



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 1 March 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 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*

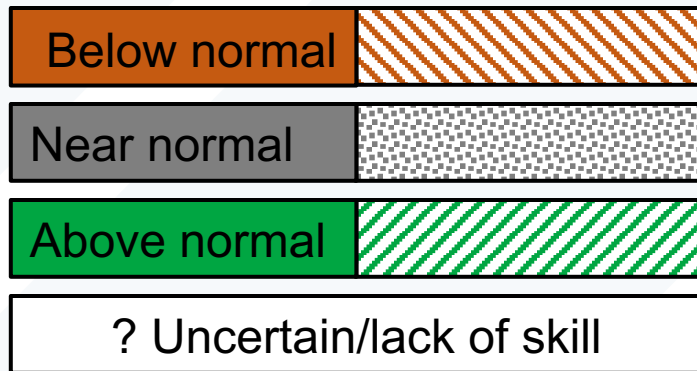
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 29 Feb 2024

Region	Week 2 (8–14 Mar)				Week 3 (15–21 Mar)				Week 4 (22–28 Mar)		
	NCEP ^{2,3}	ECCC ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{2,3}	ECCC ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{2,3}	ECMWF ²	Multi-Model Forecast
WA/OR	Green diagonal stripes	Orange solid	Orange diagonal stripes	White	Orange diagonal stripes	Orange solid	Orange solid	Orange solid	Orange diagonal stripes	Orange solid	Orange solid
Northern CA	Green diagonal stripes	Orange solid	Orange diagonal stripes	White	Orange diagonal stripes	Orange solid	Orange solid	Orange solid	Orange diagonal stripes	Orange solid	Orange solid
Central CA	Green diagonal stripes	Orange solid	Orange diagonal stripes	White	Orange diagonal stripes	Orange solid	Orange solid	Orange solid	Orange diagonal stripes	Orange solid	Orange solid
Southern CA	Green diagonal stripes	Orange solid	Orange diagonal stripes	White	Orange diagonal stripes	Orange solid	Orange solid	Orange solid	Orange diagonal stripes	Orange solid	Orange solid

Higher Confidence | Lower Confidence



- Models disagree on forecasting precipitation in CA during Week 2, NCEP is forecasting above-normal precipitation with some uncertainty, while ECCC and ECMWF are forecasting below-normal precipitation
- Models agree on below-normal precipitation in CA during Week 3, but NCEP disagrees with the other two on the confidence level
- Models agree on below-normal precipitation in CA during Week 4

Subseasonal products included in this Outlook:

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

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

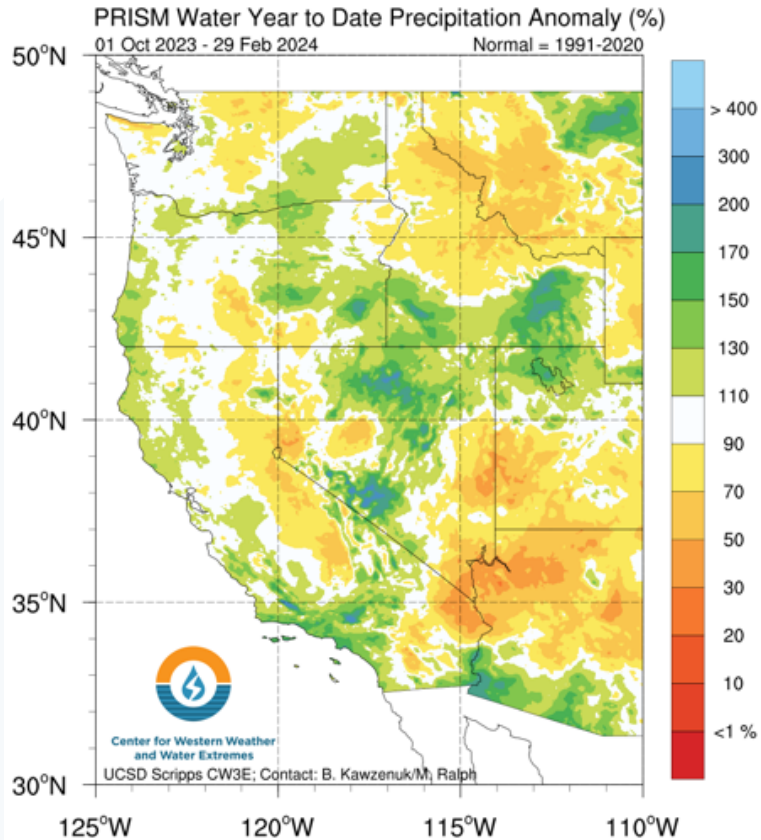
³IRI North American Weather Regime Forecasts ([Robertson et al. 2020](#))

Summary

- **Week 2 forecasts (8–14 Mar):** Models agree on low likelihood (< 30% probability) of AR activity over CA during Week 2
- Weak MJO convection is forecast to strengthen and move over the Maritime Continent during the next two weeks
 - MJO activity over the Maritime Continent in JFM is associated with a statistically significant decrease in wet extremes in Central CA at lag times of 1–4 weeks
- Ridging outlooks show low likelihood of persistent ridging activity near the US West Coast during Weeks 1–2
- **Week 3 forecasts (15–21 Mar):** All models are forecasting below-normal AR activity in CA with high confidence (> 75% ensemble agreement)
- Models disagree on likelihood of above-normal ridging activity over CA during Weeks 3–4
 - NCEP is forecasting low North-ridge activity, but ECMWF is forecasting high likelihood of above-normal North-ridge activity, which is typically associated with dry conditions over all of CA
- IRI weather regime tool shows moderate-to-high likelihood of transition from Pacific Ridge to Pacific Trough (wet conditions in CA) during Week 2, moderate likelihood of Greenland High during Week 3, and moderate likelihood of West Coast Ridge conditions (dry conditions in CA) during Week 4
- CW3E's statistical forecast tool based on current MJO and QBO conditions is predicting high probability of below-normal AR occurrence and precipitation during Weeks 5-6 in CA in general

Hydrologic Summary

Precipitation

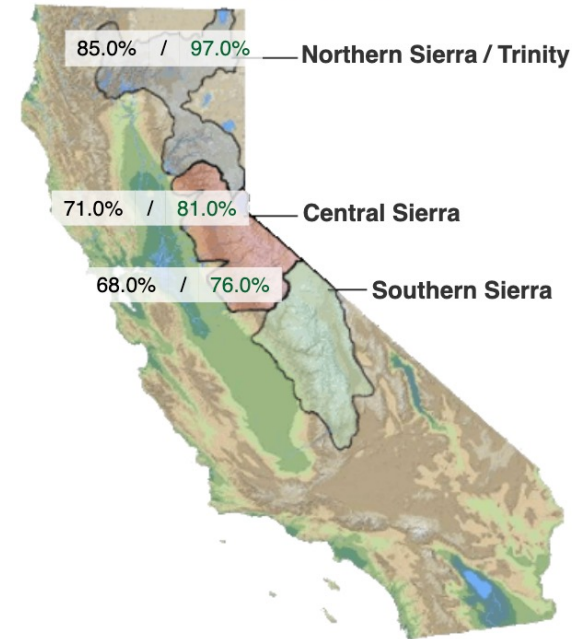


Snowpack Conditions

Provided by the California Cooperative Snow Surveys

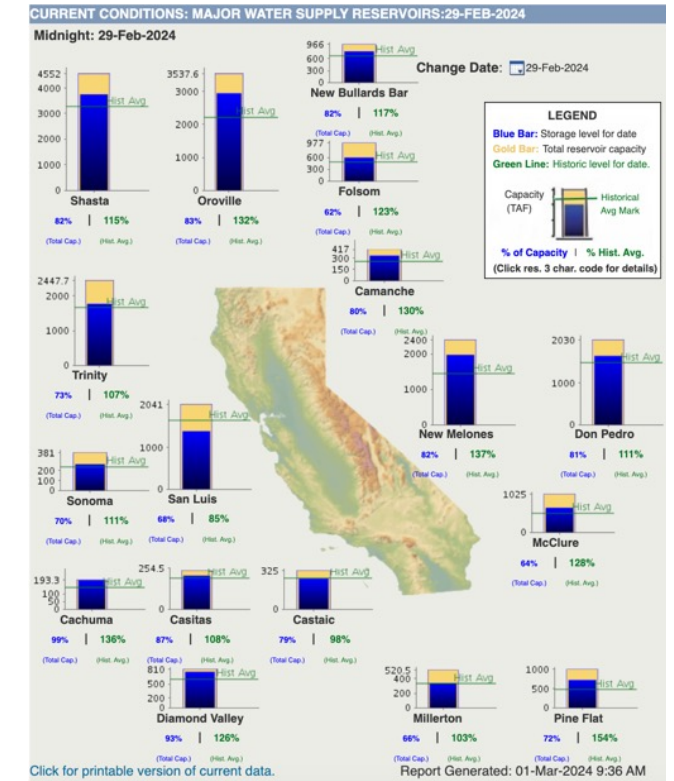
Data For: 01-Mar-2024

% Apr 1 Avg. / % Normal for this Date



Source: California DWR

Reservoir Storage



Source: California DWR

- As of 29 Feb, water-year-to-date precipitation is well-above normal in coastal Southern CA, slightly above normal in coastal Northern and Central CA, and slightly below-normal over the Sierra Nevada
- Current snowpack is near-normal for this time of year over the Northern Sierra Nevada and ~80% of normal in the Central and Southern Sierra Nevada
- Most large reservoirs in CA are operating at $\geq 70\%$ storage capacity and above-normal storage for this time of year

