



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 8 March 2024

Prepared by: J. Wang, C. Castellano, Z. Yang, 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*

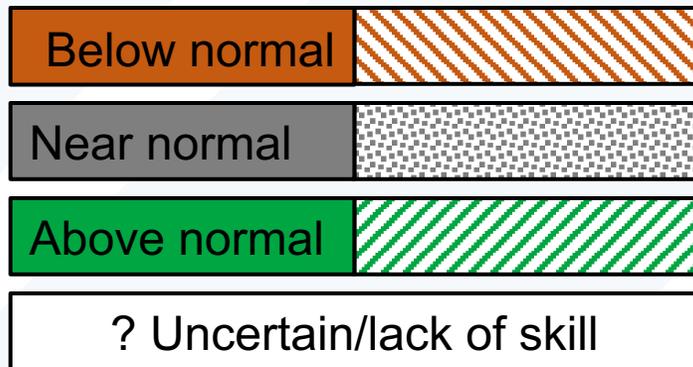
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 7 Mar 2024

Region	Week 2 (15–21 Mar)				Week 3 (22–28 Mar)				Week 4 (29–4 Apr)		
	NCEP ^{2,3}	ECCE ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{2,3}	ECCE 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	
Northern CA		Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal		Below normal	
Central CA		Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	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



- ECCE and ECMWF agree on below-normal precipitation in CA during Week 2 while uncertainty exists between different products for NCEP
- Week 3 forecasts are suggesting below-normal precipitation over CA with high confidence
- 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](#))

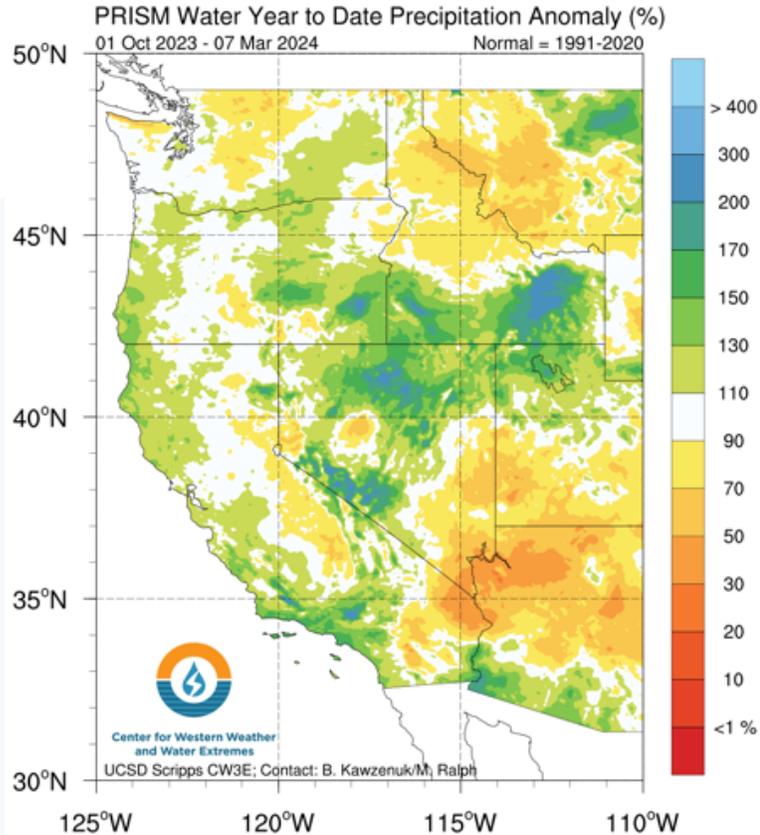
³IRI North American Weather Regime Forecasts ([Robertson et al. 2020](#))

Summary

- **Week 2 forecasts (15–21 Mar):** Models agree on very low likelihood of AR activity in CA during Week 2
- As of 7 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 be propagating from the Maritime Continent into the Western Pacific in the next two weeks
- Models agree on 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 (22–28 Mar):** Models agree on below-normal AR activity in 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 transition from Pacific Trough (wet conditions in CA) to West Coast Ridge (dry conditions in CA) around the middle of Week 2, and moderate-to-high likelihood of West Coast Ridge continuing through the rest of 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 Weeks 4-5

Hydrologic Summary

Precipitation

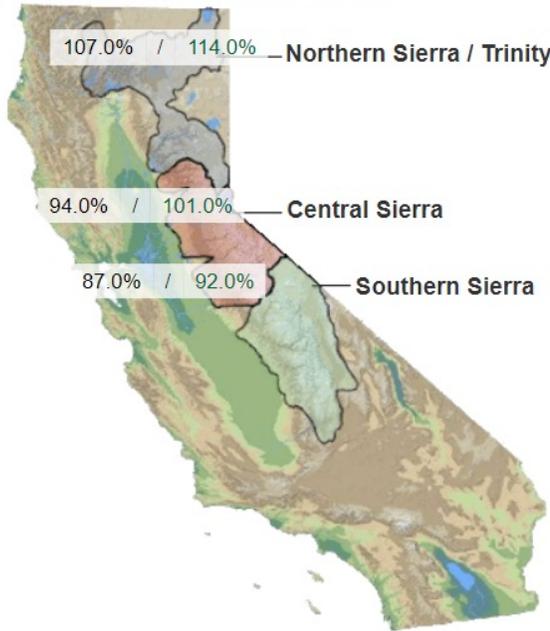


Snowpack Conditions

Provided by the California Cooperative Snow Surveys

Data For: 07-Mar-2024

% Apr 1 Avg. / % Normal for this Date



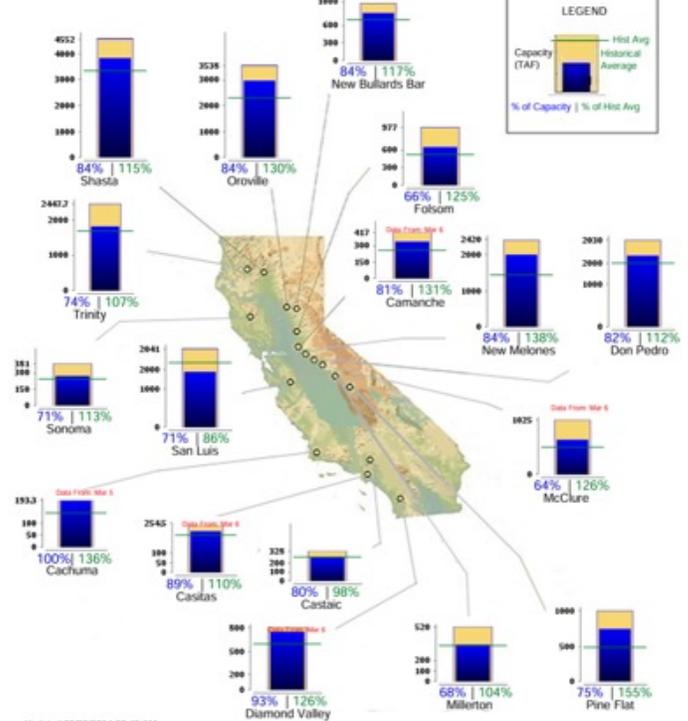
Source: California DWR

Reservoir Storage

CALIFORNIA MAJOR WATER SUPPLY RESERVOIRS

CURRENT CONDITIONS

Midnight - March 7, 2024



Source: California DWR

- As of 7 Mar, WY-to-date precipitation is >150% 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 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

