



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 10 December 2024

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UC San Diego



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Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 9 Dec 2024

Region	Week 2 (16–22 Dec)				Week 3 (23–29 Dec)					Week 4 (30 Dec – 5 Jan)			
	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													
Northern CA													
Central CA													
Southern CA													

Higher Confidence | Lower Confidence

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

- Models lean towards above-normal precipitation in Northern CA (with low confidence) during Week 2; more uncertainty over Central and Southern CA
- High degree of uncertainty in precipitation over all of CA during Week 3
- Models lean towards below-normal precipitation in Central and Southern CA (with low confidence) during Week 4; more uncertainty over Northern CA

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 5); QBO is in the westerly phase
 - Without considering QBO/ENSO conditions, MJO in Phases 4&5 during OND is also associated with increases in wet extremes in all of CA at lag times of 2–4 weeks
- Models forecast MJO to remain over the Maritime Continent during Weeks 1–2

Week 2 forecasts (16–22 Dec):

- Good agreement between ECCO and ECMWF regarding AR activity in CA during Week 2, but NCEP differs
 - ECCO and ECMWF are forecasting above-normal AR activity over Northern CA, slightly above-normal AR activity over Central CA, and near-normal AR activity over Southern CA
 - NCEP is forecasting near-normal AR activity over Northern CA and slightly below-normal AR activity over Central and Southern CA
- Ridging outlooks show high likelihood of above-normal North-ridge (dry conditions over all of CA) and South-ridge (dry conditions in Southern CA) activity during Weeks 1–2
- IRI weather regime tool shows low likelihood of Pacific Trough (above-normal precipitation in CA) during Week 2

Summary

Week 3 Forecasts (23–29 Dec):

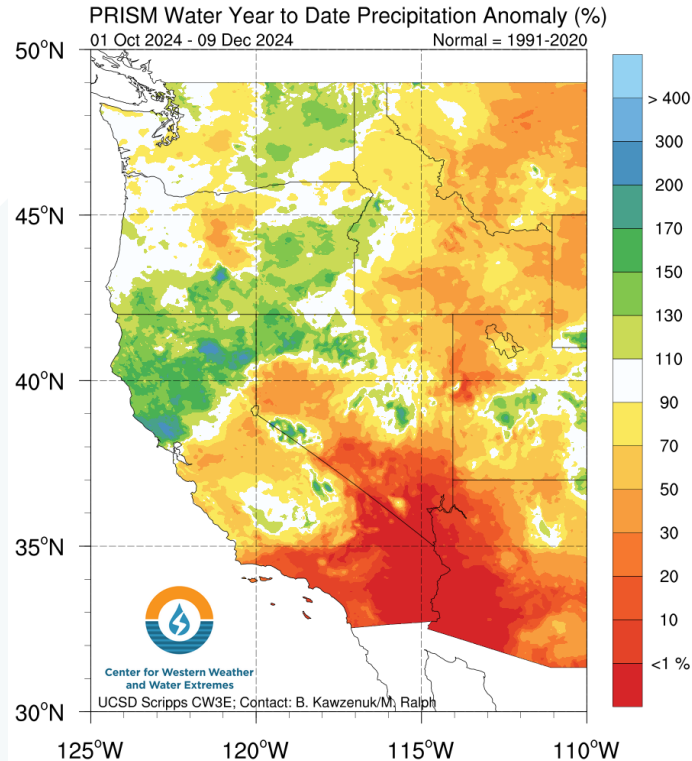
- Models disagree somewhat on AR activity in CA during Week 3
 - For Northern CA, NCEP is forecasting near-normal AR activity, ECCC is forecasting above-normal AR activity, and ECMWF is forecasting slightly above-normal AR activity
 - For Central CA, NCEP is forecasting slightly below-normal AR activity, ECCC is forecasting slightly above-normal AR activity, and ECMWF is forecasting near-normal AR activity
 - For Southern CA, NCEP is forecasting slightly below-normal AR activity, and ECCC and ECMWF agree on near-normal AR activity
- Ridging outlooks show moderate-to-high likelihood of above-normal North-ridge activity (dry conditions over all of CA) during Weeks 3–4
- IRI weather regime tool shows high degree of uncertainty in regime type during Weeks 3–4, with low confidence in West Coast Ridge (below-normal precipitation in CA) during most of the period

Week 4 Forecasts (30 Dec – 5 Jan):

- Models disagree somewhat on AR activity in CA during Week 4
 - NCEP is forecasting slightly above-normal AR activity over all of CA
 - ECCC and ECMWF agree on near-normal AR activity over Northern CA and slightly below-normal AR activity over Southern CA
 - For Central CA, ECCC is forecasting slightly below-normal AR activity, and ECMWF is forecasting near-normal AR activity

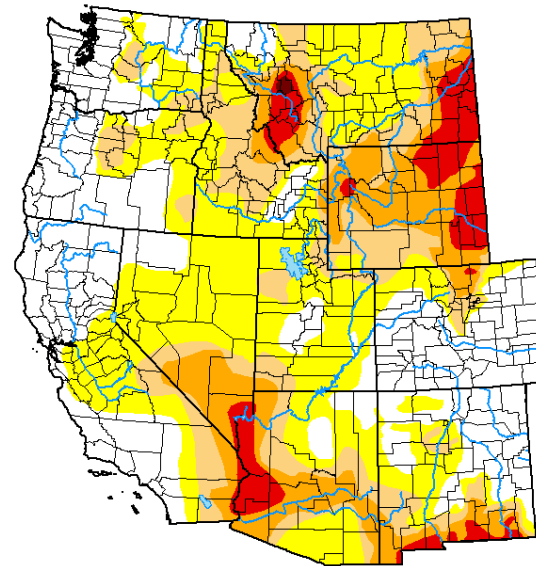
Hydrologic Summary

Precipitation



Drought Conditions

U.S. Drought Monitor Western U.S.



December 3, 2024

(Released Thursday, Dec. 5, 2024)

Valid 7 a.m. EST

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	32.36	67.64	35.00	18.50	6.02	0.10
Last Week 11-26-2024	25.87	74.13	34.99	18.28	6.06	0.10
3 Months Ago 09-03-2024	19.39	80.61	35.82	8.77	1.99	0.11
Start of Calendar Year 01-01-2024	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 12-05-2023	55.83	44.17	24.70	14.62	5.17	0.66

Intensity:

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

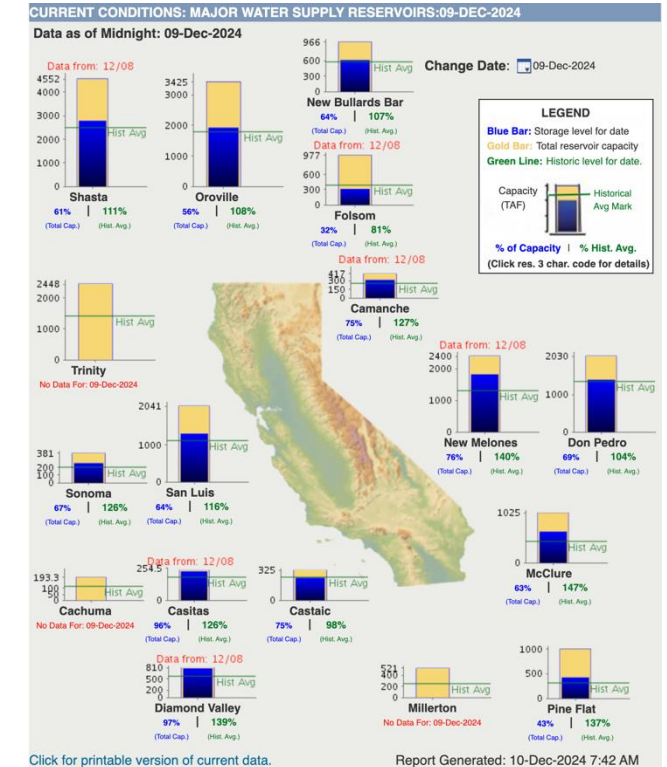
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

David Simeral
Western Regional Climate Center



Reservoir Storage



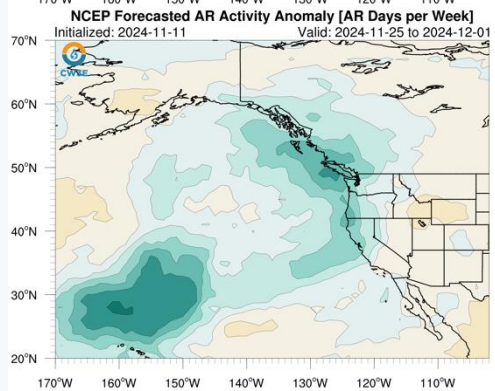
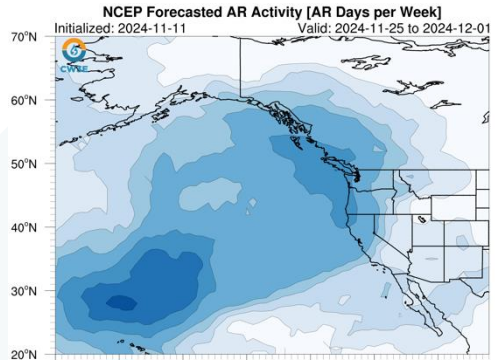
Source: California DWR

- As of 9 Dec, water-year-to-date precipitation is **above normal (> 130% of normal)** in Northern CA, **slightly below-normal (50–90% of normal)** in Central CA, and **well-below normal (< 20% of normal)** in Southern CA
- The most recent drought monitor update is showing **abnormally dry conditions (D0)** over the San Joaquin Basin and **moderate drought-to-severe drought (D1–D2)** in the desert regions of southeastern CA
- Most large reservoirs in CA are still operating at **near or above-normal storage** for this time of year