Looking Back: Week 3 AR Activity Forecasts

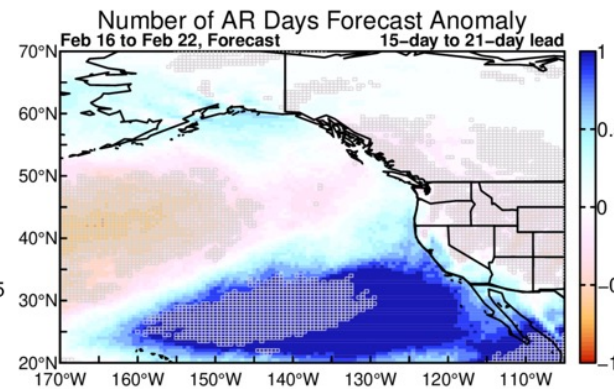
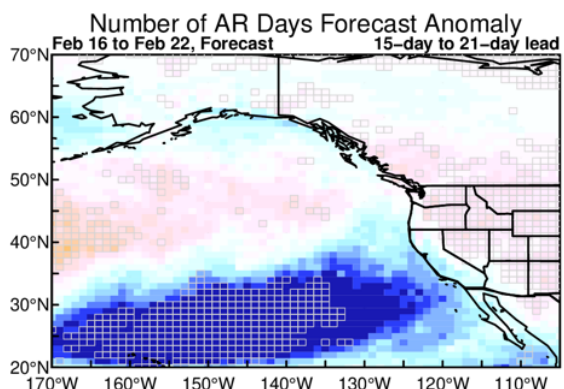
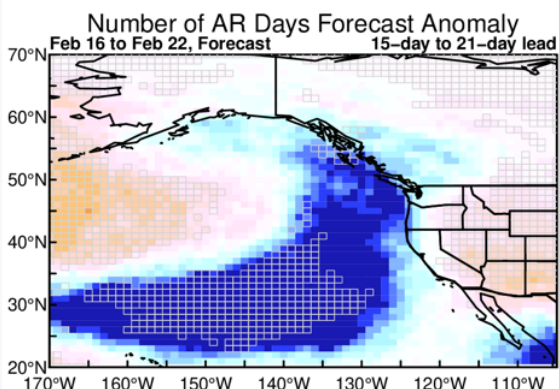
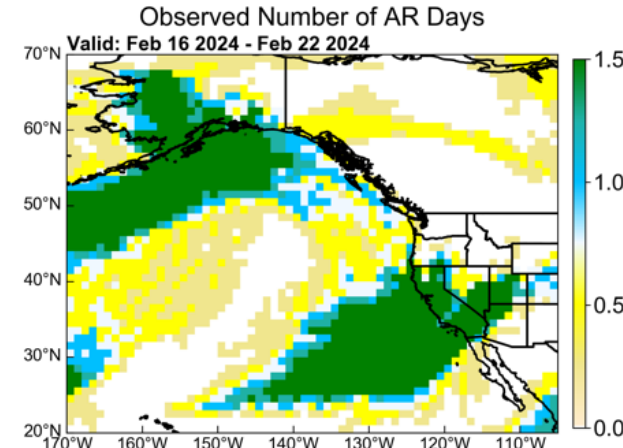
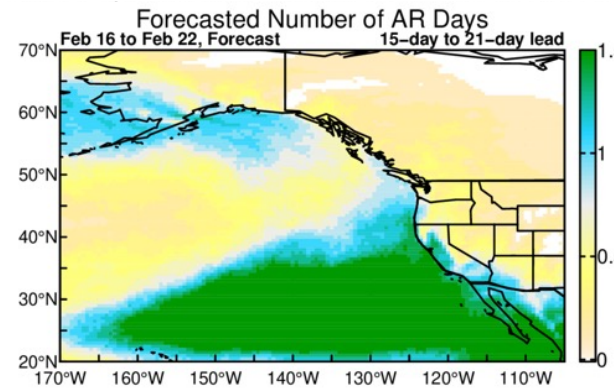
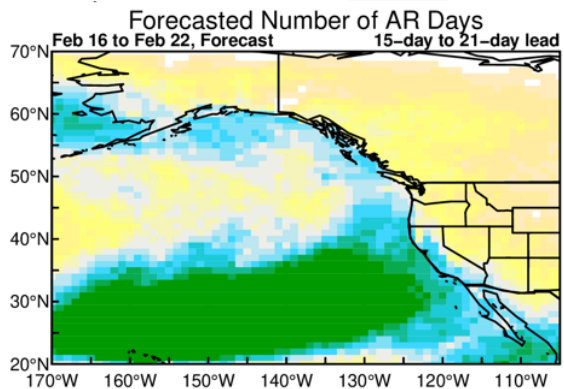
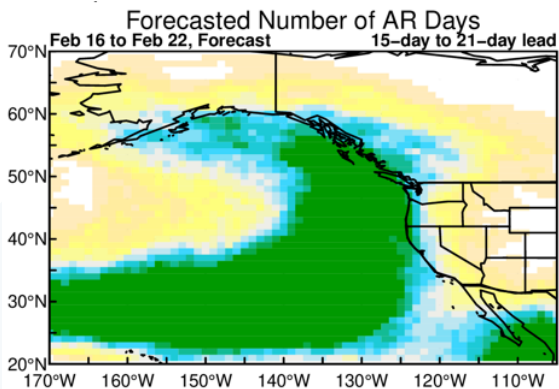
Forecasts Initialized 1 Feb 2024; Valid: 16–22 Feb 2024

NCEP

ECCE

ECMWF

Observed (GFS Analysis)

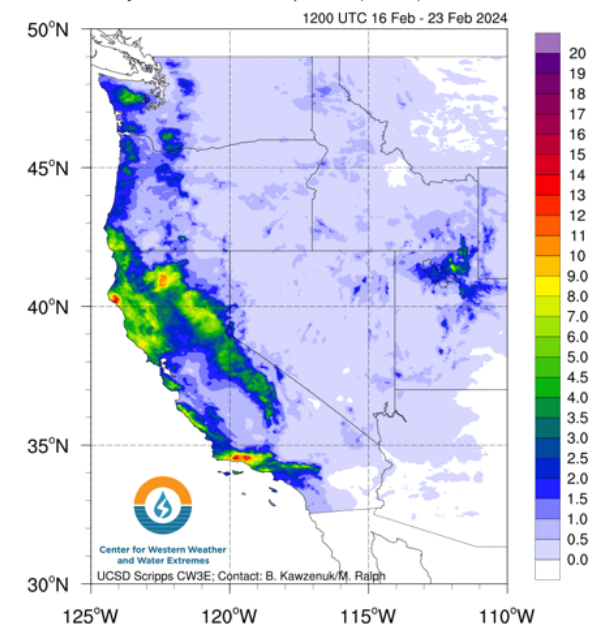


Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

- Models generally captured large-scale troughing over Northeast Pacific and AR activity near coastal CA, but underestimated the inland AR penetration
- NCEP struggled to capture the axis of AR activity extending from the subtropical Eastern Pacific to the southwestern US, with forecast AR activity directed northward along the US West Coast into British Columbia
- A moderate-strength AR produced heavy precipitation in the Northern Sierra Nevada, southern Cascades, Northern CA Coast Ranges, and western Transverse Ranges on 18–20 Feb

Observed Precipitation

7-day Accumulated Precipitation (inches)



