NWS Weather Prediction Center (CPC)
Review of Extended and Seasonal Winter Outlooks
and
Experimental Regime Prognostic Tool (Subseasonal)

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NWS Federal Contributors:
Hui Wang, Arun Kumar (former federal), Mingyue Chen, and Cory Baggett (former federal)

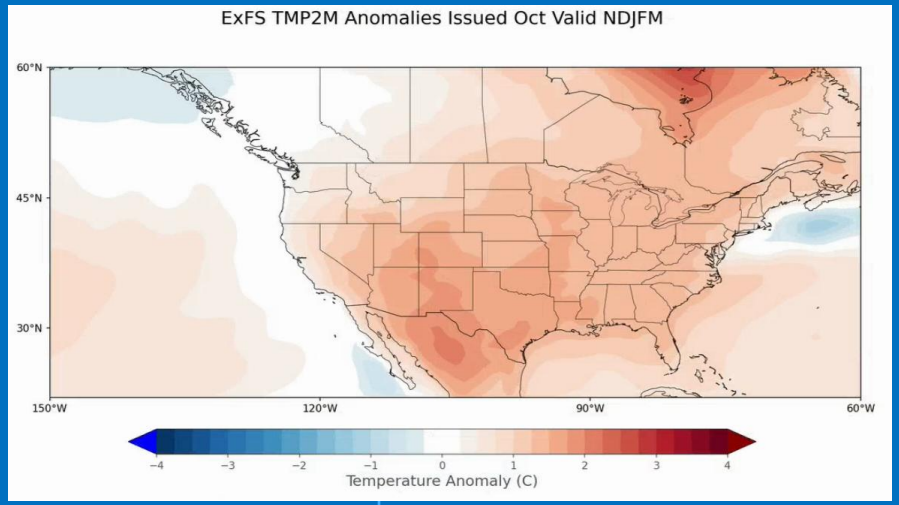
Review of Extended Winter Outlook (Experimental)

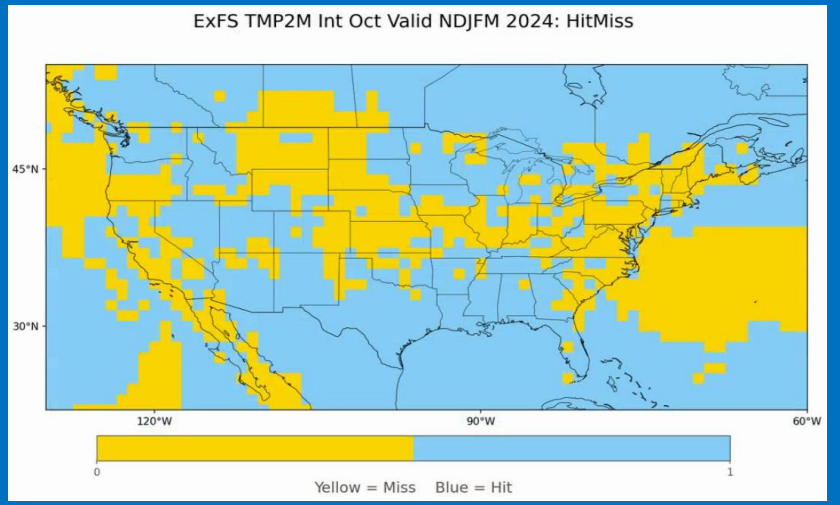
Anomaly Forecasts

- **ExFS (w/o CFSv2)**
- **Hui's Switanek-esque Tool**

Observed Anomalies

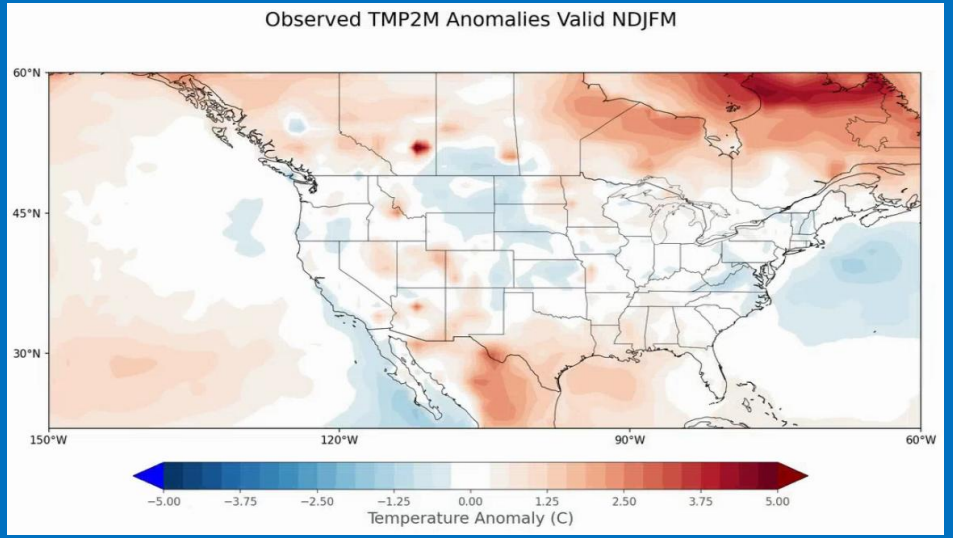
Hit Miss Verification

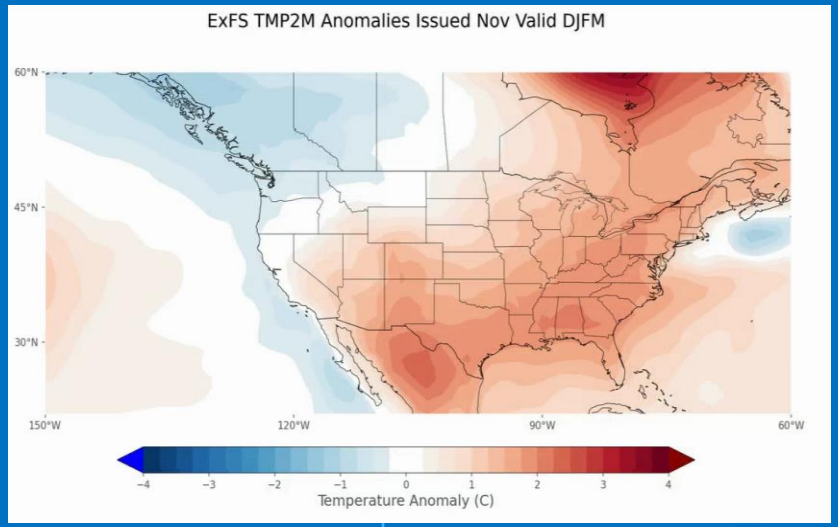


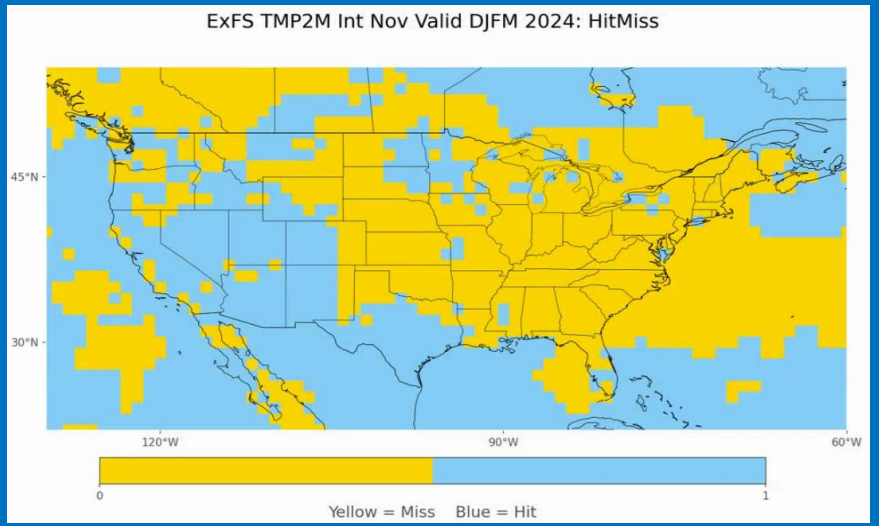


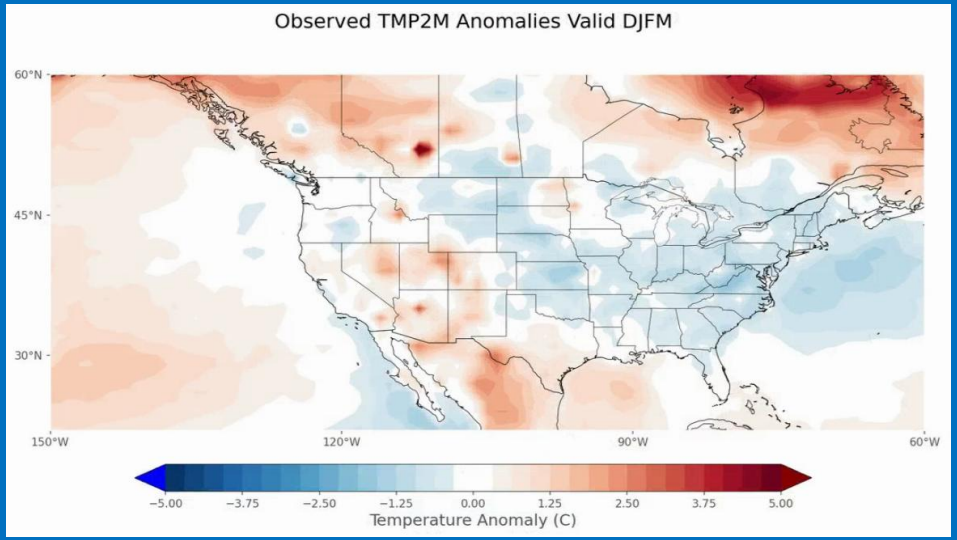
NB: 'ExFS' is an adaptation of the operational seasonal dynamical model suite, known as the North American Multi-Model Ensemble, or NMME

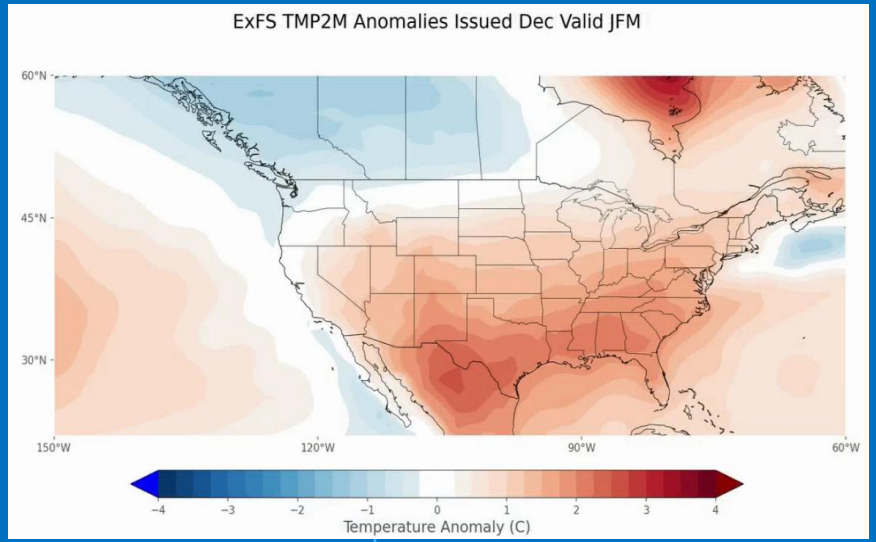
NMME suite of models (some updated July):
Two from Canada
Two from NCAR
1 from GFDL
1 from NASA
1 from NCEP

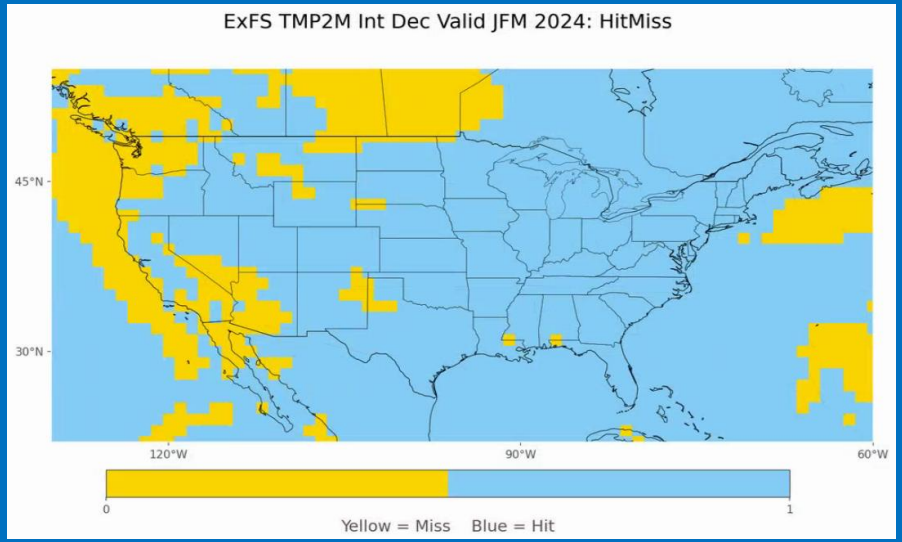



ExFS TMP2M Anomalies Issued Nov Valid DJFM
60°N
45°N
30°N
150°W
120°W
90°W
60°W
−4
−3
−2
−1
0
1
2
3
4
Temperature Anomaly (C)

