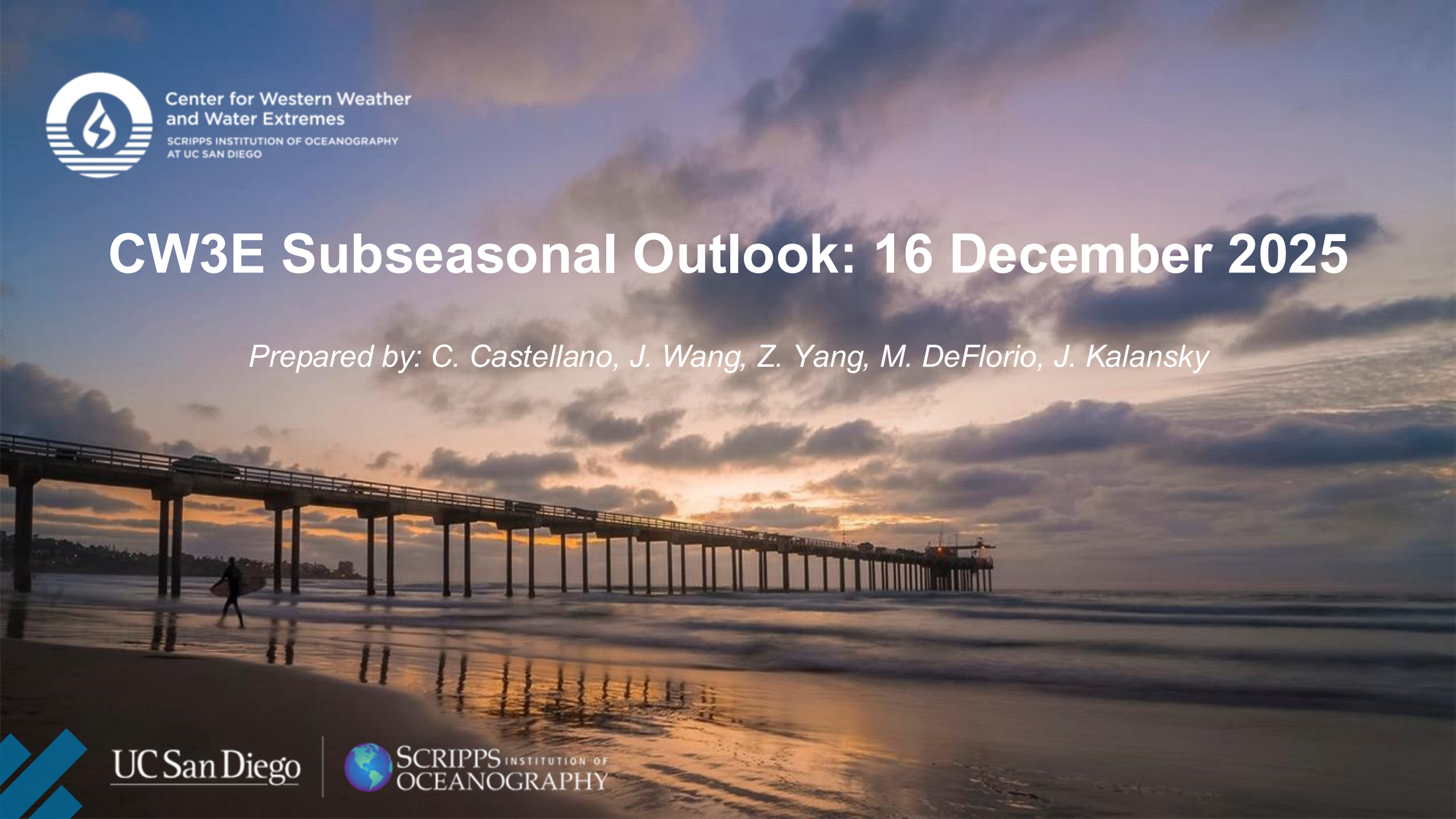
Center for Western Weather
and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO
CW3E Subseasonal Outlook: 16 December 2025
Prepared by: C. Castellano, J. Wang, Z. Yang, M. DeFlorio, J. Kalansky
UC San Diego
SCRIPPS INSTITUTION OF
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CW3E Subseasonal Outlooks: Glossary & Context

- **The outlooks are based on CW3E subseasonal forecast products that can be found here: https://cw3e.ucsd.edu/s_and_s_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 CFSv2 (US Model): Weeks 2–4
  - ECCC (Canadian Model): Weeks 2–4
  - ECMWF (European model): Weeks 2–4

- ***On the following slides, the term confidence refers to the forecasters' interpretation of the magnitude of the anomalies, the level of ensemble agreement, and the skill of the products used to generate the forecasts. All the tools used are shown in the outlook presentation.***

- ***The thresholds for below-normal, near-normal, and above-normal conditions are determined by forecast product and noted on each forecast product slide***

Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 15 Dec 2025

Region	Week 2 (22–28 Dec)				Week 3 (29 Dec – 4 Jan)				Week 4 (5–11 Jan)			
	NCEP[1,2,3,4]	ECCC[1]	ECMWF[1,2]	Multi-Model Forecast	NCEP[1,2,3,4]	ECCC[1]	ECMWF[1,2]	Multi-Model Forecast	NCEP[1,2,3,4]	ECCC[1]	ECMWF[1,2]	Multi-Model Forecast
WA/OR		Above normal	Above normal	? Uncertain/lack of skill	? Uncertain/lack of skill	Above normal	? Uncertain/lack of skill	? Uncertain/lack of skill		Above normal		
Northern CA	? Uncertain/lack of skill	Above normal	Above normal	Above normal		Above normal	? Uncertain/lack of skill	? Uncertain/lack of skill		Above normal	? Uncertain/lack of skill	? Uncertain/lack of skill
Central CA	? Uncertain/lack of skill	Above normal	? Uncertain/lack of skill	? Uncertain/lack of skill		? Uncertain/lack of skill				? Uncertain/lack of skill		
Southern CA		Above normal				? Uncertain/lack of skill				? Uncertain/lack of skill		

Higher Confidence | Lower Confidence

- Below normal
- Near normal
- Above normal
- ? Uncertain/lack of skill

- Forecasts show high confidence in above-normal precipitation in Northern CA and lean toward above-normal precipitation in Central CA during Week 2; more uncertainty over Southern CA
- Forecasts lean toward above-normal precipitation in Northern CA during Weeks 3–4; more uncertainty over Central and Southern CA

Subseasonal products included in this Outlook:

[1]CW3E/JPL Atmospheric River Activity Forecasts (DeFlorio et al. 2019, Zhang et al. 2023)
[2]CW3E/JPL Ridging Forecasts (Gibson et al. 2020)
[3]IRI North American Weather Regime Forecasts (Robertson et al. 2020)
[4]CW3E West Coast Weather Regime Forecasts (Guirguis et al. 2023a and 2023b)

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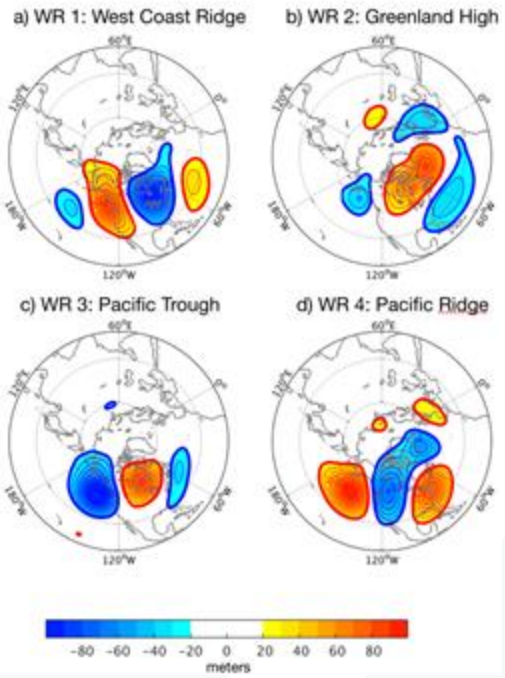
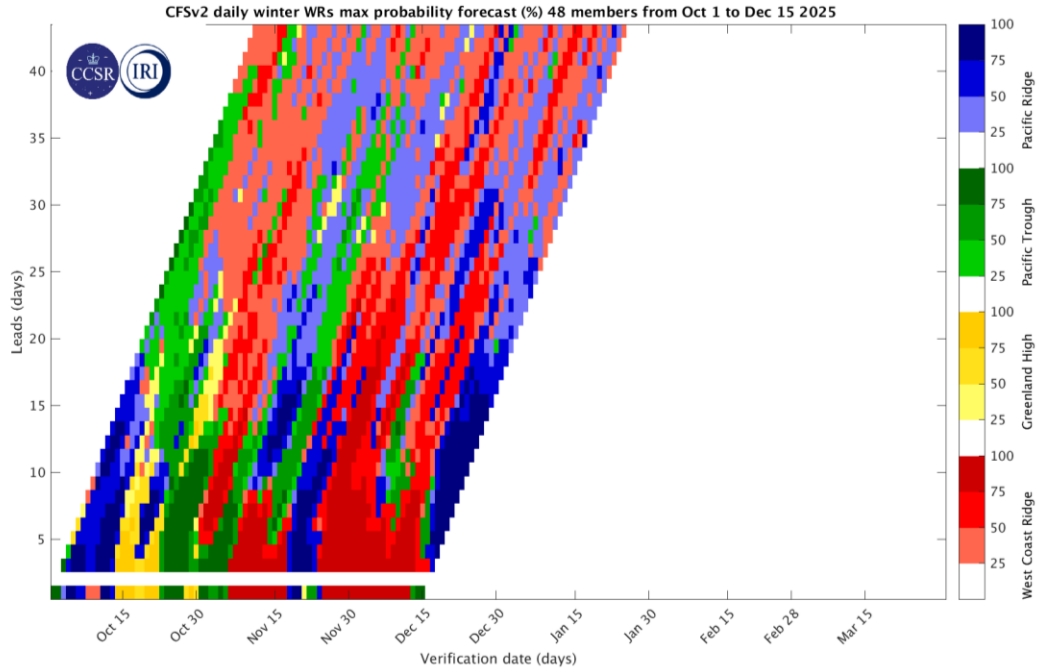
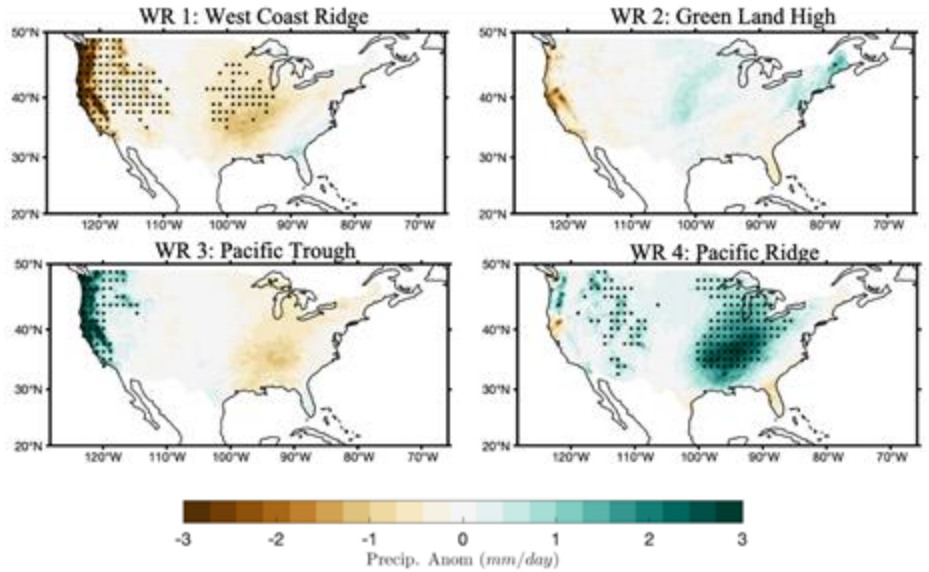
Potential Regime Shifts and Persistence







Product	Week 2 (22–28 Dec)	Week 3 (29 Dec – 4 Jan)	Week 4 (5–11 Jan)
IRI North American Weather Regime Forecasts	Pacific Ridge	Pacific Ridge	

Regime Persistence (Pacific Ridge) Regime Shift Uncertain

- Potential for persistence of Pacific Ridge regime (cool pattern in CA) during Weeks 2–3
- Low confidence in regime forecasts during Week 4

Summary

MJO/QBO Conditions

- Strong MJO convection is currently located over the Central Pacific/Western Hemisphere (Phase 8); QBO is in the easterly phase
  - Without considering QBO/ENSO conditions, MJO in the Western Hemisphere is associated with an increase in extreme precipitation over Central and Southern California at lag times of 1–2 weeks

- NCEP is forecasting MJO convection to weaken toward the end of Week 1 and remain weak during Weeks 2
  - The statistical relationship between the MJO and extreme precipitation is consistent with the Week 2 AR activity forecasts over Central and Southern CA

Week 2 Forecasts (22–28 Dec):

- Models agree on above-normal AR activity over all of CA

- Ridging outlooks show high likelihood of persistent South-ridge activity (ridging centered over southwestern US) during Weeks 1–2
  - South-ridge type is associated with dry conditions over Southern CA and wet conditions over Northern CA

- IRI North American weather regime tool shows high likelihood of persistence in Pacific Ridge (near-normal precipitation and below-normal temperature in CA) during most of Week 2

- CW3E West Coast weather regime tool shows high likelihood of patterns associated with above-normal precipitation in Central CA

Summary

Week 3 Forecasts (29 Dec – 4 Jan):

- ECCC and ECMWF agree on above-normal AR activity over Northern and Central CA; more model disagreement over Southern CA
  - NCEP is forecasting slightly above-normal AR activity over Northern and Central CA
  - In Southern CA, NCEP is forecasting near-normal AR activity, ECCC is forecasting slightly above-normal AR activity, and ECMWF is forecasting above-normal AR activity