Looking Back: Week 3 AR Activity Forecasts

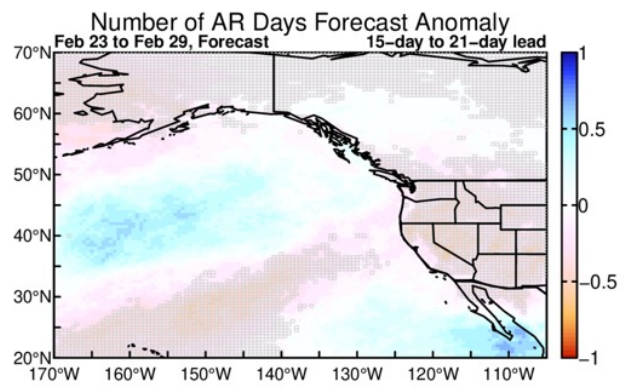
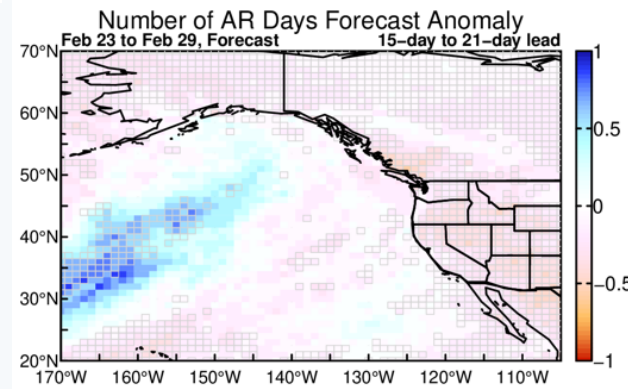
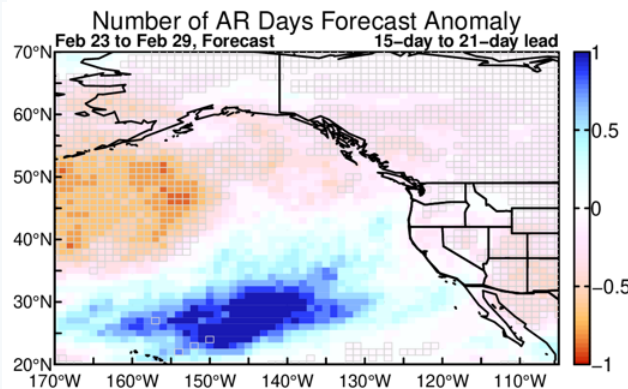
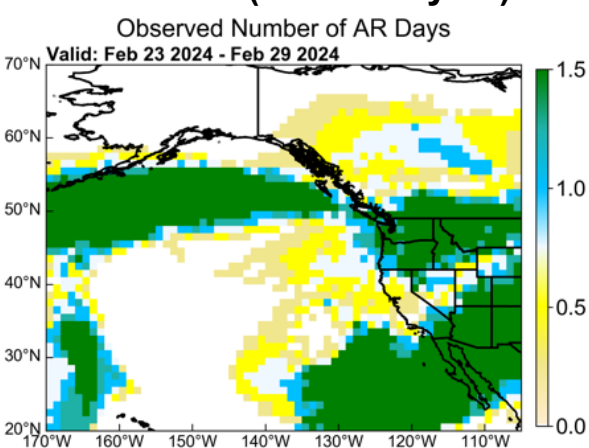
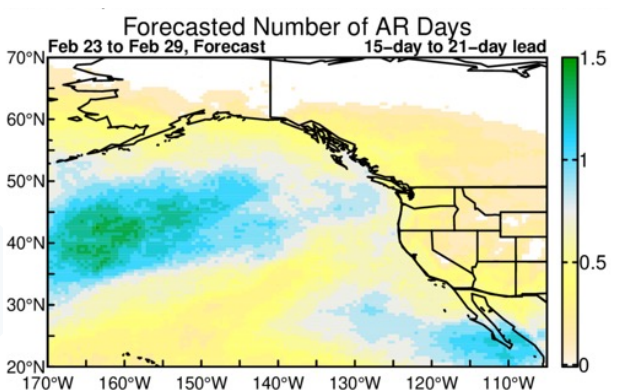
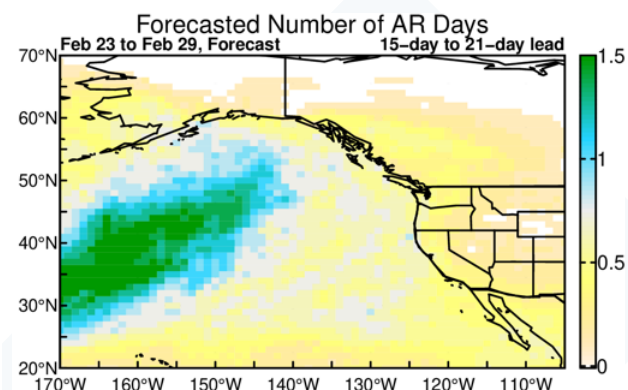
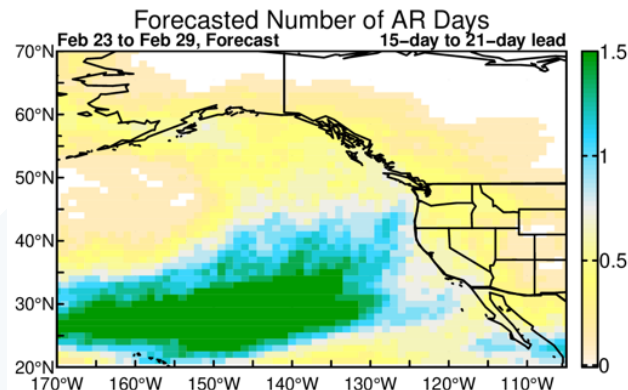
Forecasts Initialized 8 Feb 2024; Valid: 23–29 Feb 2024

NCEP

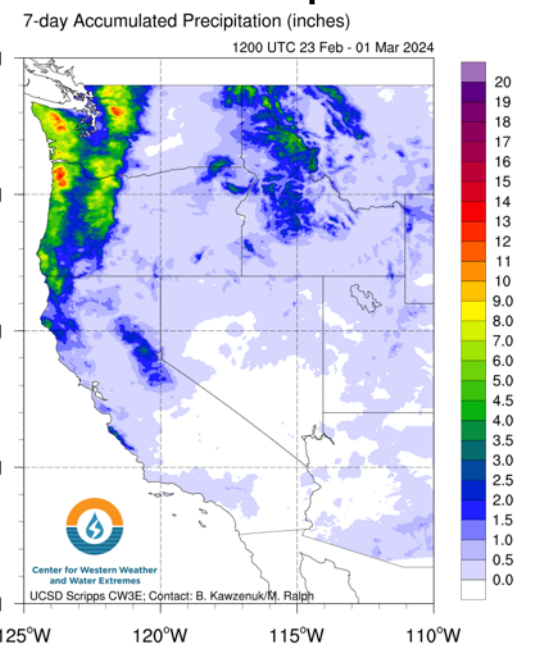
ECNC

ECMWF

Observed (GFS Analysis)



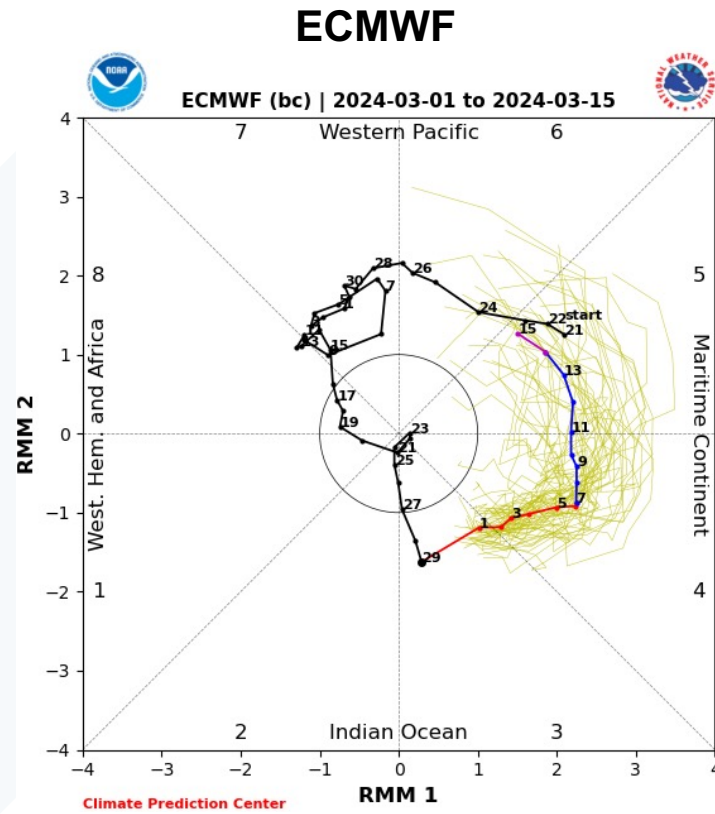
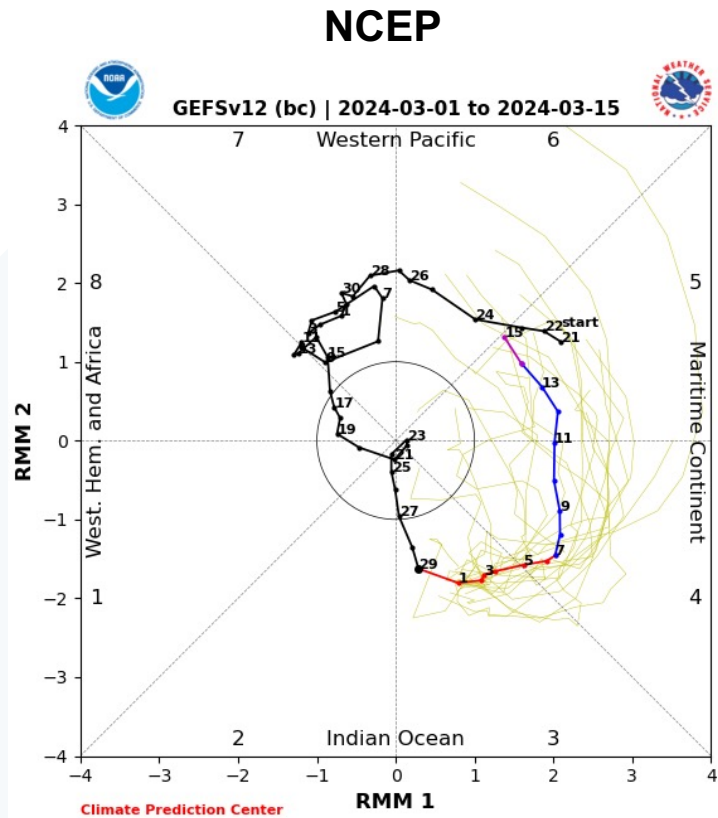
Observed Precipitation



