



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

CW3E S2S Outlook: 3 Apr 2023

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UC San Diego



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CW3E S2S Forecasts: Glossary & Context

- The outlooks are based on CW3E subseasonal to seasonal 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 GFS (US Model): Weeks 2–3
 - NCEP CFSv2 (US Model): Weeks 2–6
 - ECCO (Canadian Model): Weeks 2–3
 - ECMWF (European model): Weeks 2–6
- CW3E seasonal precipitation products are produced using statistical and machine learning models. The suite of models includes:
 - CCA (canonical correlation analysis) based statistical model
 - Machine learning model, which also includes comparison to NMME (North American Multi-Model Ensemble)
- *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*

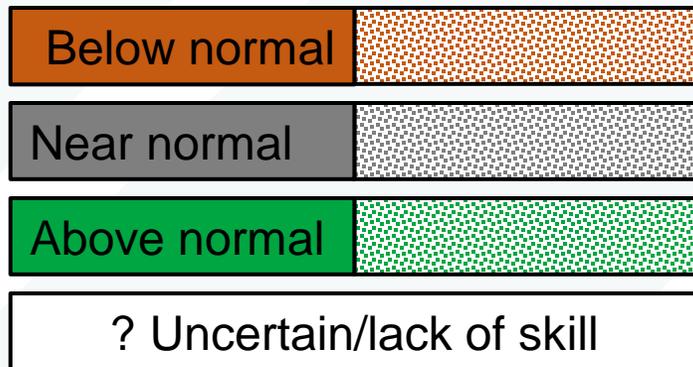
Summary: Subseasonal Precipitation Outlook by Model

This slide shows the CW3E synthesis of subseasonal products by model

Forecasts Initialized 30 Mar 2023

Region	Week 2 (7–13 Apr)				Week 3 (14–20 Apr)				Week 4 (21–27 Apr)		
	NCEP ^{1,2}	ECMWF ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ^{1,2}	ECMWF ¹	ECMWF ^{1,2}	Multi-Model Forecast	NCEP ²	ECMWF ²	Multi-Model Forecast
WA/OR	Below normal	Below normal	Below normal	Below normal	Below normal	Above normal	Below normal	Below normal	Uncertain	Uncertain	Uncertain
Northern CA	Below normal	Below normal	Below normal	Below normal	Below normal	Uncertain	Below normal	Below normal	Uncertain	Uncertain	Uncertain
Central CA	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Uncertain	Uncertain	Uncertain
Southern CA	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Below normal	Uncertain	Uncertain	Uncertain

Higher Confidence | Lower Confidence



- Models are showing high confidence in below-normal precipitation over CA during Week 2
- Models agree on below-normal precipitation over CA during Week 3, but forecast confidence is lower in Northern and Central CA
- Week 4 forecasts are uncertain

Subseasonal products included in this Outlook:

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

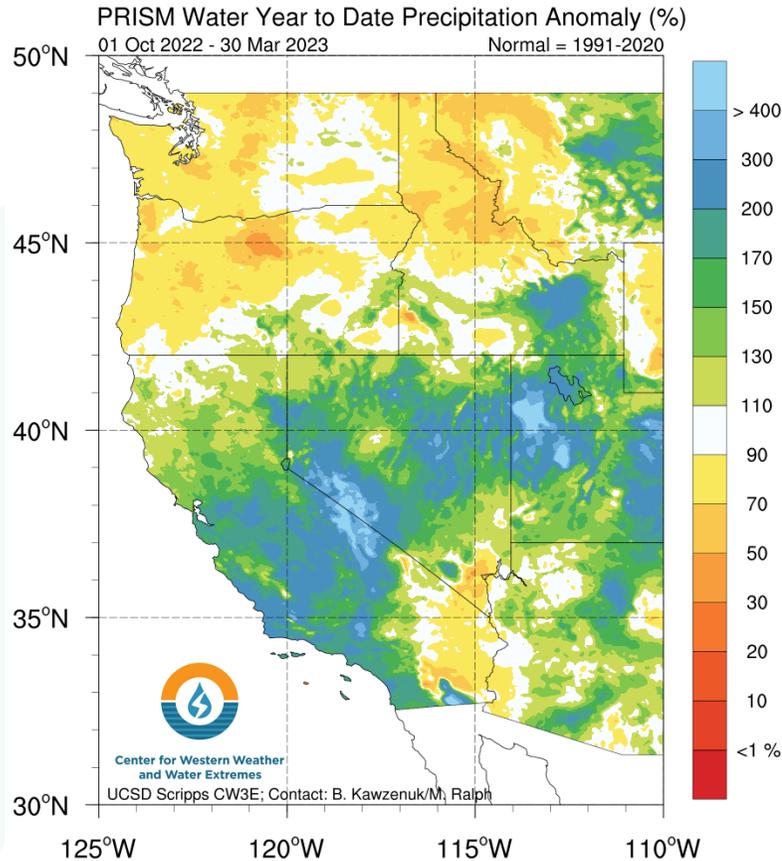
²CW3E/JPL Ridging Forecasts ([Gibson et al. 2020](#))

Summary

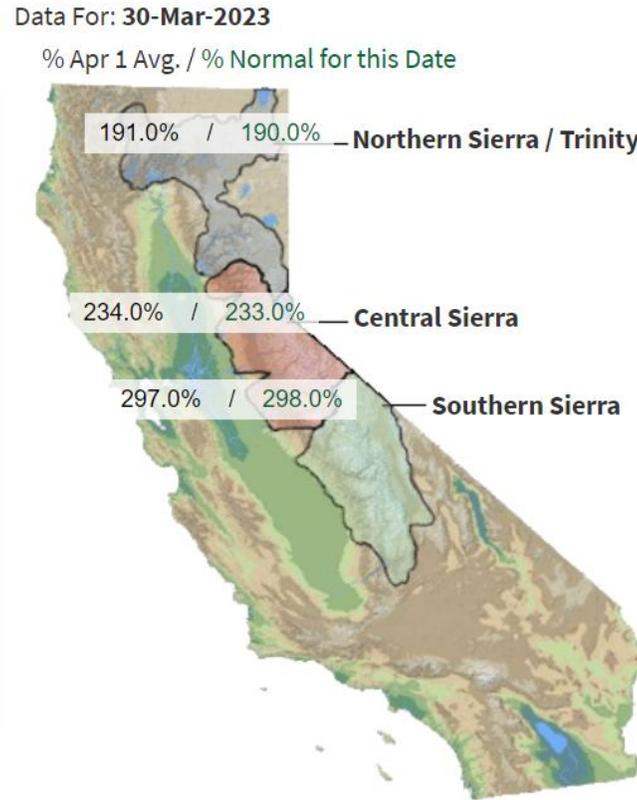
- **Week 2 forecasts (7–13 Apr):** Models agree on very low likelihood (< 20% probability) of AR activity over California
- NCEP is showing low likelihood of persistent ridging activity near the US West Coast during Weeks 1–2, but ECMWF is more confident in above-normal occurrence of the North Ridge
 - The North-ridge type is typically associated with dry conditions over the entire US West Coast
- **Week 3 forecasts (14–20 Apr):** NCEP and ECMWF generally agree on low amount of AR activity over CA, but ECCO is forecasting more AR activity in Northern CA
 - NCEP and ECMWF are predicting below-normal AR activity in Northern and Central CA with high confidence
 - ECCO and ECMWF are predicting below-normal AR activity in Southern CA with high confidence
- Both NCEP and ECMWF are showing the potential for ridging activity near the US West Coast during Weeks 3–4, but there is large uncertainty in the location and frequency of ridging

