



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 15 March 2024

Prepared by: Z. Yang, C. Castellano, J. Wang, M. DeFlorio, J. Kalansky

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*

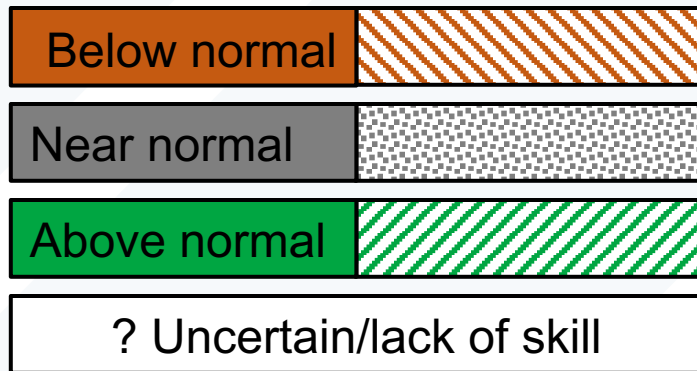
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 14 Mar 2024

Region	Week 2 (22–28 Mar)				Week 3 (29 Mar–4 Apr)				Week 4 (5–11 Apr)		
	NCEP ^{2,3}	ECMWF ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{1,2,3}	ECMWF ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ²	ECMWF ²	Multi-Model Forecast
WA/OR	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Uncertain	Uncertain	Uncertain
Northern CA	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Uncertain	Uncertain	Uncertain
Central CA	Below normal	Below normal	Below normal	Below normal	Near normal	Near normal	Below normal	Uncertain	Uncertain	Uncertain	Uncertain
Southern CA	Below normal	Below normal	Below normal	Below normal	Near normal	Near normal	Below normal	Uncertain	Uncertain	Uncertain	Uncertain

Higher Confidence | Lower Confidence



- Models favor below-normal precipitation in CA and WA/OR during Week 2
- Week 3 forecasts are suggesting below-normal precipitation over Northern CA and WA/OR
- Large uncertainty in precipitation conditions 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](#))

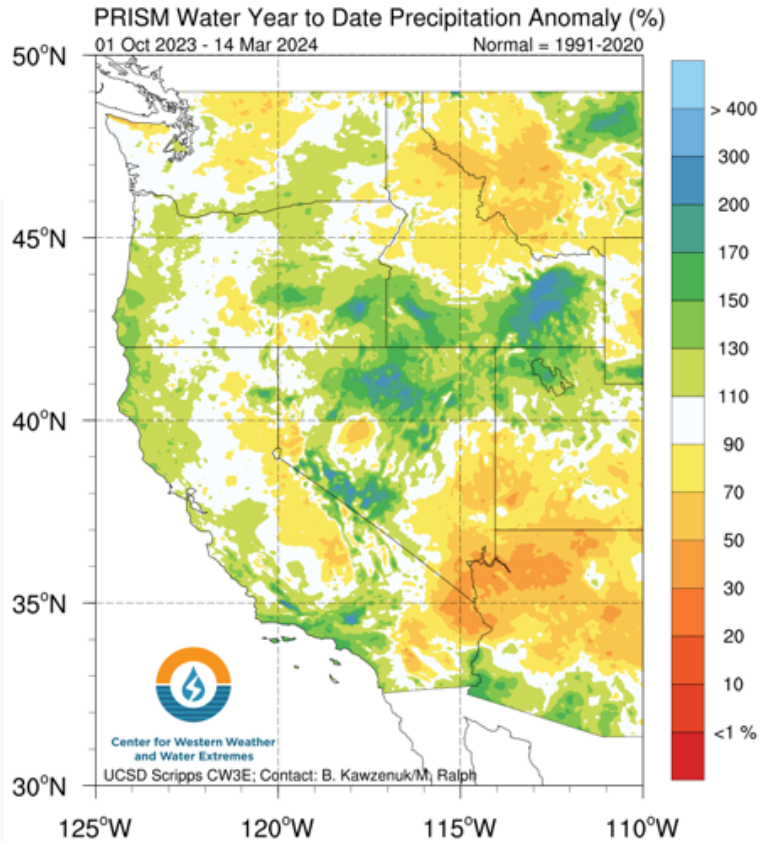
³IRI North American Weather Regime Forecasts ([Robertson et al. 2020](#))

Summary

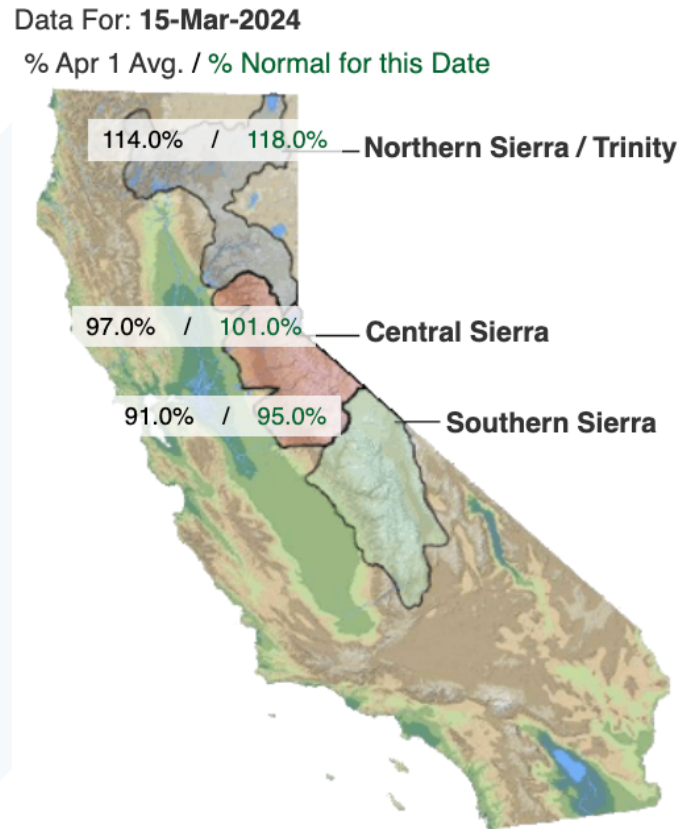
- **Week 2 forecasts (22–28 Mar):** Models favor very low likelihood of AR activity in CA during Week 2
- As of 14 Mar, MJO convection is located over the Maritime Continent
 - MJO activity in the Maritime Continent during JFM is associated with a significant decrease in wet extremes in Central CA at lag times of 1-4 weeks
 - Models agree that MJO will remain strong and propagate eastward into the Western Pacific (Phases 6-7) during Week 1 and early Week 2. Subsequently, it is expected to propagate towards the Western Hemisphere and Africa (Phases 1 and 8), weakening toward the end of Week 2
- Models favor above-normal North-ridge activity during Weeks 1-2, which is typically associated with widespread dry conditions across the entire western US
- **Week 3 forecasts (29 Mar–4 Apr):** Models favor below-normal AR activity in Northern CA
 - Models show uncertain AR activity over Central and Southern CA
- Models show low likelihood of persistent ridging near the US West Coast during Weeks 3–4
- IRI weather regime tool shows high likelihood of West Coast Ridge conditions (warm and dry conditions in CA) during 22-24 March and moderate-to-high likelihood of Pacific Ridge (cold conditions in CA) during 25-29 March
- Statistical forecast tool based on current MJO/QBO conditions is showing a high likelihood (>50%) of below-normal AR activity and precipitation in Northern CA during Week 4 and Week 6, in Central CA during Week 1, and in Southern CA during Week 6

