



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 9 January 2024

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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***

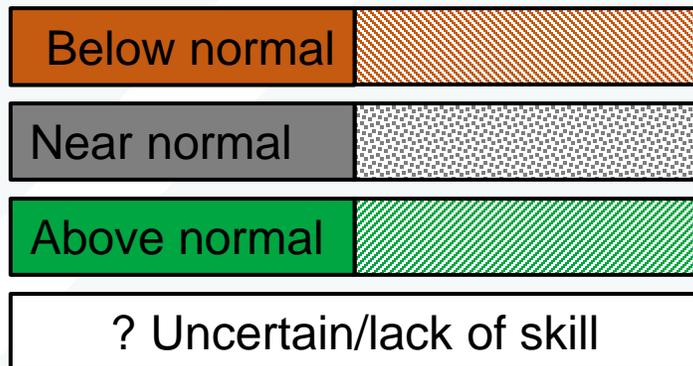
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 8 Jan 2024

Region	Week 2 (16-22 Jan)			Week 3 (23 – 29 Jan)			Week 4 (30 Jan– 5 Feb)		
	NCEP ^{1,2,3,4}	ECMWF ^{1,2,4}	Multi-Model Forecast	NCEP ^{1,2,3}	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{2,3}	ECMWF ²	Multi-Model Forecast
WA/OR	Higher Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence
Northern CA	Higher Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence
Central CA	Higher Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence
Southern CA	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence	Lower Confidence

Higher Confidence | Lower Confidence



- Large uncertainty in Week 2 forecasts due to lack of agreement between forecast products
- Dry conditions are predicted in CA during Week 3 by both models with high confidence
- Dry conditions are also predicted in CA during Week 4, but with low confidence

Subseasonal products included in this Outlook:

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

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

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

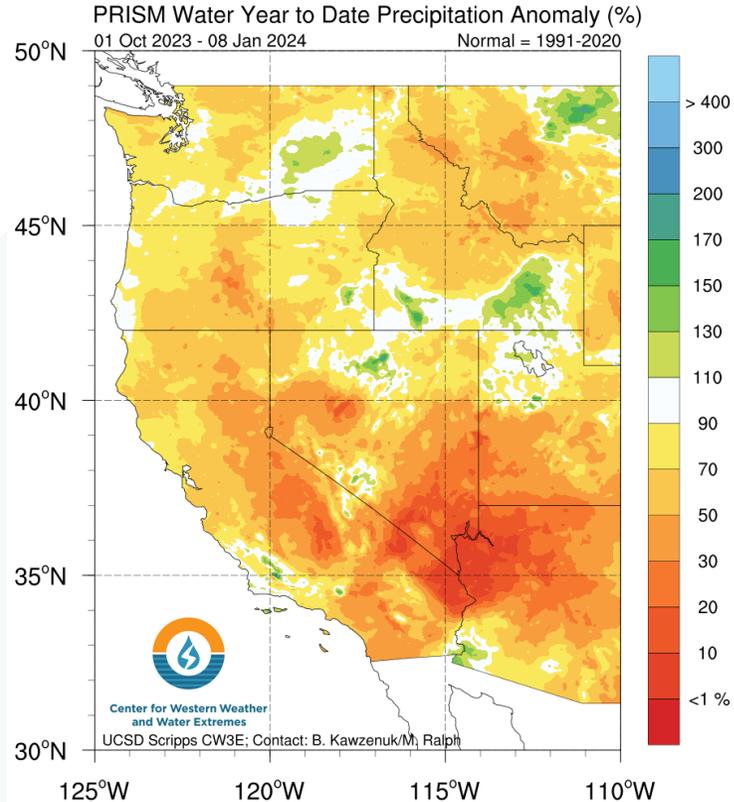
⁴CW3E Extended-Range AR Landfall Forecasts

Summary

- **Week 2 forecasts (16–22 Jan):** Models disagree on the likelihood of AR activity
 - ECMWF is showing low likelihood of AR activity over OR/WA and CA during Week 2
 - NCEP is showing high likelihood of AR activity over CA during 16-20 Jan, and high likelihood of AR activity over OR/WA on 20 Jan
- Models are predicting a strengthening in MJO activity during the next two weeks located over the Indian Ocean during Week 1 and over the Maritime Continent during Week 2 and after, which is historically associated with a significant decrease in the likelihood of wet extremes in CA at lag times of 1–4 weeks
- Models are predicting below-normal ridging activity near the US West Coast during Weeks 1–2
- **Week 3 forecasts (23–29 Jan):** Models generally agree on significantly below-normal AR activity over CA with high confidence during Week 3
- High likelihood of persistent North Ridge activity during Weeks 3–4, which is historically associated with dry conditions over CA
 - IRI weather regime forecasts show low-to-moderate likelihood of West Coast Ridge during Weeks 3–4 which is typically associated with dry conditions in CA

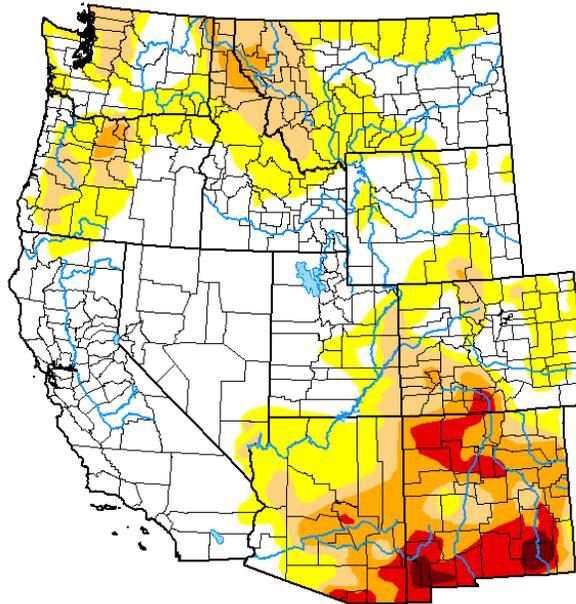
Hydrologic Summary

Precipitation



Drought Conditions

U.S. Drought Monitor West



January 2, 2024

(Released Thursday, Jan. 4, 2024)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	51.19	48.81	25.08	13.17	4.67	0.66
Last Week 12-26-2023	52.79	47.21	24.17	13.46	4.95	0.66
3 Months Ago 10-03-2023	55.48	44.52	31.63	18.19	5.36	0.70
Start of Calendar Year 01-01-2024	51.19	48.81	25.08	13.17	4.67	0.66
Start of Water Year 09-26-2023	55.99	44.01	31.24	17.70	6.09	0.70
One Year Ago 01-03-2023	12.08	87.92	62.42	38.84	12.41	0.27

Intensity:



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

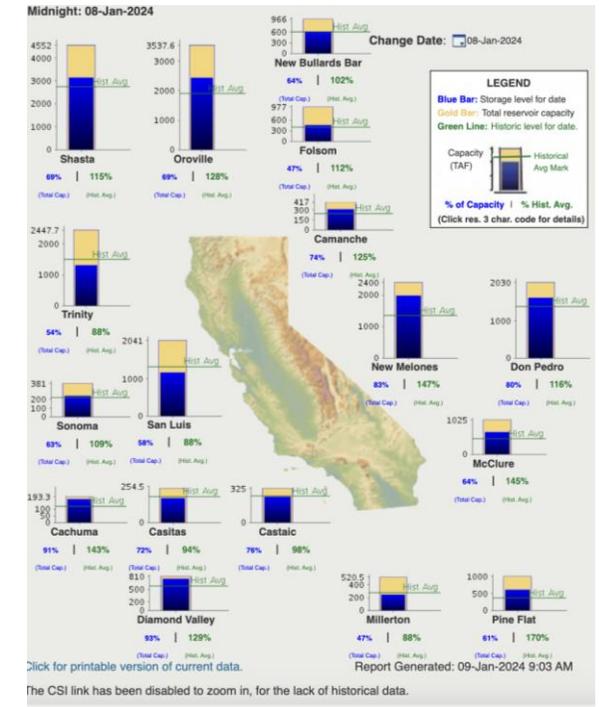
Author:

Lindsay Johnson
National Drought Mitigation Center



droughtmonitor.unl.edu

Reservoir Storage

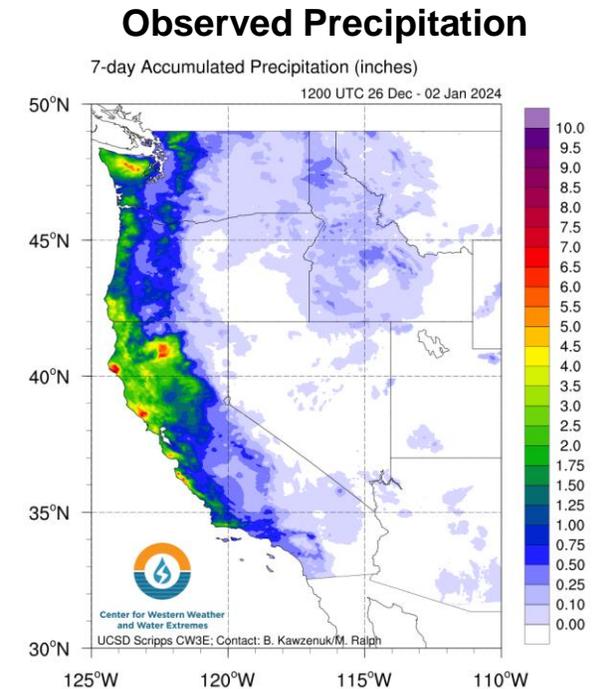
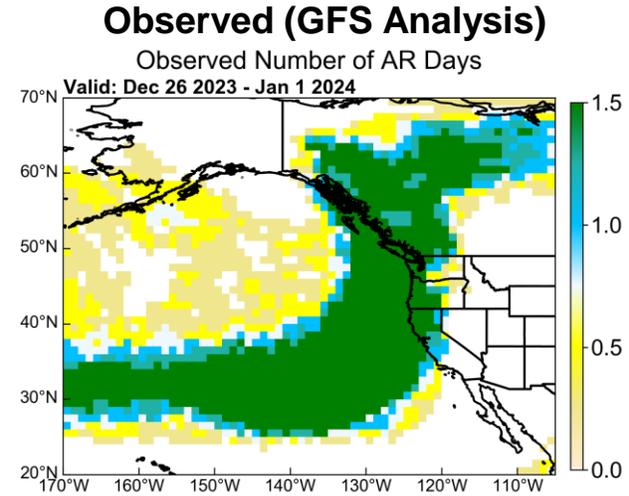
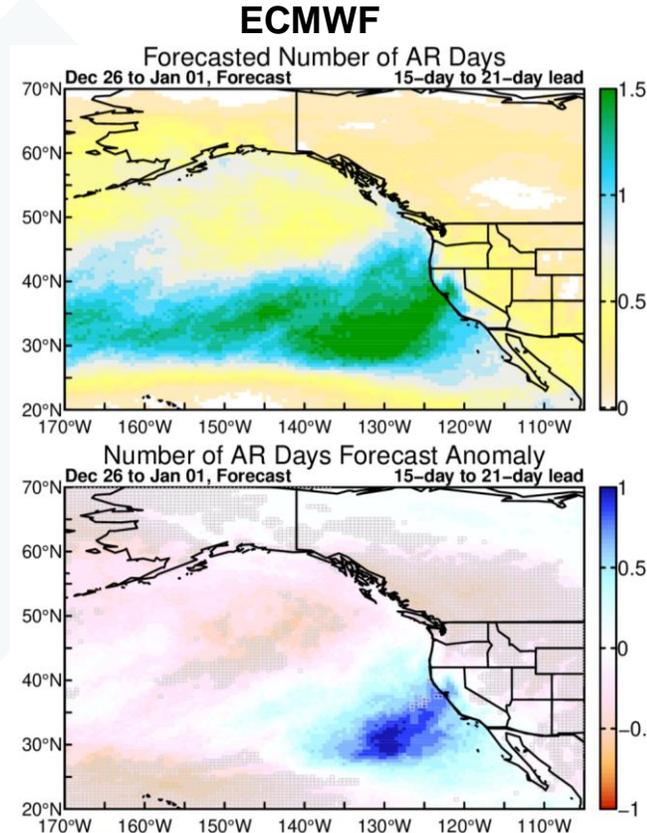
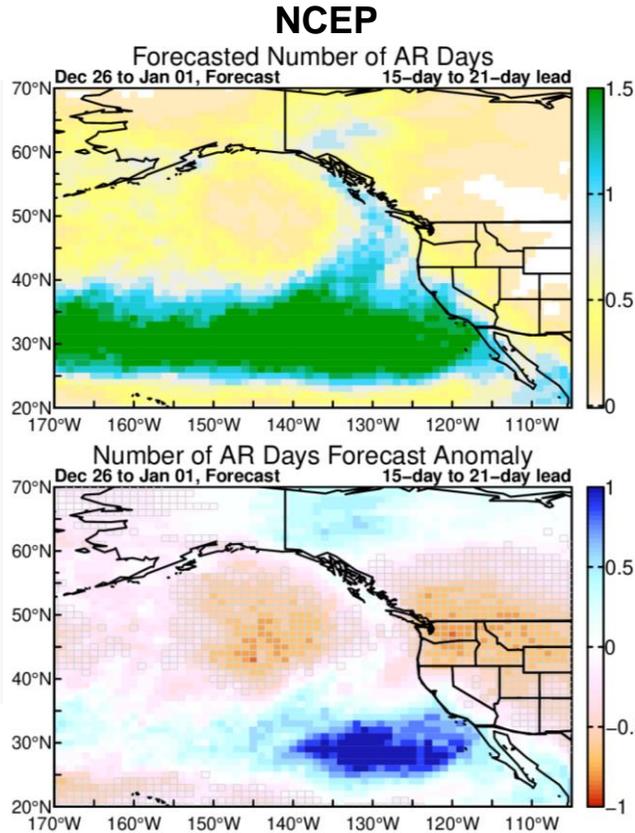


Source: California DWR

- As of 8 Jan 2024, water-year-to-date precipitation is running below normal in much of CA and AZ, especially Central to Southern CA and Northern AZ
- Nearly all of CA remains drought-free, but portions of the interior Southwest were experiencing severe, extreme, or exceptional drought conditions as of 2 Jan
- Most large reservoirs in CA are still operating at greater than 50% storage capacity

Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 11 Dec 2023; Valid: 26 Dec 2023 – 1 Jan 2024



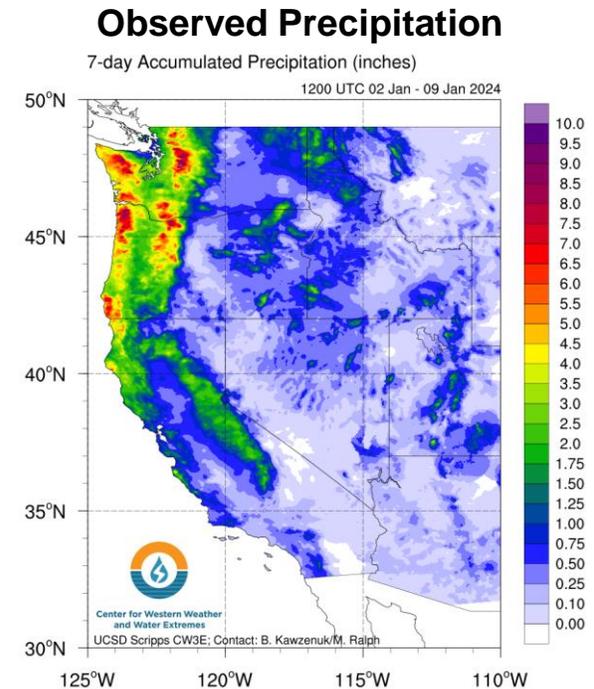
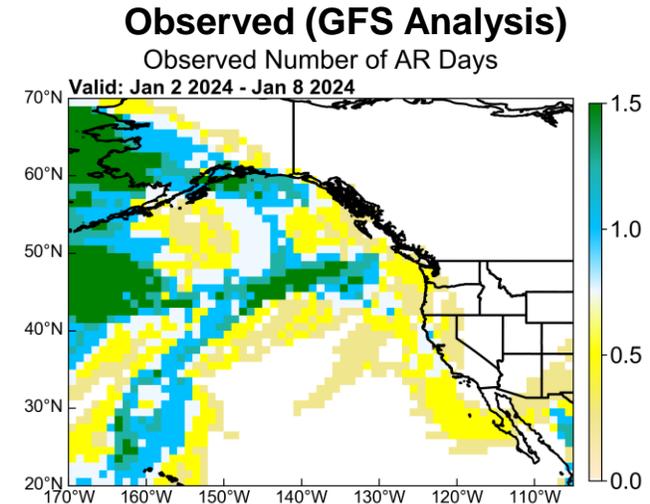
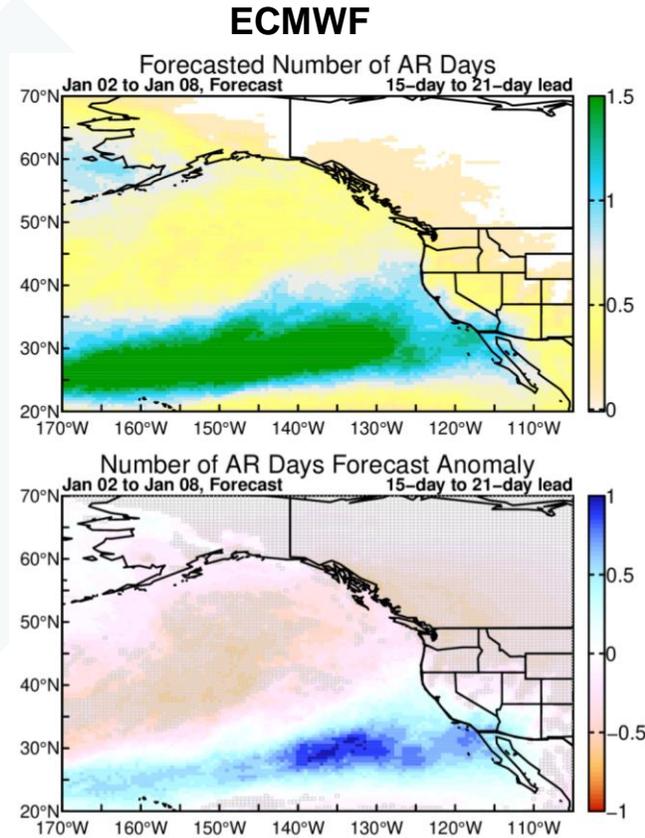
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

