



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E Subseasonal Outlook: 23 February 2024

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

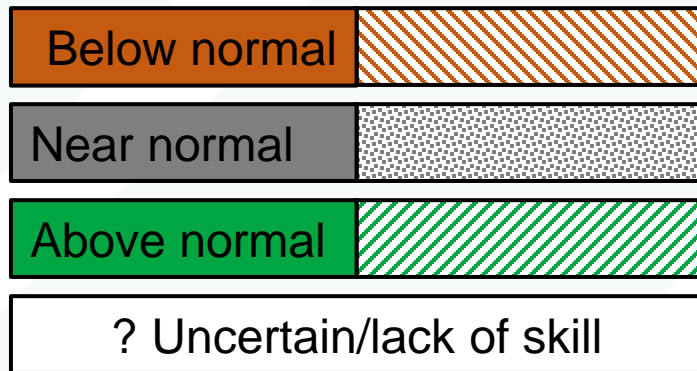
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 22 Feb 2024

Region	Week 2 (1–7 Mar)				Week 3 (8–14 Mar)				Week 4 (15–21 Mar)		
	NCEP ^{1,2,3}	ECMWF ^{1,2}	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{1,2,3}	ECMWF ^{1,2}	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{2,3}	ECMWF ²	Multi-Model Forecast
WA/OR	Diagonal (Green)	Stippled			Diagonal (Orange)	Solid (Orange)	Solid (Orange)	Solid (Orange)		Diagonal (Orange)	
Northern CA	Solid (Green)	Solid (Green)	Diagonal (Green)	Solid (Green)	Diagonal (Orange)	Solid (Orange)	Solid (Orange)	Solid (Orange)		Diagonal (Orange)	
Central CA	Solid (Green)	Solid (Green)	Diagonal (Green)	Solid (Green)		Solid (Orange)	Solid (Orange)	Diagonal (Orange)		Diagonal (Orange)	
Southern CA	Solid (Green)	Stippled				Solid (Orange)	Solid (Orange)	Diagonal (Orange)		Diagonal (Orange)	

Higher Confidence | Lower Confidence



- Models agree on above-normal precipitation in Northern and Central CA during Week 2, but disagree over Southern CA
- Models agree on below-normal precipitation in Northern CA during Week 3, but disagree somewhat over Central and Southern CA
- Week 4 forecasts are uncertain due to lack of agreement between models

Subseasonal products included in this Outlook:

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

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

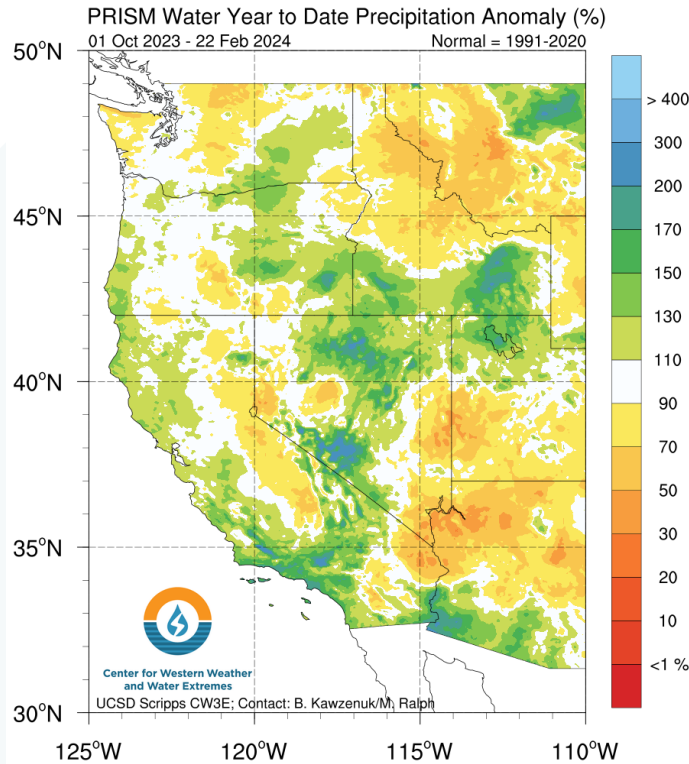
³IRI North American Weather Regime Forecasts ([Robertson et al. 2020](#))

Summary

- **Week 2 forecasts (1–7 Mar):** Models agree on moderate-to-high likelihood (60–80% probability) of AR activity in Northern and Central CA on 1–2 Mar and low likelihood (< 20% probability) of AR activity in all of CA during 4–7 Mar
 - Model disagreement on AR activity over Central and Southern CA on 3 Mar
- Weak MJO convection is forecast to strengthen during Weeks 1–2, but there is uncertainty in the exact location of convection (Indian Ocean or Maritime Continent)
 - MJO activity over the Indian Ocean or Maritime Continent during JFM is associated with a decreased likelihood of wet extremes in Central CA at lag times of 1–4 weeks
- Ridging outlooks show very low likelihood of ridging activity near the US West Coast during Weeks 1–2
- **Week 3 forecasts (8–14 Mar):** All models are predicting below-normal AR activity in Northern CA and Central CA, but there is more confidence in below-normal AR activity over Northern CA
 - NCEP is forecasting near-normal AR activity in Southern CA
 - ECCO and ECMWF are forecasting below-normal AR activity in Southern CA with high confidence
- Models disagree on likelihood of persistent ridging activity over the Pacific Northwest during Weeks 3–4
 - NCEP is forecasting low North-ridge activity, but ECMWF is forecasting moderate likelihood of above-normal North-ridge activity, which is typically associated with dry conditions over all of CA
- IRI weather regime tool shows moderate-to-high likelihood of Pacific Trough (wet conditions in CA) during Week 2 and uncertainty in regime type during Weeks 3–4
- CW3E's statistical forecasts based on current MJO and QBO conditions are unavailable due to weak MJO activity

