relative. There's no set number that divides high and low pressure. Wind is used to describe the prevailing direction from which the wind is blowing with the speed given usually in miles per hour or knots.

Wind Advisory: Issued for sustained winds strong enough to cause inconvenience or minor damage. Criteria for Southern California are sustained winds 30 to 39 mph and/or gusts to 57 mph in coastal and valley areas, and sustained winds 35 to 44 mph and/or gusts to 57 mph in the mountains and deserts.

Wind Aloft: The wind speeds and wind directions at various levels in the atmosphere above the area of surface.

Wind Chill: The wind chill is the effect of the wind on people and animals. The wind chill temperature is based on the rate of heat loss from exposed skin caused by wind and cold and gives an approximation of how cold the air feels on your body. As the wind increases, it removes heat from the body, driving down skin temperature and eventually the internal body temperature.

Therefore, the wind makes it *FEEL* much colder. If the temperature is 0°F and the wind is blowing at 15 mph, the wind chill temperature is -19°F. At this level, exposed skin can freeze in just a few minutes. The only effect wind chill has on inanimate objects, such as car radiators and water pipes, is to shorten the amount of time for the object to cool. The inanimate object will not cool below the actual air temperature. For example, if the temperature outside is -5°F and the wind chill temperature is -31°F, then your car's radiator temperature will be no lower than the air temperature of -5°F.

Wind Chill Advisory: The NWS issues this product when the wind chill becomes dangerous. The criteria for this warning vary from state to state.

Wind Chill Warning: The NWS issues this product when the wind chill is life threatening. The criteria for this warning vary from state to state.

Wind Direction: The true direction FROM which the wind is moving at a given location. It is normally measured in tens of degrees from 10° to 360°.

Wind Gust: They are rapid fluctuations in the wind speed with a variation of 10 knots or more between peaks and lulls. The speed of the gust will be the maximum instantaneous wind speed.

Wind Rose: A diagram that shows the percent of time that the wind blows from different directions at a given location over a given time.

Wind Shear: The rate of change of wind speed and/or direction over a given distance. Also, see shear.

Wind Shift: A change in wind direction of 45° or more in less than 15 minutes with sustained wind speeds of 10 knots or more throughout the wind shift.

Wind Sock: A tapered fabric shaped like a cone that indicates wind direction by pointing away from the wind. It is also called a *wind cone*.

Wind Speed: The rate at which air is moving horizontally past a given point. It may be a 2-minute average speed (reported as wind speed) or an instantaneous speed (reported as a peak wind speed, wind gust, or squall).

Wind Vane: An instrument that determines the direction from which a wind is blowing.

Wind Waves: Local, short period waves generated from the action of wind on the water surface (as opposed to *swell*). Commonly referred to as waves.

Winter Storm Warning: Issued when more than one type of hazardous winter weather is occurring, imminent, or highly likely over part or all of the forecast area. Winter storm warnings are normally issued for the first period of the forecast but can be extended into the second period. They are reissued whenever there is a change to the timing, areal extent, or expected condition.

Winter Storm Watch: Issued when conditions are favorable for hazardous winter weather conditions to develop over part or all of the forecast area in the next 6-36 hours, but the occurrence is still uncertain. Watches will be reissued whenever there is a change in the timing, areal extent, or expected conditions. Winter storm watches either evolve into winter storm warnings or advisories, or they are canceled.

WSR-88D: Weather Surveillance Radar - 1988 Doppler; NEXRAD unit.

Zone Forecast Product (ZFP): This NWS product will provide the general public with a clear statement of the expected weather conditions within a given zone. The forecast will include: sky condition, temperature, type of precipitation and its probability, and wind direction and speed (probability of precipitation and winds are normally given only during the first 5 periods of the forecast).

Zonal Flow: Large-scale atmospheric flow in which the east-west component (i.e., latitudinal) is dominant. The accompanying meridional (north-south) component often is weaker than normal. Compare with meridional flow.

Zulu (Z) Time: For practical purposes, the same as Coordinated Universal Time (UTC). The notation formerly used to identify time Greenwich Mean Time. The word “Zulu” is notation in the phonetic alphabet corresponding to the letter “Z” assigned to the time zone on the Greenwich Prime Meridian.

Appendix C - Weather Education Resources and Bibliography of Local Weather

Education in person

Most colleges and universities offer courses in basic Meteorology. Many of these are part of the Geography department in a Physical Geography course, which usually contain significant study in weather and climate. In Southern California, the only university to offer a degree in Atmospheric Science or Meteorology is UCLA.

Online Education

Many resources for learning more about weather in general are available online. Here are some of our favorite weather education web sites on the Internet:

Online tutorials
www.srh.noaa.gov/jetstream
ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/home.rxml

Disaster Preparedness
www.fema.gov/hazard/index.shtm
emergency training courses: training.fema.gov

General weather basics education
wps.prenhall.com/esm_aguado_uwac_3
http://www.usatoday.com/weather/wgraph0.htm
www.weatherworks.com
eo.ucar.edu/basics/index.html

Advanced weather education
A warehouse of great learning modules: meted.ucar.edu

Interpretation of weather models
https://www.meted.ucar.edu/training_detail.phpweather.unisys.com/model/details.html
www.theweatherprediction.com/models

Weather Books

Numerous books about weather and meteorology are available, including these finest examples:

Understanding Weather and Climate by Edward Aguado and James Burt. This book focuses on explaining, rather than describing, the processes that produce Earth's weather and climate. Companion web site available (see in links above).

The Audubon Society Field Guide to North American Weather by David M. Ludlum can be used to identify clouds and other sky phenomena in much the way a field guide to birds is used.

The USA TODAY Weather Book by Jack Williams explains the basics of meteorology with easy to understand text and colorful graphics.

Meteorology Today: An Introduction to Weather, Climate, and the Environment by C. Donald Ahrens, is one of the most popular college textbooks. It is designed for students who are not planning to major in meteorology, which means little mathematical knowledge is required.

Meteorology: Understanding the Atmosphere by Steven Ackerman, John A. Knox. A college text written by college professors containing generous graphics and photographs.

The Atmosphere: An Introduction to Meteorology by Frederick K. Lutgens, Edward J. Tarbuck and Dennis Tasa. Using everyday, easy-to-grasp examples to reinforce basic concepts, this highly regarded handbook remains the standard introduction to meteorology and the atmosphere – components, problems, and applications.

Weatherwise is a weather magazine devoted to both professional and amateur weather enthusiasts. See **www.weatherwise.org**.

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Appendix D - Product Cross Reference

The following chart is a cross references for weather products issued by the NWS with the World Meteorological Organization (WMO) headers. The NWS identifier used is the final five or six letters of the complete nine digit identifier. Actual issuance times may occur before the indicated issuance times below.

Product	**NWS Header (for Weatherwire and EMWIN)**	**WMO Header**	**Issuance Times**
Area Forecast Discussion	AFDSGX	FXUS66	330 am, 930 am, 230 pm, 930 pm, and as needed
Airport Weather Warning (Lindbergh Field only)	AWWSAN	WWUS86	as needed
Climatological Report (Monthly)	CLM XXX (XXX dependent on location)	CSUX46	1st day of the month
Climatological Report (Daily)	CLIXXX (XXX dependent on location)	CDUS46	2 am, 4 pm
Coastal Flood Statement (incl. High Surf Advisory)	CFWSGX	FZUS68	as needed
Coastal Waters Forecast	CWFSGX	FZUS56	330 am/pm, 930 am/pm PDT (230 am/pm, 830 am/pm PST)
Coastal Weather Observations	CGRSGX	SXUS8	7 am, 10 am, 1 pm, 4 pm, 7 pm, 10 pm, (possibly 1 am, 4 am)
Earthquake Report	EQREQI	SEUS61	as needed
Fire Weather Planning Forecast	FWFSGX	FNUS56	400 am, 230 pm (during season), as needed
Fire Weather Watch, Red Flag Warning	RFWSGX	WWUS86	as needed
Flash Flood Warning	FFWSGX	WGUS56	as needed
Flood Watch (flash or river)	FFASGX	WGUS46	as needed
Flash Flood Statement	FFSSGX	WGUS76	as needed

Flood Potential Outlook	ESFSGX	FGUS76	as needed
Flood Statement or Advisory	FLSSGX	WGUS46	as needed
Flood Warning	FLWSGX	WGUS46	as needed
Hazardous Weather Outlook	HWOSGX	FLUS46	6 am, when needed
Hourly Weather Roundup	RWRSGX	ASUS46	hourly
Hurricane Local Statement	HLSSGX	WTUS84	as needed
Local Storm Report	LSRSGX	WWUS30	as needed
Marine Weather Statement	MWSSGX	FZUS76	as needed
Mexican Weather Roundup	RWRMX	AXUS46	hourly
Non Precipitation Warnings/ Watches/ Advisories	NPWSGX	WWUS45	as needed
Offshore Waters Forecast	OFFPZ6	FZPN26	330 am/pm, 930 am/pm
Public Information Statement	PNSSGX	ABUS34	as needed
Quantitative Precipitation Forecast	QPSSGX	FSUS46	4 am/pm (1 Nov - 15 Apr), as needed
Rainfall Storm Total Summary	RRMSGX	SGUS46	as needed
Record Event Report	RERSGX	SXUS99	as needed
Red Flag Warning, Fire Weather Watch	RFWSGX	FXUS70	as needed
Regional Max/Min Temp and Precipitation Table	RTPSGX	ASUS66	530 am, 430 pm, 530 pm, and as needed
River Statement	RVSSGX	RWUS15	as needed
Tabular State Forecast for California	SFTSGX	FOUS45	330 am, 230 pm
Severe Local Storm Watch and Areal Outlook	SLSCA	WWUS32	as needed
Severe Thunderstorm Warning	SVRSGX	WUUS56	as needed

