Circulation Study: On the Relationship of Temperature and Precipitation with 500-hPa Heights at the Week 3-4 Timescale

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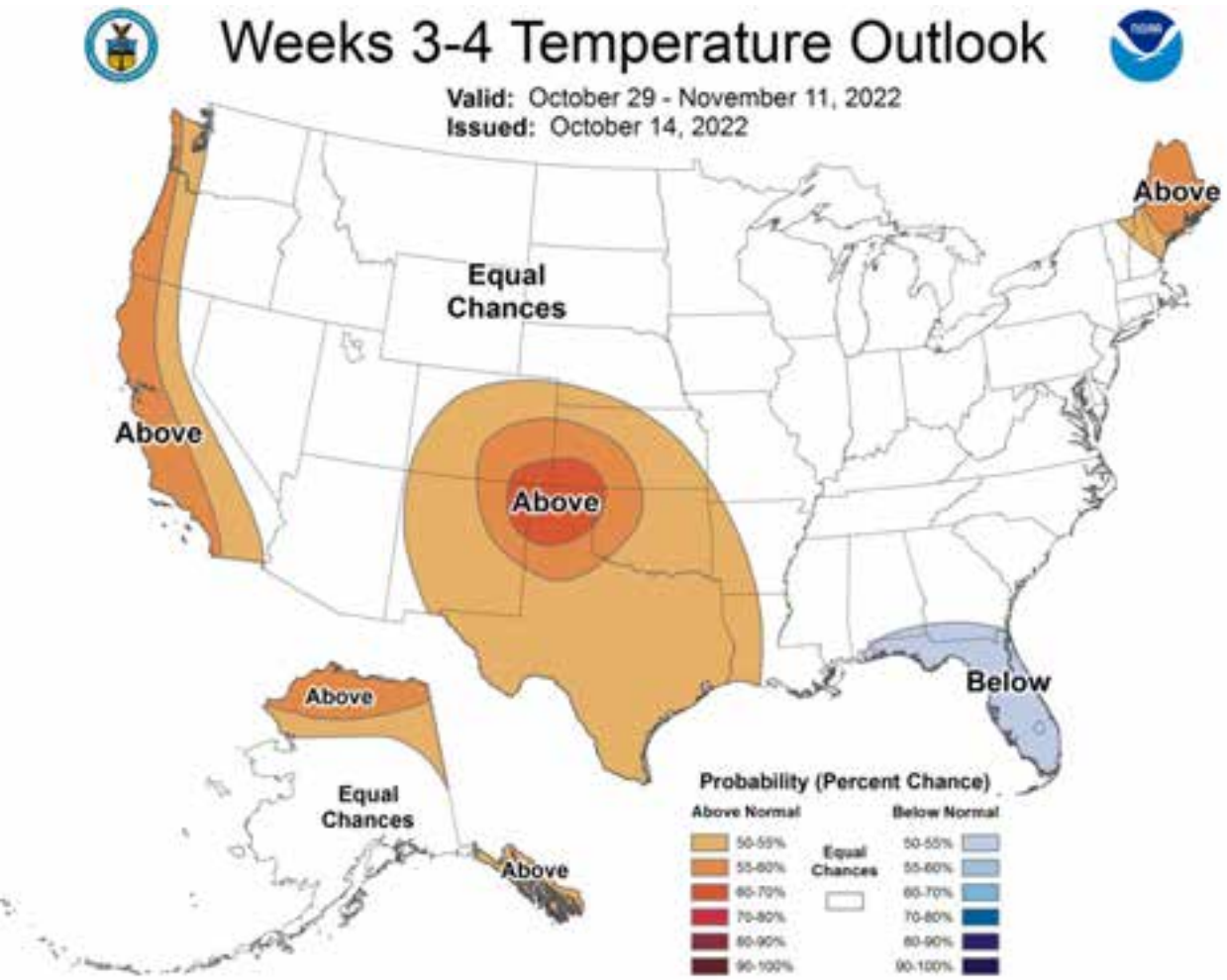
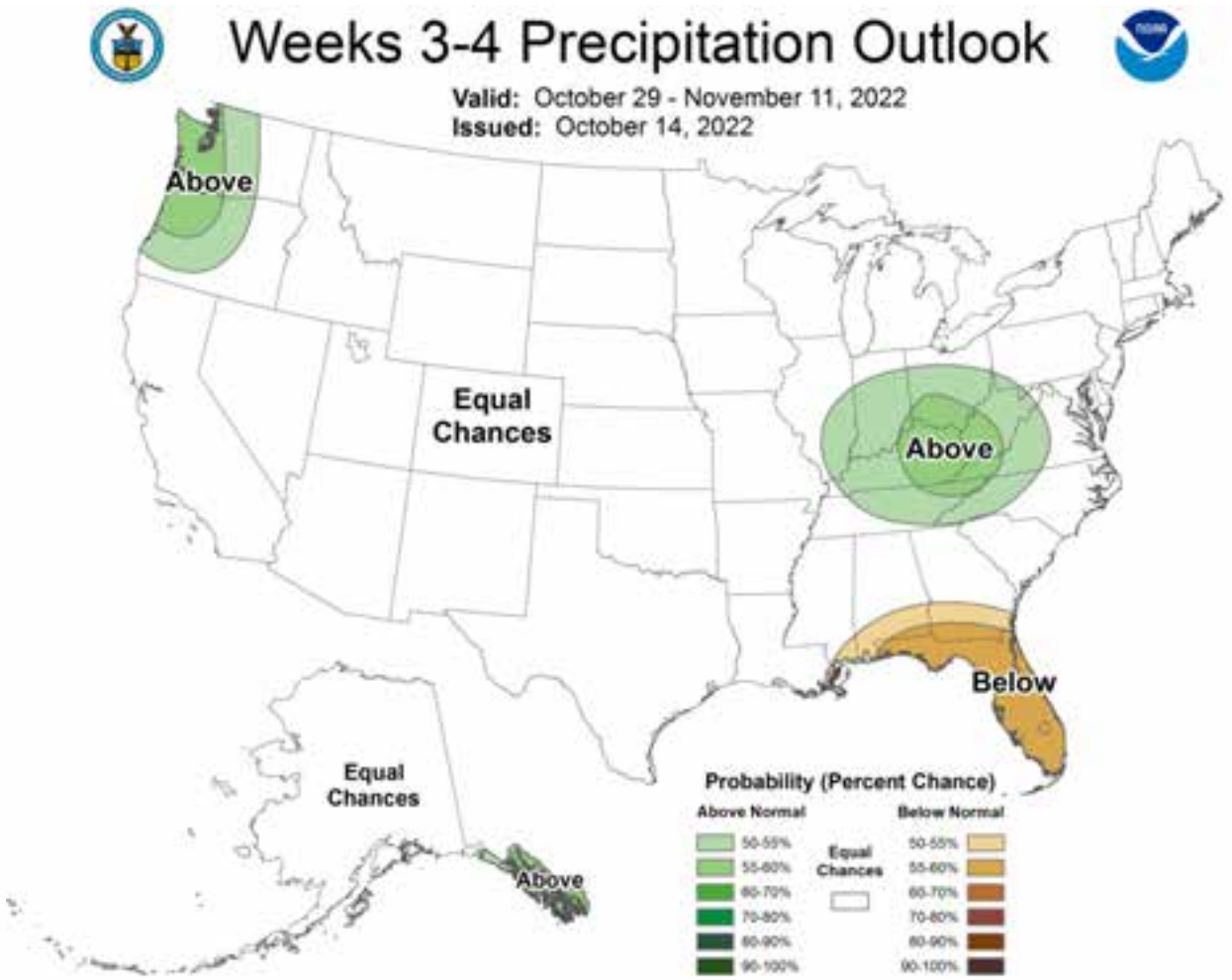
47th Climate Diagnostics and Prediction Workshop