Water Year Hydrologic Summary

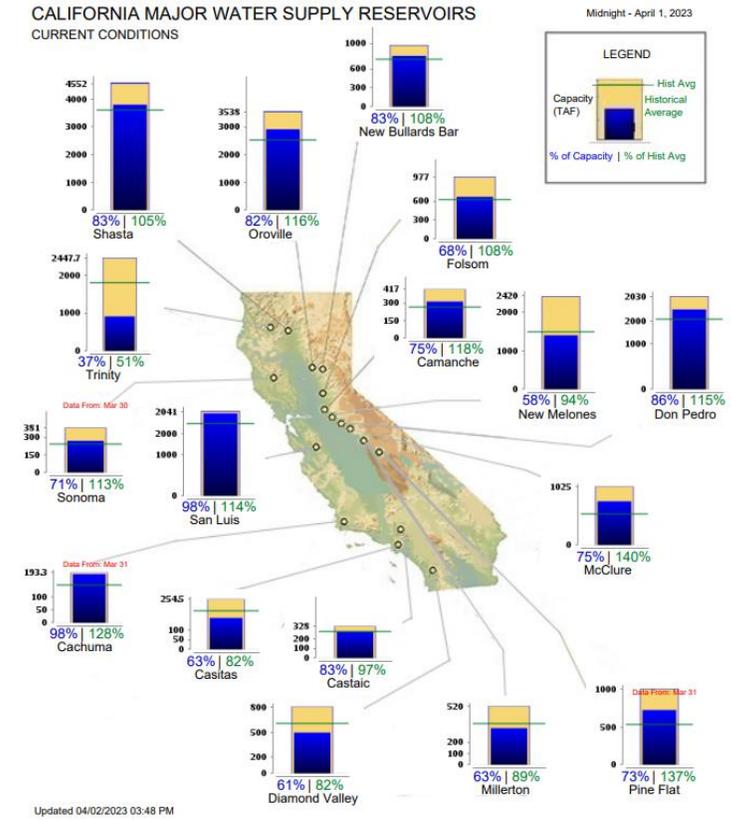
Precipitation



Snowpack Conditions



Reservoir Storage

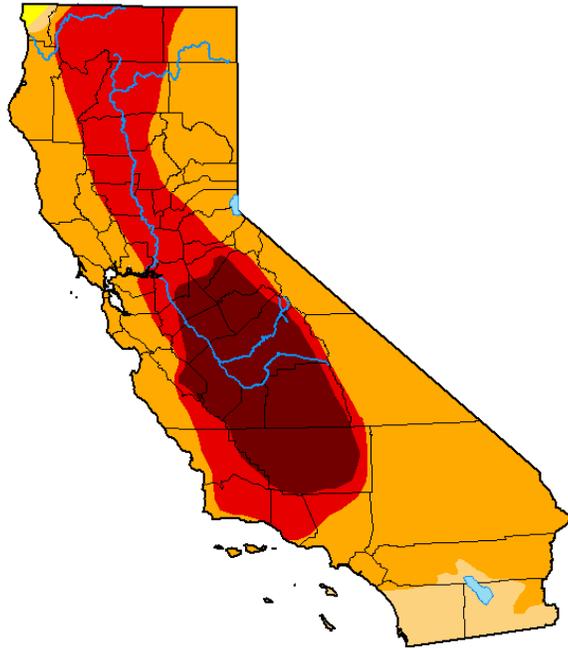


Source: California Department of Water Resources

- As of 30 Mar, water-year-to-date precipitation is above normal across much of the state, especially in Central CA and coastal Southern CA
- Statewide snowpack is well-above normal, especially in Southern Sierra Nevada, where current snowpack is 298% of normal for this date
- The wet winter has led to significant increases in water storage throughout the state
- Many large reservoirs in California are currently operating at greater than 70% storage capacity

Drought Conditions

U.S. Drought Monitor California



September 27, 2022
(Released Thursday, Sep. 29, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.76	94.01	40.91	16.57
Last Week 09-20-2022	0.00	100.00	99.76	94.06	40.91	16.57
3 Months Ago 06-28-2022	0.00	100.00	99.79	97.48	59.81	11.59
Start of Calendar Year 01-04-2022	0.00	100.00	99.30	67.62	16.60	0.84
Start of Water Year 09-28-2021	0.00	100.00	100.00	93.93	87.88	45.66
One Year Ago 09-28-2021	0.00	100.00	100.00	93.93	87.88	45.66

Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

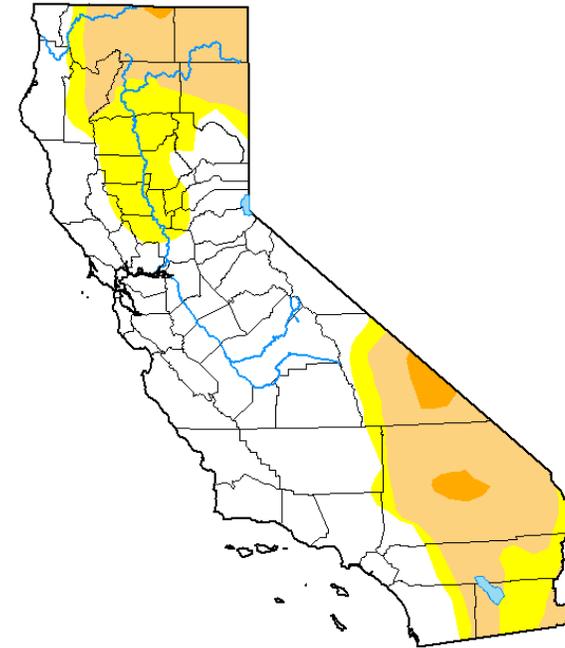
Author:

Richard Heim
NCEI/NOAA



droughtmonitor.unl.edu

U.S. Drought Monitor California



March 28, 2023
(Released Thursday, Mar. 30, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	55.34	44.66	28.11	1.95	0.00	0.00
Last Week 03-21-2023	48.51	51.49	35.88	8.49	0.00	0.00
3 Months Ago 12-27-2022	0.00	100.00	97.94	80.56	35.50	7.16
Start of Calendar Year 01-03-2023	0.00	100.00	97.93	71.14	27.10	0.00
Start of Water Year 09-27-2022	0.00	100.00	99.76	94.01	40.91	16.57
One Year Ago 03-29-2022	0.00	100.00	100.00	93.65	40.25	0.00

Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

- A very wet water year has brought substantial drought relief to nearly all of California
- At the start of the water year, 94% of the state was experiencing severe or worse drought conditions, and 41% of the state was experiencing extreme or exceptional drought
- As of 28 Mar, only 28% of the state is experiencing drought conditions, and no areas are experiencing extreme or exceptional drought
- The greatest improvement in drought conditions has occurred over Central California

Looking Back: Week 3 AR Activity Forecasts

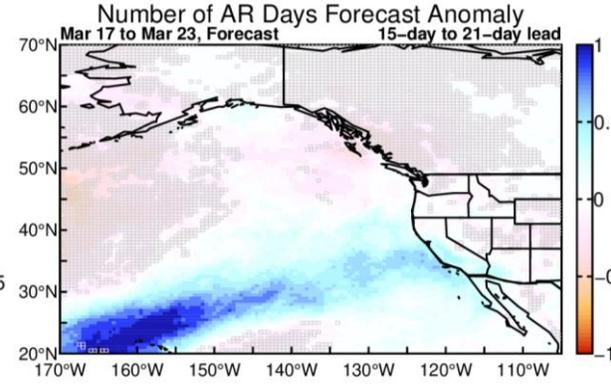
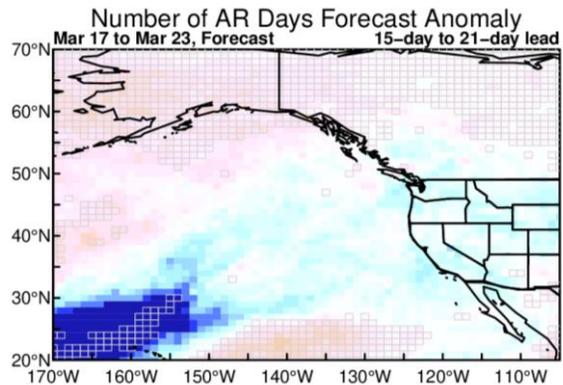
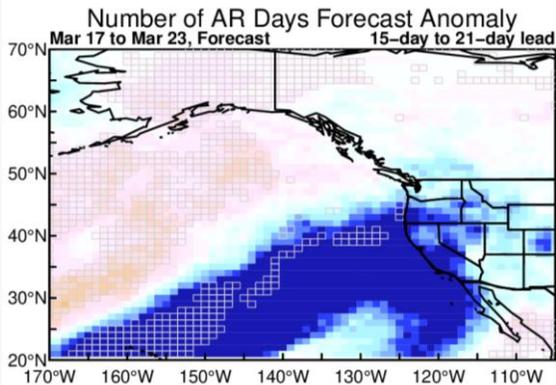
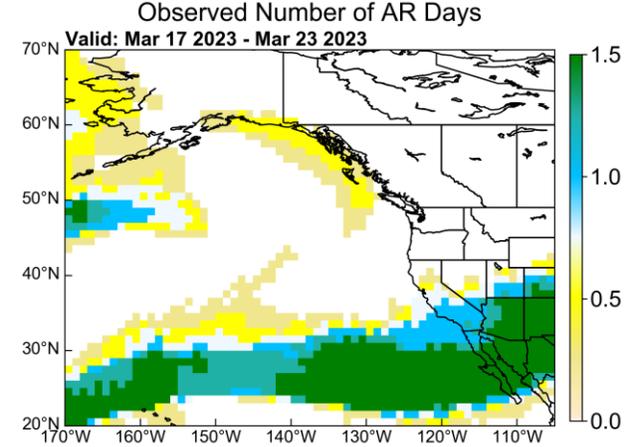
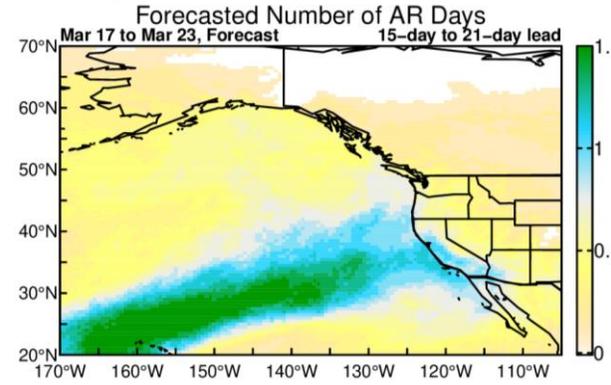
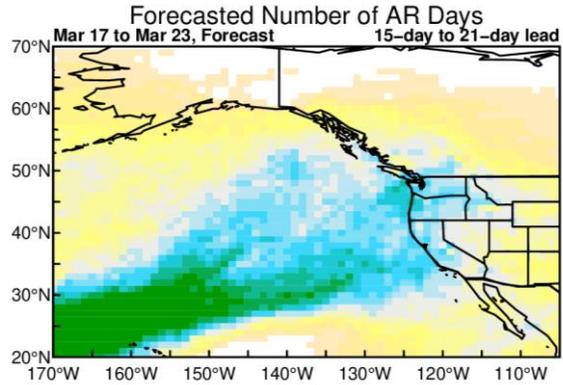
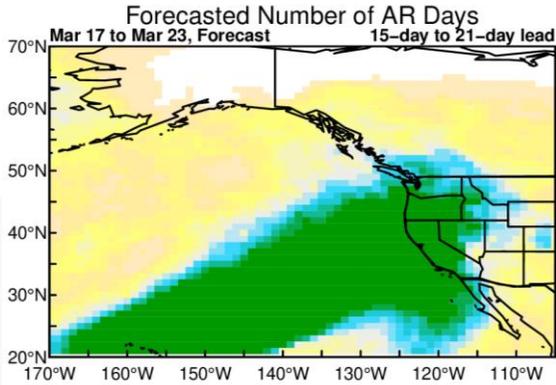
Forecasts Initialized 2 Mar 2023; Valid: 17–23 Mar 2023