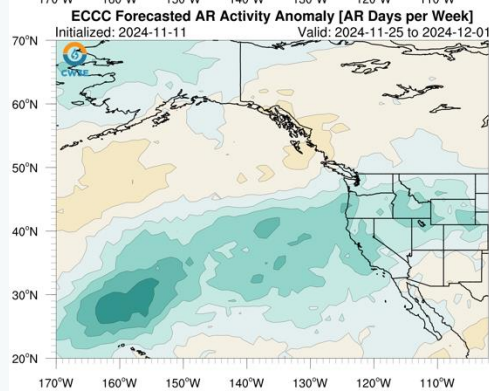
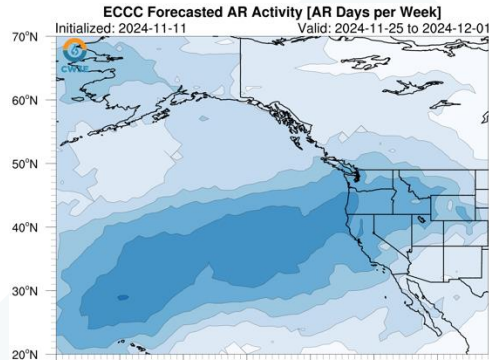
Looking Back: Week 3 AR Activity Forecasts

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

NCEP

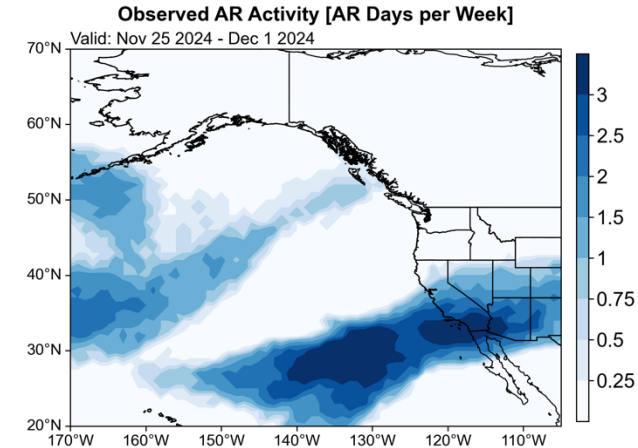


ECCC



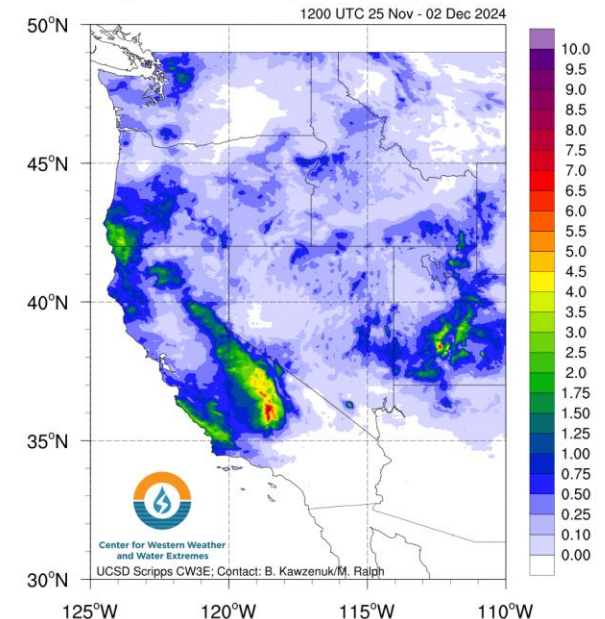
ECMWF
unavailable

Observed (GFS Analysis)



Observed Precipitation

7-day Accumulated Precipitation (inches)



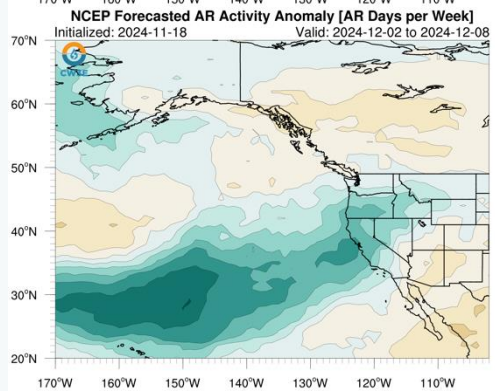
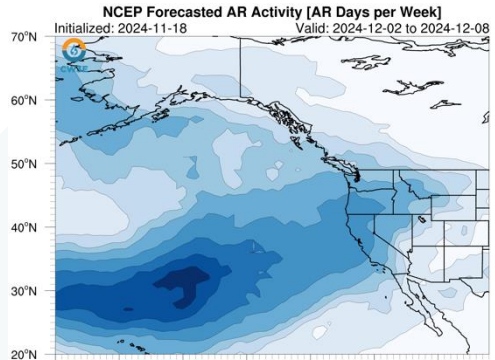
Shading: Fractional # of AR days forecast over a 7-day period (top) and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

- Both NCEP and ECCC captured some AR activity over Central CA
- ECCC also captured some AR activity over Southern CA and the interior western US, 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

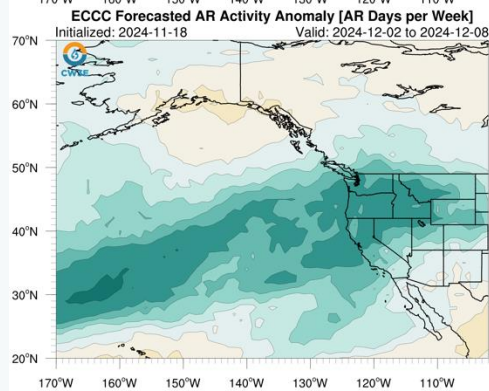
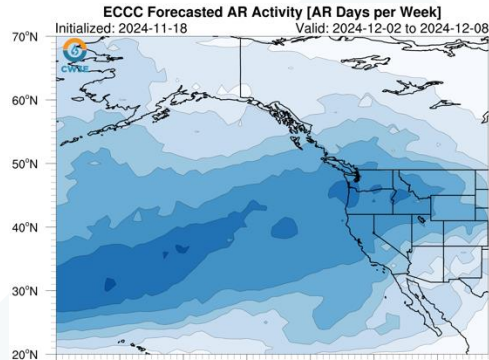
Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 18 Nov 2024; Valid: 2–8 Dec 2024

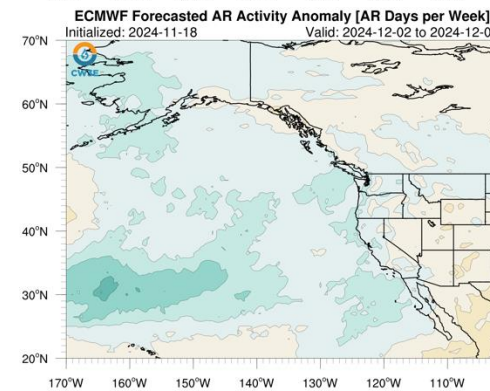
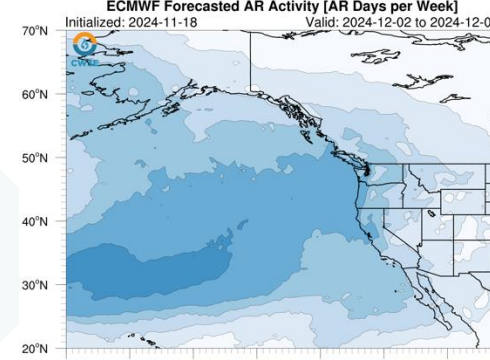
NCEP



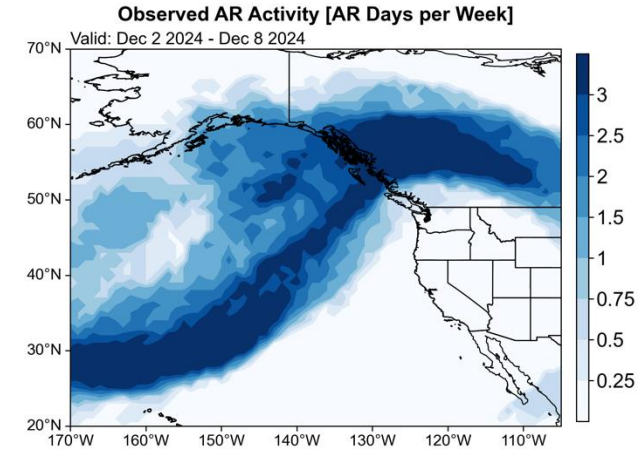
ECNC



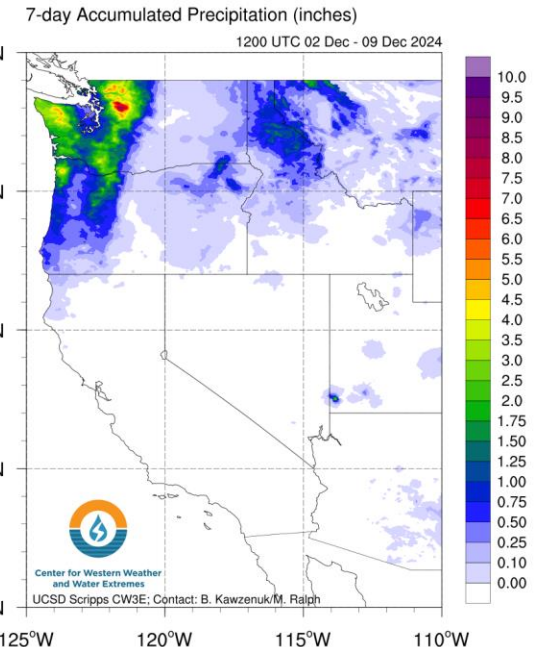
ECMWF



Observed (GFS Analysis)