Severe Weather Statement	SVSSGX	WWUS34	as needed
Short Term Forecast	NOWSGX	FPUS76	as needed
Special Marine Warning	SMWSGX	WMUS1	as needed
Special Weather Statement	SPSSGX	WWUS35	as needed
Surf Forecast	SRFSGX	FZUS56	2 am/pm
Tornado Warning	TORSGX	WFUS56	as needed
Tsunami Warning	TSWSGX	WEXX20	as needed
Tsunami Watch or Advisory	TSASGX	WEPA41	as needed
Tsunami Statement	TSSSGX	WEPA43	as needed
Winter Weather Warnings/ Watches/Advisories	WSWSGX	WWUS46	as needed
Zone Forecast	ZFPSGX	FPUS56	330 am, 230 pm, and as needed

Non- Routine Products

For the current Watches, Warnings and Advisories issued by the San Diego Weather Forecast Office please use this link: **www.wrh.noaa.gov/warnings.php?wfo=sgx**.

SEVERE WEATHER	FLOODING	NON-PRECIPITATION HAZARDS (NPW)	FIRE WEATHER	WINTER WEATHER	OTHER
TORNADO WATCH **(LAXWCNSGX)**	FLOOD WATCH **(LAXFFASGX)**	**WIND**	FIRE WEATHER WATCH **(LAXRFWSGX)**	WI NTER WEATHER OUTLOOK **(LAXSPSSGX)**	SHORT TERM FORECAST **(LAXNOWSGX)**
TORNADO WARNING **(LAXTORSGX)**	FLOOD WARNING **(LAXFLWSGX)**	HIGH WIND WATCH **(LAXNPWSGX)**	RED FLAG WARNING **(LAXRFWSGX)**	WINTER WEATHER ADVISORY **(LAXWSWSGX)**	LOCAL STORM REPORT **(LAXLSRSGX)**
FUNNEL CLOUD **(LAXSPSSGX)**	FLASH FLOOD WATCH **(LAXFFASGX)**	HIGH WIND WARNING **(LAXNPWSGX)**	**MARINE**	SNOW ADVISORY **(LAXWSWSGX)**	SPECIAL WEATHER STATEMENT **(LAXSPSSGX)**
SEVERE THUNDERSTORM WATCH **(LAXWCNSGX)**	FLASH FLOOD WARNING **(LAXFFWSGX)**	WIND ADVISORY **(LAXNPWSGX)**	WATERSPOUT **(LAXSMWSGX)**	SNOW AND BLOWING SNOW ADVISORY **(LAXWSWSGX)**	PUBLIC INFORMATION STATEMENT **(LAXPNSSGX)**
SEVERE THUNDERSTORM WARNING **(LAXSVRSGX)**	FLASH FLOOD STATEMENT **(LAXFFSSGX)**	**FROST/FREEZE**	MARINE WEATHER STATEMENT **(LAXMWSSGX)**	WINTER STORM WATCH **(LAXWSWSGX)**	HAZARDOUS WEATHER OUTLOOK **(LAXHWOSGX)**
SEVERE WEATHER STATEMENT **(LAXSVSSGX)**	URBAN AND SMALL STREAM FLOOD ADVISORY **(LAXFLSSGX)**	FREEZE WARNING **(LAXNPWSGX)**	SPECIAL MARINE WARNING **(LAXSMWSGX)**	WINTER STORM WARNING **(LAXWSWSGX)**	
	FLOOD STATEMENT **(LAXFLSSGX)**	FROST ADVISORY **(LAXNPWSGX)**	STORM WARNING **Headlined in (LAXCWFSGX)**	BLIZZARD WARNING **(LAXWSWSGX)**	
	COASTAL FLOOD WATCH **(LAXCFWSGX)**	**HEAT**	GALE WARNING **Headlined in (LAXCWFSGX)**	WIND CHILL ADVISORY **(LAXWSWSGX)**	
	COASTAL FLOOD WARNING **(LAXCFWSGX)**	EXCESSIVE HEAT WATCH **(LAXNPWSGX)**	SMALL CRAFT ADVISORY **Headlined in (LAXCWFSGX)**	WIND CHILL WARNING **(LAXWSWSGX)**	
	COASTAL FLOOD STATEMENT **(LAXCFWSGX)**	EXCESSIVE HEAT WARNING **(LAXNPWSGX)**	**AVIATION**	HEAVY SNOW WARNING **(LAXWSWSGX)**	
		OTHER	AIRPORT WEATHER WARNING **(LAXAWWSAN)**		
		HIGH SURF ADVISORY **(LAXCFWSGX)**			
		DENSE FOG ADVISORY **(LAXNPWSGX)**			

Appendix E – Warning and Advisory Criteria

(**www.wrh.noaa.gov/sgx/document/WWA_Criteria.pdf**)

WIND

Location	**Wind Advisory (NPW)**	**High Wind Warning (NPW)**
Coastal Areas and Valleys	Sustained 30 mph (26 kt) or more and/or gusts 35 mph (30 kt) or more	Sustained 40 mph (35 kt) or more and/or gusts 58 mph (50 kt) or more
Desert and Mountains below 7000 ft	Sustained 35 mph (30 kt) or more and/or gusts 45 mph (39 kt) or more	Sustained 45 mph (39 kt) or more and/or gusts 58 mph (50 kt) or more
Mountains above 7000 ft	Sustained 45 mph (39 kt) or more and/or gusts 55 mph (48 kt) or more	Sustained 55 mph (48 kt) or more and/or gusts 75 mph (65 kt) or more

FOG

Location	**Dense Fog Advisory (NPW)**
More than isolated pockets	Less than one quarter mile visibility for any length of time

WINTER WEATHER

Location	**Winter Weather Advisory (WSW)**	**Winter Strom Warning (WSW)**
Mountains above 7000 ft	4-7” in 12 hours with visibilities below ½ mile in strong wind	12” in 12 hours or 18” in 24 hours
Mountains below 7000 ft (3000-7000 ft)	4-7” in 12 hours with visibilities below ½ mile in strong wind	8” in 12 hours or 12” in 24 hours
All other areas	1-4” in 12 hours with visibilities below ½ mile in strong wind	4” in 12 hours or 6” in 24 hours

Location	**Wind Chill Warning (NPW)**	**Wind Chill Advisory (NPW)**	**Blizzard Warning (WSW)**	**Freezing Rain or Drizzle Advisory (WSW)**	**Ice Storm Warning (WSW)**
any	-20 degree wind chill	-10 to -19 degree wind chill	Sustained wind 35 mph (30 kt) or more with visibility 1/4 mile or less for 3 hours or more	Freezing rain or drizzle accumulations of a trace to less than 1/4”	Freezing rain or drizzle accumulations of 1/4” or more

SEVERE THUNDERSTORM – TORNADO

Location	Severe Thunderstorm Warning (SVR)	Tornado Warning (TOR)
any	Hail 1" or larger and/or winds 58 mph (50 kt) sustained or gusts	If tornado is sighted or if radar or other data suggest existence or formation is likely

TEMPERATURE

Location	Excessive Heat Warning (NPW)	Frost Advisory (NPW)	Freeze Warning (NPW)
Coastal Sections	Heat Index 105 degrees or more	Widespread temps from 28 to 32 degrees	Widespread temps 28 degrees or less
Valleys	Heat Index 110 degrees or more	Widespread temps from 28 to 32 degrees	Widespread temps 28 degrees or less
Apple and Yucca Valleys	Heat Index 120 degrees or more	The 1st and 2nd time temp is forecast to be 32 degrees or less for 2 or more consecutive hours or anytime between 1 Mar and 15 Nov	The 1st and 2nd time temp is forecast to be 28 degrees or less for 2 or more consecutive hours or anytime between 1 Mar and 15 Nov
Lower Deserts	Heat Index 120 degrees or more	Widespread temps from 28 to 32 degrees	Widespread temps 28 degrees or less
Mountains (> 3 kft)	Heat Index 105 degrees or more	Not issued	Not issued

MARINE

Small Craft Advisory (MWW)	Gale Warning (MWW)	Storm Warning (MWW)
Wind 21 to 33 kt and/or combined seas 10 ft or more	Wind 34 to 47 kt	Wind 48 kt or more

These three hazards above are also headlined in the text of the Coastal Waters Forecast (CWF).

