Vintage 2018
North Willamette Valley

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Summary:
A relatively mild and dry winter set the stage for a 2018 growing season that was highlighted by a cool spring, a summer with low heat stress but high drought stress along with numerous regional fires, and a glorious October. The moderately cool spring led to a late start to the growing season with an average bud break of April 17th delayed by 5-10 days compared to average. However, a warm May through August brought plant growth timing to near average to slightly ahead of average in the region (average bloom June 12th, véraison August 15th and harvest September 29th). The 2018 vintage ended with growing degree-day totals that were above average, but lower than the previous four vintages in the North Willamette Valley. The vintage saw a few mild frosts during early April, a warm and mostly dry bloom period, experienced a string of 60-90 days or more without precipitation during the middle of the summer, and had a prolonged harvest period from very beneficial weather conditions in October. Overall the growing season saw substantially lower heat stress (compared to the last few vintages) but greater drought stress compared to average.

Background:
This vintage summary is derived from weather and phenological observations from twelve locations across the north Willamette Valley. The locations include one in the Chehalem Mountains AVA, three in the Dundee Hills AVA, four in the Eola-Amity Hills AVA, two in the Yamhill-Carlton AVA, and two in the Willamette Valley AVA. The locations average 529 ft. in elevation, ranging from 205 ft. to 841 ft. Additional comparisons are made with the long-term McMinnville weather station located at the McMinnville Municipal Airport (157 ft.), and other stations in other growing regions in Oregon.

Climate:

PNW Assessment
Following a relatively cool and wet March in the PNW, early April brought near average precipitation but cooler than average temperatures. As a result, a later than average bud break was reported in most regions in the PNW. A warm late April, with a record high temperature of 84°F on April 25th at the McMinnville station, started off a period five months of mostly warmer than average temperatures with May being +3.1°F warmer than average for McMinnville. The warm May caught plant growth up to near average conditions in most regions in the PNW. May was the last month that the McMinnville station and the region saw above average precipitation the rest of the year. Across the west many locations saw 70-120 days or more without any precipitation from mid-May through mid-September. The warmer mid-summer conditions produced véraison that was near average for most regions in the PNW. While the summer was warmer than normal, the overall signature was fewer extremes. The McMinnville station reported 20 days over 90°F but only 8 days over 95°F, and no days over 100°F (summer maximum of 98°F on July 15th and 29th). In addition, there were no record maximum temperature events at the

McMinnville station. The warmest periods during the growing season occurred during early May, mid-June, and early July to early August in the PNW. September 2018 started off relatively warm, then cooled off during the middle of the month during a week-long stretch with 1-3" of precipitation in the region. Ultimately September ended up slightly below average in terms of temperatures (-1.5°F at McMinnville) and near average in overall rainfall. Harvest in 2018 across the PNW started similar to what was seen in 2017, but slightly later than the 2013-2016 vintages with the first picking reported in early September. The bulk of the harvest came in from the last couple of days in September through mid-October. A relatively warm (+2.4°F at McMinnville) and largely dry early October allowed for a relatively slow progression through to the end of harvest.

Overall the growing season daily temperature departures observed at the McMinnville weather station were cooler than the 2014-2017 vintages but 1.5°F warmer than the 1981-2010 climate normals. All four main wine growing regions in Oregon were warmer than normal, ranging from 1.4 to 2.3°F above average during April-October. The substantially drier conditions during the dormant period (5-15" below average), continued into the growing season. The McMinnville station totaled 10.8" during the growing season which was 21% (2.8") below average for the location. But was even more extreme when the majority of the season total (72%) came in the first two weeks of April and last 10 days of October.

