

Subseasonal to seasonal weather regime forecasts and IRI seasonal precipitation outlooks & verifications for winter 2021-22

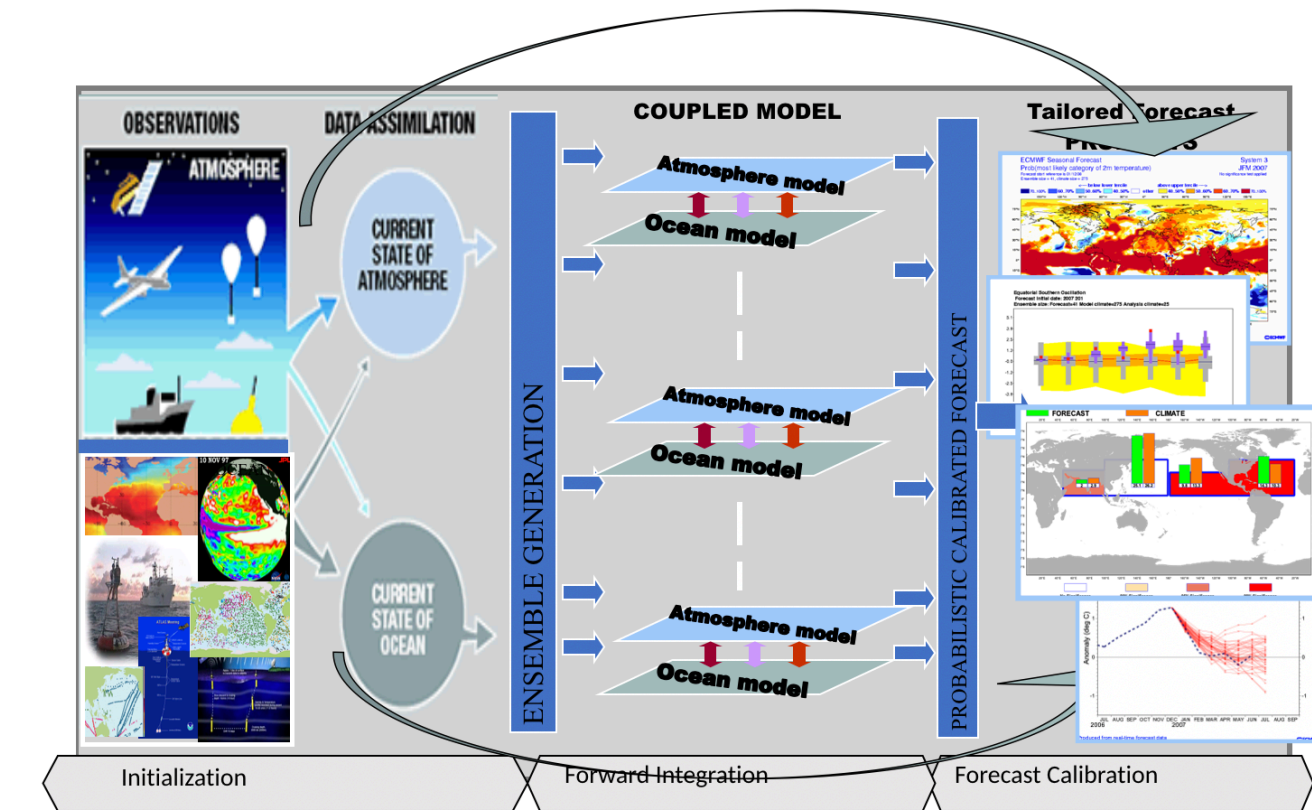
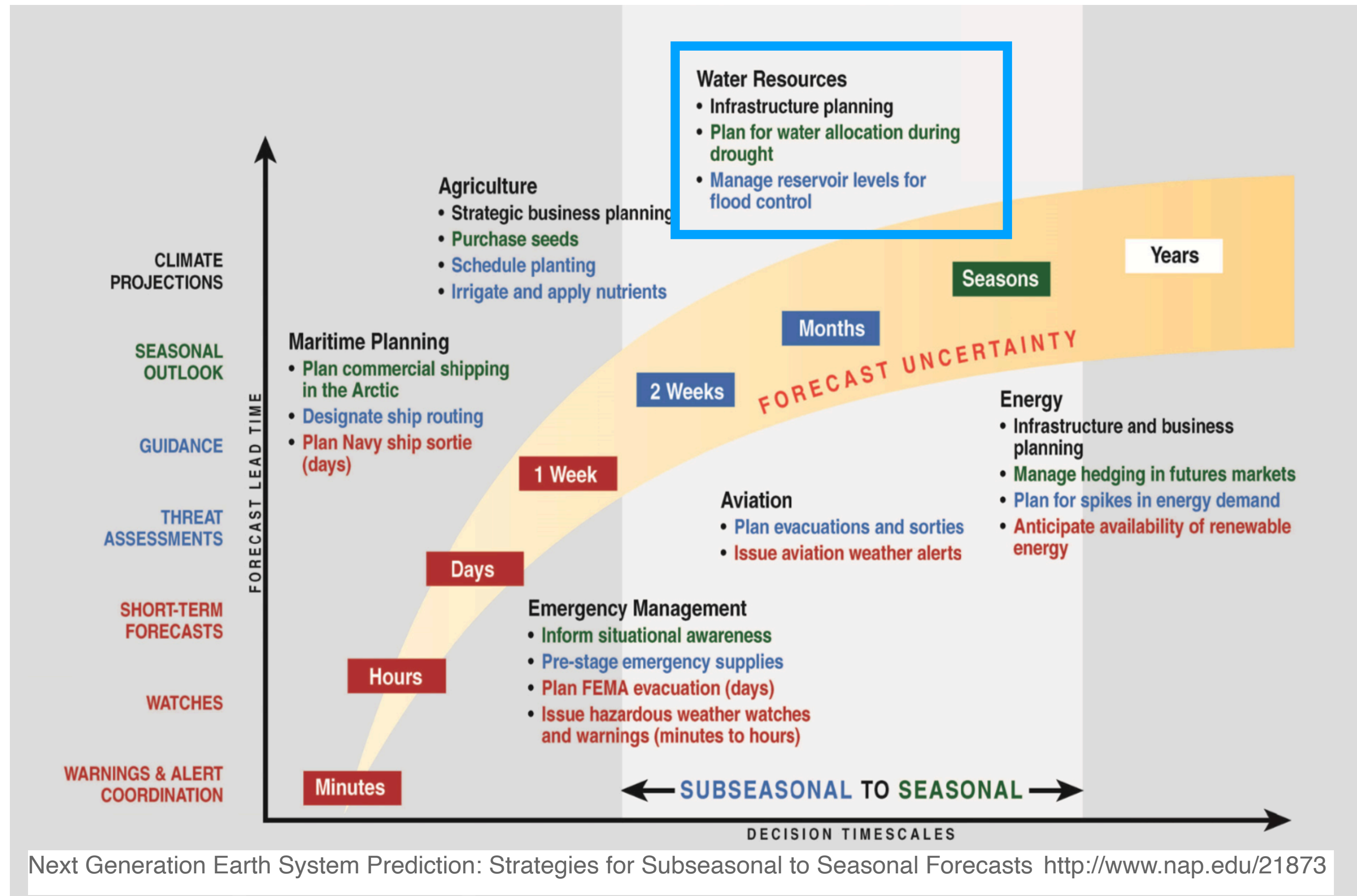
Andrew W Robertson, Bohar Singh,
Angel G. Muñoz, Jing Yuan



Outline

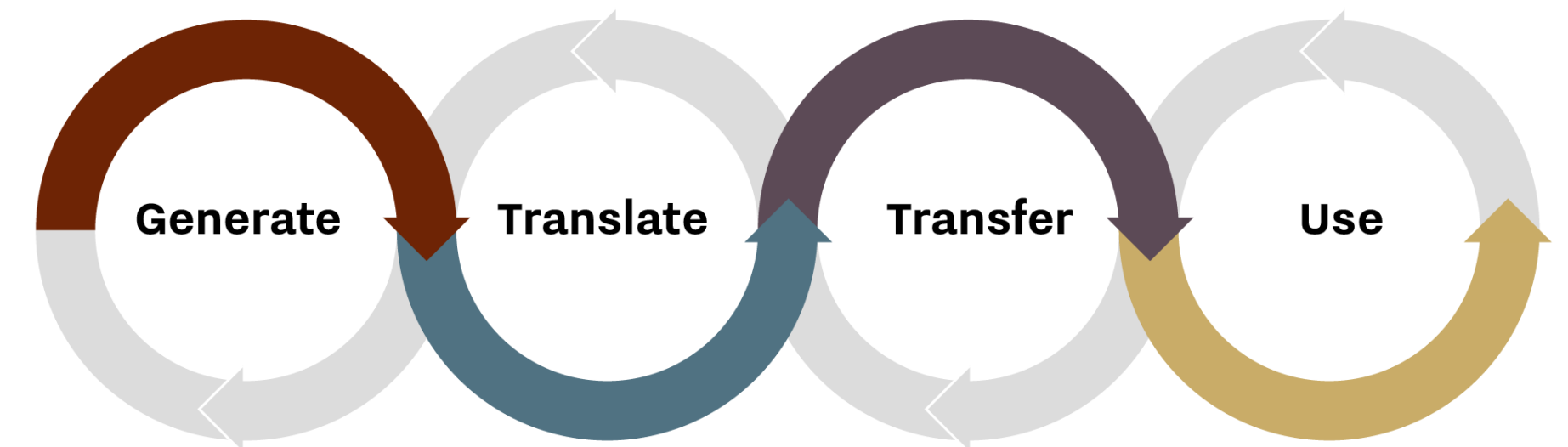
- IRI/CPC ENSO Forecast
- IRI Seasonal and Sub-seasonal precipitation forecast and verification
- Weather Regime diagnostic tool applied CFSv2 ensemble forecasts
- Sub-seasonal forecast, 1-45 days ahead
- S2S seamless forecast, 1 day to 6 months ahead
- Cross timescale interactions between MJO, La Niña and the Stratosphere Quasi-Biennial Oscillation in the context of water year 2022

S2S Climate Services for Water



■ Generate climate information and knowledge - learn from the past, monitor the present, forecast the future.

■ Transfer the translated information to the appropriate beneficiaries, in formats and media most useful to their operations

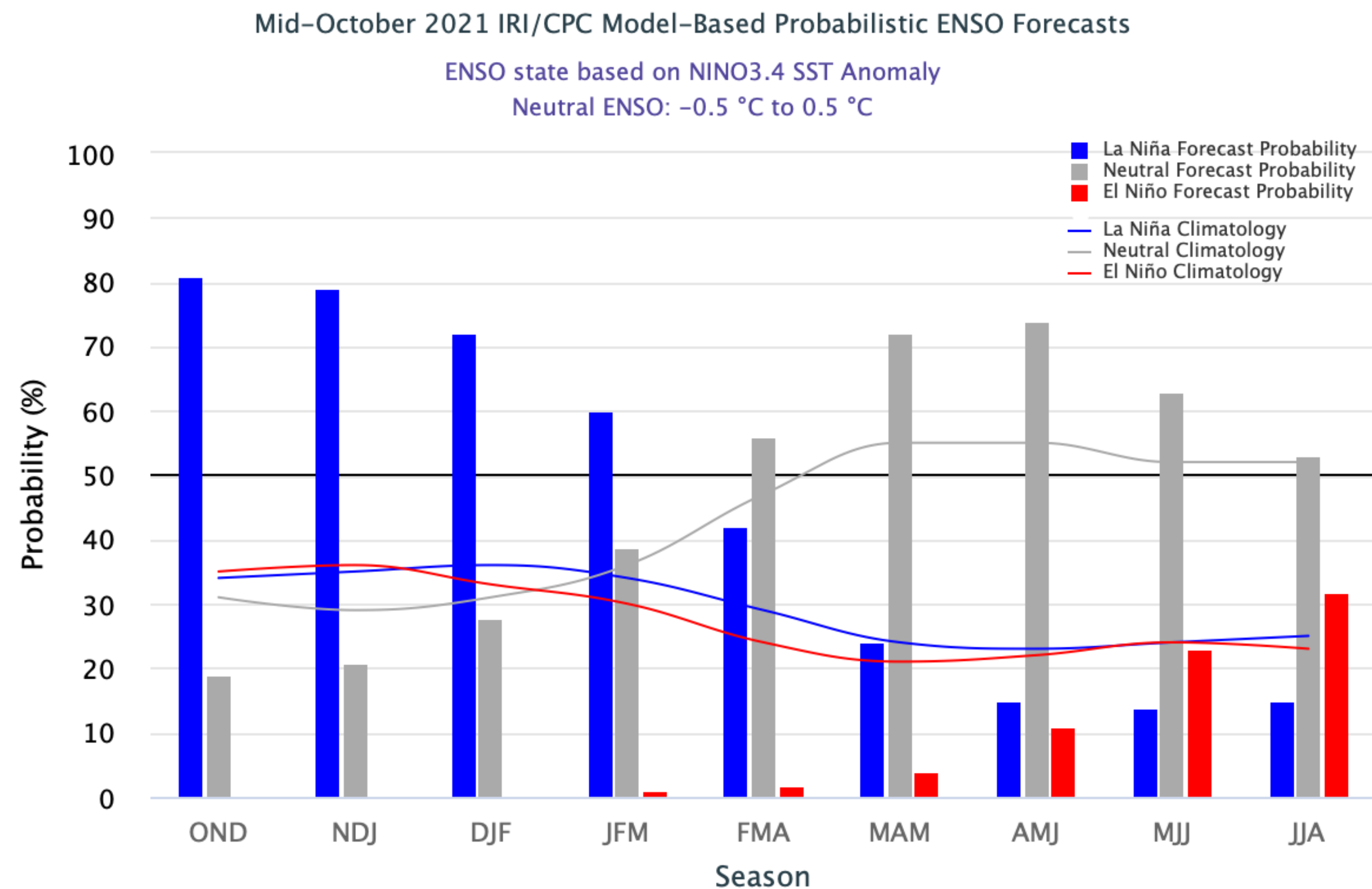
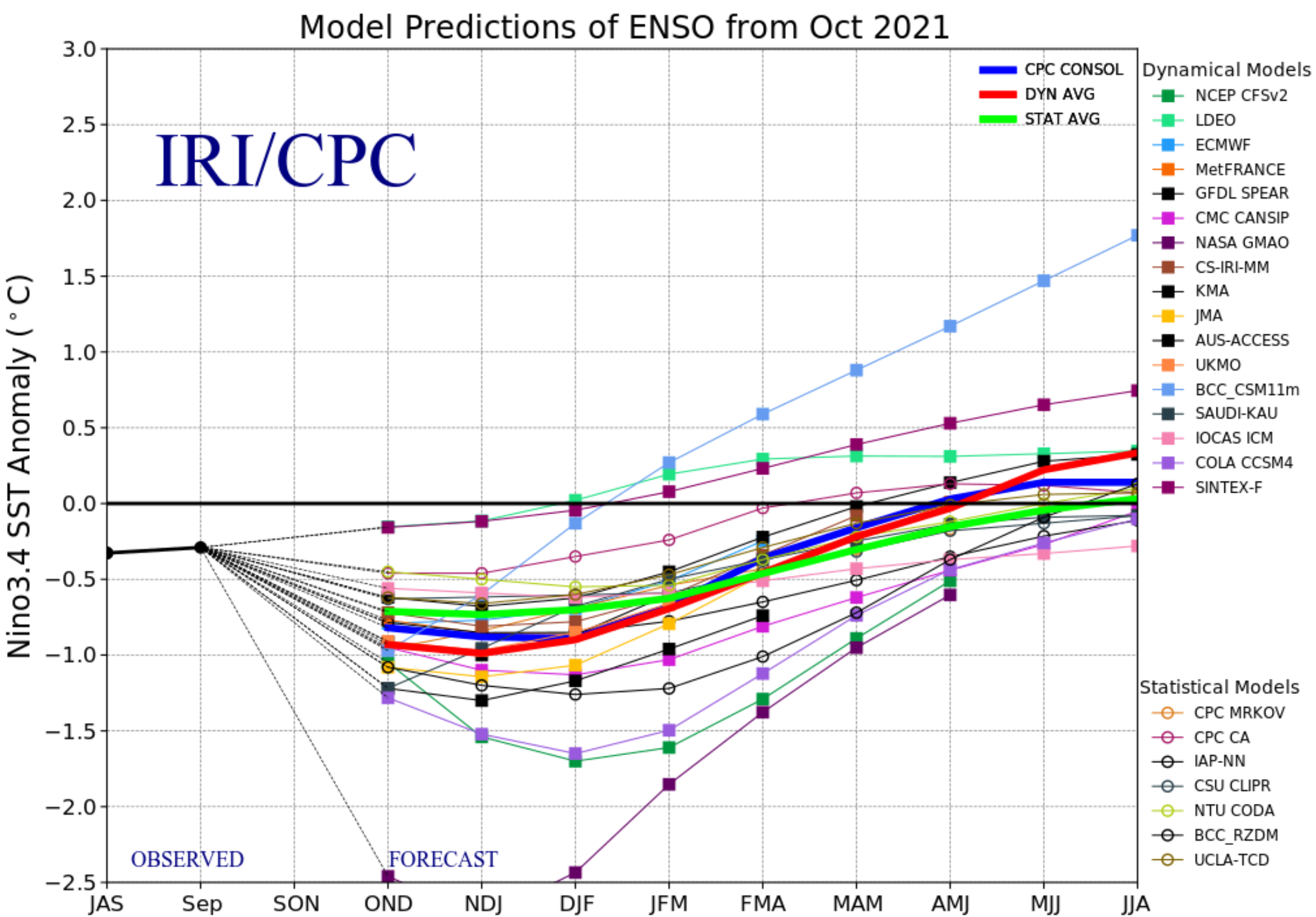


■ Translate the climate knowledge into information that is relevant to agriculture, public health and other target sectors.

