



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 1 Dec 2023

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UC San Diego



CW3E S2S Forecasts: Glossary & Context

- The outlooks are based on CW3E subseasonal to seasonal 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*

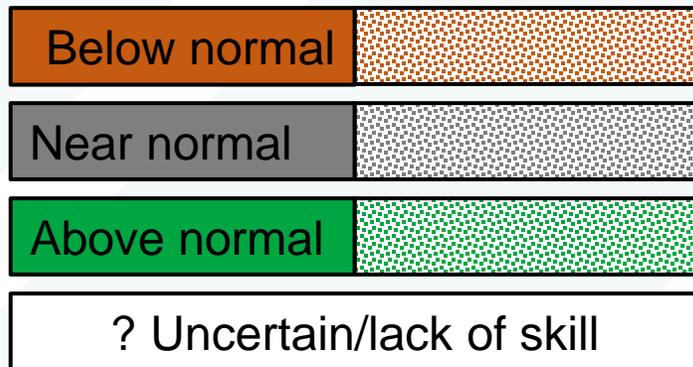
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 30 Nov 2023

Region	Week 2 (8–14 Dec)				Week 3 (15–21 Dec)				Week 4 (22–28 Dec)		
	NCEP ^{1,2,3}	ECMWF ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{1,2,3}	ECMWF ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{2,3}	ECMWF ²	Multi-Model Forecast
WA/OR	Below normal	Below normal	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain
Northern CA	Below normal	Below normal	Uncertain	Uncertain	Uncertain	Below normal	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain
Central CA	Uncertain	Below normal	Below normal	Below normal	Uncertain	Below normal	Below normal	Uncertain	Uncertain	Uncertain	Uncertain
Southern CA	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain

Higher Confidence | Lower Confidence



- Models agree on below-normal precipitation over Southern CA during Week 2; less agreement over Northern and Central CA
- Week 3 and Week 4 forecasts are uncertain

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](#))

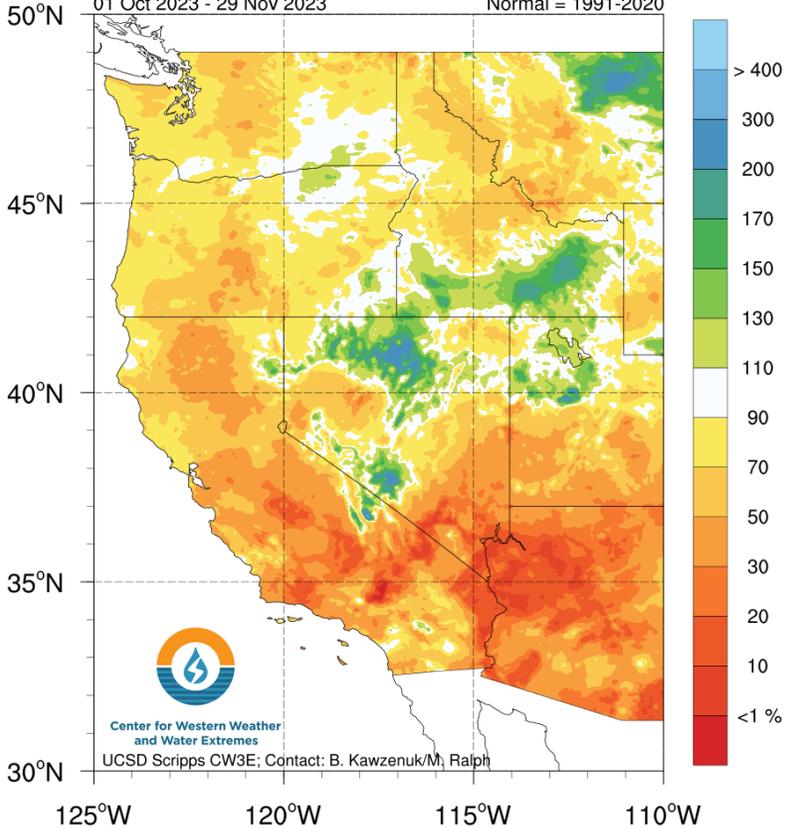
Summary

- **Week 2 forecasts (8–14 Dec):** Models generally agree on low likelihood (< 30% probability) of AR activity over Southern and Central CA
 - NCEP shows higher likelihood of AR activity in Northern CA
- Models agree on strong MJO activity over the Maritime Continent during early Week 2 which is historically associated with an increased likelihood of wet extremes in Central and Southern CA in the following weeks
- Ridging outlooks show high likelihood of persistent ridging activity across the southwestern US during Weeks 1–2, but IRI weather regime outlooks show high likelihood of a Pacific Trough
 - Both agree on above-normal precipitation over Northern CA but disagree on precipitation over Central and Southern CA
- **Week 3 forecasts (15–21 Dec):** Models disagree on the likelihood of AR activity over CA
 - ECCO is predicting above-normal AR activity over CA
 - NCEP is predicting near-normal AR activity
 - ECMWF is predicting slightly below-normal AR activity with high confidence
- Uncertainty in frequency and location of ridging activity during Weeks 3–4

WY 2024 Hydrologic Summary

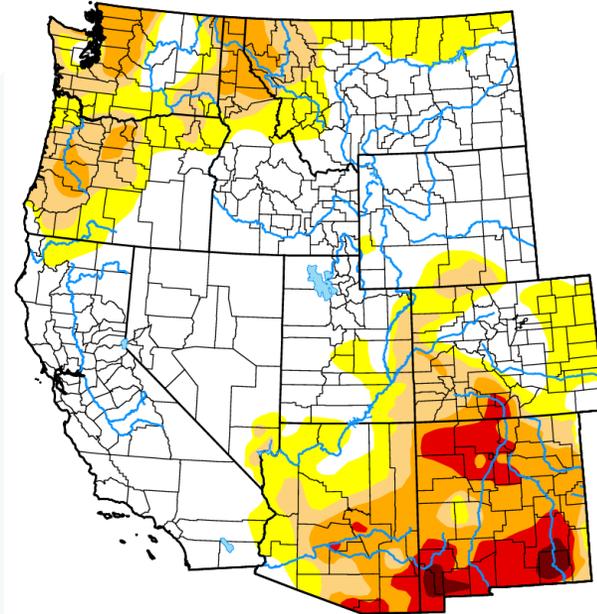
Precipitation

PRISM Water Year to Date Precipitation Anomaly (%)
01 Oct 2023 - 29 Nov 2023 Normal = 1991-2020



Drought Conditions

U.S. Drought Monitor West



November 28, 2023
(Released Thursday, Nov. 30, 2023)
Valid 7 a.m. EST

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	54.87	45.13	27.59	16.29	5.22	0.66
Last Week 11-21-2023	56.78	43.22	29.36	16.14	5.62	0.73
3 Months Ago 08-29-2023	54.48	45.52	30.75	13.31	2.92	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 11-29-2022	6.58	93.42	68.74	44.88	17.62	2.02

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>

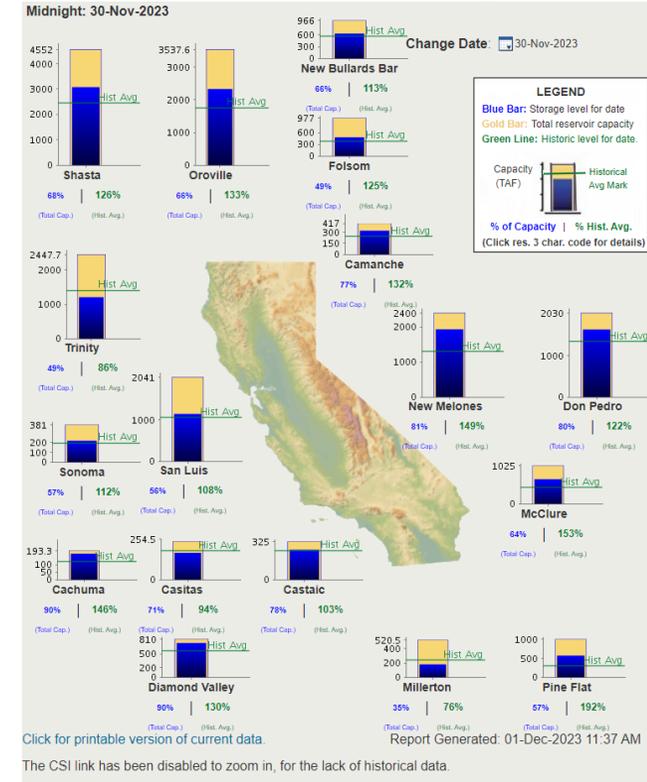
Author:

