



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 16 February 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*

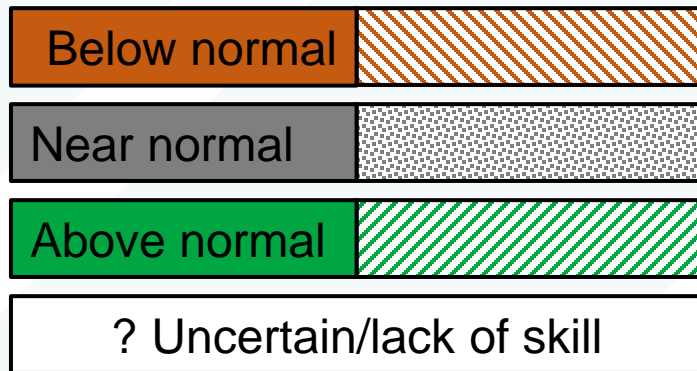
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 15 Feb 2024

| Region | Week 2 (23–29 Feb) | | | | Week 3 (1–7 Mar) | | | | Week 4 (8–14 Mar) | | |
|-------------|---------------------|--------------------|----------------------|----------------------|---------------------|--------------------|----------------------|----------------------|---------------------|--------------------|----------------------|
| | NCEP ^{2,3} | ECMWF ¹ | ECMWF ^{1,2} | Multi-Model Forecast | NCEP ^{2,3} | ECMWF ¹ | ECMWF ^{1,2} | Multi-Model Forecast | NCEP ^{2,3} | ECMWF ² | Multi-Model Forecast |
| WA/OR | Below normal | | Below normal | Below normal | | Above normal | Below normal | | | Below normal | |
| Northern CA | Below normal | | Below normal | Below normal | | Uncertain | Below normal | | | Below normal | |
| Central CA | Below normal | Below normal | | Below normal | | Uncertain | Below normal | | | Below normal | |
| Southern CA | Below normal | Below normal | Below normal | Below normal | | Below normal | Below normal | Below normal | | Below normal | |

Higher Confidence | Lower Confidence



- Models generally agree on below-normal precipitation in CA during Week 2 with the highest confidence in Southern CA
- Week 3 forecasts are suggesting below-normal precipitation over Southern CA with low confidence and uncertain conditions over Northern and Central CA due to lack of agreement between models and forecast products
- 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](#))

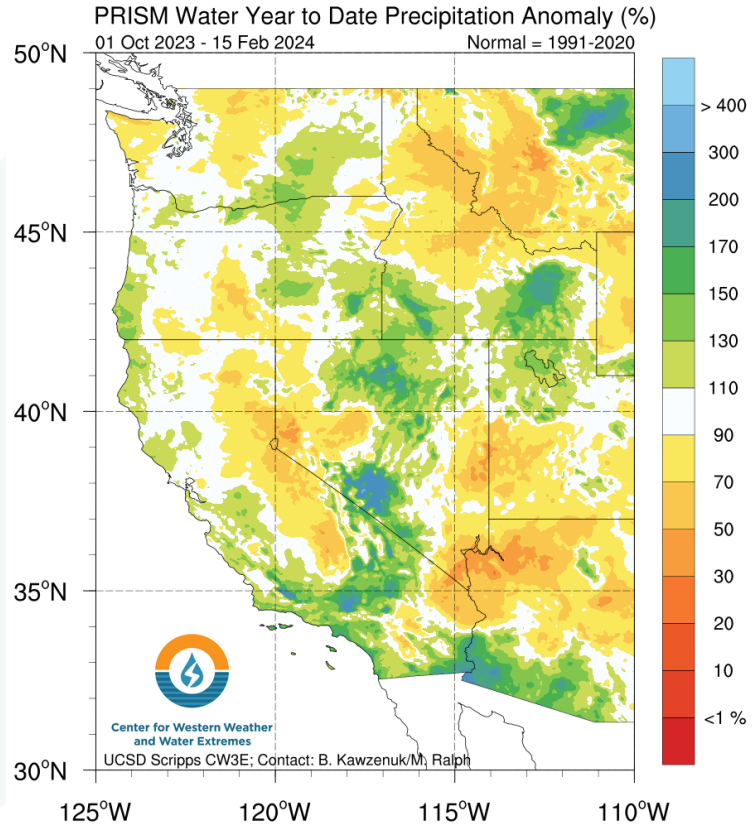
³IRI North American Weather Regime Forecasts ([Robertson et al. 2020](#))

Summary

- **Week 2 forecasts (23–29 Feb):** Models agree on low likelihood of AR activity in CA during much of Week 2 (23–27 Feb)
 - ECCC is showing moderate likelihood of AR activity in Northern CA on 29 Feb
- As of 15 Feb, MJO convection is located over the Western Pacific
 - MJO activity in the Western Pacific during JFM is associated with a decreased likelihood of wet extremes in Central and Southern CA at lag times of 4 weeks
 - Models agree that MJO will be weakening in the next two weeks
- Ridging outlooks show uncertainty in ridging activity near the US West Coast during Weeks 1–2
 - NCEP is showing moderate confidence in above-normal North-ridge activity, which is typically associated with dry conditions in CA
- **Week 3 forecasts (1–7 Mar):** Models agree on below-normal AR activity in Southern CA, but disagree somewhat on AR activity in Central and Northern CA
 - ECCC is forecasting near-normal AR activity in Central and Northern CA
 - ECMWF is forecasting below-normal AR activity in Central and Northern CA
- Ridging outlooks show uncertainty in ridging activity near the US West Coast during Weeks 3–4
 - ECMWF is showing moderate confidence in above-normal North-ridge activity
- IRI weather regime tool shows moderate-to-high likelihood of West Coast Ridge (dry conditions in CA) in Week 2
- Statistical forecast tool based on current MJO/QBO conditions is showing a high likelihood (>50%) of below-normal AR activity in Northern CA during Weeks 2-3 and below-normal precipitation in Northern CA during Weeks 2–5