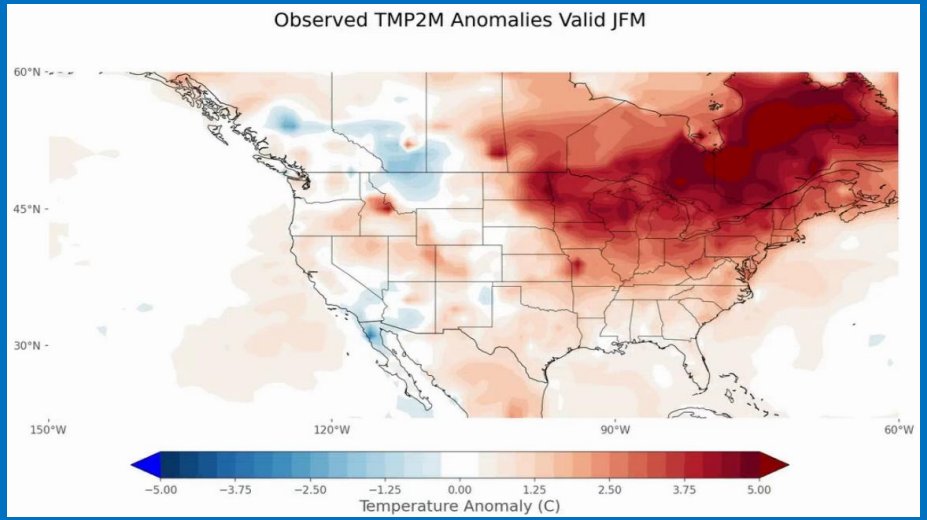

ExFS TMP2M Int Nov Valid DJFM 2024: HitMiss
45°N
30°N
120°W
90°W
60°W
0
1
Yellow = Miss
Blue = Hit

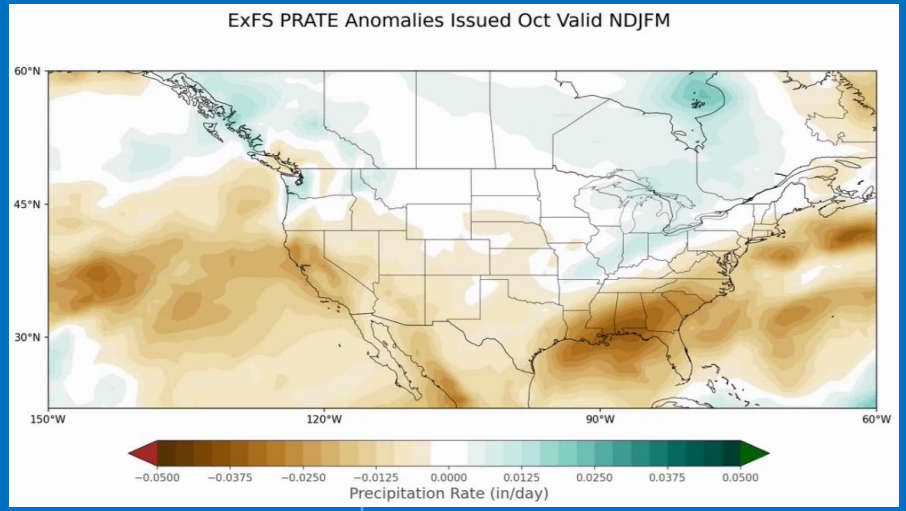

Observed TMP2M Anomalies Valid DJFM
60°N
45°N
30°N
150°W
120°W
90°W
60°W
−5.00
−3.75
−2.50
−1.25
0.00
1.25
2.50
3.75
5.00
Temperature Anomaly (C)

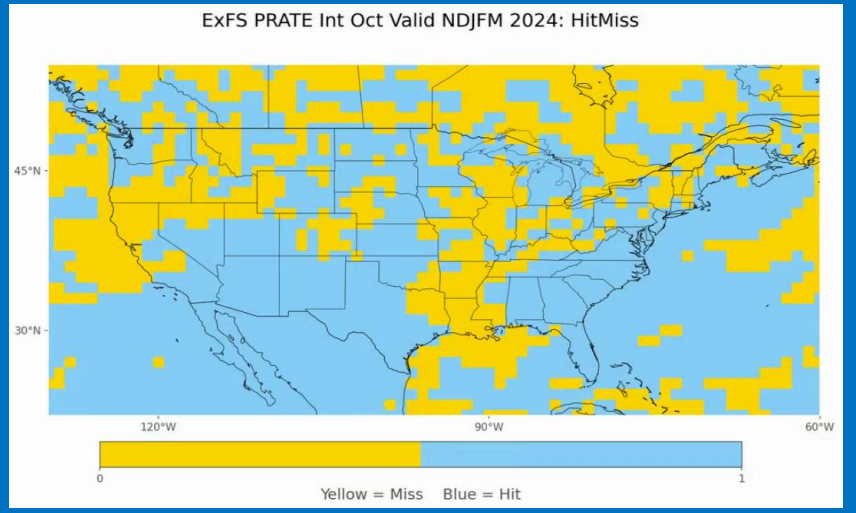


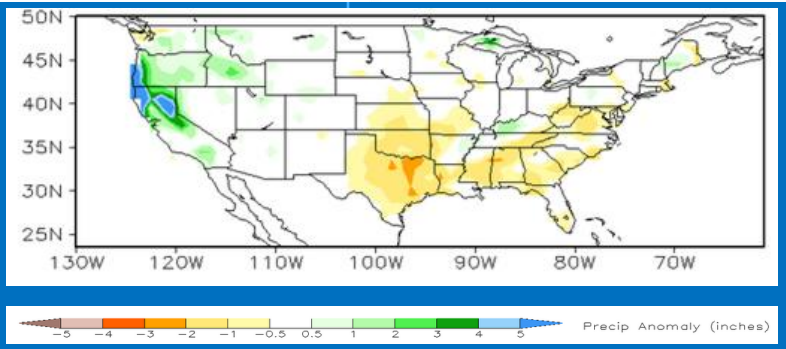


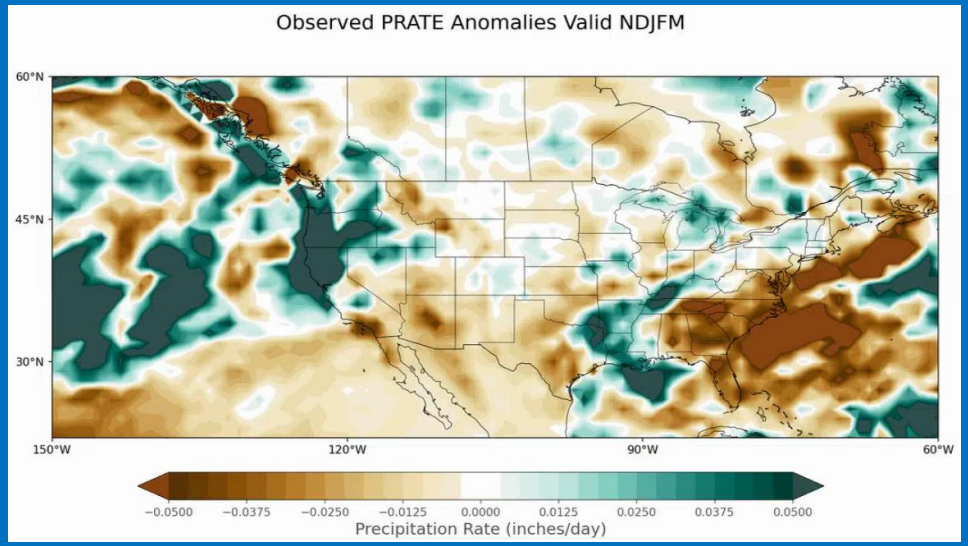
- 'Red dot' forecast
- Big flips should be attributed
- Could help with prognostics



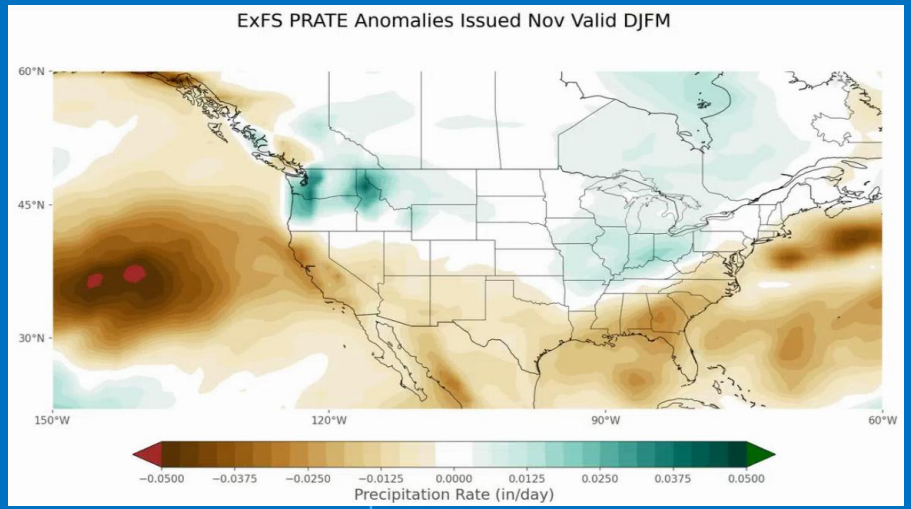


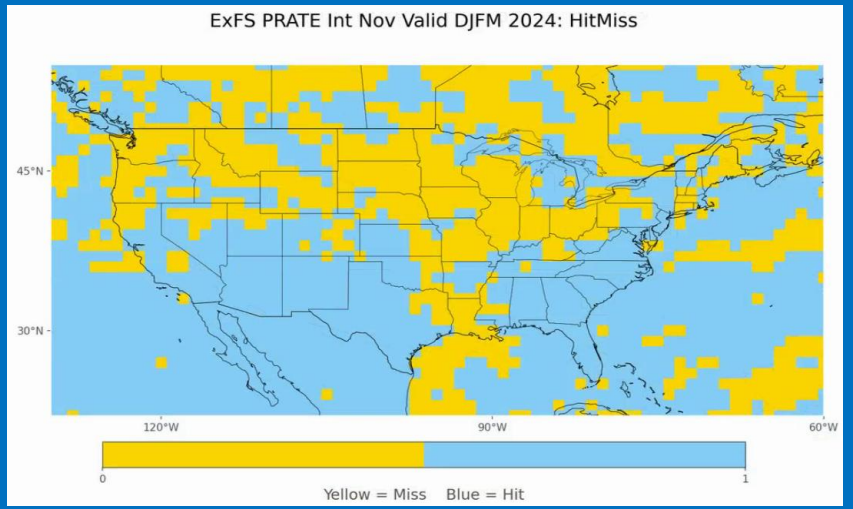


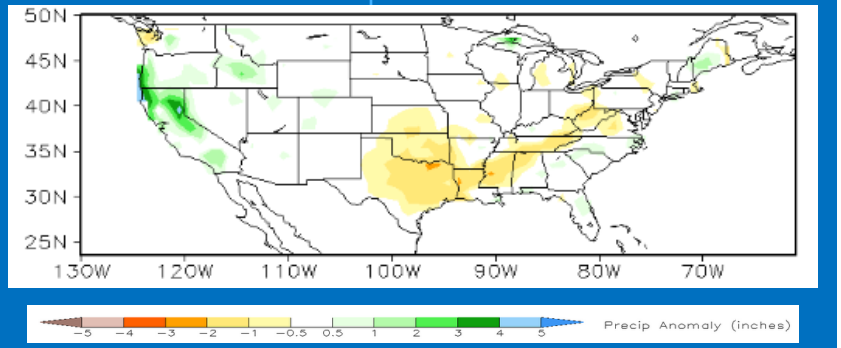


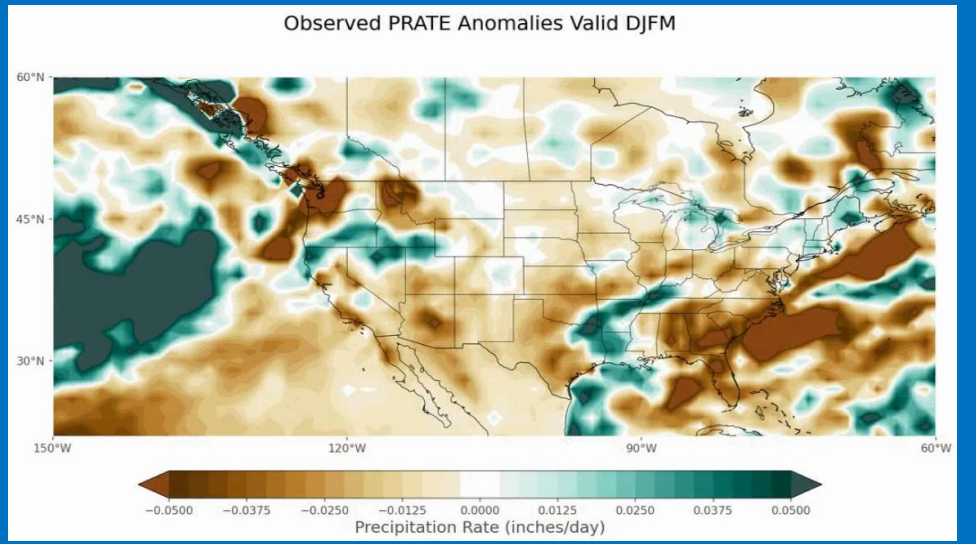


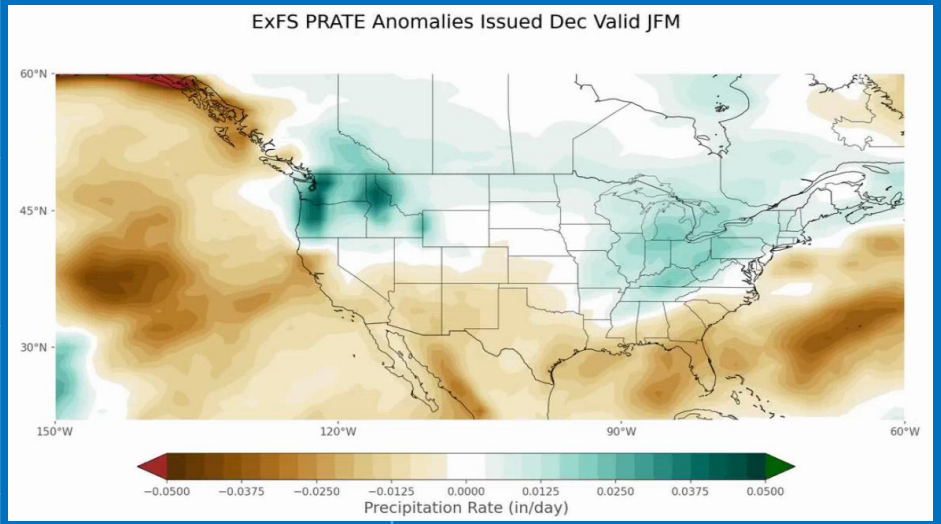
- Varied lags and modes
- Chosen based on CONUS-avg ACC
- Some distinct regions more skillful with other lags/modes