■ Put the translated and transferred climate knowledge to use in operational decision processes, policies and plans. Learn what works and what doesn't.

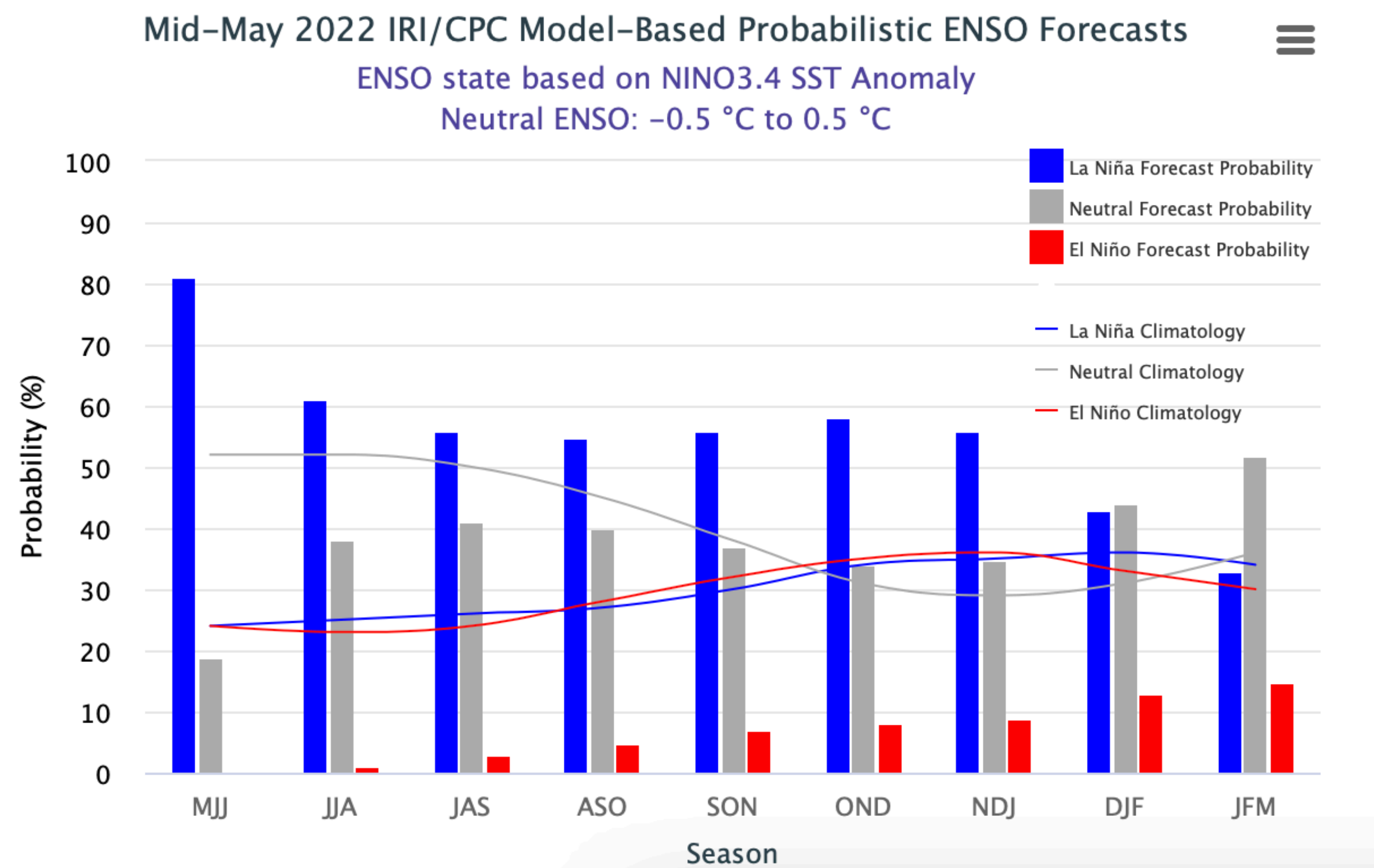
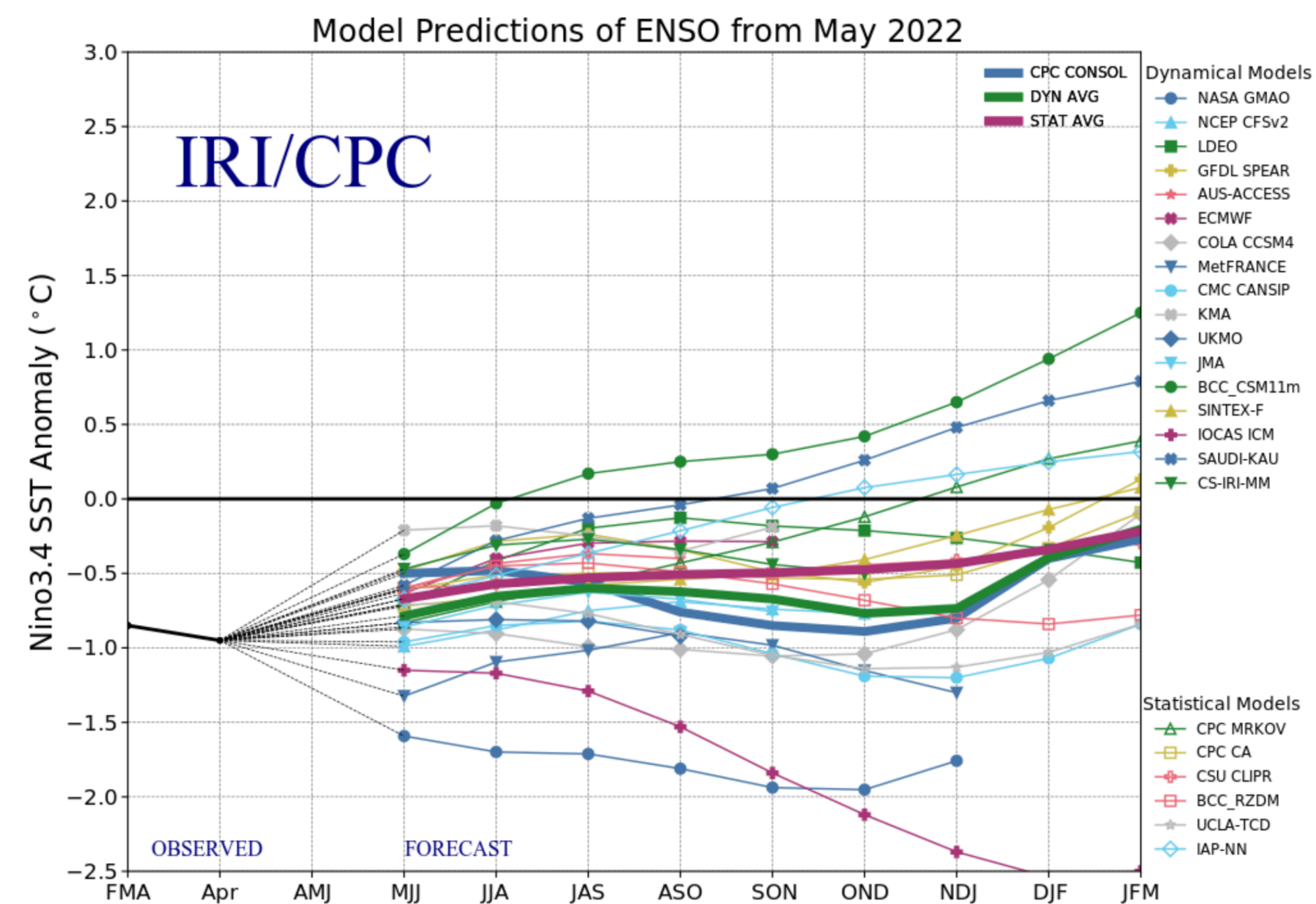


Oct 2021, IRI/CPC Multi-model ENSO Forecast



OND 2021	JFM 2021-22	FMA 2022
-0.98	-0.94	-1.0

May 2022 Sneak Peek (issued on 19th of the month)



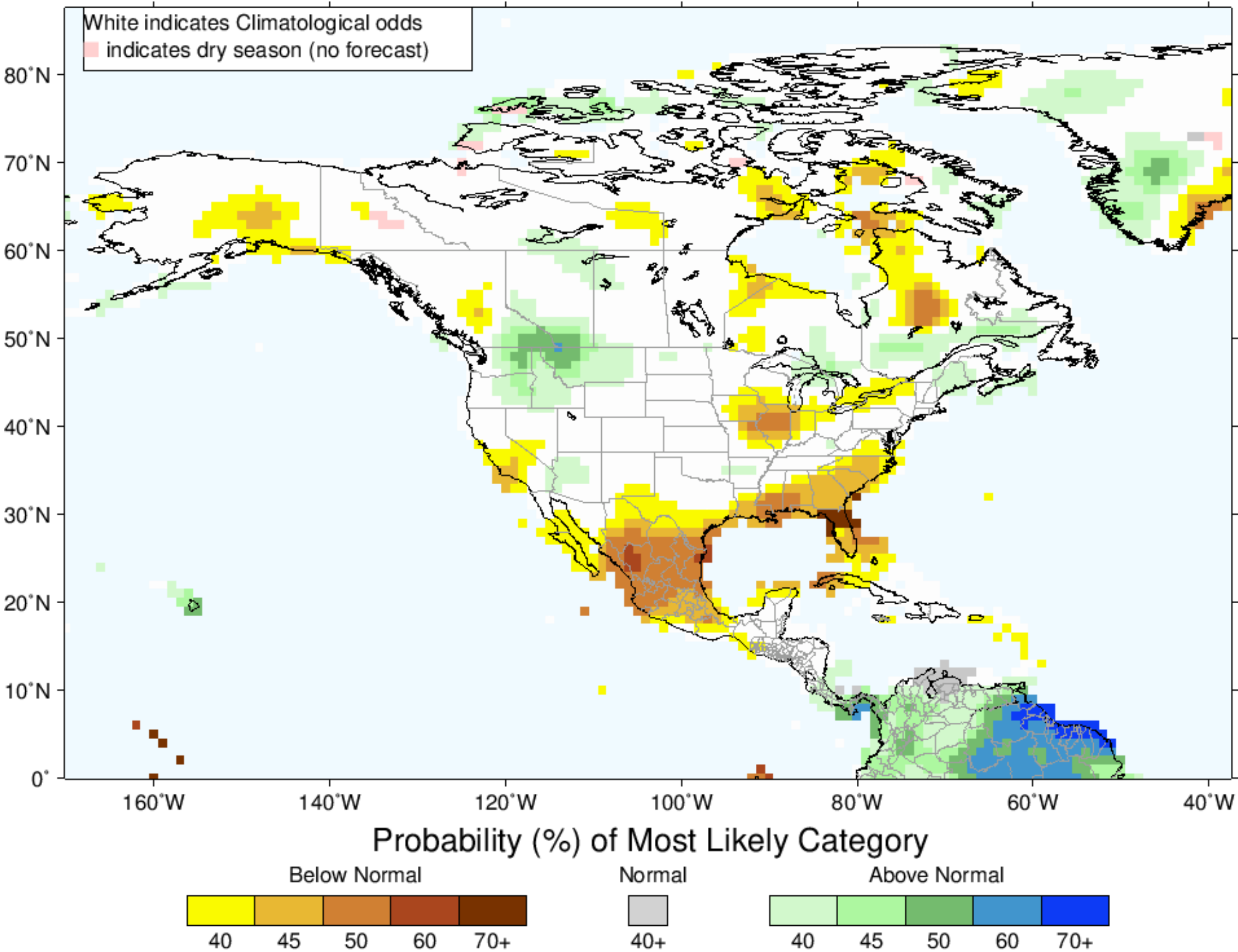
IRI NMME-based Calibrated Seasonal Precip. Forecast

NMME models* : [CanSIPSv2](#), [NCEP-CFSv2](#), [COLA-RSMAS-CCSM4](#), [GFDL-SPEAR](#)

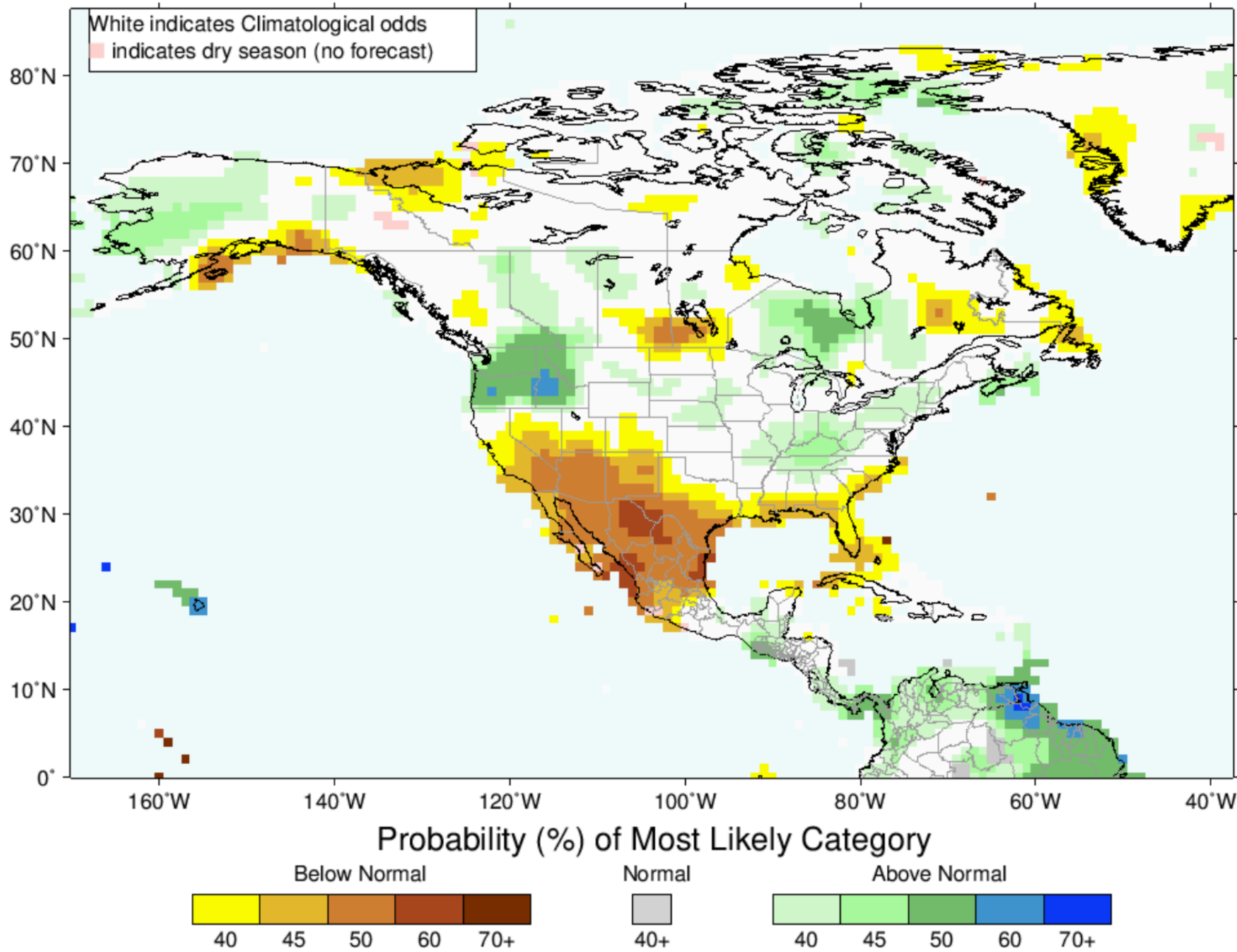
Predictand : [CPC-CMAP-URD 1x1](#), MOS: [Extended Logistic regression](#), Predictor : [NMME models precipitation](#)

Training period : [1991-2020](#)

IRI Multi-Model Probability Forecast for Precipitation for November–December–January 2022, Issued October 2021



IRI Multi-Model Probability Forecast for Precipitation for January–February–March 2022, Issued October 2021



Forecasts favor Below Normal tercile precipitation over Southwestern US: with 50-60% confidence

Dry forecast-tendencies extend further north over California as compared to NDJ season .