Hydrologic Summary

Precipitation

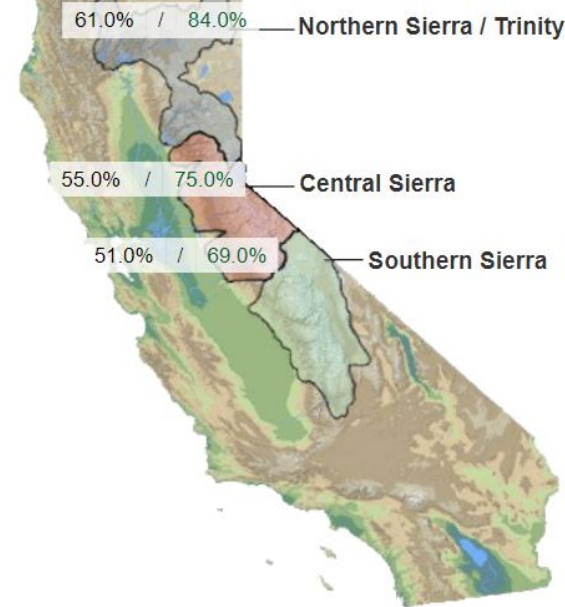


Snowpack Conditions

Provided by the California Cooperative Snow Surveys

Data For: 15-Feb-2024

% Apr 1 Avg. / % Normal for this Date



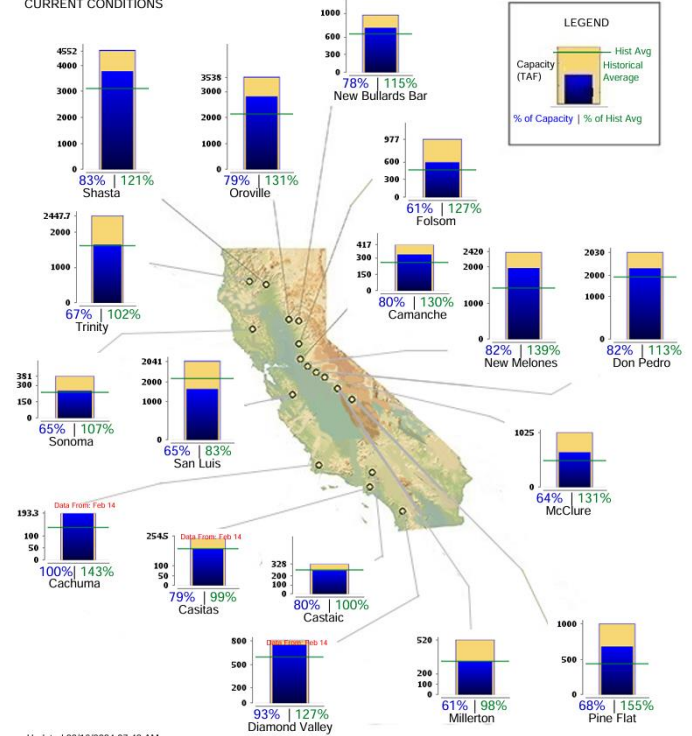
Source: California DWR

Reservoir Storage

CALIFORNIA MAJOR WATER SUPPLY RESERVOIRS

CURRENT CONDITIONS

Midnight - February 15, 2024



Updated 02/16/2024 07:48 AM

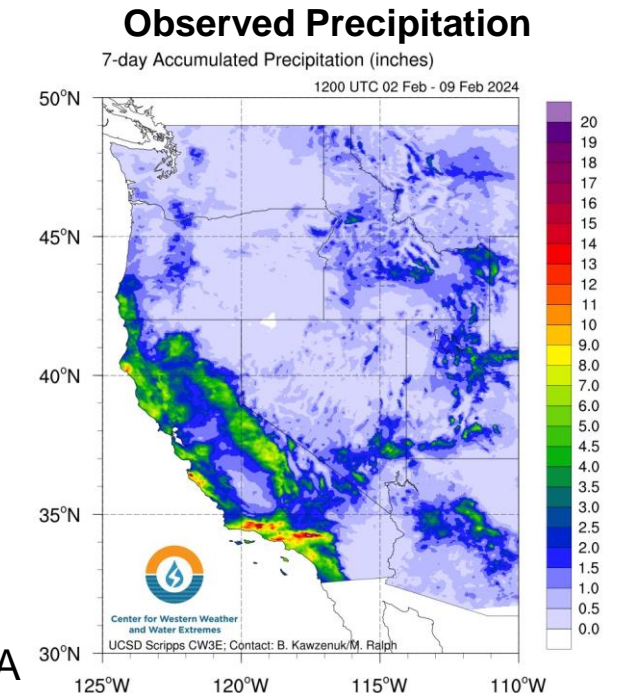
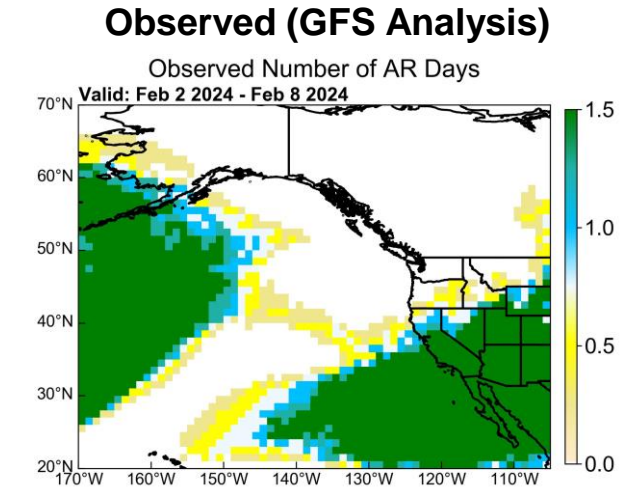
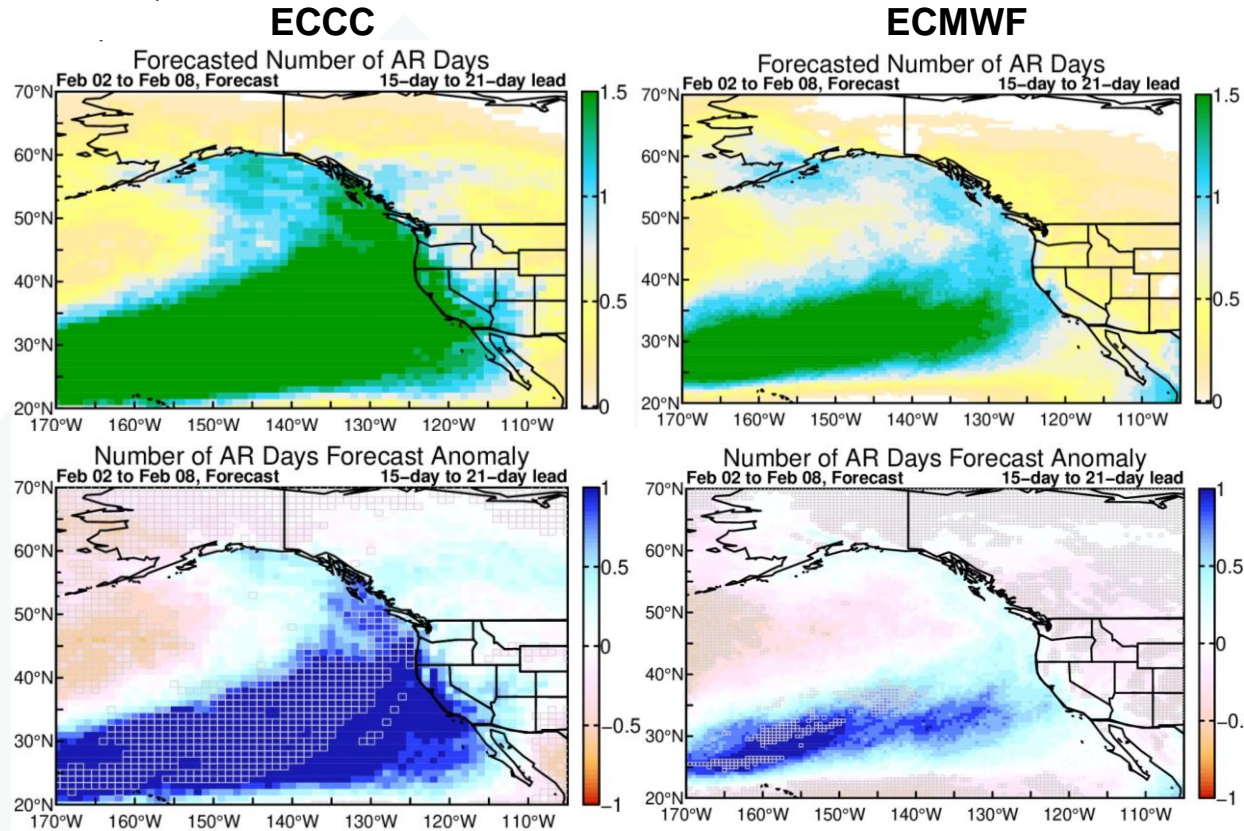
Source: California DWR

- As of 15 Feb, recent storms have brought WY-to-date precipitation to >150% above-normal along coastal Southern CA and the western half of the Mojave Desert
- Water-year-to-date precipitation is still below-normal over the Sierra Nevada
- Statewide snowpack has greatly increased compared to 1 Feb (from 39–65% to 69–84%) but is still running below-normal for this time of year, especially in the Central and Southern Sierra Nevada
- All large reservoirs in CA are operating at greater than 60% storage capacity and most are at above-normal storage for this time of year

Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 18 Jan 2024; Valid: 2–8 Feb 2024