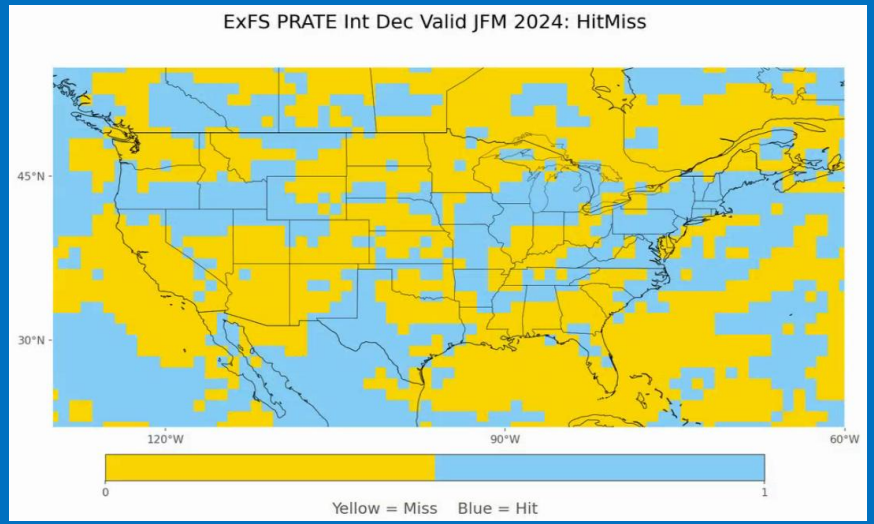

ExFS PRATE Anomalies Issued Nov Valid DJFM
60°N
45°N
30°N
150°W
120°W
90°W
60°W
−0.0500 −0.0375 −0.0250 −0.0125 0.0000 0.0125 0.0250 0.0375 0.0500
Precipitation Rate (in/day)

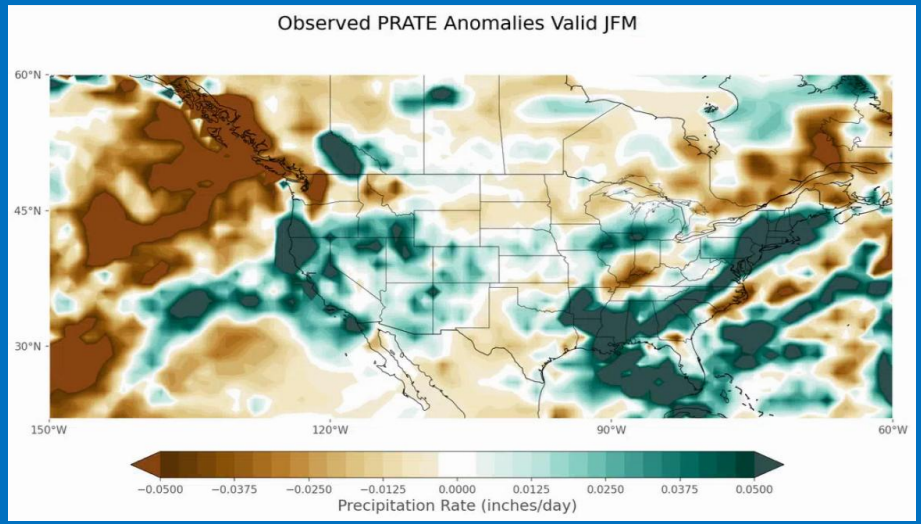

ExFS PRATE Int Nov Valid DJFM 2024: HitMiss
45°N
30°N
120°W
90°W
60°W
0
1
Yellow = Miss Blue = Hit


50N
45N
40N
35N
30N
25N
130W
120W
110W
100W
90W
80W
70W
−5 −4 −3 −2 −1 −0.5 0.5 1 2 3 4 5
Precip Anomaly (inches)


Observed PRATE Anomalies Valid DJFM
60°N
45°N
30°N
150°W
120°W
90°W
60°W
−0.0500 −0.0375 −0.0250 −0.0125 0.0000 0.0125 0.0250 0.0375 0.0500
Precipitation Rate (inches/day)


ExFS PRATE Anomalies Issued Dec Valid JFM
60°N
45°N
30°N
150°W
120°W
90°W
60°W
−0.0500
−0.0375
−0.0250
−0.0125
0.0000
0.0125
0.0250
0.0375
0.0500
Precipitation Rate (in/day)

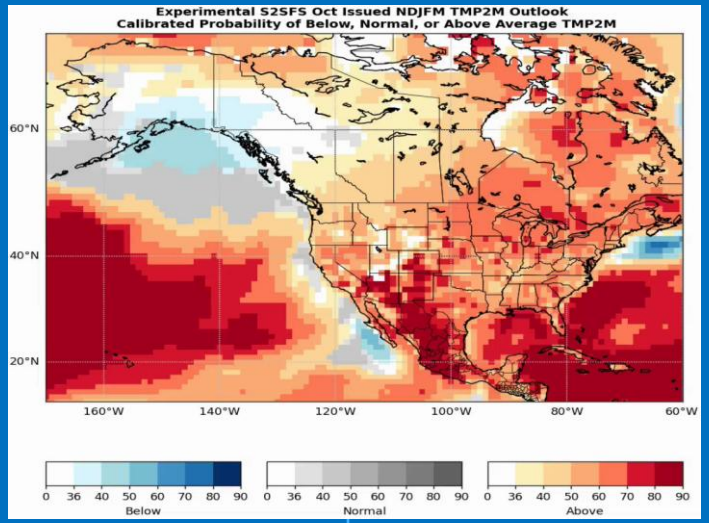

ExFS PRATE Int Dec Valid JFM 2024: HitMiss
45°N
30°N
120°W
90°W
60°W
0
1
Yellow = Miss
Blue = Hit

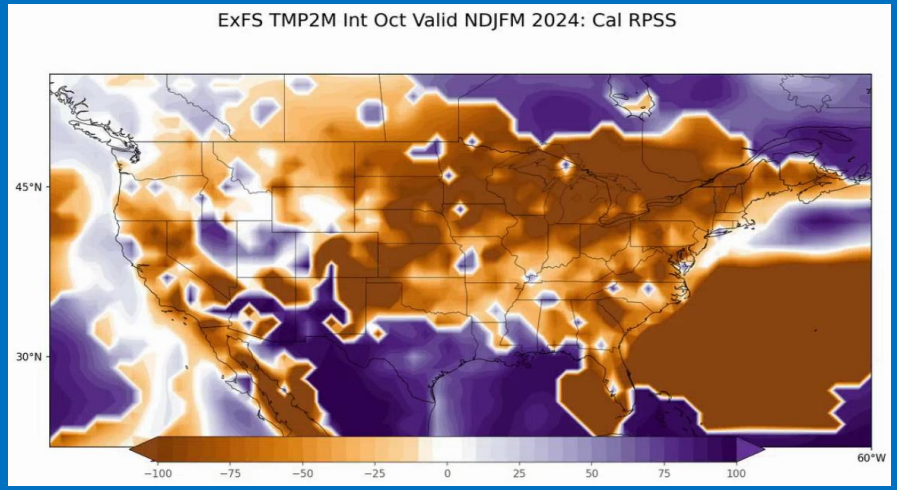

Observed PRATE Anomalies Valid JFM
60°N
45°N
30°N
150°W
120°W
90°W
60°W
−0.0500
−0.0375
−0.0250
−0.0125
0.0000
0.0125
0.0250
0.0375
0.0500
Precipitation Rate (inches/day)

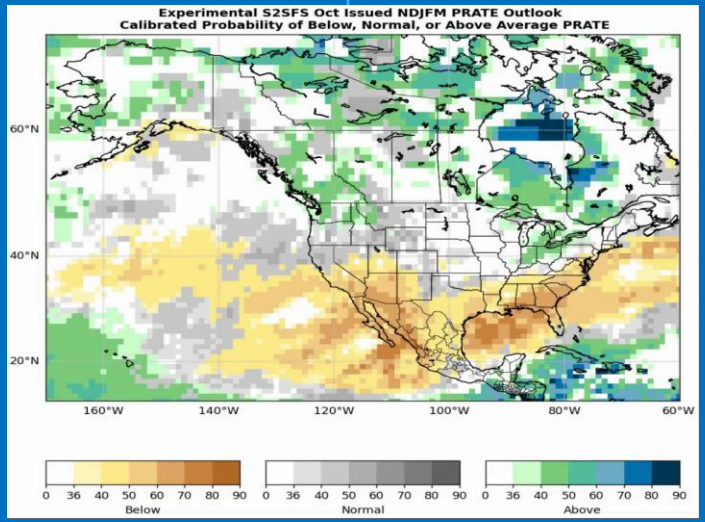
NOAA

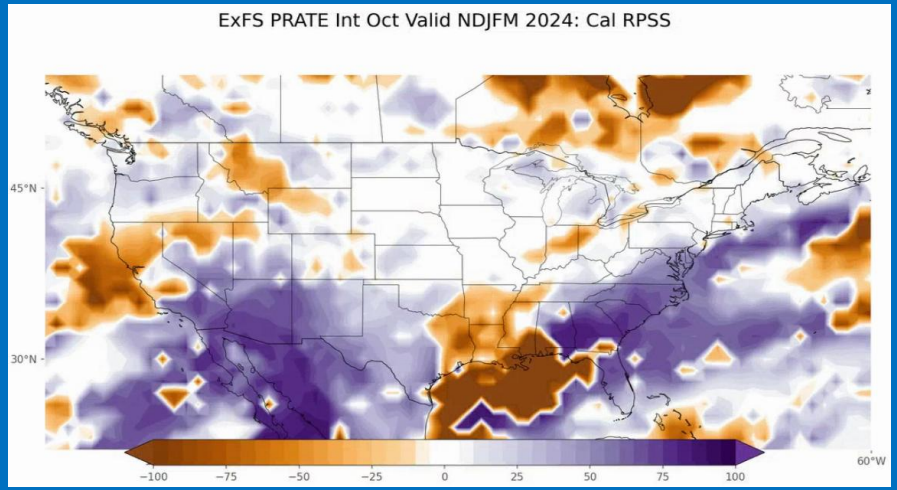
Review of Extended Winter Outlook (Experimental)

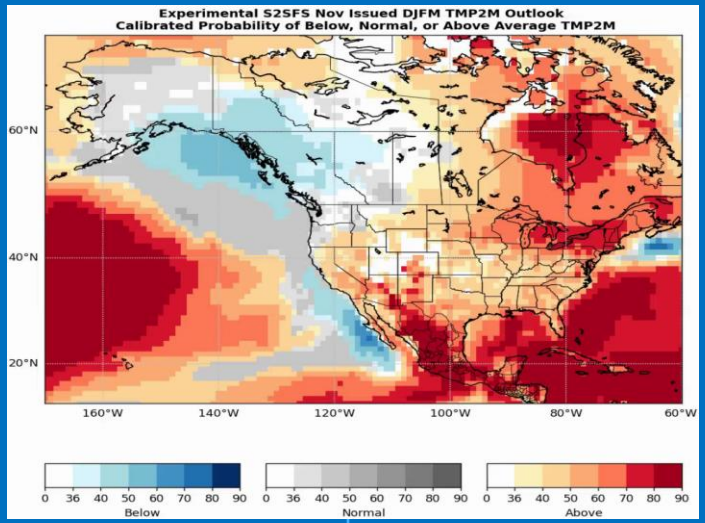
Probabilistic Outlooks and Verification

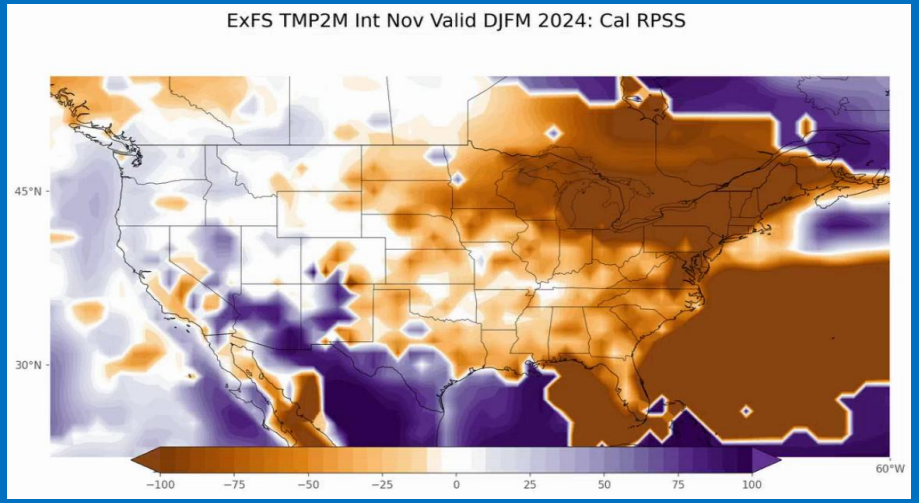

Experimental S2SFS Oct Issued NDJFM TMP2M Outlook
Calibrated Probability of Below, Normal, or Above Average TMP2M
60°N
40°N
20°N
160°W
140°W
120°W
100°W
80°W
60°W
0 36 40 50 60 70 80 90
Below
0 36 40 50 60 70 80 90
Normal
0 36 40 50 60 70 80 90
Above

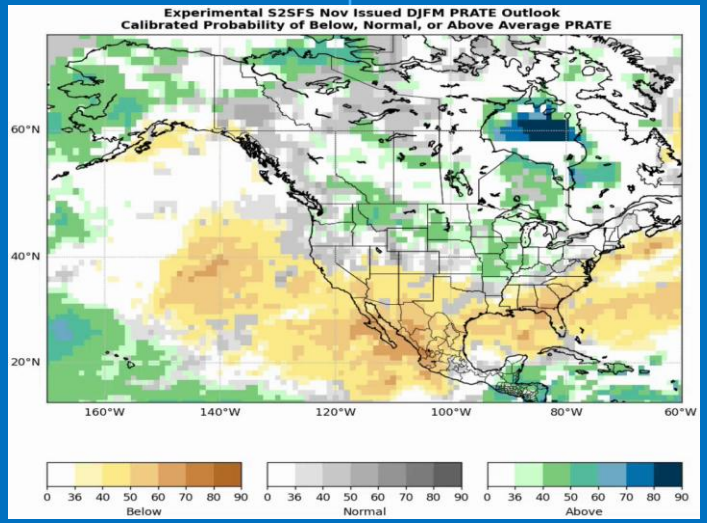

ExFS TMP2M Int Oct Valid NDJFM 2024: Cal RPSS
45°N
30°N
60°W
−100 −75 −50 −25 0 25 50 75 100

