Overview of WY19 AR Activity in FIRO watersheds

F. Cannon – FIRO Workshop - 2019

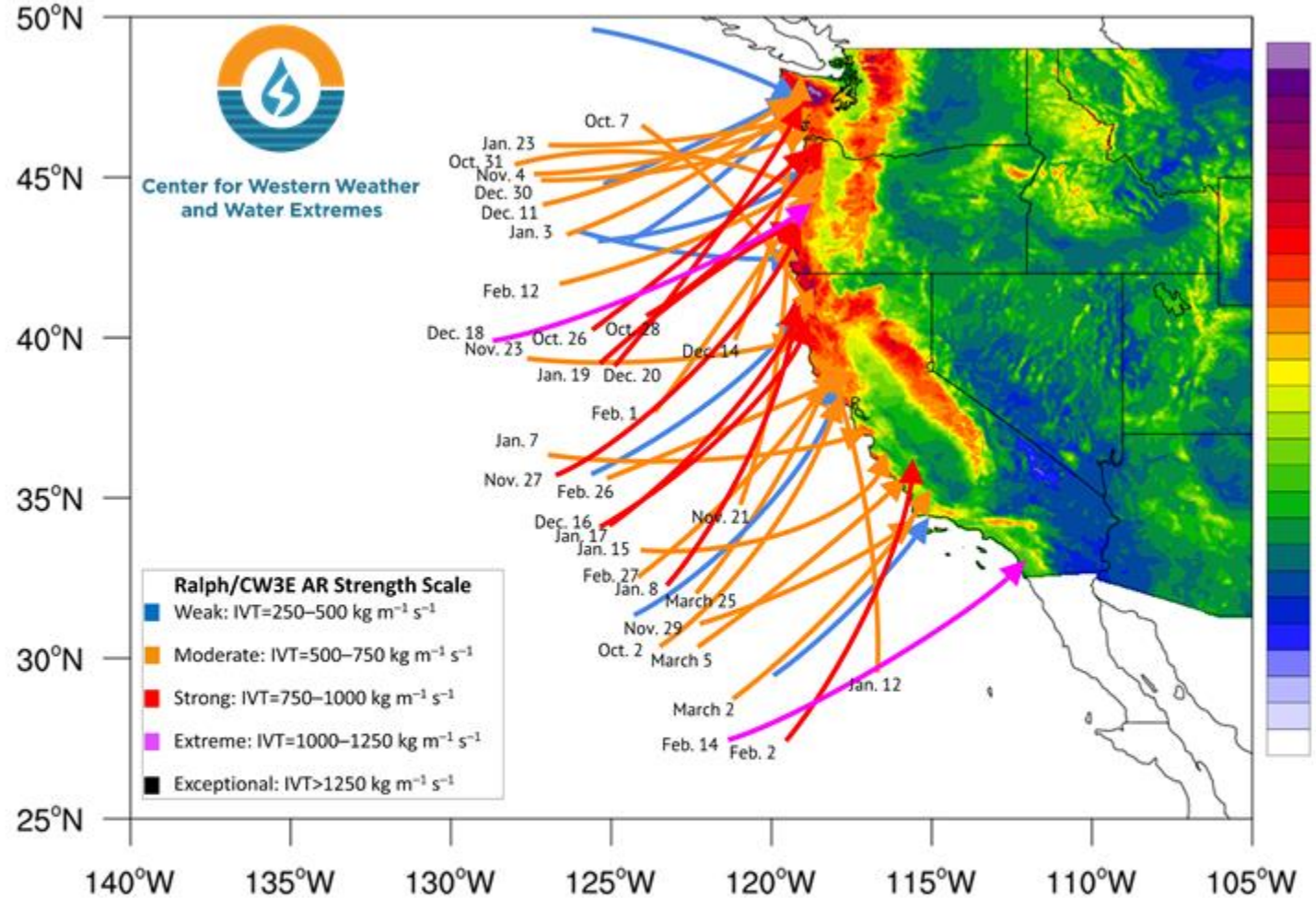
Lake Elsinore, CA

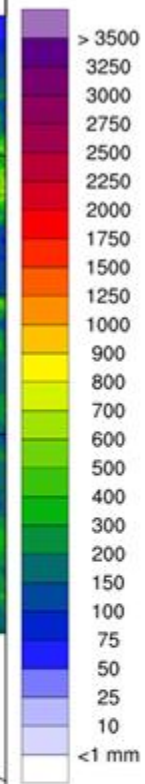
Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

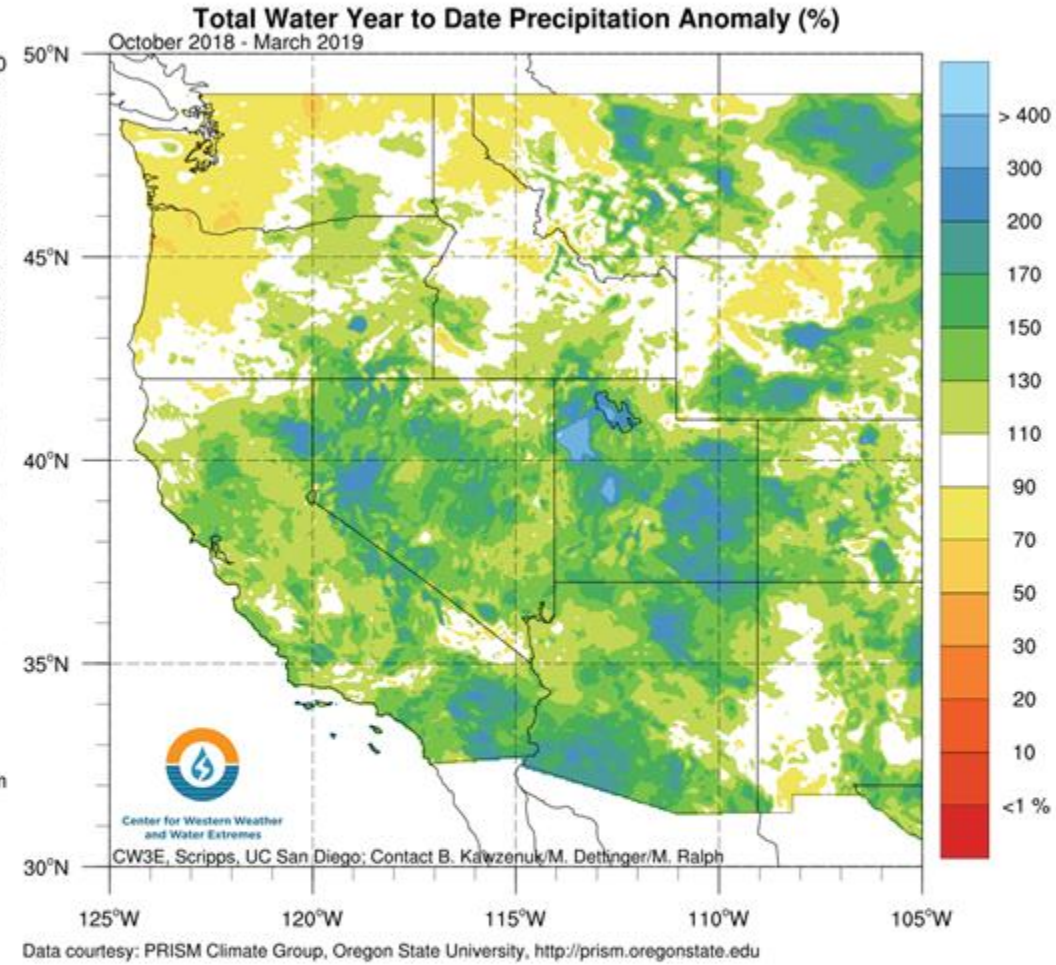
SCRIPPS INSTITUTION OF OCEANOGRAPHY

UC San Diego

Water Year to Date Summary (October through March)



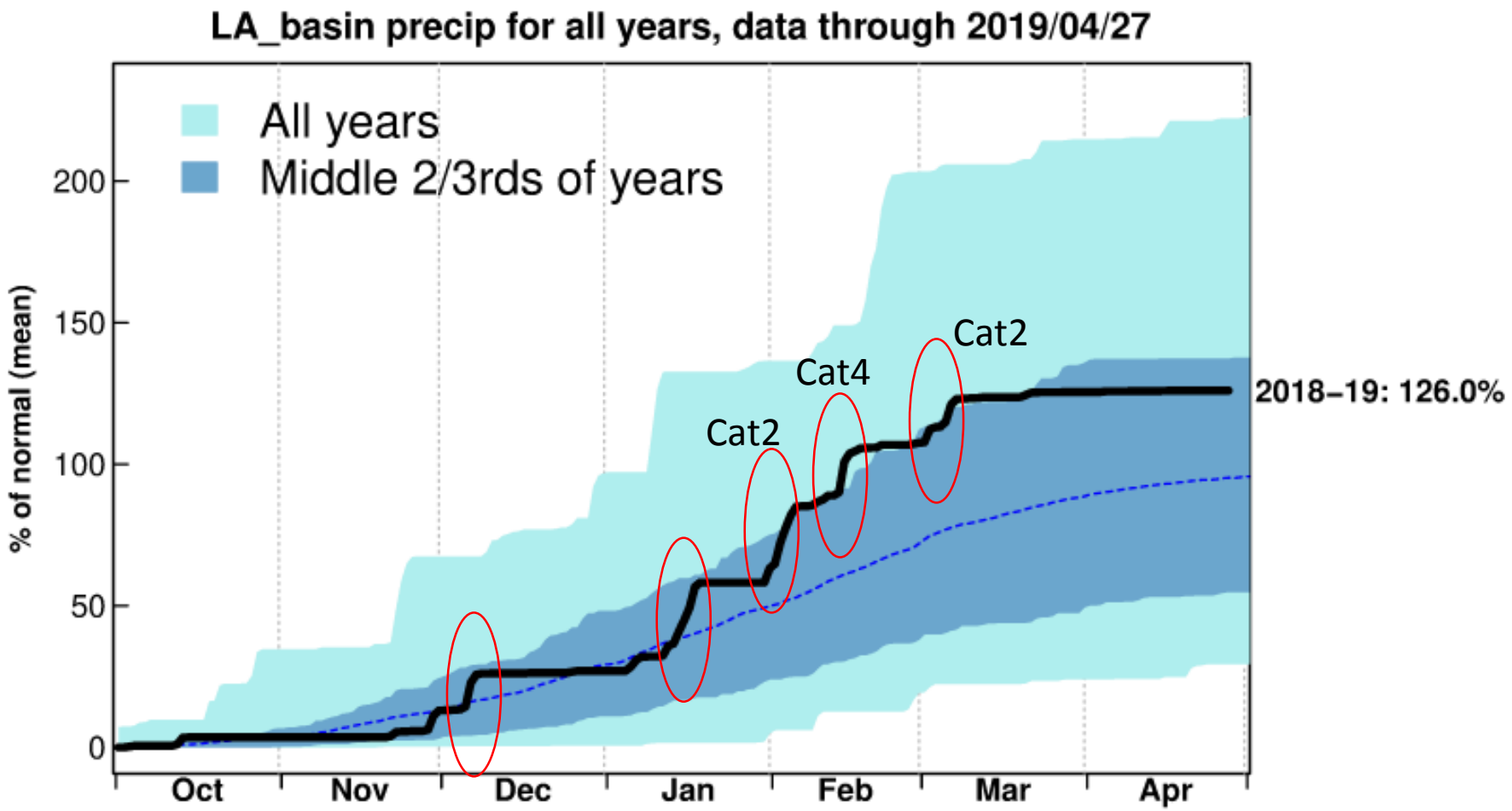




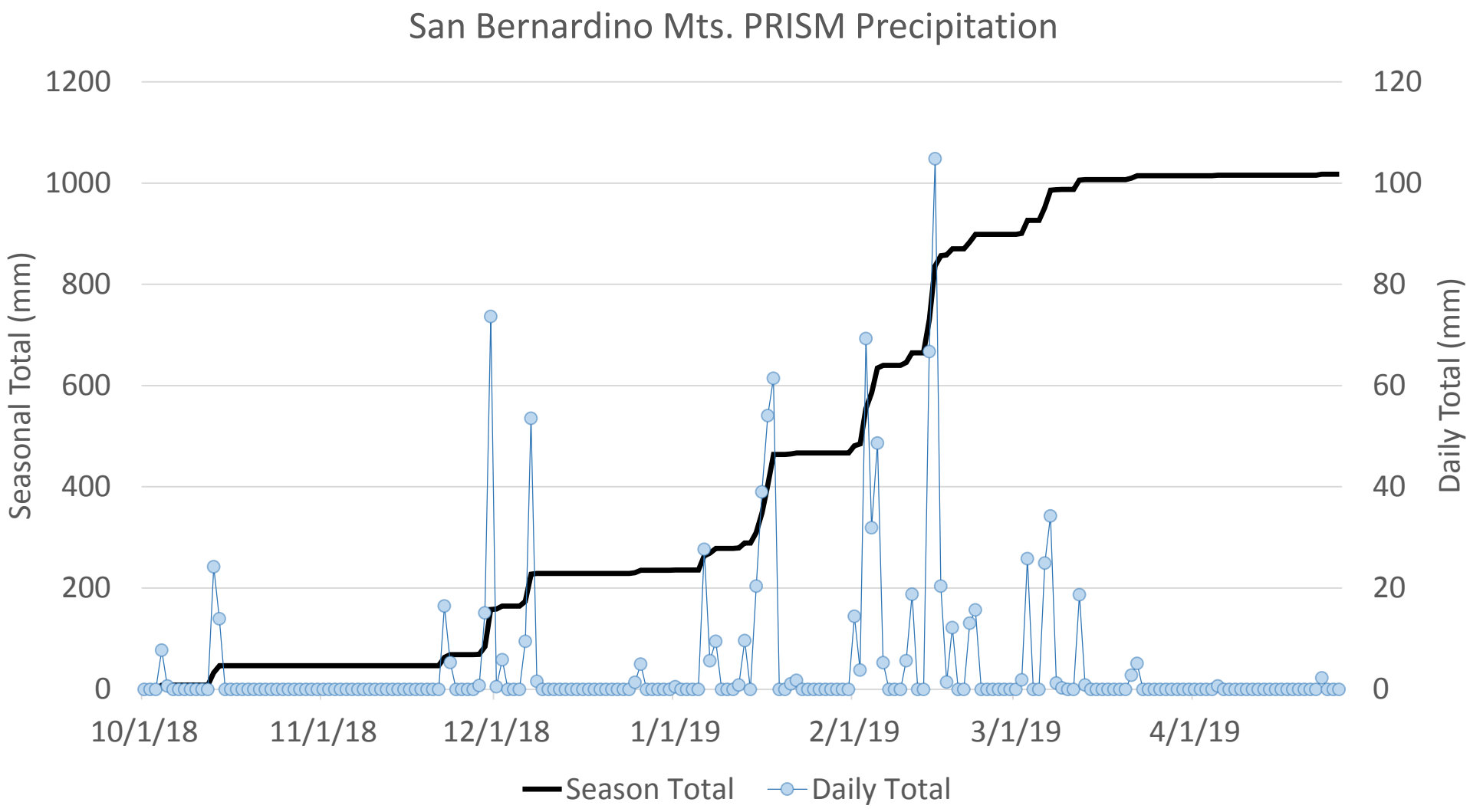
The 5 ARs that made landfall during March 2019 brings the Water Year total to 41 (8 Weak, 22 Moderate, 9 Strong, and 2 Extreme)

