



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E S2S Outlook: 6 Jan 2023

Prepared by: C. Castellano, J. Wang, M. DeFlorio, J. Kalansky

UC San Diego



SCRIPPS INSTITUTION OF
OCEANOGRAPHY

CW3E S2S Forecasts: Glossary & Context

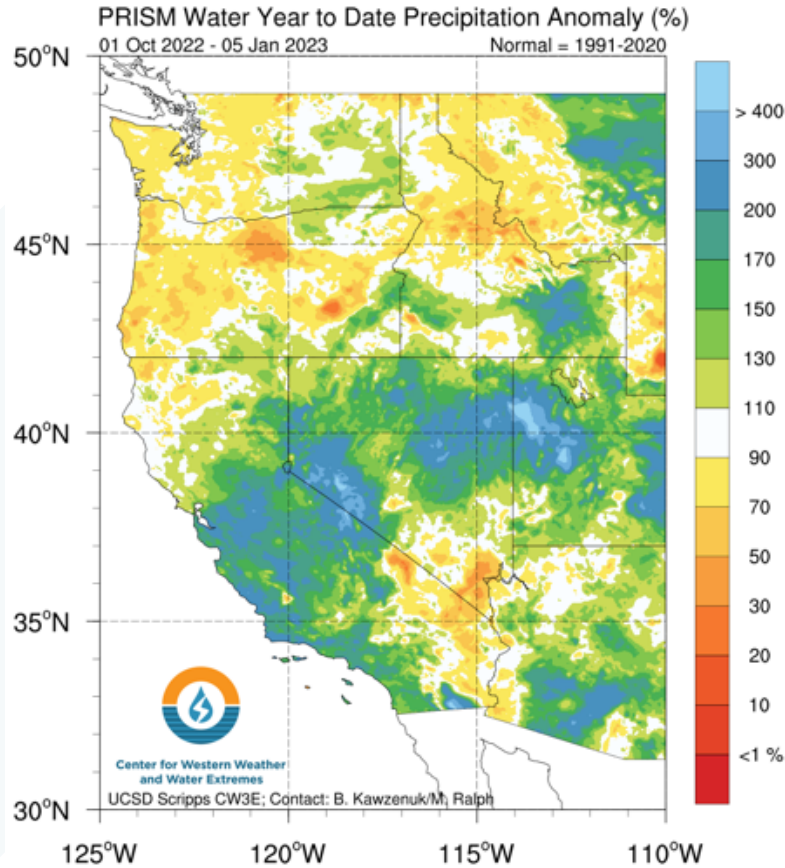
- The outlooks are based on CW3E subseasonal to seasonal forecast products that can be found here: https://cw3e.ucsd.edu/s2s_forecasts/
- CW3E subseasonal (2–6 weeks lead time) atmospheric river, ridging, and circulation regime products use three different global ensemble prediction systems to create these products:
 - NCEP GFS (US Model): Weeks 2–3
 - NCEP CFSv2 (US Model): Weeks 2–6
 - ECCO (Canadian Model): Weeks 2–3
 - ECMWF (European model): Weeks 2–6
- CW3E seasonal precipitation products are produced using statistical and machine learning models. The suite of models includes:
 - CCA (canonical correlation analysis) based statistical model
 - Machine learning model, which also includes comparison to NMME (North American Multi-Model Ensemble)

Summary

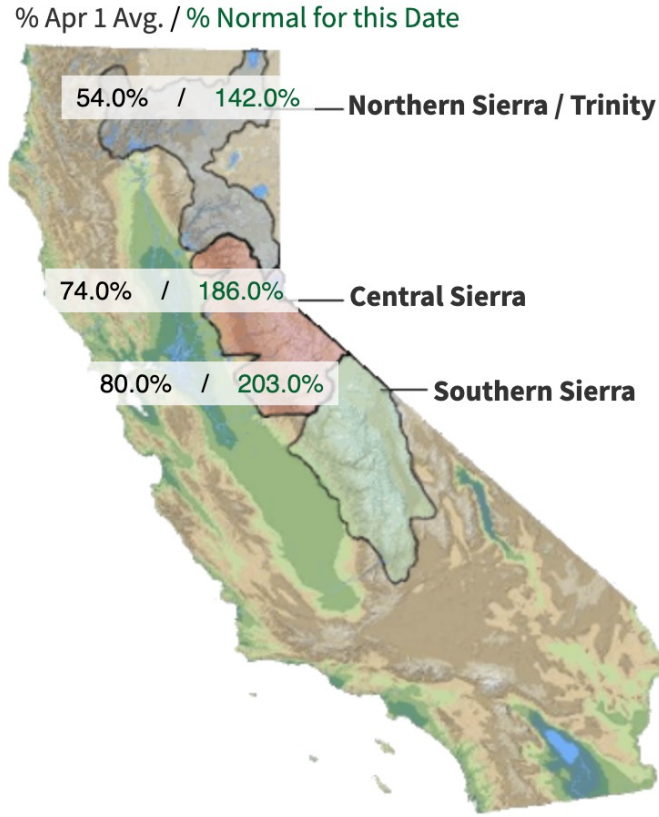
- **Week 2 forecasts (13–19 Jan):** Models agree on moderate-to-high likelihood of AR activity over California at beginning of Week 2; large model disagreement thereafter
 - NCEP is showing higher probabilities of AR activity over CA during 15–19 Jan compared to ECCO and ECMWF
- **Week 3 forecasts (20–26 Jan):** Model disagreement in forecast AR activity over US West Coast
 - NCEP is predicting near-normal to slightly above-normal AR activity along the coast of CA and OR
 - ECCO and ECMWF are predicting below-normal AR activity over CA, OR, and WA
- NCEP and ECMWF both show low likelihood of ridging activity near US West Coast during Weeks 1–2, consistent with above-normal AR activity
- NCEP and ECMWF both show potential for more ridging activity during Weeks 3–4, but there is considerable uncertainty in the location of ridging
 - NCEP is showing higher confidence in the West-ridge type, which is typically associated with dry conditions in Central and Southern CA and wet conditions in the Pacific Northwest
 - ECMWF is showing higher confidence in the North-ridge type, which is typically associated with dry conditions over all of California
- NCEP and ECMWF are predicting strong MJO activity in phases 8 and 1 during Weeks 1–2, which is somewhat favorable for increased AR activity and precipitation in California

Water Year Hydrologic Summary

Precipitation

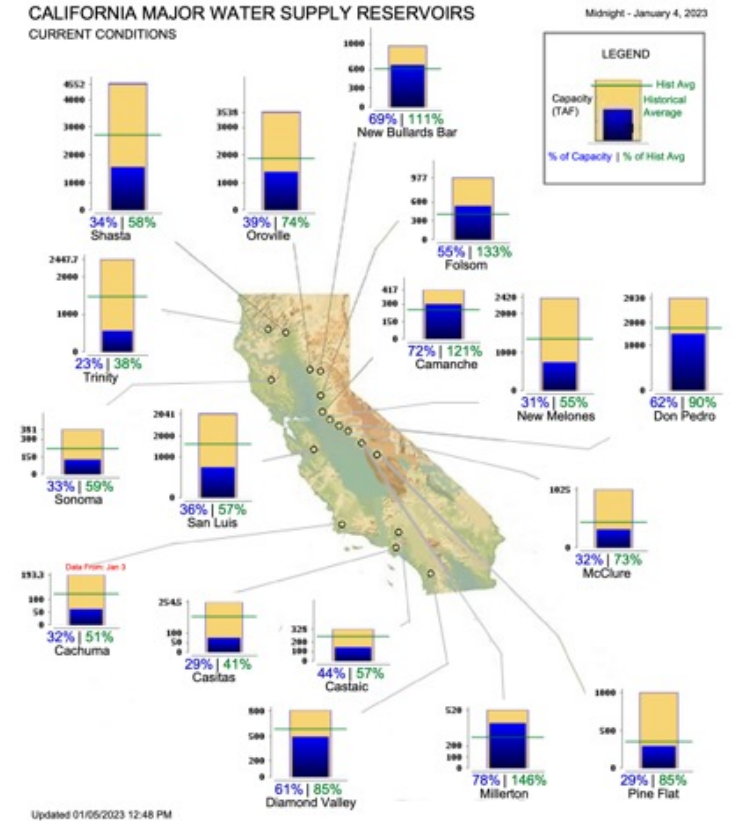


Snowpack Conditions



Source: California Department of Water Resources

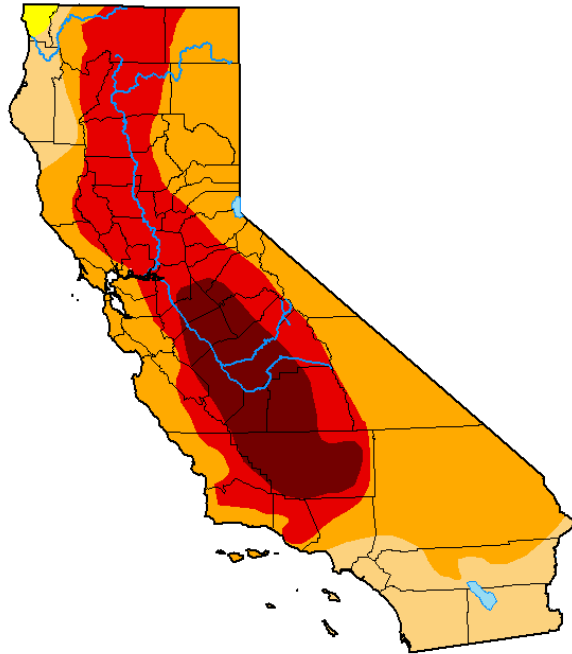
Reservoir Storage



- As of 5 Jan, water-year-to-date precipitation is above normal across much of the state, especially Central California, where some areas have received > 200% of normal precipitation since 1 Oct
- Statewide snowpack is also well-above normal, especially in the Central and Southern Sierra Nevada
- Water storage has increased in most reservoirs due to substantial precipitation in recent weeks, but many large reservoirs still remain below 35% of capacity
- Storage levels in several major reservoirs, including New Bullards Bar and Folsom, are now above the historical average for this time of year