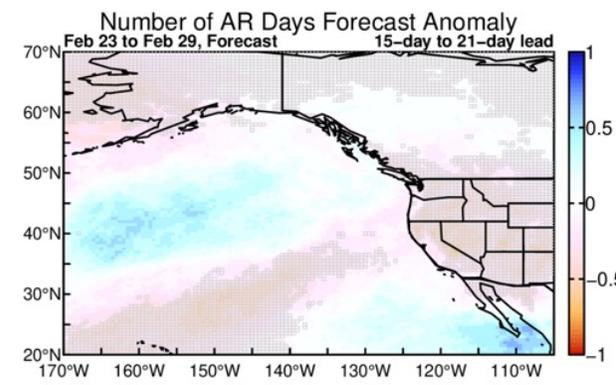
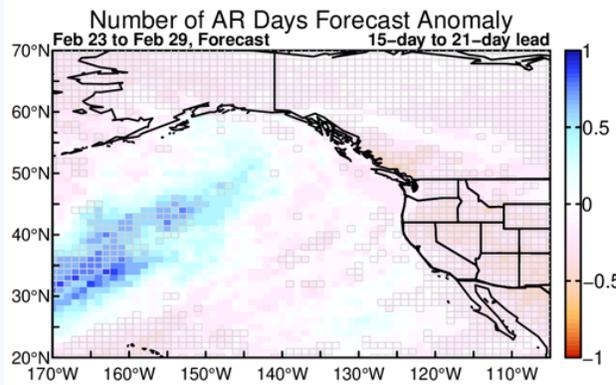
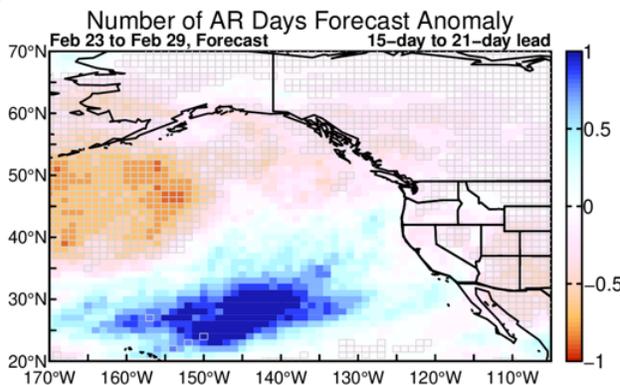
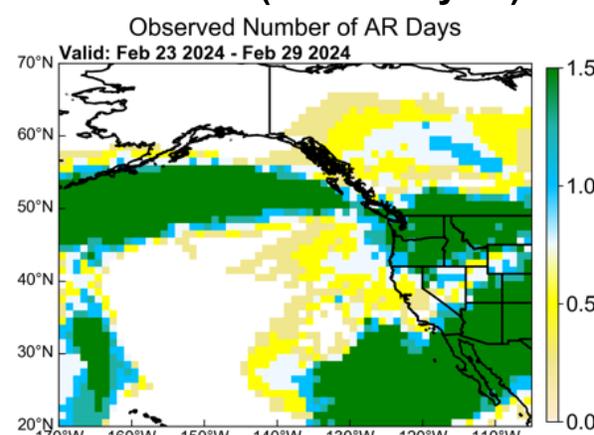
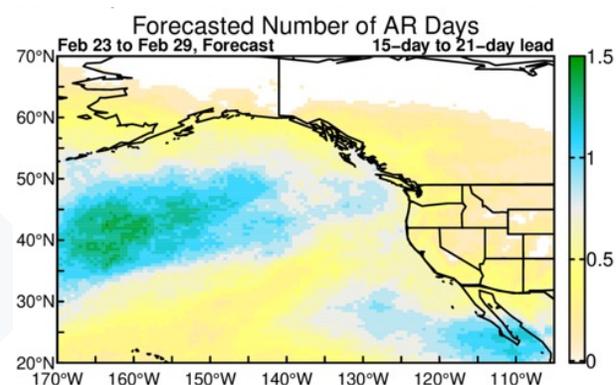
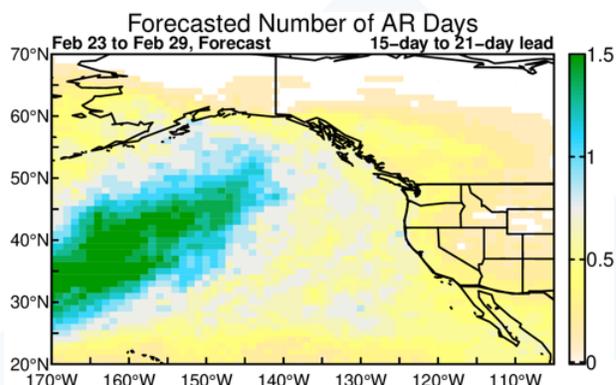
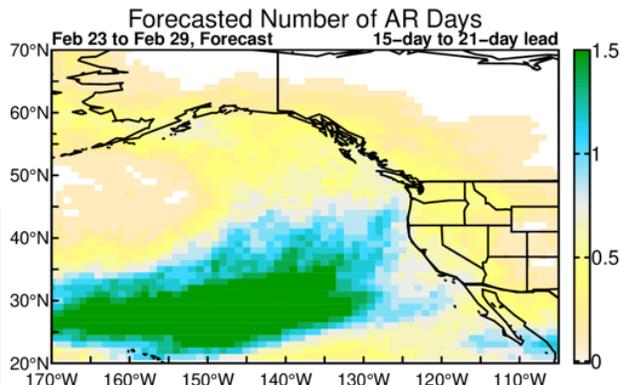
Forecasts Initialized 8 Feb 2024; Valid: 23–29 Feb 2024

NCEP

ECCC

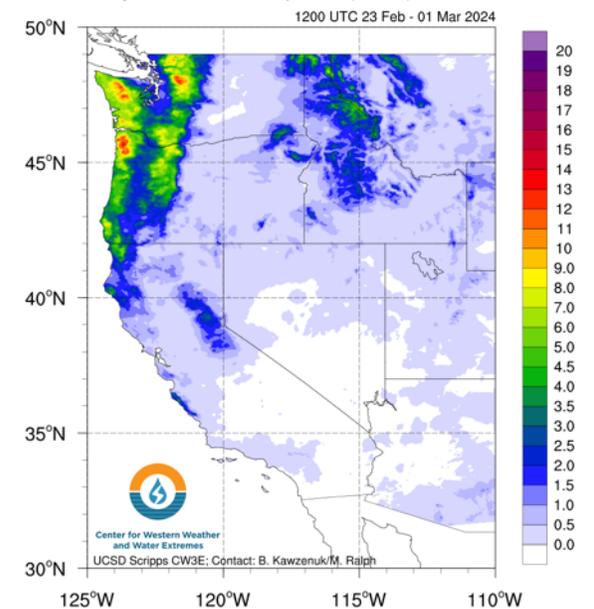
ECMWF

Observed (GFS Analysis)



Observed Precipitation

7-day Accumulated Precipitation (inches)



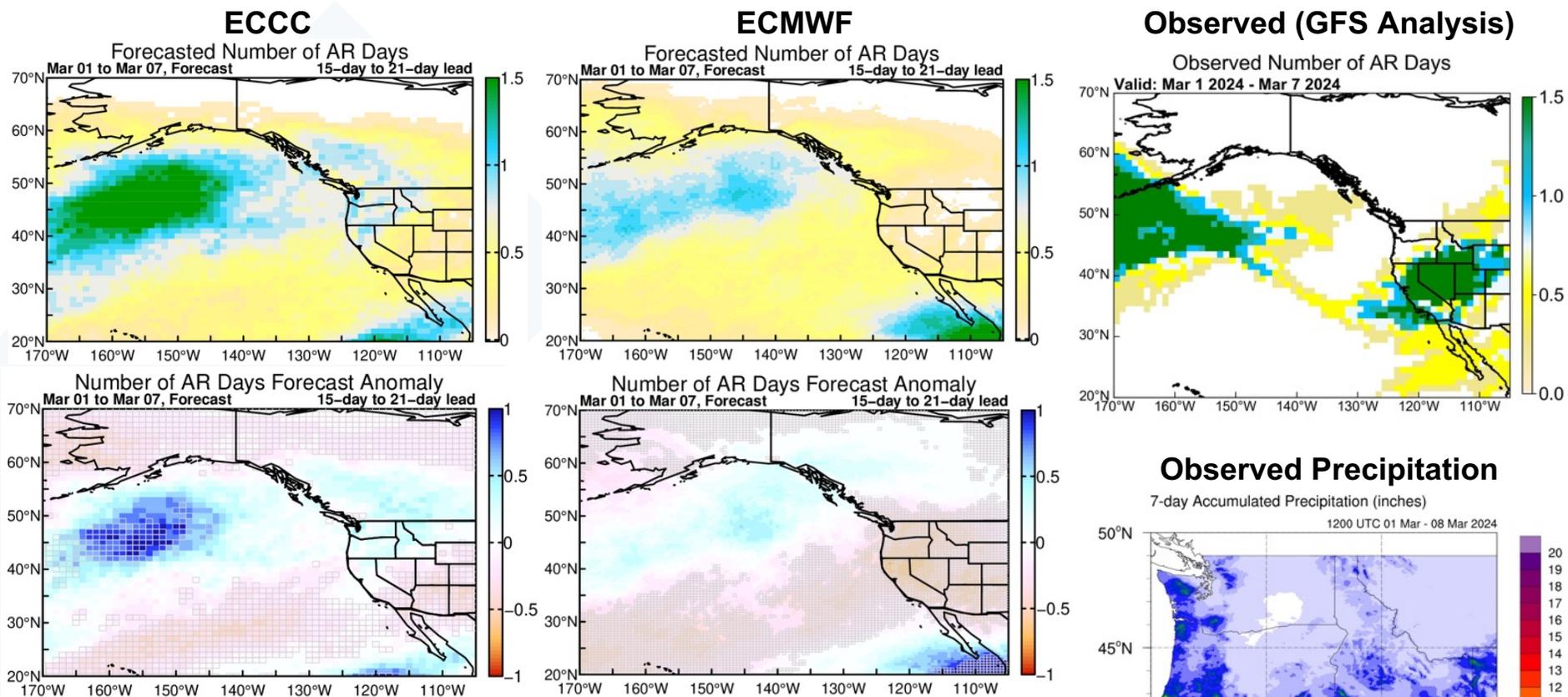
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

