Conundrums in the Creation of the USDM (U.S. Drought Monitor), DOs (U.S. Drought Outlooks), and LLFs (Long-Lead Forecasts), along with some Cures & Conclusions

10th Biennial U.S. Drought Monitor Forum
Keystone, South Dakota
Monday, April 3, 2017

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Why *Conundrum(s)*?

From Webster's New Collegiate Dictionary:

co-nun-drum *n* [origin unknown] …

1) A riddle whose answer is or involves a pun;

2) A question or problem having only a conjectural answer;

2b) An intricate and difficult problem;

syn *see* MYSTERY

How did this presentation come about?

After the extremely heavy precipitation events in California during early and mid-January 2017 (with more forecast), CPC was asked by the NWS Director Dr. Louis Uccellini why:

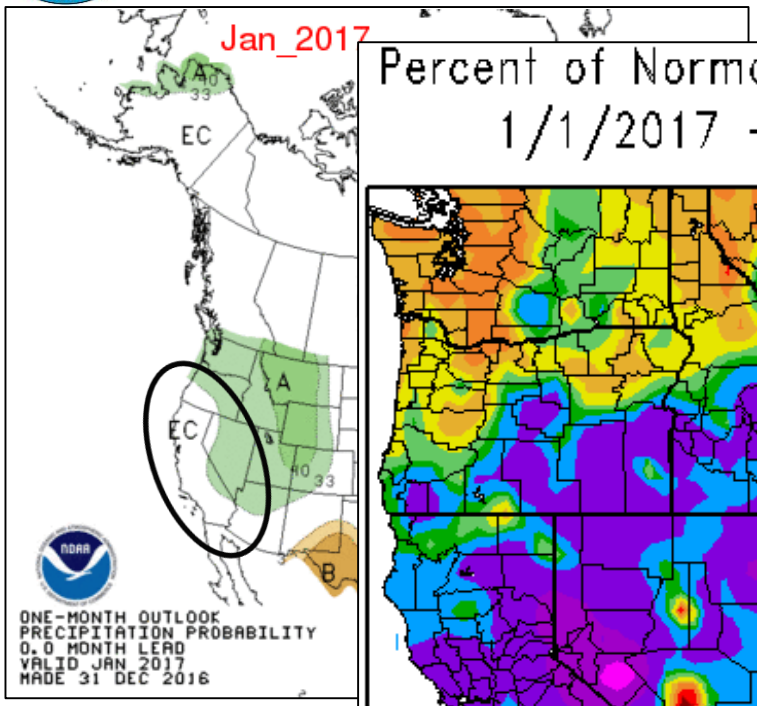
1) The 0.0 Month Lead 1-Month Precipitation LLF (January 2017) did not have probabilities for above-median totals (mostly EC – Equal Chances);

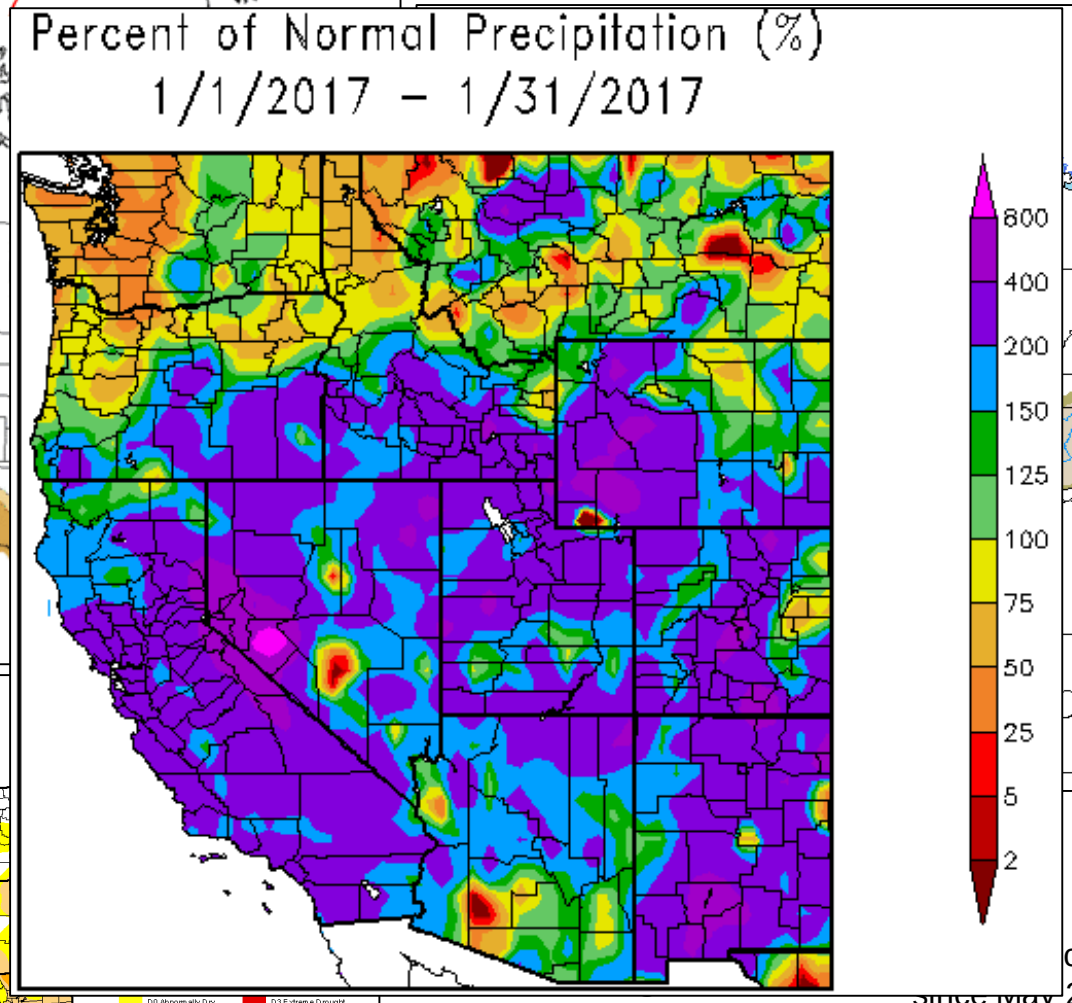
2) The Monthly Drought Outlook (Jan 2017) did not have much CA improvement/removal (mostly Persistence);

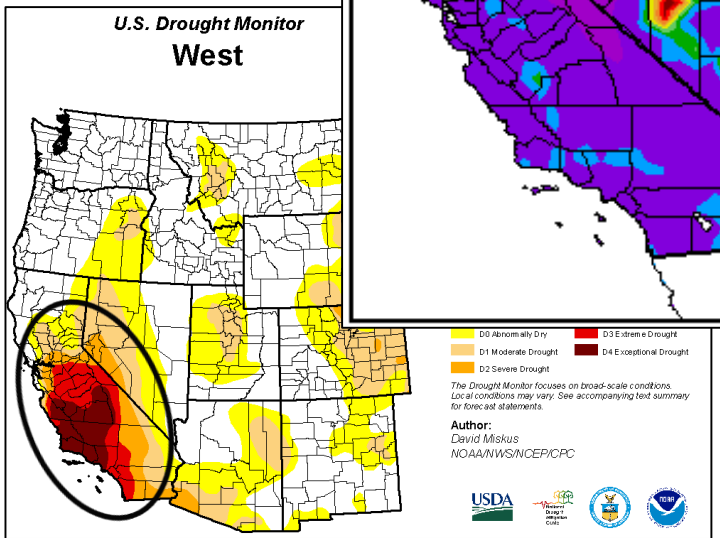
(Both 1 & 2 were criticized at an early Jan AMS Session when Dr. Uccellini was present)
(Both 1 & 2 were released at 3pm EST, December 31)

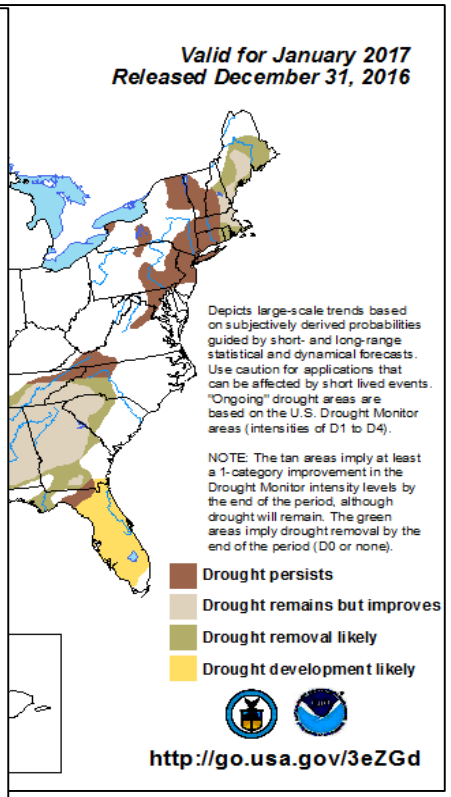
3) The U.S. Drought Monitor (as of Wed., Jan. 11) had not showed any improvements in central & southern California - still widespread D2-D4 as of 1/3/17. The DM did change dramatically, however, during the next several weeks.

January 2017 0.0-Month Lead Precipitation Probability & Monthly Drought Outlook (both released 3pm 12/31/16):





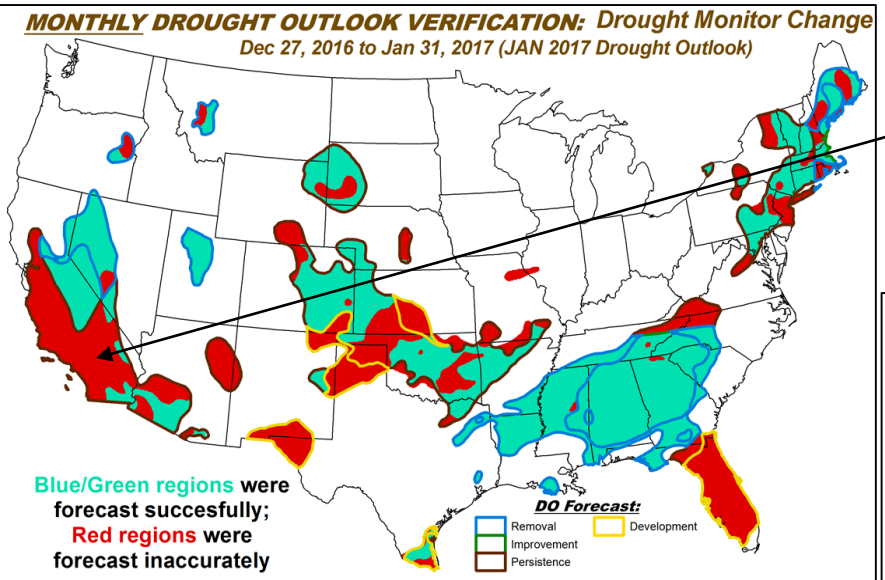




change
since May 2016)