Drought Conditions

U.S. Drought Monitor California



December 6, 2022

(Released Thursday, Dec. 8, 2022)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

| | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|------|--------|--------|-------|-------|-------|
| Current | 0.00 | 100.00 | 99.48 | 84.97 | 40.08 | 12.73 |
| Last Week 11-29-2022 | 0.00 | 100.00 | 99.48 | 84.97 | 40.92 | 12.73 |
| 3 Months Ago 09-06-2022 | 0.00 | 100.00 | 99.76 | 97.52 | 40.18 | 16.57 |
| Start of Calendar Year 01-04-2022 | 0.00 | 100.00 | 99.30 | 67.62 | 16.60 | 0.84 |
| Start of Water Year 09-27-2022 | 0.00 | 100.00 | 99.76 | 94.01 | 40.91 | 16.57 |
| One Year Ago 12-07-2021 | 0.00 | 100.00 | 100.00 | 92.43 | 80.28 | 28.27 |

Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

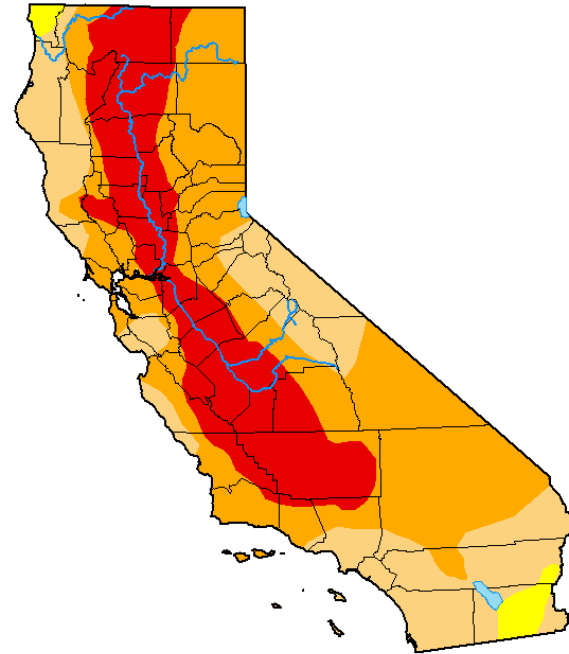
Author:

David Simeral
Western Regional Climate Center



droughtmonitor.unl.edu

U.S. Drought Monitor California



January 3, 2023

(Released Thursday, Jan. 5, 2023)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

| | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|------|--------|-------|-------|-------|-------|
| Current | 0.00 | 100.00 | 97.93 | 71.14 | 27.10 | 0.00 |
| Last Week 12-27-2022 | 0.00 | 100.00 | 97.94 | 80.56 | 35.50 | 7.16 |
| 3 Months Ago 10-04-2022 | 0.00 | 100.00 | 99.77 | 94.02 | 40.91 | 16.57 |
| Start of Calendar Year 01-03-2023 | 0.00 | 100.00 | 97.93 | 71.14 | 27.10 | 0.00 |
| Start of Water Year 09-27-2022 | 0.00 | 100.00 | 99.76 | 94.01 | 40.91 | 16.57 |
| One Year Ago 01-04-2022 | 0.00 | 100.00 | 99.30 | 67.62 | 16.60 | 0.84 |

Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Brad Pugh
CPC/NOAA



droughtmonitor.unl.edu

- Heavy precipitation associated with multiple landfalling ARs has brought some drought relief to much of California in recent weeks
- On 6 Dec, 40% of the state was experiencing extreme or exceptional drought conditions
- As of 3 Jan, 27% of the state is experiencing extreme drought and no areas are experiencing exceptional drought
- The greatest improvement in drought conditions has occurred over Central California

Looking Back: Week 3 AR Activity Forecasts

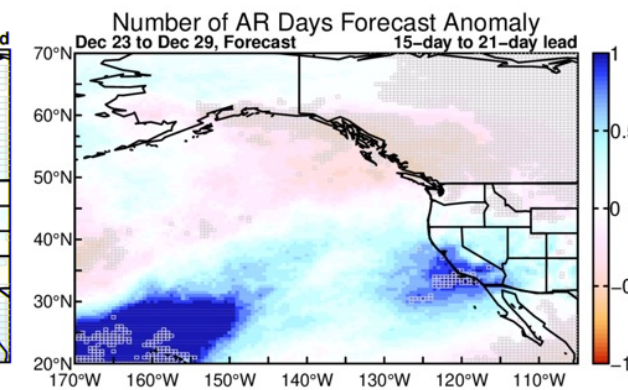
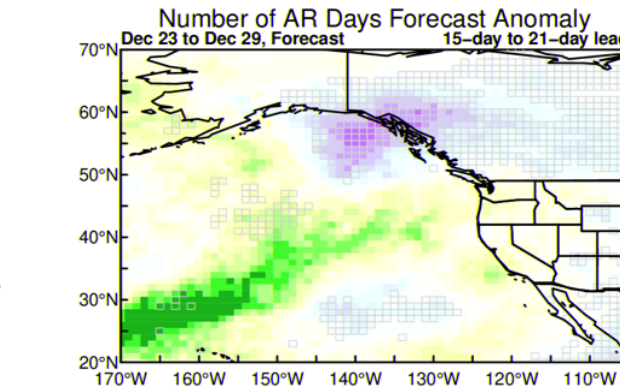
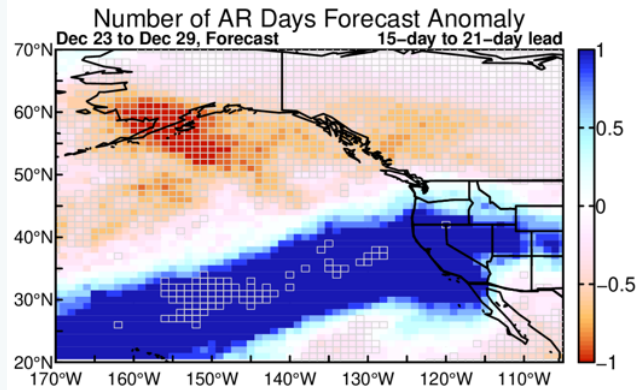
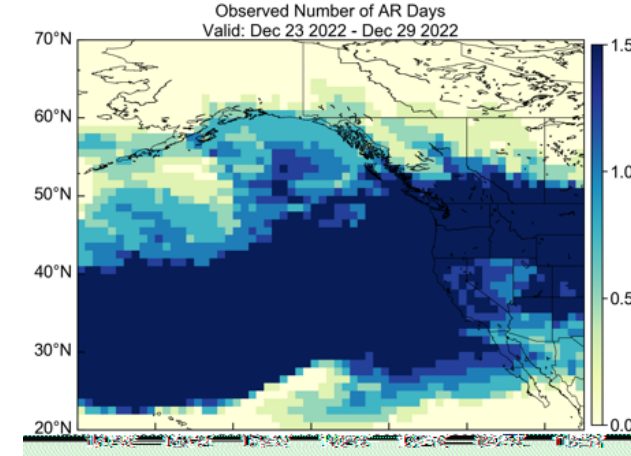
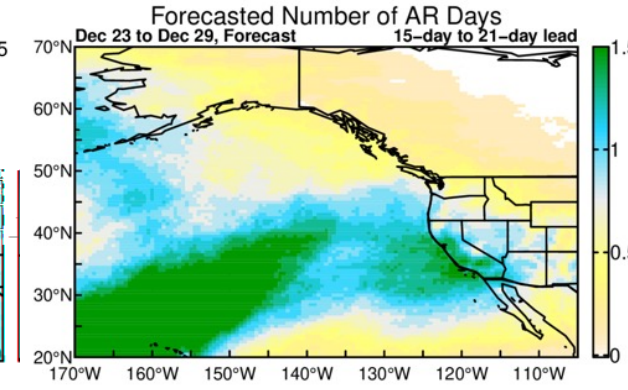
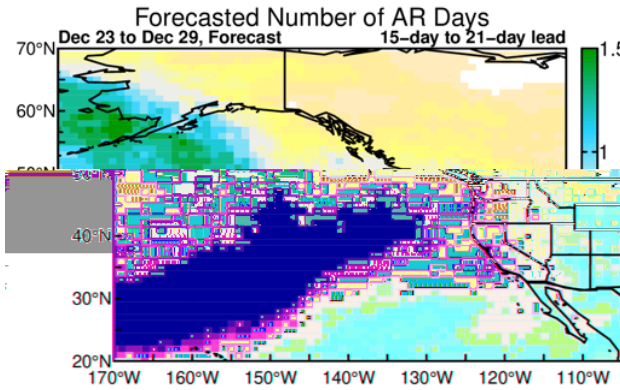
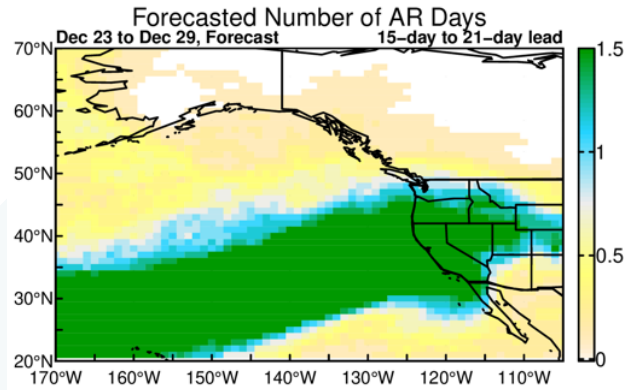
Forecasts Initialized 8 Dec; Valid: 23–29 Dec 2022