Nov-Mar Season Rainfall and Temperature Forecast : 2021-22

5-months season, Using IRI System

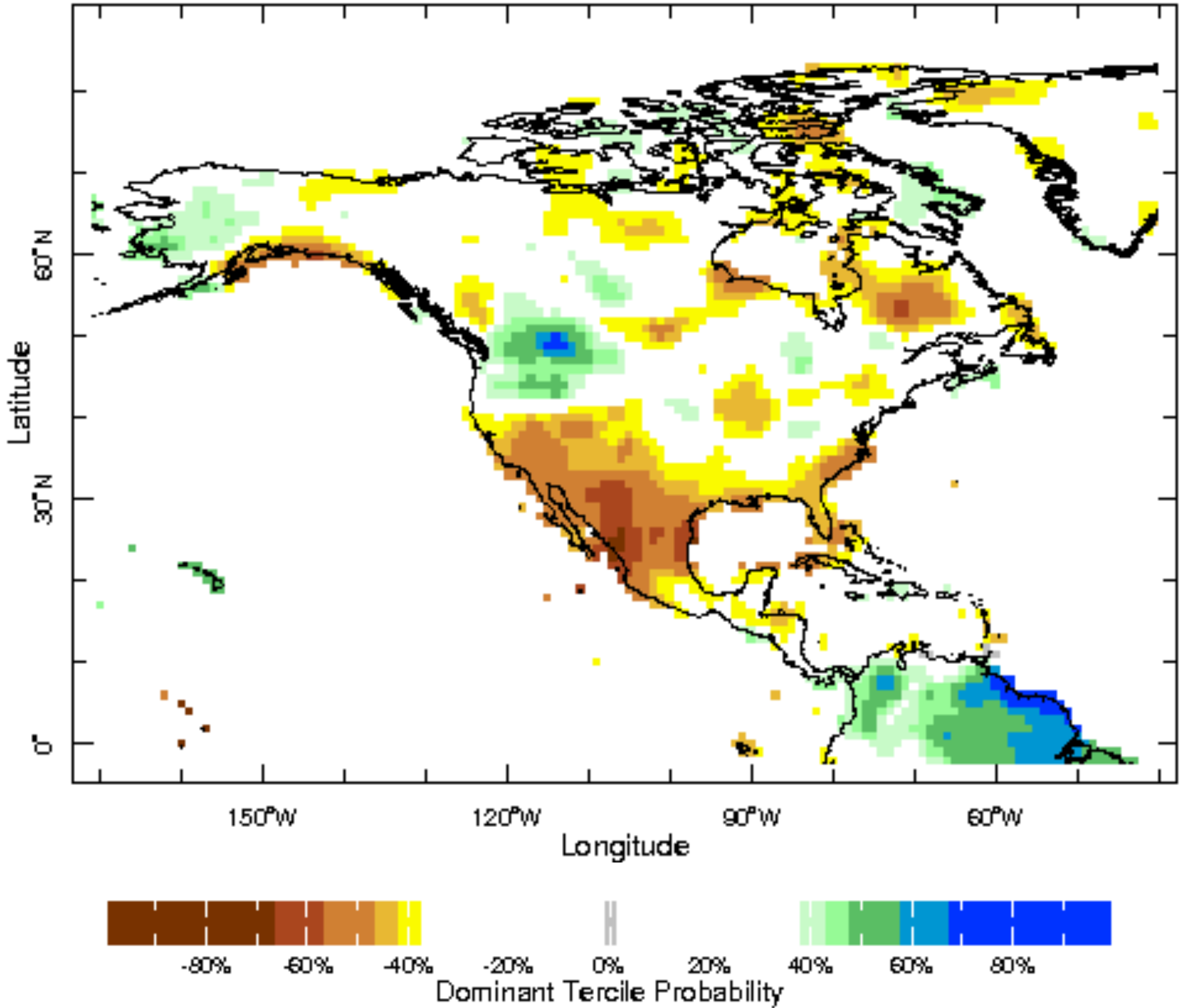
Models (NMME) : CanSIPS-IC3, NCEP-CFSv2, COLA-RSMAS-CCSM4 and GFDL-SPEAR

Predictand : CPC-CMAP-URD 1x1, MOS: Extended Logistic regression, Predictor : NMME models precipitation

Training period : 1991-2020

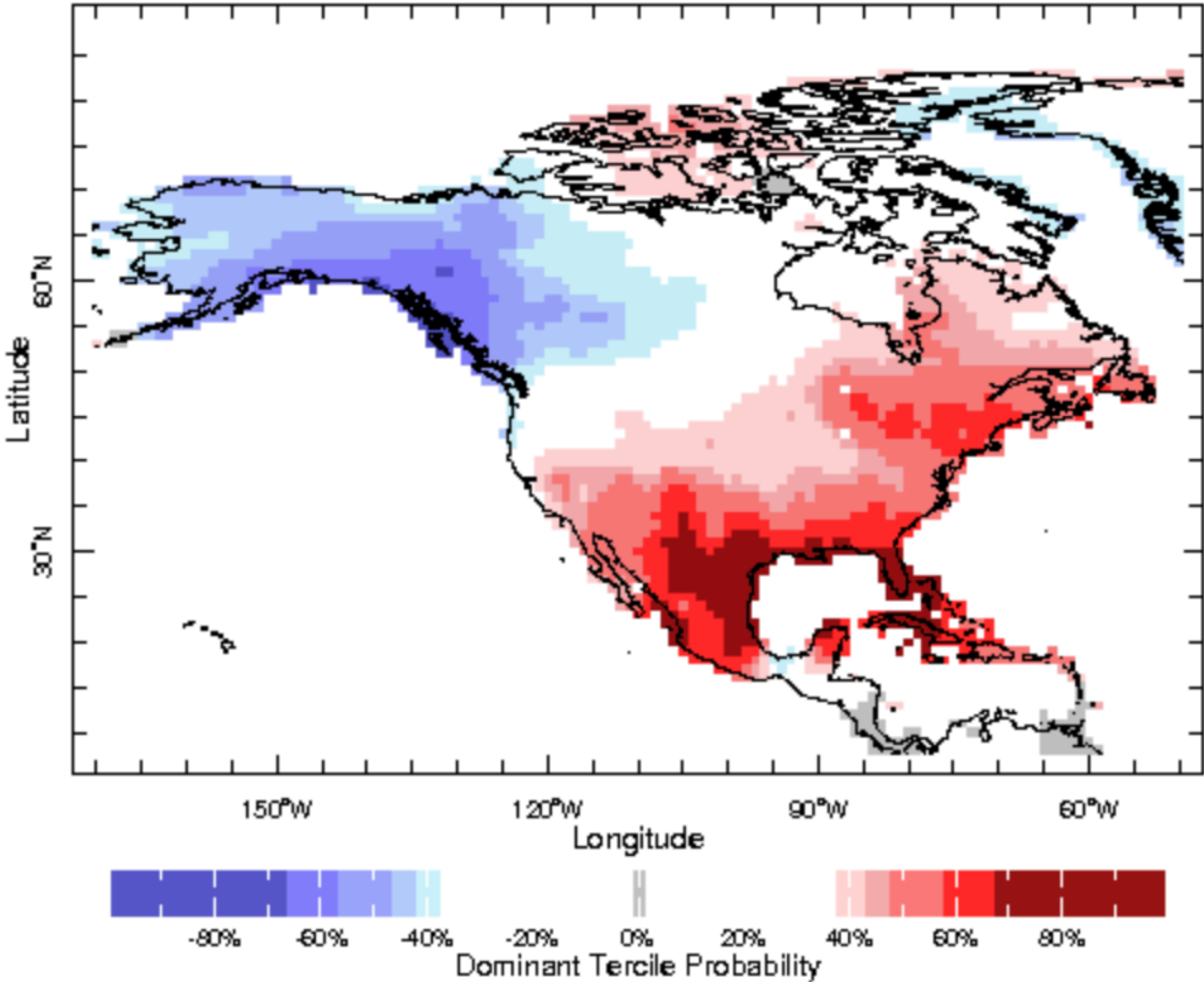
Precipitation:

Season : NDJFM, Initialization: October



Temperature:

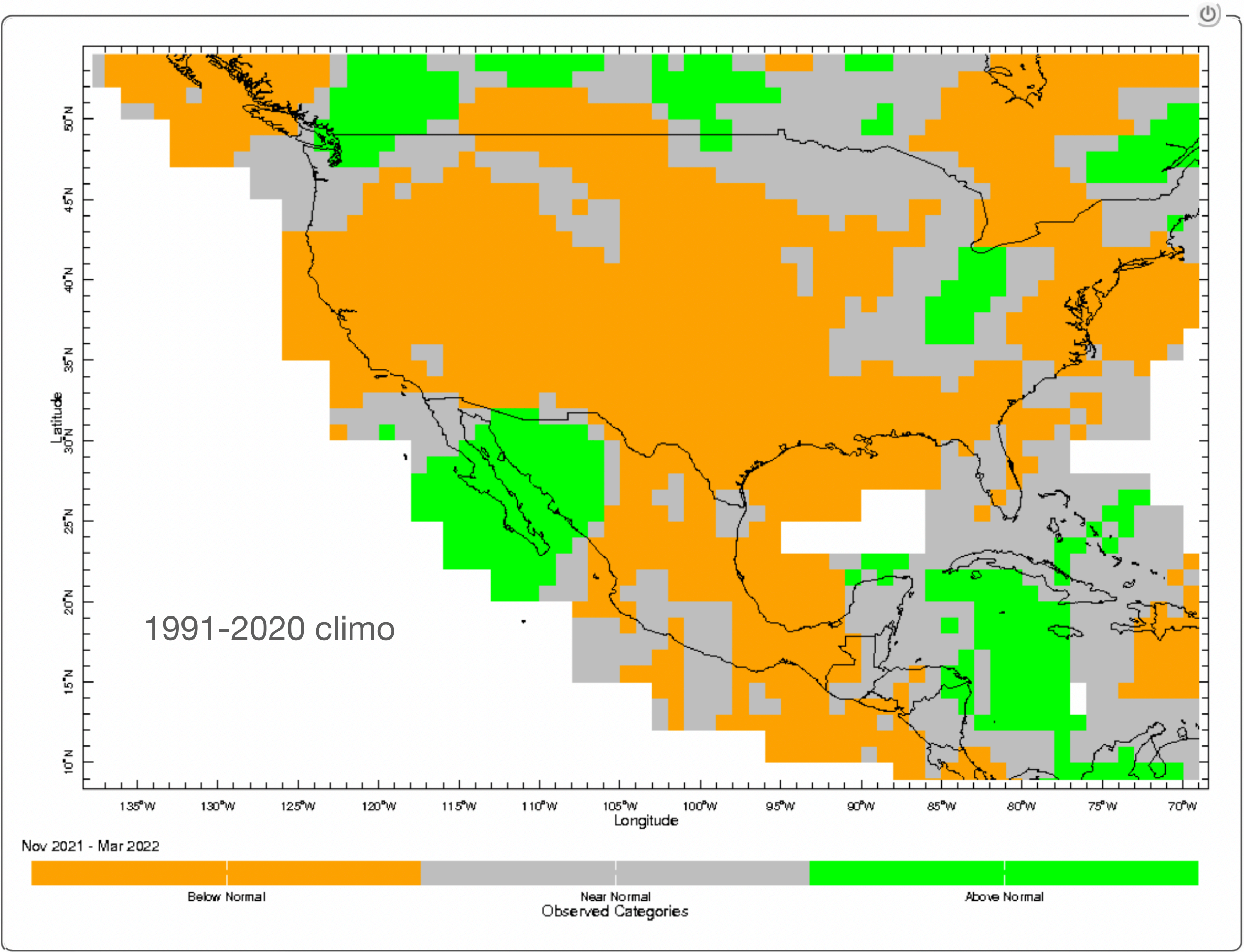
Season : NDJFM, Initialization: October



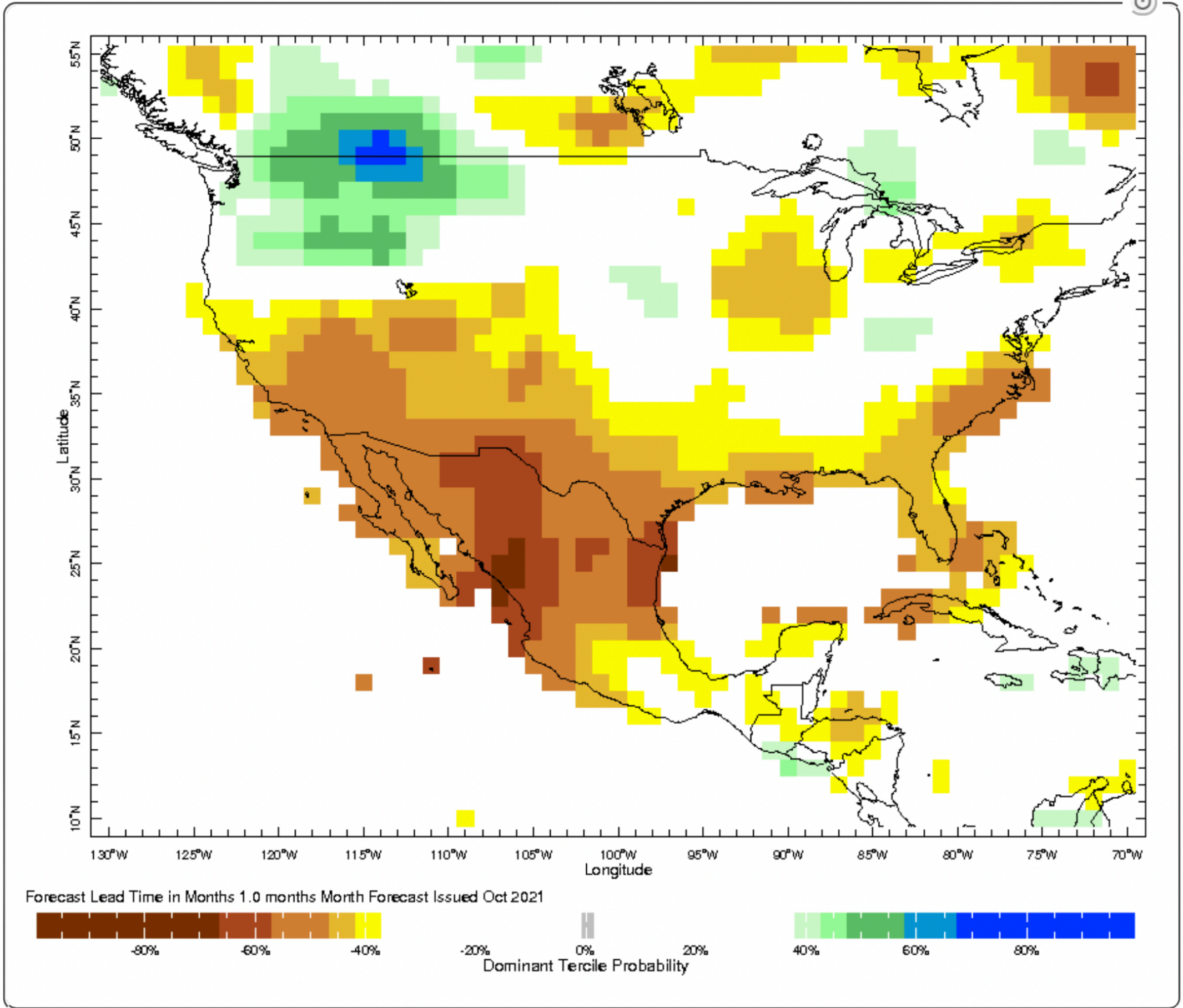
Similar to 3 month forecast; Dry southwest and wet northwest and Alaska are likely
Warm South-east and cold Alaska and western Canada