- Ridging outlooks show some uncertainty in frequency and location of ridging activity during Weeks 3–4
  - ECMWF is forecasting above-normal South-ridge activity (dry conditions over Southern CA; wet conditions over Northern CA) with moderate confidence
  - NCEP is forecasting above-normal West-ridge activity (dry conditions over Central and Southern CA) with moderate confidence

- IRI North American weather regime tool shows low-to-moderate likelihood of persistence in Pacific Ridge during Week 3

- CW3E West Coast weather regime tool shows high degree of uncertainty during Week 3

Week 4 Forecasts (5–11 Jan):

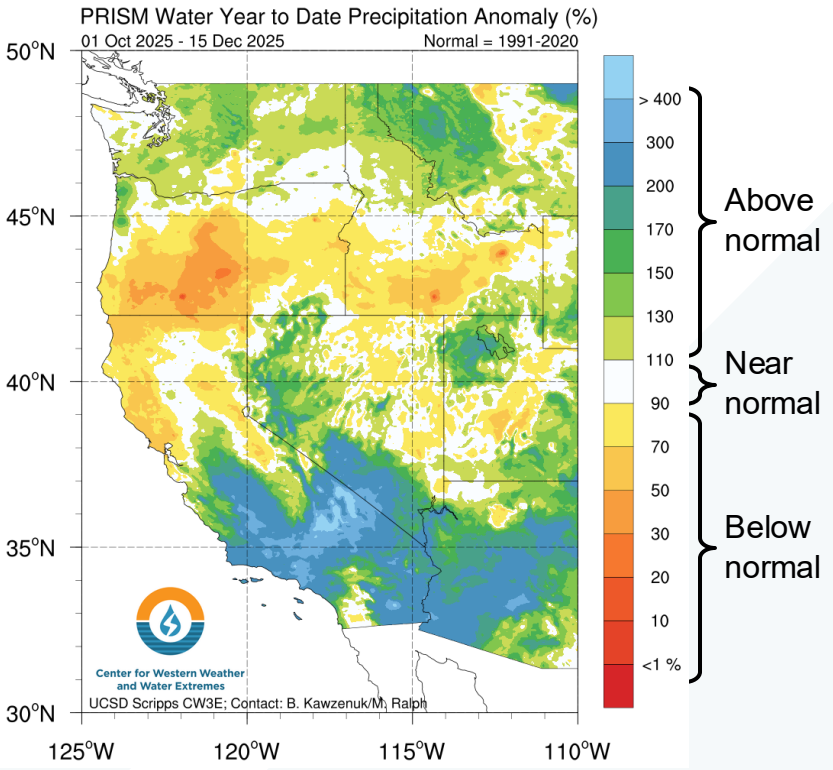
- ECCC and ECMWF generally agree on above-normal AR activity over CA, whereas NCEP is forecasting near-normal AR activity

- IRI North American weather regime tool shows a high degree of uncertainty during Week 4

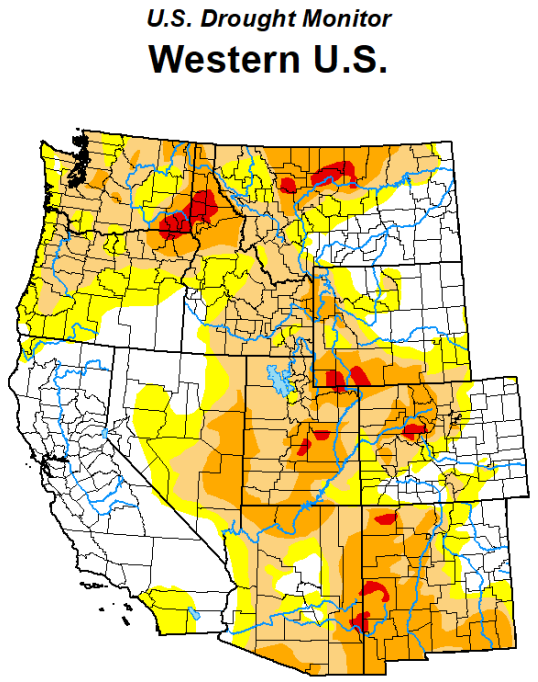
- CW3E West Coast weather regime tool shows high degree of uncertainty during Week 4

Hydrologic Summary

Precipitation



Drought Conditions



December 9, 2025
(Released Thursday, Dec. 11, 2025)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	31.81	68.19	48.25	20.84	2.04	0.00
Last Week 12-02-2025	30.75	69.25	49.86	22.18	2.06	0.00
3 Months Ago 09-09-2025	18.61	81.39	64.41	46.29	15.00	0.74
Start of Calendar Year 01-07-2025	32.22	67.78	39.02	20.30	6.87	0.00
Start of Water Year 09-30-2025	18.15	81.85	64.82	44.12	12.00	0.69
One Year Ago 12-10-2024	30.41	69.59	34.76	18.15	6.58	0.00

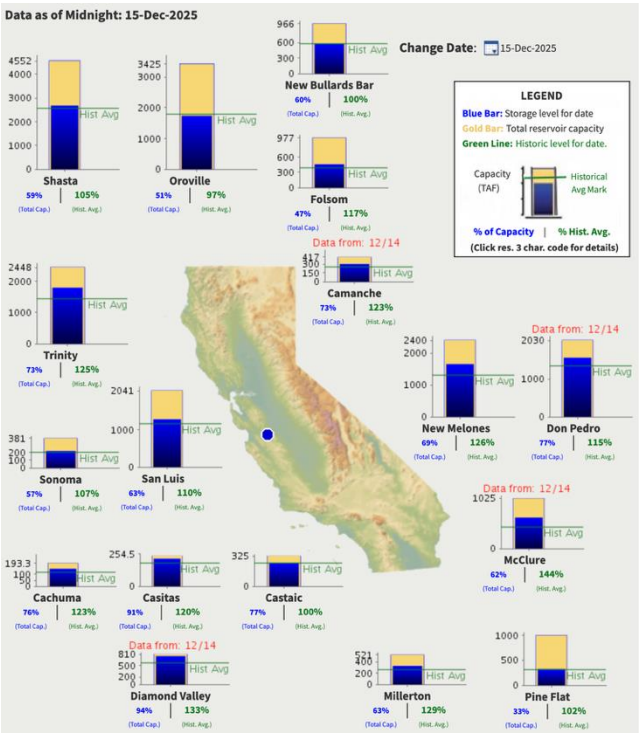
Intensity:
- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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:
Lindsay Johnson
National Drought Mitigation Center

droughtmonitor.unl.edu

Reservoir Conditions



Source: California DWR

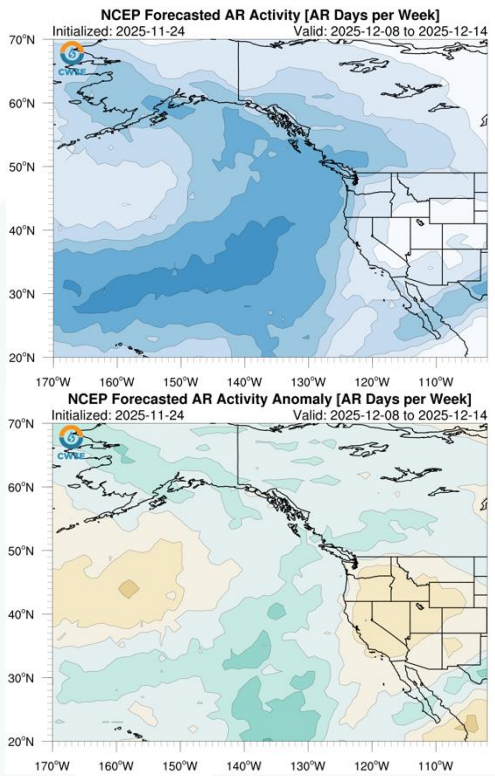
Disclaimer: In addition to climate indicators, the U.S. Drought Monitor also uses impact reports from local observers about crop failures or water restrictions to quantify drought.

- As of 15 Dec, water-year-to-date precipitation is running **below normal to near normal (50–110% of normal)** in Northern CA and **well-above normal (>150% of normal)** in much of Central and Southern CA
- The most recent drought monitor update is showing no drought over nearly all of CA, except for abnormally dry conditions (D0) over a small portion of Southern CA
- As of 15 Dec, most large reservoirs in California are operating at ≥50% capacity and near or above-normal storage for this time of year

Looking Back: Week 3 AR Activity Forecasts

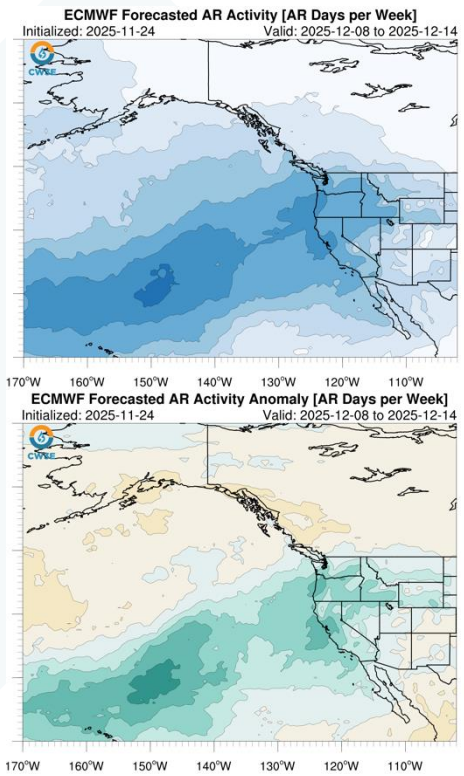
Forecasts Initialized 24 Nov 2025; Valid: 8–14 Dec 2025

NCEP

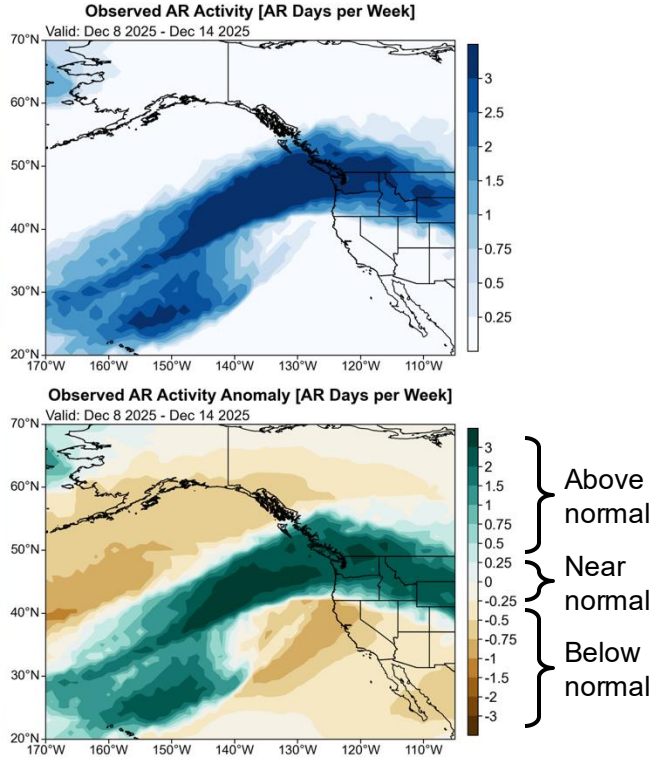


ECCC Forecast Unavailable

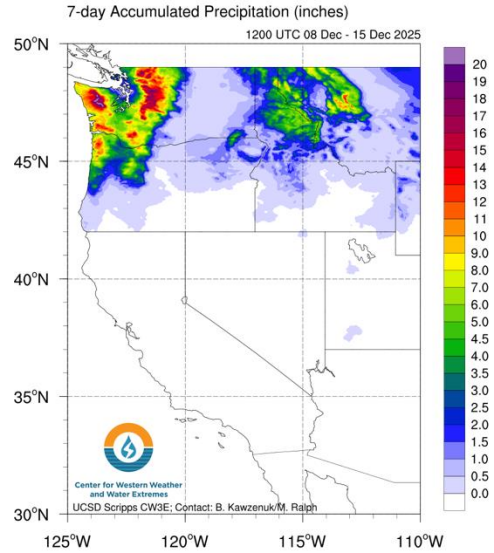
ECMWF



Observed (CFSv2 Analysis)



Observed Precipitation



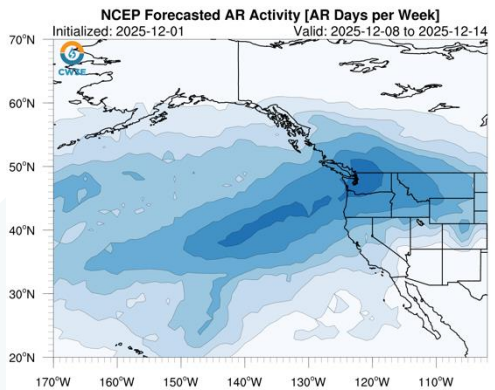
Shading: Fractional # of AR days forecast over a 7-day period (top) and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

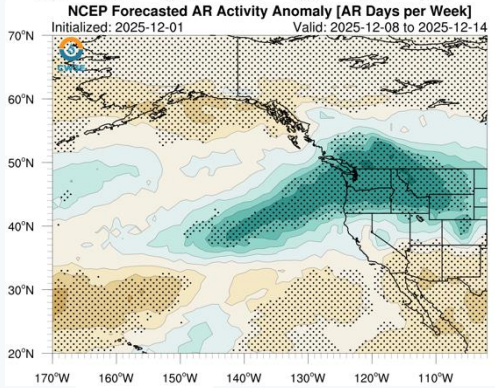
- At 3-week lead times, both models failed to predict the persistent ridge west of California that facilitated prolonged AR activity over the northwestern US and limited AR activity over CA
- While ECMWF correctly predicted a region of enhanced AR activity extending from the Northeast Pacific into the Pacific Northwest, the center of AR activity was displaced southward relative to observed AR activity
- NCEP incorrectly predicted AR activity to remain primarily offshore
- A long-duration AR produced >10 inches of precipitation in the Olympic Mountains and Washington Cascades

