



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 3 December 2024

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UC San Diego



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 2–6
 - ECCO (Canadian Model): Weeks 2–3
 - ECMWF (European model): Weeks 2–6
- *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*

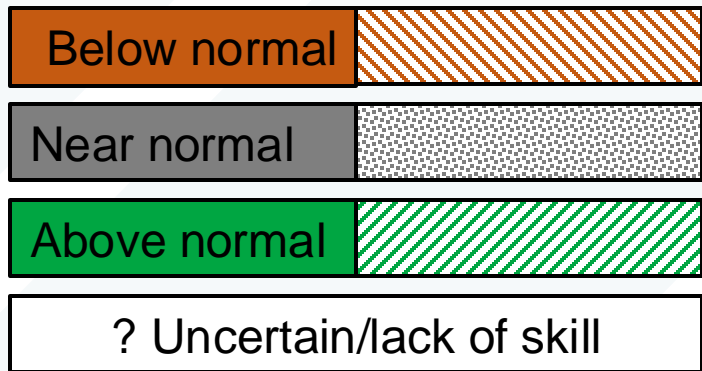
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 2 Dec 2024

Region	Week 2 (9–15 Dec)				Week 3 (16–22 Dec)				Week 4 (23–29 Dec)			
	NCEP ^{1,2,3}	ECCC ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{1,2,3}	ECCC ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{1,2,3}	ECCC ¹	ECMWF ²	Multi-Model Forecast
WA/OR		Below normal	Below normal	Below normal		Above normal	Below normal			Above normal	Below normal	
Northern CA		Below normal	Below normal	Below normal	Above normal	? Uncertain/lack of skill	Below normal			Above normal	Below normal	
Central CA		Below normal	Below normal	Below normal	Above normal	? Uncertain/lack of skill	Below normal			Above normal	Below normal	
Southern CA	Below normal	Below normal	Below normal	Below normal		? Uncertain/lack of skill	Below normal			? Uncertain/lack of skill	Below normal	

Higher Confidence | Lower Confidence



- Models agree on below-normal precipitation over CA, especially Southern CA, during Week 2
- Uncertainty in precipitation over CA during Weeks 3–4 due to poor agreement between products and models

Subseasonal products included in this Outlook:

¹CW3E/JPL Atmospheric River Activity Forecasts ([DeFlorio et al. 2019](#), [Zhang et al. 2023](#))

²CW3E/JPL Ridging Forecasts ([Gibson et al. 2020](#))

³IRI North American Weather Regime Forecasts ([Robertson et al. 2020](#))

Summary

MJO/QBO Conditions

- MJO convection is currently located over the Maritime Continent (Phase 4); QBO is in the westerly phase
 - MJO activity over the Maritime Continent during OND is associated with a significant increase in wet extremes in CA at lag times of 2–4 weeks without considering QBO/ENSO conditions
- Models forecast MJO convection to maintain over the Maritime Continent (Phases 4&5) in Weeks 1–2 (3–15 Dec)

Week 2 forecasts (9–15 Dec):

- Models generally agree on slightly below-normal AR activity in Southern CA during Week 2 (9–15 Dec), but disagree on AR activity in Northern and Central CA
 - For Northern and Central CA, ECCO and ECMWF are consistent with slightly below-normal to below-normal AR activity, and NCEP is forecasting above-normal AR activity
- NCEP and ECMWF ridging outlooks show high likelihood of above-normal North-ridge activity (dry conditions in CA) during Weeks 1–2
- IRI weather regime tool shows uncertainty in Week 2 with a possible transition from West Coast Ridge to Greenland High or Pacific Trough conditions

Summary

Week 3 Forecasts (16–22 Dec):

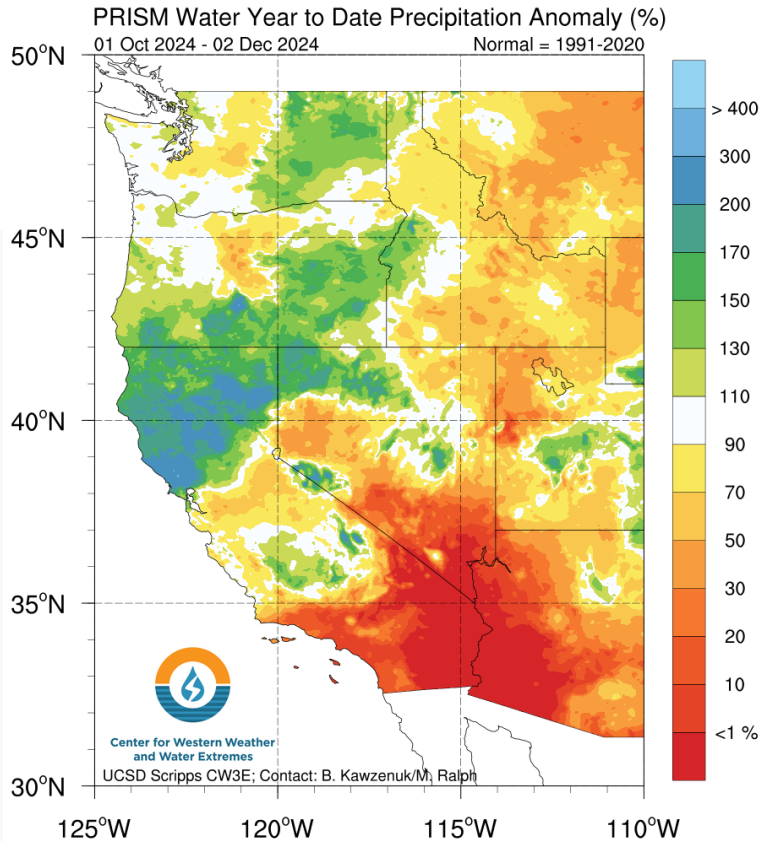
- Models disagree somewhat on AR activity in CA during Week 3 (16–22 Dec)
 - For Northern CA, NCEP is forecasting slightly above-normal AR activity, ECCO and ECMWF are forecasting near-normal AR activity
 - For Central CA, NCEP is forecasting slightly above-normal AR activity, ECCO is forecasting near-normal AR activity, and ECMWF is forecasting slightly below-normal AR activity
 - For Southern CA, NCEP and ECCO are forecasting near-normal AR activity, and ECMWF is forecasting slightly below-normal AR activity
- Uncertainty in the location of ridging activity near the US West Coast during Weeks 3–4
 - ECMWF is forecasting a moderate likelihood of above-normal North-ridge activity
- IRI weather regime tool shows low confidence in Pacific Trough (above-normal precipitation over CA) during Week 3

Weeks 4 Forecasts (23–29 Dec):

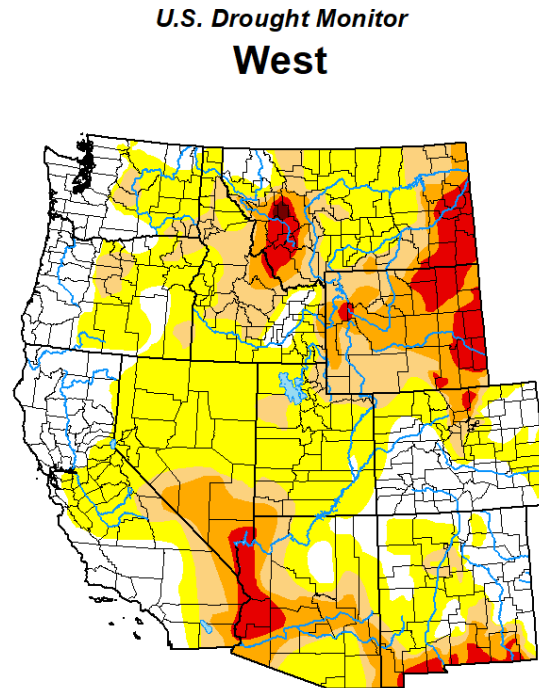
- Models generally agree on near-normal to slightly above-normal AR activity over Northern and Central CA during Week 4, and near-normal AR activity over Southern CA
- IRI weather regime tool shows low confidence in West Coast Ridge (below-normal precipitation over CA) during Week 4

Hydrologic Summary

Precipitation



Drought Conditions



November 26, 2024
(Released Wednesday, Nov. 27, 2024)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	25.87	74.13	34.99	18.28	6.06	0.10
Last Week 11-19-2024	19.56	80.44	40.91	18.03	5.81	0.10
3 Months Ago 08-27-2024	18.72	81.28	34.08	10.04	2.44	0.11
Start of Calendar Year 01-02-2024	51.19	48.81	25.08	13.17	4.67	0.66
Start of Water Year 10-01-2024	20.06	79.94	37.38	9.85	2.47	0.11
One Year Ago 11-28-2023	54.87	45.13	27.59	16.29	5.22	0.66

Intensity:

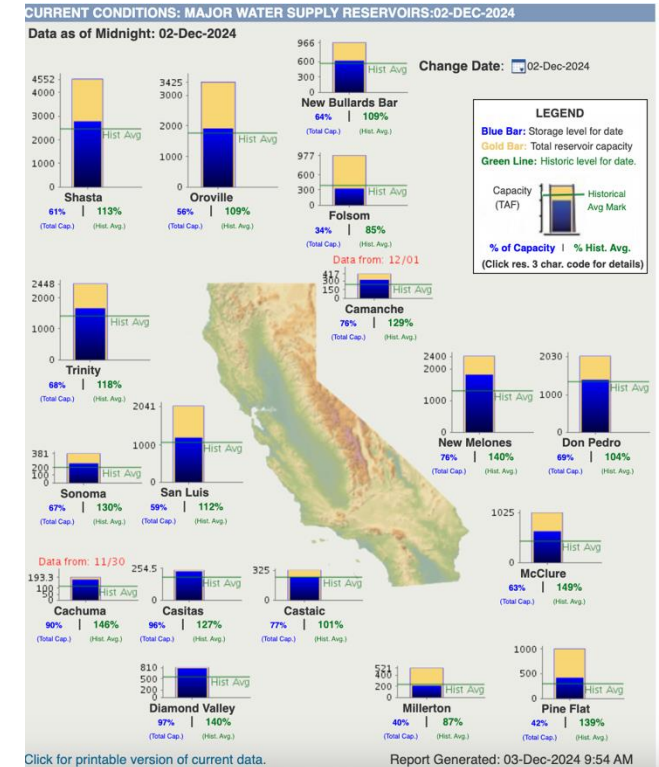
- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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:
David Simeral
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Reservoir Storage