NCEP

ECMWF

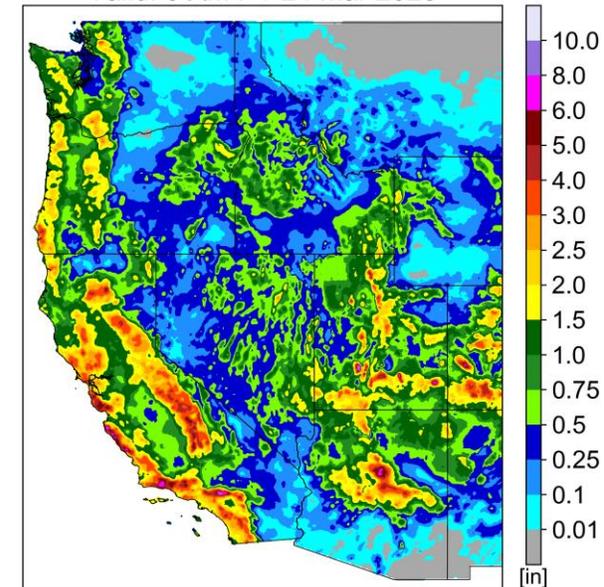
ECMWF

Observed (GFS Analysis)



Observed Precipitation

NWS Stage IV 24-day QPE
Valid: 5 AM PT 24 Mar 2023



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

All models correctly predicted some AR activity over California, but the focus of AR activity was too far north compared to observed AR activity

Models failed to predict the inland penetration of AR activity over the Southwest US

- A landfalling AR and a strong low-pressure system brought > 4 inches of precipitation to the Central CA Coast Ranges, the Sierra Nevada, and the Transverse Ranges

Looking Back: Week 3 AR Activity Forecasts

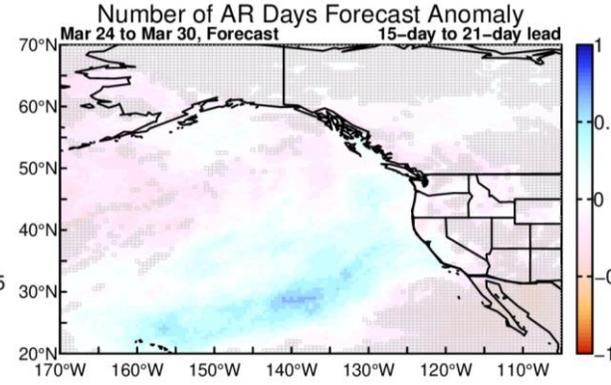
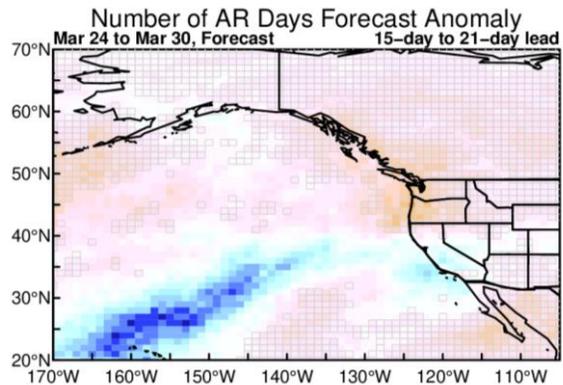
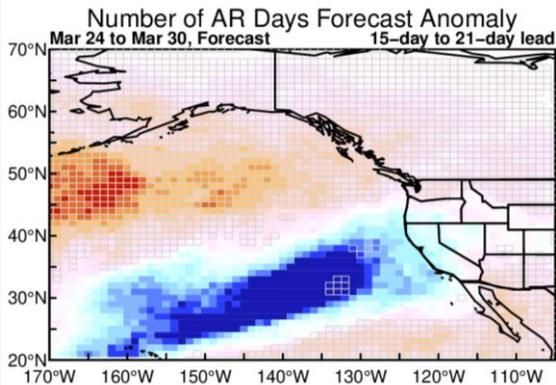
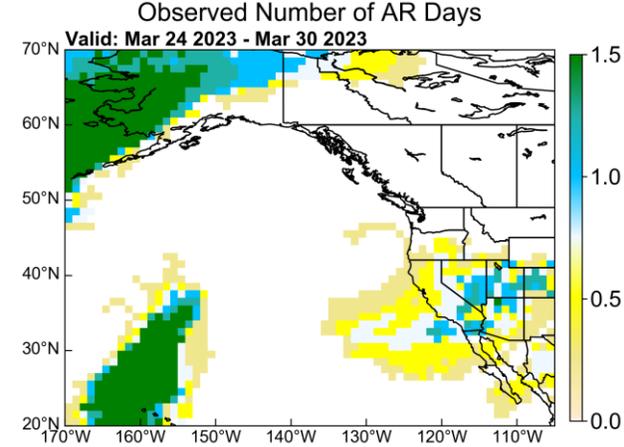
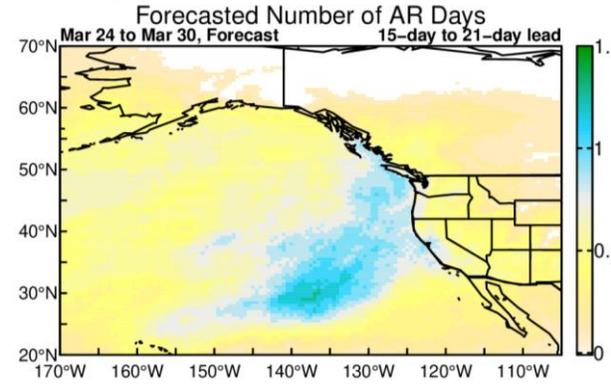
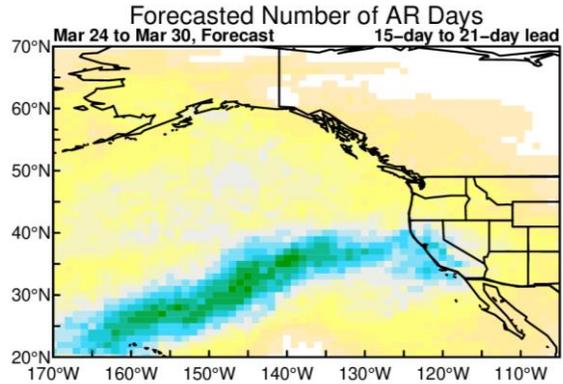
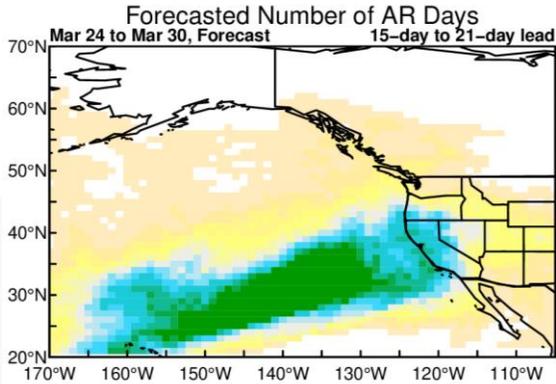
Forecasts Initialized 9 Mar 2023; Valid: 24–30 Mar 2023