Looking Back: Week 2 AR Activity Forecasts

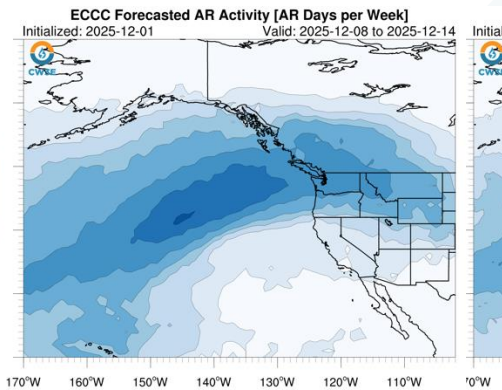
Forecasts Initialized 1 Dec 2025; Valid: 8–14 Dec 2025

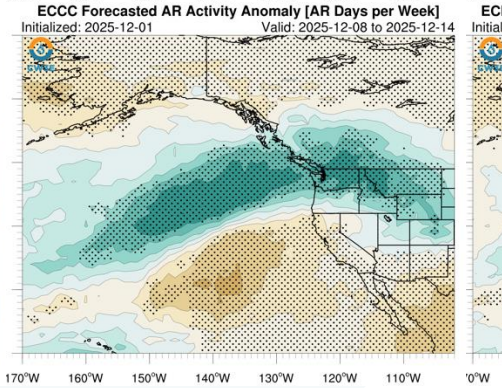
NCEP



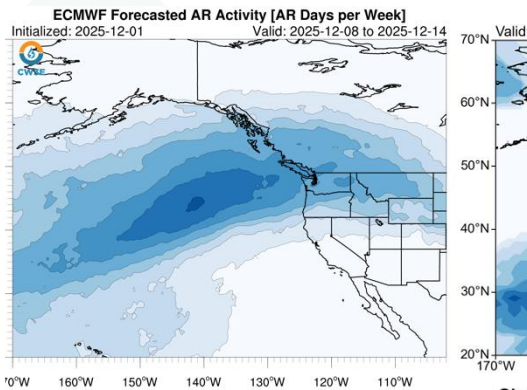


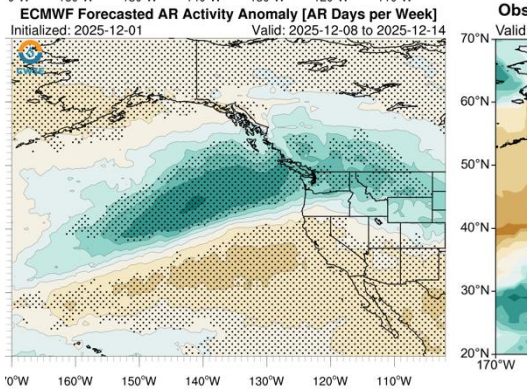
ECMWF

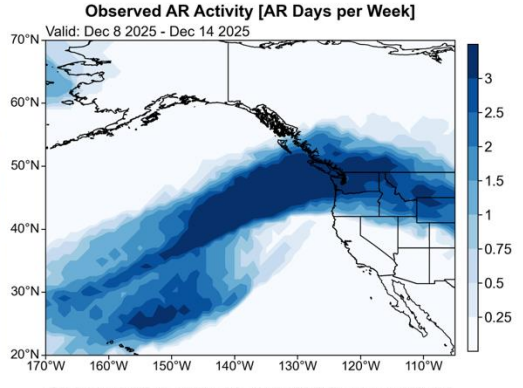


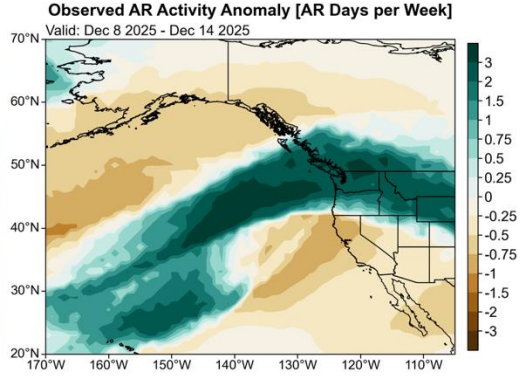


Observed (CFSv2 Analysis)







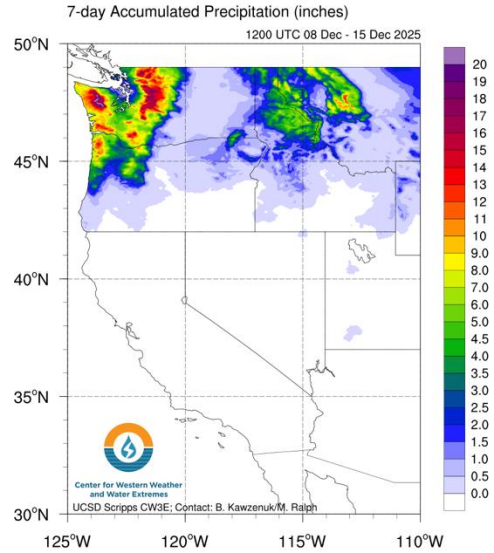


Above normal

Near normal

Below normal

Observed Precipitation



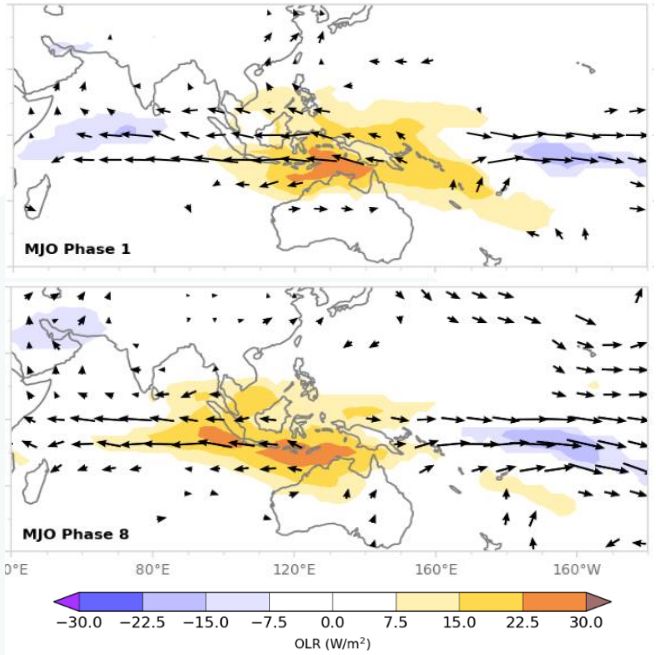
Shading: Fractional # of AR days forecast over a 7-day period (top) and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

- At 2-week lead times, all models captured the axis of enhanced AR activity extending from the Northeast Pacific into the Pacific Northwest, as well as the inland penetration of AR activity over the interior northwestern US
- Models slightly underestimated the duration of AR activity over land
- A long-duration AR produced >10 inches of precipitation in the Olympic Mountains and Washington Cascades

Dynamical Model MJO Forecasts (NCEP)

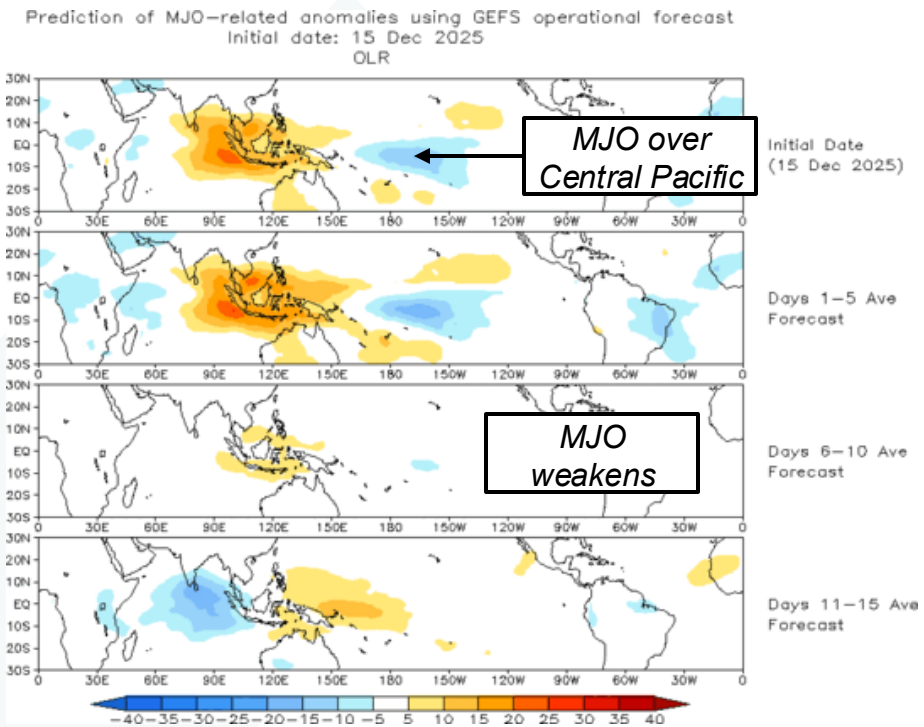
Observed MJO

Phases 8&1 (Western Hemisphere)



OLR = Outgoing longwave radiation

Weeks 1–2 MJO Prediction



Circulation and Moisture Transport Anomalies

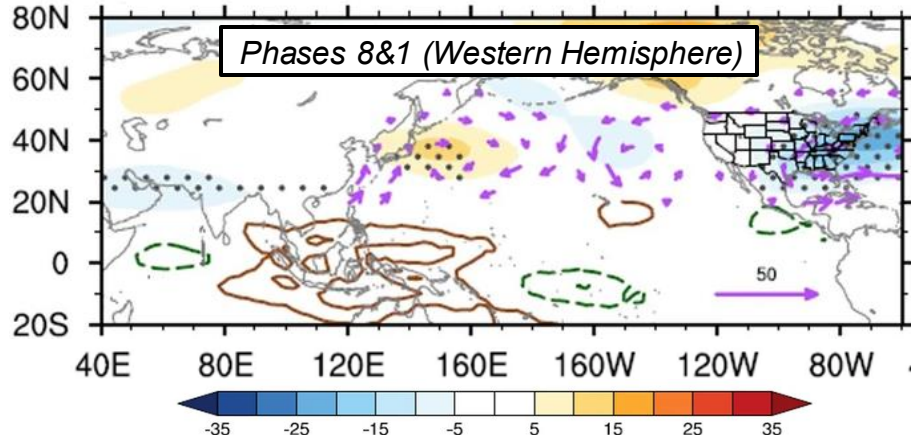


Figure 5 from Wang et al. (2024)

Composite Z500 anomalies (shading; orange = positive; blue = negative), IVT anomalies (vectors); and OLR anomalies (brown = suppressed convection; green = enhanced convection)

Extreme Precipitation Frequency

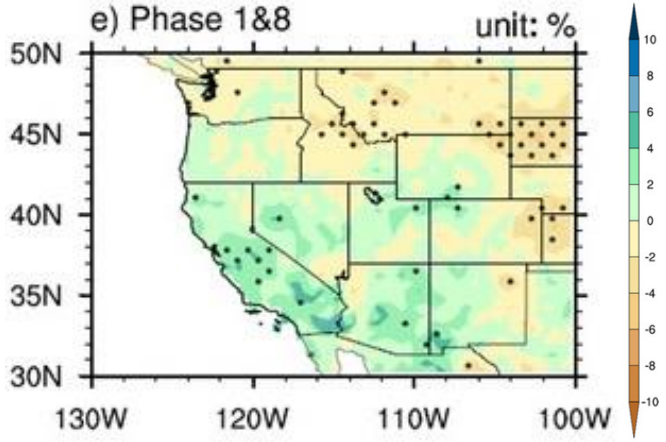
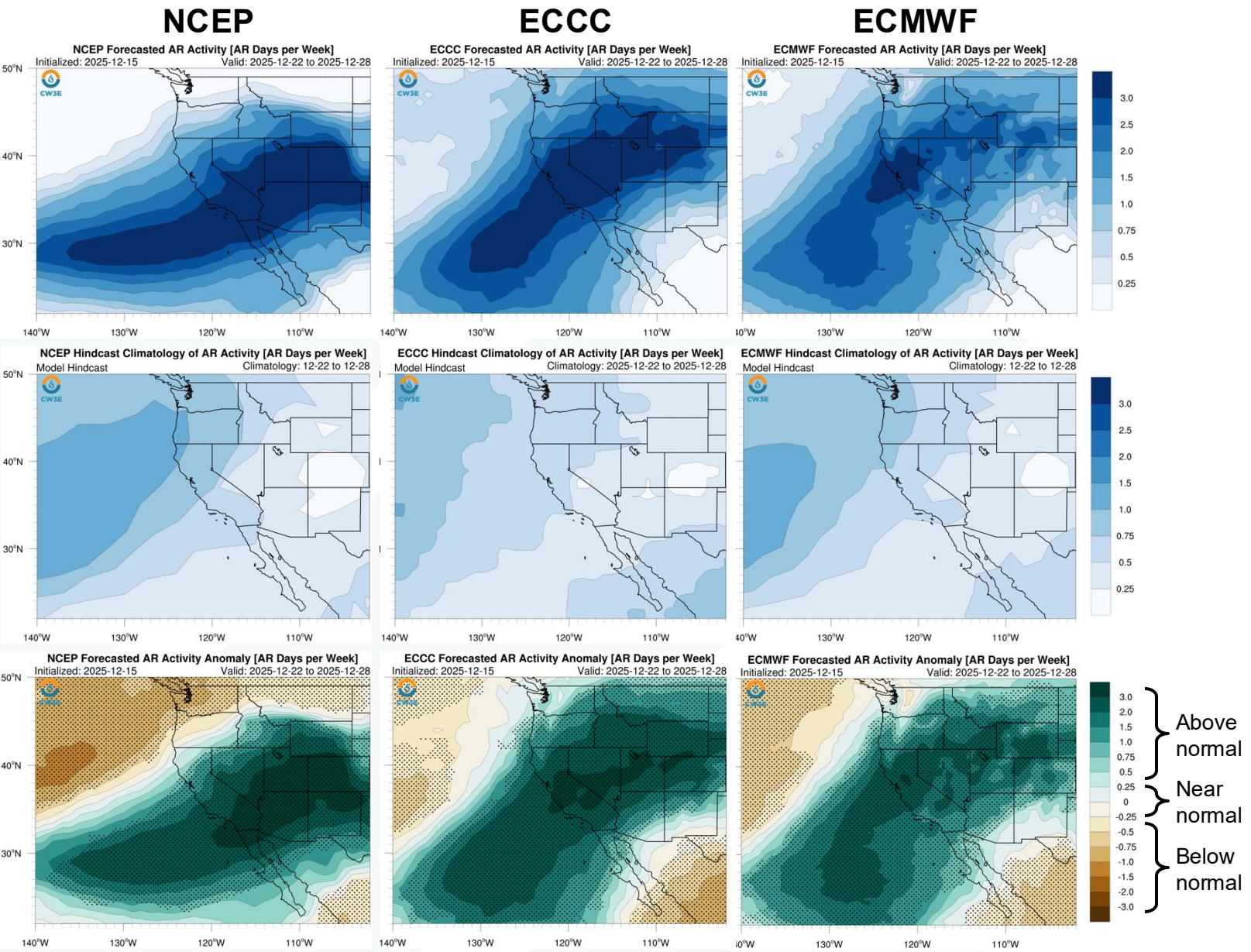