Hydrologic Summary

Precipitation

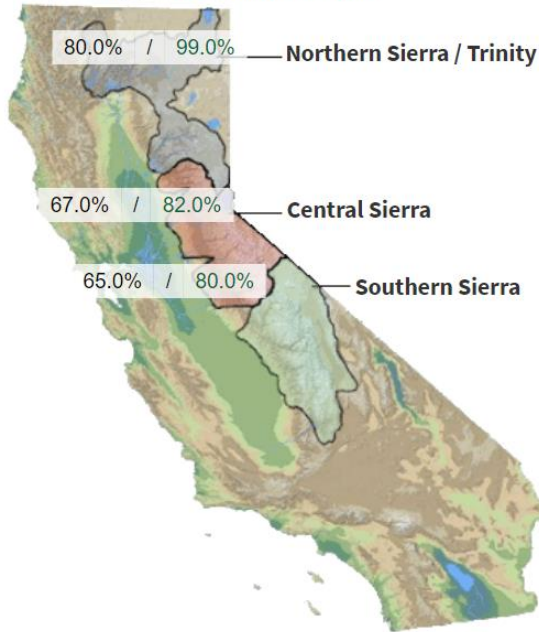


Snowpack Conditions

Provided by the California Cooperative Snow Surveys

Data For: 22-Feb-2024

% Apr 1 Avg. / % Normal for this Date

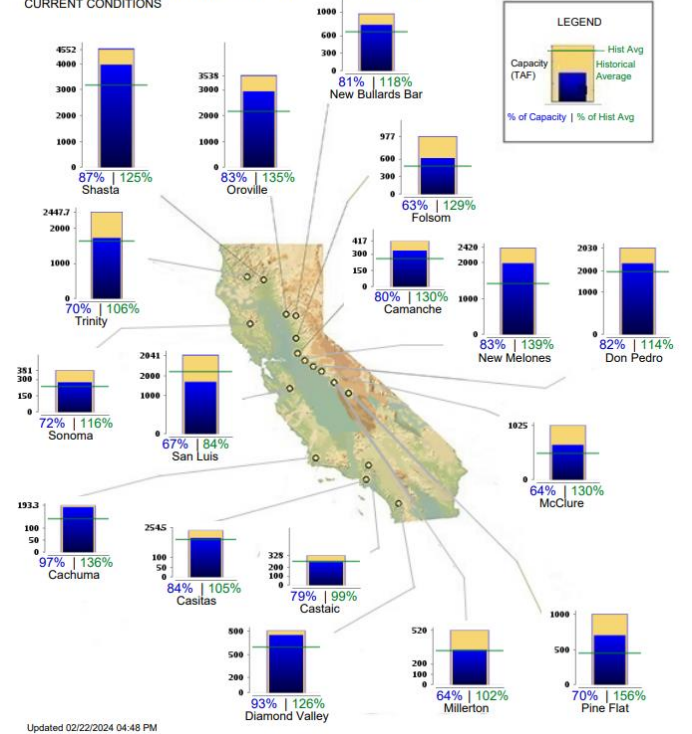


Source: California DWR

Reservoir Storage

CALIFORNIA MAJOR WATER SUPPLY RESERVOIRS
CURRENT CONDITIONS

Midnight - February 21, 2024



Source: California DWR

- As of 22 Feb, water-year-to-date precipitation is well-above normal in coastal Southern CA, slightly above normal in coastal Northern and Central CA, and slightly below-normal over the Sierra Nevada
- Recent storms have substantially improved snowpack conditions throughout the state
- Current snowpack is near-normal for this time of year over the Northern Sierra Nevada and ~80% of normal in the Central and Southern Sierra Nevada
- Most large reservoirs in CA are operating at $\geq 70\%$ storage capacity and above-normal storage for this time of year

Looking Back: Week 3 AR Activity Forecasts

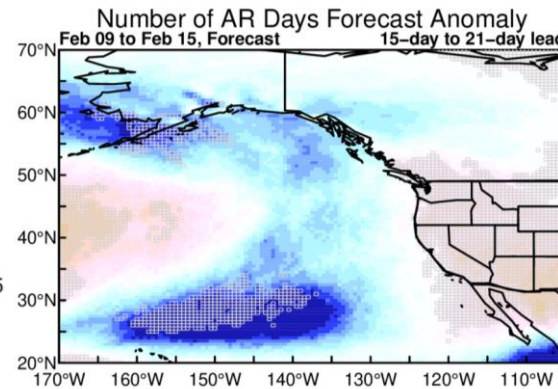
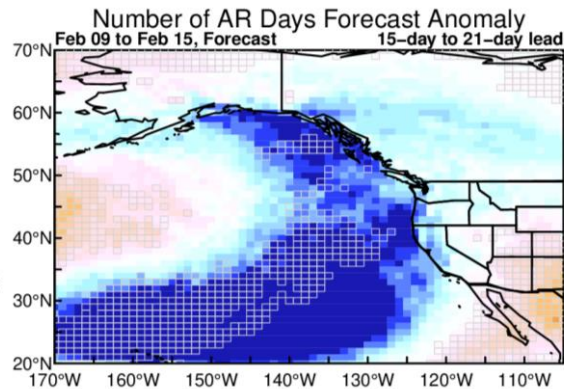
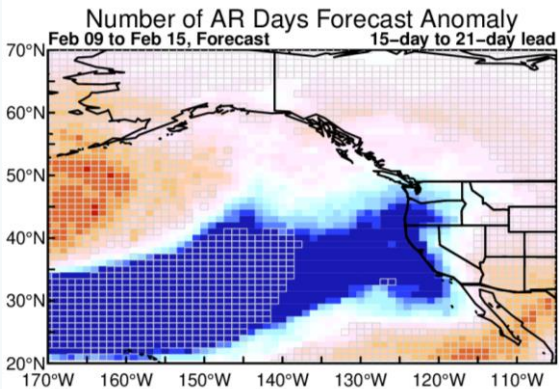
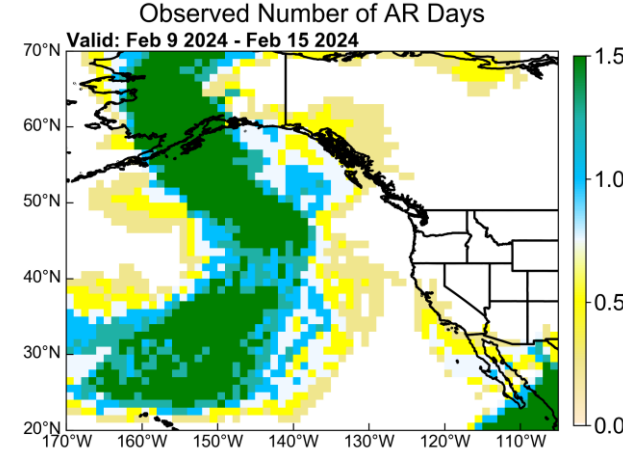
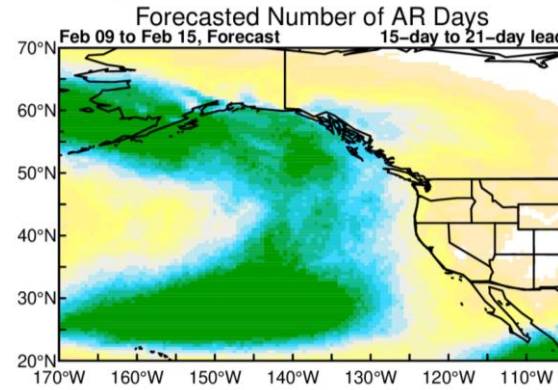
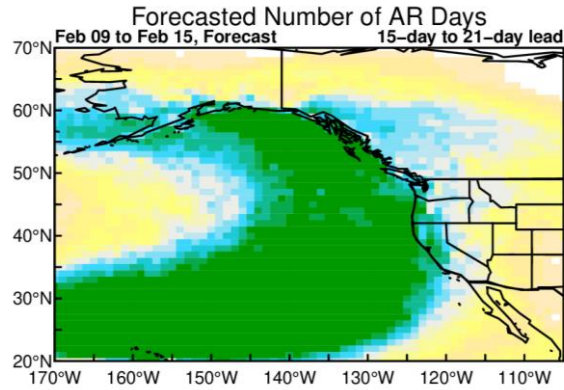
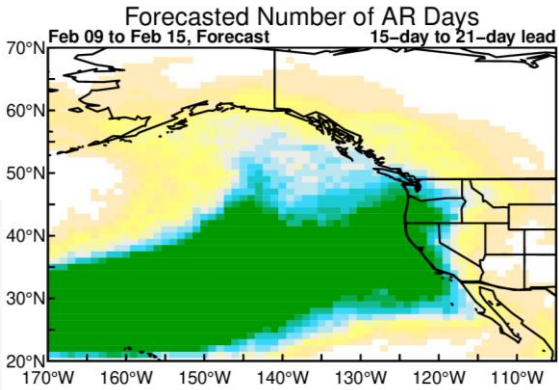
Forecasts Initialized 25 Jan 2024; Valid: 9–15 Feb 2024

NCEP

ECCE

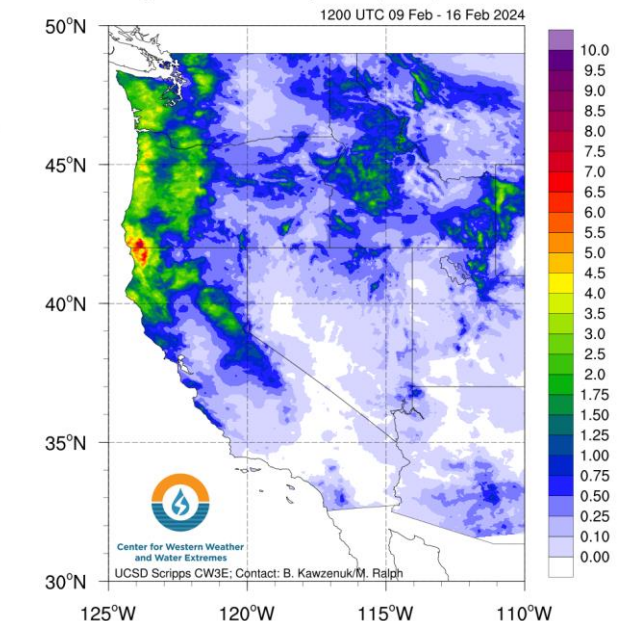
ECMWF

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

- ECCE and ECMWF both captured large-scale troughing over the Central North Pacific and cyclonically curved region of AR activity extending from Hawaii to Alaska
- Center of AR activity was too far east in ECCE forecasts
- NCEP incorrectly predicted landfalling AR activity over the US West Coast that did not verify
- A weak low-pressure system brought light precipitation to western WA on 10–11 Feb
- A stronger system brought heavier precipitation to western OR and coastal Northern CA on 14 Feb