High Surf Advisory (CFW)	Tidal Overflow Statement (CFW)
Widespread breakers of 7 ft or more. If high tides will be 5 ½ ft or more, a call to action to protect beach property is required	Tides of 7 ft or more with little or no wave or wind action. With higher wave or wind action, use Coastal Flooding products

Appendix F - Climate Data and Records

Official climate data suitable for insurance claims or for legal purposes must be certified by the National Climatic Data Center (NCDC). These data are available in hourly, daily, monthly, or seasonal breakdowns for nearly 100 locations in our area of responsibility and hundreds more locations in the western U.S. These data can be obtained through the Western Regional Climate Center in Reno, Nevada, and require a special request and a small fee. Contact them directly:

Western Regional Climate Center
2215 Raggio Parkway
Reno, Nevada 89512

email: wrcc@dri.edu
phone: 775-674-7010
fax: 775-674-7016
Internet address: **www.wrcc.dri.edu**

Southern California archives of climate normals are also available on the Western Regional Climate Center's web site at: **www.wrcc.dri.edu/summary/Climsmsca.html**
For a narrative describing the monthly climate for the city of San Diego, click on:
www.wrh.noaa.gov/sgx/climate/san-san-month.htm

Many detailed (daily and hourly) historical weather conditions are available on our website **www.weather.gov/climate/index.php?wfo=sgx** through the NOWData link (from our home page, click on Climate – Local, then NOWData). Additional climate data are made available through this web site for numerous sites in our area (Observed Weather tab). A wealth of various other climate information data is available on the Local Data/Records tab. These data featured on the web site are preliminary and not official data suitable for insurance claims or legal purposes.

The history or weather in Southern California can be viewed on a day-to-day basis each day and is headlined on our home page as "This Day in History" with a link to the daily archive. More weather history is available on our home page by clicking on "Weather History" on the left side menu.

Appendix G – Weather Safety Tips for Southern California

For more information about these and other hazards, visit: **weather.gov/safety.php**

Flash Floods

- Get out of areas subject to flooding, such as dips, low spots, canyons, washes, etc. Climb to higher ground.
- Do not let children play near storm drains.
- Avoid already flooded and high velocity flow areas. Do not attempt to cross flowing streams.
- If driving, be aware that the road bed may not be intact under flood waters. Turn around and go another way. Never drive through flooded roadways.
- If the vehicle stalls, leave it immediately and seek higher ground. Rapidly rising water may engulf the vehicle and its occupants and sweep them away.
- Be especially cautious at night when it is harder to recognize flood dangers.
- Do not camp or park your vehicle along streams and washes, particularly during threatening conditions.
- If advised to evacuate, do so immediately.

Lightning

- Postpone outdoor activities if thunderstorms are imminent. This is your best way to avoid being caught in a dangerous situation.
- Move to a sturdy building or car. Do not take shelter in small sheds, under isolated trees, or in convertible automobiles. Stay away from tall objects such as towers, fences, telephone poles, and power lines.
- If lightning is occurring and a sturdy shelter is not available, get inside a hard top automobile and keep the windows up. Avoid touching any metal.
- Utility lines and metal pipes can conduct electricity. Unplug appliances not necessary for obtaining weather information. Avoid using the telephone or any electrical appliances. Use phones ONLY in an emergency.
- Do not take a bath or shower during a thunderstorm.
- Turn off air conditioners. Power surges from lightning can cause serious damage.

<u>If caught outdoors and no shelter is nearby:</u>

- Find a low spot away from trees, fences, and poles. Make sure the place you pick is not subject to flooding.
- If you are in the woods, take shelter under the shorter trees.
- If you feel your skin tingle or your hair stand on end, squat low to the ground on the balls of your feet. Place your hands over your ears and your head between your knees. Make yourself the smallest target possible and minimize your contact with the ground. DO NOT lie down.
- If you are boating or swimming, get to land and find shelter immediately!

Tornadoes

- In a home or building, move to a pre-designated shelter, such as a basement.
- If an underground shelter is not available, move to a small interior room or hallway on the lowest floor and get under a sturdy piece of furniture. Put as many walls as possible between you and the outside.
- Stay away from windows.
- Get out of automobiles.
- Do not try to outrun a tornado in your car; instead, leave it immediately for safe shelter.
- If caught outside or in a vehicle, lie flat in a nearby ditch or depression and cover your head with your hands.
- Be aware of flying debris. Flying debris from tornadoes causes most fatalities and injuries.
- Mobile homes, even if tied down, offer little protection from tornadoes. You should leave a mobile home and go to the lowest floor of a sturdy nearby building or a storm shelter.

Winter Storms and Extreme Cold

Outside:

- Find shelter to stay dry. Cover all exposed body parts.
- If no shelter, build a lean-to, windbreak or snow cave for protection from the wind. Build a fire for heat and to attract attention. Place rocks around the fire to absorb and reflect heat.
- Melt snow for drinking water. Eating snow will lower your body temperature.

In a Vehicle:

- Stay in the vehicle. You will become quickly disoriented in wind-driven snow and cold.
- Run the motor about 10 minutes each hour for heat.
- Open the window a little for fresh air to avoid carbon monoxide poisoning.
- Make sure the exhaust pipe is not blocked.
- Be visible to rescuers. Turn on the dome light at night when running the engine.
- Tie a colored cloth, preferably red, to your antenna or door.
- After snow stops falling, raise the hood to indicate you need help.
- Exercise. From time to time, move arms, legs, fingers and toes vigorously to keep blood circulating and to keep warm.

Inside:

- Stay inside.
- When using alternate heat from a fireplace, wood stove, space heater, etc., use fire safeguards and properly ventilate.
- If no heat: close off unneeded rooms, stuff towels or rags in cracks under doors, cover windows at night. Eat and drink. Food provides the body with energy for producing its own heat. Keep the body replenished with fluids to prevent dehydration. Wear layers of loose-fitting, lightweight, warm clothing. Remove layers to avoid overheating, perspiration and

subsequent chill.

Extreme Heat

- Slow down. Limit strenuous activities to the coolest time of the day.
- Dress for summer. Wear lightweight, light-colored clothing.
- Reduce the consumption of proteins to slow down metabolism and water loss.
- Drink plenty of water even if you are not thirsty. Avoid alcoholic beverages.
- Spend more time in air-conditioned places.
- Avoid too much exposure to the sun. Sunburn reduces the body's ability to dissipate heat.

Boating

- Check NOAA All-Hazards Radio for latest warnings and forecasts.
- Watch for signs of approaching storms: dark, threatening clouds that may foretell a squall or thunderstorm, a steady increase in wind or sea lightning flashes.
- An increase in wind opposite in direction to a strong tidal current may lead to steep waves capable of broaching a boat.
- Heavy static on your AM radio may be an indication of nearby thunderstorm activity.
- If a thunderstorm is approaching, head for shore if possible. Get out of your boat and away from the water. Find shelter immediately.
- If a thunderstorm catches you while afloat, remember that gusty winds and lightning pose a threat to safety. Put on your personal flotation device and prepare for rough seas. Stay below deck if possible. Keep away from metal objects that are not grounded to the boat's protection system. Don't touch more than one grounded object at the same time (or you may become a shortcut for electrical surges passing through the protection system).

Surf and Rip Currents

- Know how to swim.
- Always swim at guarded beaches and heed the beach patrol.
- Remain calm. If caught in a rip current remember it will not pull you under.
- Swim out of the current. Since the currents are relatively narrow, escape the flow by swimming parallel to the shore until you break free, then swim diagonally toward the shore.
- Float if you cannot swim out of the current. Float until it dissipates, then swim diagonally toward the shore or float and summon the beach patrol by waving your hands.
- Use a flotation device if you attempt to rescue someone.

Appendix H — Charts and Tables

Temperature Conversion

In the formulas below, / means to divide, * means to multiply, - means subtract, + means to add and = is equal. Tc = temperature in degrees Celsius, Tf = temperature in degrees Fahrenheit.
To convert a Fahrenheit temperature into Celsius: Tc = (5/9)*(Tf-32)
To convert a Celsius temperature into degrees Fahrenheit: Tf = ((9/5)*Tc)+32