Hydrologic Summary

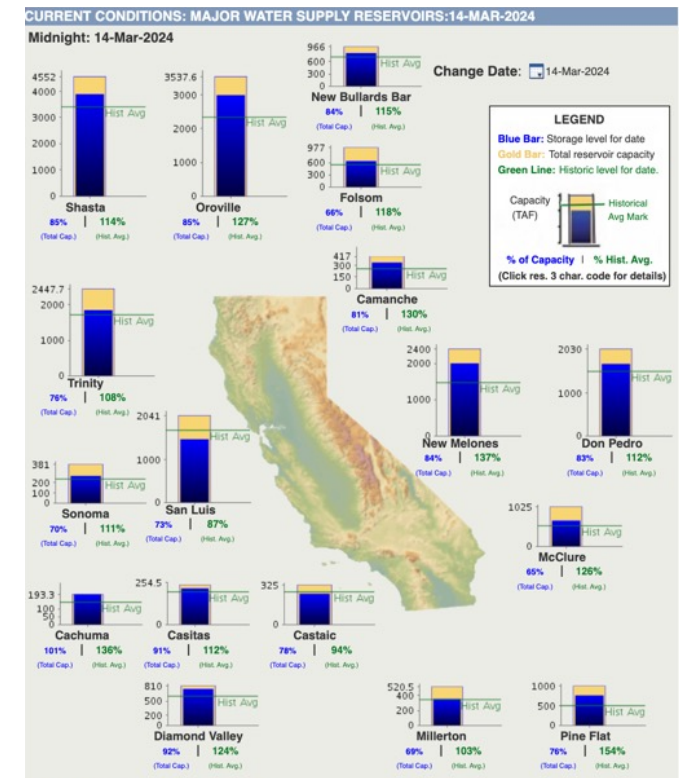
Precipitation



Snowpack Conditions



Reservoir Storage



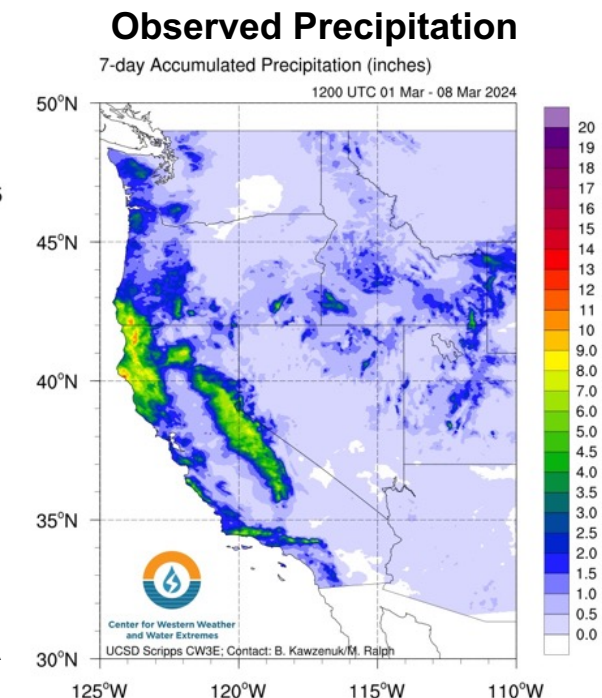
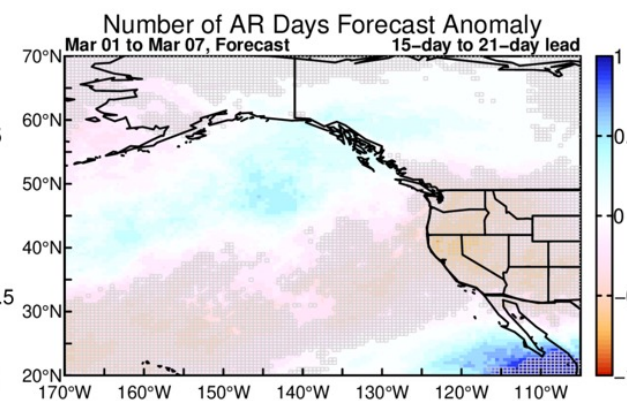
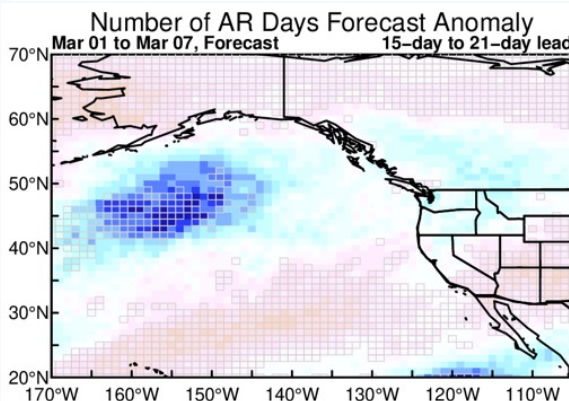
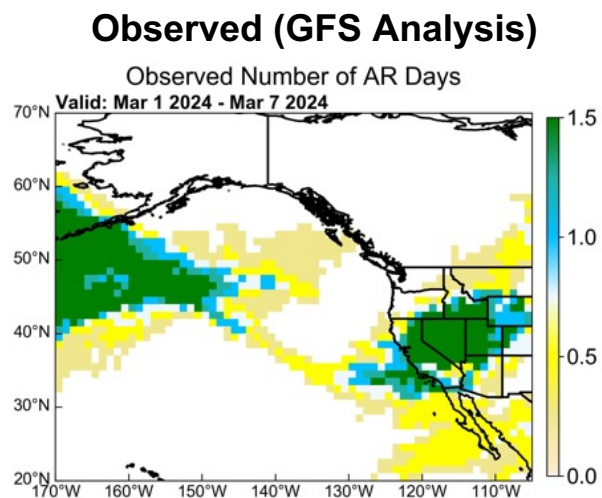
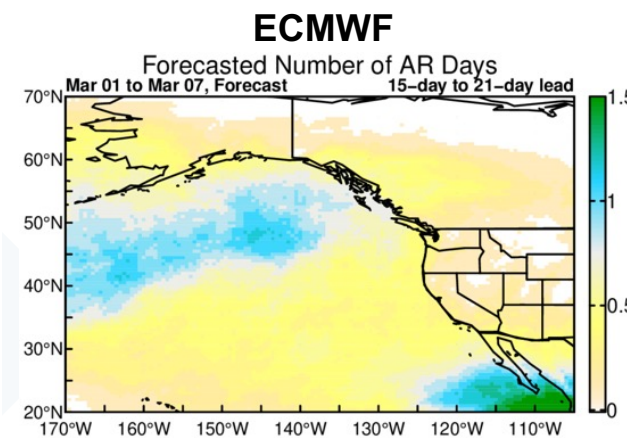
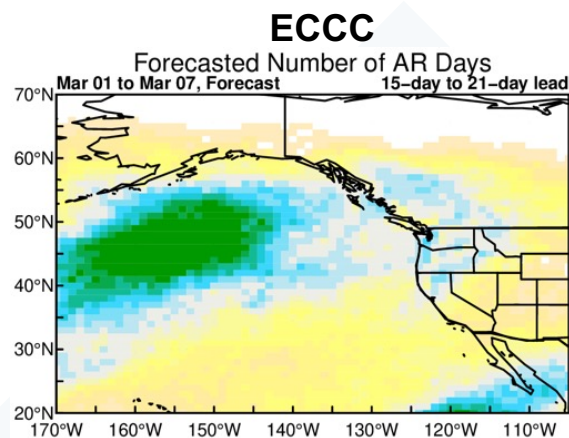
Source: California DWR

- As of 14 Mar, WY-to-date precipitation is >130% above-normal along coastal Southern CA, slightly above-normal in coastal Northern and Central CA, near-normal over the Northern and Central Sierra Nevada, and slightly below-normal over the Southern Sierra Nevada
- Current snowpack is slightly above-normal for this time of year over the Northern Sierra Nevada and near-normal in the Central and Southern Sierra Nevada
- Most 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 15 Feb 2024; Valid: 1 – 7 Mar 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

- ECCC and ECMWF failed to capture the AR activity over the western US, especially in Central CA
- An AR and a low-pressure system produced >10 inches of precipitation over Northern CA Coast Ranges and heavy snowfall in the Sierra Nevada during 1-3 Mar
- The AR also produced >2 inches of precipitation over Western OR/WA and coastal Southern CA