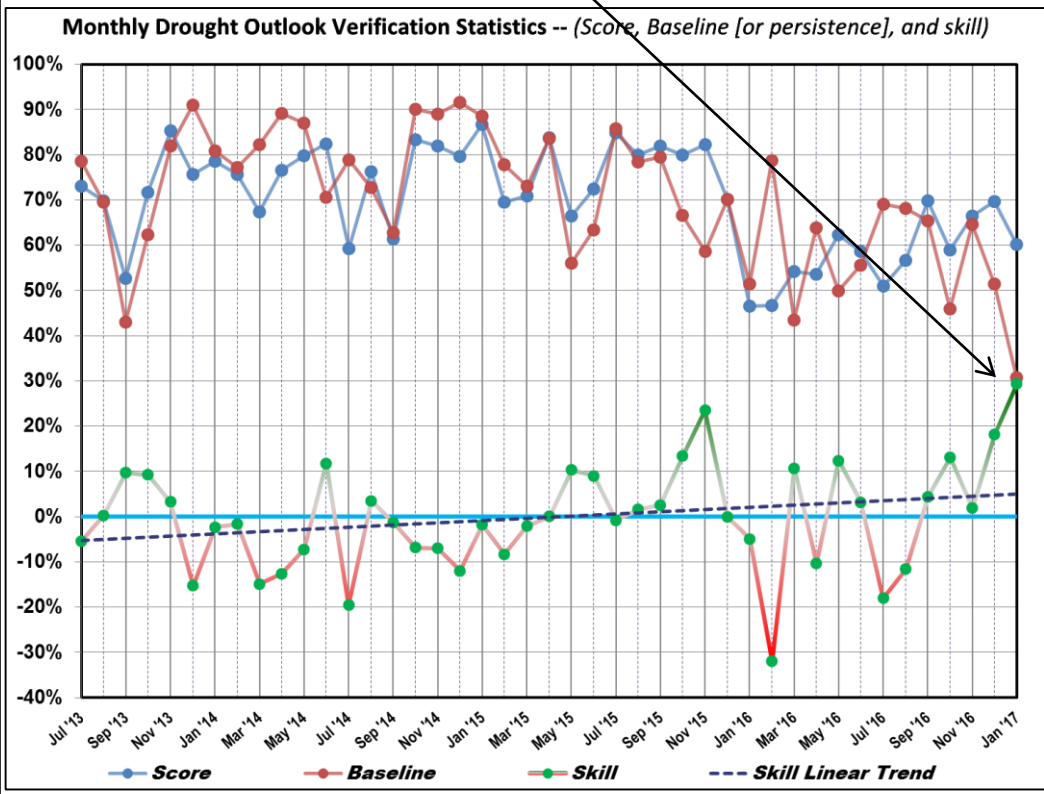
in the West

Jan'17 MDO Verification & Overall MDO Scores



FORECAST	HIT	MISS
Improvement/Removal	47,027	3,792
Persistence	32,862	31,920
Development	746	17,882
TOTAL	**80,635**	**53,592**
SCORE	***60.1***	
PERSISTENCE FORECAST BASELINE	36,974	83,035
PERSISTENCE FORECAST SCORE	***30.8***	
"SKILL"	*(forecast score) minus (persistence score)*	***+29.3***

Jan'17 MDO skill was actually the highest on record (except in California)



Guidance Summary for Jan 2017 Precip LLF & MDO

CFS:

Deterministic forecasts from last 9 days in December for January 2017 were bullish for above normal precipitation forecasts for California, while probabilistic forecasts called for near-median precipitation.

GEFS:

Probabilistic forecasts show enhanced odds of above normal precipitation over California for first two weeks of January.

IMME:

Ensemble mean (deterministic) forecast show strong negative precipitation anomalies over California for January 2017.

NMME:

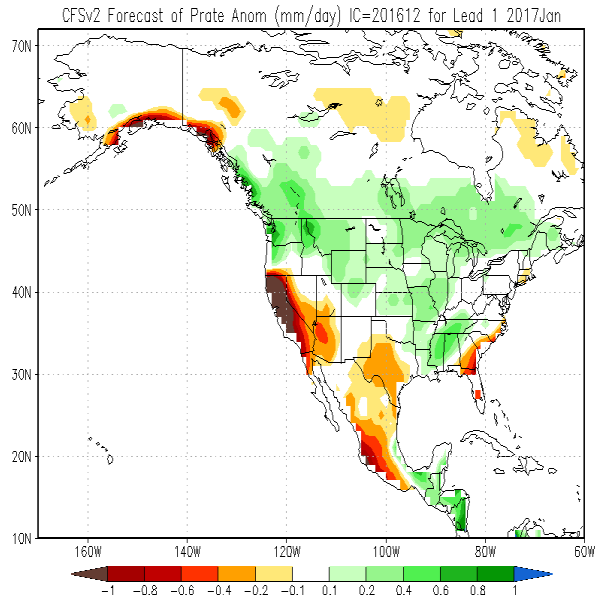
Ensemble mean (deterministic) forecasts shows strong negative precipitation anomalies over California January 2017, while the probabilistic forecast shows near-normal precipitation for this period.

Week 3-4 Forecasts for January 14-27 from CFS, JMA, and ECMWF:

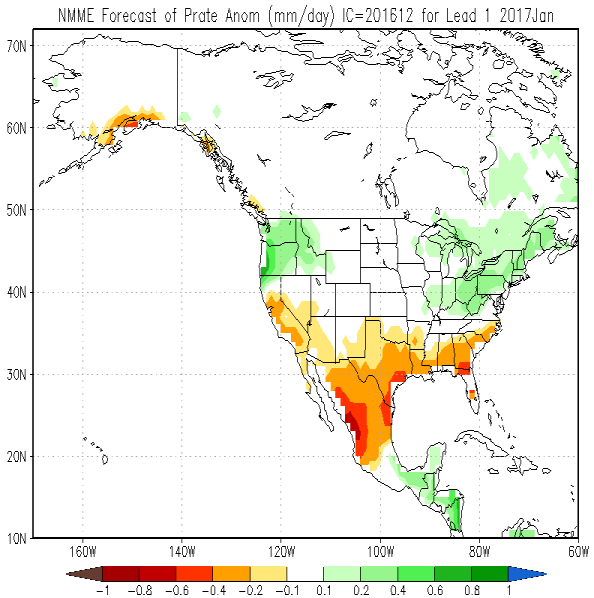
All three models show enhanced probability of below normal precipitation over California for the second half of January 2017.

Gap in the Current CPC Forecast Process: The current CPC process requires the forecaster to subjectively integrate all of this information plus empirical tools and the CPC Week 2 and WPC Week 1 forecast to make the one month forecast. This is a herculean task. CPC will conduct a deep dive to explore development of an objective consolidation (blend) of these models/products for the forecaster to use.

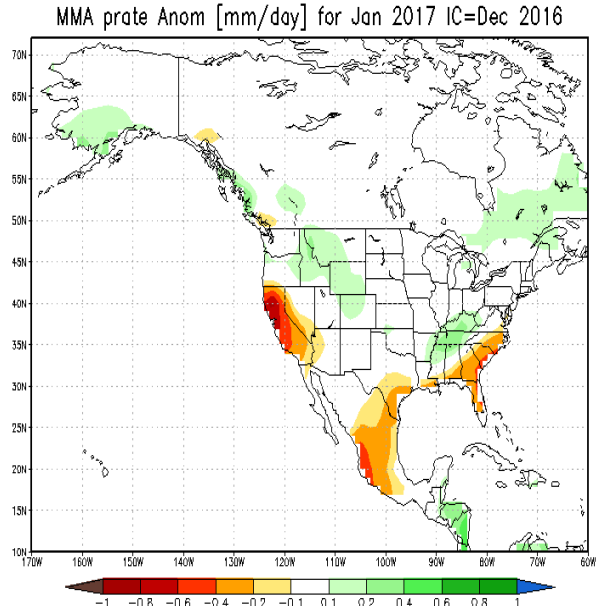
January 2017 Precipitation Forecasts From Monthly/Seasonal Models