Figure 3 from Wang et al. (2023)

Percent Change in frequency of extreme precipitation (brown = decreased frequency; green/blue = increased frequency)

- As of 15 Dec, strong MJO convection is currently located over the Central Pacific/Western Hemisphere (Phase 8)
- NCEP is forecasting MJO convection to weaken toward the end of Week 1 and remain weak during Week 2
- MJO convection over the Western Hemisphere is associated with a weak trough over the Northeast Pacific at lag times of 1–2 weeks, leading to slightly increased moisture transport and an increase in extreme precipitation frequency over Central and Southern CA

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



Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

Forecasts Initialized 15 Dec 2025

- All models show high confidence in above-normal AR activity over all of CA during Week 2 (22–28 Dec)
- NCEP is forecasting the highest AR activity over Southern CA, whereas ECCC and ECMWF are forecasting the highest AR activity over Northern and Central CA

Models agree on above-normal AR activity over CA during Week 2 (22–28 Dec)

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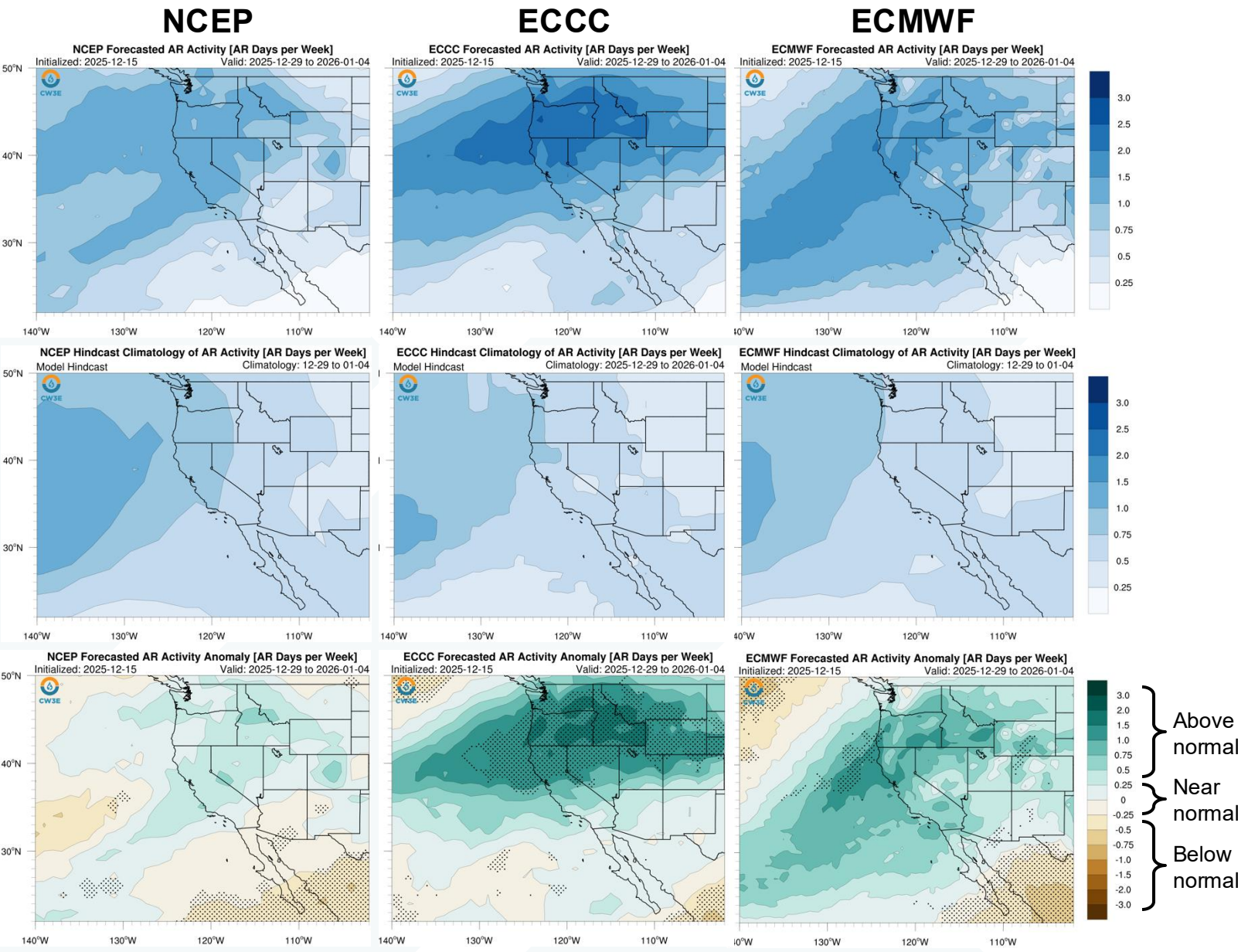
AR Activity Forecasts: Week 3 (NCEP vs. ECCC vs. ECMWF)



Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

Forecasts Initialized 15 Dec 2025

- In Northern and Central CA, ECCC and ECMWF agree on above-normal AR activity during Week 3 (29 Dec – 4 Jan), whereas NCEP is forecasting slightly above-normal AR activity
  - ECCC is showing high confidence in above-normal AR activity in Northern CA
- In Southern CA, NCEP is forecasting near-normal AR activity, ECCC is forecasting slightly above-normal AR activity, and ECMWF is forecasting above-normal AR activity

ECCC and ECMWF agree on above-normal AR activity over Northern and Central CA during Week 3 (29 Dec – 4 Jan); more model disagreement over Southern CA

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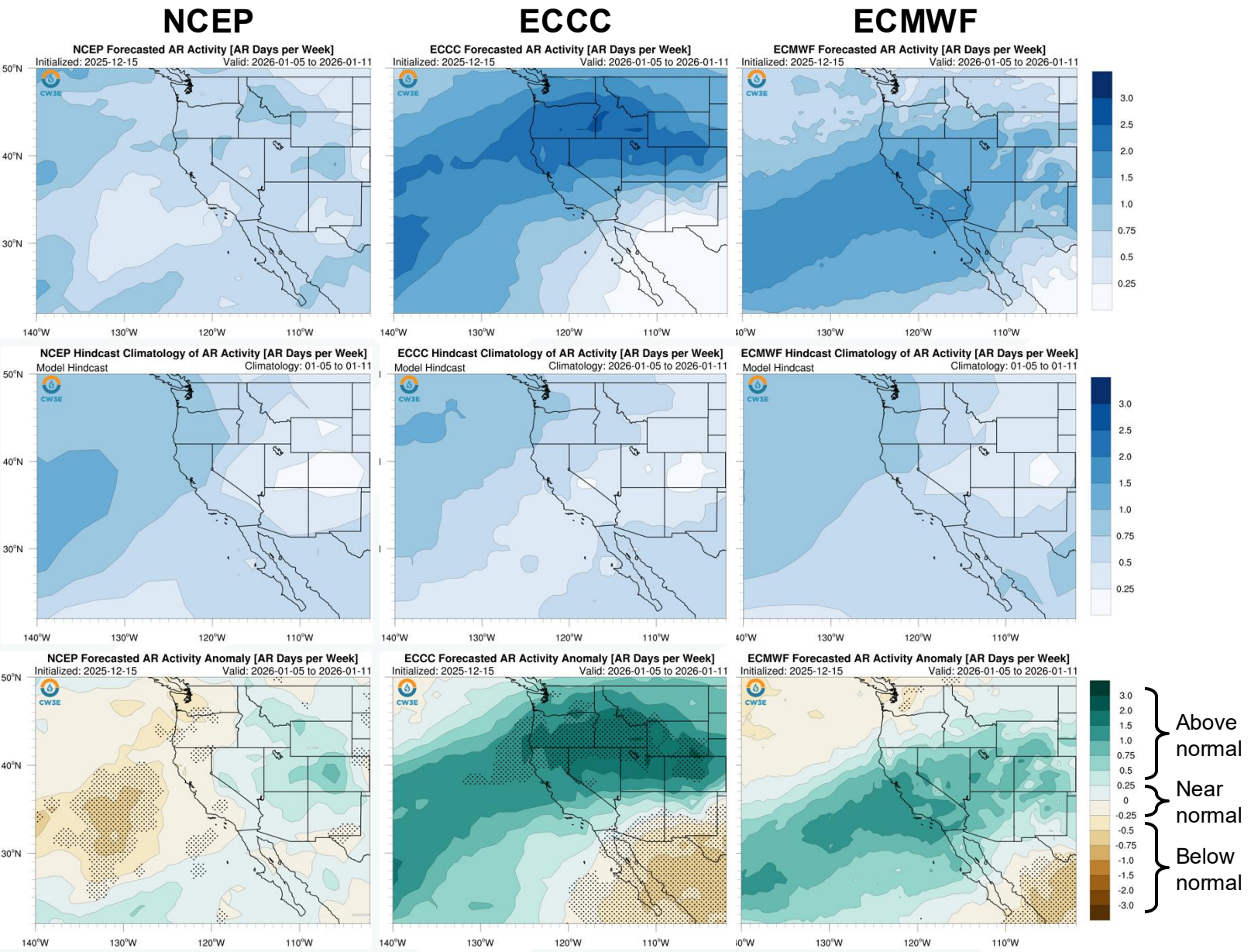
AR Activity Forecasts: Week 4 (NCEP vs. ECCC vs. ECMWF)



Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

Forecasts Initialized 15 Dec 2025

- ECCC and ECMWF generally agree on above-normal AR activity over all of CA during Week 4 (5–11 Jan)
  - ECCC is showing high confidence in above-normal AR activity in Northern CA
- NCEP is forecasting near-normal AR activity over all of CA

ECCC and ECMWF generally agree on above-normal AR activity over CA during Week 4 (5–11 Jan); NCEP differs

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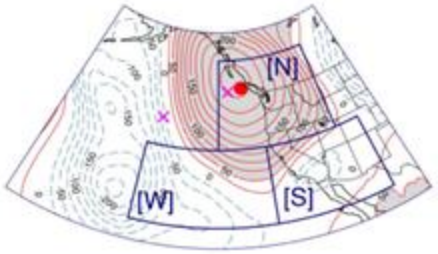
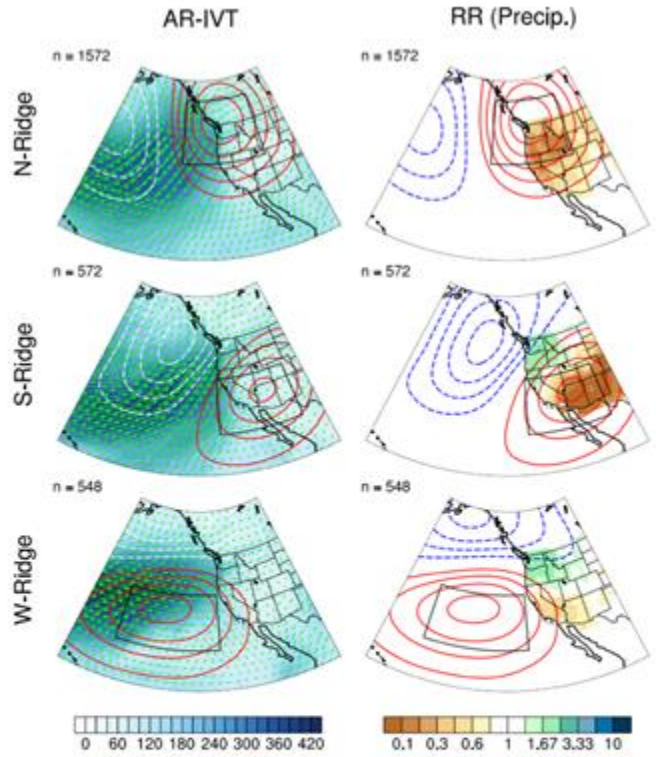
Background Info: Subseasonal Ridging Outlooks



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



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

- 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 CA and the Colorado River Basin and wet conditions in the Pacific Northwest
- The West-Ridge type is typically associated with dry conditions over Central and Southern CA and wet conditions over the Pacific Northwest