The total number that made landfall through March 2018 was also 41 (14 Weak, 16 Moderate, 9 Strong, and 2 Extreme)

- Through March 2019, a majority of the Western U.S. has received near normal or above normal water year to date precipitation
- Western WA and OR are the only locations that have received below normal accumulations

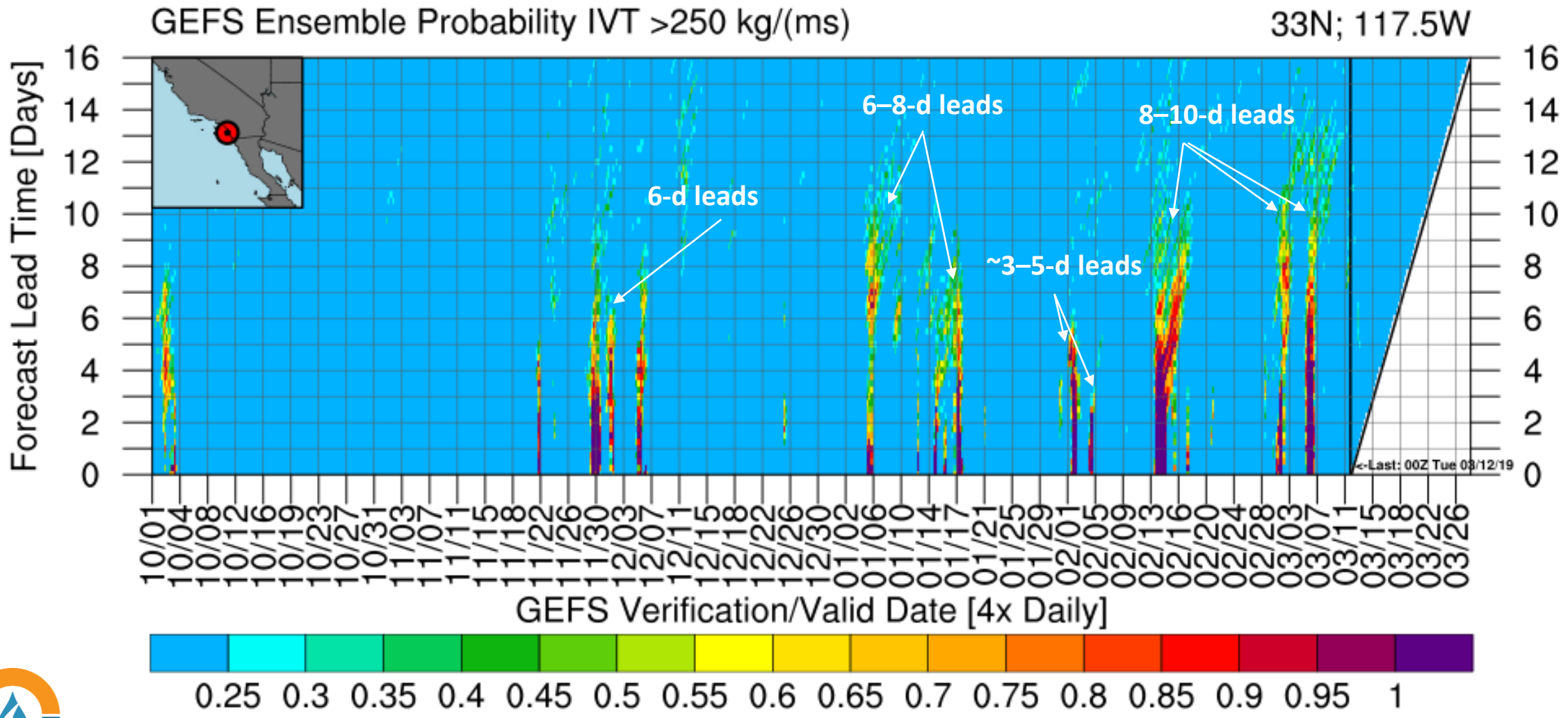


Seasonal precipitation defined by 5 AR events (all were detailed on CW3E webpage)


San Bernardino Mts. PRISM Precipitation
Seasonal Total (mm)
Daily Total (mm)
1200
1000
800
600
400
200
0
120
100
80
60
40
20
0
10/1/18
11/1/18
12/1/18
1/1/19
2/1/19
3/1/19
4/1/19
Season Total
Daily Total

SAN [33N, 117.5W]

NCEP GEFS probability of IVT magnitude >250 kg/(ms) by verification/lead



Provided by: J. Cordeira

BBY [38N, 123W]

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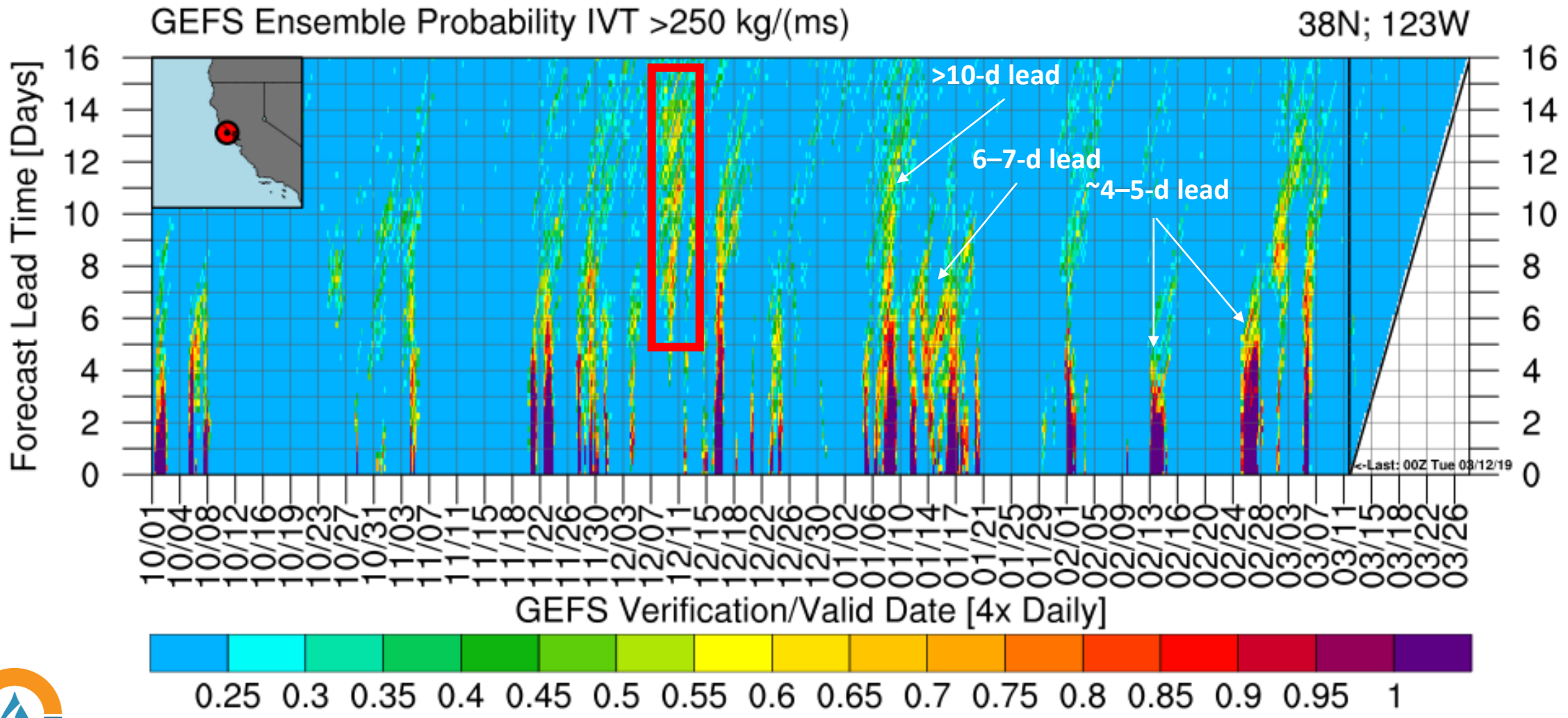


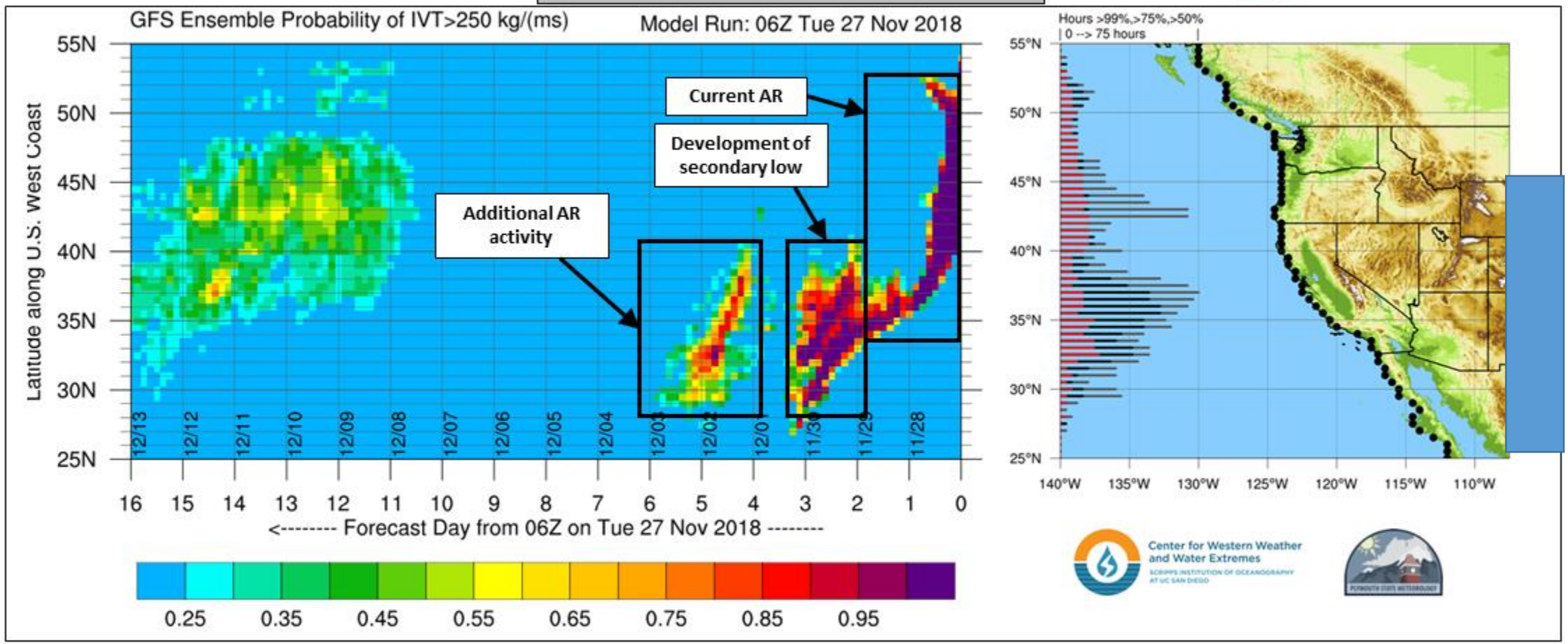
Provided by: J. Cordeira

AR Outlook: 27 November 2018

For California DWR's AR Program

Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

Odds of AR Conditions Along Coast



- The AR that is currently impacting the Pacific Northwest is forecast to propagate over the U.S. West Coast bringing AR conditions to the Bay Area today and Southern California on Thursday
- As the AR is impacting SoCal, a secondary low is forecast to develop along the cold front, resulting in extended duration of AR conditions over SoCal
- This secondary low is also forecast to propagate inland over CA, bringing additional precipitation and high winds to the mountains.