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

- Models failed to capture the AR activity over the western US, especially the Pacific Northwest and the Southern CA AR activity are largely underestimated
- A weak AR brought moderate precipitation to the Pacific Northwest on 25-26 Feb
- A stronger AR and brought heavy rain and mountain snow to western WA, western OR, and Northern CA on 27-29 Feb

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)

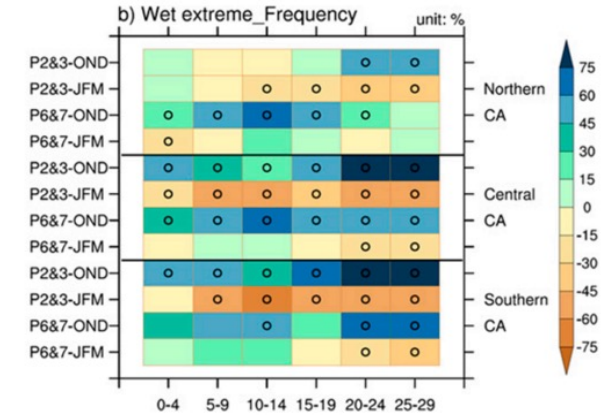


Figure 8 from Wang et al. (2023)

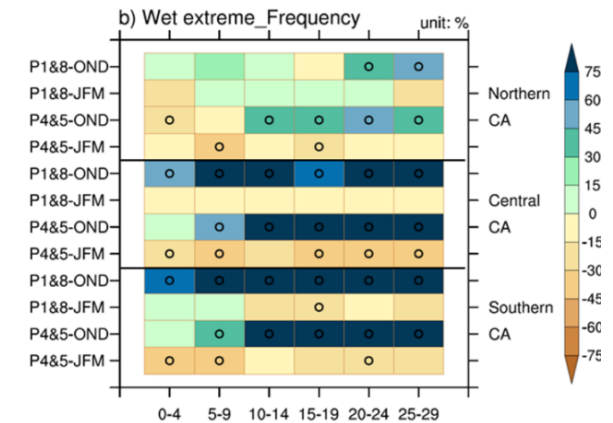
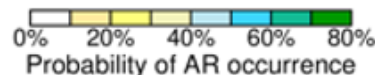
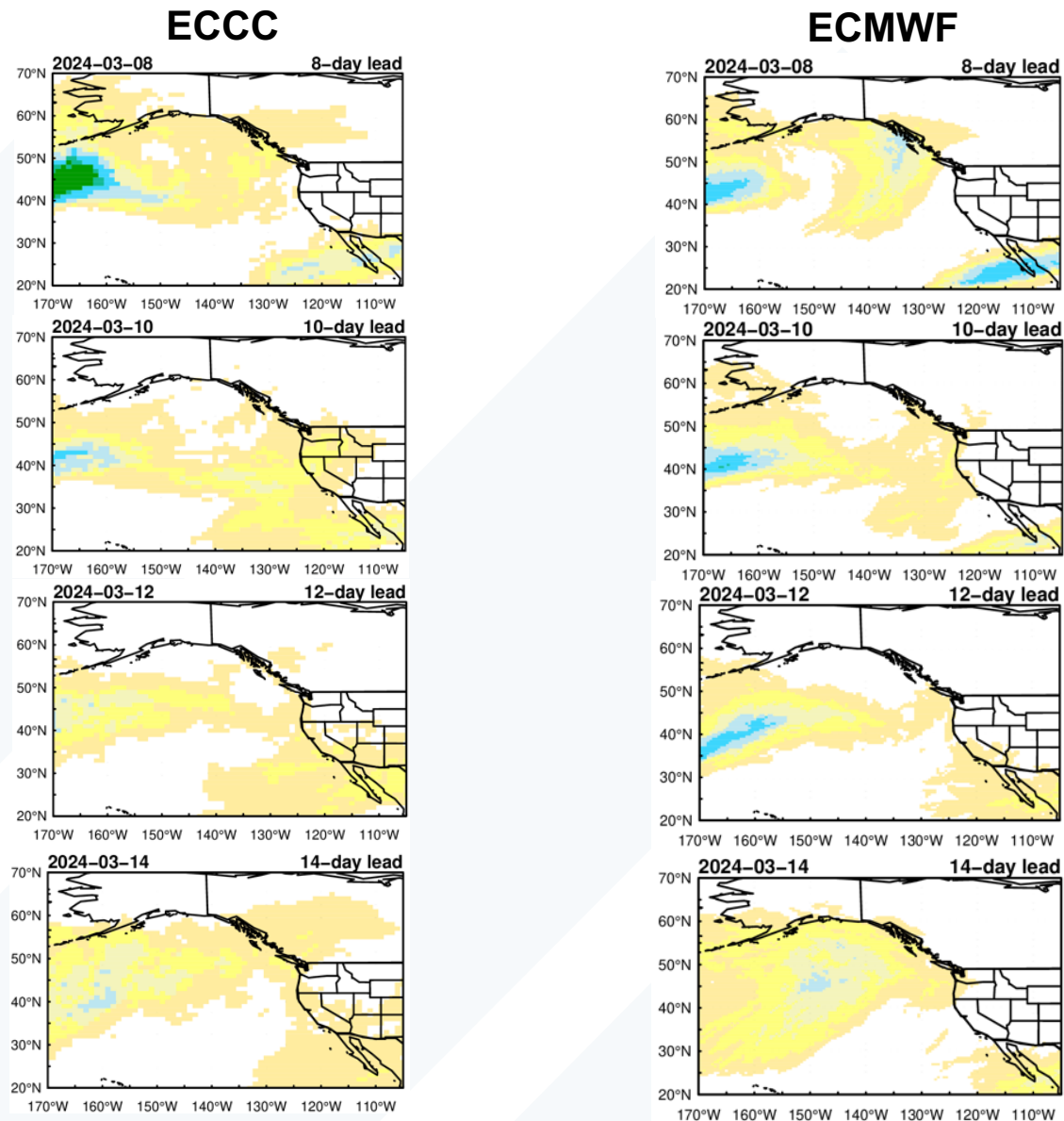


Figure S6 from Wang et al. (2023)

- MJO convection is currently strong over the Indian Ocean (Phases 2–3)
- Models are forecasting MJO convection to propagate eastward over the Maritime Continent (Phases 4–5) during Weeks 1-2
- MJO activity over the Indian Ocean and Maritime Continent during JFM is associated with a statistically significant decrease in wet extremes in CA at lag times of 2–4 weeks

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

Forecasts Initialized 29 Feb 2024

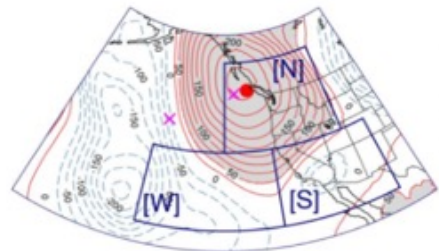


- Both models are forecasting very low likelihood (< 30% probability) of AR activity over WA/OR and CA during Week 2 (8–14 Mar)

Models generally agree on low likelihood of AR activity over CA during Week 2

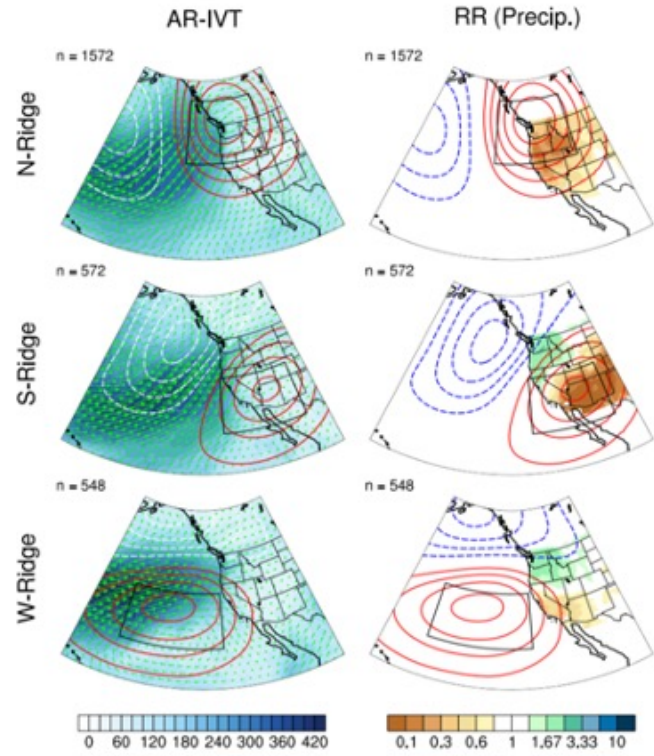
**Note that the probabilities of AR occurrence in the Week 2 AR activity plots may differ from the probabilities of AR conditions in the AR landfall tool. These discrepancies exist due to the use of different models (e.g., GEFS vs. CFSv2), model configurations (S2S models are coupled between ocean, land, and atmosphere), and methods for AR detection.*

