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NATIONAL DIGITAL FORECAST DATABASE AND LOCAL DATABASE DESCRIPTION AND SPECIFICATIONS

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Allison Allen Date

Director, Analyze, Forecast and Support Office

National Digital Forecast Database and Local Database Description and Specifications

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1 Introduction

This procedural directive describes the National Weather Service (NWS) digital data infrastructure, comprised of local digital forecast databases containing digital forecasts from Weather Forecast Offices (WFOs), River Forecast Centers (RFCs) and the National Centers for Environmental Prediction (NCEP), and used to populate a National Digital Forecast Database (NDFD). Implementation details for evolving specific products and services from these databases are described in the NWS Product Description Documents (PDDs) in accordance with NWS Instruction (NWSI) 10-102, *Products and Services Change Management*.

2 Mission Connection

The purpose of NDFD is to make NWS digital data accessible to the Weather, Water, Climate Enterprise (e.g., academia, government, and private sector) in an efficient, convenient, and

versatile form so that they can use it to develop new products of their own. Creating and maintaining local and national digital forecast databases with rapid update capability, increased temporal and spatial detail, and interpretive/supplemental information in various formats assists the entire Weather, Water, Climate Enterprise in helping the NWS accomplish its primary mission to save lives and property.

3 Local WFO Digital Forecast Database Description

3.1 Description

Forecasters at each WFO use the Graphical Forecast Editor (GFE) software on the Advanced Weather Interactive Processing System (AWIPS) to prepare a local, geospatially referenced digital forecast database. The local database is comprised of gridded weather elements for their geographic area of responsibility. WFOs and/or NWS regions determine the optimal spatial resolution for their area, which may be finer than the NDFD.

3.2 Purpose of the Local Database beyond Digital Data

From this local digital database, WFO forecast products are composed, formatted, and distributed via text formatters and other applications. Applications ingest the data and generate local products, which are distributed to users through webpages and other means. The common database helps generate a more consistent suite of local forecast products, which are easily monitored and maintained. Also, forecasters still have the capability to quality control and post-edit those products, if necessary, before distribution.

3.3 Local Digital Forecast Database Update Guidelines

The local database should be updated at least once a day to include new Day 7 grids. The WFO's local database should also be updated whenever the gridded forecast elements are no longer representative of current or expected weather conditions, especially during periods of high-impact weather. Specific local or regional update criteria may be established.

3.4 Priority of Local Grids during Active Hazardous Weather

The top priority of every WFO is to sustain office warning operations to protect life and property. WFOs effectively manage grid production during high impact events, such that it does not interfere with critical warning operations.

3.5 Local Grid Dissemination

Digital forecast information from WFO local digital databases will be displayed graphically on WFO websites in standardized formats. WFOs may use other means of disseminating digital data to meet local user needs.

3.6 Local Grid Upload to NDFD Central Server

Digital forecast information from local databases will be uploaded to a central server (NDFD) and pieced together into a mosaic of regional and national grids. To help ensure a consistent NDFD, WFOs should generate grids using the time projections listed in Appendix B. WFOs may generate additional gridded fields for the same element in different time projections (e.g.,

for local products and services based on the grids) to meet local user needs.

4 National Digital Forecast Database (NDFD)

4.1 Description Definition

The NDFD is a central database storing geospatially referenced digital forecast elements from WFOs and NCEP. The NDFD is a repository of both official and experimental (as defined in NWSI 10-102) grid fields. The NDFD provides a foundation for the development of new grid-based NWS products, including the forecast digital database itself.

The NDFD is the primary means by which grids are available to users. Users can transform the NWS digital data into a wide range of text, graphic, image products, and services.

4.2 NDFD Contents

The NDFD contains base digital data for a variety of official and experimental weather, water and climate elements generated at WFOs and NCEP. The experimental NDFD data are not an official NWS forecast product. Detailed NDFD data and support information can be found at the NDFD resource page at https://vlab.noaa.gov/web/mdl/ndfd. The status of these grid fields will be clearly denoted as official or experimental within the file or product. The specific grids (and associated resolutions) available in the NDFD are also available via the above referenced link.

4.3 Availability, Timeliness and Completeness

The NDFD is a dynamic forecast database. Forecast grids are generated and revised on an event-driven basis at WFOs, and on a scheduled basis with updates as needed from NCEP. Any new and revised digital data from a WFO or NCEP are sent to the NDFD and made available at the top of each hour. At a minimum, the digital database is updated once per day.

4.3.1 Monitoring of WFO Grids

The NDFD is routinely monitored for missing or out-of-date grids. Any missing grid points are filled in during National Blend of Models (NBM) initialization using NDFD elements that are available in the NBM. This process occurs prior to mosaicking. WFOs are automatically alerted within GFE about old grids; however, the WFO grids will be mosaicked regardless of whether they are up to date.

4.3.2 NDFD Consistency of WFO Grids

WFOs are responsible for the inter-office consistency of their local database, as well as their part of the NDFD. WFOs and National Centers are responsible to ensure consistency of gridded datasets made public within the NDFD that are duplicated on other repositories such as websites. To reduce forecast database discontinuities, WFOs and National Centers should follow collaboration guidelines as described in Appendix A or regional supplements.

4.4 Format

The NDFD data are presented as map displays or as GRIdded Binary or General Regularly-distributed Information in Binary form (GRIB) Edition 2 or GRIB2 files. The NDFD data are also available via web services (e.g., Simple Object Access Protocol [SOAP] and EXtensible Markup Language [XML]).