NCEP

EC3C

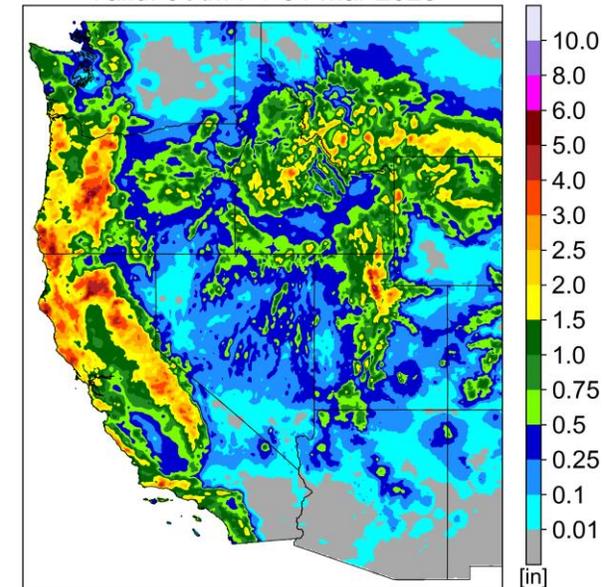
ECMWF

Observed (GFS Analysis)



Observed Precipitation

NWS Stage IV 7-day QPE
Valid: 5 AM PT 31 Mar 2023



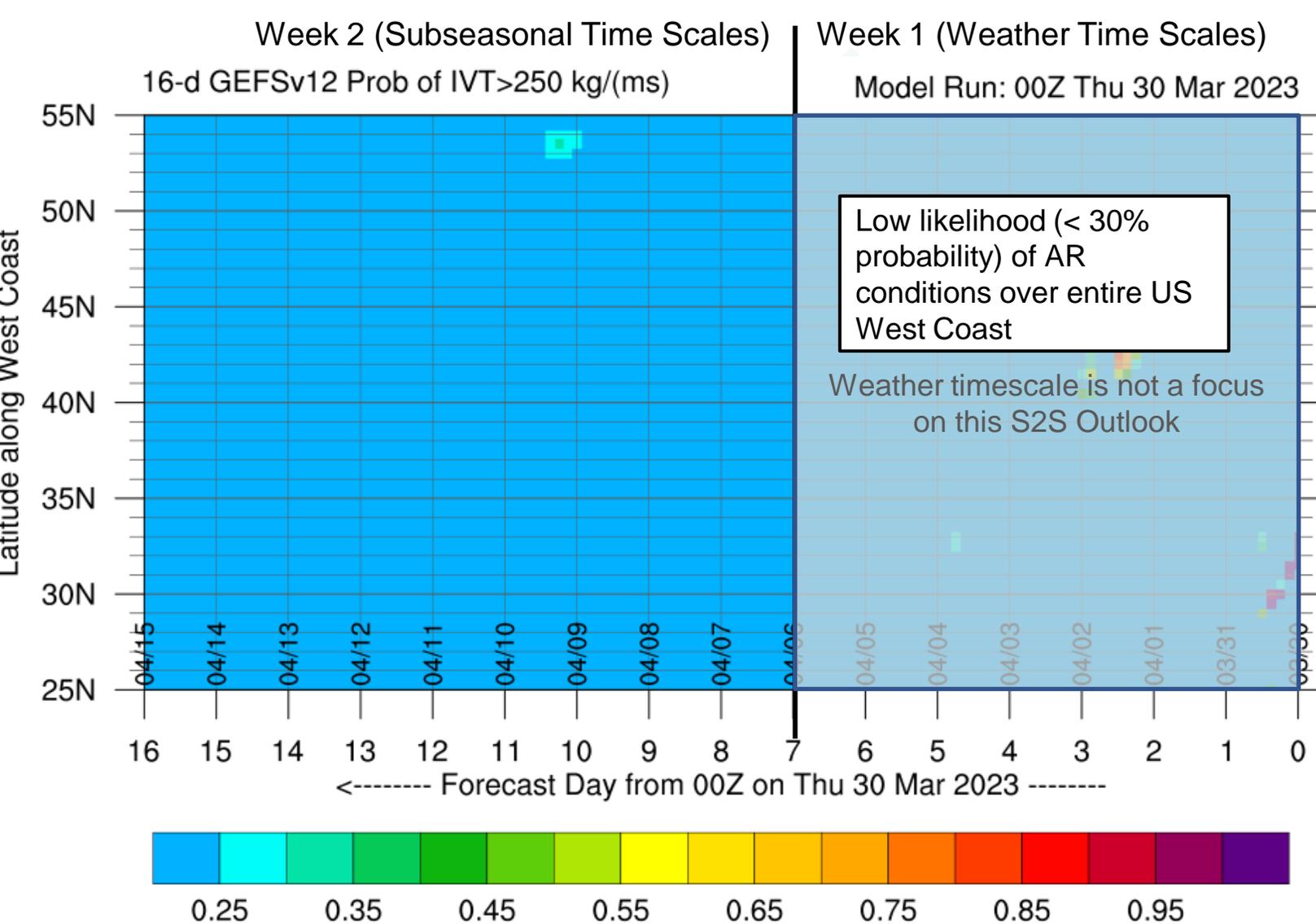
Shading: Fractional # of AR days over a 7-day period (top) and forecast minus model climatology (bottom)
Grey cells: >75% of ensemble members agree on sign of anomaly

NCEP and EC3C correctly predicted some AR activity over CA, but the focus of AR activity was too far north and west compared to observed AR activity

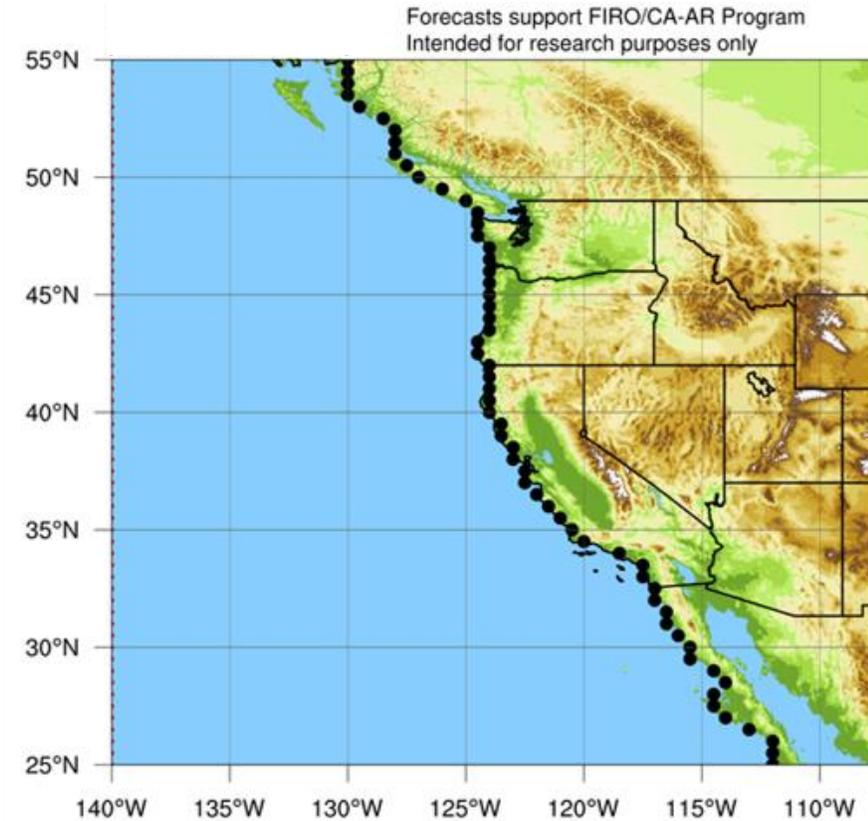
ECMWF failed to predict landfalling AR activity over the Southwest US

- A weak AR associated with a low-pressure system brought more than 3 inches of precipitation to the Coast Ranges and Cascades in Southern Oregon and Northern California, as well as the Northern Sierra Nevada