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

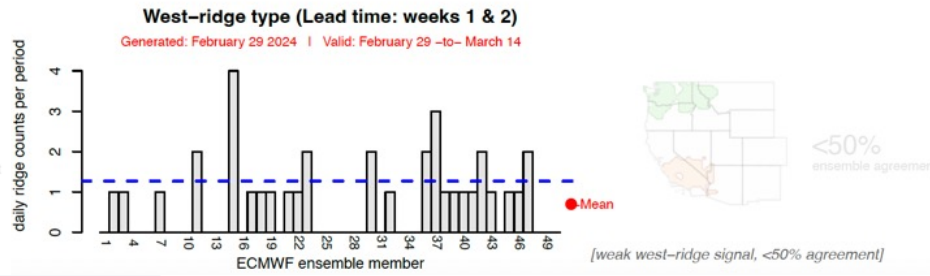
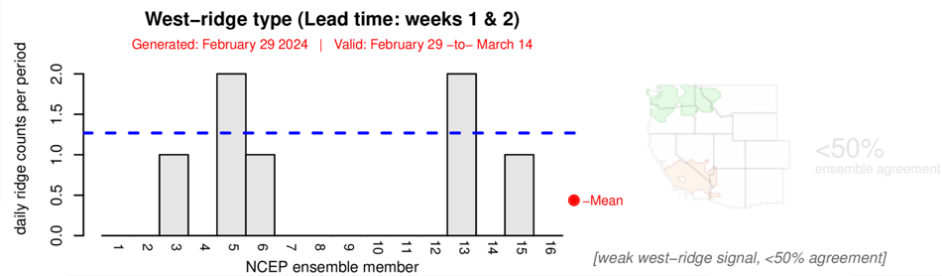
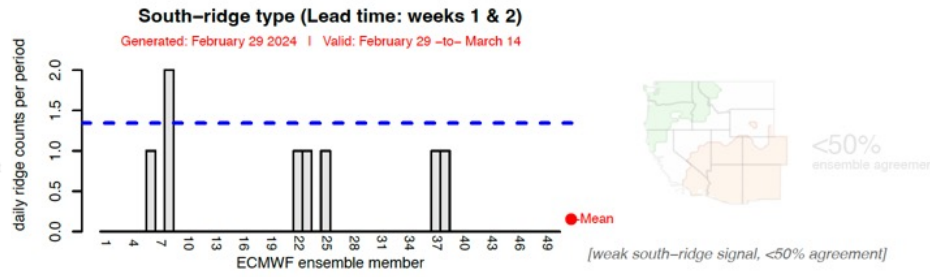
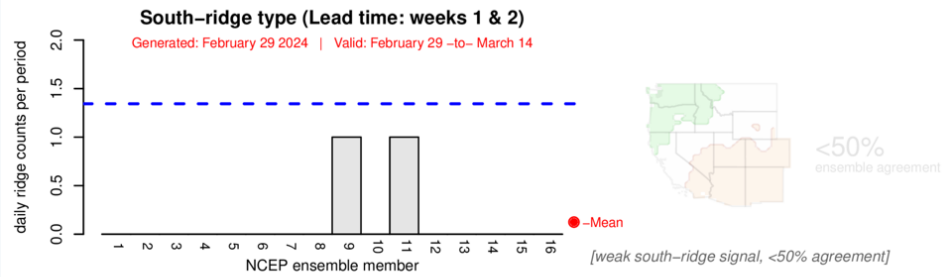
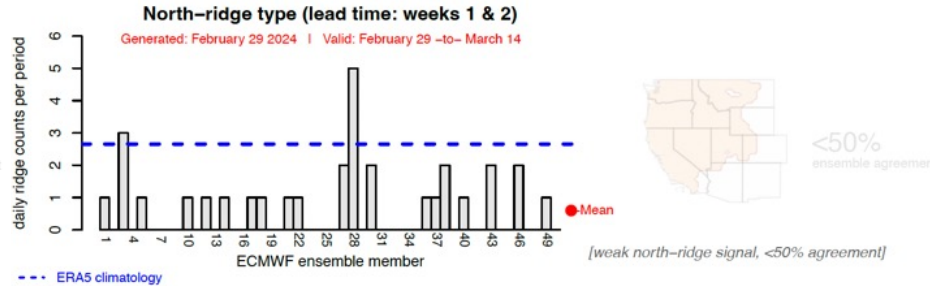
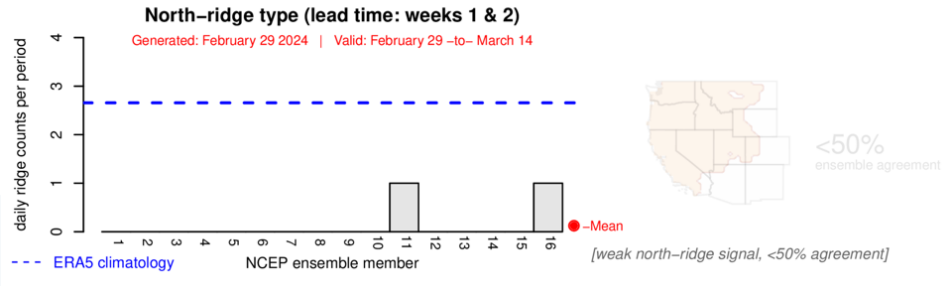
Subseasonal Outlooks: Weeks 1–2 Ridging Forecasts (NCEP vs. ECMWF)

Forecasts Initialized 29 Feb 2024

NCEP

ECMWF

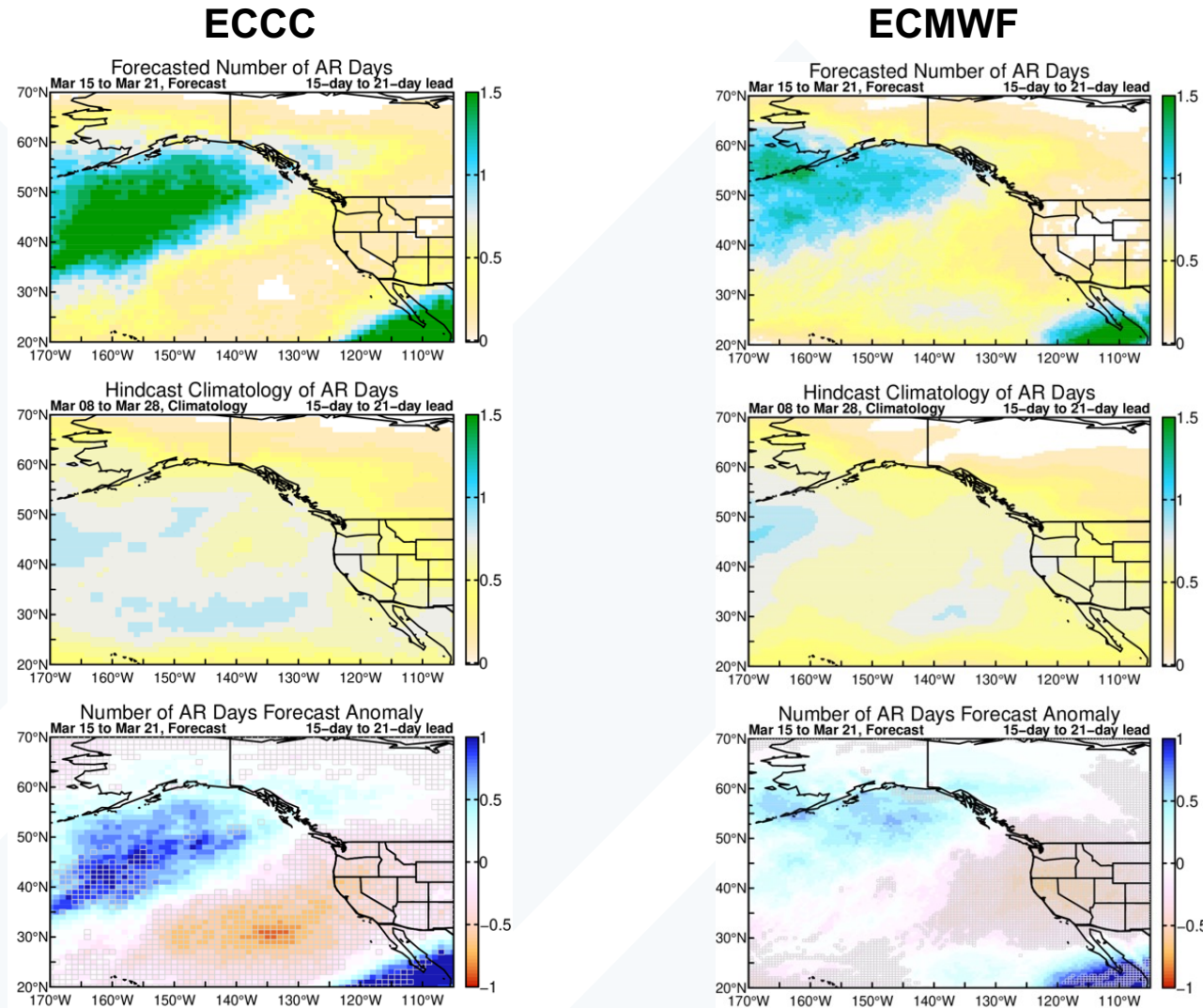
- NCEP and ECMWF are both predicting very low ridging activity near the US West Coast during Weeks 1–2 (29 Feb – 14 Mar)



Models agree on very low likelihood of persistent ridging near the US West Coast during Weeks 1–2

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

Forecasts Initialized 29 Feb 2024



- Both models are forecasting below-normal AR activity in WA/OR and CA with high confidence (> 75% ensemble agreement) during Week 3 (15–21 Mar)