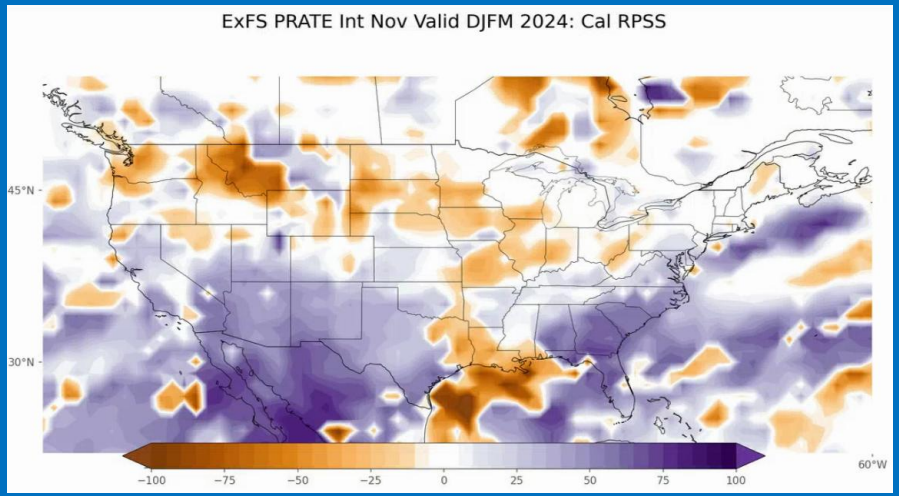

Experimental S2SFS Oct Issued NDJFM PRATE Outlook
Calibrated Probability of Below, Normal, or Above Average PRATE
60°N
40°N
20°N
160°W
140°W
120°W
100°W
80°W
60°W
0 36 40 50 60 70 80 90
Below
0 36 40 50 60 70 80 90
Normal
0 36 40 50 60 70 80 90
Above

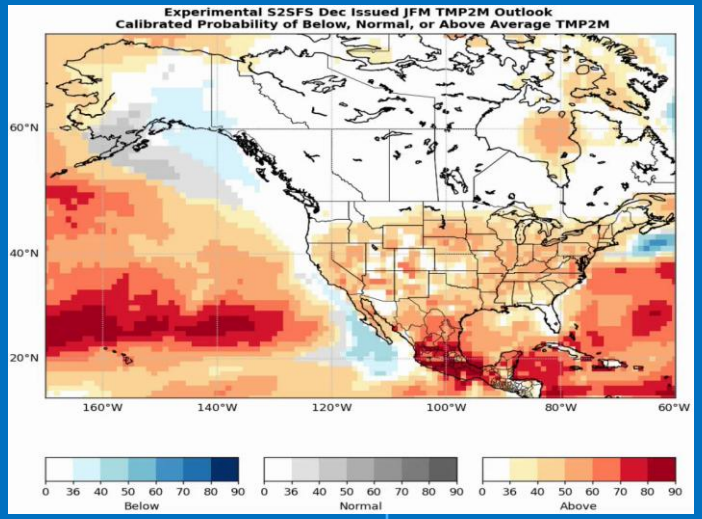

ExFS PRATE Int Oct Valid NDJFM 2024: Cal RPSS
45°N
30°N
60°W
−100 −75 −50 −25 0 25 50 75 100

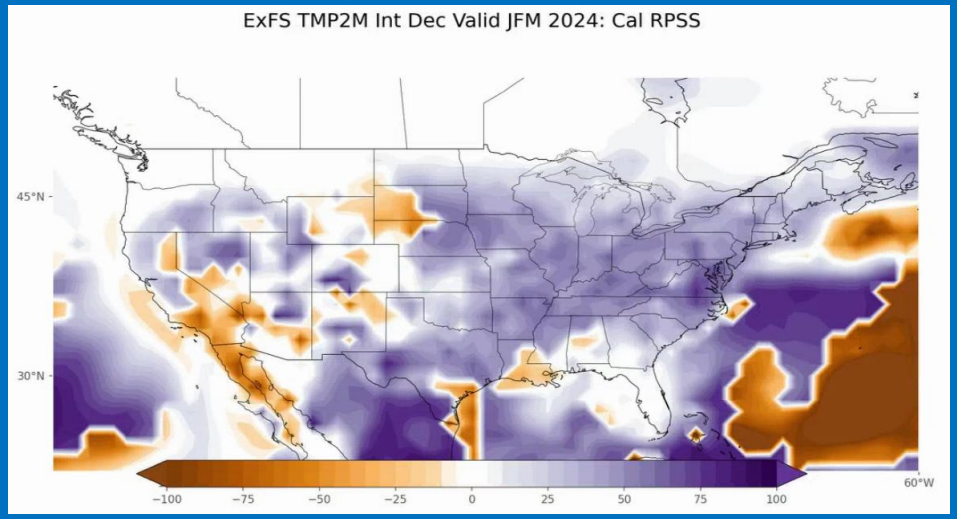

Experimental S2SFS Nov Issued DJFM TMP2M Outlook
Calibrated Probability of Below, Normal, or Above Average TMP2M
60°N
40°N
20°N
160°W
140°W
120°W
100°W
80°W
60°W
0 36 40 50 60 70 80 90
Below
0 36 40 50 60 70 80 90
Normal
0 36 40 50 60 70 80 90
Above

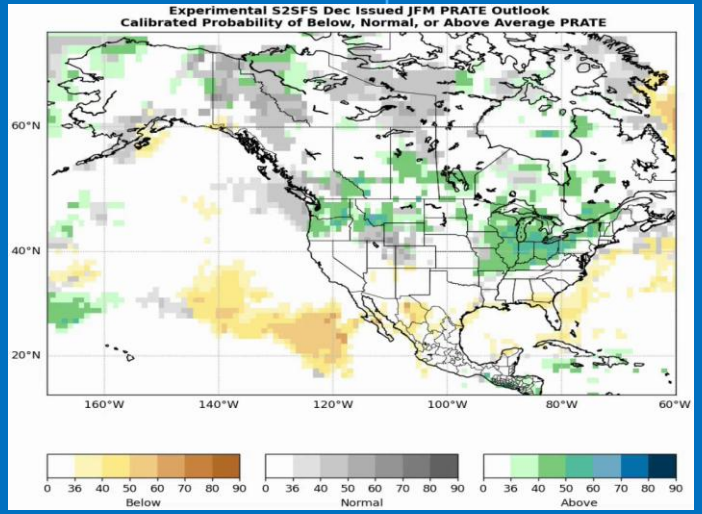

ExFS TMP2M Int Nov Valid DJFM 2024: Cal RPSS
45°N
30°N
60°W
−100 −75 −50 −25 0 25 50 75 100

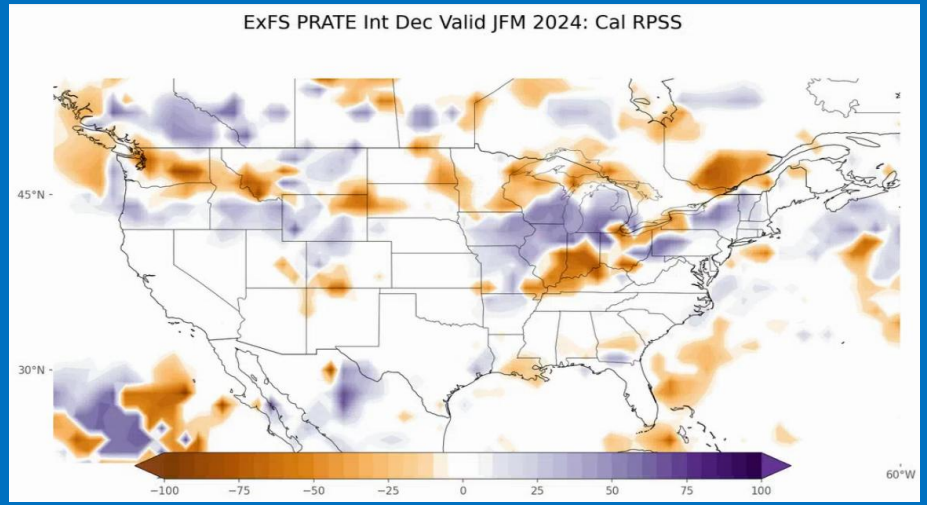

Experimental S2SFS Nov Issued DJFM PRATE Outlook
Calibrated Probability of Below, Normal, or Above Average PRATE
60°N
40°N
20°N
160°W
140°W
120°W
100°W
80°W
60°W
0 36 40 50 60 70 80 90
Below
0 36 40 50 60 70 80 90
Normal
0 36 40 50 60 70 80 90
Above


ExFS PRATE Int Nov Valid DJFM 2024: Cal RPSS
45°N
30°N
60°W
−100 −75 −50 −25 0 25 50 75 100


Experimental S2SFS Dec Issued JFM TMP2M Outlook
Calibrated Probability of Below, Normal, or Above Average TMP2M
60°N
40°N
20°N
160°W
140°W
120°W
100°W
80°W
60°W
0 36 40 50 60 70 80 90
Below
0 36 40 50 60 70 80 90
Normal
0 36 40 50 60 70 80 90
Above


ExFS TMP2M Int Dec Valid JFM 2024: Cal RPSS
45°N
30°N
60°W
−100 −75 −50 −25 0 25 50 75 100


Experimental S2SFS Dec Issued JFM PRATE Outlook
Calibrated Probability of Below, Normal, or Above Average PRATE
60°N
40°N
20°N
160°W
140°W
120°W
100°W
80°W
60°W
0 36 40 50 60 70 80 90
Below
0 36 40 50 60 70 80 90
Normal
0 36 40 50 60 70 80 90
Above


ExFS PRATE Int Dec Valid JFM 2024: Cal RPSS
45°N
30°N
60°W
−100 −75 −50 −25 0 25 50 75 100

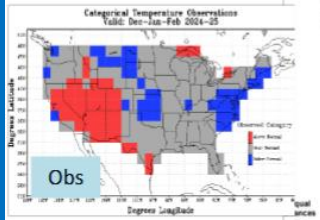
Review of Seasonal Winter Outlook (Operational)

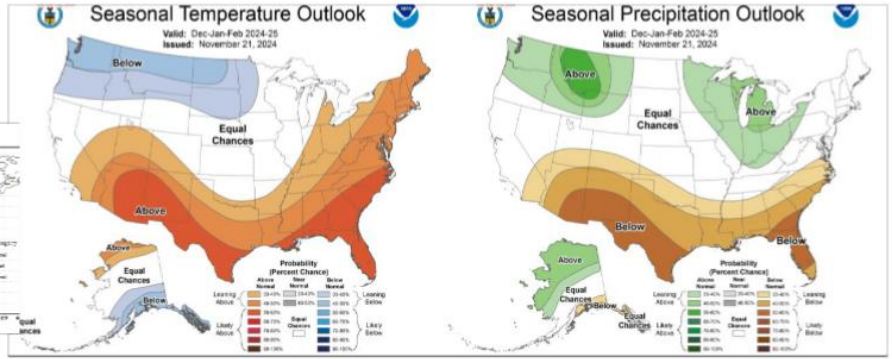
Probabilistic Outlooks and Verification

CPC Seasonal Outlooks and NMME Forecasts

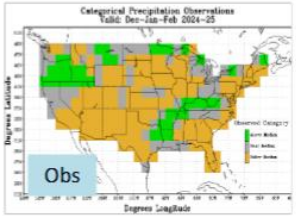
CPC

Temp nonEC
HSS=-7

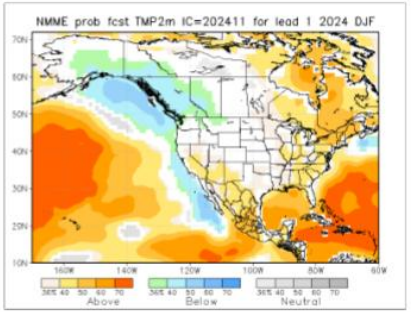


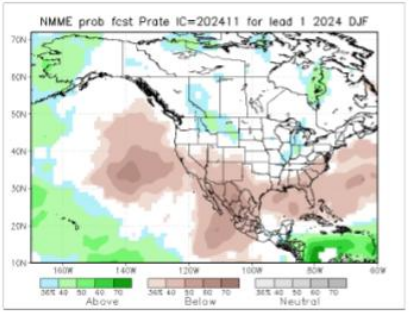


Prec nonEC
HSS=33



NMME



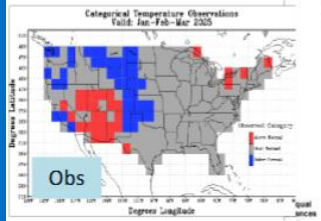


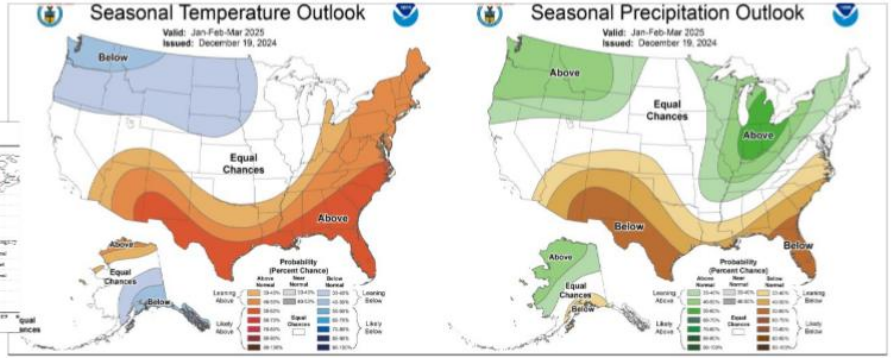
For the rationale behind CPC outlooks see https://www.cpc.ncep.noaa.gov/products/archives/long_lead/PMD/2024/202411_PMD90D

