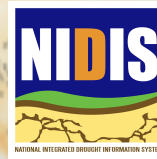


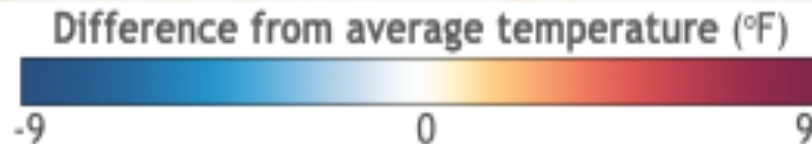
California-Nevada Drought & Climate Outlook

Amanda Sheffield
NOAA/NIDIS

September 25, 2017

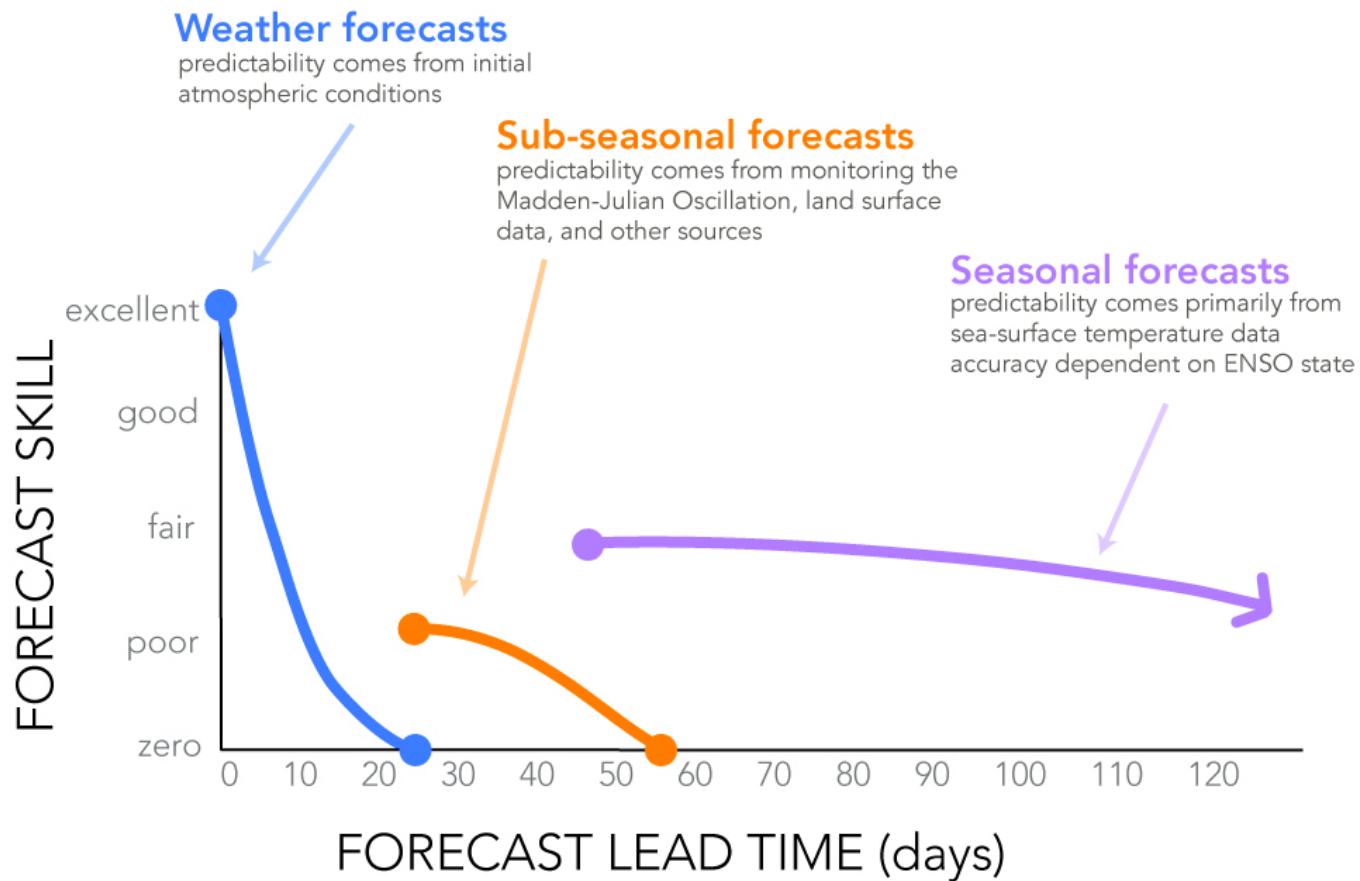


August 2017
compared to 1981-2010



Climate.gov/NNVL
Data: Geo-Polar SST

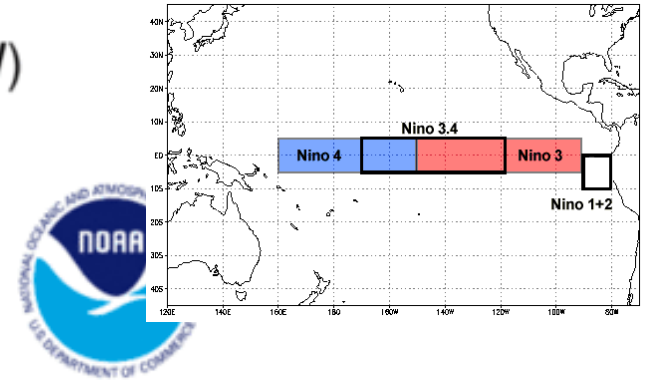
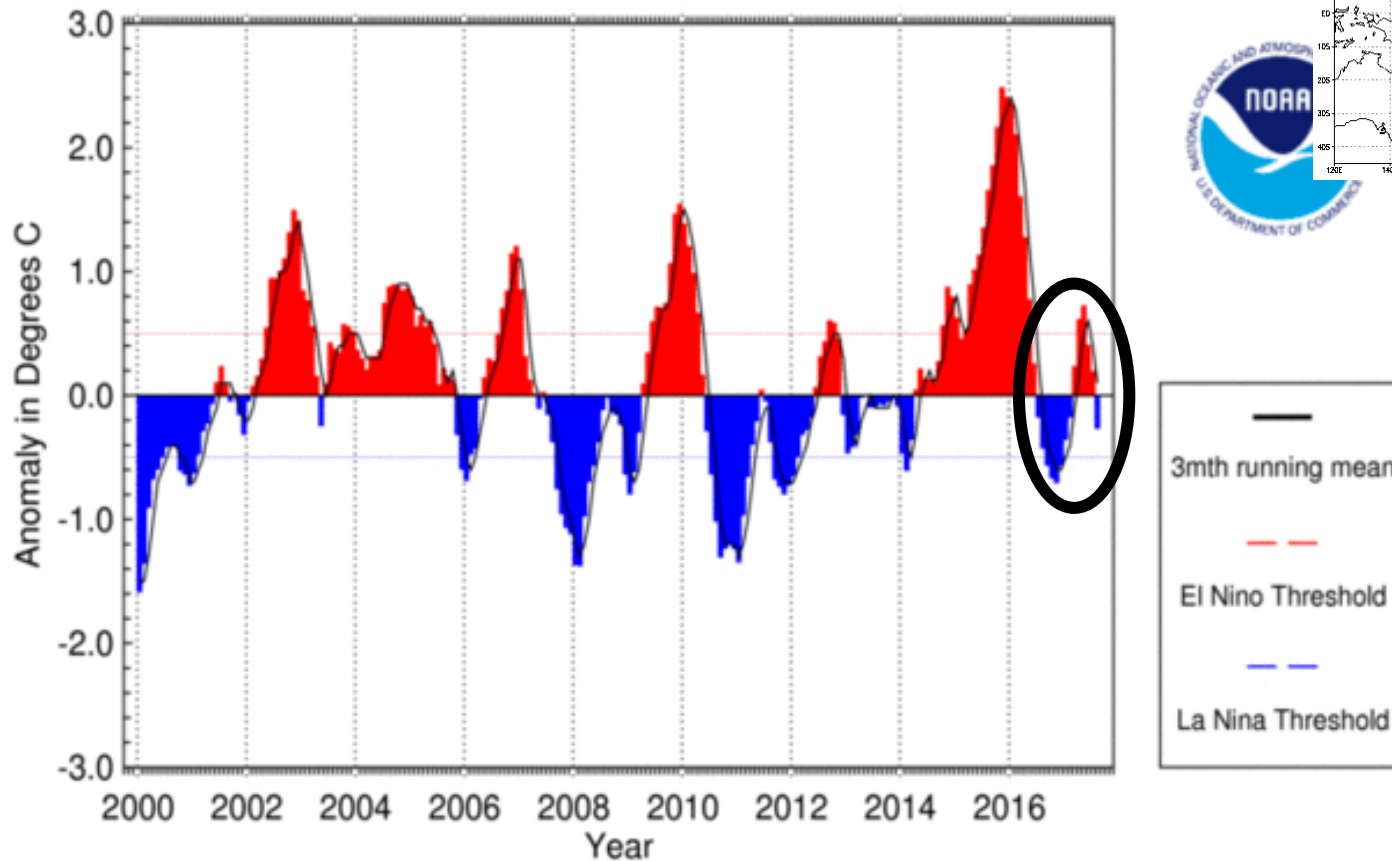
- ***ENSO Observations & Forecasts***
- ***Sub-seasonal to Seasonal Temperature & Precipitation Forecasts***