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

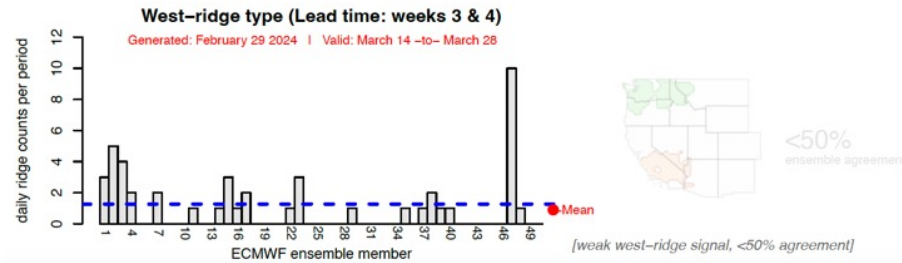
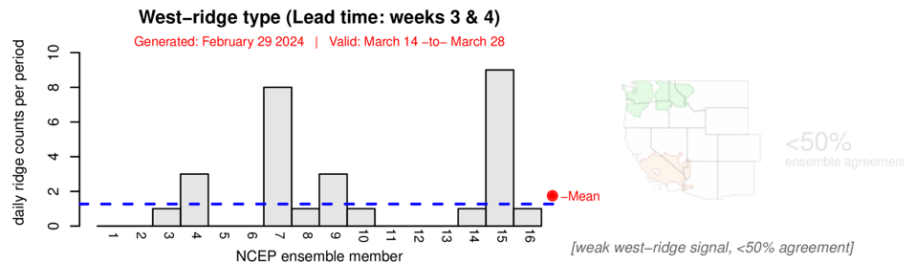
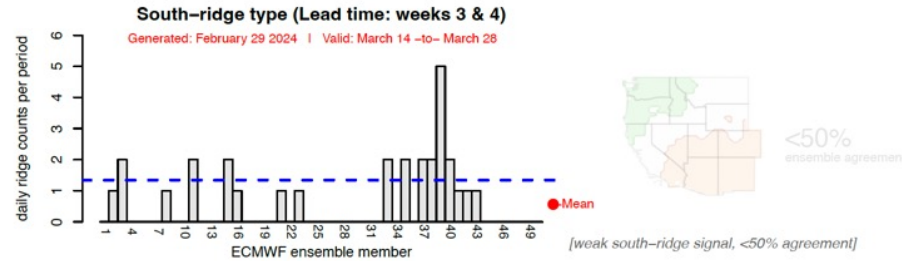
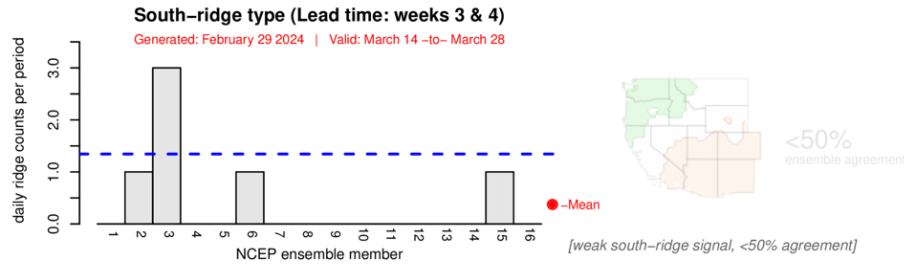
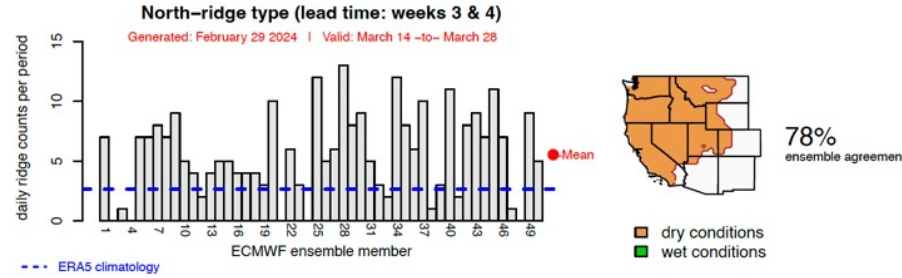
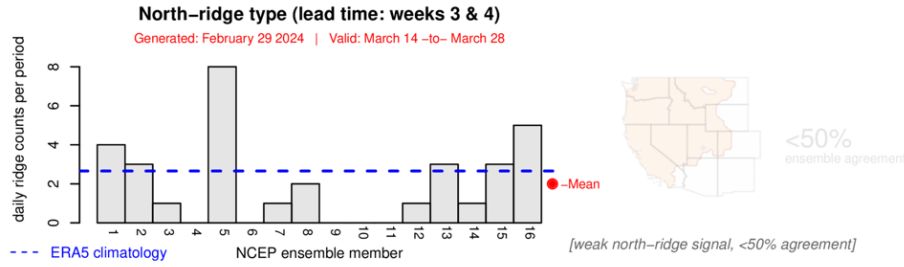
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

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

Forecasts Initialized 29 Feb 2024

NCEP

ECMWF

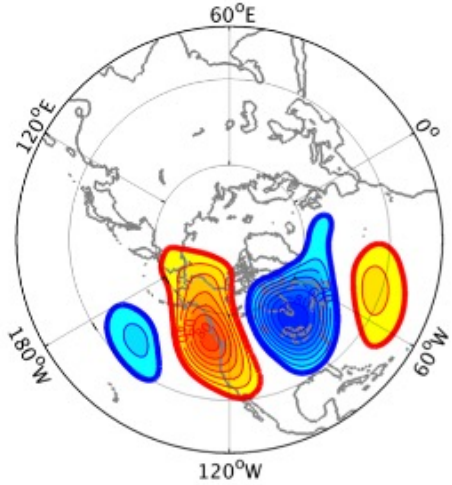


- Overall, NCEP is forecasting below-normal ridging activity near the US West Coast during Weeks 3–4 (14–28 Mar)
- ECMWF is showing a high likelihood (78% ensemble agreement) of above-normal North-ridge activity
- Both models are predicting low South-ridge and near-normal West-ridge activity

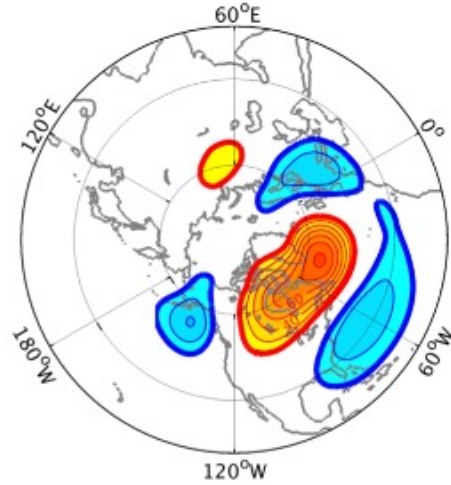
Models disagree on likelihood of above-normal ridging activity over the Pacific Northwest during Weeks 3–4

Background Info: IRI Subseasonal Weather Regime Forecasts

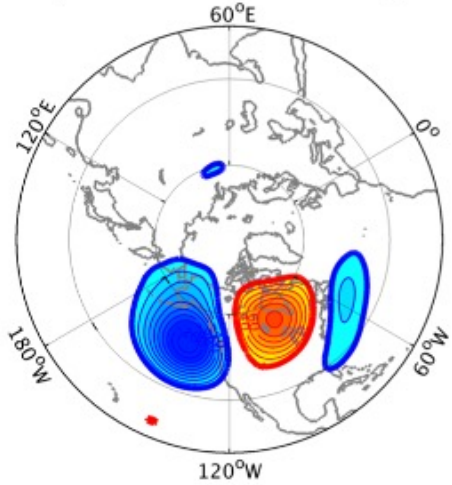
a) WR 1: West Coast Ridge



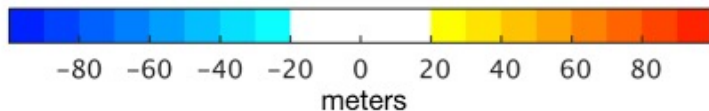
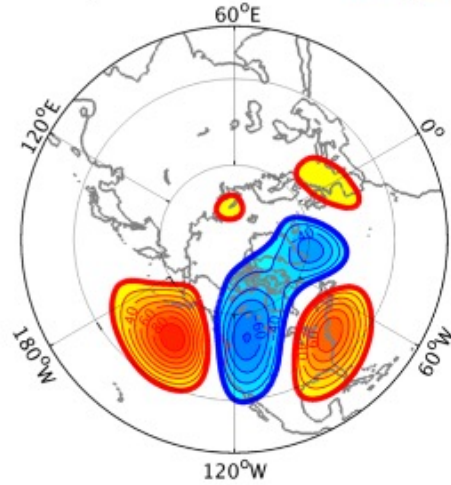
b) WR 2: Greenland High



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)