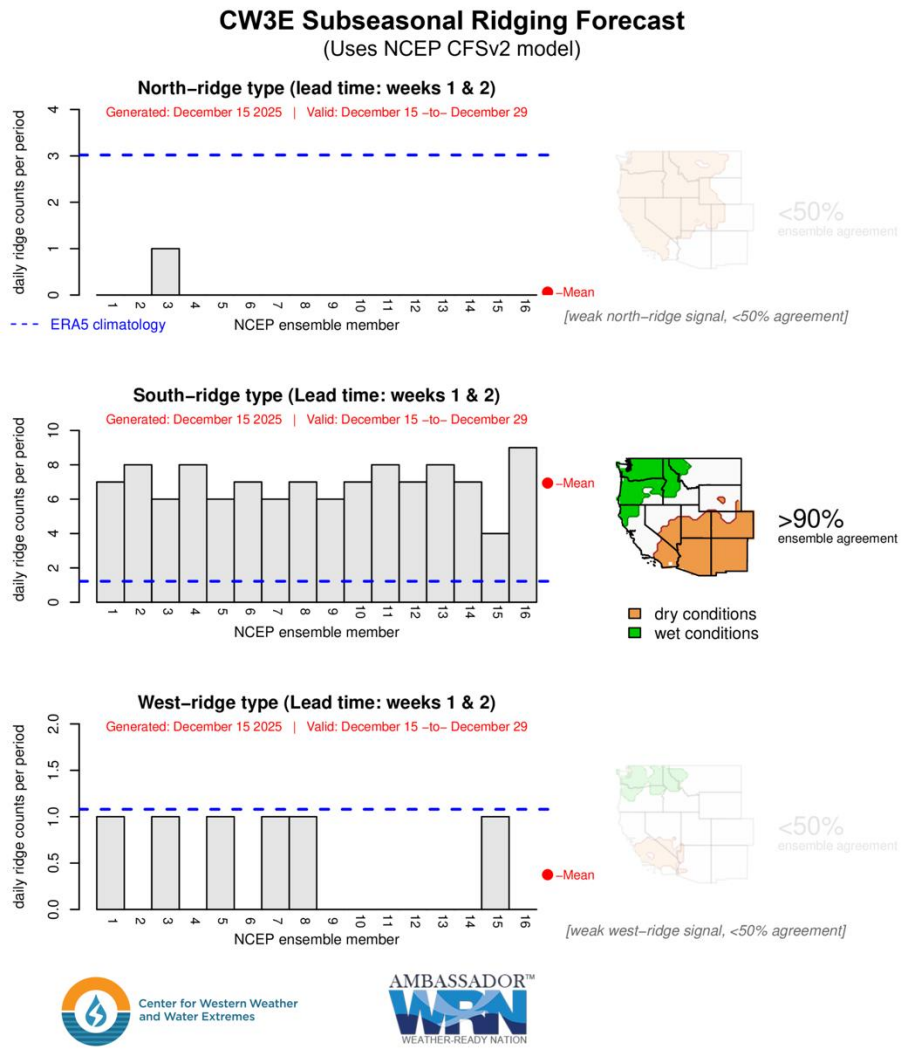
Jet Propulsion Laboratory
California Institute of Technology

Center for Western Weather and Water Extremes
Scripps Institution of Oceanography at UC San Diego

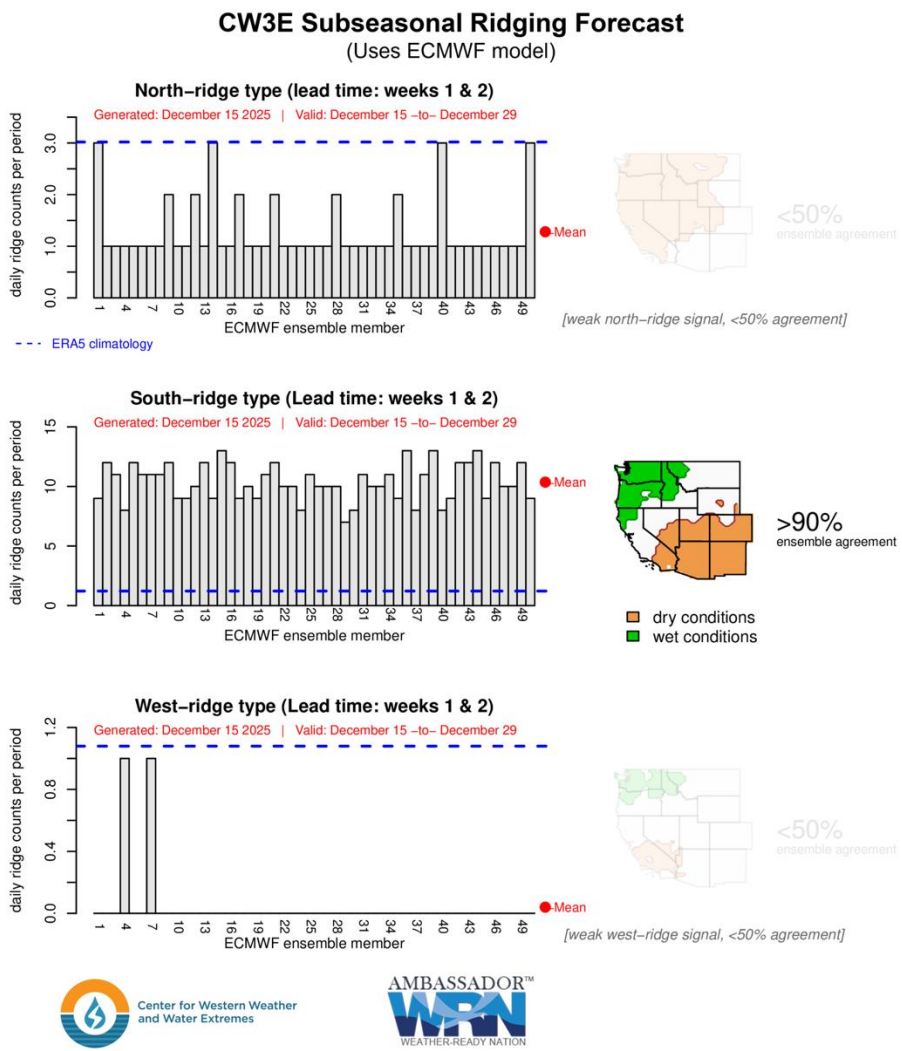
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020) Journal of Climate

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

NCEP



ECMWF



Forecasts Initialized 15 Dec 2025

- Both models are forecasting above-normal South-ridge activity with high confidence (>90% ensemble agreement) during Weeks 1–2 (15–29 Dec)
- Both models are also forecasting below-normal North-ridge and South-ridge activity

Models show high likelihood of persistent ridging activity over southwestern US during Weeks 1–2 (15–29 Dec)

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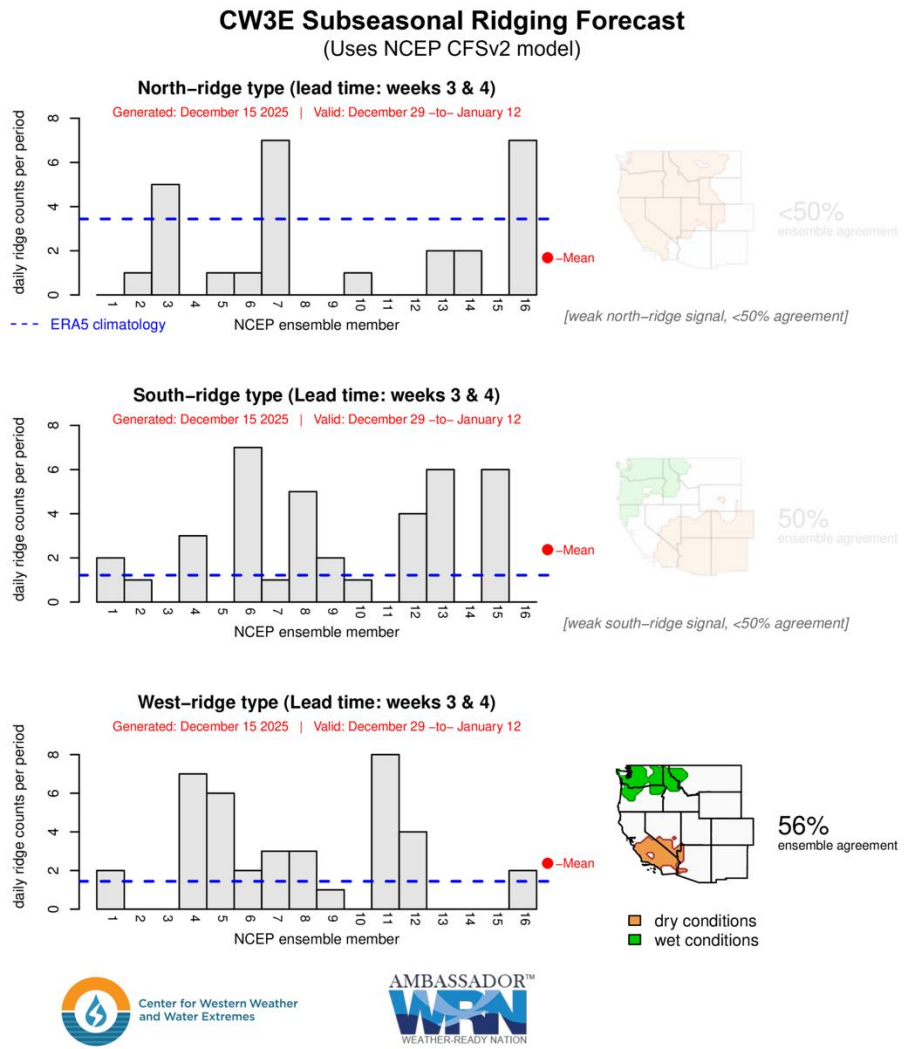
Ridging Forecasts: Weeks 3–4 (NCEP vs. ECMWF)

NCEP



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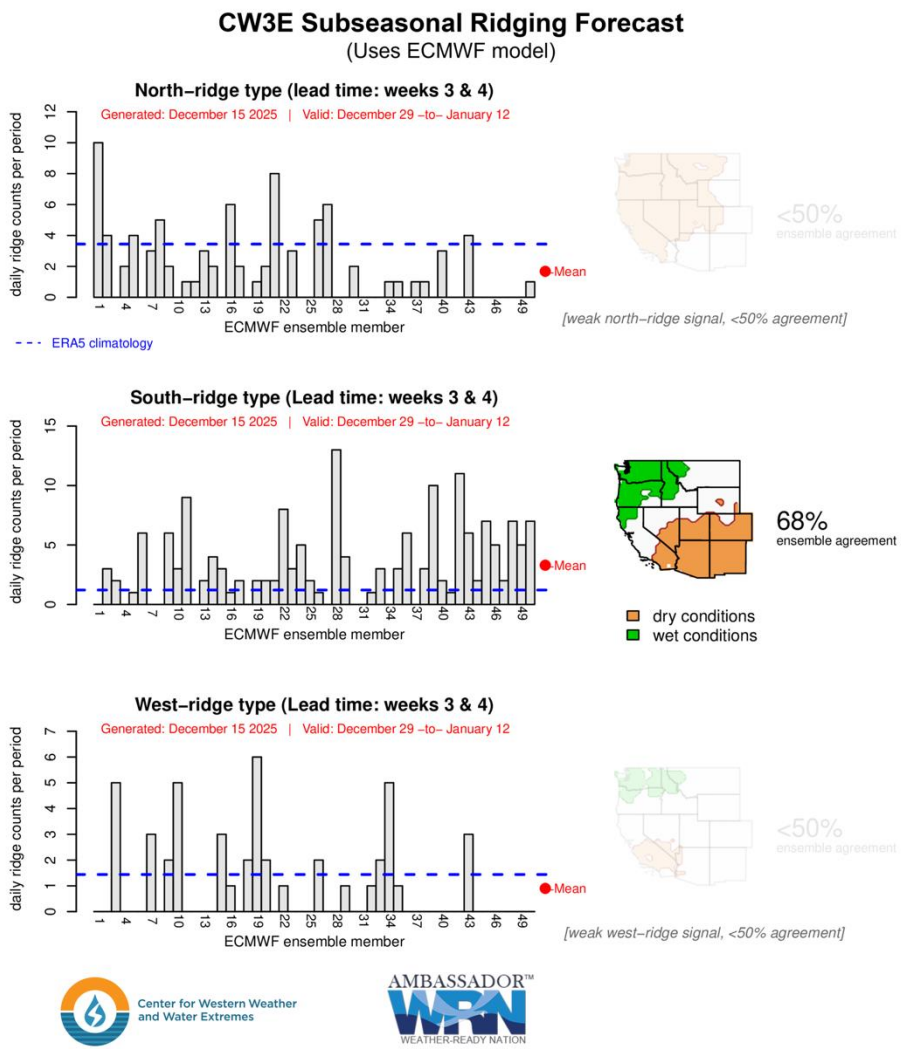
AMBASSADOR™ WRN WEATHER-READY NATION

ECMWF



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AMBASSADOR™ WRN WEATHER-READY NATION

Forecasts Initialized 15 Dec 2025

- NCEP and ECMWF are both forecasting above-normal South-ridge activity during Weeks 3–4 (29 Dec – 12 Jan), but confidence is lower in NCEP (<50% ensemble agreement) than in ECMWF (68% ensemble agreement)
- NCEP is also forecasting above-normal West-ridge activity with moderate confidence (56% ensemble agreement), whereas ECMWF is forecasting below-normal West-ridge activity
- Both models are forecasting below-normal North-ridge activity

Models show some uncertainty in frequency and location of ridging activity, but indicate a moderate likelihood of dry conditions in Southern CA during Weeks 3–4 (29 Dec – 12 Jan)