NCEP
unavailable

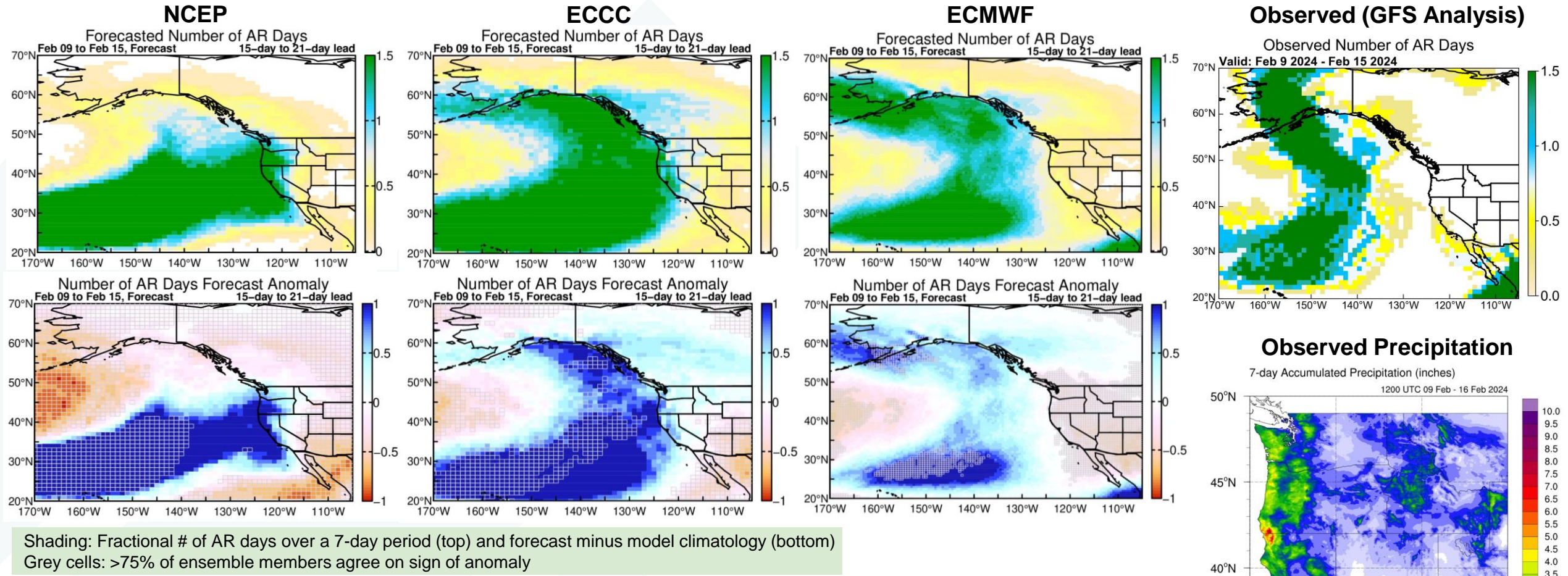


Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

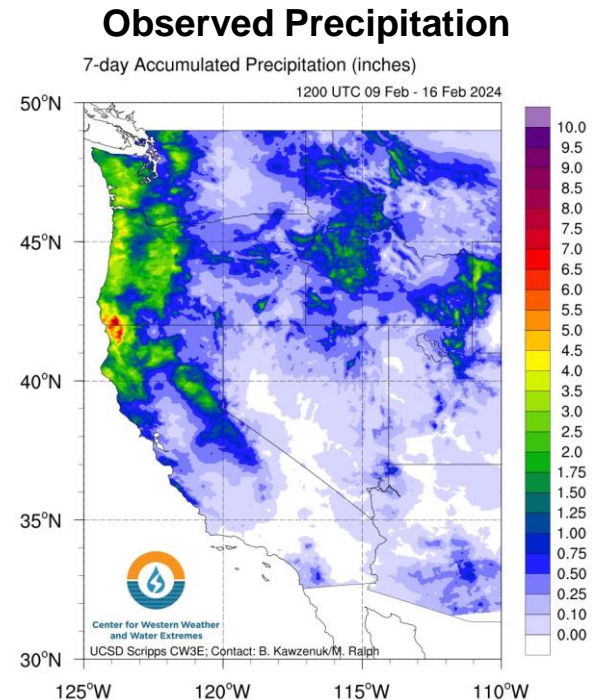
- Models failed to capture the large-scale AR activity: Observed ARs peaked over the Southwestern US and Central North Pacific while forecasted ARs peaked over the Northeastern Pacific.
- AR activity over CA is captured by ECCC but missed in ECMWF. Both models underestimated AR activity over the Southwestern US
- A strong winter storm produced > 5 inches of total precipitation in much of coastal California and Sierra Nevada on 4–6 Feb with the heaviest precipitation in the Transverse Ranges of Southern CA

Looking Back: Week 3 AR Activity Forecasts

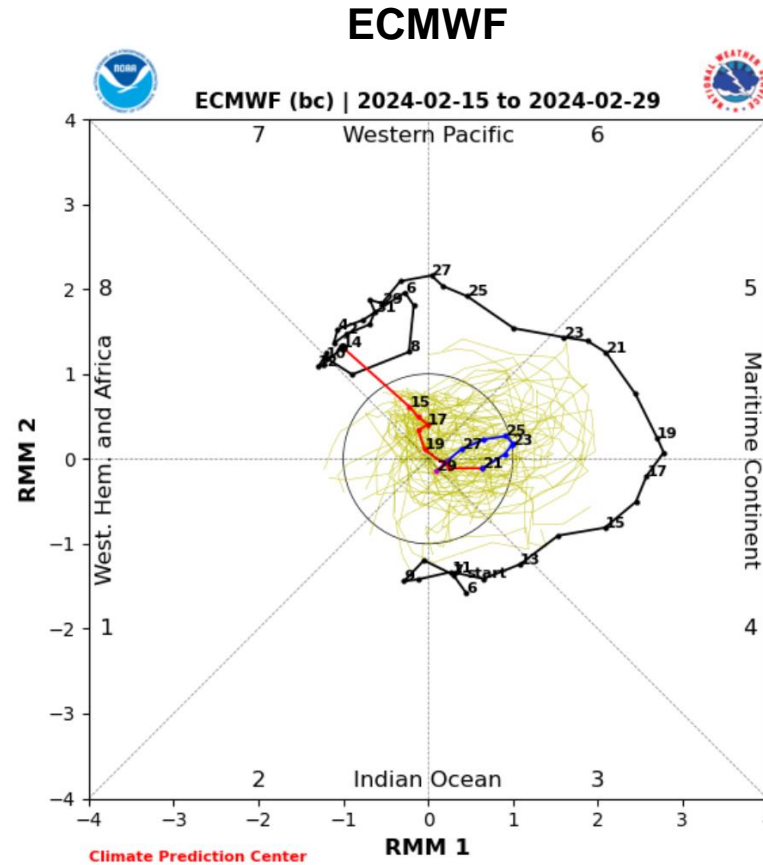
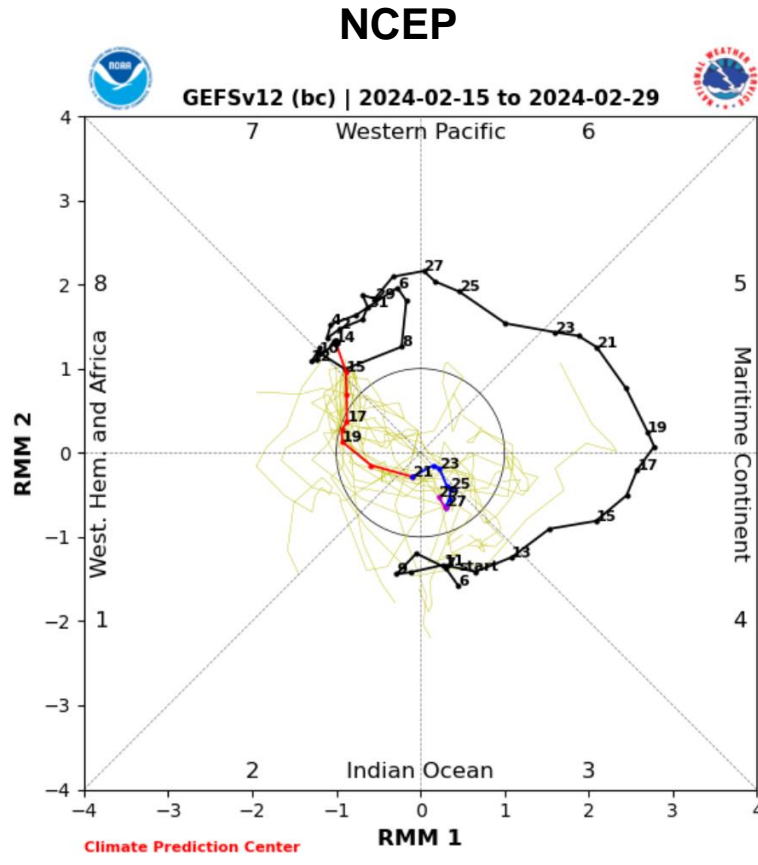
Forecasts Initialized 25 Jan 2024; Valid: 9–15 Feb 2024



- ECMWF well captured the orientation of AR activity extending from Hawaii to Alaska
- NCEP and ECCC overestimated AR activity over the US West Coast
- A series of ARs brought >2 inches of precipitation in Western WA/OR and portions of Northern CA during 12–16 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)

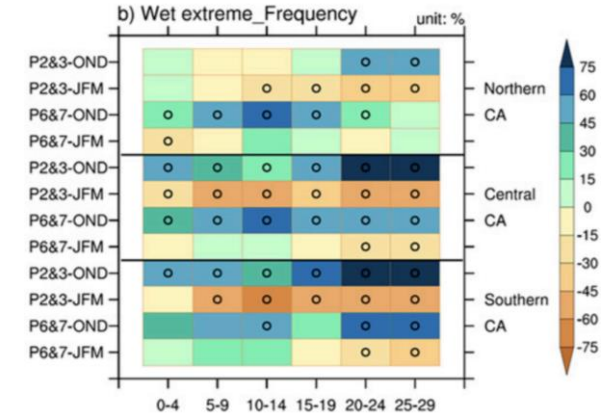


Figure 8 from Wang et al. (2023)