4.5 Spatial Resolution

Spatial resolution of the NDFD grids is as follows:

a. Contiguous United States (CONUS) – 2.5 kilometers (km)
b. Hawaii, Guam and the Commonwealth of the Northern Mariana Islands (CNMI) – 2.5 km
c. Puerto Rico – 1.25 km
d. Alaska – 3 km
e. Oceanic domain – 10 km

4.6 Temporal Resolution

The temporal resolution of forecast elements varies by forecast projection. Details can be found in Appendix B.

4.7 NDFD Grid Data Access

NDFD grid data are hosted on servers in the NWS Telecommunications Operations Center as described on the Meteorological Development Laboratory's (MDL's) NDFD Grid Data Access page.

This webpage describes the data directory structure and the data portals for obtaining both operational and Experimental GRIB2 data. These data can be accessed via Hypertext Transfer Protocol (HTTP) or File Transfer Protocol (FTP). Access to GRIB2 and other formats is described on the NDFD Home Page. Forecast data can be obtained for the entire CONUS at 2.5 km resolution or one of several overlapping CONUS geographic sectors at 5 km resolution. In addition, sectors are available for Puerto Rico, Hawaii, Guam, Alaska and the Oceanic domain. See Figure 1 for a general depiction of sector locations.

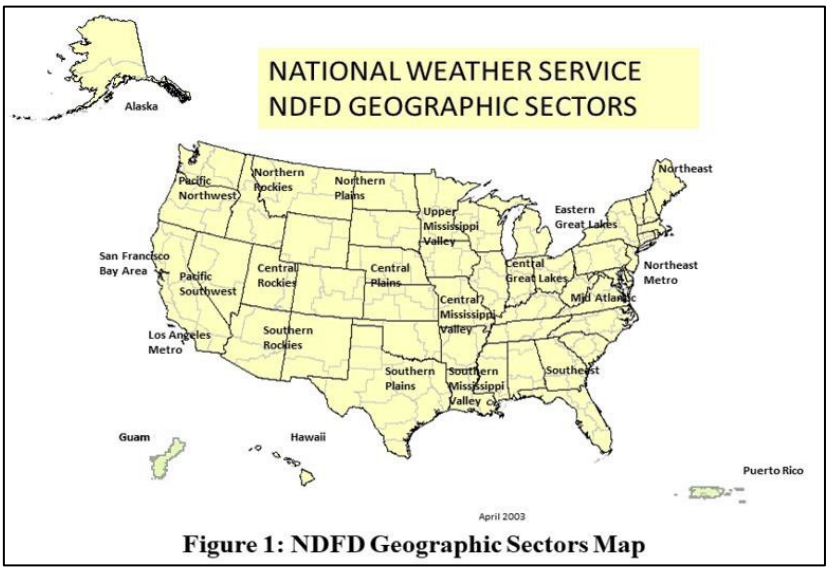

Figure 1: NDFD Geographic Sectors Map

4.8 NDFD Graphic Forecast Displays

The NWS's NDFD graphic products are derived from a prescribed set of data contained within the NDFD. These graphics are representations of the official NWS digital forecast. The graphics are created on national and regional scales and will follow a standardized format prescribed by the NWS to best meet the needs of its users. The data originate from the WFO, NCEP, or centrally derived databases via the following link: https://digital.weather.gov/.

5 Digital Forecast Collaboration

A key component of the forecast process is to mosaic digital forecasts into a near seamless set of forecast grids for the entire nation (i.e., NDFD). To attain this goal, local offices and NCEP strive to achieve meteorological consistency among weather elements and meet collaboration thresholds along WFO boundaries. As a result, "ownership" of the NDFD is shared among all those involved in the collaborative process. Appendix A describes the NDFD element definitions. Appendix B describes the NDFD weather element tables.

5.1 Collaboration Technology

Tools, such as the GFE InterSite Coordination (ISC) grids and AWIPS integrated chat/text capability, facilitate collaboration by permitting forecasters to view what adjacent offices and NCEP are forecasting in comparison to their own forecast.

5.2 Collaboration Thresholds

WFOs should adhere to a standard set of collaboration thresholds to ensure NDFD coherency, while not sacrificing forecast accuracy. Refer to the collaboration thresholds as described in Appendix A.

5.3 Collaboration Times

Collaboration may be triggered by a variety of events (e.g., receipt of new observational data, forecast discontinuities, extreme weather events). However, new model data are the most

common triggers of changes to the database beyond the first period. To collaborate effectively, forecasters will keep collaboration tools open at all times.

5.4 Collaboration Roles and Responsibilities

Effective collaboration not only creates a consistent digital forecast database, but also facilitates the exchange of scientific information. Forecasters are expected to convey their professional judgment and interpretation through meteorological discussions available to users. Each WFO collaborates with NCEP and adjacent WFOs on factors affecting their forecast area of responsibility. WFOs collaborate among neighboring offices to ensure consistency on spatial and timing issues affecting their geographic area of responsibility. WFOs exchange preliminary ISC grids to reduce discontinuities before the grids are released to users. Additionally, WFOs collaborate on regional and national scales (i.e., with NCEP), as necessary, given the size and scope of the event.