Observed Precipitation

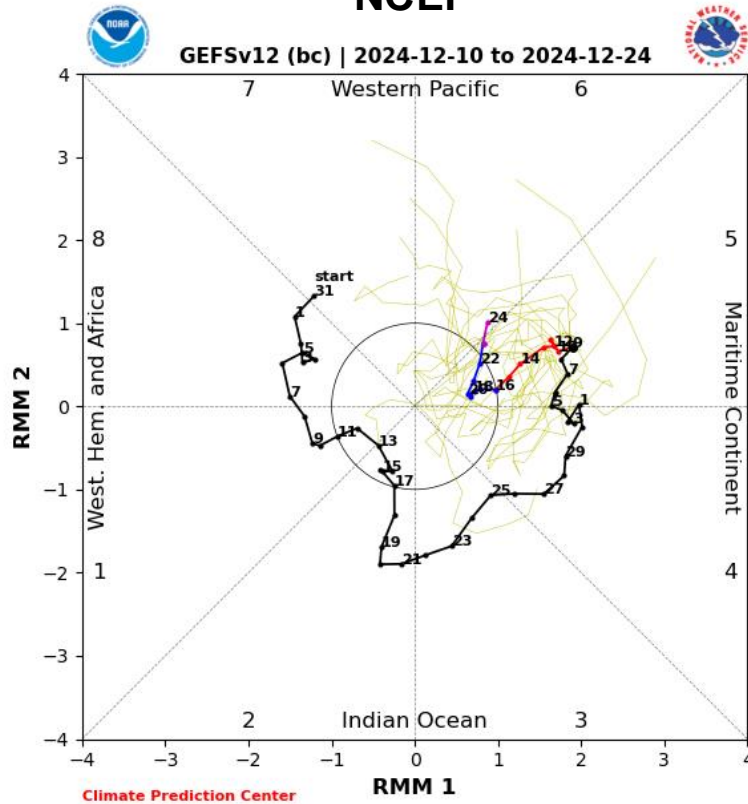


Shading: Fractional # of AR days forecast over a 7-day period (top) and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

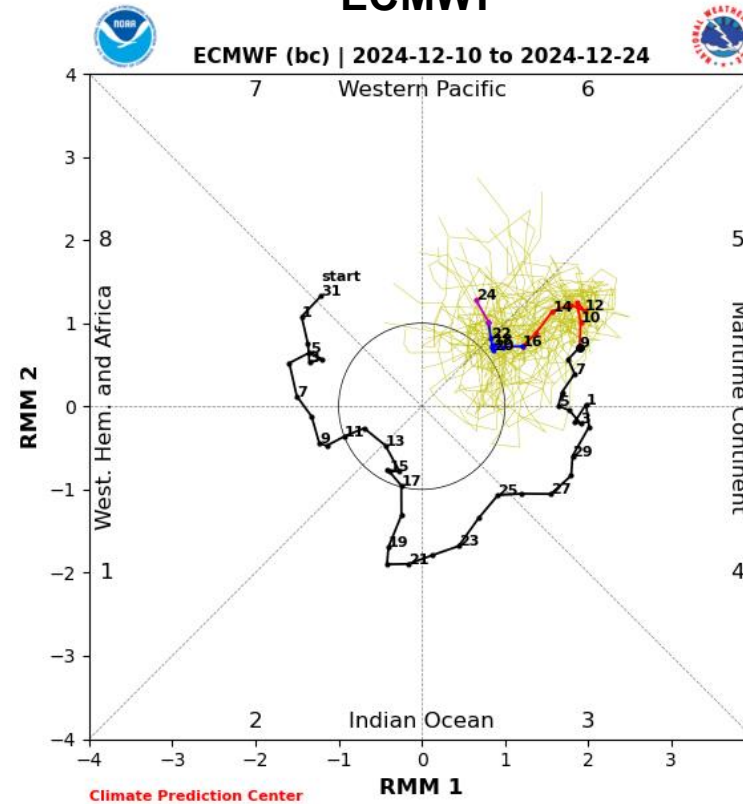
- All models overestimated AR activity over the US West Coast, especially NCEP and ECNC
- Observed AR activity was much farther north (over British Columbia) due to ridging
- The more zonal axis of AR activity in the forecasts suggests that the models struggled to predict the large-scale circulation regime over western North America at a 3-week lead time
- An AR and a low-pressure system produced at least 3–6 inches of precipitation over the Olympic Mountains and Washington Cascades during 6–8 Dec

Dynamical Model MJO Forecasts (NCEP vs. ECMWF)

NCEP

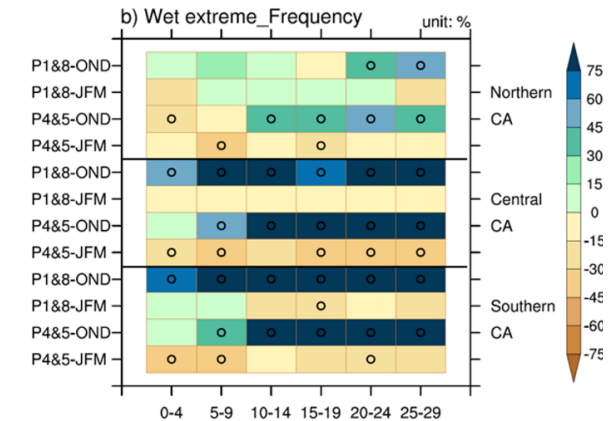
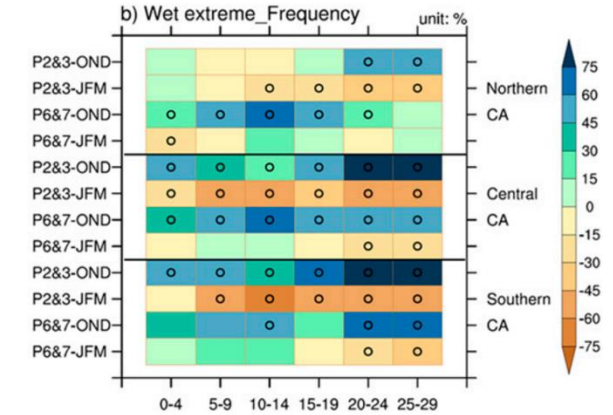


ECMWF



Black: Last 40 days of observations (31 Oct – 9 Dec); Red: Week 1 (10–16 Dec) ensemble mean; Blue: Week 2 (17–23 Dec) ensemble mean; Yellow: Ensemble members

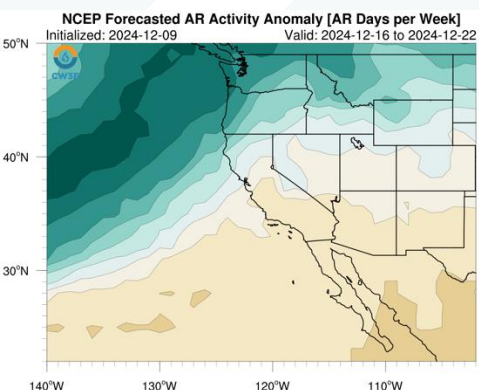
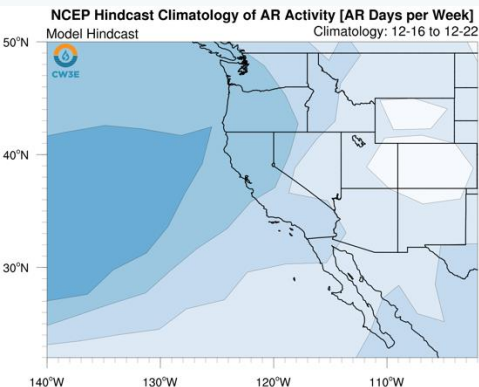
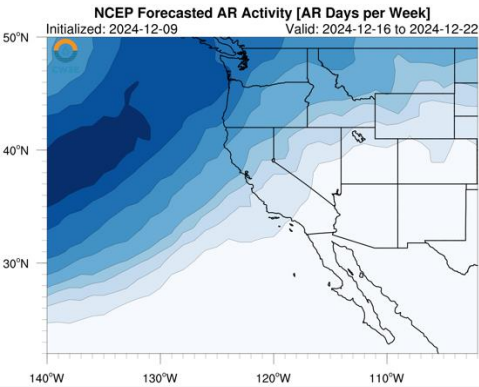
- Strong MJO convection is currently located over the Maritime Continent (Phase 5)
- Both NCEP and ECMWF models are forecasting MJO convection to remain over the Maritime Continent during Weeks 1–2
- NCEP is forecasting somewhat weaker MJO activity during Week 2 compared to ECMWF
- Without considering QBO/ENSO conditions, MJO activity over the Maritime Continent during OND is associated with statistically significant increases in wet extremes in CA at lag times of 2–4 weeks, particularly in Central and Southern CA



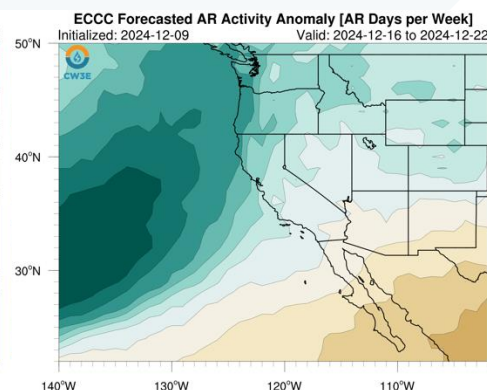
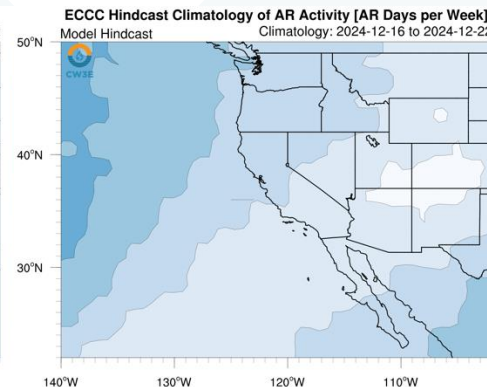
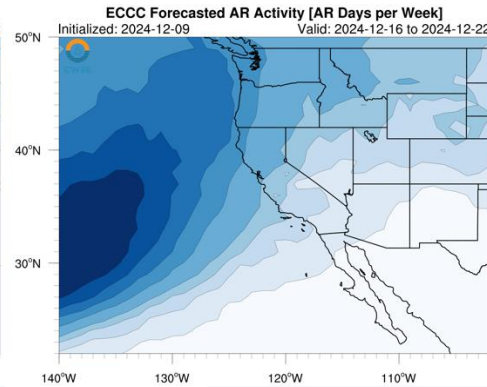
AR Activity Forecasts: Week 2 (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 9 Dec 2024