NCEP GEFS AR Landfall Tool: Valid 00Z 30 Mar – 00Z 15 Apr

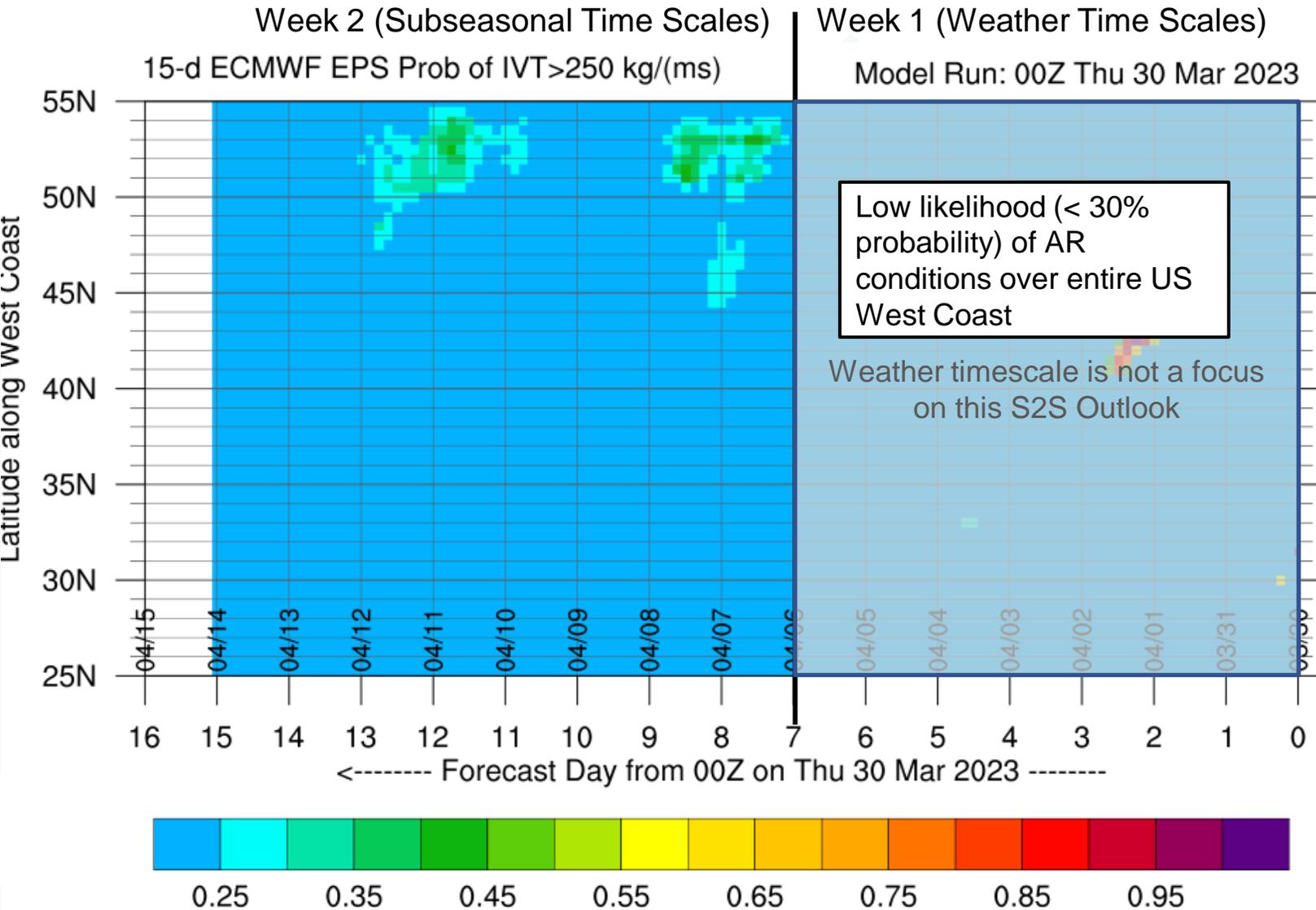


Forecasts Initialized 30 Mar 2023

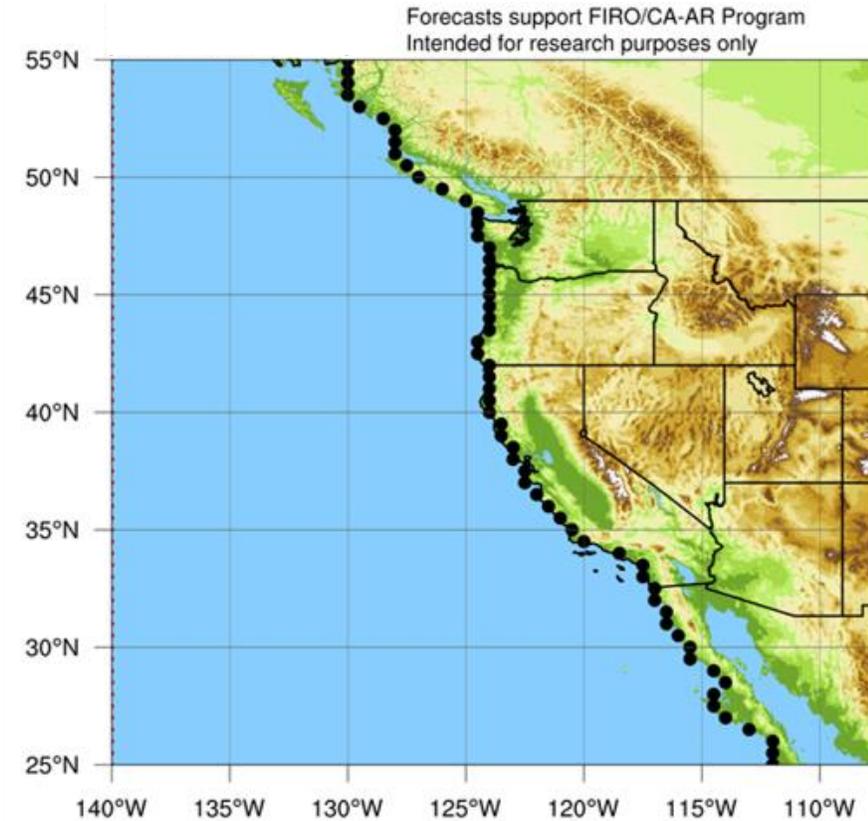


- NCEP is forecasting low likelihood of AR conditions over California in Week 2

ECMWF EPS AR Landfall Tool: Valid 00Z 30 Mar – 00Z 14 Apr

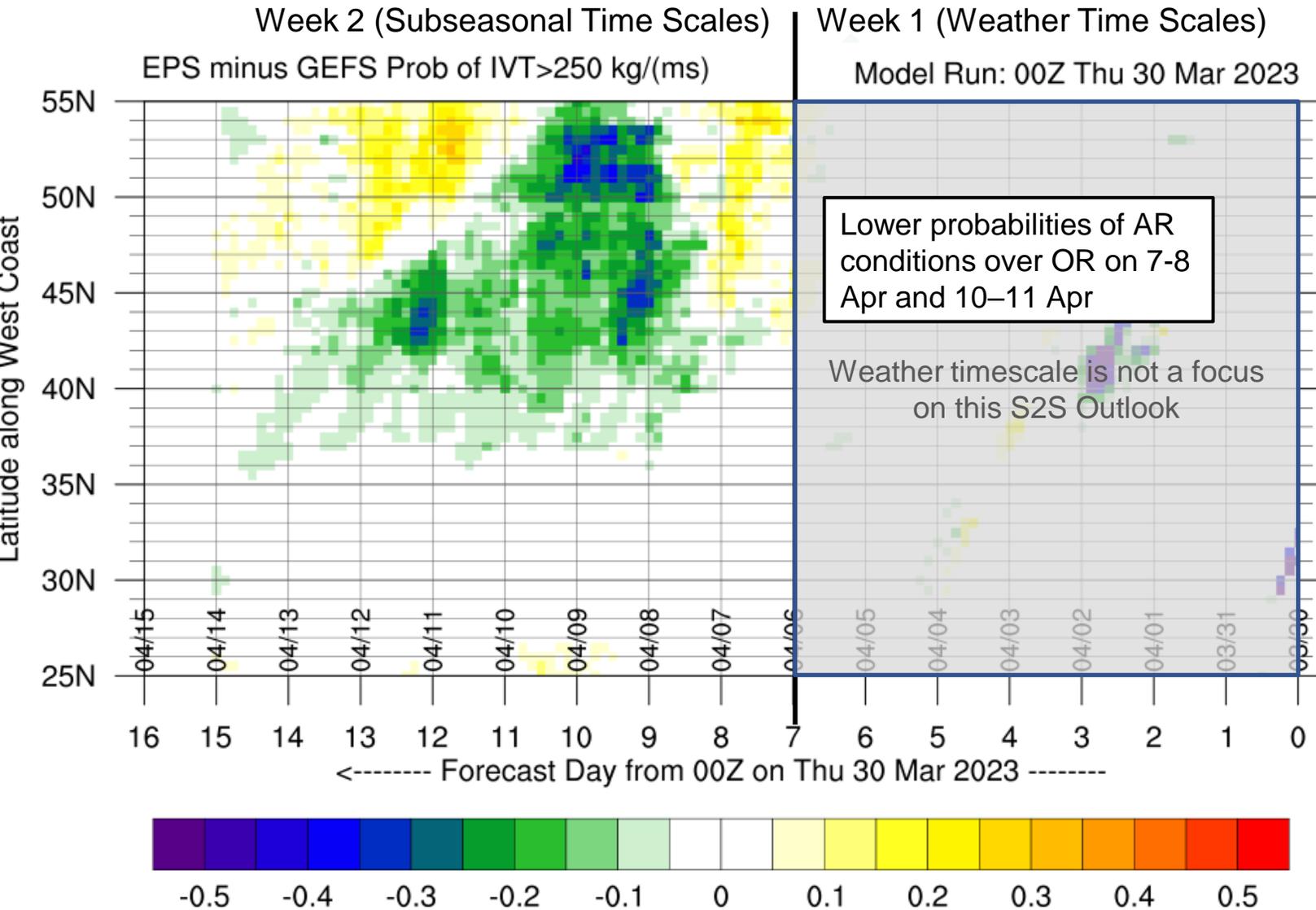


Forecasts Initialized 30 Mar 2023

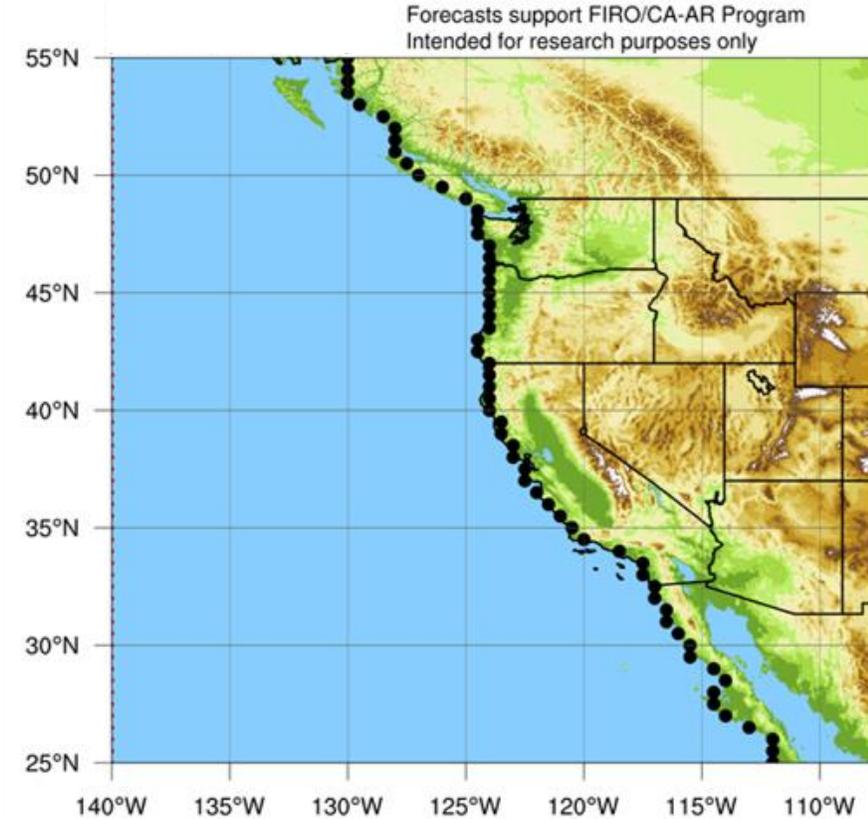


- ECMWF is forecasting low likelihood of AR conditions over California during Week 2

EPS Minus GEFS AR Landfall Tool: Valid 00Z 30 Mar – 00Z 14 Apr



