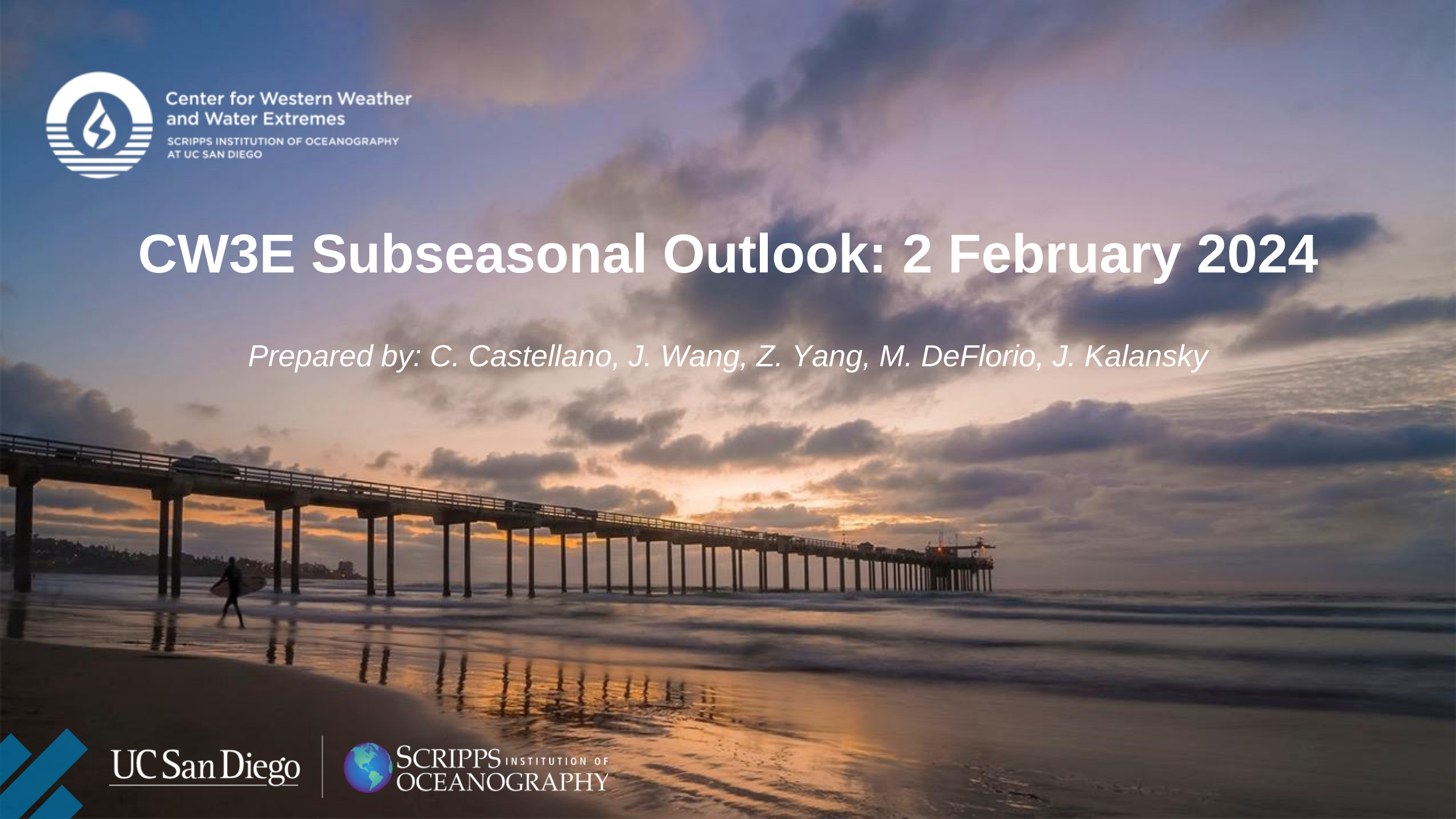

CW3E Subseasonal Outlook: 2 February 2024

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

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
  - ECCC (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 1 Feb 2024

Region	Week 2 (9–15 Feb)			Week 3 (16–22 Feb)			Week 4 (23–29 Feb)		
	NCEP[1,2,3]	ECMWF[1,2]	Multi-Model Forecast	NCEP[1,2,3]	ECMWF[1,2]	Multi-Model Forecast	NCEP[2,3]	ECMWF[2]	Multi-Model Forecast
WA/OR									
Northern CA									
Central CA									
Southern CA									

Higher Confidence | Lower Confidence

- Below normal
- Near normal
- Above normal
- ? Uncertain/lack of skill

- Models generally agree on below-normal precipitation in CA during Week 2; ECMWF is more confident in below-normal precipitation than NCEP
- Week 3 forecasts are uncertain due to lack of agreement between models and forecast products over CA
- Models agree on below-normal precipitation in CA during Week 4; NCEP is more confident in below-normal precipitation than ECMWF

Subseasonal products included in this Outlook:

[1]CW3E/JPL Atmospheric River Activity Forecasts (DeFlorio et al. 2019)
[2]CW3E/JPL Ridging Forecasts (Gibson et al. 2020)
[3]IRI North American Weather Regime Forecasts (Robertson et al. 2020)

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Summary

- **Week 2 forecasts (9–15 Feb):** Models agree on low likelihood (< 30% probability) of AR activity in CA

- As of 1 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 show some disagreement on forecasts of MJO activity during Weeks 1–2

- Ridging outlooks show some uncertainty in ridging activity near the US West Coast during Weeks 1–2
  - ECMWF is showing moderate likelihood of above-normal North-ridge activity (dry conditions in CA)
  - NCEP is showing low likelihood of above-normal North-ridge activity

- **Week 3 forecasts (16–22 Feb):** All models are predicting near-normal AR activity in Northern CA, but disagree somewhat on AR activity in Central and Southern CA
  - NCEP is forecasting slightly below-normal AR activity in Central and Southern CA with high confidence
  - ECCC and ECMWF are forecasting slightly above-normal AR activity in Central and Southern CA

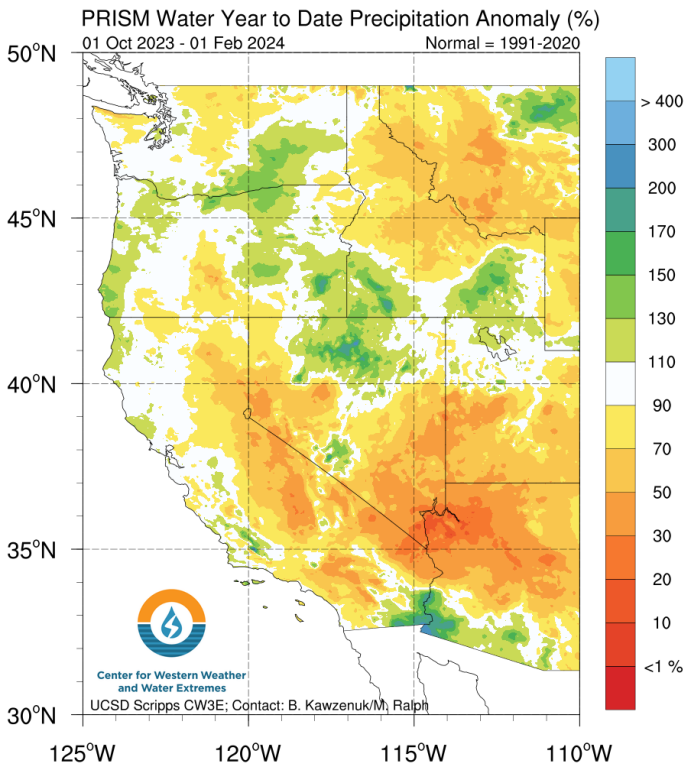
- Models agree on above-normal North-ridge activity during Weeks 3–4, but NCEP is more confident than ECMWF

- IRI weather regime tool shows moderate-to-high likelihood of Greenland High (neutral precipitation conditions in CA) in Week 2 and moderate likelihood of West Coast Ridge (dry conditions over CA) during Weeks 3–4

