



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 20 December 2023

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UC San Diego



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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/s2s_forecasts/
- CW3E subseasonal (2–6 weeks lead time) atmospheric river, ridging, and circulation regime products use three different global ensemble prediction systems to create these products:
 - NCEP GFS (US Model): Weeks 2–3
 - NCEP CFSv2 (US Model): Weeks 2–6
 - ECCO (Canadian Model): Weeks 2–3
 - ECMWF (European model): Weeks 2–6
- ***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***

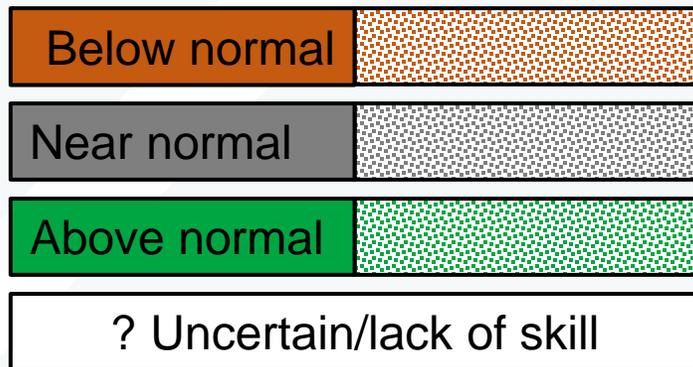
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 18 Dec 2023

Region	Week 2 (26 Dec–1 Jan)			Week 3 (2 Jan – 8 Jan)			Week 4 (9–15 Jan)		
	NCEP ^{2,3,4}	ECMWF ^{1,2,4}	Multi-Model Forecast	NCEP ^{2,3}	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{2,3}	ECMWF ²	Multi-Model Forecast
WA/OR	Higher Confidence	Uncertain	Uncertain	Uncertain	Lower Confidence	Uncertain	Uncertain	Uncertain	Uncertain
Northern CA	Higher Confidence	Uncertain	Uncertain	Uncertain	Lower Confidence	Uncertain	Uncertain	Uncertain	Uncertain
Central CA	Higher Confidence	Lower Confidence	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain
Southern CA	Uncertain	Lower Confidence	Lower Confidence	Uncertain	Uncertain	Uncertain	Lower Confidence	Lower Confidence	Lower Confidence

Higher Confidence | Lower Confidence



- Large uncertainty in Weeks 2-4 forecasts due to lack of agreement between forecasts products
- Dry condition is predicted in Southern CA during Week 4 by both models with low confidence

Subseasonal products included in this Outlook:

¹CW3E/JPL Atmospheric River Activity Forecasts ([DeFlorio et al. 2019](#)) (NCEP forecasts not available)

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

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

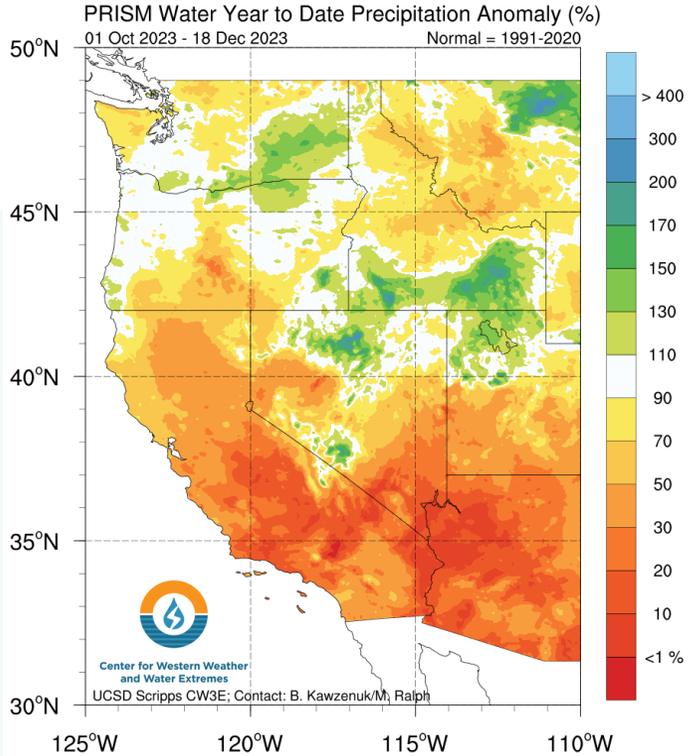
⁴CW3E Extended-Range AR Landfall Forecasts

Summary

- **Week 2 forecasts (26 Dec–1 Jan):** ECMWF is showing low likelihood of AR activity over Central and Southern CA and moderate likelihood of AR activity over Northern CA on 28 Dec
- Models are predicting a strengthening in MJO activity during the next two weeks located over the Central Pacific, which is historically associated with increased wet extremes over Northern CA and decreased wet extremes over Central and Southern CA at lag times of 2-4 weeks
- Models show potential for above-normal North Ridge activity during Weeks 1-2 which is typically associated with dry conditions in CA
- **Week 3 forecasts (2 – 8 Jan):** ECMWF is predicting significantly below-normal AR activity in Northern CA, near-normal AR activity in Central CA, and slightly above-normal AR activity in Southern CA
- Uncertainty in frequency and location of ridging activity near the US West Coast during Weeks 3–4
 - IRI weather regime forecasts show moderate likelihood of West Coast Ridge during Week 4 which is typically associated with dry conditions in CA

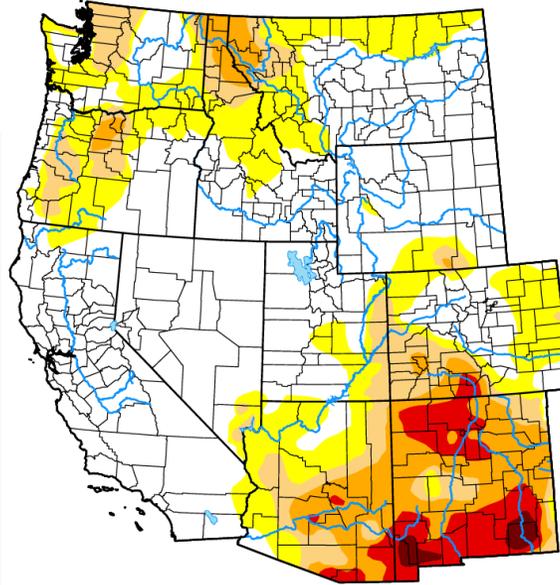
Hydrologic Summary

Precipitation



Drought Conditions

U.S. Drought Monitor West



December 12, 2023
(Released Thursday, Dec. 14, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	55.70	44.30	23.87	14.35	5.17	0.66
Last Week 12-05-2023	55.83	44.17	24.70	14.62	5.17	0.66
3 Months Ago 09-12-2023	55.69	44.31	31.67	16.59	3.57	0.00
Start of Calendar Year 01-03-2023	12.08	87.92	62.42	38.84	12.41	0.27
Start of Water Year 09-26-2023	55.99	44.01	31.24	17.70	6.09	0.70
One Year Ago 12-13-2022	8.66	91.34	64.99	44.15	14.18	1.28

Intensity:

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

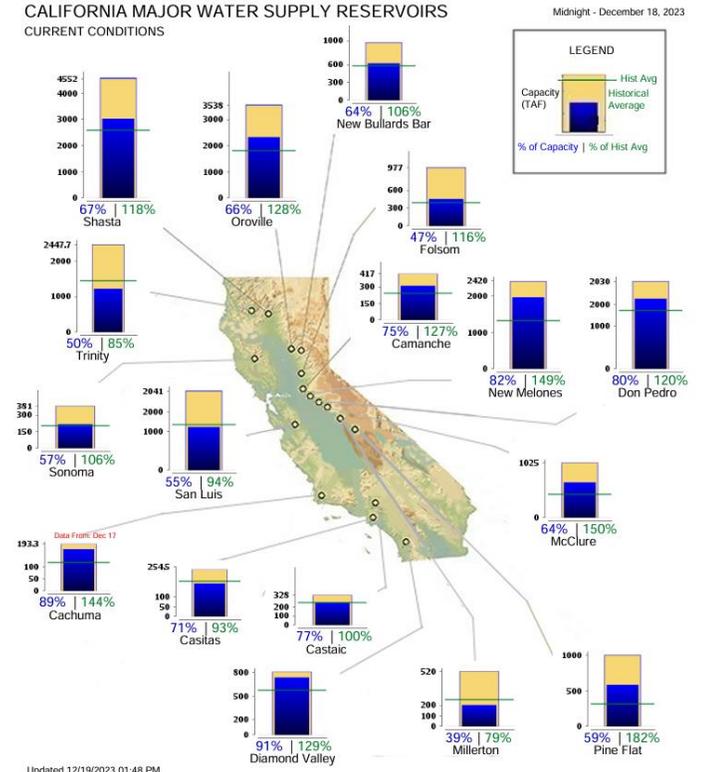
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:
Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