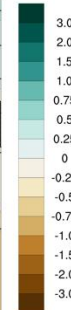
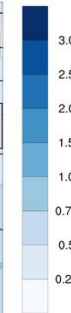
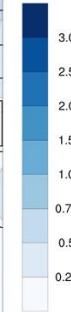
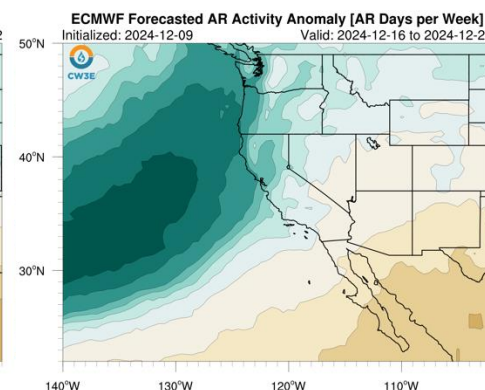
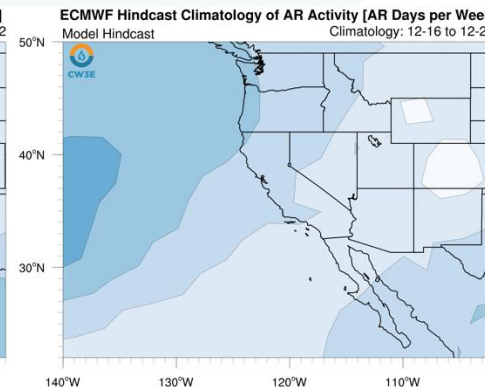
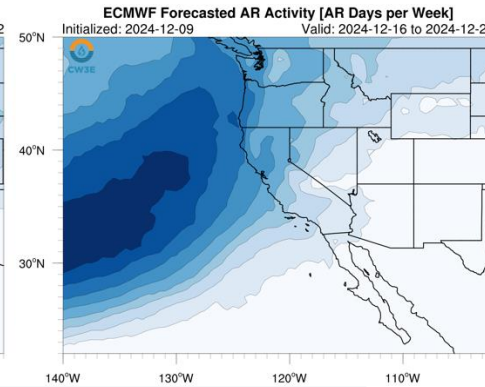
NCEP



ECCC



ECMWF



- ECCC and ECMWF agree on above-normal AR activity over Northern CA, slightly-above normal AR activity over Central CA, and near-normal AR activity over Southern CA during Week 2 (16–22 Dec)
- NCEP is forecasting near-normal AR activity over Northern CA and slightly below-normal AR activity over Central and Southern CA

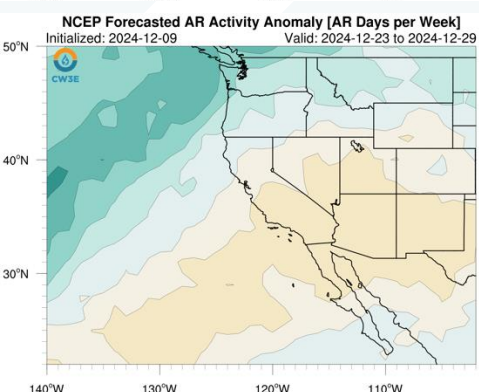
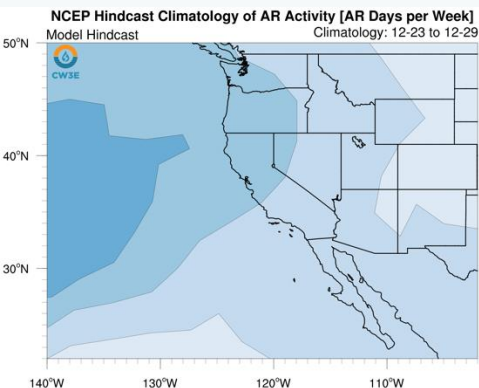
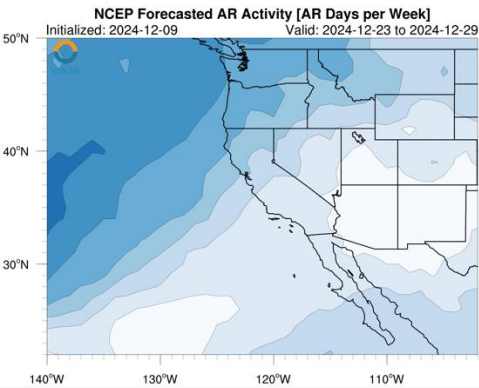
Good agreement between ECCC and ECMWF regarding AR activity over CA during Week 2 (16–22 Dec), but NCEP differs

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)

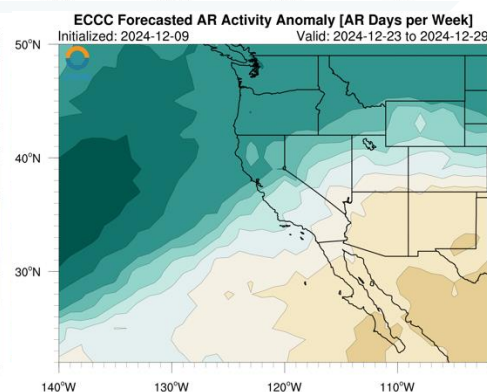
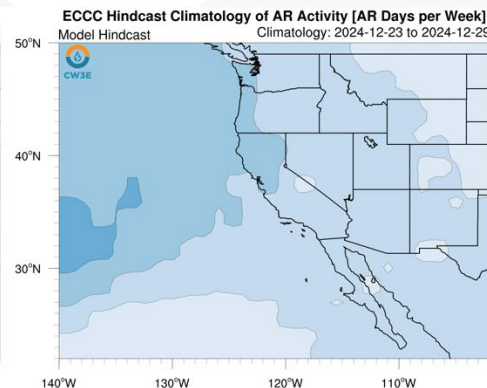
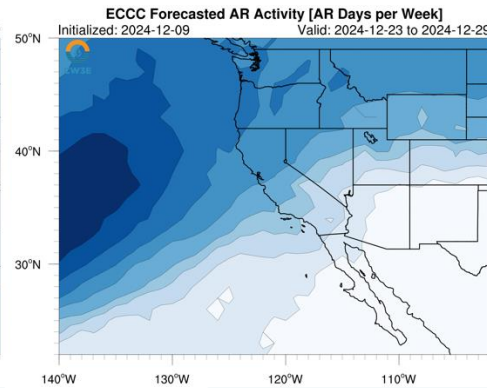
AR Activity Forecasts: Week 3 (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 9 Dec 2024

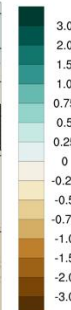
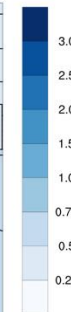
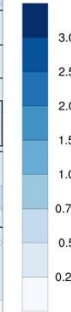
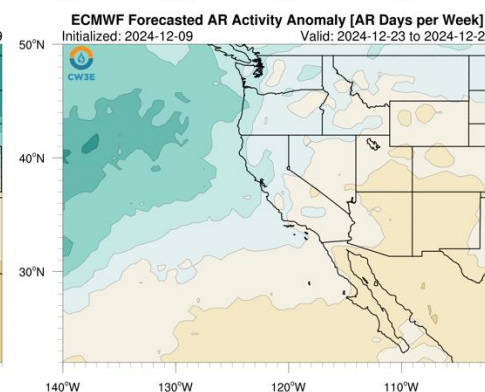
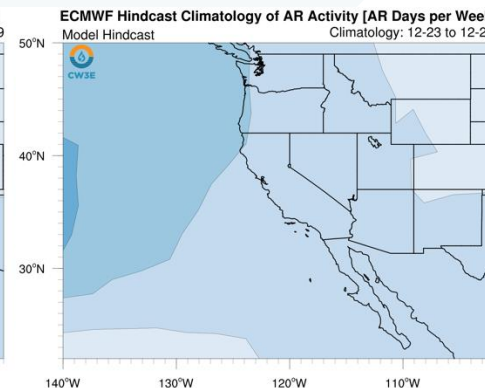
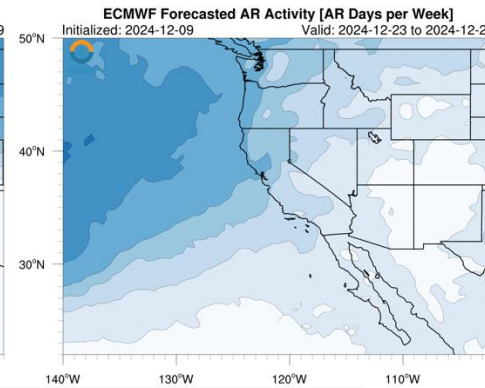
NCEP



ECCC



ECMWF



- In Northern CA, NCEP is forecasting near-normal AR activity, ECCC is forecasting above-normal AR activity, and ECMWF is forecasting slightly above-normal AR activity during Week 3 (23–29 Dec)
- In Central CA, NCEP is forecasting slightly below-normal AR activity, ECCC is forecasting slightly above-normal AR activity, and ECMWF is forecasting near-normal AR activity
- In Southern CA, NCEP is forecasting slightly below-normal AR activity, and ECCC and ECMWF agree on near-normal AR activity

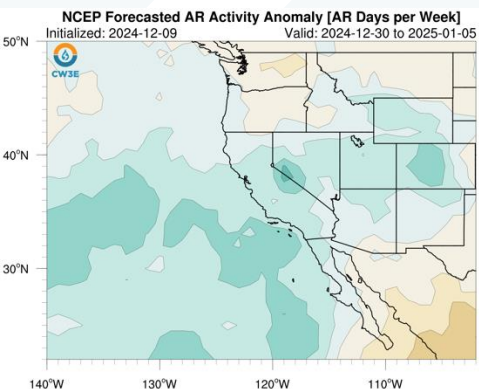
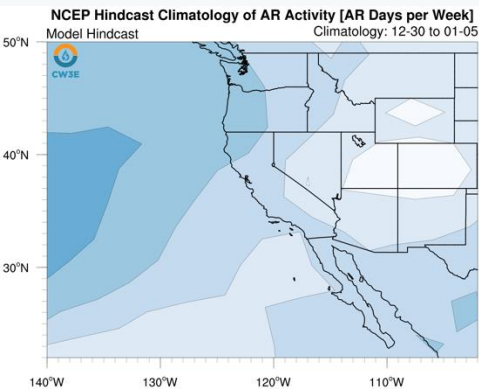
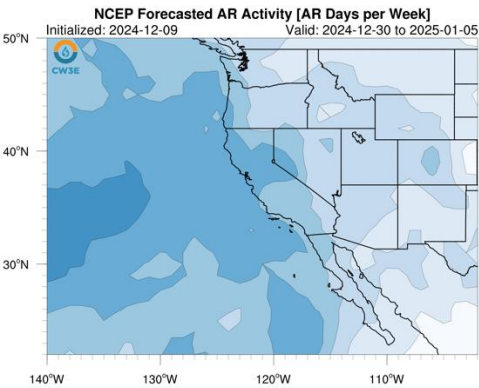
Models disagree somewhat on AR activity in CA during Week 3 (23–29 Dec)