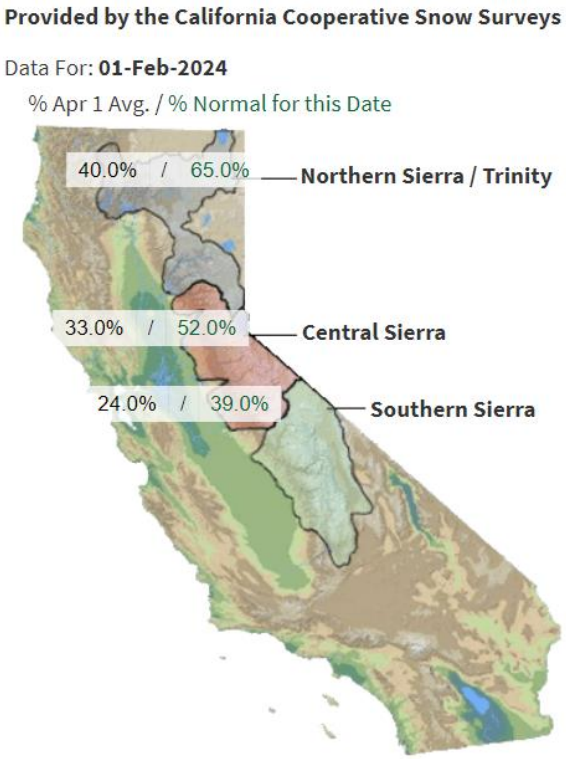
- Statistical forecast tool based on current MJO/QBO conditions is showing a high likelihood (> 50%) of below-normal AR activity in Northern CA during Weeks 2–3 and below-normal precipitation in Northern CA during Weeks 2–5

Hydrologic Summary

Precipitation

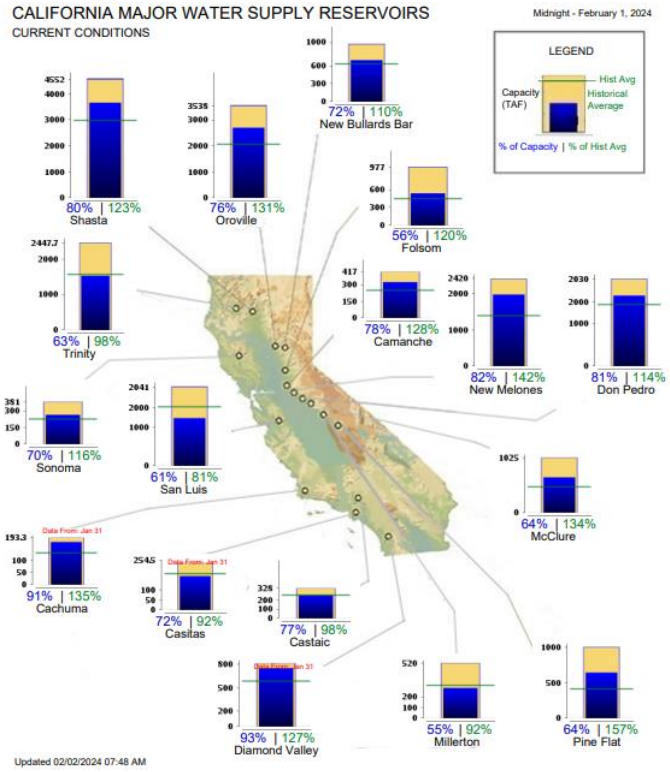


Snowpack Conditions



Source: California DWR

Reservoir Storage



Source: California DWR

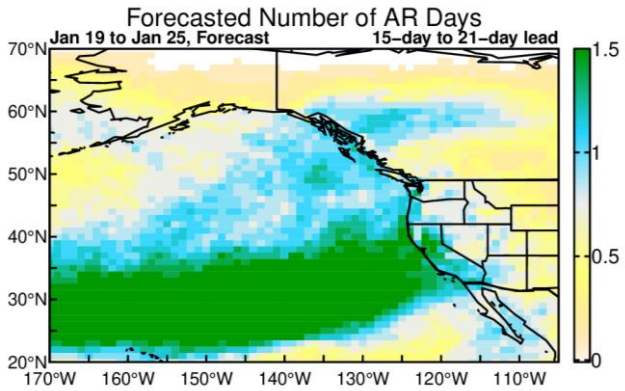
- As of 1 Feb, water-year-to-date precipitation is below-normal over the Sierra Nevada, Mojave Desert, and eastern Transverse Ranges
- Recent storms have brought WY-to-date precipitation to near-normal over much of coastal CA
- Statewide snowpack is still running below-normal for this time of year, especially in the Southern Sierra Nevada
- Most large reservoirs in CA are still operating at greater than 60% storage capacity and near- or above-normal storage for this time of year

Looking Back: Week 3 AR Activity Forecasts

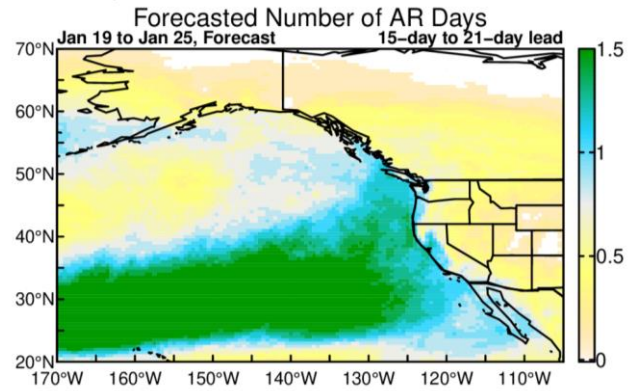
Forecasts Initialized 4 Jan 2024; Valid: 19–25 Jan 2024

NCEP Unavailable

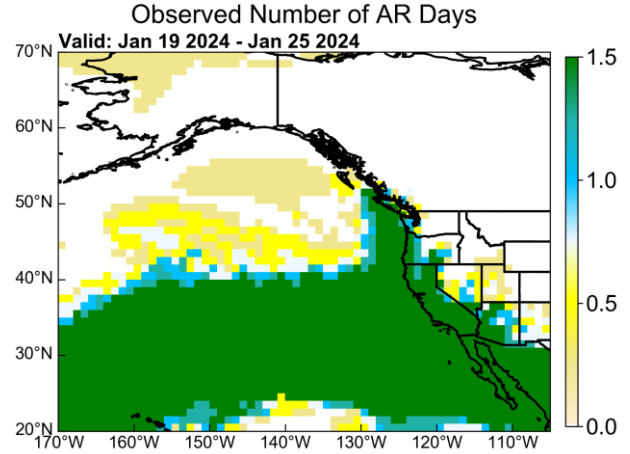
ECCC



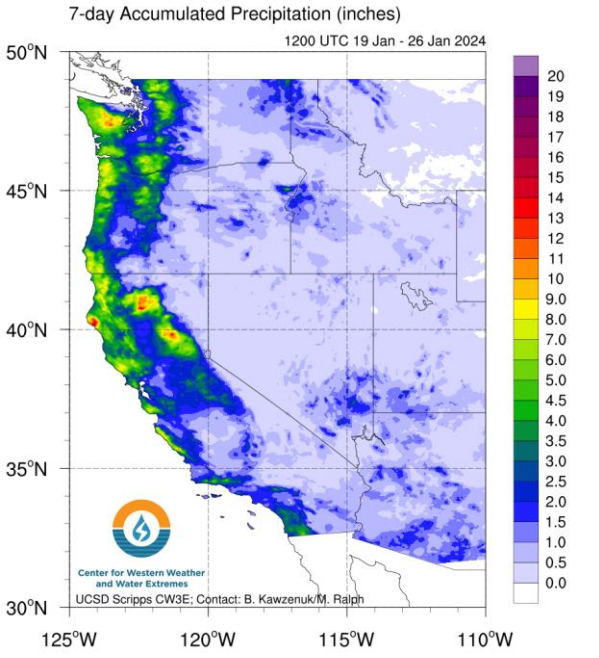
ECMWF



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

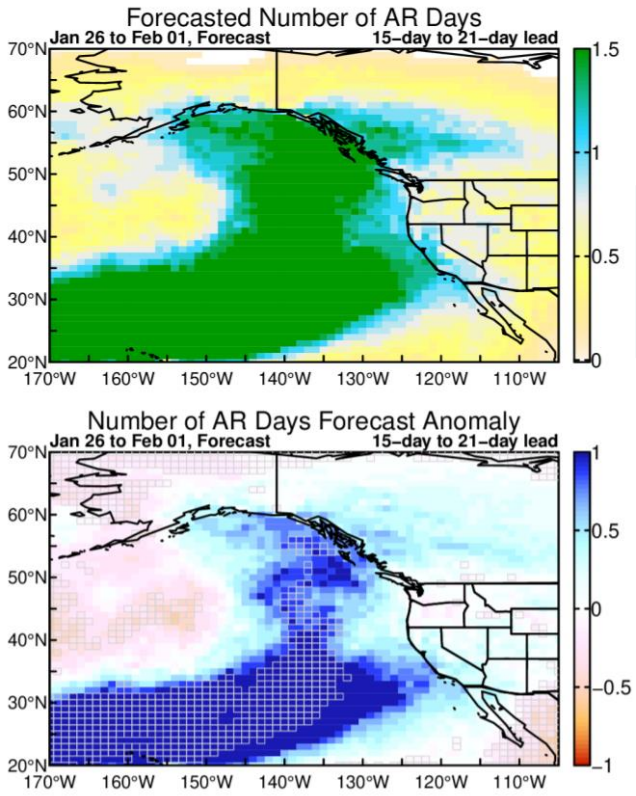
- Models captured large-scale troughing and AR activity over the Northeast Pacific
- ECCC captured AR activity over CA, but underestimated inland extent of AR activity in the southwestern US; ECMWF underestimated AR activity over CA
- Multiple ARs produced more than 5 inches of total precipitation in the Olympic Mountains, OR Coast Ranges, Northern CA Coast Ranges, southern Cascades, and Northern Sierra Nevada
- The second AR produced 2–4 inches of precipitation and major flooding in San Diego County