NCEP

EC3C

ECMWF

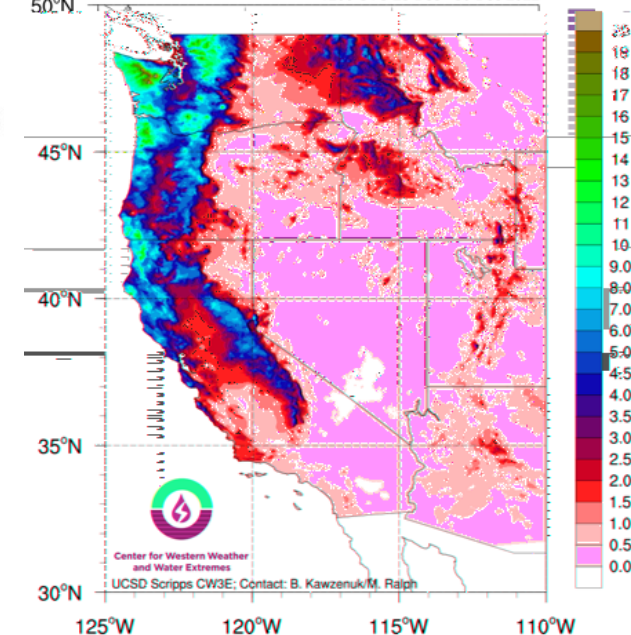
Observed (GFS Analysis)



Observed Precipitation

7-day Accumulated Precipitation (inches)

1200 UTC 23 Dec - 30 Dec 2022



Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

GFS verified over US West Coast; EC3C predicted too little AR activity over US West Coast;
ECMWF verified over CA but predicted too little AR activity over Pacific Northwest

- A series of ARs brought more than 10 inches of precipitation to portions of the Pacific Coast Ranges and Cascades, with nearly 20 inches in the Olympic Mountains
- About 4–8 inches of precipitation fell over the Sierra Nevada

Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 15 Dec; Valid: 30 Dec 2022 – 5 Jan 2022

NCEP

EC3C

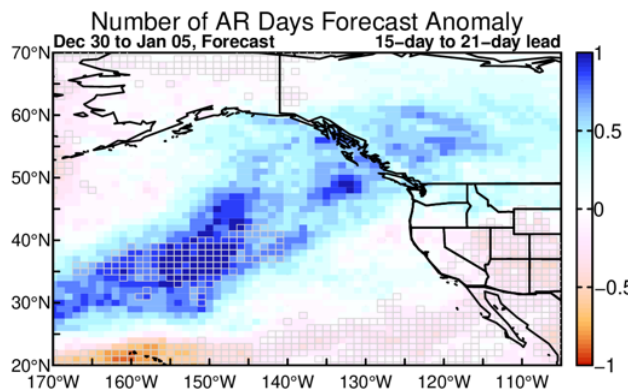
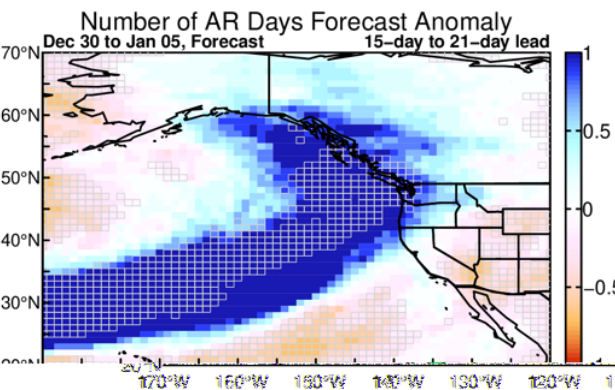
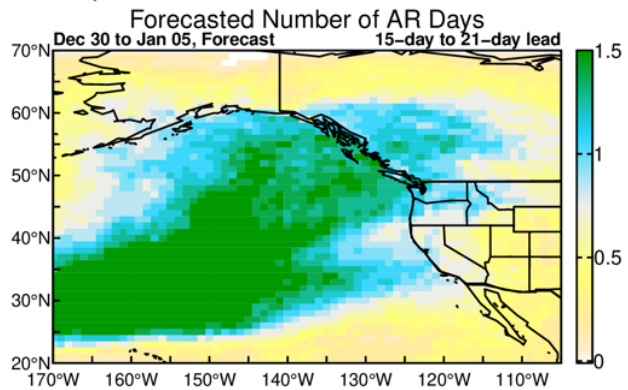
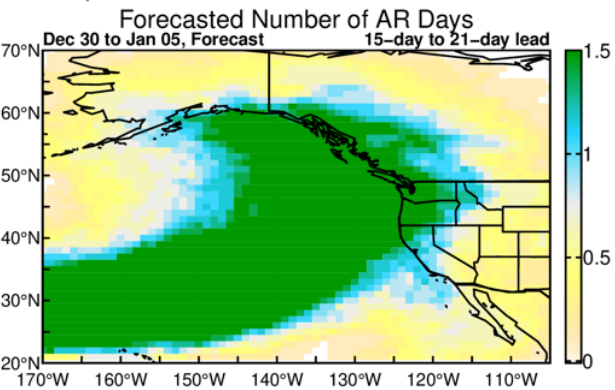
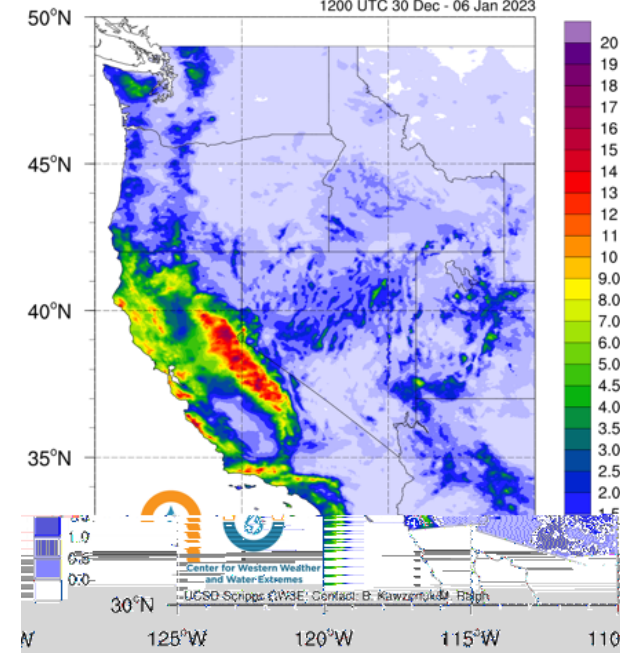
Observed (GFS Analysis)

ECMWF
Unavailable

Observed Precipitation

7-day Accumulated Precipitation (inches)

1200 UTC 30 Dec - 06 Jan 2023



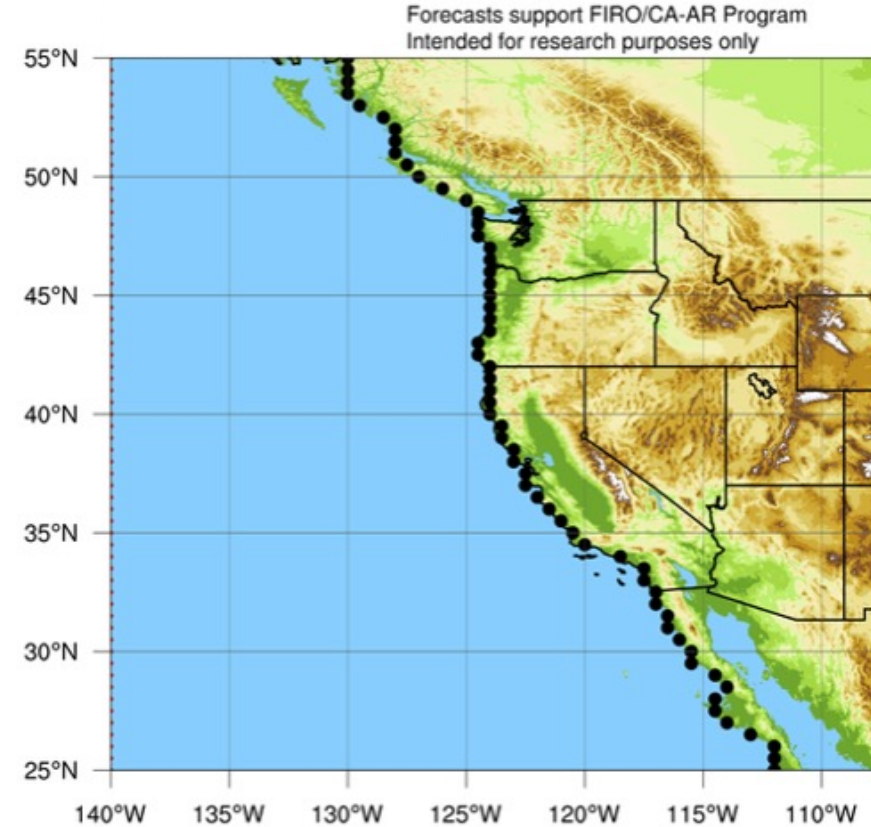
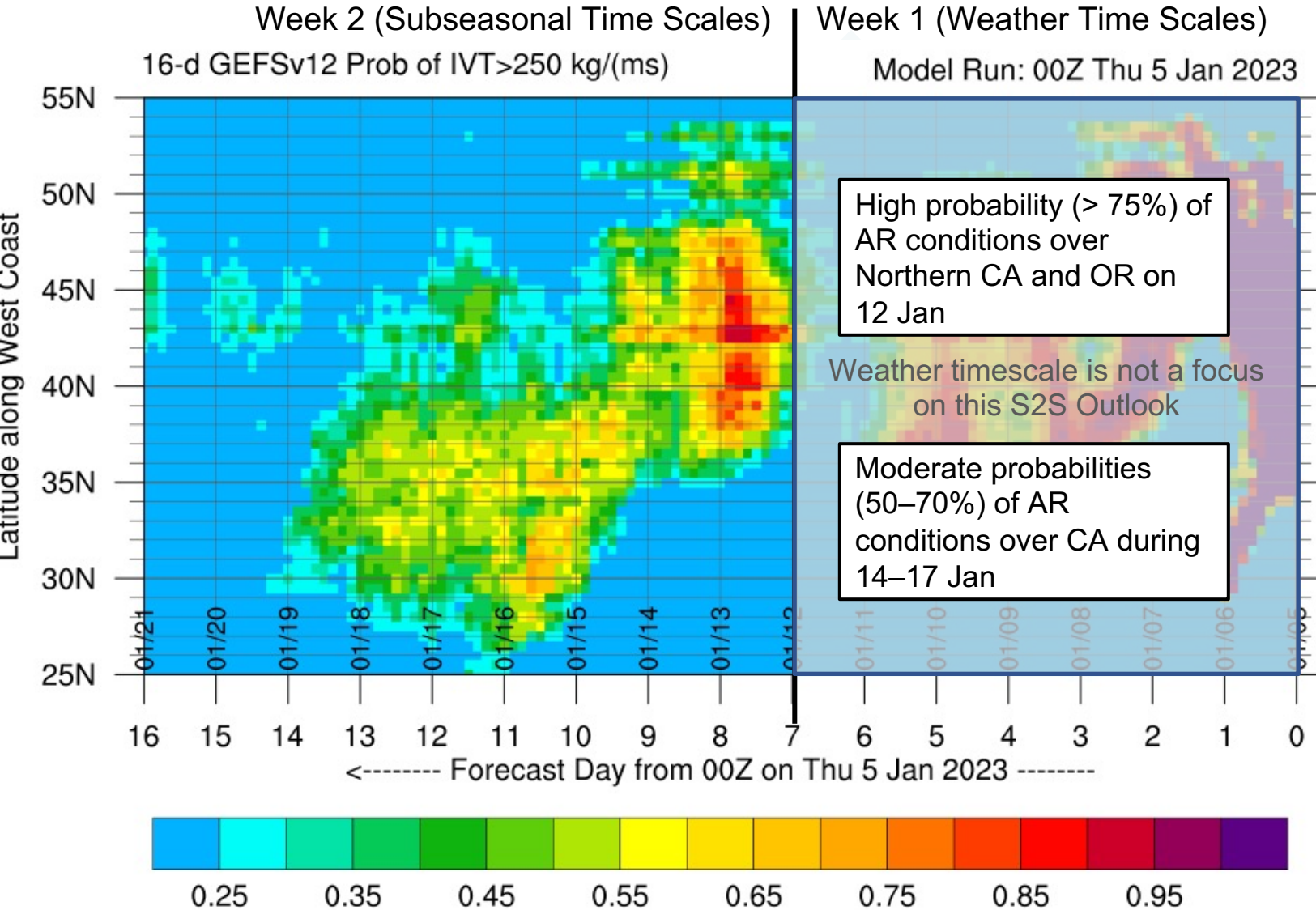
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