to C	C or F	to F	to C	C or F	to F	to C	C or F	to F	to C	C or F	to F
-28.89	-20	-4	-6.67	20	68	15.56	60	140	37.78	100	212
-28.33	-19	-2.2	-6.11	21	69.8	16.11	61	141.8	38.33	101	213.8
-27.78	-18	-0.4	-5.56	22	71.6	16.67	62	143.6	38.89	102	215.6
-27.22	-17	1.4	-5	23	73.4	17.22	63	145.4	39.44	103	217.4
-26.67	-16	3.2	-4.44	24	75.2	17.78	64	147.2	40	104	219.2
-26.11	-15	5	-3.89	25	77	18.33	65	149	40.56	105	221
-25.56	-14	6.8	-3.33	26	78.8	18.89	66	150.8	41.11	106	222.8
-25	-13	8.6	-2.78	27	80.6	19.44	67	152.6	41.67	107	224.6
-24.44	-12	10.4	-2.22	28	82.4	20	68	154.4	42.22	108	226.4
-23.89	-11	12.2	-1.67	29	84.2	20.56	69	156.2	42.78	109	228.2
-23.33	-10	14	-1.11	30	86	21.11	70	158	43.33	110	230
-22.78	-9	15.8	-0.56	31	87.8	21.67	71	159.8	43.89	111	231.8
-22.22	-8	17.6	0	32	89.6	22.22	72	161.6	44.44	112	233.6
-21.67	-7	19.4	0.56	33	91.4	22.78	73	163.4	45	113	235.4
-21.11	-6	21.2	1.11	34	93.2	23.33	74	165.2	45.56	114	237.2
-20.56	-5	23	1.67	35	95	23.89	75	167	46.11	115	239
-20	-4	24.8	2.22	36	96.8	24.44	76	168.8	46.67	116	240.8
-19.44	-3	26.6	2.78	37	98.6	25	77	170.6	47.22	117	242.6
-18.89	-2	28.4	3.33	38	100.4	25.56	78	172.4	47.78	118	244.4
-18.33	-1	30.2	3.89	39	102.2	26.11	79	174.2	48.33	119	246.2
-17.78	0	32	4.44	40	104	26.67	80	176	48.89	120	248
-17.22	1	33.8	5	41	105.8	27.22	81	177.8	49.44	121	249.8
-16.67	2	35.6	5.56	42	107.6	27.78	82	179.6	50	122	251.6
-16.11	3	37.4	6.11	43	109.4	28.33	83	181.4	50.56	123	253.4
-15.56	4	39.2	6.67	44	111.2	28.89	84	183.2	51.11	124	255.2
-15	5	41	7.22	45	113	29.44	85	185	51.67	125	257
-14.44	6	42.8	7.78	46	114.8	30	86	186.8	52.22	126	258.8
-13.89	7	44.6	8.33	47	116.6	30.56	87	188.6	52.78	127	260.6
-13.33	8	46.4	8.89	48	118.4	31.11	88	190.4	53.33	128	262.4
-12.78	9	48.2	9.44	49	120.2	31.67	89	192.2	53.89	129	264.2
-12.22	10	50	10	50	122	32.22	90	194	54.44	130	266
-11.67	11	51.8	10.56	51	123.8	32.78	91	195.8	55	131	267.8
-11.11	12	53.6	11.11	52	125.6	33.33	92	197.6	55.56	132	269.6
-10.56	13	55.4	11.67	53	127.4	33.89	93	199.4	56.11	133	271.4
-10	14	57.2	12.22	54	129.2	34.44	94	201.2	56.67	134	273.2
-9.44	15	59	12.78	55	131	35	95	203	57.22	135	275
-8.89	16	60.8	13.33	56	132.8	35.56	96	204.8	57.78	136	276.8
-8.33	17	62.6	13.89	57	134.6	36.11	97	206.6	58.33	137	278.6
-7.78	18	64.4	14.44	58	136.4	36.67	98	208.4	58.89	138	280.4
-7.22	19	66.2	15	59	138.2	37.22	99	210.2	59.44	139	282.2

Wind Speed Conversion

1 mph = 0.87 knots; 1 knot = 1.15 mph

to Kt	Kt or mph	to mph	to Kt	Kt or mph	to mph	to Kt	Kt or mph	to mph	to Kt	Kt or mph	to mph
1	1	1	23	26	30	44	51	59	66	76	87
2	2	2	23	27	31	45	52	60	67	77	89
3	3	3	24	28	32	46	53	61	68	78	90
3	4	5	25	29	33	47	54	62	69	79	91
4	5	6	26	30	35	48	55	63	70	80	92
5	6	7	27	31	36	49	56	64	70	81	93
6	7	8	28	32	37	50	57	66	71	82	94
7	8	9	29	33	38	50	58	67	72	83	96
8	9	10	30	34	39	51	59	68	73	84	97
9	10	12	30	35	40	52	60	69	74	85	98
10	11	13	31	36	41	53	61	70	75	86	99
10	12	14	32	37	43	54	62	71	76	87	100
11	13	15	33	38	44	55	63	72	76	88	101
12	14	16	34	39	45	56	64	74	77	89	102
13	15	17	35	40	46	56	65	75	78	90	104
14	16	18	36	41	47	57	66	76	79	91	105
15	17	20	36	42	48	58	67	77	80	92	106
16	18	21	37	43	49	59	68	78	81	93	107
17	19	22	38	44	51	60	69	79	82	94	108
17	20	23	39	45	52	61	70	81	83	95	109
18	21	24	40	46	53	62	71	82	83	96	110
19	22	25	41	47	54	63	72	83	84	97	112
20	23	26	42	48	55	63	73	84	85	98	113
21	24	28	43	49	56	64	74	85	86	99	114
22	25	29	43	50	58	65	75	86	87	100	115

Beaufort Wind Scale

This scale is used to estimate wind speeds when no wind equipment is available.

Speed (mph)	Description - Visible Condition
0	Calm: Smoke rises vertically
1 - 4	Light air: Direction of wind shown by smoke but not by wind vanes
4 - 7	Light breeze: Felt on face; leaves rustle; ordinary wind vane moved by wind
8 - 12	Gentle breeze: Leaves and small twigs in constant motion; wind extends light flag
13 - 18	Moderate breeze: Raises dust and loose paper; small branches are moved
19 - 24	Fresh breeze: Small trees in leaf begin to sway; crested wavelets form on inland water
25 - 31	Strong breeze: Large branches in motion; telephone wires whistle; umbrellas used with difficulty
32 - 38	Moderate gale: Whole trees in motion; inconvenience in walking against wind
39 - 46	Fresh gale: Breaks twigs off trees; generally impedes progress
47 - 54	Strong gale: Slight structural damage occurs; chimney pots and slates removed
55 - 63	Whole gale: Trees uprooted; considerable structural damage occurs
64 - 72	Storm: Very rarely experienced; accompanied by widespread damage
73+	Hurricane: Devastation occurs

Pressure Conversion

Standard Atmosphere conversion:
29.92 inches of mercury (Hg) = 1013.25 millibars

inches	millibars	inches	millibars	inches	millibars	inches	millibars	inches	millibars
28.50	965.1	29.00	982.1	29.50	999.0	30.00	1015.9	30.50	1032.8
28.51	965.5	29.01	982.4	29.51	999.3	30.01	1016.3	30.51	1033.2
28.52	965.8	29.02	982.7	29.52	999.7	30.02	1016.6	30.52	1033.5
28.53	966.1	29.03	983.1	29.53	1000.0	30.03	1016.9	30.53	1033.9
28.54	966.5	29.04	983.4	29.54	1000.3	30.04	1017.3	30.54	1034.2
28.55	966.8	29.05	983.7	29.55	1000.7	30.05	1017.6	30.55	1034.5
28.56	967.2	29.06	984.1	29.56	1001.0	30.06	1017.9	30.56	1034.9
28.57	967.5	29.07	984.4	29.57	1001.4	30.07	1018.3	30.57	1035.2
28.58	967.8	29.08	984.8	29.58	1001.7	30.08	1018.6	30.58	1035.6
28.59	968.2	29.09	985.1	29.59	1002.0	30.09	1019.0	30.59	1035.9
28.60	968.5	29.10	985.4	29.60	1002.4	30.10	1019.3	30.60	1036.2
28.61	968.8	29.11	985.8	29.61	1002.7	30.11	1019.6	30.61	1036.6
28.62	969.2	29.12	986.1	29.62	1003.0	30.12	1020.0	30.62	1036.9
28.63	969.5	29.13	986.5	29.63	1003.4	30.13	1020.3	30.63	1037.3
28.64	969.9	29.14	986.8	29.64	1003.7	30.14	1020.7	30.64	1037.6
28.65	970.2	29.15	987.1	29.65	1004.1	30.15	1021.0	30.65	1037.9
28.66	970.5	29.16	987.5	29.66	1004.4	30.16	1021.3	30.66	1038.3
28.67	970.9	29.17	987.8	29.67	1004.7	30.17	1021.7	30.67	1038.6
28.68	971.2	29.18	988.1	29.68	1005.1	30.18	1022.0	30.68	1038.9
28.69	971.6	29.19	988.5	29.69	1005.4	30.19	1022.4	30.69	1039.3
28.70	971.9	29.20	988.8	29.70	1005.8	30.20	1022.7	30.70	1039.6
28.71	972.2	29.21	989.2	29.71	1006.1	30.21	1023.0	30.71	1040.0
28.72	972.6	29.22	989.5	29.72	1006.4	30.22	1023.4	30.72	1040.3
28.73	972.9	29.23	989.8	29.73	1006.8	30.23	1023.7	30.73	1040.6
28.74	973.2	29.24	990.2	29.74	1007.1	30.24	1024.0	30.74	1041.0
28.75	973.6	29.25	990.5	29.75	1007.5	30.25	1024.4	30.75	1041.3
28.76	973.9	29.26	990.8	29.76	1007.8	30.26	1024.7	30.76	1041.6
28.77	974.3	29.27	991.2	29.77	1008.1	30.27	1025.1	30.77	1042.0
28.78	974.6	29.28	991.5	29.78	1008.5	30.28	1025.4	30.78	1042.3
28.79	974.9	29.29	991.9	29.79	1008.8	30.29	1025.7	30.79	1042.7
28.80	975.3	29.30	992.2	29.80	1009.1	30.30	1026.1	30.80	1043.0
28.81	975.6	29.31	992.6	29.81	1009.5	30.31	1026.4	30.81	1043.3
28.82	976.0	29.32	992.9	29.82	1009.8	30.32	1026.8	30.82	1043.7
28.83	976.3	29.33	993.2	29.83	1010.2	30.33	1027.1	30.83	1044.0
28.84	976.6	29.34	992.6	29.84	1010.5	30.34	1027.4	30.84	1044.4
28.85	977.0	29.35	993.9	29.85	1010.8	30.35	1027.8	30.85	1044.7
28.86	977.3	29.36	994.2	29.86	1011.2	30.36	1028.1	30.86	1045.0
28.87	977.7	29.37	994.6	29.87	1011.5	30.37	1028.4	30.87	1045.4
28.88	978.0	29.38	994.9	29.88	1011.9	30.38	1028.8	30.88	1045.7
28.89	978.3	29.39	995.3	29.89	1012.2	30.39	1029.1	30.89	1046.1
28.90	978.7	29.40	995.6	29.90	1012.5	30.40	1029.5	30.90	1046.4
28.91	979.0	29.41	995.9	29.91	1012.9	30.41	1029.8	30.91	1046.7
28.92	979.3	29.42	996.3	29.92	1013.2	30.42	1030.1	30.92	1047.1
28.93	979.7	29.43	996.6	29.93	1013.5	30.43	1030.5	30.93	1047.4
28.94	980.0	29.44	997.0	29.94	1013.9	30.44	1030.8	30.94	1047.7
28.95	980.4	29.45	997.3	29.95	1014.2	30.45	1031.2	30.95	1048.1
28.96	980.7	29.46	997.6	29.96	1014.6	30.46	1031.5	30.96	1048.4
28.97	981.0	29.47	998.0	29.97	1014.9	30.47	1031.8	30.97	1048.8
28.98	981.4	29.48	998.3	29.98	1015.2	30.48	1032.2	30.98	1049.1
28.99	981.7	29.49	998.6	29.99	1015.6	30.49	1032.5	30.99	1049.4