David Simeral
Western Regional Climate Center



droughtmonitor.unl.edu

Reservoir Storage



Source: California DWR

- As of 29 Nov, WY to date precipitation is below-normal across much of the Western US, especially in Central CA, Southern CA, portions of Nevada, and Arizona.
- As of 28 Nov, nearly all of California was drought-free
- As of 30 Nov, most large reservoirs in CA were operating at greater than 60% storage capacity and higher-than-normal storage

Looking Back: Week 3 AR Activity Forecasts

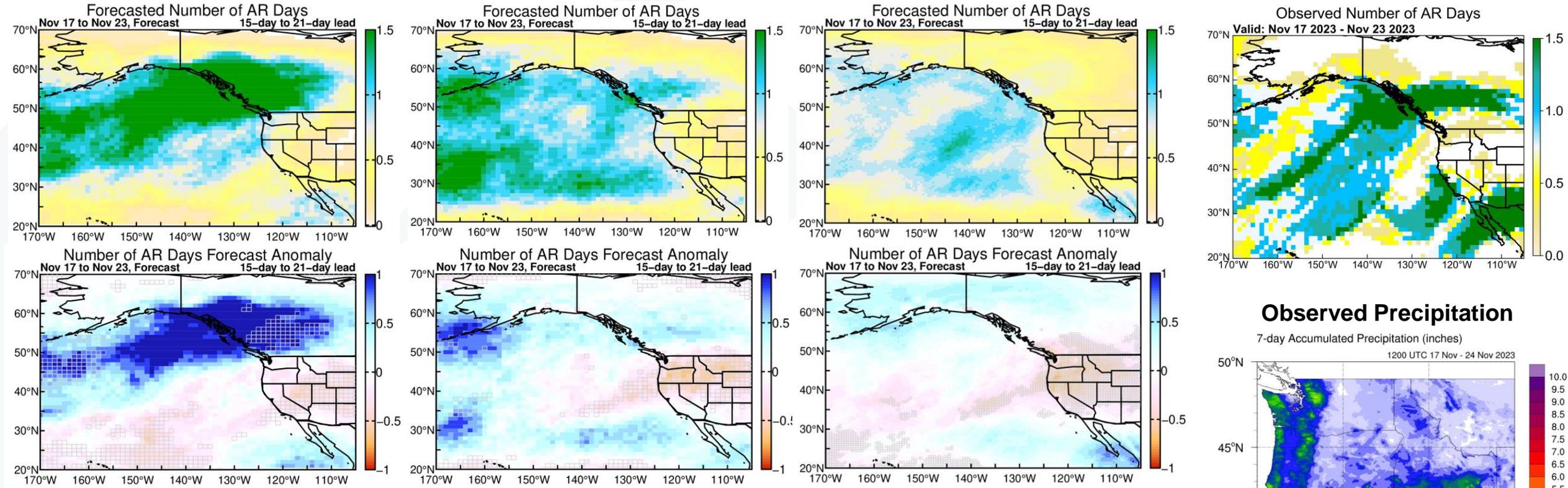
Forecasts Initialized 2 Nov 2023; Valid: 17–23 Nov 2023

NCEP

ECCE

ECMWF

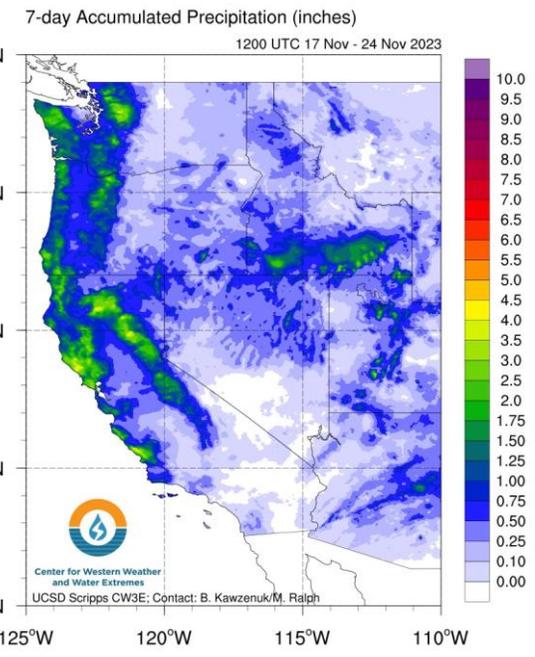
Observed (GFS Analysis)



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 and ECMWF were not able to capture the AR activity along coastal CA; ECCE did a better job capturing some AR activity, but the number of AR days is largely underestimated
- All models predicted AR activity near British Columbia as observed and the inland penetration was well captured by NCEP and ECCE
- A weak AR brought up to 4-5 inches of precipitation to Northern and Central CA on 17-19 Nov
- Another AR brought light precipitation to Western OR and WA on 22 Nov

Observed Precipitation



Center for Western Weather and Water Extremes
 UCSD Scripps CW3E; Contact: B. Kawzenuk/M. Ralph

Looking Back: Week 3 AR Activity Forecasts

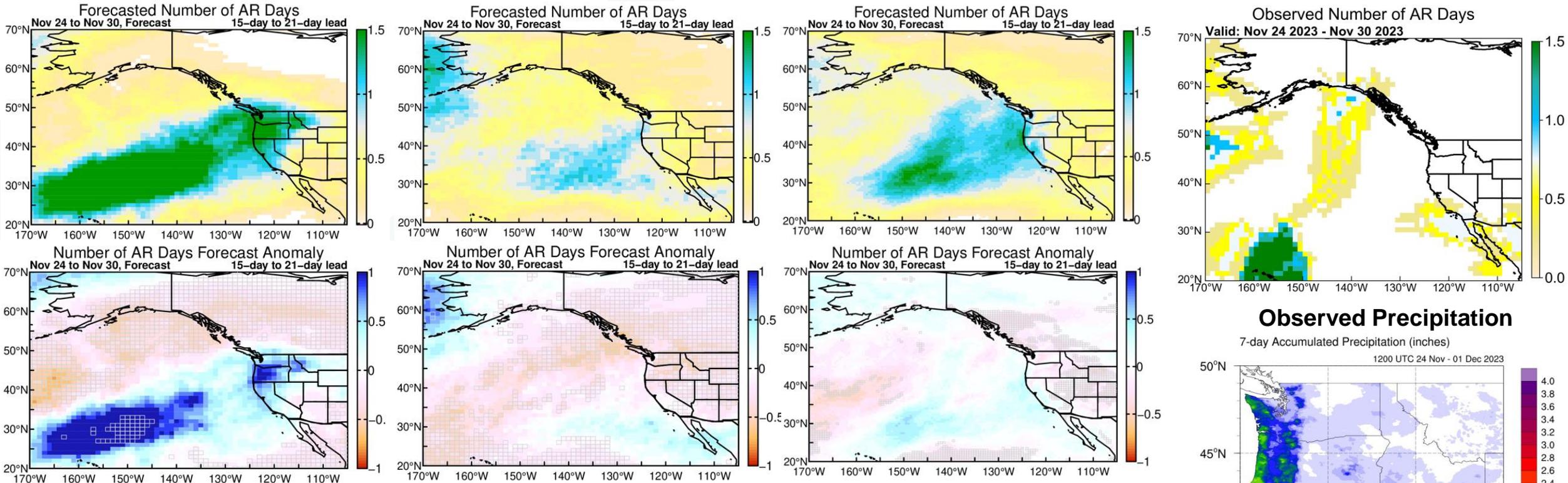
Forecasts Initialized 9 Nov 2023; Valid: 24 – 30 Nov 2023

NCEP

ECCE

ECMWF

Observed (GFS Analysis)



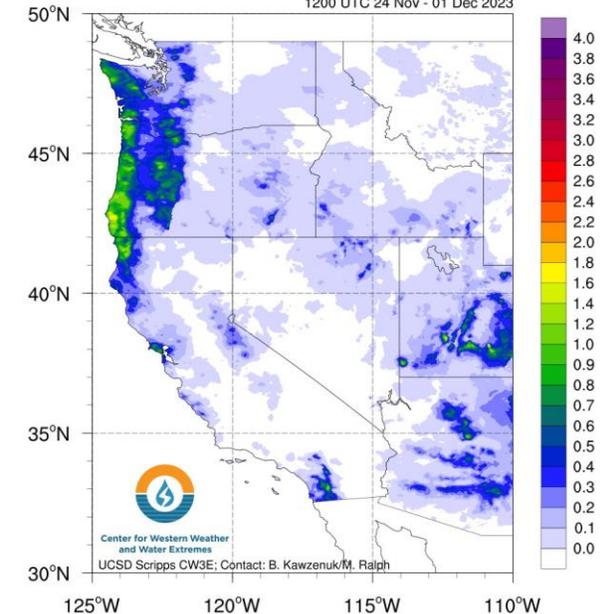
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
 Grey cells: >75% of ensemble members agree on sign of anomaly