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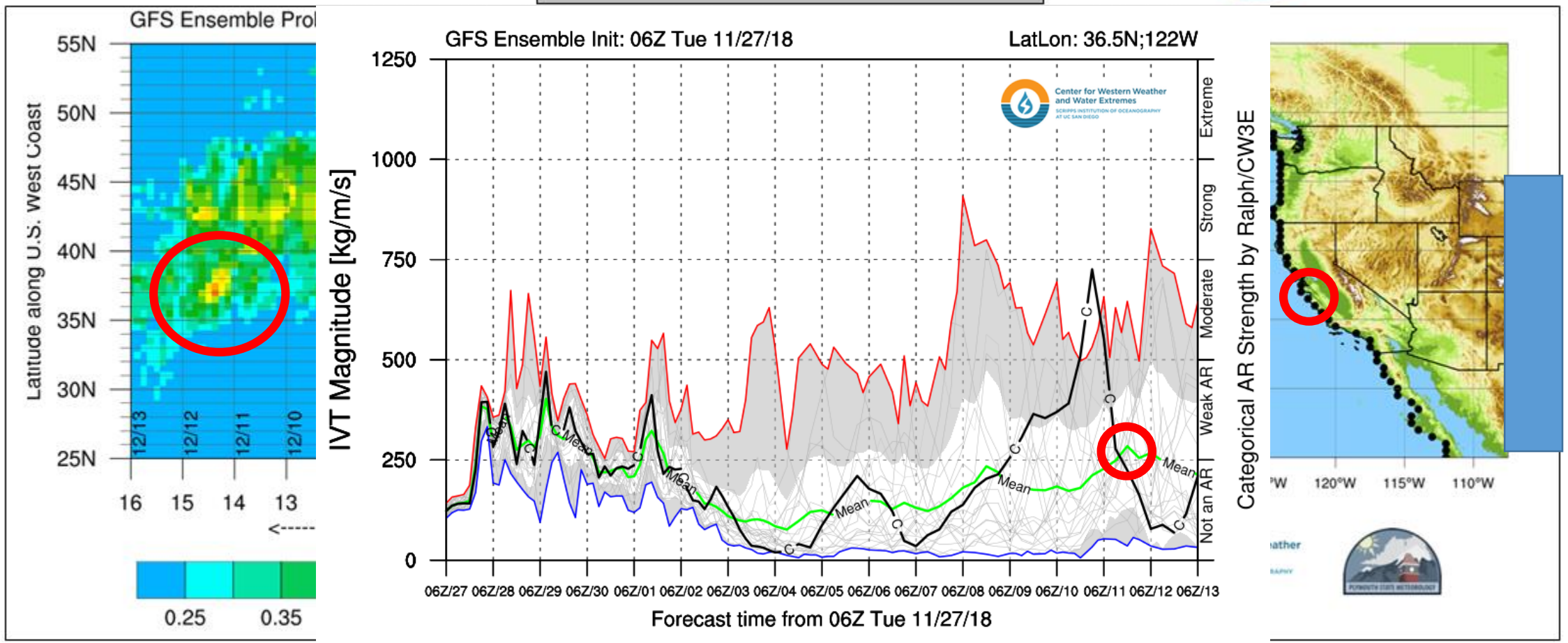

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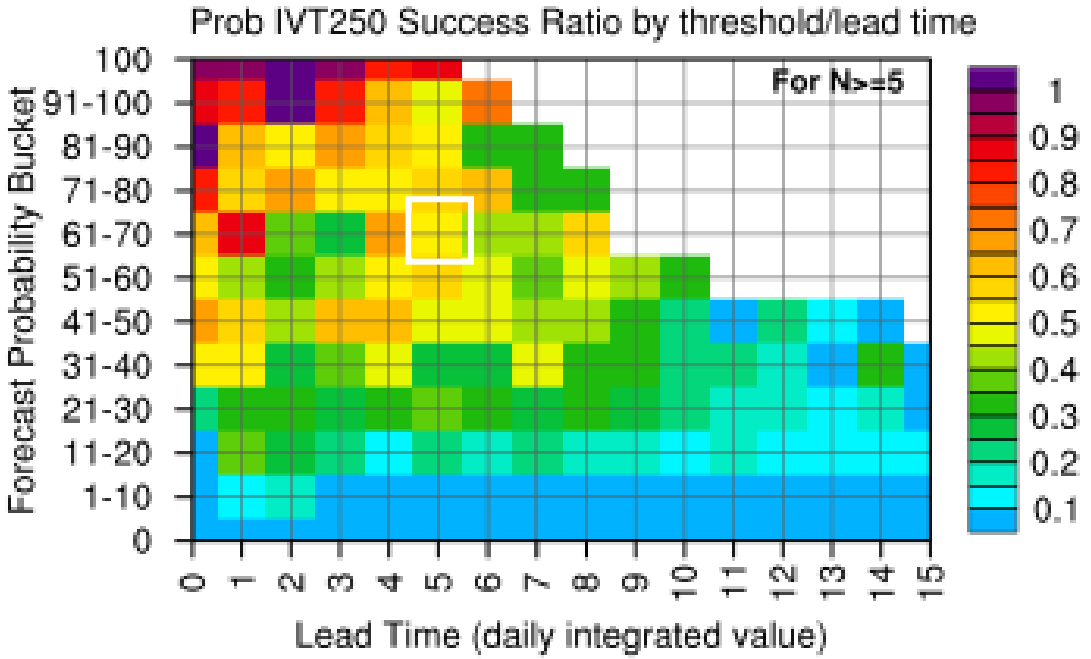
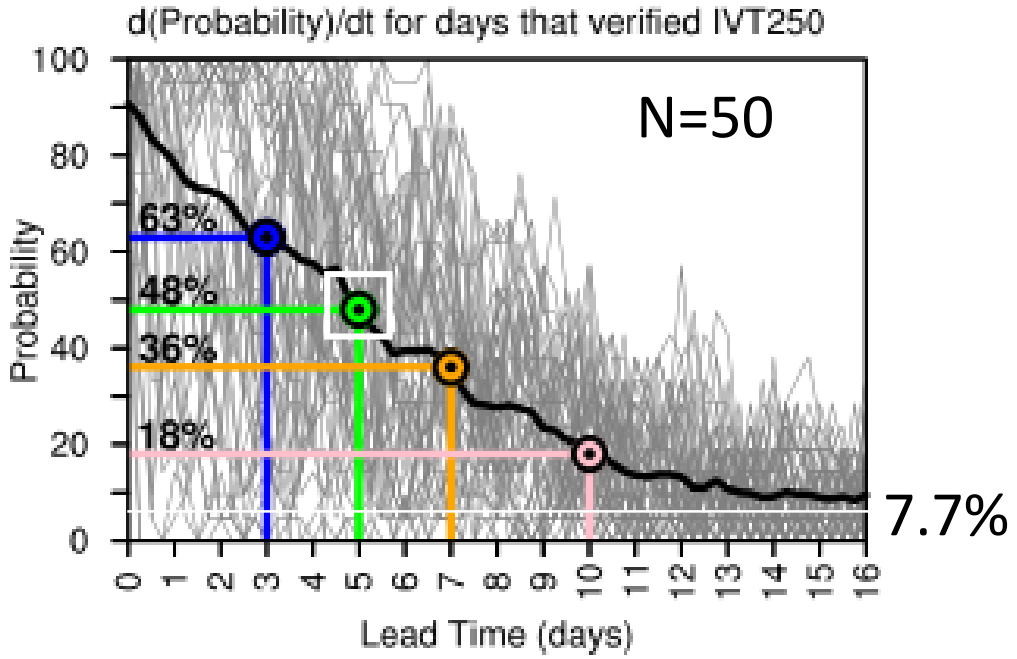
SAN [33N, 117.5W]

Summarized verification statistics by lead time:
Success Ratio & Average Probability





For a given IVT250 forecast probability (e.g., 61-70%) and a given lead time (e.g., 5 d), how often did that accurately predict IVT>250 kg/(ms) at verification? → ~50–60% of the time

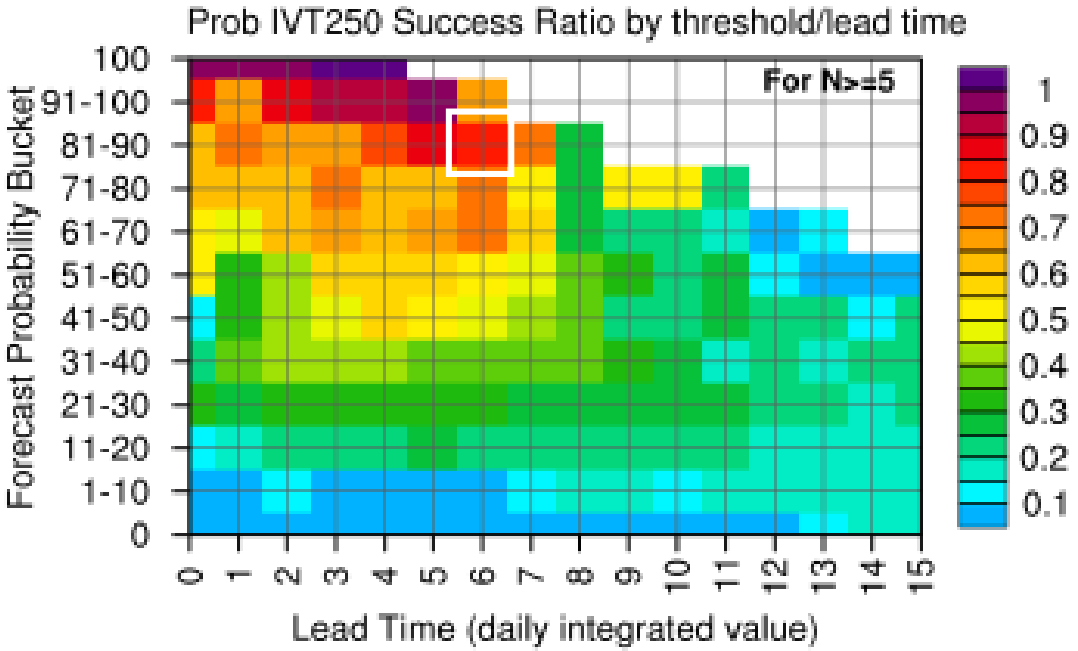
For times with IVT>250 kg/(ms) at verification, what was the lead-time IVT250 forecast probability? At 5-d lead, 48% of ensemble members predicted IVT>250 kg/(ms) on average

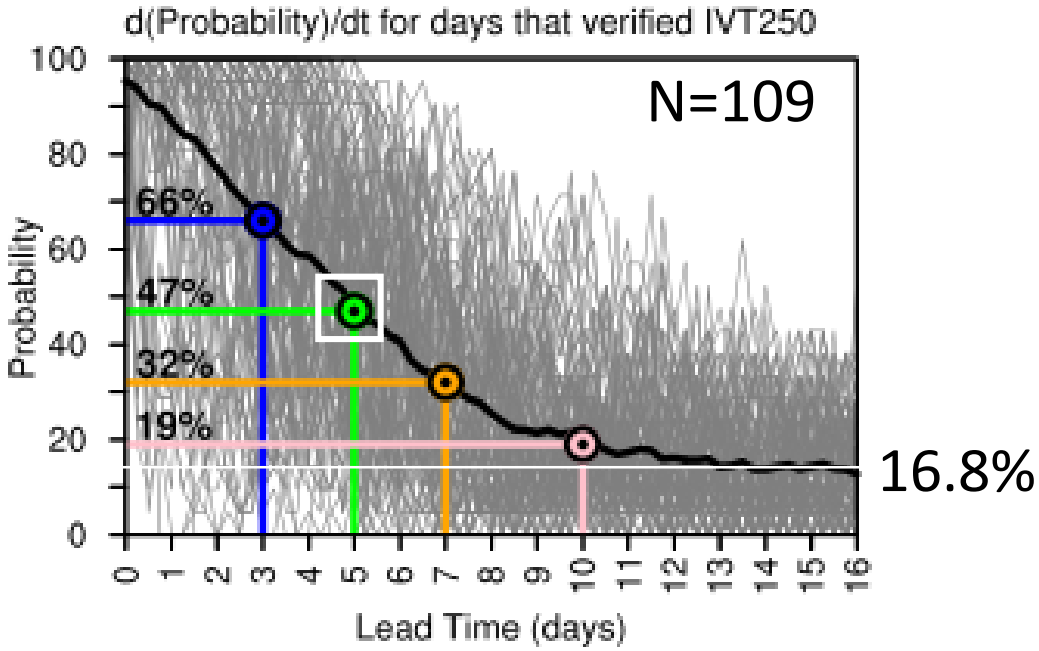
Note :7.7% of times had IVT250 (60/648)

Provided by: J. Cordeira

BBY [38N, 123W]

Summarized verification statistics by lead time:
Success Ratio & Average Probability





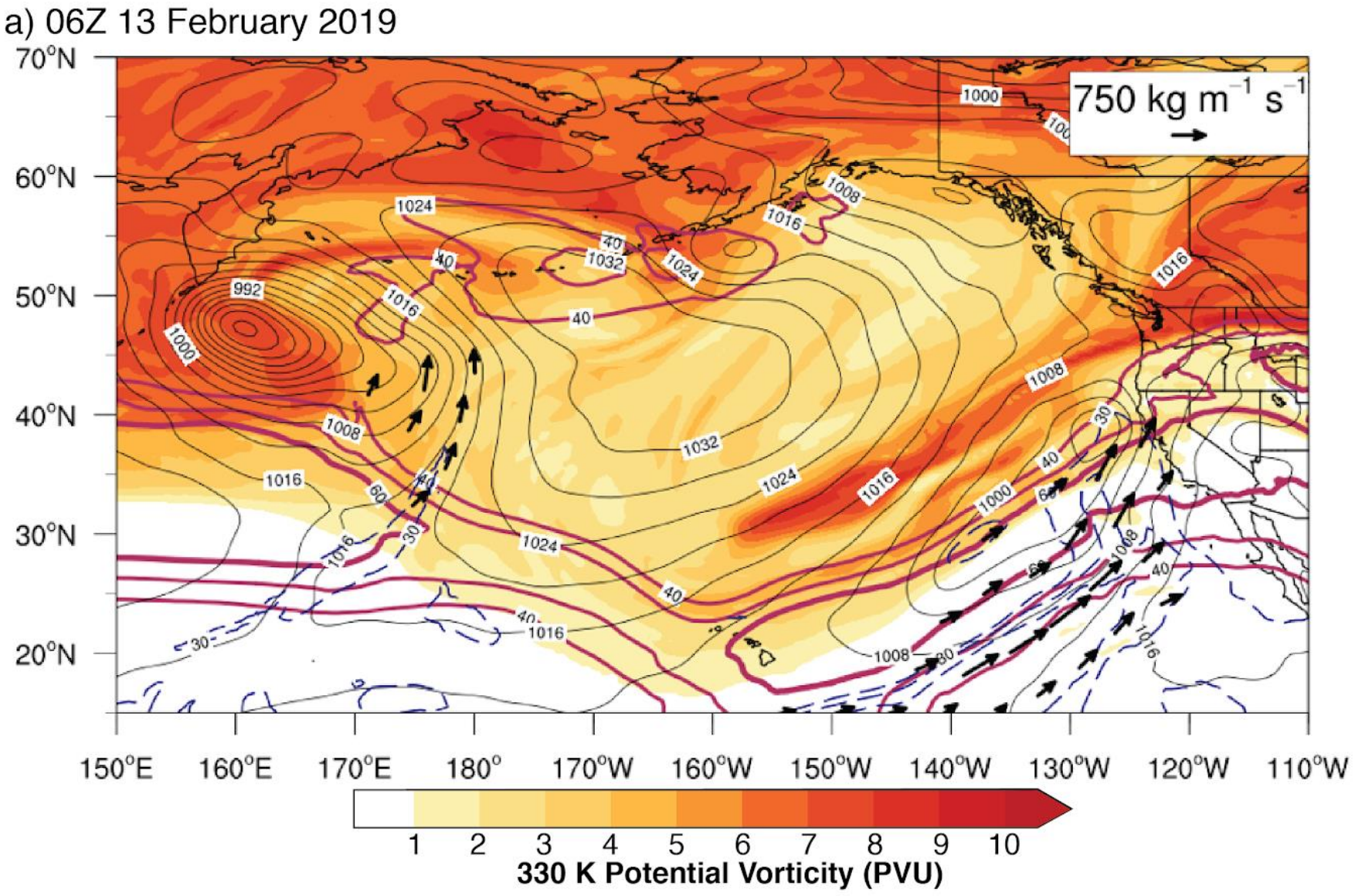
For a given IVT250 forecast probability (e.g., 81-90%) and a given lead time (e.g., 6 d), how often did that accurately predict IVT>250 kg/(ms) at verification? → ~80% of the time