Looking Back: Week 3 AR Activity Forecasts

Forecasts Initialized 11 Jan 2024; Valid: 26 Jan – 1 Feb 2024

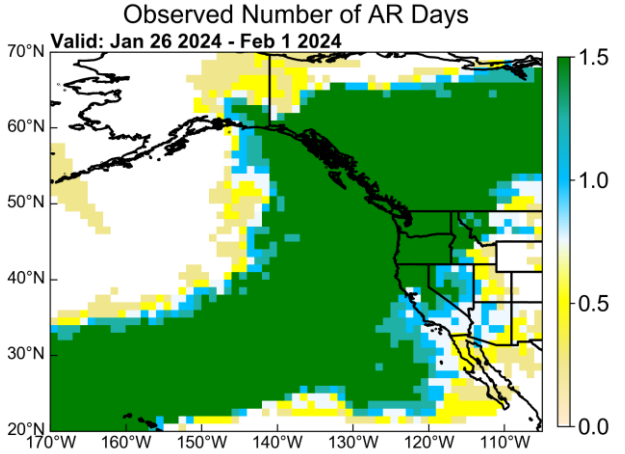
NCEP
Unavailable

ECCC



ECMWF
Unavailable

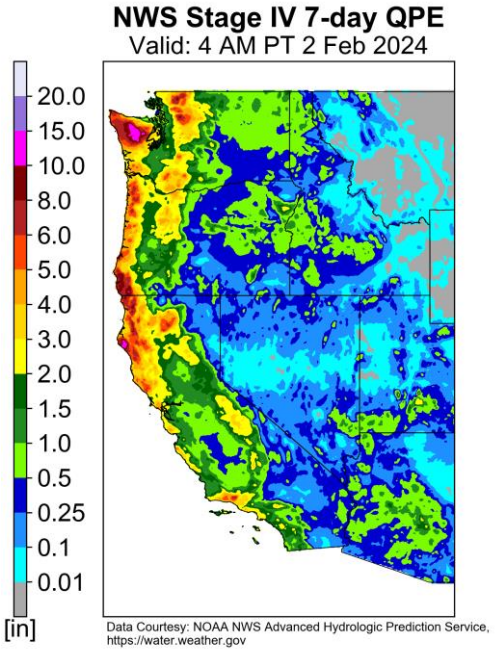
Observed (GFS Analysis)



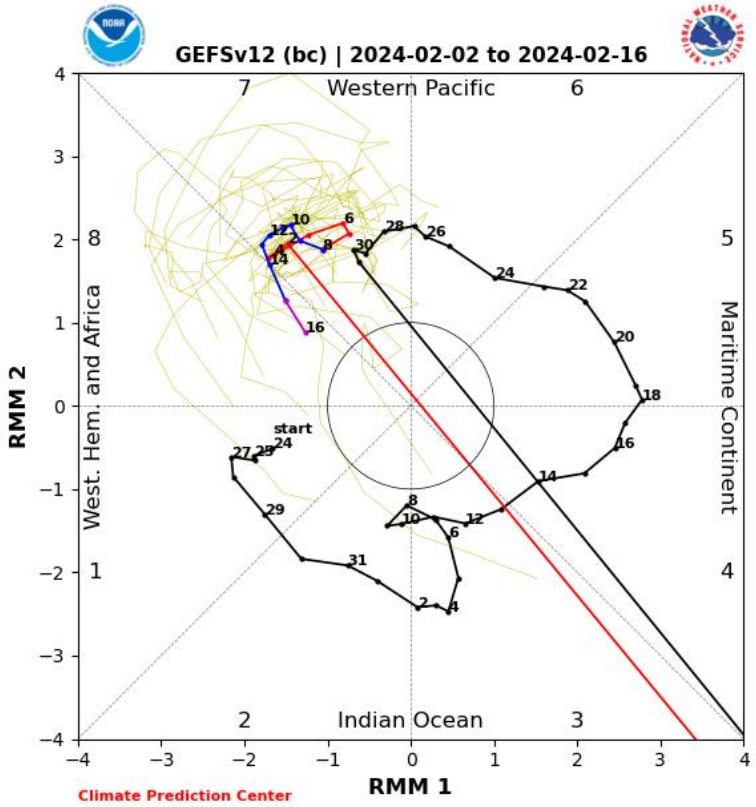
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

- ECCC captured large-scale troughing and AR activity over the Northeast Pacific, but failed to capture landfalling AR activity over the Western US
- A series of three ARs brought heavy precipitation to parts of the USWC during 26 Jan – 1 Feb
- These ARs produced at least 5–10 inches of total precipitation in the North Cascades, Olympic Peninsula, OR Coast Ranges, Northern CA Coast Ranges, and western Transverse Ranges

Observed Precipitation



Dynamical Model MJO Forecasts (NCEP)



Black line: Last 40 days of observations; Yellow lines: Ensemble members
Forecast: (Red: Week 1, Blue: Week 2, Purple: > Week 2)

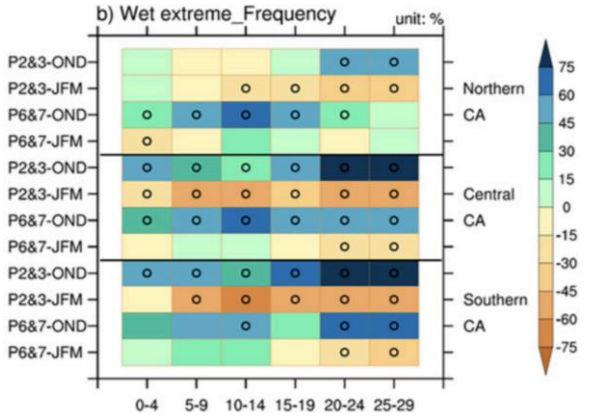


Figure 8 from Wang et al. (2023)

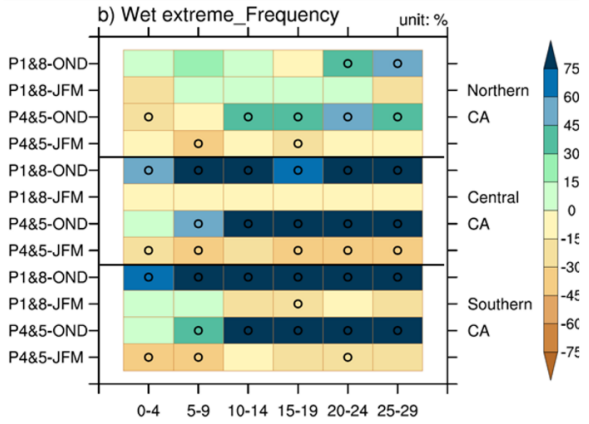


Figure S6 from Wang et al. (2023)

- As of 1 Feb, strong MJO convection is located over the Western Pacific (please ignore bad data observation)
- NCEP is forecasting strong MJO convection to continue and gradually migrate into the Western Hemisphere during the next two weeks
- 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 decrease in wet extremes in Central CA and Southern CA at lag times of 4 weeks