Looking Back: Week 3 AR Activity Forecasts

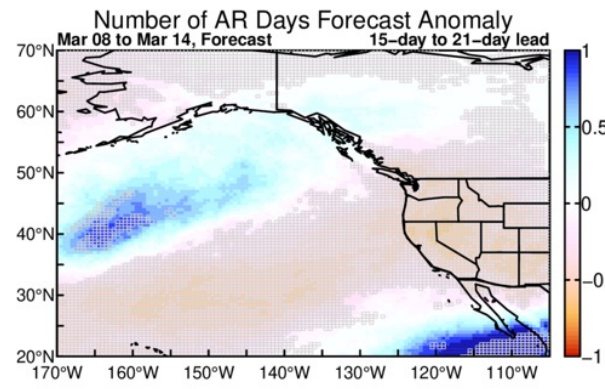
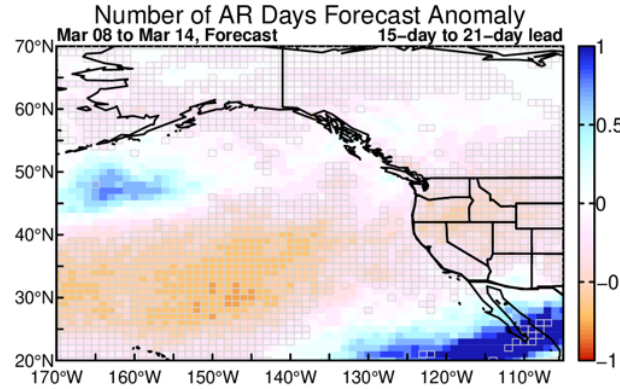
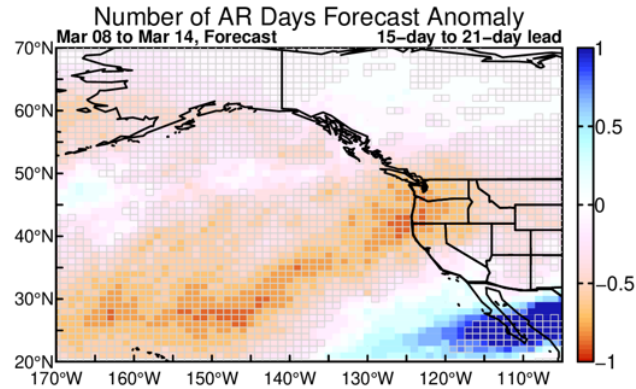
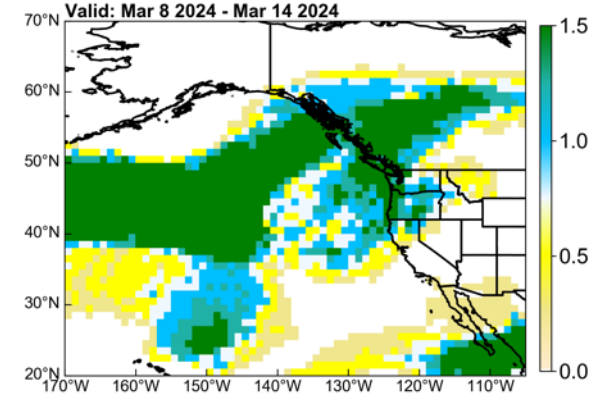
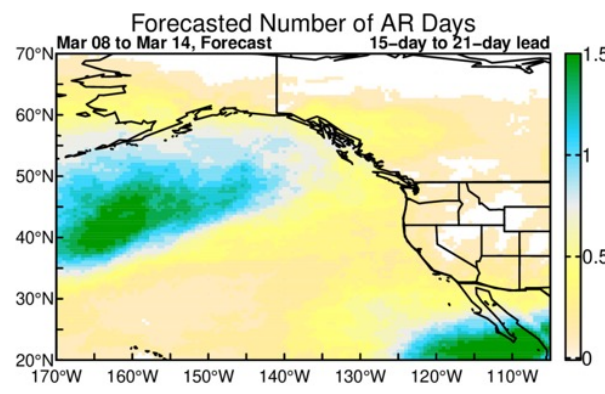
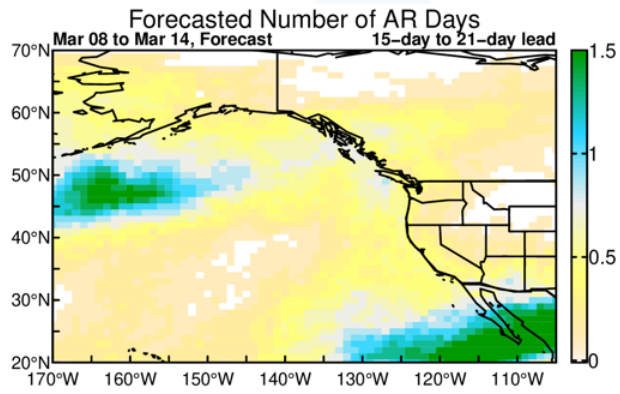
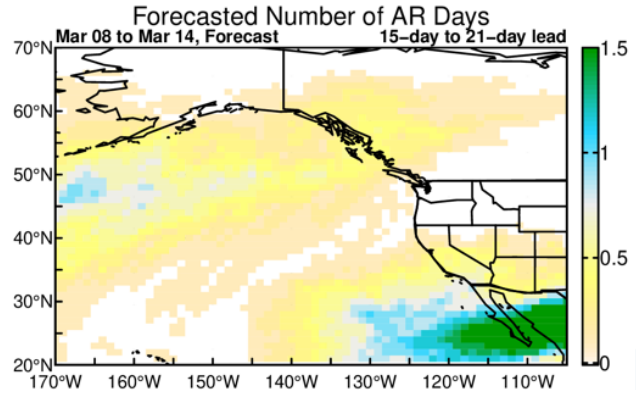
Forecasts Initialized 22 Feb 2024; Valid: 8 – 14 Mar 2024

NCEP

ECDC

ECMWF

Observed (GFS Analysis)

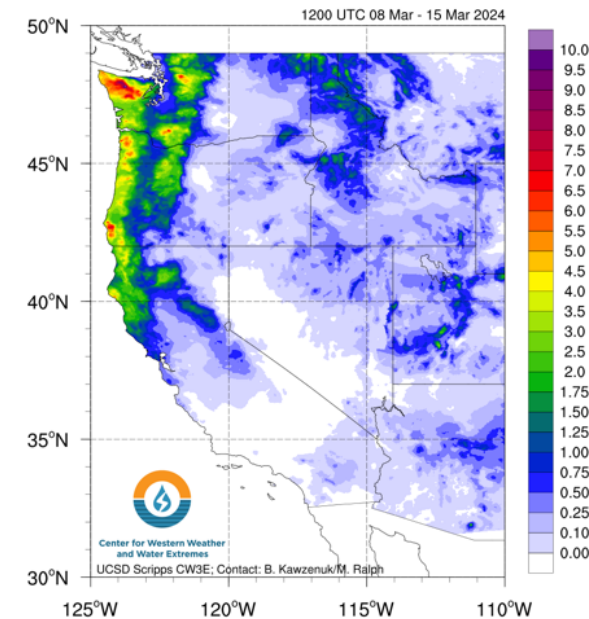


Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

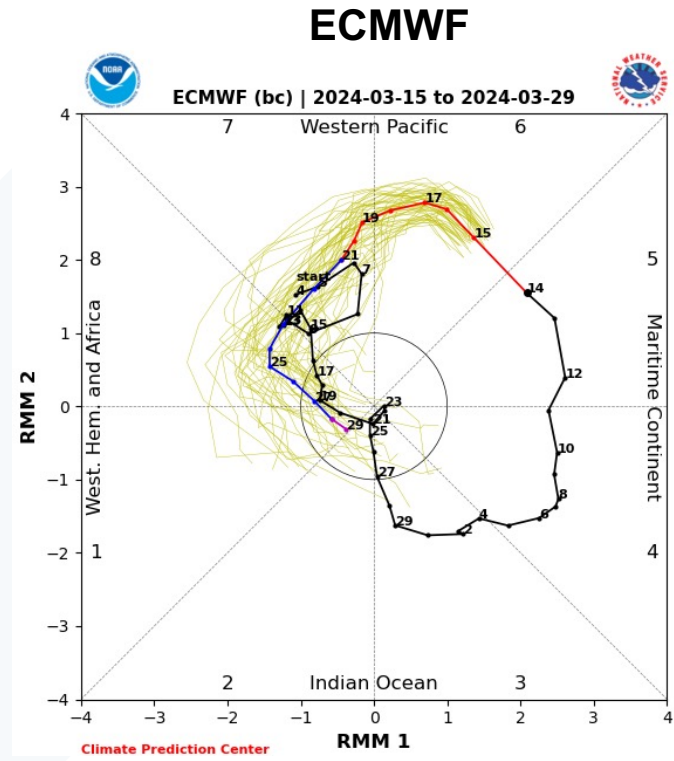
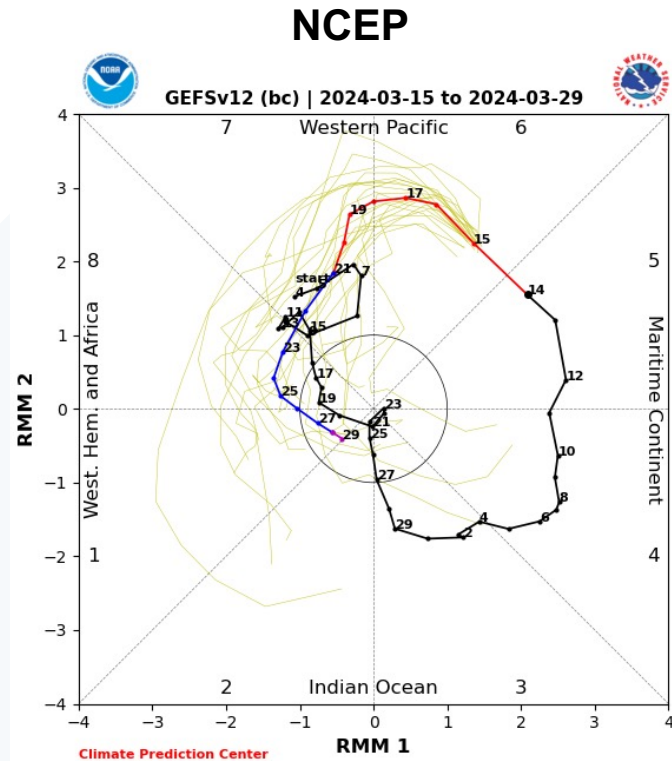
- Models failed to capture the AR activity over Northern CA and WA/OR
- ECDC and ECMWF captured some AR activity over North Pacific
- An AR brought heavy precipitation to WA/OR and Northern CA during 10-13 Mar

Observed Precipitation

7-day Accumulated Precipitation (inches)



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)

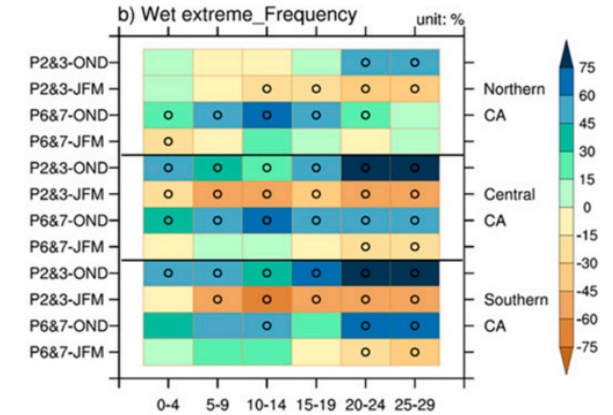


Figure 8 from Wang et al. (2023)