- Models failed to capture the two regions of AR activity concentrated over the northwestern US and Southern CA/Arizona
- 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

Looking Back: Week 3 AR Activity Forecasts

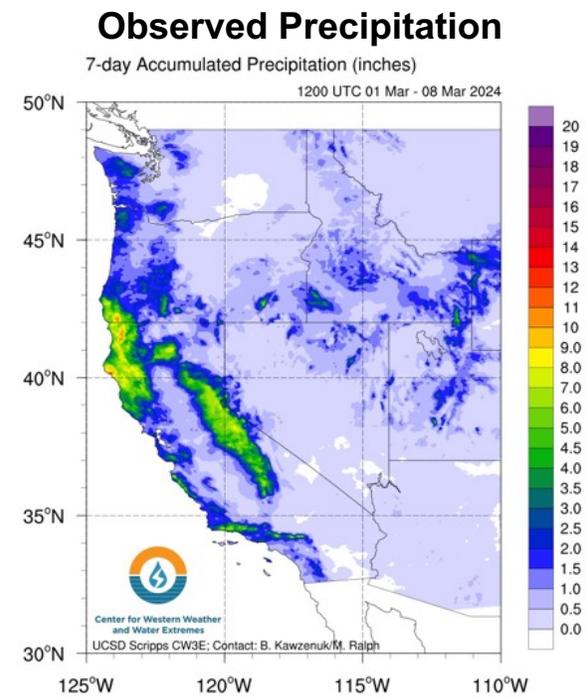
Forecasts Initialized 15 Feb 2024; Valid: 1 – 7 Mar 2024

NCEP
unavailable



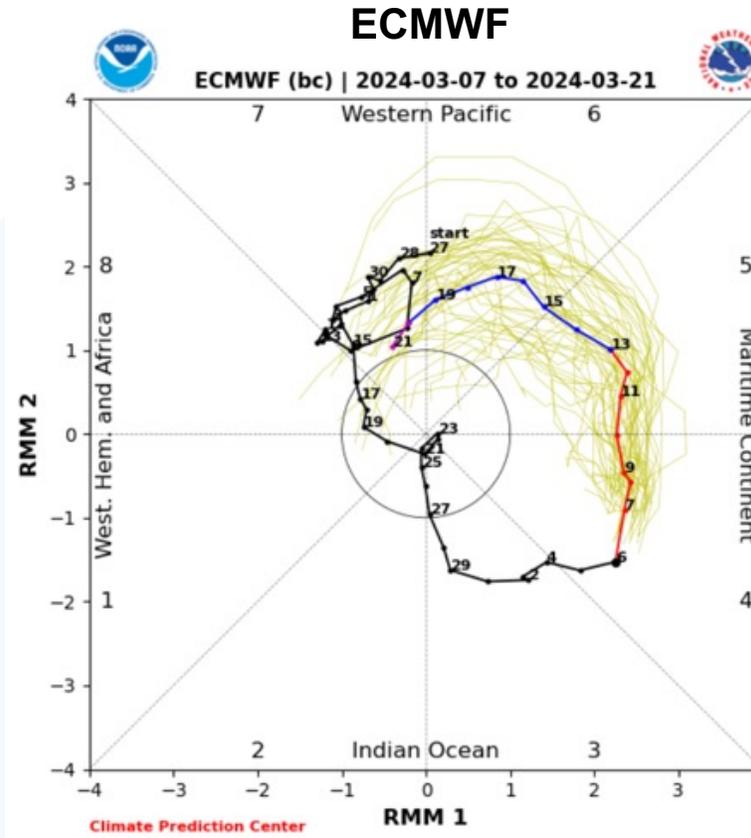
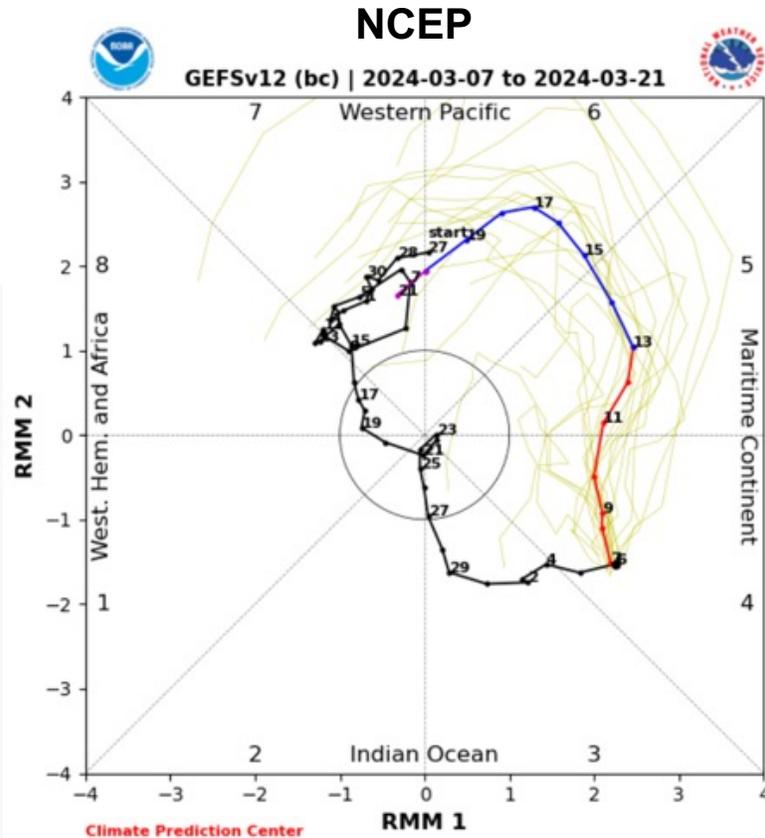
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

- ECCC and ECMWF failed to capture the AR activity over the western US, especially in Central CA
- An AR and low-pressure system produced >10 inches of precipitation over the 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



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

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)

- 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 are forecasting MJO to remain strong over the Maritime Continent in Week 1 and propagate eastward to the Western Pacific (Phases 6-7) in the later half 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

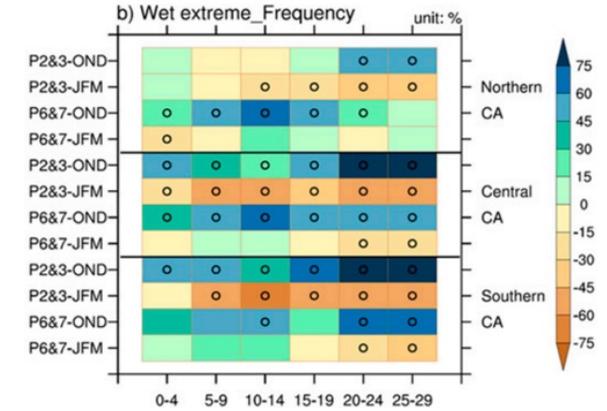


Figure 8 from Wang et al. (2023)

