Volume 3, Issue 4
June 3 , 2013

ZSE Weather Watch

A newsletter from your Seattle ARTCC Center Weather Service Unit

In This Issue

Stampede Pass Weather Reports	1-2
Marine Stratus Surges	2-4
The Importance of PIREPS	5

Stampede Pass Weather Observations

by Allen Kam, NOAA/National Weather Service, WFO Seattle, WA

Located at an elevation of approximately 4,000 feet in the Washington Cascades, the Stampede Pass (KSMP) weather station is a rarity; it's one of only a few, permanent mountain weather stations operated by the National Weather Service (NWS). It provides a continuous record of high-altitude weather, helps support local weather and climate predictions, and helps guide commercial and general aviation pilots across the Washington Cascades. It was established in 1943 and became a fully automated ASOS site in the mid-1990s.

However, getting consistent weather reports from Stampede Pass has been a challenge over the years due to poor phone line connections and harsh winter weather, which makes for hazardous and difficult travel to the pass when phone lines are in need of repair. This will remain the case even as we move into our warm season when data outages usually are not as frequent.

NWS and the Seattle Forecast Office have been analyzing a variety of options to remedy the severe data problems that have been the norm the past few years. The current plan is to leave the observing instrumentation - the Data Collection Package or DCP - intact at Stampede Pass and move the Acquisition Control Unit (ACU) down to I-90 about nine miles east of Snoqualmie Pass, where it will hook up to the 509 area code. Communication between the DCP and ACU will be via radio, using a UHF frequency. This solution means there will be no change to the actual observation site, but transmission of the observations from the Stampede Pass weather station will improve dramatically due to a more reliable communications network.

***Figure 1** – View of Stampede Pass weather station in winter.*

Plans within the National Weather Service to perform the physical part of the move remain on track. However, the actual move will not be possible until the roads to Stampede Pass are free of snow this summer. There are also some Land Use Permitting issues that need to be resolved with the U.S. Forest Service.

This solution to the Stampede Pass communications problem is unique. ASOS observing systems have one or more DCPs where all weather instruments - except the pressure sensors - are located. The pressure sensors are almost always located in the Acquisition Control Unit (ACU). At airports, DCPs are usually located near the touchdown zone of the primary instrument approach runway or near center-field. The ACU is always located indoors in a nearby building, usually a control tower or a terminal building. Data collected by the DCP is transmitted by radio in the UHF band to the ACU. The ACU sends the observations to FAA and NWS communication centers via local phone lines. The transmission distance between the DCP and ACU is line-of-sight and is usually less than a half mile. At Stampede

Pass the distance is currently a matter of yards.

The proposed solution will move the ACU from the top of the pass to a garage near I-90, about 9 miles east of Snoqualmie Pass. Line-of-sight requirements are still maintained, but the transmission distance will now be between 2.5 and 3.0 miles. The relocation down into Snoqualmie Pass will allow the ACU to connect to the more reliable 509 local access area.

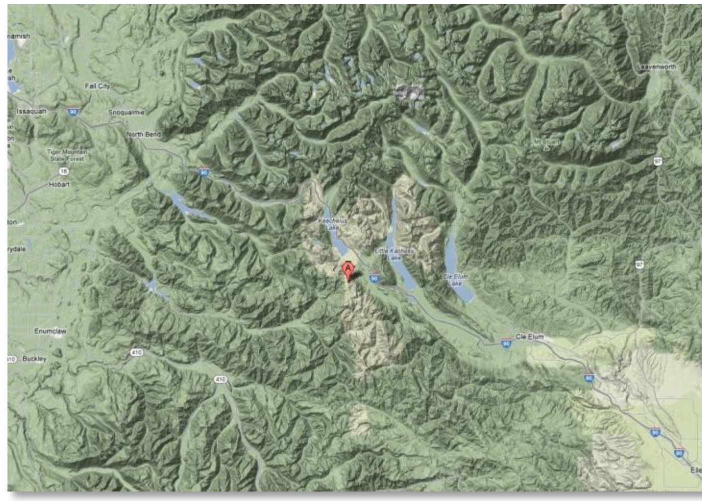

***Figure 2** – Stampede Pass approximately 65 miles ESE of Seattle, WA.*

One other planned ASOS modification is to move the pressure sensors from the ACU to the DCP. This will keep all the observing equipment up at Stampede Pass.