For times with IVT>250 kg/(ms) at verification, what was the lead-time IVT250 forecast probability? At 5-d lead, 47% of ensemble members predicted IVT>250 kg/(ms) on average

Note :16.8% of times had IVT250 (109/648)

Provided by: J. Cordeira

Valentine's Day 2019 Forecast Skill



AR Outlook: 11 February 2019

For California DWR's AR Program

Center for Western Weather and Water Extremes
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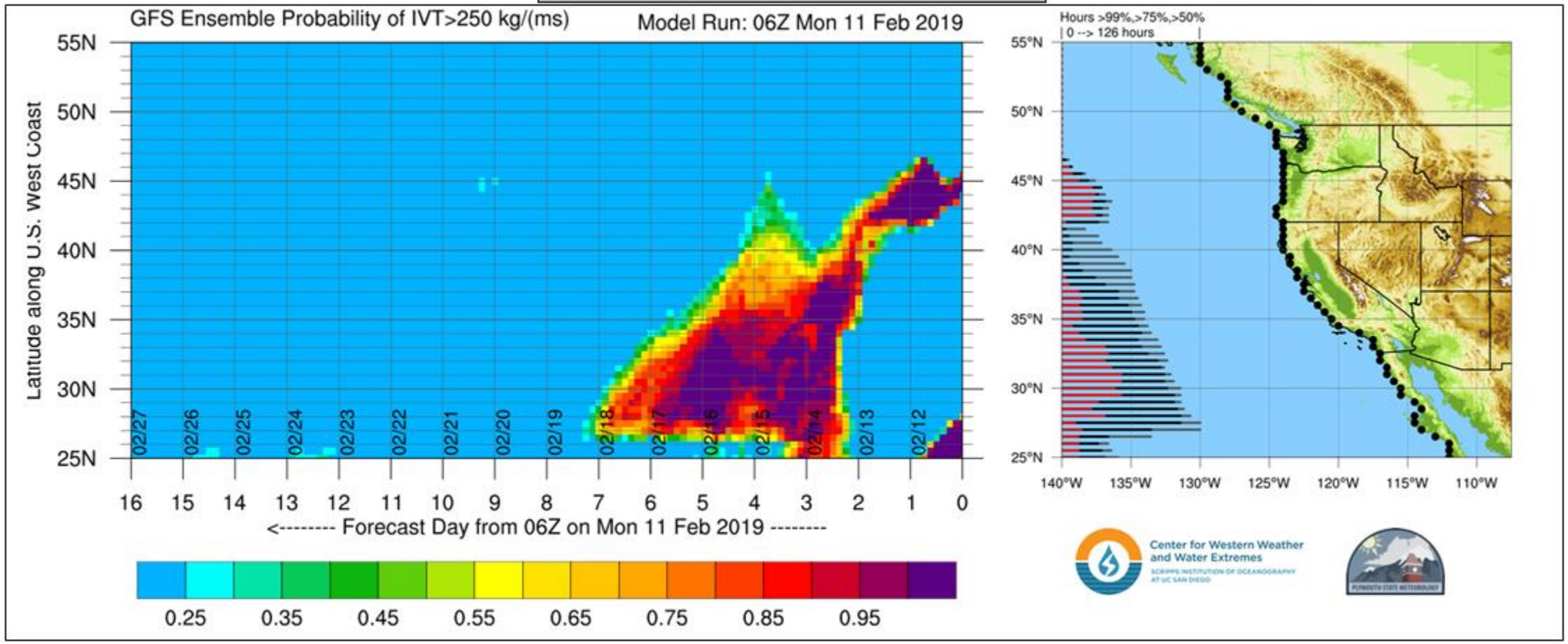
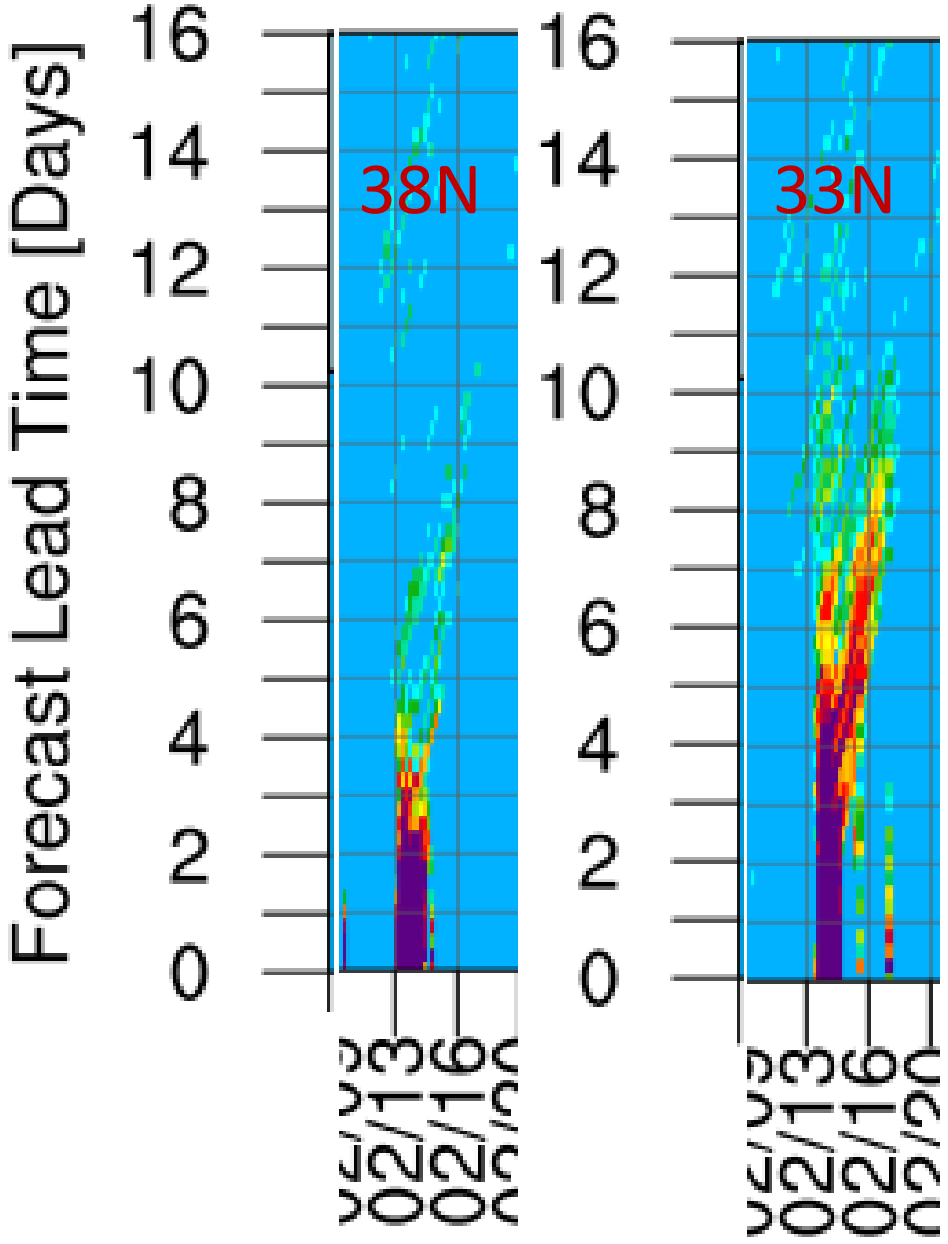
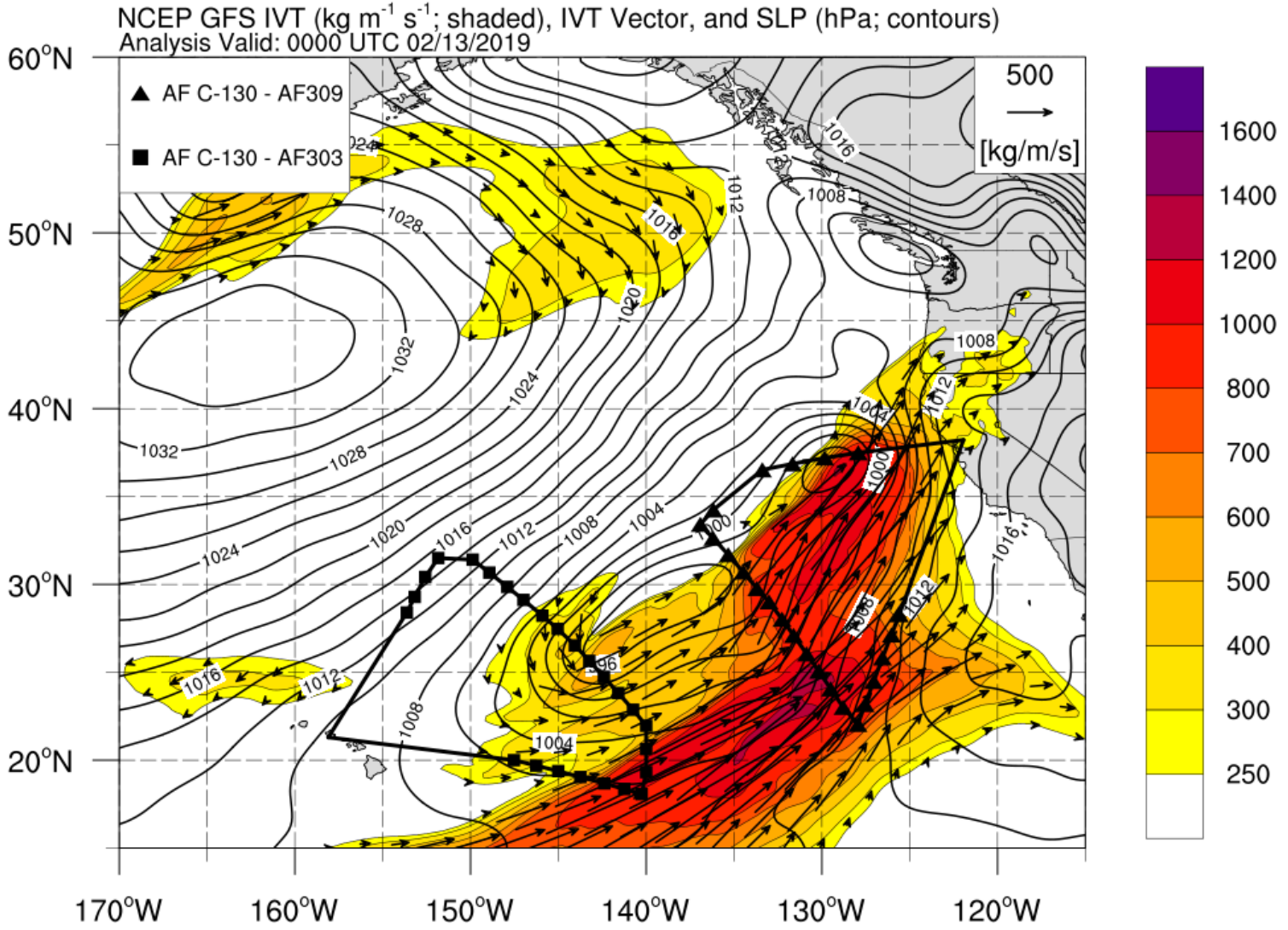
Odds of AR Conditions Along Coast

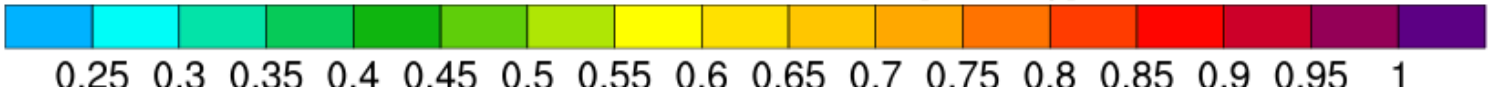


- There is high probability (80–100%) of AR conditions (IVT > 250 kg m^{-1} s^{-1}) lasting for an extended period over Southern California
- The GEFS suggests AR conditions could last for >90 hours over portions of Southern California
- Ensemble probability of AR conditions decreases after 06Z on the 16th (10 PM 15 Feb. PST) , suggesting uncertainty in the end of the AR and overall duration of AR conditions

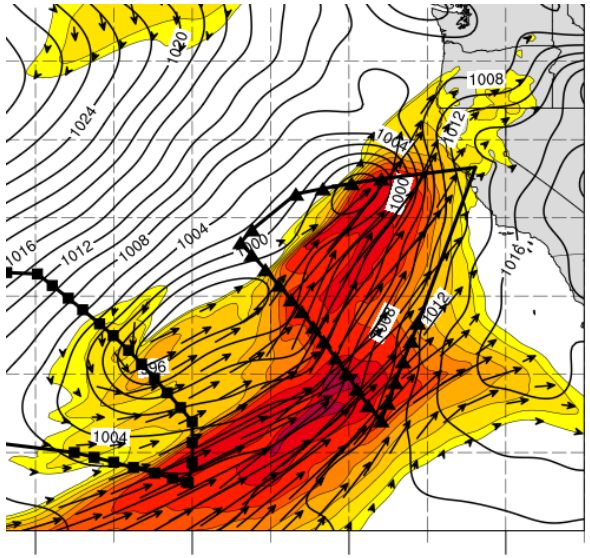
GEFS Ensemble Probability IVT >250 kg/(ms)