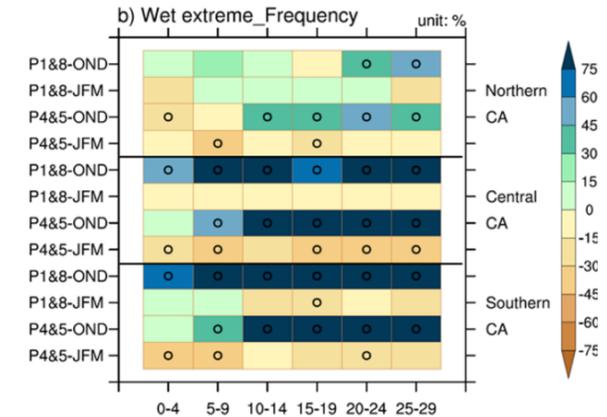
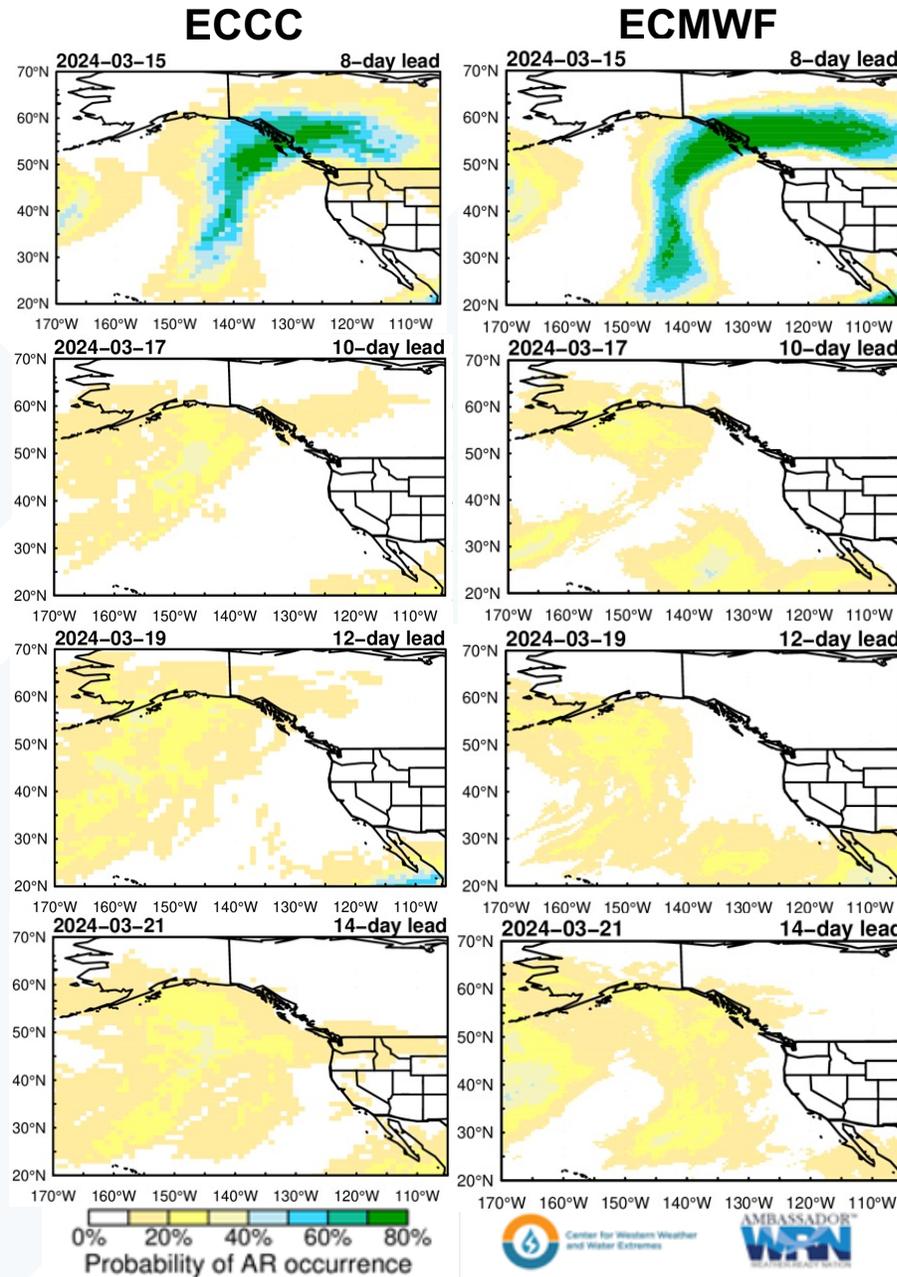


Figure S6 from Wang et al. (2023)

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

Forecasts Initialized 7 Mar 2024

NCEP
unavailable

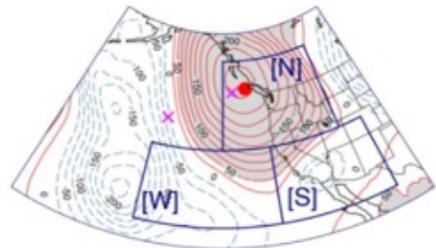


- ECCC and ECMWF are predicting very low likelihood (< 20% probability) of AR activity over CA and WA/OR during Week 2 (15–21 Mar)

Models agree on very low likelihood of AR activity over CA during Week 2 (15-21 Mar)

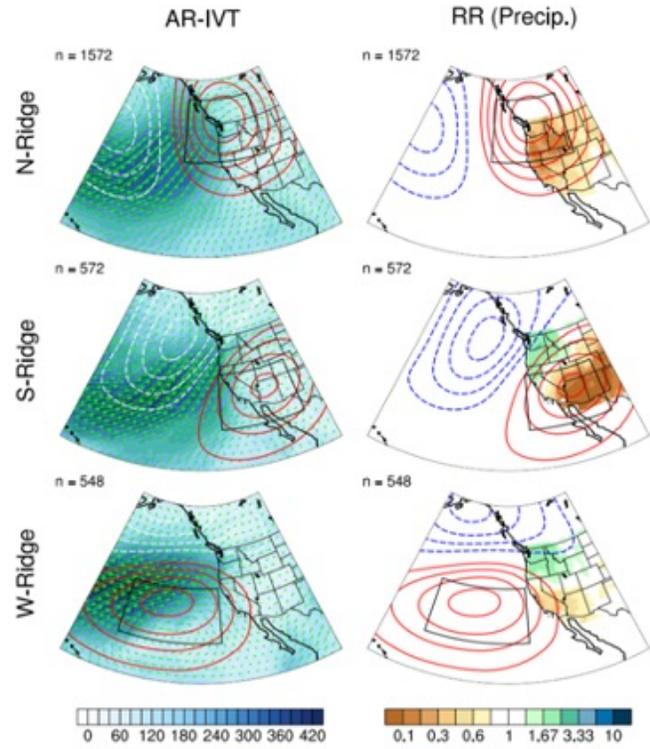
**Note that the probabilities of AR occurrence in the Week 2 AR activity plots may differ from the probabilities of AR conditions in the AR landfall tool. These discrepancies exist due to the use of different models (e.g., GEFS vs. CFSv2), model configurations (S2S models are coupled between ocean, land,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



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



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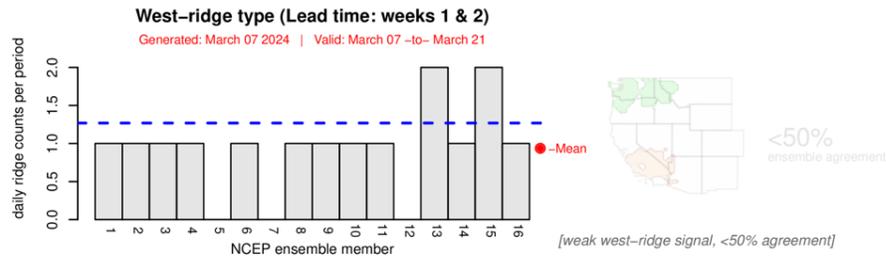
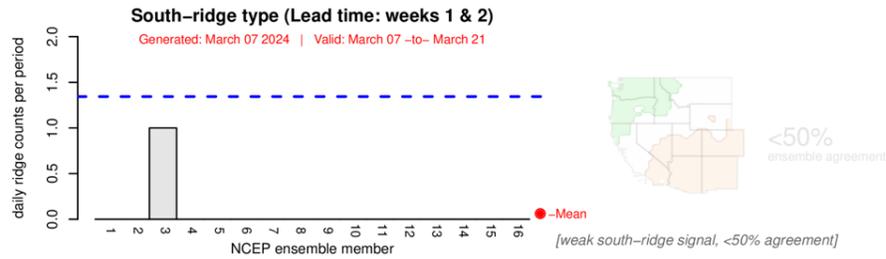
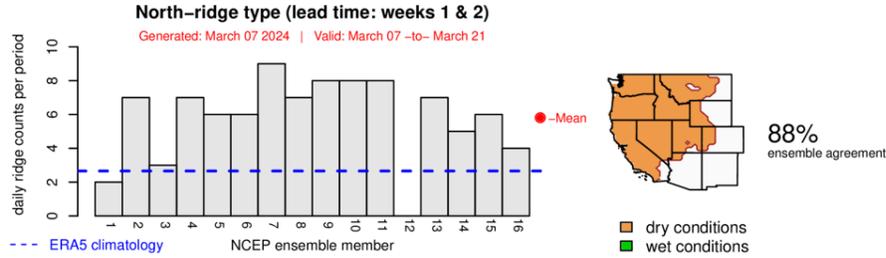
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 7 Mar 2024