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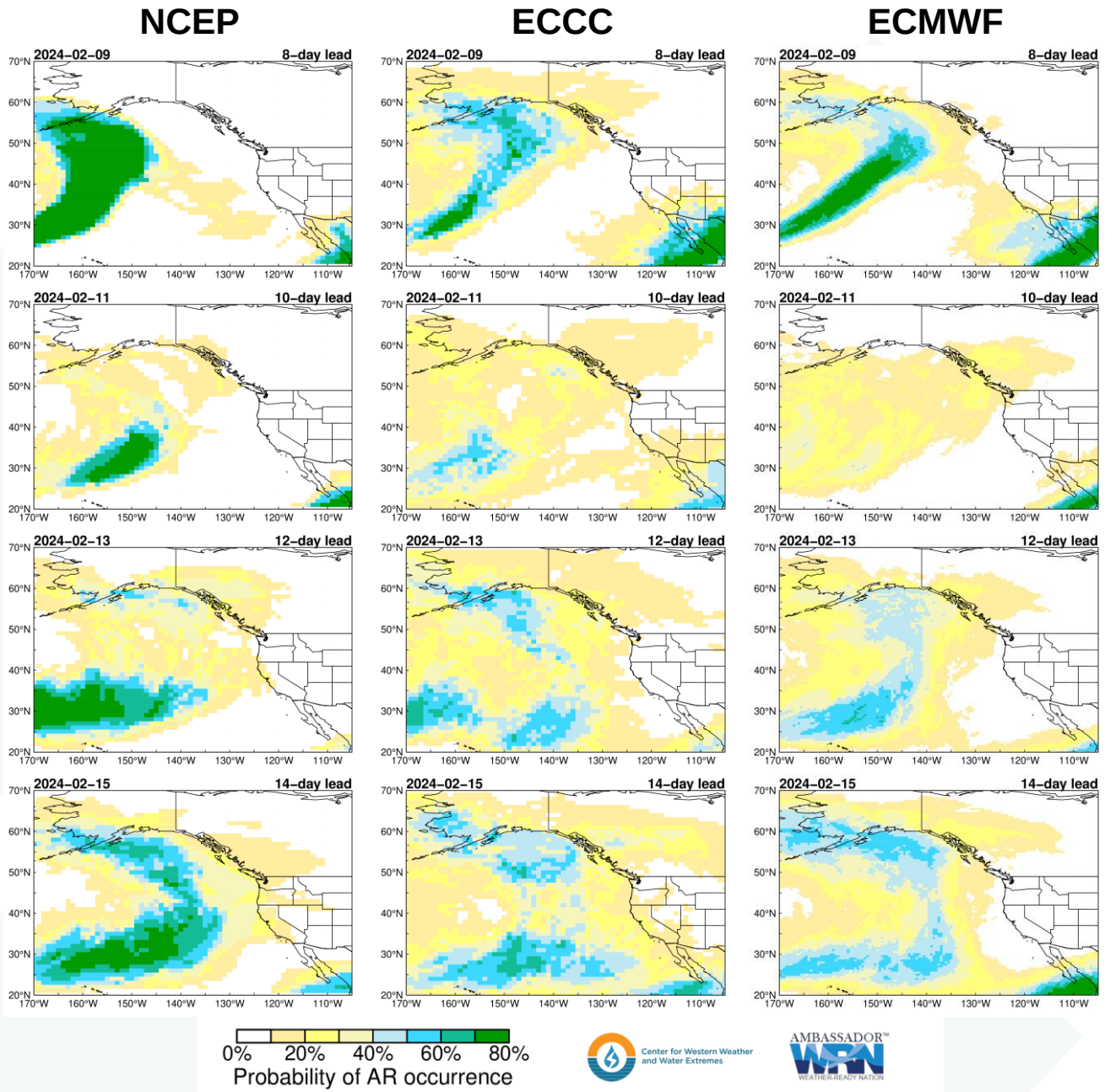
Subseasonal Outlooks: Week 2 AR Activity (NCEP vs. ECCC vs. ECMWF)



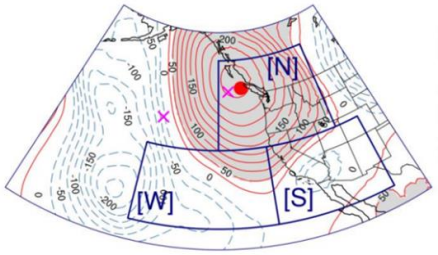
Forecasts Initialized 1 Feb 2024

- All models are predicting low likelihood (< 30% probability) of AR activity over CA and WA/OR during Week 2 (9–15 Feb)
- The highest probability of AR activity is over the subtropical North Pacific Ocean and the Gulf of Alaska

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

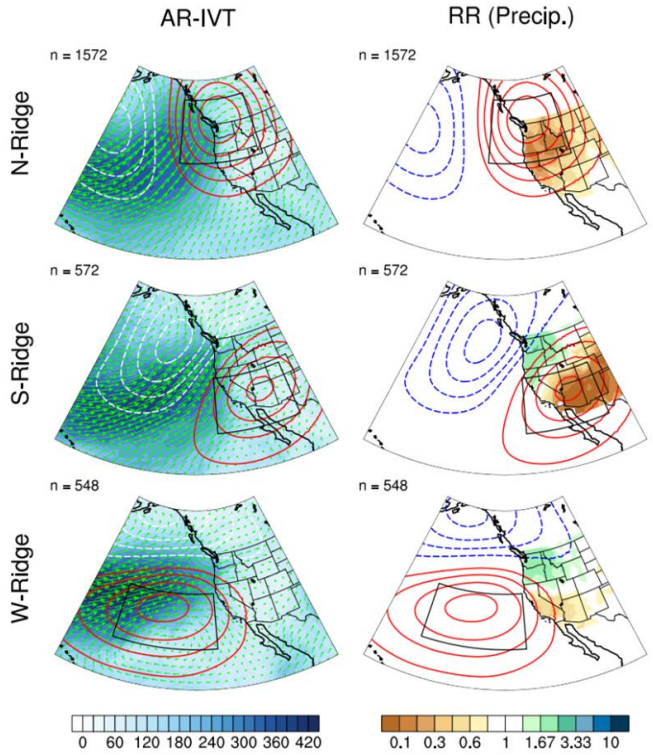
**Note that the probabilities of AR occurrence in the Week 2 AR activity plots may differ from the probabilities of AR conditions in the AR landfall tool. These discrepancies exist due to the use of different models (e.g., GEFS vs. CFSv2), model configurations (S2S models are coupled between ocean, land,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

Jet Propulsion Laboratory
California Institute of Technology

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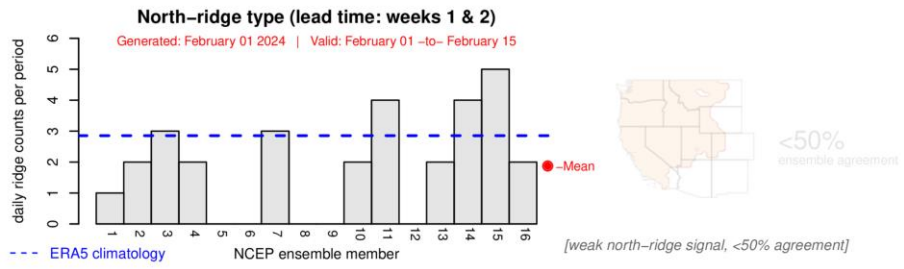
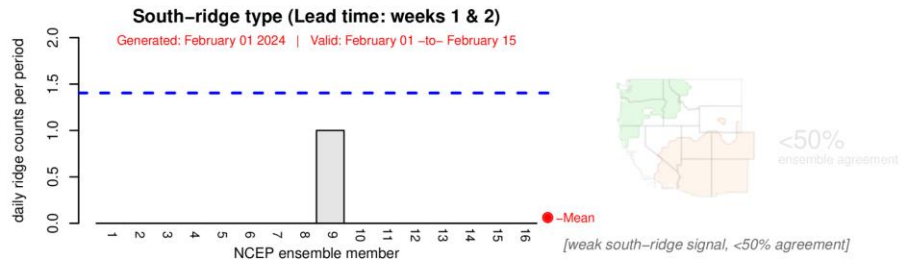
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020) Journal of Climate

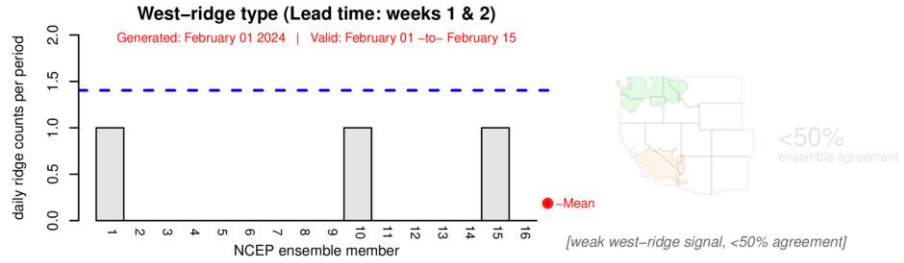
Subseasonal Outlooks: Weeks 1–2 Ridging Forecasts (NCEP vs. ECMWF)

NCEP

CW3E Subseasonal Ridging Forecast
(Uses NCEP CFSv2 model)