NCEP and EC3C correctly forecasted AR activity over the Alaska Panhandle, but failed to forecast the pronounced AR activity in CA, especially over Southern and Central CA

- Multiple ARs brought heavy precipitation to California on 30 Dec – 1 Jan and 4–5 Jan
- More than 8 inches of precipitation fell over the California Coast Ranges, the Bay Area, and the Transverse Ranges, with more than 12 inches over the Sierra Nevada

NCEP GEFS AR Landfall Tool: Valid 00Z 5 Jan – 00Z 21 Jan

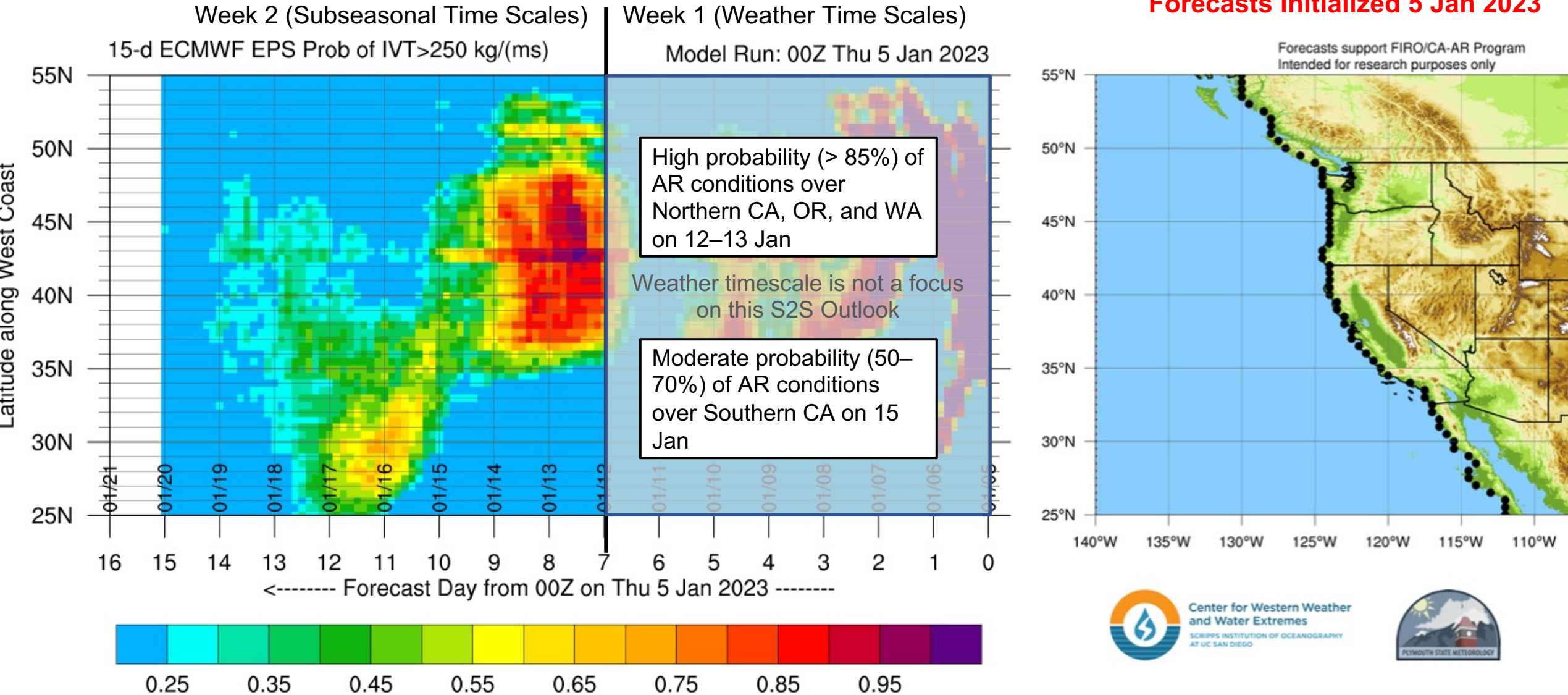
Forecasts Initialized 5 Jan 2023



- NCEP is forecasting moderate-to-high likelihood of AR conditions over California in Week 2 with low ridging activity predicted during Weeks 1–2, and strong MJO activity predicted over the Western Hemisphere

ECMWF EPS AR Landfall Tool: Valid 00Z 5 Jan – 00Z 20 Jan

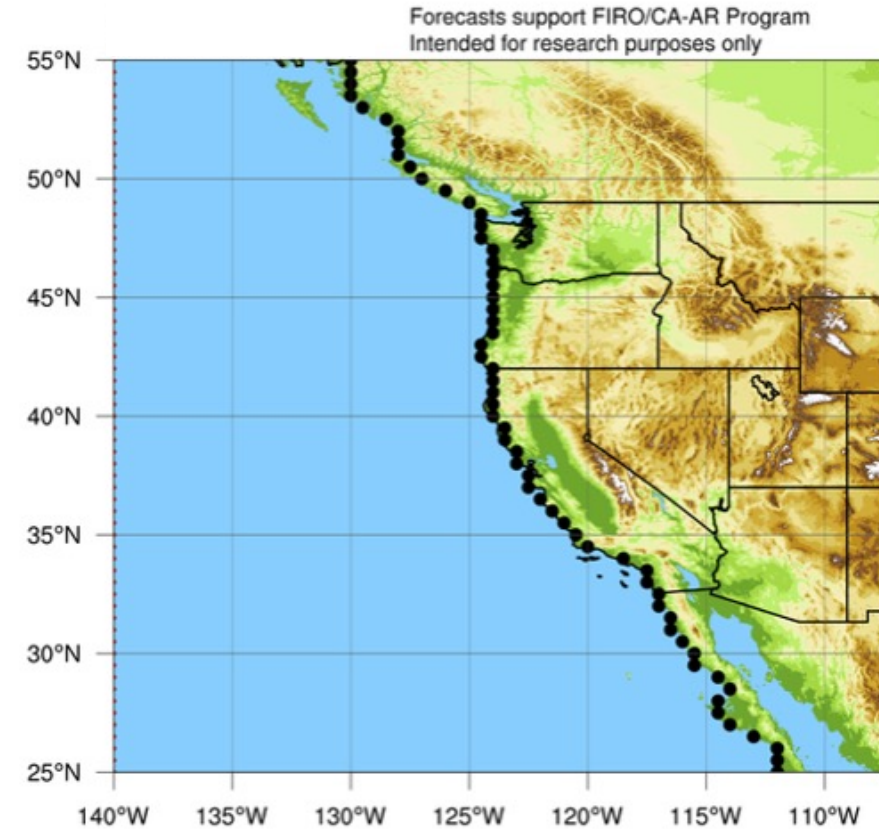
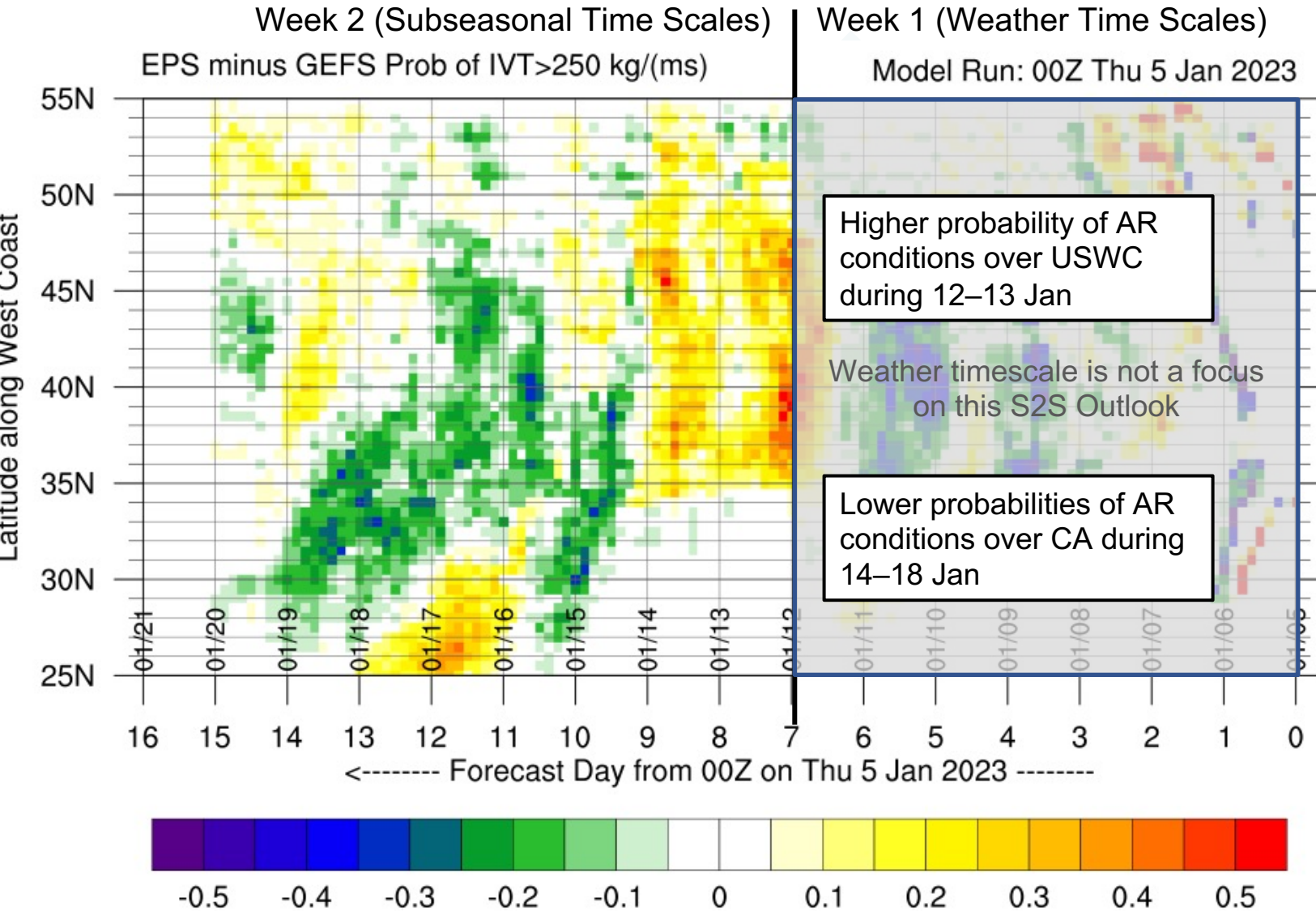
Forecasts Initialized 5 Jan 2023