Looking Back: Week 3 AR Activity Forecasts

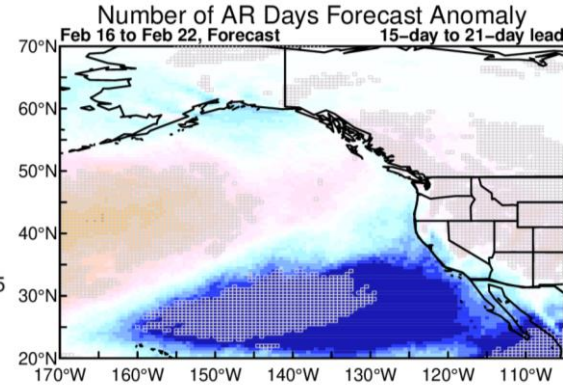
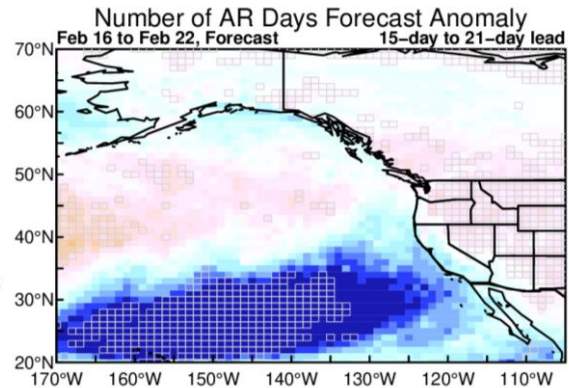
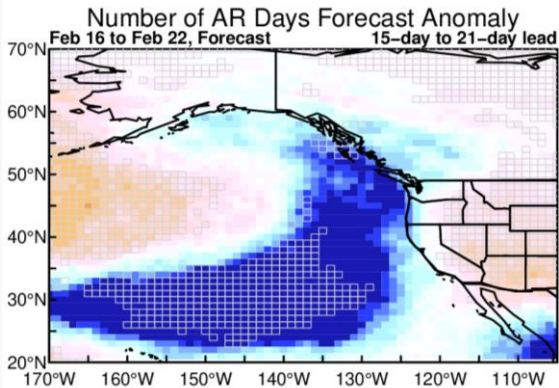
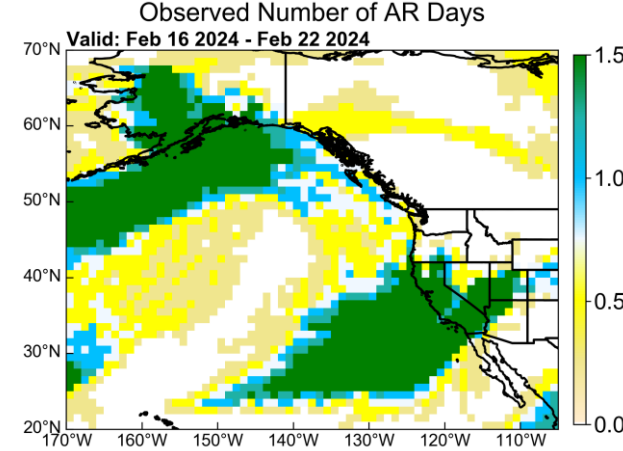
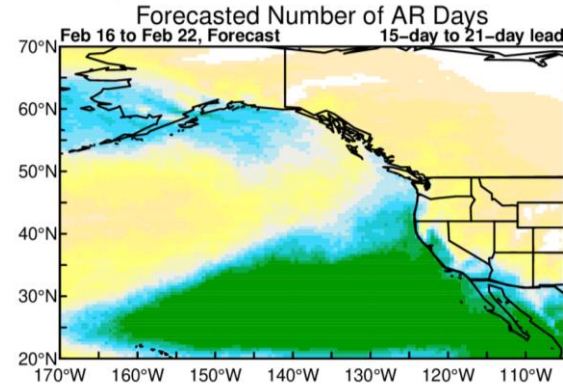
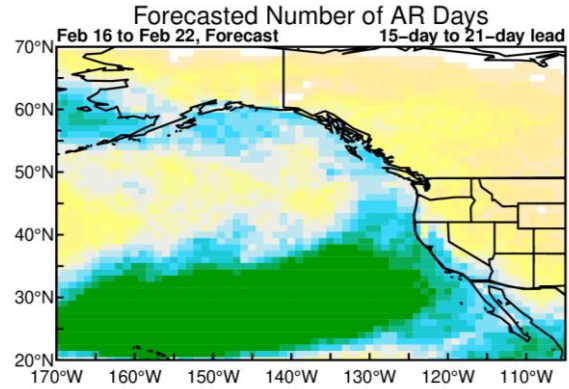
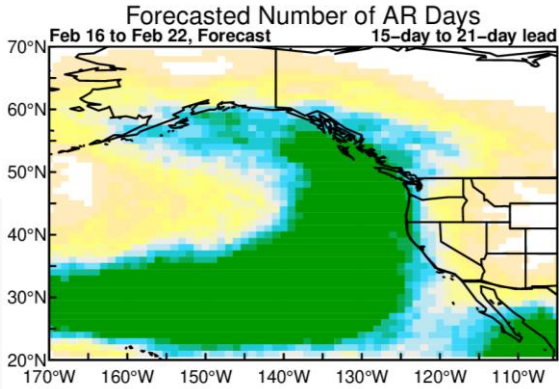
Forecasts Initialized 1 Feb 2024; Valid: 16–22 Feb 2024

NCEP

ECCC

ECMWF

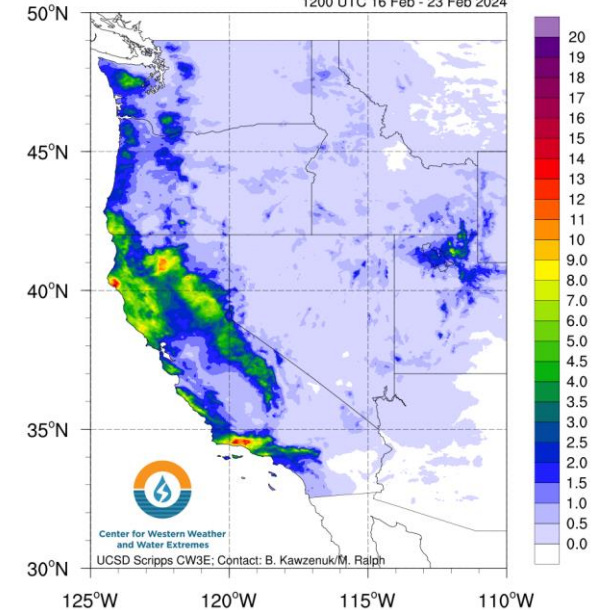
Observed (GFS Analysis)



Observed Precipitation

7-day Accumulated Precipitation (inches)