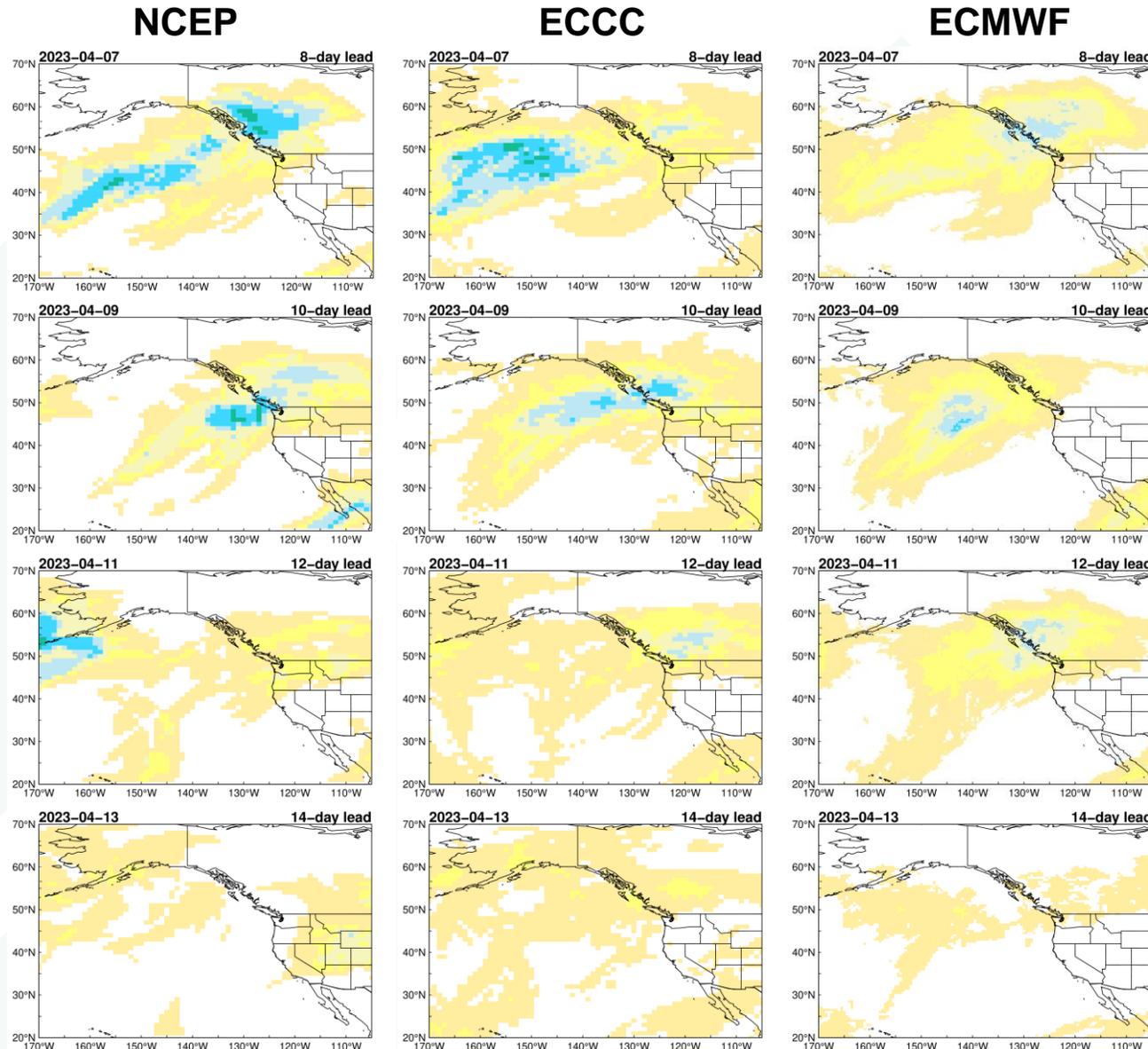
Forecasts Initialized 30 Mar 2023



- ECMWF is forecasting a lower likelihood of AR conditions over Oregon on 7–8 Apr and 10–11 Apr compared to NCEP

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

Forecasts Initialized 30 Mar 2023



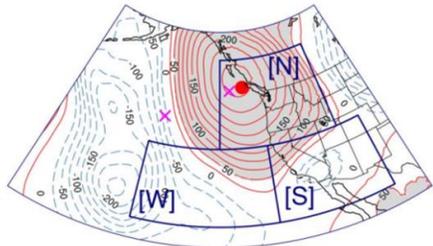
- All models are showing very low probabilities (< 20%) of AR activity over California during Week 2 (7–13 Apr)
- NCEP and ECCC are showing slightly higher probabilities (30–50%) of AR activity in WA on 9 Apr
- Highest likelihood of landfalling AR activity is farther north in British Columbia

