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ZSE Weather Watch

A newsletter from your Seattle ARTCC Center Weather Service Unit

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Seattle's "Midwest" Winter Storm *by John Werth*

In early January, long range computer models showed the potential for cold, wet weather across the Pacific Northwest by the middle of the month. A persistent upper level ridge along the west coast was forecast to weaken and be replaced by a cold, upper level trough of low pressure from the Gulf of Alaska. Arctic air was also forecast to be on the move and was expected to reach the northern portion of ZSE by mid-January. The only ingredient needed for a major snow storm in Western Washington was moisture and that was provided by storms on the 18th and 19th.

Figure 2 is the classic pattern for heavy snow in Western Washington. Arctic air to the north (**H** in **Figure 2**) is being overrun by warm, moist air moving in from the southwest. If the surface low (**L** in **Figure 2**) tracks north to Vancouver Island, precipitation may start as snow but then quickly changes to rain as warmer air is pulled north. If the low moves inland over northern Oregon, cold air over B.C. is pulled south, resulting in widespread lowland snow across Western Washington. However, if the low moves inland too far to the south, the threat of heavy snow in the Seattle area decreases as moisture stays south of the area.

Predicting the type and extent of precipitation is always a challenge for local weather forecasters when this pattern occurs, since even minor errors in the location of the surface low make the difference between a snow or rain event in Western Washington.

The pattern on the 18th (**Figure 2**) had local forecasters mentioning the possibility of record snowfall in the Seattle area. As it turned out, many locations in SW Washington reported record snowfall that day, but in the Seattle area heavy snow in the morning turned to sleet and freezing drizzle during the afternoon. SeaTac reported 6.8 inches of snow, but that was far from the record one day total of 20 inches that occurred on January 13, 1950. Still, it tied for the 11th snowiest day at SeaTac since 1945.

The low moved inland to the south as forecast but after the main precipitation event was

Figure 1 – *Typical street scene in the Seattle area January19, 2012.*

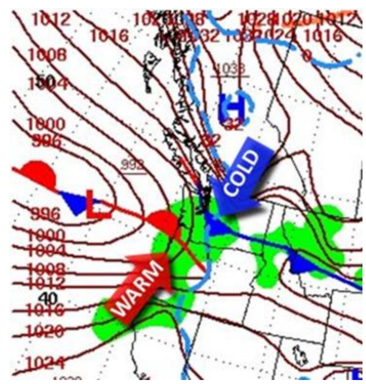

Figure 2 *– Surface weather map valid 7 am PST Wednesday January 18, 2012*

By Thursday evening over 280,000 Puget Sound Energy customers were without power and Alaska and Horizon airlines had cancelled 310 flights to and from SeaTac.

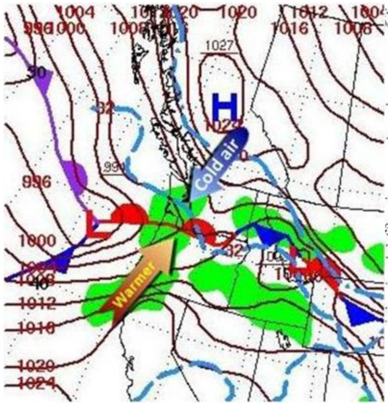

Figure 3 *– Surface weather map valid 7am PST Thursday January 19, 2012.*

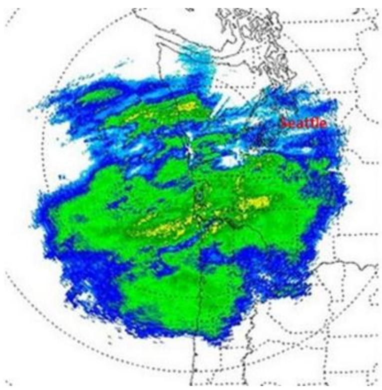

Figure *4– Langley Hill radar 4:30 AM PT January 19, 2012*

over, Seattle was left with a layer of low clouds - composed of tiny water drops - that were below freezing through the entire depth of the cloud layer. Without the introduction of ice crystals from higher clouds above or strong upward vertical motion in the atmosphere, the supercooled clouds only produced light freezing drizzle or small ice pellets that by Wednesday evening covered the snowfall with a thin layer of ice.

The weather pattern Thursday (**Figure 3**) was similar to Wednesday. However, there were a few subtle differences between the two. Thursday's storm was forecast to move inland further south, keeping Seattle north of the main precipitation area while temperatures gradually warmed to above freezing. However, by 4:30 AM, the new coastal radar showed precipitation (**Figure 4**) spreading north into the Seattle area - further north and much faster than what had been expected. It fell as snow over the north Sound, sleet and freezing rain in central Sound (Seattle area), and freezing rain over the south Sound, even though surface temperatures remained below freezing in all areas.

