Weather and Climate Summary and Forecast

Winter 2016-17

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After the past two Decembers, where temperatures over most the western US were much warmer than average, December 2016 brought generally cool to cold conditions. This was especially evident across the PNW and into the northern Rockies and Great Plains, where up to now, the winter had been very warm (Figure 1). The temperature pattern over the west for December 2016 shows a largely near normal to warmer than normal central to southern California across the southern Great Basin and into the desert SW where temperatures were 0.5-4.0°F above average (Figure 1). Across the PNW and northern Rockies temperatures ranged from 2-6°F below normal. After a November that was wet along the coast and into the desert SW, but dry elsewhere, December flipped with a drier than normal coastal zone and wetter in the Great Basin (Figure 1). Nationwide the southern tier of the US and up along the eastern seaboard was near normal to substantially warmer than normal, while portions of the Midwest and Great Plains were generally cooler than normal (not shown). The main difference between November and December was a shift of the coldest polar air masses from Siberia across into northern Canada allowing cold air to fill down over the PNW and northern states during December. Precipitation amounts nationwide were mixed with the Great Basin, northern Plains, south Texas and the southeast seeing mostly greater than normal amounts. In addition to the west coast, drier than normal regions were seen in the southern Plains and into the northern Ohio River valley and across central Florida (not shown).

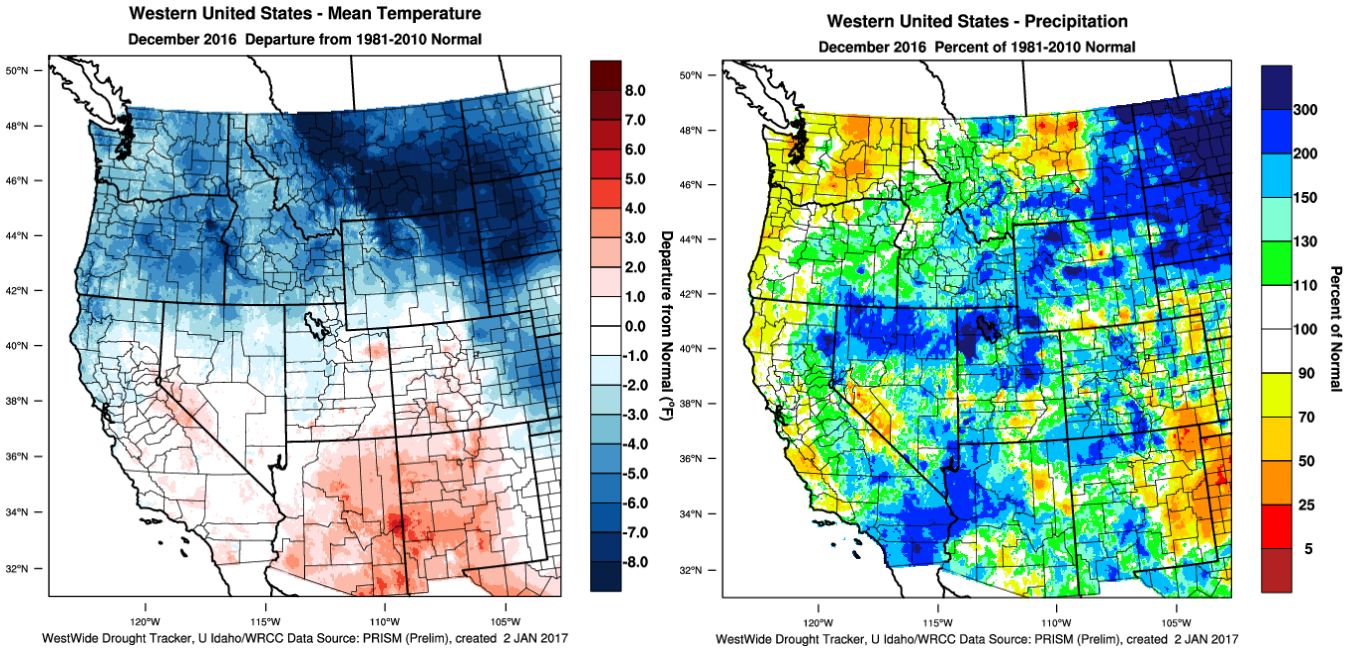

Figure 1 – Western US December 2016 temperature departure from normal (left) and percent of normal precipitation (right; images from WestWide Drought Tracker, Western Region Climate Center; University of Idaho).