October 26, 2022

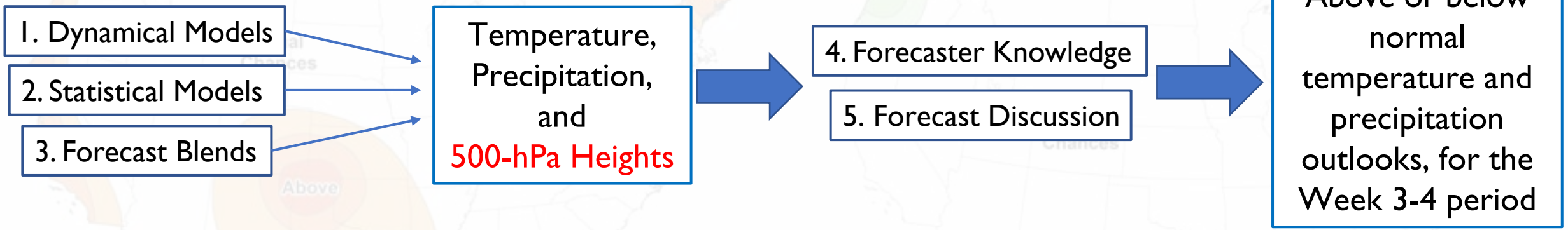
CPC's Week 3-4 Temperature and Precipitation Outlook





500-hPa Heights Forecast Tools

What role do 500-hPa heights play during the forecasting process?

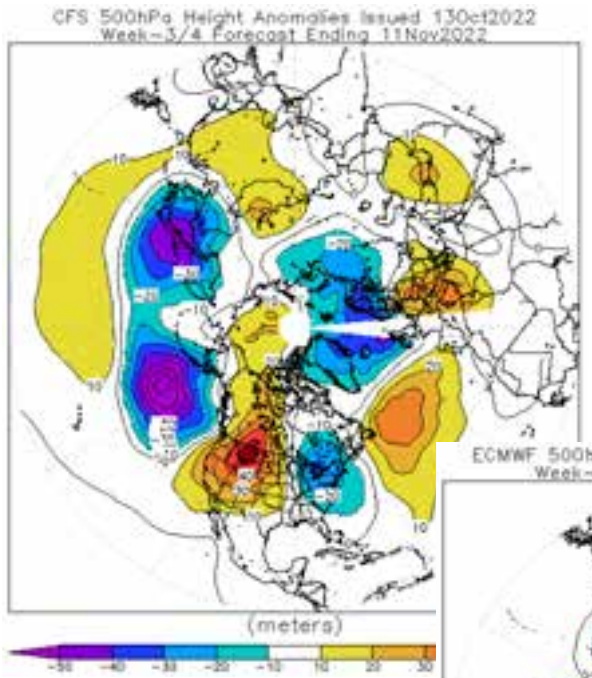


- While CPC does not issue an official Week 3-4 500-hPa heights outlook, the circulation is a critical component of the forecasting process for temperature and precipitation.

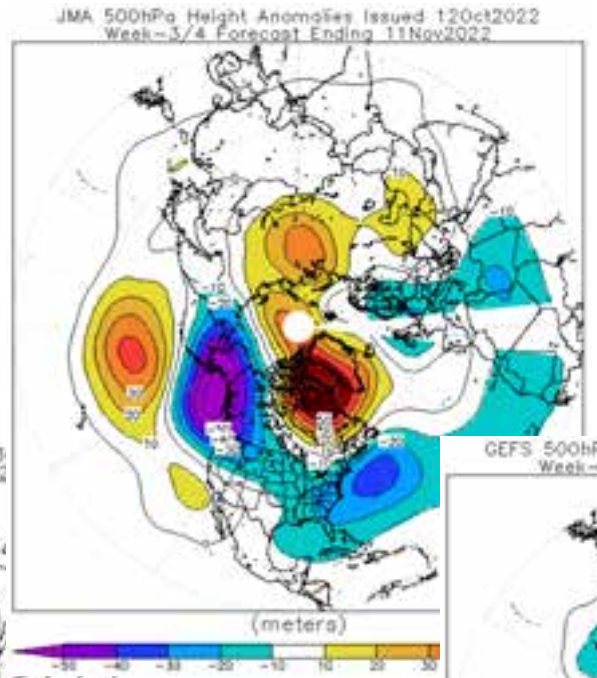
500-hPa Heights Forecast Tools: Dynamical Models