- ECMWF is forecasting high likelihood of AR conditions over California at the beginning of Week 2, with low ridging activity predicted during Weeks 1-2, and strong MJO activity predicted over the Western Hemisphere

EPS Minus GEFS AR Landfall Tool: Valid 00Z 5 Jan – 00Z 20 Jan

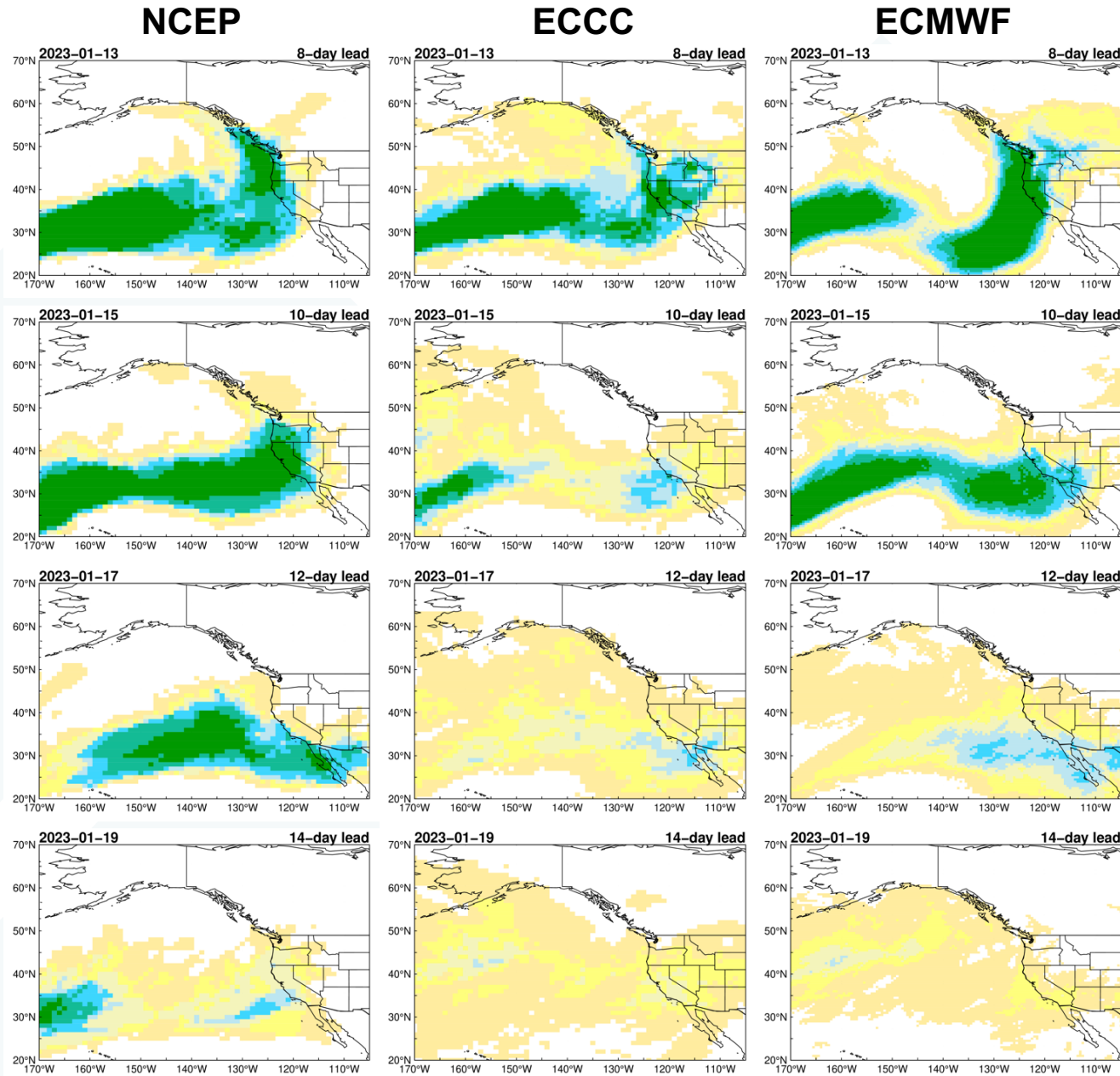
Forecasts Initialized 5 Jan 2023



- ECMWF is forecasting lower likelihood of AR conditions during 14–18 Jan due to a potential shift in the large-scale flow regime over the North Pacific

Subseasonal Outlooks: Week 2 AR Activity (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 5 Jan 2023

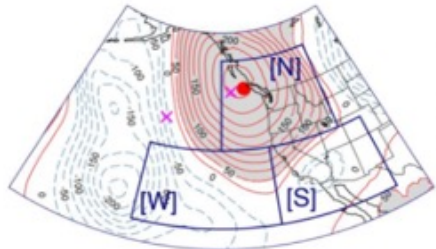


- All models are showing moderate-to-high probabilities (50–80+%) of AR activity over Northern and Central CA on 13 Dec
- NCEP is showing the highest probabilities of AR activity over CA during 15–19 Jan, particularly on 15 Dec
- ECCC is showing the lowest probabilities of AR activity over CA during 15–19 Jan

All models agree on moderate-to-high likelihood of AR activity over California at the start of Week 2, with large differences during 15–19 Jan

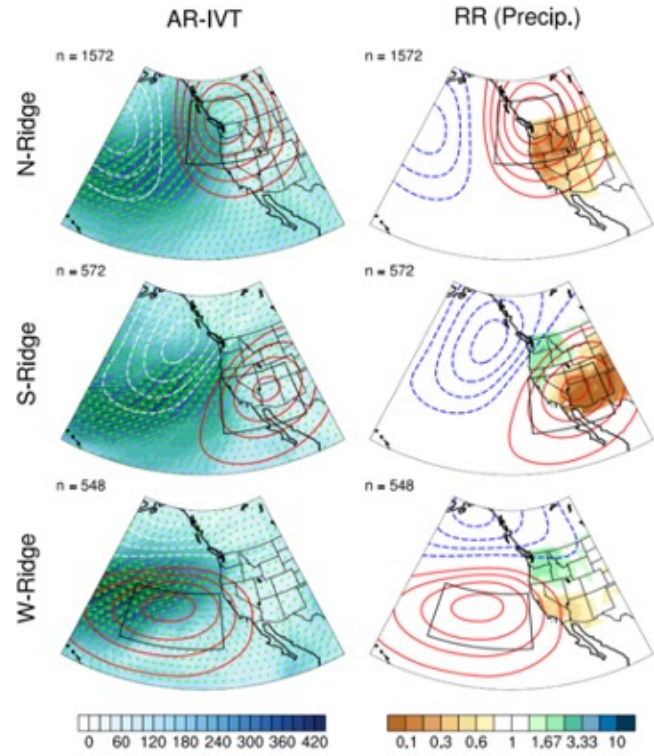


Background Info: Subseasonal Ridging Outlooks



N = North Ridge
S = South Ridge
W = West Ridge

This slide contains background information about the three different ridge types in CW3E's subseasonal ridging outlook tool



- The North-Ridge type is typically associated with widespread dry conditions across the entire western US
- The South-Ridge type is typically associated with dry conditions in Southern California and the Colorado River Basin and wet conditions in the Pacific Northwest
- The West-Ridge type is typically associated with dry conditions over California and wet conditions over the Pacific Northwest

How each ridge type typically influences precipitation
Left: Maps showing the average influence of each ridge type (red contours) on integrated vapor transport (IVT, blue shading indicates greater moisture transport, arrows indicate direction) during atmospheric river events
Right: Maps showing the 'Relative Risk' (RR) of precipitation under each ridge type. Brown shading indicates a reduced chance of precipitation when ridging occurs. For example, a RR value of 0.2 indicates a 5-fold reduction in the likelihood of precipitation