- ECMWF captured the region of high AR activity over Northern CA, but underestimated AR activity
- Both models failed to capture the AR activity over WA/OR, and overestimated AR activity over coastal Southern CA
- An AR produced light precipitation in WA/OR and Northern CA on 26-27 Dec
- Another AR produced light precipitation in Northern and Central CA during 28-29 Dec

Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 18 Dec 2023; Valid: 2 – 8 Jan 2024

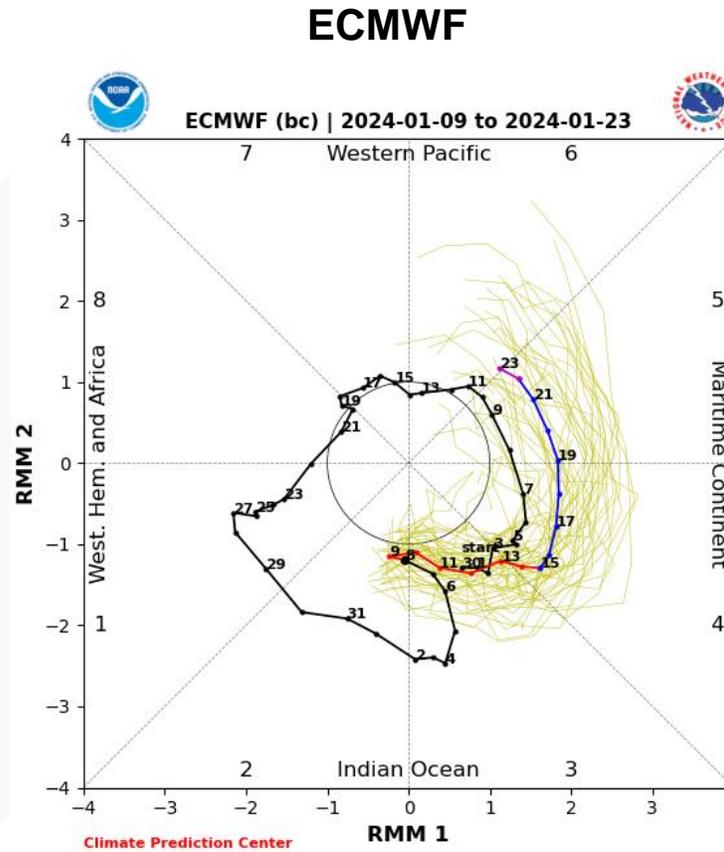
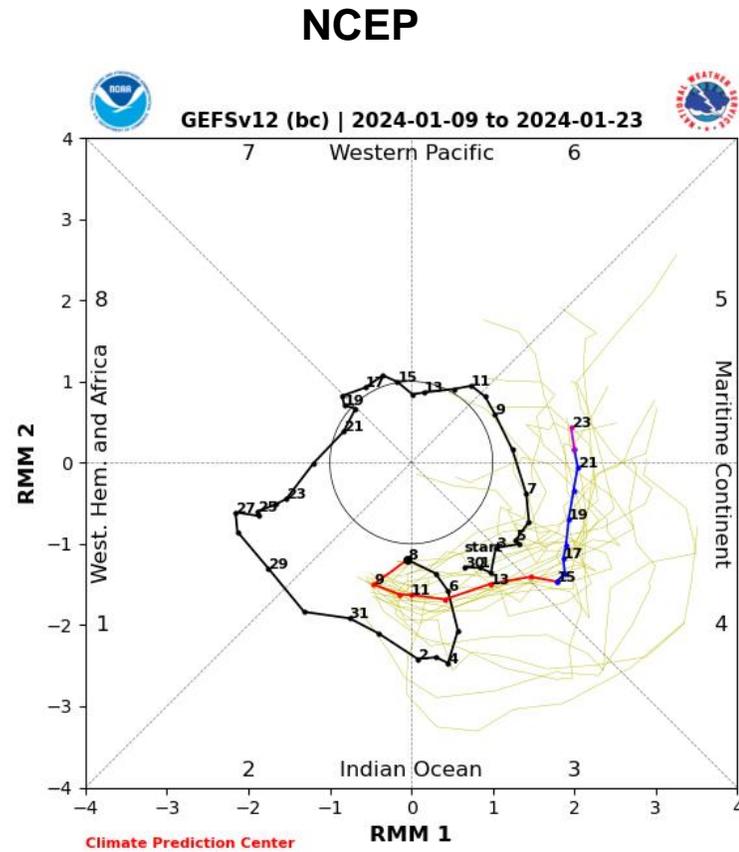
NCEP unavailable



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 CA
- ECMWF incorrectly forecasted the main region of AR activity to be over the subtropical Northeast Pacific, whereas observed AR activity extended from Hawaii northward into the Gulf of Alaska
- A weakening AR and associated low-pressure system produced light precipitation in CA during 2–3 Jan
- Another weak AR brought moderate precipitation to WA/OR and snow to the Sierra Nevada during 5–6 Jan

Dynamical Model MJO Forecasts (NCEP vs. ECMWF)



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

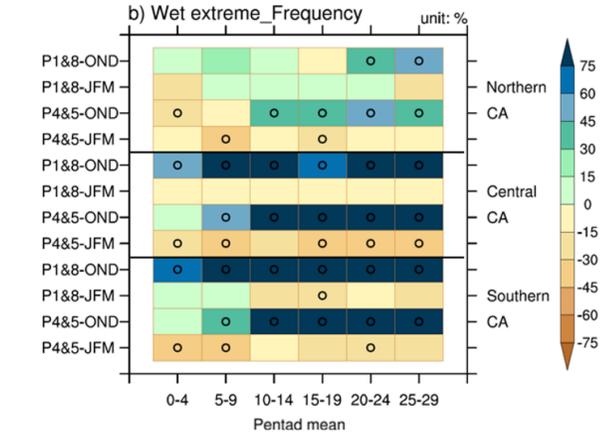


Figure S6 from Wang et al. (2023)