Reservoir Storage

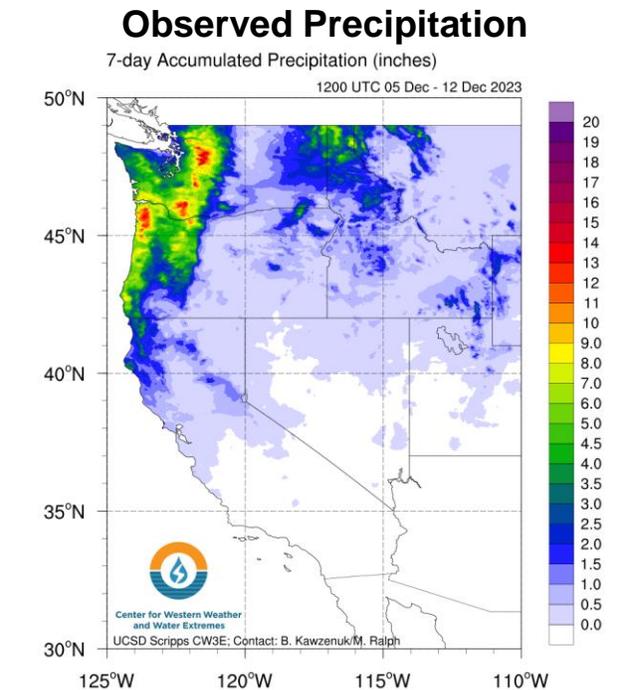
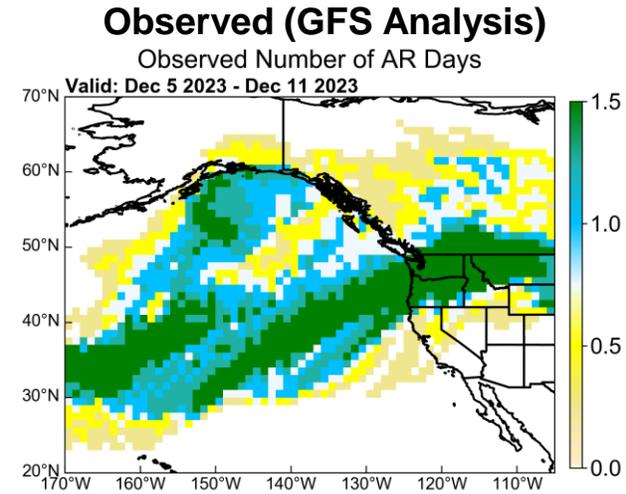
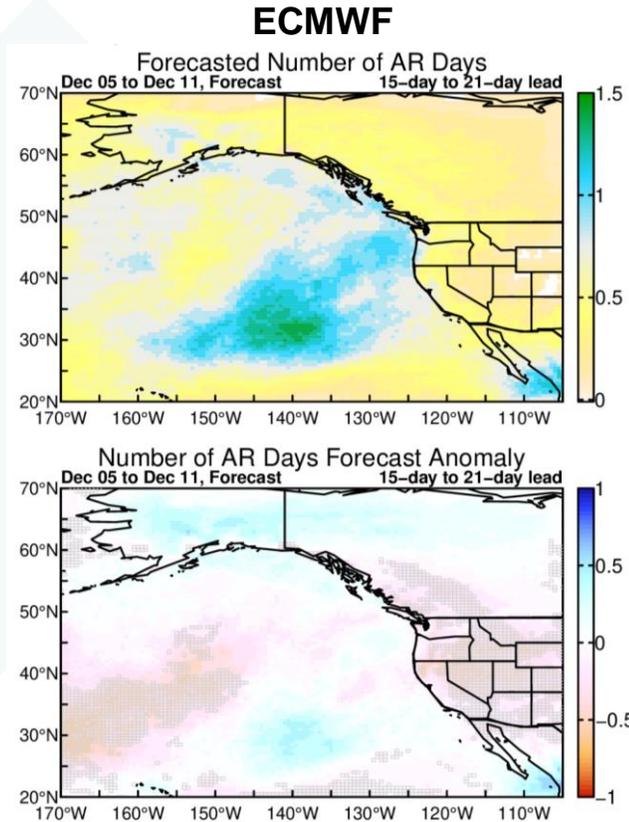
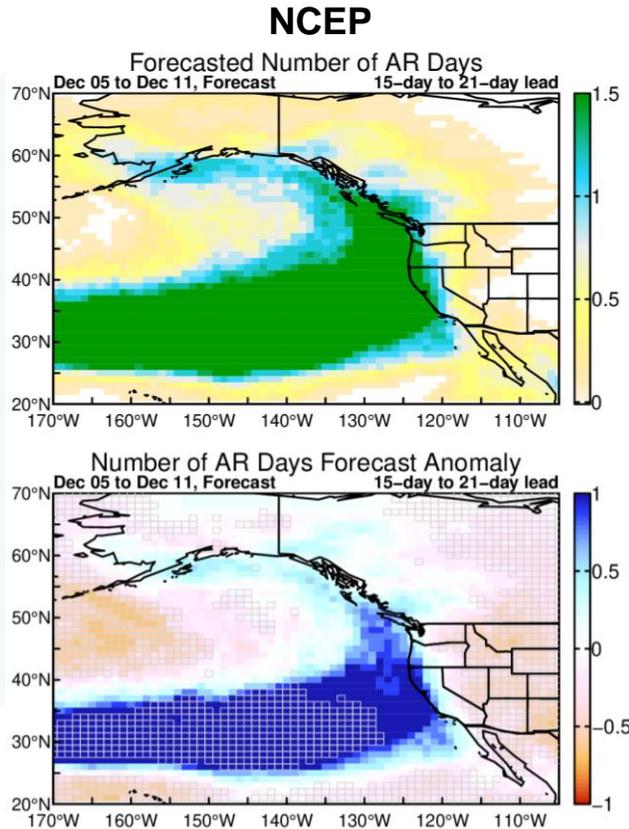


Source: California DWR

- As of 18 Dec, water-year-to-date precipitation is running well-below normal (< 50% of normal) in much of CA and AZ
- Nearly all of CA remains drought-free, but portions of the interior Southwest were experiencing severe, extreme, or exceptional drought conditions
- Most large reservoirs in CA are still operating at greater than 50% storage capacity and higher-than-normal storage for this time of year

Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 20 Nov 2023; Valid: 5–11 Dec 2023



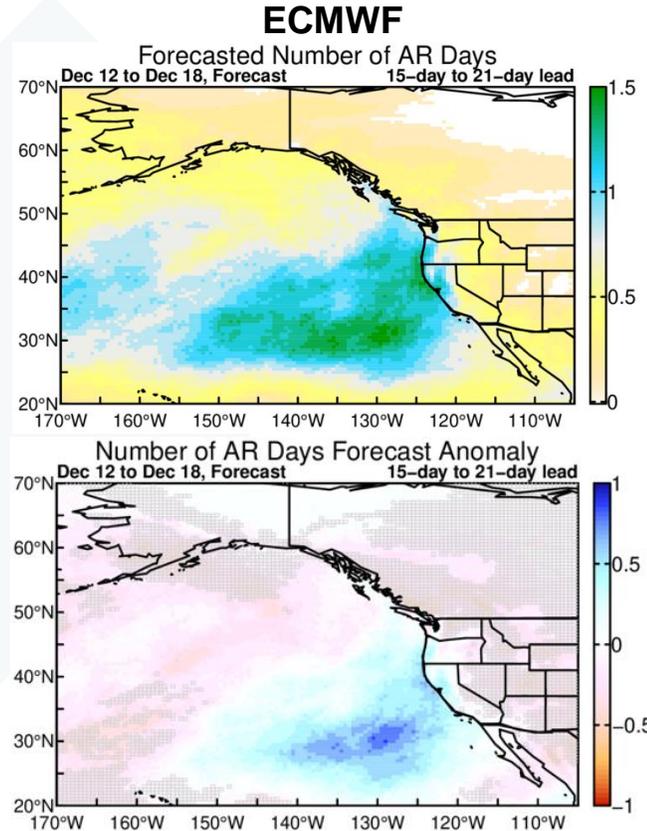
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