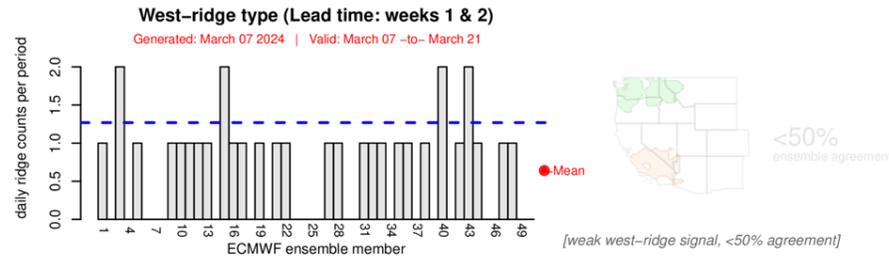
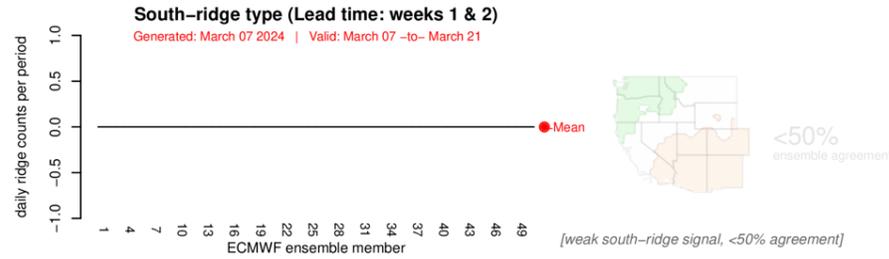
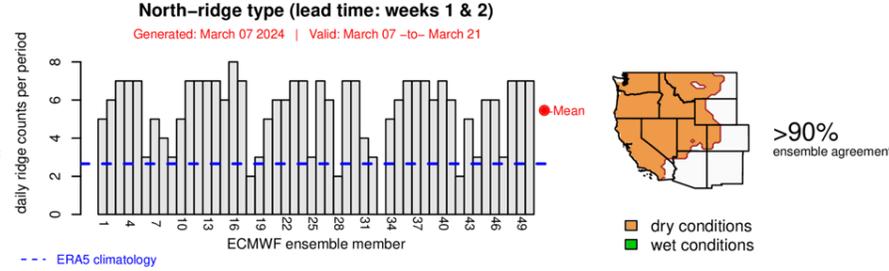
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



- Both models are showing high likelihood (88% ensemble agreement in NCEP and >90% ensemble agreement in ECMWF) of above-normal North-ridge activity during Weeks 1-2 (7-21 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 (7-21 Mar)



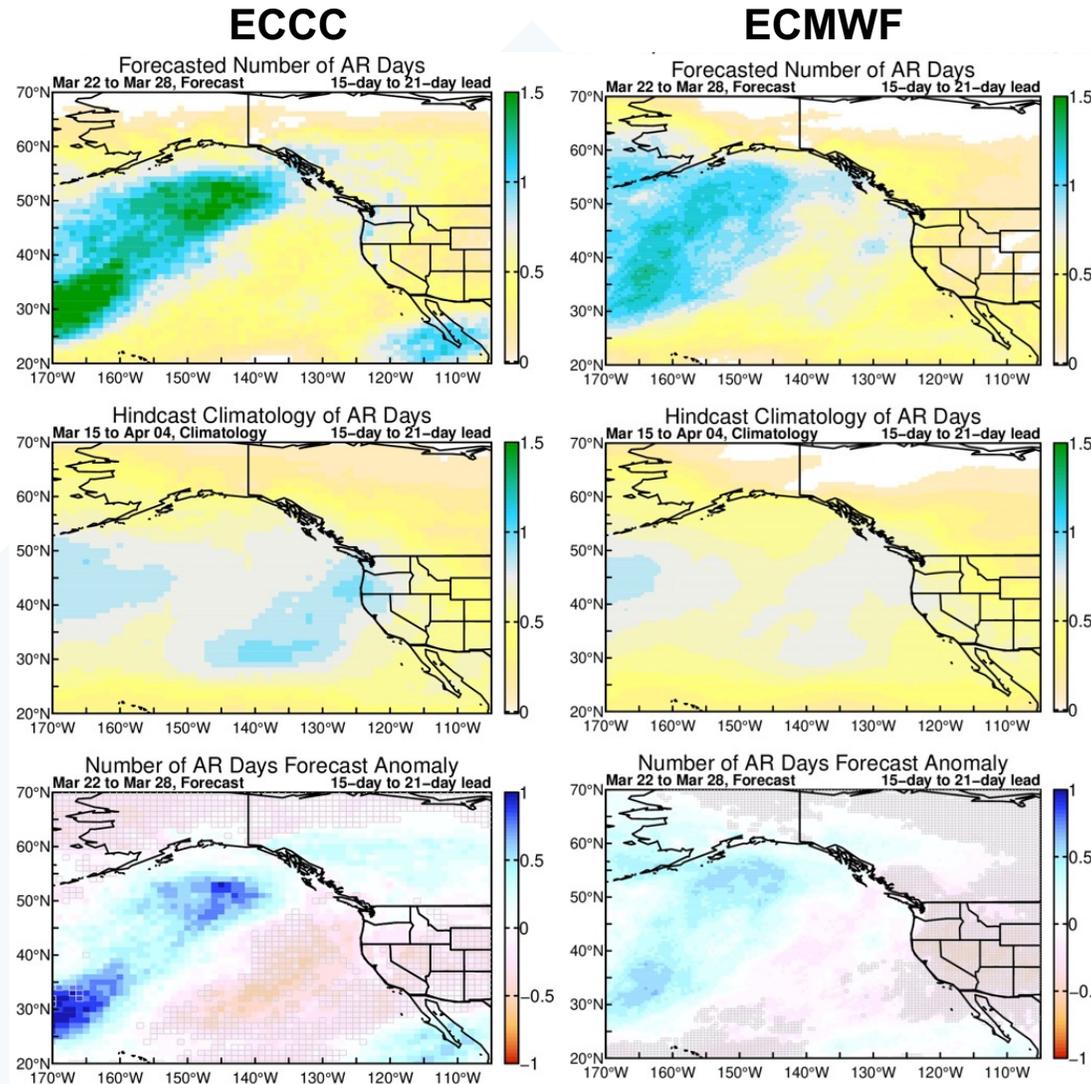
Subseasonal Outlooks: Week 3 AR Activity (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 7 Mar 2024

- ECCC and ECMWF are predicting below-normal AR activity over Central and Southern CA during Week 3 (22–28 Mar) with high confidence (>75% ensemble agreement)
- Both models also predict below-normal AR activity over OR and Northern CA with high confidence in ECMWF and low confidence in ECCC
- ECCC is predicting near-normal AR activity over WA with low confidence and ECMWF predicts below-normal AR activity over WA with high confidence

Models agree on below-normal AR activity in CA during Week 3 (22-28 Mar)

NCEP
unavailable



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)

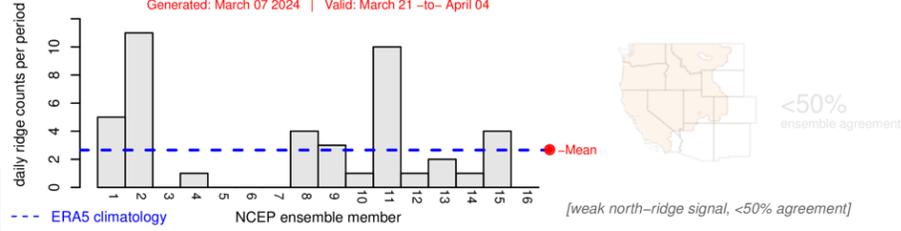
Forecasts Initialized 7 Mar 2024

NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)

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

Generated: March 07 2024 | Valid: March 21 –to– April 04

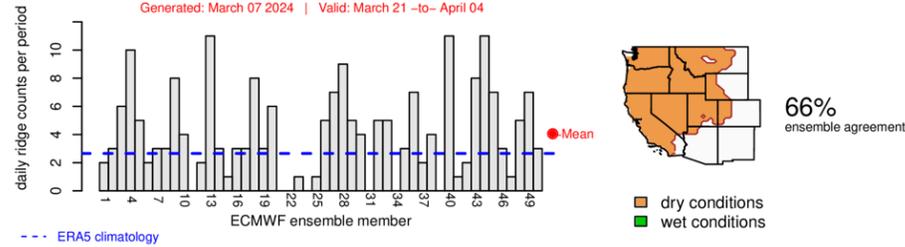


ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)