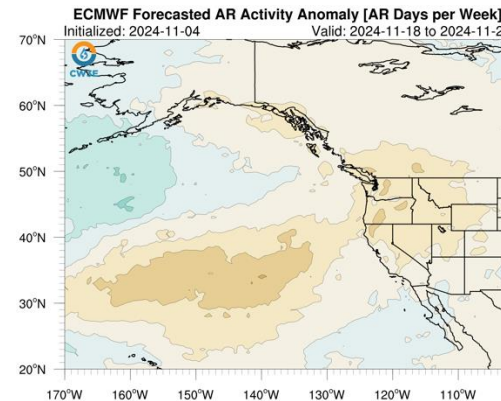
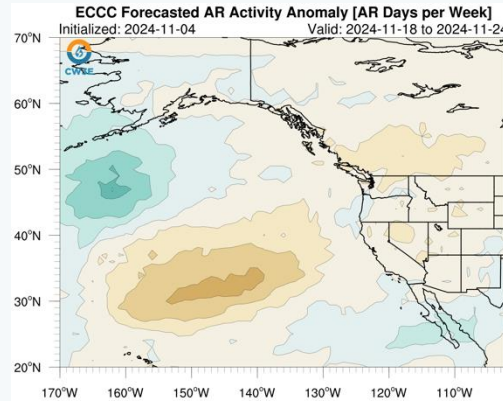
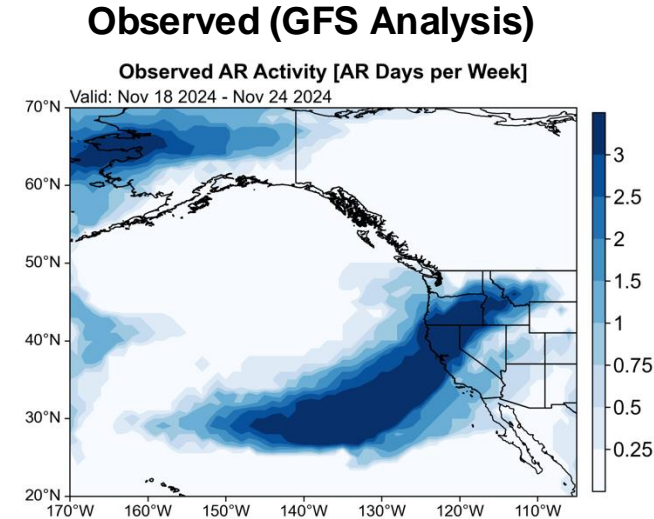
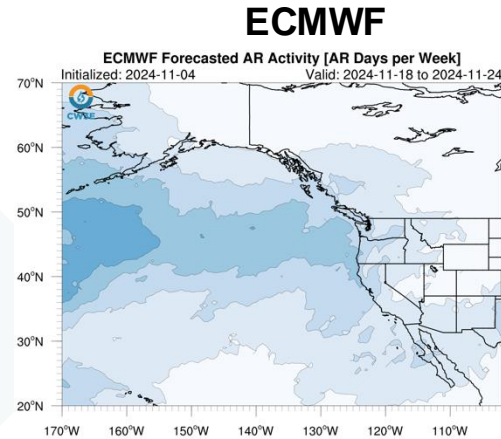
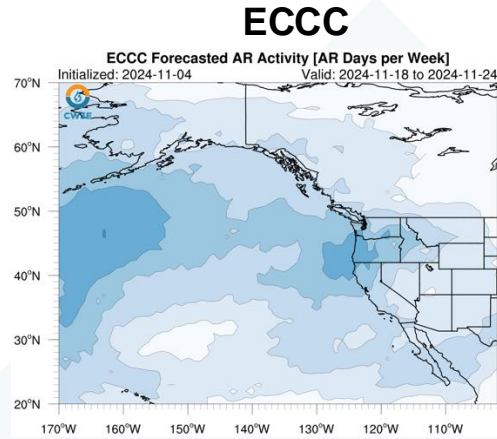
Source: California DWR

- As of 2 Dec, recent ARs brought water-year-to-date precipitation to >200% above normal over Northern CA and near normal over Central CA.
- WY-to-date precipitation is still below normal (<10% of normal) over Southern CA
- The most recent drought monitor update (as of 26 Nov) is showing abnormally dry conditions (D0) over Central CA, and moderate drought-to-severe drought (D1–D2) in southeastern CA
- Most large reservoirs in CA are still operating at near or above-normal storage for this time of year

Looking Back: Week 3 AR Activity Forecasts

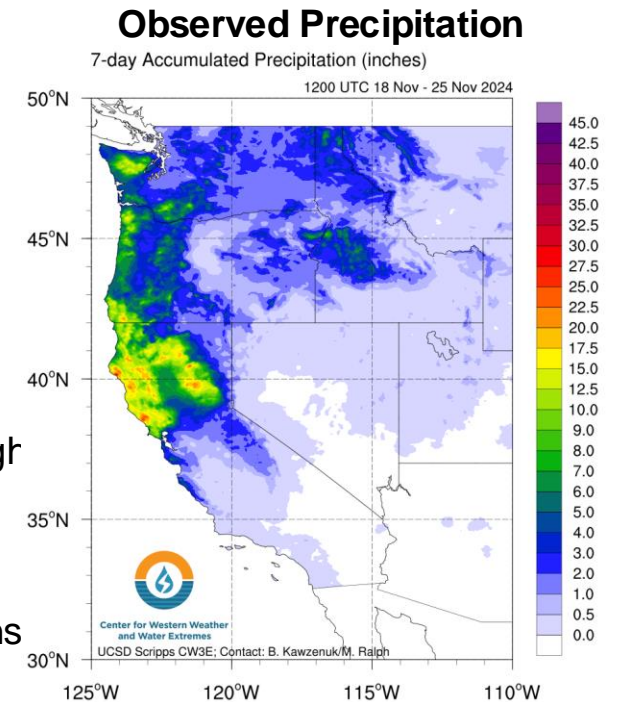
Forecasts Initialized 4 Nov 2024; Valid: 18–24 Nov 2024

NCEP
unavailable



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)

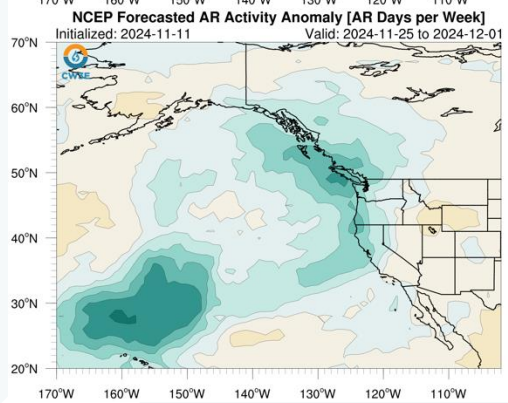
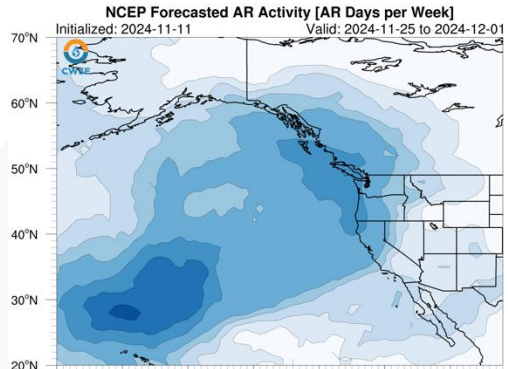
- Both ECCC and ECMWF captured some AR activity near the Oregon coast, but failed to predict the axis of high AR activity extending from the subtropical Northeast Pacific into Northern CA
- Both models largely underestimated the inland penetration of AR activity over the northwestern US
- A strong AR produced >10 inches of precipitation over Northern CA during 20–23 Nov
- The AR also produced >5 inches of precipitation over western OR/WA and >2 inches of precipitation in portions of Central CA



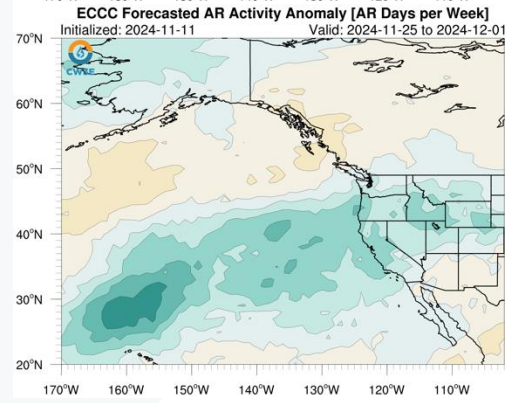
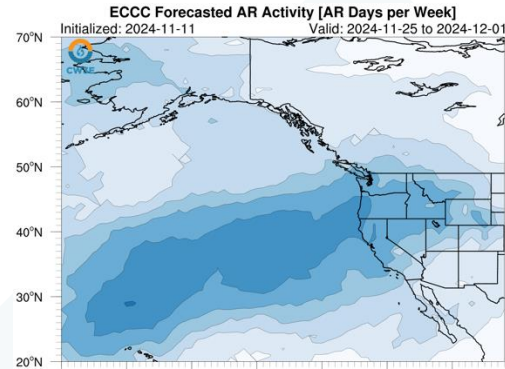
Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 11 Nov 2024; Valid: 25 Nov – 1 Dec 2024