- NCEP captured AR activity along the coast of OR and WA, but overestimated AR activity over CA, and failed to capture the inland penetration of AR activity over the northwestern US
- ECMWF significantly underestimated AR activity over the northwestern US
- A strong AR produced heavy precipitation in western WA and OR during 5–6 Dec
- Another AR produced moderate precipitation in western WA and OR during 9–10 Dec

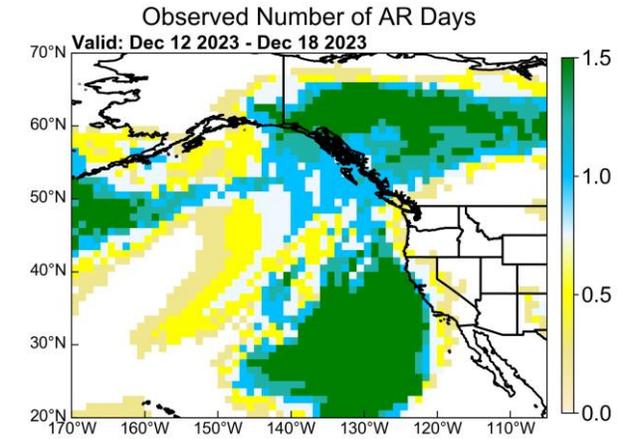
Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 27 Nov 2023; Valid: 12 – 18 Dec 2023

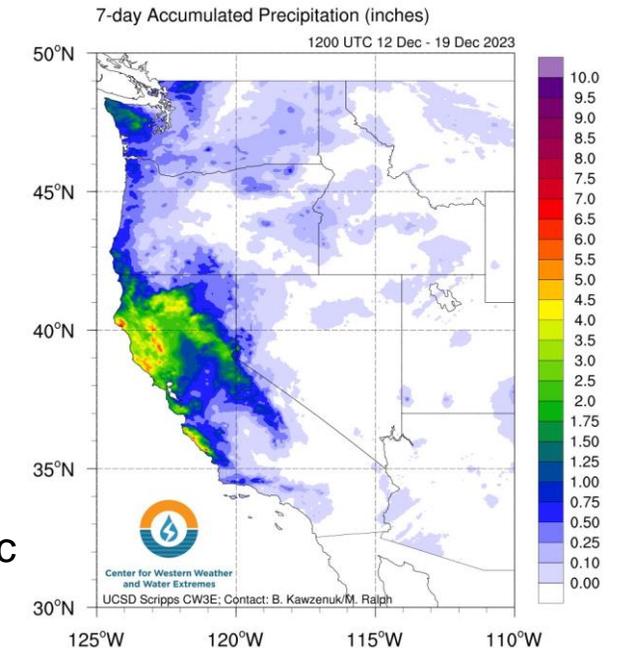
NCEP unavailable



Observed (GFS Analysis)



Observed Precipitation

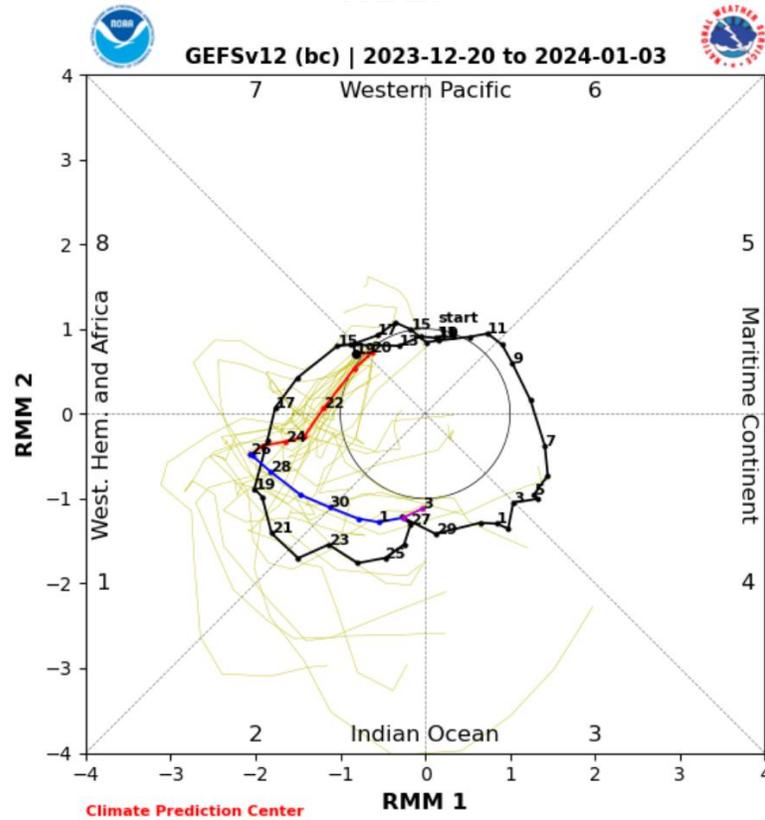


Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

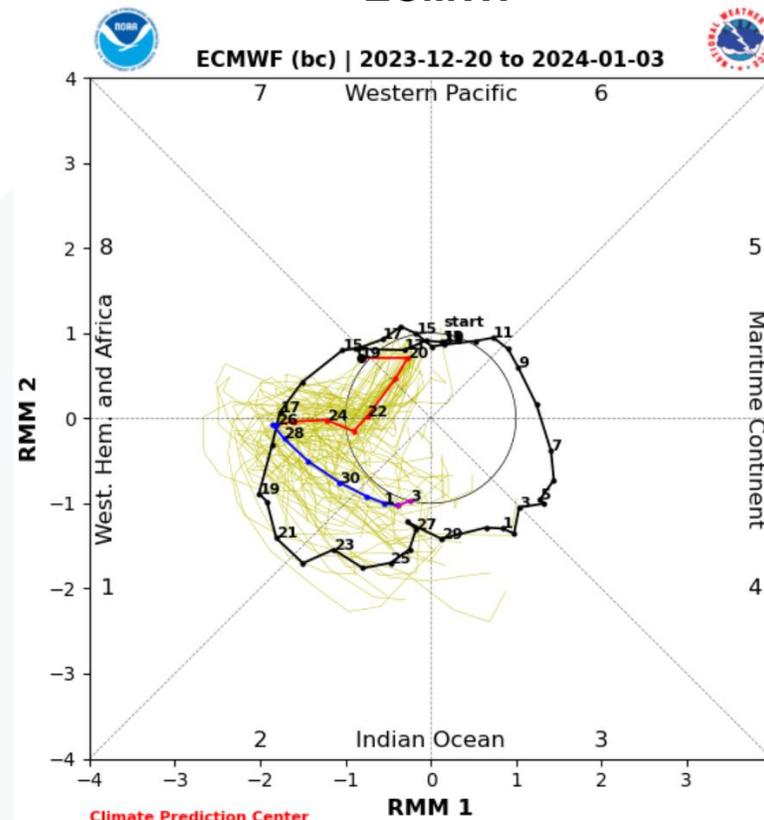
- ECMWF overall captures the AR activity near coastal CA with an overestimate of AR days in Northern CA and coastal WA/OR
- An AR produced light precipitation in western WA during 14–15 Dec
- A strong AR brought moderate to heavy precipitation in Central and Northern CA during 18-19 Dec

Dynamical Model MJO Forecasts (NCEP vs. ECMWF)

NCEP



ECMWF



Black line: Last 40 days of observations; Yellow lines: Ensemble members
Forecast: (Red: Week 1, Blue: Week 2, Purple: > Week 2)