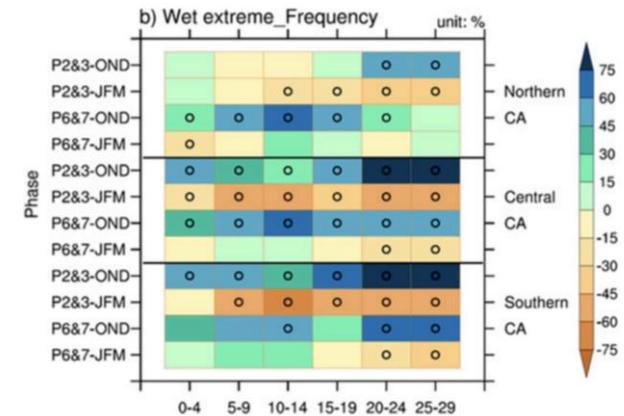
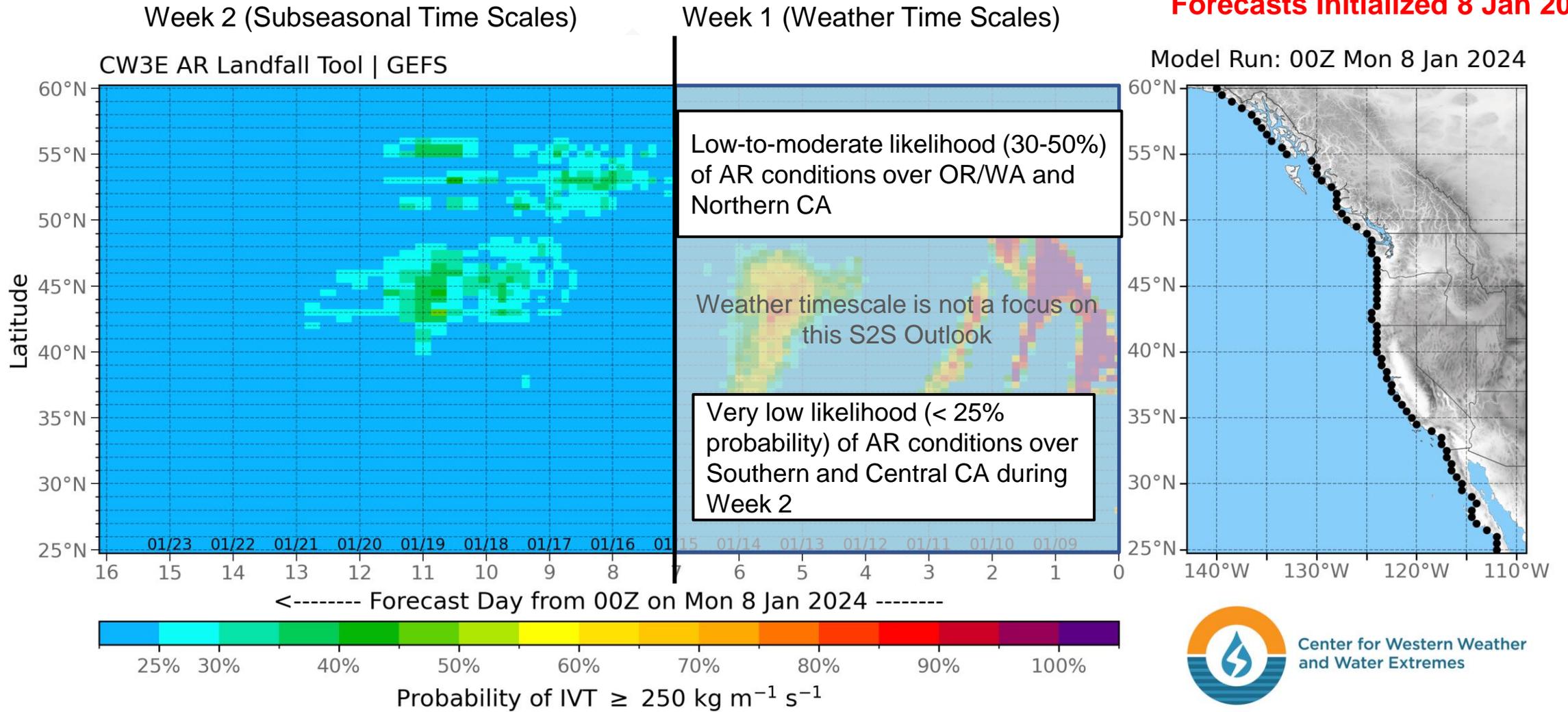


Figure 8 from Wang et al. (2023)

- NCEP and ECMWF are forecasting strong MJO convection in the next two weeks
- Both models are forecasting MJO convection over the Indian Ocean (Phases 2-3) during Week 1 and over the Maritime Continent (Phases 4-5) during Week 2
- MJO activity in the Indian Ocean during JFM is associated with a significant decrease in the likelihood of wet extremes in CA at lag times of 1–4 weeks