The Stampede Pass ASOS also has a ground-to-air radio that transmits observations to pilots VHF 135.275 mhz. On ASOS units, the antenna for the ground-to-air radio is located with the ACU. Unfortunately, there is no ASOS system modification available to locate ground-to-air antennas with the DCP, so the antenna will also have to be moved down the hill into Snoqualmie Pass along I-90, which will likely limit the available reception area.

The current plan is to complete the relocation of the ACU this summer once the roads are free of snow. Since this ACU relocation solution is unique, there may still be unanticipated problems that could arise.

Marine Stratus Surges

by Clinton Rockey, NOAA/National Weather Service, WFO Portland, OR

Summer brings good flying conditions to the region. As many can attest, the most problematic issue to for pilots, and forecasters, is the arrival and dissipation of marine stratus. This is often a major headache in determining a 'go' or 'no-go' flight situation for many general aviation pilots who are VFR (visual flight rules) rated.

Marine surges can occur at any time during the year, but tend to favor spring through early autumn, coinciding with the temperature differentials between the coast and the interior. This differential is often a direct result of the pressure pattern, where high pressure offshore battles for control with the thermal low pressure that shifts between the coastal strip and the Columbia Basin.

Nearly every marine stratus surge follows a similar meteorological pattern. Typically, there will be a period of northerly or offshore flow prior to the event. This is due to surface thermal low pressure that was over some part of the coastal region, either just offshore or hugging the coast. In this pattern, low level flow keeps winds from the north, northeast or east, with lower humidity air from the interior pushing onto coastal areas. The end result is mostly clear skies across the coastal areas (**Figure 3**).

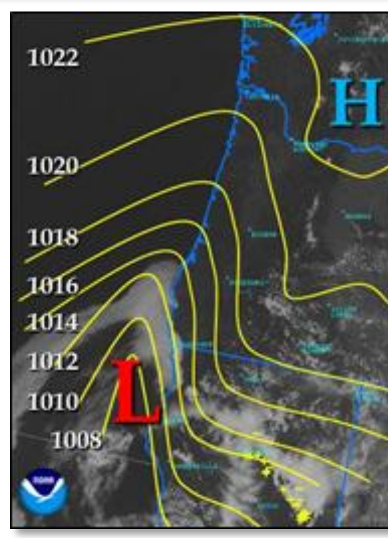

***Figure 3** – Isobaric pattern of thermal low pressure along the West Coast.*

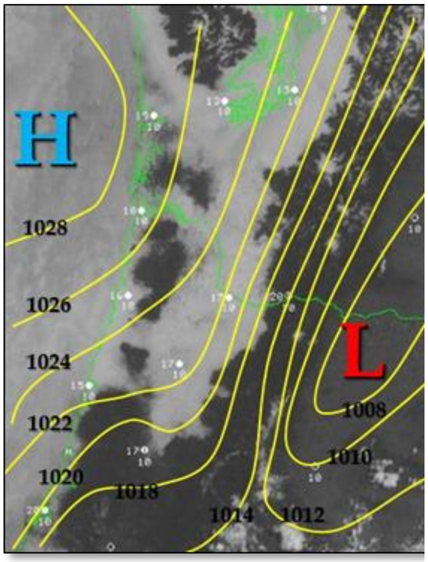

Figure 4 – *Typical meteorological setup at the height of a marine stratus surge, showing the isobaric pattern of a thermal low pressure located in Columbia Basin*.

This thermal trough will remain in place as long as there is high pressure in the interior Pacific Northwest and over the northeast Pacific. Generally, this will be about 3 to 5 days. Forecasters often claim that once temperatures in the 90s occur in the Willamette Valley, it is only a few days before the marine surge arrives and cools the air mass. Indeed, there is some truth to this. As warming over the interior increases, pressure over the interior falls. Eventually, pressure is lower over the Interstate 5 corridor, which will allow the thermal trough axis to gradually move inland. Once the thermal axis shifts inland, pressure over the near coastal Pacific rises. This allows for the winds to turn onshore, with cooler moist marine air spreading onshore. Often, low clouds will be accompanying this onshore flow. Unfortunately for pilots, these clouds are often below 1000 feet, and visibility is often less than one mile in fog and sometimes drizzles as the low clouds spread inland. If the surge is weak, these conditions may persist for 12 to 24 hours before improving to MVFR conditions.