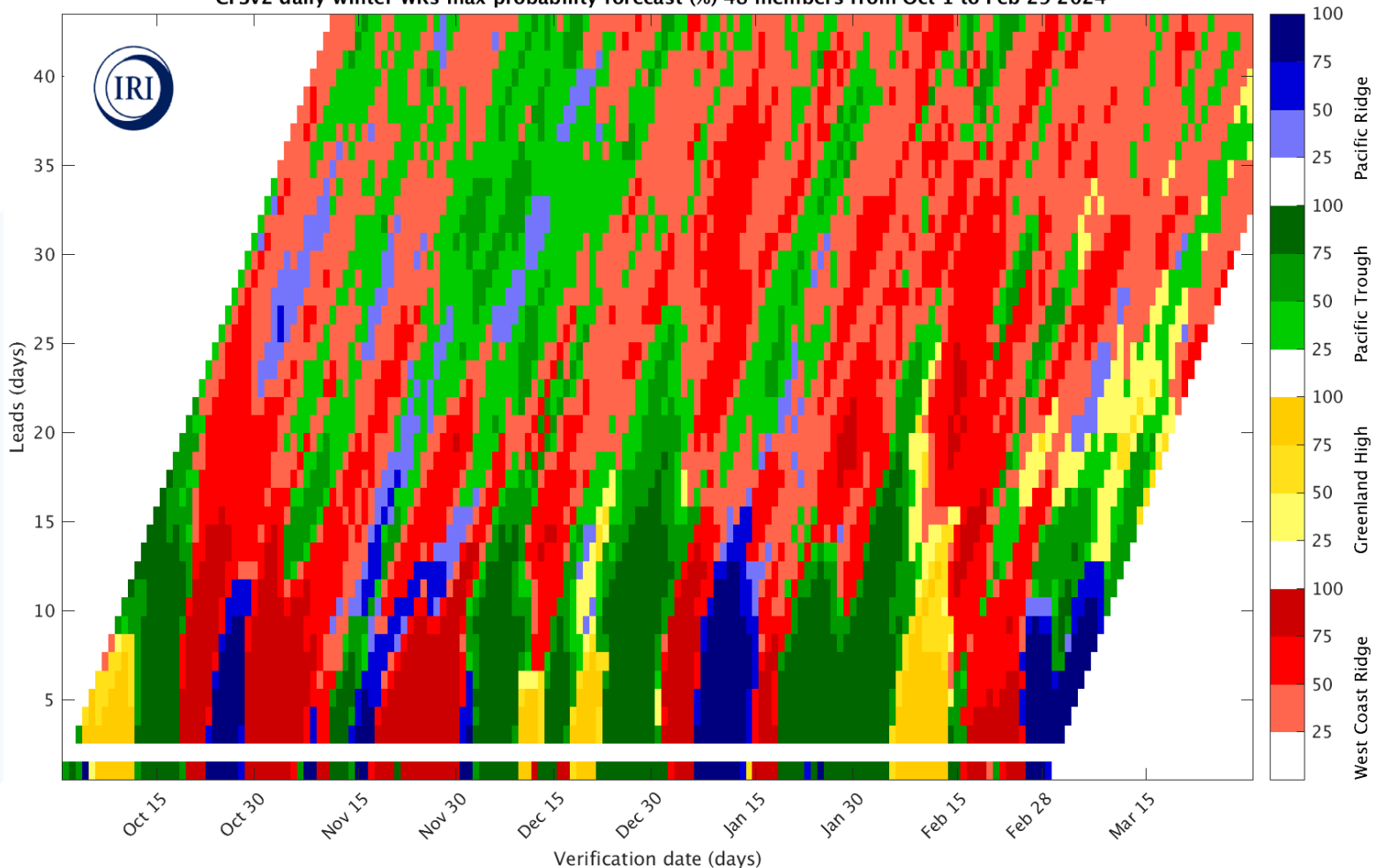
Reference: [Robertson et al. \(2020\)](#)

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

CFSv2 daily winter WRs max probability forecast (%) 48 members from Oct 1 to Feb 29 2024



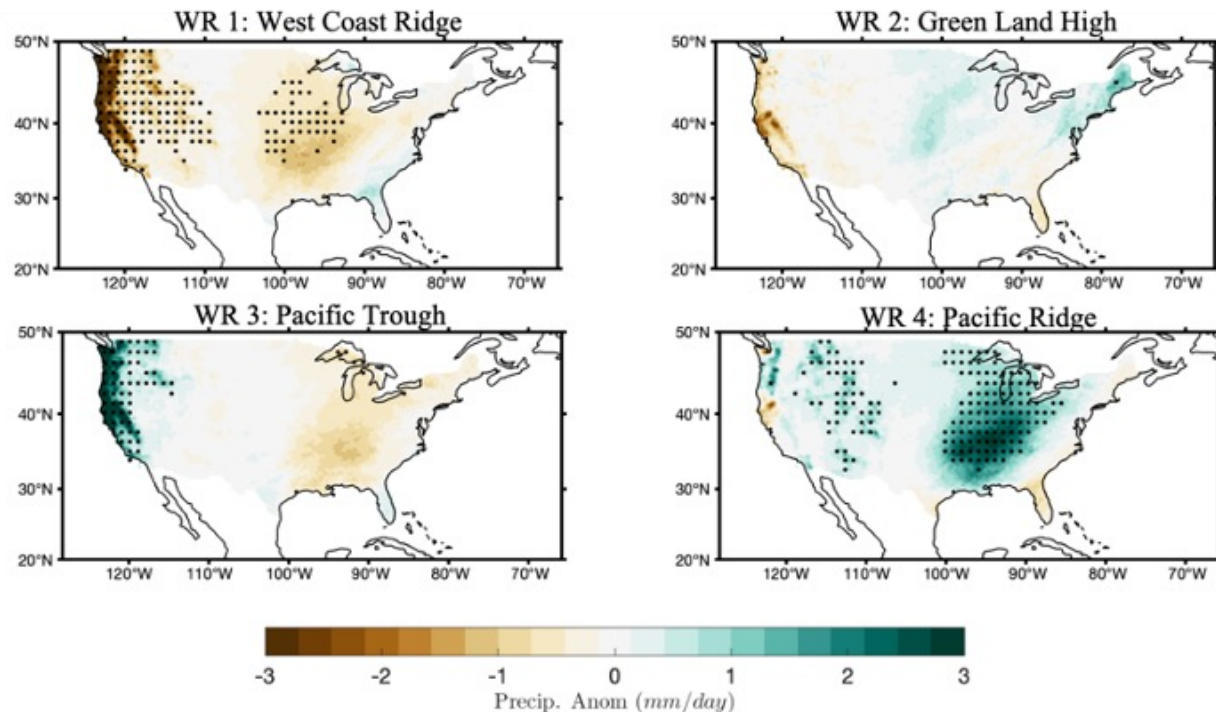
Forecast Initialized 29 Feb 2024

- 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 Pacific Trough during Week 2 (8-14 Mar)
- Moderate likelihood (50-75% ensemble agreement) of Greenland High conditions during most of Week 3 (15–21 Mar)
- Moderate likelihood (50-75% ensemble agreement) of West Coast Ridge conditions during Week 4 (22-28 Mar)

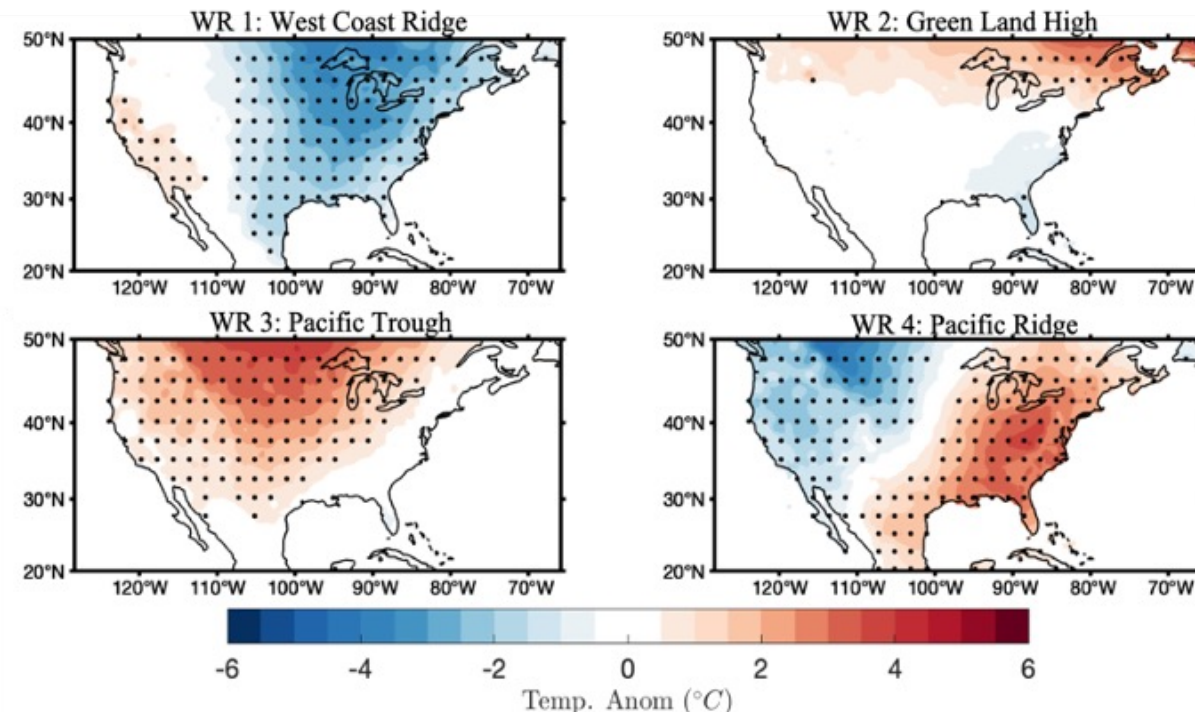
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime. See the next slide for temperature/precipitation implications.