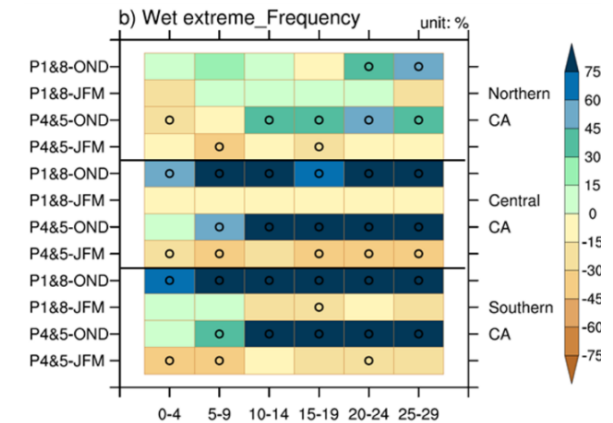


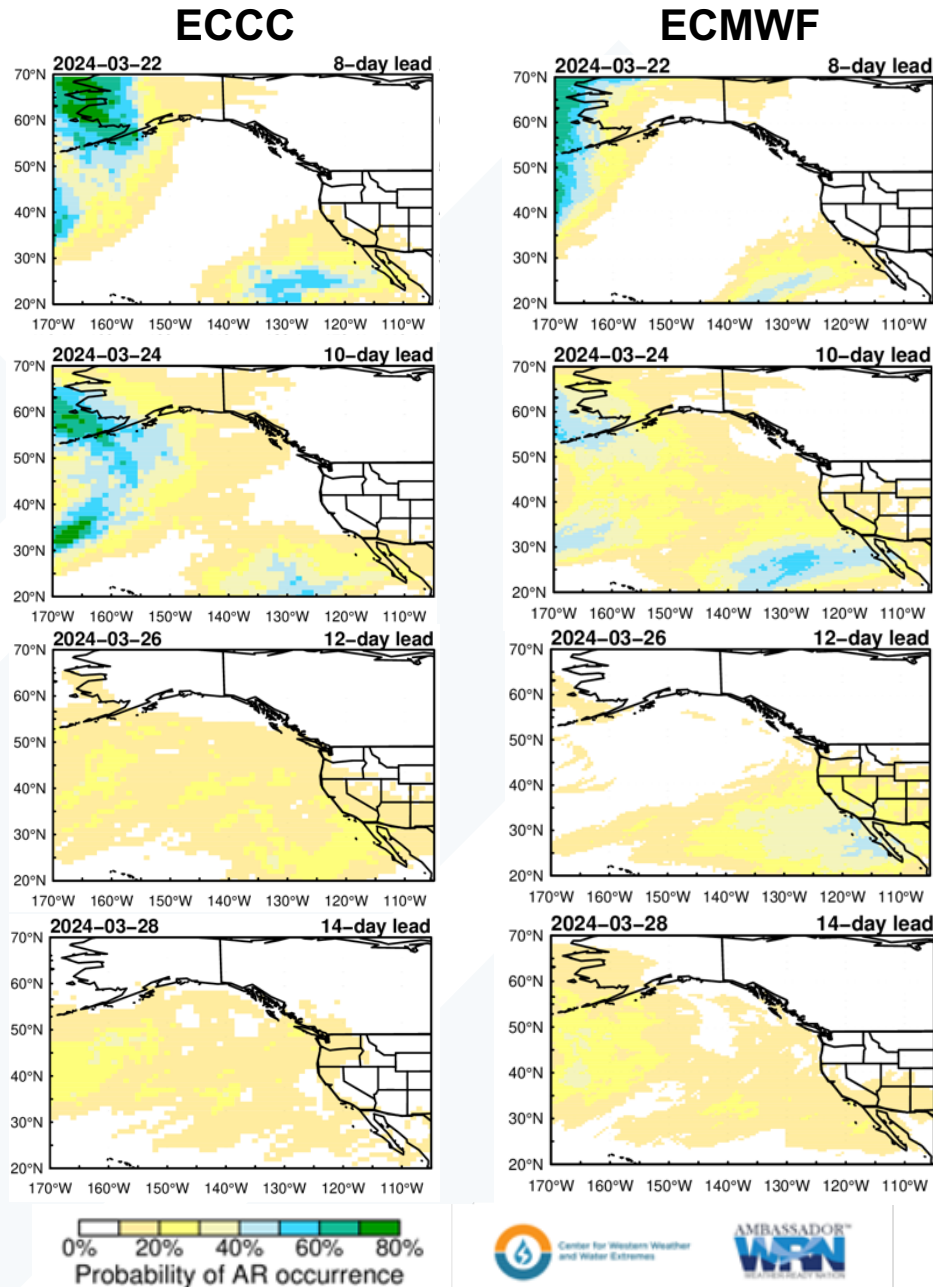
Figure S6 from Wang et al. (2023)

- Strong MJO convection is currently located over the Maritime Continent (Phases 4-5)
- MJO activity in the Maritime Continent during JFM is associated with a significant decrease in wet extremes in Central CA at lag times of 1-4 weeks
- Both models forecast the MJO to remain strong and propagate eastward into the Western Pacific (Phases 6-7) during Week 1 and early Week 2. Subsequently, it is expected to propagate towards the Western Hemisphere and Africa (Phases 1 and 8), weakening toward the end of Week 2
- MJO activity in the Western Pacific during JFM is associated with a significant decrease in wet extremes in Central and Southern CA at lag times of 3-4 weeks

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

Forecasts Initialized 14 Mar 2024

NCEP
unavailable

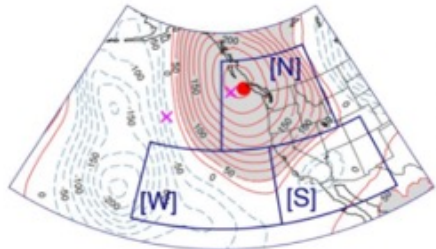


- ECCC and ECMWF are predicting very low likelihood (< 30% probability) of AR activity over CA and WA/OR during most of Week 2 (22-28 Mar)
- ECMWF is forecasting slightly higher likelihood of AR activity (30-40% probability) in Central/Southern CA during 24-26 Mar, with probabilities exceeding 40% along the coast

Models generally agree on low likelihood of AR activity over CA, especially in Northern CA during Week 2 (22-28 Mar)

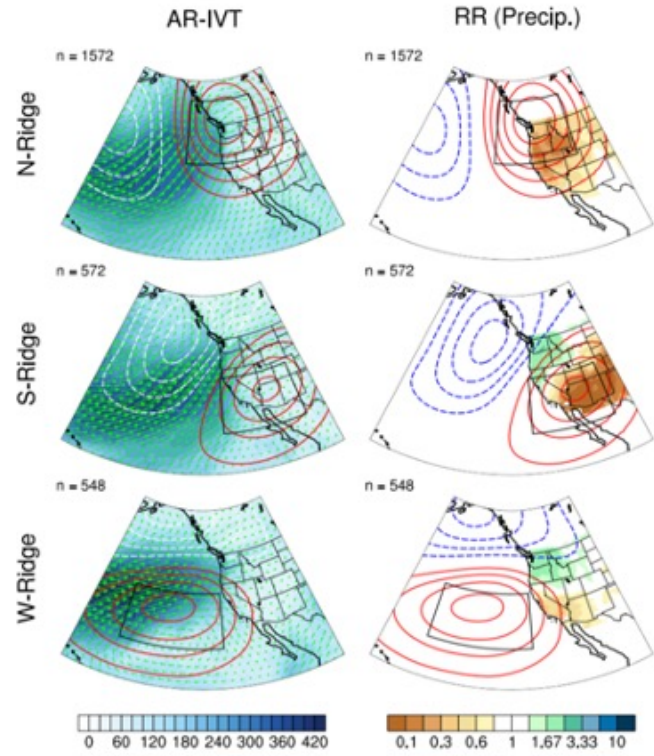
**Note that the probabilities of AR occurrence in the Week 2 AR activity plots may differ from the probabilities of AR conditions in the AR landfall tool. These discrepancies exist due to the use of different models (e.g., GEFS vs. CFSv2), model configurations (S2S models are coupled between ocean, land,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