NCEP GEFS AR Landfall Tool: Valid 00Z 8 Jan – 00Z 24 Jan

Forecasts Initialized 8 Jan 2024

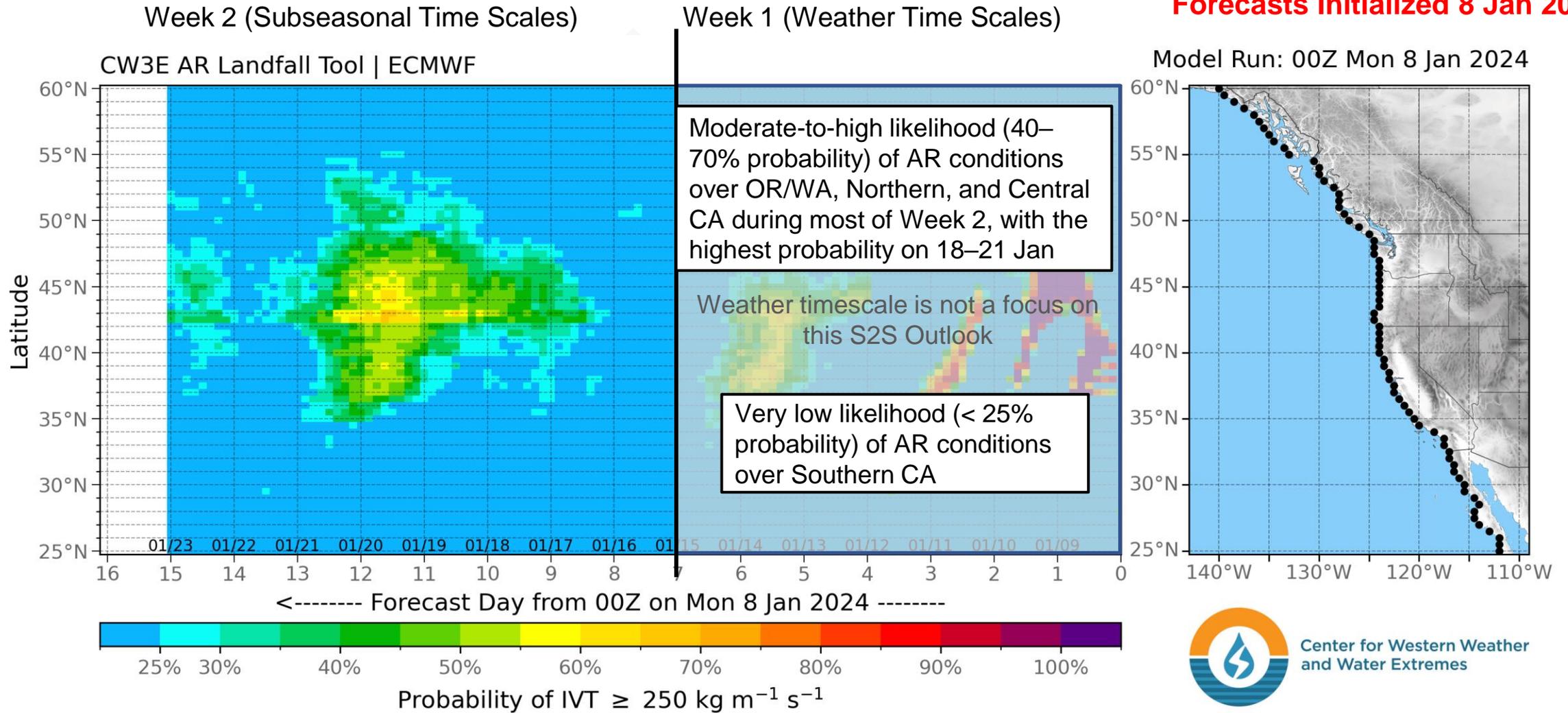


Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

- NCEP is forecasting low likelihood of AR conditions over CA during Week 2

ECMWF EPS AR Landfall Tool: Valid 00Z 8 Jan – 00Z 23 Jan

Forecasts Initialized 8 Jan 2024

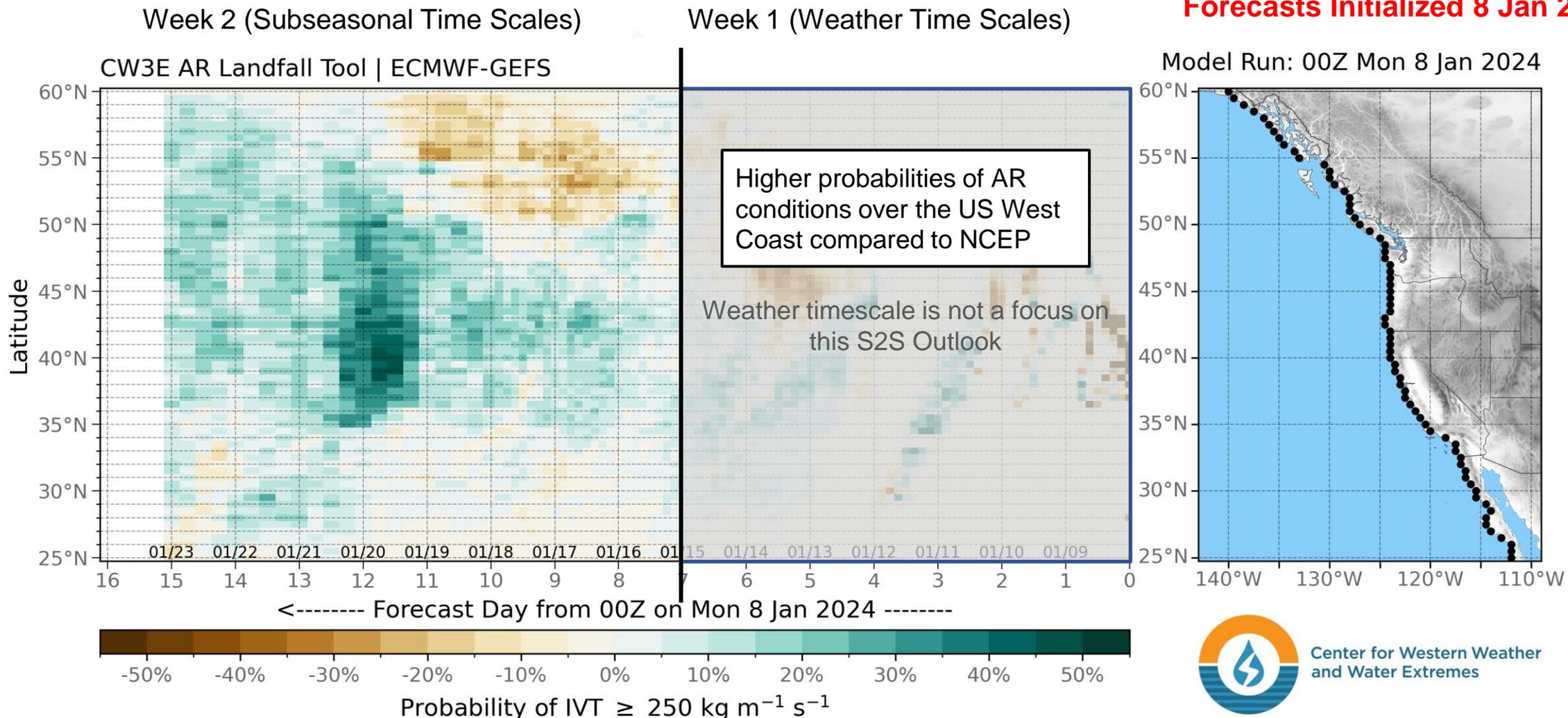


Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

- ECMWF is forecasting moderate 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 8 Jan – 00Z 23 Jan

Forecasts Initialized 8 Jan 2024



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

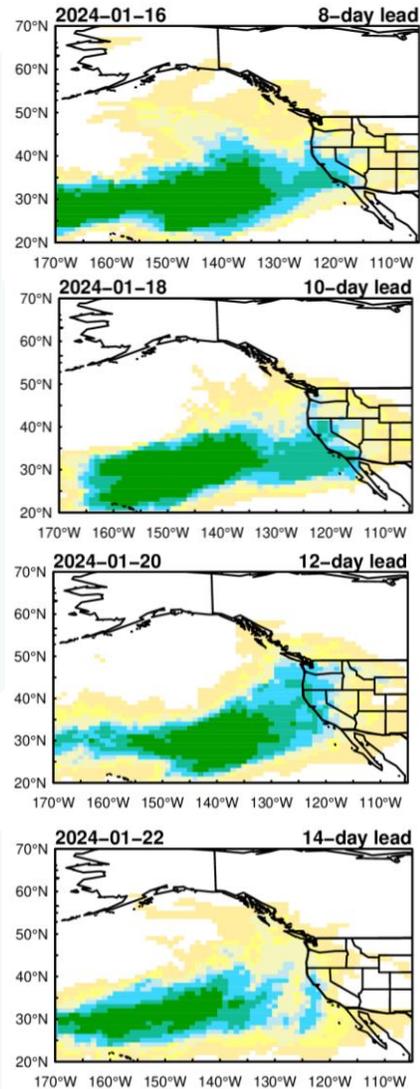


- ECMWF is forecasting higher likelihood of AR conditions over Northern CA during 19–20 Jan, with the peak occurrence situated more southward

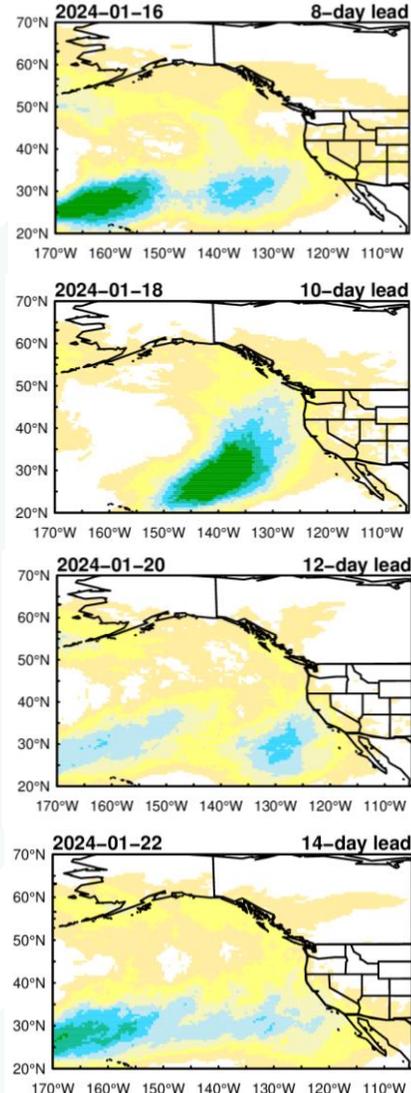
Subseasonal Outlooks: Week 2 AR Activity (NCEP vs. ECMWF)

Forecasts Initialized 8 Jan 2024

NCEP

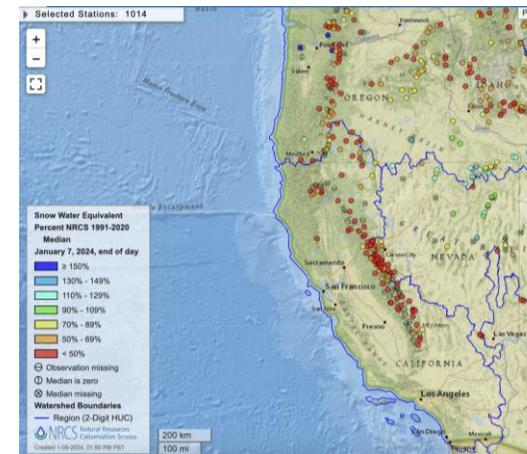


ECMWF



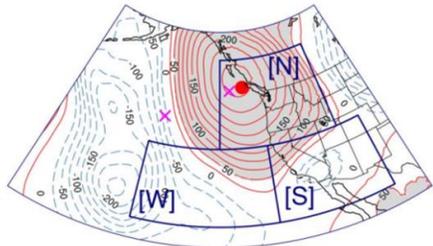
- ECMWF is showing low likelihood (< 30% probability) of AR activity over OR/WA and CA during Week 2 (16–22 Jan)
- NCEP is showing higher likelihood (60-70% probability) of AR activity over CA during 16-20 Jan and OR/WA on 20 Jan

Models generally agree on low likelihood of AR activity over OR/WA during early Week 2 but show some uncertainty over CA



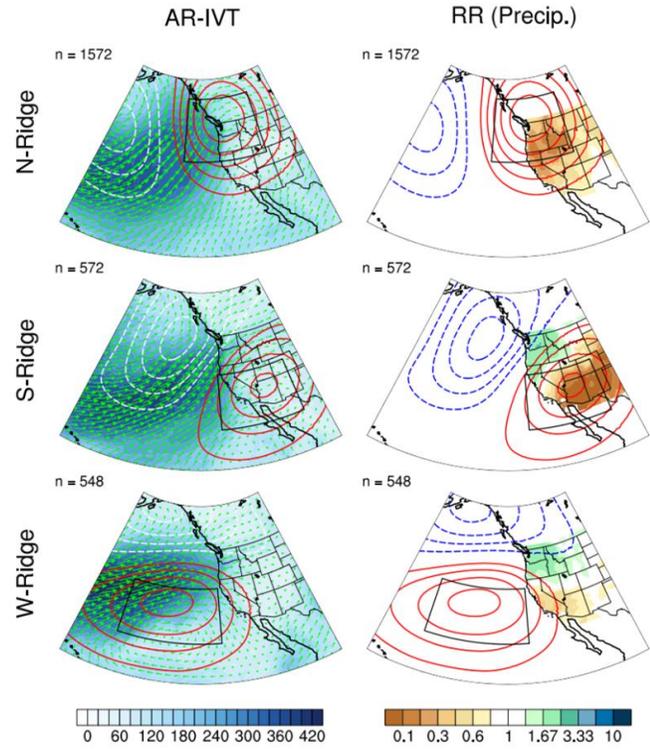
NCEP is showing a high likelihood of AR activity over CA, which has a probability to mitigate low snowpack situation but with large uncertainty