Models agree on low likelihood of AR activity over CA during Week 2 (7–13 Apr)

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

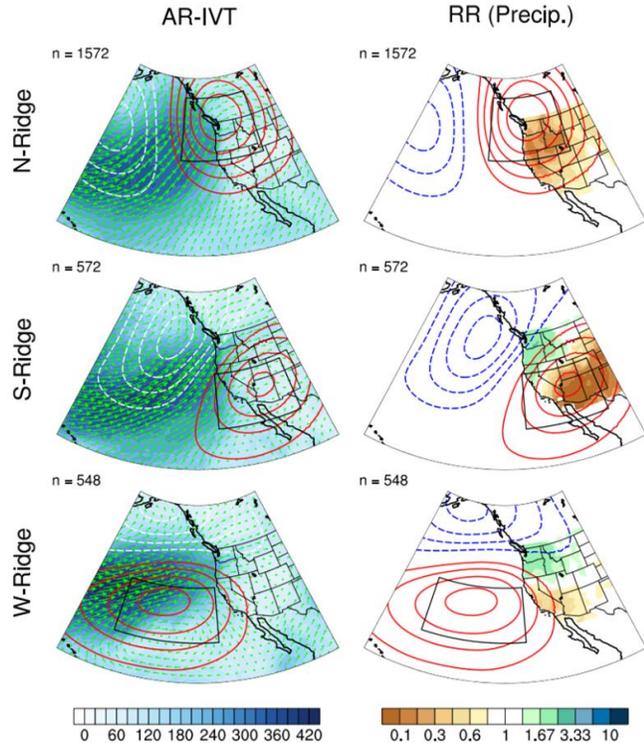


Background Info: Subseasonal Ridging Outlooks



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 California 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 California and wet conditions over the Pacific Northwest



Jet Propulsion Laboratory
California Institute of Technology



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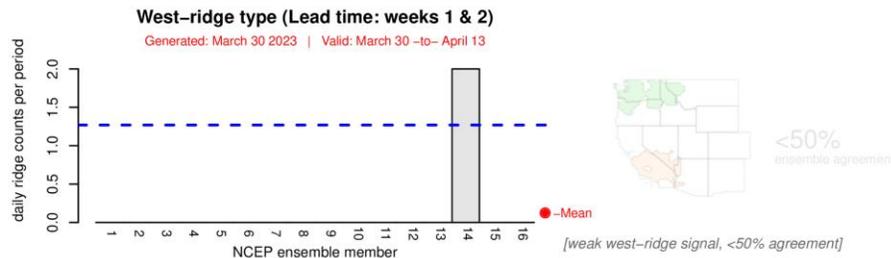
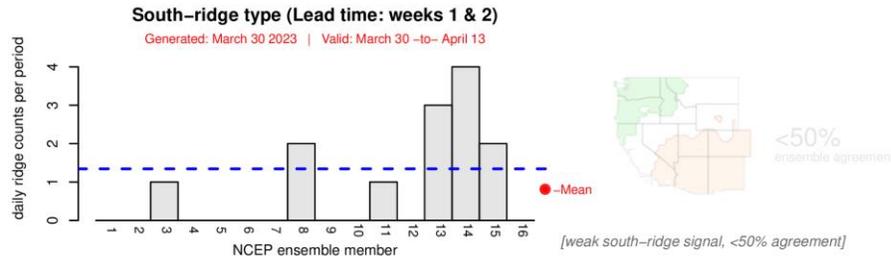
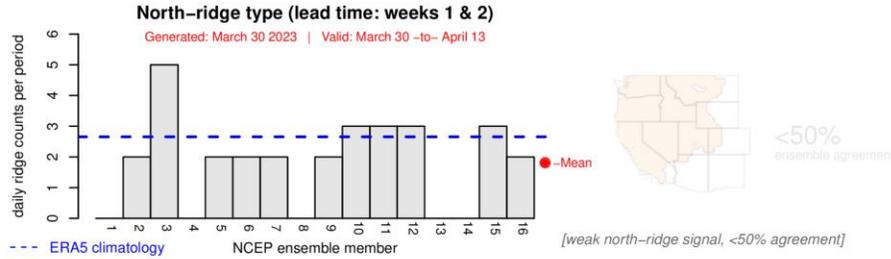
Contact: pgibson@ucsd.edu
Reference: Gibson et al. (2020)
Journal of Climate

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

Forecasts Initialized 30 Mar 2023

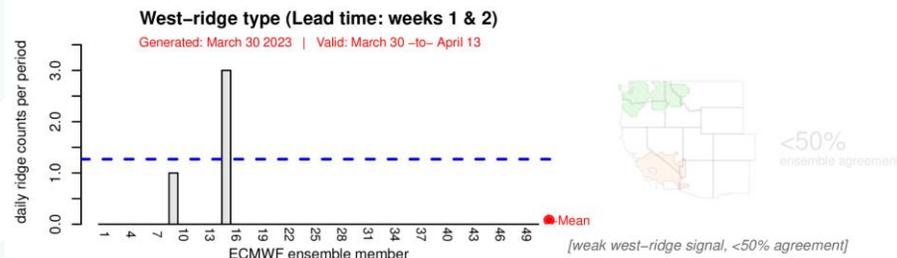
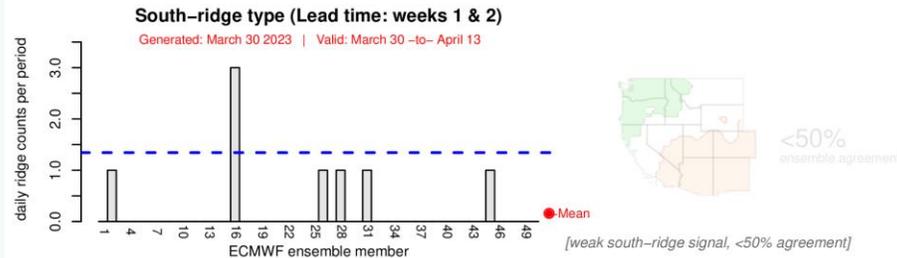
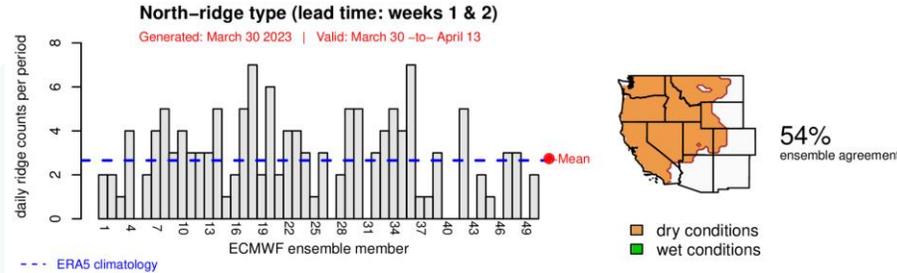
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



- Both NCEP and ECMWF are predicting low occurrence of the South- and West-ridge types during Weeks 1–2 (31 Mar – 13 Apr)
- NCEP is also predicting low likelihood of the North-ridge type
- ECMWF is showing moderate confidence (54% ensemble agreement) in persistent ridging near the Pacific Northwest

Generally low likelihood of persistent ridging activity near the US West Coast during Weeks 1–2; model disagreement on likelihood of North-ridge type