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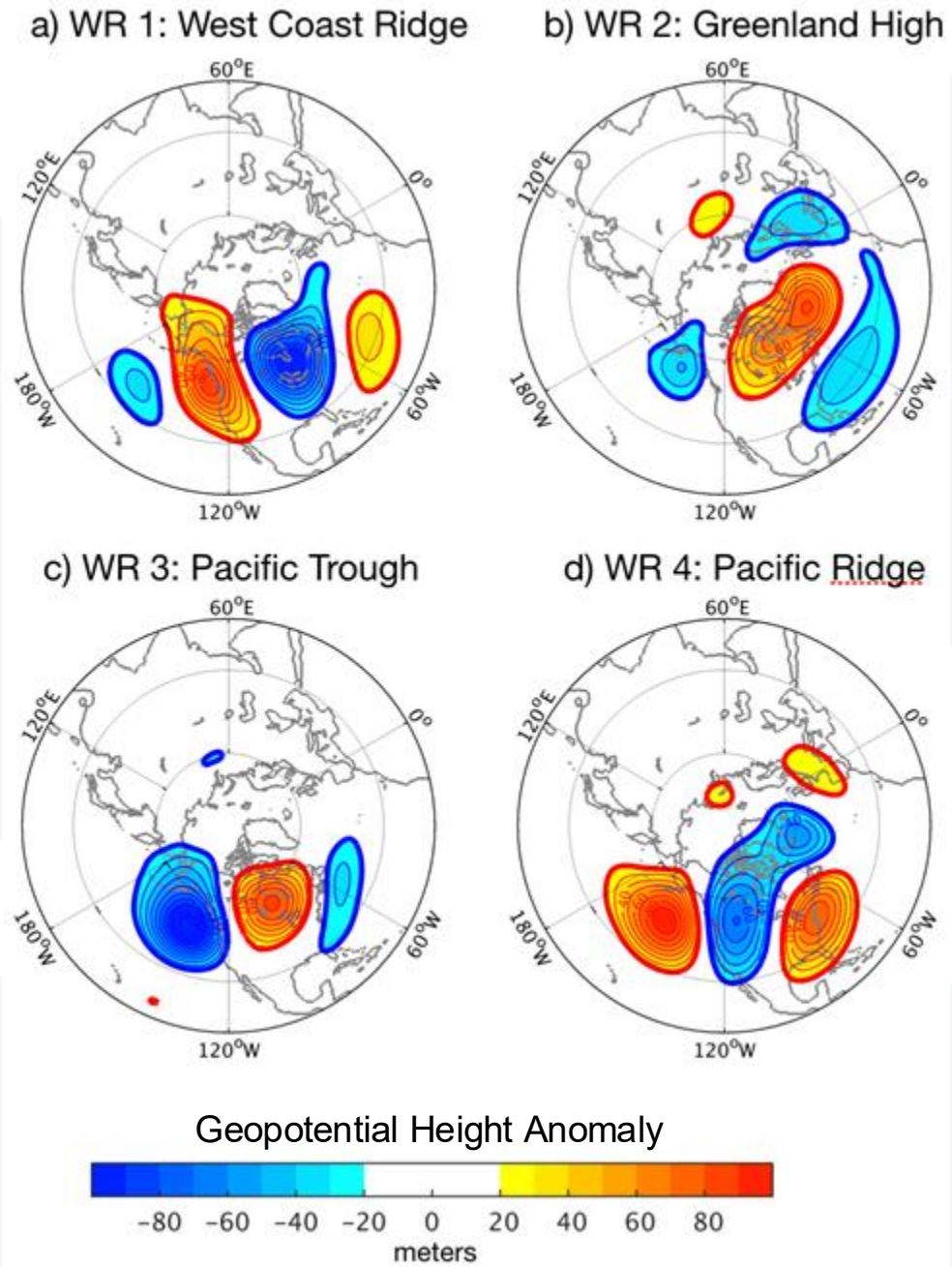
Background Info: IRI Subseasonal Weather Regime Forecasts

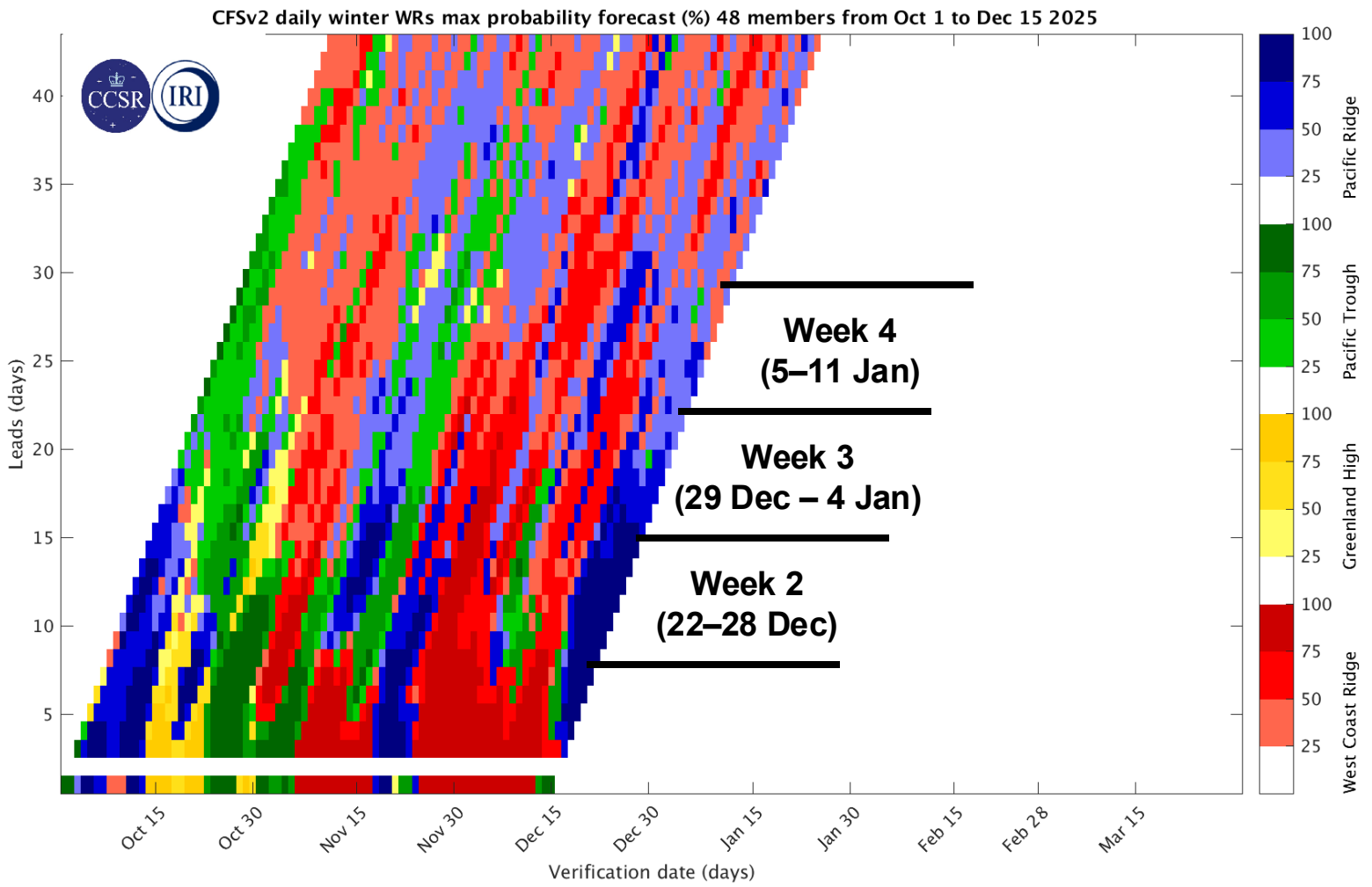


This slide contains background information about IRI's North American weather regime forecast product

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

Reference: Robertson et al. (2020)
For more information about the forecast product:
https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs

IRI North American Weather Regime Forecasts



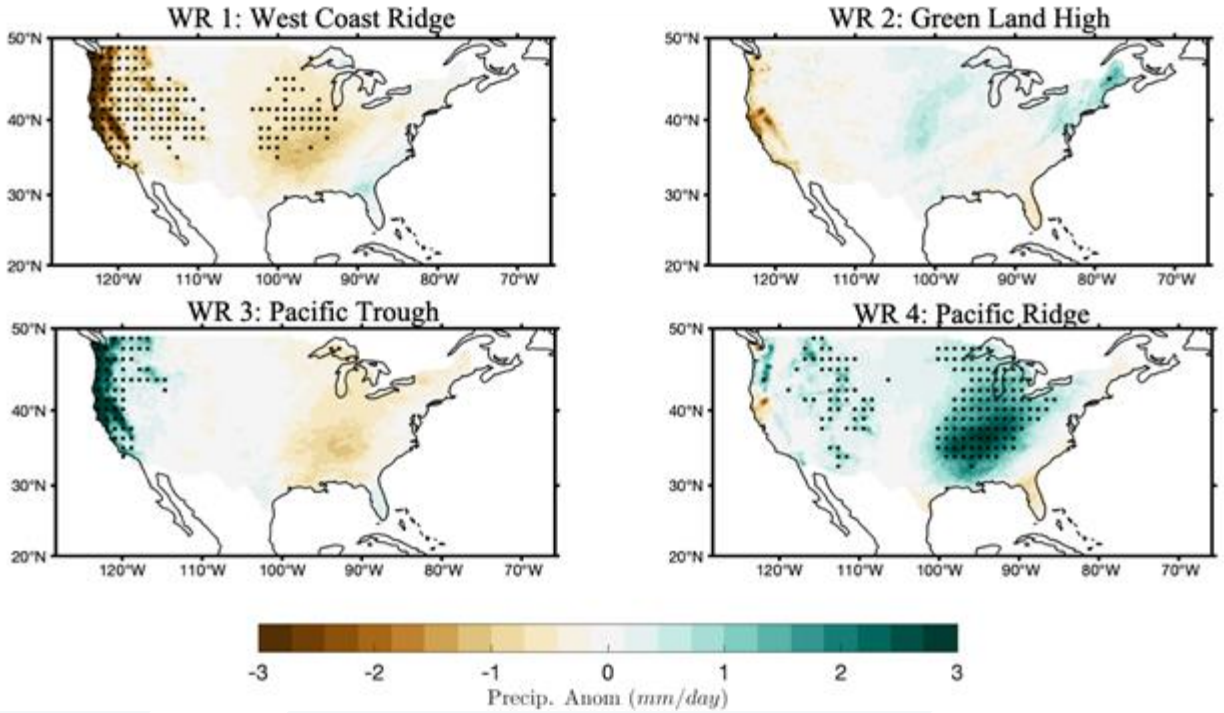
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime. See the next slide for temperature/precipitation implications.

Forecast Initialized 15 Dec 2025

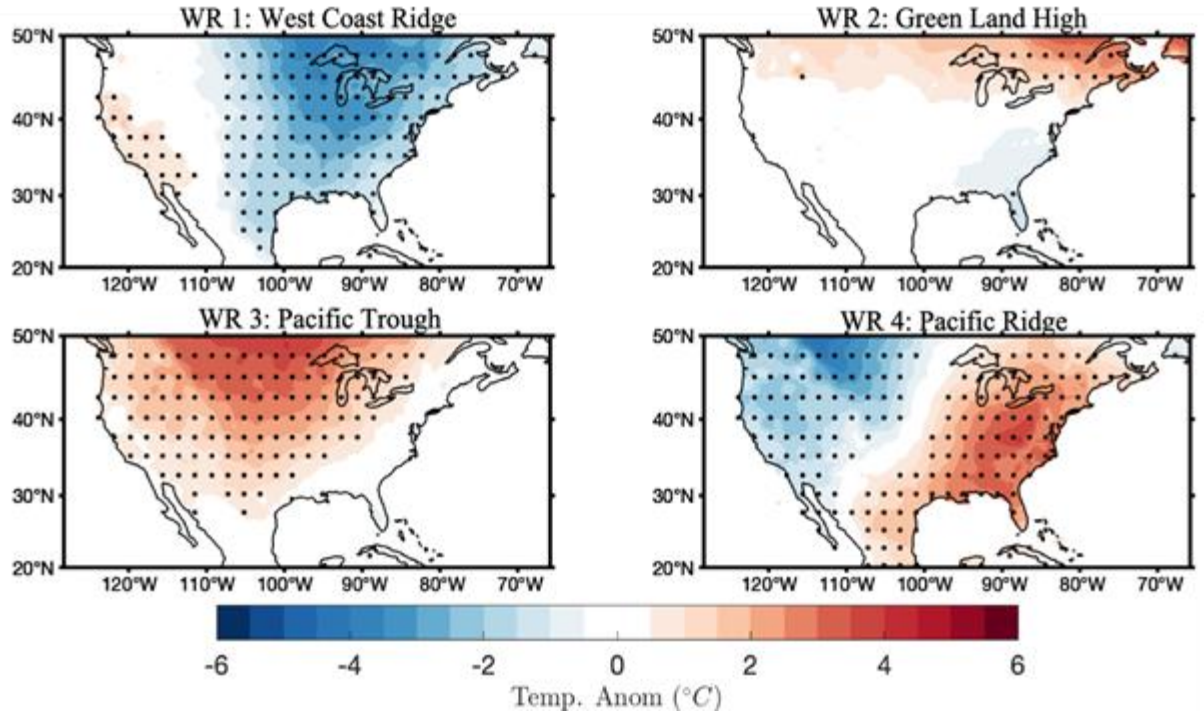
- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- High likelihood (≥75% ensemble agreement) of persistence in Pacific Ridge during Week 2 (22–28 Dec)
- Low-to-moderate likelihood (25–75% agreement) of persistence in Pacific Ridge during Week 3 (29 Dec – 4 Jan)
- Uncertain conditions during Week 4 (5–11 Jan), with a plurality of ensemble members predicting either Pacific Ridge or West Coast Ridge