1200 UTC 16 Feb - 23 Feb 2024

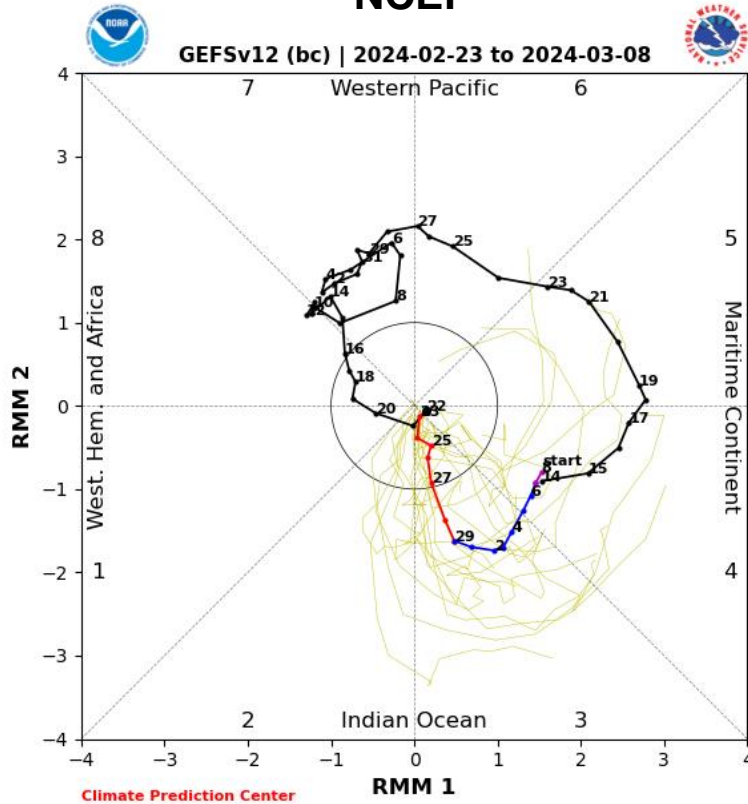


Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

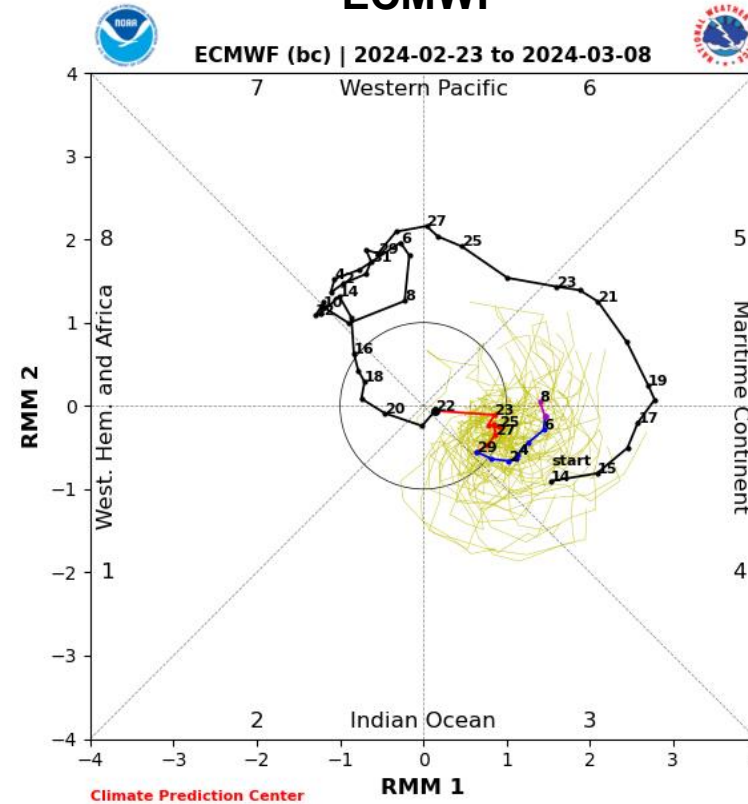
- NCEP and ECCC struggled to predict the axis of AR activity extending from the subtropical Eastern Pacific to the southwestern US
- ECMWF did a better job of capturing this region of enhanced AR activity but still underestimated the inland penetration of AR activity
- A moderate-strength AR produced heavy precipitation in the Northern Sierra Nevada, southern Cascades, Northern CA Coast Ranges, and western Transverse Ranges on 18–20 Feb

Dynamical Model MJO Forecasts (NCEP vs. ECMWF)

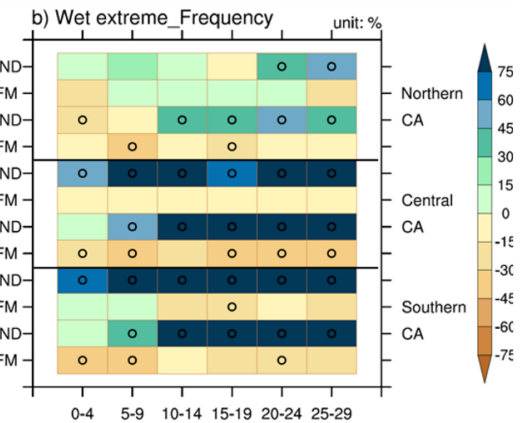
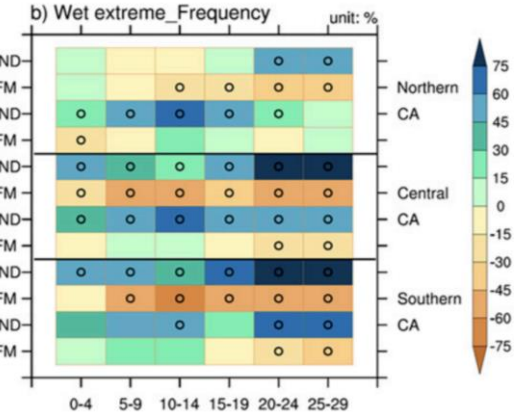
NCEP



ECMWF



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



- Weak MJO convection is forecast to strengthen during the next two weeks, but there is uncertainty in the exact location of convection
- NCEP is forecasting MJO convection to initially strengthen over the Indian Ocean (Phases 2–3) and then propagate eastward over the Maritime Continent (Phases 4–5)
- ECMWF is forecasting MJO convection to strengthen primarily over the Maritime Continent
- MJO activity over the Indian Ocean or Maritime Continent during JFM is associated with a statistically significant decrease in wet extremes in Central CA at lag times of 1–4 weeks

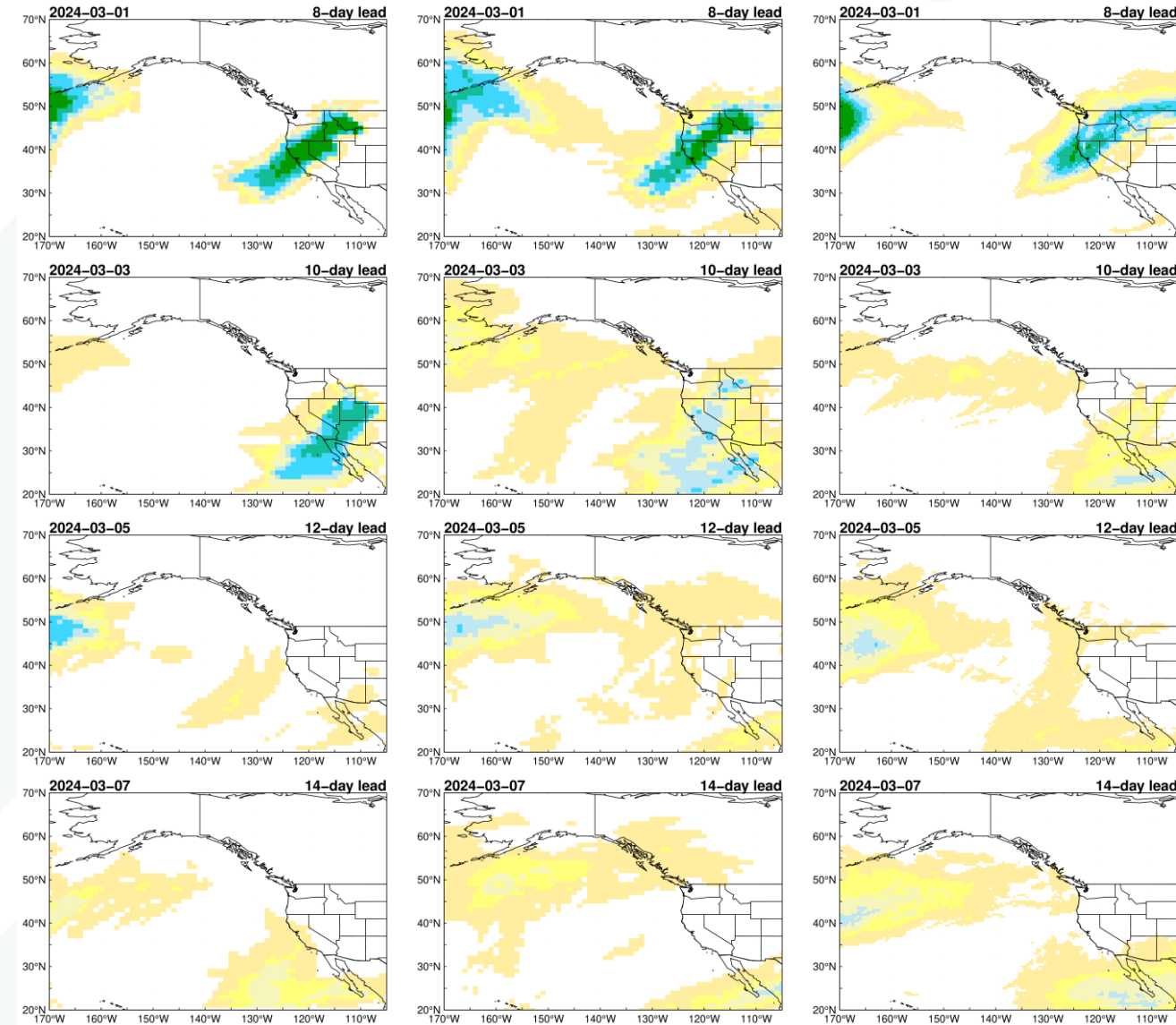
Subseasonal Outlooks: Week 2 AR Activity (NCEP vs. ECCC vs. ECMWF)