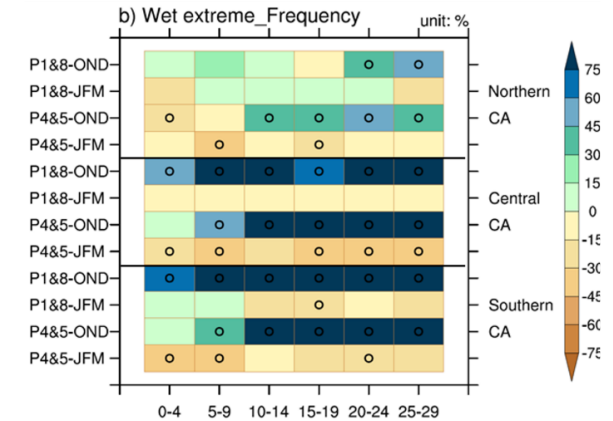


Figure S6 from Wang et al. (2023)

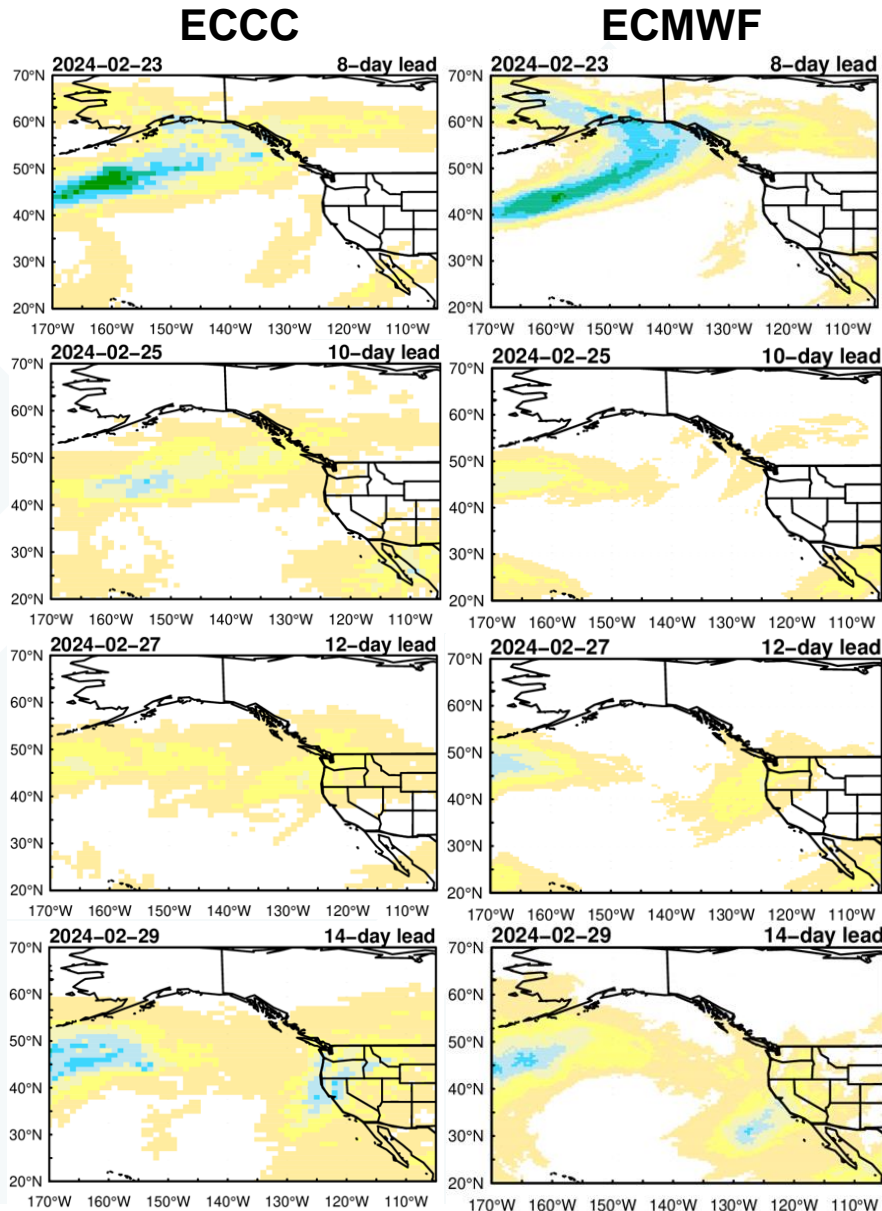
- Strong MJO convection is currently located over the Western Pacific
- Both models are forecasting MJO to weaken in Week 1 and remain weak in Week 2
- MJO activity in the Western Pacific during JFM is associated with a slight increase (not statistically significant) in wet extremes in Southern CA at lag times of 1–2 weeks, and a significant decrease in wet extremes in Central and Southern CA at lag times of 4 weeks

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

Forecasts Initialized 15 Feb 2024

NCEP
unavailable

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

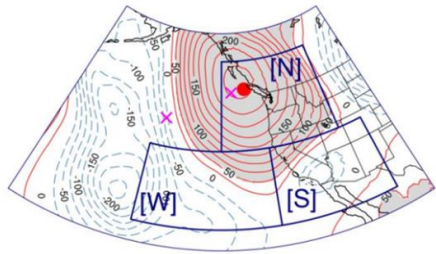


- ECCC and ECMWF are predicting low likelihood (< 30% probability) of AR activity over CA and WA/OR during 23–27 Feb
- ECCC shows low-to-moderate likelihood (30–60% probability) of AR activity over Northern CA and OR/WA on 29 Feb
- ECMWF shows slightly higher likelihood (30–40% probability) of AR activity over Coastal Central CA on 29 Feb

Models agree on low likelihood of AR activity over CA during much of Week 2 (23–27 Feb)

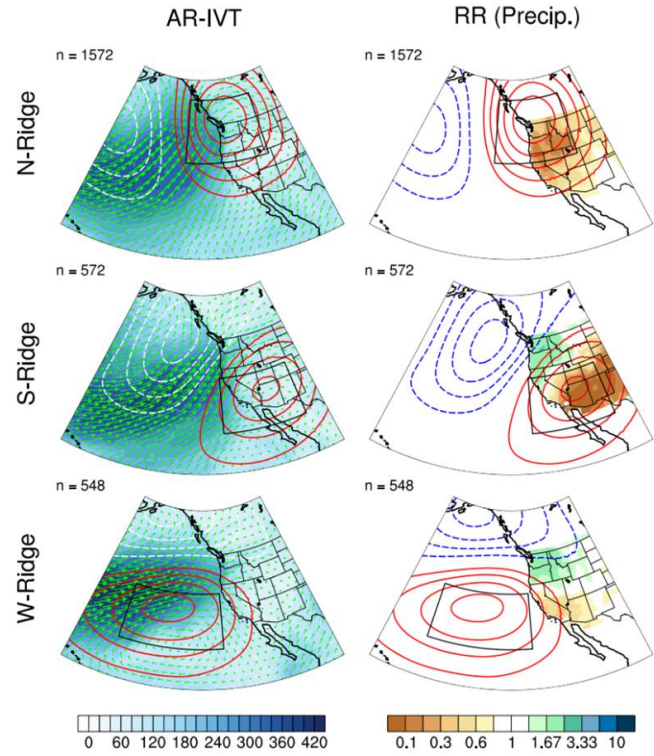
**Note that the probabilities of AR occurrence in the Week 2 AR activity plots may differ from the probabilities of AR conditions in the AR landfall tool. These discrepancies exist due to the use of different models (e.g., GEFS vs. CFSv2), model configurations (S2S models are coupled between ocean, land, 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 15 Feb 2024

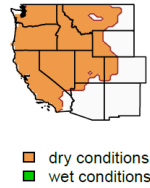
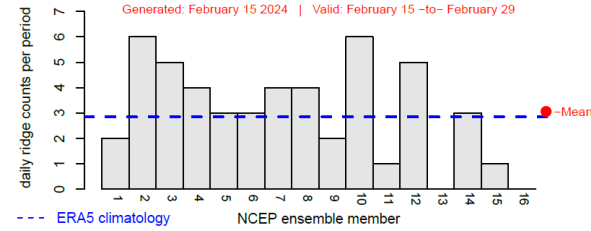
NCEP

CW3E Subseasonal Ridging Forecast

(Uses NCEP CFSv2 model)

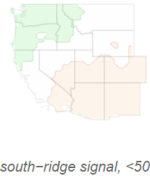
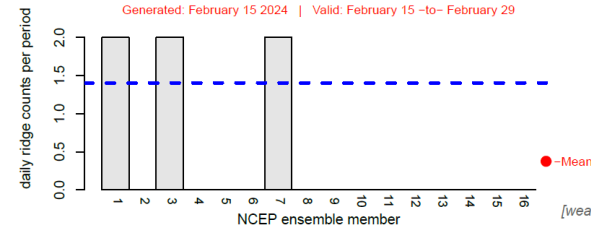
North-ridge type (lead time: weeks 1 & 2)