Nov-Mar Observed Category vs Forecast

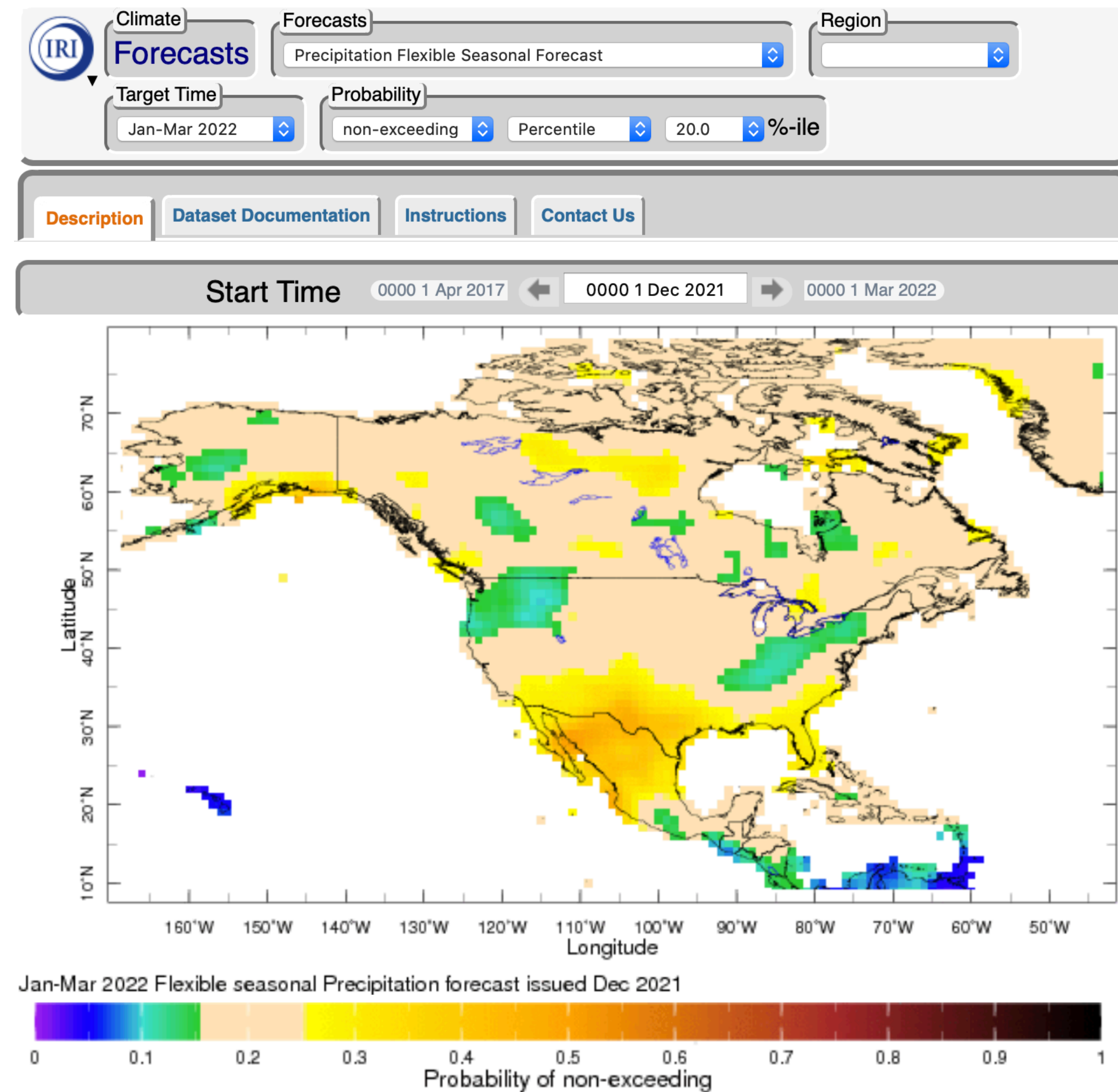
Precip Observed Category (CPC data)



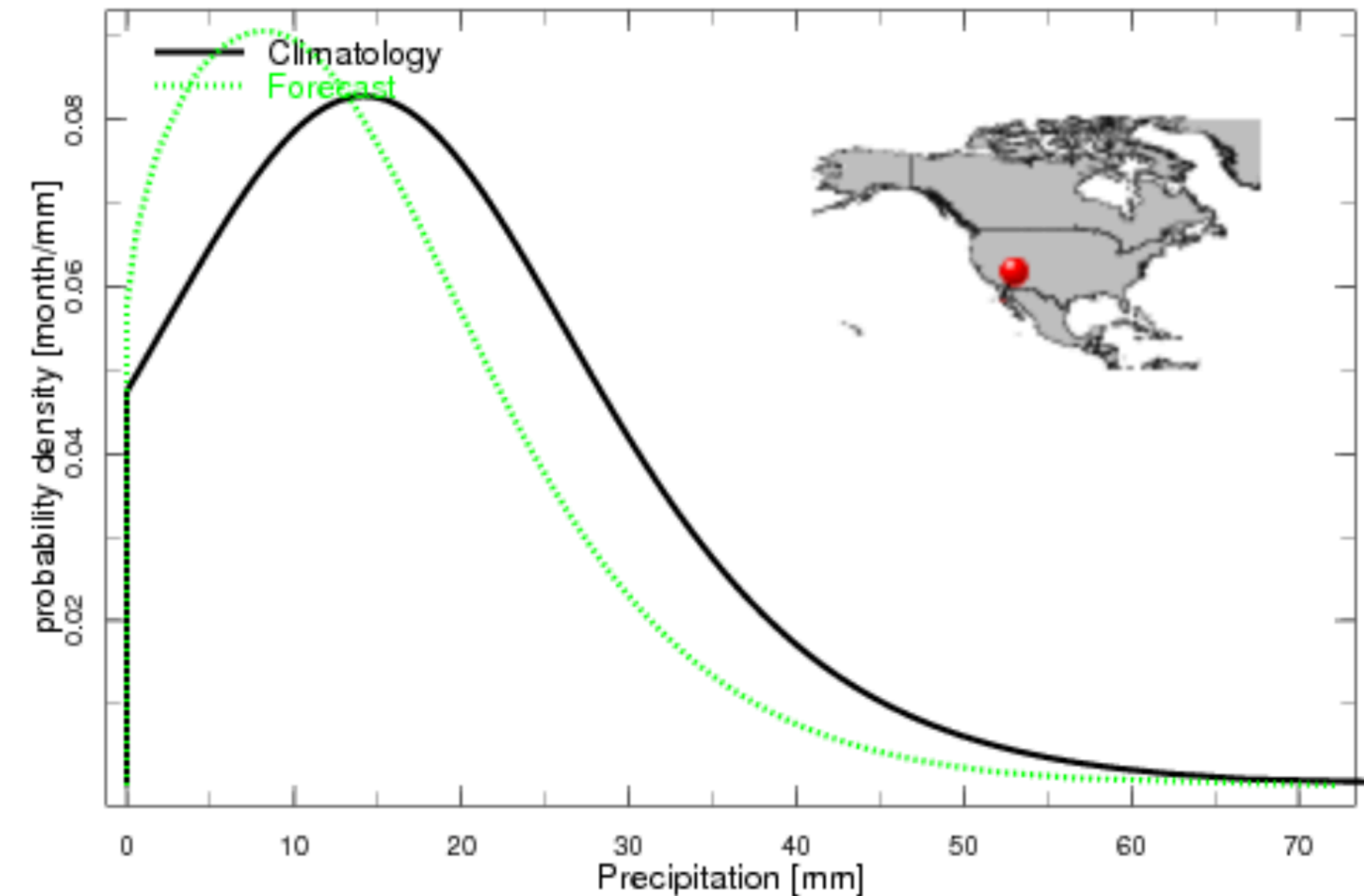
Precip Forecast issued in October



IRI Flexible Format Seasonal Forecasts



Probability Distribution



Jan-Mar 2022 Flexible seasonal Precipitation forecast issued Dec 2021

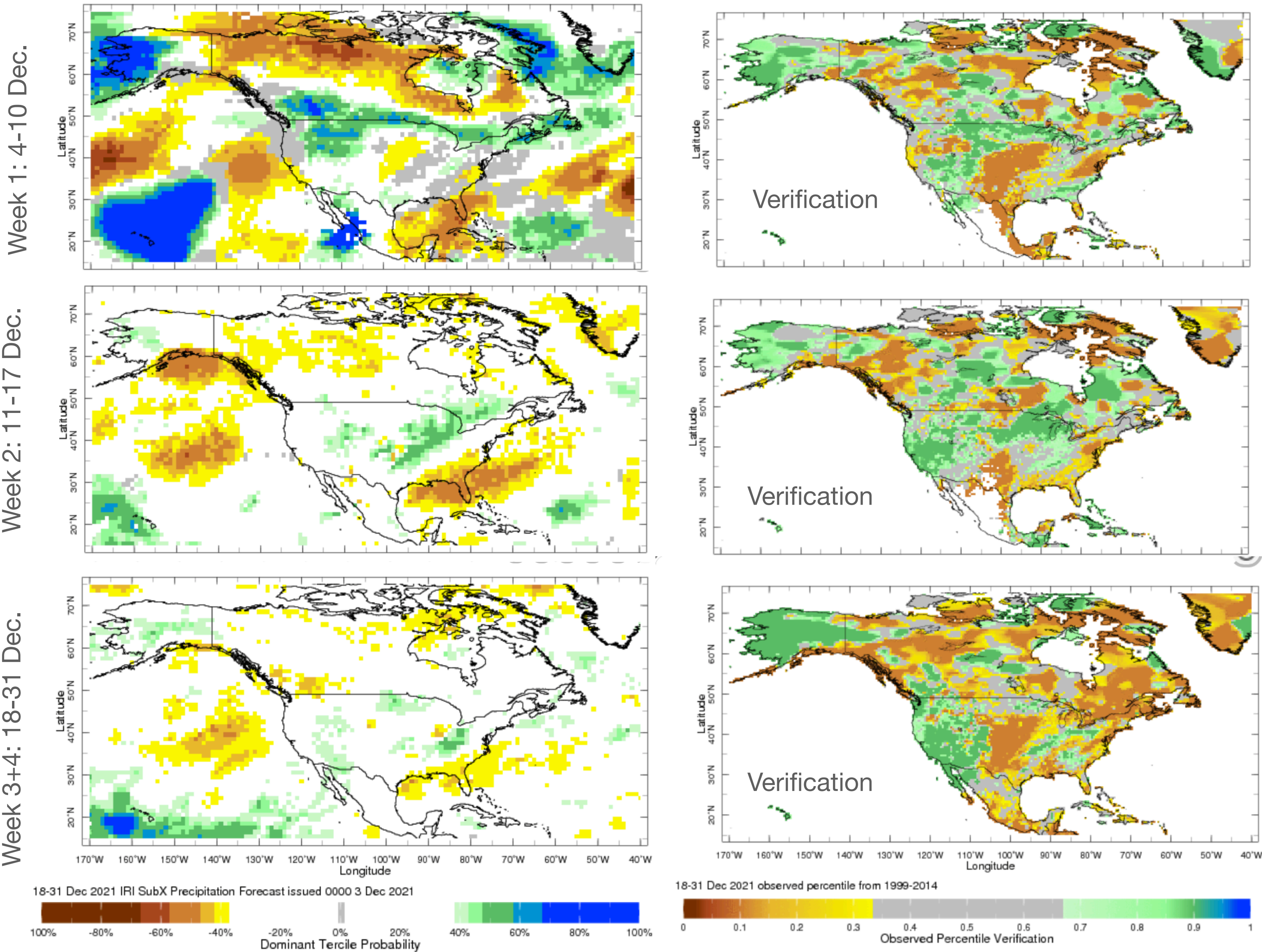
User-selectable thresholds: 20%-ile shown

IRI SubX-based Calibrated Sub-Seasonal Precip. Forecast

Models (SubX) : NCEP-CFSv2, NCEP GEFS, and NOAA/ESRL FIM HYCOM

Predictand : Global 1° CPC UNIFIED precipitation , MOS: Extended Logistic Regressions, Predictor : SubX model precipitation

Forecast issued : 3 Dec 2021



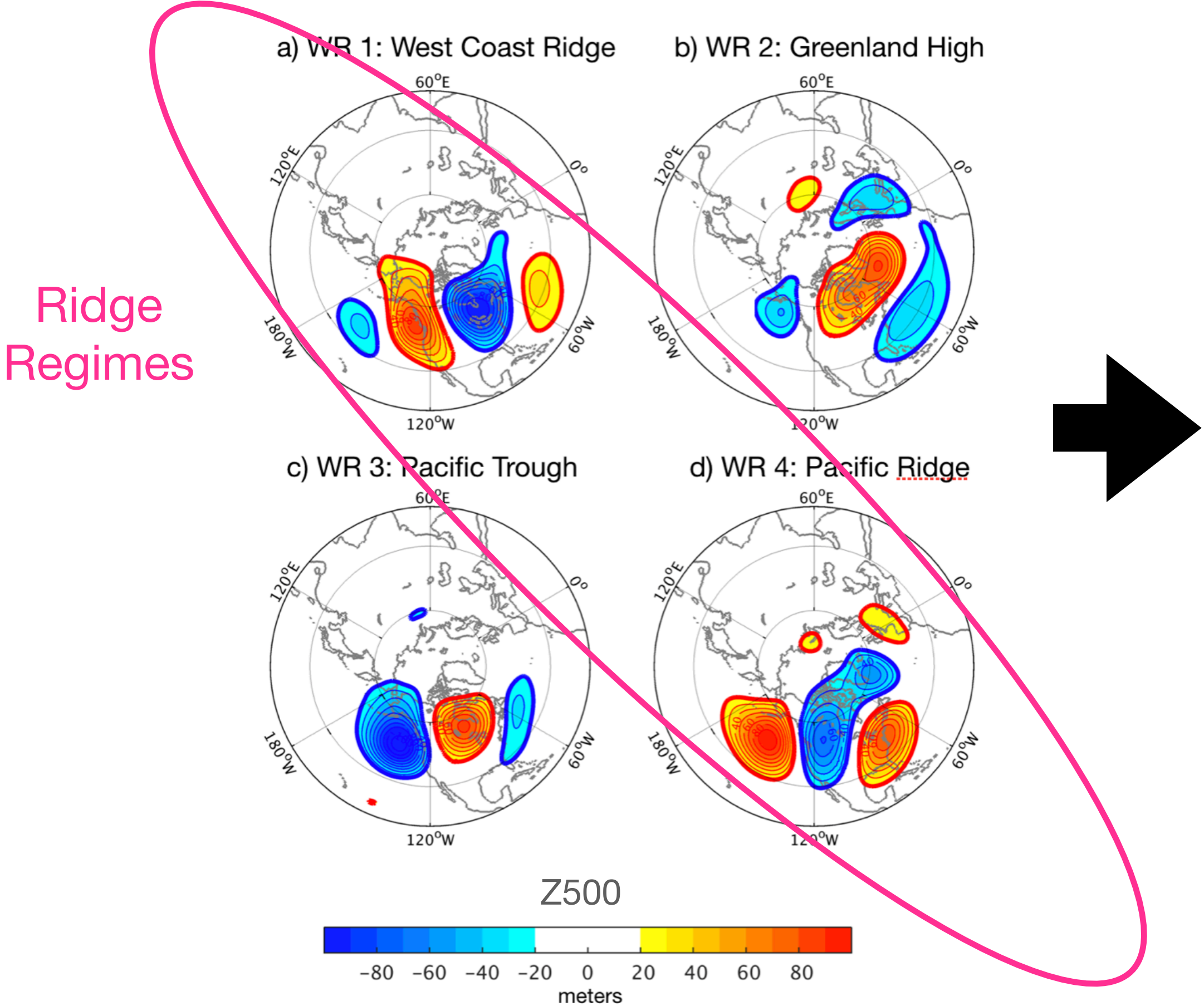
Forecast are issued weekly on every Friday