From a growing degree-day (GDD) standpoint spring heat accumulation in the PNW started off near average but much lower than the very warm springs in the last few years. However, by early May the spring ended up being above the accumulation during the 2015 spring which held until early June. From mid-June on heat accumulation tracked above the 1981-2010 climate normals. The relatively cool conditions in early to mid-September slowed heat accumulation, but it picked back up in the warmer than average October ending the growing season total for McMinnville of 2317 GDD (5% up). Compared to other locations statewide, McMinnville ended up with the lowest heat accumulation compared to state's four main wine producing regions (Roseburg 3164, Milton-Freewater 3417, and Medford 3457).

North Willamette Valley Assessment

For the 2018 vintage, site temperature data from the twelve vineyards exhibited an average GDD of 2372 with a standard deviation of 176 units (Table 1). Maximum accumulation was 2618 GDD while the minimum was 2069 GDD. Growing season temperatures averaged to 60.7°F across the sites while maximum temperatures averaged 73.1°F and minimum temperatures 50.2°F. The site variation in average minimum temperatures (5.1°F) was twice that of average maximum temperatures (2.5°F) and was mostly due to elevation differences which affected minimums more than maximums. In terms of heat extremes there were 17 days on average with temperatures over 90°F across these sites, however only six days on average with temperatures over 95°F. The hottest days of the year were over mid to late July and mid to late August with the majority of sites being over 90°F nearly every day. The highest vineyard average maximum of 97.8°F and absolute maximum of 99.9°F was observed on July 29th.

The coldest nights observed at these sites during the 2018 growing season occurred in the first few days of April with temperatures dipping down to 29.9-34.6°F. Overall, there were only a few locations with temperatures below freezing during the growing season, occurring both in early April and mid-October. As such the median last frost in the spring at these sites occurred March 23rd with the latest on April 3rd (Table 1). Many sites did not see a fall frost until early November resulting in a median first date of November 9th while the earliest was October 18th. The resulting frost-free period median at these sites was 231 days in 2018, ranging 33 days from the shortest to the longest.

Precipitation during the growing season at these sites averaged 9.1”, varying from a low of 6.7” to 11.0” (Table 1). The highest daily precipitation total of 1.8” was observed on April 7th when each site recorded 0.7” or more during a two-week period when nearly half of the season’s rainfall occurred (Figure 1, Table 1). Other notable periods with precipitation include June 8-11 with 0.76”, September 10-16 with 0.78”, October 5-8 with 0.39”, and October 25-31 with 2.26” (Figure 1). Of the 214 days between April 1st and October 31st there were on average 167 days without rain, 35 with precipitation amounts less than 0.25” and 12 days with precipitation amounts greater than 0.25” (Table 1). On average, these sites experienced 86 consecutive days without measurable precipitation during the 2018 growing season.

Table 1 – Weather and climate characteristics from twelve vineyard locations in North Willamette Valley for the growing season (April 1-October 31, 2018). Growing degree-days are calculated with a base of 50°F with no upper cut-off.

Growing Season (Apr 1 – Oct 31)	***Average-Median***	***Standard Deviation***	***Maximum***	***Minimum***	***Range***
Growing Degree-Days	2372	176	2618	2069	549
Growing Season Average Temperature (°F)	60.7	0.8	61.9	59.3	2.6
Average Maximum Temperature (°F)	73.1	0.8	74.4	71.9	2.5
Absolute Maximum Temperature (°F)	97.8	1.5	99.9	95.1	4.8
# of Days > 95°F	6	3	10	1	9
Average Minimum Temperature (°F)	50.2	1.8	52.1	47.0	5.1
Absolute Minimum Temperature (°F)	32.5	1.3	34.6	29.9	4.7
# of Days < 32°F	0	0.9	3	0	3
Median Last Spring Frost (date or days)	3/23	5 days	4/3	3/23	11 days
Median First Fall Frost (date or days)	11/9	6 days	11/9	10/18	22 days
Median Frost Free Period (days)	231	10 days	231	198	33
Total Precipitation (inches)	9.09	1.4	10.95	6.65	4.30
Highest Daily Total (inches)	1.17	0.3	1.74	0.66	1.08
Number of Days Without Precipitation (days)	167	5	177	161	16
Number of Days With Precipitation < 0.25” (days)	35	6	43	26	17
Number of Days With Precipitation > 0.25” (days)	12	2	15	8	7