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation



Temperature



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

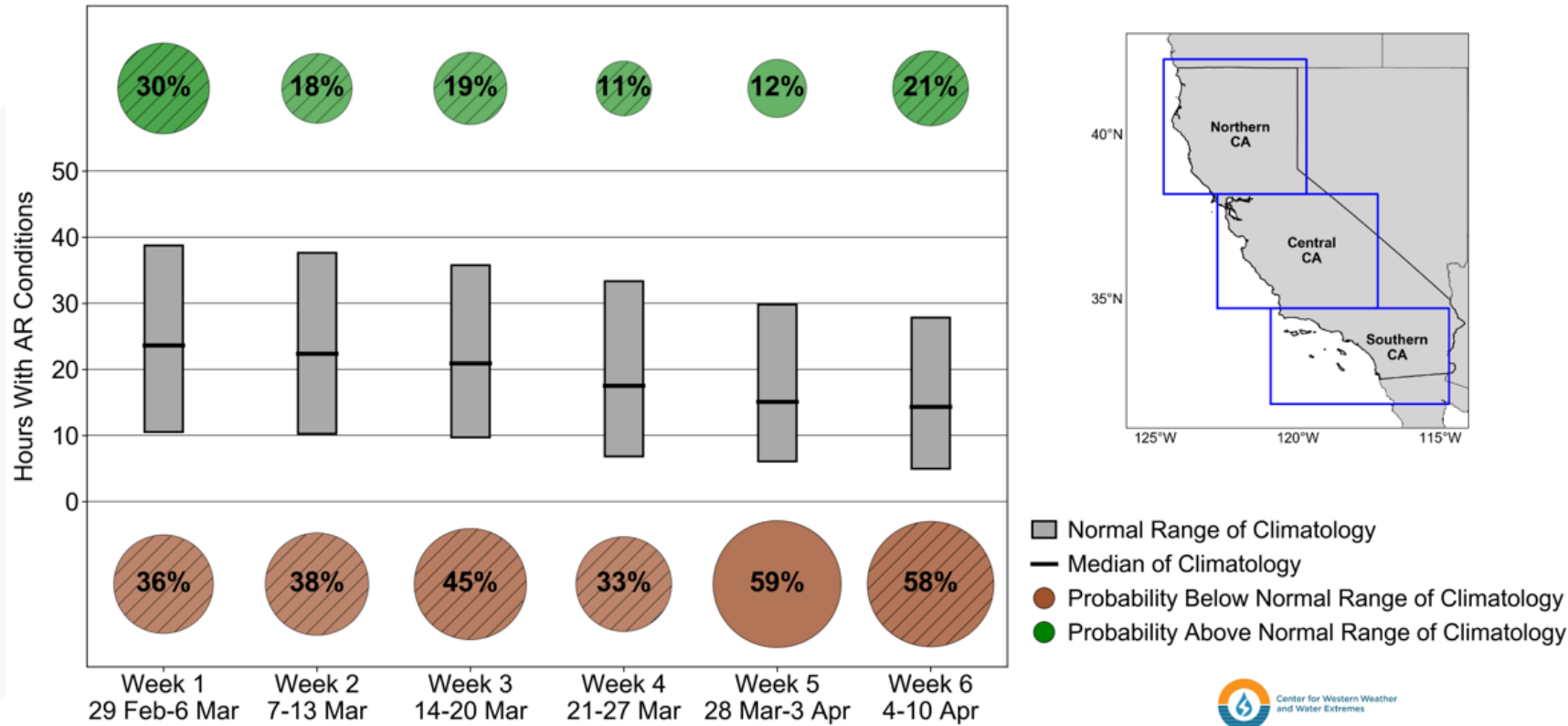
- Cold conditions transition to warm and wet conditions are predicted over CA during the second week of March with moderate-to-high confidence
- Dry and warm conditions are predicted over CA during the fourth week in March with moderate confidence

Subseasonal Outlooks: AR Activity and Precipitation Based on MJO and QBO

Forecasts Initialized 28 Feb 2024

AR Occurrence: Northern CA

Northern CA Subseasonal AR Occurrence Outlook
Issued: 28 Feb 2024 MJO Phase 3 EQBO



- CW3E's statistical forecast tool based on current MJO and QBO conditions is showing a high likelihood (> 50%) of below-normal AR occurrence during Weeks 5-6 in Northern CA
- The same product is showing a high likelihood of below-normal AR occurrence in Central CA during Weeks 2 and 5 and in Southern CA during Weeks 2 and 6



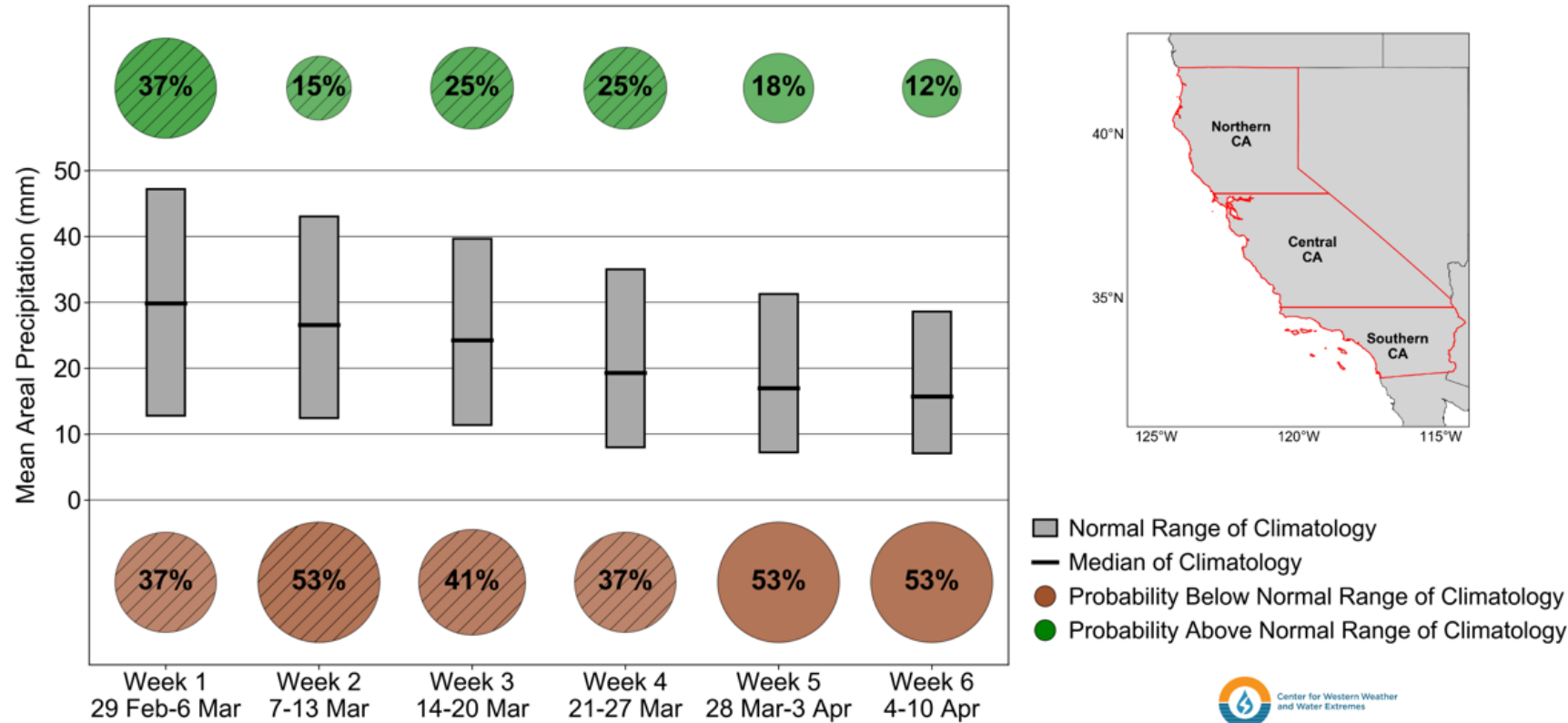
This product shows weekly probabilities of above-normal and below-normal AR occurrence in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If MJO convection is weak or the QBO is in a neutral phase, no probabilities will be displayed. Circles without hatching denote periods with higher predictability based on the hindcast skill assessment in [Castellano et al. \(2023\)](#)

Subseasonal Outlooks: AR Activity and Precipitation Based on MJO and QBO

Forecasts Initialized 28 Feb 2024

Precipitation: Northern CA

Northern CA Subseasonal Precipitation Outlook
 Issued: 28 Feb 2024 MJO Phase 3 EQBO



- CW3E's statistical forecast tool based on current MJO and QBO conditions is showing a high likelihood (> 50%) of below-normal precipitation during Weeks 2 and 5-6 in Northern CA
- The same product is showing a high likelihood of below-normal precipitation in Central CA in Weeks 2 and 5-6 and in Southern CA during Weeks 3 and 5-6

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 higher predictability based on the hindcast skill assessment in [Castellano et al. \(2023\)](#)