Generated: February 15 2024 | Valid: February 15 -to- February 29



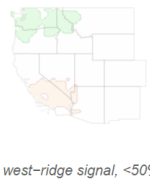
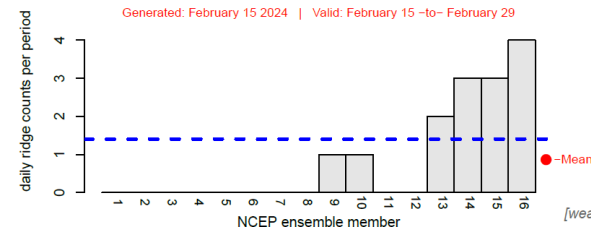
South-ridge type (Lead time: weeks 1 & 2)

Generated: February 15 2024 | Valid: February 15 -to- February 29



West-ridge type (Lead time: weeks 1 & 2)

Generated: February 15 2024 | Valid: February 15 -to- February 29



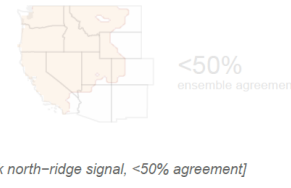
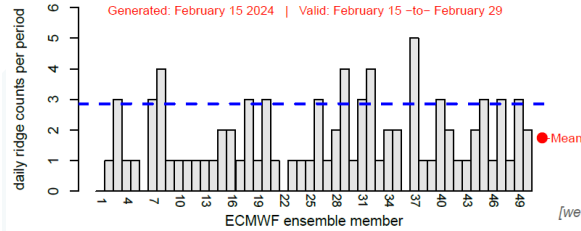
ECMWF

CW3E Subseasonal Ridging Forecast

(Uses ECMWF model)

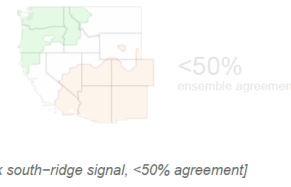
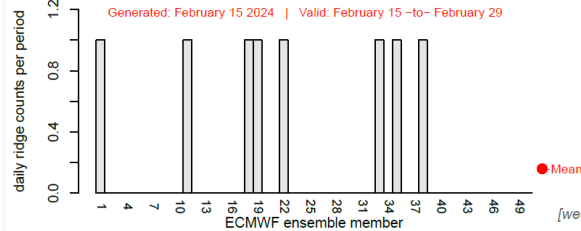
North-ridge type (lead time: weeks 1 & 2)

Generated: February 15 2024 | Valid: February 15 -to- February 29



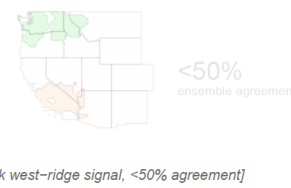
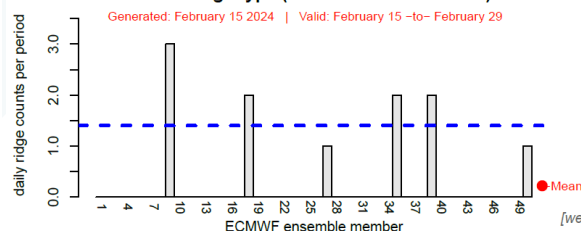
South-ridge type (Lead time: weeks 1 & 2)

Generated: February 15 2024 | Valid: February 15 -to- February 29



West-ridge type (Lead time: weeks 1 & 2)

Generated: February 15 2024 | Valid: February 15 -to- February 29



- NCEP is showing a moderate likelihood (62% ensemble agreement) of above-normal North-ridge activity during Weeks 1–2 (15–29 Feb)
- Both models are predicting below-normal South-ridge and West-ridge activity
- ECMWF is also predicting below-normal North-ridge activity

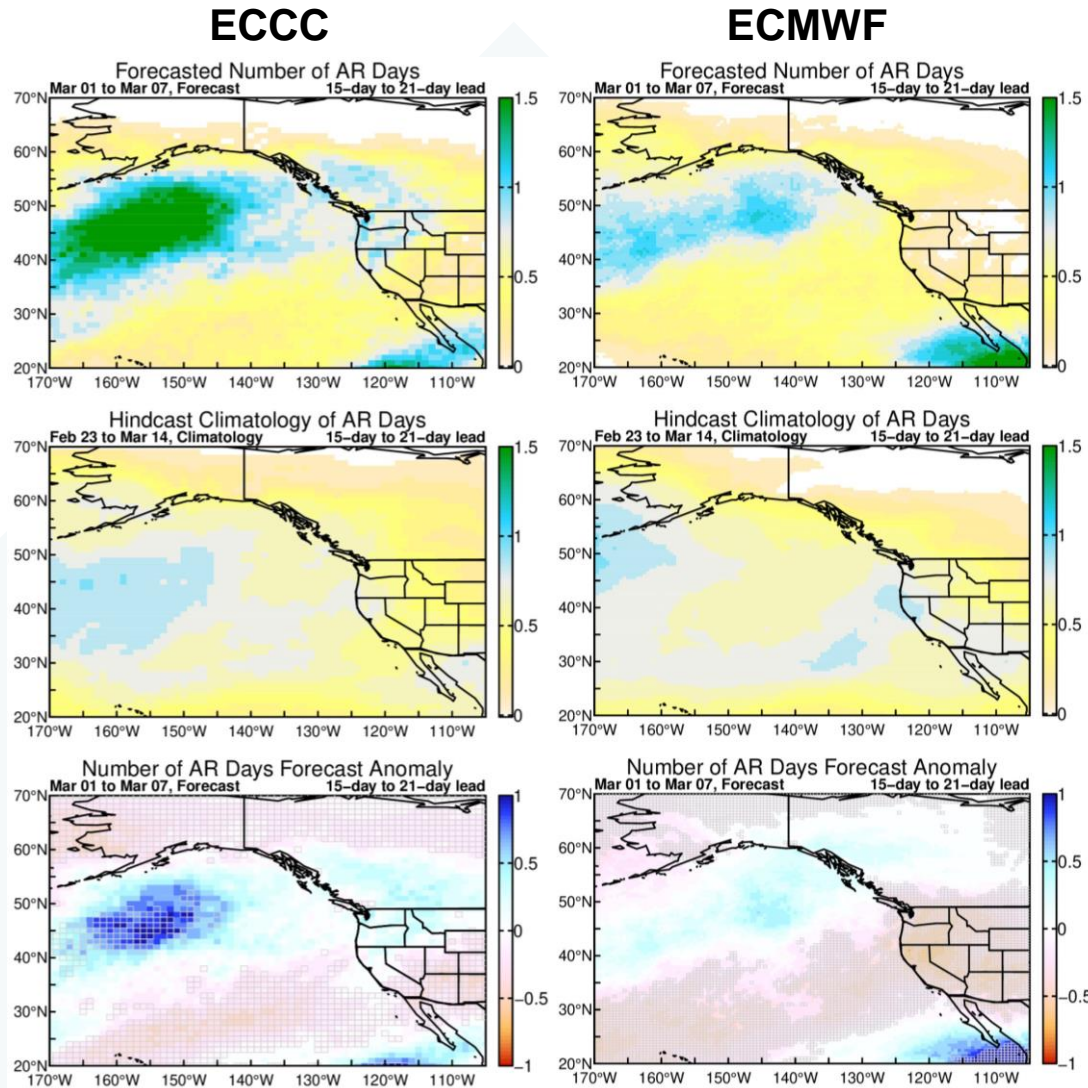
Model uncertainty regarding the likelihood of persistent ridging near the US West Coast and during Weeks 1–2 (15–29 Feb)



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

Forecasts Initialized 15 Feb 2024

NCEP
unavailable



- ECCC and ECMWF are predicting below-normal AR activity over Southern CA during Week 3 (1–7 Mar) with high confidence (>75% ensemble agreement)
- ECMWF is also predicting below-normal AR activity over OR/WA and Central and Northern CA with high confidence
- ECCC is predicting slightly above-normal AR activity over OR/WA and near-normal AR activity over Northern and Central CA with low confidence

Models agree on below-normal AR activity in Southern CA but disagree on AR activity in Northern and Central CA during Week 3 (1–7 Mar)