Early Development of Cool Tropical Pacific

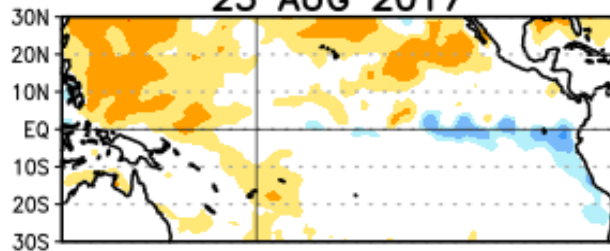
Sea Surface Temperature Anomalies Following Weak La Niña Conditions of 2016-2017

SST Anomaly in Nino 3.4 Region (5N-5S,120-170W)

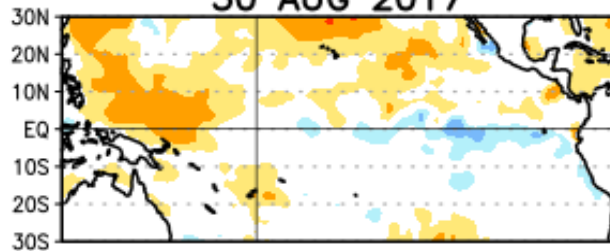


Weekly SST Anomalies (DEG C)

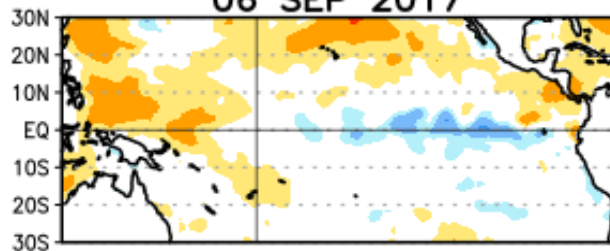
23 AUG 2017



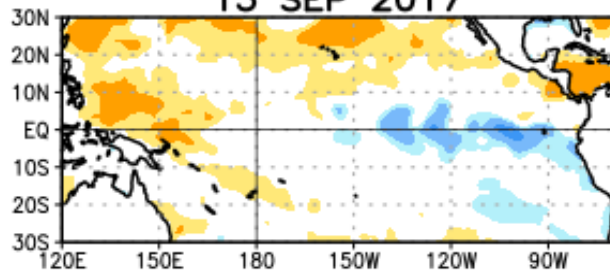
30 AUG 2017



06 SEP 2017

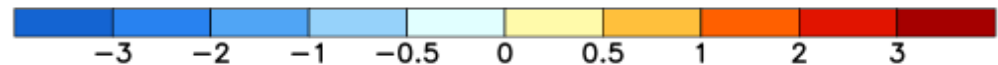
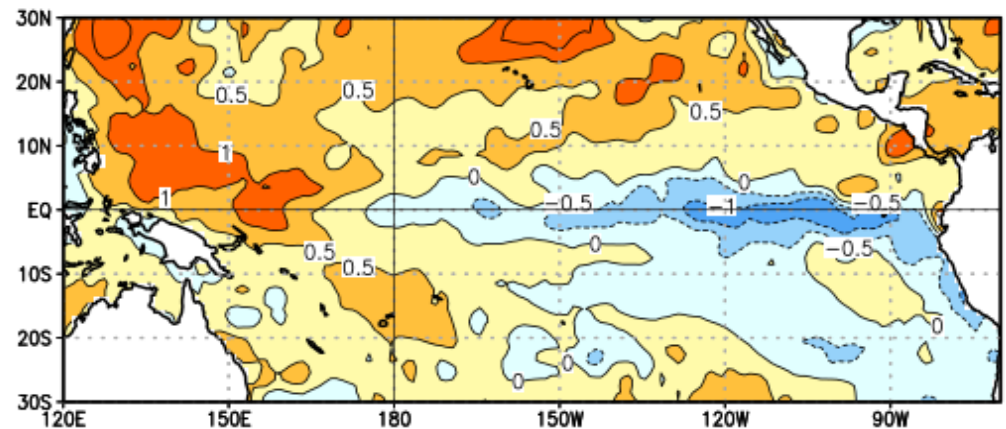


13 SEP 2017



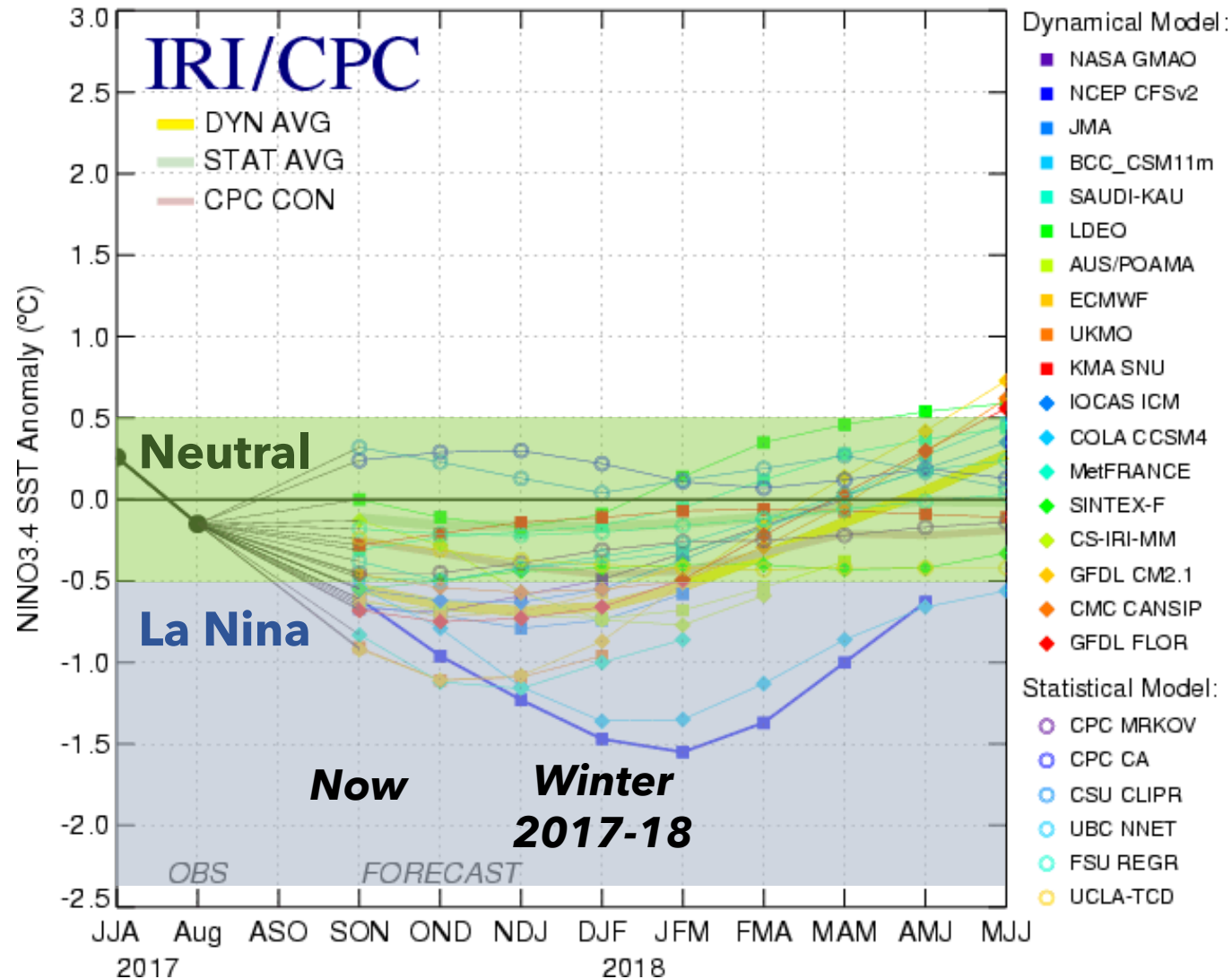
During the last four weeks, below-average SSTs grew across the central and eastern Pacific Ocean.