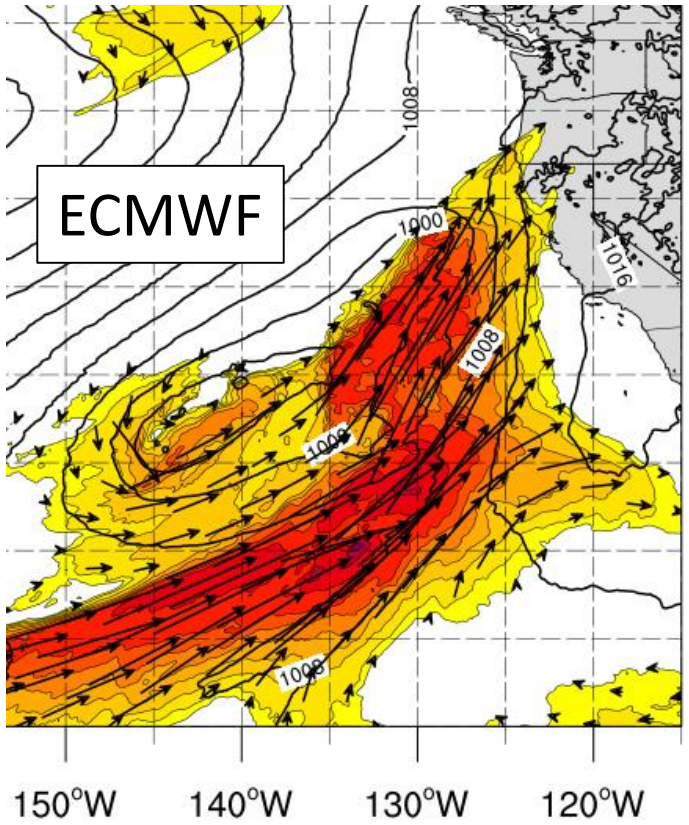


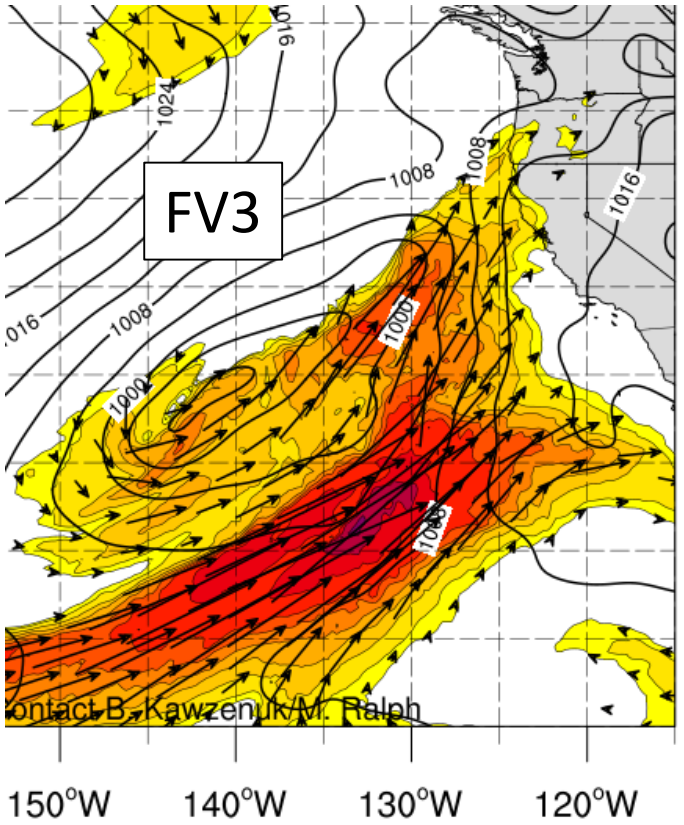


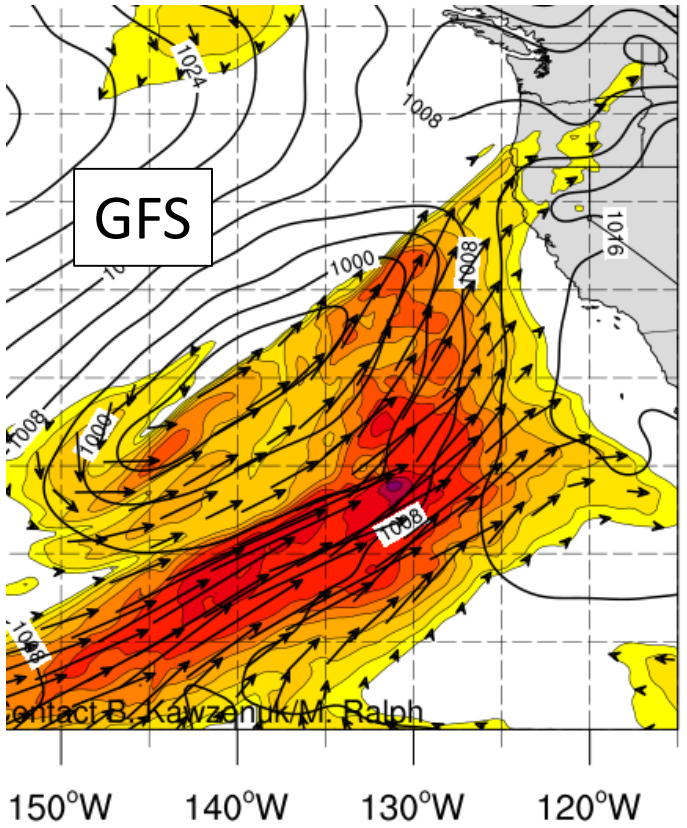


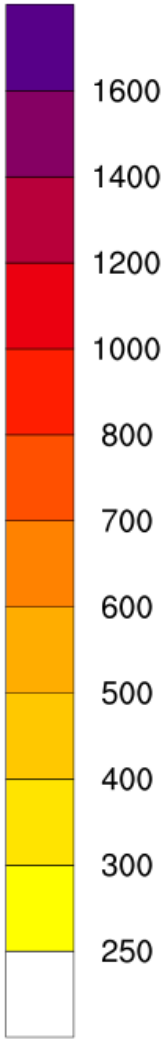
2 Day Lead : Model Comparison
00Z 13 Feb