<http://iridl.ldeo.columbia.edu/maproom/Global/ForecastsS2S/index.html>

North American Daily Circulation Patterns

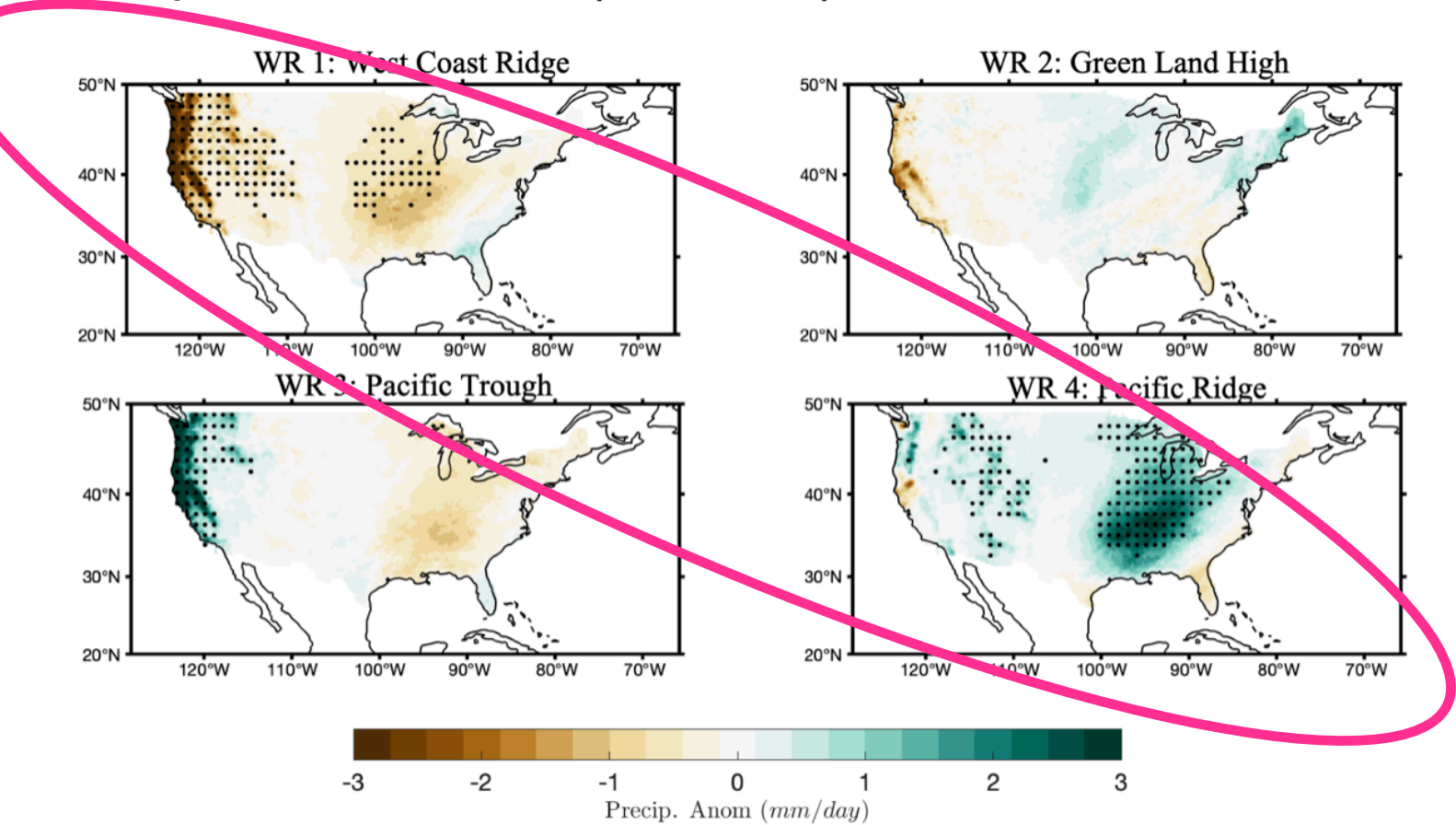
“Weather Regimes” = Summary description of variability in terms of 4 large-scale recurrent daily patterns

Mid-Tropospheric Pressure Anomaly Patterns

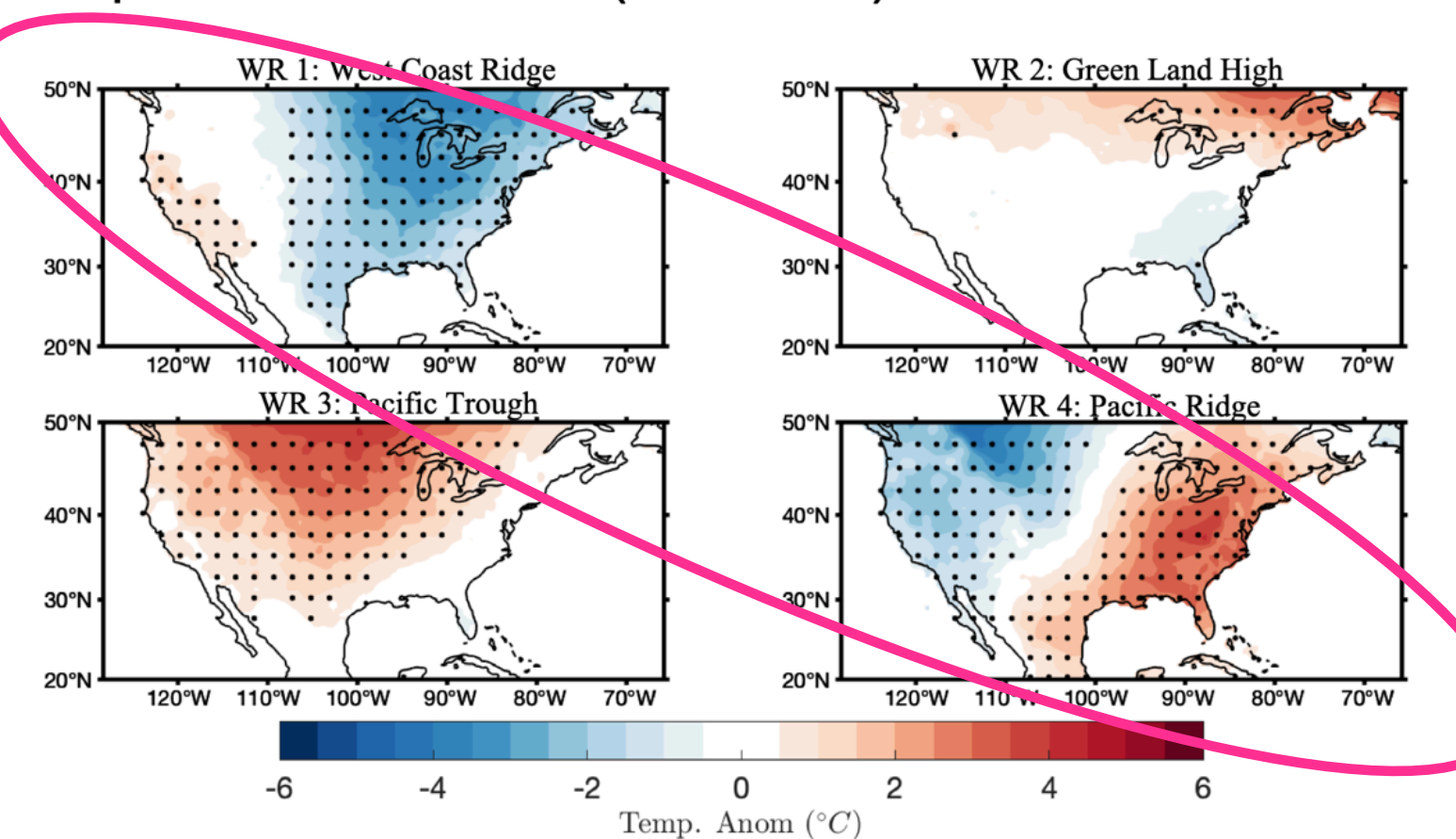


Surface Weather Expressions

Precipitation anomalies (CPC data)



Temperature anomalies (CPC data)

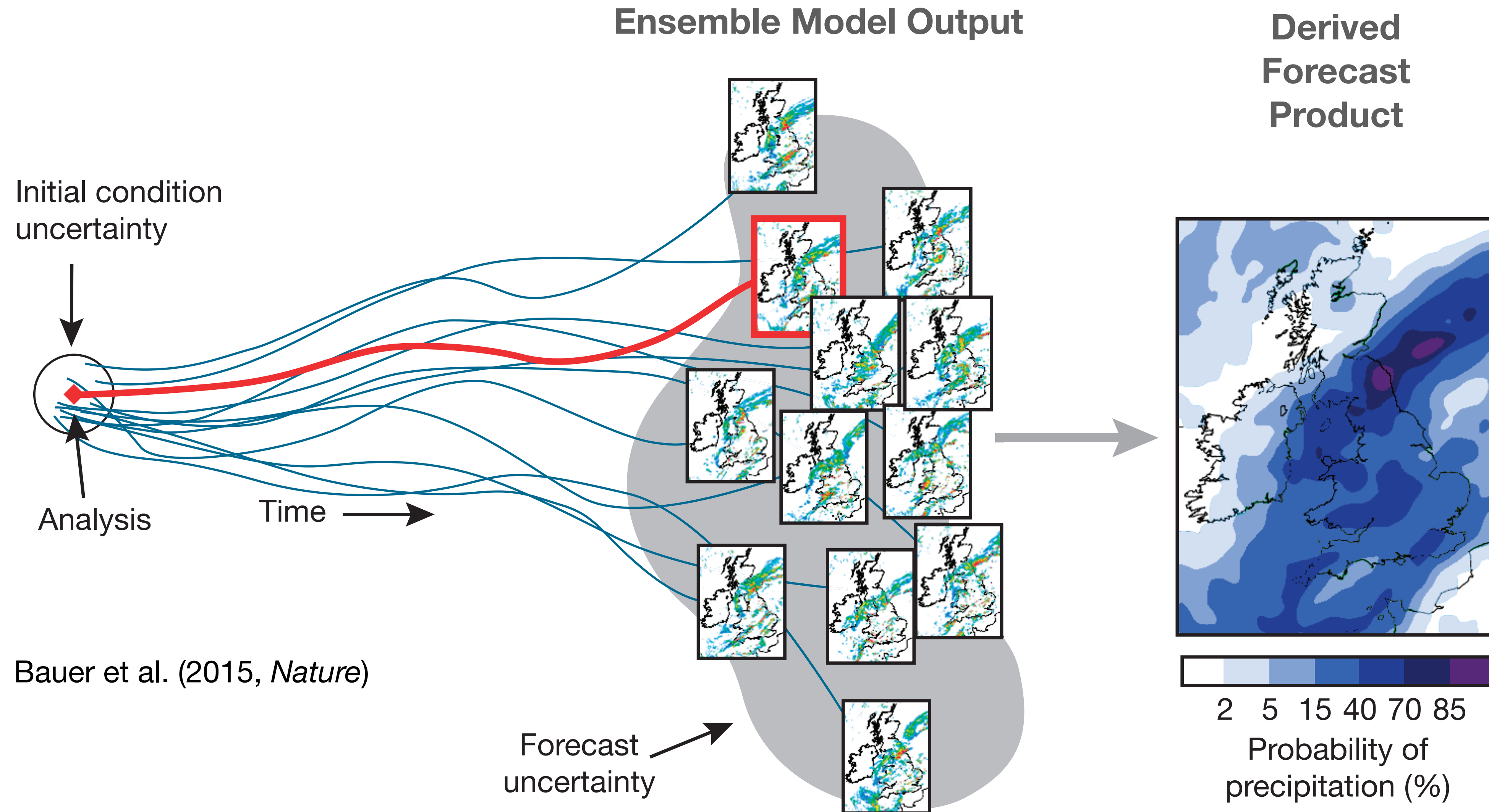


Stippling indicates statistical significance at the 95% confidence level.

K-means analysis
of Z500 daily
Oct-Mar fields
from MERRA
reanalysis data
[150E-40W,
10N-70N],
1982-2015

Anomalies from the
mean seasonal cycle,
filtered to retain larger
scales using 10
leading EOFs of 5-day
running averaged
data.

Dynamical Ensemble Prediction

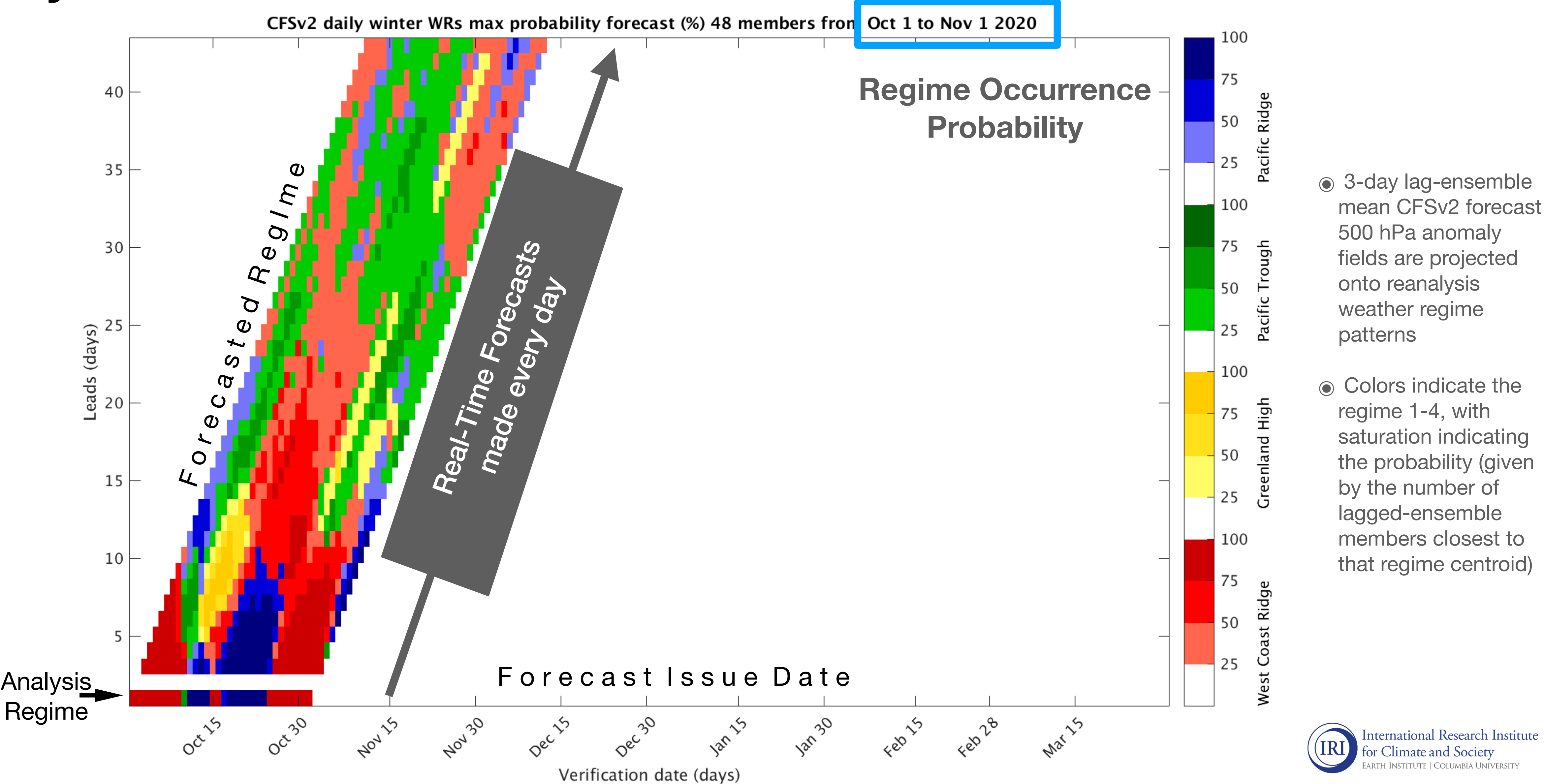


Bauer et al. (2015, *Nature*)