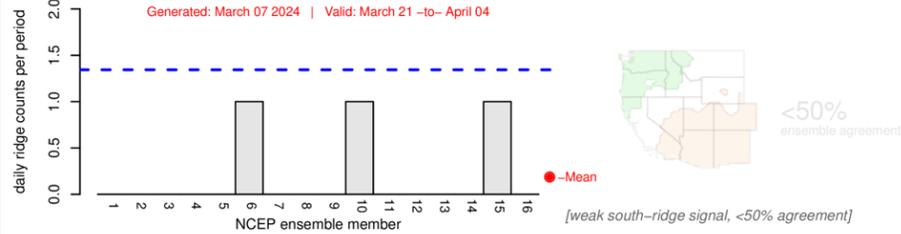
North-ridge type (lead time: weeks 3 & 4)

Generated: March 07 2024 | Valid: March 21 –to– April 04



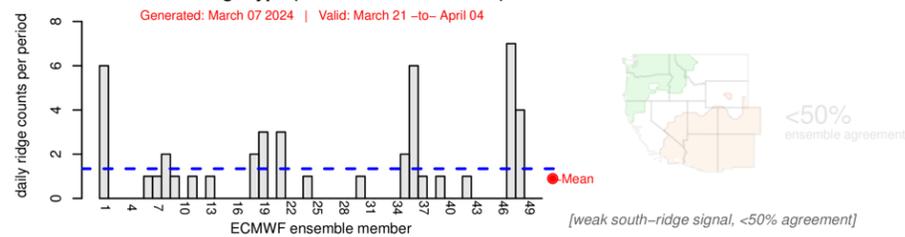
South-ridge type (Lead time: weeks 3 & 4)

Generated: March 07 2024 | Valid: March 21 –to– April 04



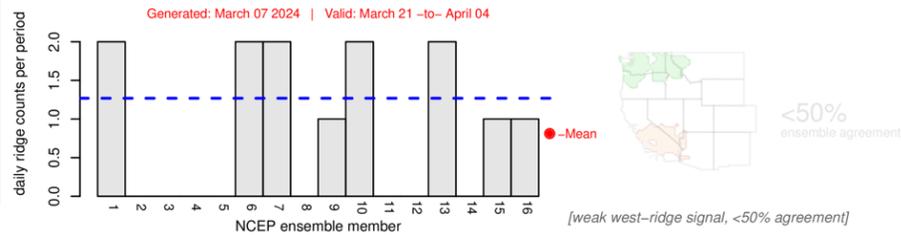
South-ridge type (Lead time: weeks 3 & 4)

Generated: March 07 2024 | Valid: March 21 –to– April 04



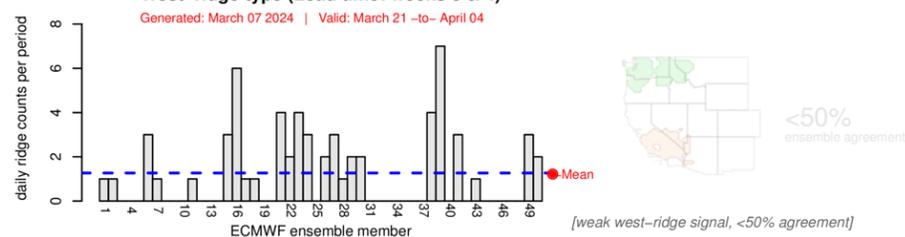
West-ridge type (Lead time: weeks 3 & 4)

Generated: March 07 2024 | Valid: March 21 –to– April 04



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

Generated: March 07 2024 | Valid: March 21 –to– April 04



- ECMWF is showing moderate likelihood (66% ensemble agreement) of above-normal North-ridge activity during Weeks 3–4 (21 Mar – 4 Apr)
- ECMWF is also showing near-normal South-ridge and West-ridge activity
- NCEP is predicting near-normal North-ridge activity and below-normal South-ridge and West-ridge activity

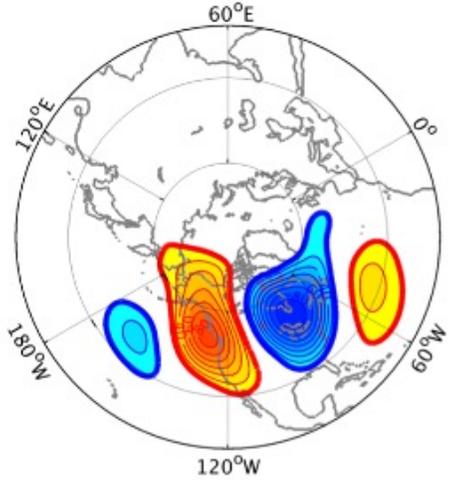


Model uncertainty regarding the likelihood of persistent ridging near the US West Coast during Weeks 3–4 (21 Mar – 4 Apr)

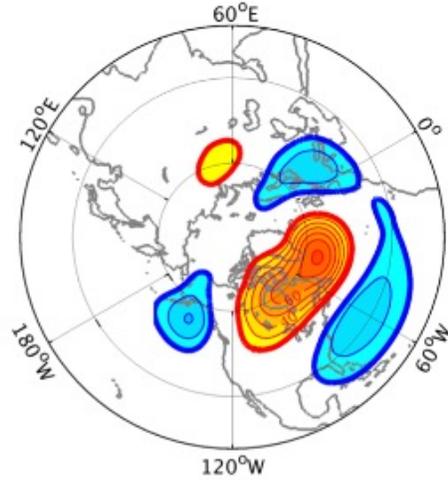


Background Info: IRI Subseasonal Weather Regime Forecasts

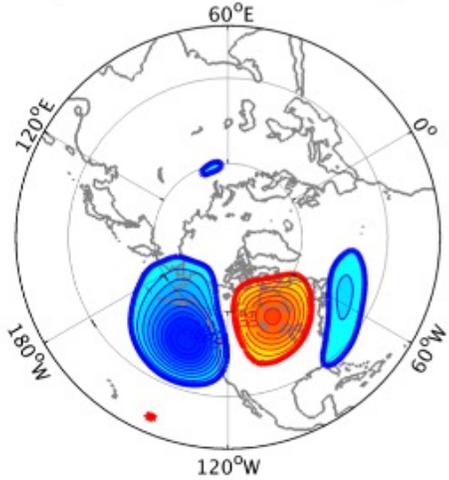
a) WR 1: West Coast Ridge



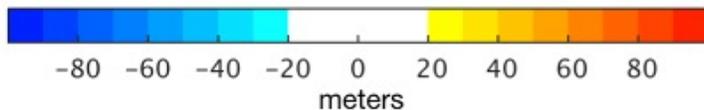
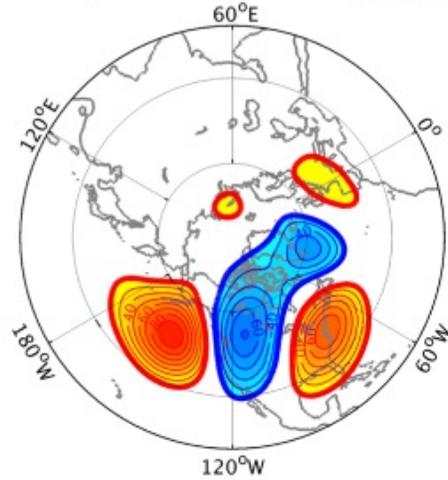
b) WR 2: Greenland High



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. \(2020\)](#)