1. Dynamical Models:

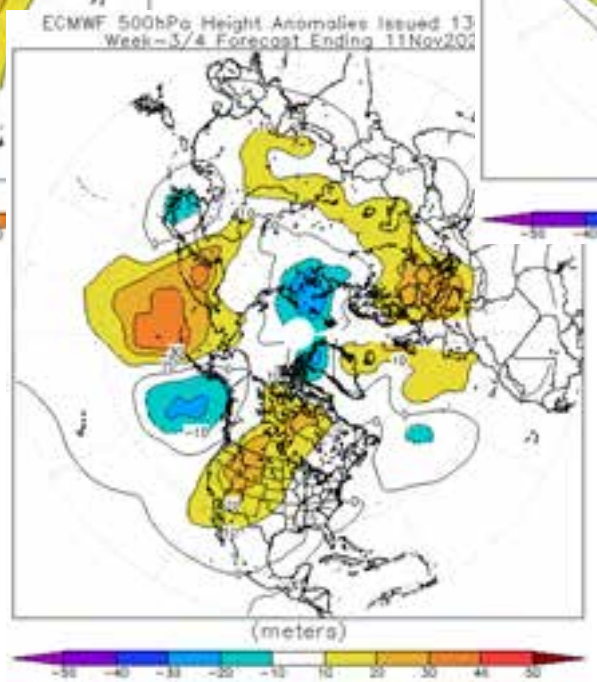
CFSv2



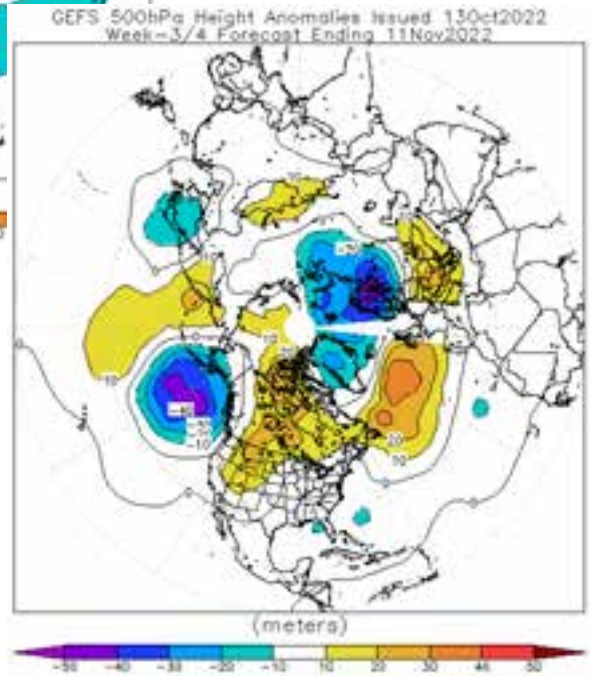
JMA



ECMWF



GEFSv12

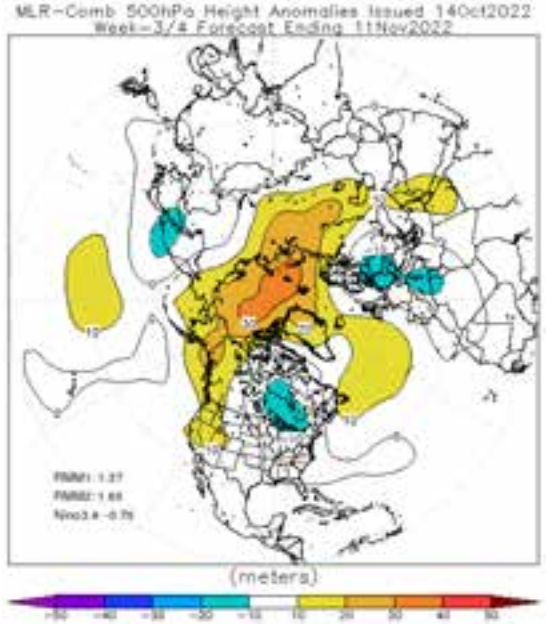


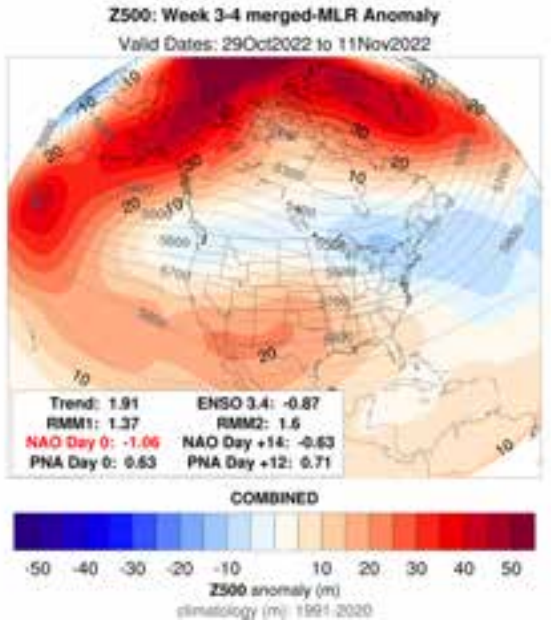
500-hPa Heights Forecast Tools: Statistical Models

2. Statistical Models:

Operational MLR

Predictors: ENSO, MJO, and Trend