- All models incorrectly predicted AR activity near/over the Pacific Northwest, especially NCEP
- NCEP and ECMWF also predicted too much AR activity over Northern CA
- NCEP and ECMWF captured some AR activity near coastal Central CA, with an over-prediction
- A weak cutoff low brought light precipitation to Coastal Northern CA on 29 Nov
- A weak low-pressure system produced light precipitation over Coastal OR, Central, and Southern CA on 30 Nov

Observed Precipitation

7-day Accumulated Precipitation (inches)

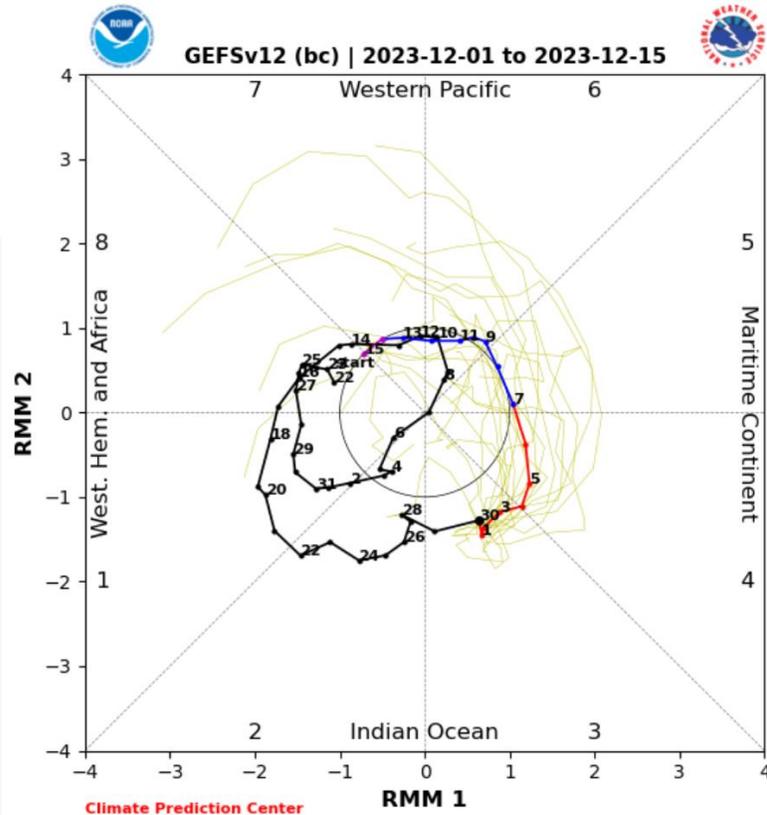
1200 UTC 24 Nov - 01 Dec 2023



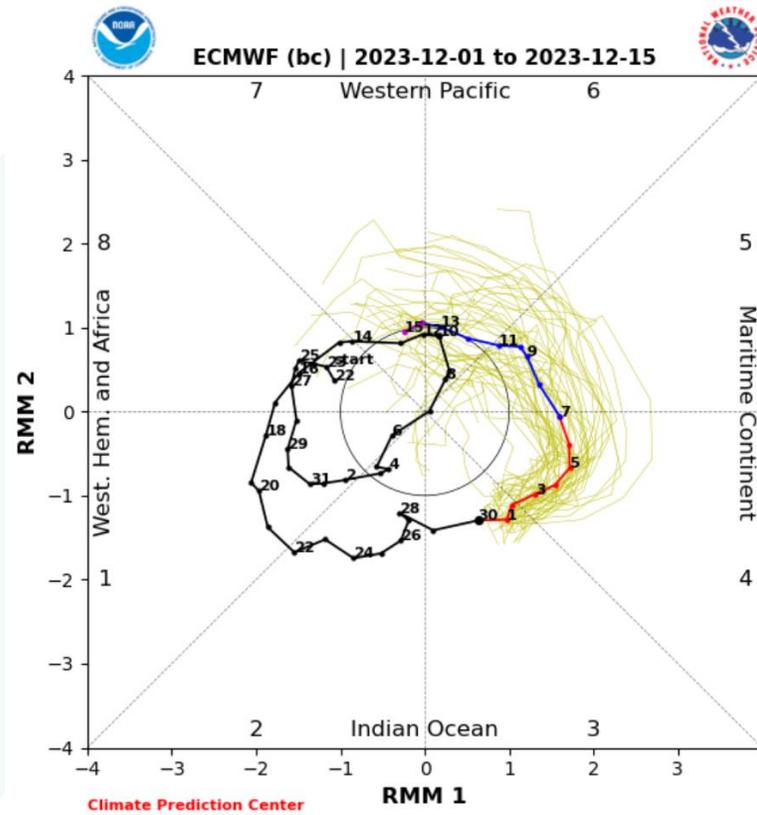
Center for Western Weather and Water Extremes
 UCSD Scripps CW3E; Contact: B. Kawzenuk/M. Ralph

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)

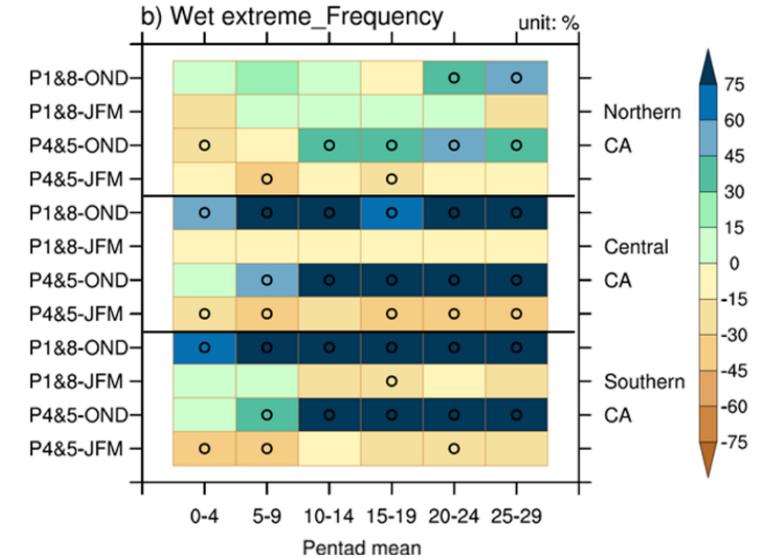
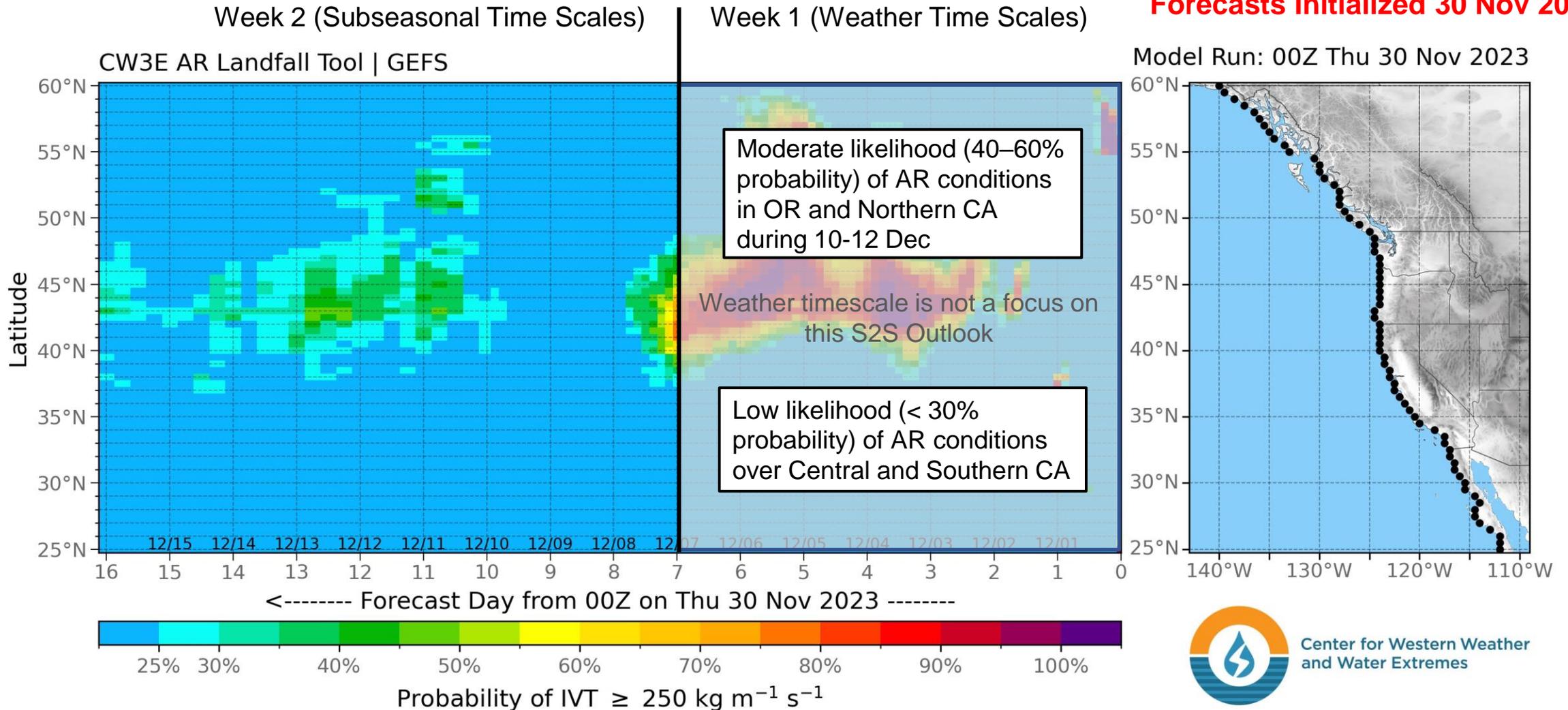