Sunrise/Sunset Table and Tide Predictions for San Diego

Sunrise and Sunset Tables have been computed for any location by the U.S. Naval Observatory. Click on: **http://aa.usno.navy.mil/data/docs/RS_OneYear.php**

The chart below shows the times of sunrise and sunset in San Diego for any year in Pacific Standard Time. Add one hour for daylight time (between the second Sunday in March and the first Sunday in November at 2 am).

	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set	Rise Set
1	0651 1653	0644 1721	0617 1746	0537 1809	0502 1830	0442 1851	0444 1901	0502 1847	0523 1814	0543 1733	0606 1658	0633 1642
2	0651 1654	0643 1722	0615 1746	0536 1809	0501 1831	0441 1852	0445 1900	0503 1846	0524 1812	0543 1732	0607 1657	0634 1642
3	0651 1655	0642 1723	0614 1747	0534 1810	0500 1832	0441 1853	0445 1900	0504 1845	0524 1811	0544 1731	0608 1656	0634 1642
4	0651 1656	0641 1724	0613 1748	0533 1811	0459 1832	0441 1853	0445 1900	0504 1845	0525 1810	0545 1730	0609 1655	0635 1642
5	0652 1657	0641 1725	0612 1749	0532 1811	0458 1833	0441 1854	0446 1900	0505 1844	0526 1808	0545 1728	0610 1654	0636 1642
6	0652 1657	0640 1726	0611 1750	0530 1812	0457 1834	0440 1854	0446 1900	0506 1843	0526 1807	0546 1727	0610 1654	0637 1642
7	0652 1658	0639 1727	0609 1750	0529 1813	0456 1835	0440 1855	0447 1900	0506 1842	0527 1806	0547 1726	0611 1653	0638 1642
8	0652 1659	0638 1728	0608 1751	0528 1813	0455 1835	0440 1855	0447 1900	0507 1841	0528 1804	0547 1724	0612 1652	0638 1642
9	0652 1700	0637 1729	0607 1752	0527 1814	0454 1836	0440 1856	0448 1859	0508 1840	0528 1803	0548 1723	0613 1651	0639 1643
10	0652 1701	0637 1729	0606 1753	0525 1815	0454 1837	0440 1856	0448 1859	0508 1839	0529 1802	0549 1722	0614 1651	0640 1643
11	0652 1702	0636 1730	0604 1753	0524 1816	0453 1837	0440 1856	0449 1859	0509 1838	0530 1800	0550 1721	0615 1650	0641 1643
12	0652 1702	0635 1731	0603 1754	0523 1816	0452 1838	0440 1857	0450 1859	0510 1837	0530 1759	0550 1719	0616 1649	0641 1643
13	0651 1703	0634 1732	0602 1755	0522 1817	0451 1839	0440 1857	0450 1858	0510 1836	0531 1758	0551 1718	0617 1649	0642 1643
14	0651 1704	0633 1733	0600 1756	0521 1818	0451 1840	0440 1858	0451 1858	0511 1835	0531 1756	0552 1717	0618 1648	0643 1644
15	0651 1705	0632 1734	0559 1756	0519 1818	0450 1840	0440 1858	0451 1857	0512 1834	0532 1755	0552 1716	0618 1648	0643 1644

16	0651 1706	0631 1735	0558 1757	0518 1819	0449 1841	0440 1858	0452 1857	0513 1833	0533 1754	0553 1715	0619 1647	0644 1644
17	0651 1707	0630 1736	0557 1758	0517 1820	0449 1842	0440 1859	0452 1857	0513 1832	0533 1752	0554 1713	0620 1646	0645 1645
18	0650 1708	0629 1737	0555 1759	0516 1821	0448 1842	0440 1859	0453 1856	0514 1830	0534 1751	0555 1712	0621 1646	0645 1645
19	0650 1709	0628 1737	0554 1759	0515 1821	0447 1843	0441 1859	0454 1856	0515 1829	0535 1750	0555 1711	0622 1646	0646 1646
20	0650 1710	0627 1738	0553 1800	0513 1822	0447 1844	0441 1859	0454 1855	0515 1828	0535 1748	0556 1710	0623 1645	0646 1646
21	0649 1711	0626 1739	0551 1801	0512 1823	0446 1844	0441 1900	0455 1855	0516 1827	0536 1747	0557 1709	0624 1645	0647 1646
22	0649 1712	0625 1740	0550 1801	0511 1823	0446 1845	0441 1900	0456 1854	0517 1826	0537 1746	0558 1708	0625 1644	0647 1647
23	0649 1713	0624 1741	0549 1802	0510 1824	0445 1846	0441 1900	0456 1853	0517 1825	0537 1744	0559 1707	0626 1644	0648 1647
24	0648 1714	0622 1742	0547 1803	0509 1825	0445 1847	0442 1900	0457 1853	0518 1823	0538 1743	0559 1706	0627 1644	0648 1648
25	0648 1714	0621 1742	0546 1804	0508 1826	0444 1847	0442 1900	0458 1852	0519 1822	0539 1741	0600 1705	0627 1643	0649 1649
26	0647 1715	0620 1743	0545 1804	0507 1826	0444 1848	0442 1900	0458 1852	0519 1821	0539 1740	0601 1704	0628 1643	0649 1649
27	0647 1716	0619 1744	0543 1805	0506 1827	0443 1848	0443 1900	0459 1851	0520 1820	0540 1739	0602 1703	0629 1643	0649 1650
28	0646 1717	0618 1745	0542 1806	0505 1828	0443 1849	0443 1901	0500 1850	0520 1819	0541 1737	0603 1702	0630 1643	0650 1650
29	0645 1718		0541 1806	0504 1829	0443 1850	0443 1901	0500 1849	0521 1817	0541 1736	0604 1701	0631 1643	0650 1651
30	0645 1719		0540 1807	0503 1829	0442 1850	0444 1901	0501 1849	0522 1816	0542 1735	0604 1700	0632 1642	0650 1652
31	0644 1720		0538 1808		0442 1851		0502 1848	0522 1815		0605 1659		0651 1653

Tide Predictions

Tide predictions for California and coastal locations throughout the country can be found on the National Ocean Service’s web site: **co-ops.nos.noaa.gov/index.shtml**.

Heat Index

The NWS has devised the Heat Index, sometimes called the "apparent temperature." It is the temperature the body feels when the heat and humidity are combined. High relative humidity inhibits the evaporation of perspiration and hence the body's ability to cool itself. For more information about the heat index: **www.nws.noaa.gov/om/heat/index.shtml**.
Note: Exposure to full sunshine can increase HI values by up to 15° F