APPENDIX A – NDFD Element Definitions and Collaboration Thresholds

1 Introduction

This appendix provides descriptions and definitions for all operational grid elements in the national databases. The grid elements may originate at the WFOs, NCEP, or be derived centrally from the NDFD.

2 Overarching Grid Element Concept and Guidelines

Element values represent conditions of meteorological fields at the resolution of the grid. They should not be interpreted as exact point forecasts in time and space. Individual elements are sampled at the times defined in the NDFD Grid Availability Table found in Appendix B of this document.

Collaboration thresholds are not calculated for an adjacent grid if elevation differences are greater than 1,000 feet.

Grids that lie on opposite sides of a coastal (i.e., land/water) boundary are excluded from collaboration threshold requirements.

The NDFD performs the following inter-element integrity checks and records (but does not alter the forecast elements) when the following conditions occur:

- Dew Point (Td) > Temperature (T)
- T > the Maximum Temperature (MaxT)
- T < the Minimum Temperature (MinT)
- Quantitative Precipitation Forecast (QPF) > 0 and Probability of Precipitation (PoP) = 0
- QPF = 0 and PoP >= 50
- QPF = 0 and SnowAmt > 0
- Wind Speed > Wind Gust Speed

3 Grid Element Definitions (General)

3.1 Maximum/Minimum Temperature (Max/Min Temp) – The maximum daytime temperature or minimum overnight temperature in degrees Fahrenheit (°F). Daytime is defined as **0700-1900 Local Standard Time** and overnight is defined as **1900-0800 Local Standard Time**. The 1-hour overlap helps cover situations when minimum temperatures occur just after sunrise. In the Alaska Region, daytime is defined as 0500-2000 Local Standard Time and overnight is defined as 1700-1100 Local Standard Time, to account for extended/decreased hours of daylight in the region.

- **NDFD Grid Availability:** A Maximum or Minimum Temperature grid will be valid for each 12- or 13-hour period (15- or 18-hour period in Alaska Region) out to 168 hours from 0000 Coordinated Universal Time (UTC) Day 1.
- **Collaboration Threshold:** Five (5) degrees (seven (7) degrees in complex terrain, i.e., greater than 500-foot differences in elevation between adjacent grids).

3.2 Temperature – Temperature in °F valid at the top of the indicated hour.

- **NDFD Grid Availability:** Temperature grids will be valid at the top of the hour. They are available hourly[1] out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold:** Five (5) degrees (seven (7) degrees in complex terrain, i.e., greater than 500-foot differences in elevation between adjacent grids).

3.3 Dew Point – Dew Point temperature in °F valid at the top of the indicated hour.

- **NDFD Grid Availability:** Dew Point grids will be valid at the top of the hour. They are available hourly out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold:** Five (5) degrees (seven (7) degrees in complex terrain, i.e., greater than 500-foot differences in elevation between adjacent grids).

3.4 Relative Humidity (RH) – RH in percent derived from the associated Temperature and Dew Point grids for the top of the indicated hour. Operationally produced NDFD RH forecasts are centrally processed with no interaction from WFOs.

- **NDFD Grid Availability:** RH grids will be valid at the top of the hour. They are available hourly out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold:** 5% difference when RH values are < 20%; 10% difference when RH values are between 20% and < 25%; 15% difference when RH values are between 25% and < 50%; 20% difference when RH values are between 50% and < 75%; 25% difference when RH values are between 75% and 100%.

3.5 Apparent Temperature – The perceived temperature derived from either a combination of temperature and wind (Wind Chill), or temperature and humidity (Heat Index) for the top of the indicated hour. Apparent temperature grids will signify the Wind Chill when temperatures fall to 50°F or less, and the Heat Index when temperatures rise above 80°F. Between 51°F and 80°F, the Apparent Temperature grids will be populated with forecast temperature. Operationally produced NDFD Apparent Temperature forecasts are centrally processed with no interaction from WFOs.

- **NDFD Grid Availability:** Apparent temperature grids will be valid at the top of the hour. They are available hourly out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold:** Seven (7) degrees (nine (9) degrees in complex terrain, i.e., greater than 500-foot differences in elevation between adjacent grids).

3.6 Wet-Bulb Globe Temperature (WBGT) – A composite parameter that is an indication of expected heat stress in direct sunlight, which takes into account: temperature, humidity, wind speed, sun angle, and cloud cover (solar radiation). This parameter is an effective means of assessing heat risk to healthy, active individuals involved in physical outdoor activity. Operationally produced NDFD WBGT forecasts are centrally processed with no interaction from the WFOs. This is similar to the Relative Humidity and Apparent Temperature (TA) grids that display on NDFD. WBGT gridded forecasts are provided for the CONUS, Hawaii, Guam and Puerto Rico.

- **NDFD Grid Availability:** CONUS data will be available hourly out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1. Data for Hawaii, Guam and Puerto Rico will be available every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold:** N/A (discrete element).

3.7 Hazard Grids – Long-fused watches, warnings, and advisories issued by the WFOs and National Centers in effect at the appropriate valid time will be included in this *one* grid element.

- **NDFD Grid Availability:** Hazard grids will be valid at one (1)-hour increments out to 72 hours when weather warrants the issuance of this grid.
- **Collaboration Threshold:** N/A (discrete element).

3.8 Probability of Precipitation (PoP) – The probability, expressed in percent, of measurable precipitation (at least 0.01 inch) valid for the specified 12-hour period. Trace events are excluded. Valid periods begin at 0000 UTC and 1200 UTC.