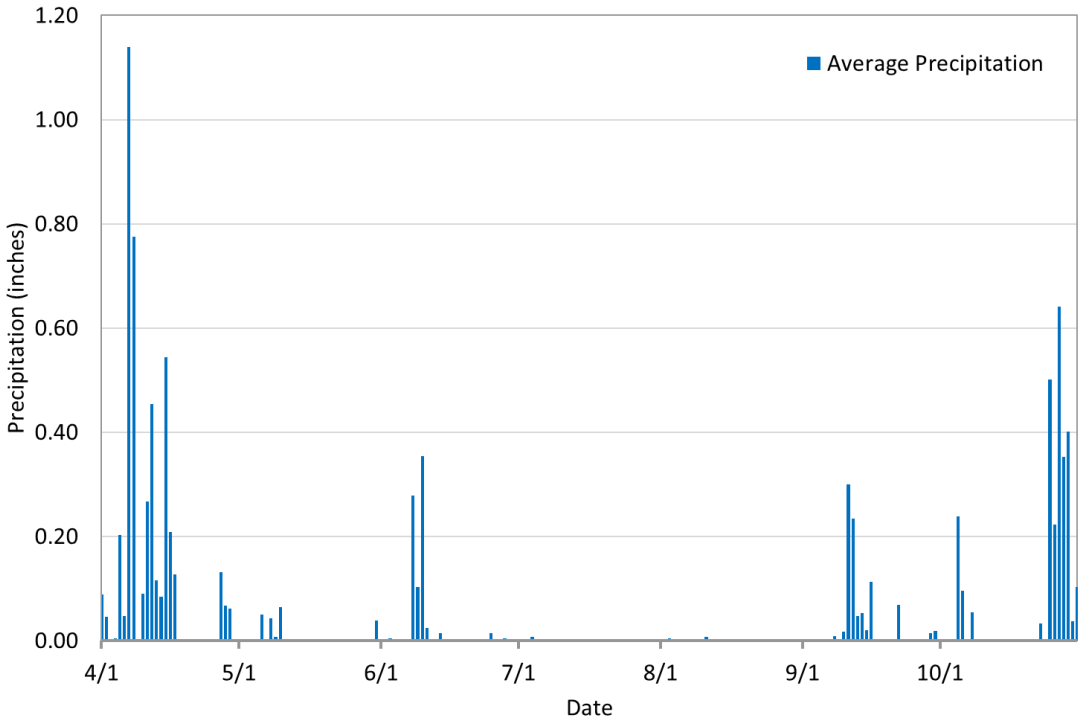

Figure 1 – April through October precipitation averaged across the twelve vineyard sites.

Comparison to the McMinnville Station

Compared to the long-term station at the McMinnville airport, which had 2317 GDD, the twelve locations representing a range of elevations across five AVAs averaged 2372 GDD. Figure 2 shows that the average GDD accumulation at the twelve sites (red line) is similar to the McMinnville airport location (black line). Figure 2 also shows that the three cooler sites had 2018 GDD totals that were similar to slightly less than the 2203 GDD for the 1981-2010 climate normals for the McMinnville station. Figure 3 shows the same degree-day data but, instead of cumulative as in Figure 2, it gives the daily accumulation values. As is common in most springs, 2018 saw wide swings in heat accumulation during April through June, with the warm May the most evident departure in Figure 3. Leading up to flowering there was a period of cool and highly variable conditions that resulted in near average heat accumulation. The rest of the growing season saw mostly average to greater than average daily accumulation, especially in mid-July through mid-August, until the significant drop off in the middle of September. The daily GDD accumulation in Figure 3 also shows that individual sites (gray lines) deviate slightly on both the higher and lower ends of the McMinnville airport station values. Figure 4 shows GDD at the McMinnville airport from 1999 to 2018, showing that 2018 is most similar to values observed in 2003 and 2012 and intermediate to the coolest vintage (2010; 1853 GDD) and the warmest vintage (2014; 2858 GDD) during this time period. It should be noted that the 2014 vintage is the warmest since data records have been kept for the McMinnville weather station, but that 2010 was near the climate normal average and moderately warmer than the majority of the vintages during the 1980s and 1990s.