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



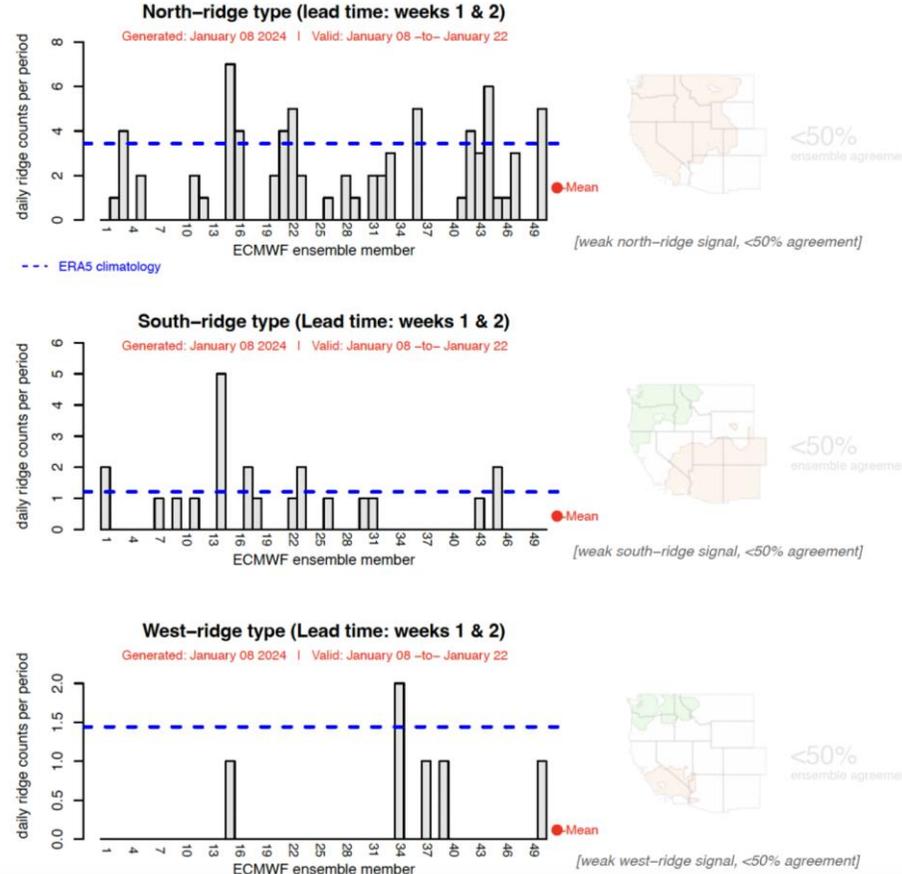
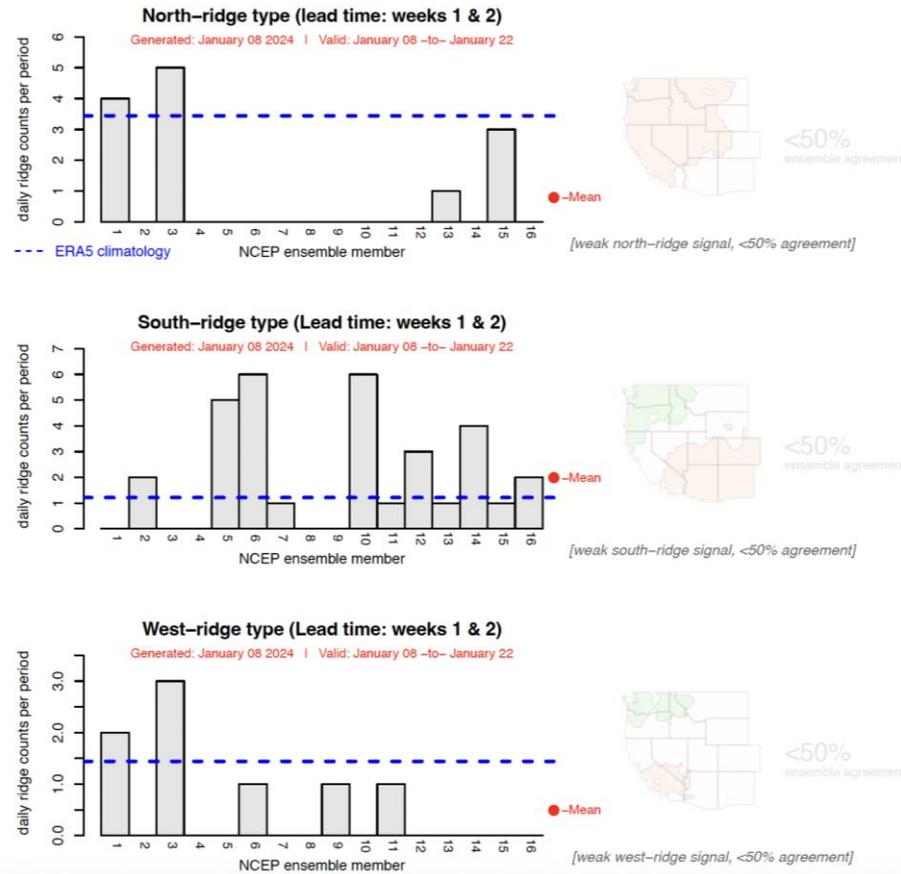
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 8 Jan 2024

NCEP

ECMWF



- ECMWF is predicting below-normal occurrence of the three ridge types during Weeks 1-2
- NCEP is predicting below-normal occurrence of the North- and West-ridge types, and slightly above-normal occurrence of the South-ridge type

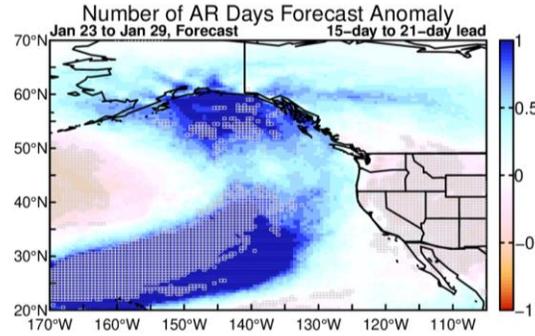
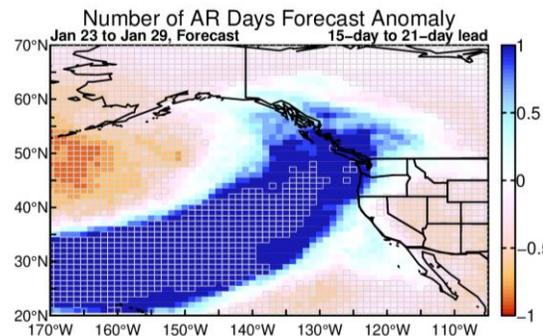
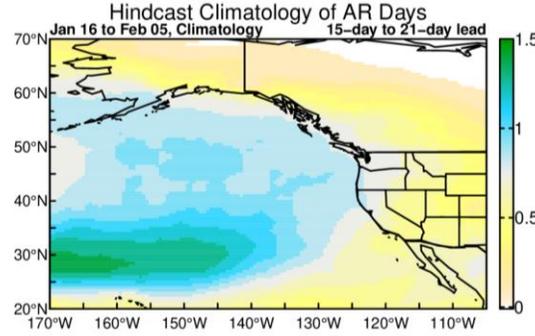
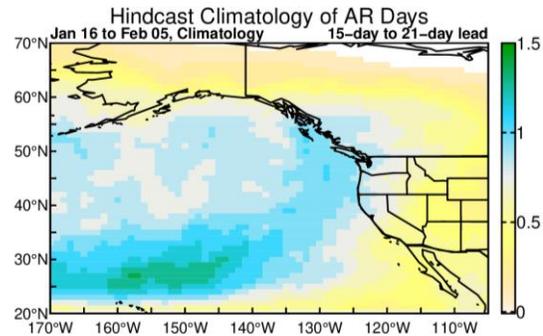
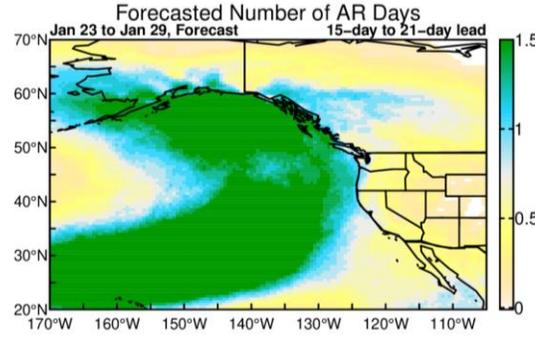
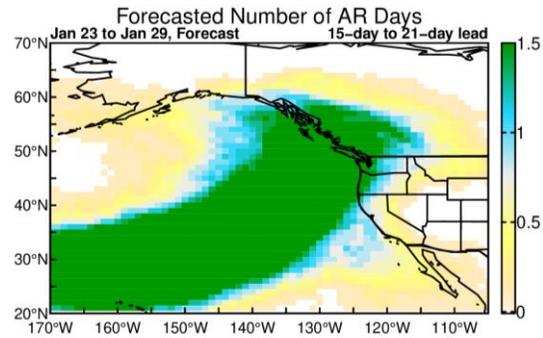
Both models are predicting below-normal ridging activity near the US West Coast during Weeks 1-2