Forecasts Initialized 22 Feb 2024

NCEP

ECCC

ECMWF



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

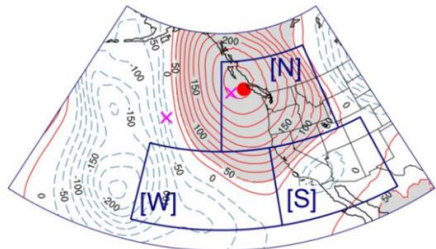


- All models are forecasting moderate-to-high likelihood (60–80% probability) of AR activity in Northern and Central CA on 1–2 Mar
- Models disagree on AR activity over CA on 3 Mar
 - NCEP is forecasting moderate likelihood (40–70% probability) of AR activity in Southern CA
 - ECCC is forecasting moderate likelihood (40–50% probability) of AR activity in Central and Southern CA
 - ECMWF is forecasting low likelihood (< 30% probability) of AR activity over all of CA
- All models are forecasting very low likelihood (< 20% probability) of AR activity over CA during 4–7 Mar

Models generally agree on moderate-to-high likelihood of AR activity over Northern/Central CA during early part of Week 2 and low likelihood of AR activity over all of CA during second half of Week 2

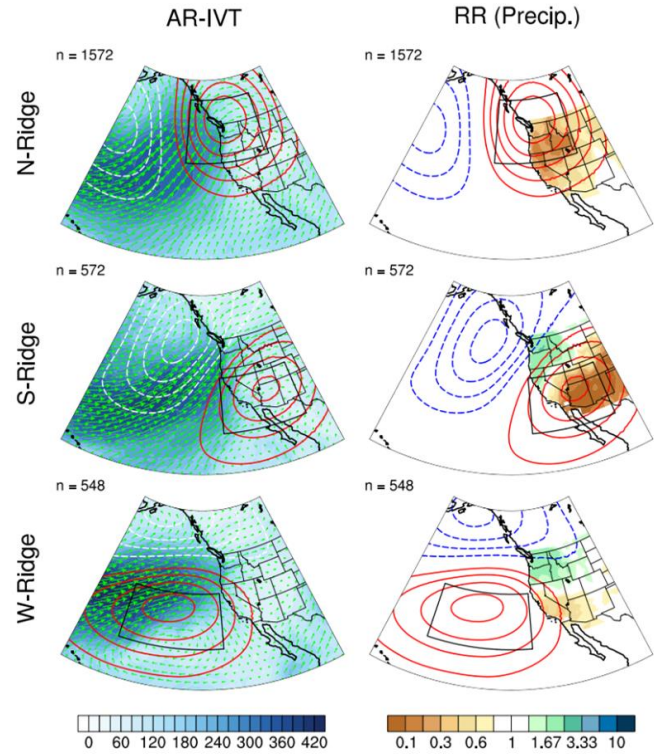
**Note that the probabilities of AR occurrence in the Week 2 AR activity plots may differ from the probabilities of AR conditions in the AR landfall tool. These discrepancies exist due to the use of different models (e.g., GEFS vs. CFSv2), model configurations (S2S models are coupled between ocean, land,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



- 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

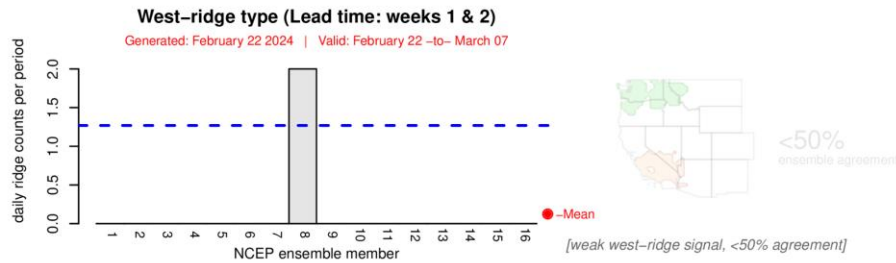
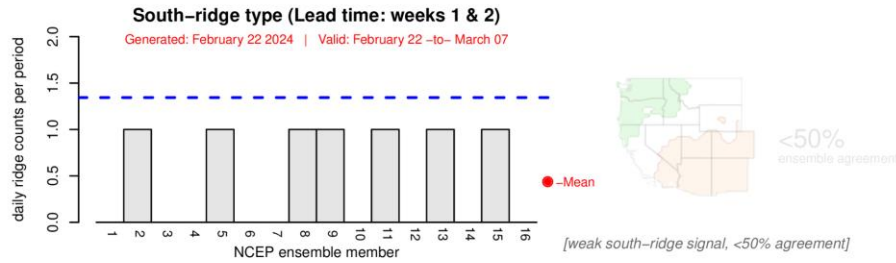
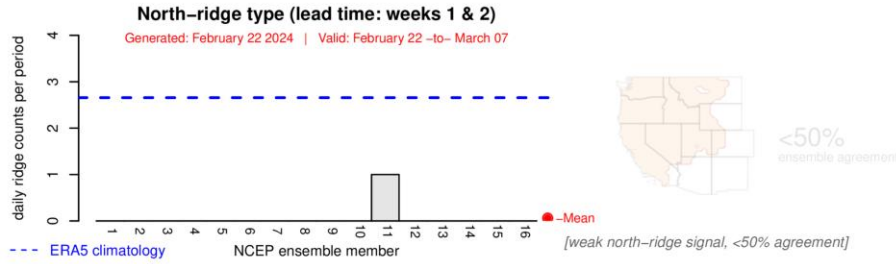
Subseasonal Outlooks: Weeks 1–2 Ridging Forecasts (NCEP vs. ECMWF)

Forecasts Initialized 22 Feb 2024

NCEP

CW3E Subseasonal Ridging Forecast

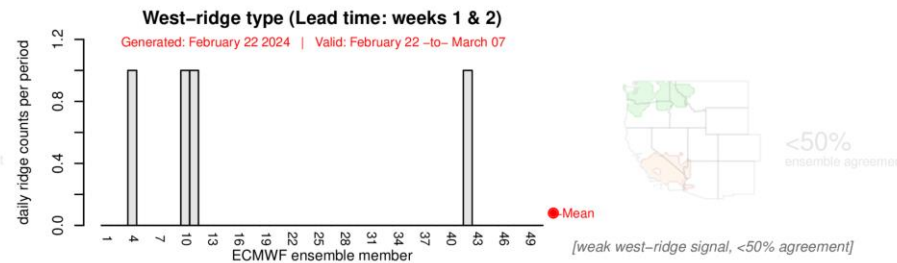
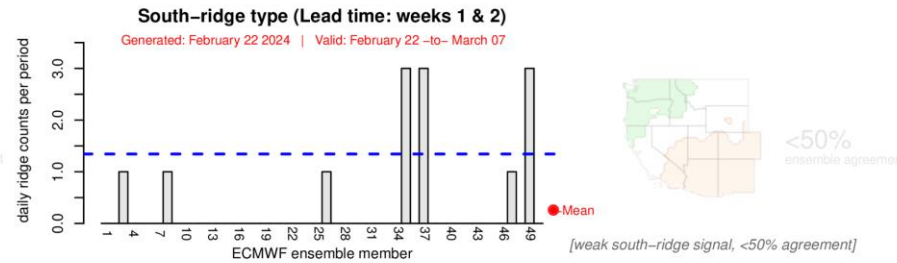
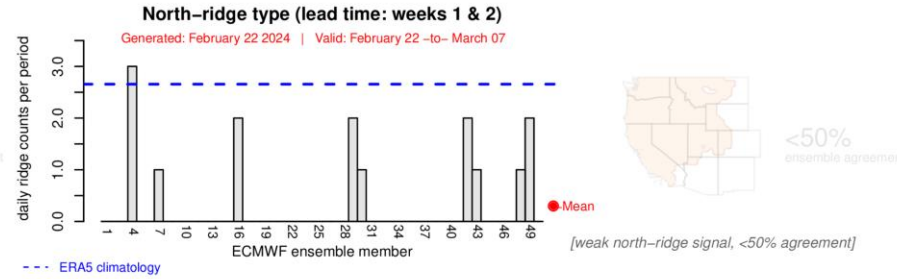
(Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast

(Uses ECMWF model)

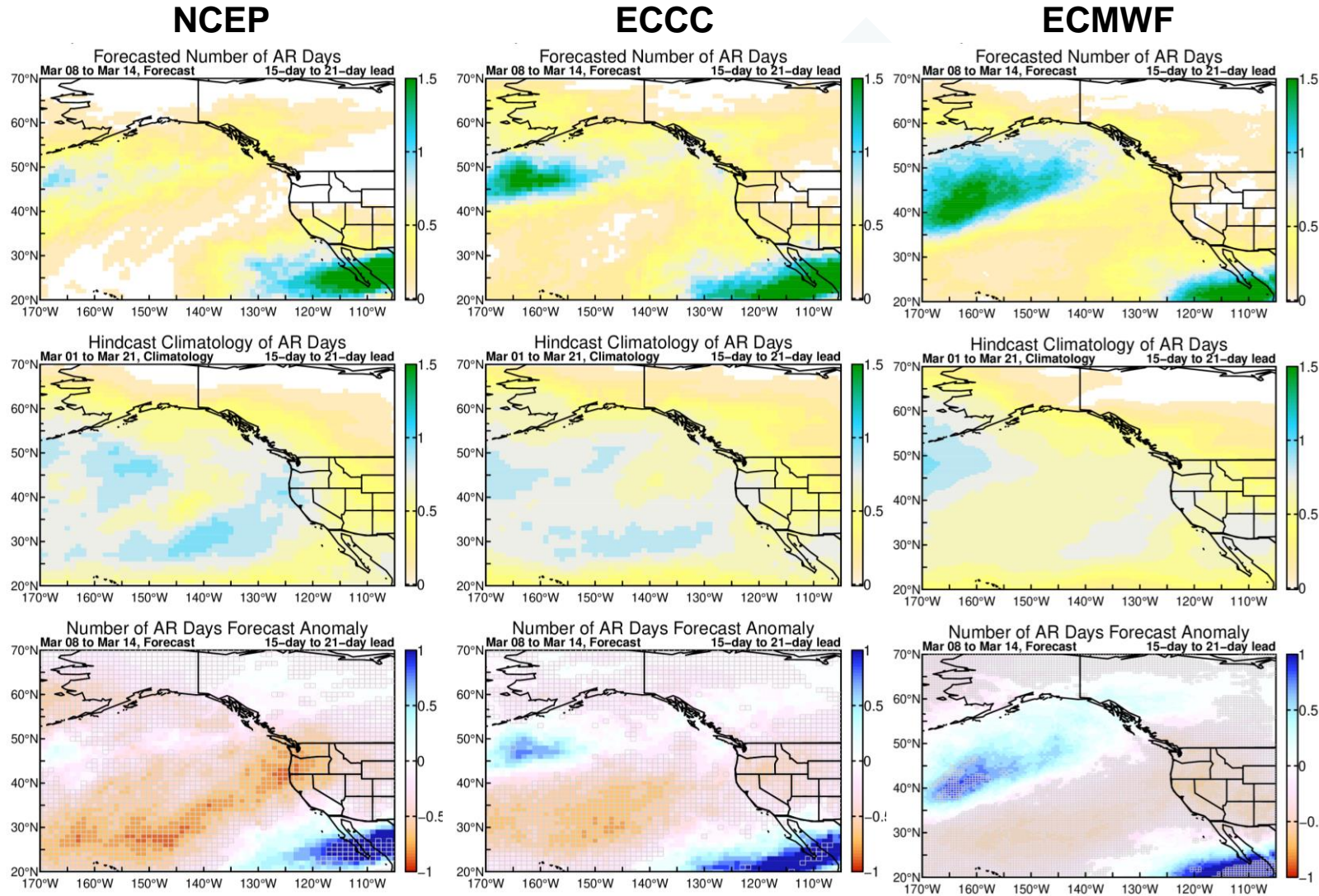


- NCEP and ECMWF are both forecasting very low ridging activity near the US West Coast during Weeks 1–2 (22 Feb – 7 Mar)

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

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

Forecasts Initialized 22 Feb 2024



- All models are forecasting below-normal AR activity in Northern CA with high confidence (> 75% ensemble agreement) during Week 3 (8–14 Mar)
- ECCC and ECMWF are also forecasting below-normal AR activity over Central and Southern CA with high confidence
- NCEP is forecasting below-normal AR activity in Central CA with low confidence and near-normal AR activity in Southern CA

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

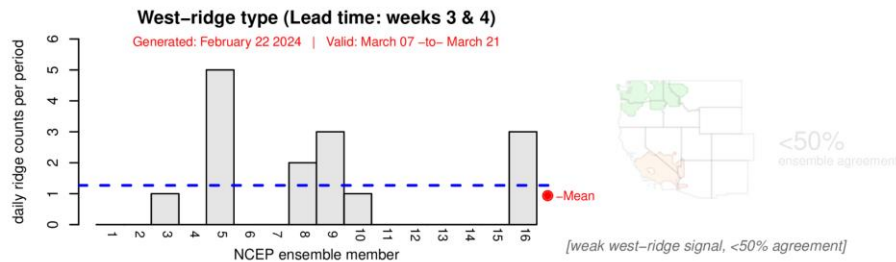
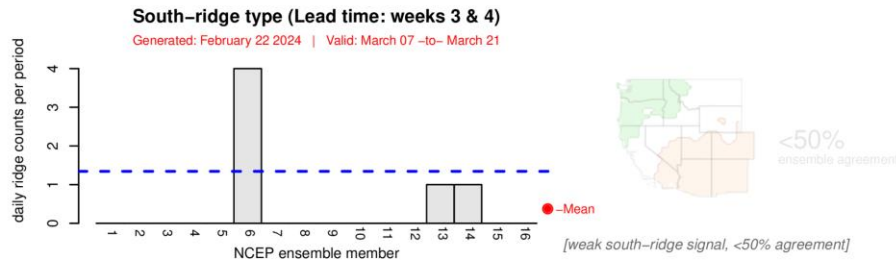
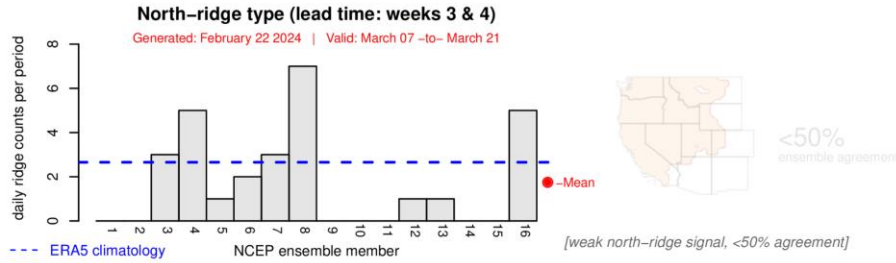
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