Figure S6 from Wang et al. (2023)

- Both models are forecasting strong MJO activity over the Maritime Continent during Week 1 and early Week 2, and weakening MJO after 11 Dec
- MJO activity in the Maritime Continent during OND is associated with an increased likelihood of wet extremes in Central and Southern CA at lag times of 1–4 weeks

NCEP GEFS AR Landfall Tool: Valid 00Z 30 Nov – 00Z 16 Dec

Forecasts Initialized 30 Nov 2023



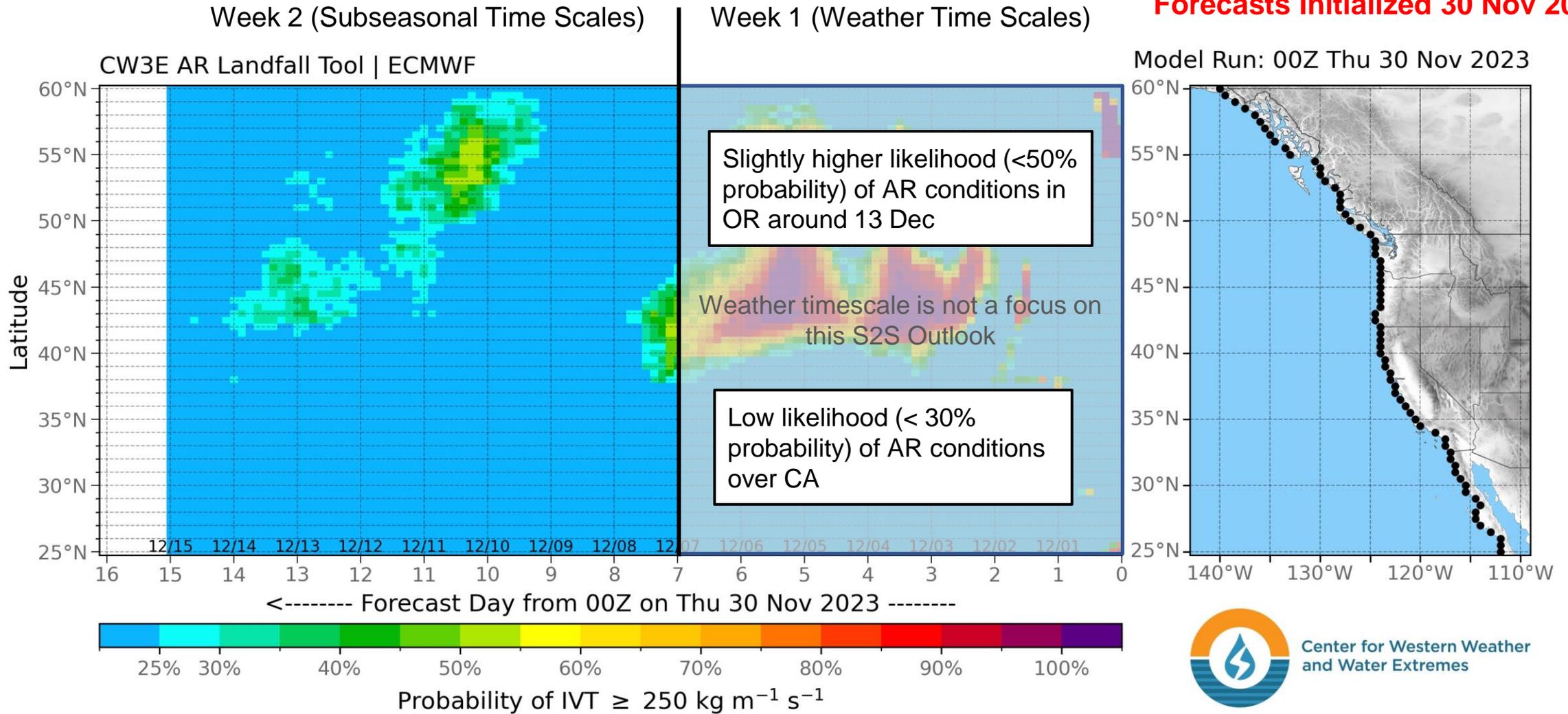
Center for Western Weather and Water Extremes