CFS



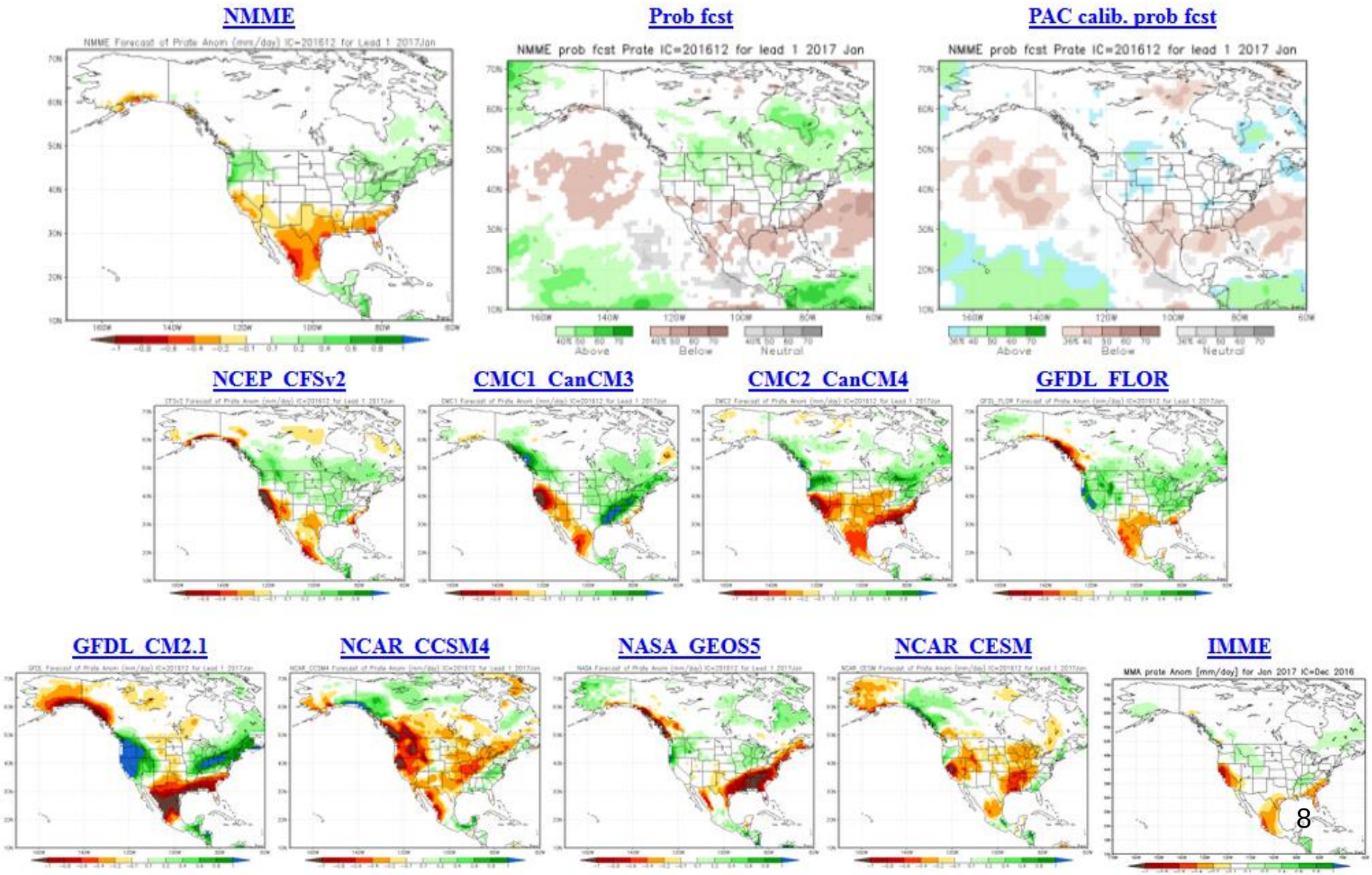
NMME



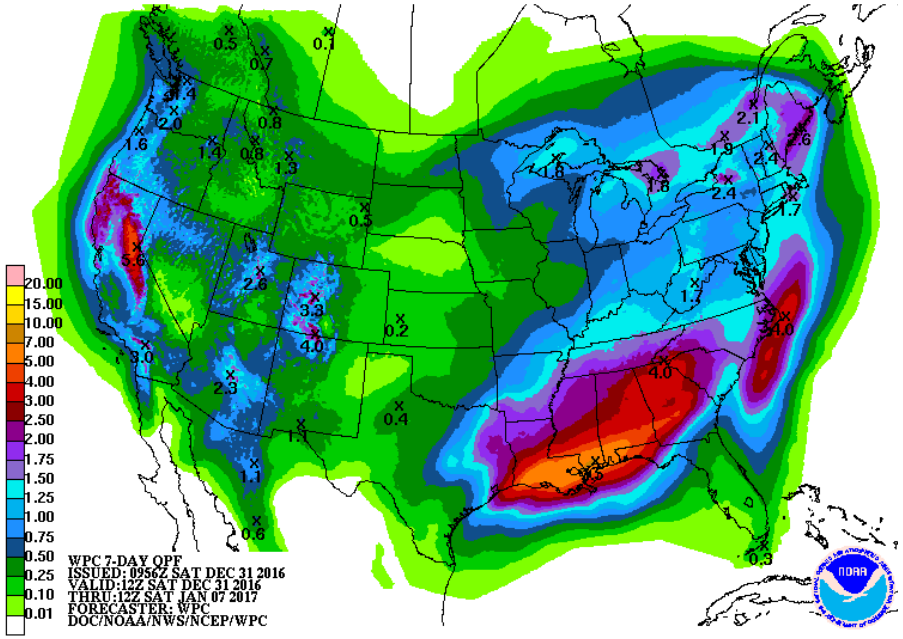
IMME

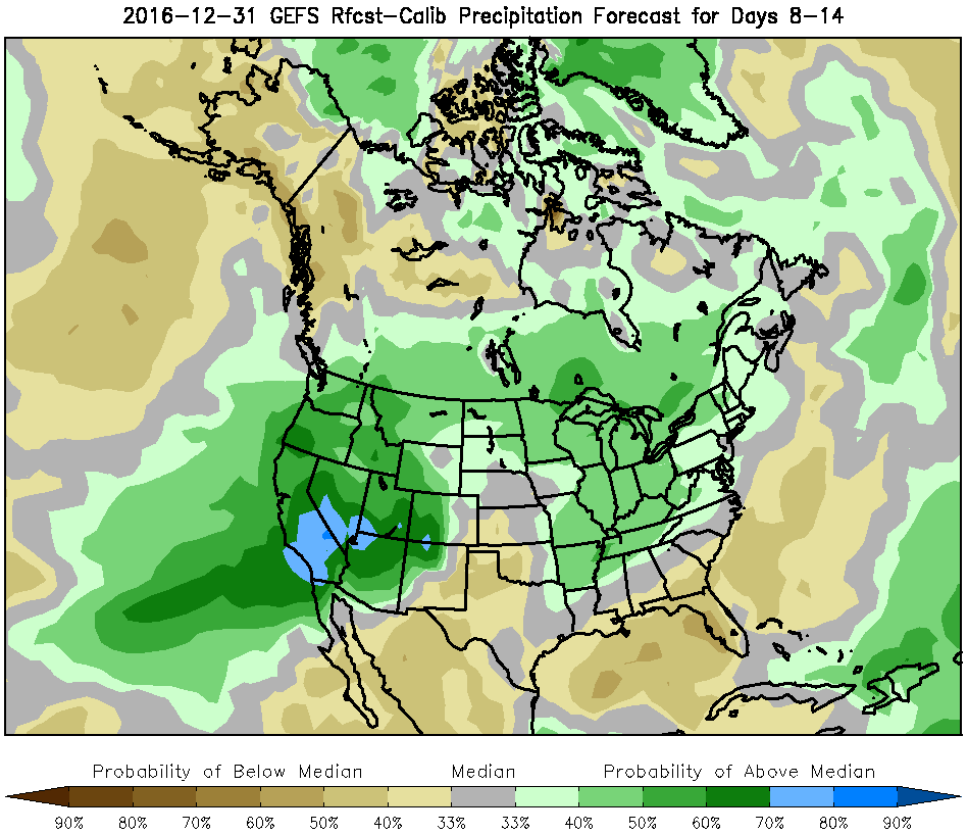
Ensemble Mean From State of the Art US Seasonal model and National and International Multi-Model Ensembles Forecast Below Normal Precipitation over California

January 2017 NMME Forecasts: NMME Probabilistic Forecast Indicates Near Normal Precipitation for California



Precipitation Forecast Products
Week 1 and 2 of January 2017

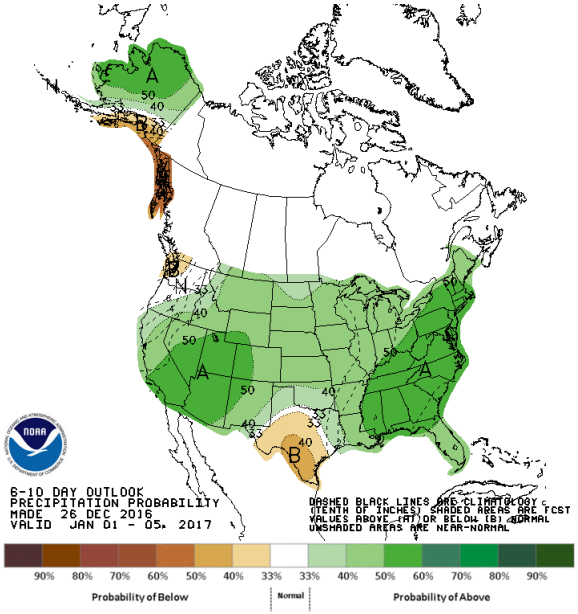




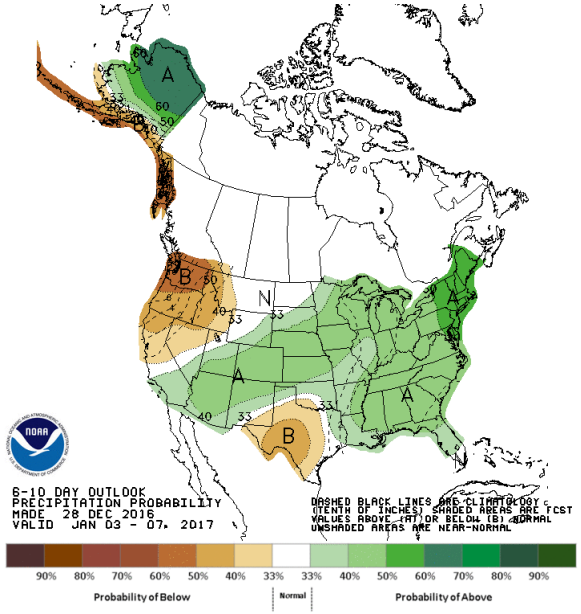
WPC 7 Day QPF: Forecast Above Normal Precipitation for Week One (But deterministic)

CPC Calibrated GEFS Day 8 to 14: Forecast Enhanced Probability of Above Normal Precipitation Over California. But probability is modest in Northern California

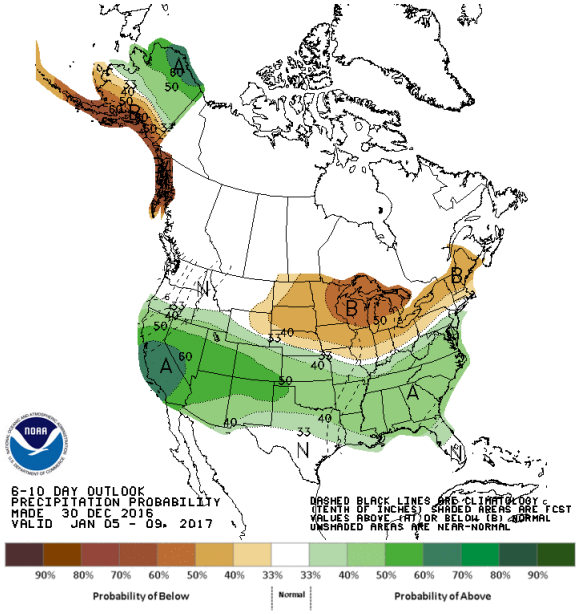
CPC 6-10 Day Precipitation Forecasts in Early January 2017



Valid January 1-5



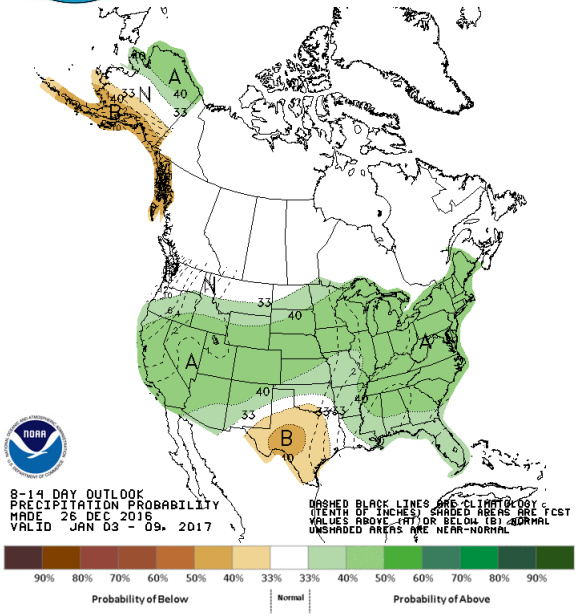
Valid January 3-7



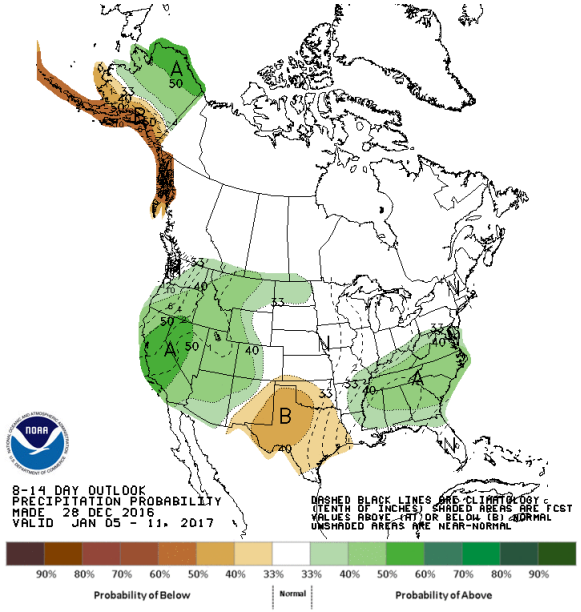
January 5-9

CPC Day 6 to 10 Forecasters Call for Enhanced Probability of Above Normal Precipitation for Early January 2017