CFSv2 Forecasts of Weather Regimes

Days 1–45 ahead

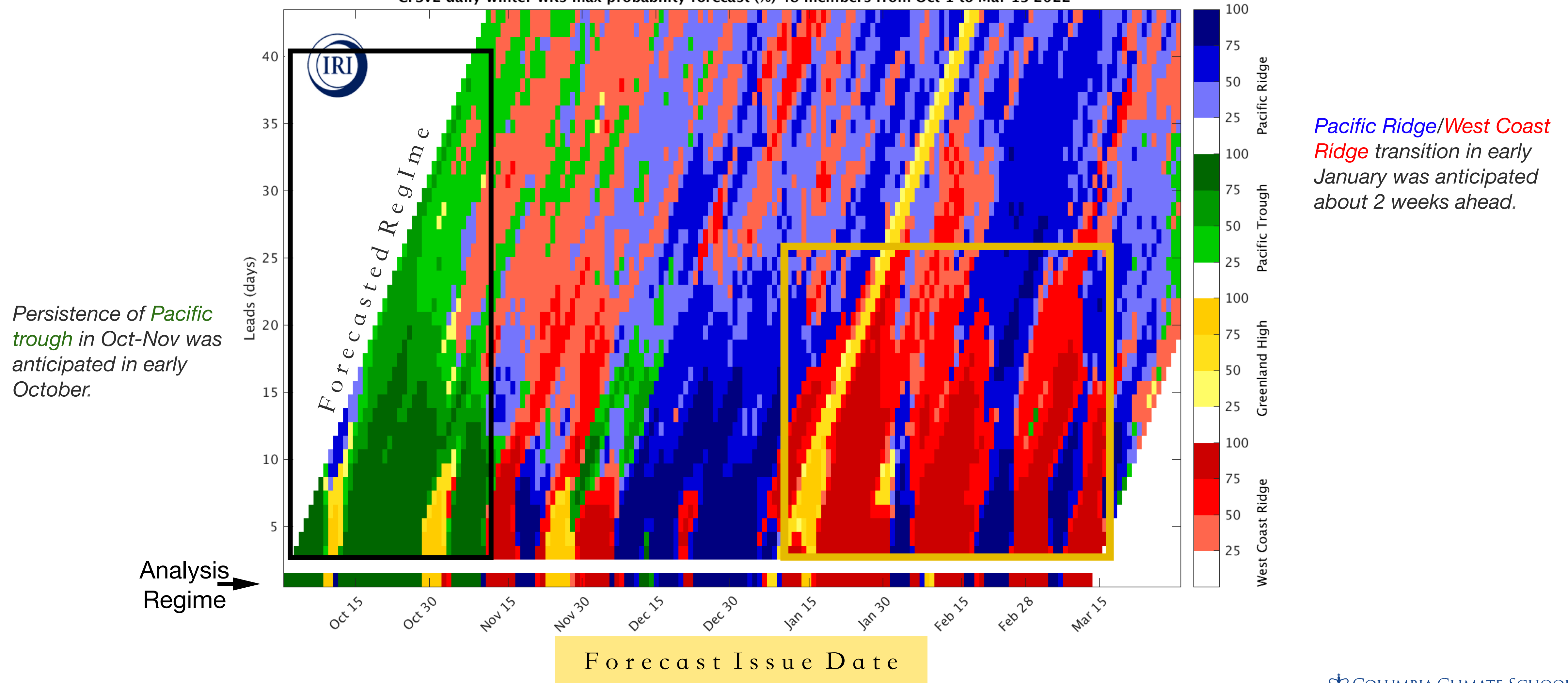
<http://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs>



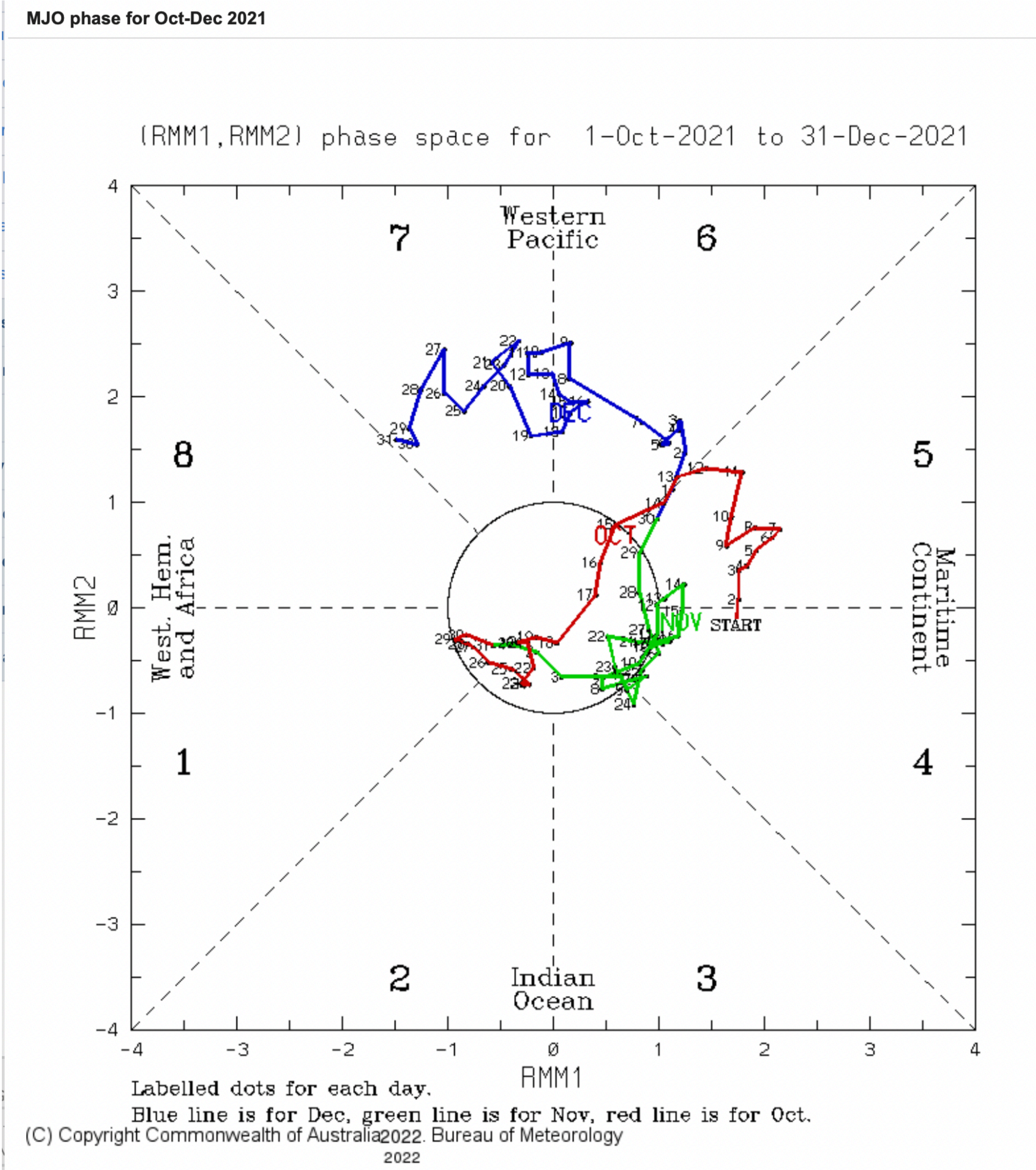
Day-by-Day Evolution of CFSv2 Forecasts: Year 2021-22

Days 1 – 45 ahead

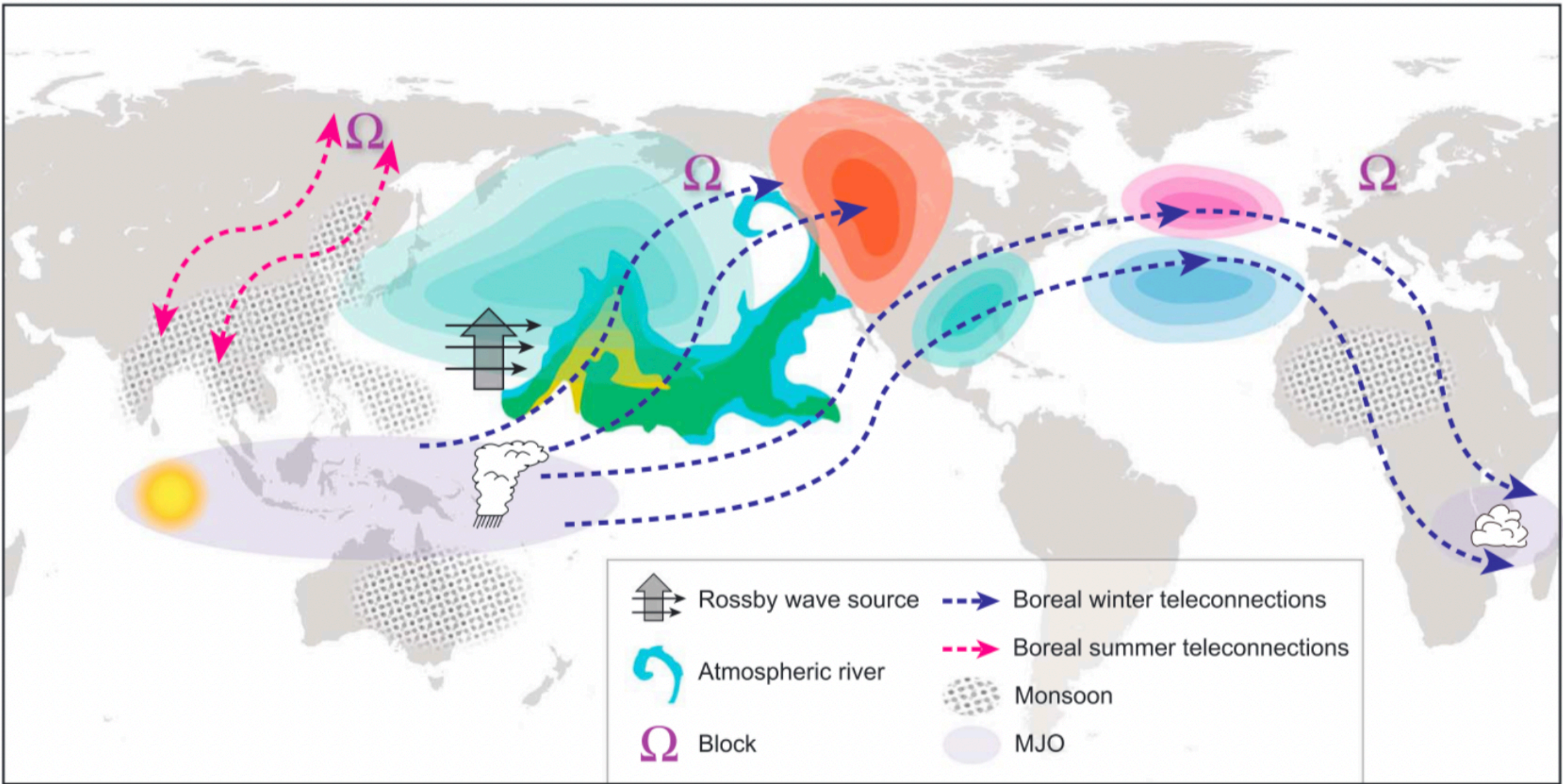
CFSv2 daily winter WRs max probability forecast (%) 48 members from Oct 1 to Mar 13 2022



MJO Evolution



This Phase 6-7 MJO east-west dipole in tropical convection is efficient at exciting the PNA pattern with the ridge (orange shading) situated over western N America ...



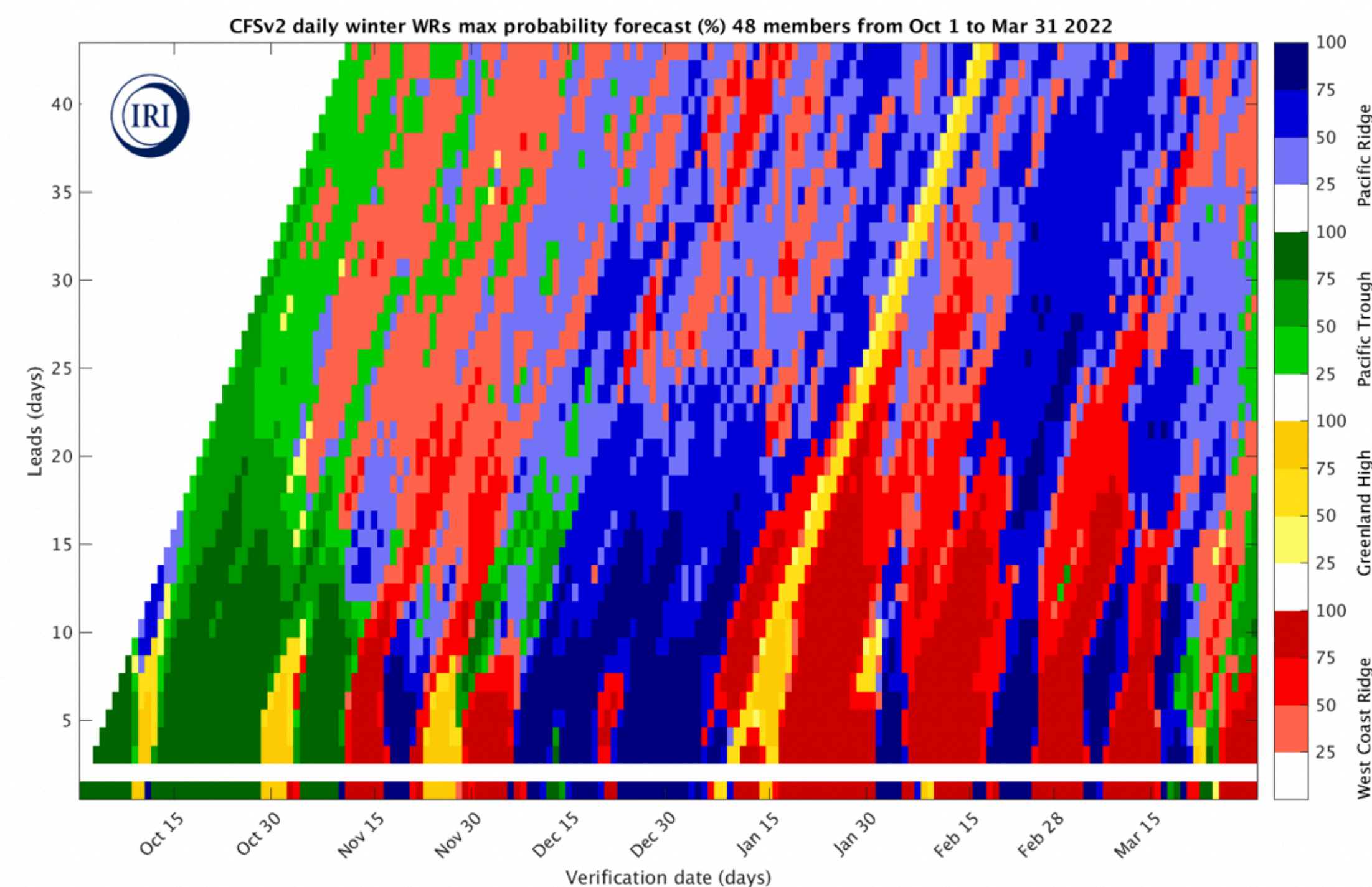
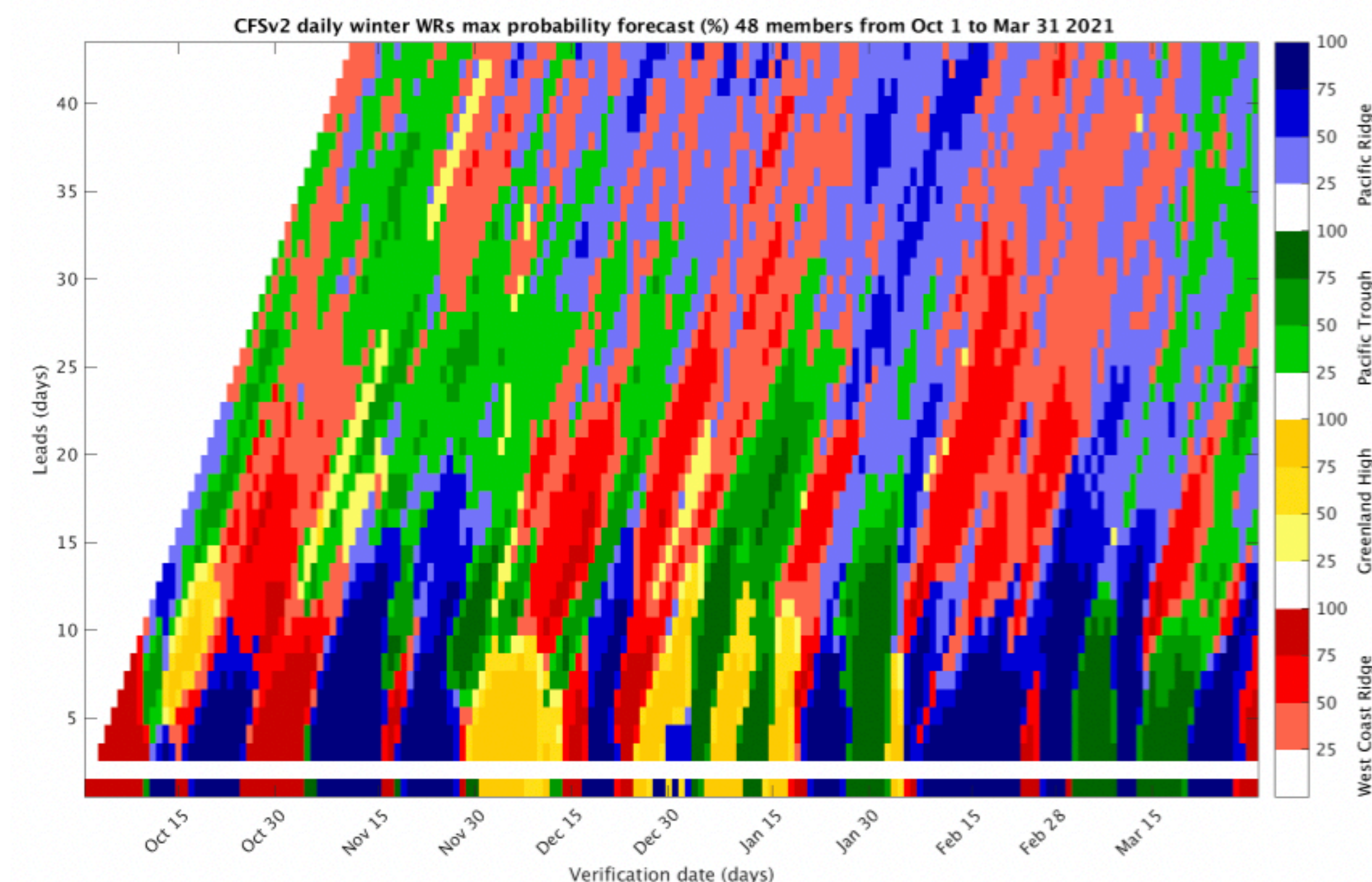
Stan et al. 2017: <https://doi.org/10.1002/2016RG000538>