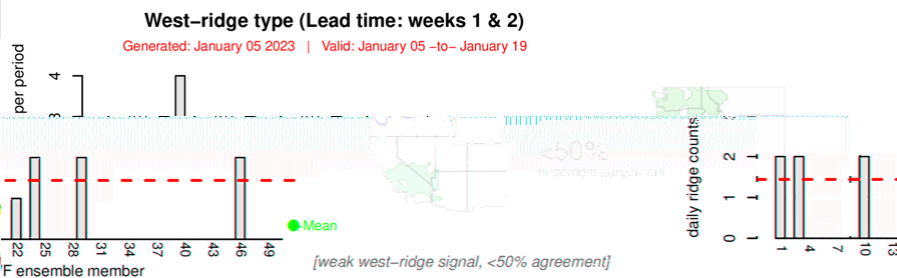
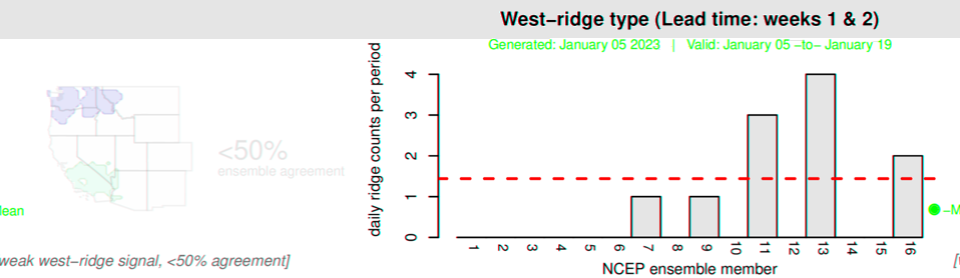
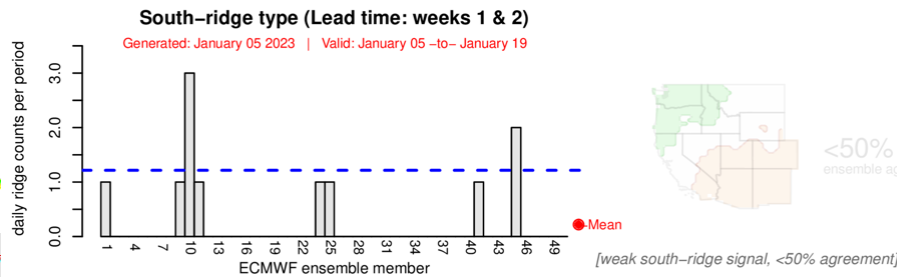
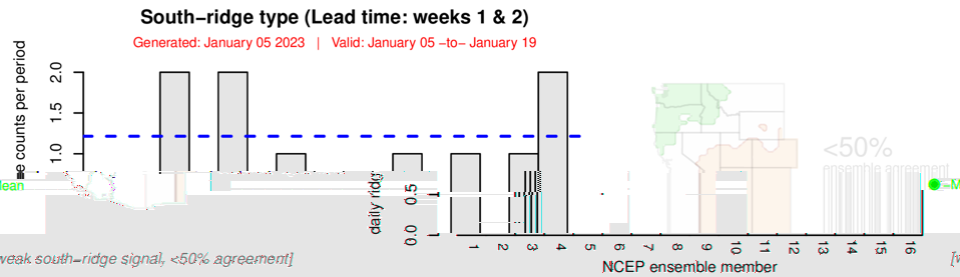
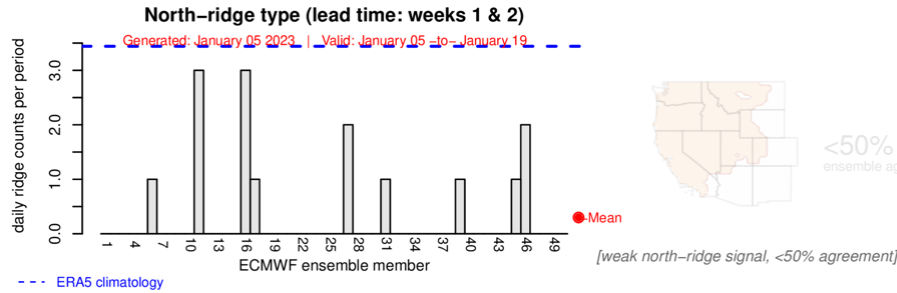
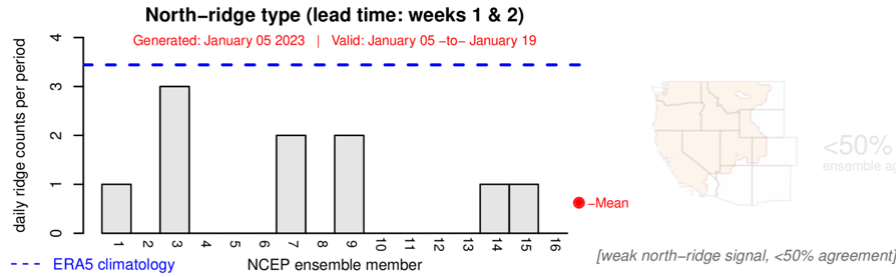
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020) Journal of Climate

Subseasonal Outlooks: Weeks 1–2 Ridging Forecasts (NCEP vs. ECMWF)

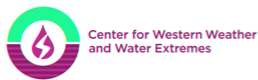
Forecasts Initialized 5 Jan 2023

NCEP

ECMWF



- Both models are showing low confidence (< 50% ensemble agreement) in any one particular ridge type during Weeks 1–2 (5–19 Jan)
- Most ensemble members are predicting little-to-no ridging activity along the US West Coast



There is a low likelihood of persistent ridging activity near the US West Coast during Weeks 1–2 (5–19 Jan)

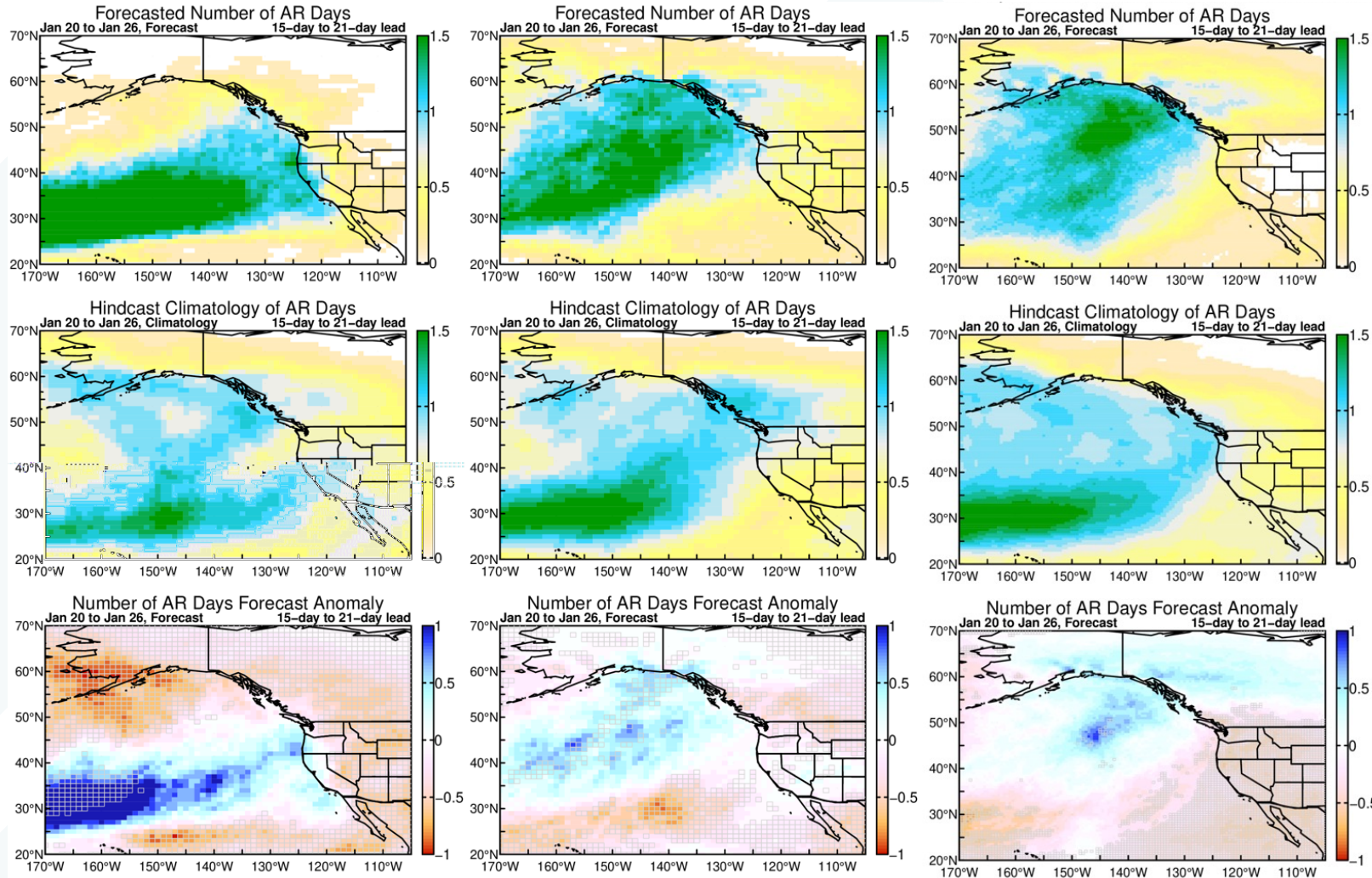
Subseasonal Outlooks: Week 3 AR Activity (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 5 Jan 2023

NCEP

ECCC

ECMWF



- ECCC and ECMWF are predicting little AR activity over CA during Week 3 (20–26 Jan)
- ECMWF ensemble members are in strong agreement in forecasting below-normal AR activity over CA
- NCEP is predicting higher AR activity over CA and OR