Even with a moderately cold December for a large part of the western US, the region ended the year warmer than normal (Figure 2). Preliminary data shows that the average temperatures for 2016 for the western US will end up 0.5-2.5°F or more above the 1981-2010 climate normals for California, Oregon, Washington and Idaho. Nationwide the lower 48 states ended up being 1-4°F above normal (not shown), and the NCDC has already reported the US will end up with a top five annual temperature record for the year. Western US precipitation for 2016 ended up with areas from central California, along coastal Oregon, throughout Washington, and from NE Nevada into the northern Plains seeing 110-170% of normal (Figure 2). Dry conditions (50-80% of normal) continue to hold across eastern Oregon into southwestern Idaho and eastern Montana along with Southern California, across the southwest, and up into western

Colorado. For the rest of the US, drought conditions continued in Oklahoma, the piedmont region of the southeast, and up into New England with 50-90% of normal precipitation (see drought conditions below). Wetter than average conditions for the year (110-150% of normal) were experienced across most of Texas, into the upper Midwest and Great Plains, and along the southeast coast and Florida (not shown).

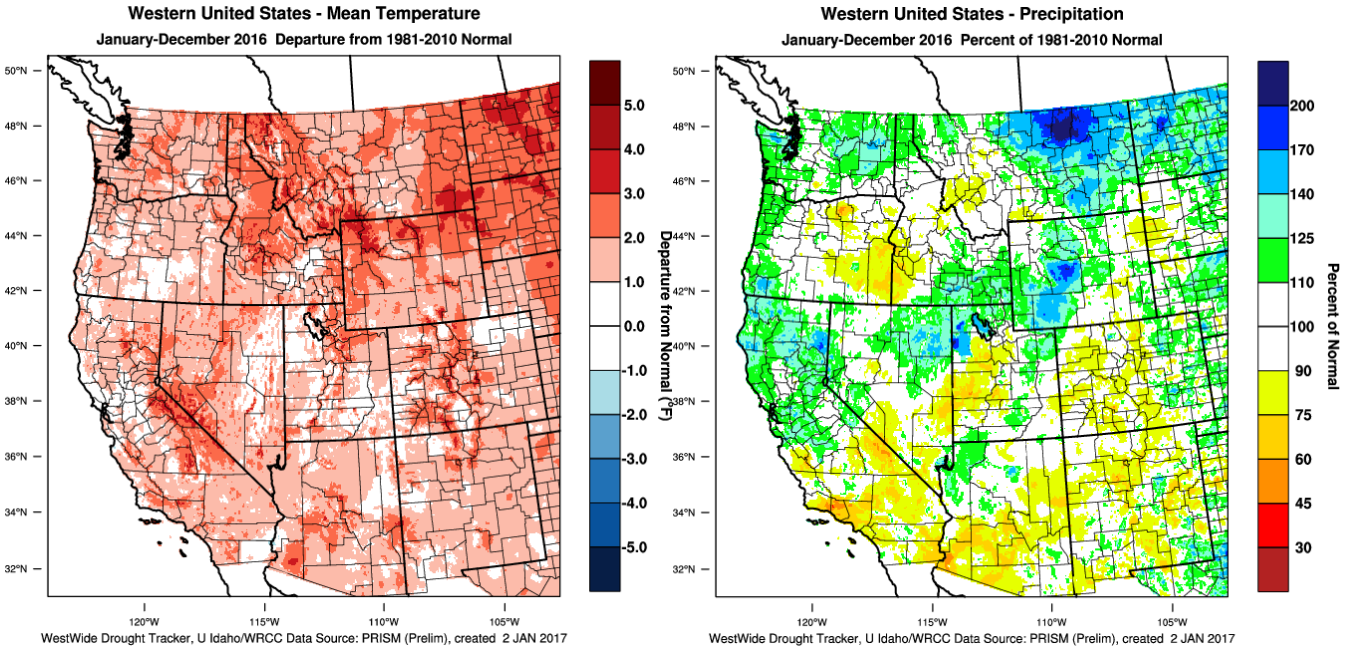

Figure 2 – Western US January-December 2016 temperature departure from normal (left) and percent of normal precipitation (right; images from WestWide Drought Tracker, Western Region Climate Center; University of Idaho).

Drought Watch – The most recent Drought Monitor brings some welcomed changes. While the drought continues in Central to Southern California, across New England and the southeast, the overall extent and intensity of the drought conditions as lessened in each area (Figure 3). For the western US the big change is the lowering and even removal of drought conditions from portions of Northern California throughout the majority of the PNW. The US seasonal drought outlook (Figure 3) forecasts that the driest regions that remain in California and Arizona will likely persist through the end of March, while drought removal/recovery is likely to expand across northern California, eastern Nevada and eastern Oregon.

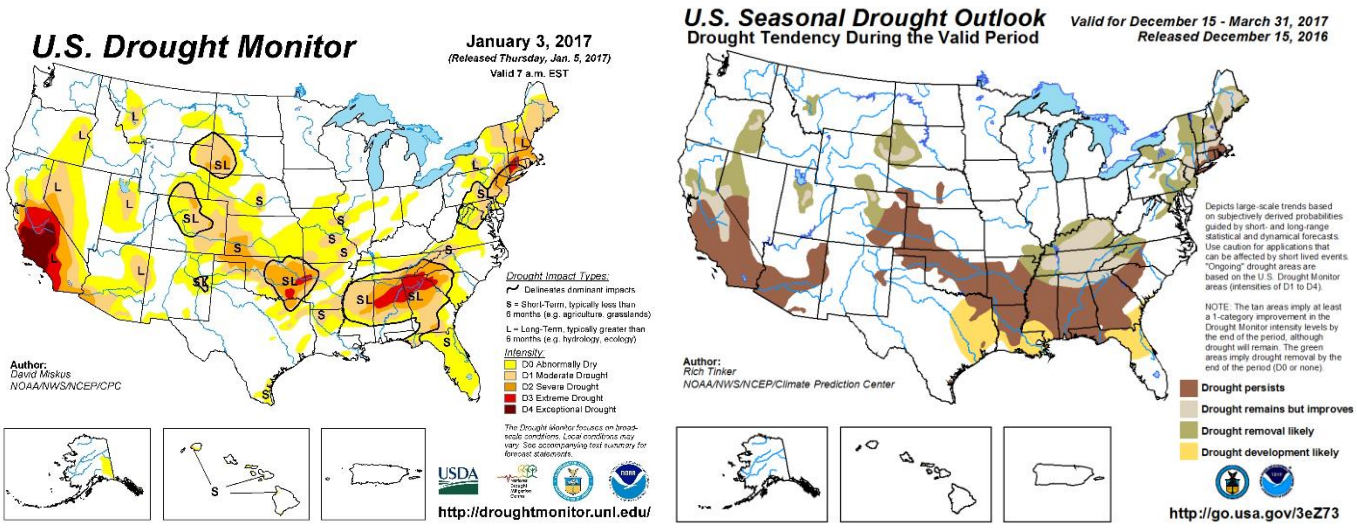

Figure 3 – Current US Drought Monitor and seasonal drought outlook.