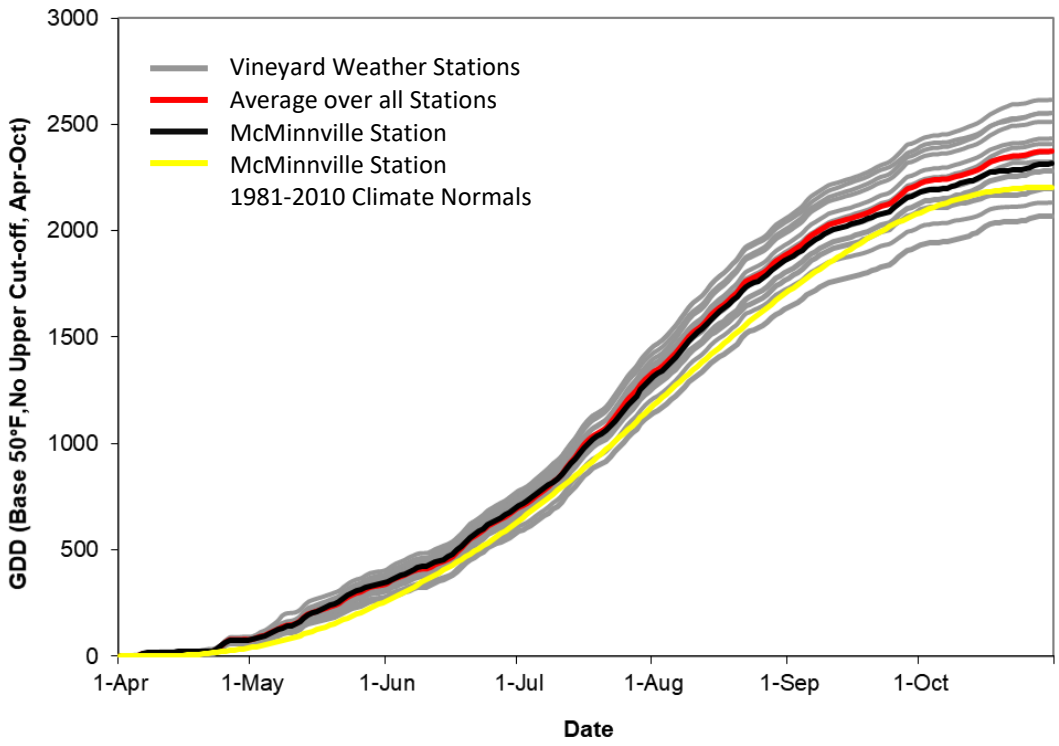

Figure 2 – Growing degree-day accumulation during April-October 2018 from each of the vineyard weather stations (grey lines), the average over all vineyard weather stations (red line), and the McMinnville Airport weather station (black line). The long-term average (yellow line) is from the 1981-2010 climate normals for the McMinnville weather station. Calculated from daily Tmax and Tmin observations for April 1st through October 31st using a base of 50°F with no upper cut-off.