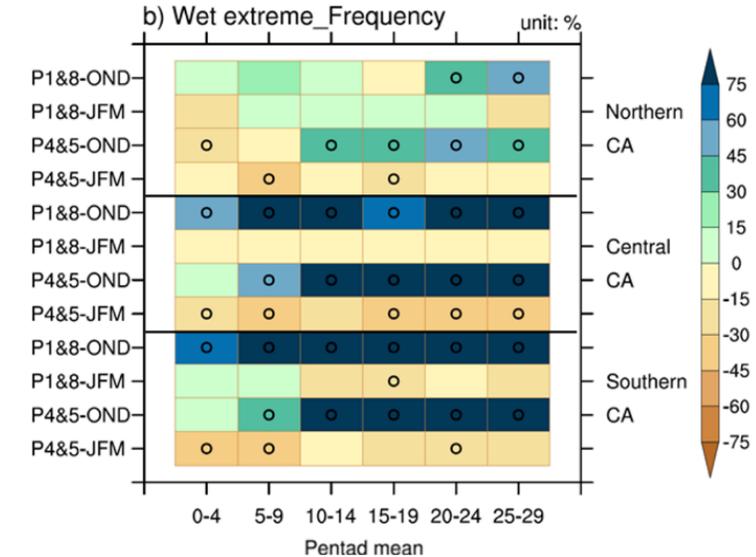
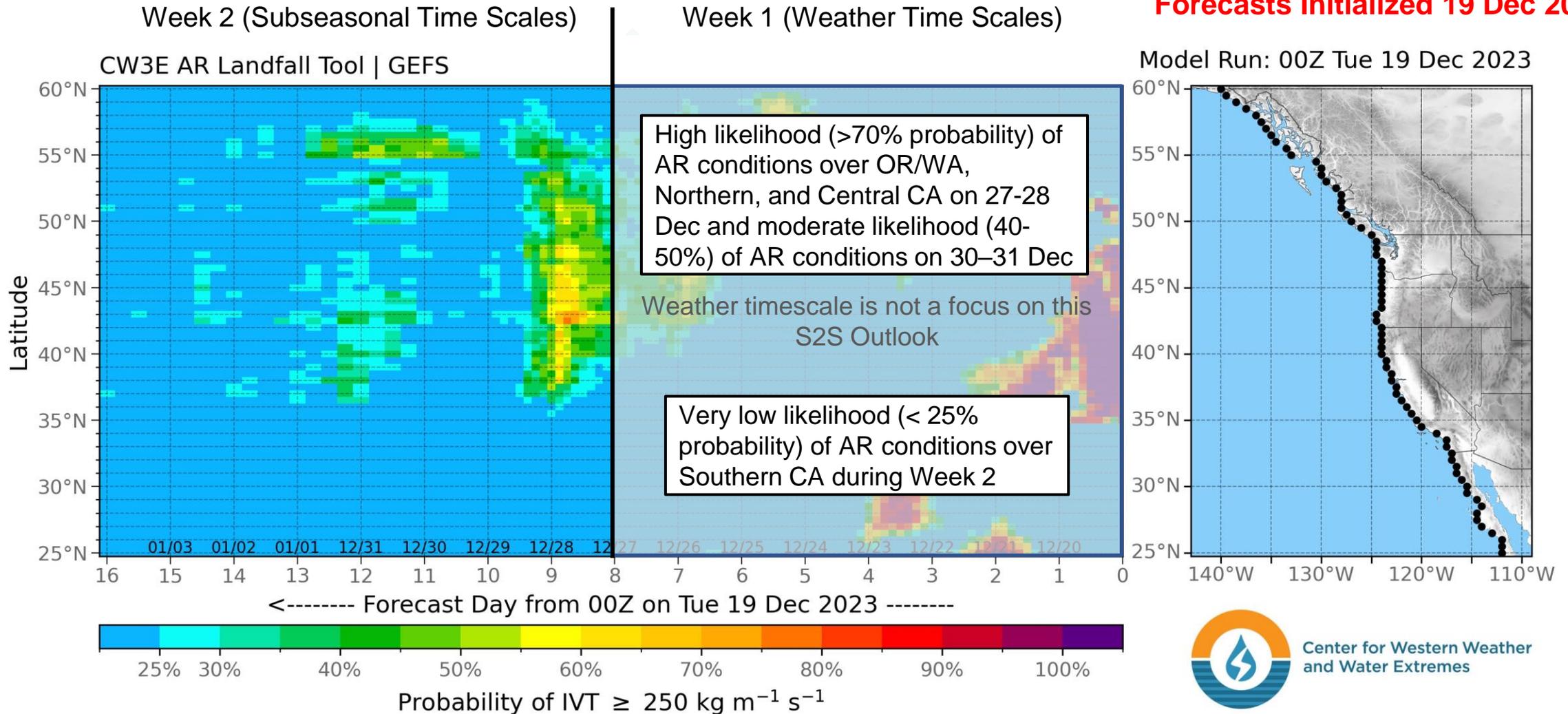


Figure S6 from Wang et al. (2023)

- Both models are suggesting a strengthening of MJO convection in the next two weeks located in the Central Pacific (Western Hemisphere), but the models disagree on the timing of the strengthening
- The relationship between MJO and wet extremes is weak in JFM. MJO activity over the Central Pacific in JFM is associated with an increased likelihood of wet extremes in Northern CA and decreased likelihood of wet extremes in Central and Southern CA at lag times of 2-4 weeks

NCEP GEFS AR Landfall Tool: Valid 00Z 19 Dec – 00Z 4 Jan

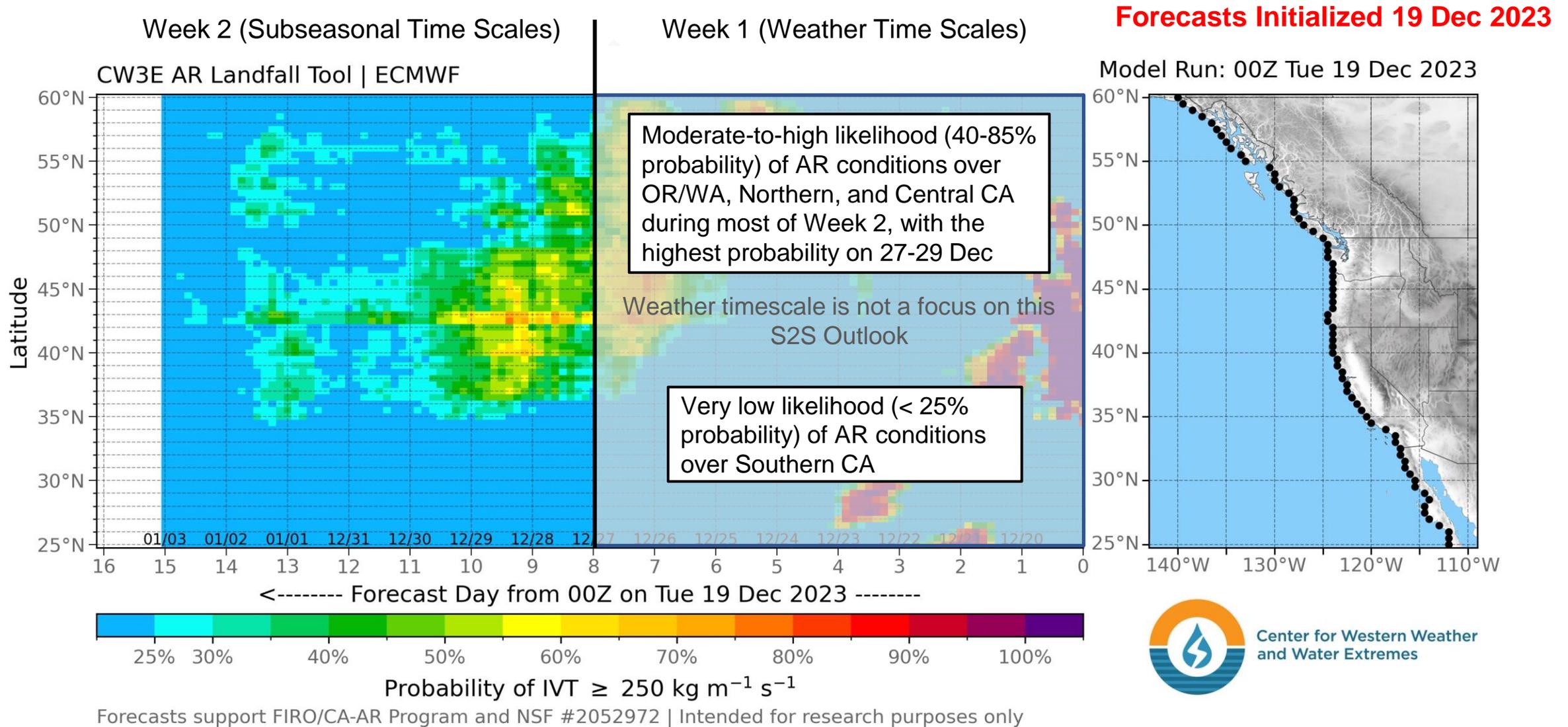
Forecasts Initialized 19 Dec 2023



Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

- NCEP is forecasting moderate-to-high likelihood of AR conditions over Northern and Central CA during Week 2, and low likelihood of AR conditions over Southern CA

