• Two Atmospheric Rivers (ARs) made landfall over the Pacific Northwest over the previous four days
• These events combined to produce >400 mm of precipitation in southern OR and northwest WA (R-Cat 3)
• Dry soil conditions resulted in absorption of high amounts of rain and large increases in soil moisture
Observed Precipitation

- Radar imagery shows widespread precipitation over the Pacific Northwest on 14–17 Oct 2016
- Severe convection on 14 Oct produced multiple tornadoes in OR and high winds across the region
- Throughout the period the PNW was impacted by several alternating periods of stratiform and convective precipitation


Provided by B. Kawzenuk
Observed Precipitation

Observed Precipitation 8:00 AM PDT 14 – 19 Oct 2016

<table>
<thead>
<tr>
<th>Location/Date</th>
<th>Record Daily Maximum Rainfall (inches) / prev. record (year)</th>
</tr>
</thead>
</table>
| Seattle-Tacoma Airport | Thursday, 10/13/16 1.76 / 0.76 (1988)  
                        | Friday, 10/14/16 1.36 / 0.77 (1990) |
| Olympia Airport     | Thursday, 10/13/16 1.61 / 0.56 (2014)  
                        | Friday, 10/14/16 2.01 / 0.99 (1956) |
| Hoquiam Airport     | Thursday, 10/13/16 2.5 / 1.18 (2014)  
                        | Saturday, 10/15/16 2.11 / (1.12 year) |

Provided by B. Kawzenuk and R. Weih
Significant precipitation occurred in the Lake Mendocino Watershed, but it did not lead to an increase in reservoir level.

<table>
<thead>
<tr>
<th>Rain Gauge</th>
<th>72-hr Precip (in.) 14-17 Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willits Howard</td>
<td>4.08</td>
</tr>
<tr>
<td>Potter Valley</td>
<td>2.71</td>
</tr>
</tbody>
</table>

The Northern Sierra 8-Station Index received >5 inches of precipitation, equivalent to ~10% of the normal water year precipitation.
### Weather conditions at Mary’s Peak, OR

#### Observed Conditions

<table>
<thead>
<tr>
<th>Location</th>
<th>Max Wind Gust (mph)</th>
<th>Time/Date</th>
<th>Lat/Lon/Elev. (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bellingham Airport</td>
<td>52</td>
<td>1139 PM 10/13</td>
<td>48.79N/122.54W/158</td>
</tr>
<tr>
<td>1 NNW Blanchard</td>
<td>61</td>
<td>0111 AM 10/14</td>
<td>48.61N/122.43W/1066</td>
</tr>
<tr>
<td>6 W Crystal Mountain</td>
<td>99</td>
<td>0600 PM 10/13</td>
<td>46.92N/121.64W/6900</td>
</tr>
<tr>
<td>3 SSW Crystal Mountain</td>
<td>87</td>
<td>1200 AM 10/14</td>
<td>46.88N/121.52W/6240</td>
</tr>
<tr>
<td>Crystal Mountain</td>
<td>85</td>
<td>1100 PM 10/13</td>
<td>46.94N/121.50W/6830</td>
</tr>
<tr>
<td>Crystal Mountain Nwac</td>
<td>85</td>
<td>1100 PM 10/13</td>
<td>46.93N/121.47W/4570</td>
</tr>
<tr>
<td>Sunrise Mt. Rainier Np</td>
<td>76</td>
<td>0900 PM 10/13</td>
<td>46.91N/121.64W/6420</td>
</tr>
<tr>
<td>2E Oceanside</td>
<td>103</td>
<td>0716 PM 10/13</td>
<td>45.47N/123.92W/1420</td>
</tr>
<tr>
<td>1 WNW Snoqualmie Pass</td>
<td>65</td>
<td>0200 AM 10/14</td>
<td>47.44N/121.44W/5470</td>
</tr>
<tr>
<td>Alpentaliski Area Nwac</td>
<td>65</td>
<td>0200 AM 10/14</td>
<td>47.44N/121.43W/3100</td>
</tr>
<tr>
<td>Snoqualmie Pass</td>
<td>65</td>
<td>0200 AM 10/14</td>
<td>47.42N/121.43W/3760</td>
</tr>
<tr>
<td>Mount Baker</td>
<td>87</td>
<td>0300 AM 10/14</td>
<td>48.85N/121.68W/5020</td>
</tr>
<tr>
<td>Mt. Baker Base Nwac</td>
<td>87</td>
<td>0300 AM 10/14</td>
<td>48.86N/121.68W/4210</td>
</tr>
</tbody>
</table>

**Wind gust >100 mph**

>60 mph winds from 400m to 5km

*Provided by A. Wilson*
Observed Conditions

Snow level >9000 ft for significant portions of the storm

500m snow level change 14 October after frontal passage

AR conditions sustained at CA coast for 24 hours
Impacts on Soil Moisture

The PNW saw >90 mm increase in soil moisture anomaly in one week.

Large portions of the U.S. West Coast show >35% soil moisture.

Data from NIDIS

Provided by A. Wilson
Streamflow Response

Large streamflow response along a broad region of coastal Washington, Oregon and California [image 3PM, October 17 from USGS real-time conditions]

Provided by B. Henn
Streamflow Response

Many rivers set daily flow records; some peak flows approached ~1 year return period. However, widespread damaging flooding did not occur (despite large precipitation accumulations) because of low antecedent soil moisture and streamflow in the region.

Rivers generally did not exceed warning or flood stage.

Prior flows near average for mid-October.

Flow increased from 2,000 to >30,000 cfs.

Daily records exceeded.

Large streamflow response along a broad region of coastal Washington, Oregon and California [image 3PM, October 17 from USGS real-time conditions].
Forecast Errors

GFS forecast trend indicated a closer trajectory onshore as lead time decreased

Forecast shifting south

4 day lead time

3 day lead time

2 day lead time

1 day lead time

Northerly track kept strongest winds to the north and offshore of Washington

Several model forecasts of storm center initialized on 15 Oct 2016

Actual storm trajectory

Credit: NWS Seattle Facebook

Provided by R. Weihs
Comparison on WPC QPF issued 1200 UTC 14 Oct 2016 to Stage IV 72-h QPE 1200 UTC 14-17 Oct 2016

- Many mountainous areas were slightly under forecasted while low-lying valley areas were over forecasted.
- Southern CA coast under forecasted up to 2 in.
- Maxima over the N. Sierra Nevada and Coastal Range near the OR/CA border were accurately forecasted.
- Considering the extreme nature of this event, precipitation amounts and locations were overall well forecasted for the Western U.S.

Provided by B. Kawzenuk
Storm Summary

- Two back to back ARs impacted the Western U.S. over the weekend of 14-17 October 2016
- Precipitation >400 mm occurred in some locations, and snow accumulations at high elevations both on the coast and inland (up to 18” according to NWS Reno)
- Wind gusts were as high as 103 mph, with sustained winds 20-40 mph

Tillamook County Pioneer, EF-2 tornado damage in downtown Manzanita, OR 14 Oct

Seattle, WA (@KSeattleWeather, 15 Oct)

Fife, WA (@MattLorchQ13FOX, 15 Oct)

Olympia, WA (@Q13FOX, 15 Oct)

Provided by A. Wilson