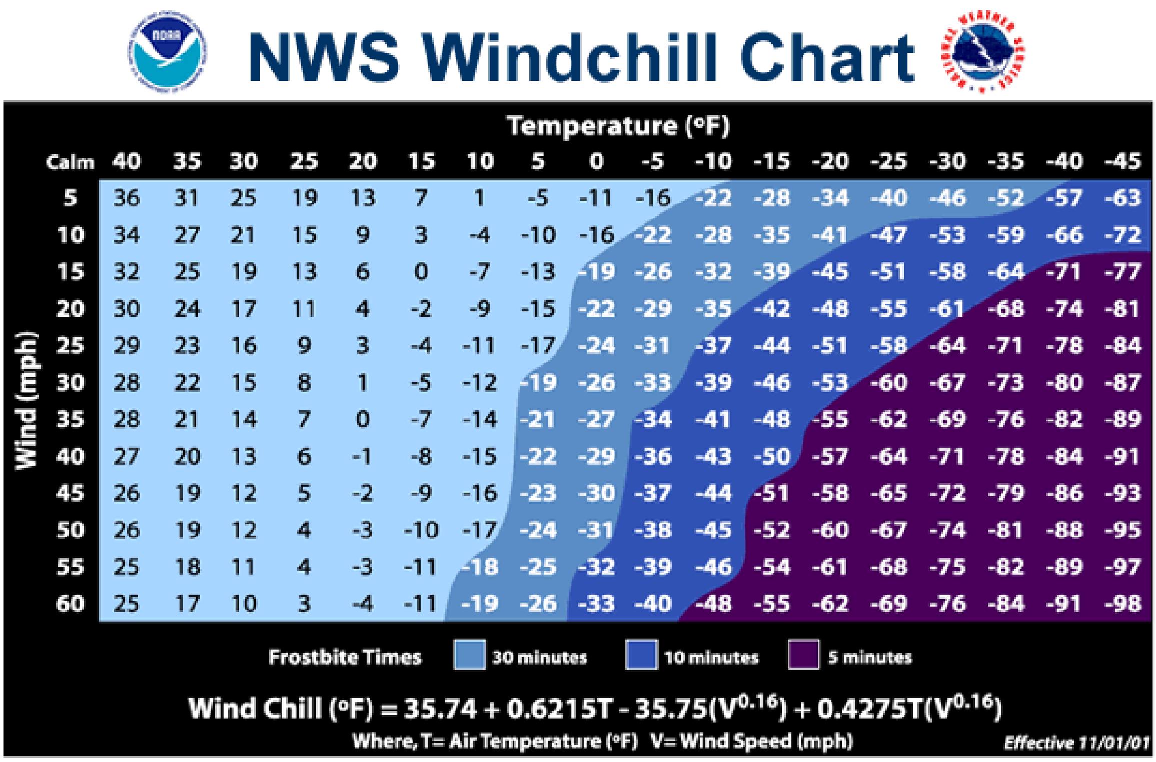
HEAT INDEX °F													
	RELATIVE HUMIDITY (%)												
Temp.	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
110	136												
108	130	137											
106	124	130	137										
104	119	124	131	137									
102	114	119	124	130	137								
100	109	114	118	124	129	136							
98	105	109	113	117	123	128	134						
96	101	104	108	112	116	121	126	132					
94	97	100	103	106	110	114	119	124	129	135			
92	94	96	99	101	105	108	112	116	121	126	131		
90	91	93	95	97	100	103	106	109	113	117	122	127	132
88	88	89	91	93	95	98	100	103	106	110	113	117	121
86	85	87	88	89	91	93	95	97	100	102	105	108	112
84	83	84	85	86	88	89	90	92	94	96	98	100	103
82	81	82	83	84	84	85	86	88	89	90	91	93	95
80	80	80	81	81	82	82	83	84	84	85	86	86	87

Category	**Heat Index**	**Possible heat disorders for people in high risk groups**
Extreme Danger	130°F or higher (54°C or higher)	Heat stroke or sunstroke likely.
Danger	105 - 129°F	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with

	(41 - 54°C)	prolonged exposure and/or physical activity.
Extreme Caution	90 - 105°F (32 - 41°C)	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	80 - 90°F (27 - 32°C)	Fatigue possible with prolonged exposure and/or physical activity.

Wind Chill

The wind chill temperature is how cold people and animals feel when outside. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, lowering skin temperature and eventually the internal body temperature. Therefore, the wind makes it *feel* much colder. See chart and calculation formula below. Inanimate objects, such as car radiators and water pipes will not cool below the actual air temperature. For more information about wind chill, click on: **www.nws.noaa.gov/om/windchill/index.shtml**.



NWS Windchill Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill } (^\circ F) = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ultraviolet Index

The Environmental Protection Agency (EPA) and the National Weather Service developed the Ultraviolet Index (UVI) to provide important information to help you plan your outdoor activities and prevent overexposure to the sun's rays.

The UV Index can range from 0 (at night) to 15 or 16 (in the tropics at high elevations under clear skies). UV radiation is greatest when the sun is highest in the sky and rapidly decreases as the sun approaches the horizon. The higher the UV Index, the greater the rate of skin-damaging (and eye damaging) UV radiation. Consequently, the higher the UV Index, the shorter the time it takes before skin damage occurs. For more information about the UVI, including forecast maps, click on:
www.epa.gov/sunwise/uvindex.html, also see
www.cpc.ncep.noaa.gov/products/stratosphere/uv_index.

The UV index is categorized by the EPA as follows:

UVI	Exposure Level
0 1 2	Minimal
3 4	Low
5 6	Moderate
7 8 9	High
10 and greater	Very High

Tropical Cyclones

Common Definitions

Tropical Depression	**Tropical Storm**	**Hurricane**
Wind speed less than 33 kt (39 mph)	Wind speed 34 to 63 kt (39-73 mph)	Wind speed greater than 63 kt (73 mph)

The Saffir-Simpson Hurricane Scale

The Saffir-Simpson Hurricane Scale is a 1-5 rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the landfall region. Note that all winds are using the U.S. 1-minute average. For more information about hurricanes, click on: **www.nhc.noaa.gov**.

Category One Hurricane:
Winds 74-95 mph (64-82 kt or 119-153 km/hr). Storm surge generally 4-5 ft above normal. No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage. Hurricanes Allison of 1995 and Danny of 1997 were Category One hurricanes at peak intensity.

Category Two Hurricane:
Winds 96-110 mph (83-95 kt or 154-177 km/hr). Storm surge generally 6-8 feet above normal. Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings. Hurricane Bonnie of 1998 was a Category Two hurricane when it hit the North Carolina coast, while Hurricane Georges of 1998 was a Category Two Hurricane when it hit the Florida Keys and the Mississippi Gulf Coast.

Category Three Hurricane:
Winds 111-130 mph (96-113 kt or 178-209 km/hr). Storm surge generally 9-12 ft above normal. Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large tress blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the hurricane center. Flooding near the coast destroys smaller structures with larger structures damaged by battering of floating debris. Terrain continuously lower than 5 ft above mean sea level may be flooded inland 8 miles (13 km) or more. Evacuation of low-lying residences with several blocks of the shoreline may be required. Hurricanes Roxanne of 1995 and Fran of 1996 were Category Three hurricanes at landfall on the Yucatan Peninsula of Mexico and in North Carolina, respectively.

Category Four Hurricane:
Winds 131-155 mph (114-135 kt or 210-249 km/hr). Storm surge generally 13-18 ft above normal. More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut by rising water 3-5 hours before arrival of the hurricane center. Major damage to lower floors of structures near the shore. Terrain lower than 10 ft above sea level may be flooded requiring massive evacuation of residential areas as far inland as 6 miles (10 km). Hurricane Luis of 1995 was a Category Four hurricane while moving over the Leeward Islands. Hurricanes Felix and Opal of 1995 also reached Category Four status at peak intensity.

Category Five Hurricane:
Winds greater than 155 mph (135 kt or 249 km/hr). Storm surge generally greater than 18 ft above normal. Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destructon of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the hurricane center. Major damage to lower floors of all structures located less than 15 ft above sea level and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5-10 miles (8-16 km) of the shoreline may be required. Hurricane Mitch of 1998 was a Category Five hurricane at peak intensity over the western Caribbean. Hurricane Gilbert of 1988 was a Category Five hurricane at peak intensity and is the strongest Atlantic tropical cyclone of record.

Tropical Cyclone Names

Names have been given to tropical cyclones attaining tropical storm status by the National Hurricane Center since 1953. Currently, the name lists are maintained and updated by an international committee of the World Meteorological Organization. The lists featured only women's names until 1979. Since then, men's and women's names have been alternated. When a hurricane is particularly deadly or costly, the name is retired and a new name is chosen to replace it. These lists are recycled every six years (e.g., the 2012 list will be used again in 2018). For these lists and more information about the naming of tropical cyclones and hurricanes, click on: **www.nhc.noaa.gov/aboutnames.shtml**.

Tornadoes - The Enhanced Fujita (EF) Scale

The original Fujita (F) Scale was developed in 1971 by T. Theodore Fujita of the University of Chicago. It is a scale that measures the severity of tornadoes based on extent of damage. In 2007 the NWS implemented the Enhanced Fujita Scale as an update. It continues to support and maintain the original tornado database.
For more information about tornadoes, click on: **www.spc.noaa.gov/faq/tornado**.

EF - Scale	Wind Estimate* (3 second gust) (mph)	Typical Damage
EF0	65-85	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
EF1	86-110	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
EF2	111-135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
EF4	166-200	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.

EF5	Over 200	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

* IMPORTANT NOTE ABOUT EF-SCALE WINDS: The Enhanced F-scale still is a set of wind estimates (not measurements) based on damage. Its uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to 28 indicators. These estimates vary with height and exposure. Important: The 3 second gust is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures, using a directly measured, “one minute mile” speed.

Earthquake Magnitude Classes (based on the Richter Scale)

Although the National Weather Service has no earthquake responsibility, earthquake information can be relayed through the agency’s communications networks. For the latest updates on recent earthquakes, click on: **earthquake.usgs.gov/earthquakes/recenteqscanv**.
For more information on earthquakes with a focus on Southern California, click on: **earthquake.usgs.gov/regional/sca**.