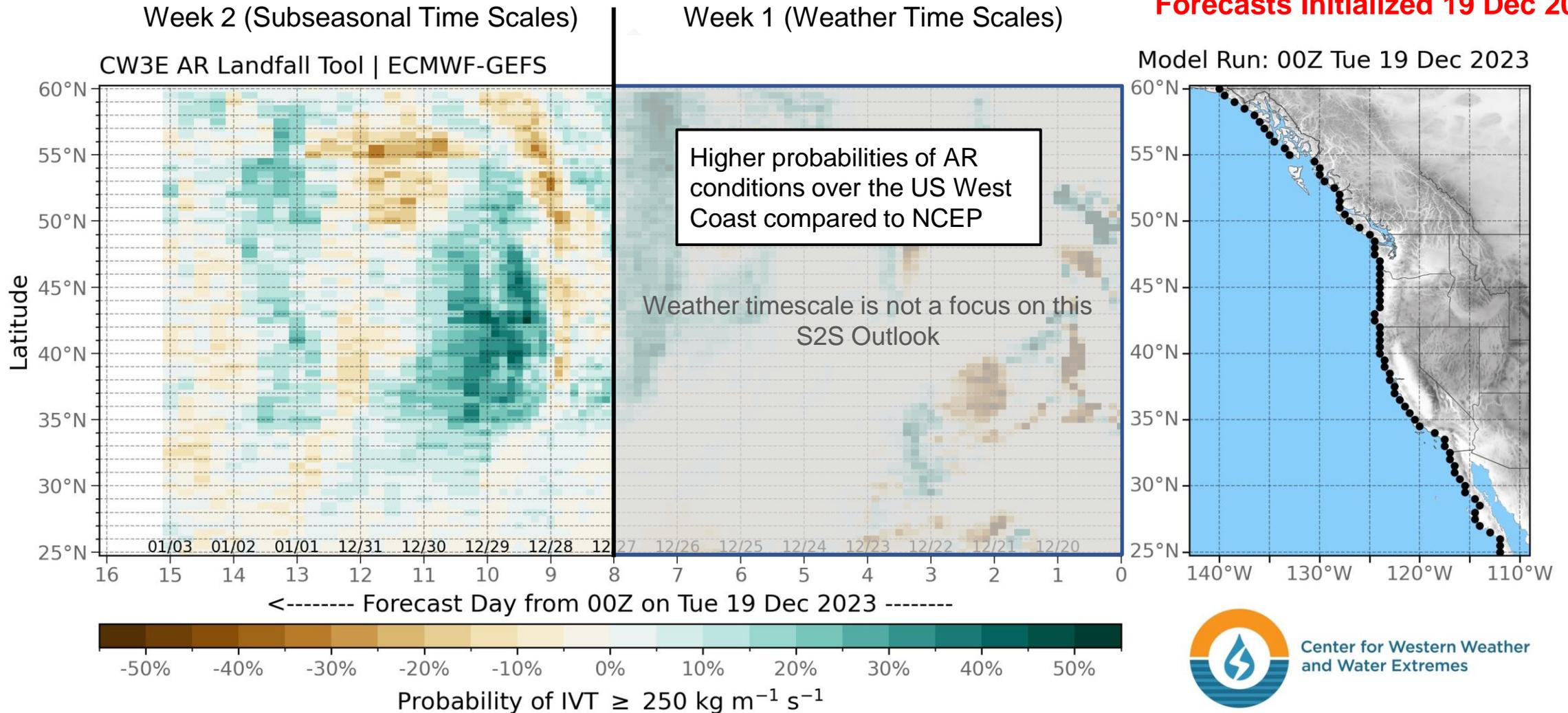
ECMWF EPS AR Landfall Tool: Valid 00Z 19 Dec – 00Z 3 Jan



- ECMWF is forecasting moderate-to-high likelihood of AR conditions over Northern and Central CA during Week 2, and low likelihood of AR conditions over Southern CA

ECMWF Minus NCEP AR Landfall Tool: Valid 00Z 19 Dec – 00Z 3 Jan

Forecasts Initialized 19 Dec 2023



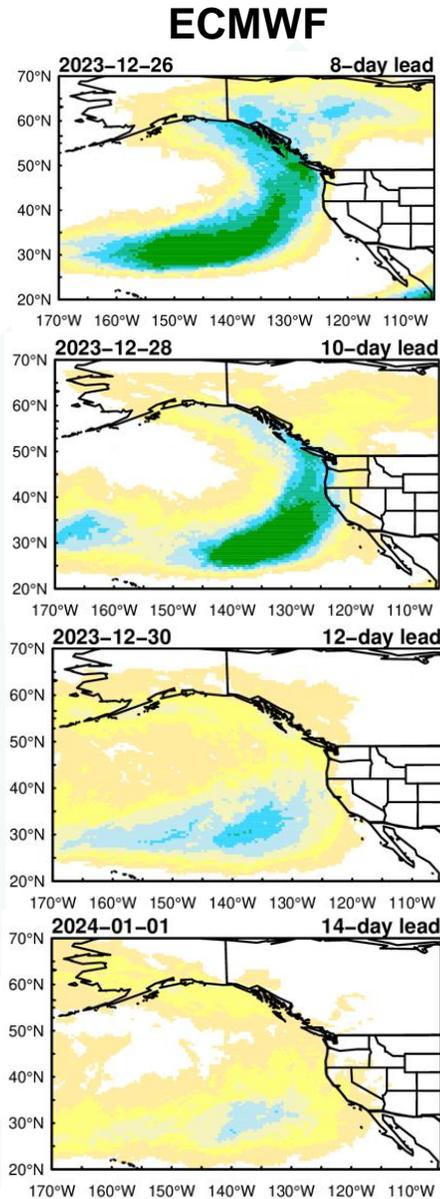
Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

- ECMWF is forecasting higher likelihood of AR conditions over the US West Coast during much of Week 2
- Models generally agree on high likelihood of AR conditions over Central and Northern CA and low likelihood of AR conditions over Southern CA

Subseasonal Outlooks: Week 2 AR Activity (ECMWF)

Forecasts Initialized 18 Dec 2023

NCEP
unavailable

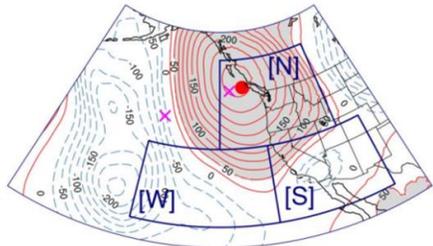


- ECMWF is showing low likelihood (< 30% probability) of AR activity over Central and Southern CA during Week 2 (26 Dec – 1 Jan), and moderate likelihood (50–60% probability) of AR activity over coastal Northern CA and OR/WA on 28 Dec

Low likelihood of AR activity over Central and Southern CA during Week 2 and higher likelihood of AR activity along coastal Northern CA