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

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

ECMWF EPS AR Landfall Tool: Valid 00Z 30 Nov – 00Z 15 Dec

Forecasts Initialized 30 Nov 2023

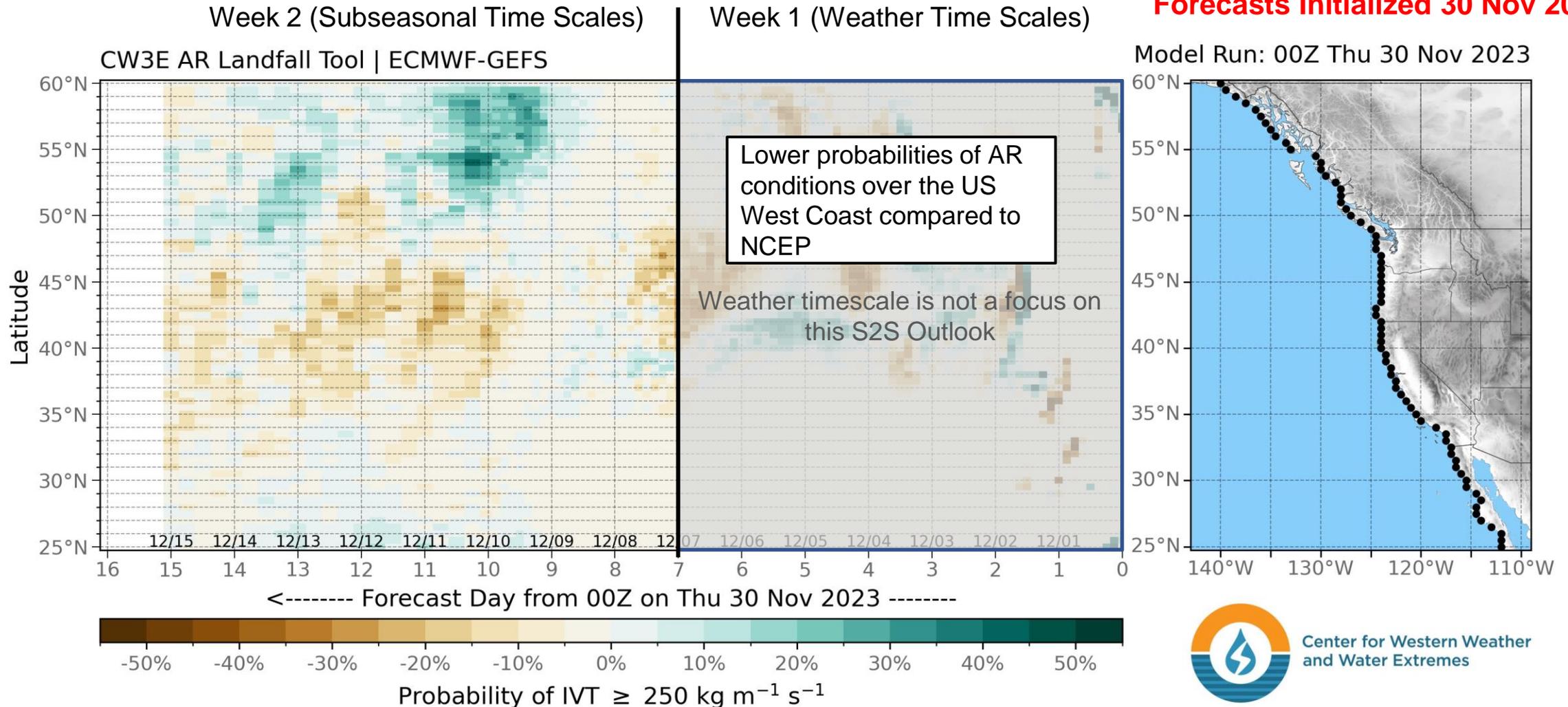


Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

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

EPS Minus GEFS AR Landfall Tool: Valid 00Z 30 Nov – 00Z 15 Dec

Forecasts Initialized 30 Nov 2023

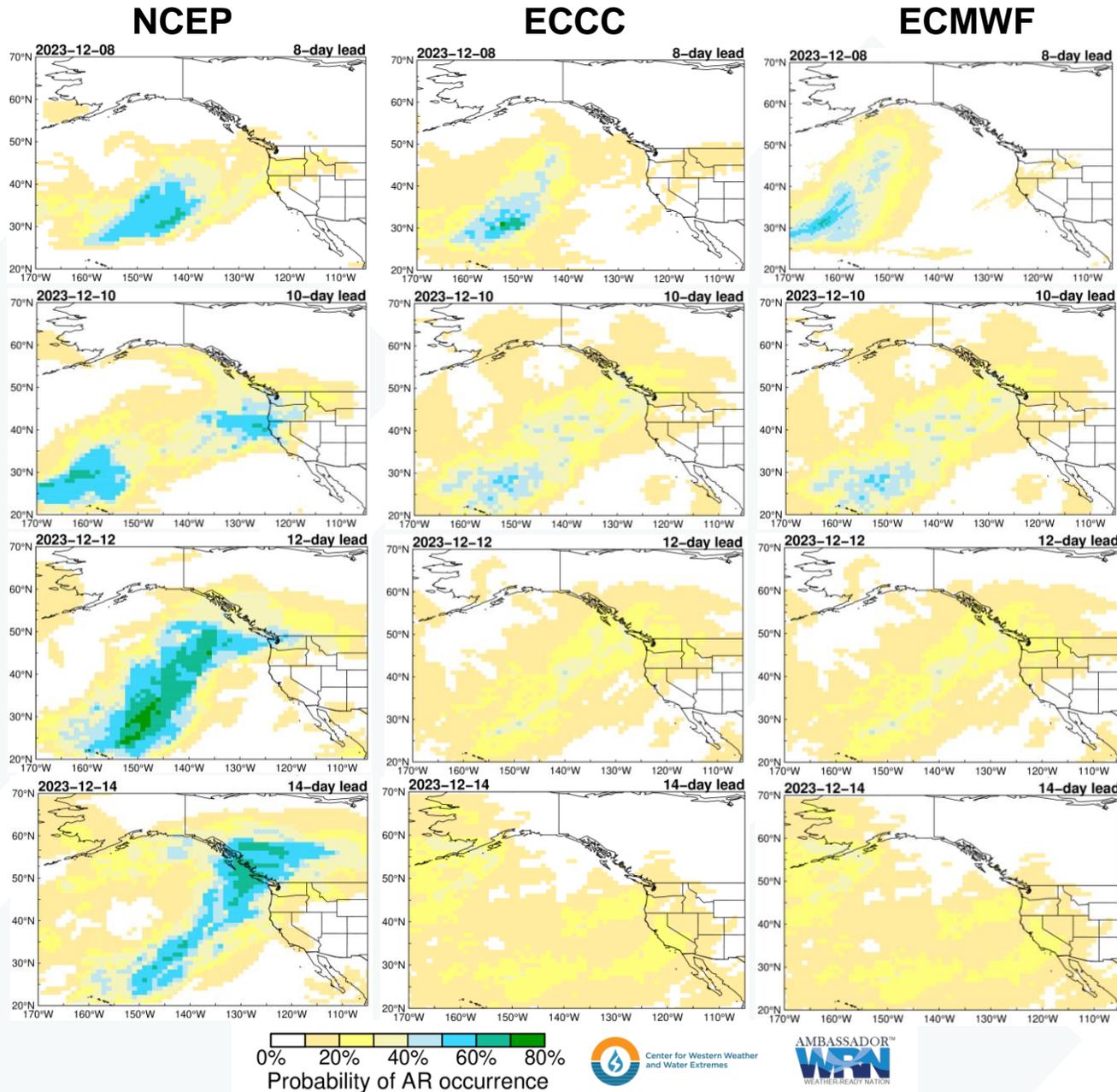


Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

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

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

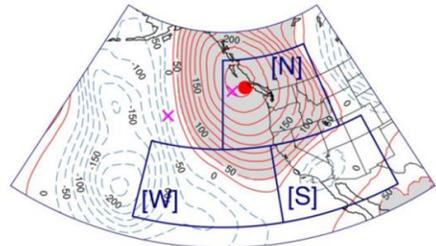
Forecasts Initialized 30 Nov 2023



- ECCC and ECMWF are showing low likelihood (< 30%) of AR activity over CA and WA/OR during Week 2 (8–14 Dec)
- NCEP is showing higher likelihood (40–70%) of AR activity in WA/OR and Northern CA on 10 Dec, and higher likelihood of AR activity in WA on 12 Dec
- Similar to ECCC and ECMWF, NCEP is showing low likelihood (< 30%) of AR activity over Central and Southern CA during Week 2

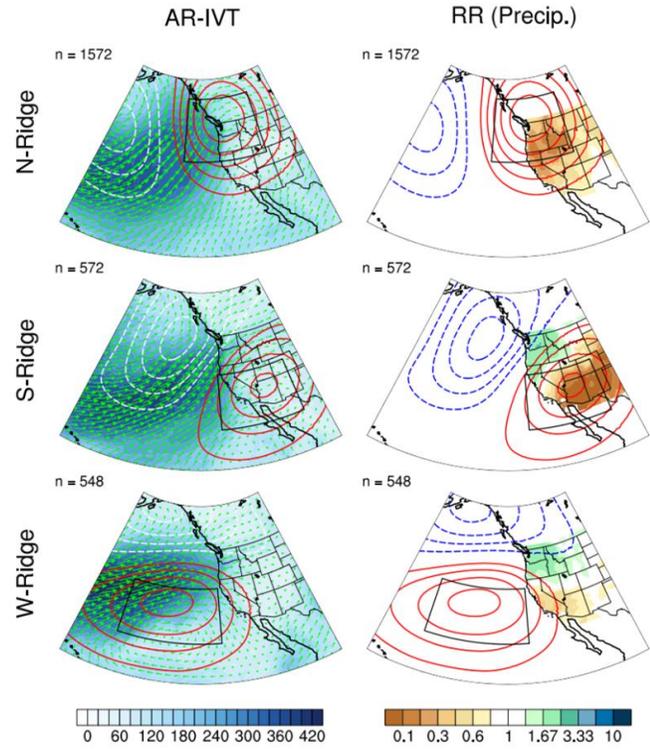
Models agree on low likelihood of AR activity in Central and Southern CA;
Some model disagreement on AR activity over Northern CA during Week 2

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 California 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 California and wet conditions over the Pacific Northwest



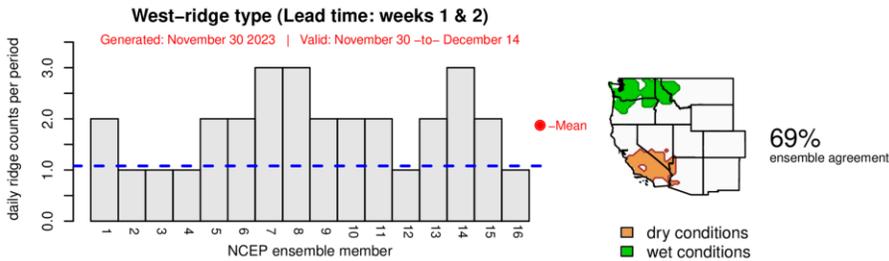
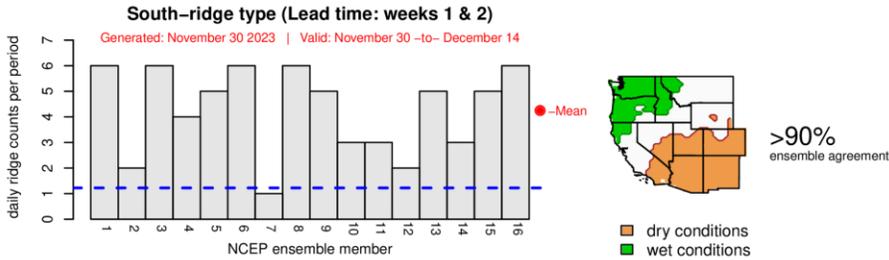
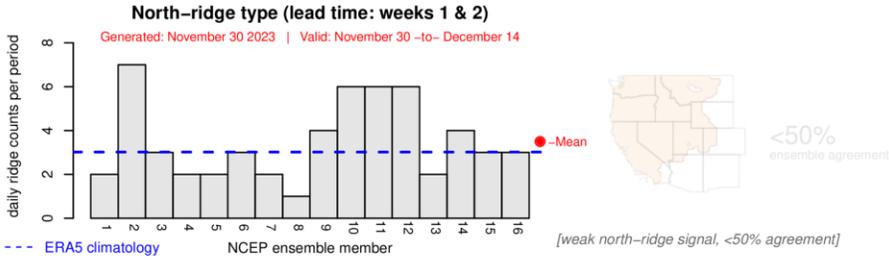
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 30 Nov 2023