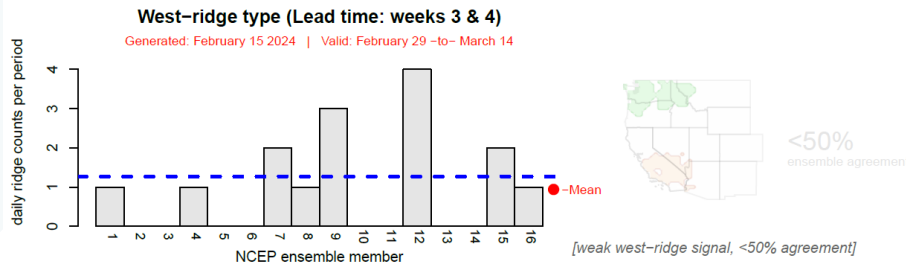
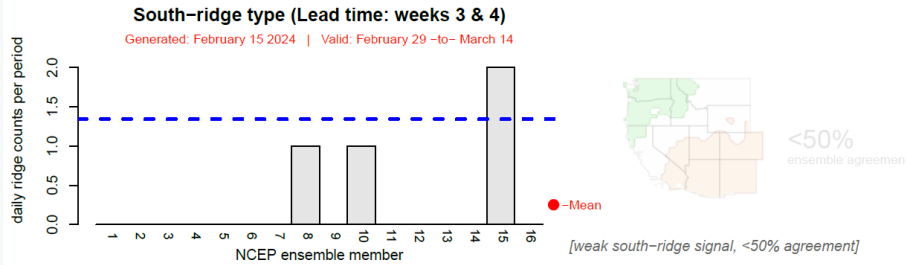
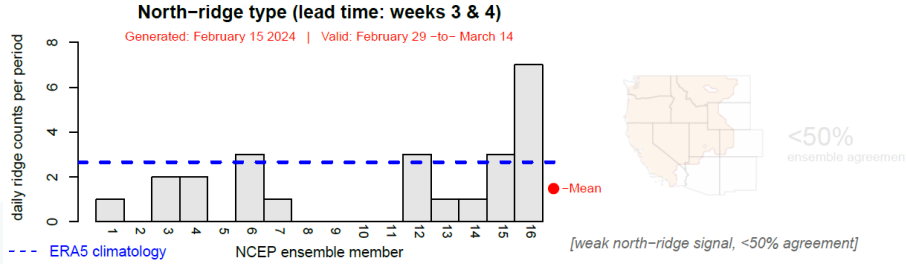
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

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

Forecasts Initialized 15 Feb 2024

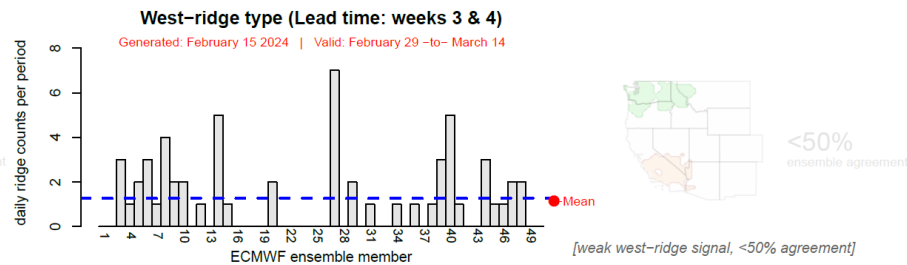
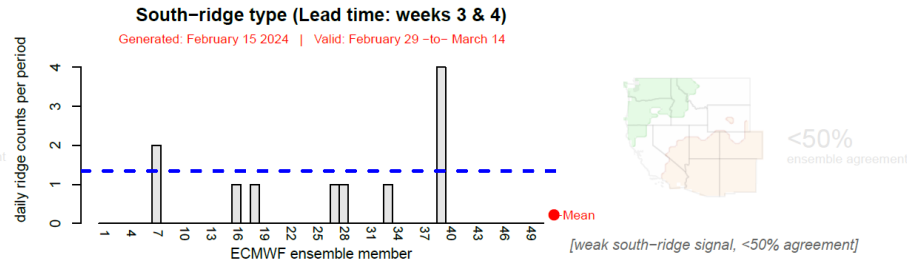
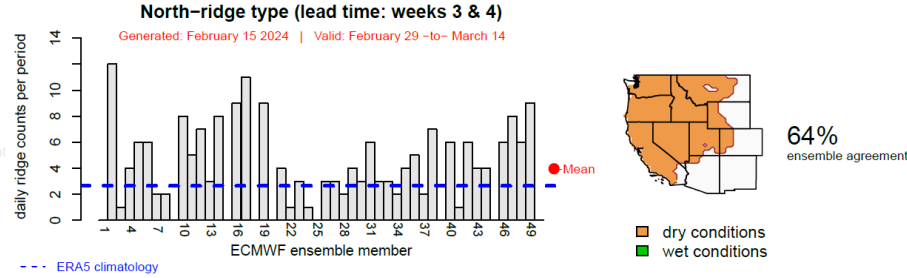
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



- ECMWF is showing a moderate likelihood (64% ensemble agreement) of above-normal North-ridge activity during Weeks 3–4 (29 Feb – 14 Mar)

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

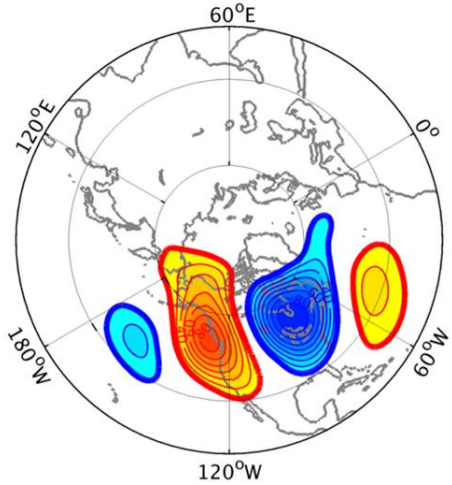
- NCEP is also showing below-normal North-ridge activity

Model uncertainty regarding the likelihood of persistent ridging near the US West Coast during Weeks 3–4 (29 Feb – 14 Mar)

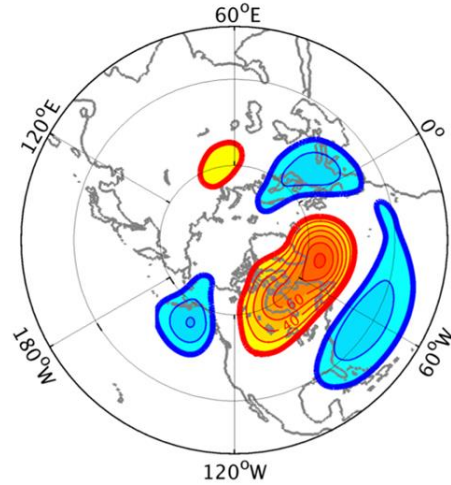


Background Info: IRI Subseasonal Weather Regime Forecasts

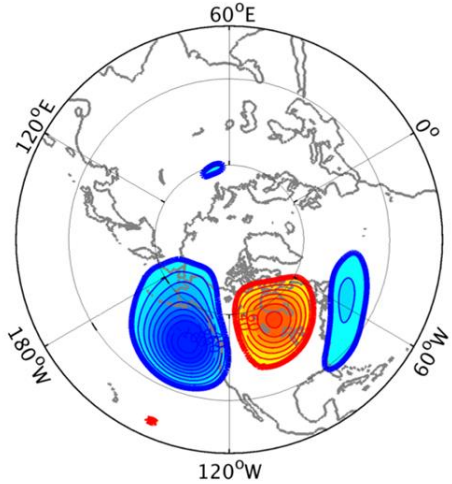
a) WR 1: West Coast Ridge



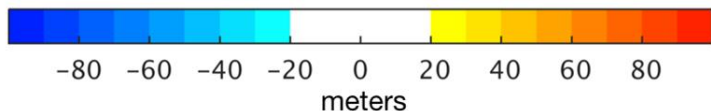
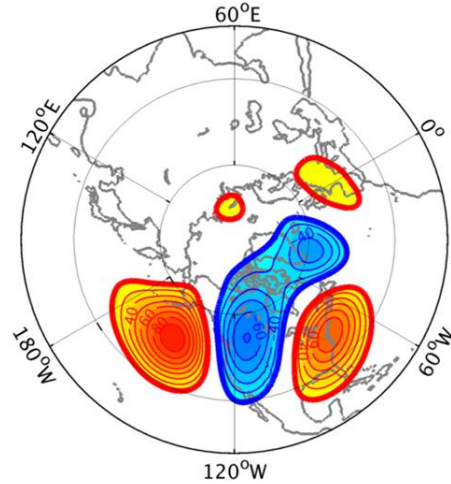
b) WR 2: Greenland High



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)