The process continues as areas east of the Cascades warm, and pressure there becomes lower than that west of the Cascades. Like before, the thermal trough axis will shift across the Cascades and into central Oregon and eastern Washington. Again, pressure to west of the axis continues rising, with the high offshore pushing more of the cool marine air through the gaps in the Coast Range, and thus deepening the marine layer. How far inland the low clouds reach will depend on the strength of the marine surge, and how deep the marine layer becomes.

Studies have found that the difference in sea level pressure (pressure gradient) between Spokane and North Bend is instrumental in describing the strength of the marine stratus surge, or marine push. As the marine push intensifies, so the marine layer deepens. The table below shows the relationship between the pressure gradient and typical ceilings seen at airports on the Oregon coast and the Willamette Valley. Tops of the stratus tend to be about 1500 to 2500 feet above the ceilings, with the stronger pushes having the thickest clouds (bases 3000 to 4000 feet, with tops at 6500 ft.

OTH-GEG	**Surge**	**Depth (ft) of Marine Layer**	**Inland Extent of Stratus**	**Typical CEILINGS (feet AGL)**	
Gradient (mb)				***Oregon Coast***	***Willamette Valley***
+0 to +3	Weak	1000-2000	Coast Range	200 to 800	None
+4 to +7	Moderate	2000-3500	Willamette Valley	800 to 1200	700 to 1200
+7 to +11	Strong	3500-5000	Cascades/Foothills	1500 to 2500	1500 to 2500
+12 or more	Intense	>5000	Cascades	2500 to 3500	3000 to 4000

On the strong and intense marine surges, the onshore flow is so strong that moisture rolling over the Cascades and into eastern Oregon and Washington will create streamers of clouds downwind of the passes in the Cascades. Gusty westerly winds can be found in the Columbia Gorge and downwind of the Cascades as well, with gusts of 35 to 45 knots.

Interestingly, there are two types of marine surges, or marine pushes—Northwest and Southwest pushes. The Northwest push (**Figure 4 and Figure 5 right**) is the better of the two in terms of initial flight conditions, with mostly MVFR and VFR. Southwest pushes (**Figure 3 and Figure 5 left**) bring the worst, with IFR common, and MVFR over the interior.

The Northwest push (**Figure 4 and Figure 5 right**) is often associated with post-frontal high pressure. Once a front moves across the region, high pressure builds over the northeast Pacific, while lower pressure resides over southwest Oregon and north California. As the layer deepens, marine stratus over the northeast Pacific is pushed to the coast, and depending on the strength of the pressure gradients, will push inland. Low clouds will push up the Columbia River, affecting Portland and Troutdale. During the spring, these clouds can reach Portland soon after midnight. However, in the summer, it may take until nearly sunrise to reach Portland. Either way, the stratus will push into the Cascades and will also spread south into the Willamette Valley.

On the other hand, the Southwest push (**Figure 3 and Figure 5 left**) is associated with the thermal trough axis moving inland, often due to an upper level low or trough pushing into southwest Oregon and/or northern California. As the trough axis moves, it tends to buckle and move inland over southwest Oregon, but arcs from there back to the central Oregon coast. The thermal trough will continue moving north and east, eventually to a position from Portland to Kelso to Hoquiam, and finally being completely pushed into eastern Washington and Oregon. As a result, building surface pressure along the coast will push cool, moist marine air into the interior of the south Willamette Valley, where low clouds will appear at Eugene. As the push progresses, low clouds will spread north along the coast and over the interior. Wind shifts with the Southwest push can be abrupt, with a period of gusty south winds on the coast just ahead of the stratus and continuing for a few hours afterwards. Typical winds will be 10 to 15 knots, but in the stronger pushes, coastal winds can be 20 to 25 knots with gusts to 35 knots.