Average SST Anomalies
20 AUG 2017 – 16 SEP 2017

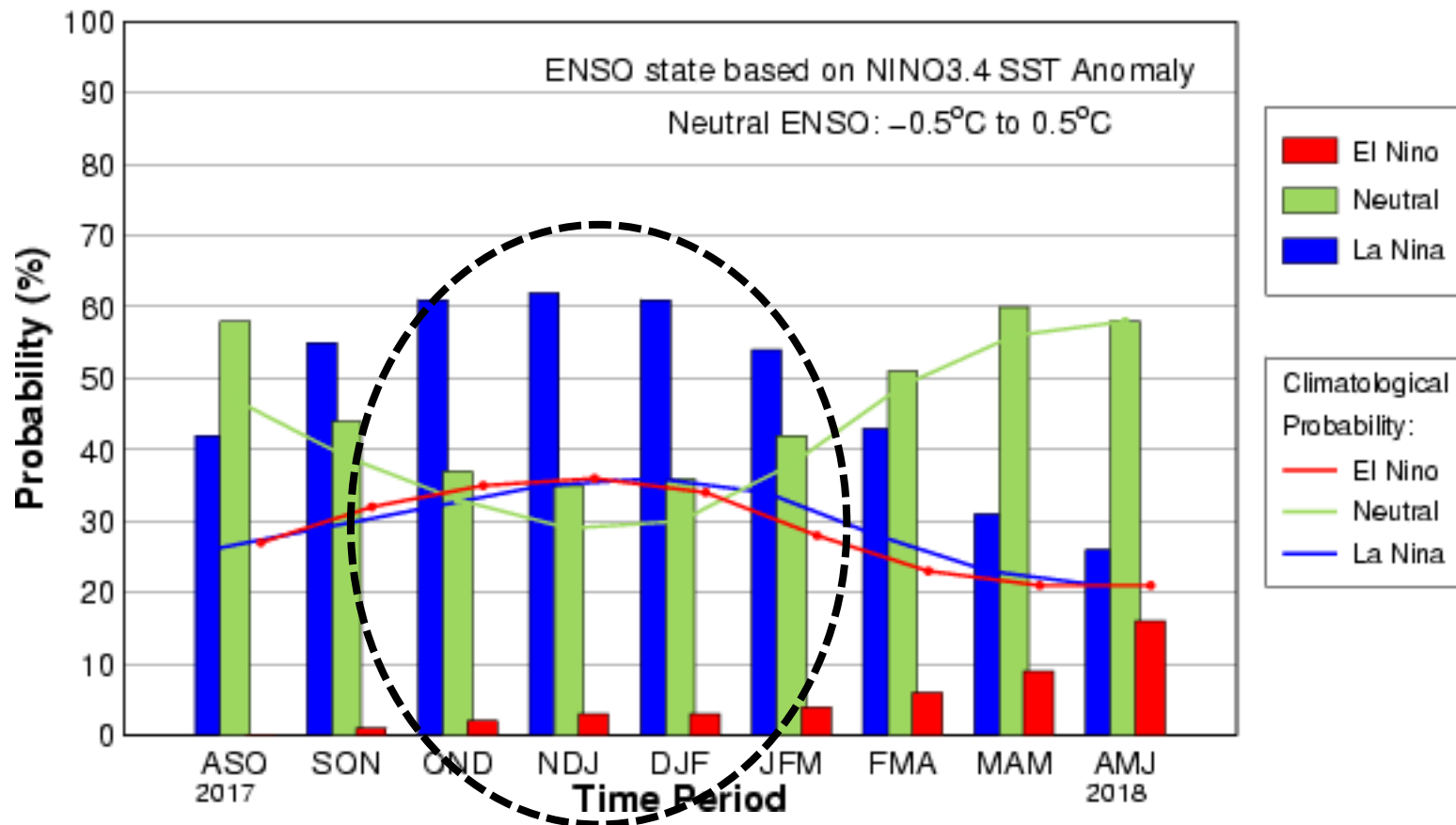


ENSO Neutral Favored with La Niña Watch

Plume of Predictions of Tropical Pacific El Niño/La Niña Status through the Coming Season (from mid-September 2017)



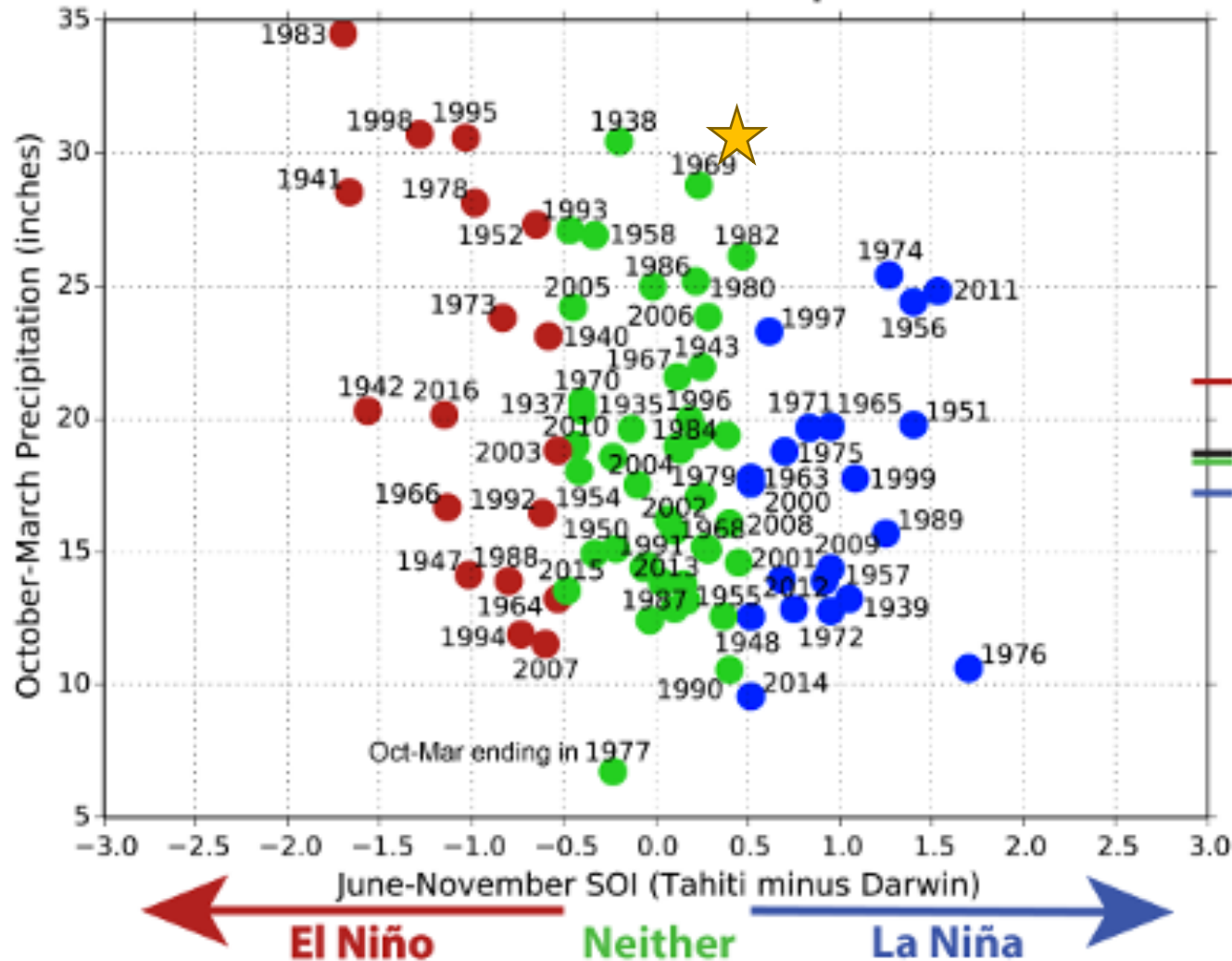
Early-Sep CPC/IRI Official Probabilistic ENSO Forecast



<http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/>

	La Niña	Neutral	El Niño
Climatology	35%	30%	35%
OND, 2017	61%	37%	2%
NDJ, 2016-17	62%	35%	3%
DJF, 2016-2017	61%	36%	3%
JFM, 2017	54%	42%	4%

CA Statewide October-March Precipitation (versus Southern Oscillation Index for prior June-November)