NCEP

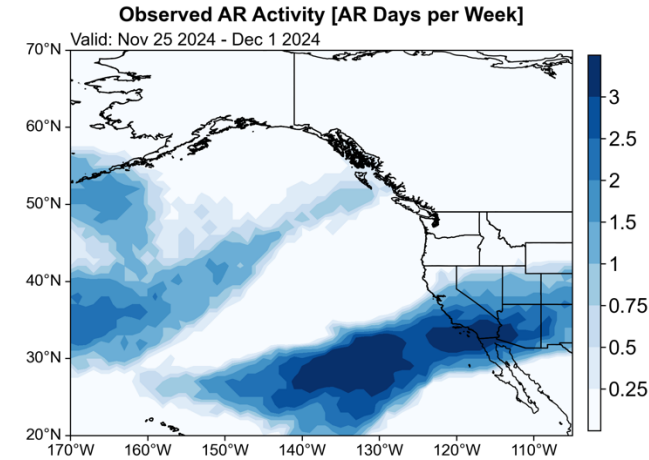


ECCE

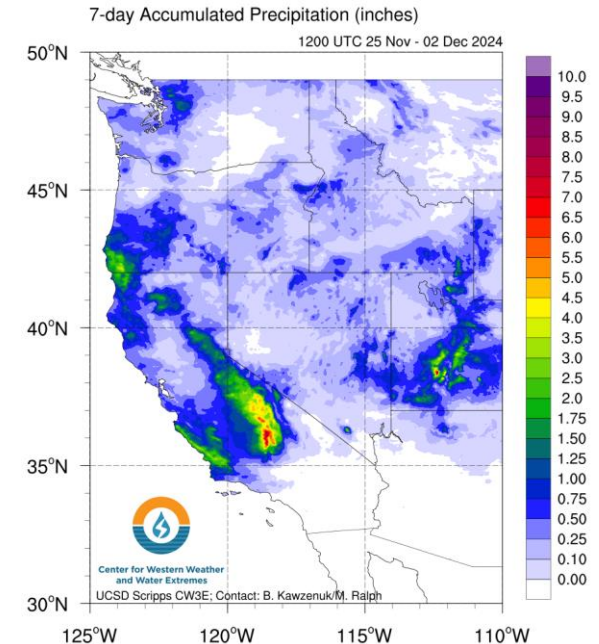


ECMWF
unavailable

Observed (GFS Analysis)



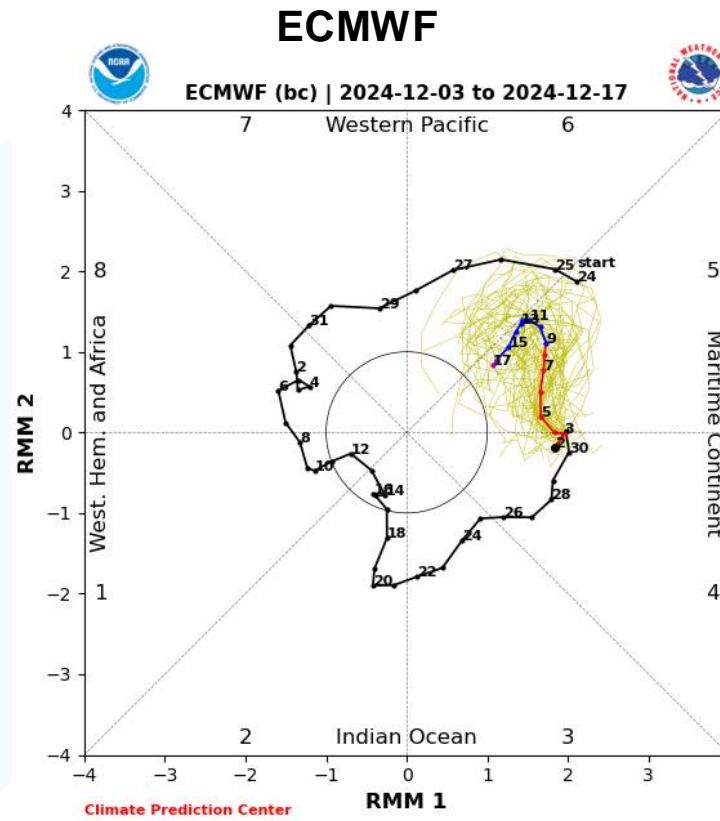
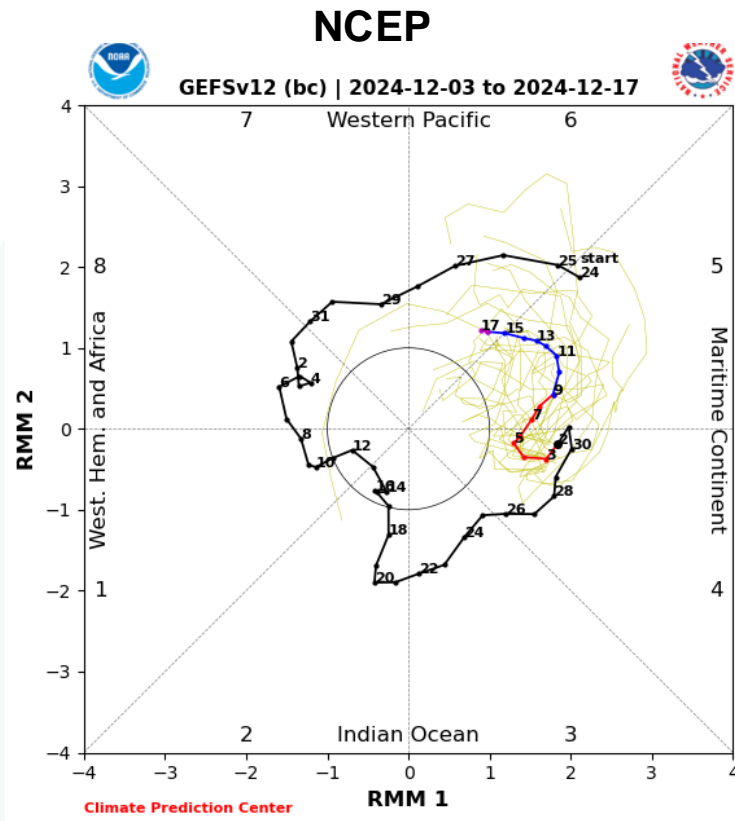
Observed Precipitation



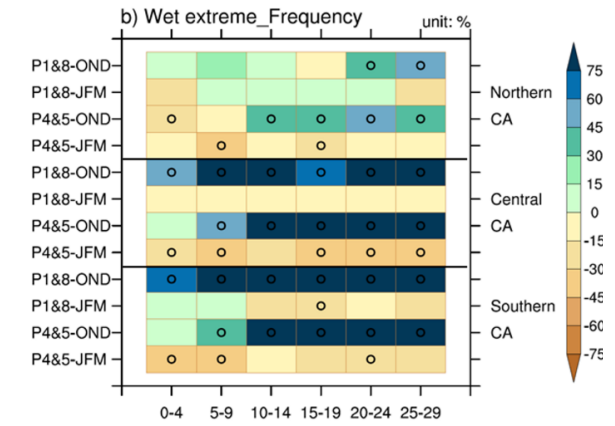
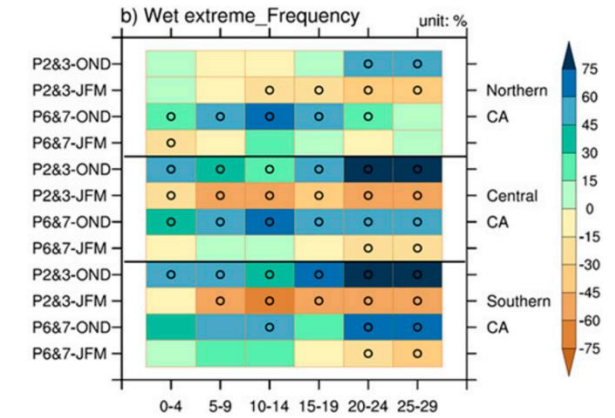
Shading: Fractional # of AR days forecast over a 7-day period (top) and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

- Both NCEP and ECCE captured some AR activity over Central CA
- ECCE also captured some AR activity over Southern CA and inland penetration, but the forecast axis of AR activity was too far north compared to the analysis
- Both models underestimated the amount of AR activity over Southern CA
- An AR produced >4 inches of precipitation over the Southern Sierra Nevada during 25–27 Nov

Dynamical Model MJO Forecasts (NCEP vs. ECMWF)



Black: Last 40 days of observations (24 Oct – 2 Dec); Red: Week 1 (3 Dec–9 Dec) ensemble mean; Blue: Week 2 (10–17 Dec) ensemble mean; Yellow: Ensemble members



- MJO convection is currently located over the Maritime Continent (Phase 4)
- Both models are forecasting strong MJO convection to maintain over the Maritime Continent (Phases 4&5) in the following two weeks (3–15 Dec), and NCEP is forecasting MJO convection to propagate to Western Pacific at the end of Week 2
- MJO activity over the Maritime Continent during OND is associated with a significant increase in wet extremes in CA at lag times of 2–4 weeks without considering QBO/ENSO conditions