- **NDFD Grid Availability**: PoP12 grids will be valid for each 12-hour period out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold**: 20%.

3.9 Sky Cover – The expected amount of opaque clouds or other opaque phenomena that might be aloft such as elevated smoke layers from wildfires or volcanic ash (in percent) covering the sky valid for the top of the indicated hour.

- **NDFD Grid Availability**: Sky Cover grids will be valid at the top of the hour. They are available hourly out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold**: 25% (35% in complex terrain).

3.10 Wind Direction – The 10-meter wind direction using 36 points of a compass valid at the top of the indicated hour.

3.11 Wind Speed – The sustained 10-meter wind speed (in knots) valid at the top of the indicated hour. For information regarding WFO-generated wind forecast grids for tropical

cyclones, refer to NWSI 10-601, *Weather Forecast Office Tropical Cyclone Products*, Section 3.

- **NDFD Grid Availability:** Wind Direction and Wind Speed grids will be valid at the top of the hour. They are available hourly out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1.
- **Collaboration Threshold (Wind Direction):** 45 degrees regular**,** 90 degrees complex terrain. Enforce if both WFOs have forecast wind speed >= 12 knots (kt.).
- **Collaboration Threshold (Wind Speed):** 10-kt. difference for speeds > 12 kt. and < 20 kt.; 15-kt. difference for speeds >= 20 kt. Enforce if at least one WFO has forecast wind speed > 12 kt.

3.12 Wind Gust – The maximum three (3) second wind speed (in knots) forecast to occur within a two (2)-minute interval at a height of 10 meters. Wind gust forecasts are valid at the top of the indicated hour. When a wind gust is not forecast for the top of the indicated hour, the wind gust grid will assume the value of the sustained wind forecast.

- **NDFD Grid Availability:** Wind Gust grids will be valid at the top of the hour. CONUS grids are available hourly out 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000 UTC Day 1. OCONUS Wind Gust grids are available every three (3) hours out to 72 hours from NDFD 0000 UTC Day 1 issuance time.
- **Collaboration Threshold:** 10-kt. difference for gusts > 12 kt. and < 20 kt.; 15-kt. difference for gusts >= 20 kt. Enforce if at least one WFO has forecast wind gust > 12 kt.

3.13 Weather – The weather (precipitating or non-precipitating) valid at the top of the indicated hour.

a. **Precipitating Weather** (e.g., rain, freezing rain; ice pellets; snow) is described as the type of precipitation accompanied by descriptors of intensity, coverage, or likelihood.

b. **Non-Precipitating Weather** (e.g., fog, haze, smoke) is described as the type of obstruction to vision (non-precipitating variety) accompanied by descriptors of intensity or coverage. Non-Precipitating Weather is indicated whenever the expected visibility is six (6) statute (five (5) nautical) miles or less. Fog is indicated as being dense whenever the expected visibility is a quarter statute mile or less over land. All forecasters should use "light" as the default intensity on the Weather grid for Days 1-7, unless the predicted meteorological situation warrants a different intensity.

The exception is Pacific Region, as that tropical location supports a consistently higher probability of moderate or heavy rainfall events; therefore, a "moderate" default intensity will be assigned.

- **NDFD Grid Availability:** Weather grids will be valid at the top of the hour. They are available hourly out to 36 hours from NDFD issuance time, then every three (3) hours out to 72 hours from 0000 UTC Day 1, then every six (6) hours out to 168 hours from 0000

UTC Day 1.
- **Collaboration Threshold:** N/A (discrete element).

3.14 Quantitative Precipitation Forecast (QPF) – The expected amount of liquid precipitation (in hundredths of inches) accumulated over a six (6)-hour period. NDFD valid periods are six hours in length beginning and ending at 0600, 1200, 1800 and 0000 UTC.

- **NDFD Grid Availability:** QPF grids will be valid each six (6)-hour period out to 72 hours from 0000 UTC Day 1 when new forecast projections are introduced into NDFD at 2200 UTC on Day 0. They will be extended by two six (6)-hour periods to 84 hours from 0000 UTC Day 1 beginning at 1100 UTC Day 1 in the CONUS and 1300 UTC Day 1 in the OCONUS.
- **Collaboration Threshold:**
  0.25 inch difference for precipitation amounts < 1.5 inches;
  0.50 inch difference for precipitation amounts < 3.0 inches; and
  1.0 inch difference for precipitation amounts >= 3.0 inches.

  Enforce if at least one WFO has forecast > 0.25 inch.

3.15 Snow Accumulation – The expected total accumulation of new snow (in inches) during a six (6)-hour period. A snow accumulation grid will be specified whenever a measurable snowfall is forecast for any hour during a valid period. Valid periods for the NDFD begin and end at 0600, 1200, 1800 and 0000 UTC.

- **NDFD Grid Availability:** Snow Accumulation grids will be valid each six (6)-hour period out to 72 hours from 0000 UTC Day 1 when new forecast projections are introduced into NDFD at 2200 UTC on Day 0. They will be extended by two six (6)-hour periods to 84 hours from 0000 UTC Day 1 beginning at 1100 UTC Day 1 in the CONUS and 1300 UTC Day 1 in the OCONUS.
- **Collaboration Threshold:**
  Two (2)-inch difference for snowfall amounts < 6 inches;
  Four (4)-inch difference for snowfall amounts < 12 inches; and
  Six (6)-inch difference for snowfall amounts >= 12 inches.