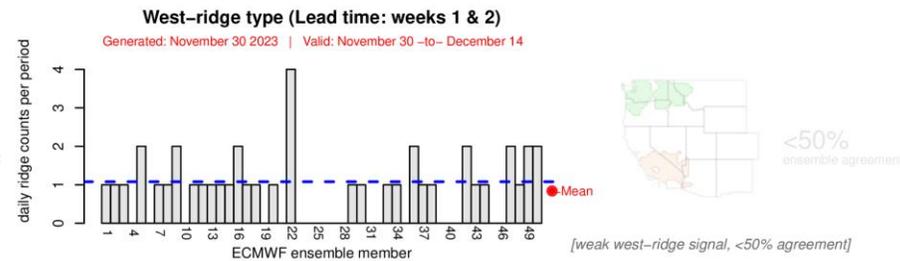
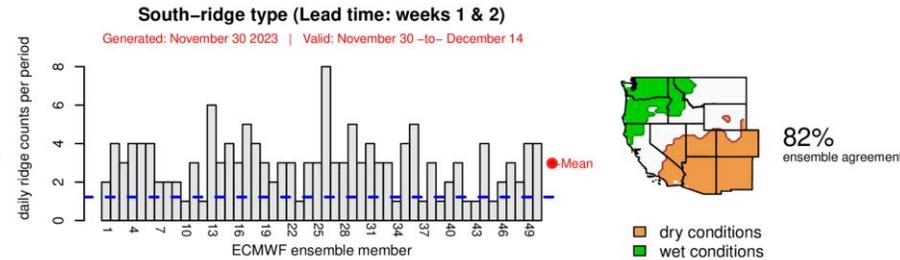
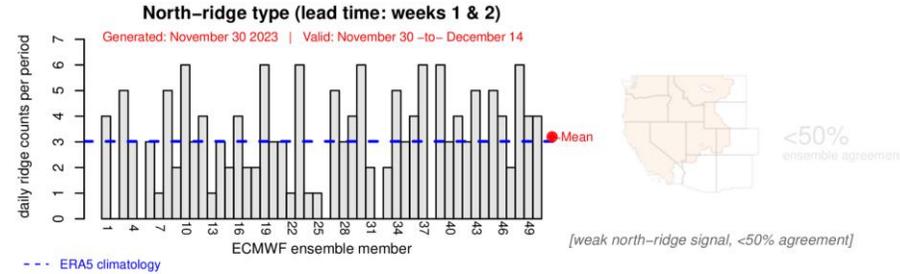
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



- Both NCEP and ECMWF are showing high likelihood (> 80% ensemble agreement) in persistent South Ridge activity during Weeks 1–2 (30 Nov–14 Dec)
- NCEP is also showing moderate likelihood (69% ensemble agreement) in persistent West Ridge activity
- Both models are predicting near-normal occurrence of the North-ridge type

Models generally agree on high likelihood in persistent South Ridge activity during Weeks 1–2

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

Forecasts Initialized 30 Nov 2023

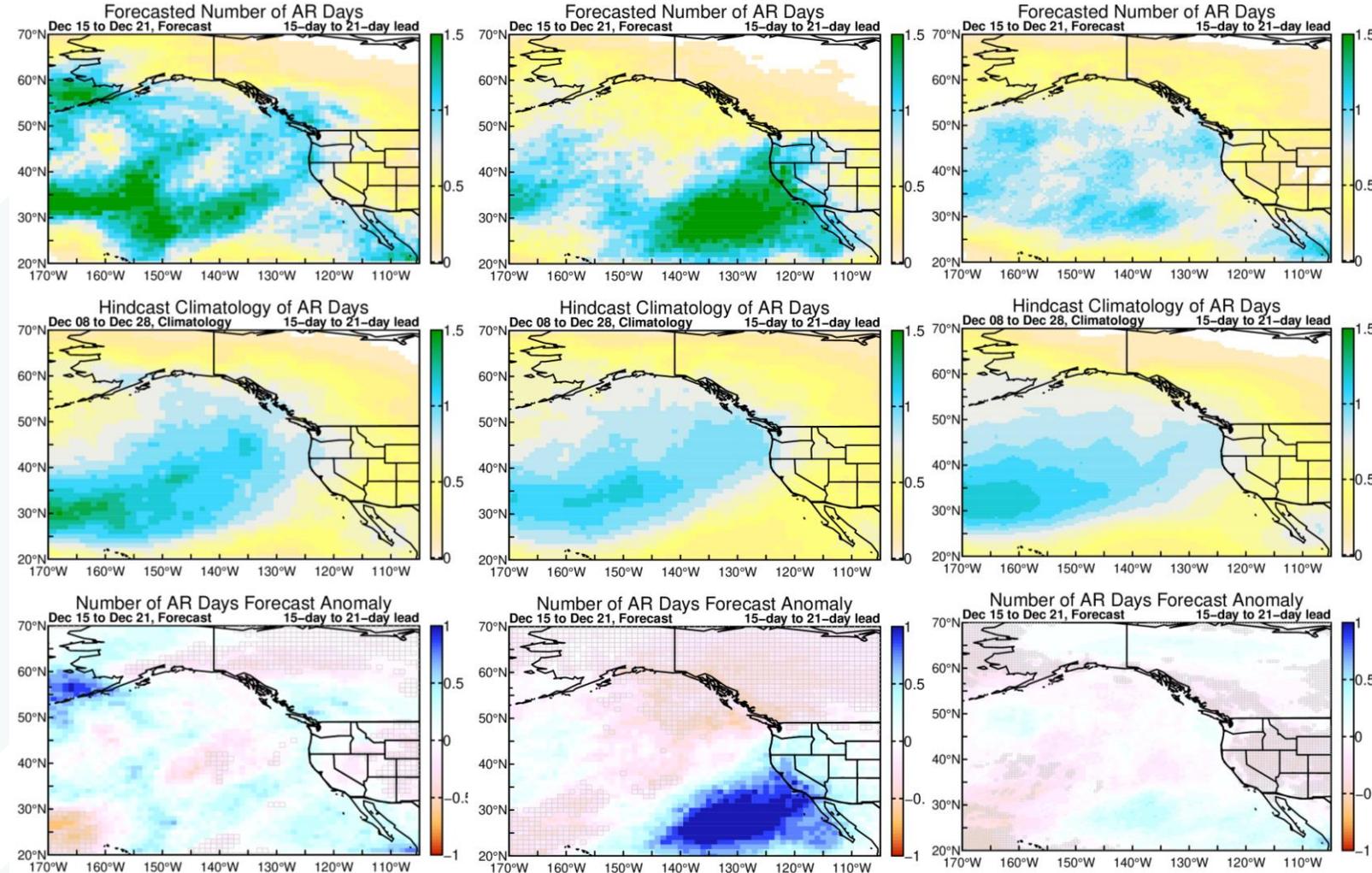
NCEP

ECCC

ECMWF

- ECCC is predicting above-normal AR activity in CA during Week 3 (15–21 Dec)
- NCEP is predicting near-normal AR activity in CA
- ECMWF is predicting slightly below-normal AR activity in CA with high confidence
- Models agree on near-normal AR activity in WA but disagree on AR activity in OR

Large model uncertainty in AR conditions over 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)

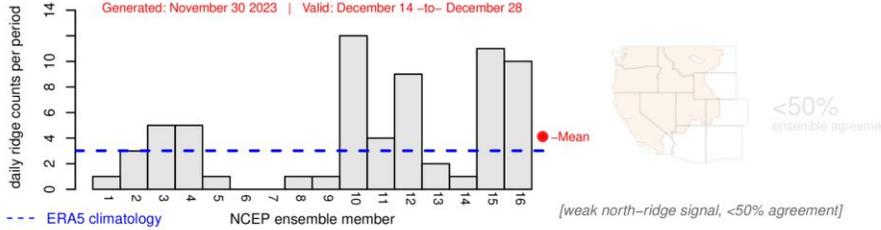
Forecasts Initialized 30 Nov 2023

NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)

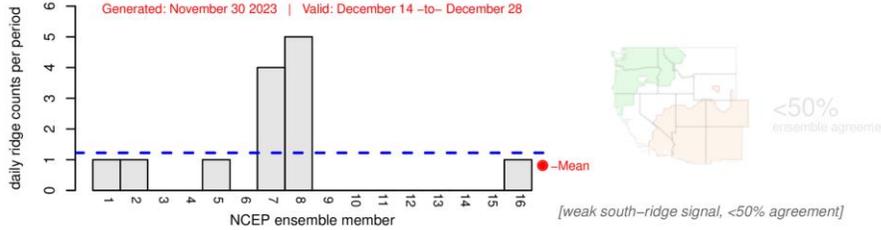
North-ridge type (lead time: weeks 3 & 4)