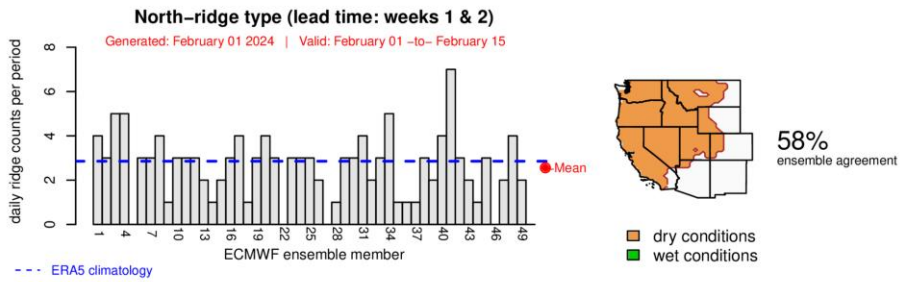


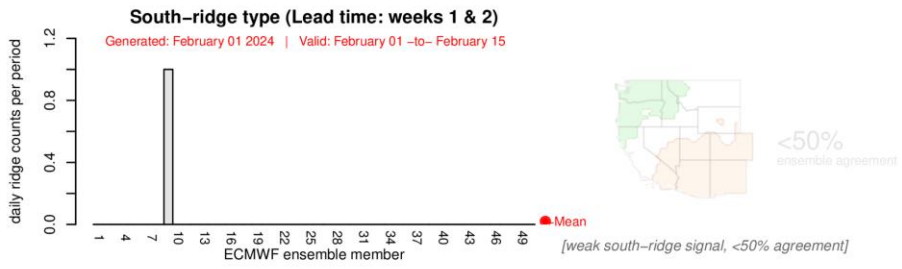


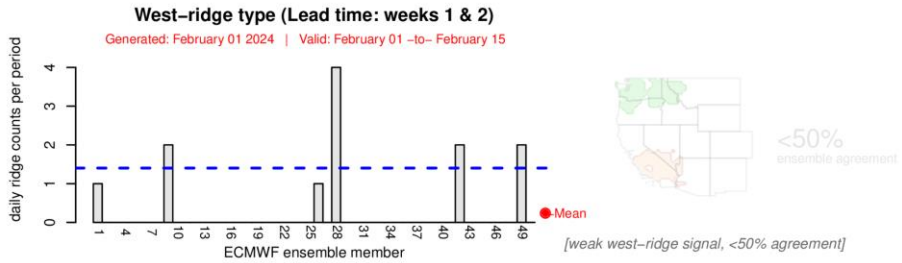


ECMWF

CW3E Subseasonal Ridging Forecast
(Uses ECMWF model)







Forecasts Initialized 1 Feb 2024

- Overall, both models are predicting below-normal ridging activity near the US West Coast during Weeks 1–2 (1–15 Feb), especially NCEP
- ECMWF is showing a moderate likelihood (58% ensemble agreement) of above-normal North-ridge activity
- Both models are predicting very low South-ridge and West-ridge activity

Some model uncertainty regarding the likelihood of persistent ridging near the US West Coast and during Weeks 1–2

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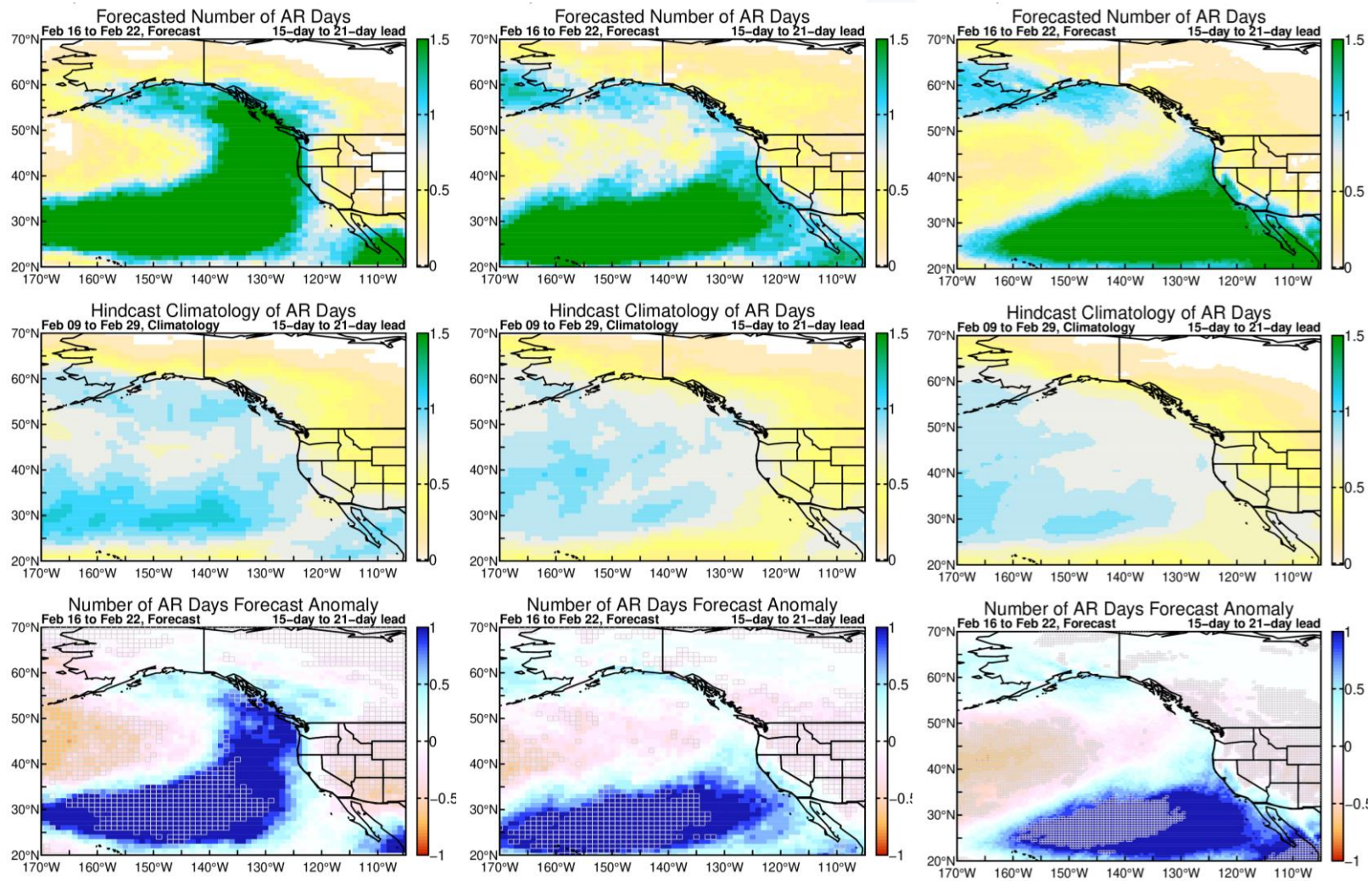
Subseasonal Outlooks: Week 3 AR Activity (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 1 Feb 2024



- All models are predicting near-normal AR activity over Northern CA during Week 3 (16–22 Feb)
- NCEP is predicting slightly below-normal AR activity over Central and Southern CA with high confidence (> 75% ensemble agreement)
- ECCC and ECMWF are predicting slightly above-normal AR activity over Central and Southern CA

Models agree on AR activity in Northern CA, but disagree somewhat on AR activity in Central and Southern CA during Week 3