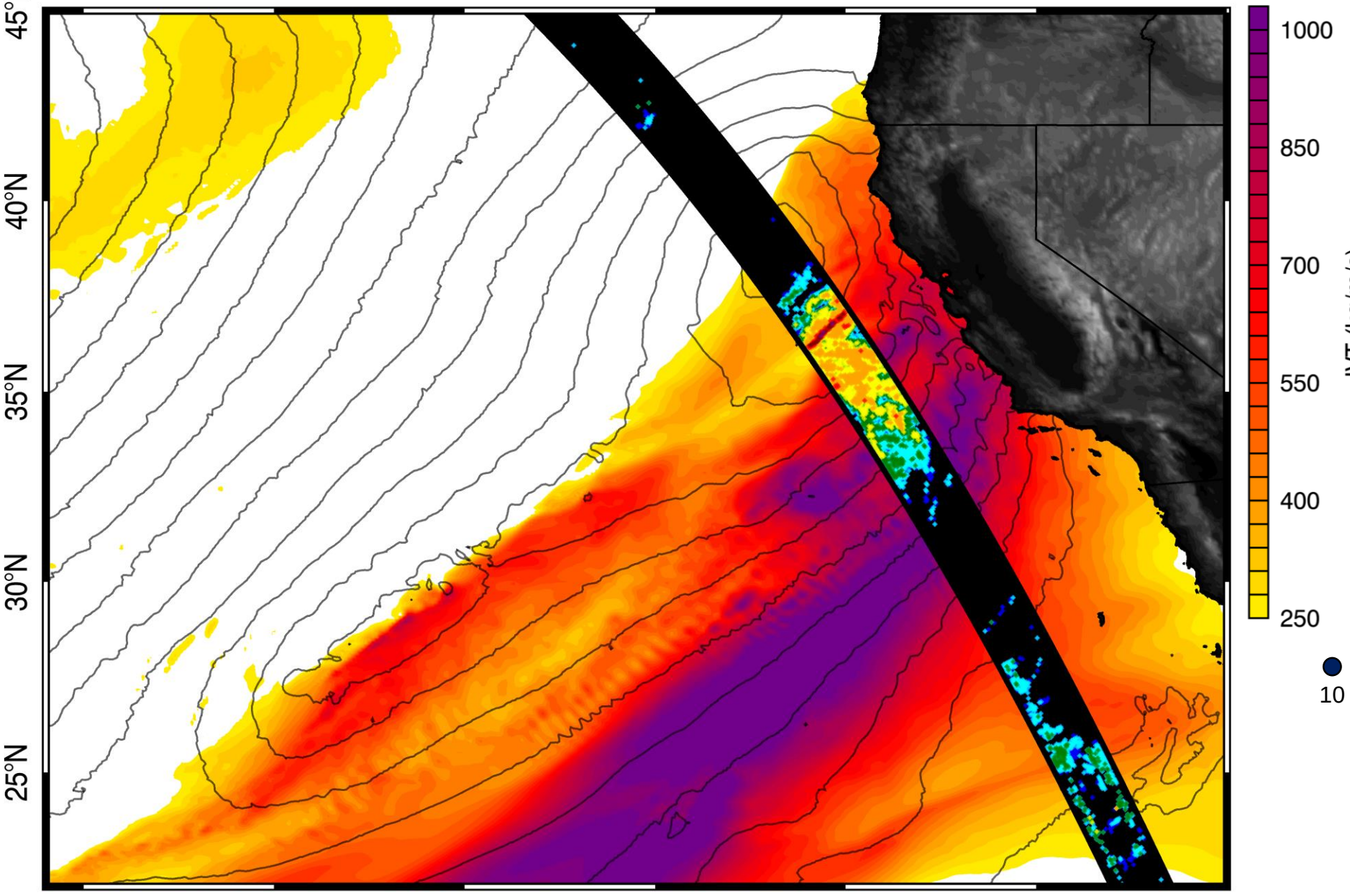


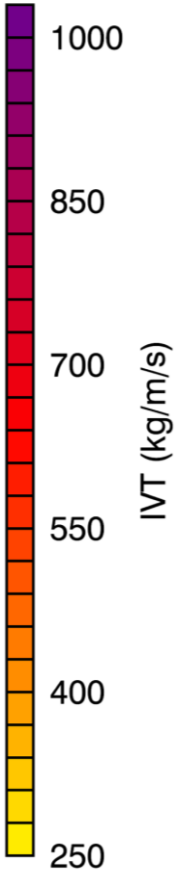


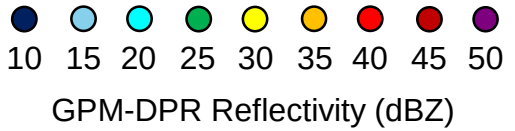




WRF IVT & SLP – 13 Feb. 2019 1200 UTC

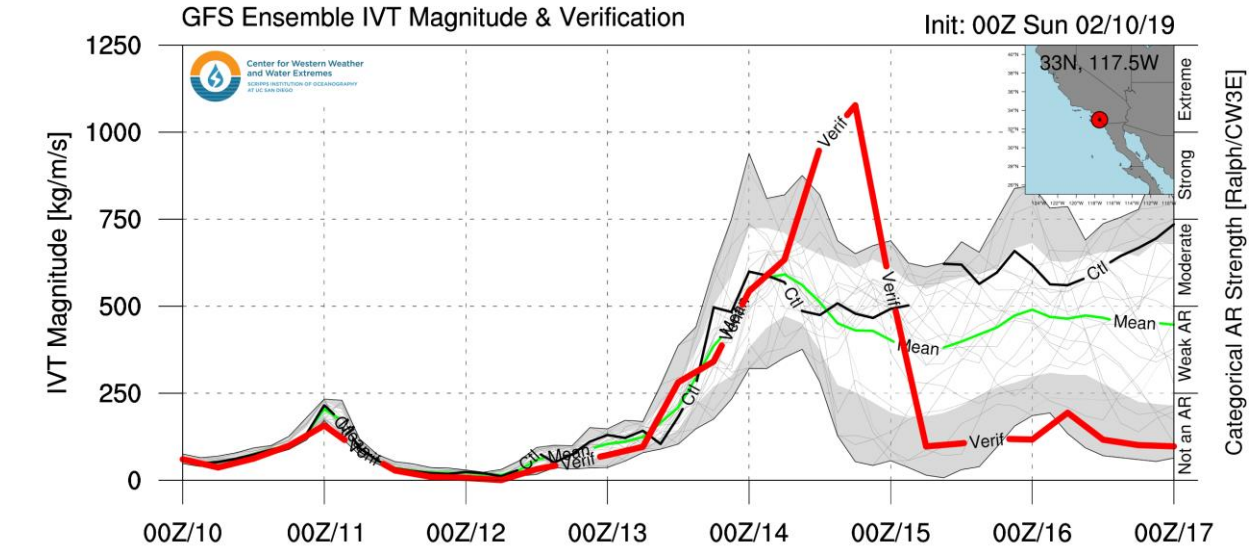


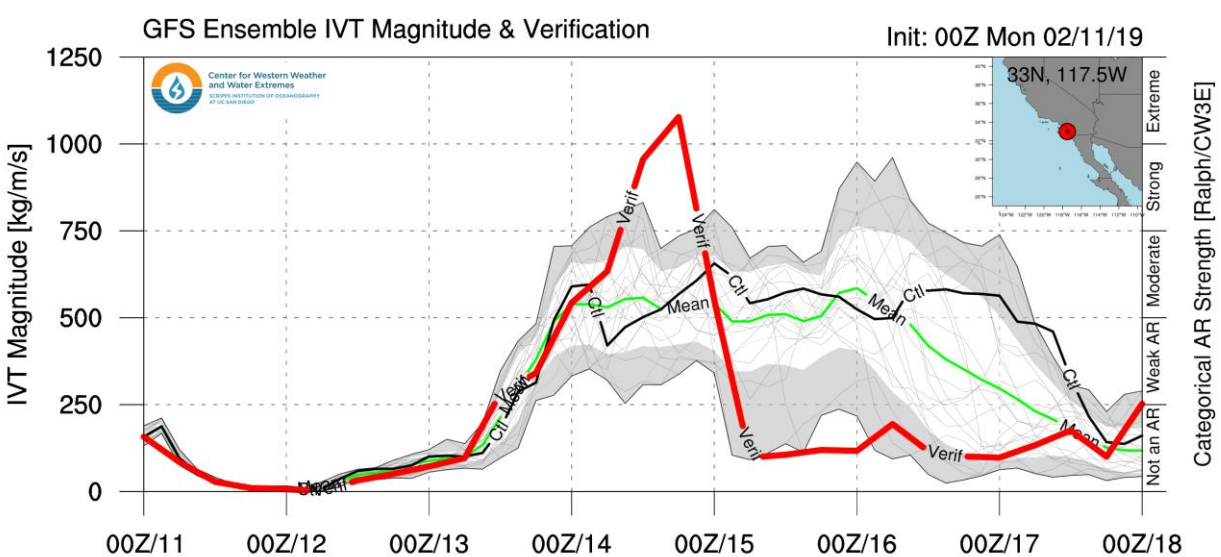


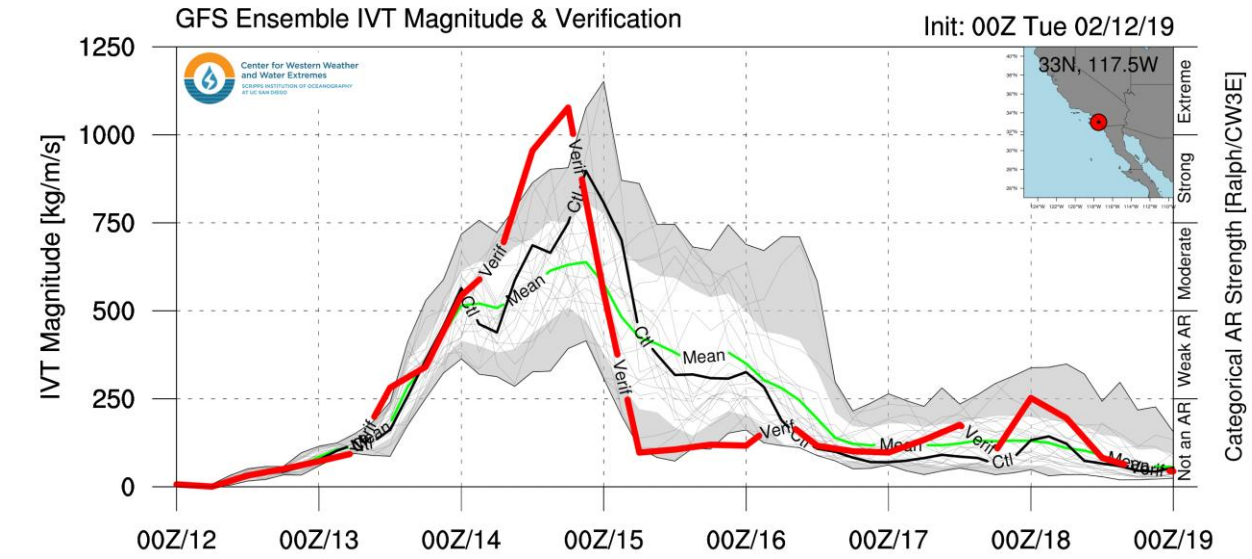


Rain Rate Max = 91mm/h

Latent Heat Max = 80k/h







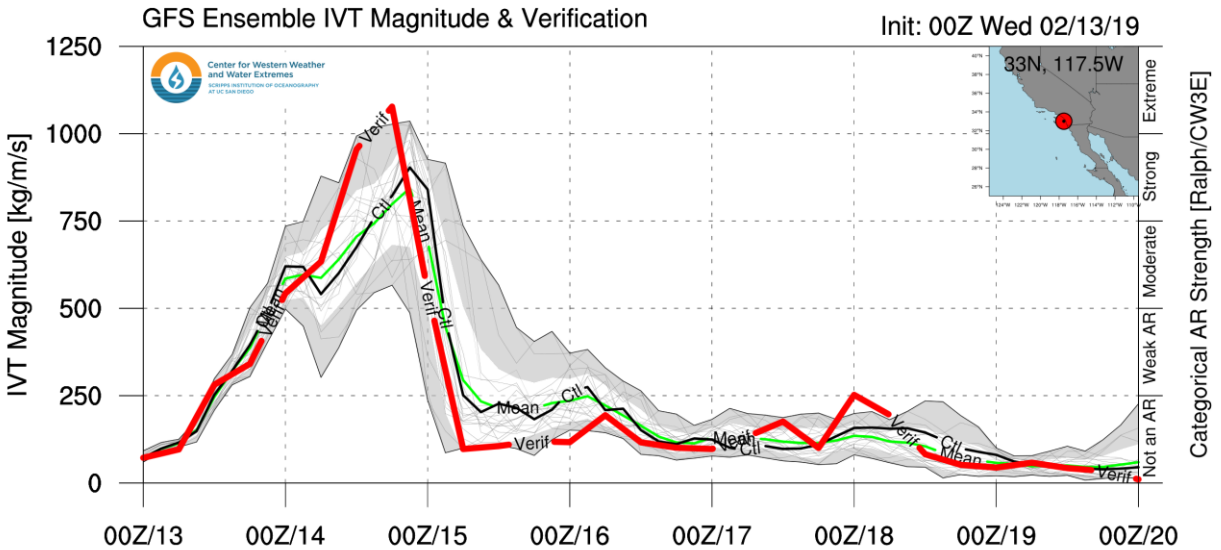


Figure: Plume diagram forecast and verification of IVT magnitude (kg/(ms)) for 33N; 117.5W initialized on 00Z/10 Feb 2019 and 00Z/11 Feb 2019. The control-member forecast is in black and the ensemble-mean forecast is in green. Each ensemble member is plotted in light gray and the spread of the ensemble (+/- 1 standard deviation) is shaded in white. Verification is in red.

1 day lead

Precipitation Verification (inches) (forecast - observed)

-4.00 -3.00 -2.00 -1.00 0.00 +1.00 +2.00 +3.00 +4.00

Download QPF Verification Data

Date: 02/15/2019 (ending 4am PST / 5am PDT)

3 day lead

Precipitation Verification (inches) (forecast - observed)

-4.00 -3.00 -2.00 -1.00 0.00 +1.00 +2.00 +3.00 +4.00

Download QPF Verification Data

Date: 02/15/2019 (ending 4am PST / 5am PDT)

5 day lead

Precipitation Verification (inches) (forecast - observed)

-4.00 -3.00 -2.00 -1.00 0.00 +1.00 +2.00 +3.00 +4.00

Download QPF Verification Data

Date: 02/15/2019 (ending 4am PST / 5am PDT)

AR Event Summary: 13-14 February 2019

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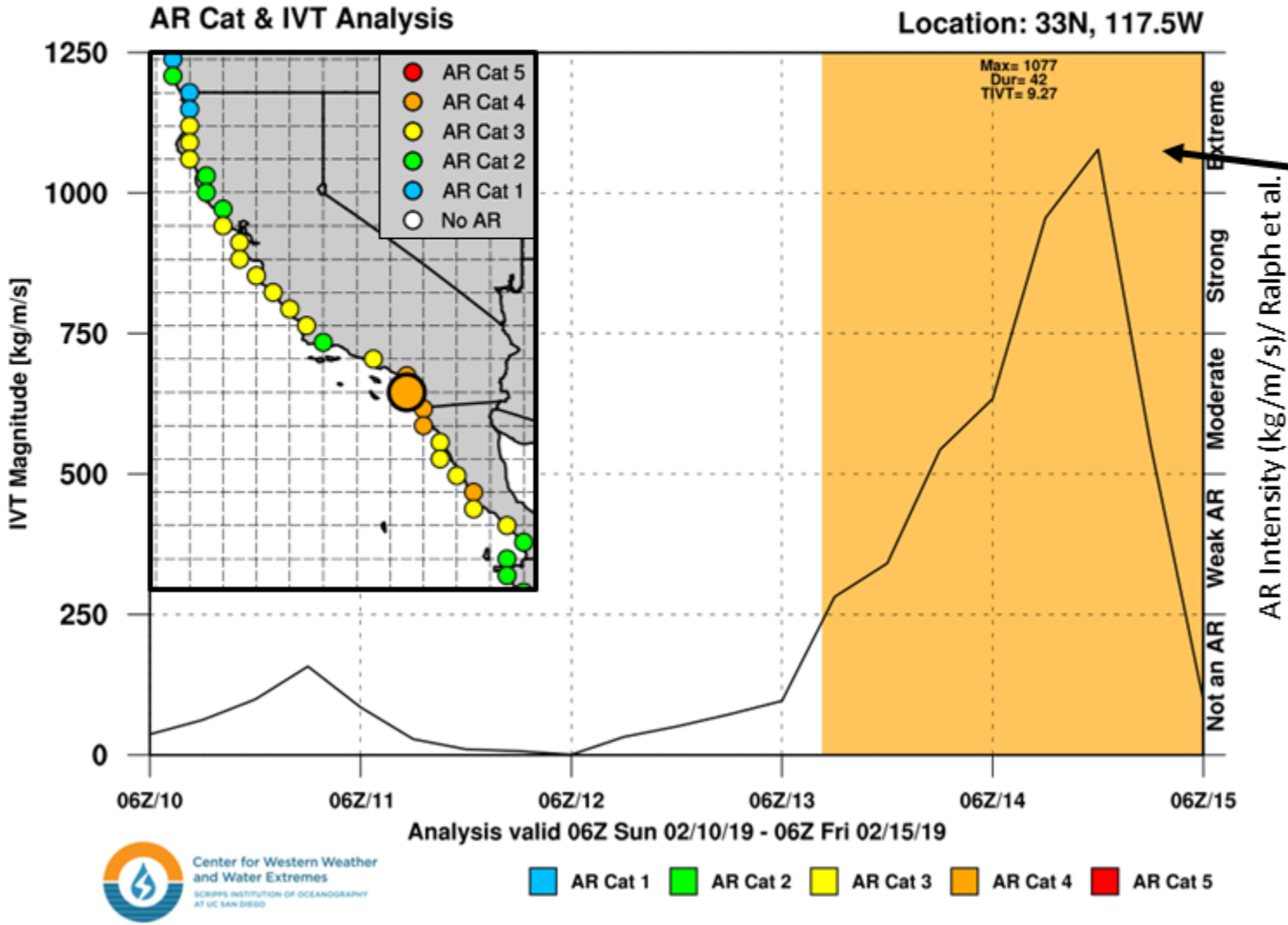
A scale for atmospheric river intensity and impacts was published in the *Bulletin of the American Meteorological Society on 5 February 2019*. This is its first application to a current event.