La Niña Watch – The Tropical Pacific continues to exhibit moderate La Niña conditions. The cool and relatively wet PNW has shown the typical signs of a La Niña winter, including the recent cold and snow event during the first few days of January. The main difference from a typical La Niña winter and what we are seeing now is that more moisture is extending further south into California and even into the desert southwest than what is normally seen. Given the current atmospheric and oceanic conditions (Figure 4), along with model forecasts, the forecaster consensus favors the continuation of weak La Niña conditions through January-February-March with waning conditions to neutral afterward. If the forecasted conditions hold true, the statistical forecast would favor the next few months to be warm and dry across the southern half of the US; wet and cool to cold in the north (see forecast periods below and Appendix Figure 1). However, as mentioned here previously, conditions in the North Pacific have already and will likely continue to play a more prominent role for our winter (see below).

North Pacific Watch – The North Pacific has continued its considerable cooling (Figure 4). Sea surface temperatures (SST) across the North Pacific show a tongue of cooler than normal waters extending nearly all the way to the west coast of the US. This region has seen the SST cool over 5°F during the past 12 months. Cooler waters in the North Pacific are tied to the positive phase of the Pacific Decadal Oscillation or PDO, a large-scale, long-term climate variability mechanism in the North Pacific Ocean that is closely associated with El Niño-La Niña cycles. The current conditions show a North Pacific that is slightly out of phase with the Tropical Pacific, but much cooler than anything we have seen over the last decade or so. There is little historical analog to the current conditions, but given the extent and magnitude of the cooling in the North Pacific and a weak La Niña I would continue to expect a relatively cool to cold and wet PNW into Northern California and a moderately dry and slightly warmer than normal southern California extending across the desert southwest. The observed extension of the cool waters all the way to west coast would point to a greater chance for a cool and late spring.