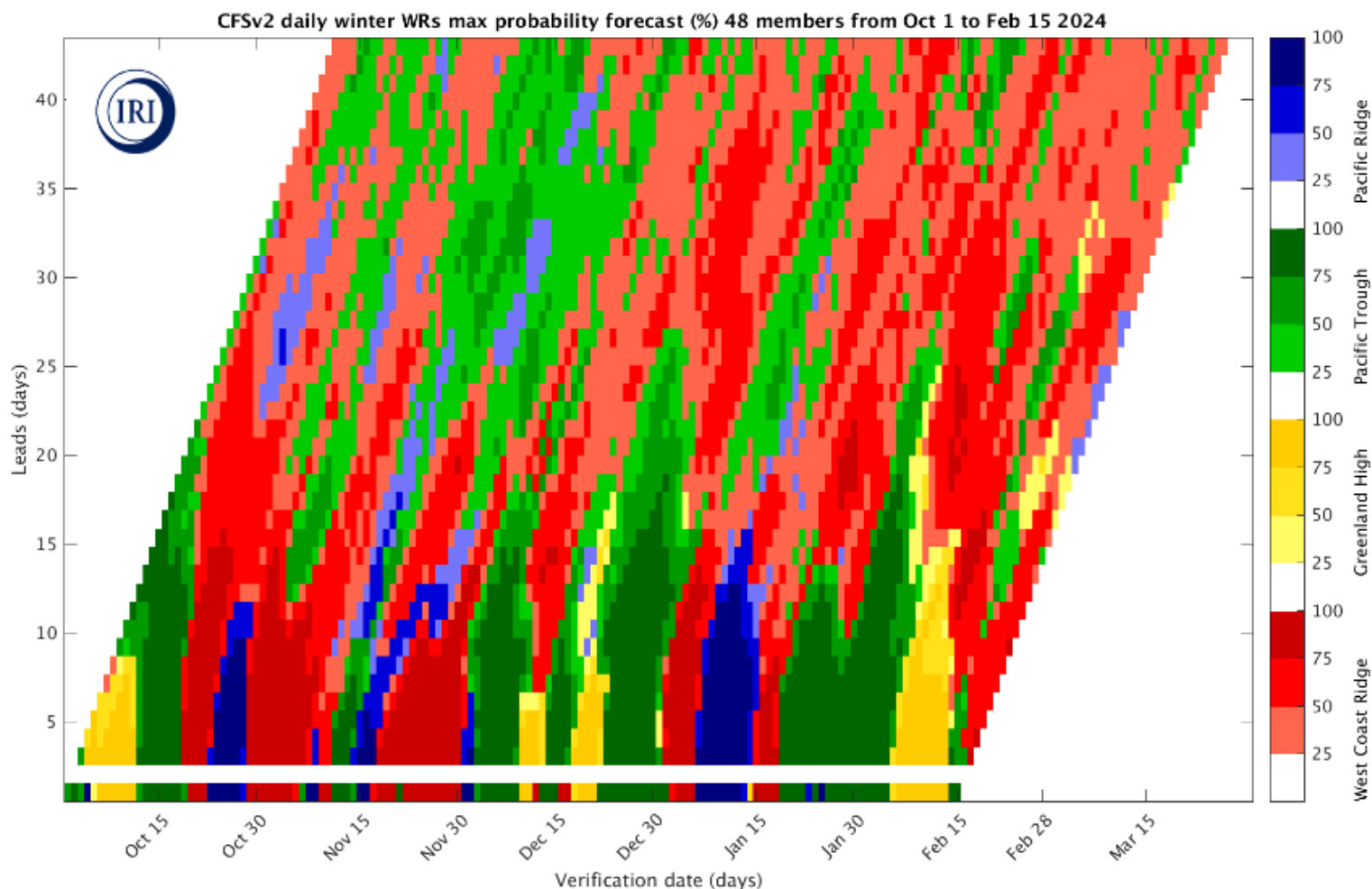
Reference: [Robertson et al. \(2020\)](#)

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 15 Feb 2024

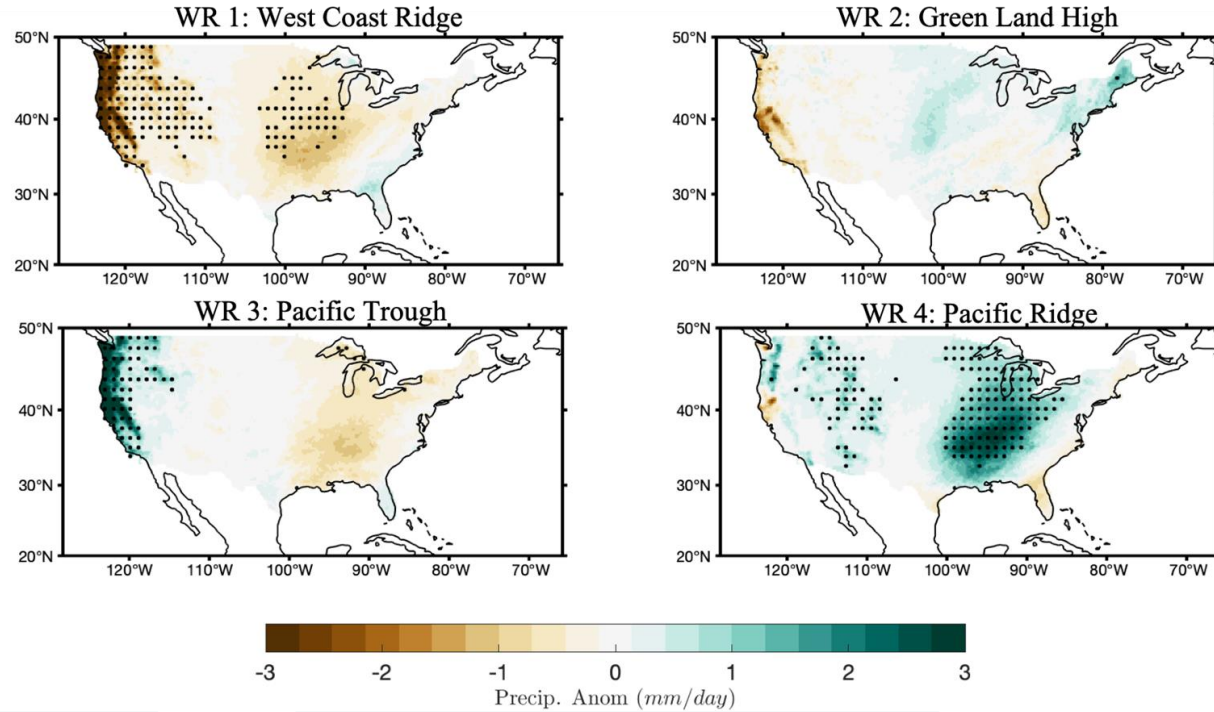


- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- Moderate-to-high likelihood (> 50% ensemble agreement) of West Coast Ridge conditions during Week 2 (23–29 Feb)
- Large uncertainty in Week 3 with low likelihood (25-50% ensemble agreement) of transition to Greenland High conditions in much of Week 3 (1–7 Mar)
- Large uncertainty in Week 4 with low likelihood (25-50% ensemble agreement) of transition to Pacific Ridge conditions in much of Week 3 (8–14 Mar)

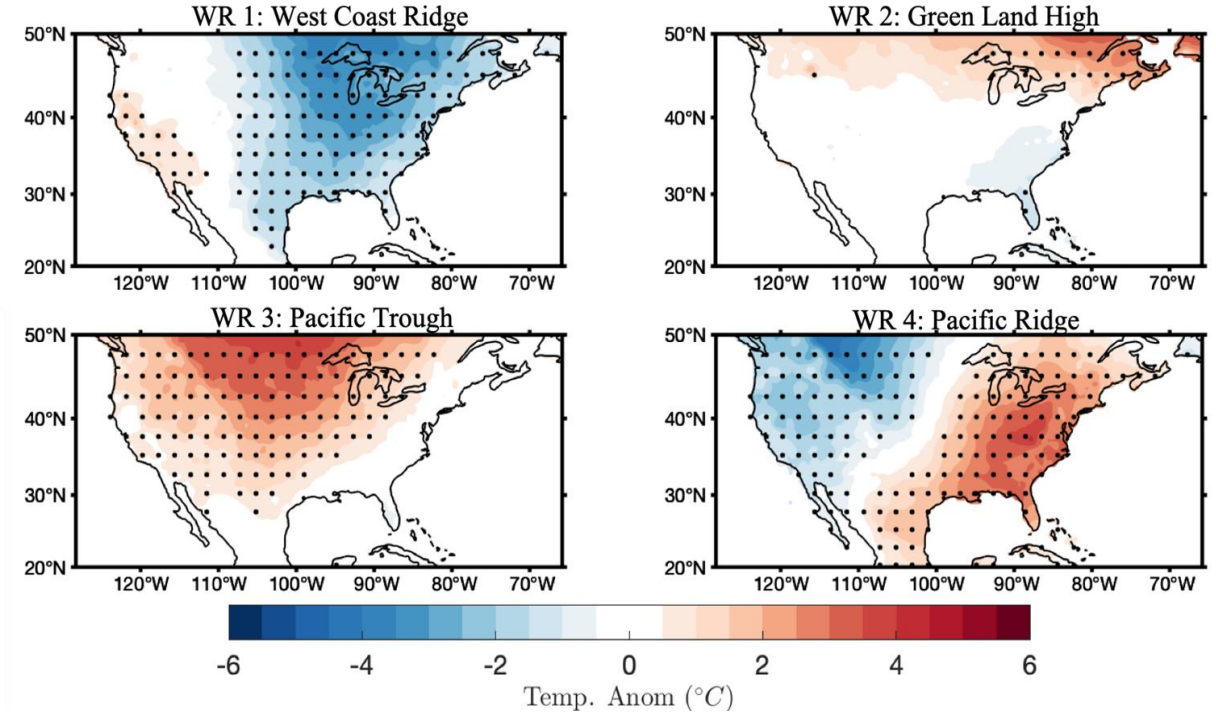
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime. See the next slide for temperature/precipitation implications.