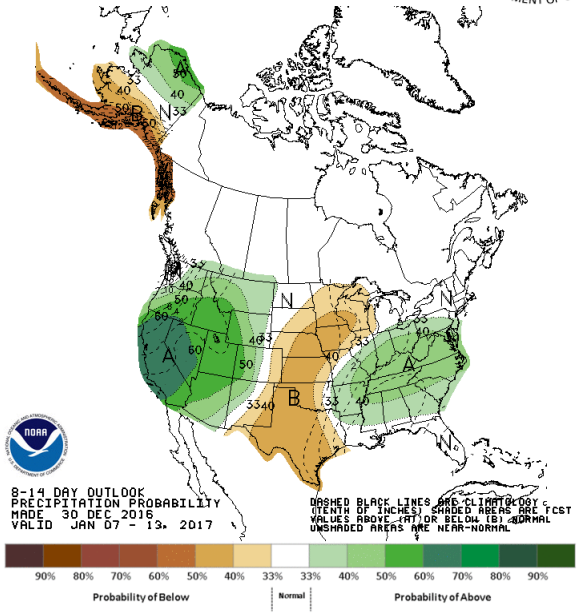
CPC 8-14 Day Precipitation Forecasts



Valid January 3-9



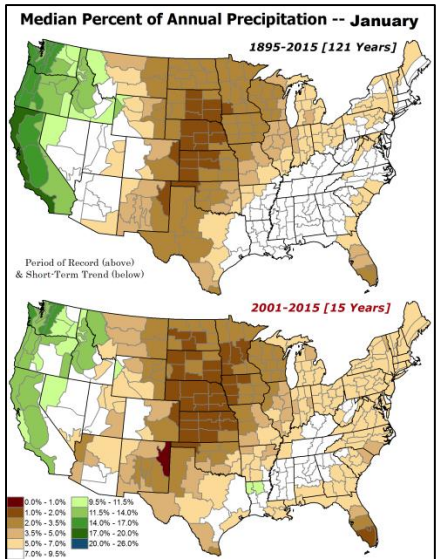
Valid January 5-11



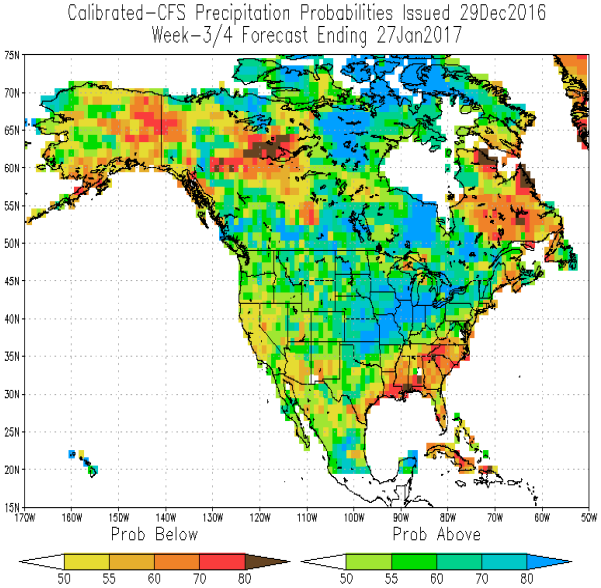
Valid January 7-13

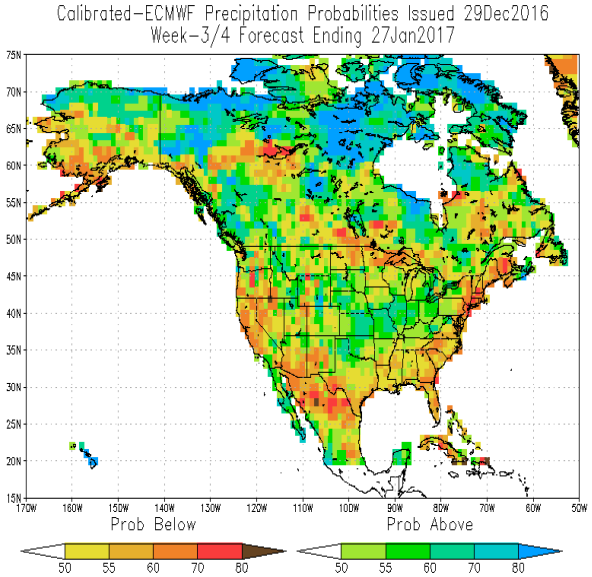
CPC Week Two Forecasters Call for Enhanced Probability of Above Normal Precipitation for Early January 2017

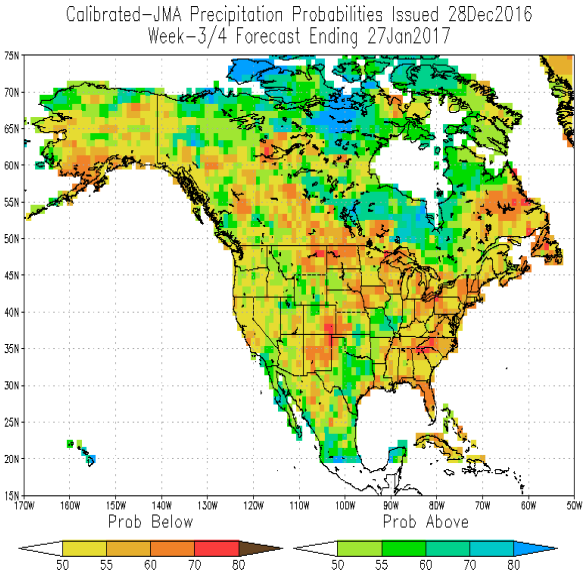
January Precipitation Climatology (long-term) has parts of California with up to 15-20% of their annual total, but lower percentage in the short-term. →



Week 3-4 Numerical Guidance Precipitation Forecasts Valid January 14-27, 2017:



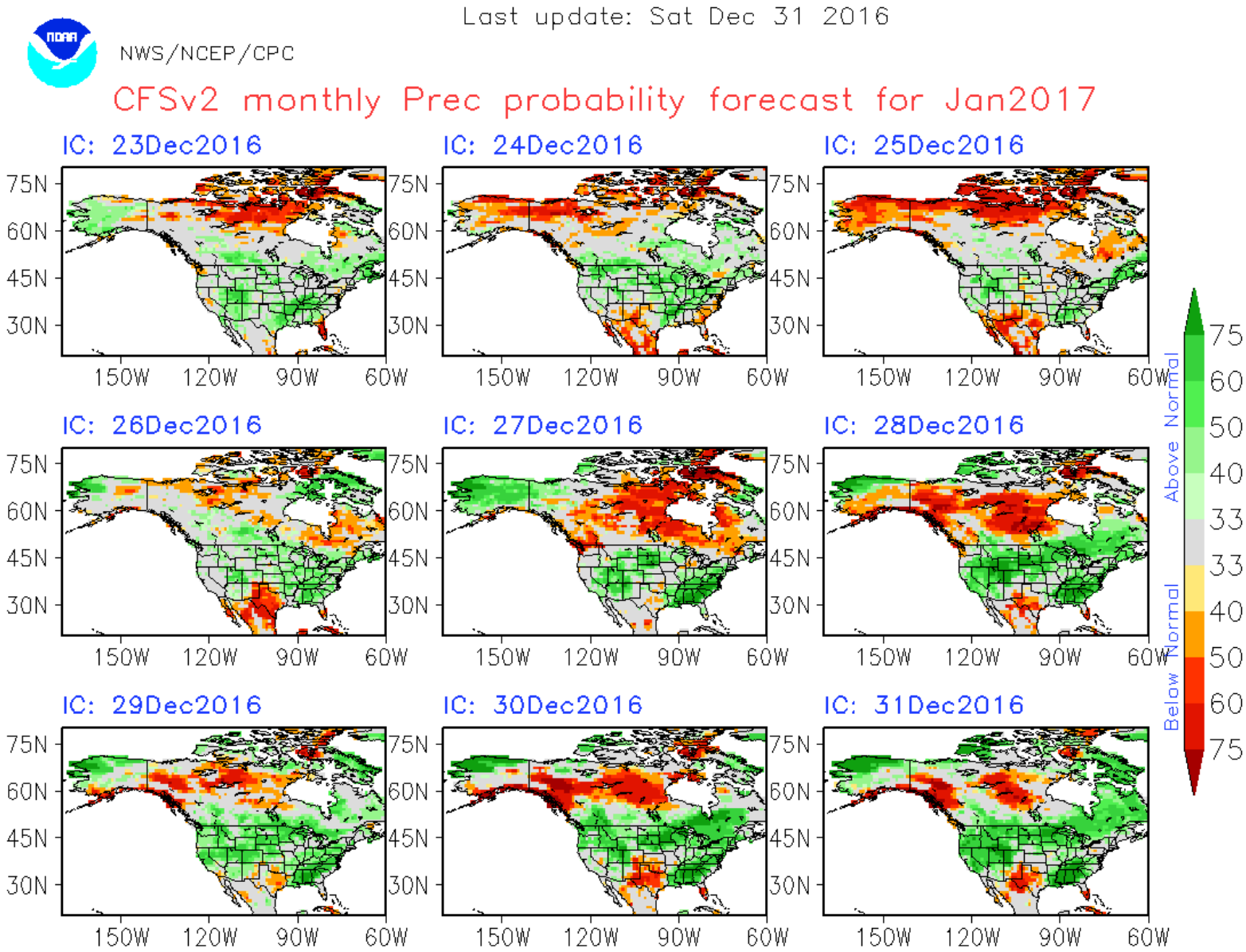




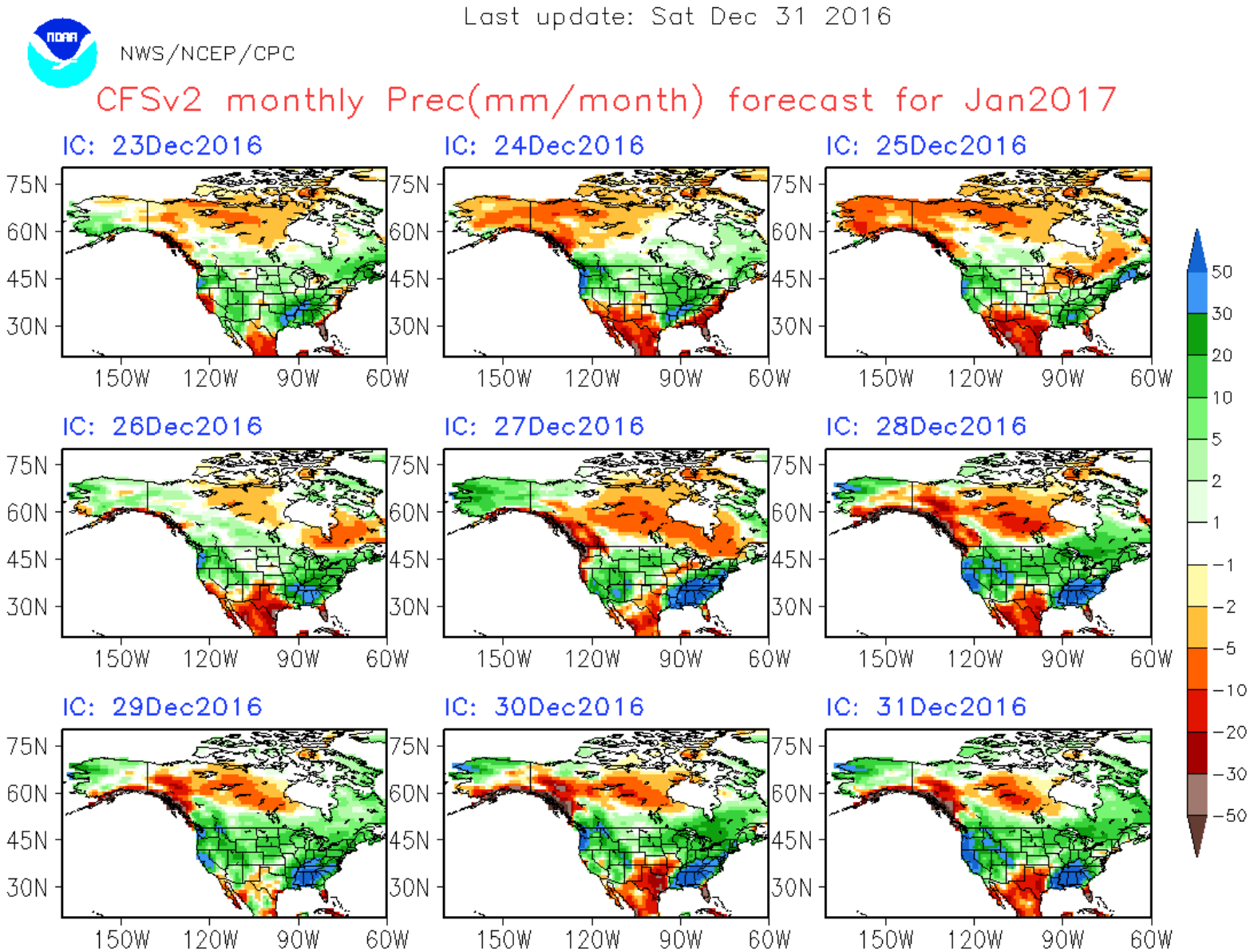
CFS **ECMWF** **JMA**

State of the Art Week 3-4 Guidance is Unanimous on Enhanced Probability of Below Normal Precipitation for California for Last Two Weeks of January 2017

CFS Probabilistic Forecasts for January 2017

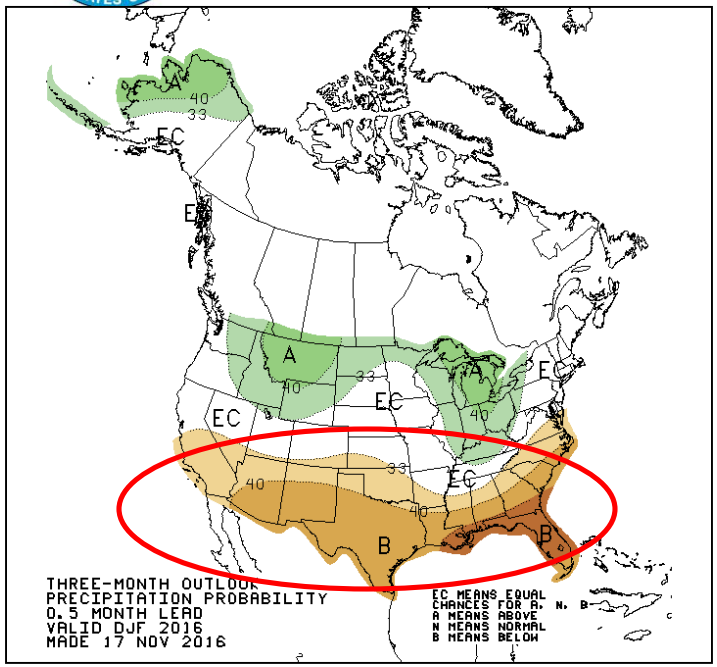


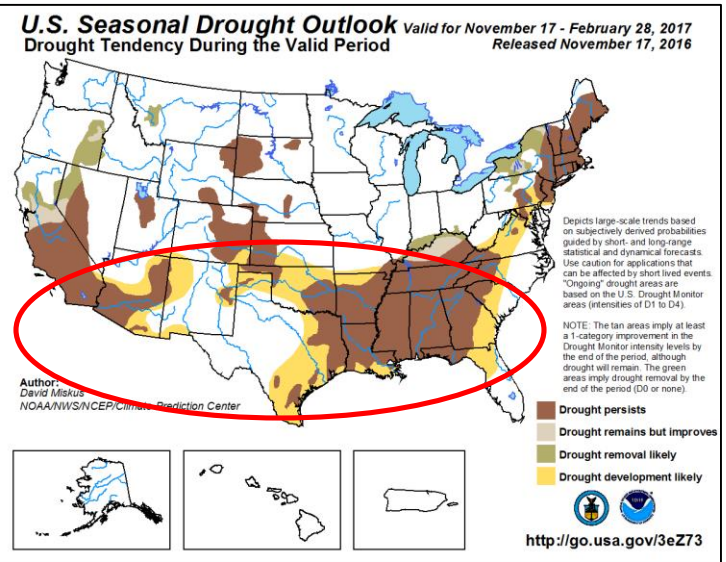
CFS Deterministic Forecasts for January 2017

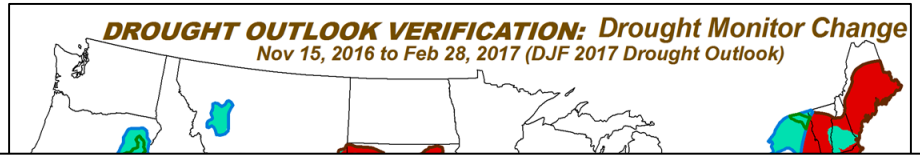


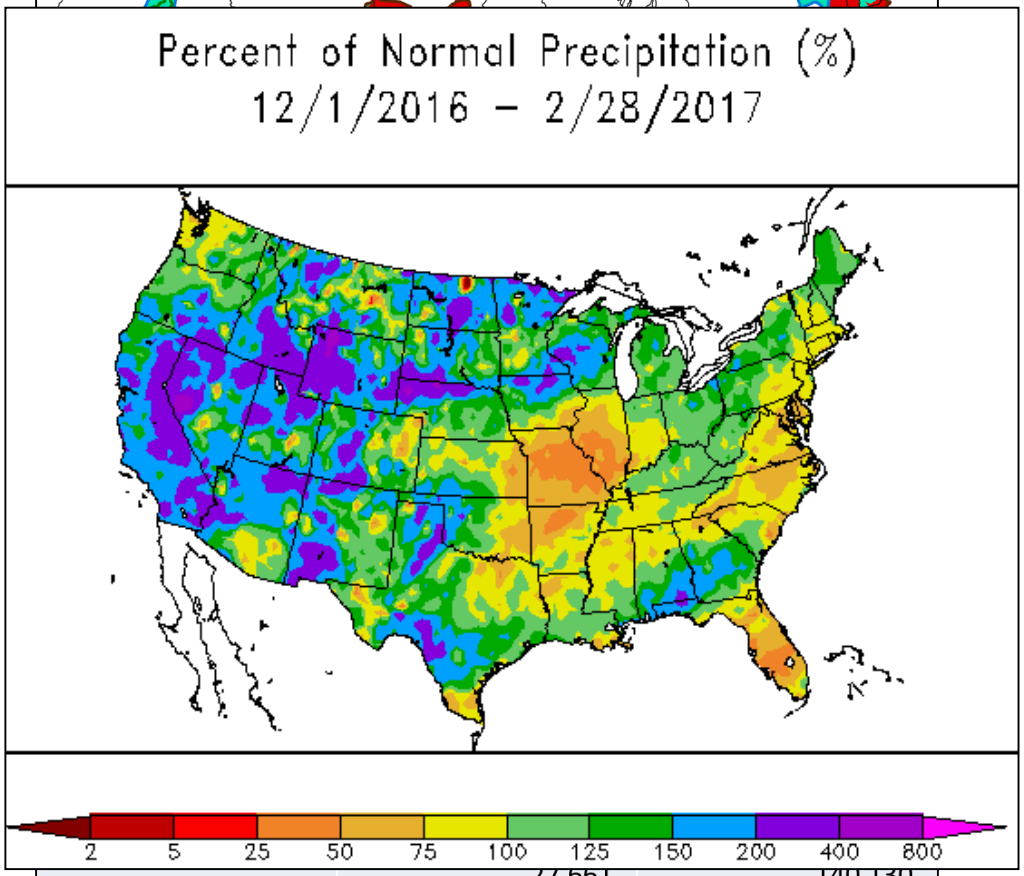
Consistency Between 3-Month Precipitation LLF & SDO

(If 3-Month PCP LLF is wrong, then SDO skill will be off [unless Persistence low]