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

Forecasts Initialized 8 Jan 2024

NCEP

ECMWF



- ECMWF is predicting below-normal AR activity over most of WA/OR and CA with high confidence (> 75% ensemble agreement) during Week 3 (23–29 Jan)
- NCEP is also predicting below-normal AR activity over CA with high confidence during Week 3
- NCEP is predicting above-normal AR activity along coastal WA/OR

Models generally agree on below-normal AR activity over CA with high confidence during Week 3

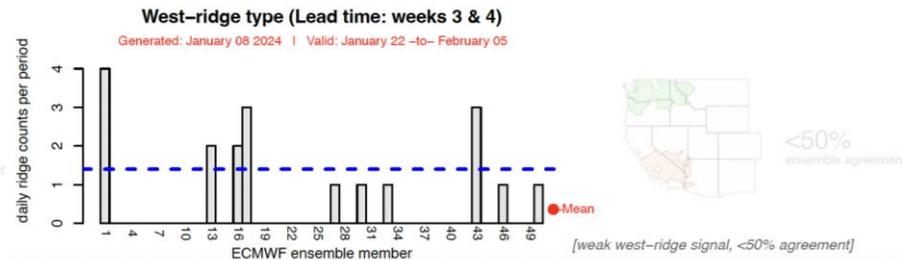
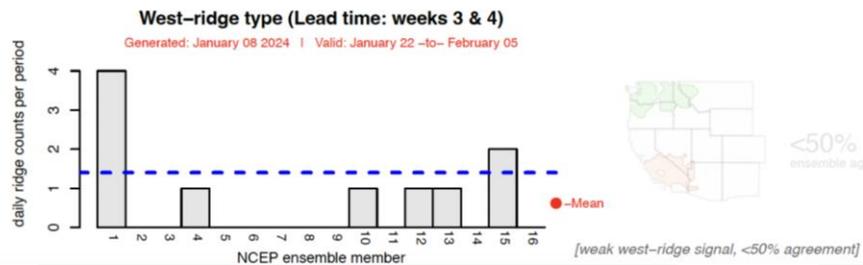
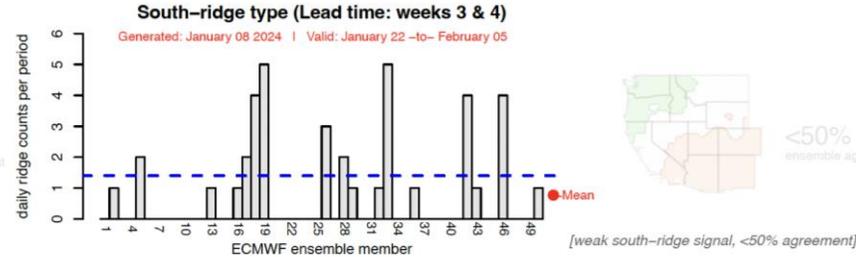
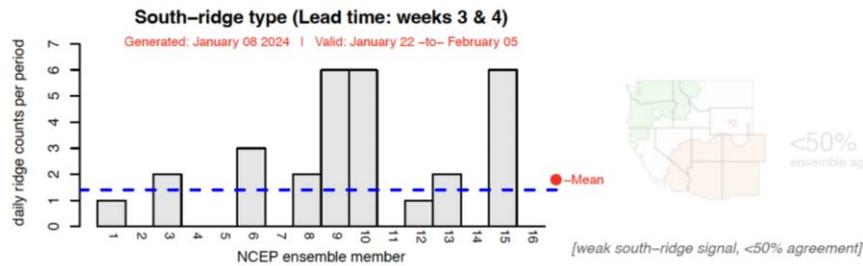
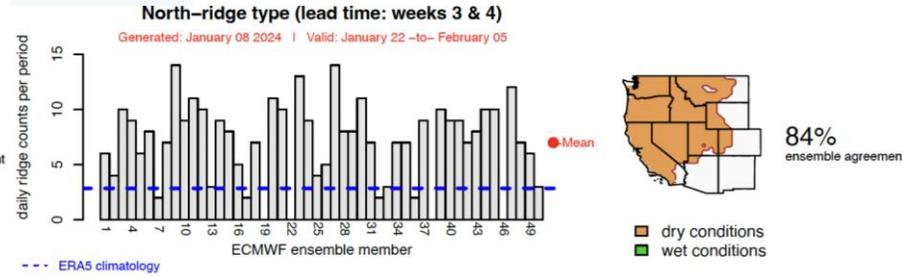
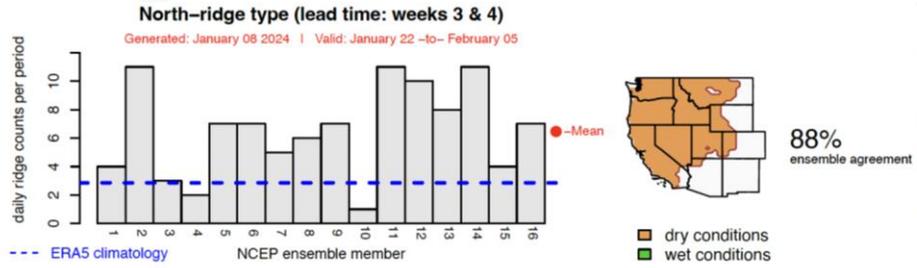
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

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

Forecasts Initialized 8 Jan 2024

NCEP

ECMWF

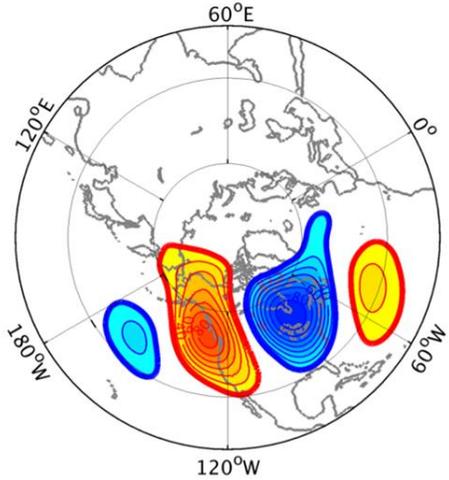


- Both models are predicting high likelihood (>80% ensemble agreement) in persistent North Ridge activity during Weeks 3–4 (22 Jan – 5 Feb)
- Both models are predicting below-normal occurrence of West-ridge activity
- NCEP is predicting near-normal occurrence of South-ridge activity

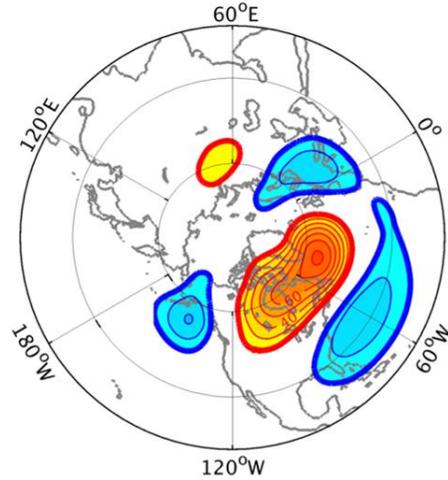
High likelihood in persistent North Ridge activity during Weeks 3–4