Models are showing large differences in the location of AR activity during Week 3 (20–26 Jan)

Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

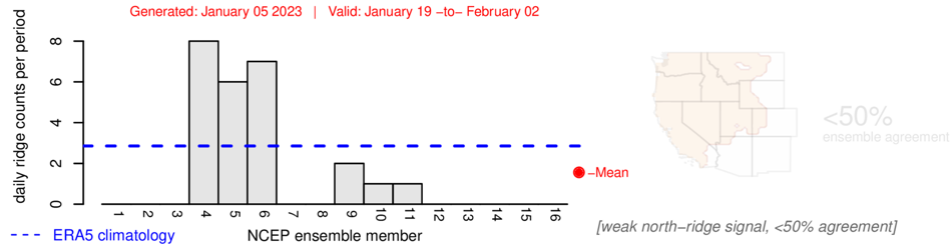
Subseasonal Outlooks: Weeks 3–4 Ridging Forecasts (NCEP vs. ECMWF)

Forecasts Initialized 5 Jan 2023

NCEP

North-ridge type (lead time: weeks 3 & 4)

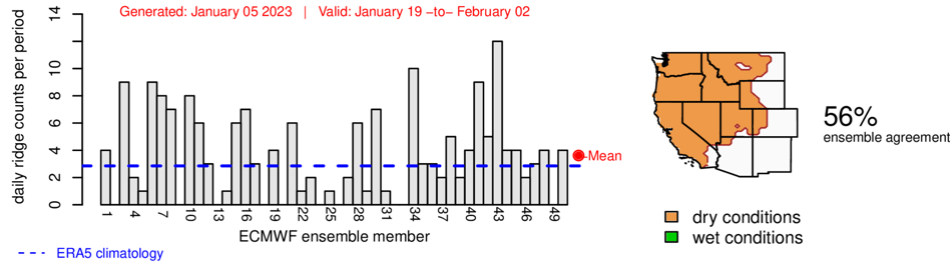
Generated: January 05 2023 | Valid: January 19 –to– February 02



ECMWF

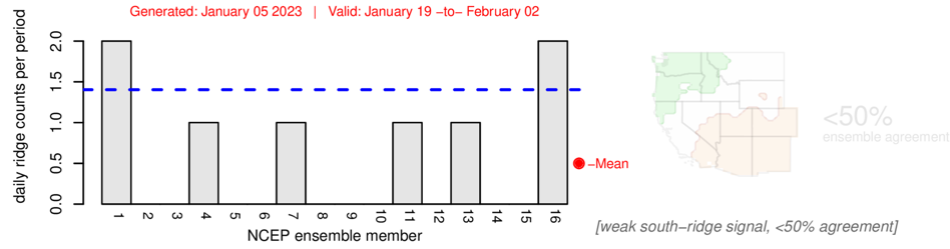
North-ridge type (lead time: weeks 3 & 4)

Generated: January 05 2023 | Valid: January 19 –to– February 02



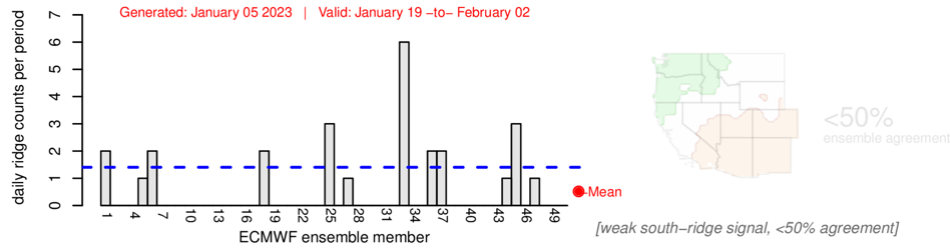
South-ridge type (Lead time: weeks 3 & 4)

Generated: January 05 2023 | Valid: January 19 –to– February 02



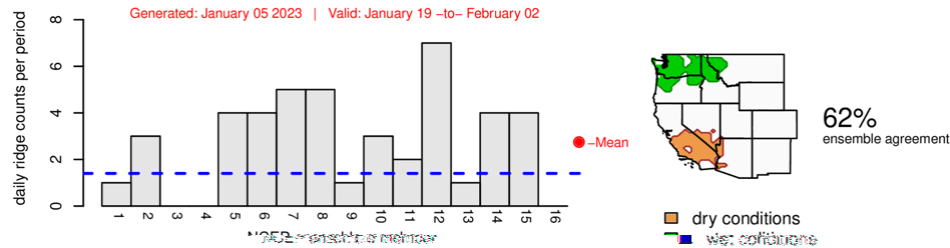
South-ridge type (Lead time: weeks 3 & 4)

Generated: January 05 2023 | Valid: January 19 –to– February 02



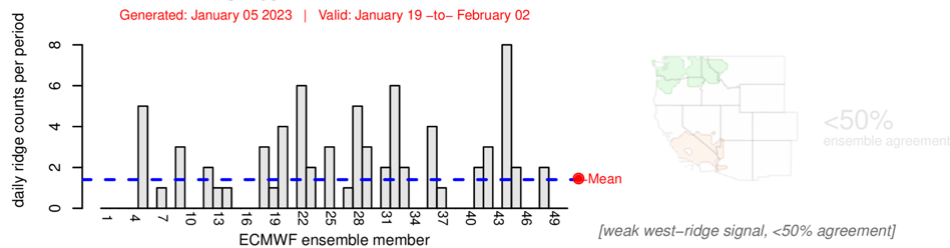
West-ridge type (Lead time: weeks 3 & 4)

Generated: January 05 2023 | Valid: January 19 –to– February 02

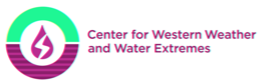


West-ridge type (Lead time: weeks 3 & 4)

Generated: January 05 2023 | Valid: January 19 –to– February 02



- NCEP shows moderate confidence (62% ensemble agreement) in above-normal ridging activity west of California during Weeks 3–4 (19 Jan – 2 Feb)
- ECMWF shows moderate confidence (56% ensemble agreement) in above-normal ridging activity over the Pacific Northwest
- ECMWF is also predicting near-normal ridging activity west of California

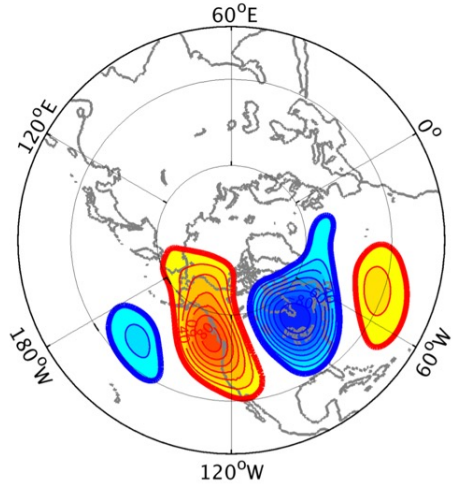


There is a moderate likelihood of above-normal ridging activity near the US West Coast during Weeks 3–4 (19 Jan – 2 Feb)

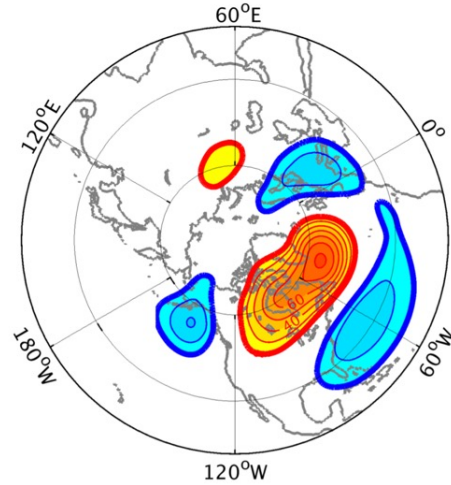


Background Info: IRI Subseasonal Weather Regime Forecasts

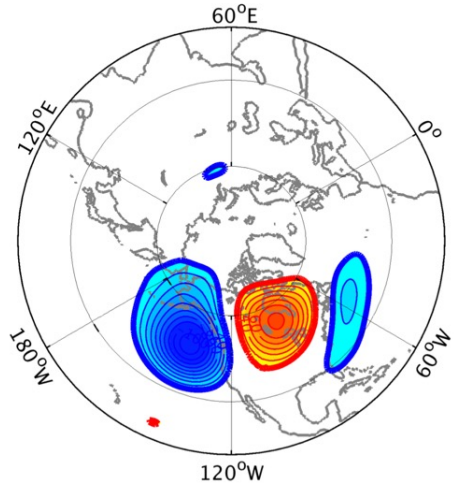
a) WR 1: West Coast Ridge



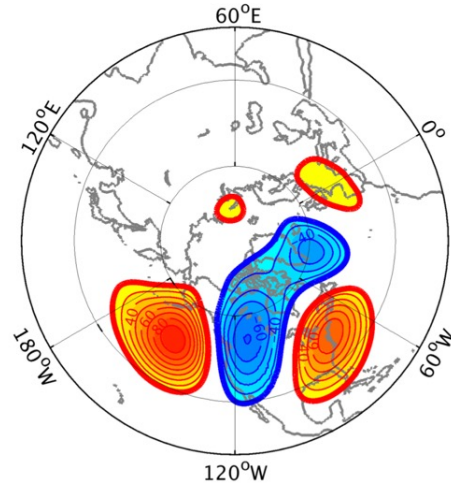
b) WR 2: Greenland High



c) WR 3: Pacific Trough

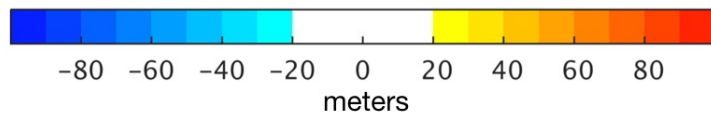


d) WR 4: Pacific Ridge



This slide contains background information about IRI's North American weather regime forecast product