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

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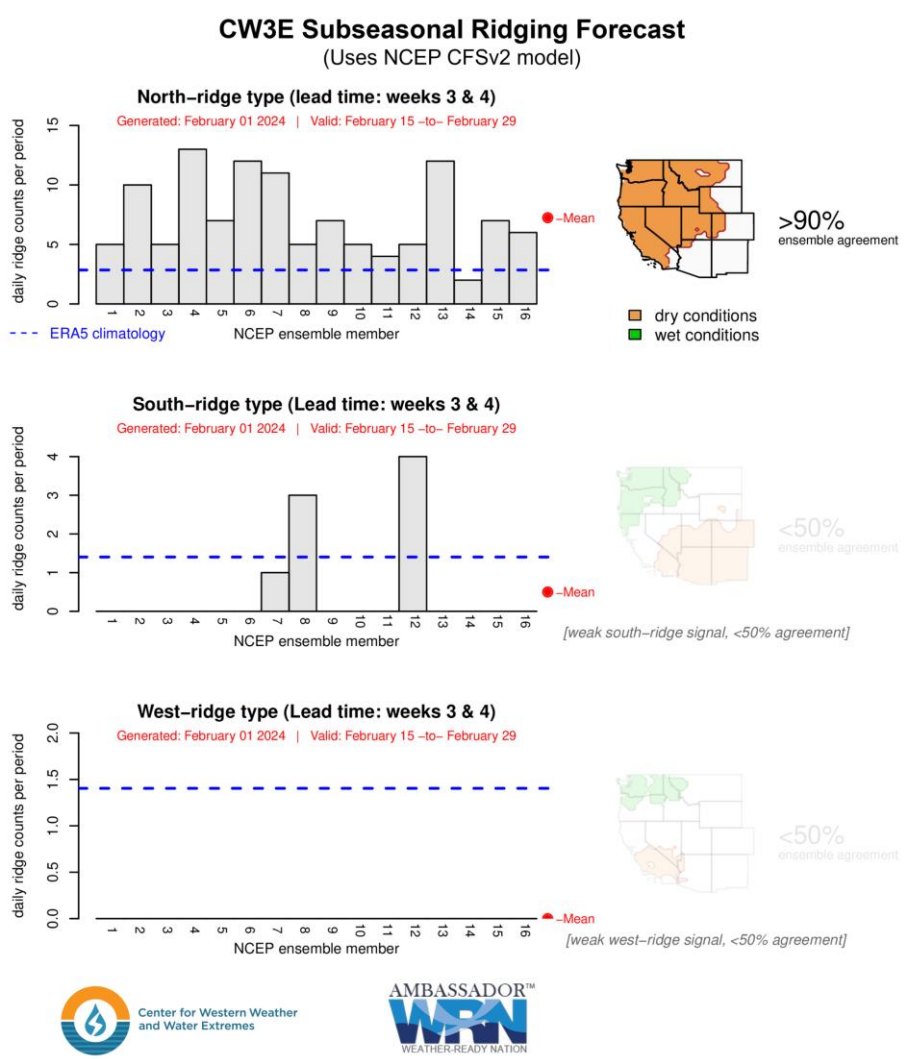
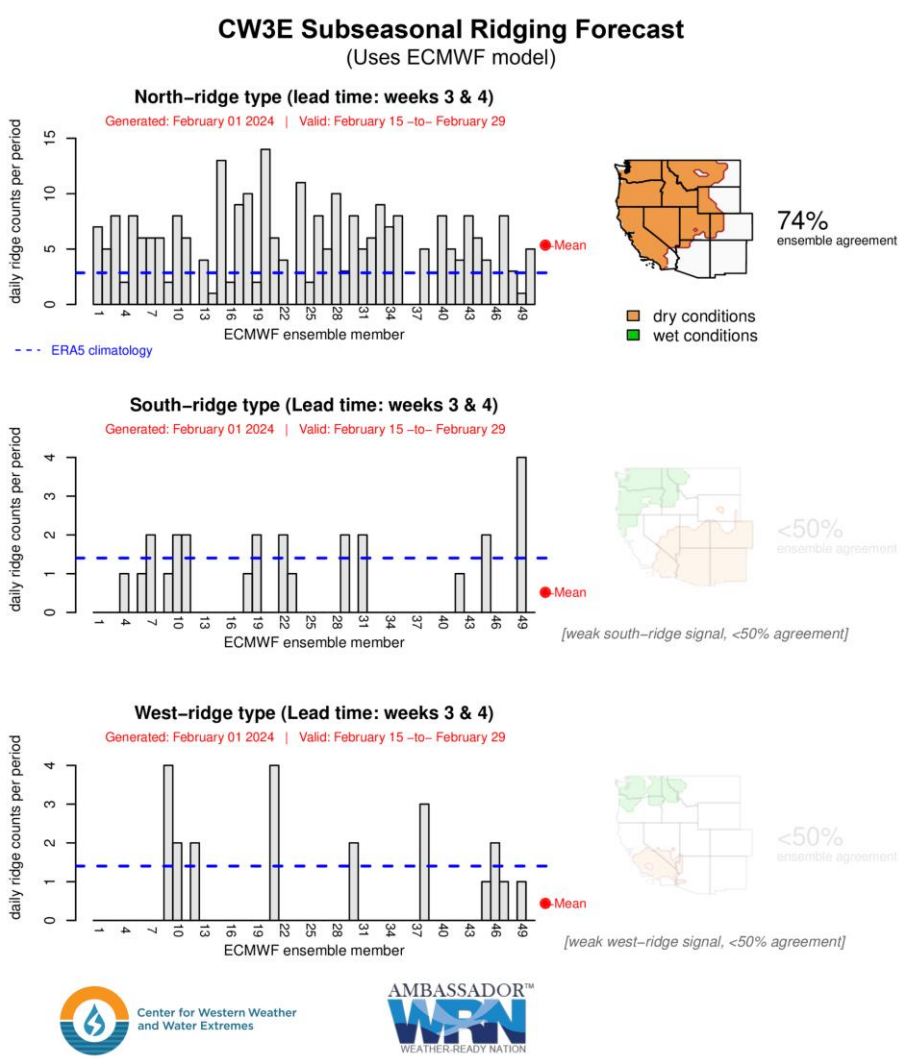
AMBASSADOR™ WRN WEATHER-READY NATION

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

NCEP



ECMWF



Forecasts Initialized 1 Feb 2024

- NCEP is showing a high likelihood (> 90% ensemble agreement) of above-normal North-ridge activity during Weeks 3–4 (15–29 Feb)
- ECMWF is showing a moderate likelihood (74% ensemble agreement) of above-normal North-ridge activity
- 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 3–4

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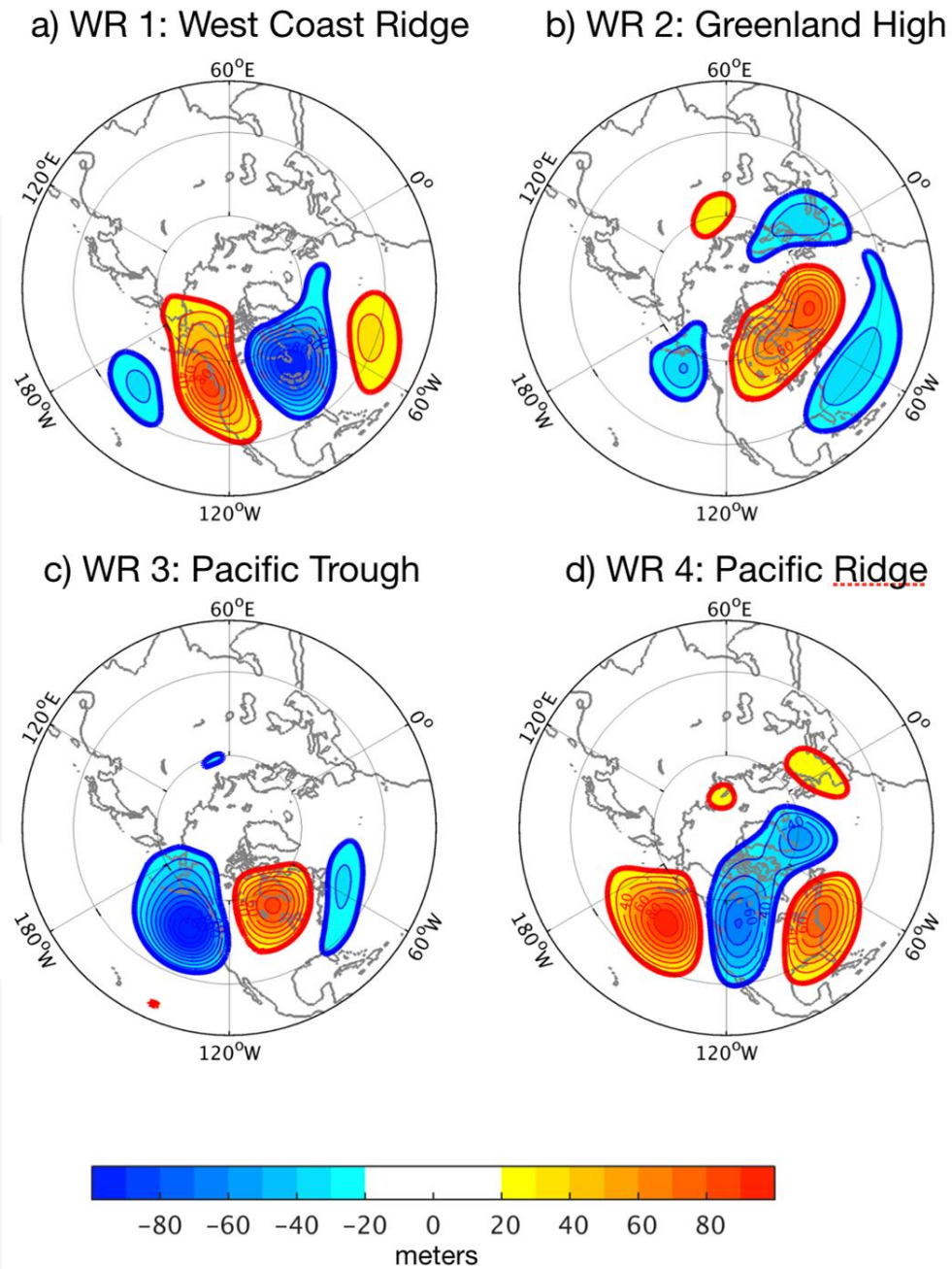
Background Info: IRI Subseasonal Weather Regime Forecasts