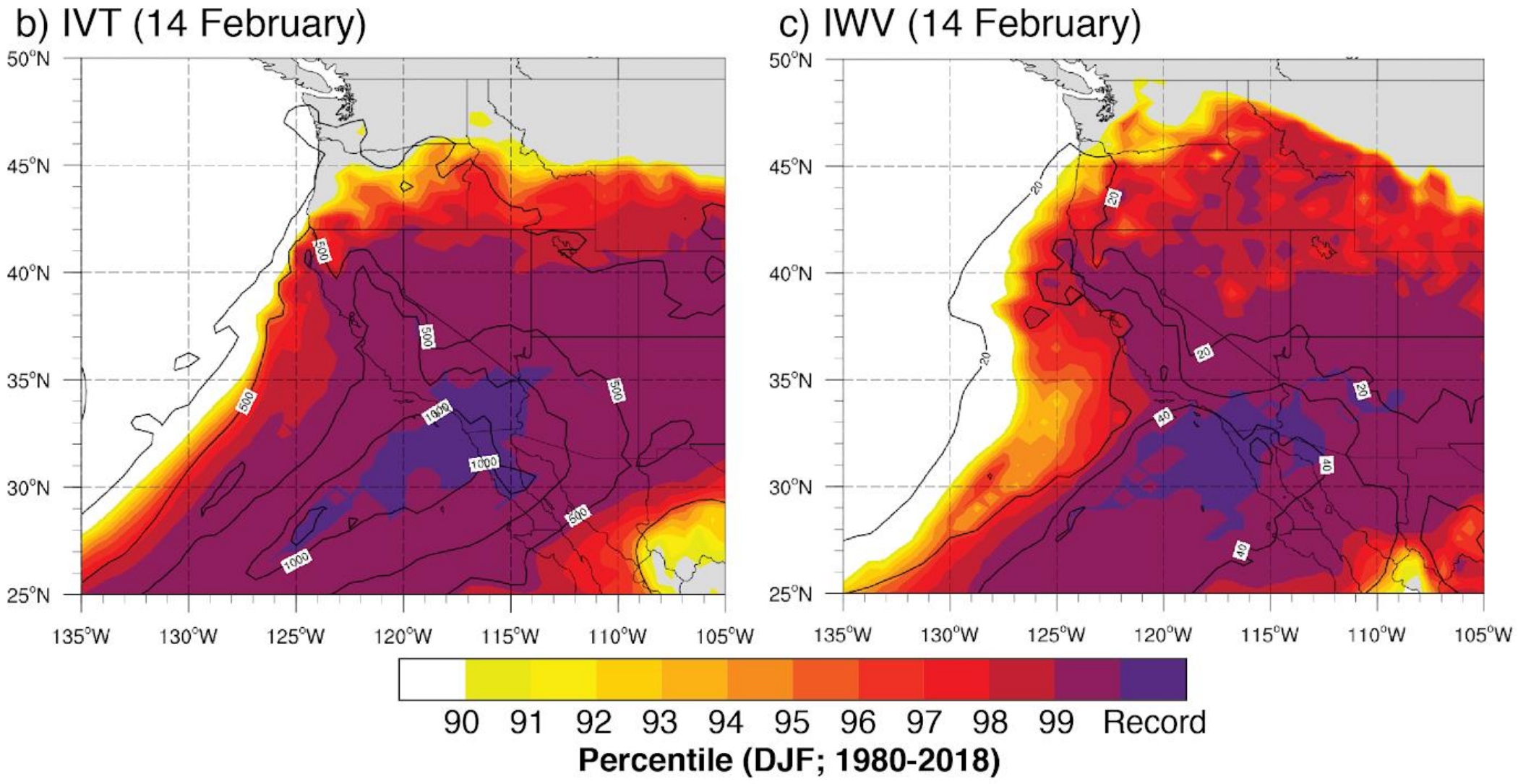


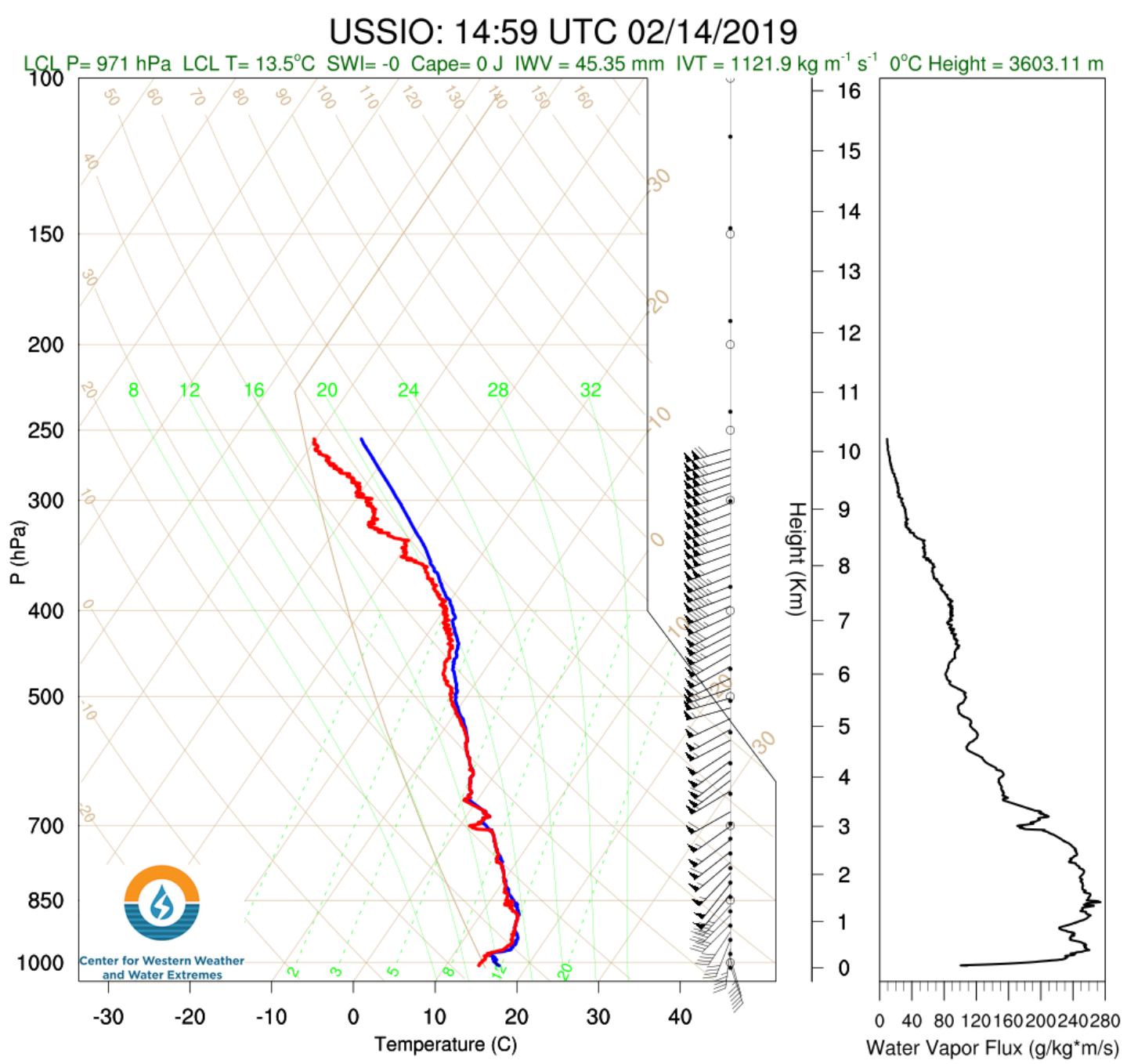
Coastal San Diego County (33N, 117.5W; Approximately Oceanside California) experienced a max IVT of 1077 kg/m/s and AR conditions lasted 42 hours, which is an Atmospheric River Category 4 (Based on GFS Analysis) using the Ralph et al scale.

The AR Category scale was developed by CW3E director F. Martin Ralph (lead) with J. Rutz, M. Anderson, J. Cordeira, M. Dettinger, D. Reynolds, L. Schick and C. Smallcomb. *(Ralph et al. 2019)*

A large portion of other Coastal California locations experienced AR-Cat 3 conditions with a few experiencing AR-Cat 2 or lower

Valentine's Day 2019: IVT/IWV in MERRA2



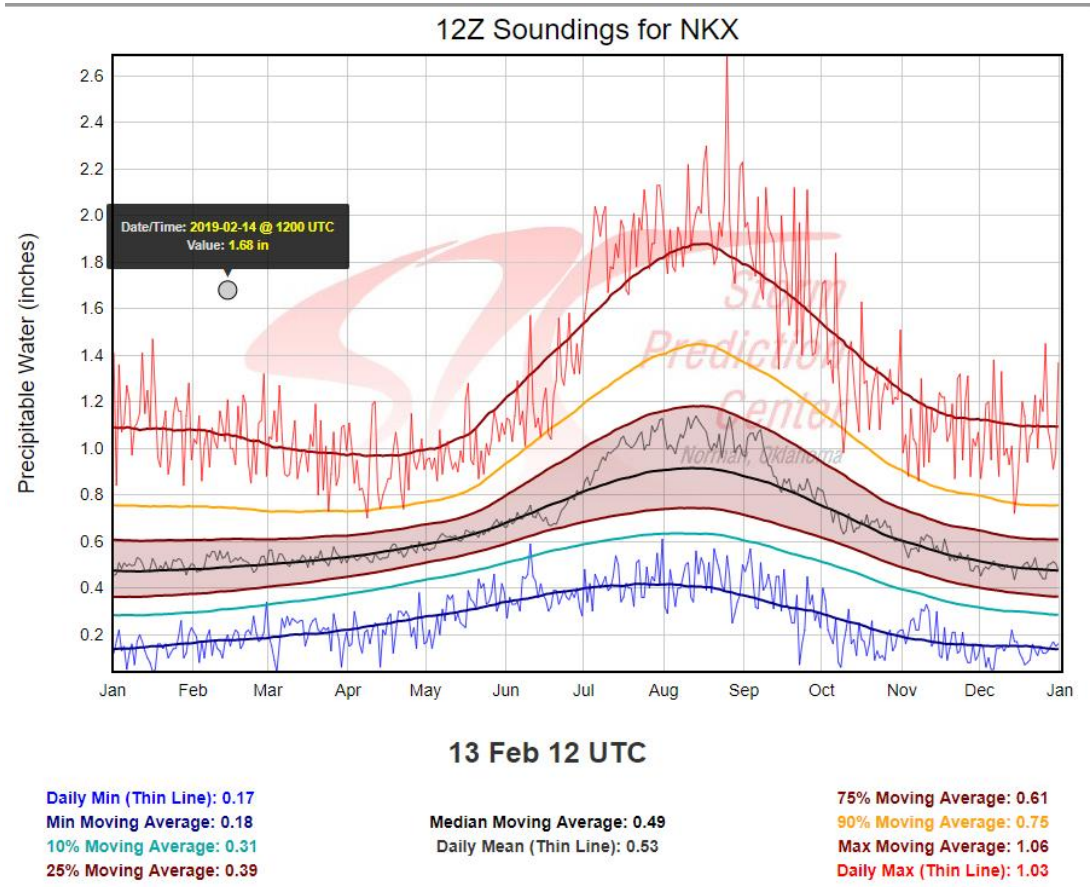


Launched from Scripps Pier

Record IVT & IWV for SD

6 hours of sondes > 1000 IVT

Snow Level > 11000ft



Valentine's Day Record Rain

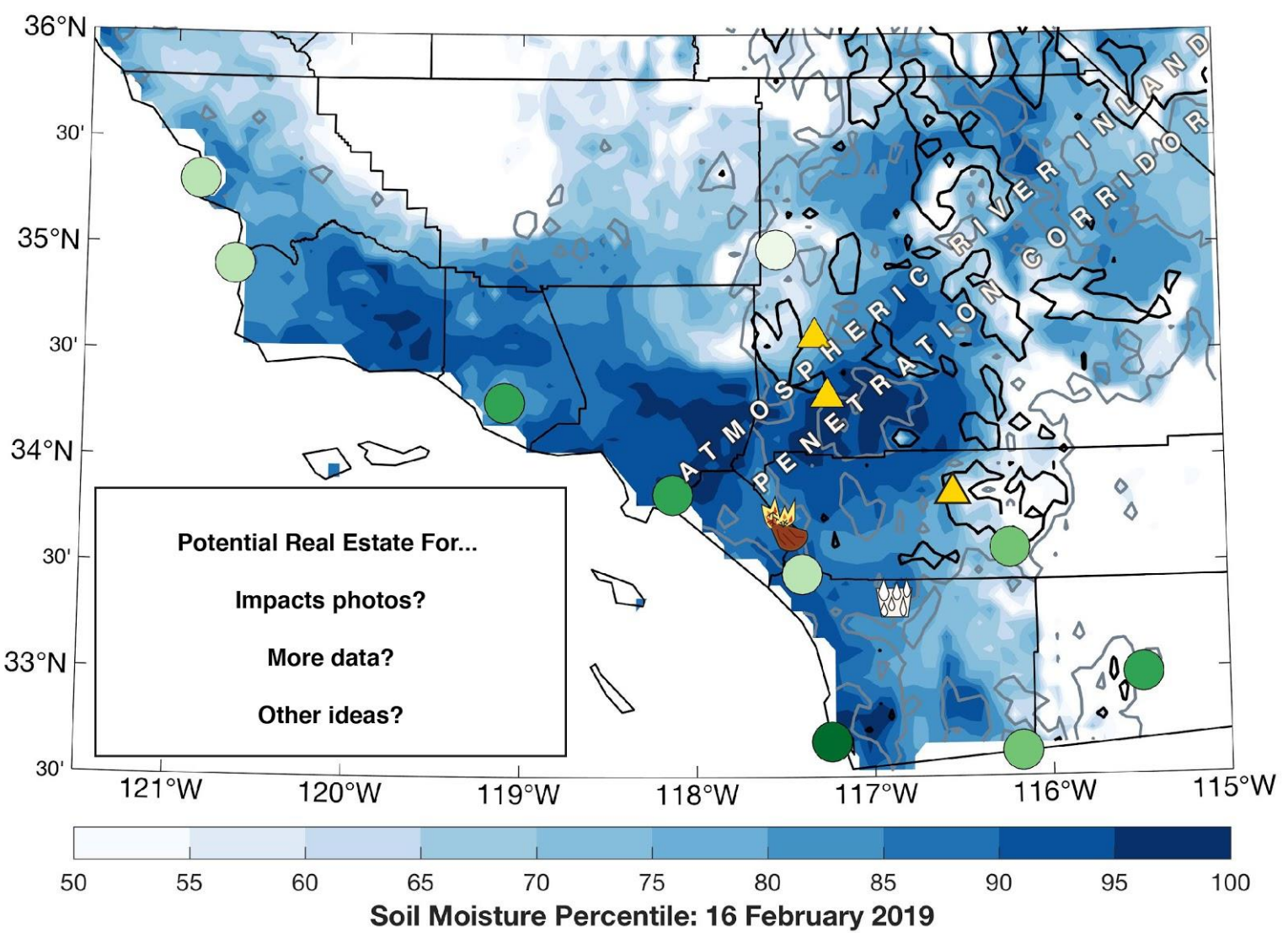
The following sites reported record rain for February 14th

*Palomar Observatory Recorded their wettest day EVER on record

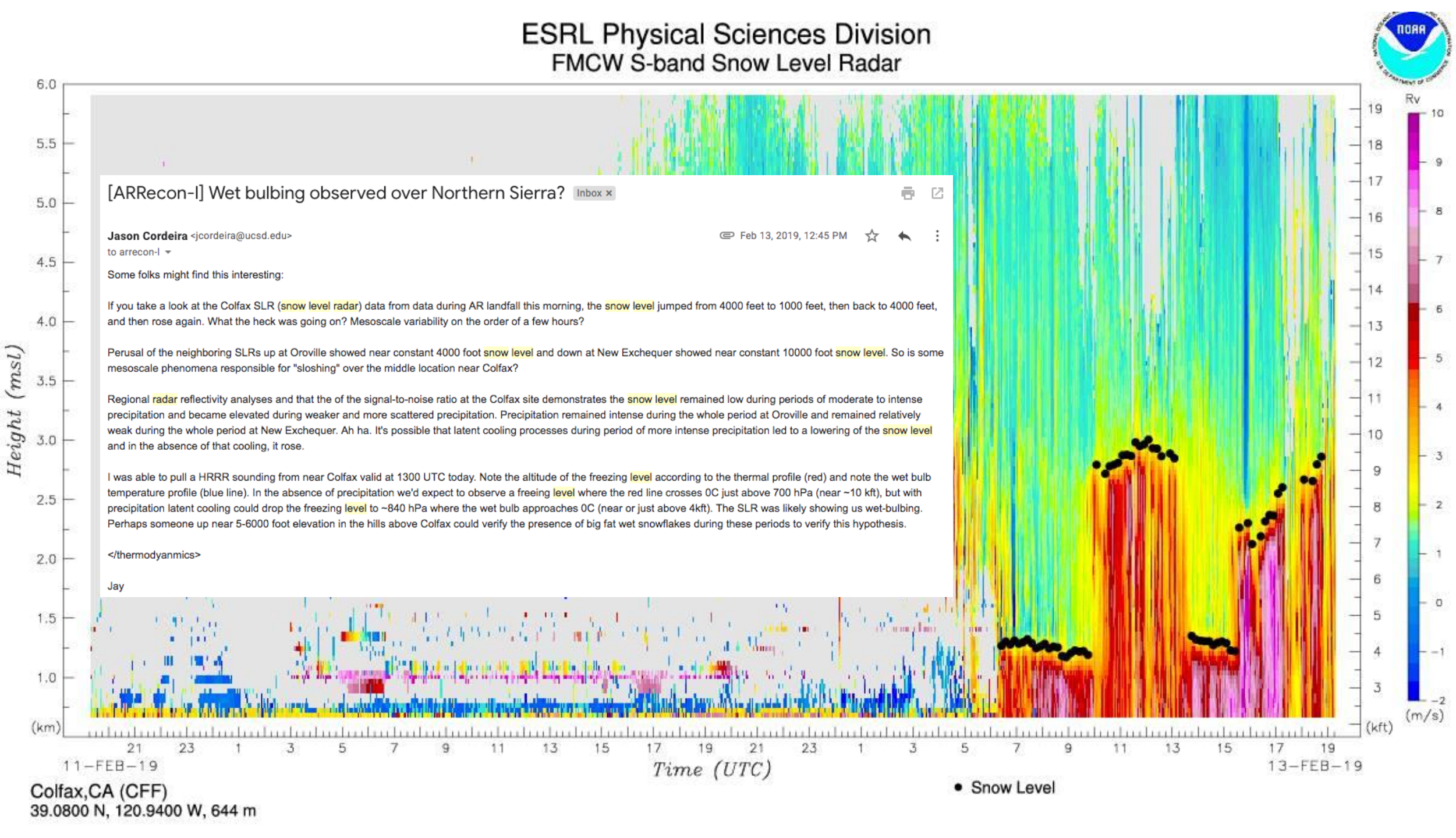
	New Record	Old Record	Period of Record
*Palomar Observatory	10.10"	9.58" in 1901	1901
Ramona	4.02"	2.15" in 1995	1974
Campo	3.75"	2.12" in 1954	1948
Palm Springs	3.68"	1.14" in 1980	1893
Vista	3.01"	2.58" in 1980	1957
Alpine	2.94"	2.60" in 1995	1951
Borrego Springs	2.68"	1.73" in 1980	1942