Figure 5 explains why this happened. It shows the change in wind and temperature with height and time over Seattle starting 19Z (11am) Wednesday. Time increases from right to left in this image with cold air (<32°F) shaded blue and warm air (>32°F) shaded red. By Thursday morning, stronger southwest winds aloft brought warmer air aloft into the Seattle area, while north winds at lower levels kept cold air near the surface.

The depth of the cold air determined the observed precipitation type. Up north where it snowed, the layer of warmer air aloft didn't exist or was too shallow to melt the ice crystals as they fell through the clouds. In the central and south Sound, ice crystals melted as they fell through the layer of warmer air aloft. Falling as raindrops through the colder air below, they became supercooled and froze on contact with any surface they struck. However, where the cold air was deeper, raindrops froze into sleet or ice pellets before hitting the ground.

The event on the 19th started as freezing rain and sleet over much of Western Washington but then changed to snow again by afternoon and evening. Many areas received several more inches of snow before the event finally ended Friday morning.

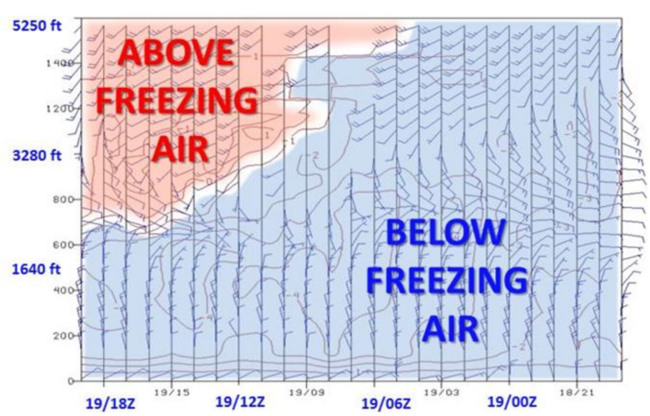

Figure 5 *– Time/height cross section of temperature and wind over Seattle, WA on January19, 2012.*

New Dual-pol Radar Products *by John Werth*

NEXRAD dual-pol installation is now in full stride across the U.S. with 5 teams working to complete the task by the end of spring 2013. Several sites in ZSE's airspace were among the first to get the upgrade.

Dual-pol technology gives radars the ability to transmit and receive radio waves on horizontal and vertical axes. The radars measure how similar or different the returned horizontal and vertical pulses are behaving within each pulse volume. The data is used to create several new radar products, one of which is the Correlation Coefficient (CC) product. CC values vary between 0.20 and 1.05 and are unitless. In general, CC is best at discriminating between meteorological and non-meteorological echoes. It's also good at discriminating between different types of meteorological echoes.

Non-meteorological echoes such as birds and insects have CC values less than 0.80. Uniform rain and snow particles have CC values greater than 0.97, while non- uniform meteorological echoes such as hail, wet snow, or a rain/snow mix have values between 0.80 and 0.97.

Figure 6 is the 1420Z CC image from the Langley Hill radar on February 9, 2012. CC values in the yellow circle are between 0.90 and 0.95, indicating a mix of wet snow or rain and snow. The inner circle (maroon and purple) has values above 0.97 indicating uniform rain or snow. The pink area (outside the yellow ring) has values around 1.0, indicating a mix of dry snow and/or ice crystals. Knowing the type of scatterers in the radar return provides forecasters greater insight into the underlying atmospheric processes taking place.

Dual-pol NEXRADs also come with a new algorithm called the Hydrometeor Classification Algorithm (HCA), which provides a best guess estimate of the echo type, using the echo's CC values and other polarimetric characteristics. **T**he HCA product in **Figure 7** corresponds to the CC data display in **Figure 6**.

HCA classified echoes inside the yellow ring (light green) as rain. Echoes outside the ring (cyan and pink) were classified as dry snow and ice crystals. Echo returns in the ring were classified as wet snow (blue), graupel (dark pink), and big rain drops (tan) - all good indicators of the melting layer. On CWSU NWS workstations, cursor readout will show the echo type and its height, bearing and distance from the radar.

In winter storms, the HC product will provide a quick look at the location and altitude of rain, snow, and the melting layer and how they change in time and space. During spring and summer, HC will be used to discriminate between areas of heavy rain and hail in convective storms and will be able to see storm debris from tornadoes.