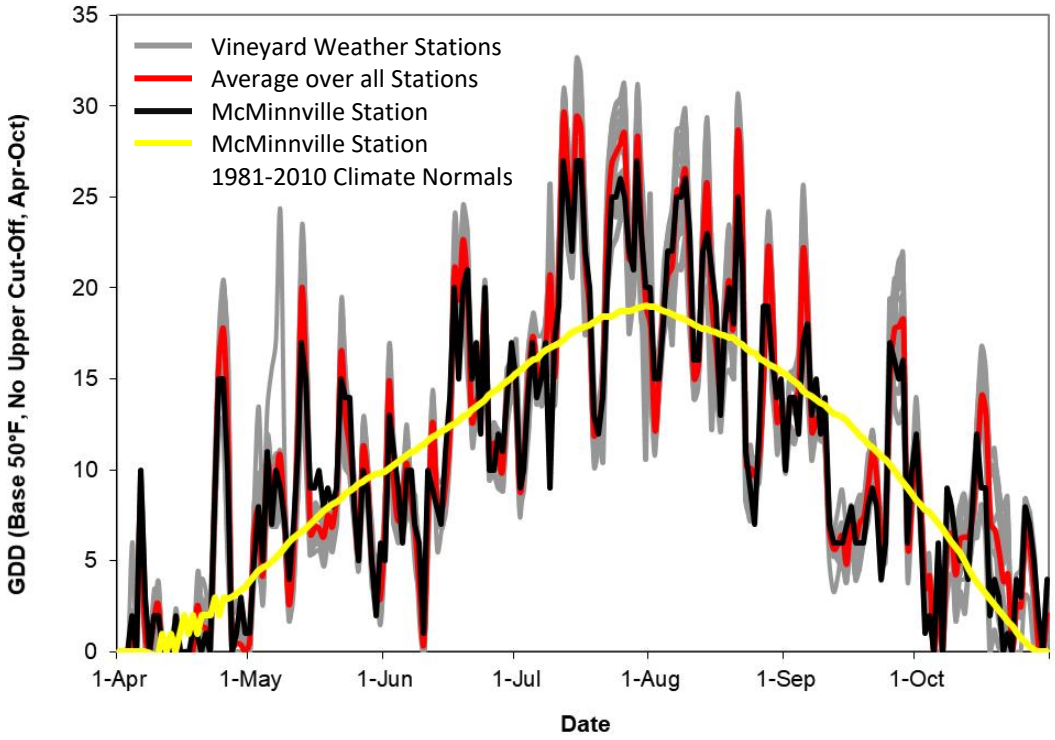

Figure 3 – Same data as in Figure 2, but shown as daily growing degree-day values during April-October 2018 from each of the vineyard weather stations (grey lines), the average over all vineyard weather stations (red line), and the McMinnville Airport weather station (black line). The long-term average (yellow line) is from the 1981-2010 climate normals for the McMinnville weather station. Calculated from daily Tmax and Tmin observations for April 1st through October 31st using a base of 50°F with no upper cut-off.