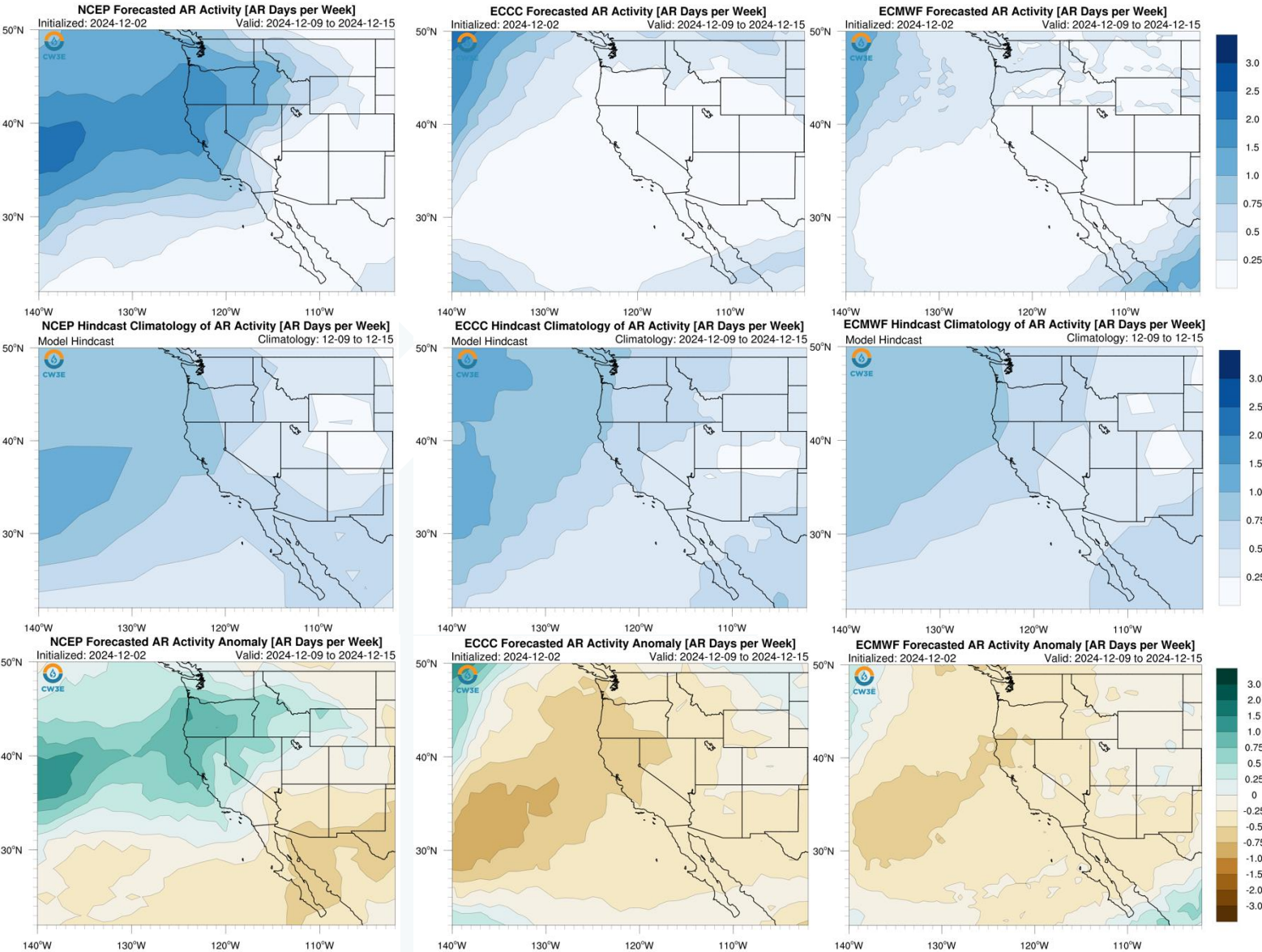
AR Activity Forecasts: Week 2 (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 2 Dec 2024

NCEP

ECCC

ECMWF



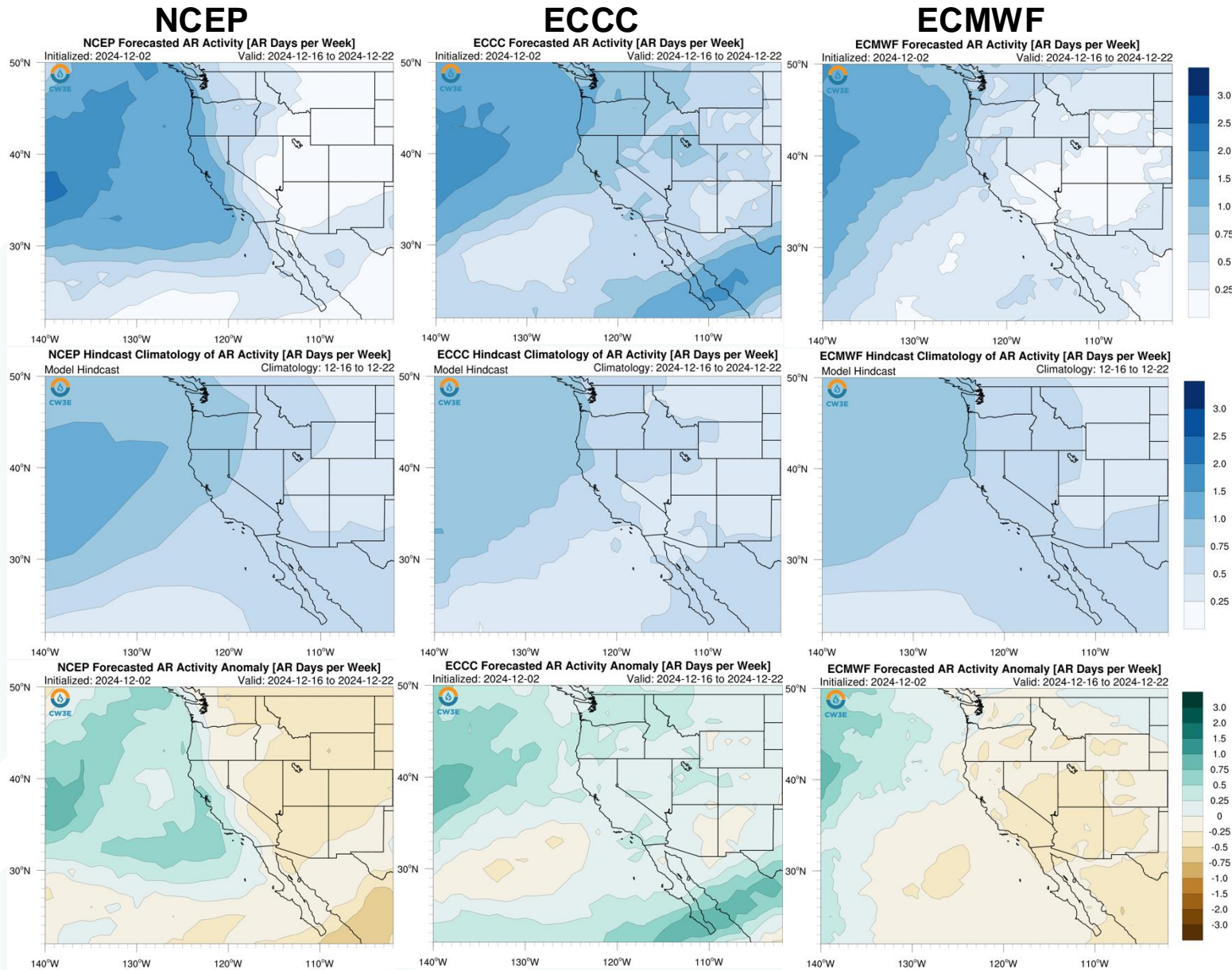
- All models are forecasting slightly below-normal AR activity over Southern CA during Week 2 (9–15 Dec)
- ECCC and ECMWF are also forecasting slightly below-normal to below-normal AR activity over Northern and Central CA, and NCEP is forecasting above-normal AR activity

Models generally agree on slightly below-normal AR activity in Southern CA during Week 2 (9–15 Dec), but disagree on AR activity in Northern and Central CA

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)

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

Forecasts Initialized 2 Dec 2024



- For Northern CA, NCEP is forecasting slightly above-normal AR activity, ECCC and ECMWF are forecasting near-normal AR activity during Week 3 (16–22 Dec)
- For Central CA, NCEP is forecasting slightly above-normal AR activity, ECCC is forecasting near-normal AR activity, and ECMWF is forecasting slightly below-normal AR activity
- For Southern CA, NCEP and ECCC are forecasting near-normal AR activity, and ECMWF is forecasting slightly below-normal AR activity

Models disagree somewhat on AR activity in CA during Week 3 (16–22 Dec)

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)

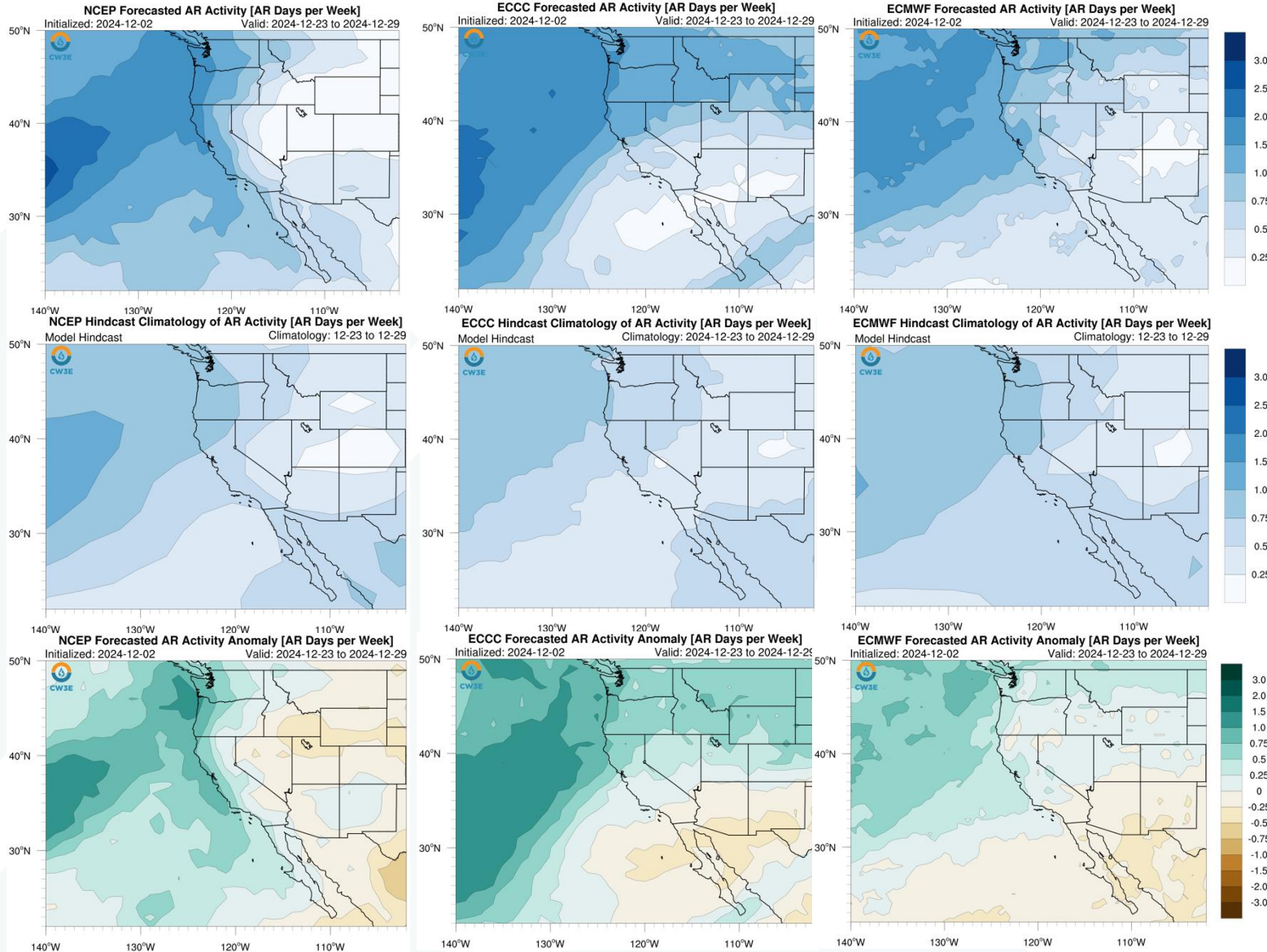
AR Activity Forecasts: Week 4 (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 2 Dec 2024