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

Forecasts Initialized 22 Feb 2024

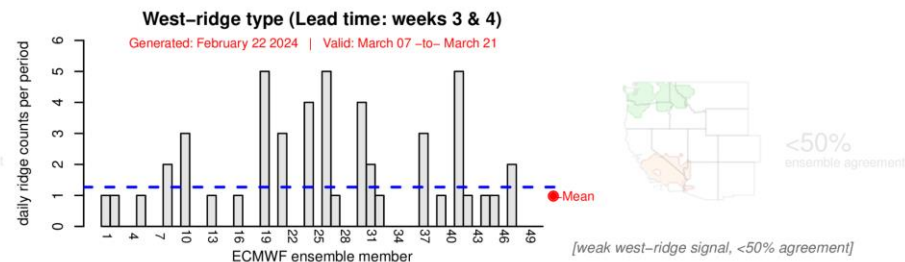
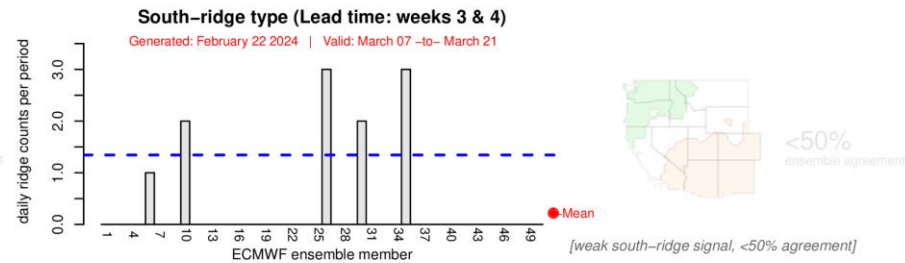
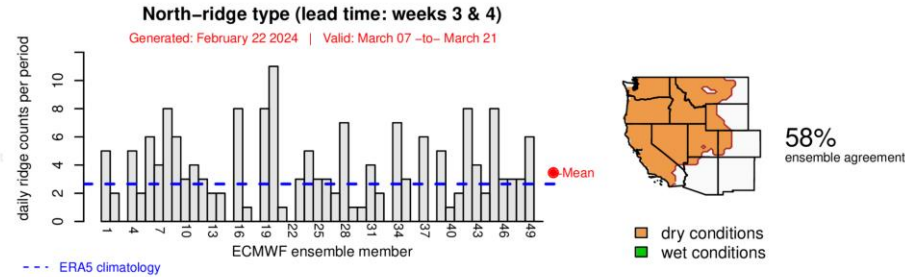
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)

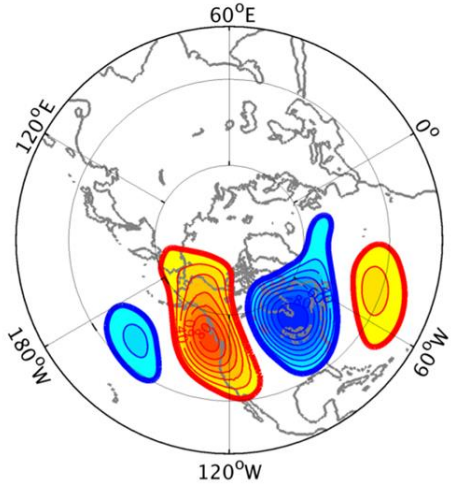


- NCEP is forecasting below-normal ridging activity near the US West Coast during Weeks 3–4 (7–21 Mar)
- ECMWF is showing a moderate likelihood (58% ensemble agreement) of above-normal North-ridge activity
- Both models are predicting very low South-ridge and near-normal West-ridge activity

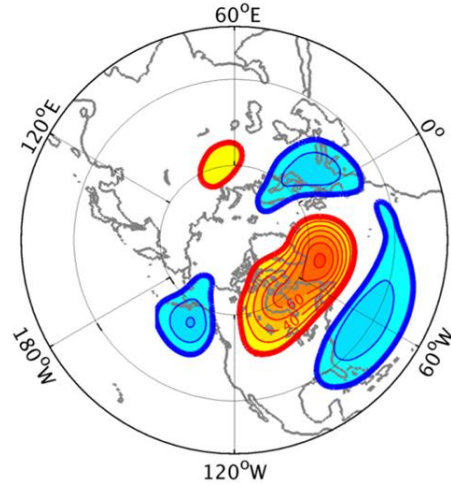
Models disagree on likelihood of above-normal ridging activity over the Pacific Northwest during Weeks 3–4

Background Info: IRI Subseasonal Weather Regime Forecasts

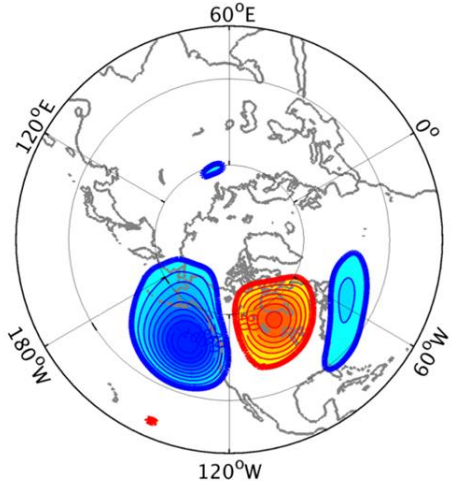
a) WR 1: West Coast Ridge



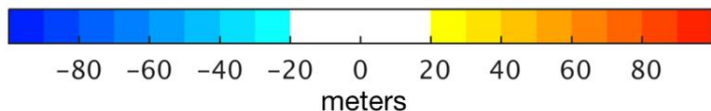
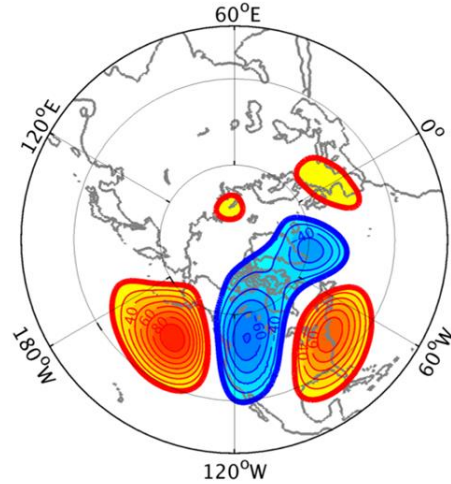
b) WR 2: Greenland High



c) WR 3: Pacific Trough



d) WR 4: Pacific Ridge



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

- Four dominant weather regimes identified using cluster analysis on daily 500-hPa geopotential height anomalies from MERRA data (1981–2015)

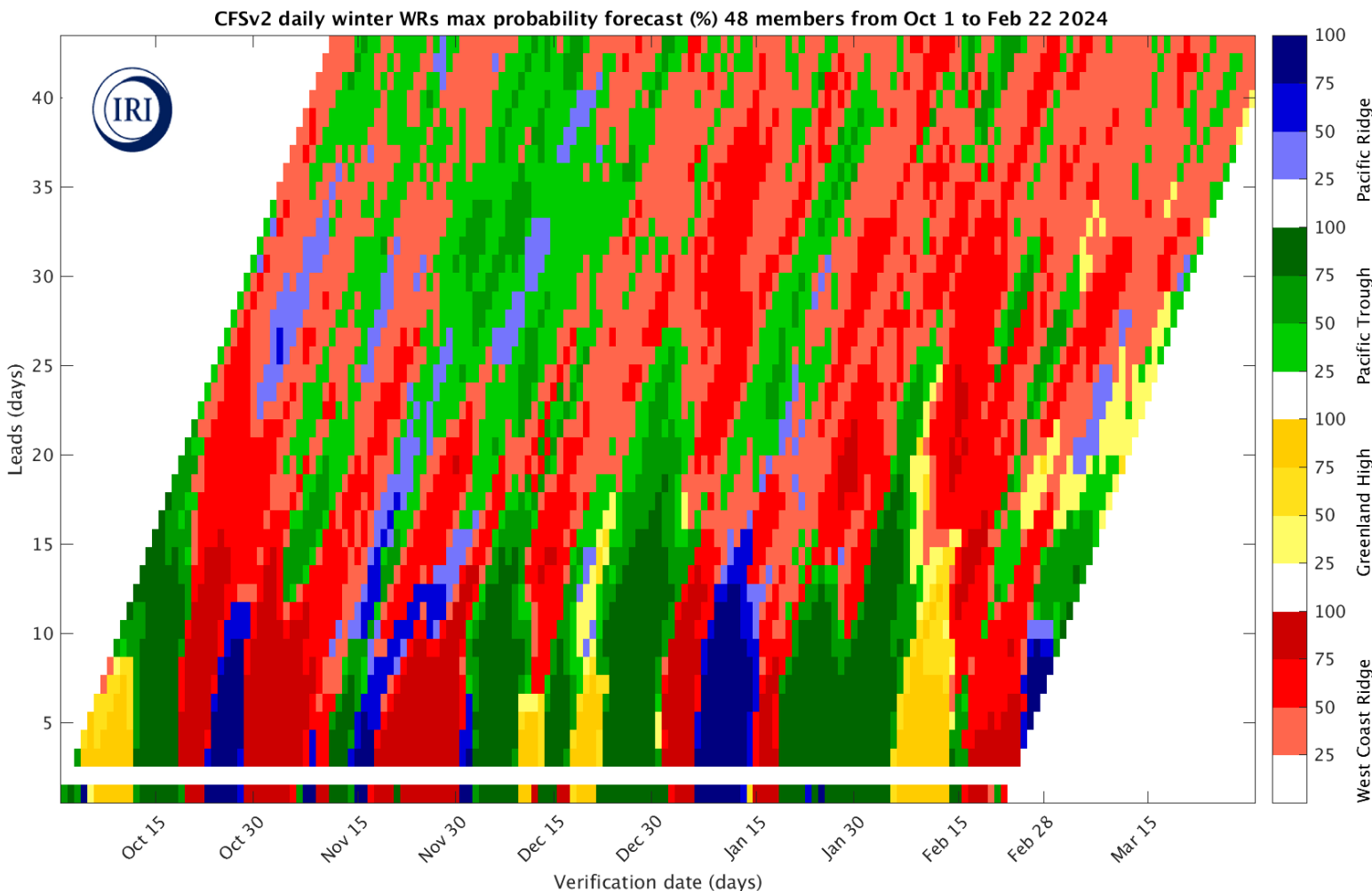
Reference: [Robertson et al. \(2020\)](#)