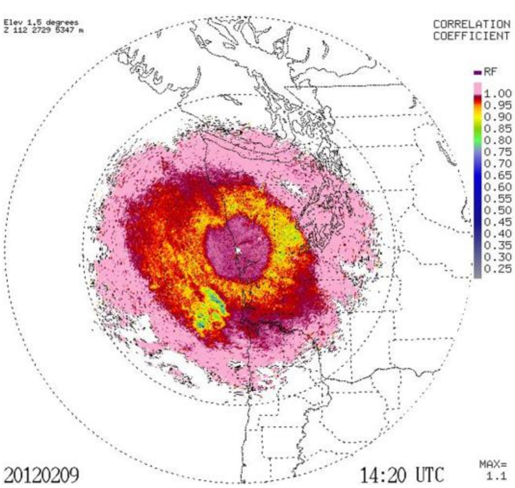

***Figure 6** – Correlation Coefficient Feb. 9, 2012.*

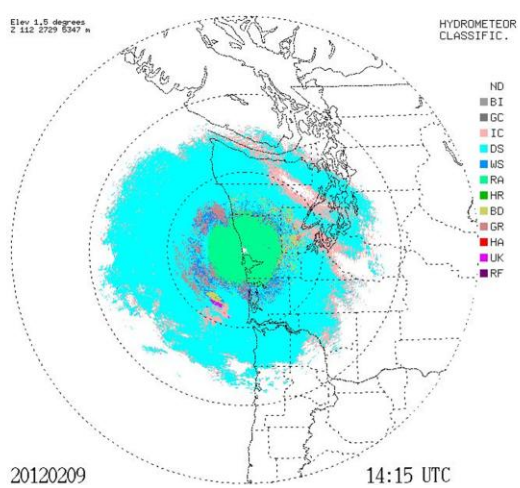

***Figure 7** – Hydrometeor Classification Feb. 9, 2012.*

We're on the Web!

Main web page

www.wrh.noaa.gov/zse

Mobile page

www.wrh.noaa.gov/zse/mobile.htm

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"Protecting Life and Property"

CWSU Space Weather Procedures *by Steve Adams*

Space weather refers to conditions and processes in space which has the potential to affect the near-Earth environment. As discussed in a previous newsletter, these solar-related phenomena can produce changes in the near-Earth environment that can cause significant disruptions in satellite-based and ground-based technological systems. In turn, these disruptions can cause significant hazard to aviation operations. Researchers forecast a peak in solar activity between 2013 and 2014 (**Figure 8**) which would impact the near-Earth environment to a higher level than what has occurred over the last decade.

Right on cue in late January and early February, a series of powerful solar flares touched off solar explosions known as coronal mass ejections, sending highly-charged particles into the Earth's atmosphere. The solar flares were mainly weak to moderate with only minor disruptions to satellite and/or ground-based communication systems.

NOAA's Space Weather Prediction Center (SWPC) has a dedicated web site of space weather products and services customized for the aviation community.

www.swpc.noaa.gov/aviation

SWPC uses a scale called the Space Weather Scales to communicate to the general public current and future space weather conditions and their possible effects on people and systems. The scales are used to describe the severity of three types of space weather events: geomagnetic storms, solar radiation storms, and radio blackouts. Each event has its own scale numbered from 1 (minor) to 5 (extreme). Each level contains information on the possible impacts to power systems, HF and LF radio communications, spacecraft operations and satellite navigation systems. See www.swpc.noaa.gov/NOAAscales for a complete list of the effects for each space weather event.

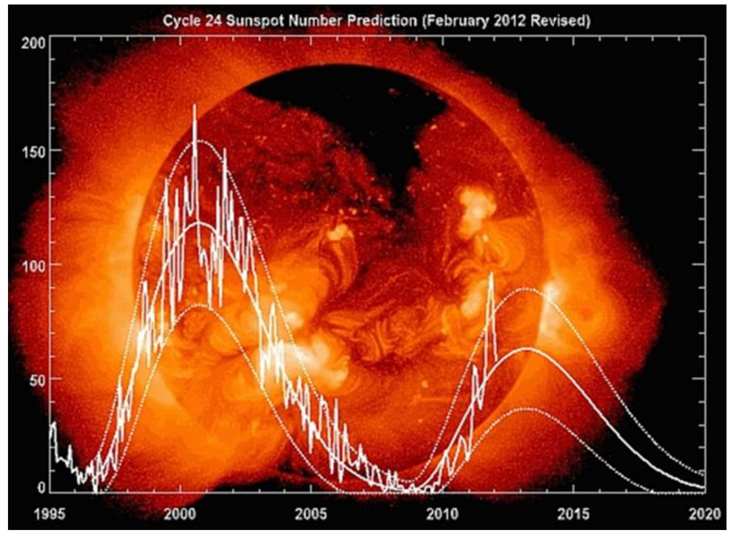

***Figure 8** – Sunspot cycle forecast*

ZSE CWSU's Role

At the request of the FAA, CWSUs are now required to routinely monitor SWPC forecasts. When an event reaches or is forecast to reach a level 3 or higher, the CWSU forecaster will alert the on-duty Operations Manager (OM) and the Service Operations Center (SOC) with pertinent information regarding the event, including any possible impacts to aviation in ZSE's airspace.

NOAA Scales Activity

NOAA Scale	Past 24 hours	Current
Geomagnetic Storms	G1	none
Solar Radiation Storms	S2	S3
Radio Blackouts	R5	none

***Figure 9** – NOAA Scales Activity from SWPC's aviation web page showing yesterday's and today's level of space weather activity.*