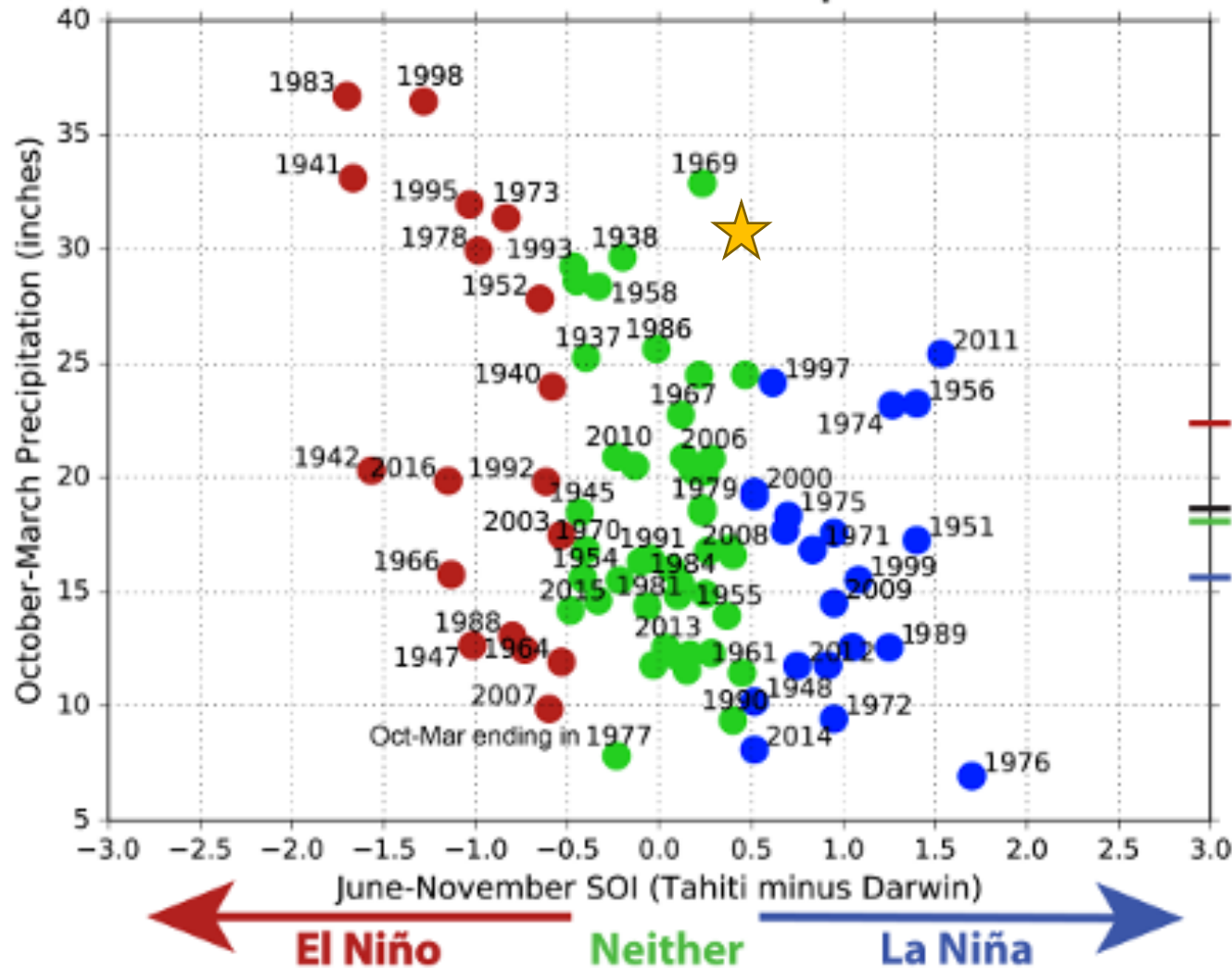


Western Regional
Climate Center

★ 2016-2017 Estimate

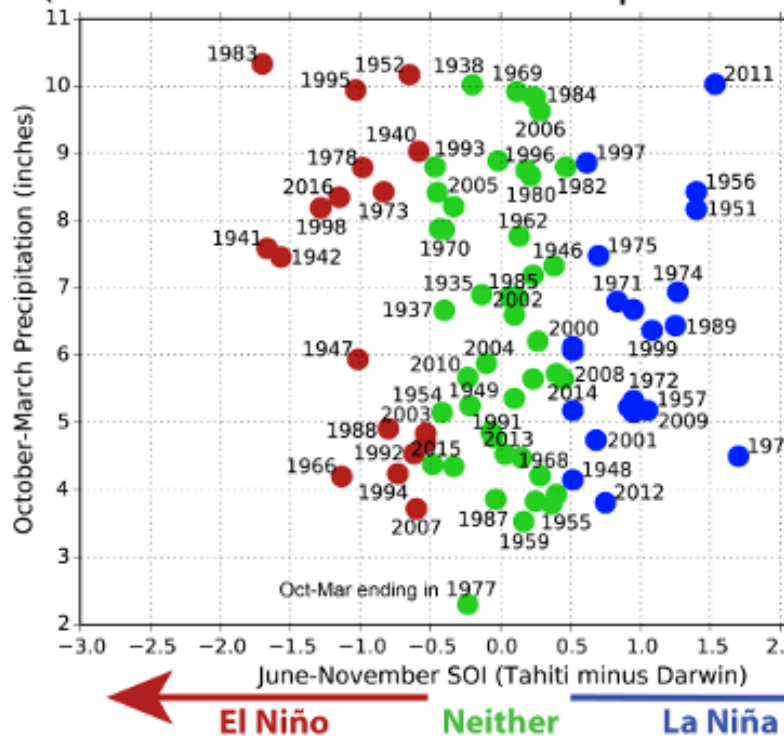
CA Division 4 October-March Precipitation

(versus Southern Oscillation Index for prior June-November)



★ 2016-2017 Estimate

NV Division 1 October-March Precipitation (versus Southern Oscillation Index for prior June-November)

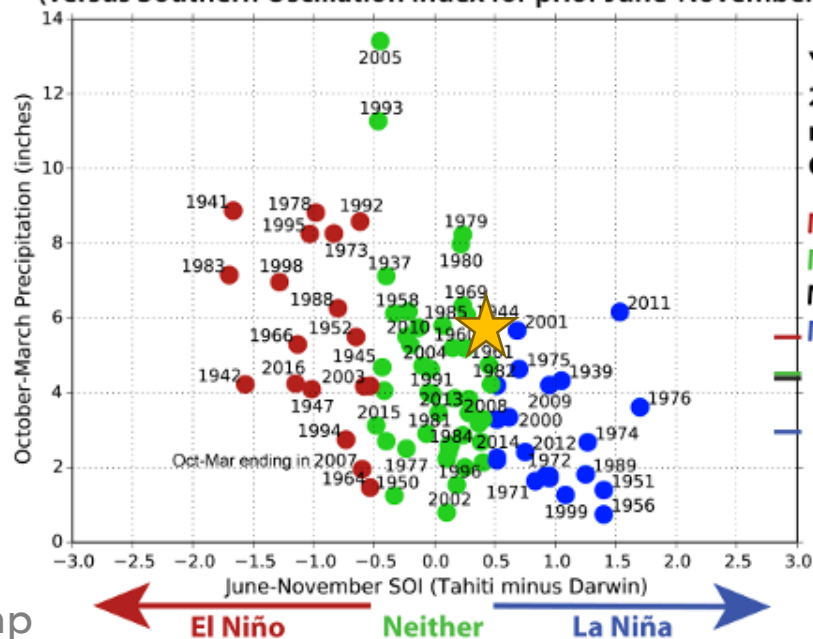


Years 1933/1934-
2015/2016
 $r^2 = 0.02$
Correlation = -0.13

Mean = 6.96 in
Mean all = 6.53 in
Mean = 6.48 in
Mean = 6.27 in

★ 2016-2017 Estimate

NV Division 4 October-March Precipitation (versus Southern Oscillation Index for prior June-November)



Years 1933/1934-
2015/2016
 $r^2 = 0.22$
Correlation = -0.46

Mean = 5.62 in
Mean = 4.46 in
Mean all = 4.32 in
Mean = 2.91 in



Western Regional
Climate Center

SUB-SEASONAL TO SEASONAL FORECASTING

MAY 2017

What is Sub-Seasonal to Seasonal (S2S) Forecasting?

Everyday decisions are made based on weather forecasts for various time ranges within 14 days (short-term), but **sub-seasonal to seasonal (S2S) forecasts** (longer-term climate forecasts for 2 weeks to 12 months from now) are greatly needed by decision makers in water resources, energy and agriculture. According to the National Academy of Science in 2016, S2S forecasts will become more widely used in the future.

The "skill," or accuracy, of S2S forecasts varies with season, region, and variable (temperature, precipitation). They are also dependent on how far in advance one is forecasting (figure 1). Each type of forecast (short-term, sub-seasonal, and seasonal) makes the best use of knowledge of how the atmosphere works and the latest atmospheric, oceanic, and land surface conditions. S2S forecasts are different than short-term weather forecasts. They are limited by the above factors as well as the chaotic nature of the atmosphere-ocean-land system. Given these uncertainties, S2S forecasts are given in terms of probabilities rather than as forecasts for specific weather events.

S2S forecasts include information from computer models based on our current understanding of the atmosphere, ocean and land system, and from statistical methods linked to historical observations.

Mid-November Precipitation Forecast Skill for All December to Februarys from 1995-2016

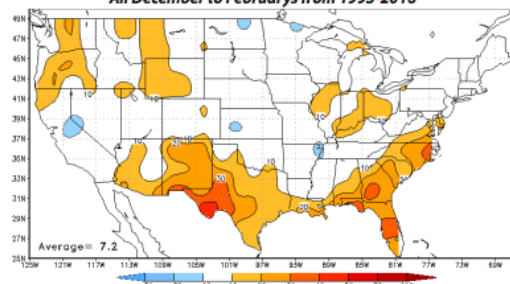


Figure 2. Heidke skill scores show low skill (whites and blues) for December-Februarys from 1995 to 2016, more so in precipitation (shown) forecasts than temperature. Source: <http://www.cpc.ncep.noaa.gov/products/verification/summary/index>.

CONTACTS: Amanda Sheffield - amsheffield@ucsd.edu
Alexander Tardy - alexander.tardy@noaa.gov

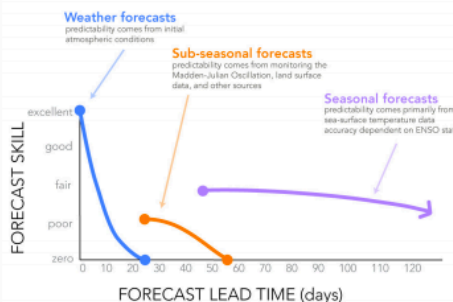


Figure 1. Different type of forecast skill by type of forecast (weather, sub-seasonal, seasonal) which depends on how far out (or lead time) the forecast is for. Source: <http://iri.columbia.edu/news/qa-subseasonal-prediction-project/>

FORECAST PERFORMANCE

Forecast **skill** is a gauge of the performance of a forecast relative to a given standard. Often, the standard used is the long-term (30-year) average - called the climatology - of temperature or precipitation. Thus, skill scores measure the improvement of the forecast over a solely climatological forecast. NOAA's Climate Prediction Center (CPC) uses the Heidke skill score (figure 2), comparing how often the forecast category correctly match the observed category, over and above the number of correct "hits" expected by chance alone. A score of 0 means that the forecast was not better than what would be expected by chance. A score of 100 depicts a perfect forecast and a score of -50 depicts a perfectly wrong forecast. For example, California and Nevada are shown (figure 2) to have low forecast skill in precipitation as do many other regions of the United States.