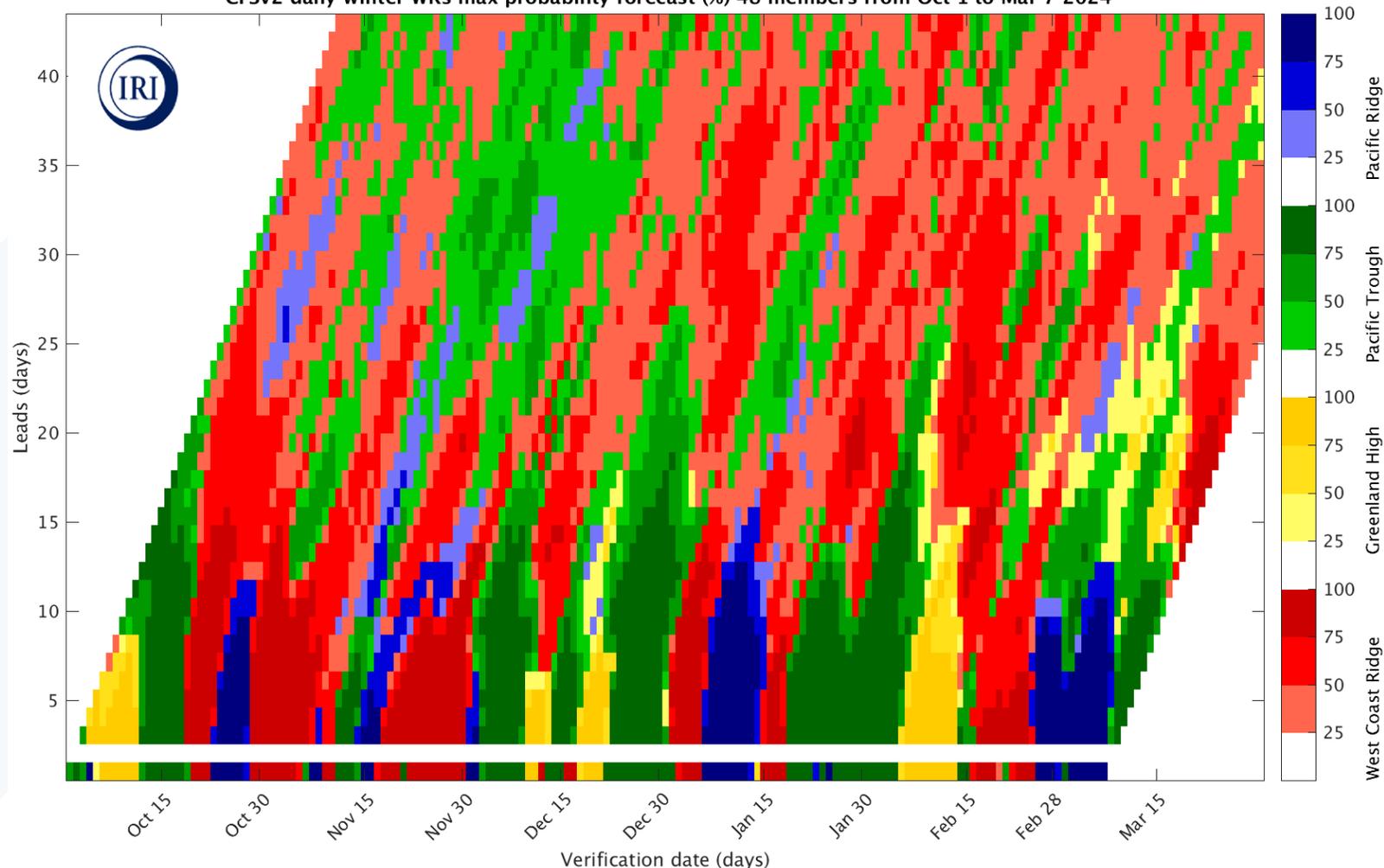
For more information about the forecast product:

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

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Forecast Initialized 7 Mar 2024

CFSv2 daily winter WRs max probability forecast (%) 48 members from Oct 1 to Mar 7 2024



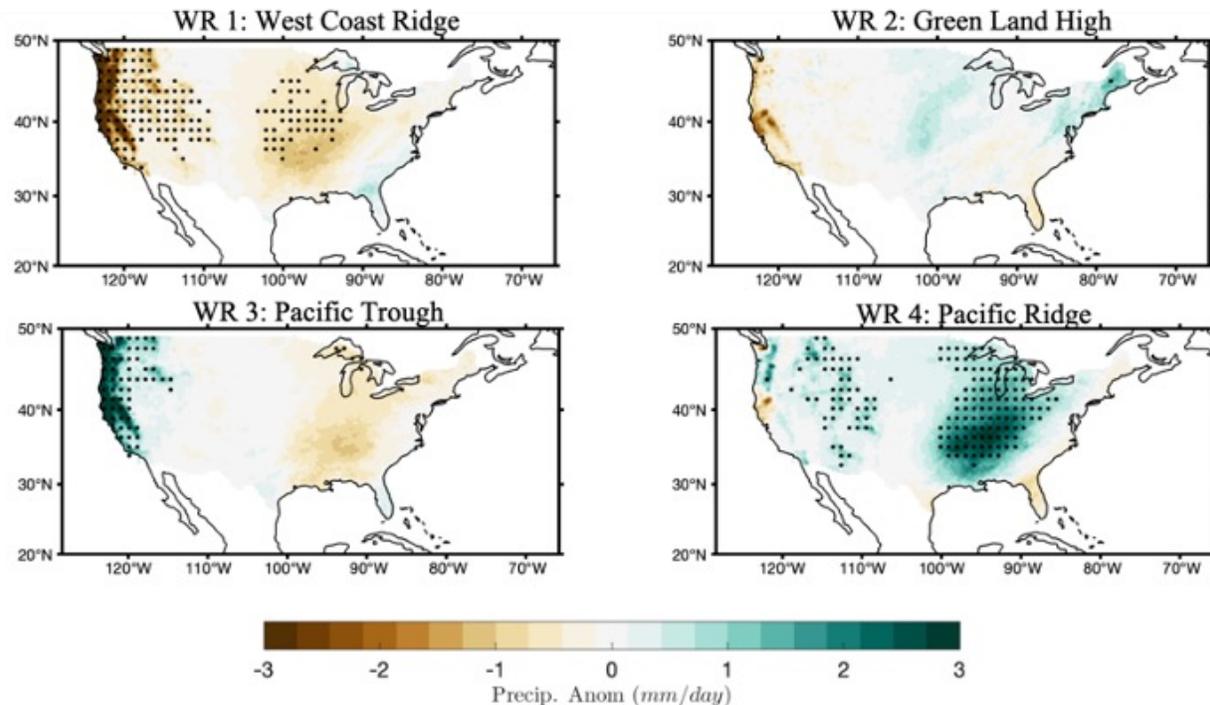
- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- Moderate-to-high likelihood (> 50% ensemble agreement) of transition from Pacific Trough to West Coast Ridge around the middle of Week 2
- West Coast Ridge is forecast to persist into Week 3 (22-28 Mar) with moderate-to-high likelihood and the first half of Week 4 with low likelihood

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

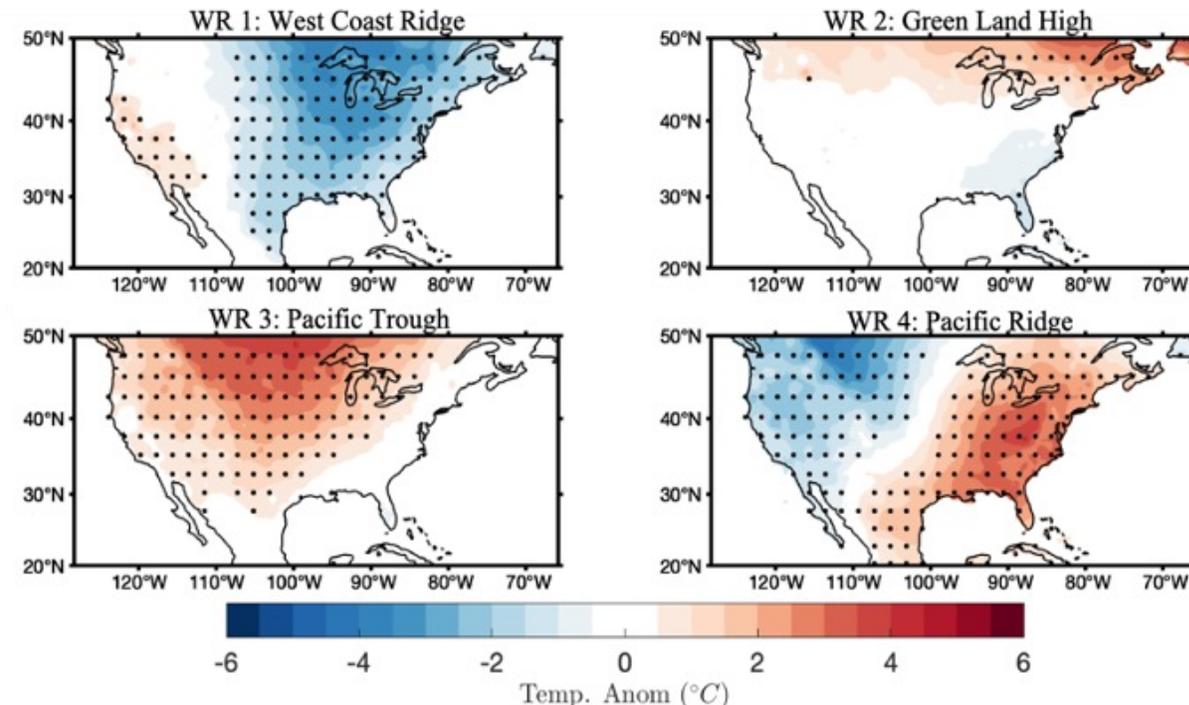
For more information about the forecast product: <https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs>