NCEP

ECCC

ECMWF

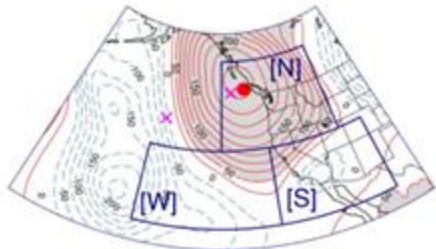


- All models are forecasting near-normal to slightly above-normal AR activity over Northern and Central CA during Week 4 (23–29 Dec)
- All models are forecasting near-normal AR activity over Southern CA

Models generally agree on near-normal to slightly above-normal AR activity over Northern and Central CA during Week 4 (23–29 Dec), and near-normal AR activity over Southern CA

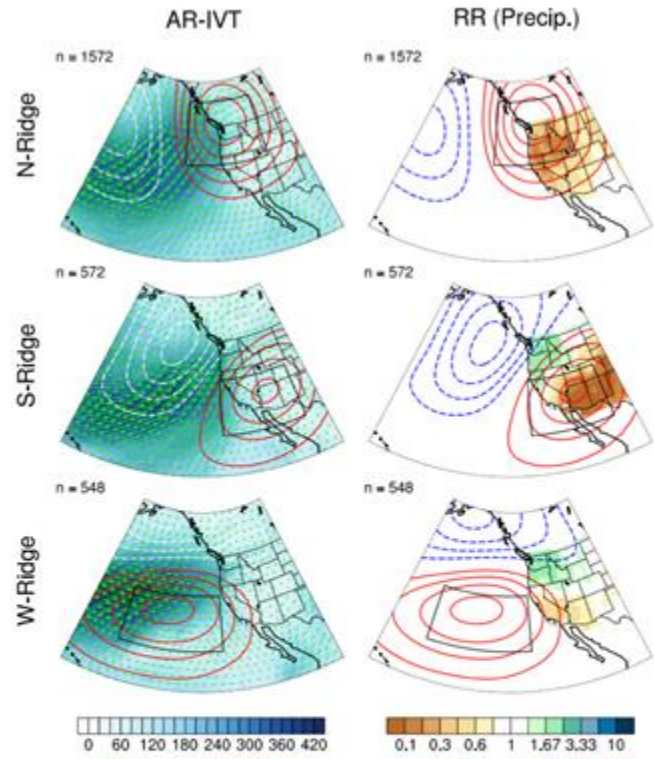
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

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 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

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



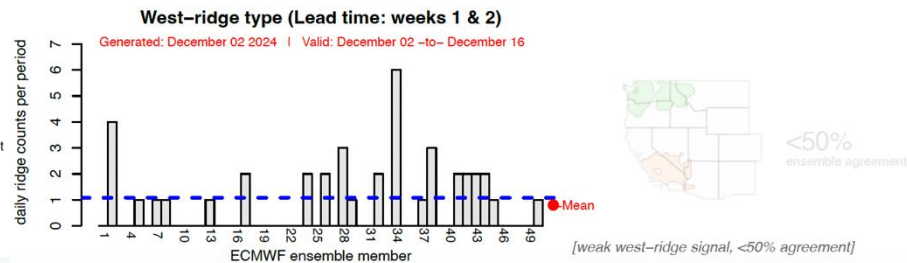
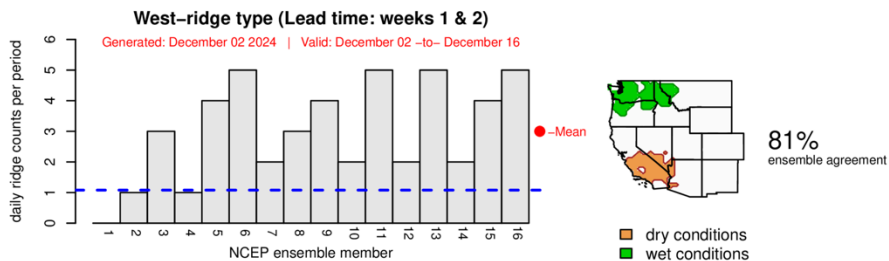
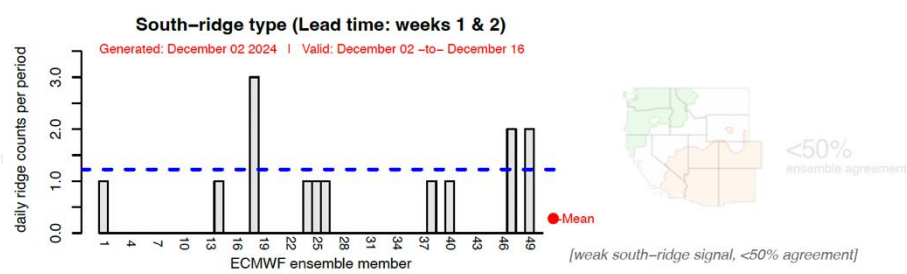
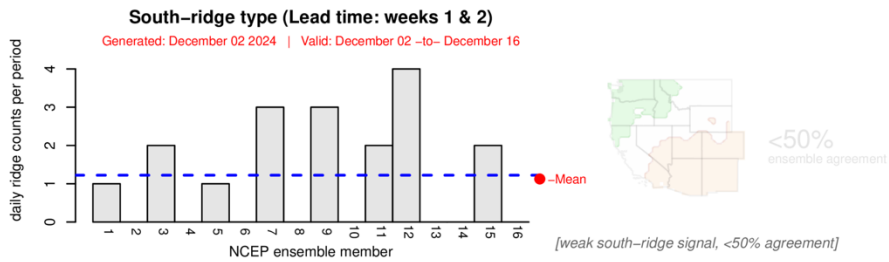
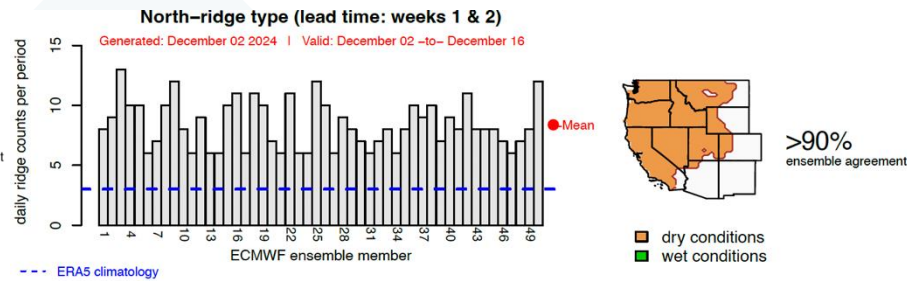
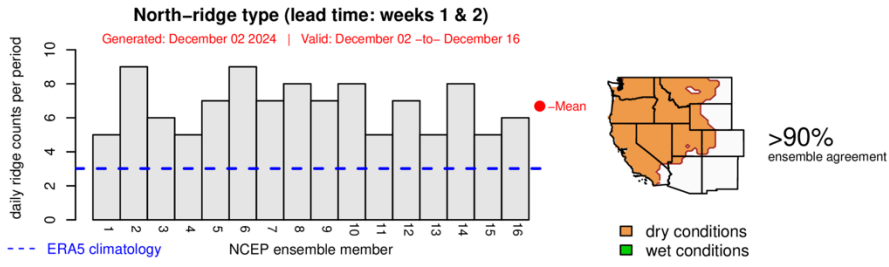
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 2 Dec 2024

NCEP

ECMWF



- NCEP and ECMWF are both forecasting a high likelihood (>90% ensemble agreement) of above-normal North-ridge activity during Weeks 1–2 (2–16 Dec)
- NCEP is forecasting a high likelihood (>81% ensemble agreement) of above-normal West-ridge activity

Models agree on high likelihood of above-normal North-ridge activity during Weeks 1–2 (2–16 Dec)