Generated: November 30 2023 | Valid: December 14 –to– December 28



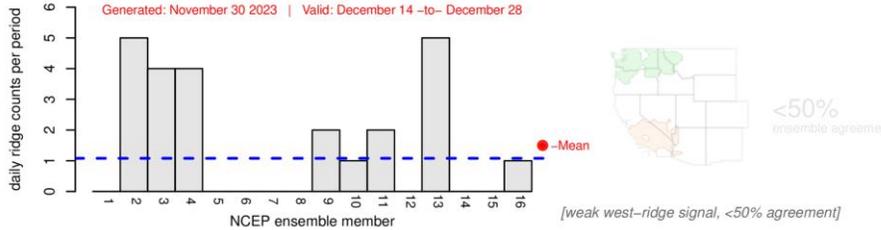
South-ridge type (Lead time: weeks 3 & 4)

Generated: November 30 2023 | Valid: December 14 –to– December 28



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

Generated: November 30 2023 | Valid: December 14 –to– December 28

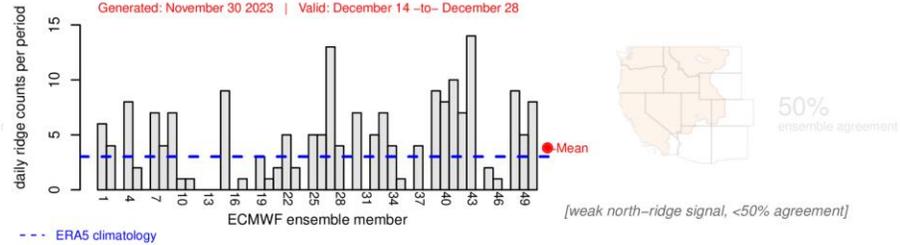


ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)

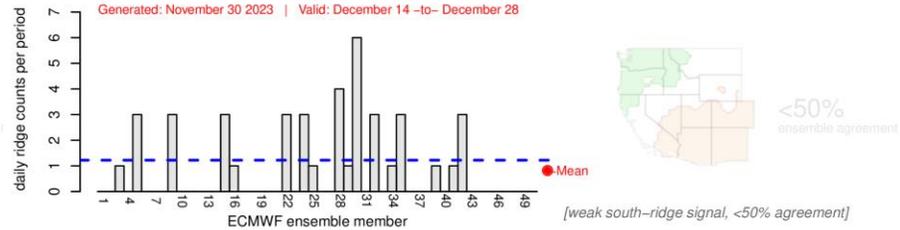
North-ridge type (lead time: weeks 3 & 4)

Generated: November 30 2023 | Valid: December 14 –to– December 28



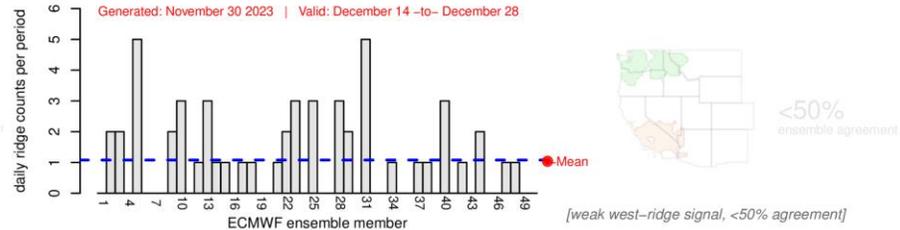
South-ridge type (Lead time: weeks 3 & 4)

Generated: November 30 2023 | Valid: December 14 –to– December 28



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

Generated: November 30 2023 | Valid: December 14 –to– December 28

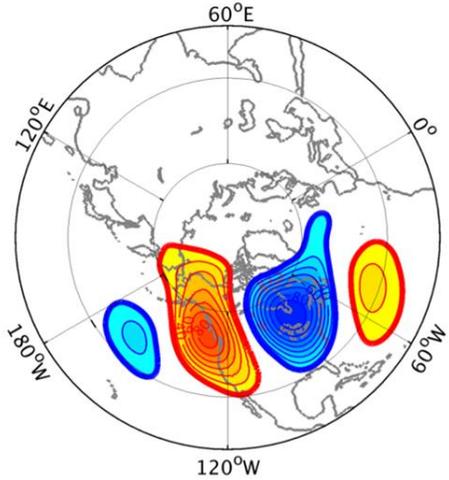


- Both models are predicting near-normal occurrence of ridging activities during Weeks 3–4 (14–28 Dec)

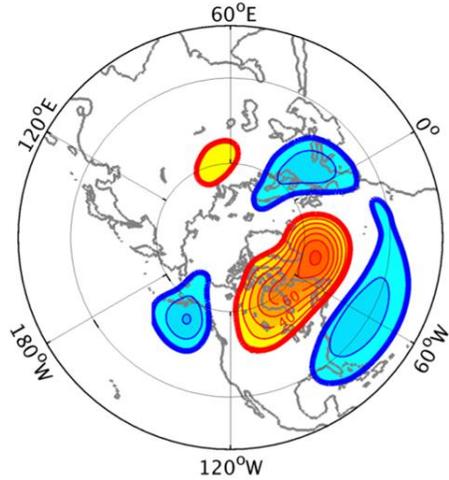
Uncertainty in frequency and location of ridging activity near the US West Coast during Weeks 3–4

Background Info: IRI Subseasonal Weather Regime Forecasts

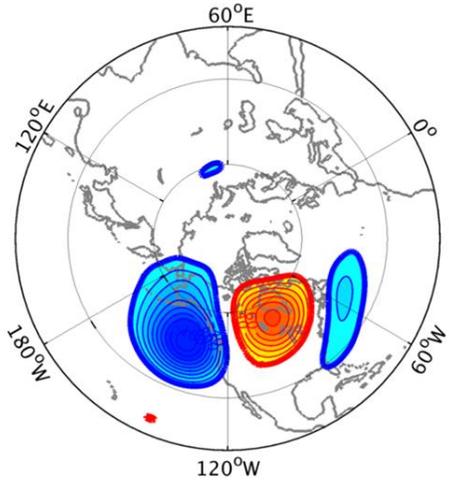
a) WR 1: West Coast Ridge



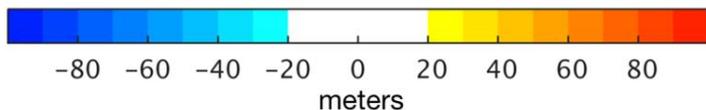
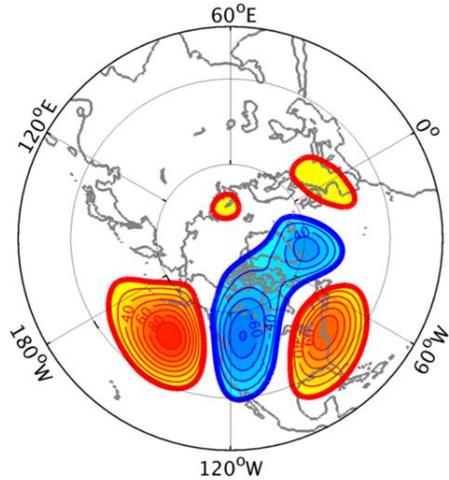
b) WR 2: Greenland High