CPC Seasonal Outlooks and NMME Forecasts

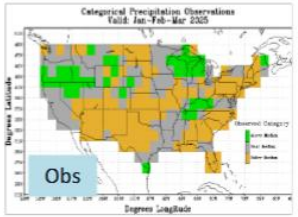
CPC

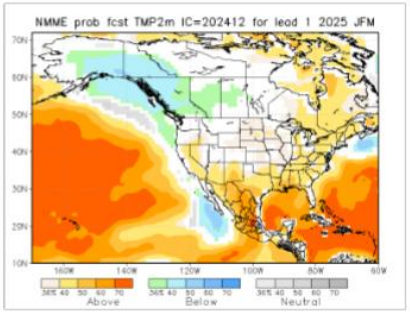
Temp nonEC
HSS=-6



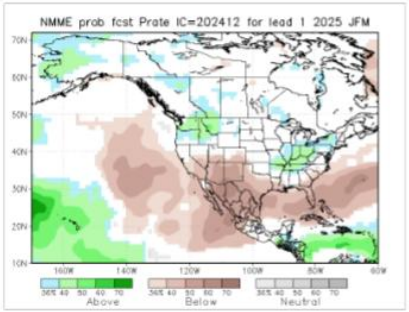


Prec nonEC
HSS=29





NMME



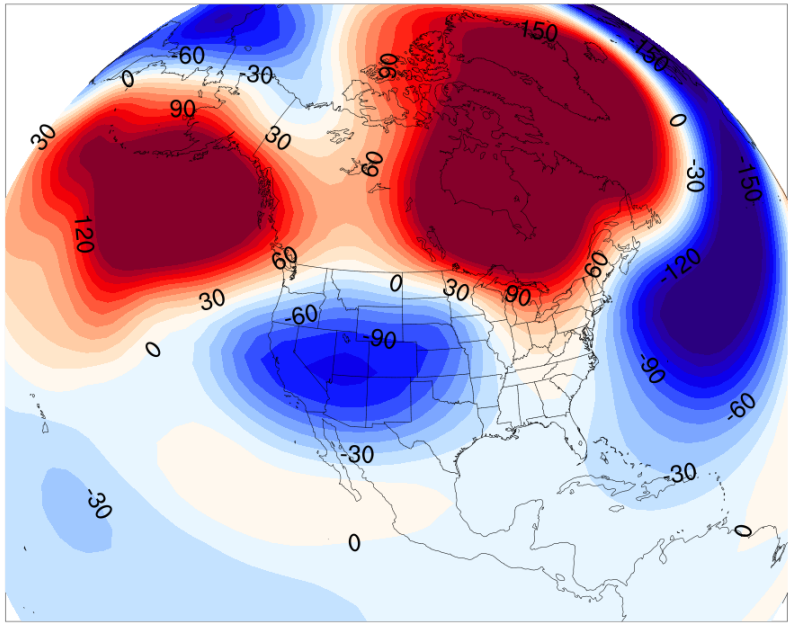
For the rationale behind CPC outlooks see https://www.cpc.ncep.noaa.gov/products/archives/long_lead/PMD/2024/202412_PMD90D

Experimental Regime Change Prognostic Tool

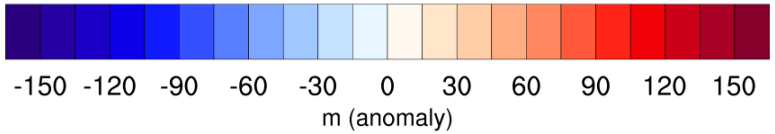
December 2022/January 2023 Extreme Pattern Changes

500-hPa Heights Anomaly

7-day period beginning 20221210

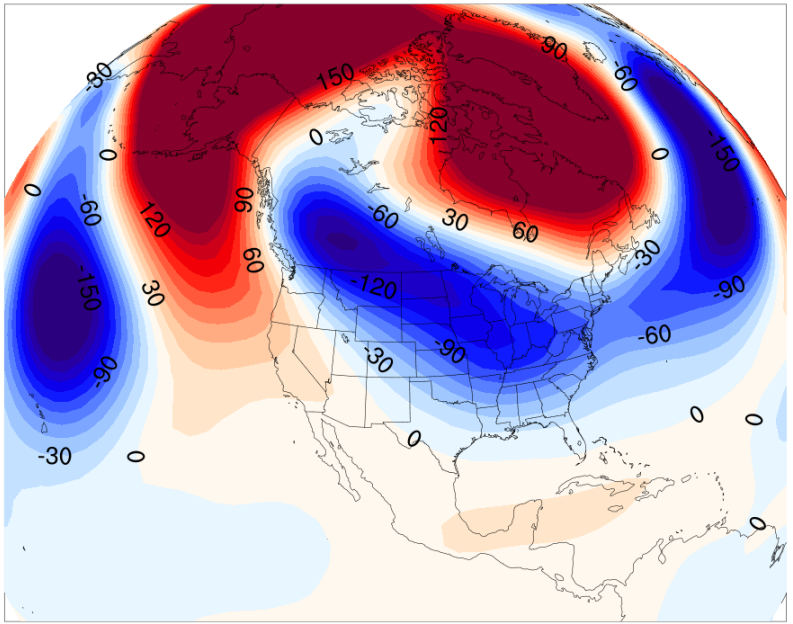


Climate Normal: 1991-2020

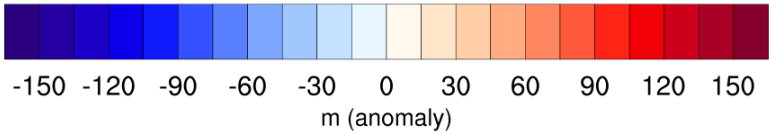


500-hPa Heights Anomaly

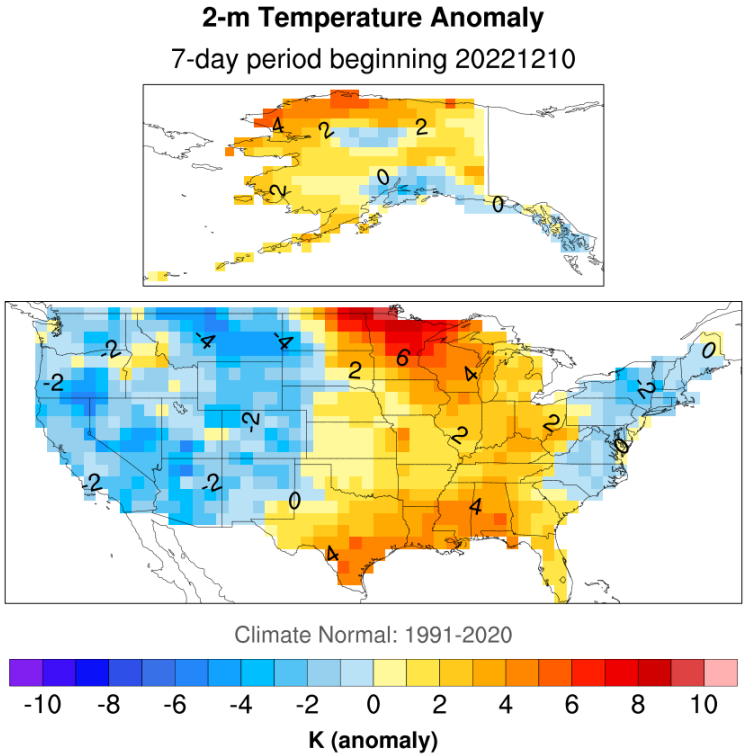
7-day period beginning 20221217

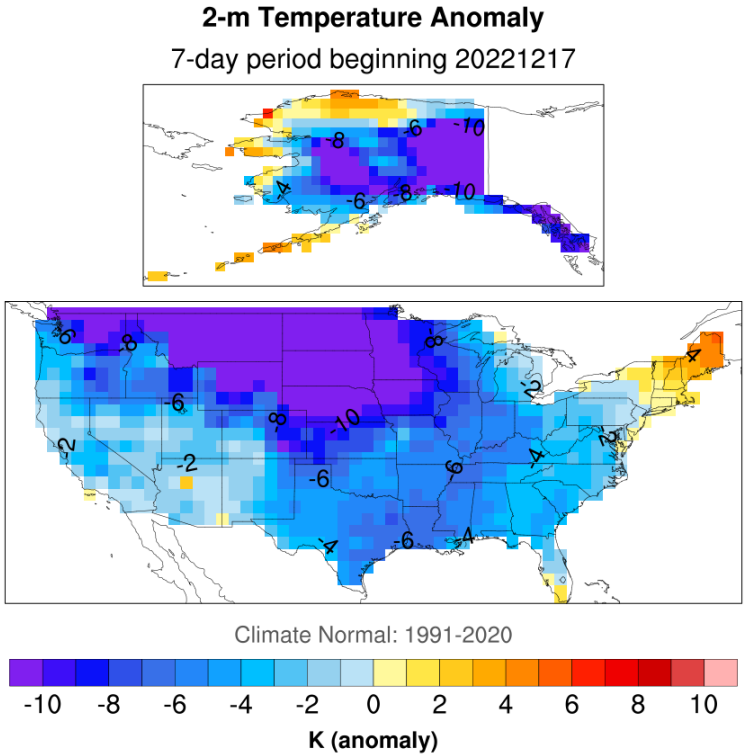


Climate Normal: 1991-2020

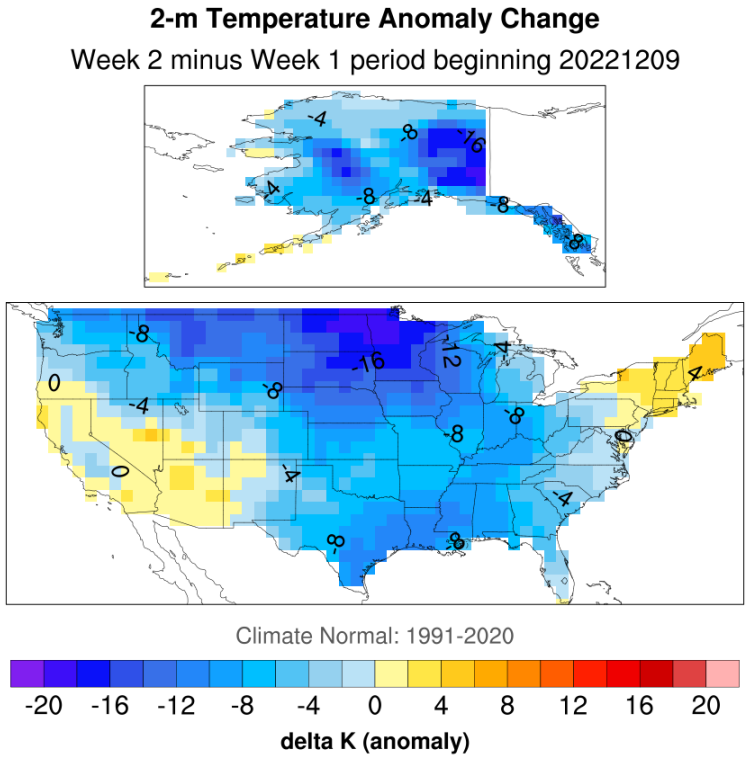


December 2022/January 2023 Extreme Pattern Changes



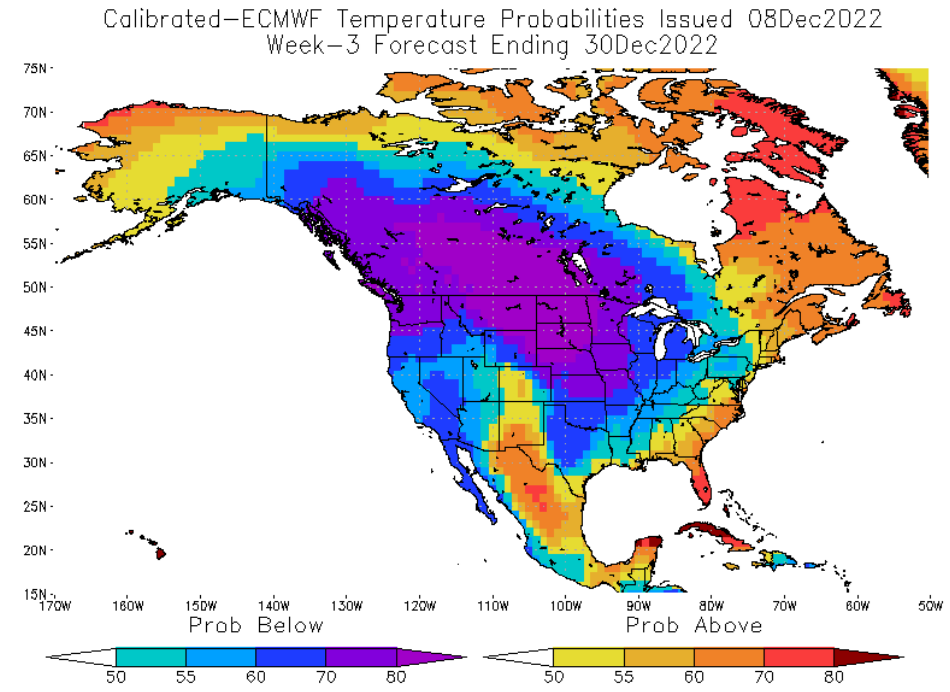


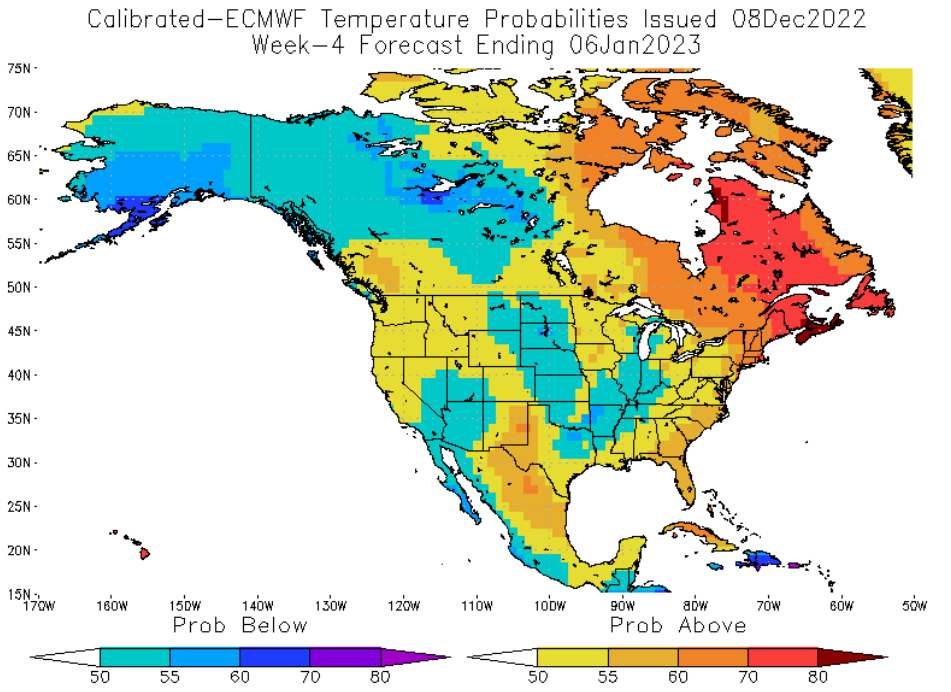
December 2022/January 2023 Extreme Pattern Changes