  Enforce if at least one WFO has forecast > 2 inches.

3.16 Ice Accumulation (IceAccum) – The expected thickness of new ice accumulation upon an elevated horizontal flat surface (in hundredths of inches) during a six (6)-hour period. An ice accumulation grid will be specified whenever at least .01 inch of ice accumulation is forecast for any hour during a valid period. Valid periods for the NDFD begin and end at 0600, 1200, 1800 and 0000 UTC.

- **NDFD Grid Availability:** Ice Accumulation grids will be valid each six (6)-hour period out to 72 hours from 0000 UTC Day 1 when new forecast projections are introduced into NDFD at 22 UTC on Day 0. They will be extended by two six (6)-hour periods to 84 hours from 0000 UTC Day 1 beginning at 1100 UTC Day 1 in the CONUS and 1300

UTC Day 1 in the OCONUS.

- **Collaboration Threshold:**
  0.1-inch difference for ice amounts < 0.5 inches;
  0.2-inch difference for ice amounts < 1.0 inch; and
  0.4 inch-difference for ice amounts >= 1.0 inch.

  Enforce if at least one WFO has forecast > 0.1 inch.

4 Grid Element Definition (Fire Weather)

4.1 Maximum/Minimum (Max/Min) Relative Humidity (RH) – The highest humidity value for the 12-hour period from 0600 - 1800 UTC. The Minimum RH is the lowest humidity value for the 12-hour period from 1800 - 0600 UTC.

- **NDFD Grid Availability**: Maximum and minimum RH grids are valid at 24-hour intervals for 156 hours from 0600 UTC Day 1 and 1800 UTC Day 1, respectively.
- **Collaboration Threshold:** Same as for RH.

Storm Prediction Center (SPC) Fire Weather Outlooks – See the following link for details:

https://www.spc.noaa.gov/products/fire_wx/.

5 Grid Element Definitions (Marine and Tropical)

5.1 Significant Wave Height – Defined as the average wave height (trough to crest) of the one- third largest waves valid for the top of the designated hour.

- **NDFD Grid Availability:** Significant Wave Height is valid at the top of the hour every hour for the first 36 hours from NDFD issuance time, at three (3)-hour resolution through three (3) days and at six (6)-hour resolution through six (6) days.
- **Collaboration Threshold**:
  > 2 and < 6 feet (2)
  < 12 (3)
  < 16 (4)
  < 20 (5)
  < 24 (6)
  < 28 (7)
  < 32 (8)

Enforce if both WFOs have forecast > 0 feet and at least one WFO has forecast > 2 feet.

5.2 Hurricane Threats and Impacts (HTI) – Defined as grids used for communicating tropical storm and hurricane decision-making information on threats and impacts of tropical hazards. Local threat grids (wind, storm surge, flooding rain, and tornado) are generated locally based on national center forecasts. There are five levels to describe each threat (all threat levels

are based on worst case plausible scenario):

a. **Wind Threat** – values are based on the official NDFD wind grids created from the official hurricane center forecast along with a measure of uncertainty provided by the official tropical cyclone wind speed probabilities.
b. **Storm Surge Threat** – grid is computed based on the probabilistic storm surge guidance. The guidance used will be the same the National Hurricane Center (NHC) uses to determine the range of values used in their public advisories.
c. **Flooding Rain Threat** – grid is computed using the Excessive Rainfall Outlook probabilities from the Weather Prediction Center (WPC).
d. **Tornado Threat** – computed for the event analyzing SPC Tornado Probabilities for day 1 and severe weather probabilities as a proxy for tornado threat for days 2 and 3 (in case event falls in days 2 or 3).

- **NDFD Grid Availability**: NDFD Hurricane Threat grids are valid upon issuance for a 72-hour period and are available whenever tropical storm and/or hurricane watches and warnings are in effect (except for WFO Guam or WSO Pago Pago). These grids can also be issued prior to issuance of tropical hazards depending on core partner needs and coordination with neighboring offices and NHC. Updates will be provided at least every six (6) hours and will cease when tropical wind watches and / or warnings are no longer in effect.
- **Collaboration Threshold**: N/A.

6 Grid Element Definitions (Water Resources)

6.1 Forecast of Reference Crop Evapotranspiration for Short Canopy Vegetation Significant (FRET) – Defined as the expected depth of water (in hundredths of inches) that would evaporate and transpire from a reference crop under the forecast weather conditions on a daily and weekly basis over the next seven (7) days.

- **NDFD Grid Availability:** Three (3) FRET grids for the CONUS are available in NDFD as follows:
    a. Daily FRET grids available for Days 1 through 7 beginning and ending at 0000 UTC.
    b. Daily FRET Departure from Normal grids available for Days 1 through 7 beginning and ending at 0000 UTC.
    c. Total Weekly FRET grids available for Days 1 through 7 ending at 0000 UTC Day 7.
- **Collaboration Threshold**: N/A – This is a derived gridded field using the Penman-Monteith Reference Evapotranspiration Equation and the NDFD temperature, relative humidity, wind, and cloud cover grids. Collaboration thresholds for base grids are defined in this Appendix.

7 Grid Element Definitions (NCEP-Produced)

7.1 8- to 14-Day Average Temperature above Normal is the probability, expressed as a percent, of above normal (median) categories of seven (7)-day mean temperature at a lead-time of one week for the CONUS and Alaska.