Classes	**Magnitude**
Great	Greater than or equal to 8
Major	7 to 7.9
Strong	6 to 6.9
Moderate	5 to 5.9
Light	4 to 4.9
Minor	3 to 3.9
Micro	Less than 3

Time Zone Conversions (UTC, GMT, Z) Conversions from UTC to US time zones:
* = previous day

UTC (GMT)	PACIFIC Standard/Daylight	MOUNTAIN Standard/Daylight	CENTRAL Standard/Daylight	EASTERN Standard/Daylight
00	4 pm* / 5 pm*	5 pm* / 6 pm*	6 pm* / 7 pm*	7 pm* / 8 pm*
01	5 pm* / 6 pm*	6 pm* / 7 pm*	7 pm* / 8 pm*	8 pm* / 9 pm*
02	6 pm* / 7 pm*	7 pm* / 8 pm*	8 pm* / 9 pm*	9 pm* / 10 pm*
03	7 pm* / 8 pm*	8 pm* / 9 pm*	9 pm* / 10 pm*	10 pm* / 11 pm*
04	8 pm* / 9 pm*	9 pm* / 10 pm*	10 pm* / 11 pm*	11 pm* / 12 am
05	9 pm* / 10 pm*	10 pm* / 11 pm*	11 pm* / 12 am	12 mid / 1 am
06	10 pm* / 11 pm*	11 pm* / 12 am	12 mid / 1 am	1 am / 2 am
07	11 pm* / 12 am	12 mid / 1 am	1 am / 2 am	2 am / 3 am
08	12 mid / 1 am	1 am / 2 am	2 am / 3 am	3 am / 4 am
09	1 am / 2 am	2 am / 3 am	3 am / 4 am	4 am / 5 am
10	2 am / 3 am	3 am / 4 am	4 am / 5 am	5 am / 6 am
11	3 am / 4 am	4 am / 5 am	5 am / 6 am	6 am / 7 am
12	4 am / 5 am	5 am / 6 am	6 am / 7 am	7 am / 8 am
13	5 am / 6 am	6 am / 7 am	7 am / 8 am	8 am / 9 am
14	6 am / 7 am	7 am / 8 am	8 am / 9 am	9 am / 10 am
15	7 am / 8 am	8 am / 9 am	9 am / 10 am	10 am / 11 am
16	8 am / 9 am	9 am / 10 am	10 am / 11 am	11 am / 12 pm
17	9 am / 10 am	10 am / 11 am	11 am / 12 pm	12 pm / 1 pm
18	10 am / 11 am	11 am / 12 pm	12 pm / 1 pm	1 pm / 2 pm
19	11 am / 12 pm	12 pm / 1 pm	1 pm / 2 pm	2 pm / 3 pm
20	12 pm / 1 pm	1 pm / 2 pm	2 pm / 3 pm	3 pm / 4 pm
21	1 pm / 2 pm	2 pm / 3 pm	3 pm / 4 pm	4 pm / 5 pm
22	2 pm / 3 pm	3 pm / 4 pm	4 pm / 5 pm	5 pm / 6 pm
23	3 pm / 4 pm	4 pm / 5 pm	5 pm / 6 pm	6 pm / 7 pm

Appendix I – Weather Extremes

Temperature

The world’s highest temperature on record was 136° at Al Aziziyah, Libya, on September 13, 1922.

Vostok, Antarctica holds the world's record for coldest temperature: -129° on July 21, 1983.

On January 22, 1943 in Spearfish, SD: The temperature rose 49 degrees in two minutes, from - 4 to 45; later the same morning, it dropped 60 degrees in 27 minutes, from 56° to - 4°. Plate glass windows cracked as a result of the wild fluctuation in temperatures caused by Chinook winds.

The greatest 24- hour U.S. temperature difference in one place was set January 23- 24, 1916, in Browning, MT, at 100 degrees when it went from a low of -56° to a high of 44°.

Alaska and Hawaii share the same record high temperature of 100°. Pahala, Hawaii, reached that temperature on April 27, 1913; Fort Yukon, Alaska, hit 100° on June 27, 1915.

It was 134° at Death Valley on July 10, 1913. It remains the highest reading on record for the Western Hemisphere, the nation’s highest temperature on record for July, and the second highest reading in the world. Sandstorm conditions accompanied the heat.

The greatest diurnal range of temperature on record for the U.S. is 65 degrees, at Deeth, NV. After a morning low of 12°, the mercury rose to 87° on 9.21.1954.

Precipitation

Dry

Arica, Chile is the world’s driest place, receiving 0.03” of rain annually. It never rained at all in one 14- year period.

Death Valley is the driest place in the United States, receiving 2.33” annually (1971-2000 normals). In 1929, it did not rain at all.

Bagdad, California holds the U.S. record for continuous days without rain at 767.

The driest state in the U.S. is Nevada, with an average annual rainfall of 9.0”.

Wet

The wettest locations in the world according to the most average annual rainfall are Mawsynram, India: 467.4 inches, Tutunendo, Colombia: 463.4 inches, and Mt. Waialeale, Kauai, Hawaii: 460 inches. At Mt. Waialeale it averages more than one inch a day, on the average of 355 days a year. In India, most of the rainfall occurs in a six month period.

Greatest one minute rainfall in the world: 1.5 inches in Guadeloupe, West Indies, on Nov 26, 1970.
In the U.S.: 1.23 inches in Unionville, MD, on July 4, 1956.

Greatest one hour rainfall in the world: 15.78 inches in Muduocaidoang, Inner Mongolia, on Aug 1, 1977.
In the U.S.: 12.0 inches in Holt, MO, in June 1947.

Greatest 24- hour rainfall in the world: 73.62 inches at La Reunion Island, Indian Ocean, on March 15- 16, 1952.
In the U.S.: 43 inches in Alvin, Texas, on July 25- 26, 1979.

Greatest one month rainfall in the world: 366 inches in Cherrapunji, India, in July 1861.
In the U.S.: 107 inches in Kukui, Hawaii, in March 1942.

Greatest one year rainfall in the world: 1,042 inches in Cherrapunji, India, in 1860- 1861.
In the U.S.: 739 inches in Kukui, Hawaii, in 1981- 1982.

Hail

Large hailstones fall at speeds faster than 100 mph.

Hailstones sometimes contain foreign matter such as pebbles, leaves, twigs, nuts, and insects.

The costliest U.S. hailstorm occurred in Denver, Colorado, on July 11, 1990. Total damage was $625 million.

The most deadly international hailstorm on record occurred in India on April 30, 1888. This hailstorm killed 230 people at Moradabad, about 100 miles east of Delhi, and 16 others at Bareilly.

The heaviest hailstones on record reportedly weighed 2.25 pounds and killed 92 people in Gopalganj, a district of Bangladesh, on April 14, 1986.

A hailstone that fell June 22, 2003 at Aurora, NE, measured 7.0 inches in diameter and 18.75 inches in circumference. This was the largest hailstone ever recorded in the state of Nebraska, and the largest hailstone ever documented in the U.S. and the world. Another hailstone from the same storm measured 6.5 inches in diameter, with a circumference of 17.3 inches, and weighed 1.33 pounds. The previous U.S. record was held by a Coffeyville, KS hailstone, which fell on September 3, 1970. It measured 5.7 inches in diameter, had a circumference of 17.5 inches, and weighed 1.67 pounds. A Potter, NE hailstone that fell on July 6, 1928, held the U.S. record for 42 years. It measured around 7 inches in diameter and weighed about 1.5 pounds.

A 1959 hailstorm in northwestern Kansas lasted 1.5 hours and covered an area of 54 square miles with hailstones 18 inches deep.

Hail was swept into drifts in Iowa on August 6, 1890. The hail was so deep in some protected areas that hail remained on the ground for 26 days.

Snow

Greatest 24- hour snowfall in the world: 75.8 inches at Silver Lake, Colorado, on April 14- 15, 1921.

Greatest one storm snowfall in the world: 189 inches at Mt. Shasta Ski Bowl, California, on February 13- 19, 1959.

Greatest one month snowfall in the world: 390 inches at Tamarack, California, in January 1911.

Greatest one season snowfall in the world: 1140 inches at Mt. Baker, Washington, in 1998- 99.
The largest reported snowflake on record fell at Bratsk, Siberia, in 1971 and was 12 inches across.

Wind

The highest surface wind speed of 231 mph was recorded at Mt. Washington, New Hampshire on April 12, 1934. Its average wind speed is 35 mph.

Tornadoes

75% of the world=s tornadoes occur in the United States.
In 1990, there were 1126 tornadoes reported in the U.S., a record for a single year.

In the year 2005, California was hit by 27 tornadoes, while Oklahoma managed only 25.

Thunderstorms

At any given time, there are nearly 2,000 thunderstorms occurring over the planet.
The U.S. has over 100,000 thunderstorms annually.

The estimated number of global thunderstorms in a single year is about 16 million.

Hurricanes

Hurricane Andrew was the costliest hurricane on record, leaving $25-30 billion in damage on August 24, 1992. It left a quarter of a million people homeless before it died. Only 40 lives were lost thanks to advanced warning.

The deadliest weather event in U.S. history was the Galveston Hurricane that hit Galveston, Texas, on September 8, 1900. More that 8,000 people (some estimates say nearly 12,000) lost their lives.

Typhoon Tip in the Northwest Pacific Ocean on October 12, 1979 was measured to have the lowest central pressure on record of 870 mb and estimated surface sustained winds of 190 mph.