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)

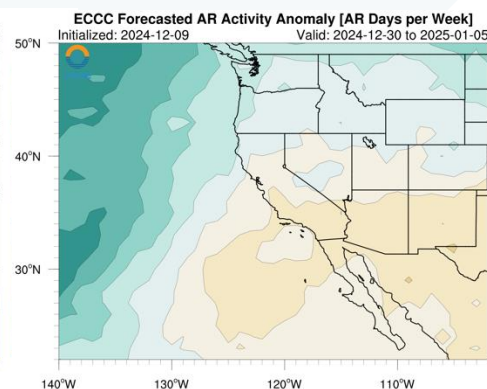
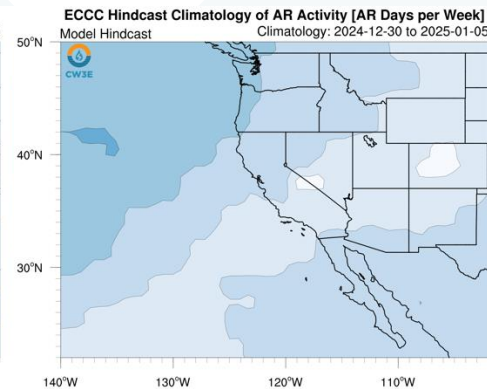
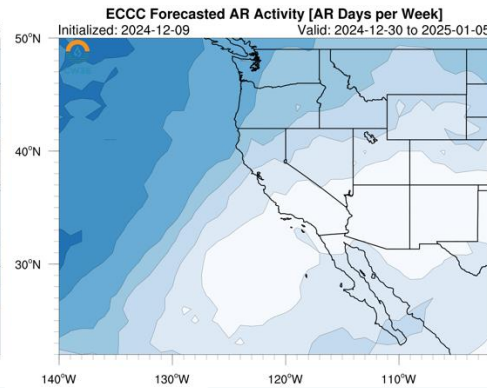
AR Activity Forecasts: Week 4 (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 9 Dec 2024

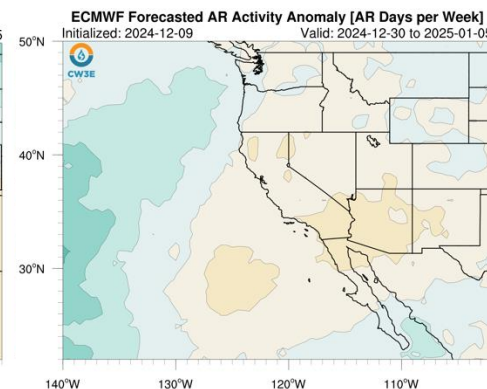
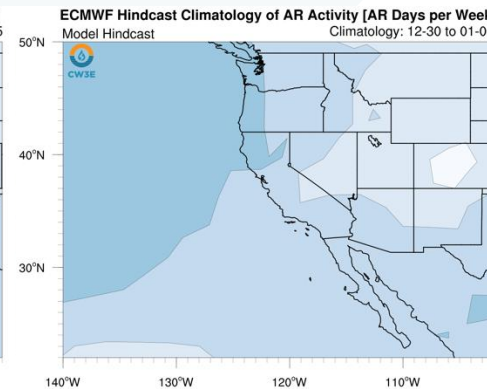
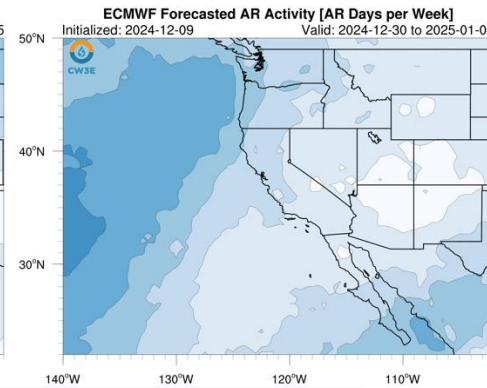
NCEP



ECCC



ECMWF

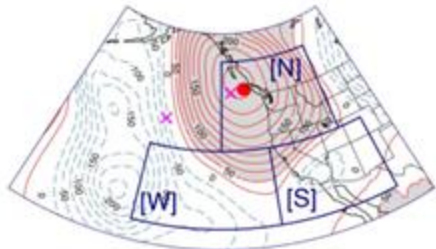


- NCEP is forecasting slightly above-normal AR activity over all of CA during Week 4 (30 Dec – 5 Jan)
- ECCC and ECMWF agree on near-normal AR activity over Northern CA and slightly below-normal AR activity over Southern CA
- In Central CA, ECCC is forecasting slightly below-normal AR activity, and ECMWF is forecasting near-normal AR activity

Models disagree somewhat on AR activity in CA during Week 4 (30 Dec – 5 Jan)

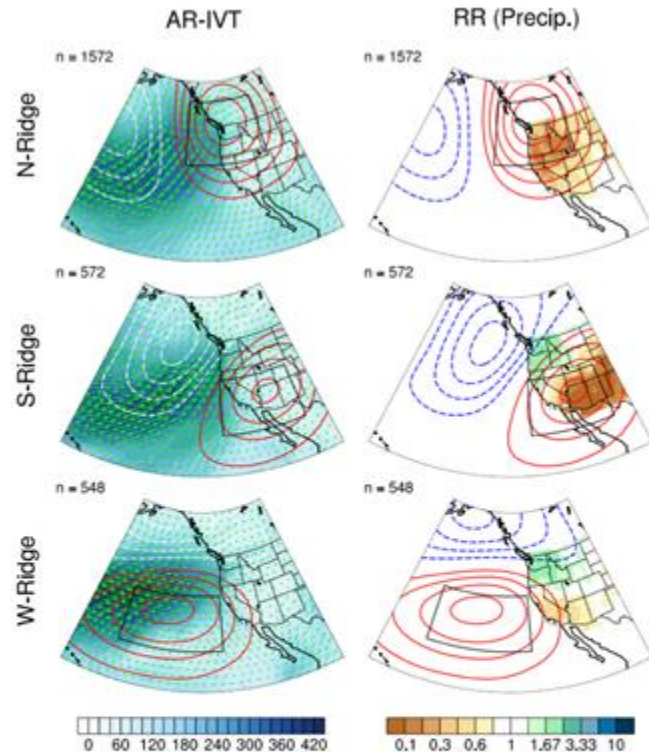
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom; green/blue = higher than climatology; brown = lower than climatology)

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



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
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AT UC SAN DIEGO

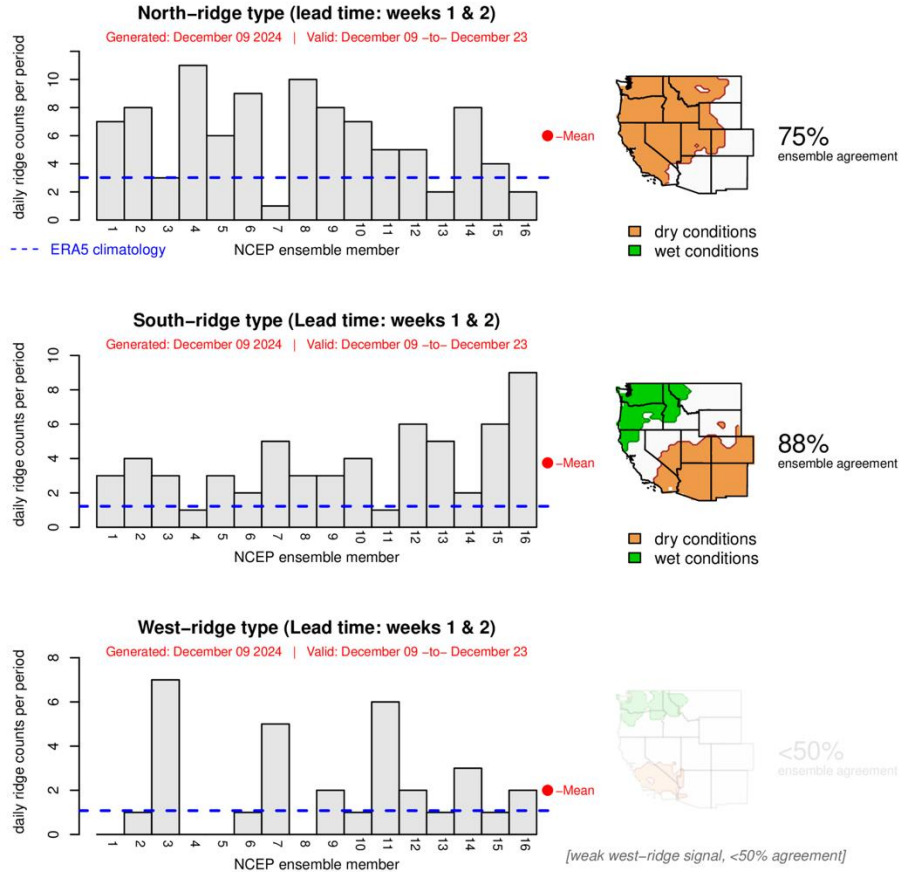
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 9 Dec 2024