- **NDFD Grid Availability**: 8- to 14-Day Outlook grids are available at 3:00 p.m. Eastern local time each day with one-week lead-time. The grid is one projection out to 14 days at a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.2 8- to 14-Day Average Temperature below Normal is the probability, expressed as a percent, of below normal (median) categories of seven (7)-day mean temperature at a lead-time of one (1) week for the CONUS and Alaska.

- **NDFD Grid Availability**: 8- to 14-Day Outlook grids are available at 3:00 p.m. Eastern local time each day with one (1)-week lead-time. Grid is one projection out to 14 days at a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.3 8- to 14-Day Total Precipitation above Normal is the probability, expressed as a percent, of above normal (median) categories of seven (7)-day total precipitation at a lead-time of one (1) week for the CONUS and Alaska.

- **NDFD Grid Availability**: 8- to 14-Day Outlook grids are available at 3:00 p.m. Eastern local time each day with one (1)-week lead-time. The grid is one projection out to 14 days at a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.4 8- to 14-Day Total Precipitation below Normal is the probability, expressed as a percent, of below normal (median) categories of seven (7)-day total precipitation at a lead-time of one (1) week for the CONUS and Alaska.

- **NDFD Grid Availability**: 8- to 14-Day Outlook grids are available at 3:00 p.m. Eastern local time each day with one (1)-week lead-time. The grid is one projection out to 14 days at a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.5 Categorical Convective Hazard Outlook is a categorical forecast of the potential for severe thunderstorms (hail, damaging winds, and tornadoes) through Day 8 for the CONUS. Through Day 3, the categorical convective outlooks include areas of general non-severe thunderstorms, and areas of severe thunderstorms can be up to three categories (slight risk, moderate risk, and high risk). For Days 4-8, only one category of severe convection is depicted.

- **NDFD Grid Availability**:
    - Day 1 grids are produced by SPC at 0600 UTC, 1300 UTC, 1630 UTC, 2000 UTC and 0100 UTC.
    - Day 2 grids are produced by SPC at 0700 UTC (0600 UTC during Daylight

Savings Time) and 1730 UTC.
    - Day 3 grids are produced by SPC at 0830 UTC (0730 UTC during Daylight Savings Time).
    - Day 4-8 grids are produced by SPC at 1000 UTC (0900 UTC during Daylight Savings Time).
- **Collaboration Threshold**: N/A.

7.6 One-Month Average Temperature above Normal is the probability, expressed as a percent, of above normal (median) categories of one (1)-month mean temperature at a lead-time of one-half month for the CONUS and Alaska.

- **NDFD Grid Availability**: One (1)-Month Outlook grids are available twice a month; at around 8:30 a.m. Eastern local time on the third Thursday of the month (about one-half month lead-time) and 3:00 p.m. Eastern local time on the last day of the month ("zero lead-time"). The grid is one projection with a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.7 One-Month Average Temperature below Normal is the probability, expressed as a percent, of below-normal (median) categories of one (1)-month mean temperature at a lead-time of one-half month for the CONUS and Alaska.

- **NDFD Grid Availability**: One (1)-Month Outlook grids are available twice a month; at around 8:30 a.m. Eastern local time on the third Thursday of the month (about one-half month lead-time) and 3:00 p.m. Eastern local time on the last day of the month ("zero lead-time"). The grid is one projection with a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.8 One-Month Total Precipitation above Normal is the probability, expressed as a percent, of above-normal (median) categories of one (1)-month total precipitation at a lead-time of one-half month for the CONUS and Alaska.

- **NDFD Grid Availability**: One (1)-Month Outlook grids are available twice a month; at around 8:30 a.m. Eastern local time on the third Thursday of the month (about one-half month lead-time) and 3:00 p.m. Eastern local time on the last day of the month ("zero lead-time"). The grid is one projection with a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.9 One-Month Total Precipitation below Normal is the probability, expressed as a percent, of below-normal (median) categories of one (1)-month total precipitation at a lead-time of one-half month for the CONUS and Alaska.

- **NDFD Grid Availability**: One (1)-Month Outlook grids are available twice a month; at around 8:30 a.m. Eastern local time on the third Thursday of the month (about one-half month lead-time) and 3:00 p.m. Eastern local time on the last day of the month ("zero lead-time"). The grid is one projection with a resolution of five (5) km.
- **Collaboration Threshold**: N/A.

7.10 Probabilistic Tropical Cyclone Surface Wind Speed (Cumulative) is the probability (in percent) of sustained surface wind speed greater than 34-, 50- and 64-kt (three separate elements) from a tropical cyclone sometime during the specified cumulative forecast period (0 - 6 hours, 0 - 12, 0 - 18, etc.) at each specific point. Grids cover the Atlantic and Pacific basins in the Northern Hemisphere.

- **NDFD Grid Availability**: These grids are available no earlier than 15 minutes following the issuance deadlines for routine tropical cyclone advisories (0300, 0900, 1500 and 2100 UTC) and after special advisories for all potential and ongoing tropical and subtropical cyclones. The grids are available for cumulative increments from six (6) hours to 120 hours.
- **Collaboration Threshold**: N/A.

7.11 Probabilistic Tropical Cyclone Surface Wind Speed (Incremental) is the probability (in percent) of sustained surface wind speed greater than 34-, 50-, and 64-kt (three separate elements) from a tropical cyclone sometime during the specified 6-hour forecast period (0 - 6 hours, 6 - 12, 12 - 18, etc.) at each specific point. Grids cover the Atlantic and Pacific basins in the Northern Hemisphere.