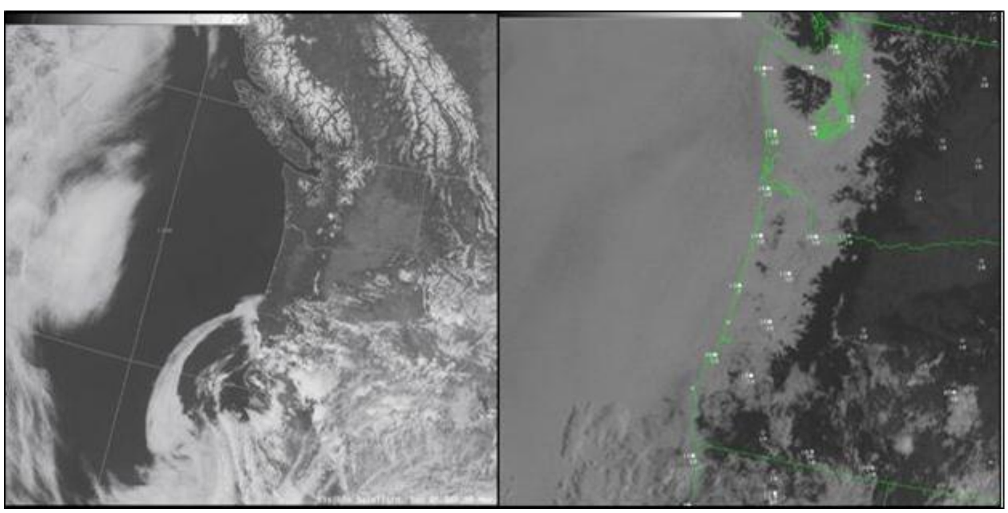

Figure 5: (Left) *Early stages of a Southwest Push. Notice low stratus on the south Oregon Coast, pushing northward.* ***(Right)*** *Moderate to strong Northwest Push, where stratus is well into the Cascades.*

Forecasters have developed tools to better anticipate the development and impacts of the marine stratus surges. Once the forecaster determines the strength of the anticipated push, a more extensive examination of model graphics and atmospheric soundings can yield more detailed information about the character of the stratus surge. For example, a forecast of low level humidity (**Figure 6, Left**) gives a good idea of the northern extent of the northward moving stratus (**Figure 6, Right**). Often, computer models ‘play catch up’ on where the leading edge of stratus will be located.

Local studies and programs have been developed that are used at the forecast offices. Bob Jackson, a former Seattle ARTCC CWSU forecaster, developed several programs that are exceptionally good at determining stratus breakout times. Forecasters at Seattle and Portland have incorporated these programs and their output when constructing aviation terminal forecasts.

Despite the huge impact of marine stratus on aviation, both general and commercial, forecasters have become increasingly proficient at forecasting the arrival and dissipation of the marine stratus, and its overall impacts during a marine stratus surge.