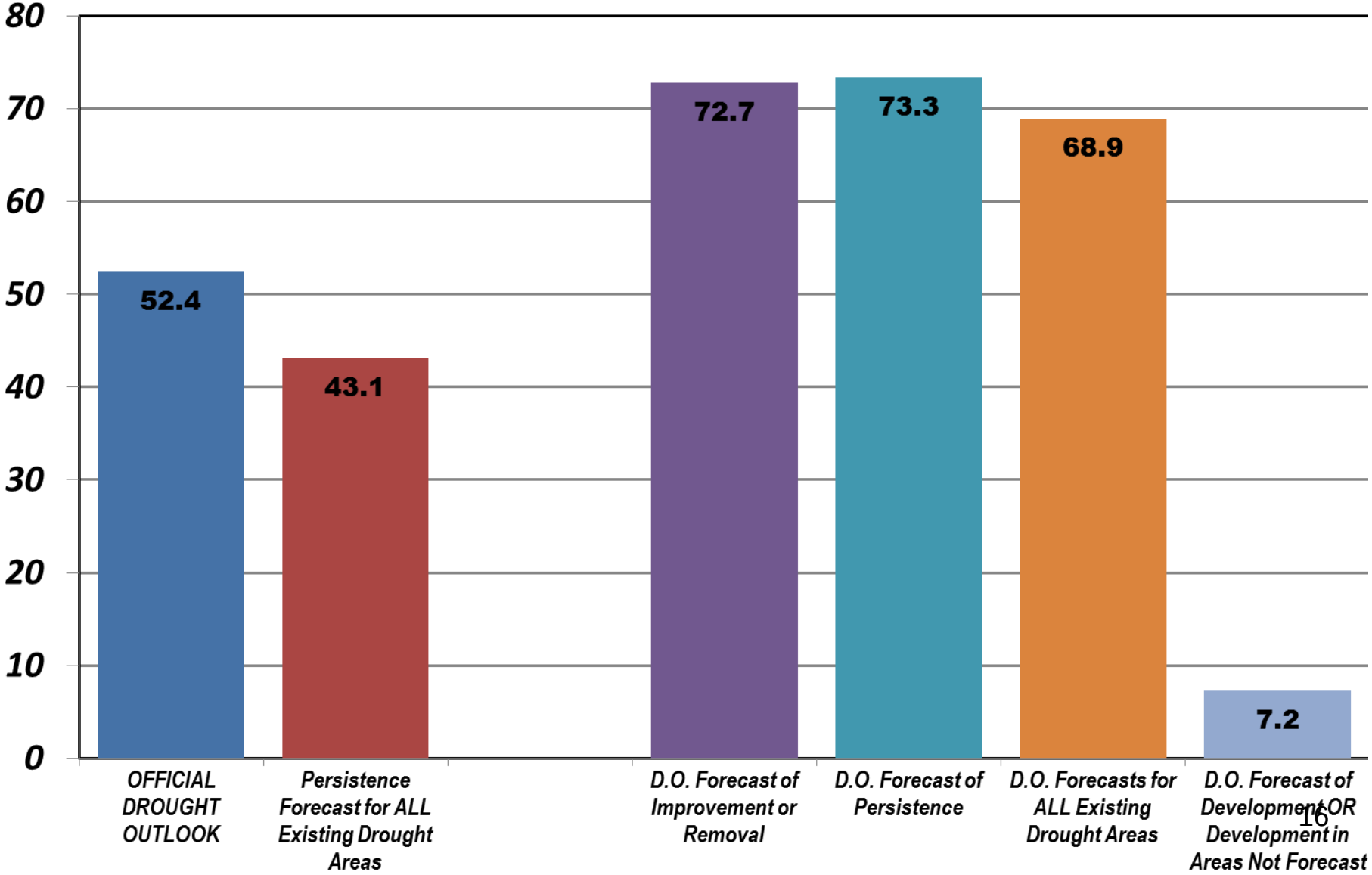






FORECAST BASELINE	27,661	140,130
PERSISTENCE FORECAST SCORE	***16.5***	
"SKILL"	*(forecast score) minus (persistence score)*	***+10.8***

Seasonal Drought Outlook: Median Percent of Area Successfully Forecast -- *DJF 2009/10 - OND 2016 Median*



Drought Outlook Challenges

- **Blending short-term forecasts with seasonal forecasts;**
- **Improving skill of forecasts (especially Precip & DO's Development) at all time ranges;**
- **Automation of production & verification;**
- **Providing useful information for both the agricultural & hydrologic community;**
- **Although there are many objective inputs into the Drought Outlook forecast generation, ultimately the forecast is produced subjectively using a human in the loop;**
- **Extensive stakeholder engagement in production leads to long production time (*hence no weekly or bi-weekly updates*);**
- **Should we move to a totally objective Drought Outlook?**
- **Should we move to a probabilistic Drought Outlook?**

  (According to Dr. Uccellini, a longer DO should be probabilistic)

Possible Solutions to the LLF and DO Products

CPC Deep Dive on Forecast Process and Tools Given the January 2017 Forecast

CPC has established a project to conduct a deep-dive review of our existing forecast tools and procedures to ensure that we are providing the most accurate forecasts and that forecasts are consistent across timescales and between products – "Consistency Improvement Project".

Deep dive parameters:

Led by CPC Deputy Director Mike Halpert;

Formally managed as a project with regular progress reports and a charter.

Charter will be provided to the NCEP Director, COO, and NWS AA for review to ensure that there is agreement on scope and timeline.

Technical issues to be discussed as part of the deep dive include:

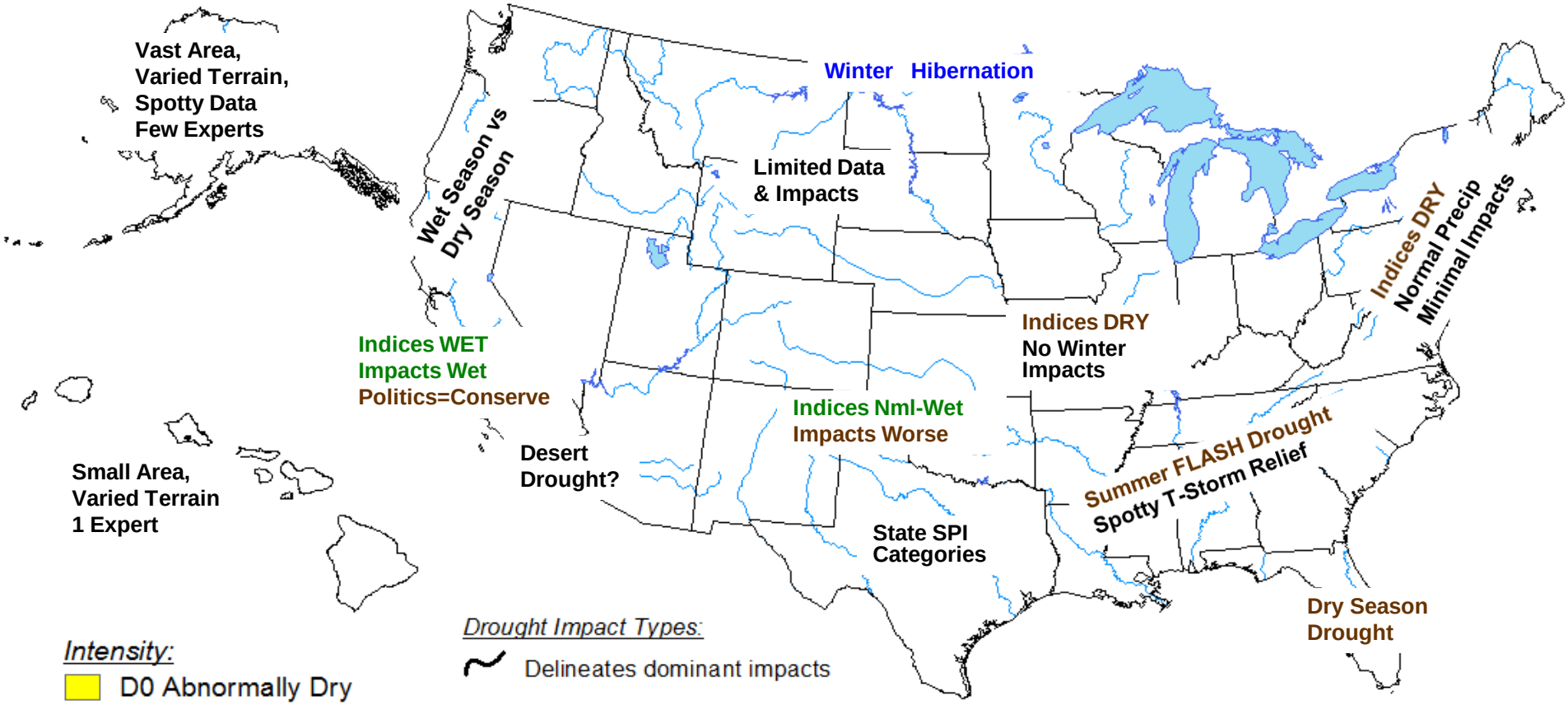
Evaluation of potential for objectively combining some or all of the following products/tools to provide the forecaster with better guidance to inform the monthly forecast and ensure consistency with shorter timescale products: GEFS, CFS, NMME, Environment Canada, WPC Day 1-7 QPF and temperature, CPC Days 6-10 & Days 8-14 Temperature and Precipitation Outlooks, CPC Weeks 3-4 Temperature & Precipitation Outlooks.

Review of procedures for generating extended range and long-lead forecasts, Drought Outlook, and Drought Monitor. ***Recommendations to evolve the Drought Monitor will need to be taken in consultation with other partners in the consortium (Wed., Session 8, NDMC talk?).***

USDM Decision Process

- 11 different authors, 11 different "personalities" of analyzing the DM;
- 2-week shifts: 1st week generally more difficult (acclimation & spin-up) than 2nd week;
- Some authors get early jump on DM (Fri-Sun), others wait until Monday;
- Monday afternoon: Objective blends (Short, Long, Unified, Worst) provide a good general overview of the week's moisture conditions (by climate divisions). Worst blend provides general outline for Impact types. Unfortunately, weekly blends are not always produced on-time or routinely.
- Applicable data/products are color-coded to the appropriate D0-D4 level on the ArcMap. This makes it easier to see where improvement (wetter) or deterioration (drier) occurred that week;
- The DM data/product input and GIS map overlay display slightly differs between organizations. So NDMC is planning for DM author consistency by hosting a "one stop DM production shop" with secure 24/7 VPN Remote Access to updated data/products and GIS map overlay display [but will take ~1 year];
- Various weekly telecons/webinars (TX, NC, CA/NV, NM), state/regional NIDIS summaries (CO River Basin, ACF River Basins), and dozens of state climatologists with local impacts (some with specific Dx recommendations). Some authors take the recommendations as is, others make DM changes first, then look at recommendations and verify with modifications. This sometimes depends on the amount of time to work on the DM as many authors have other tasks to do Mon-Wed;
- DM analysis tries to take into account the seasonality (winter vs summer); regional climatology (West vs East); elevations; vegetation , soil, temperatures, wind differences (e.g. flash droughts in ag areas during growing season); and past moisture conditions (e.g. CA & S Plains long-term droughts with lingering hydro concerns). *Users have to remember the DM focuses on broad-scale conditions, and local conditions may vary*;
- With all of the various types of input to summarize, the DM is produced both objectively & subjectively since the indices sometimes do not match the field impacts (e.g. OK [indices wet, but reported ground impacts much drier] vs IL [indices dry, but no obvious dry impacts]);
- Unfortunately, some "users" have recently discovered the DM trigger for USDA $ drought relief and may be exaggerating their condition. *DM authors & local experts are unbiased w/r to the Dx levels and want proof of the impacts – hence the following CONUNDRUM slides*;

U.S. Drought Monitor



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months
(e.g. agriculture, grasslands)

L = Long-Term, typically >6 months
(e.g. hydrology, ecology)

Small Area,
Varied Terrain
Few Experts

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

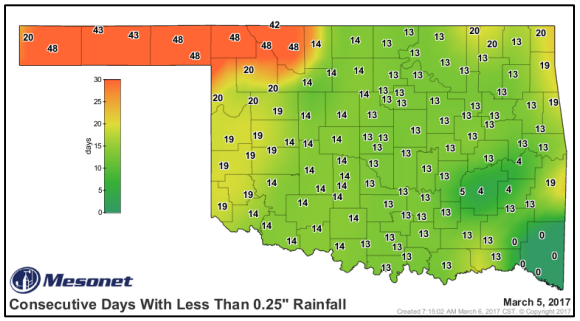
USDA National Drought Mitigation Center NOAA