- **NDFD Grid Availability**: These grids are available no earlier than 15 minutes following the issuance deadlines for routine tropical cyclone advisories (0300, 0900, 1500 and 2100 UTC) and after special advisories for all potential and ongoing tropical and subtropical cyclones. The grid increment is every six (6) hours out to 120 hours.
- **Collaboration Threshold**: N/A.

7.12 Probability of Damaging Thunderstorm Winds (Day 1) is the probability (in percent) of a wind gust 58 miles per hour or greater occurring within 25 miles of any point during the outlook period for the CONUS. The higher the probability, the higher the threat of severe thunderstorm winds occurring.

- **NDFD Grid Availability**: These grids are produced by SPC at 0600 UTC, 1300 UTC, 1630 UTC, 2000 UTC and 0100 UTC. The grid is composed of one projection.
- **Collaboration Threshold:** N/A.

7.13 Probability of Extreme Hail (Day 1) is the probability (in percent) of hail two (2) inches or greater in diameter within 25 miles of any point during the outlook period for the CONUS. The higher the probability, the higher the threat of extreme hail occurring.

- **NDFD Grid Availability**: These grids are produced by SPC at 0600 UTC, 1300 UTC, 1630 UTC, 2000 UTC and 0100 UTC. The grid is composed of one projection.
- **Collaboration Threshold**: N/A.

7.14 Probability of Extreme Thunderstorm Winds (Day 1) is the probability (in percent) of a wind gust 75 miles per hour or greater occurring within 25 miles of any point during the outlook period for the CONUS. The higher the probability, the higher the threat of extreme thunderstorm winds occurring.

- **NDFD Grid Availability**: These grids are produced by SPC at 0600 UTC, 1300 UTC, 1630 UTC, 2000 UTC and 0100 UTC. The grid is composed of one projection.
- **Collaboration Threshold**: N/A.

7.15 Probability of Extreme Tornadoes (Day 1) is the probability (in percent) of Enhanced Fujita scale 2 (EF2) or greater tornadoes occurring within 25 miles of any point during the outlook period for the CONUS. The higher the probability, the higher the threat of extreme tornadoes occurring.

- **NDFD Grid Availability**: These grids are produced by SPC at 0600 UTC, 1300 UTC, 1630 UTC, 2000 UTC and 0100 UTC. The grid is composed of one projection.
- **Collaboration Threshold**: N/A.

7.16 Probability of Hail (Day 1) is the probability (in percent) of hail one (1) inch in diameter (quarter-size coin) or greater occurring within 25 miles of any point during the outlook period for the CONUS. The higher the probability, the higher the threat of severe hail occurring.

- **NDFD Grid Availability**: These grids are produced by SPC at 0600 UTC, 1300 UTC, 1630 UTC, 2000 UTC and 0100 UTC. The grid is composed of one projection.
- **Collaboration Threshold**: N/A.

7.17 Probability of Tornadoes (Day 1) is the probability (in percent) of a tornado occurring within 25 miles of any point during the outlook period for the CONUS. The higher the probability, the higher the threat of tornadoes occurring.

- **NDFD Grid Availability**: These grids are produced by SPC at 0600 UTC, 1300 UTC, 1630 UTC, 2000 UTC and 0100 UTC. The grid is composed of one projection.
- **Collaboration Threshold**: N/A.

7.18 Three-Month Average Temperature above Normal is the probability, expressed as a percent, of above normal categories of three-month mean temperature at lead-times ranging from one-half month to 12-1/2 months for the CONUS and Alaska.

- **NDFD Grid Availability**: The Climate Prediction Center (CPC) issues these 13 outlooks simultaneously once a month on the third Thursday of the month at around 8:30 a.m. Eastern local time. CPC will issue the 13 outlooks with lead-times from one-half month to 12-1/2 months. For example, in mid-January, CPC will issue 3-Month Outlooks for February through April, March through May, April through June, and so on to February through April of the following year.
- **Collaboration Threshold**: N/A.

7.19 Three-Month Average Temperature below Normal is the probability, expressed as a percent, of below normal categories of three-month mean temperature at lead-times ranging from one-half month to 12-1/2 months for the CONUS and Alaska.

- **NDFD Grid Availability**: CPC issues these 13 outlooks simultaneously once a month on the third Thursday of the month at around 8:30 a.m. Eastern local time. CPC will issue the 13 outlooks with lead-times from one-half month to 12-1/2 months. For example, in mid-January, CPC will issue 3-Month Outlooks for February through April, March through May, April through June, and so on to February through April of the following year.
- **Collaboration Threshold**: N/A.

7.20 Three-Month Total Precipitation above Normal is the probability, expressed as a percent, of above normal categories of three-month total precipitation at lead-times ranging from one-half month to 12-1/2 months for the CONUS and Alaska.

- **NDFD Grid Availability**: CPC issues these 13 outlooks simultaneously once a month on the third Thursday of the month at around 8:30 a.m. Eastern local time. CPC will issue the 13 outlooks with lead-times from one-half month to 12-1/2 months. For example, in mid-January, CPC will issue 3-Month Outlooks for February through April, March through May, April through June, and so on to February through April of the following year.
- **Collaboration Threshold**: N/A.