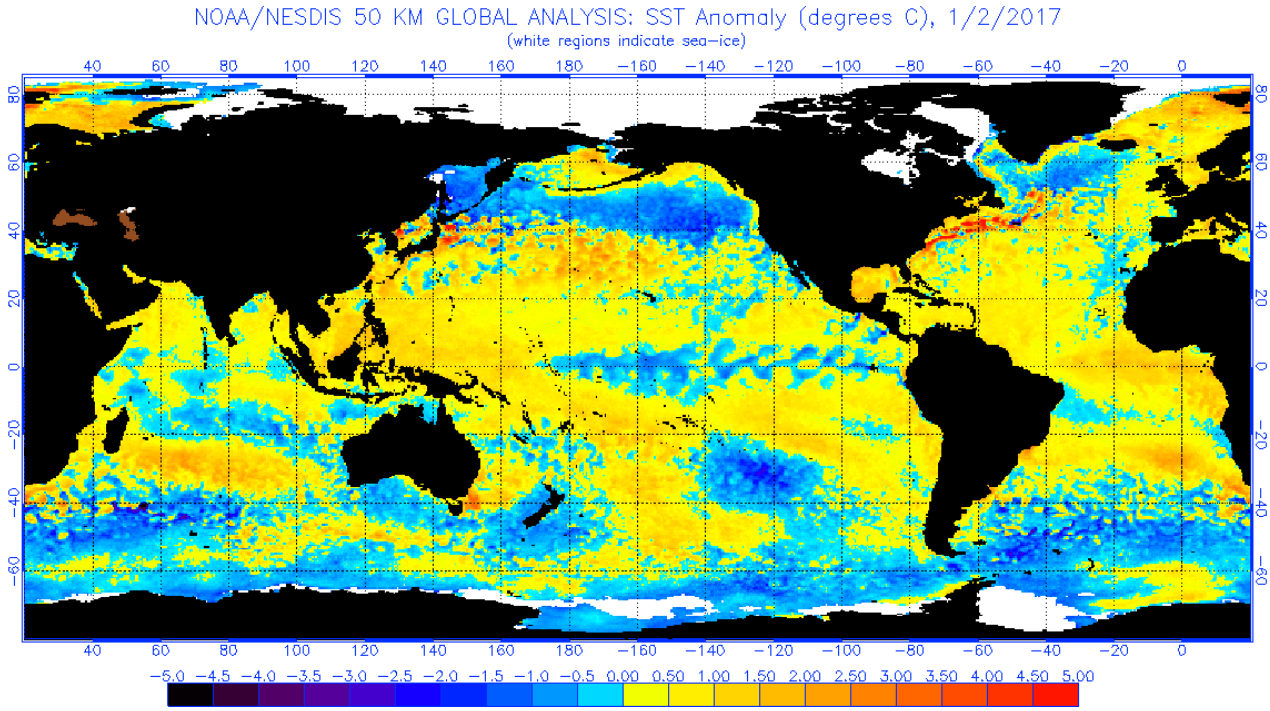

Figure 4 – Global sea surface temperatures (°C) for the period ending January 2, 2017 (image from NOAA/NESDIS).

Forecast Periods:

6-10 Day (valid Jan 10-14): The coldest air of the winter will likely continue to flow down over the majority of the northern tier of the western United States from the PNW to Minnesota. The core of the cold air will continue to be substantially below normal over this region. The rest of the US from Southern California across the southern states and into New England is forecasted to have a high likelihood of being moderately to substantially above normal temperatures. The main storm track is expected to continue the above average precipitation amounts from central

California into the PNW and across into the Great Basin. This pattern is the result of the so-called 'atmospheric river' of moisture taking aim at the west coast over the period. Above average precipitation is also forecasted for the Great Lakes and into New England, while Texas and the Gulf Coast into Florida has a high likelihood of being dry.

8-14 Day (valid Jan 12-18): General forecast pattern does not change much from the 6-10 day period. Cooler than normal forecasted across the PNW and northern Rockies. Warmer than average forecasted everywhere else with the highest above average zones shifting to the southeastern US. The precipitation forecast during this period continues the high likelihood of a wet western US (onshore flow of moisture continues its aim at central California) across to the Great Lakes and New England, while the Gulf Coast and Florida will likely remain dry.

30 Day (valid Jan 1-31): For the western US the 30 day forecast for the month of January is dominated by the cold conditions that currently exist and will likely continue through the third week of the month. A broad area of a high likelihood of having below average temperatures is forecasted for the PNW across the Northern Rockies and into central California and the Great Basin (see Appendix Figure 1). Much of the central US and intro the Great Lakes has an equal chance of being slightly above to slightly below normal temperatures while the Gulf Coast, Florida and the eastern seaboard is forecasted to be warmer than normal. The January precipitation forecast follows the general pattern out in the 8-14 day forecast with a high likelihood of wetter than average conditions across much of the west but with California having an equal chance of being slightly above to slightly below normal precipitation (see Appendix Figure 1). Portions of Texas and Florida are forecasted to have a higher likelihood of being drier than normal while the southeast is forecast to be wetter than normal.

90 Day (valid Jan-Feb-Mar): The long lead forecast for the second half of winter (January-February-March; JFM) from the CPC continues the general conditions from the 30 day forecast. Namely a cooler than average northern PNW across the northern Rockies and into the northern Plains and western Great Lakes (NOAA's Climate Prediction Center, see Appendix Figure 1). Northern California and Oregon across the central Rockies, Plains, and into the Great Lakes are forecast to have an equal chance of being slight warmer to slightly cooler than average, while the southern tier of the country and up into New England is forecast to be warmer than normal. The JFM precipitation forecast is holding to a likely higher than average rain/snow amounts across the northern states and into the Great Lakes. The southern tier of states is forecasted to remain drier than average while areas in between are forecasted to have an equal chance to be slightly above average, normal, or slightly below average precipitation.