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

Forecasts Initialized 30 Mar 2023

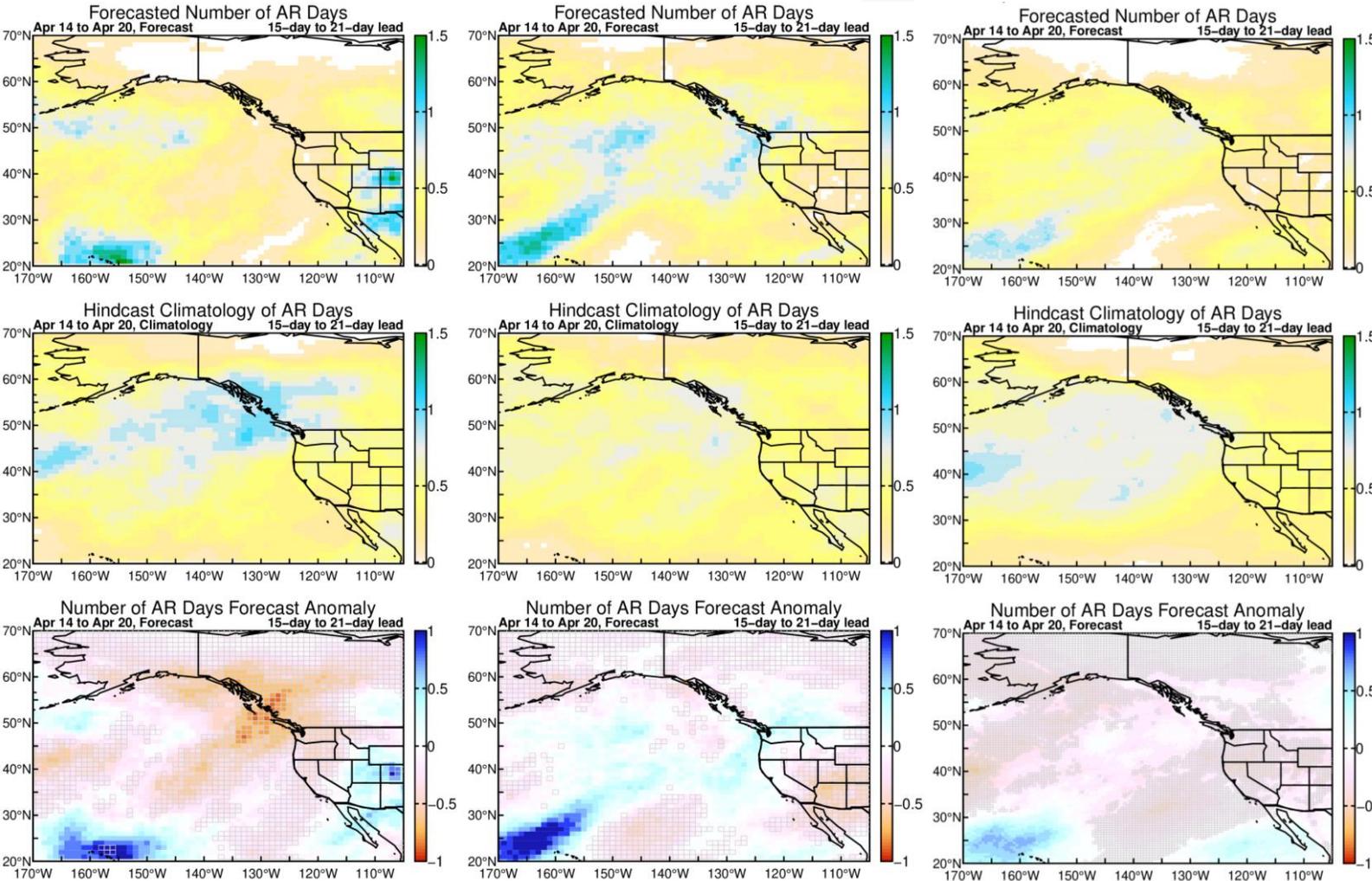
NCEP

ECCC

ECMWF

- NCEP and ECMWF are both predicting below-normal AR activity in Northern and Central CA during Week 3 (14–20 Apr) with high confidence (> 75% ensemble agreement)
- ECCC is predicting near-normal AR activity in Northern CA
- ECCC and ECMWF are also predicting below-normal AR activity in Southern CA with high confidence

NCEP and ECMWF generally agree on predicted AR activity over CA during Week 3 (14–20 Apr); ECCC is predicting slightly more AR activity in Northern CA



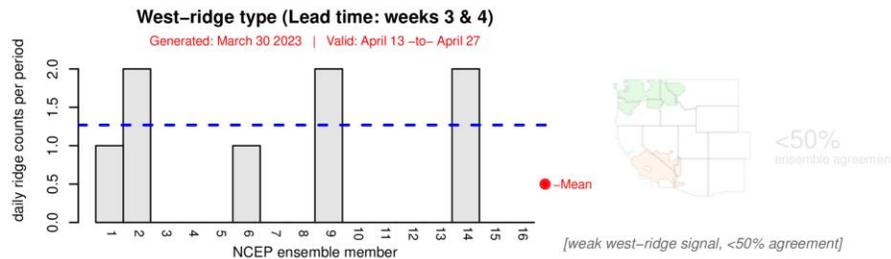
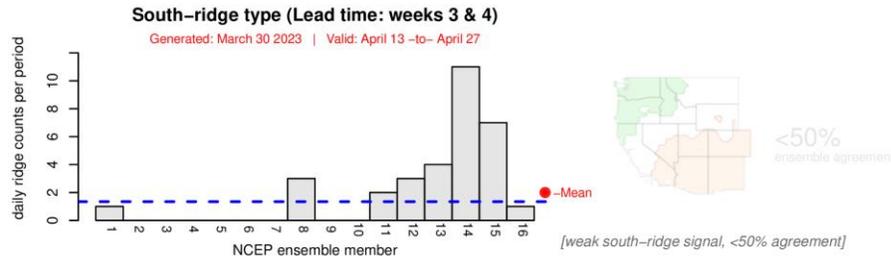
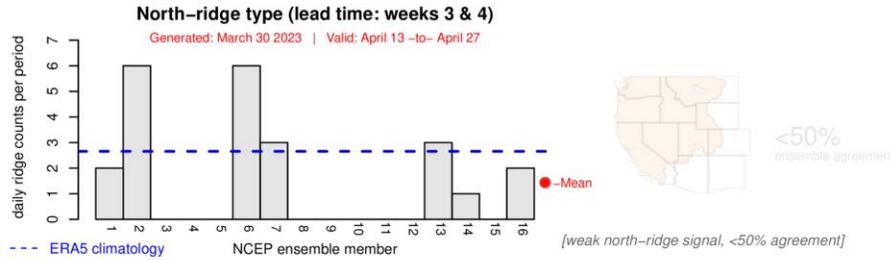
Shading: Fractional # of AR days forecast over a 7-day period (top), model climatology (middle), and forecast minus model climatology (bottom)
 Grey cells: >75% of ensemble members agree on sign of anomaly

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

Forecasts Initialized 30 Mar 2023

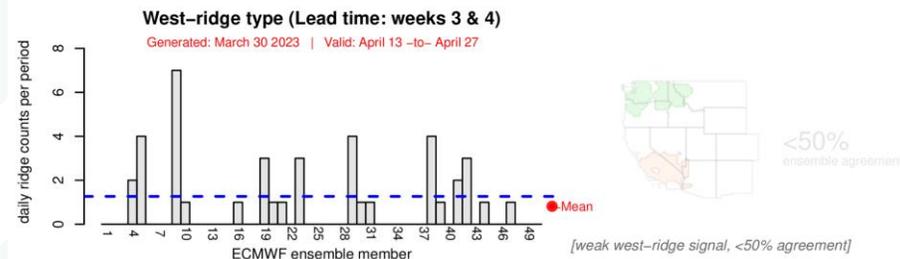
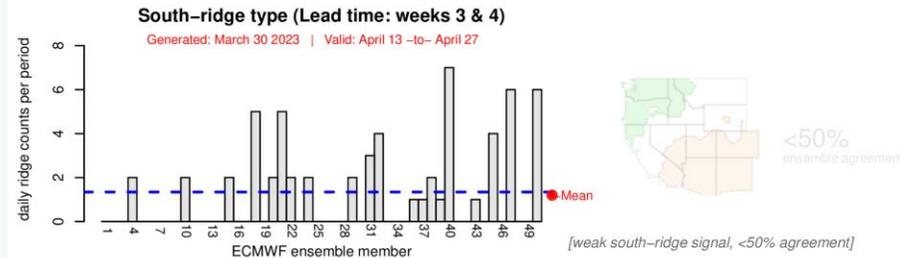
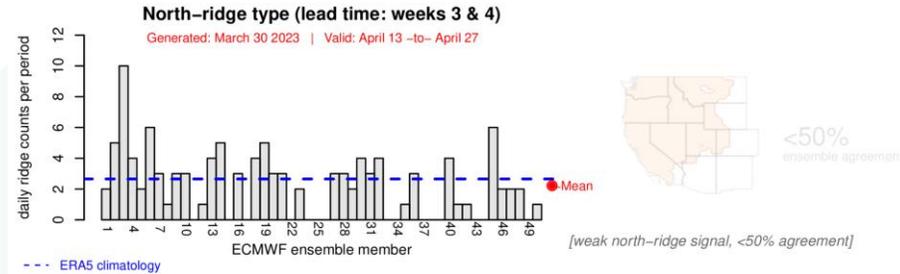
NCEP

CW3E Subseasonal Ridging Forecast (Uses NCEP CFSv2 model)



ECMWF

CW3E Subseasonal Ridging Forecast (Uses ECMWF model)



- Both NCEP and ECMWF are showing low likelihood (< 50% ensemble agreement) of above-normal ridging activity near the US West Coast during Weeks 3–4 (13–27 Apr)
- ECMWF is predicting near-normal ridging activity, but ensemble members disagree on location of center of ridging
- NCEP is predicting near-normal ridging over the Southwest US

Uncertainty in frequency and location of ridging activity near the US West Coast during Weeks 3–4