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

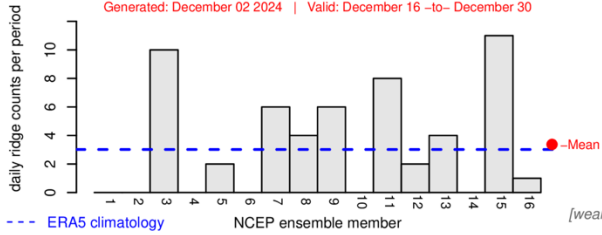
Forecasts Initialized 2 Dec 2024

NCEP

ECMWF

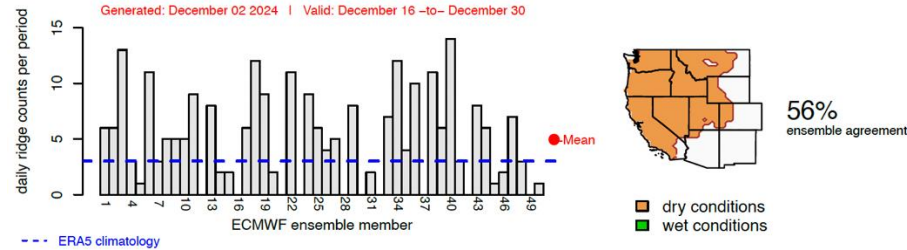
North-ridge type (lead time: weeks 3 & 4)

Generated: December 02 2024 | Valid: December 16 –to– December 30



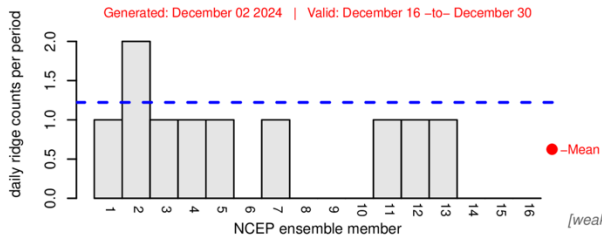
North-ridge type (lead time: weeks 3 & 4)

Generated: December 02 2024 | Valid: December 16 –to– December 30



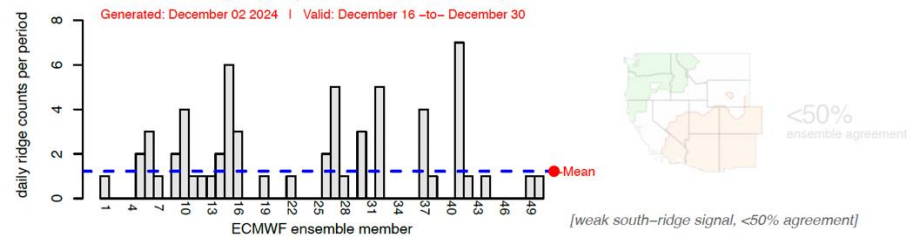
South-ridge type (Lead time: weeks 3 & 4)

Generated: December 02 2024 | Valid: December 16 –to– December 30



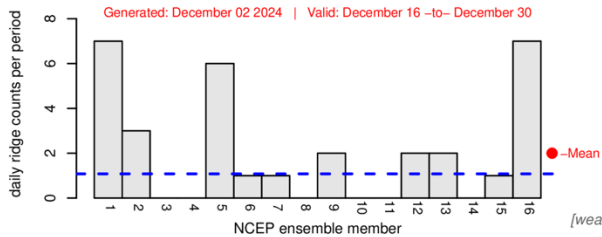
South-ridge type (Lead time: weeks 3 & 4)

Generated: December 02 2024 | Valid: December 16 –to– December 30



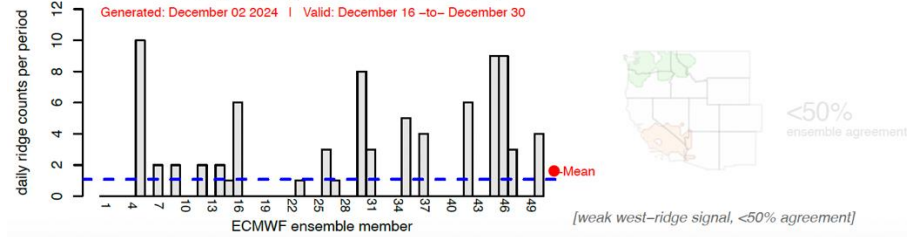
West-ridge type (Lead time: weeks 3 & 4)

Generated: December 02 2024 | Valid: December 16 –to– December 30



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

Generated: December 02 2024 | Valid: December 16 –to– December 30

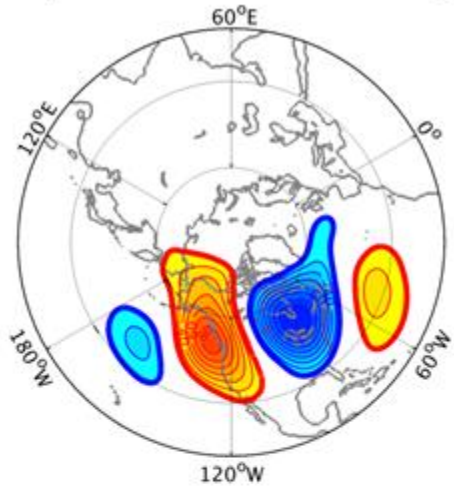


- ECMWF is forecasting a moderate likelihood (56% ensemble agreement) of above-normal North-ridge activity during Weeks 3–4 (16–30 Dec)
- ECMWF is also forecasting near-normal South-ridge and West-ridge activity
- NCEP is showing the potential for persistent ridging activity near the US West Coast, but there is uncertainty in the location of ridging

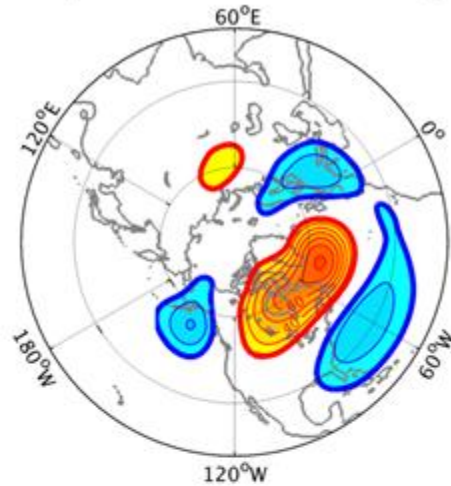
Uncertainty in location of ridging activity near US West Coast during Weeks 3–4 (16–30 Dec)

Background Info: IRI Subseasonal Weather Regime Forecasts

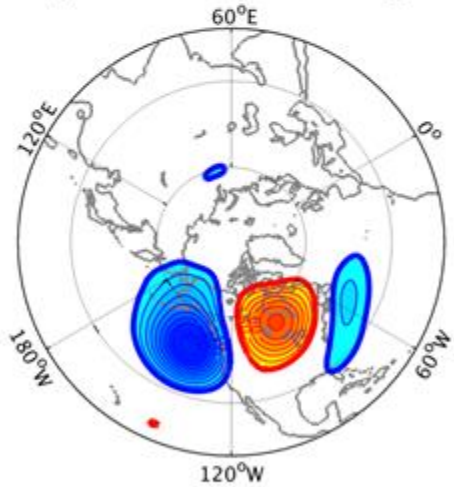
a) WR 1: West Coast Ridge



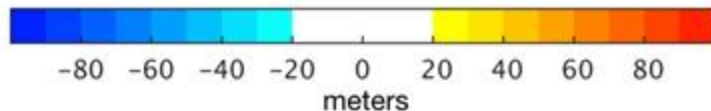
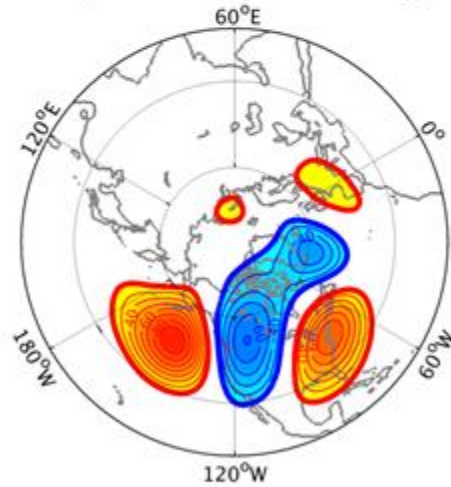
b) WR 2: Greenland High



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)

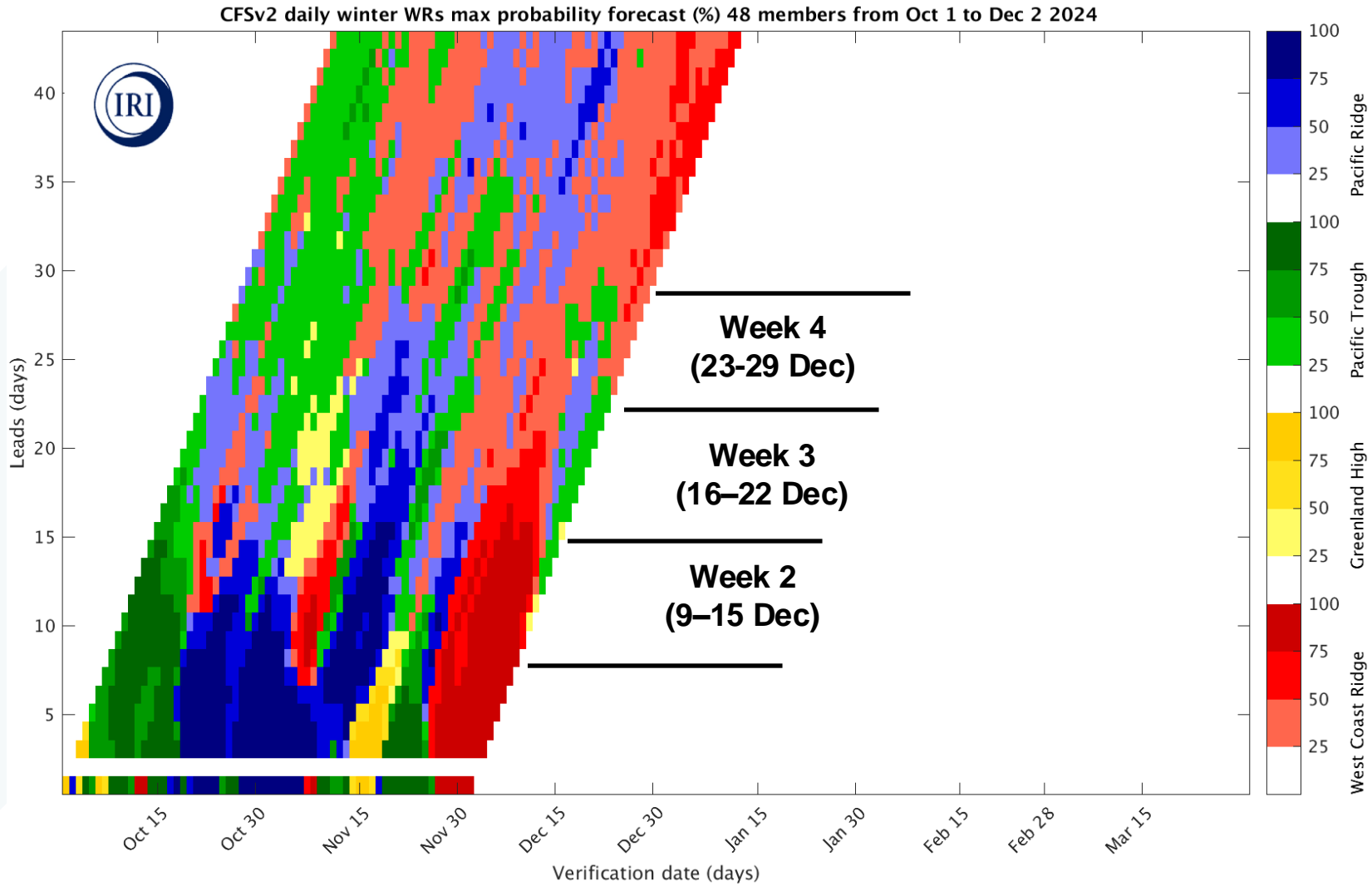
Reference: [Robertson et al. \(2020\)](#)