Background Info: IRI Subseasonal Weather Regime Forecasts

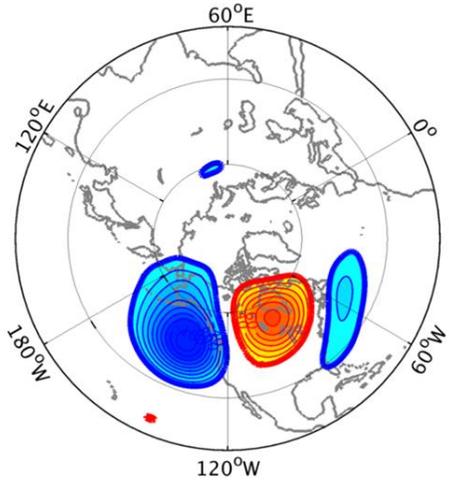
a) WR 1: West Coast Ridge



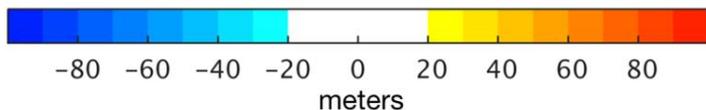
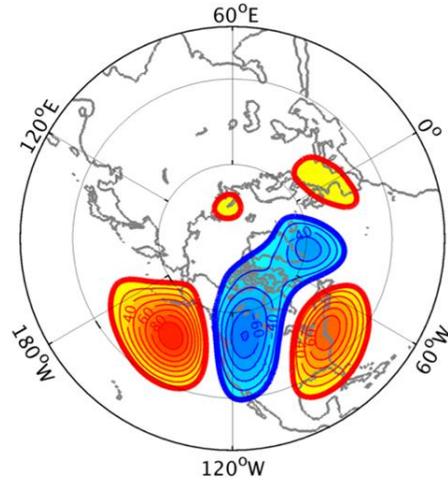
b) WR 2: Greenland High



c) WR 3: Pacific Trough



d) WR 4: Pacific Ridge



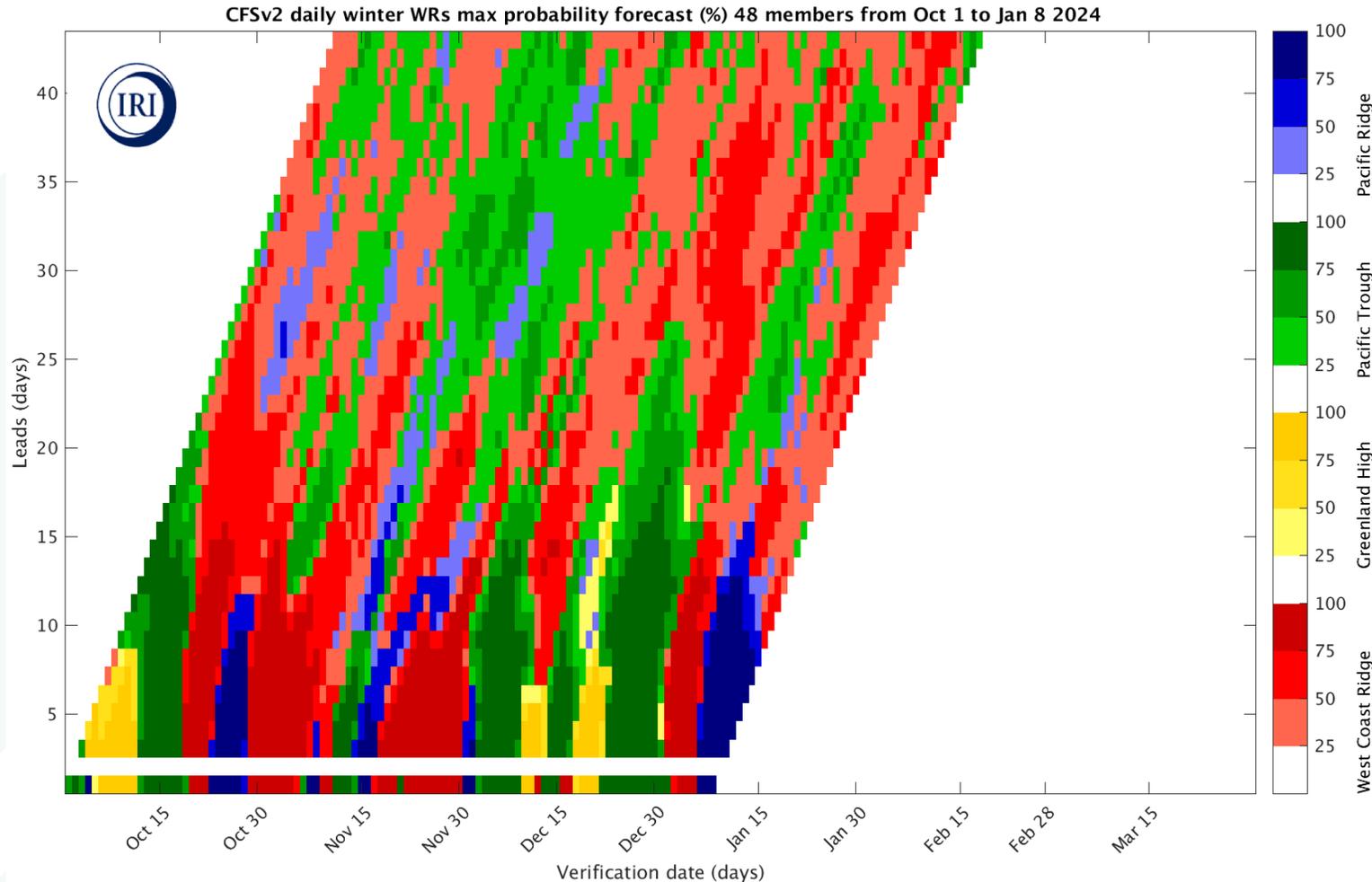
This slide contains background information about IRI's North American weather regime forecast product

- 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

Forecast Initialized 8 Jan 2024



- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- Moderate-to-high likelihood (> 50% ensemble agreement) of transition from Pacific Ridge to West Coast Ridge during Week 2
- Low-to-moderate likelihood (25-50% ensemble agreement) of West Coast Ridge during Week 3 and Week 4

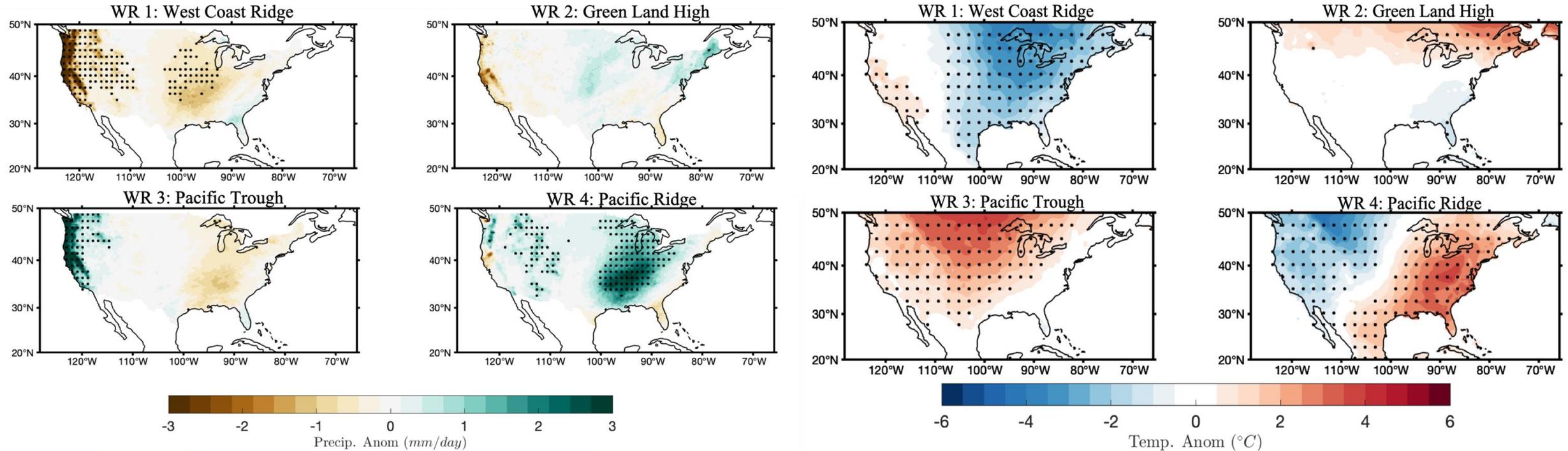
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime. See the next slide for temperature/precipitation implications.

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

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation

Temperature



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

- A transition from cold conditions to warm and dry weather in CA during the middle of January with moderate-to-high confidence
- Warm and dry conditions are predicted over CA during the end of January with low-to-moderate confidence