Wide-Ranging Southern California Impacts

San Gorgonio avalanches



ESRL Physical Sciences Division
FMCW S-band Snow Level Radar



Colfax,CA (CFF)
39.0800 N, 120.9400 W, 644 m

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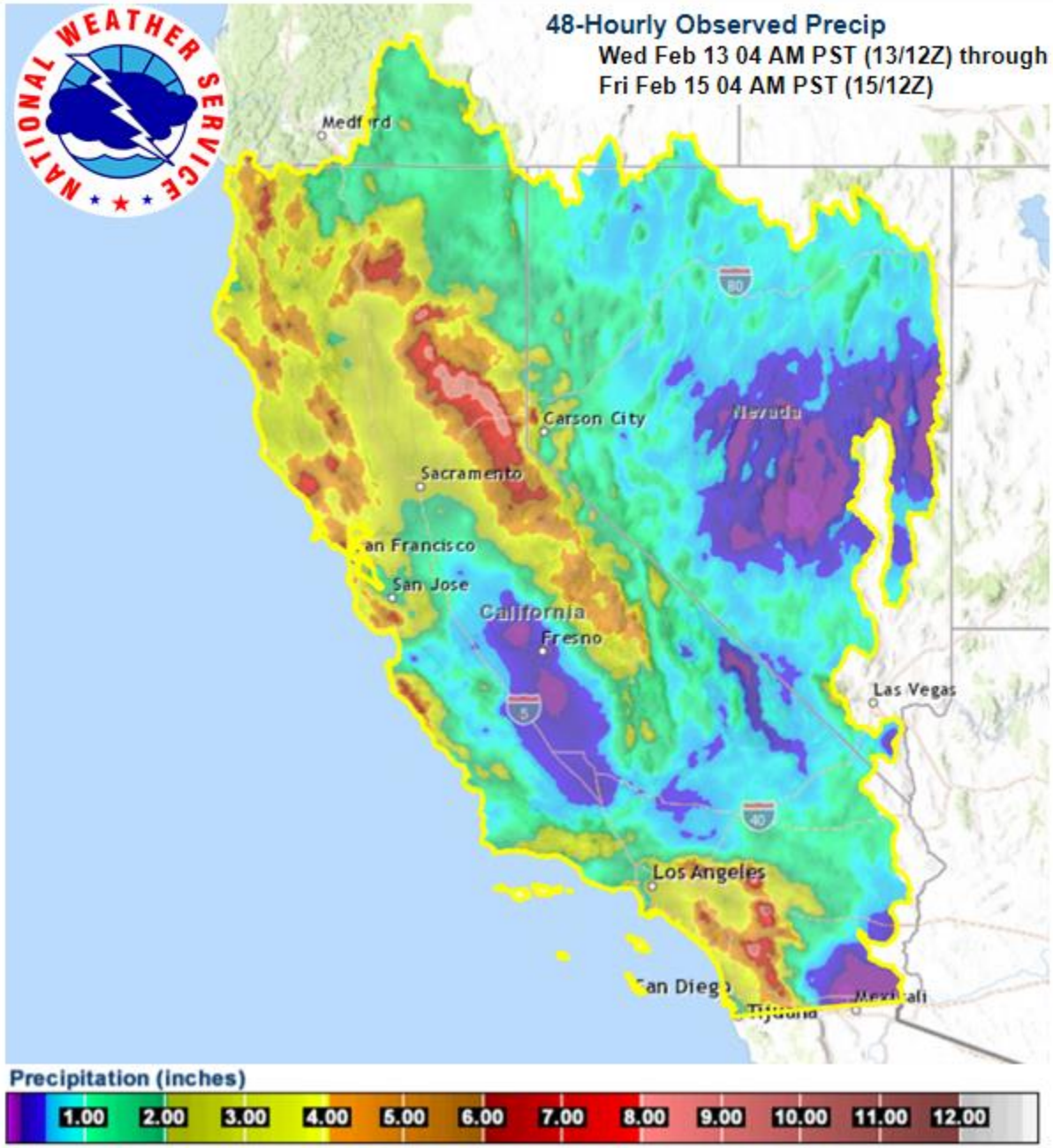


Numerous high elevation locations across California received greater than 6 inches of precipitation from 12Z 13 through 12Z 15 February 2019 (4 AM to 4 AM PST)

Statewide Maxima

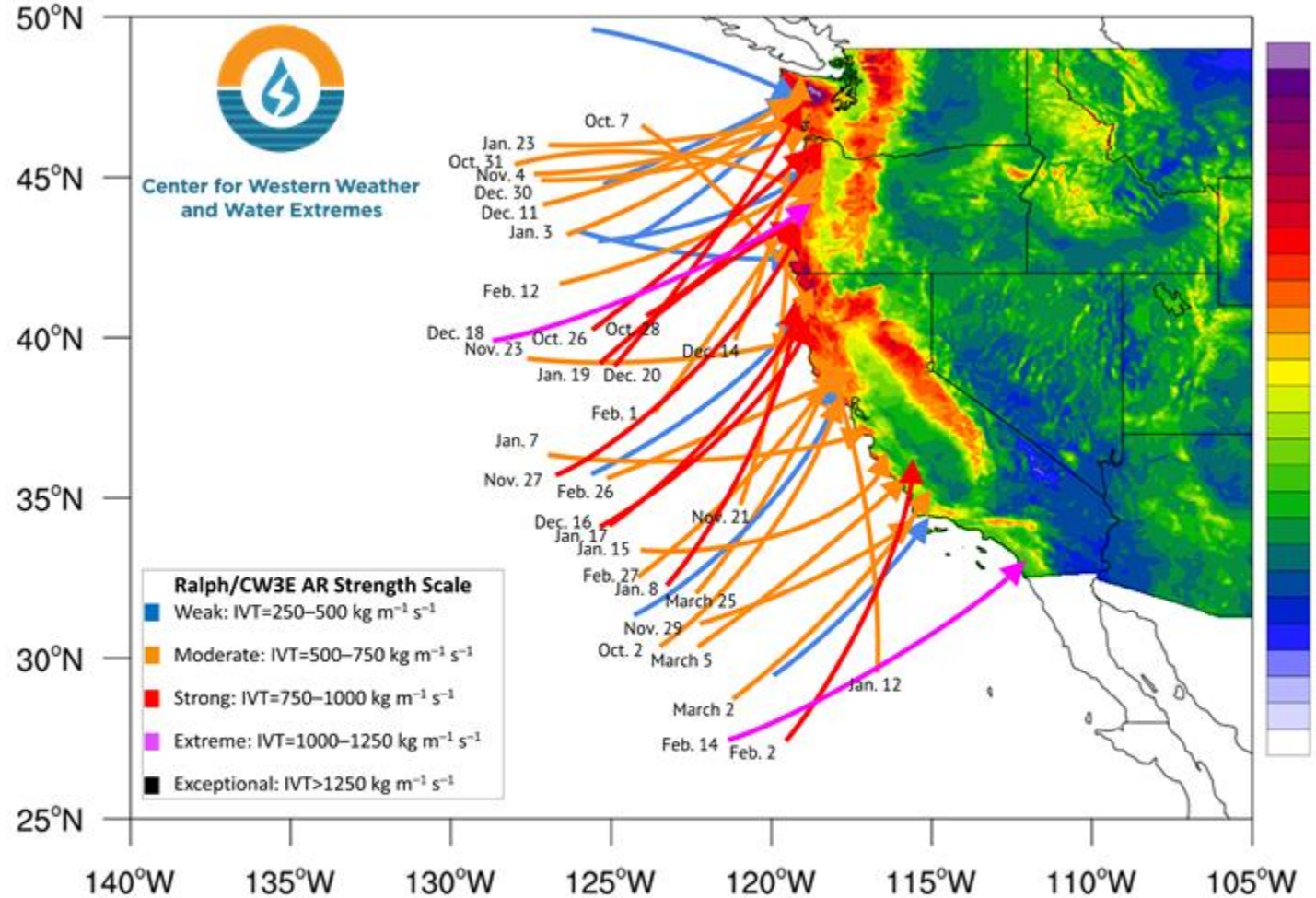
Northern Sierra: 8.75 inches
Sonoma/Mendocino Coast: 8.85 inches
Big Sur: 6.7 inches
Palomar Mountain (Southern CA): 10.16 inches

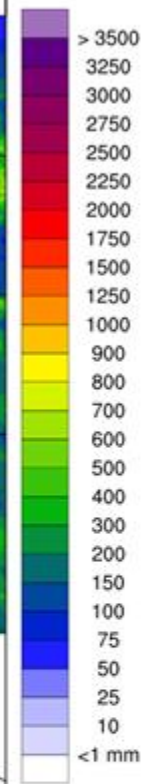
Palomar Observatory in northern San Diego County received 10.1 inches of rain in 24-hours, a record for 14 February (Previous Record: 9.58 in 1901)

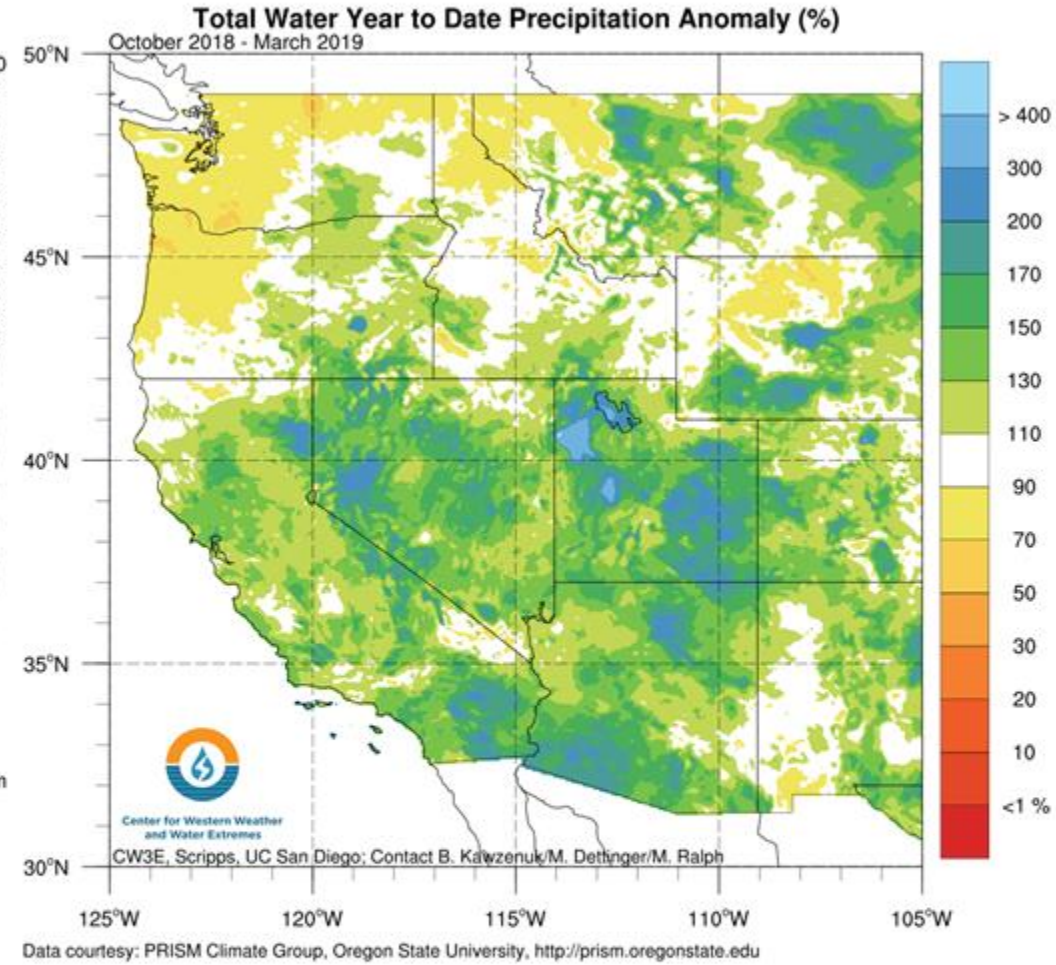
Other low elevation locations, such as the Central Valley, the Los Angeles Basin, San Francisco Bay Area, Orange County, and San Diego County received 1.5–4.5 inches or precipitation

NWS CNRFC Quantitative Precipitation Estimates available at https://cnrfc.noaa.gov/

Water Year to Date Summary (October through March)







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