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation



Temperature



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

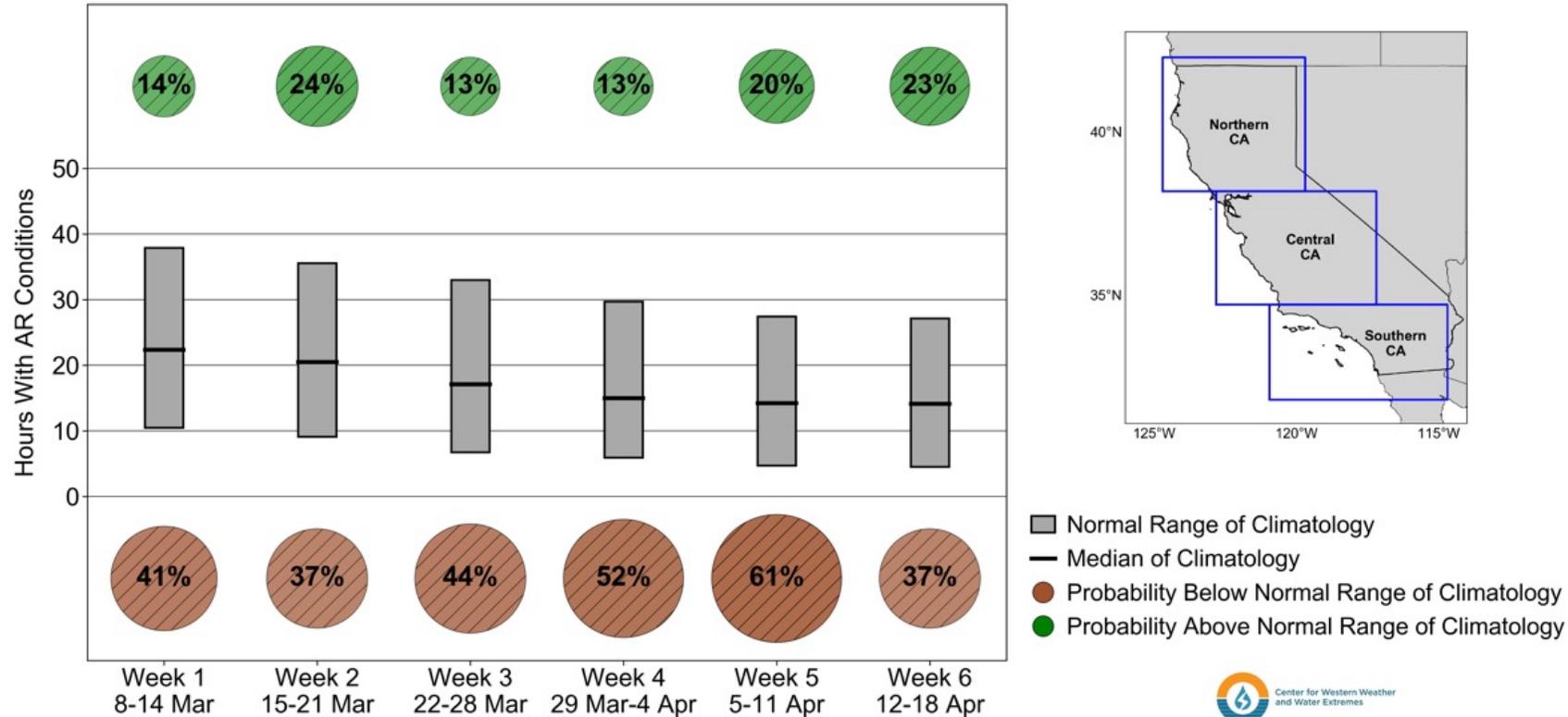
- Warm and wet conditions are predicted over CA during early-to-mid March with moderate-to-high confidence
- Warm and dry conditions are predicted over CA during the last two weeks in March with moderate-to-high confidence

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

Forecasts Initialized 7 Mar 2024

AR Occurrence: Northern CA

Northern CA Subseasonal AR Occurrence Outlook
Issued: 7 Mar 2024 MJO Phase 4 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 4–5 in Northern CA
- The same product is showing a high likelihood of below-normal AR occurrence in Central CA in Week 5 and in Southern CA during Week 1 and Weeks 4–6



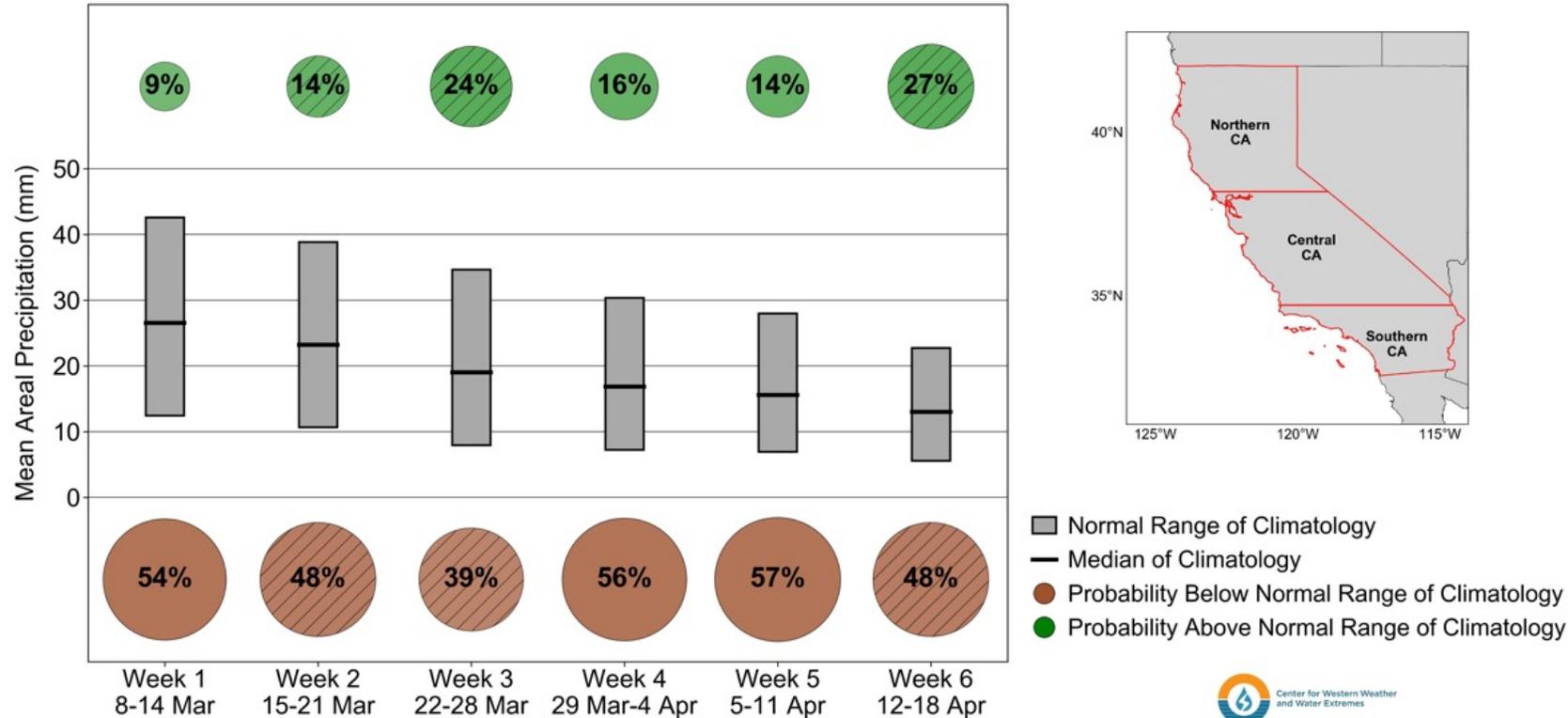
This product shows weekly probabilities of above-normal and below-normal AR occurrence in California. These probabilities are calculated for lead times of 1–6 weeks based on the current season (i.e., OND or JFM) and phases of the Madden-Julian Oscillation (MJO) and Quasi-biennial Oscillation (QBO). If 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 7 Mar 2024

Precipitation: Northern CA

Northern CA Subseasonal Precipitation Outlook
Issued: 7 Mar 2024 MJO Phase 4 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 4–5 in Northern CA
- The same product is showing a high likelihood of below-normal precipitation in Central CA during Weeks 1-2 and Weeks 4-6 and in Southern CA during Weeks 1-2 and Weeks 4-5



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. \(2023\)](#)