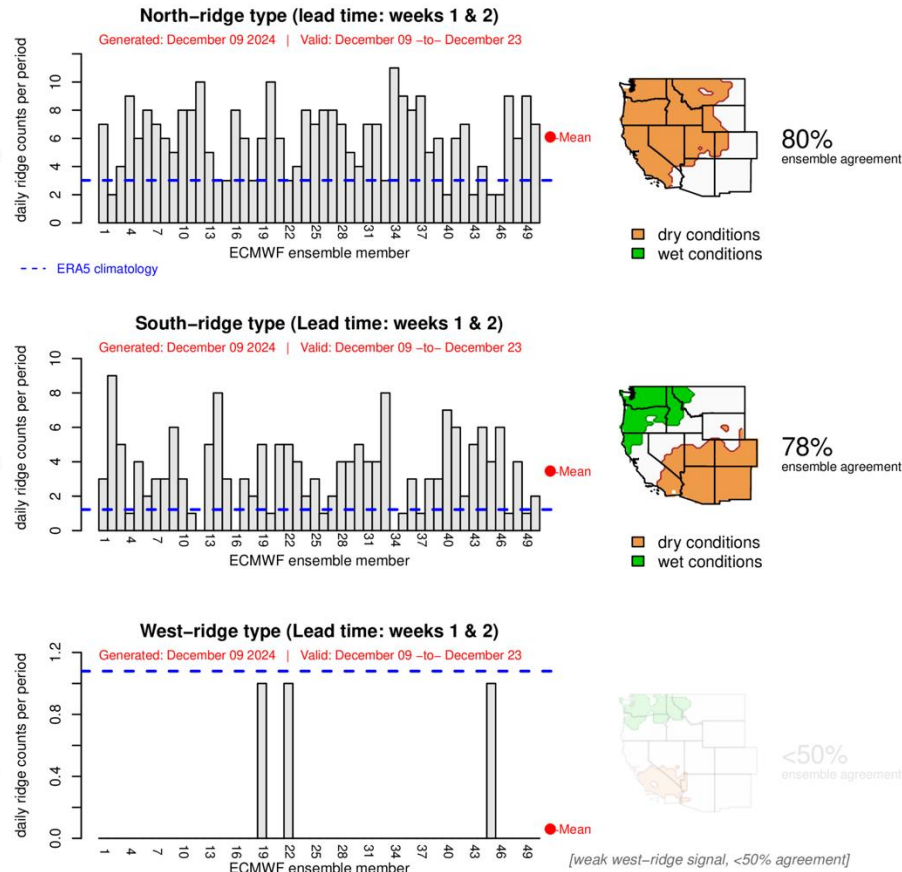
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



- NCEP and ECMWF are both forecasting a high likelihood ($\geq 75\%$ probability) of above-normal North-ridge and South-ridge activity during Weeks 1–2 (9–23 Dec)
- NCEP is also forecasting slightly above-normal West-ridge activity, but with low confidence ($< 50\%$ ensemble agreement)
- ECMWF is forecasting very low West-ridge activity

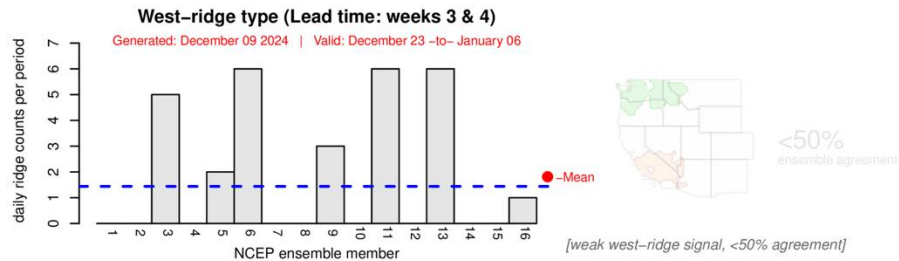
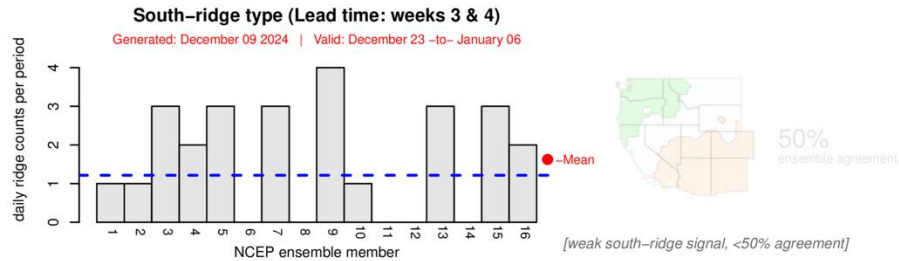
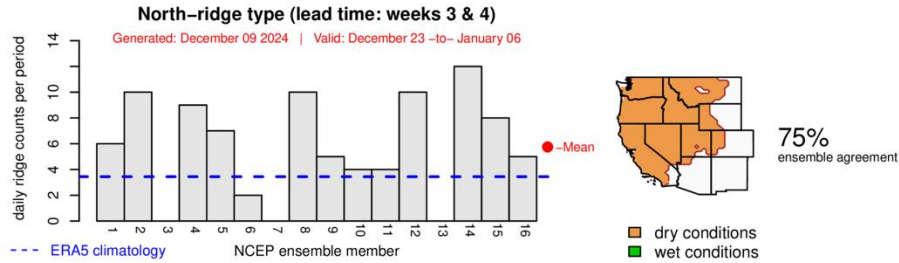
Models agree on high likelihood of above-normal ridging activity over the Pacific Northwest and Southwest during Weeks 1–2 (9–23 Dec)

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

Forecasts Initialized 9 Dec 2024

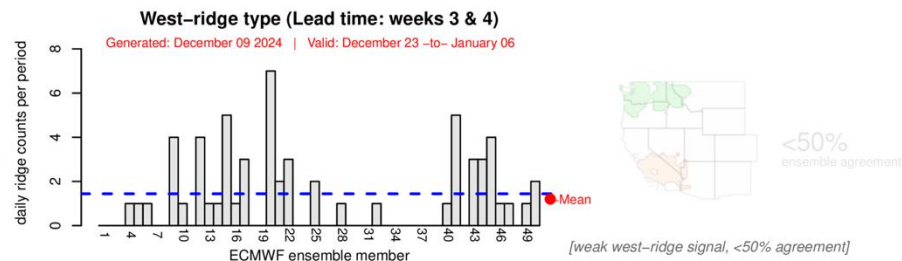
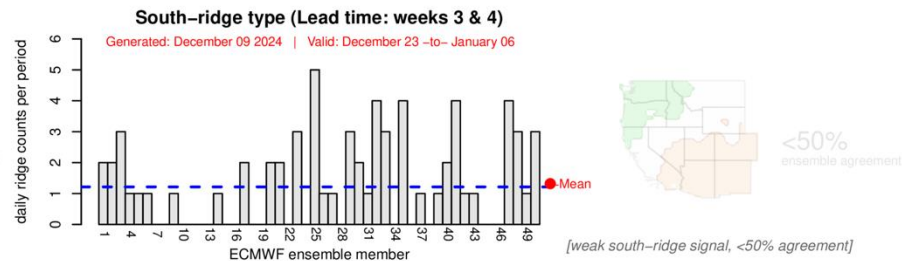
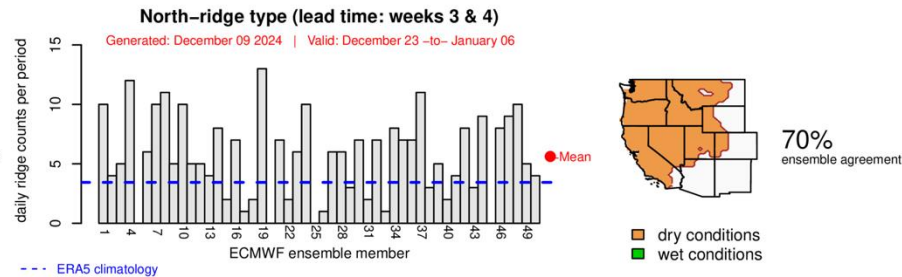
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)

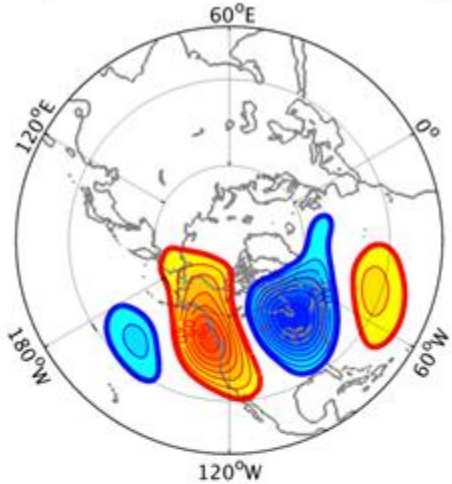


- NCEP is forecasting a high likelihood (75% ensemble agreement) of above-normal North-ridge activity during Weeks 3–4 (23 Dec – 6 Jan)
- ECMWF is forecasting a moderate likelihood (70% of ensemble agreement) of above-normal North-ridge activity
- Both models are also forecasting near-normal South-ridge and West-ridge activity

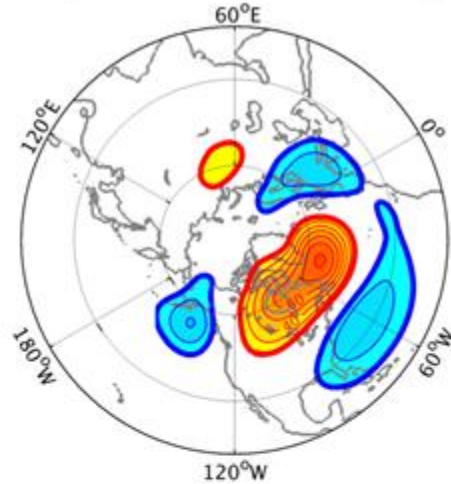
Models agree on moderate-to-high likelihood of above-normal ridging activity over the Pacific Northwest during Weeks 3–4 (23 Dec – 6 Jan)