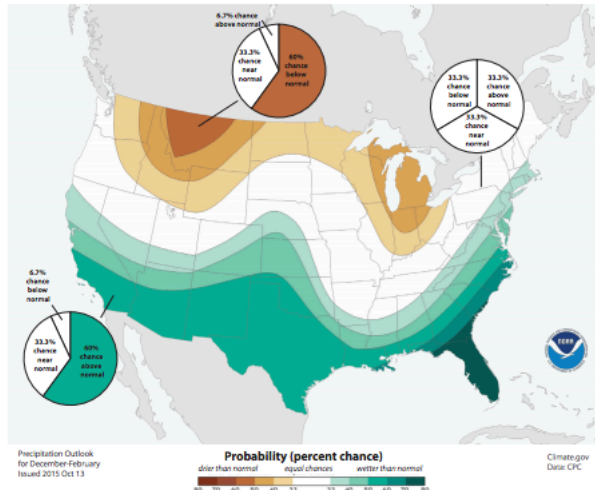


Figure 3. National precipitation outlook for December 2015 to February 2016, issued on October 15, 2015. Colors indicate the odds of the most favored category (i.e. above-, near-, or below-average) for seasonal total precipitation. White indicates equal chances for any outcome—above-, below-, or near-average precipitation—not a prediction of "normal" seasonal total precipitation. Map by NOAA Climate.gov (<https://www.climate.gov/news-features/videos/2015-16-winter-outlook>), based on data from the Climate Prediction Center.

NOAA Climate Prediction Center (CPC) Suite of Official Forecasts can be found at <http://www.cpc.ncep.noaa.gov/products/predictions/>

Understanding NOAA Climate Prediction Center S2S Forecasts

S2S forecasts are made by several federal programs and universities, each encompassing different methods and skill. A widely used set of S2S forecasts are NOAA's Climate Prediction Center (CPC) color shaded maps of extended range outlooks (for example, 6-10 or 8-14 days to 1 month) and longer lead time (up to 12.5 months) outlooks for 3-month time periods. There is a shift in forecast skill as one moves across time scales from the extended range outlooks to the 3-month outlook as shown in figure 1. Although the color shading indicates the probability of above- or below-average temperature or precipitation, the forecasts do not indicate how much above or below average (i.e. how extreme) a forecast period might be.

How are these forecast likelihoods displayed on CPC maps determined? NOAA's seasonal forecasts start with the assumption that for any summer or winter, there are three possible climate outcomes: temperature or precipitation that is above normal (upper third of the 1981-2010 record), near normal (middle third), or below normal (lower third). Without looking at the current forecast, at a given location each category has equal chances of occurring, and together they must add up to 100%. Thus the default probability for each outcome is 33.3%.

Determining how the odds shift to favor above or below normal conditions is controlled by a number of factors such as the

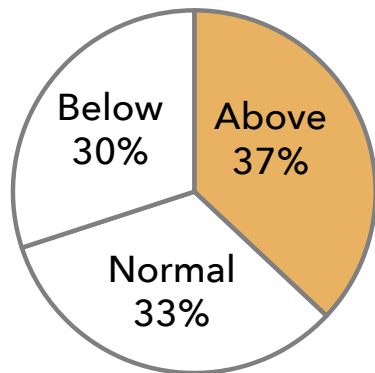
status of large scale climate factors (e.g. ENSO), statistical forecast tools and the characteristics of the output from dynamical models. For example in the forecast for December 2015 to February 2016 made in (or issued in) October 2015 (figure 3), a wetter-than-normal Southwest US was anticipated, with drier than average conditions in the Northwest US. The consistent and nearly unanimous model predictions for a wetter than normal season in Southern California contributed significantly to CPC forecasters setting the odds at a 60% chance of wetter than normal conditions. That left a 40% chance of near normal or below normal precipitation. Forecasters divided this remaining fraction (40%) by holding the chances for near-normal conditions at the default (equal chances) 33.3% leaving 6.7% as the probability of the least favored category, for this example being below normal precipitation. S. California was then color shaded to match the more favored category, here being wetter than normal precipitation. CPC does the same types of maps for temperature using this same approach.

When the odds of above or below normal are very high (70% or more) such that the remaining fraction is smaller than 33.3%, forecasters set a minimum 3.3% chance for the opposite outcome, and assign the larger portion of the remainder to the near-normal outcome. This prevents the least-favored category from being assigned an impossible negative value.

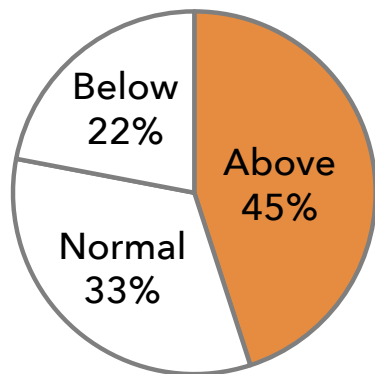
- **CNAP**, the California Nevada Applications Program, is a NOAA RISA team conducting applied climate research that is inspired by and useful to decision makers in the region. cnap.ucsd.edu
- The **National Weather Service** is tasked with providing weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy. weather.gov
- **NIDIS**, National Integrated Drought Information System, works with federal, state, tribal and local partners to improve drought early warning, preparedness, and response to impacts. drought.gov
- **CW3E**, Center for Western Weather and Water Extremes, provides science to support effective policy on extreme weather and water events. cw3e.ucsd.edu
- Thank you to **California Department of Water Resources and NOAA's Climate Prediction Center** for suggestions and revisions to this document.