- 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

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



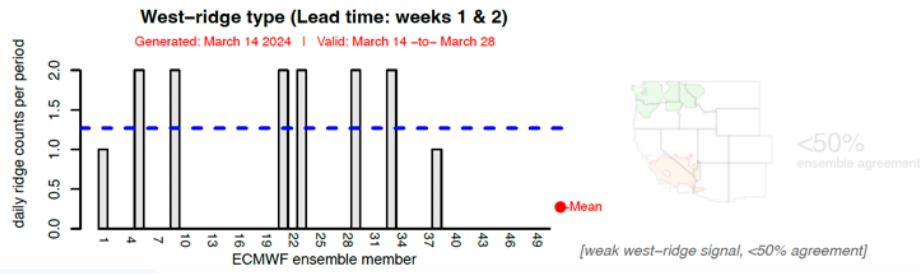
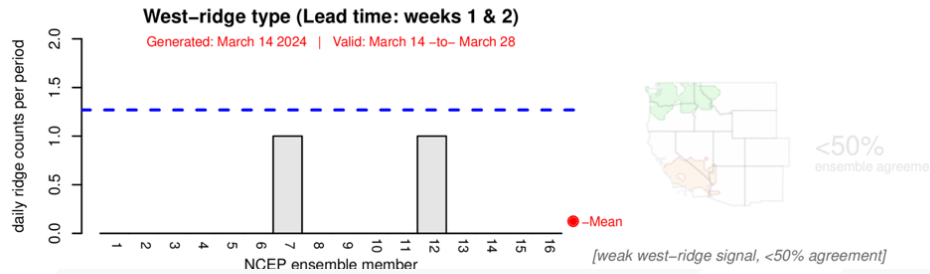
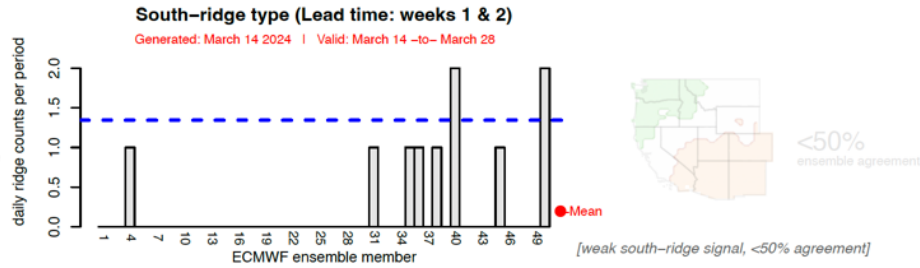
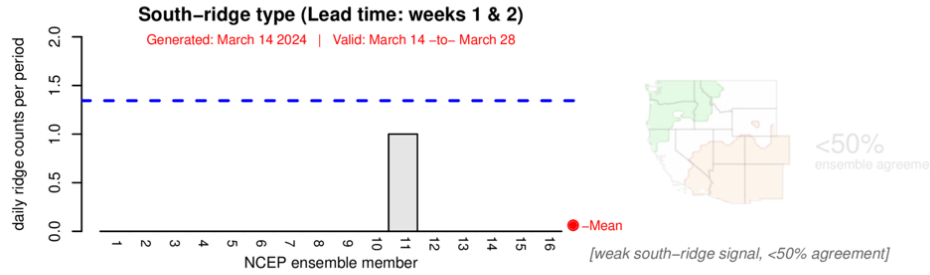
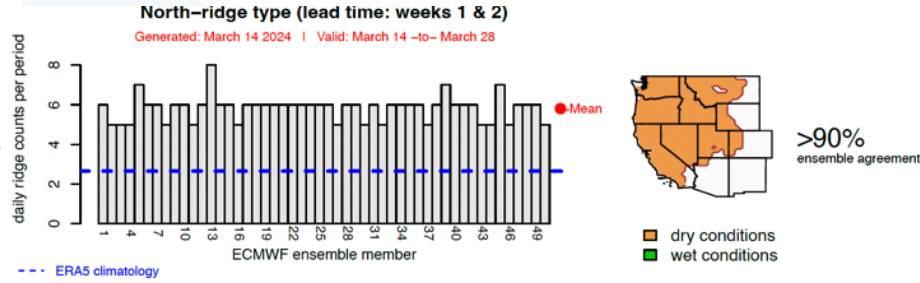
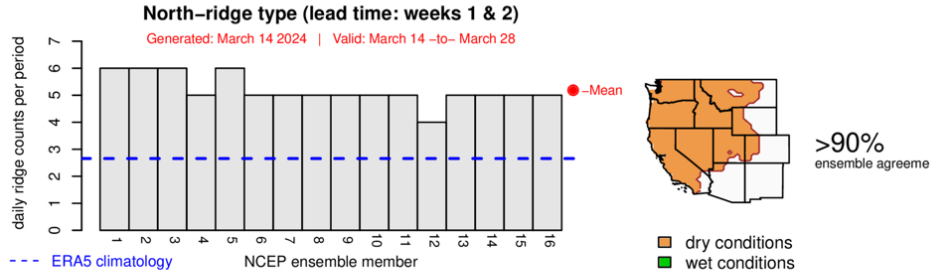
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 14 Mar 2024

NCEP

ECMWF



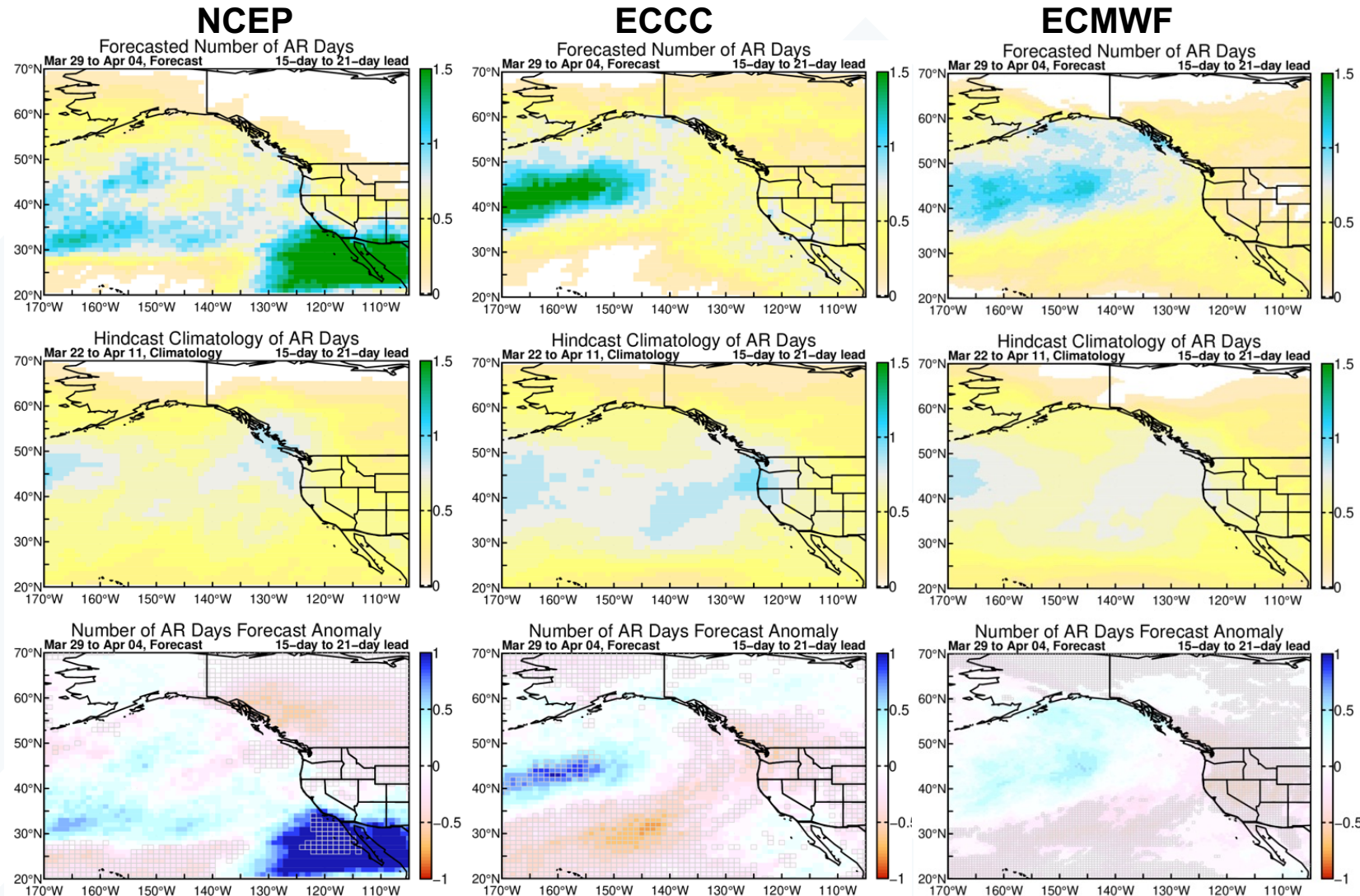
- Both models are showing high likelihood (>90% ensemble agreement) of above-normal North-ridge activity during Weeks 1-2 (14-28 Mar)

- Both models are predicting below-normal South-ridge and West-ridge activity

Models agree on above-normal ridging activity over the Pacific Northwest during Weeks 1-2 (14-28 Mar)

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

Forecasts Initialized 14 Mar 2024



- Models are predicting below-normal AR activity over Northern CA and most of WA/OR during Week 3 (29 Mar-4 Apr) with high confidence (>75% ensemble agreement)
- ECMWF is predicting below-normal AR activity over Central and Southern CA with high confidence
- ECCC is predicting near-normal AR activity over Central and Southern CA and NCEP predicts near-normal AR activity over Central and slightly above-normal AR activity over Southern CA

Models agree on below-normal AR activity in Northern CA during Week 3 (29 Mar-4 Apr)