Background Info: IRI Subseasonal Weather Regime Forecasts

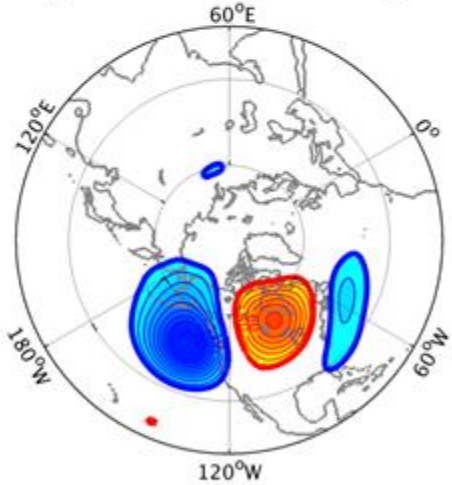
a) WR 1: West Coast Ridge



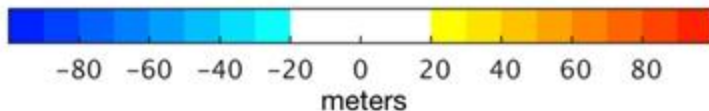
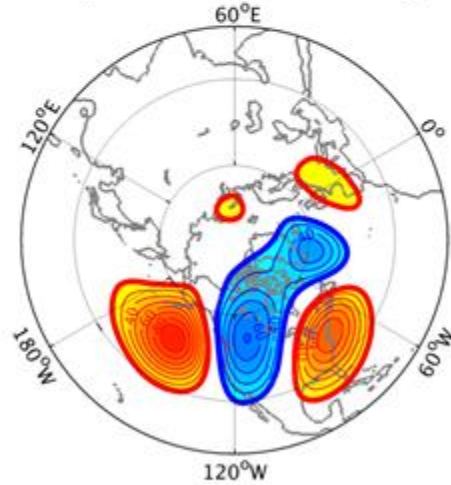
b) WR 2: Greenland High



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)

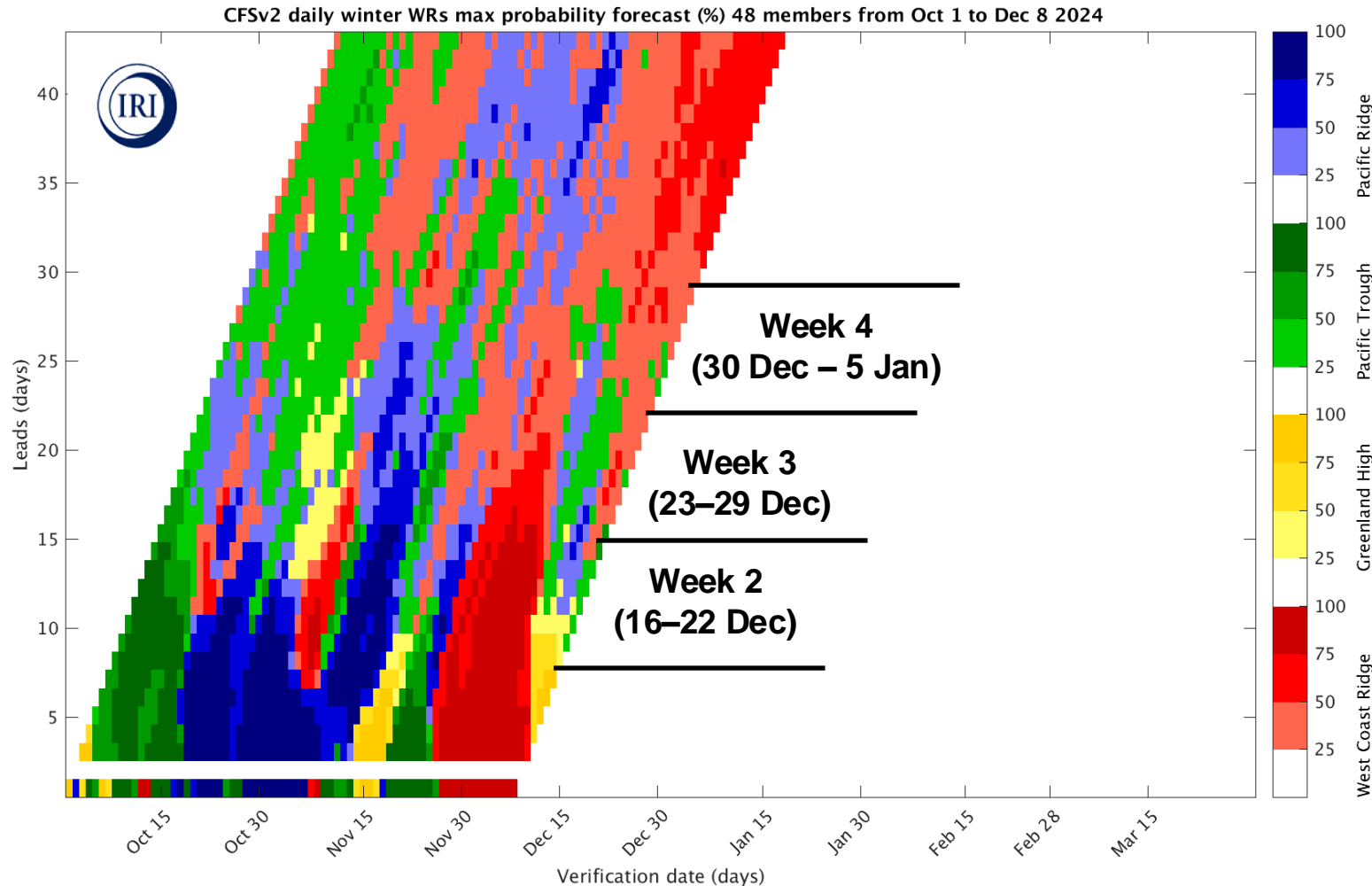
Reference: [Robertson et al. \(2020\)](#)

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 9 Dec 2024



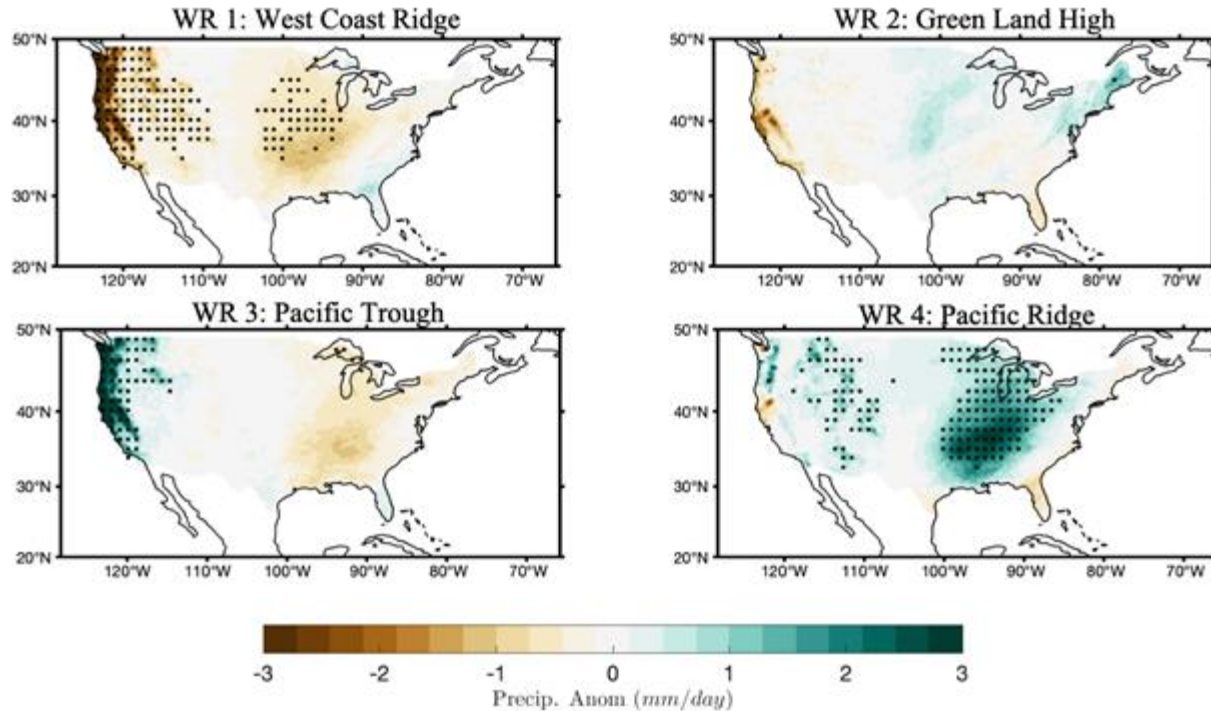
- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- Low likelihood (< 50% ensemble agreement) of Pacific Trough during most of Week 2 (16–22 Dec)
- High degree of uncertainty in regime type during Weeks 3–4 (23 Dec – 5 Jan), with a plurality of ensemble members West Coast Ridge during most of the period

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.