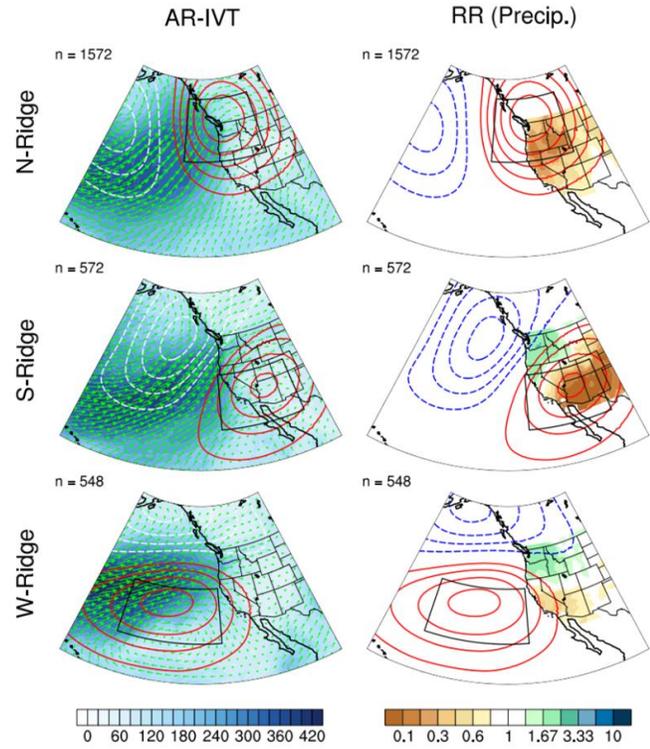
0% 20% 40% 60% 80%
Probability of AR occurrence

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



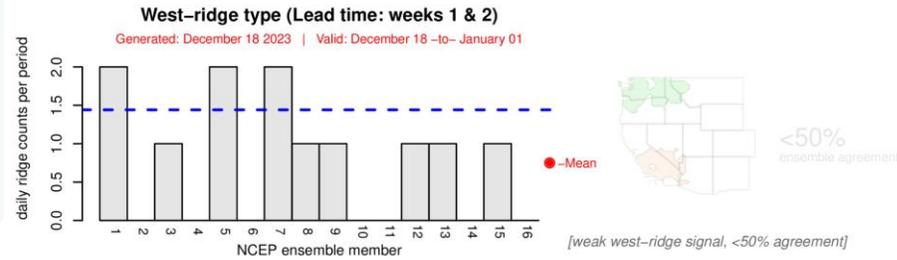
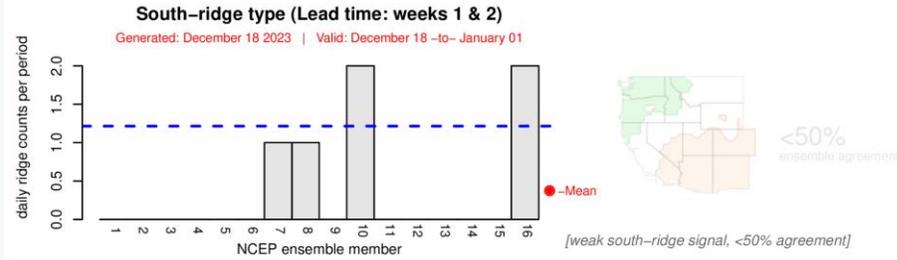
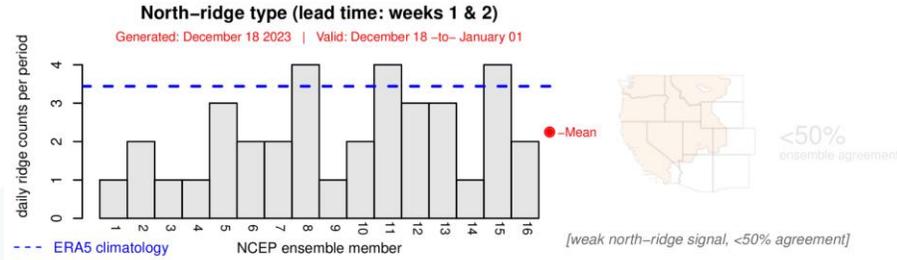
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 18 Dec 2023

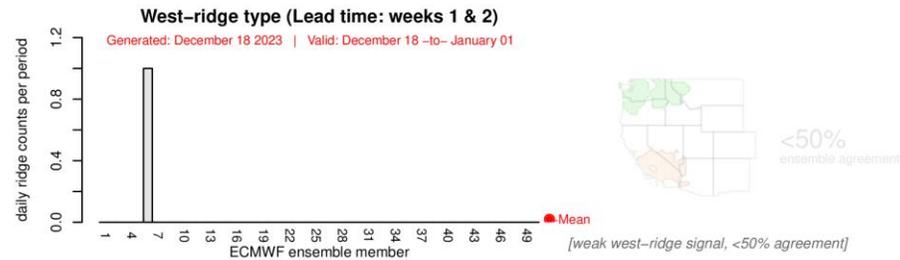
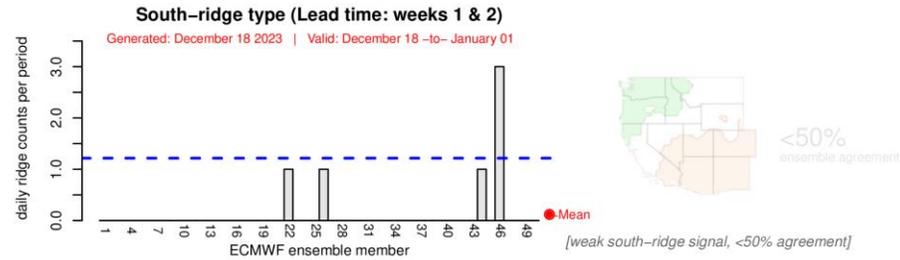
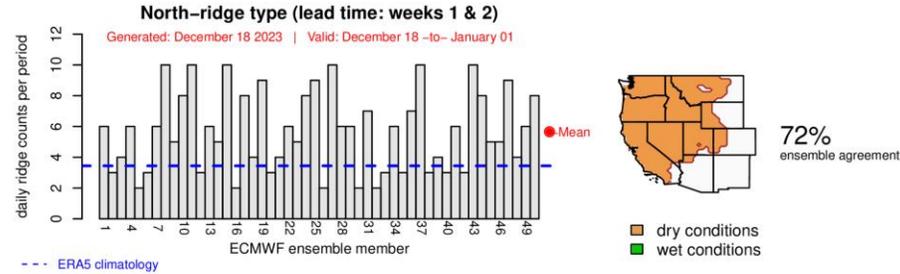
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



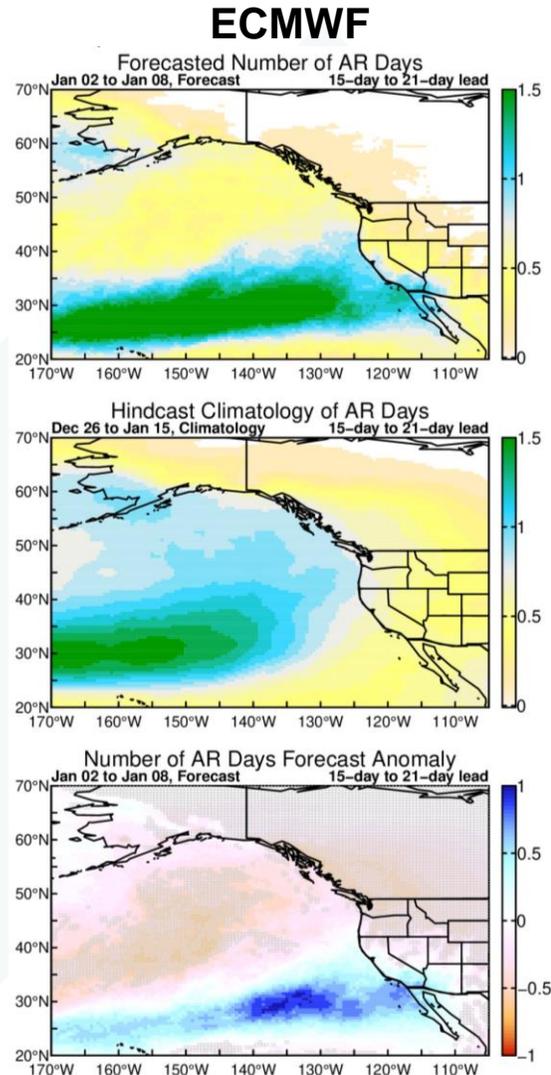
- ECMWF is predicting persistent North-ridge activity with high confidence (> 72% ensemble agreement) during Weeks 1–2 (18 Dec–1 Jan)
- NCEP is predicting low occurrence of the North-ridge activity
- Both models are also predicting low occurrence of the South-ridge and West-ridge types