December 2022/January 2023 Extreme Pattern Changes

From ECMWF initialized December 8, 2022



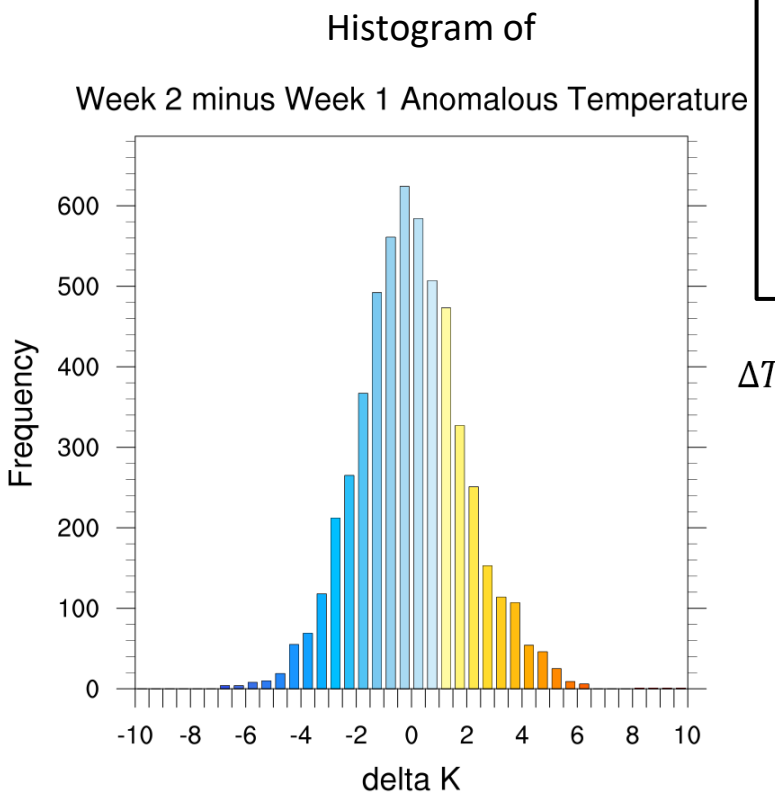


December 2022/January 2023 Extreme Pattern Change

Motivation for a “Pattern Change Tool”

- How extreme was the pattern change from cold to warm during December 2022/January 2023?

December 2022/January 2023 Extreme Pattern Changes



ONDJFM; 1991-2020; area-weighted average over CONUS/AK

- **In observations for each grid point and season, calculate the observed consecutive, non-overlapping week-to-week change in temperature anomaly during 1991-2020**
- **Can also do this for other timescales and variables**
- **Examine the underlying distributions to identify the 15th and 85th percentiles of week-to-week temperature anomaly changes**

$$\Delta T_{weekly}(d) = \frac{\sum_{i,j}\left[w(i,j) * \left(T_{weekly}(d+8,i,j) - T_{weekly}(d+1,i,j)\right)\right]}{\sum_{i,j}[w(i,j)]}$$

T_{weekly} = weekly averaged temperature

d = day in daily continuous timeseries

i = latitude

j = longitude

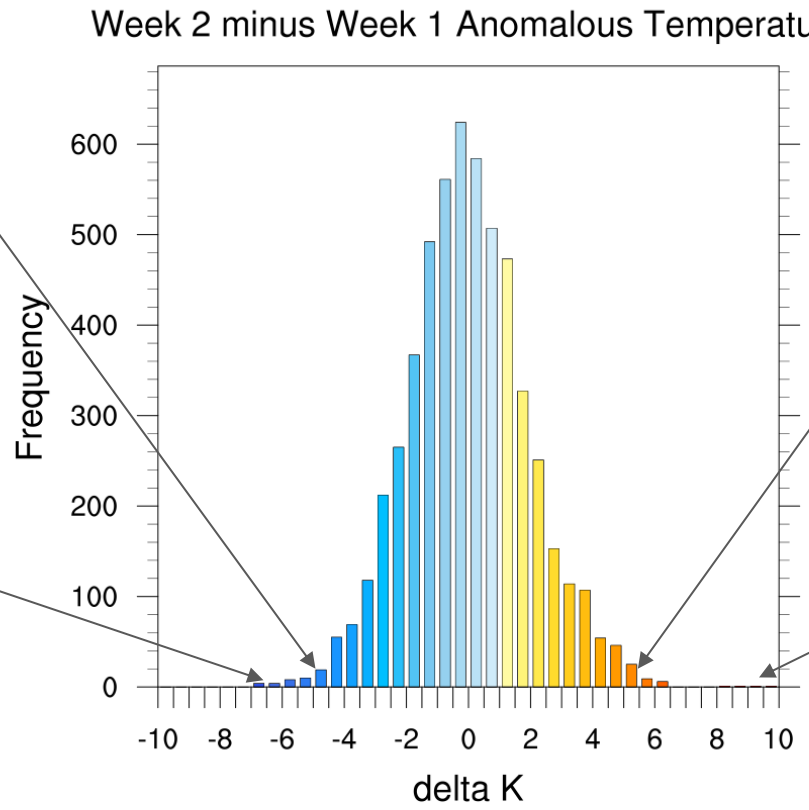
$w(i,j)$ = cosine-weight of grid point i,j

Essentially ΔT_{weekly} is the change in temperature from Week 1 to Week 2 averaged over CONUS/AK.

December 2022/January 2023 Extreme Pattern Changes

November 4, 2022:
ΔT_{weekly}= -4.86 K

December 9, 2022:
ΔT_{weekly}= -6.27 K

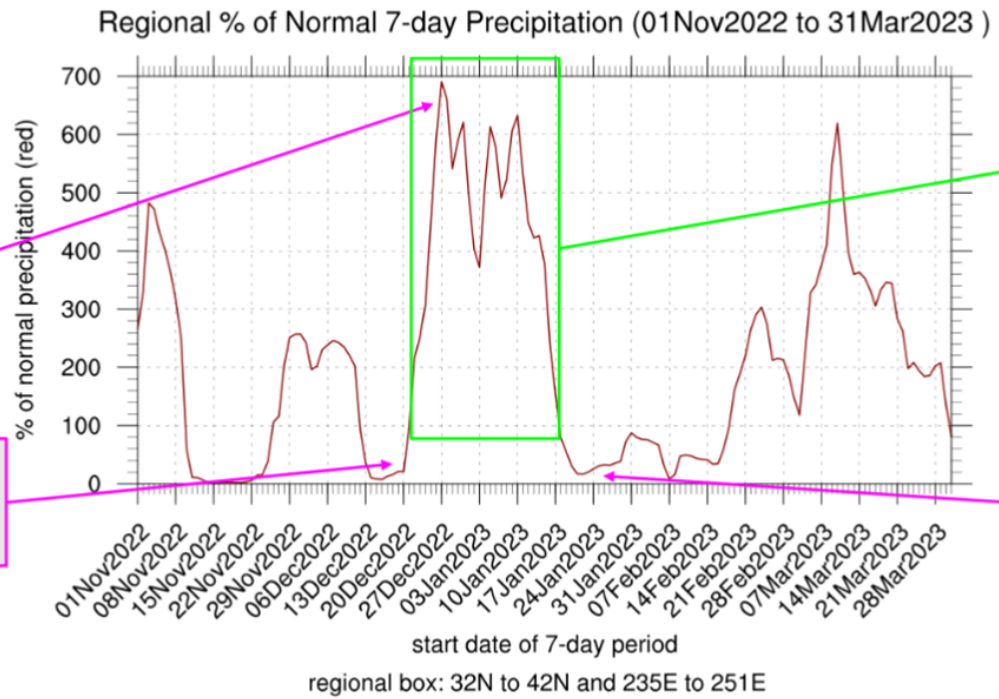


ONDJFM; 1991-2020; area-weighted average over CONUS/AK

November 13, 2022:
ΔT_{weekly}= +4.91 K

December 19, 2022:
ΔT_{weekly}= +9.28 K

Abrupt Precipitation Regime Changes



Week beginning December 27, 2022: near 700% of normal precipitation

Week beginning December 20, 2022: near zero precipitation

Next ~3 Weeks: atmospheric rivers and heavy precipitation continue

Week beginning January 20, 2023: near zero precipitation

Precipitation Onset

Could we see and message the pattern change toward more precipitation?

Lead Week 2:
Beginning December 20

Lead Week 3:
Beginning December 27

Regime Change Prognostic Tool

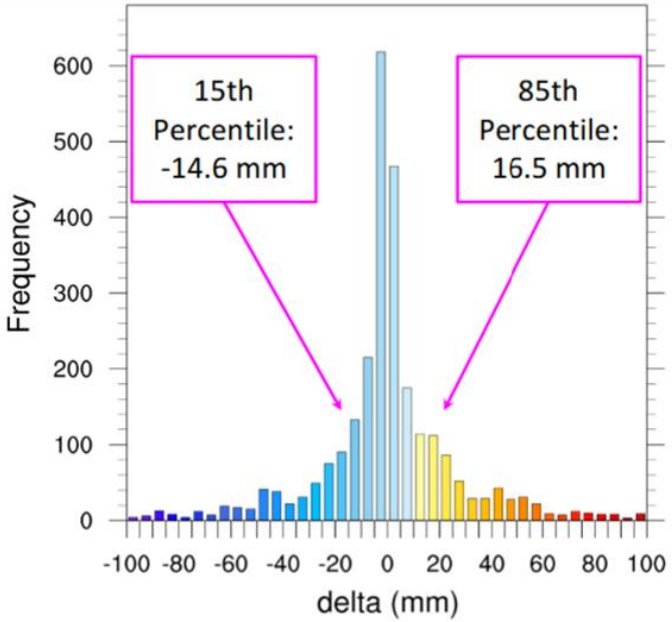
Observational Study

- For each grid point and season, calculate the observed consecutive, non-overlapping week-to-week change in precipitation anomaly during 1991-2020.
- Similar statistics were calculated for other timescales (1-Day, 3-Day, 5-Day, 14-day, etc.) and variables (temperature, etc.)
- Examine the underlying distributions to identify the 15th and 85th percentiles of week-to-week precipitation anomaly changes.
- **Example (right):** Distribution of week-to-week precipitation anomaly changes in Los Angeles, CA.

The Tool

- From probabilistic, dynamical model ensemble guidance, determine the percent chance of exceeding (or not exceeding) the percentile thresholds derived from observations.

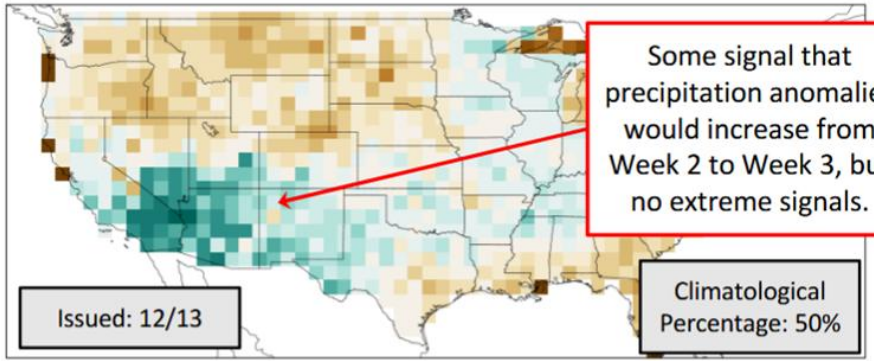
Los Angeles: Histogram of Observed Week-to-Week Change in Precipitation Anomaly



DJF; 1991-2020; Std. Dev.: 29.4833
consecutive periods; Lat: 35N, Lon: 241E

Regime Change Prognostic Tool: Precipitation Onset

Percentage of ECMWF ensemble members with a wetter anomaly (> 50th percentile) in Week 3 than Week 2



Climate Normal: 1991-2020

0 10 20 30 40 50 60 70 80 90 100

Percentage

Some signal that precipitation anomalies would increase from Week 2 to Week 3, but no extreme signals.