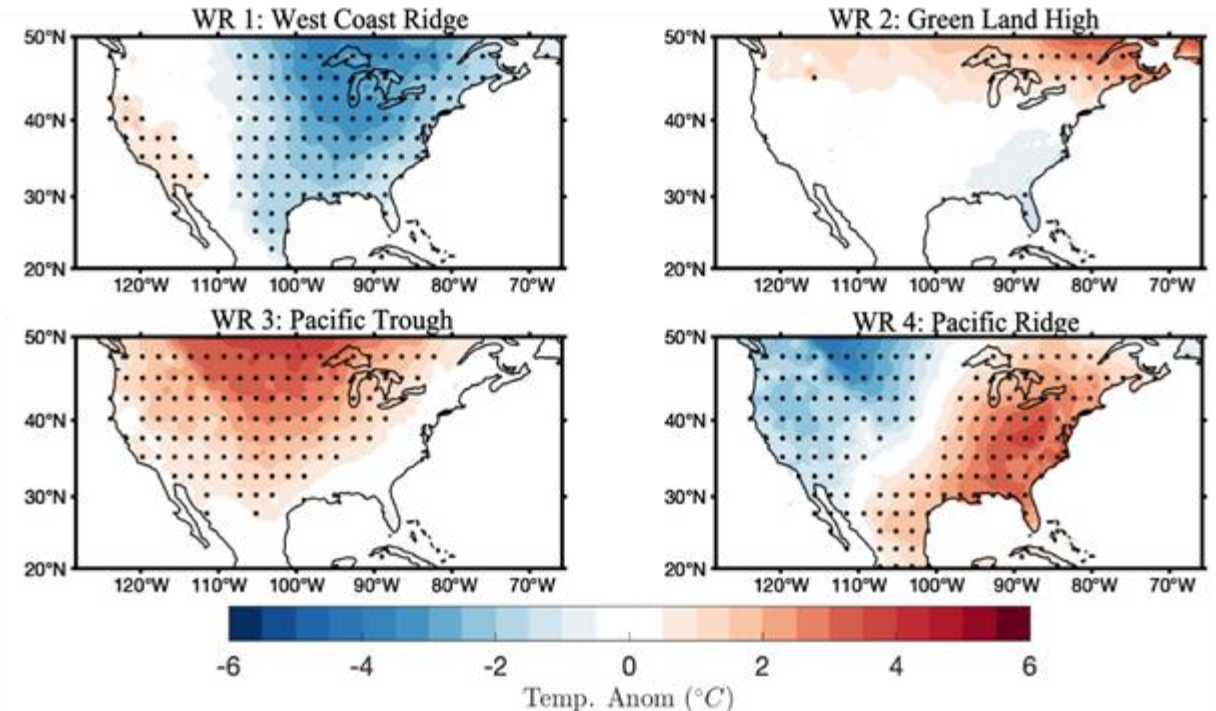
For more information about the forecast product: <https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs>

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.

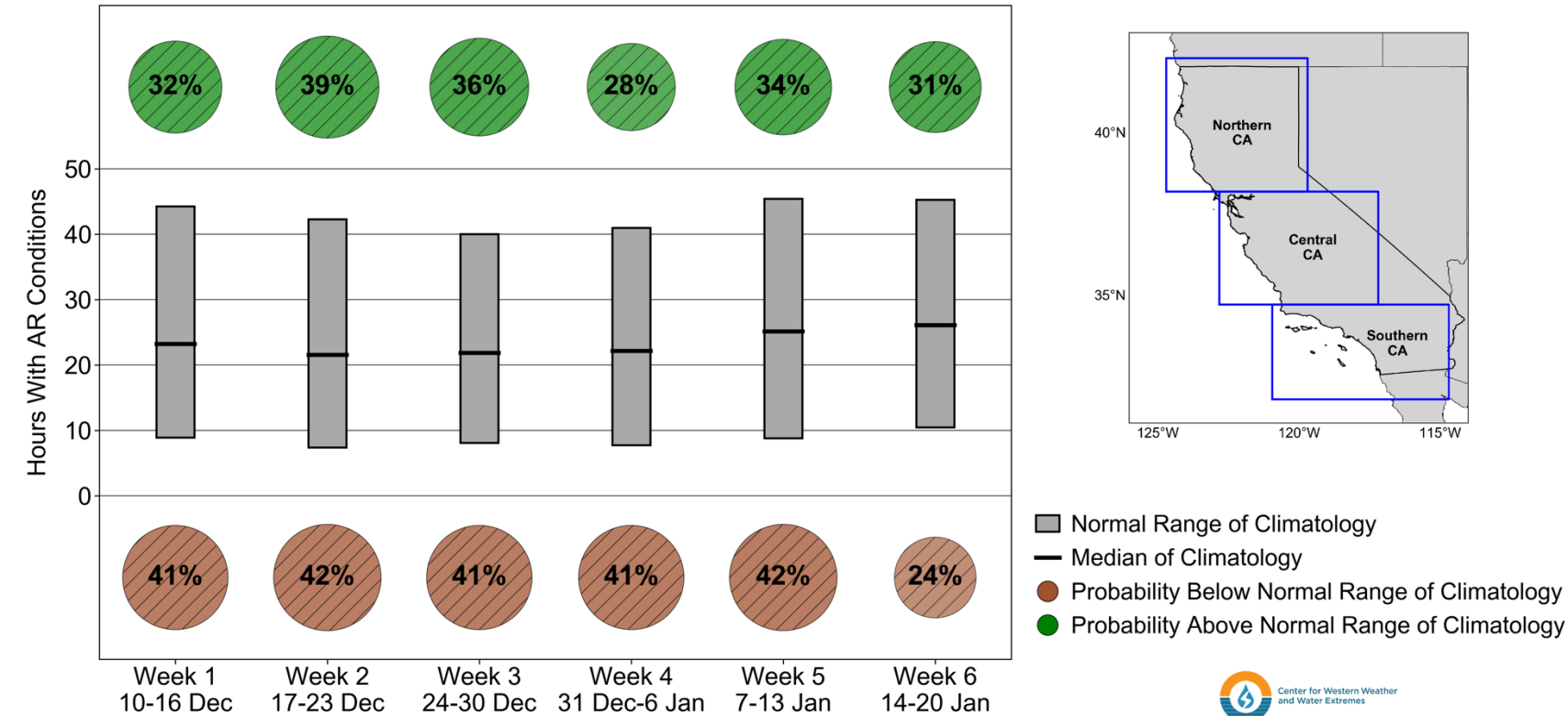
- Above-normal precipitation and temperature predicted over CA during Week 2 (16–22 Dec) with low confidence in Pacific Trough regime
- Below-normal precipitation and above-normal temperature predicted over CA during Weeks 3–4 (23 Dec – 5 Jan) with low confidence in West Coast Ridge regime

AR Activity and Precipitation Based on MJO and QBO

Forecasts Initialized 9 Dec 2024

AR Occurrence: Northern CA

Northern CA Subseasonal AR Occurrence Outlook
Issued: 9 Dec 2024 MJO Phase 5 WQBO



- 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 in Northern CA during Weeks 2–4 (17 Dec – 6 Jan)**
- Moderate likelihood of below-normal AR occurrence in Central CA during Week 4 (31 Dec – 6 Jan)



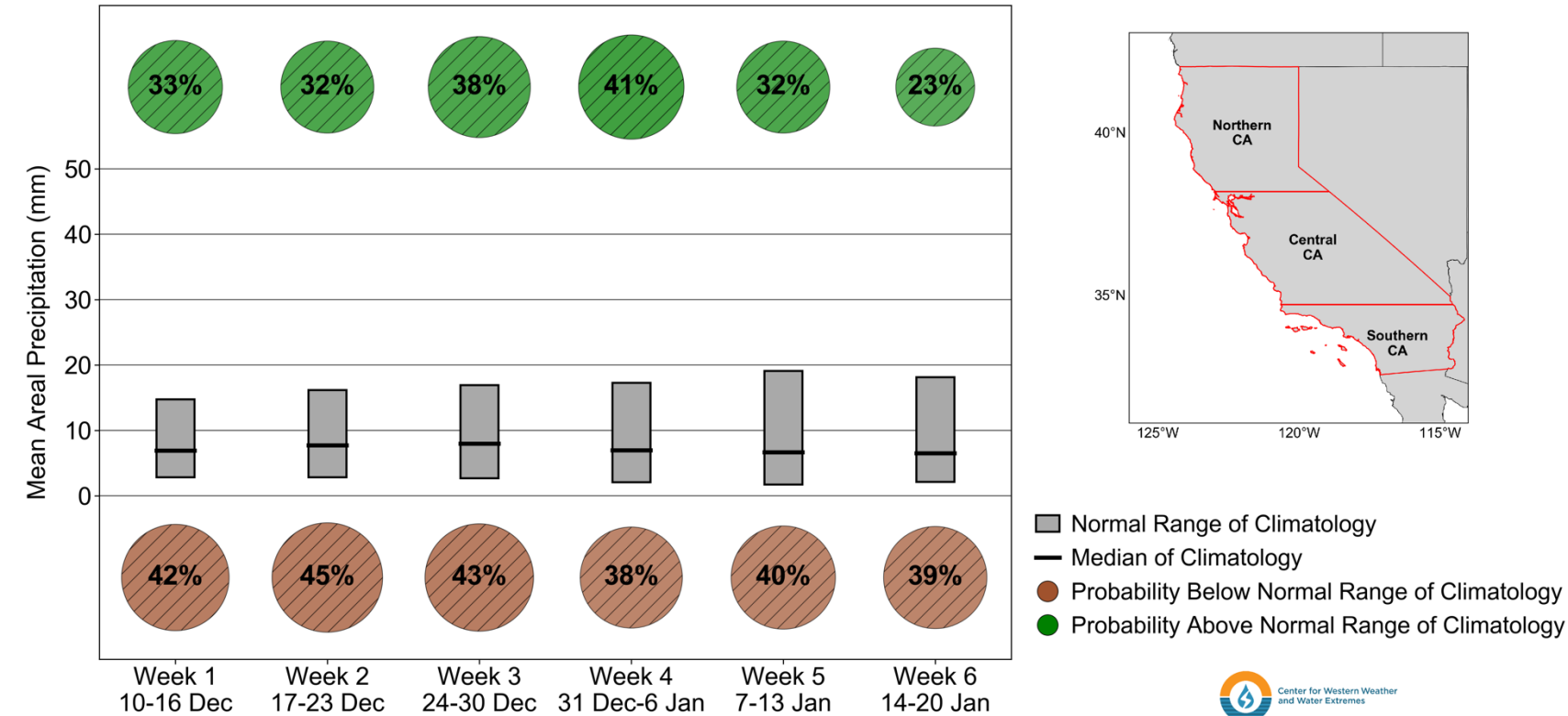
This product shows weekly probabilities of above-normal and below-normal AR occurrence in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If 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 9 Dec 2024

Precipitation: Central CA

Central CA Subseasonal Precipitation Outlook
Issued: 9 Dec 2024 MJO Phase 5 WQBO



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



- 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 Weeks 2–3 (17–30 Dec) and above-normal precipitation in Central CA during Week 4 (31 Dec – 6 Jan)**
- Moderate likelihood of below-normal precipitation in Northern and Southern CA during Week 2 (17–23 Dec)

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 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*