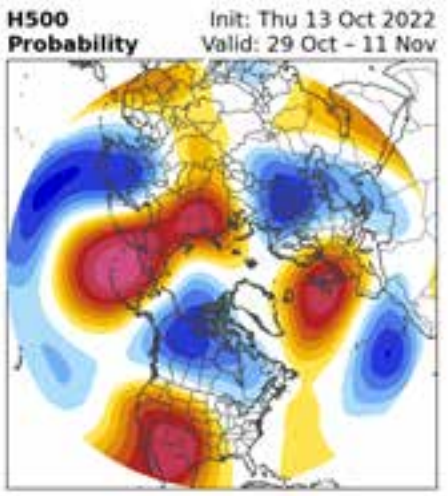
Experimental merged-MLR

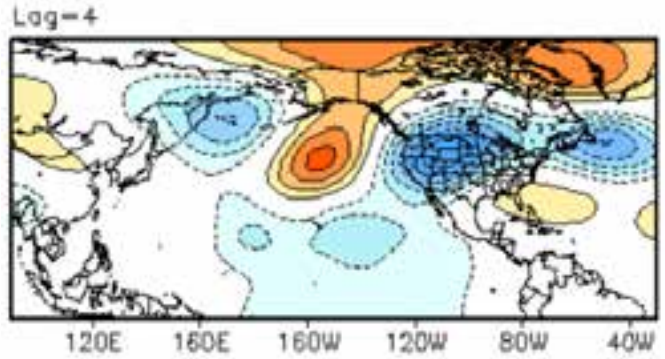
Predictors: ENSO, MJO, Day +14 NAO, Day+12 PNA, and Trend

Linear Inverse Model

(technically an empirical-dynamical model)

(Albers and Newman)





Simple MJO Composites

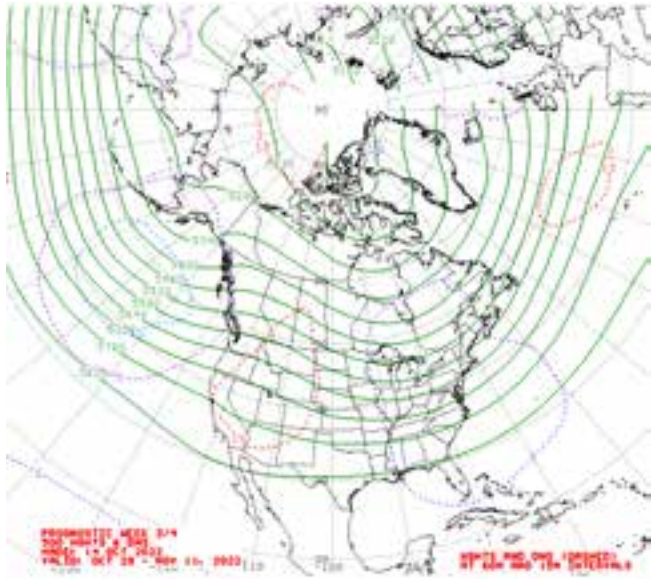
Pentad +4 following phase 6 of the MJO during OND