... thus the transition from Pacific Ridge to West Coast Ridge in early January 2022 was like driven by the MJO

Comparison of past two winters

2020–21

2021–22



After a wet start, the Pacific Trough was shut out in 2021-22, which was dominated by ridging in both the observations and the forecasts. Winter 2020-21 was much more variable, and less predictable.

Seamless S2S Forecasts

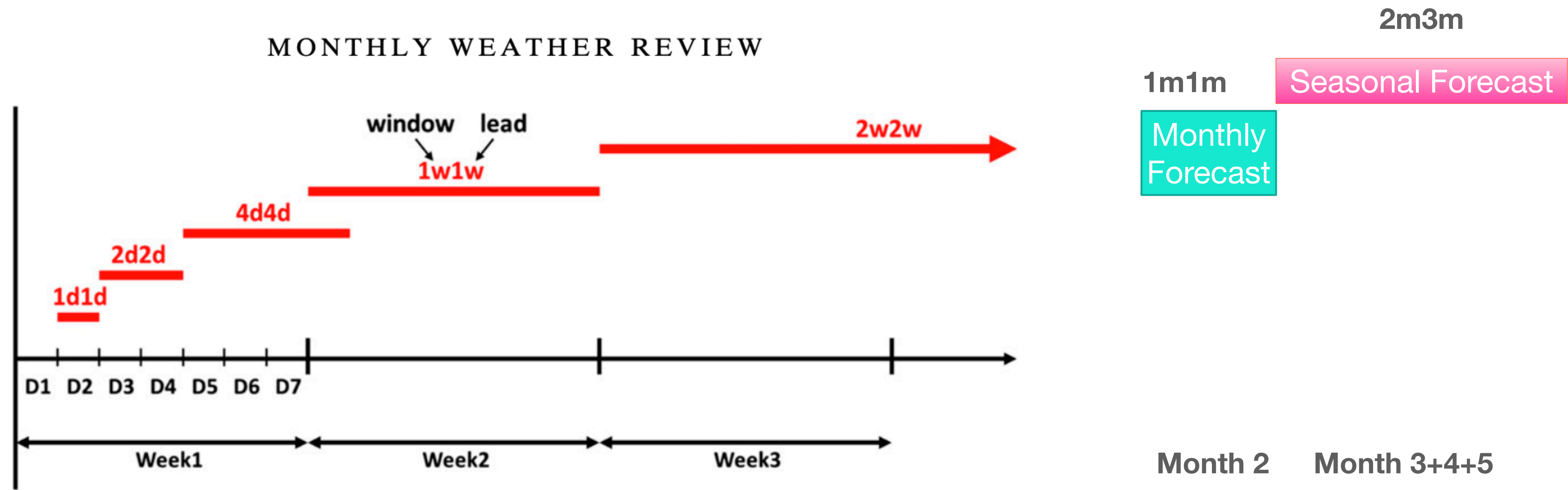
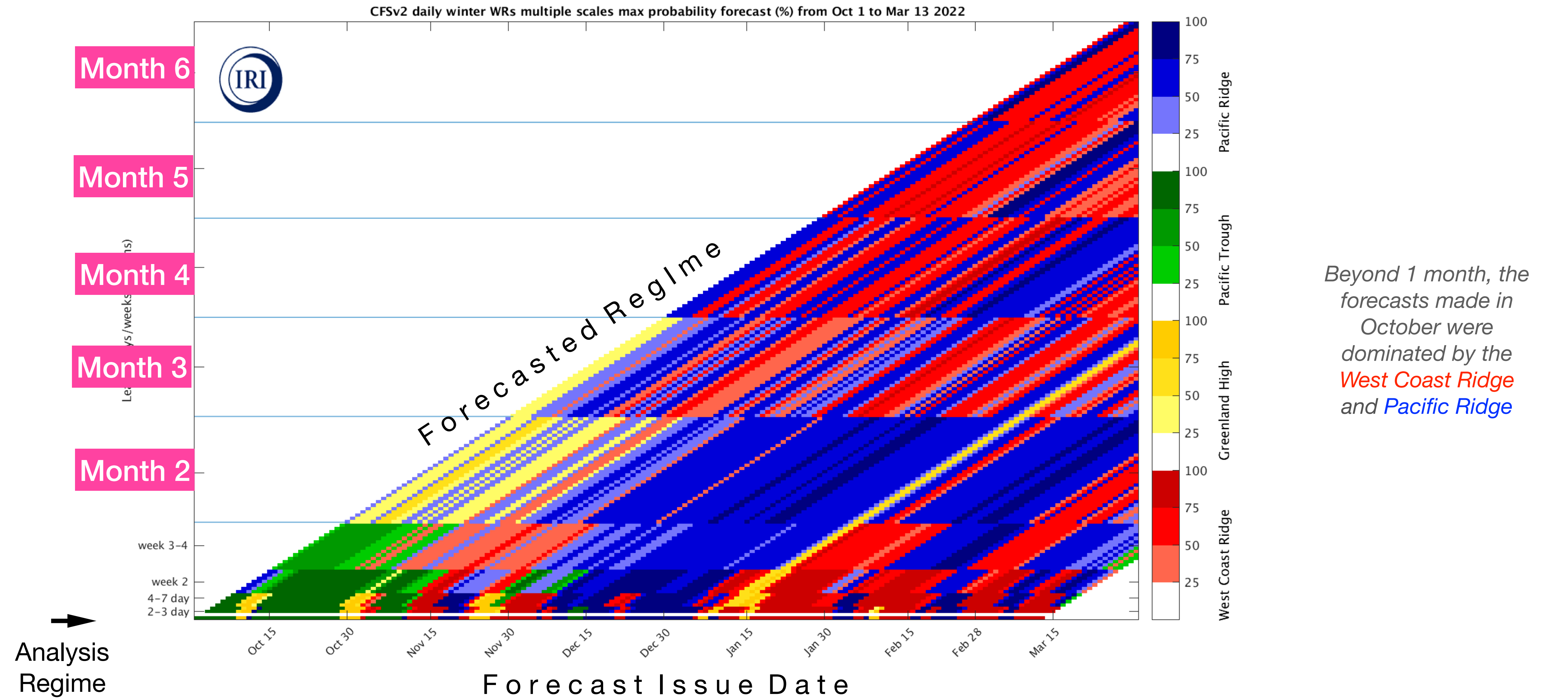


FIG. 1. Schematic of the time window and lead time definitions used in this analysis. The horizontal axis represents forecast time from the initial condition. The expression “1d1d” refers to an averaging window of 1 day at a lead time of 1 day. Similarly, “2d2d” represents an averaging window of 2 days at a lead time of 2 days, and so on. Note that 1d1d is what is usually called “day 2” in other papers, and 1w1w is what is usually called “week 2.”

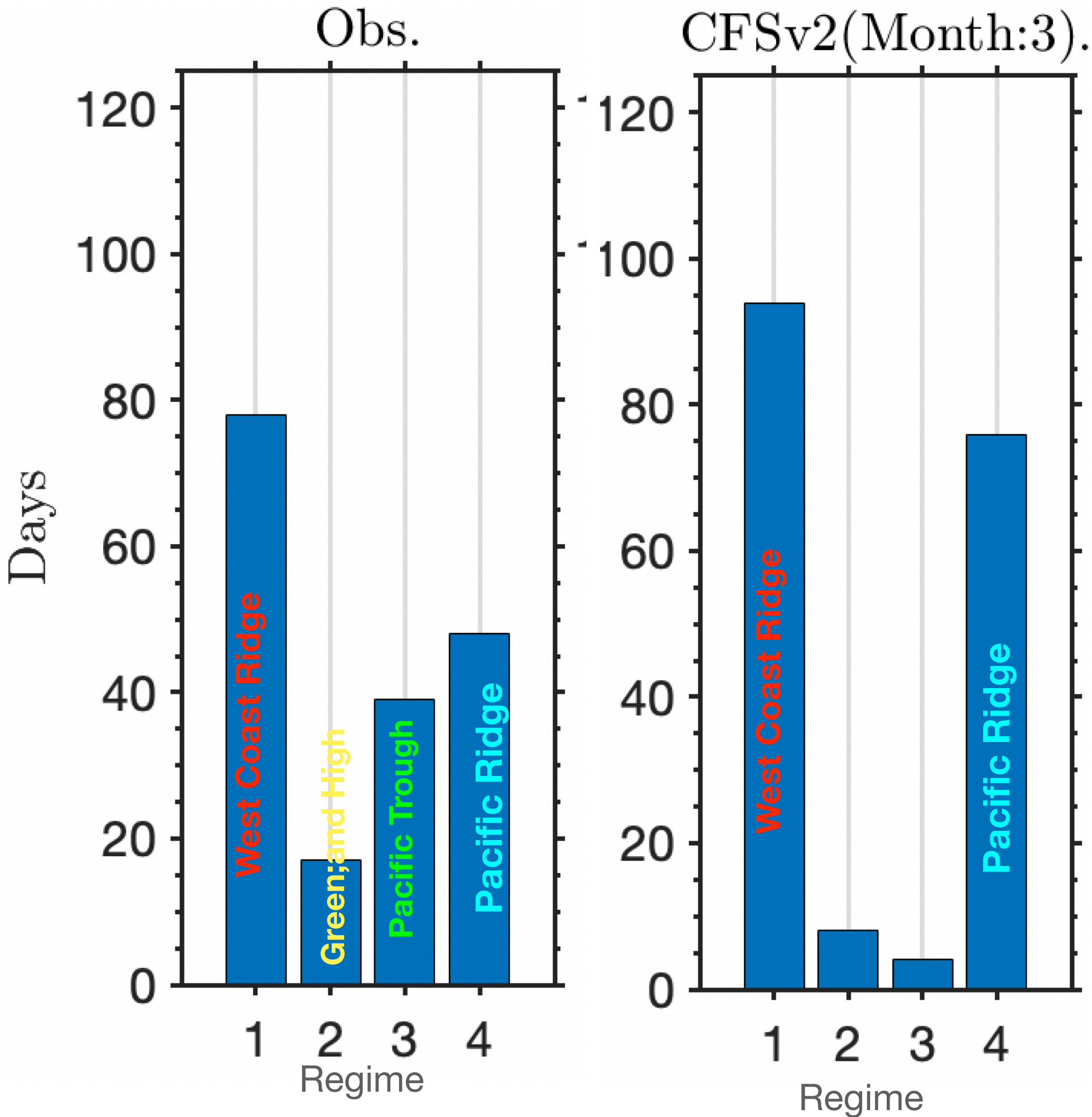
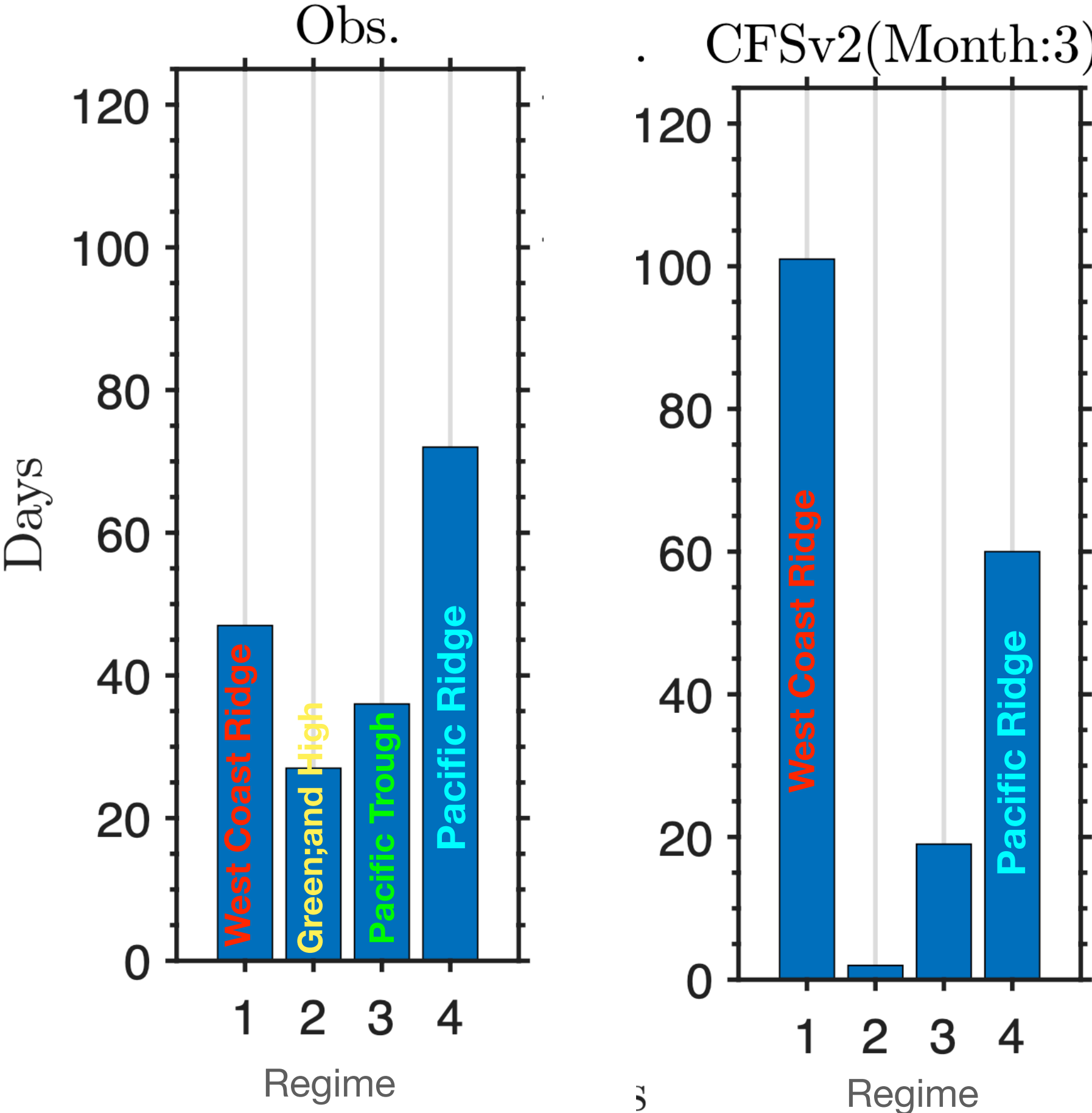
Seamless Evolution of CFSv2 Forecasts