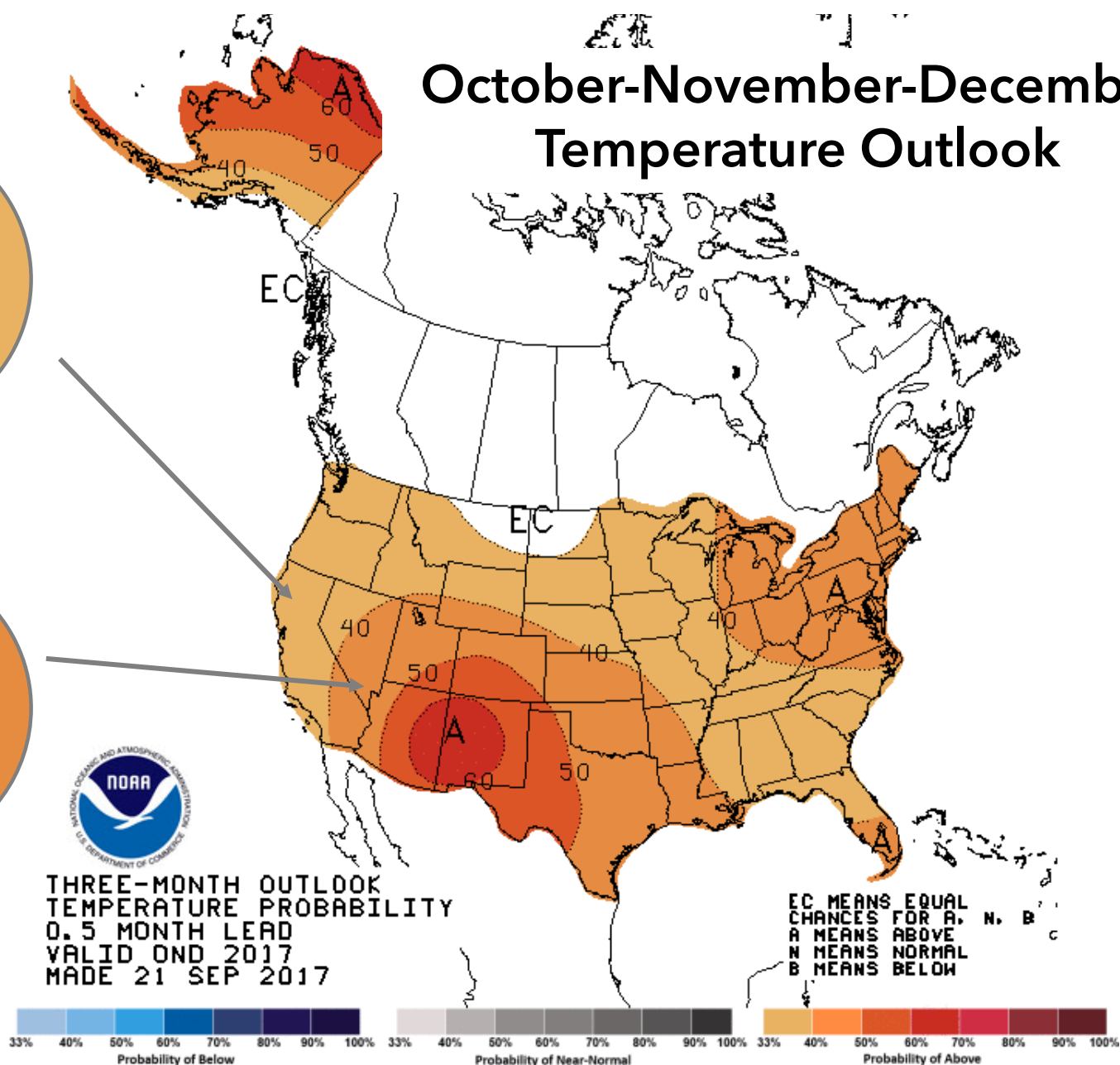
Sacramento



Las Vegas



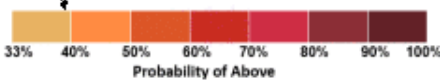
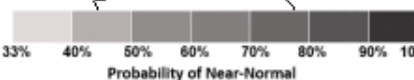
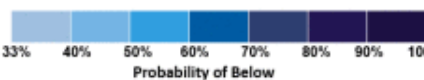
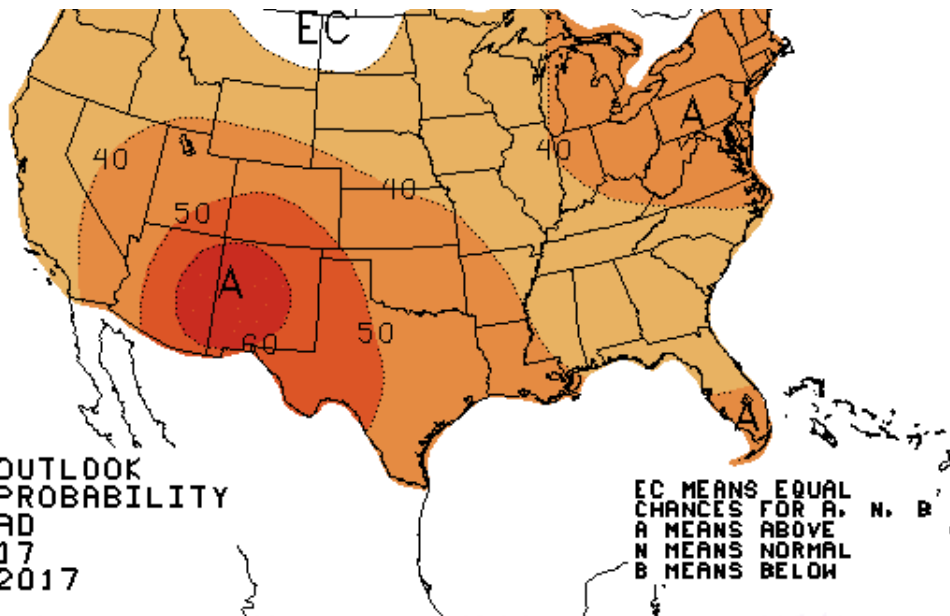
October-November-December Temperature Outlook



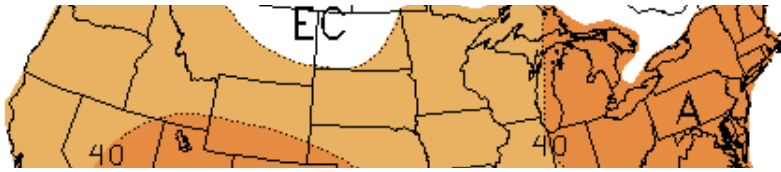
October-November-December



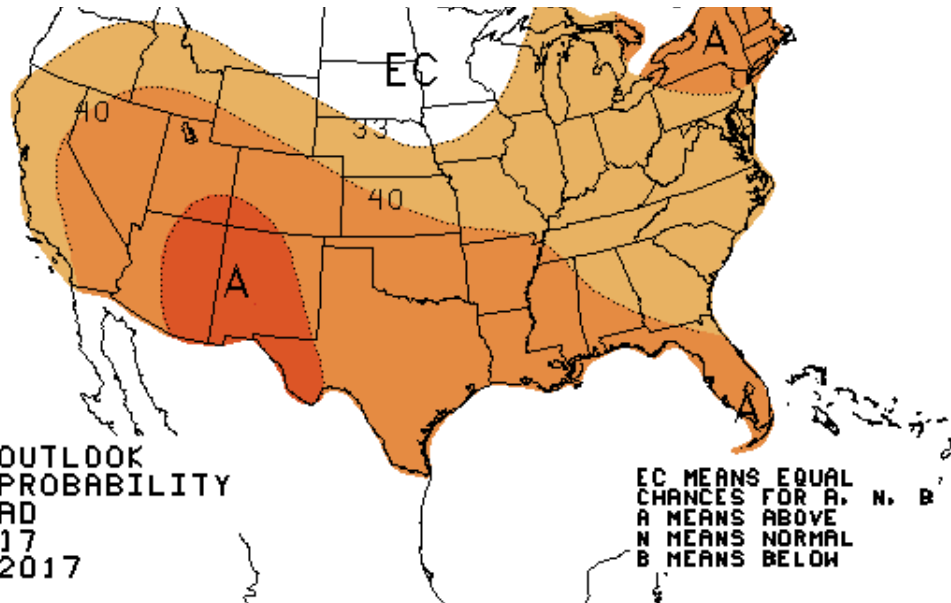
THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
0.5 MONTH LEAD
VALID OND 2017
MADE 21 SEP 2017



October-November-December



November-December-January

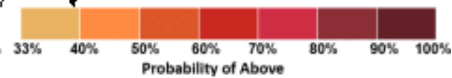
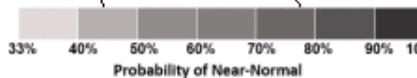
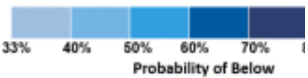


THREE-MONTH
TEMPERATURE
0.5 MONTH LEAD
VALID OND 20
MADE 21 SEP

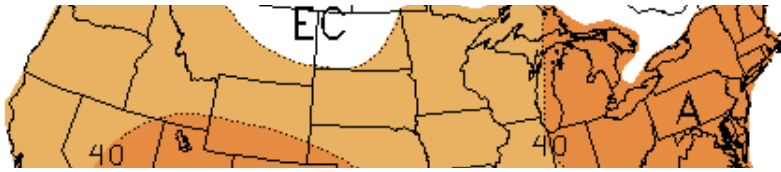


THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
1.5 MONTH LEAD
VALID NDJ 2017
MADE 21 SEP 2017

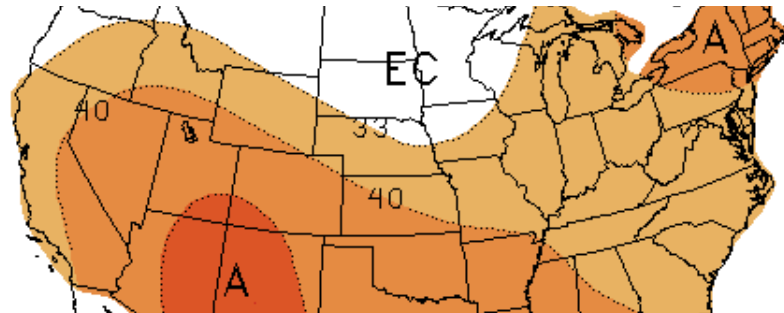
EC MEANS EQUAL
CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW



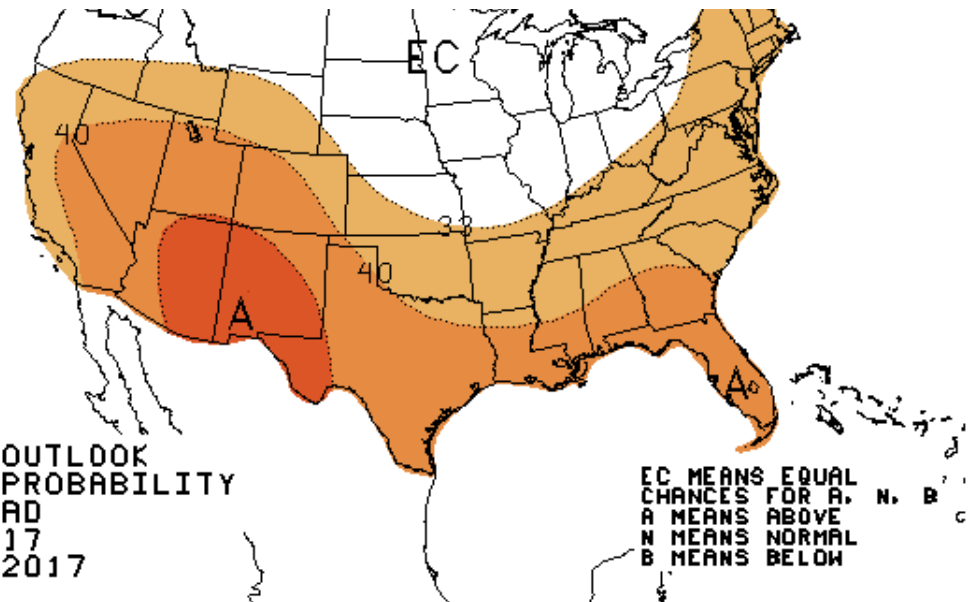
October-November-December



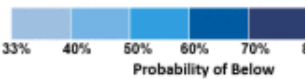
November-December-January



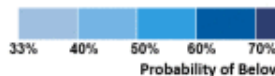
December-January-February



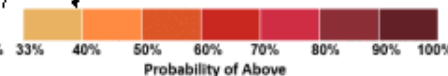
THREE-MONTH
TEMPERATURE
0.5 MONTH LEAD
VALID OND 20
MADE 21 SEP



THREE-MONTH
TEMPERATURE
1.5 MONTH LEAD
VALID NDJ 20
MADE 21 SEP



THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
2.5 MONTH LEAD
VALID DJF 2017
MADE 21 SEP 2017