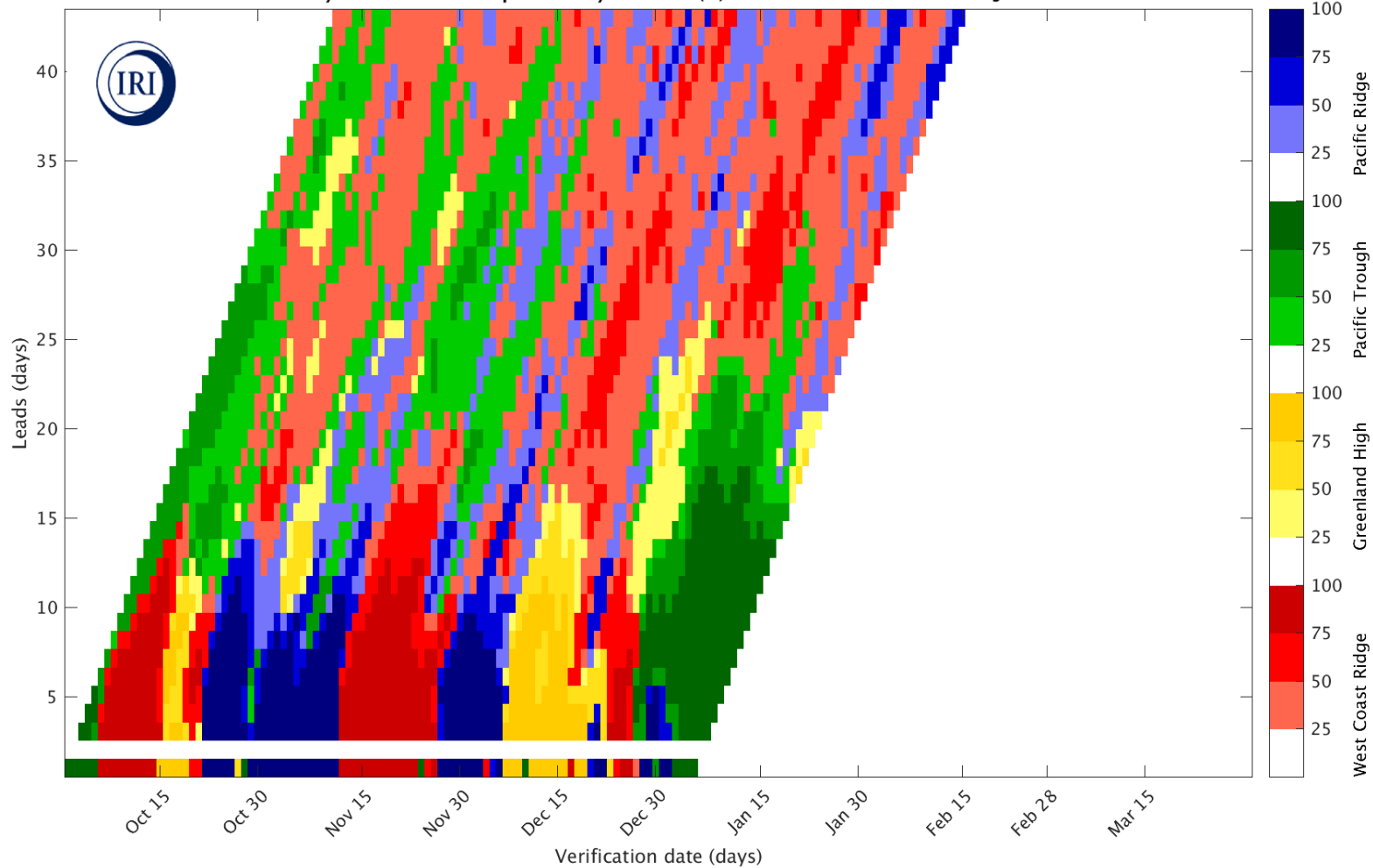
- Four dominant weather regimes identified using cluster analysis on daily 500-hPa geopotential height anomalies from MERRA data (1981–2015)



More info: <https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs>

Subseasonal Outlooks: IRI North American Weather Regime Forecast

CFSv2 daily winter WRs max probability forecast (%) 48 members from Oct 1 to Jan 5 2023



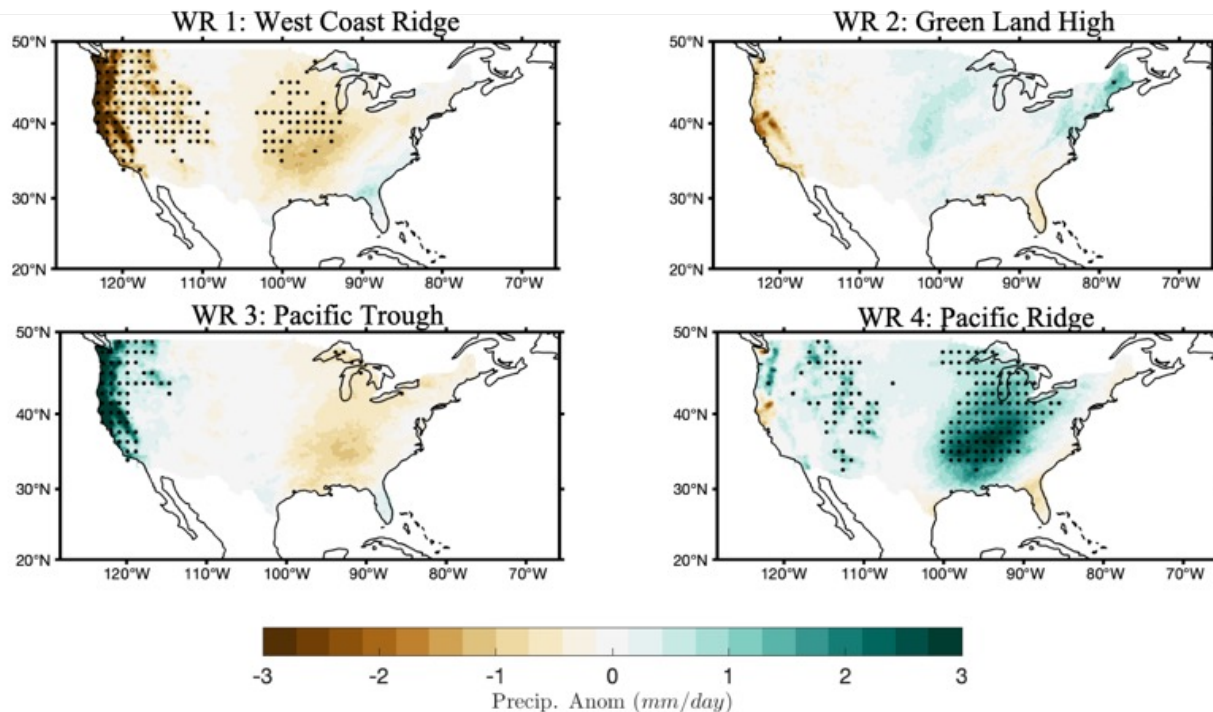
Latest Forecast Initialized 5 Jan 2023

- Daily forecast out to 45 days based on NCEP CFSv2 ensemble
- High likelihood (> 75%) of Pacific Trough during Weeks 1–2
- Moderate likelihood (50–75%) of both Pacific Trough and Greenland High during Week 3
- Low-to-moderate likelihood (25–75%) of West Coast Ridge during Week 4
- NCEP CFSv2 skillfully predicted the recent shift to Pacific Trough conditions at lead times of ~15 days

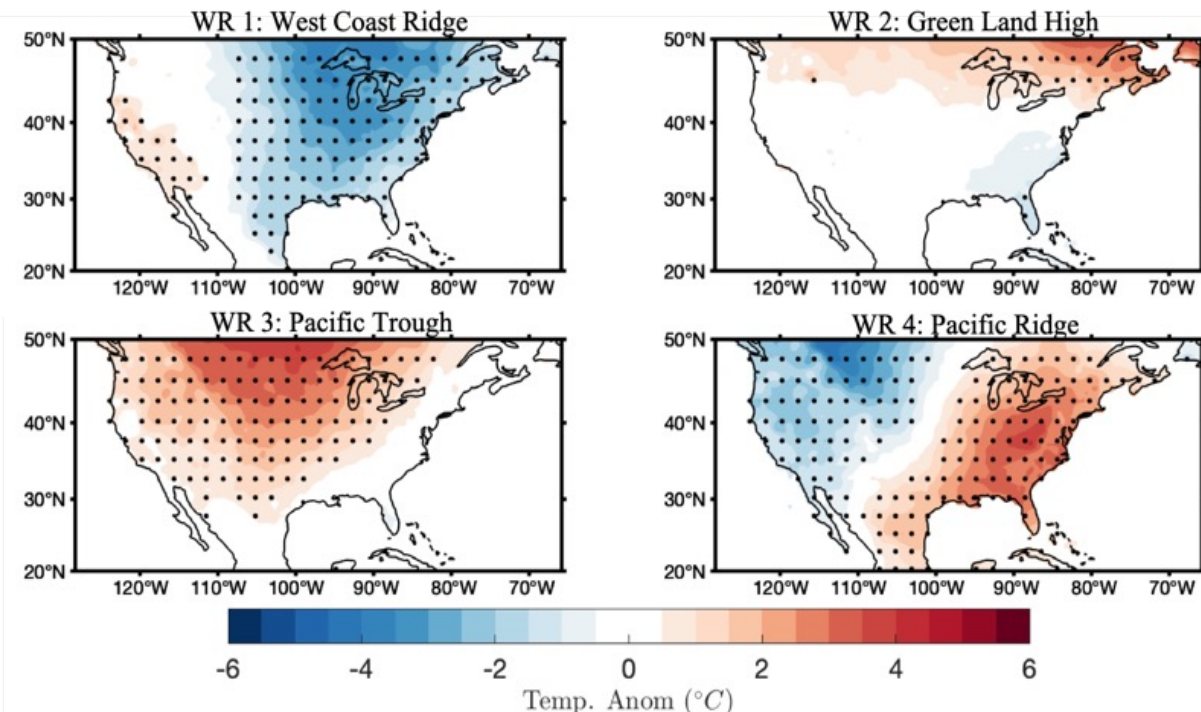
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime.

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation



Temperature



Historical precipitation (left) and temperature (right) composites associated with each regime

- Anomalously wet conditions are predicted over California in early-to-mid January with high confidence
- Anomalously warm and dry conditions are predicted over California in early February with low confidence