Number of Regime Days Oct 1 – Mar 31: Observed vs Forecasted

2020–21

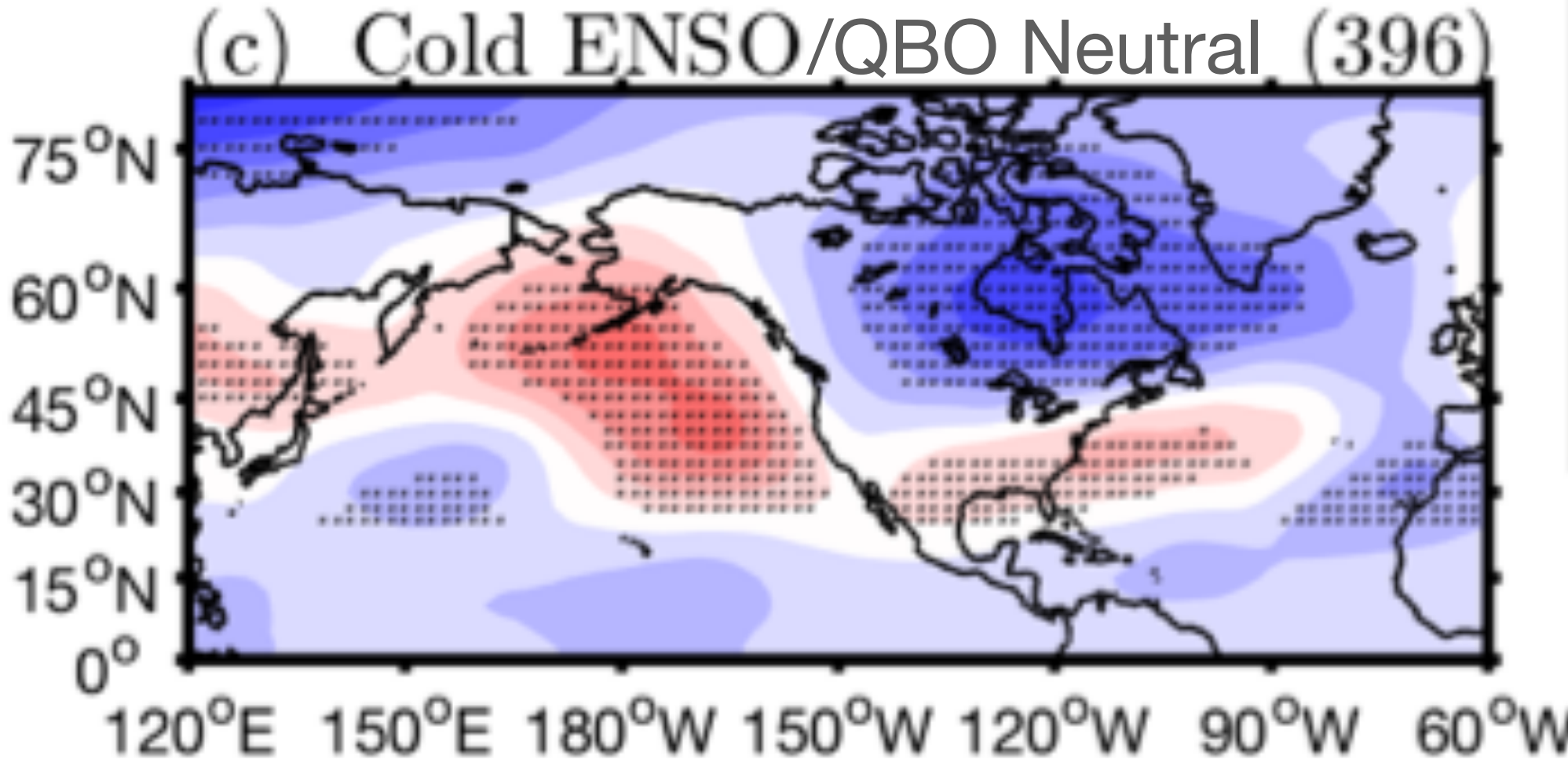
2021–22



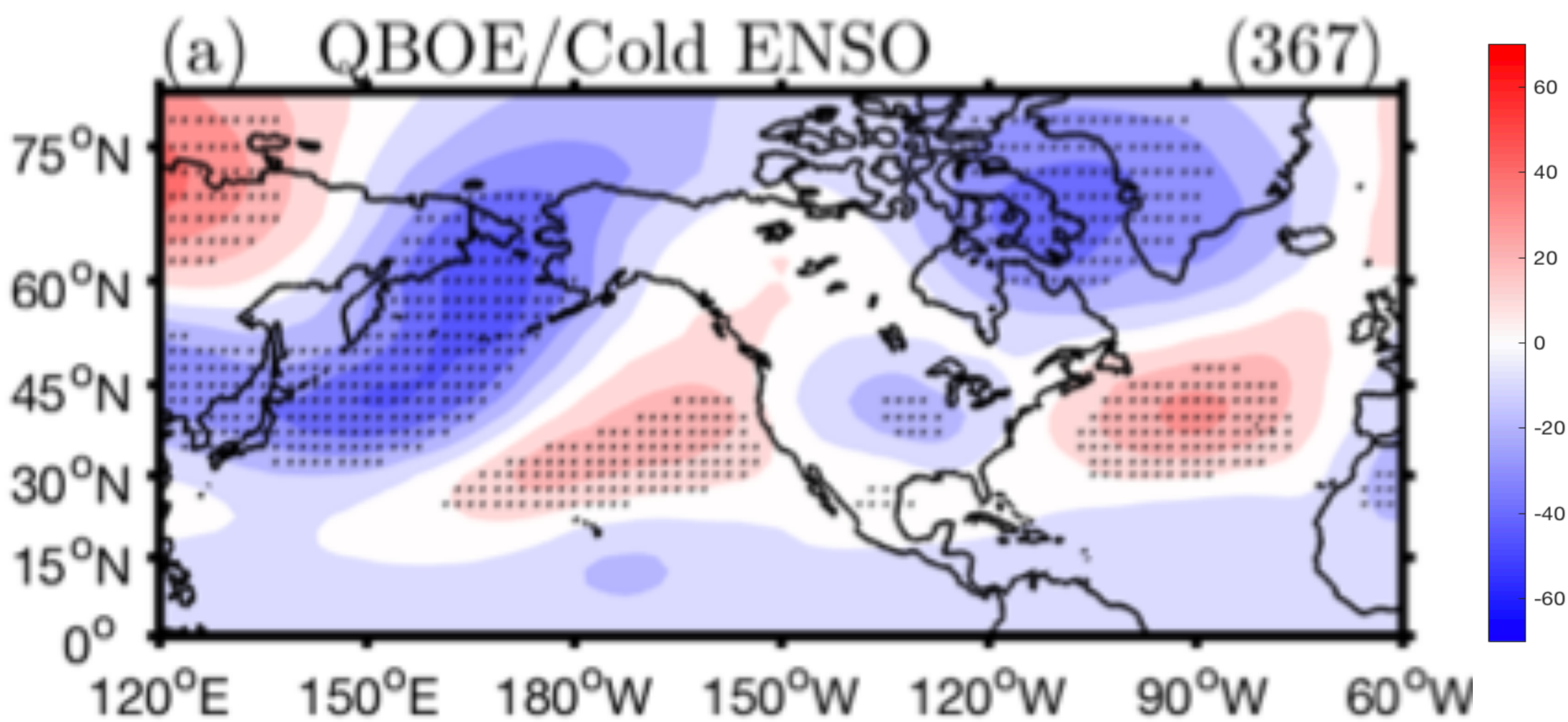
The prevalence of ridging was captured in both La Niña winters.

Climate Drivers

Geopotential height (500hPa) Composites for La Niña and Easterly QBO

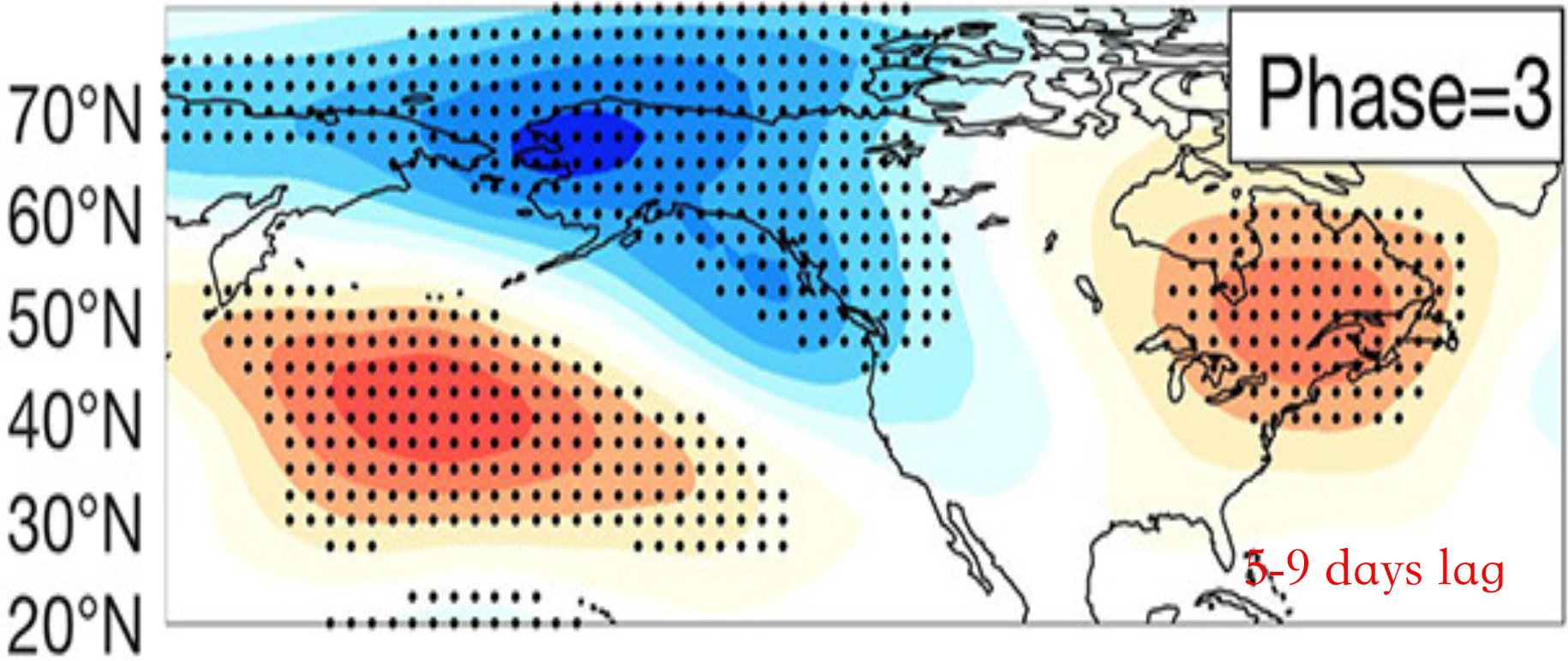


Pacific Ridge during La-Niña

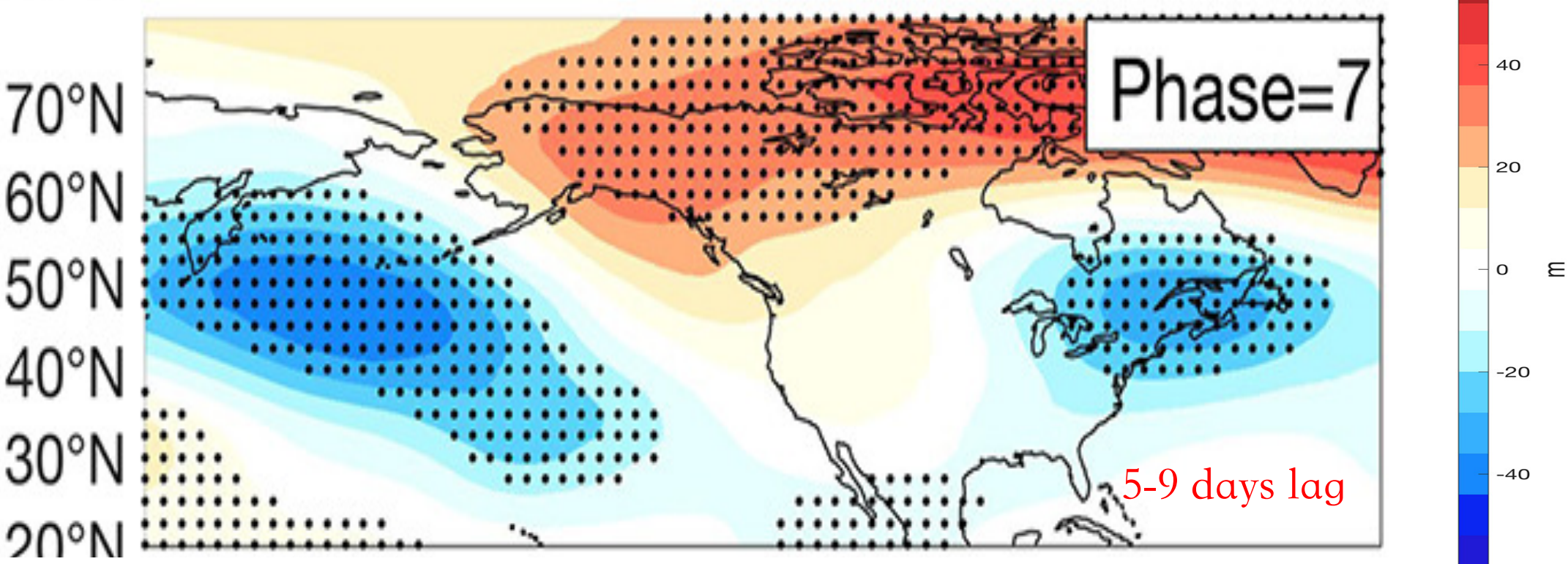


West Coast Ridge during La-Niña+QBOE

Midlatitude Response to Madden - Julian Oscillation Events on S2S Time Scales



Week after MJO active in phase 3 -> Pacific ridge



Week after MJO active in phase 7 -> west coast ridge

Height Anomaly (m); Dec-Mar; 95% significance; daily samples 1979-2017

Tseng et al., 2017

Summary

- The IRI ENSO outlooks and NMME-based precipitation forecasts for the November-March period, issued in October 2021, were broadly correct.
 - They correctly predicted La Niña and below-normal precipitation over the Southwest and California with high confidence.
- The weather regime tool based on CFSv2 seamless forecasts from 1 day to 6 months in advance, was issued every day Oct 1 – Mar 31.
 - The regimes provide temporal context and continuous guidance on a daily basis, with opportunities for action based on seamless days —> months information
 - After a wet start, the Pacific Trough was shut out in 2021-22, which was dominated by ridging in both the observations and the forecasts.
 - Transition to West Coast Ridge in early January 2022 can be attributed to a strong MJO event in December
 - The previous winter 2020-21 was much more variable, and less predictable.