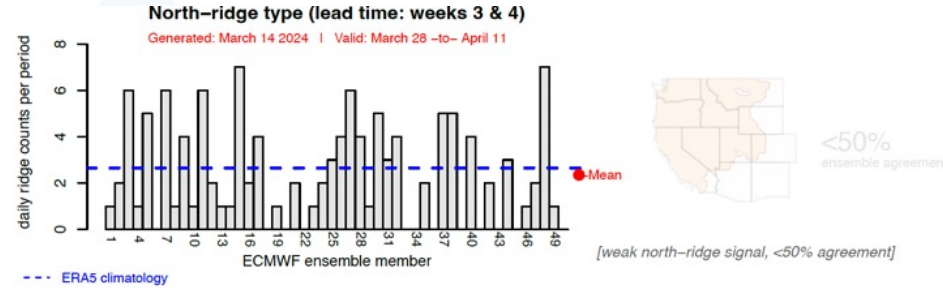
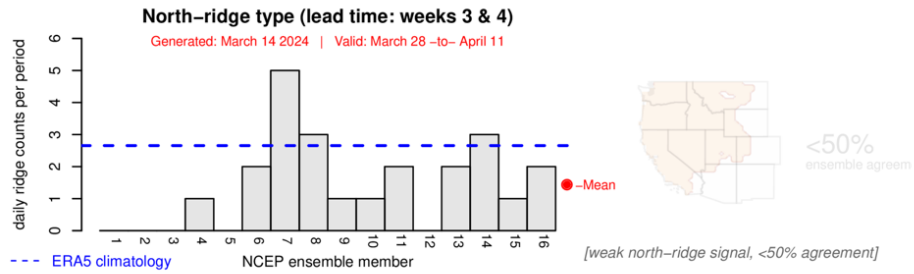
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom)
 Grey cells: >75% of ensemble members agree on sign of anomaly

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

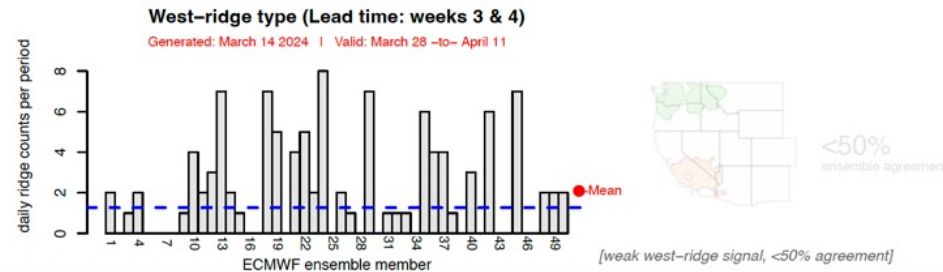
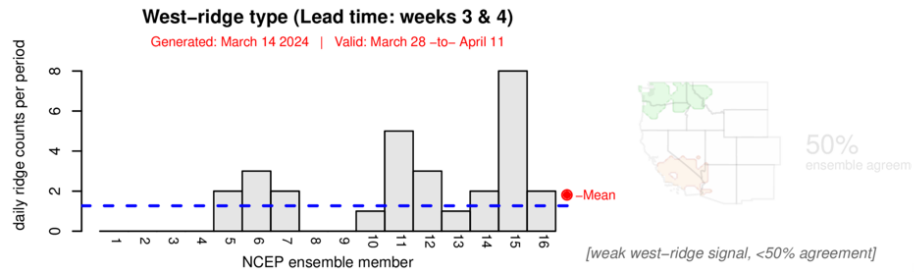
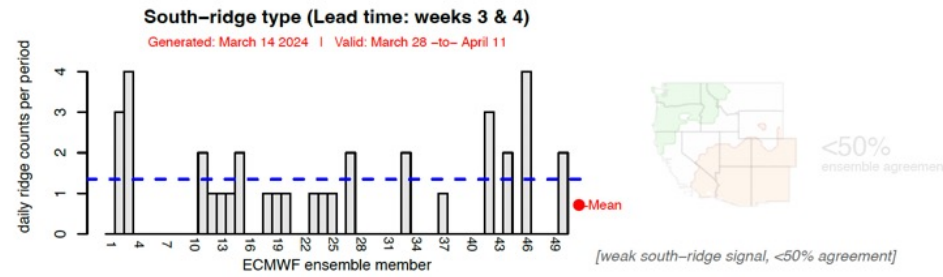
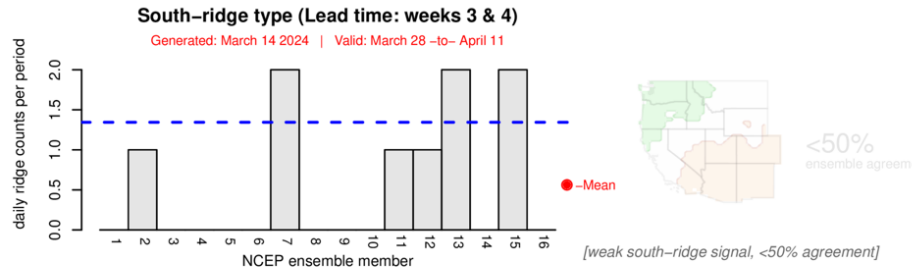
Forecasts Initialized 14 Mar 2024

NCEP

ECMWF



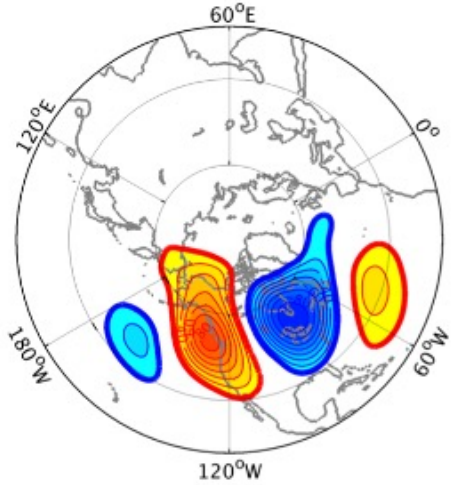
- Both models are predicting below-normal South-ridge activity and slightly-above normal West-ridge activity, but ensemble agreement is low during Weeks 3–4 (28 Mar – 11 Apr)



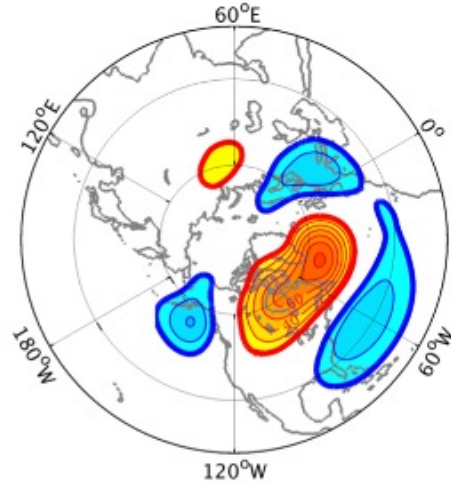
Models are showing low likelihood persistent ridging near the US West Coast during Weeks 3–4 (28 Mar – 11 Apr)

Background Info: IRI Subseasonal Weather Regime Forecasts

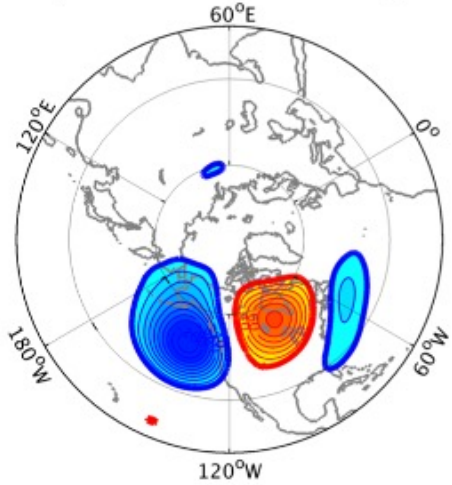
a) WR 1: West Coast Ridge



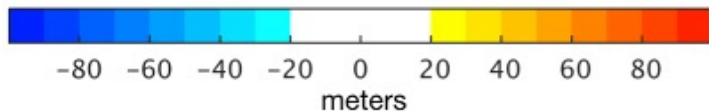
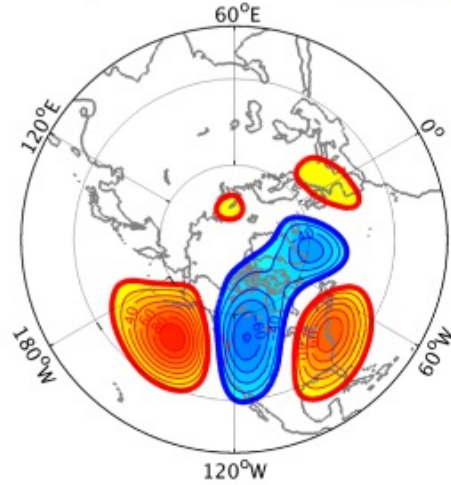
b) WR 2: Greenland High



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. \(2020\)](#)