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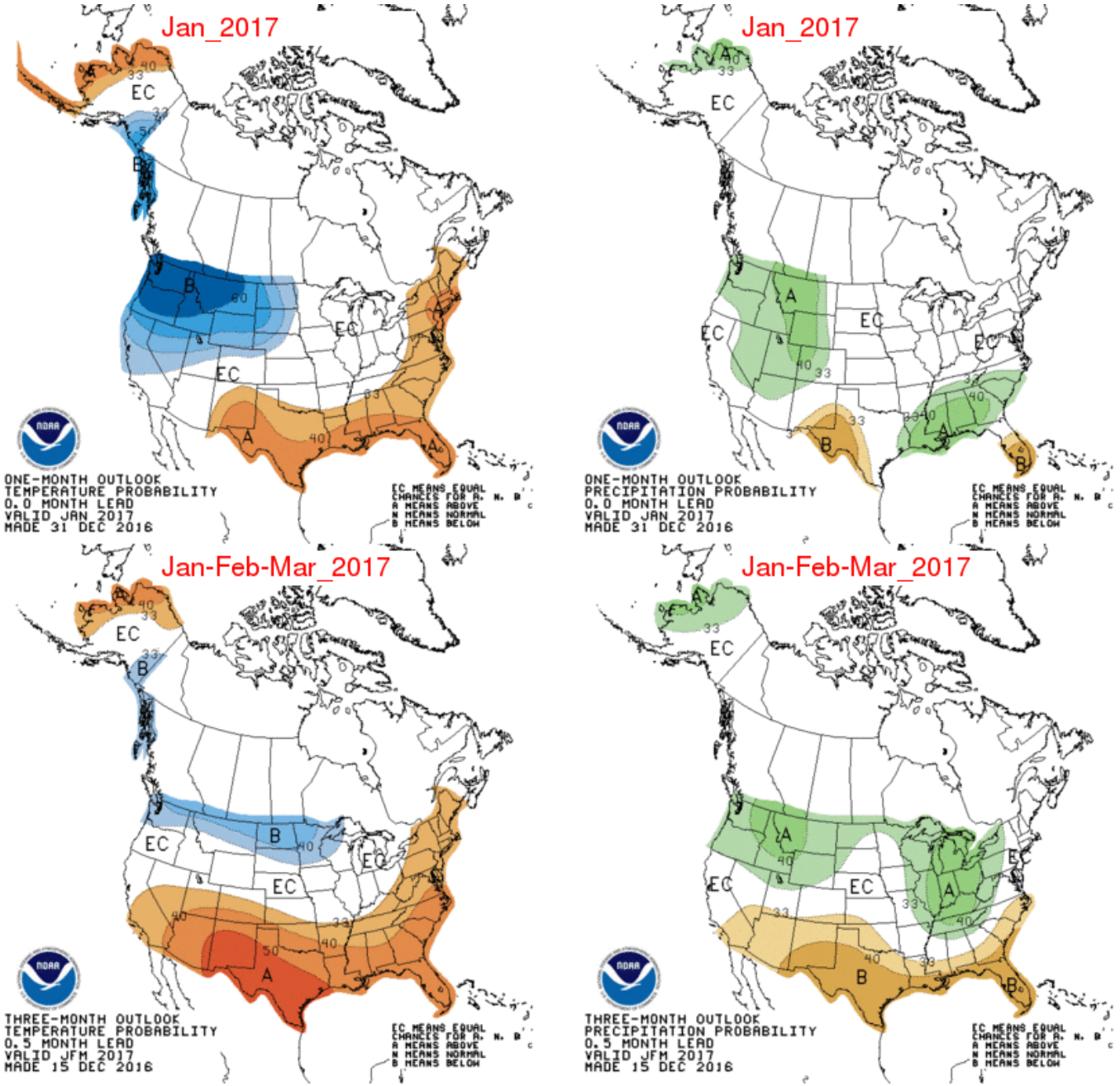

Appendix Figure 1 – Temperature (left panel) and precipitation (right panel) outlooks for the month of December (top panel) and December, January, and February (bottom panel) (Climate Prediction Center, climate.gov).