7.21 Three-Month Total Precipitation below Normal is the probability, expressed as a percent, of below normal categories of 3-month total precipitation at lead-times ranging from one-half month to 12-1/2 months for the CONUS and Alaska.

- **NDFD Grid Availability**: CPC issues these 13 outlooks simultaneously once a month on the third Thursday of the month at around 8:30 a.m. Eastern local time. CPC will issue the 13 outlooks with lead-times from one-half month to 12-1/2 months. For example, in mid-January, CPC will issue 3-Month Outlooks for February through April, March through May, April through June, and so on to February through April of the following year.
- **Collaboration Threshold**: N/A.

7.22 Total Probability of Extreme Severe Thunderstorms (Day 2 and Day 3) is the probability in percent of EF2 (Enhanced Fujita scale 2) tornadoes or greater, damaging wind gusts of 75 miles per hour or greater, or hail two (2) inches in diameter or greater occurring within 25 miles of any point during the outlook period for the CONUS.

- **NDFD Grid Availability**: Day 2 grids are produced by SPC at 0700 UTC (0600 UTC during Daylight Savings Time) and 1730 UTC. Day 3 grids are produced by SPC at 0830 UTC (0730 UTC during Daylight Savings Time). The grid is composed of two projections.
- **Collaboration Threshold**: N/A.

7.23 Total Probability of Severe Thunderstorms (Day 2 and Day 3) is the probability in percent of tornadoes, damaging wind gusts 58 miles per hour or greater, or large hail one (1) inch

in diameter (quarter-size coin) or greater occurring within 25 miles of any point during the outlook period for the CONUS.

- **NDFD Grid Availability**: Day 2 grids are produced by SPC at 0700 UTC (0600 UTC during Daylight Savings Time) and 1730 UTC. Day 3 grids are produced by SPC at 0830 UTC (0730 UTC during Daylight Savings Time). The grid is composed of two projections.
- **Collaboration Threshold**: N/A.

7.24 Winter Weather Outlook (Days 4–7) is the probability of winter precipitation (snow/sleet) exceeding 0.25 inches (~six (6) mm) water equivalent over a 24-hour period (1200 UTC to 1200 UTC). The product is comprised of four grids showing the forecast for Day 4, Day 5, Day 6 and Day 7 for the CONUS.

- **NDFD Grid Availability:** The grids are prepared by WPC twice daily by 0900 UTC and 1930 UTC.
- **Collaboration Threshold:** N/A.

APPENDIX B – NDFD Weather Element Tables (CONUS only)

The following tables show forecast projection times at which samples for NDFD grids are taken from local grids furnished by WFOs. These projection times equate to the grid production requirements for the NDFD and should be followed by all WFOs when forecasts are generated for those elements. For some fields, this is a *subset* of the hourly grids needed in the local WFO database to produce local products and services (requiring local time). Locally produced grid resolutions (e.g., for products and services based on the grids) to meet user needs are permitted; however, those gridded fields would be in addition to generating grids using the required time projections within these tables. The requirement for hourly grids runs 36 hours from each hourly NDFD issuance. Required projections for other forecasts are from 0000 UTC, Day 1 and extend out to a maximum of 168 hours. Derived fields are indicated by the "*" symbol.

General Weather Element Grid Availability **Time Projections from 0000 "00" UTC, Day 1** →

Diurnal Day (CONUS)	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7
UTC Day	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8
UTC Hour	03	06	09	12	15	18	21	00	03	06	09	12	15	18	21	00	03	06	09	12	15	18	21	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00
Hours	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	78	84	90	96		108		120		132		144		156		168
Max/Min Temperature	A				A				A				A				A				A				A		A		A		A		A		A		A		A	
Temperature	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Dew Point	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Apparent Temperature*	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Relative Humidity*	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Probability of Precipitation (12h)*	A				A				A				A				A				A				A		A		A		A		A		A		A		A	
Sky Cover	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Wind Direction and Speed	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Wind Gust	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Weather (type, intensity, prob/cvrg)	A----------[hourly] ----------A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Quantitative Precipitation^	A		A		A		A		A		A		A		A		A		A		A		A		A	A														
Snow Accumulation^	A		A		A		A		A		A		A		A		A		A		A		A		A	A														
Ice Accumulation^	A		A		A		A		A		A		A		A		A		A		A		A		A	A														

A - Required grid time projections for NDFD

^QPF, Snow Accumulation, and Ice Accumulation extend 12 hours into Day 4 beginning at 11 UTC.

Program-specific Weather Element Grid Availability **Time Projections from 00 UTC, Day 1** →

Diurnal Day (CONUS)	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7
UTC Day	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8
UTC Hour	03	06	09	12	15	18	21	00	03	06	09	12	15	18	21	00	03	06	09	12	15	18	21	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00
Hours	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	78	84	90	96		108		120		132		144		156		168
Daily FRET*	A				A				A				A				A				A				A				A				A				A			
Daily FRET Departure*	A				A				A				A				A				A				A				A				A				A			
Total Weekly FRET*	A																																							
Max/Min Relative Humidity*	A				A				A				A				A				A				A				A				A				A			
Significant Wave Height	A----------[hourly] ---------- A												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
Hurricane Wind Threat	A																																							
Hurricane Storm Surge	A																																							
Hurricane Flooding Rain Threat	A																																							
Hurricane Tornado Threat	A																																							

A - Required grid time projections for NDFD
*Derived field