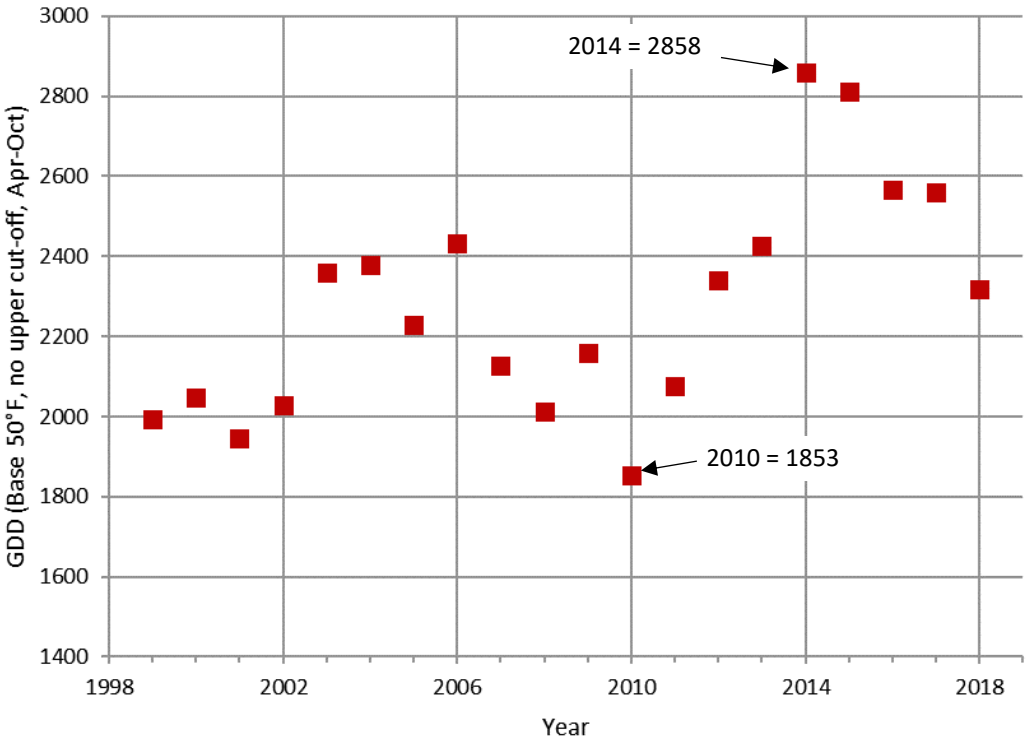

Figure 4 – Growing degree-days amounts for the 1999-2018 vintages at the McMinnville weather station. During the twenty years in this chart, 2014 was the highest GDD accumulation while 2010 was the lowest GDD accumulation. It should be noted however, that 2010 was near the average from the 1981-2010 climate normals for the McMinnville weather station. Calculated from daily Tmax and Tmin for April 1st through October 31st using a base of 50°F with no upper cut-off.

Precipitation amounts for the growing season (April through October) ended up at 10.8" at the McMinnville station while averaging 9.1" at the vineyard sites. The season saw a similar pattern of rainfall region-wide with McMinnville experiencing two record events in April, 0.86" on the 7th and 1.44" on the 8th, which compares to the vineyard site maximums on those days of 0.93" and 1.74" respectively. During the early June events, the McMinnville station recorded slightly more precipitation than the vineyard sites, however during the mid-September events the vineyard sites recorded moderately more than the McMinnville station. Due to a few trace precipitation events in the summer, the McMinnville only recorded 64 days without measurable precipitation during the 2018 growing season while the vineyard sites averaged 86 days.

For temperature extremes, the McMinnville station experienced a record high of 84°F on April 25th while these vineyard sites ranged from 78-85°F. there were 17 days on average with temperatures over 90°F across these sites, compared to 20 at the McMinnville station. The highest vineyard average maximum of 97.8°F and absolute maximum of 99.9°F was observed on July 29th when the McMinnville station recorded a high of 98°F.

The coldest nights observed at these vineyard sites during the 2018 growing season occurred in the first few days of April with temperatures dipping down to 29.9-34.6°F, which coincided with the McMinnville overall minimum temperature of 29°F on April 3rd. A similar occurrence and timing of fall minimums were seen at both the vineyard sites and the McMinnville as well. The result was virtually identical first and last dates of frost and the length of the frost-free season between the vineyards and the regional weather station at McMinnville.

Phenology:

Phenology was observed at each of the locations with bud break, bloom, and véraison record at 25% occurrence and harvest as the date that picking started for each location. Summarizing the phenological observations for the locations and averaged across all varieties shows an average bud break of April 21st (Table 2), however, the observations show a two week range across sites, reported as early as April 10th and as late as April 24th. The average date of flowering was June 12th with two weeks between the earliest (June 4th) and latest (June 18th) sites. Véraison and the start of the ripening phase during 2018 occurred over a 14-day period during early to mid-August (average August 15th). The earliest véraison was observed on August 7th while the latest was observed on August 21st. Harvest ranged over a 20-day period from September 19th to October 8th across the sites with an average date of September 29th (Table 2).