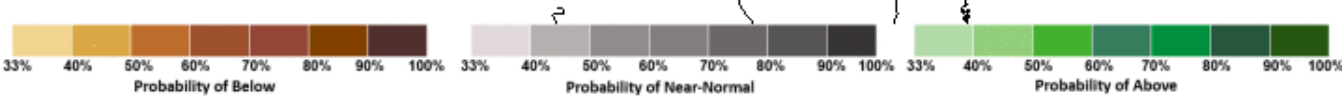
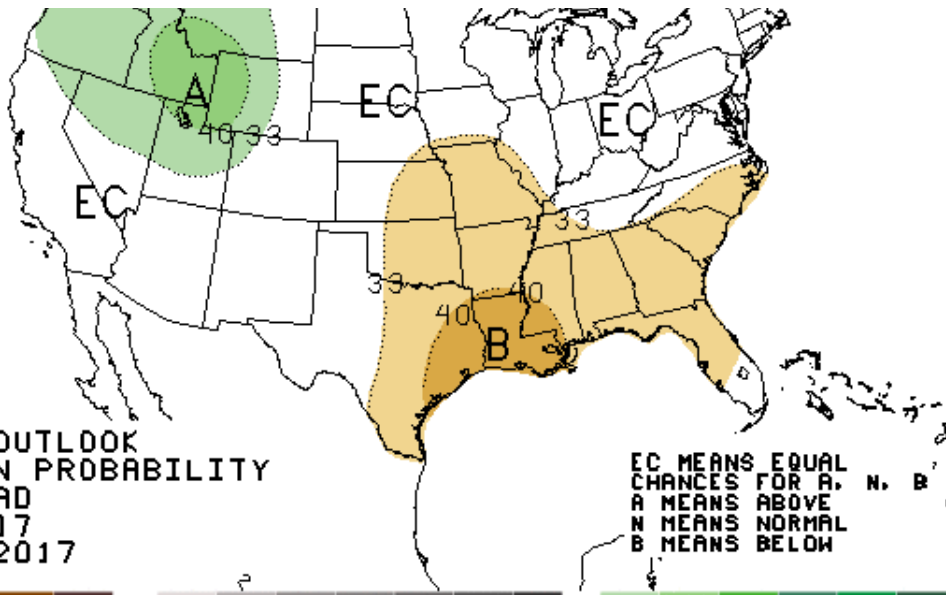


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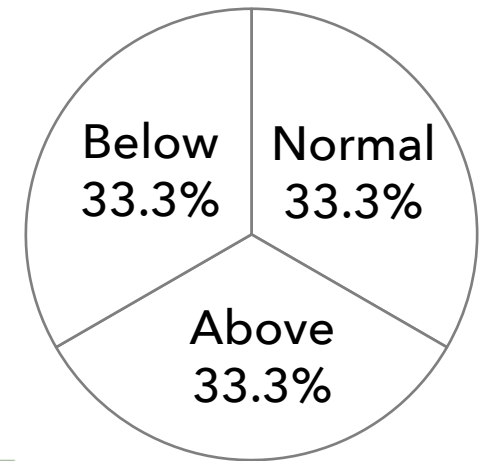
October-November-December



THREE-MONTH OUTLOOK
PRECIPITATION PROBABILITY
0.5 MONTH LEAD
VALID OND 2017
MADE 21 SEP 2017



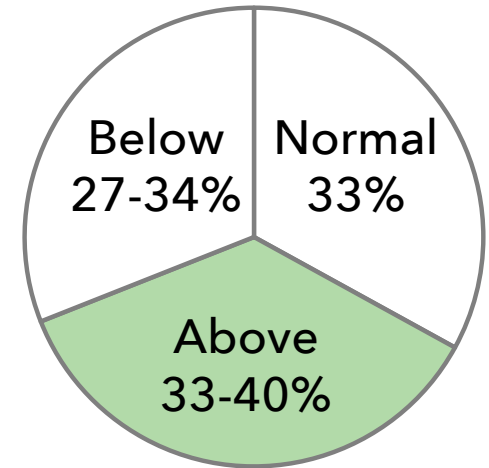
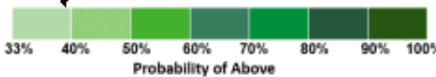
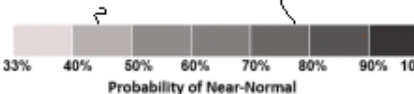
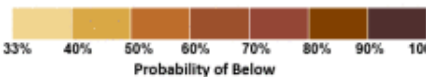
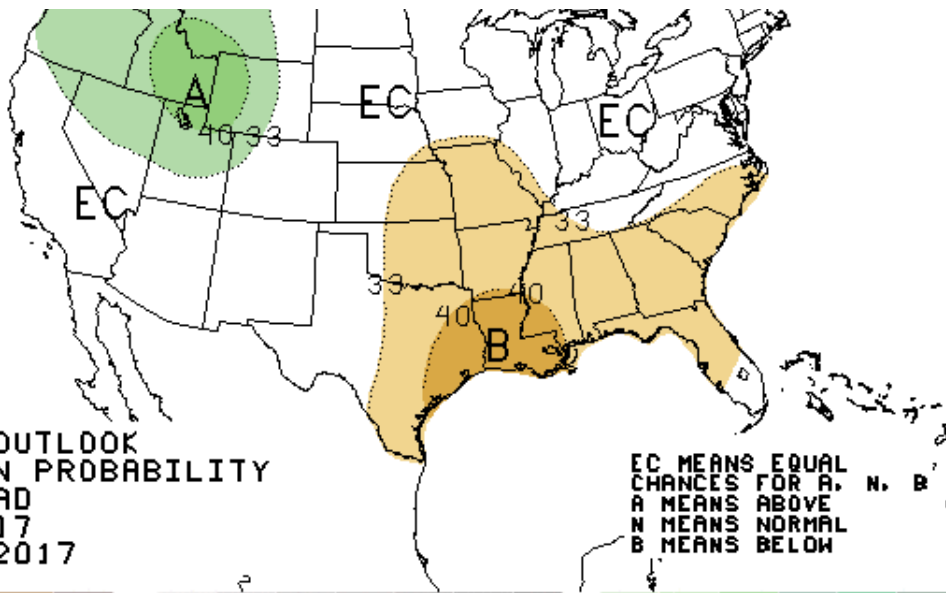
Equal Chances = EC



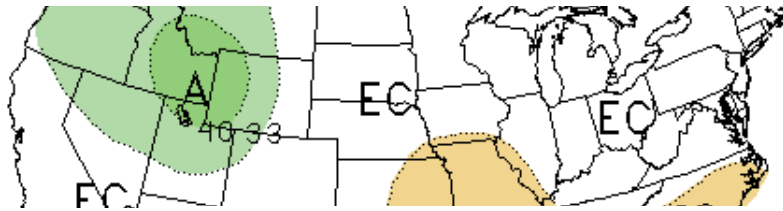
October-November-December



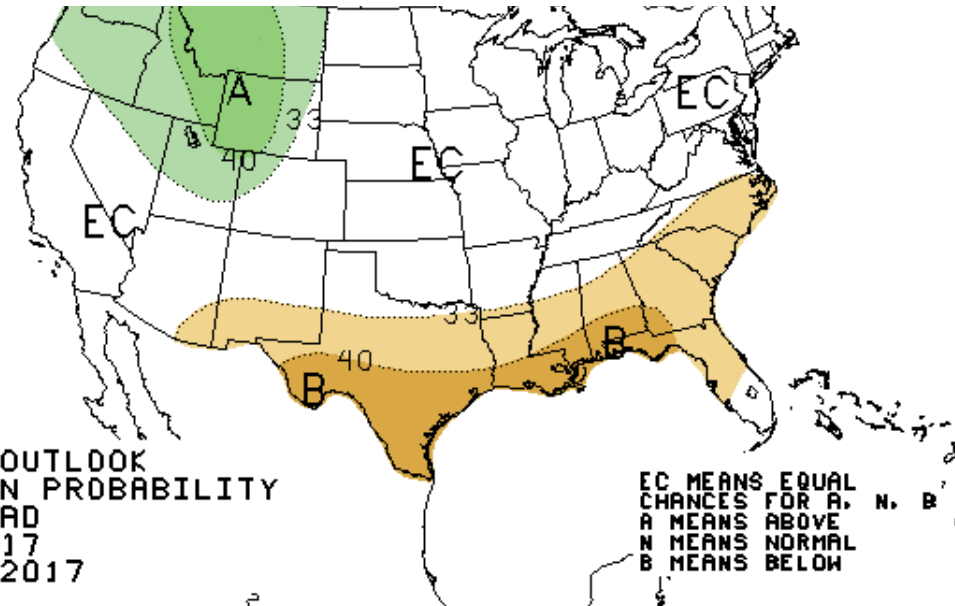
THREE-MONTH OUTLOOK
PRECIPITATION PROBABILITY
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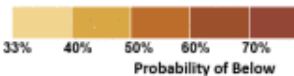
October-November-December



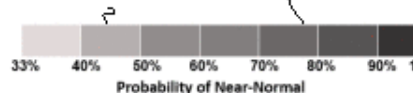
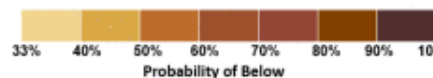
November-December-January