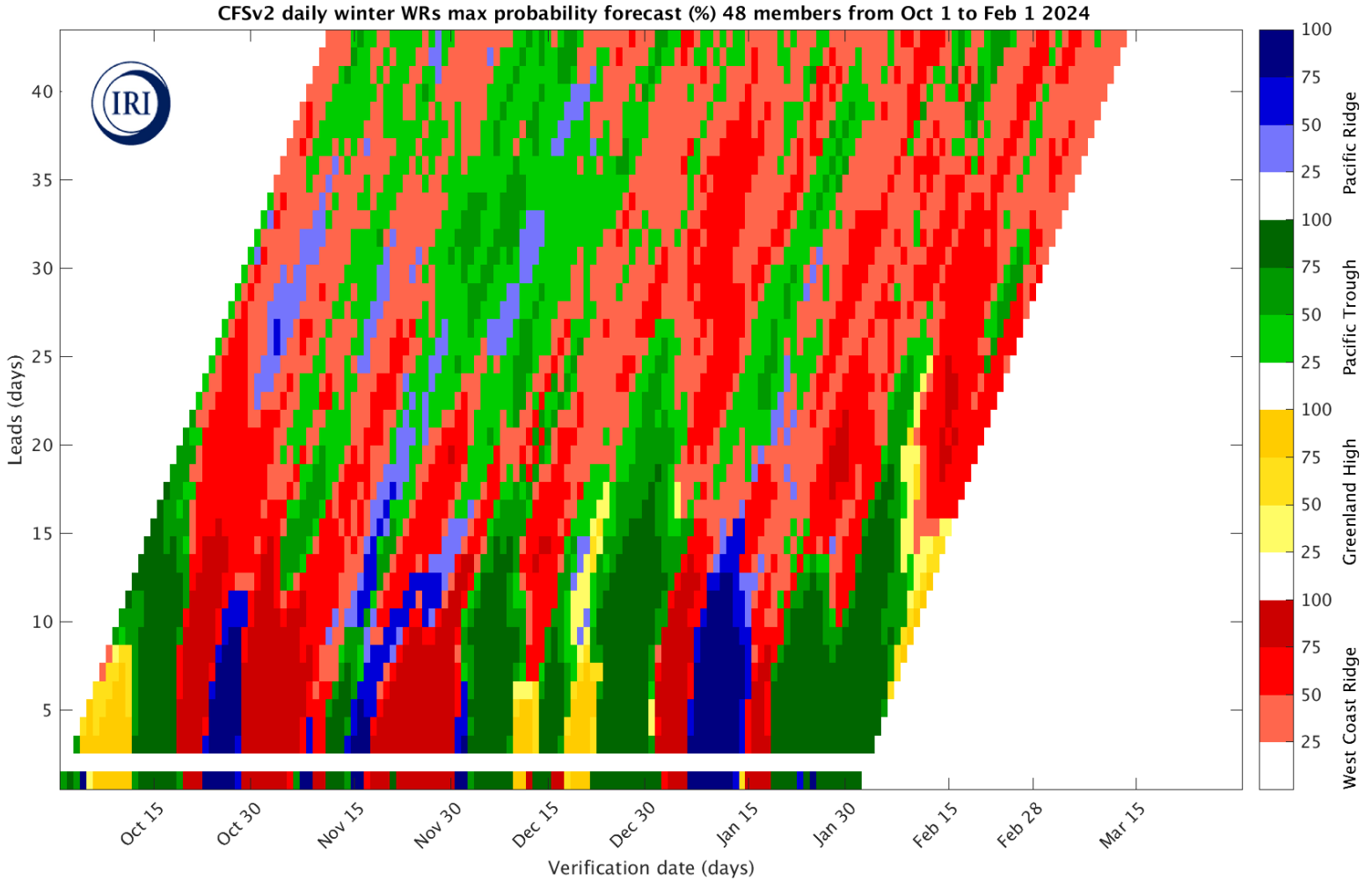


This slide contains background information about IRI's North American weather regime forecast product

- 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 1 Feb 2024

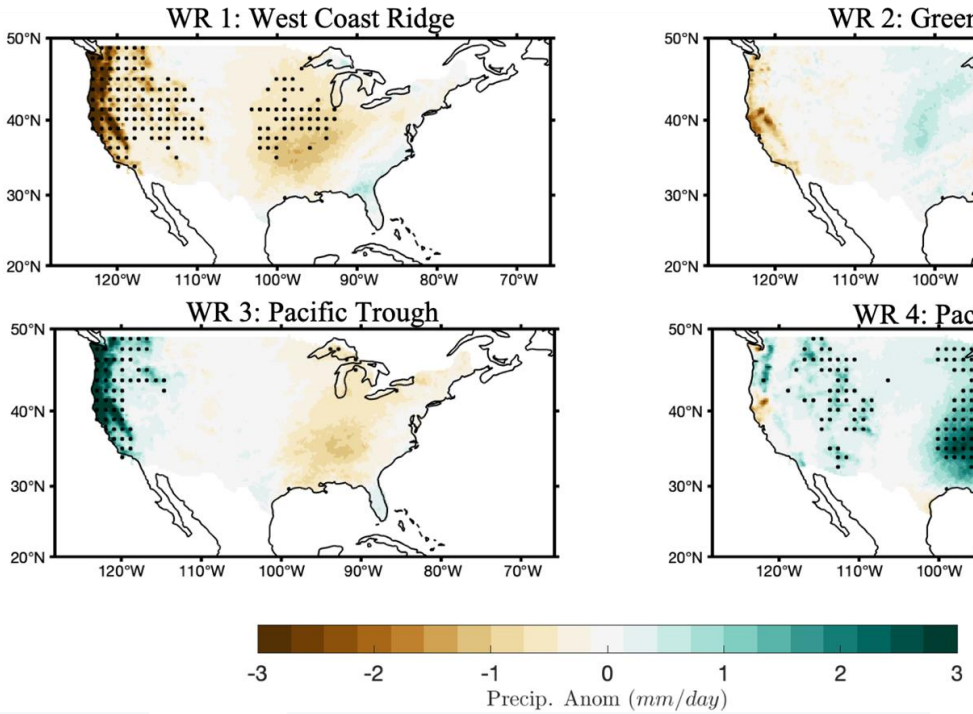
- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- Moderate-to-high likelihood (> 50% ensemble agreement) of Greenland High conditions during Week 2 (9–15 Feb)
- Moderate likelihood (50–75% ensemble agreement) of transition to West Coast Ridge conditions in Week 3 (16–22 Feb)
- Moderate likelihood of West Coast Ridge conditions continuing though Week 4 (23–29 Feb)

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.

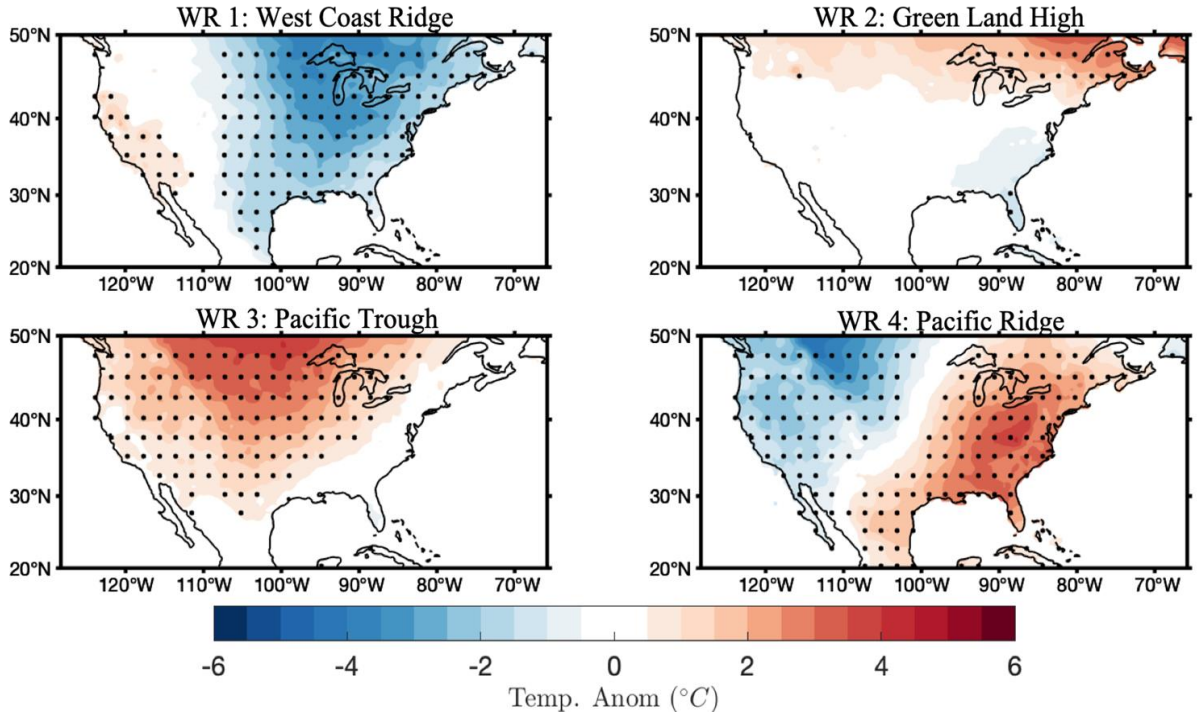
For more information about the forecast product: https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation



Temperature



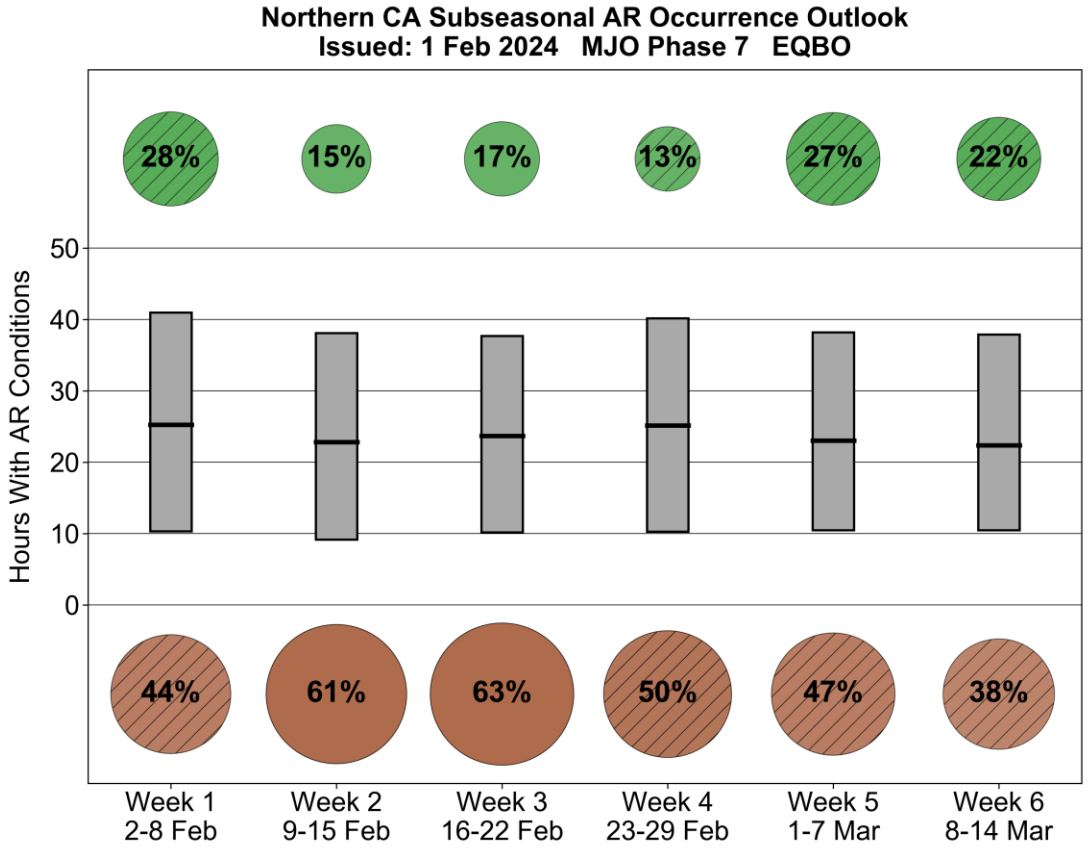
Historical precipitation (left) and temperature (right) composites associated with each regime

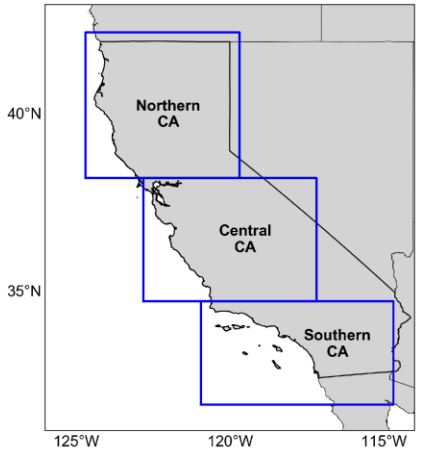
- Warm and dry conditions are predicted over CA during the second half of February with moderate confidence

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

Forecasts Initialized 1 Feb 2024

AR Occurrence: Northern CA





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

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- 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 indicating a high likelihood of below-normal precipitation in Central CA during Weeks 2–5 and in Southern CA during Weeks 4–5 (not shown here)

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)

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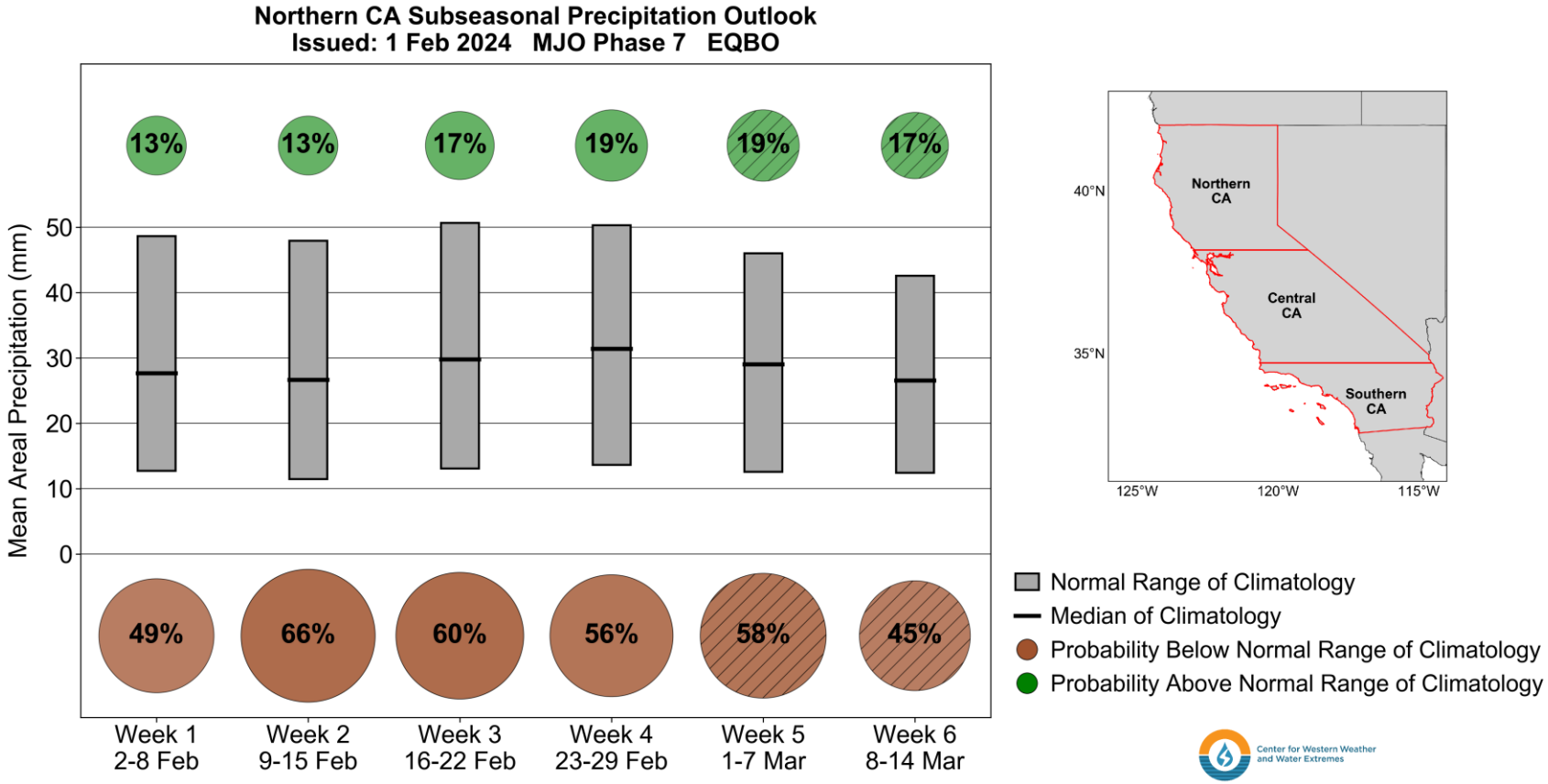
Subseasonal Outlooks: AR Activity and Precipitation Based on MJO and QBO

Forecasts Initialized 1 Feb 2024

Precipitation: Northern CA



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

Center for Western Weather and Water Extremes

- 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 indicating a high likelihood of below-normal precipitation in Central CA in Week 2 and Week 5 (not shown here)

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)

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