IRI North American Weather Regime Forecasts

Precipitation Anomalies



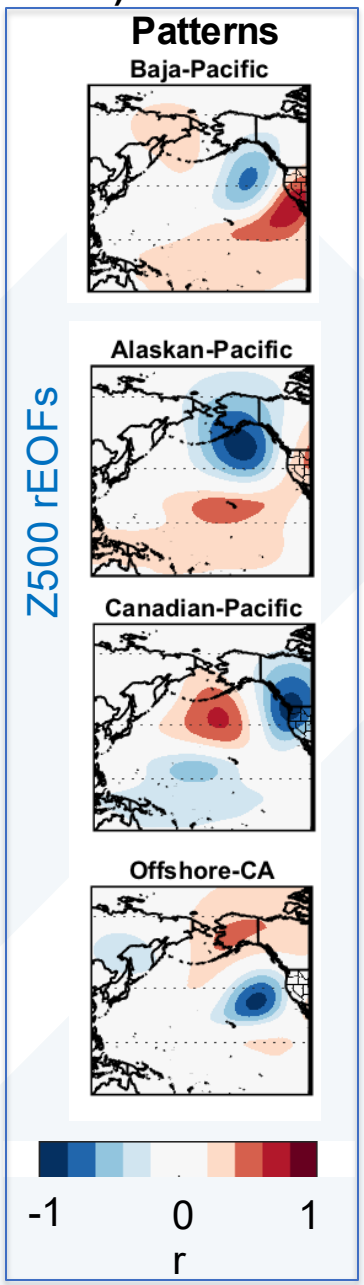
Temperature Anomalies

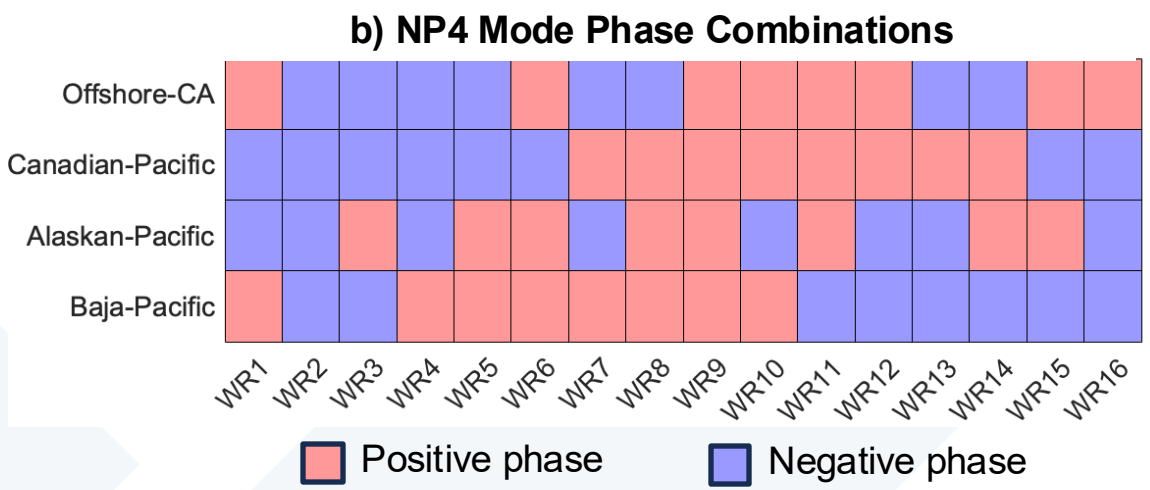


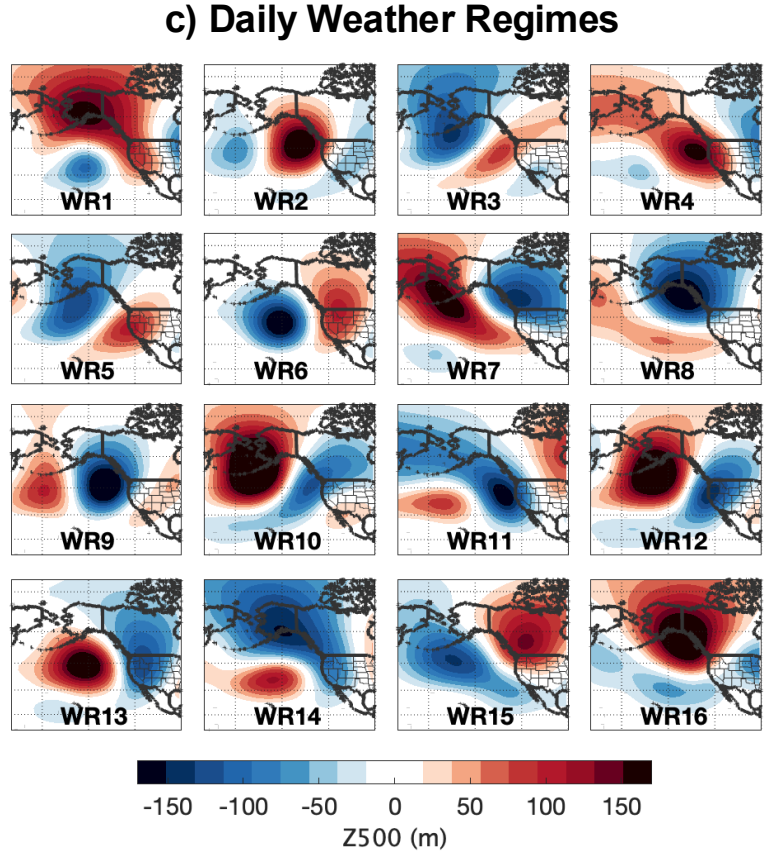
This graphic shows composite mean precipitation (left) and temperature (right) anomalies associated with each weather regime. Stippling (black dots) indicate statistically significant anomalies.

- Near-normal precipitation and below-normal temperature predicted over CA during Week 2 (22–28 Dec) with high confidence in Pacific Ridge regime
- Near-normal precipitation and below-normal temperature predicted over CA during Week 3 (29 Dec – 4 Jan) with low-to-moderate confidence in Pacific Ridge regime
- High degree of uncertainty in precipitation and temperature over CA during Week 4 (5–11 Jan)

Background Info: Hybrid Weather Regime Impacts Forecast







a) NP4 Mode Patterns
Four key modes of atmospheric variability over the North Pacific (called the "NP4 Modes", shown in the positive phase) capture most of the variance in atmospheric circulation in this region.

b) NP4 Mode Phase Combinations
The day-to-day changes in the amplitude and phase of the NP4 modes control ridge-trough positioning over the West Coast.

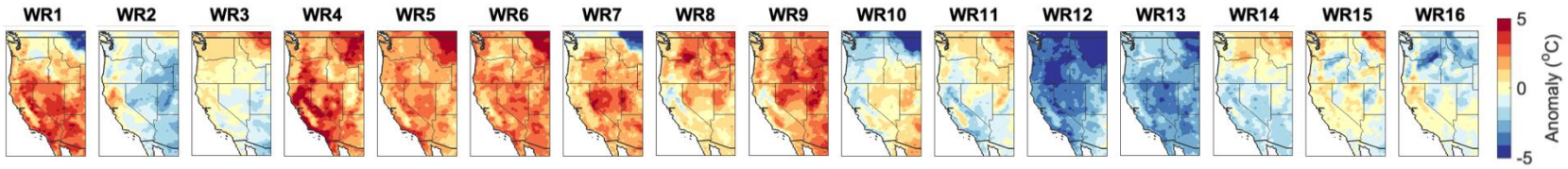
c) Daily Weather Regimes
Sixteen daily weather regimes are defined by the joint phase state of the four NP4 modes. These represent short-duration daily weather patterns.

This slide contains background information about CW3E's hybrid weather regimes forecast product.
Reference:
Guirguis et al. 2023a and 2023b

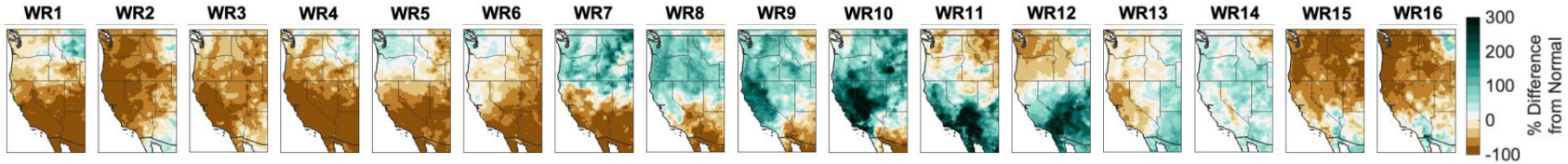
Relevance to West Coast Weather
These regimes are historically linked to impactful West Coast weather, including AR landfalls, precipitation and flooding, temperature extremes, Santa Ana winds, and wildfire conditions.

Hybrid Weather Regime Impacts Forecast

a) Temperature Anomaly Associated With Each Weather Regime

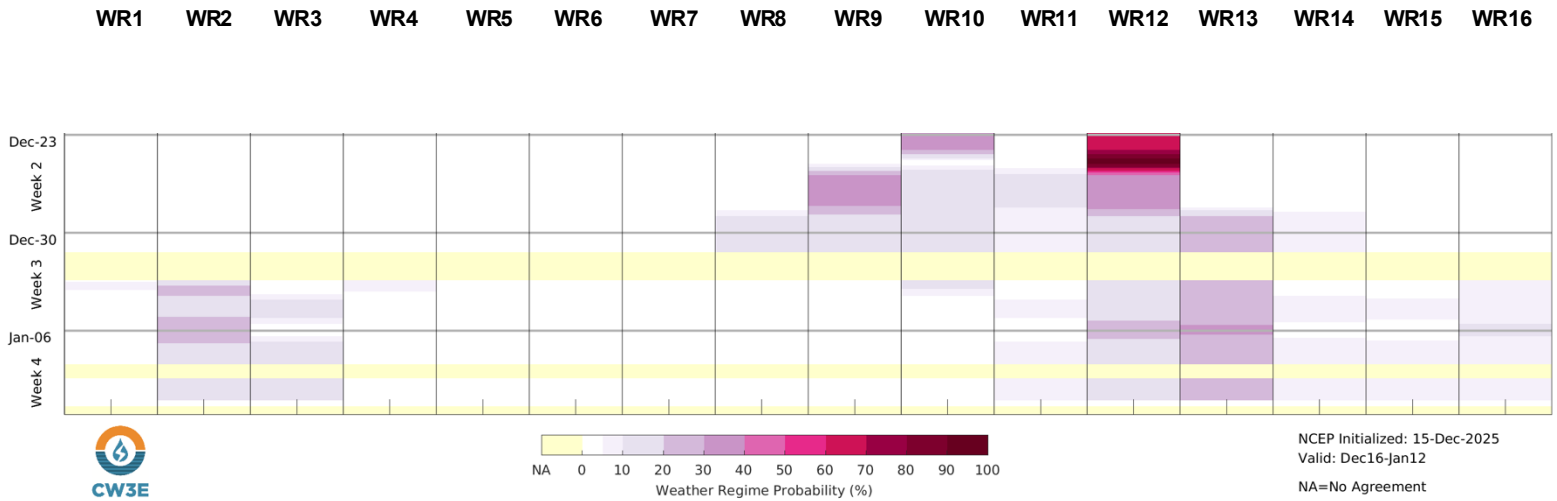


b) Precipitation Anomaly Associated With Each Weather Regime



Valid 9 Dec – 5 Jan

c) Weather Regime Forecast



Forecasts Initialized 15 Dec 2025

Week 2: Dominated by WR12 during 23–25 Dec, which features a trough over the US West Coast. More uncertainty during 26–28 Dec, with >60% likelihood of WR9 or WR12. WR 12 is associated with near-normal conditions in Northern CA and wet conditions in Central/Southern CA. WR9 is associated with wet conditions in Northern/Central CA and near-normal conditions in Southern CA.