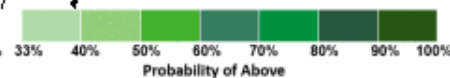
THREE-MONTH
PRECIPITATION
0.5 MONTH LEAD
VALID NDJ 2017
MADE 21 SEP 2017



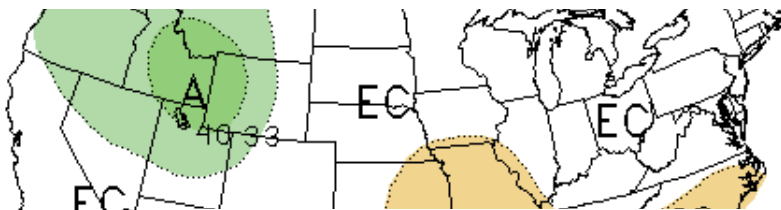
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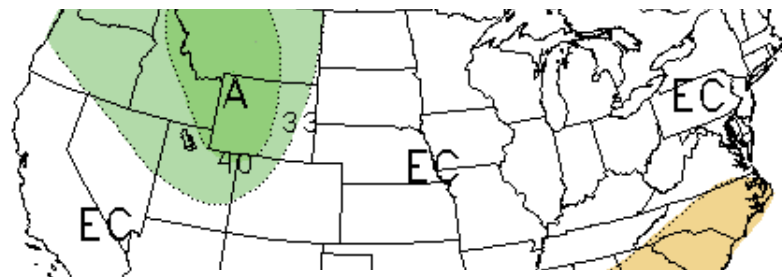
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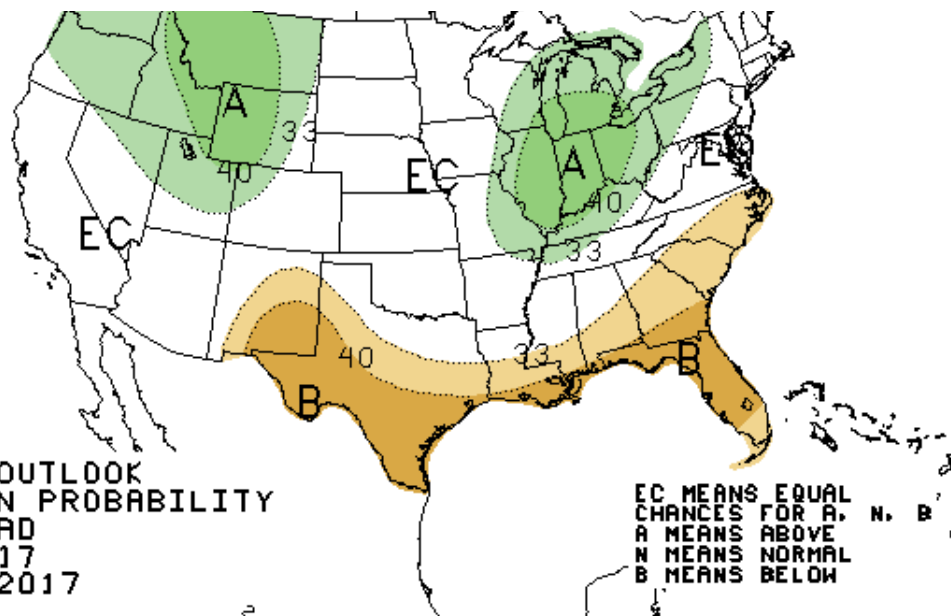
October-November-December



November-December-January



December-January-February

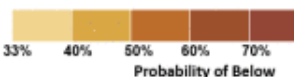


THREE-MONTH OUTLOOK
PRECIPITATION PROBABILITY
2.5 MONTH LEAD
VALID DJF 2017
MADE 21 SEP 2017

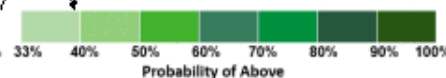
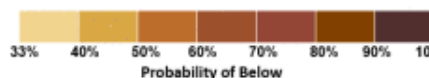
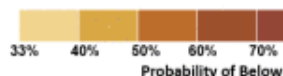
EC MEANS EQUAL
CHANCES FOR A, N, B
A MEANS ABOVE
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B MEANS BELOW



THREE-MONTH
PRECIPITATION
0.5 MONTH LEAD
VALID OND 2017
MADE 21 SEP

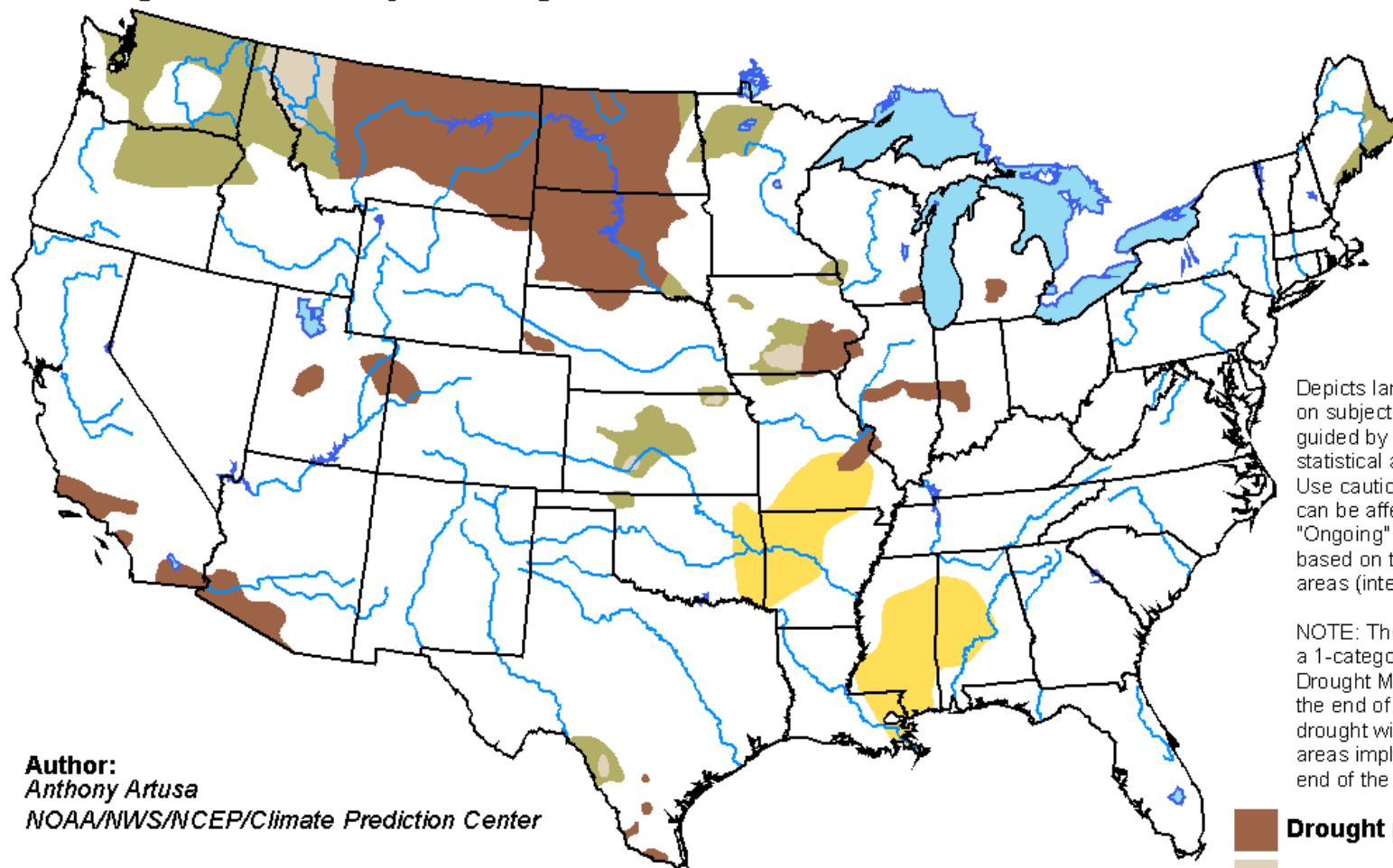


THREE-MONTH
PRECIPITATION
1.5 MONTH LEAD
VALID NDJ 2017
MADE 21 SEP



U.S. Seasonal Drought Outlook

valid for September 21 - December 31, 2017
Drought Tendency During the Valid Period
Released September 21, 2017

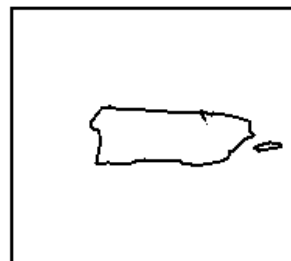
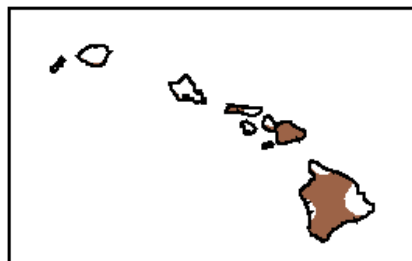
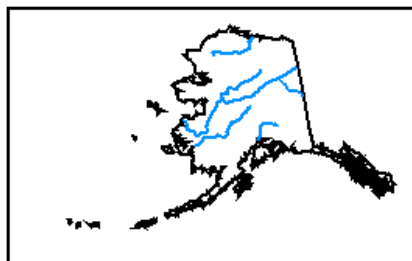


Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

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-  **Drought persists**
-  **Drought remains but improves**
-  **Drought removal likely**
-  **Drought development likely**



<http://go.usa.gov/3eZ73>

Summary

- Extended range prediction beyond the two week time frame relies on more slowly changing elements of the climate system that have been connected to our weather and climate – such as ENSO
- La Niña conditions for this water year have been forecasted, but the tropical ocean and atmosphere are currently in a **state of neutral conditions** with recent downward cooling trend in SSTs. Models (mid-September) are projecting 55-60% chance of La Niña this fall/winter.
- ENSO is one part of the sub-seasonal to seasonal forecast toolbox, and we'll have to wait and see how this season develops.
- CA-NV favored to have **above normal temperatures this winter and equal chances of above normal, normal, and below normal precipitation.**
- Keep engaged with your local NWS offices as well as NIDIS and other NOAA and partner programs as we move through this winter.