Average intervals between phenological events shows that bud break to flowering during 2018 had an average interval across these sites of 56 days; that flowering to véraison was 65 days on average; and that véraison to harvest was 45 days on average (Table 2). These intervals had 3 to 6-day standard deviations across sites, but a wide range between the shortest and longest intervals due to site elevation/temperature differences. For 2018, the length of flowering to harvest averaged 110 days while the length of the bud break to harvest period averaged 167 days with 16 days between vineyard sites with the shortest and longest intervals.

Table 2 –Phenological date (25% occurrence) and interval characteristics for the 2018 vintage averaged over all sites and varieties.

Event/Interval	*Average*	*Standard Deviation*	*Latest or Longest*	*Earliest or Shortest*
Bud Break	April 17	3 days	April 24	April 10
Flowering	June 12	3 days	June 18	June 4
Véraison	August 15	3 days	August 21	August 7
Harvest	September 29	6 days	October 8	September 19
Bud Break to Flowering	56 days	3 days	63 days	48 days
Flowering to Véraison	65 days	3 days	71 days	57 days
Véraison to Harvest	45 days	6 days	53 days	34 days
Flowering to Harvest	110 days	6 days	120 days	102 days
Bud Break to Harvest	167 days	6 days	173 days	157 days

Current Conditions:

The warmer conditions during the past five vintages (2012-2018) throughout the western US has been linked to a moderate rebound in sea surface temperatures over both the North and Tropical Pacific Ocean. However, the winter of 2017 through much of 2018 was characterized by La Niña conditions (cooler tropical sea surface temperatures) which contributed significantly to the slightly cooler conditions, and moderately to the drier conditions seen across the west. We also continue to see more variability in both ocean temperatures and the atmosphere. Given this backdrop and the current conditions, what does the 2018-19 winter and the spring of 2019 hold for the western US and the North Willamette Valley?

Signs of El Niño development continue as we progress further into winter with east-central tropical Pacific SSTs warming to El Niño levels. Both surface and subsurface waters also continue to be markedly warmer than average, however, the atmospheric variables over the region have shown mainly ENSO-neutral patterns. Only lower-level wind anomalies averaged weakly westerly in the eastern Pacific provide a suggestion of El Niño conditions in the atmosphere. The official Climate Prediction Center (CPC) outlook calls for an 80% chance of El Niño prevailing during winter, and a 55-60% chance of continuing into spring 2019. As such the CPC has indicated that an El Niño watch is in effect. New forecasts of statistical and dynamical models also collectively show ongoing El Niño-level SSTs, most likely weak to moderate in strength, continuing through spring. If these conditions for El Niño development continue to hold, the weather across the PNW and the northern tier of states is forecast to be warmer than average and near average to drier than average, while central to southern California across the southern tier of states is forecast to see near average temperatures and higher than average precipitation.

Forecasting conditions during the late winter and into spring of 2019 will depend on how the dynamic patterns of sea surface temperatures in the Pacific play out and how the Tropical to Arctic circulation of the atmosphere responds. Another area to watch is the North Pacific and the Gulf of Alaska as the ocean continues to warm to record levels with the upper 300 ft. of the North Pacific Ocean north of 40°N now warmer (relative to normal) than at any time in the modern data record (1980-present). The current North Pacific sea surface temperatures (SSTs) have had a strong influence over our fall and start of winter conditions, but the spatial pattern is not quite what we saw with the 'Blob' in 2012-2016 as the bulk of the warmth is a little further to the west. Most observation networks believe that the warming

North Pacific will likely interact with the warming Tropical Pacific (see above) to enhance the normal weather/climate patterns in the west during El Niño years. The evidence currently would point to a warmer than average spring, like what we experienced in 2014-2016. As ocean and atmospheric conditions unfold over the next 2-3 months, we will have a much better picture of what the spring of 2019 will bring to Oregon and the rest of the western US. Further updates will be provided as more information becomes available.

Acknowledgements
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