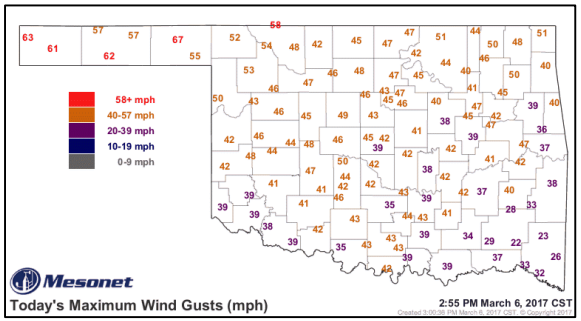
Conundrums

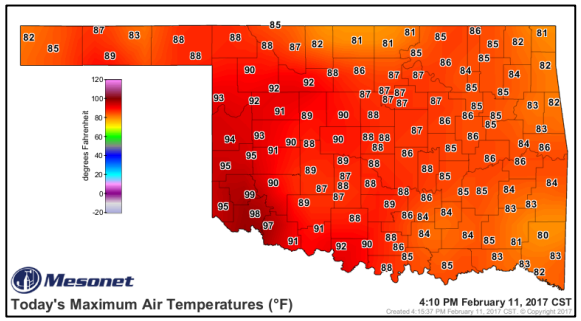
A Sampling of Conundrums

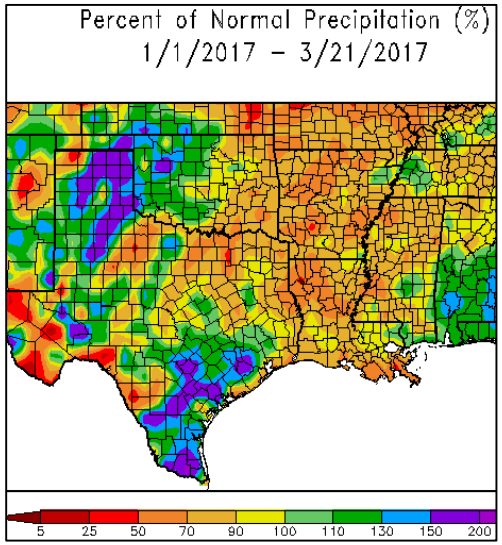
1) South-Central Plains (OK):

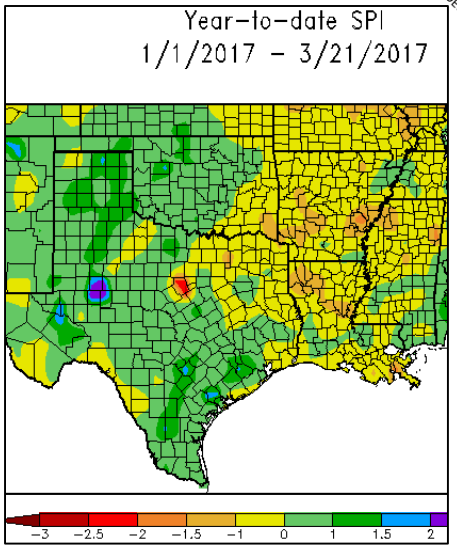
Short-Term Indices Normal-Wet,
but Impacts Severely Dry;
(Winter Warmth, Wind, low RH)

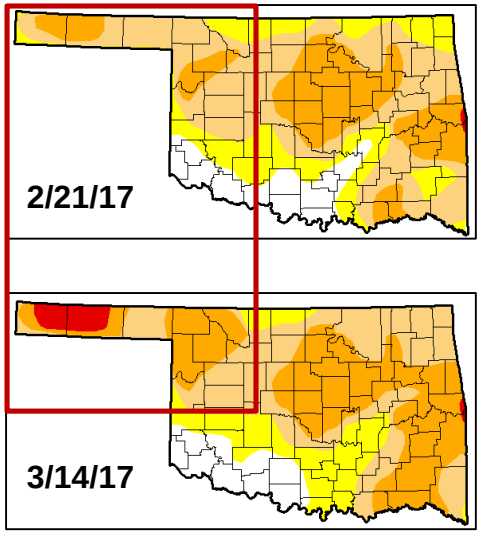








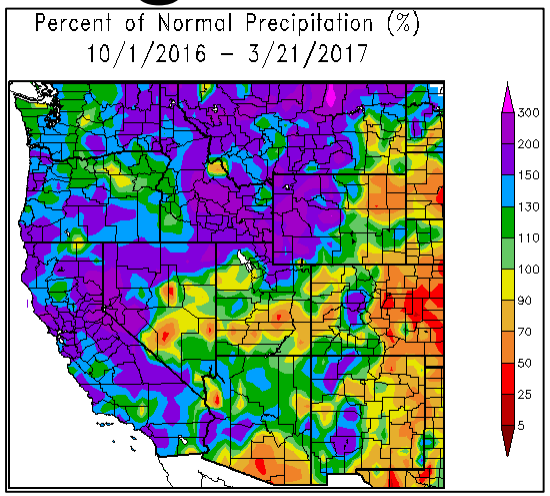


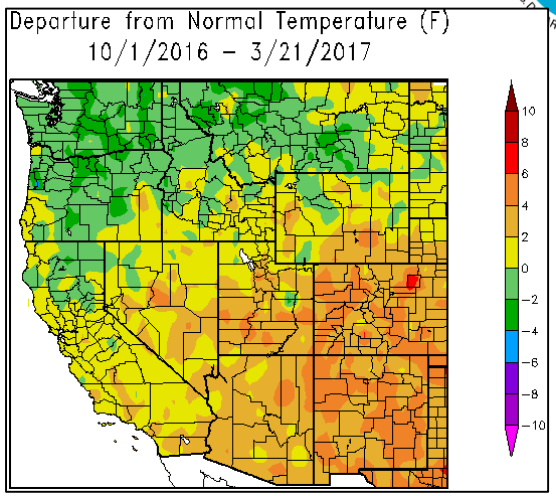


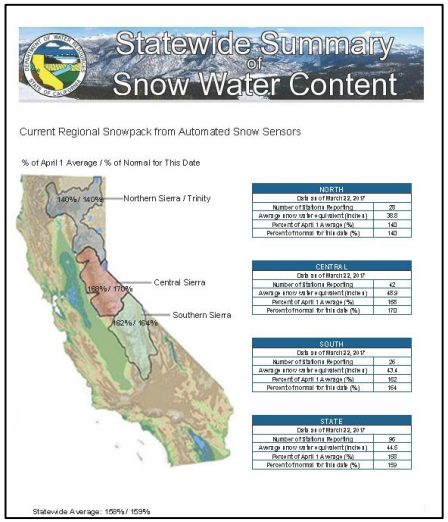
A Sampling of Conundrums

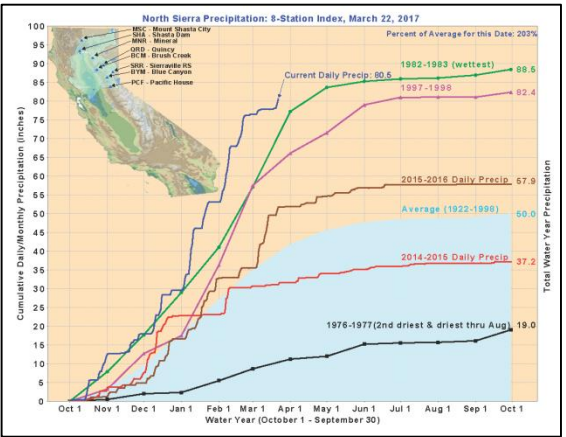
2) Far West (CA):

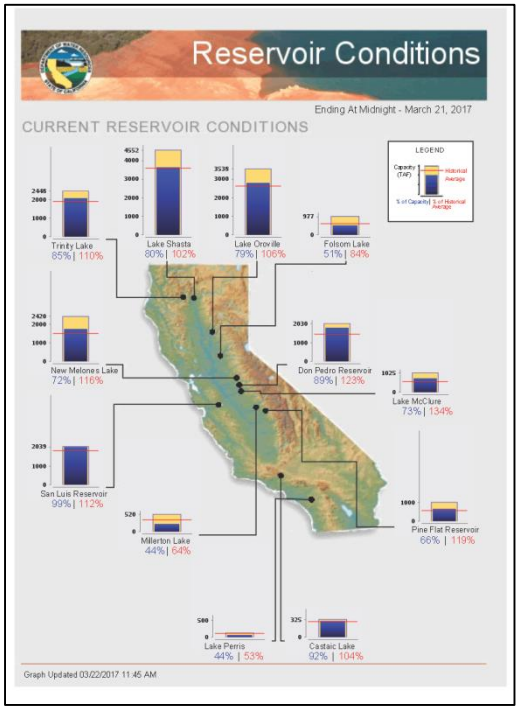
Short-Term Indices Very Wet,
Most Impacts Very Wet;
(Water Conservation - Drought)
"*Wait until April 1 for changes*"

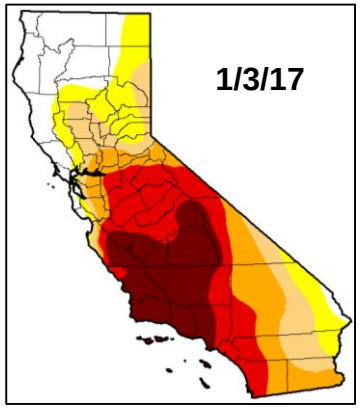


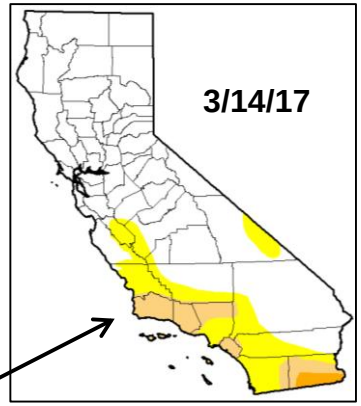










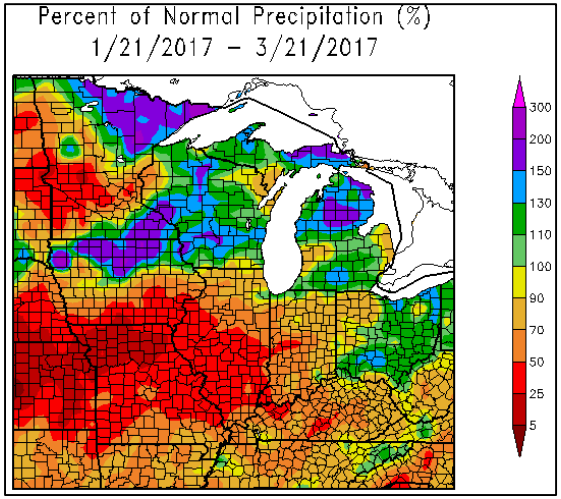


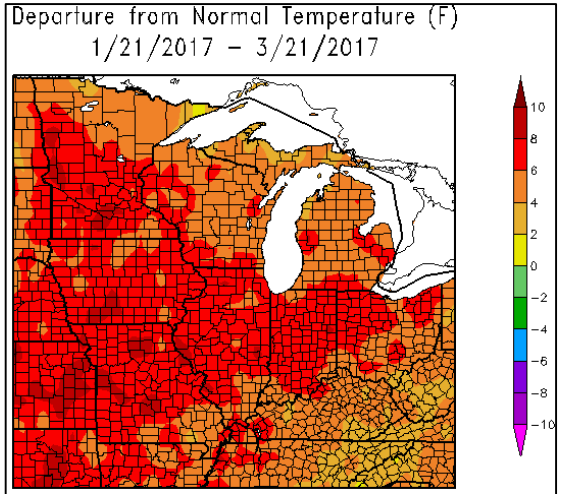
D1: Less precipitation & runoff
led to lower reservoir levels,
plus low ground water supplies