For more information about the forecast product:

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

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Forecast Initialized 22 Feb 2024

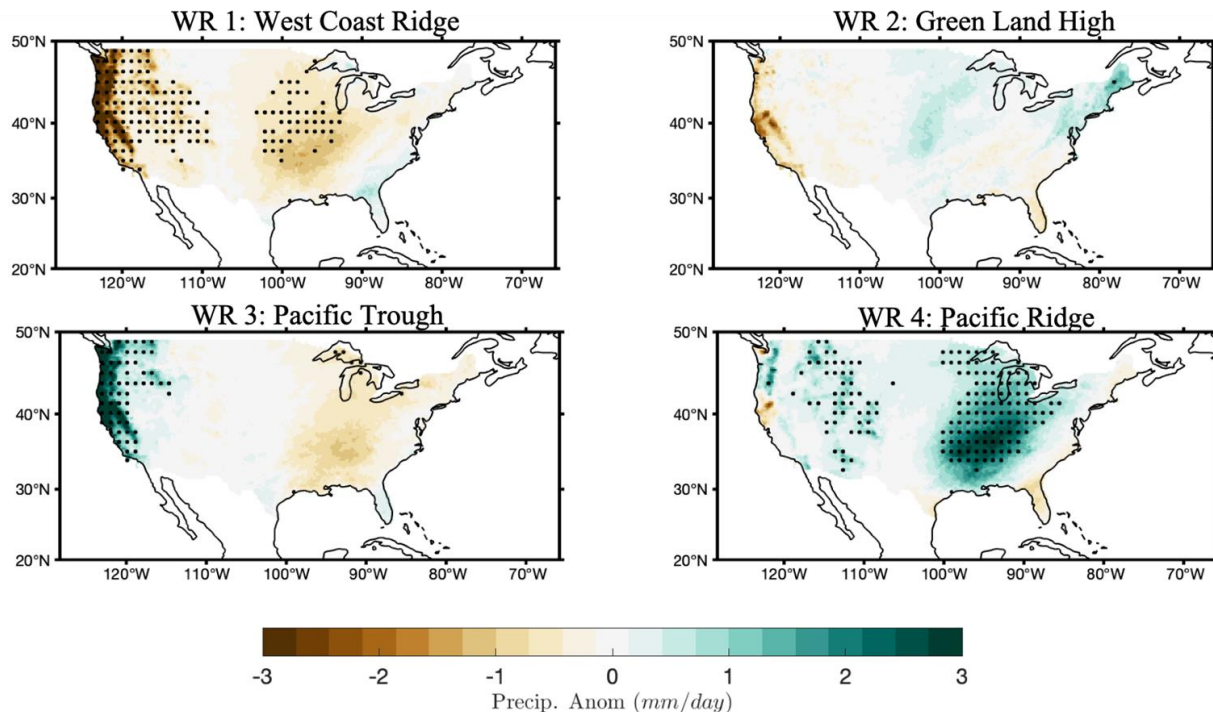


- Daily forecast out to 45-day lead time based on NCEP CFSv2 ensemble
- Moderate-to-high likelihood (> 50% ensemble agreement) of transition from Pacific Ridge to Pacific Trough during Week 2 (1–7 Mar)
- High degree of uncertainty in regime type during Weeks 3–4 (8–21 Mar), with a plurality of ensemble members forecasting either Greenland High or Pacific Trough conditions

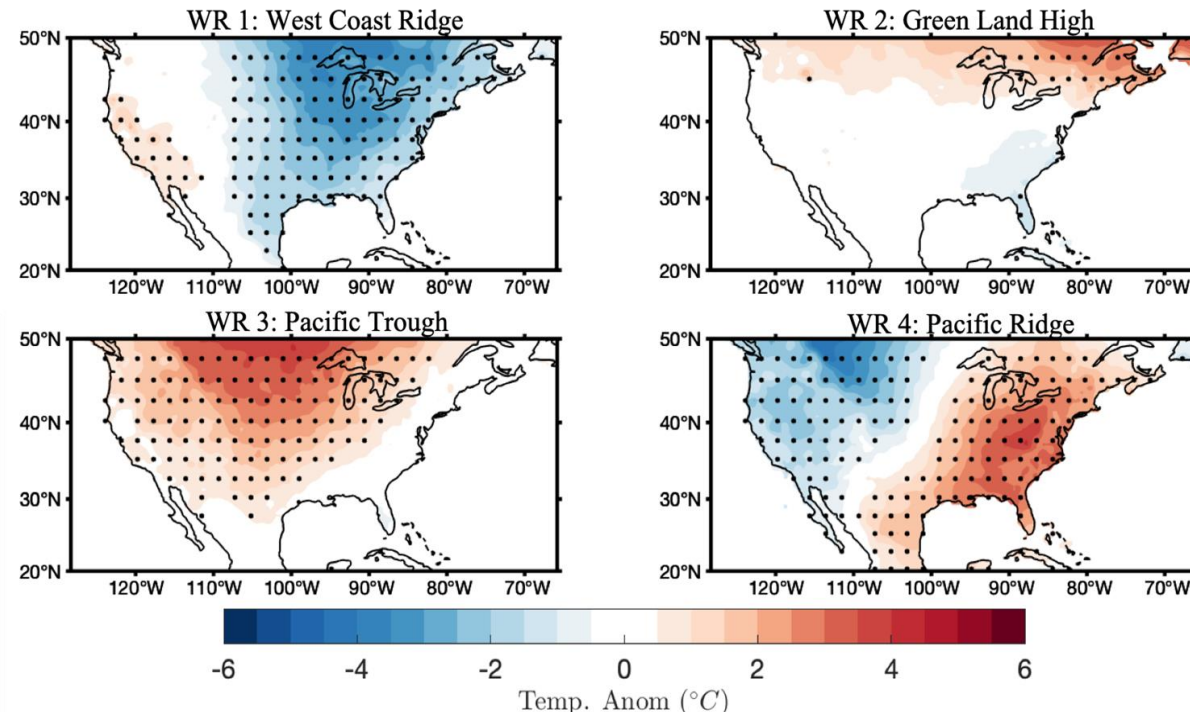
This graphic shows the which of the four North American weather regimes (different colors) is most likely to occur over the next 45 days. Darker (lighter) shading denotes higher (lower) probability of a particular regime. See the next slide for temperature/precipitation implications.

Subseasonal Outlooks: IRI North American Weather Regime Forecasts

Precipitation



Temperature



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

- Warm and wet conditions are predicted over CA during the first week of March with moderate-to-high confidence
- High degree of uncertainty in precipitation and temperature anomalies during the second and third weeks of March