c) WR 3: Pacific Trough



d) WR 4: Pacific Ridge



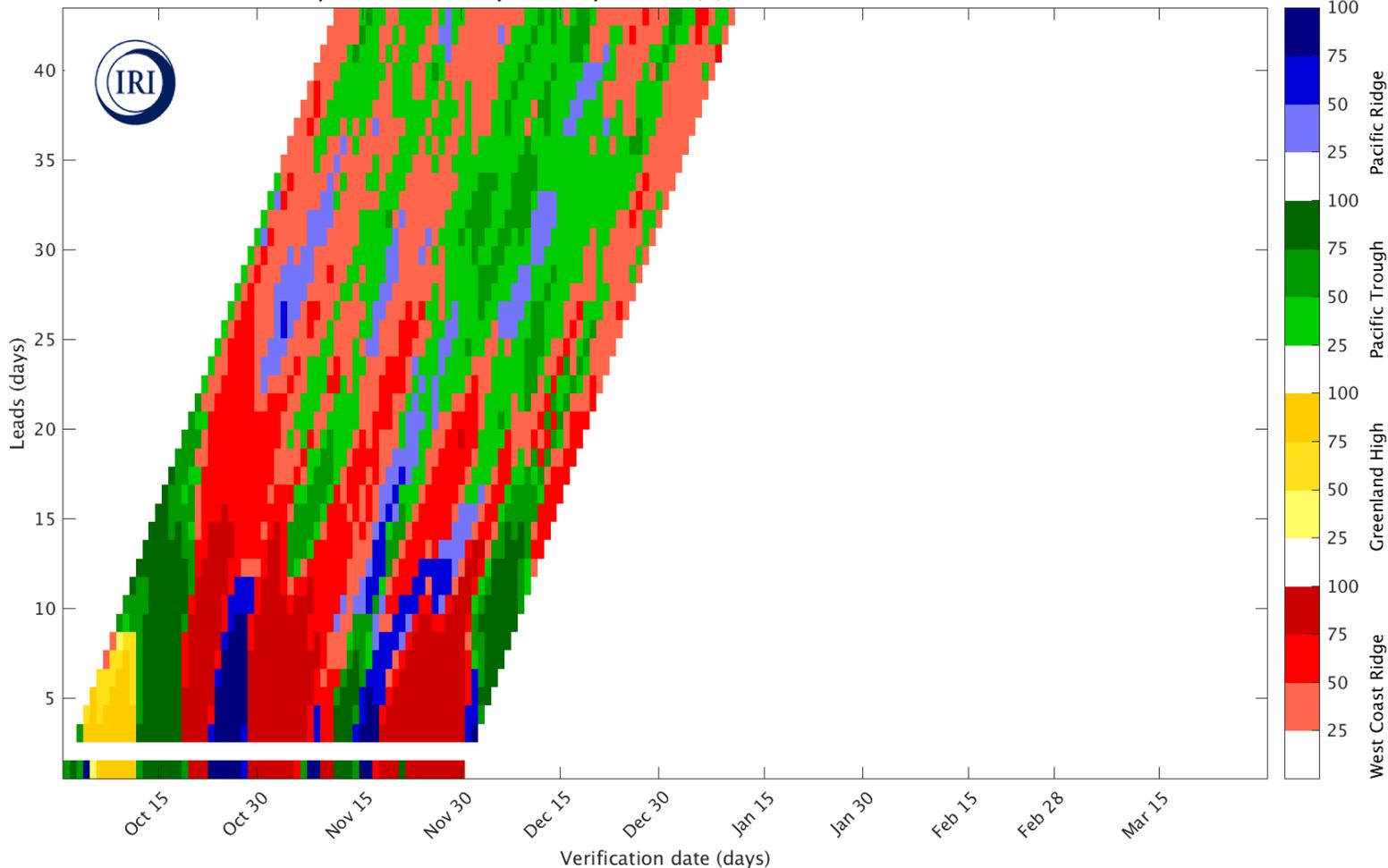
This slide contains background information about IRI's North American weather regime forecast product

- 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 Nov 30 2023



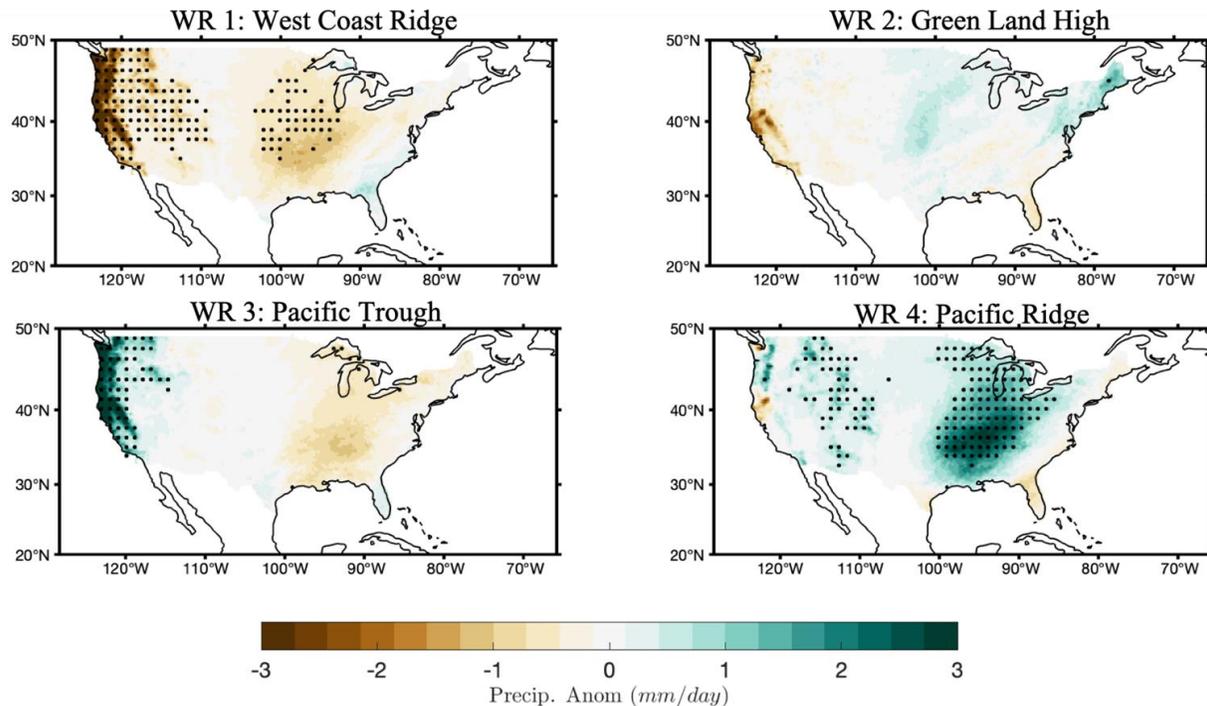
Forecast Initialized 30 Nov 2023

- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- High likelihood (> 75% ensemble agreement) of Pacific Trough during the first half of Week 2
- Uncertainty in the timing of the transition from Pacific Trough to West Coast Ridge toward the end of Week 2
- Low-to-moderate likelihood (25-75% ensemble agreement) of West Coast Ridge during Weeks 3-4, the likelihood is generally higher (50-75%) during Week 3 than Week 4 (25-50%)

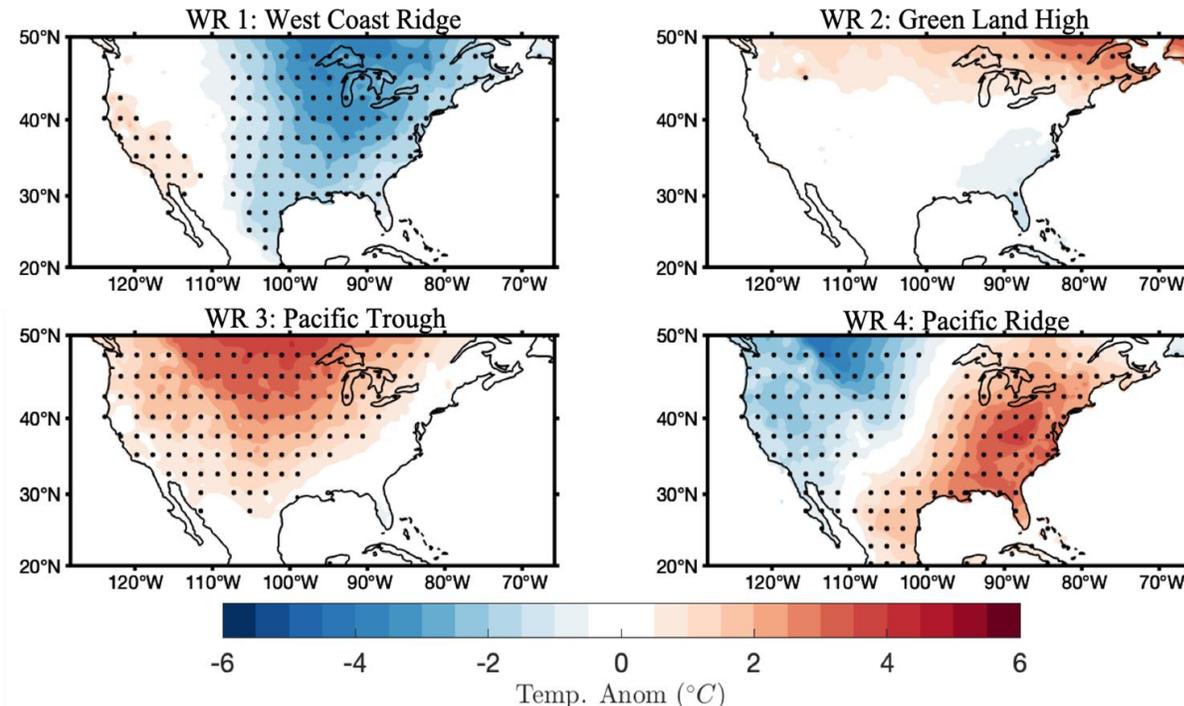
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime.

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 in the 2nd week of December with high confidence
- Warm and dry conditions are predicted over CA during the rest of December with low-to-moderate confidence