Percentage of ECMWF ensemble members with a MUCH wetter anomaly (> 85th percentile) in Week 3 than Week 2

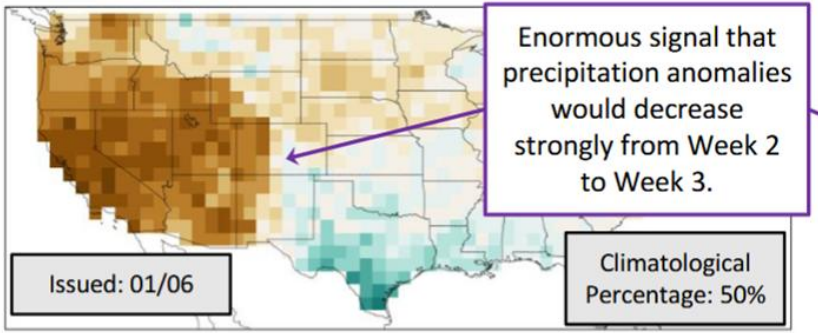
Climate Normal: 1991-2020

20 28 36 44 52 60 68 76 84 92 100

Percentage

Regime Change Prognostic Tool: Precipitation Cessation

Percentage of ECMWF ensemble members with a wetter anomaly (> 50th percentile) in Week 3 than Week 2



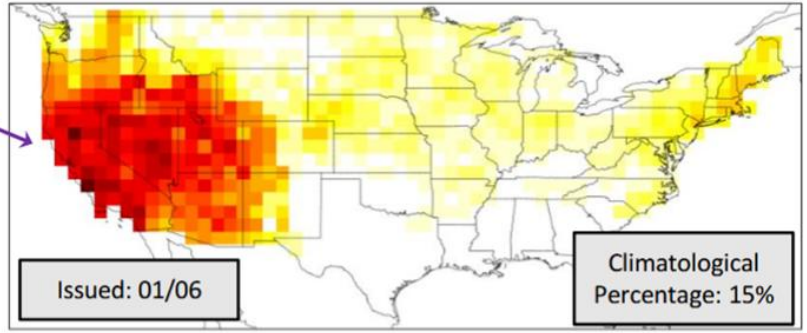
Climate Normal: 1991-2020

0 10 20 30 40 50 60 70 80 90 100

Percentage

Enormous signal that precipitation anomalies would decrease strongly from Week 2 to Week 3.

Percentage of ECMWF ensemble members with a MUCH drier anomaly (< 15th percentile) in Week 3 than Week 2

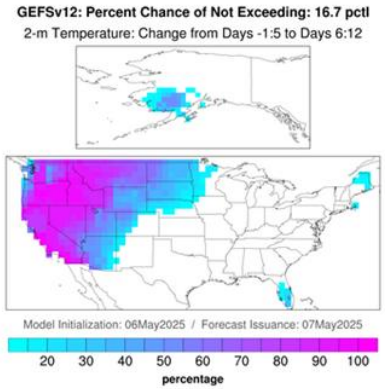


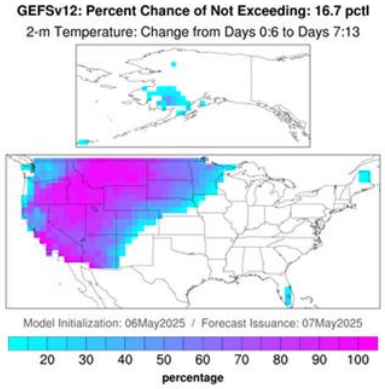
Climate Normal: 1991-2020

20 28 36 44 52 60 68 76 84 92 100

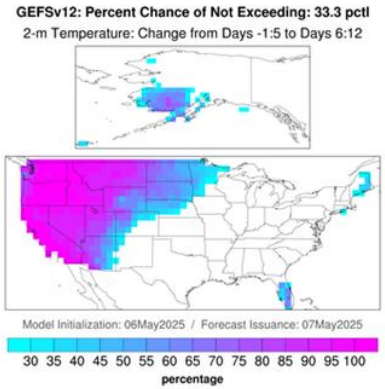
Percentage

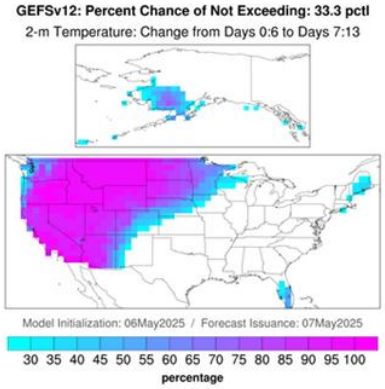
16.7 PCTL



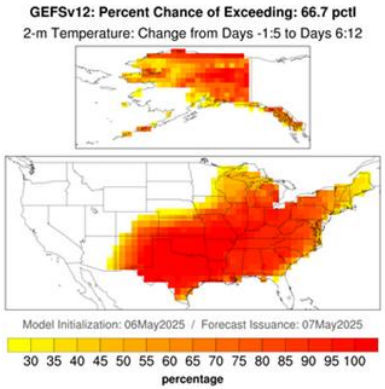


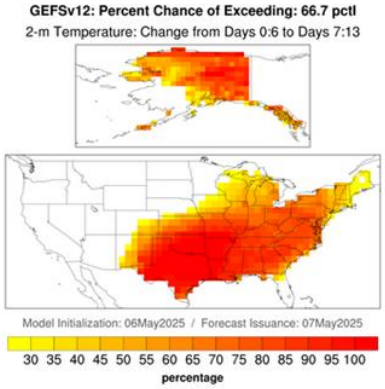
33.3 PCTL



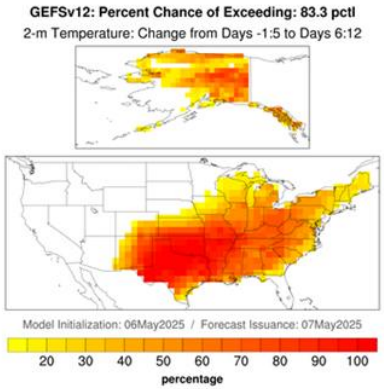


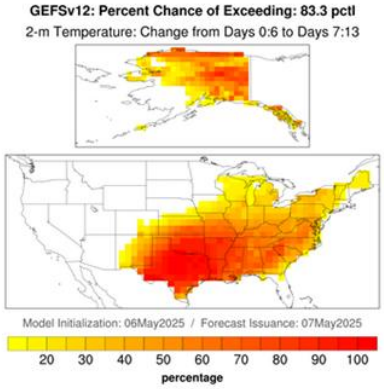
66.7 PCTL





83.3 PCTL





The End

Hui's Experimental Switanek-esque Tool

Forecast and Verification of ONDJFM, NDJFM, and DJFM 2024/25 CONUS Precipitation Using the SVD-CLSST Tool

Three categories:

Based on the rank of rainfall anomalies from 1982 to 2021

- Above normal: Top 33%
- Near normal: Middle 34%
- Below normal: Bottom 33%

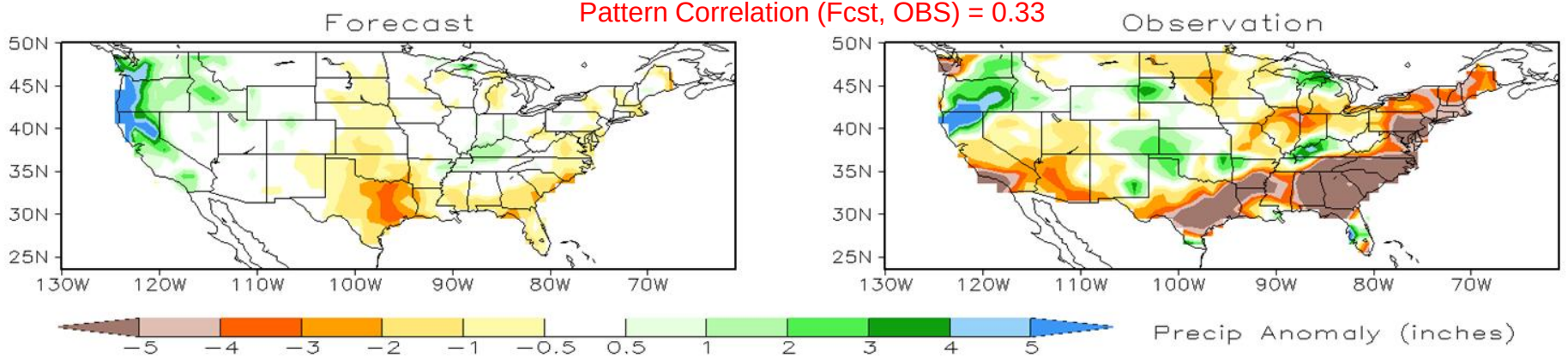
- For each target season (ONDJFM, NDJFM, DJFM), the first slide presents the real-time forecast, generated using a model configuration (SST lags and SVD modes) selected based on anomaly correlation skill evaluated over the 1982–2021 validation period.
- The second slide shows an alternative forecast using a different combination of SST lags and SVD modes that yields higher skill. However, we cannot determine whether this is truly a better forecast until the observations become available.

Precipitation Forecast Issued Sep 2024 Valid ONDJFM 2024/25

ONDJFM

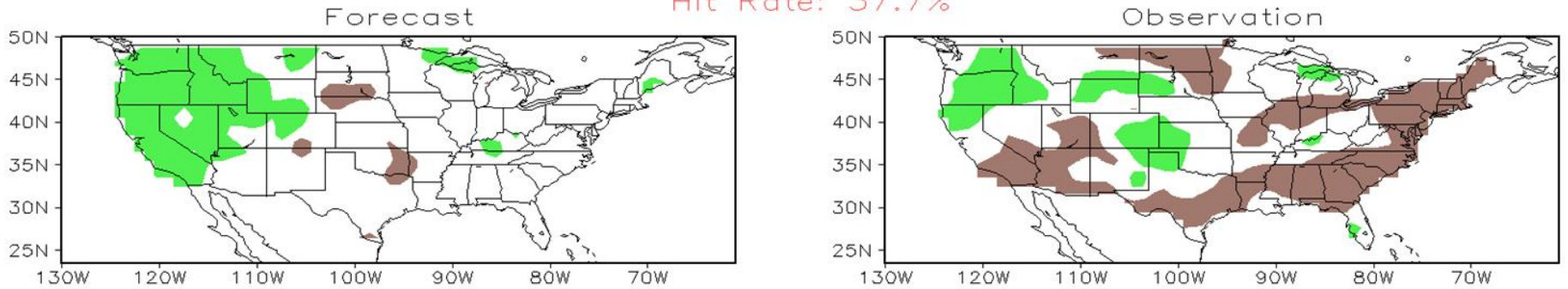
Predictor: Pac + IO SST (30S–30N)

Pattern Correlation (Fcst, OBS) = 0.33



Three Categories: Below– (brown), Near– (white), Above–Normal (green)

Hit Rate: 37.7%



Real-Time Forecast

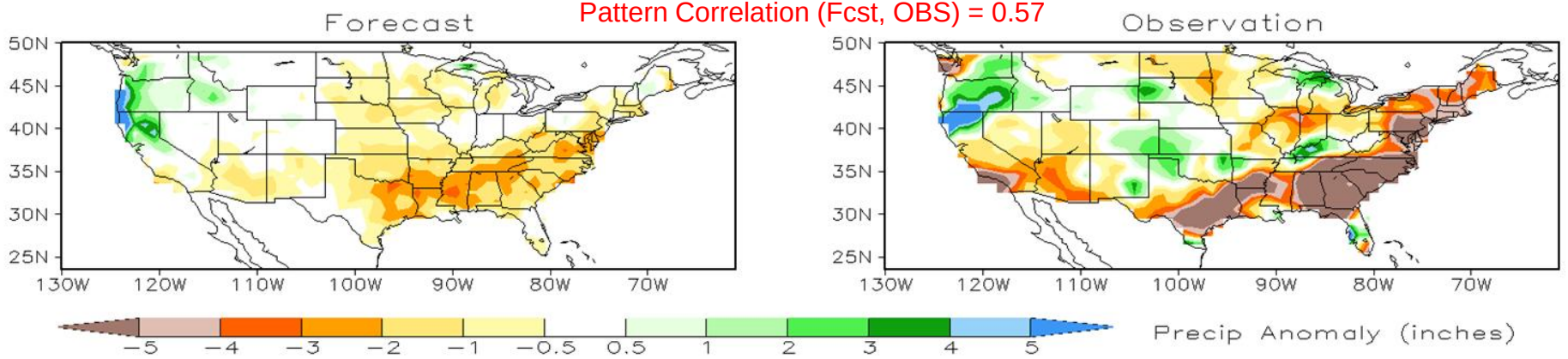
Hit: Foreacst and observation are in the same category.

Precipitation Forecast Issued Sep 2024 Valid ONDJFM 2024/25

ONDJFM

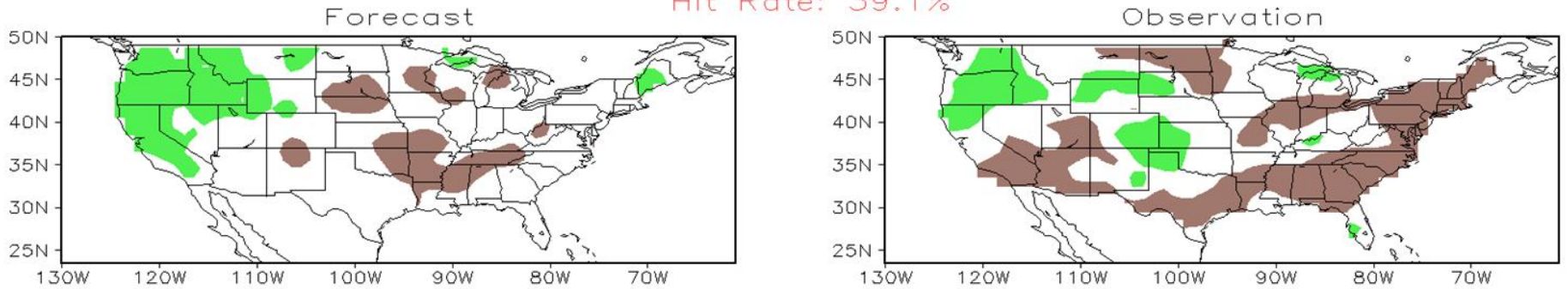
Predictor: Pac + IO SST (30S–30N)

Pattern Correlation (Fcst, OBS) = 0.57



Three Categories: Below– (brown), Near– (white), Above–Normal (green)

Hit Rate: 39.1%



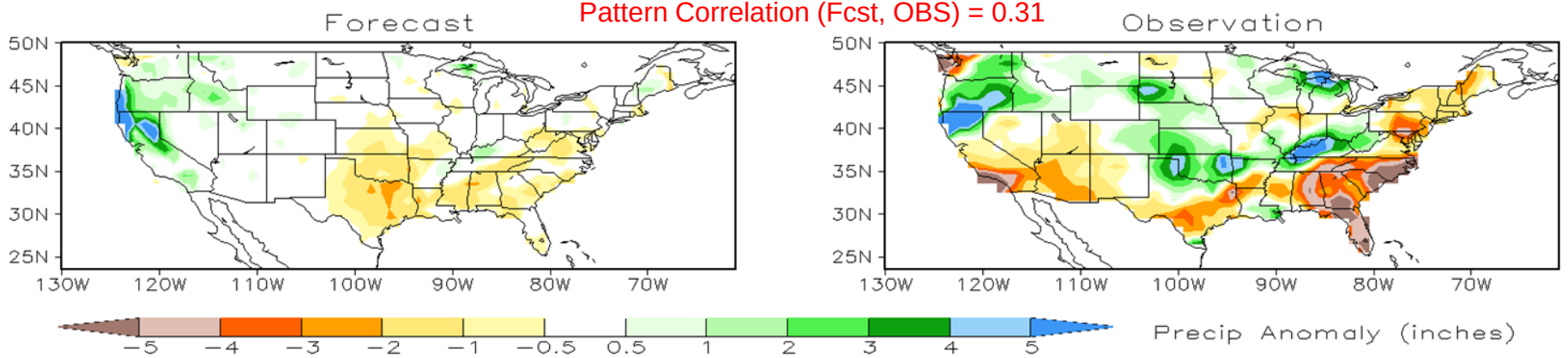
Hit: Foreacst and observation are in the same category.