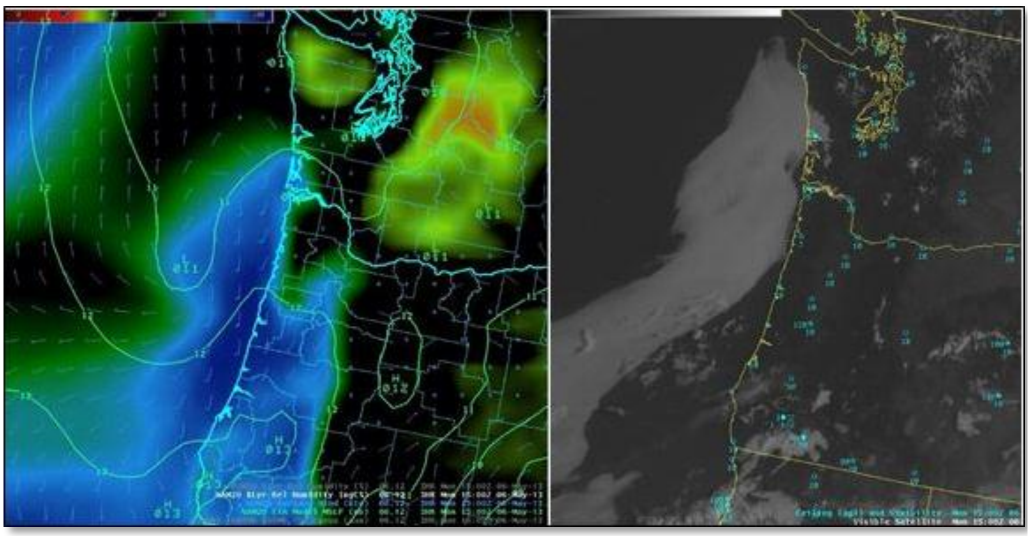

***Figure 6 - (Left)** 12UTC Model guidance of mean sea level pressure (lines) and boundary layer humidity (image color), valid at 15Z May 6, 2013. **(Right)** Validating satellite imagery 15Z May 6, 2013.*

The Importance of Pilot Reports: A Forecaster's Perspective *by Shad Keene, NOAA/National Weather Service, WFO Medford, OR*

Imagine this: it's fall over the inland valleys of Southern Oregon. We've had months of mostly dry weather, with only an occasional weak cold front generating a few thunderstorms over the Cascades and dropping a tenth of an inch of rain. Flying hazards have been very minimal over the summer and early fall, and pilots have generally been able to enjoy the "big bubble, no trouble", meaning persistent high pressure and fair weather.

That's all about to change as a 970mb low pressure system is barreling toward the coast, increasing the winds and moisture in all levels of the flying environment. Pilots in the area are about to experience a significant change compared to the benign weather of the summer and early fall. By 2 PM the front has reached the coast, I've issued the most recent set of TAFs, and it's time for me to write the Aviation Portion of the Area Forecast Discussion. This is a product that, if done well, should provide pilots a synopsis of our forecast reasoning and confidence, as well as some insight into potential flying hazards affecting the forecast area. In the overall scheme of things, it's another tool for pilots to increase their weather situational awareness. East of the Cascades, winds are gusting to 45 mph ahead of the front, and west of the Cascades a thick cloud layer is forming and freezing levels are beginning to fall. I take a look at the many recent regional PIREPs to determine how much icing and turbulence pilots are experiencing, then I look at the Graphical AIRMETs product from Aviation Weather Center, and I use this data to create a representative forecast discussion. In it I write, "Significant icing is affecting areas west of the Cascades this afternoon and will spread to areas east of the Cascades tonight. Freezing levels will fall sharply tonight, behind the cold front. Low level turbulence is widespread east of the Cascades and should diminish late tonight as surface winds decrease."

Now I'll paint another picture where PIREPs are unavailable, and the forecast suffers as a result. It's a summer morning and the marine stratus is hugging the coast and coastal valleys. I'm creating the TAF for North Bend, located on the Oregon coast. The current observation is showing 500 foot bases, preventing VFR pilots from flying, and these pilots are very interested in knowing if and when the marine stratus is going to clear. Typically, clouds that have a greater depth take longer to clear. PIREPs represent one of the few ways to get an accurate depiction of the depth of the cloud layer, so it's critical to get nearby pilot reports of cloud bases and cloud tops in order to generate a TAF that has the best chance at being accurate. This morning I have no bases or tops from PIREPs, so I'm guessing at how deep the cloud layer actually is. I put in the TAF that the clouds will clear in four hours, similar to what has happened over the past few mornings. Some pilots are already altering their plans based on the forecast. Unfortunately, the clouds clear one hour later and conditions become VFR, likely because the cloud depth was shallower than I thought. This inaccurate forecast likely resulted in misspent money and time.

The summary of these two stories is this: **PIREPs** are a key part of aviation forecasts, and when they are plentiful, forecasts are more accurate, and the aviation community as a whole benefits. The next time you relay a PIREP, you could be enhancing the safety and overall weather awareness of neighboring pilots and you will likely be helping your friendly local weather forecaster to deliver the most accurate forecast possible.

For the Aviation Weather Center's PIREP Entry Forms website go to:

https://aviationweather.gov/exp/pirep_submit/select.php?name=SWA

SEATTLE CWSU
FAA ARTCC
3101 Auburn Way S.
Auburn, WA 98095

Phone: 253-351-3741
Fax: 253-351-3412

Web Page:
www.wrh.noaa.gov/zse

"Protecting Life and Property"