Potential for above-normal North Ridge activity during Weeks 1-2

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

Forecasts Initialized 18 Dec 2023

NCEP
unavailable



- ECMWF is predicting significantly below-normal AR activity over WA/OR and Northern CA with high confidence (> 75% ensemble agreement) during Week 3 (2 – 8 Jan)
- ECMWF is also predicting near-normal AR activity over Central CA and slightly above-normal AR activity in Southern CA with low confidence

ECMWF is predicting significantly below-normal AR activity in Northern CA, near-normal AR activity in Central CA, and slightly above-normal AR activity in Southern CA during Week 3

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

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

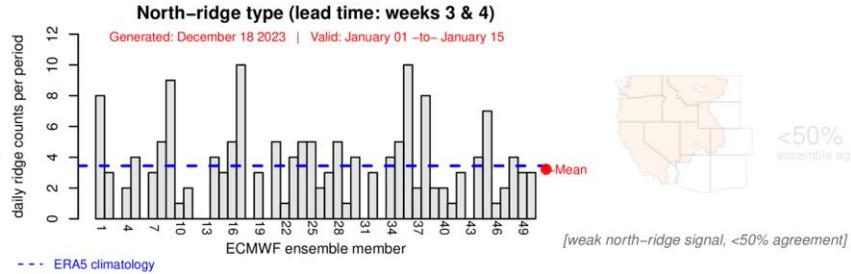
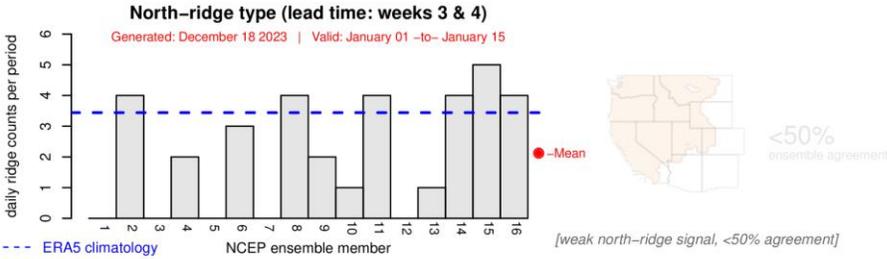
Forecasts Initialized 18 Dec 2023

NCEP

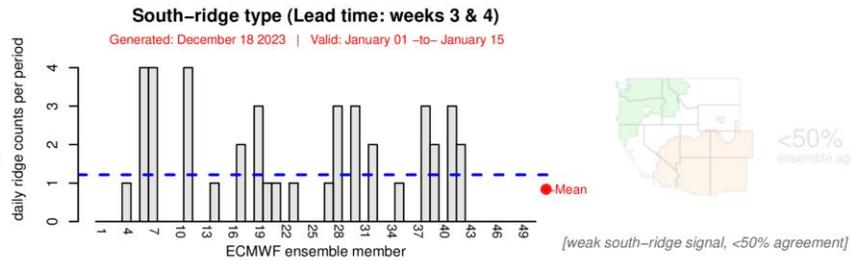
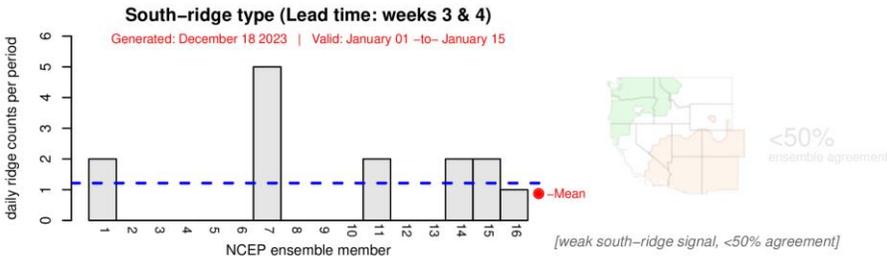
CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)

ECMWF

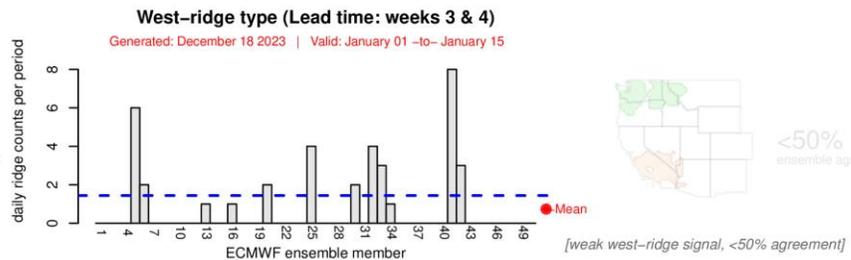
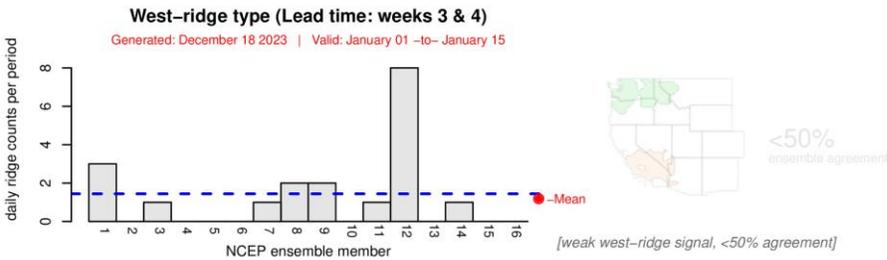
CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



- Both models are predicting near-normal occurrence of South-ridge and West-ridge activities during Weeks 3-4 (1-15 Jan)



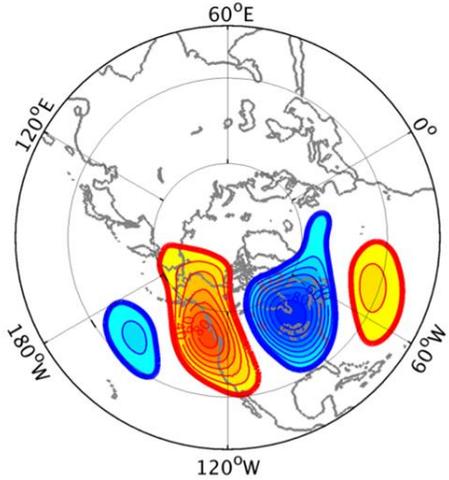
- ECMWF is also predicting near-normal occurrence of North-ridge activity



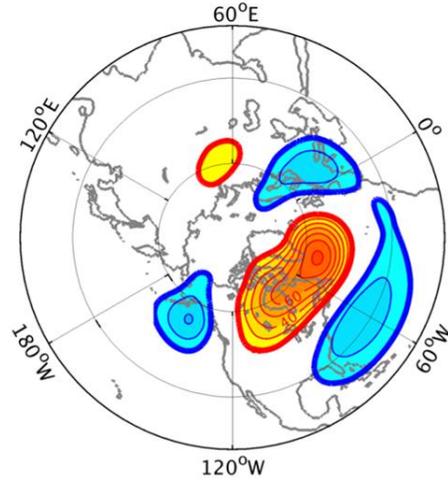
Uncertainty in frequency and location of ridging activity near the US West Coast during Weeks 3–4