Hurricane Gilbert's 888 mb lowest pressure in mid-September 1988 is the most intense [as measured by lowest sea level pressure] for the Atlantic basin.

The most deadly tropical cyclone was the infamous Bangladesh Cyclone of 1970. The death toll has had several estimates, some wildly speculative, but it seems certain that at least 300,000 people died from the associated storm tide [surge] in the low-lying deltas.

Pressure

The world's highest barometric reading at sea level was 32.01 inches (1083.6 mb) recorded on December 31, 1968 at Agata, U.S.S.R (Siberia). The station elevation is 263 meters; the temperature was -46° C. Extraordinarily high surface pressures observed nearby at the same time corroborated the record measurement.

The North American record for high pressure was 31.85 inches (1078.4 mb) set on January 31,1989, in Northway Alaska (on the Alaska highway in east central Alaska). When pressures occur in this range, many commercial aircraft are grounded because their altimeters aren't designed for such high settings.

The lowest pressure ever recorded was 25.69 inches (870 mb) in the eye of Typhoon Tip, in the tropical western Pacific Ocean, on October 12, 1979. Since average sea level pressure is 29.92 inches (1013.25 mb), this record pressure was more than 14% lower than average.

The lowest pressure ever recorded in the United States was 26.35 inches (892.3 mb), recorded at Matecumbe Key, Florida, on September 2, 1935.

San Diego, because of its unique location and favorable latitude, has the U.S. record for the least difference or "shortest" barometer between the record high and record low. It is only 1.16 inches of mercury. The highest sea level pressure recorded in the downtown area was 30.53 inches of mercury on February 17, 1883 and the lowest was 29.15 inches of mercury, on January 21, 2010.

Appendix J - Web Sites for Weather Information

Forecasts, Current Conditions, Maps, Satellite, Radar, Etc.

National Weather Service (NWS) San Diego	weather.gov/sandiego
Servicio Meteorológico Nacional - San Diego	www.wrh.noaa.gov/sgx/spanish/spanish.php?wfo=sgx
NWS Forecast Office Web Pages Nationwide	weather.gov/organization.php
NWS National Home Page	weather.gov
NWS Internet Weather Source	weather.noaa.gov

Weather Maps - Models

Selection of Weather Maps	www.hpc.ncep.noaa.gov
Environmental Modeling Center	www.emc.ncep.noaa.gov
List of Numerical Weather Prediction Sites	www.nhc.noaa.gov/aboutlinkmodel.html
Guide to Reading Weather Maps	ww2010.atmos.uiuc.edu/(Gh)/guides/maps/home.rxml
Advanced Meteorology Education Modules	meted.ucar.edu
Unisys Forecast Model Details	weather.unisys.com/model/details.html
The Weather Prediction - Models	www.theweatherprediction.com/models

Weather Learning - Education and Research

NWS Weather Tutorial	www.srh.weather.gov/jetstream
NWS Office of Climate, Water and Weather Services	www.nws.noaa.gov/om
Online Weather Tutorial (Univ. of Illinois)	ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/home.rxml
Understanding Weather and Climate online	wps.prenhall.com/esm_aguado_uwac_3
USA Today Weather Basics Page	http://www.usatoday.com/weather/wgraph0.htm
Resources for Educators	www.nssl.noaa.gov/edu/resources
How the Weather Works Homepage	www.weatherworks.com
National Center for Atmospheric Research	ncar.ucar.edu
University Corp. for Atmospheric Research	spark.ucar.edu

NOAA Research	www.oar.noaa.gov
NOAA Hurricane Research Division	www.aoml.noaa.gov/hrd
Center for Ocean-Land-Atmospheric Studies	wxmaps.org
NOAA – NWS Climate Page	www.climate.gov
EPA – Climate change	www.epa.gov/climatechange
NCDC Climate Change Research	www.ncdc.noaa.gov/oa/climate/climateextremes.html
NCDC Global Warming FAQ	www.ncdc.noaa.gov/oa/climate/globalwarming.html
Listing of Meteorology Schools Nationwide	www.srh.noaa.gov/jetstream/nws/careers.htm
UCLA Department of Atmospheric Sciences	www.atmos.ucla.edu
AMS Meteorology Career Guide	www.ametsoc.org/atmoscareers/index.html
NOAA Career Page	www.careers.noaa.gov

Weather for Young Students and Their Teachers

NOAA Play Time For Kids	www.nws.noaa.gov/om/reachout/kidspage.shtml
NOAA Weather Education	www.education.noaa.gov
National Severe Storms Laboratory	www.nssl.noaa.gov/edu
FEMA for Kids	www.fema.gov/kids
Dan's Wild Wild Weather Page for Kids	www.wildwildweather.com
The Weather Dude	www.wxdude.com
Discovery School Weather	school.discoveryeducation.com/lessonplans/weather.html
Severe Weather Plan for Schools	www.nws.noaa.gov/er/lwx/swep/index.htm
Univ. of Illinois Weather links for kids	www.illiniweather.com/pages/kids_weather_links.htm

Stormy Weather and Disaster Preparedness

NWS Winter Weather Awareness	www.nws.noaa.gov/om/winter
Storm Prediction Center	www.spc.noaa.gov
National Severe Storms Laboratory	www.nssl.noaa.gov
The Tornado Project	www.tornadoproject.com

Stormtrack Storm Chaser Homepage	www.stormtrack.org
National Lightning Safety Institute	www.lightningsafety.com
Severe Weather Awareness	www.nws.noaa.gov/om/severeweather
StormReady	www.nws.noaa.gov/stormready
Spotter and Skywarn Page - San Diego	www.wrh.noaa.gov/sgx/spotter/spotter.php
Federal Emergency Mgmt. Agency	www.fema.gov
The Disaster Center	www.disastercenter.com

Hurricanes and Tropical Weather

Tropical Storm Tracker	www.solar.ifa.hawaii.edu/Tropical/tropical.html
National Hurricane Center	www.nhc.noaa.gov
Central Pacific Hurricane Center	www.prh.noaa.gov/hnl/cphc
Atlantic Tropical Weather Center	www.atwc.org
NWS Hurricane Awareness	www.weather.gov/om/hurricane
NRL Navy Monterey Tropical Cyclone Page	www.nrlmry.navy.mil/tc_pages/tc_home.html
Good Hurricane Resources	ggweather.com/hurricane.htm

Rainfall, Floods and Drought

Local Rainfall Maps and Charts	www.wrh.noaa.gov/sgx/obs/rainobs.php?wfo=sgx
California-Nevada River Forecast Center	www.cnrfc.noaa.gov
Hydrometeorological Prediction Center	www.hpc.ncep.noaa.gov
California Data Exchange Center	cdec.water.ca.gov
California Department of Water Resources	www.dwr.water.ca.gov
Climate Diagnostics Center	www.cdc.noaa.gov/ClimateInfo/drought.html
NOAA's Drought Information Center	www.drought.gov
National Drought Mitigation Center	www.drought.unl.edu

Climate Data and Long Term Prediction

Earth System Research Lab	www.esrl.noaa.gov/psd
NOAA's El Niño Theme Page	www.pmel.noaa.gov/tao/elnino/nino-home.html
Climate Prediction Center	www.cpc.noaa.gov
Seasonal Outlooks from CPC	www.cpc.ncep.noaa.gov/products/forecasts
Western Regional Climate Center	www.wrcc.dri.edu
National Climatic Data Center	www.ncdc.noaa.gov
Weatherbase Climate Data	www.weatherbase.com

Aviation Weather

Aviation Digital Data Service	aviationweather.gov/adds
Aviation Weather Center	aviationweather.gov
NWS Aviation Program	www.weather.gov/os/aviation.shtml
NWS San Diego Aviation Page	www.wrh.noaa.gov/sgx/aviation/aviation.php?wfo=sgx
USA Today Aviation Weather	www.usatoday.com/weather/wpilots0.htm
Air Traffic Control System Command Center	www.fly.faa.gov/flyfaa/usmap.jsp

Marine Weather and Surf

NWS Marine Weather Homepage	www.nws.noaa.gov/om/marine/home.htm
Ocean Prediction Center	www.opc.ncep.noaa.gov
Guide to Marine Weather Services	www.nws.noaa.gov/om/marine/marine.shtml
National Data Buoy Center	www.ndbc.noaa.gov
NWS San Diego Marine Page	www.wrh.noaa.gov/sgx/marine/marine.php?wfo=sgx
La Jolla Surfing Weather	www.lajollasurf.org
Scripps Inst. of Oceanography	sio.ucsd.edu/Research/Areas/Atmosphere_and_Climate
Coastwatch Program - West Coast	coastwatch.noaa.gov/
Tsunami Warning Centers	tsunami.gov

Weather Organizations, Publications

National Weather Service	weather.gov
Nat.Oceanic and Atmospheric Admin.	www.noaa.gov
World Meteorological Organization	www.wmo.int
Foreign Weather Services	www.nhc.noaa.gov/aboutlinkabroad_short.html
American Meteorological Society	www.ametsoc.org
National Weather Association	www.nwas.org
Weatherwise Magazine	www.weatherwise.org
Mariners Weather Log Magazine	www.vos.noaa.gov/mwl.shtml
Weather Books from USA Today	www.usatoday.com/weather/science/books/books0.htm