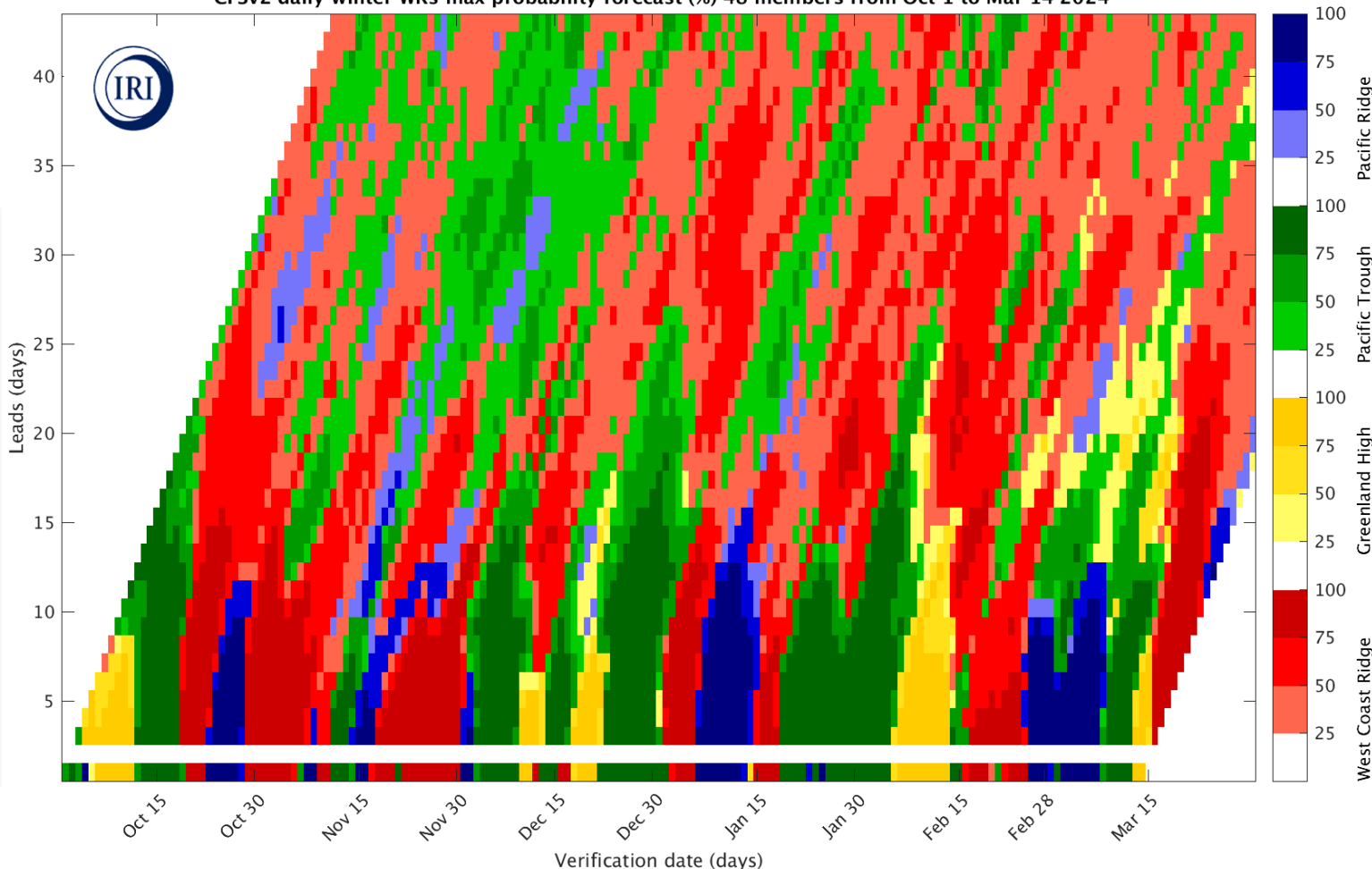
For more information about the forecast product:

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

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Forecast Initialized 14 Mar 2024

CFSv2 daily winter WRs max probability forecast (%) 48 members from Oct 1 to Mar 14 2024

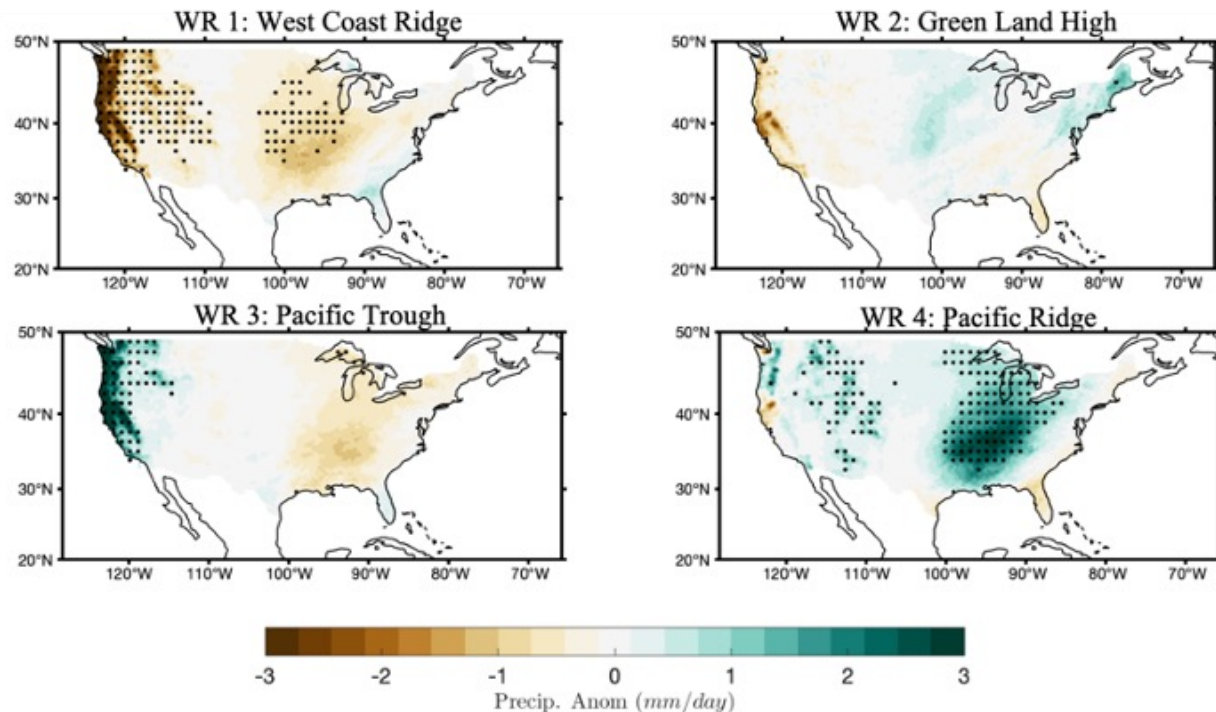


- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- High likelihood (> 75% ensemble agreement) of West Coast Ridge conditions early in Week 2 (22-23 Mar)
- Moderate-to-high likelihood (> 50% ensemble agreement) of transition to Pacific Ridge during the rest of Week 2 (24-28 Mar)
- Large uncertainty during Week 3

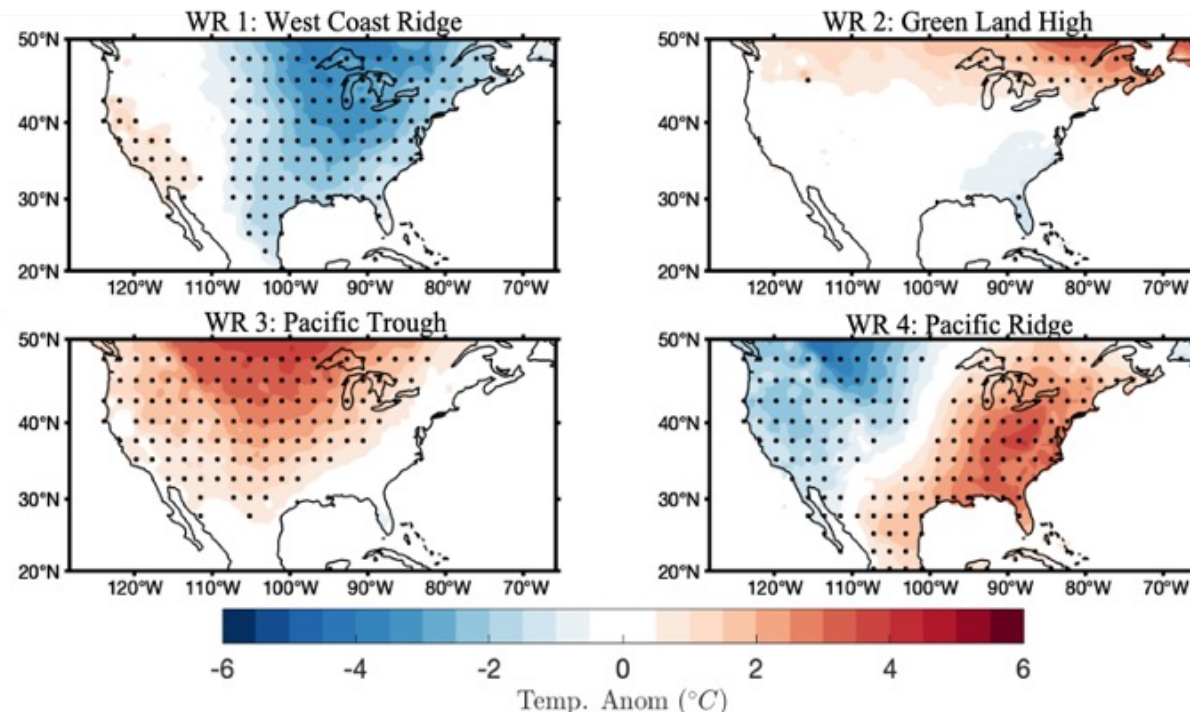
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime. See the next slide for temperature/precipitation implications.