Background Info: IRI Subseasonal Weather Regime Forecasts

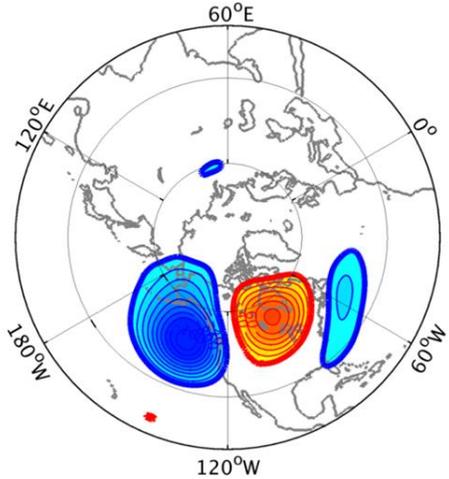
a) WR 1: West Coast Ridge



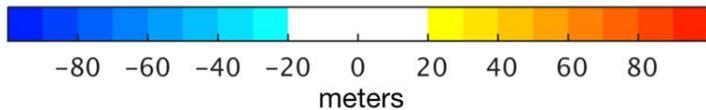
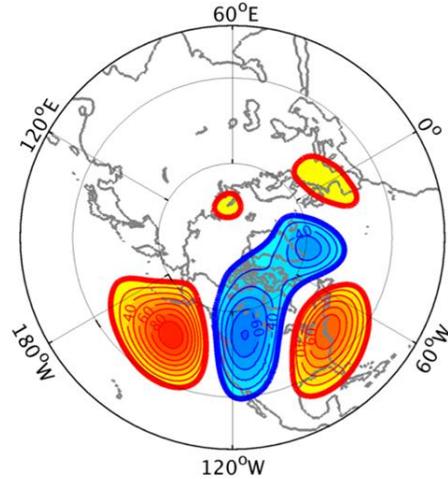
b) WR 2: Greenland High



c) WR 3: Pacific Trough



d) WR 4: Pacific Ridge



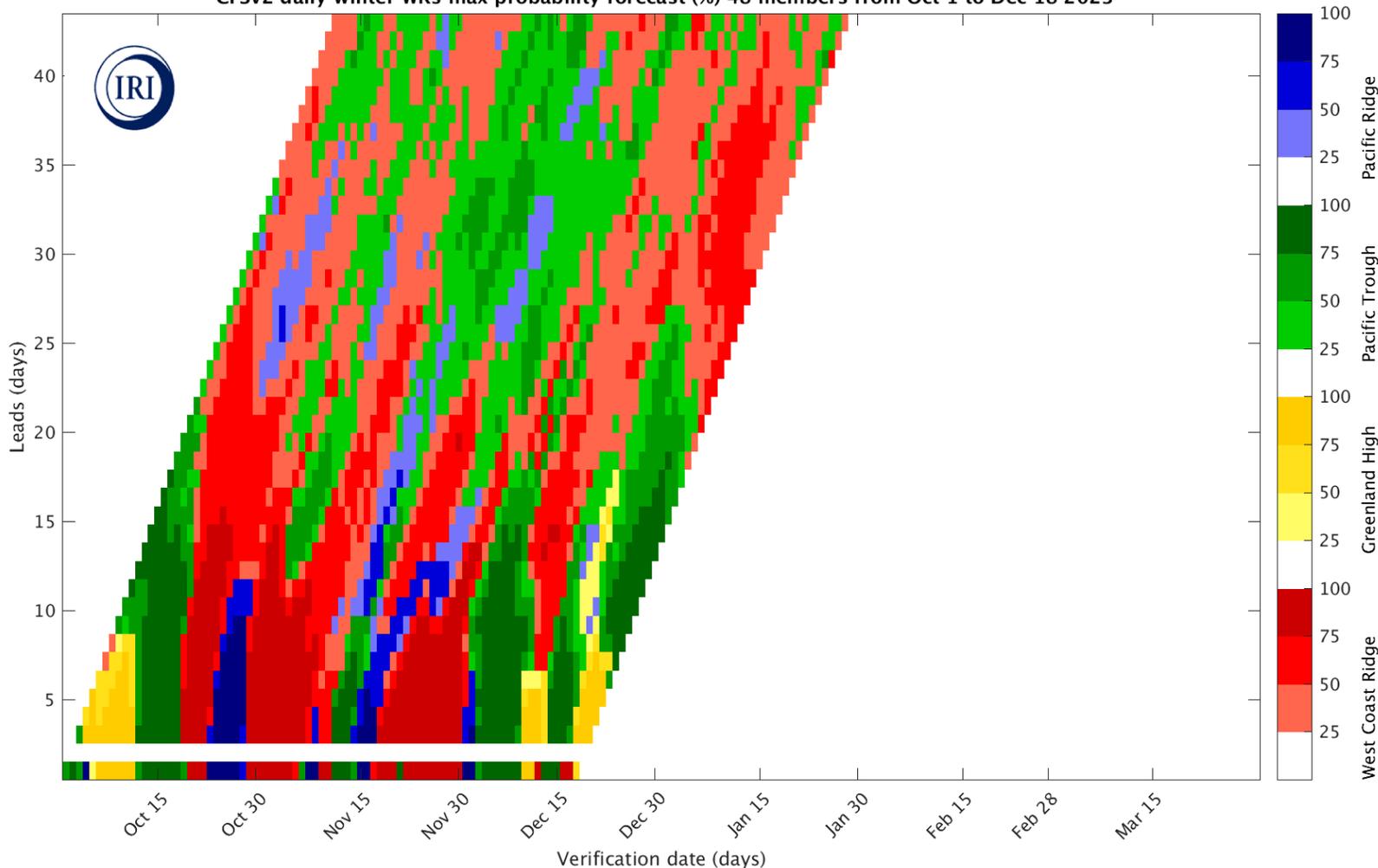
This slide contains background information about IRI's North American weather regime forecast product

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

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

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

CFSv2 daily winter WRs max probability forecast (%) 48 members from Oct 1 to Dec 18 2023



Forecast Initialized 18 Dec 2023

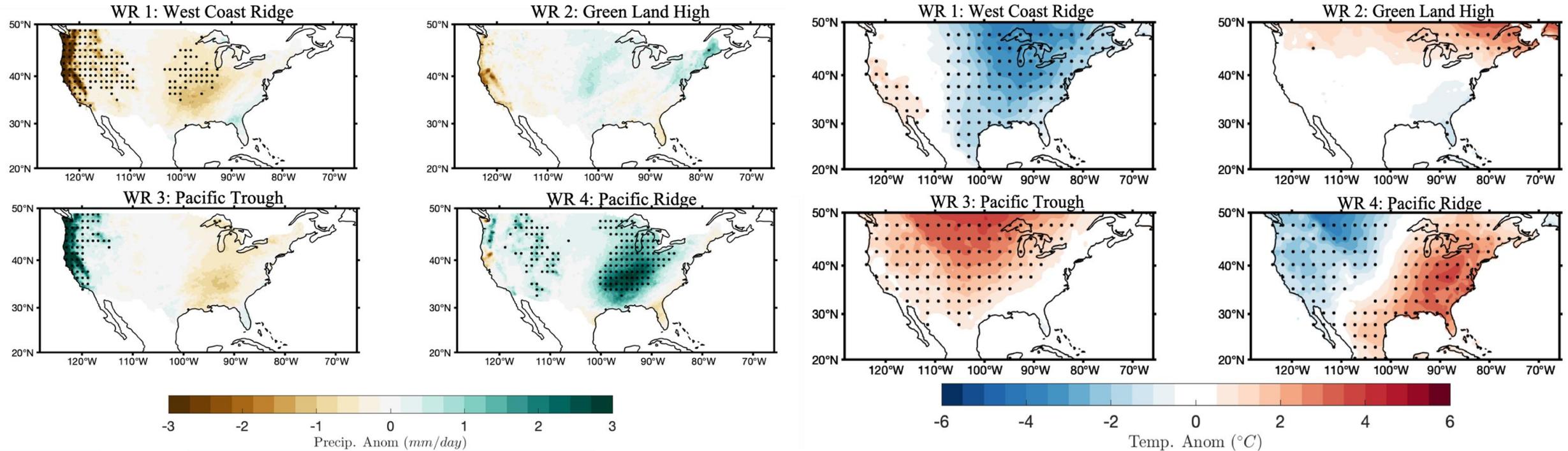
- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- High likelihood (> 75% ensemble agreement) of Pacific Trough during Week 2
- Possible transition from Pacific Trough to West Coast Ridge during Week 3
- Moderate likelihood (50–75% ensemble agreement) of West Coast Ridge during Week 4

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.

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation

Temperature



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

- Warm and wet conditions are predicted over CA during the last week of December with high confidence
- Warm and dry conditions are predicted over CA during early-to-mid January with moderate confidence