Precipitation Forecast Issued Oct 2024 Valid NDJFM 2024/25

NDJFM

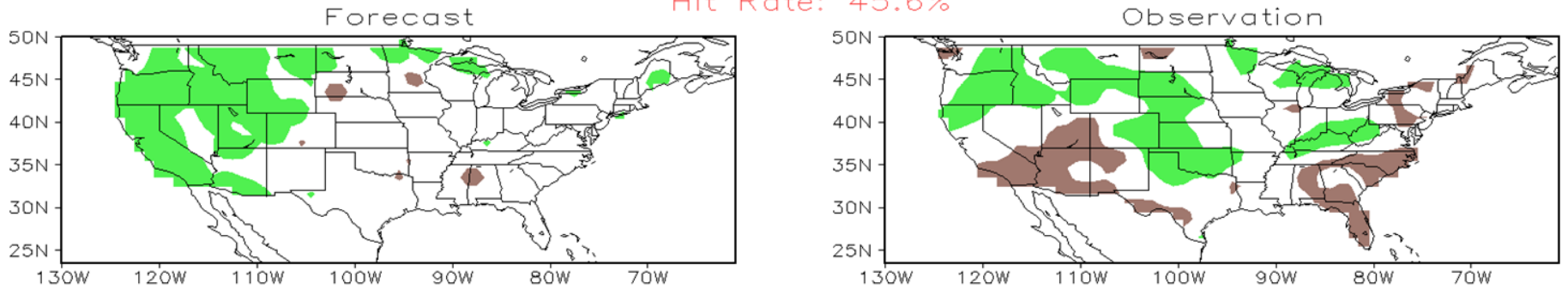
Predictor: Pac + IO + Atl SST (30S–30N)

Pattern Correlation (Fcst, OBS) = 0.31



Three Categories: Below– (brown), Near– (white), Above–Normal (green)

Hit Rate: 45.6%



Real-Time Forecast

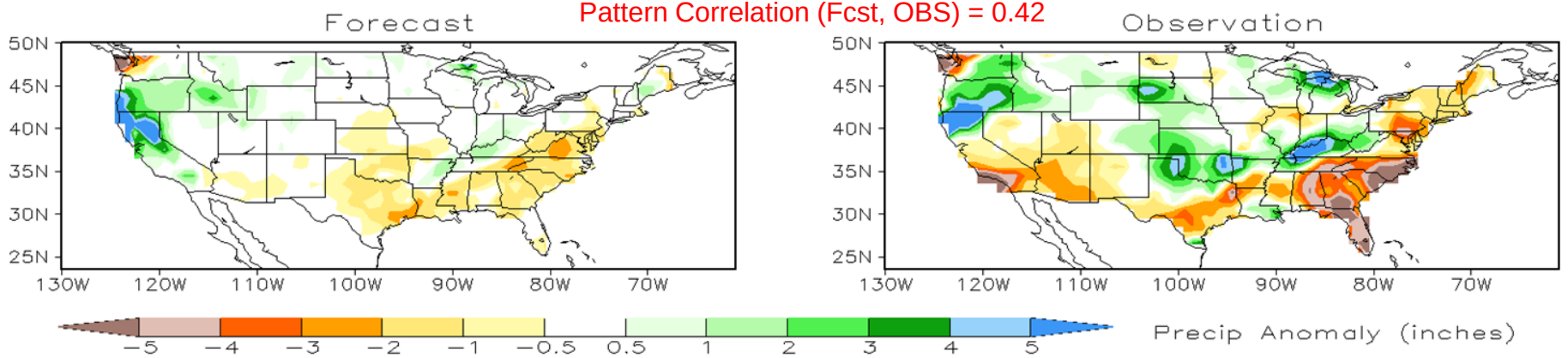
Hit: Foreacst and observation are in the same category.

Precipitation Forecast Issued Oct 2024 Valid NDJFM 2024/25

NDJFM

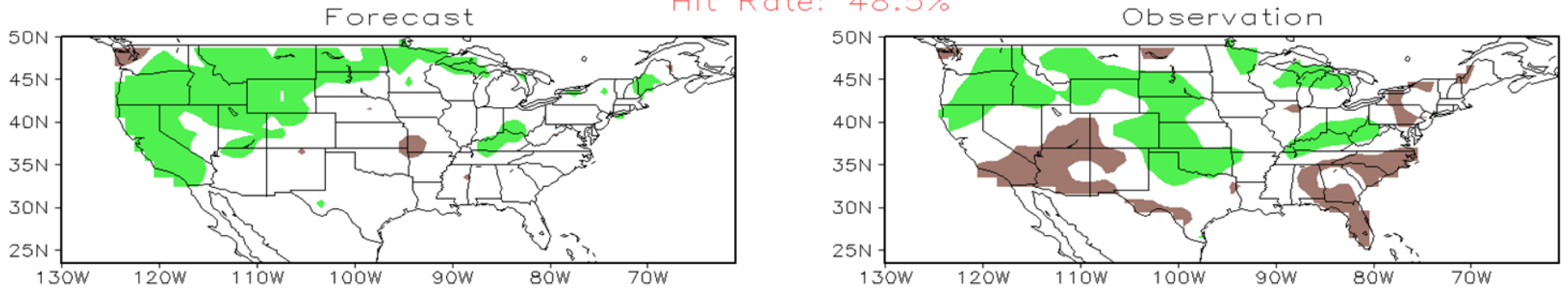
Predictor: Pac + IO + Atl SST (30S–30N)

Pattern Correlation (Fcst, OBS) = 0.42



Three Categories: Below– (brown), Near– (white), Above–Normal (green)

Hit Rate: 48.5%



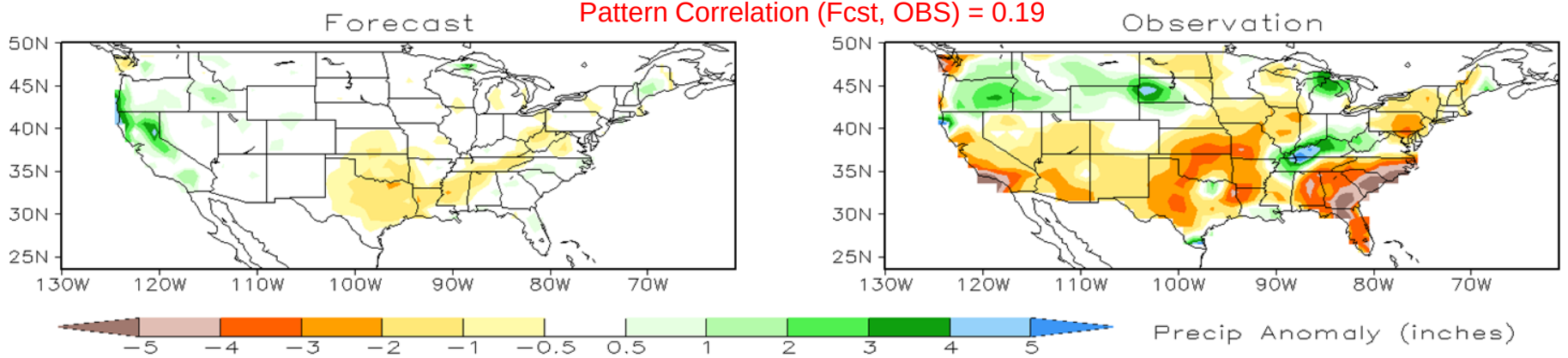
Hit: Foreacst and observation are in the same category.

Precipitation Forecast Issued Nov 2024 Valid DJFM 2024/25

DJFM

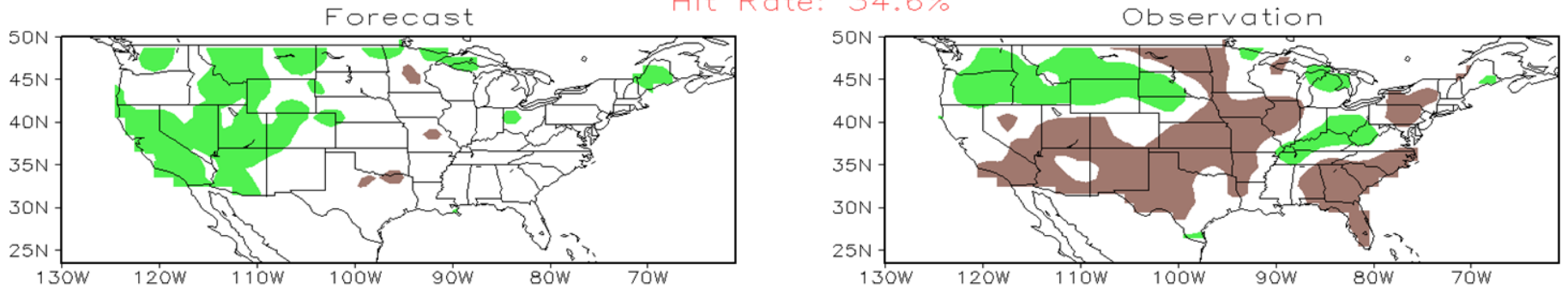
Predictor: Pac + IO + Atl SST (30S–30N)

Pattern Correlation (Fcst, OBS) = 0.19



Three Categories: Below– (brown), Near– (white), Above–Normal (green)

Hit Rate: 34.6%



Real-Time Forecast

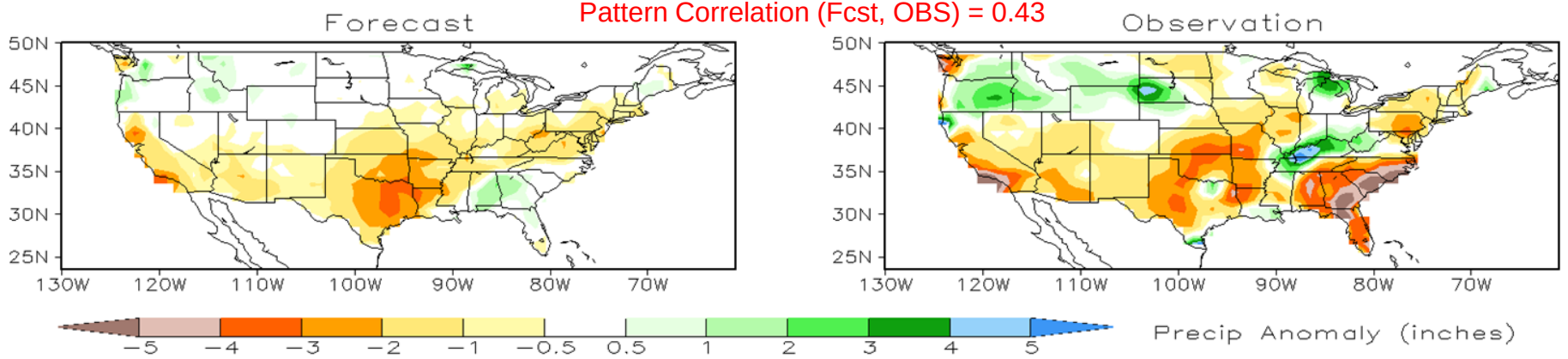
Hit: Foreacst and observation are in the same category.

Precipitation Forecast Issued Nov 2024 Valid DJFM 2024/25

DJFM

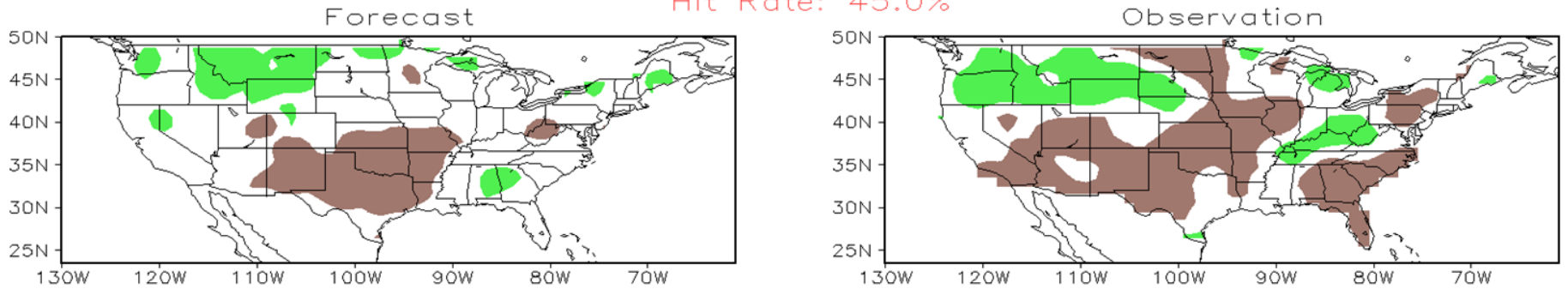
Predictor: Pac + IO + Atl SST (30S–30N)

Pattern Correlation (Fcst, OBS) = 0.43



Three Categories: Below– (brown), Near– (white), Above–Normal (green)

Hit Rate: 45.0%



Hit: Foreacst and observation are in the same category.