Week 3: Uncertain

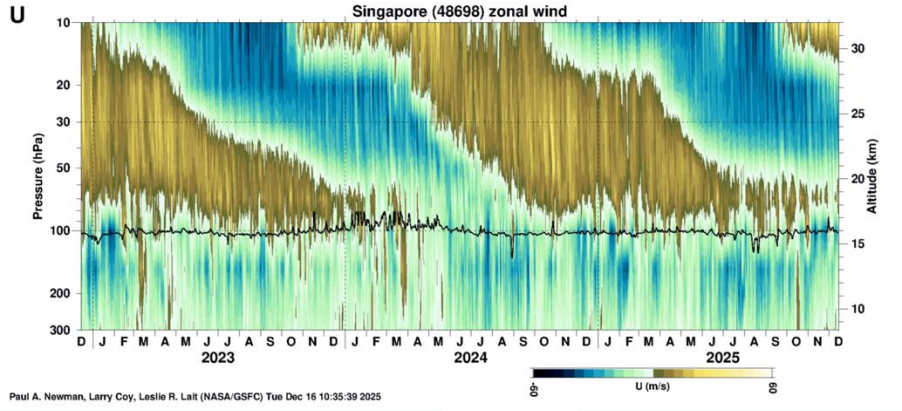
Week 4: Uncertain

a-b: Weather regime impacts based on historical relationships
c: Forecast weather regime probability based on the NCEP dynamical model

NA=No Agreement/Uncertain

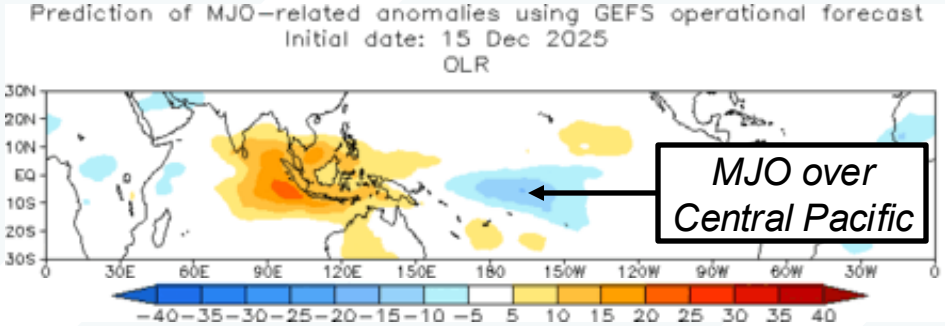
Background Info: AR Activity and Precipitation Based on MJO and QBO

QBO Conditions



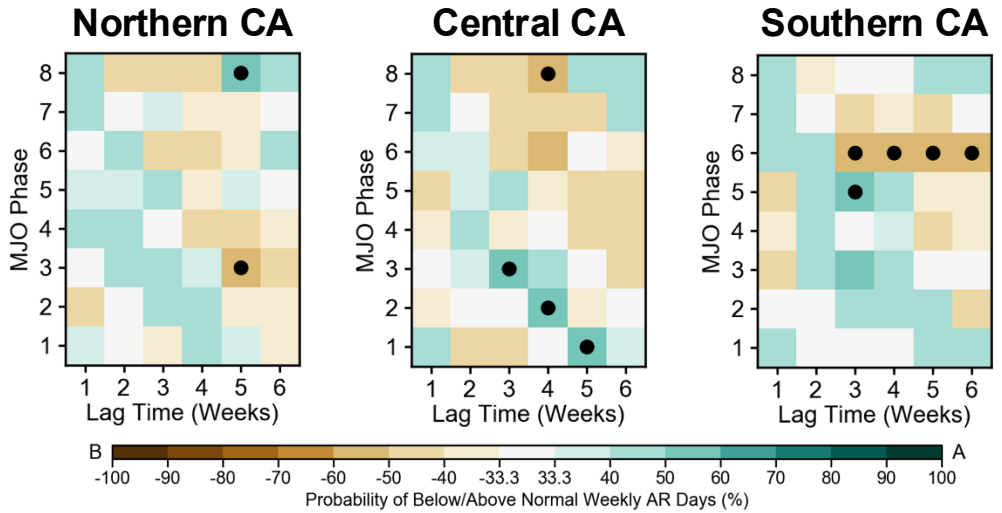
QBO is in the easterly phase at 50-hPa

MJO Conditions

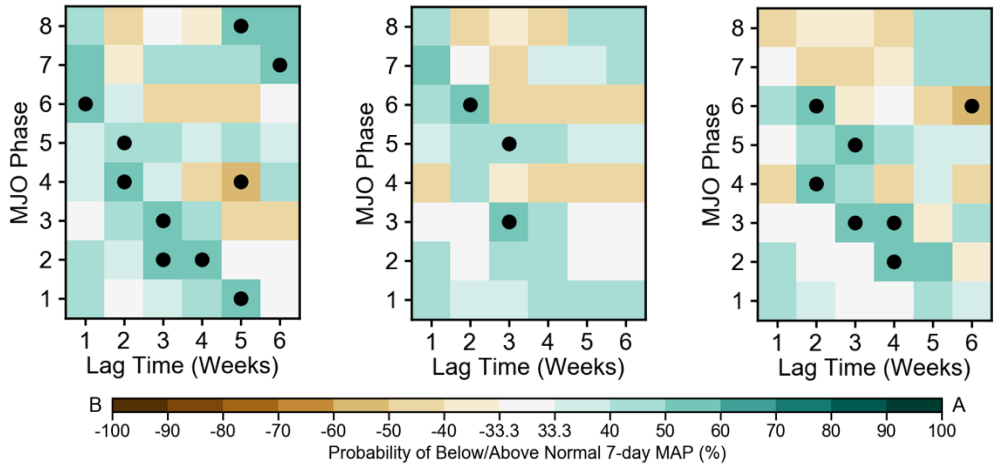


MJO convection is currently located over the Central Pacific/Western Hemisphere (Phase 8)

Probability of Above/ Below-Normal AR Occurrence (EQBO in OND)



Probability of Above/ Below-Normal Precipitation (EQBO in OND)

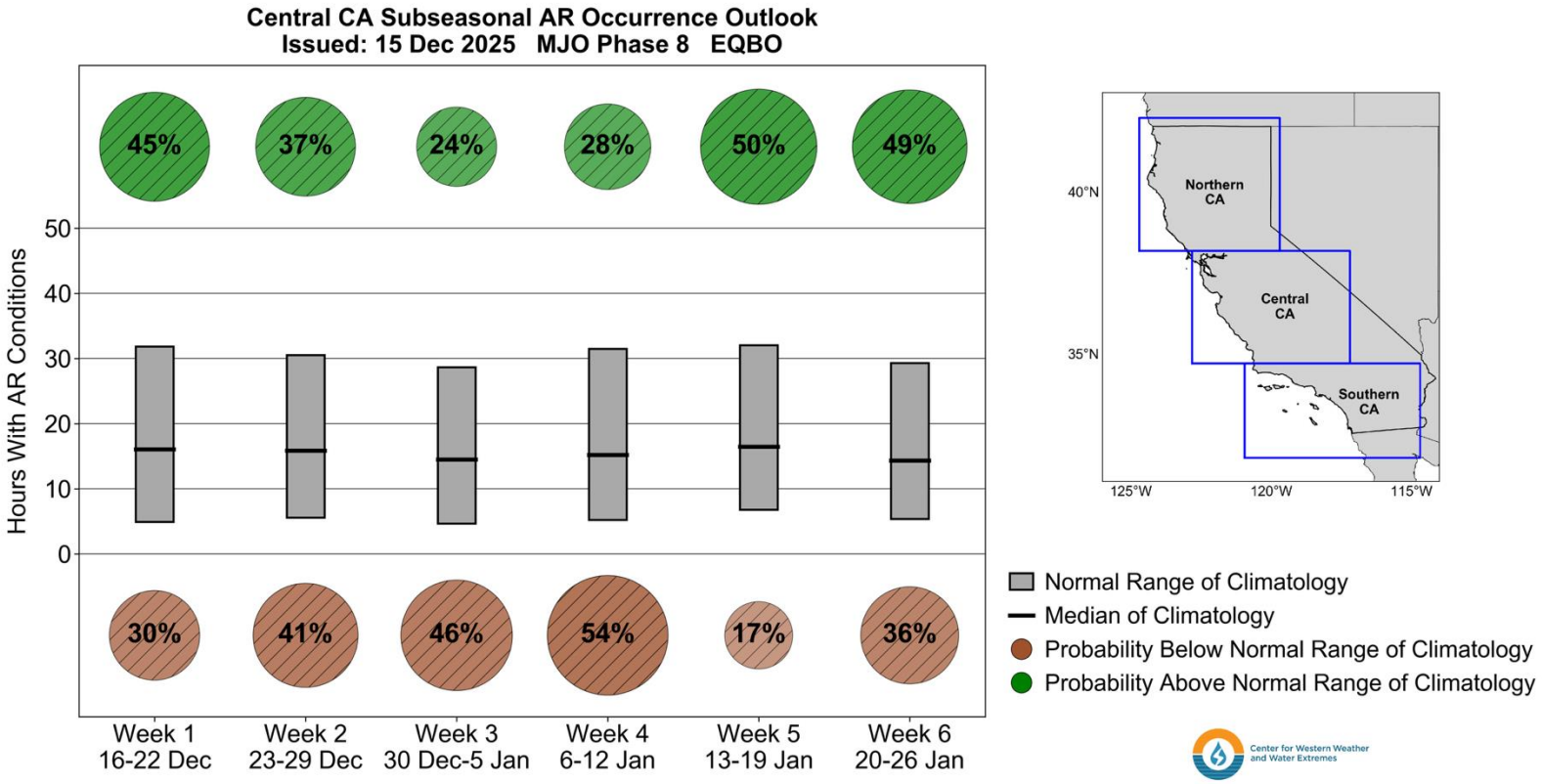


Probability matrices illustrating the weeks 1–6 lagged probability of below-normal (brown shading) or above-normal (green shading) AR occurrence and precipitation for all MJO phases when the QBO is in the westerly phase during OND in Northern CA (left), Central CA (middle), and Southern CA (right). White squares indicate that the near-normal category has the highest probability. The black dots denote statistically significant probabilities of below- or above-normal conditions based on a bootstrapping analysis. Historical observations less (more) than the lower (upper) tercile of climatology (1981–2019 period) are considered below (above) normal.

AR Activity and Precipitation Based on MJO and QBO

Forecasts Initialized 15 Dec 2025

AR Occurrence: Central CA



Normal Range of Climatology
Median of Climatology
Probability Below Normal Range of Climatology
Probability Above Normal Range of Climatology

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- CW3E's probabilistic AR occurrence forecast based on current MJO and QBO conditions (see forecast for all regions here)
- **Moderate likelihood (>40% probability) of below-normal AR occurrence during Weeks 2–4 (23 Dec – 12 Jan) in Central CA**
- Moderate likelihood of below-normal AR occurrence in Northern CA during Weeks 2–4

This product shows weekly probabilities of above-normal and below-normal AR occurrence in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If MJO convection is weak or the QBO is in a neutral phase, no probabilities will be displayed. Circles without hatching denote periods with high confidence based on the hindcast skill assessment in Castellano et al. (2023)

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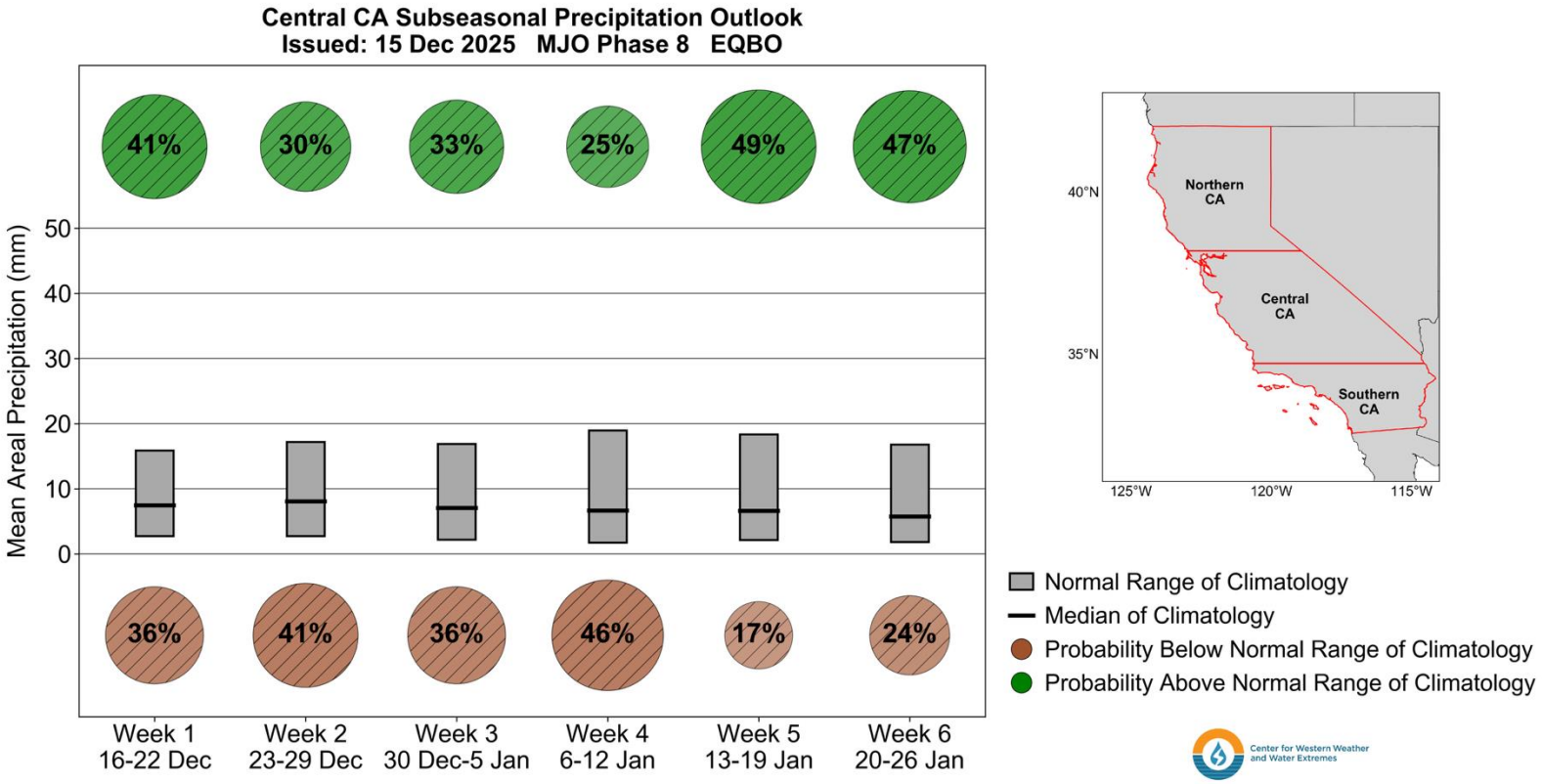
AR Activity and Precipitation Based on MJO and QBO

Forecasts Initialized 15 Dec 2025

Precipitation: Central CA



This product shows weekly probabilities of above-normal and below-normal precipitation in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If MJO convection is weak or the QBO is in a neutral phase, no probabilities will be displayed. Circles without hatching denote periods with high confidence based on the hindcast skill assessment in Castellano et al. (2023)

- CW3E's probabilistic precipitation forecast based on current MJO and QBO conditions (see forecast for all regions here)
- **Moderate likelihood of below-normal precipitation in Central CA during Week 2 (23–29 Dec) and Week 4 (6–12 Jan)**
- Moderate likelihood of both above-normal and below-normal precipitation in Northern CA during Week 2; moderate likelihood of above-normal precipitation with historically higher predictability in Northern CA during Week 5 (13–19 Jan)
- Moderate likelihood of below-normal precipitation in Southern CA during Week 4

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