For more information about the forecast product:

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

IRI North American Weather Regime Forecasts

Forecast Initialized 2 Dec 2024



- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- Uncertainty in regime type during Week 2 (9–15 Dec), with a possible transition from West Coast Ridge to Greenland High or Pacific Trough
- Low likelihood (25-50% ensemble agreement) of persistent Pacific Trough during Week 3 (16–22 Dec)
- Low likelihood (25-50% ensemble agreement) of persistent West Coast Ridge in Week 4 (23–29 Dec)

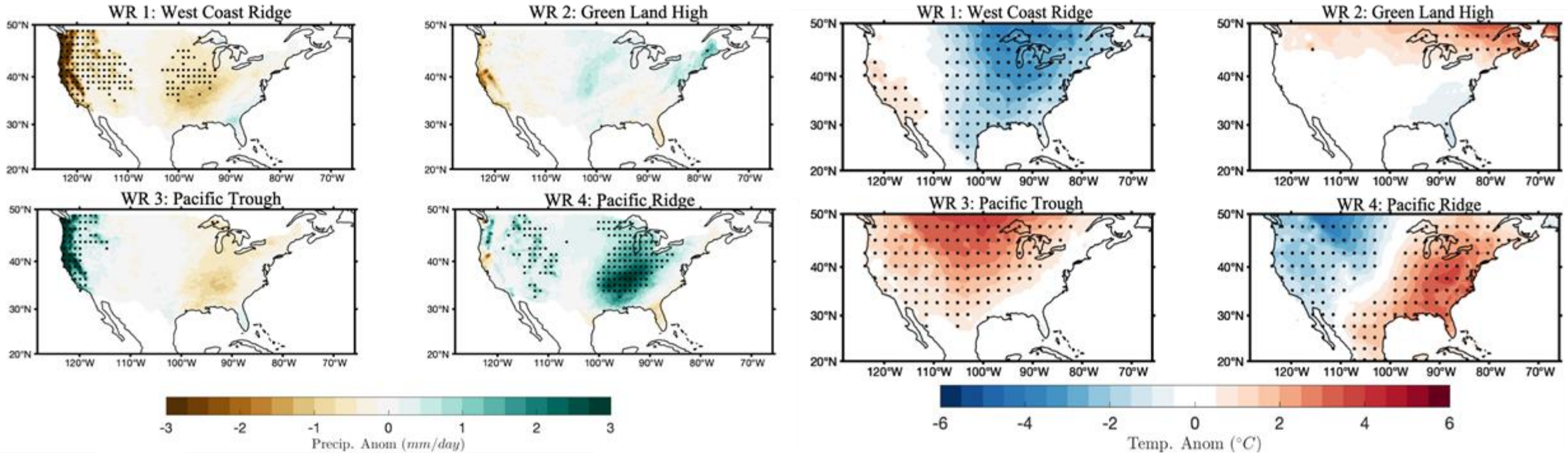
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime. See the next slide for temperature/precipitation implications.

For more information about the forecast product: <https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs>

IRI North American Weather Regime Forecasts

Precipitation

Temperature



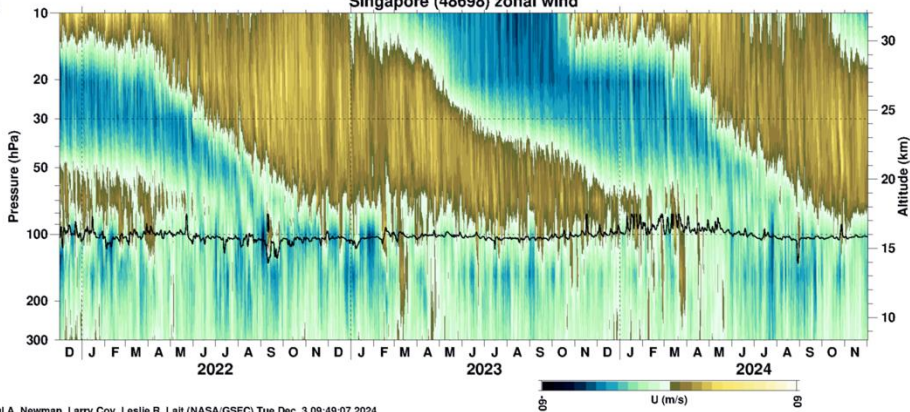
This graphic shows composite mean precipitation (left) and temperature (right) anomalies associated with each weather regime. Stippling (black dots) indicate statistically significant anomalies.

- Above-normal precipitation and above-normal temperature predicted over CA during Week 3 (16–22 Dec) with low confidence in Pacific Trough regime
- Below-normal precipitation and above-normal temperature predicted over CA during Week 4 (23–29 Dec) with low confidence in West Coast Ridge regime

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

QBO Conditions

Singapore (48698) zonal wind

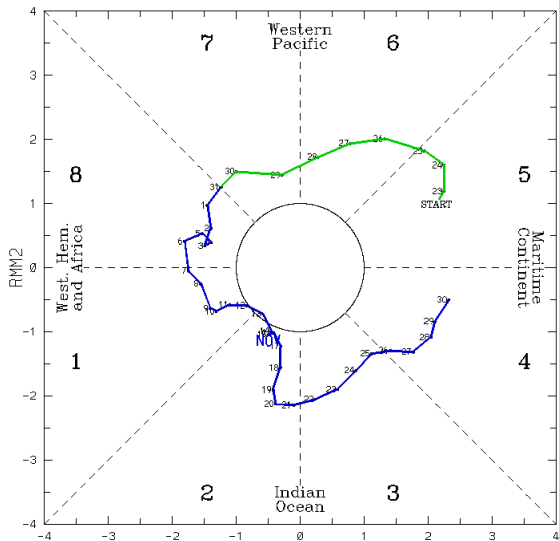


Paul A. Newman, Larry Coy, Leslie R. Lait (NASA/GSFC) Tue Dec 3 09:49:07 2024

QBO is in the westerly phase at 50-hPa

MJO Conditions

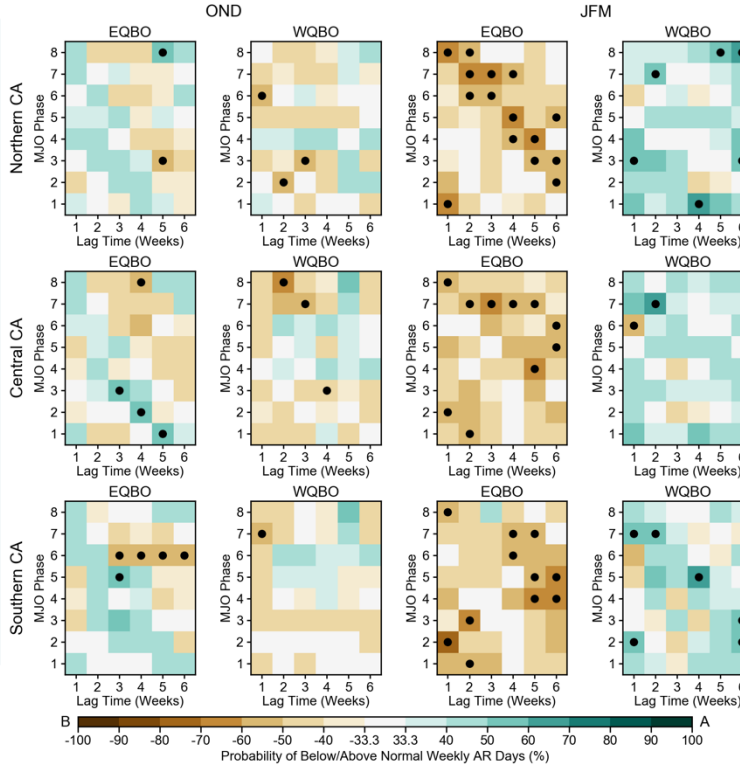
(RMM1, RMM2) phase space for 22-Oct-2024 to 30-Nov-2024