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation



Temperature



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

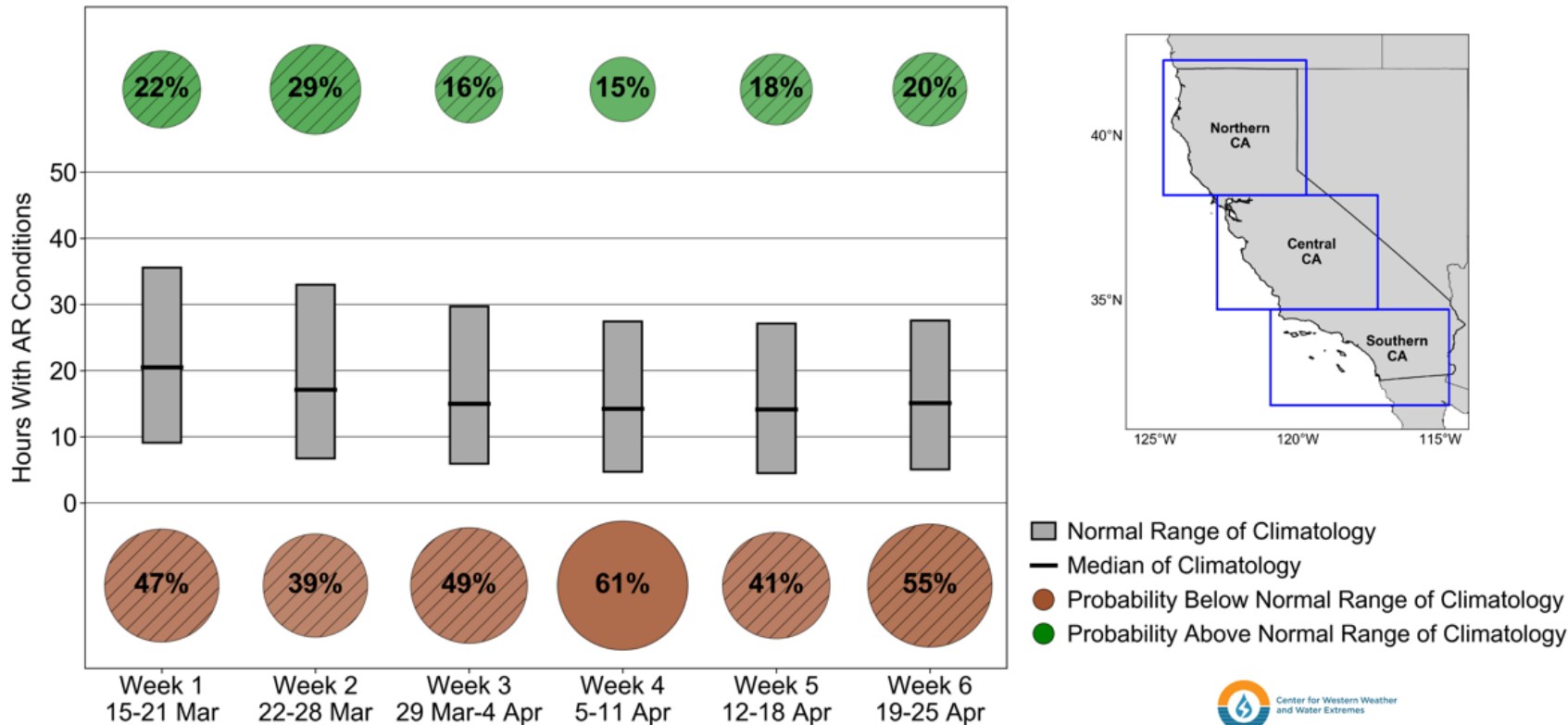
- Warm and dry conditions are predicted over CA through 23 March with high confidence
- Cold conditions are predicted over CA during 24-28 Mar with moderate-to-high confidence

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

Forecasts Initialized 14 Mar 2024

AR Occurrence: Northern CA

Northern CA Subseasonal AR Occurrence Outlook
Issued: 14 Mar 2024 MJO Phase 5 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 Week 4 and Week 6 in Northern CA
- The same product is showing a high likelihood of below-normal AR occurrence in Central CA during Week 1 and Weeks 4-6 and in Southern CA during Weeks 5-6



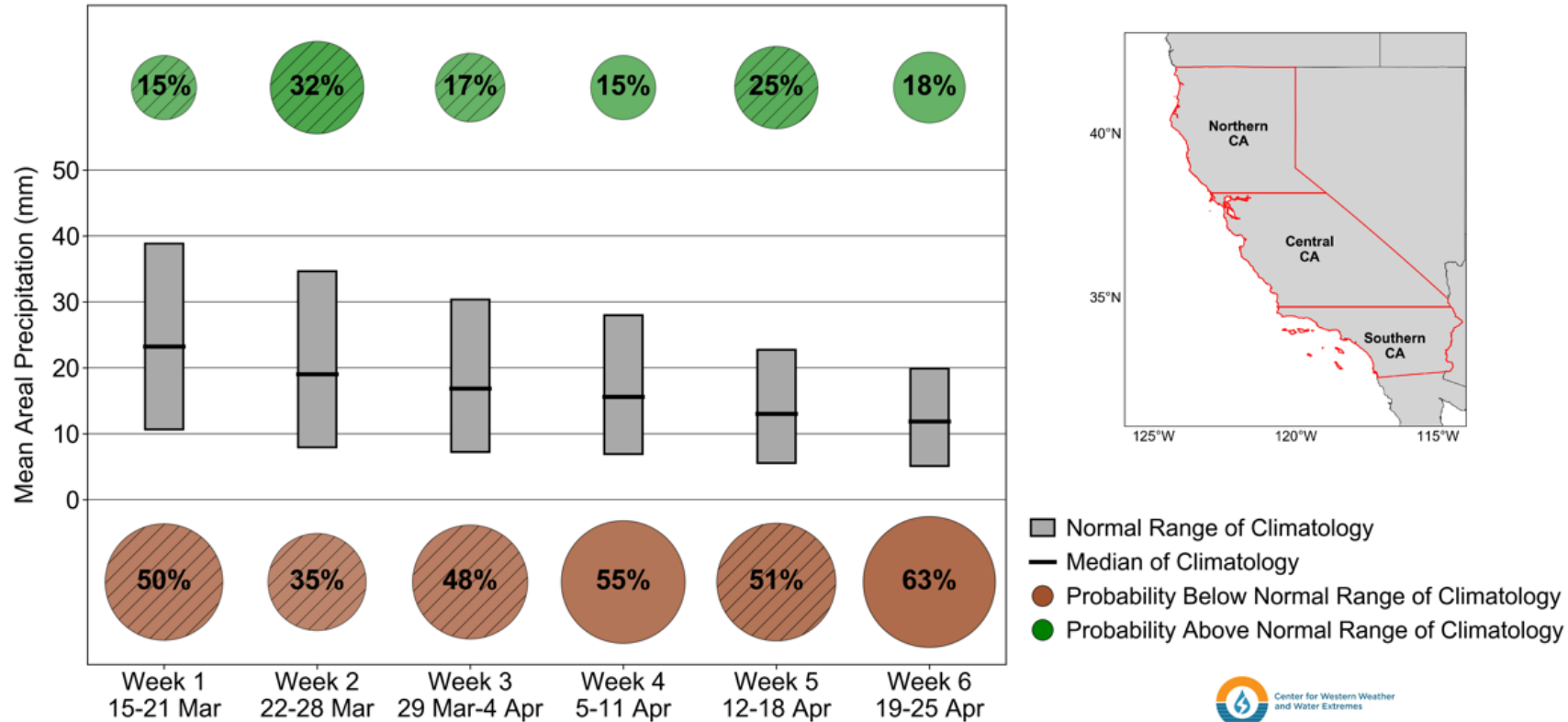
This product shows weekly probabilities of above-normal and below-normal AR occurrence in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If 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 14 Mar 2024

Precipitation: Northern CA

Northern CA Subseasonal Precipitation Outlook
Issued: 14 Mar 2024 MJO Phase 5 EQBO



- CW3E's statistical forecast tool based on current MJO and QBO conditions is showing a high likelihood ($> 50\%$) of below-normal precipitation during Week 1 and Weeks 4–6 in Northern CA
- The same product is showing a high likelihood of below-normal precipitation in Central CA during Week 1 and in Southern CA during Week 2 and Week 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. \(2023\)](#)