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation



Temperature



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

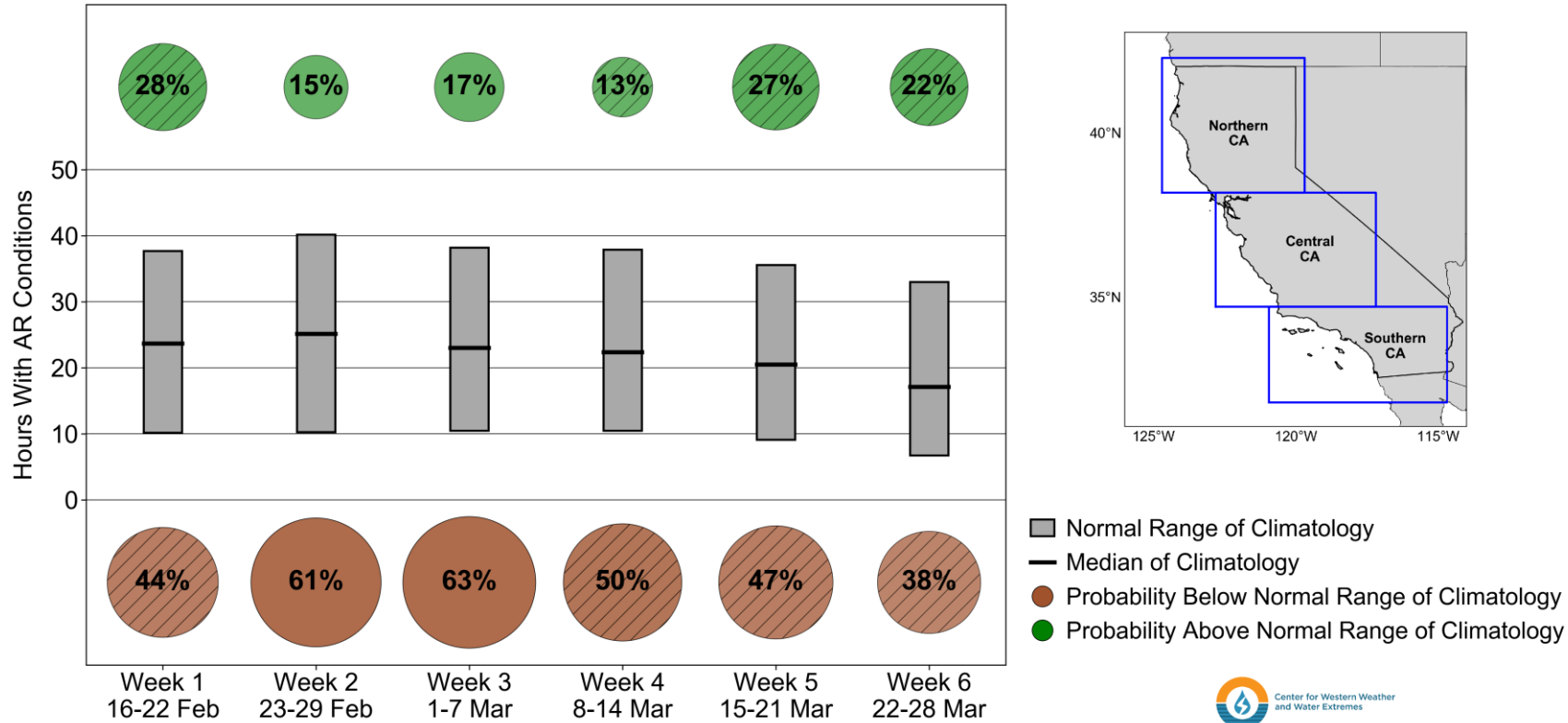
- Warm and dry conditions are predicted over CA during the rest of February with moderate confidence
- Large uncertainty of weather conditions during early March

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

Forecasts Initialized 15 Feb 2024

AR Occurrence: Northern CA

Northern CA Subseasonal AR Occurrence Outlook
Issued: 15 Feb 2024 MJO Phase 7 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 2–3 in Northern CA
- The same product is showing a high likelihood of below-normal AR occurrence in Central CA during Weeks 2–5 and in Southern CA during Weeks 4–5



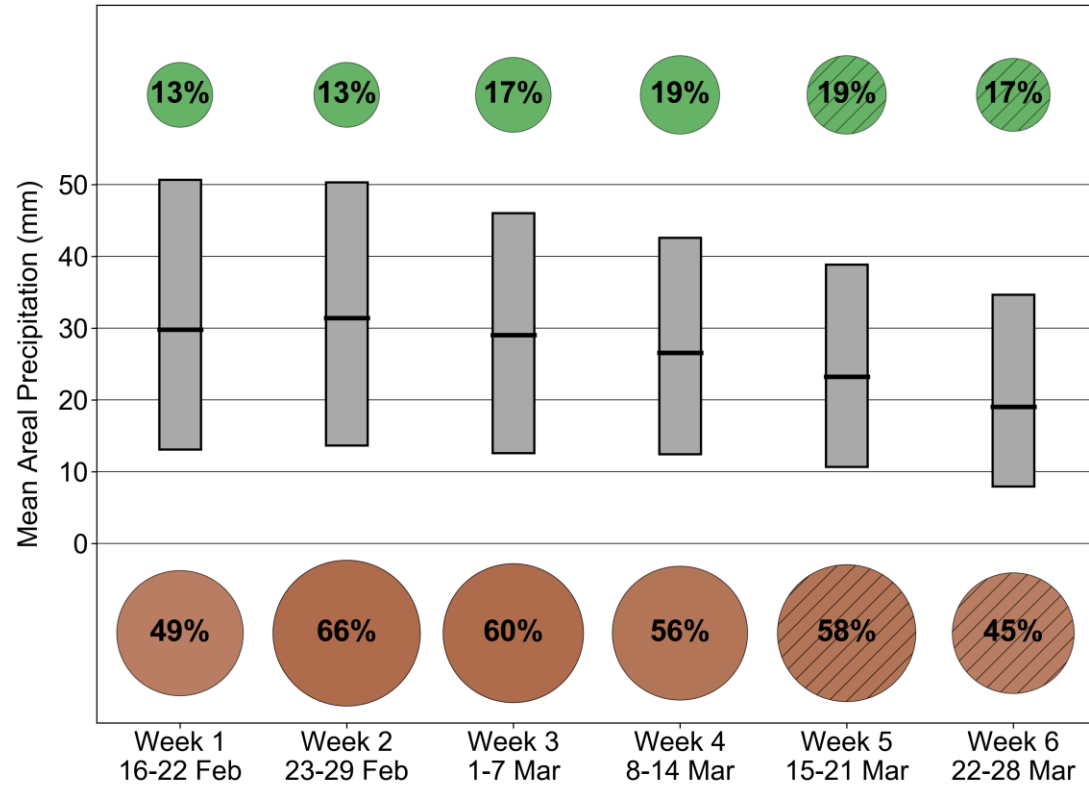
This product shows weekly probabilities of above-normal and below-normal AR occurrence in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If 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 15 Feb 2024

Precipitation: Northern CA

Northern CA Subseasonal Precipitation Outlook
Issued: 15 Feb 2024 MJO Phase 7 EQBO



- Normal Range of Climatology
- Median of Climatology
- Probability Below Normal Range of Climatology
- Probability Above Normal Range of Climatology



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

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. \(2023\)](#)