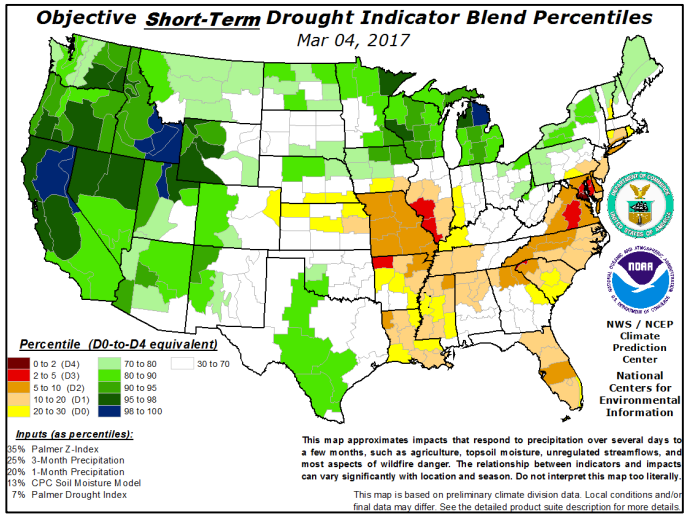
A Sampling of Conundrums

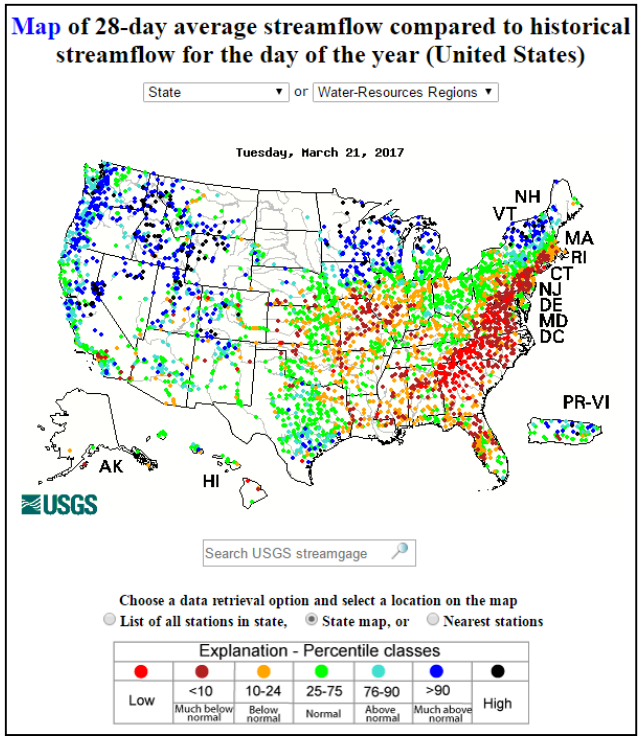
3) Middle MS Valley (MO, IL):

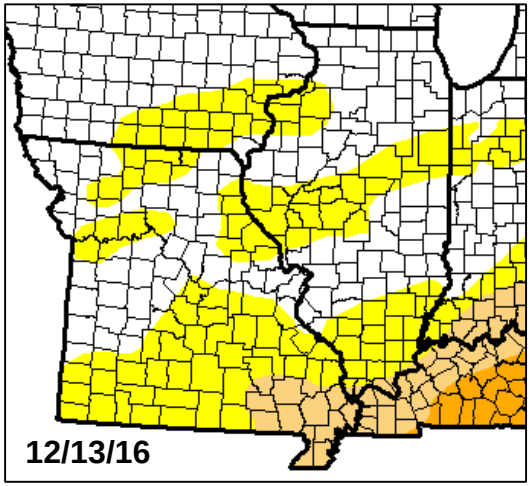
Short-Term Indices Dry & Warm
but No Real Impacts;
"*Drought without Impacts?*"

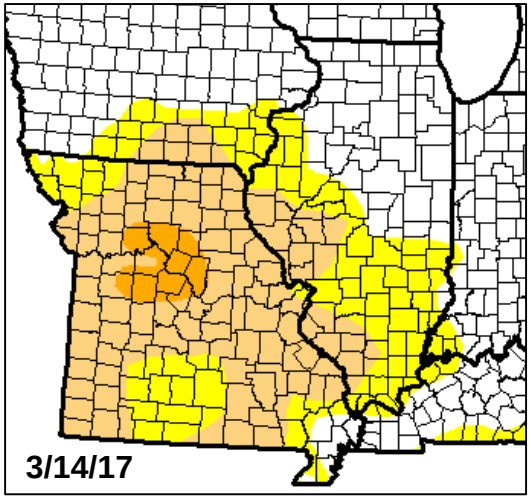






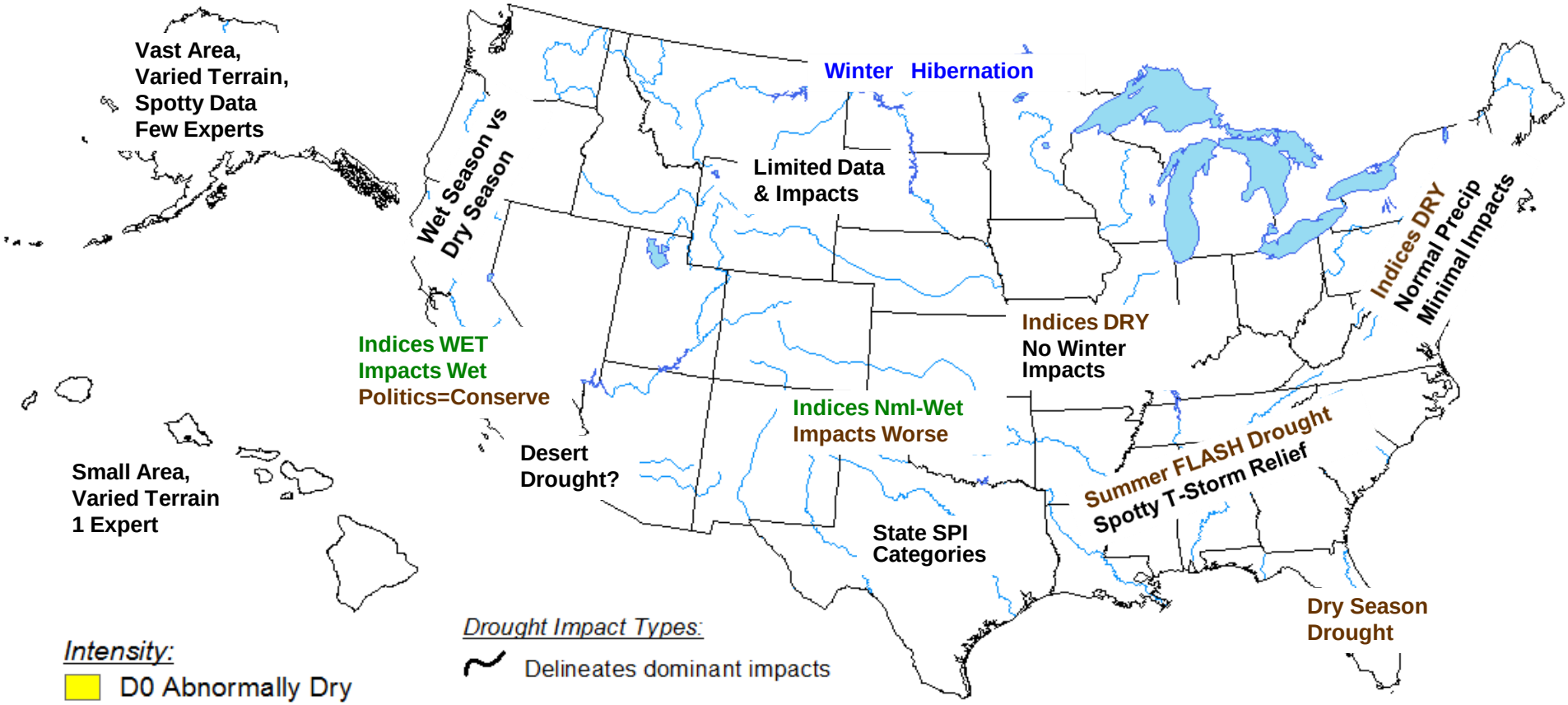






Farmers prefer drier spring fields for plowing & seeding, but if not depicted earlier, drought would quickly appear during growing season.

U.S. Drought Monitor



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months
(e.g. agriculture, grasslands)

L = Long-Term, typically >6 months
(e.g. hydrology, ecology)

Small Area,
Varied Terrain
Few Experts

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

USDA National Drought Mitigation Center NOAA

Conundrums

USDM Conundrum Conclusions

- ***Can Drought Develop during Winter in northern (cold) States?***

  Yes, especially when extended subnormal precipitation is combined with abnormal mildness and lack of snow & frozen ground, even if there are no obvious impacts. If not designated during the winter, drought could quickly ramp up ("pseudo flash drought") in the Spring once temperatures and evapotranspiration increases. Similarly, drought can develop in southern (mild) States with a dry Winter season [e.g. Florida], although it may take a while. In contrast, areas in winter hibernation [e.g. completely frozen ground with snow cover; interior Alaska] generally do not, but may have "snow drought" designated as D0 (keep an eye on).

- ***When most indices/data = normal/wet but Impacts = dry, it is drought?***

  Yes, as the indices may not catch all of the subtle signs from unusual parameters [e.g. abnormal warmth, high winds, low humidity] or from past long-term drought [e.g. 2011 SC Plains] that probably did not get completely alleviated. This is why ground-based reported impacts are critical to the DM.

- ***When indices/data AND Impacts = less drought & local experts say no change?***

  A tough one as sometimes the local experts are basing their recommendations on government/political concerns [e.g. CA - keeping mandatory water restrictions after heavy precipitation events], or, unfortunately, wanting to maintain or get USDA drought aid based on >D2 ratings. However, we must produce an unbiased DM analysis based upon "*convergence of evidence*".

Considering the demands placed upon each author and all of the evidence [indices, impacts, emails, etc.] to sift through, I believe we have & are doing a very good job. Can we do better? Sure, but that's a discussion for another talk on Wed.

Thank You!

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