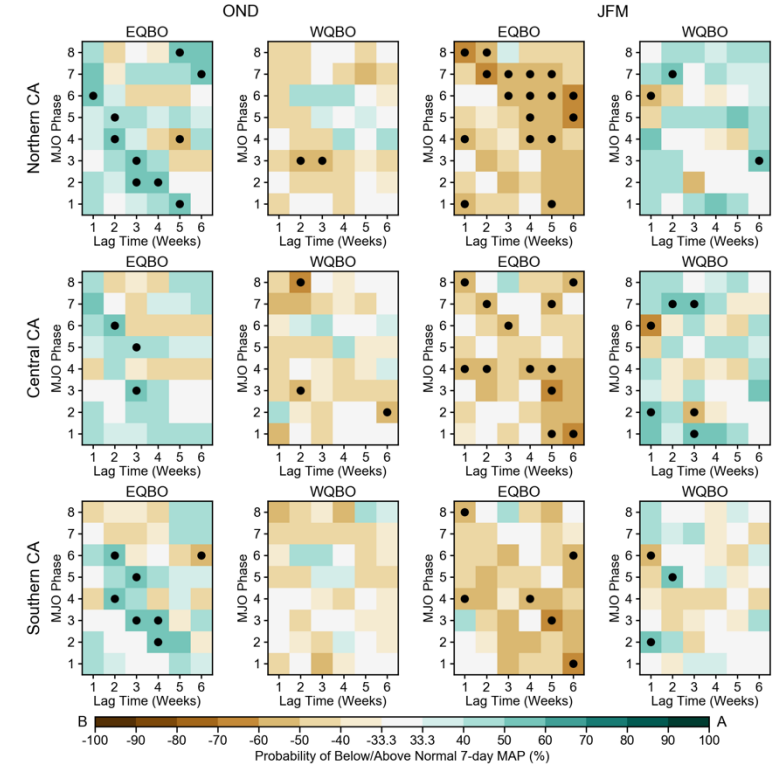
MJO convection is currently located over the Maritime Continent (Phase 4)

Labelled dots for each day. Blue line is for Nov, green line is for Oct, red line is for Sep.

Probability of Above/Below-Normal AR Occurrence



Probability of Above/Below-Normal Precipitation



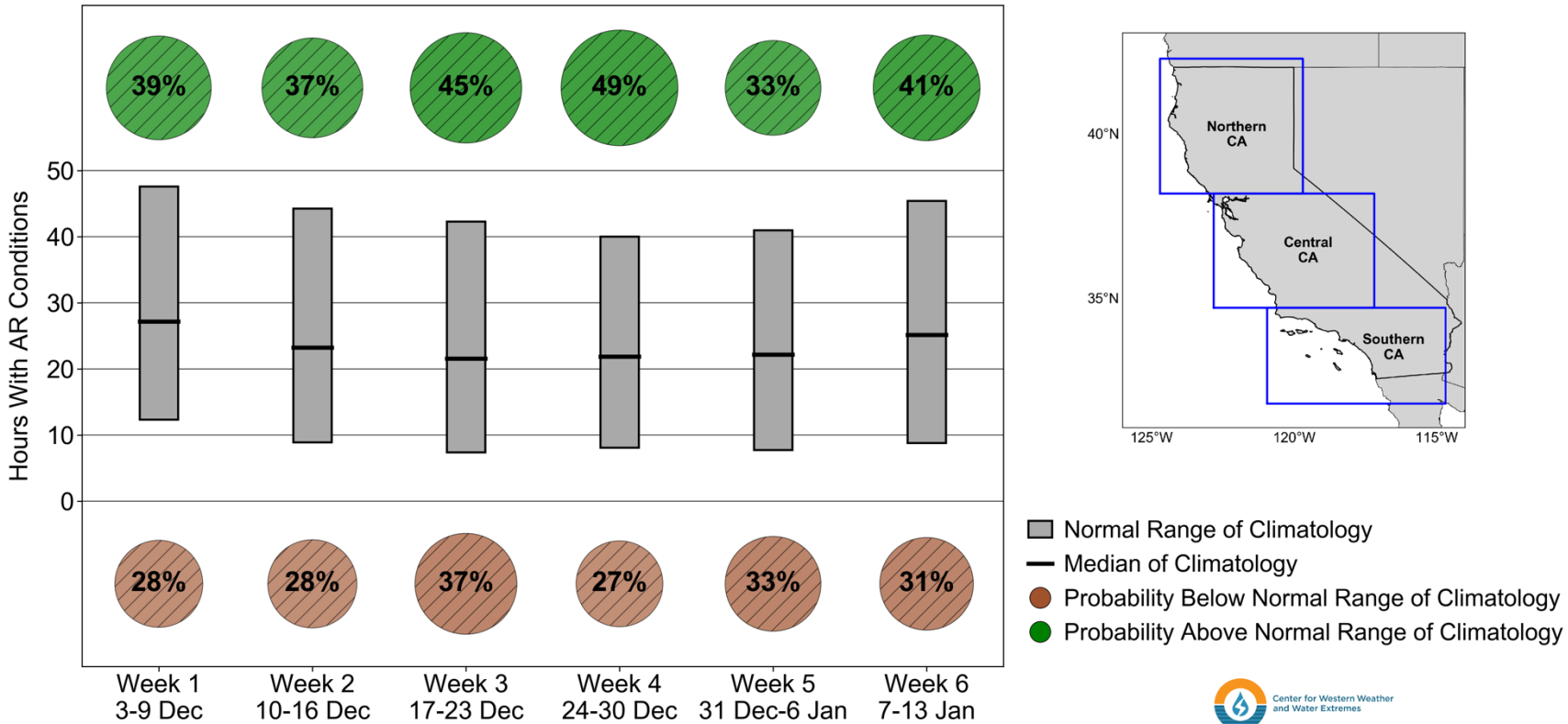
Probability matrices illustrating the weeks 1–6 lagged probability of below-normal (brown shading) or above-normal (green shading) AR occurrence and precipitation for all MJO/QBO phase configurations during OND (left) and JFM (right) in Northern CA (top), Central CA (middle), and Southern CA (bottom). 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 2 Dec 2024

AR Occurrence: Northern CA

Northern CA Subseasonal AR Occurrence Outlook
Issued: 2 Dec 2024 MJO Phase 4 WQBO



- CW3E's probabilistic AR occurrence forecast based on current MJO and QBO conditions (see forecast for all regions [here](#))
- Moderate likelihood of above-normal AR occurrence in Northern CA during Weeks 3–4



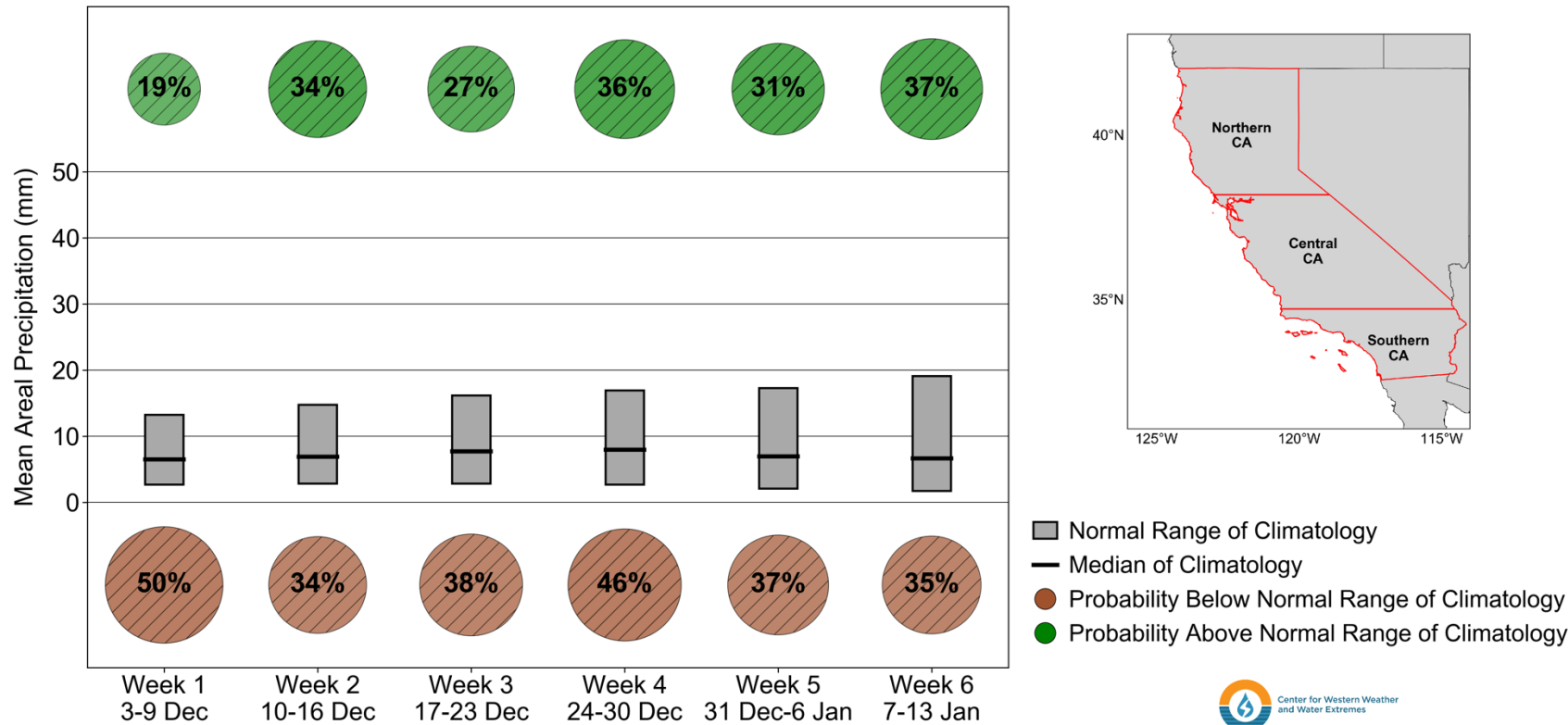
This product shows weekly probabilities of above-normal and below-normal AR occurrence in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If 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. \(2023\)](#)

AR Activity and Precipitation Based on MJO and QBO

Forecasts Initialized 2 Dec 2024

Precipitation: Central CA

Central CA Subseasonal Precipitation Outlook
Issued: 2 Dec 2024 MJO Phase 4 WQBO



- 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 4



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. \(2023\)](#)