500-hPa Heights Forecast Tools: Forecast Blends

3. Forecast Blends:

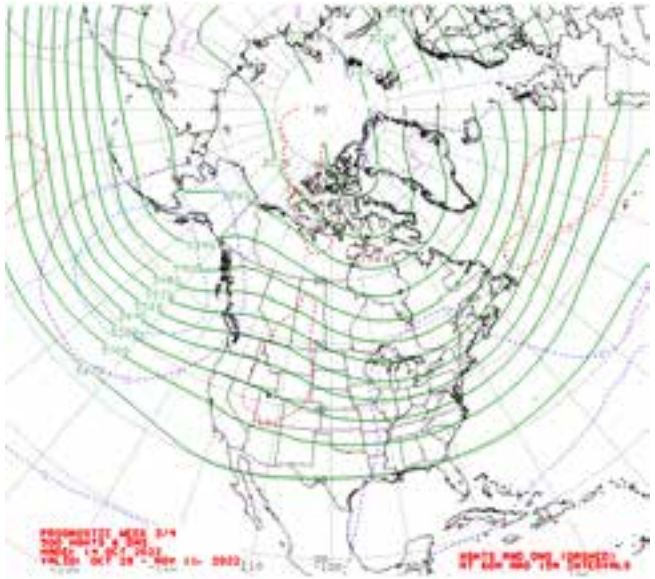
Auto Blend

MLR 35%, ECMWF 30%, CFSv2 25%, JMA 10%



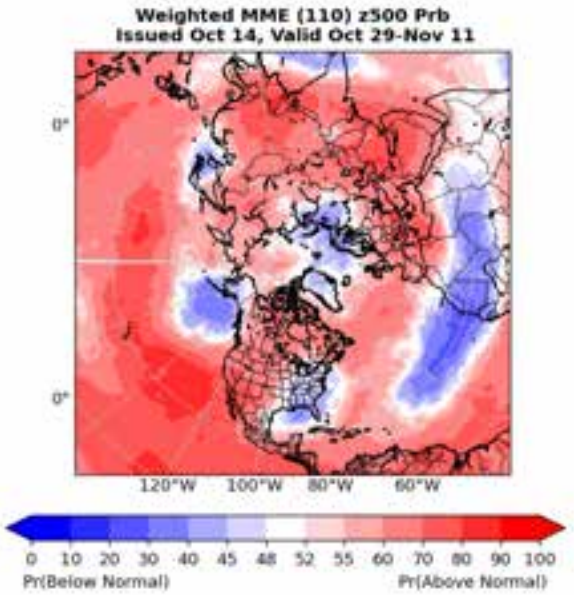
Manual Blend

MLR 25%, ECMWF 25%, CFSv2 15%, JMA 10%



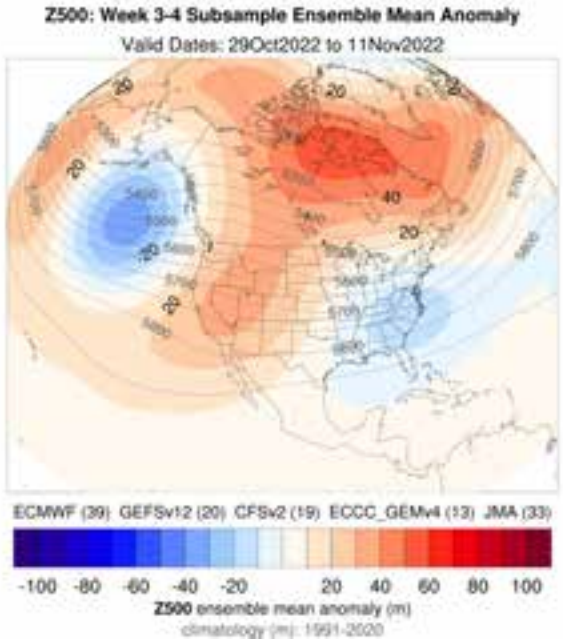
SubX

110-Member, Multi-model Ensemble from SubX



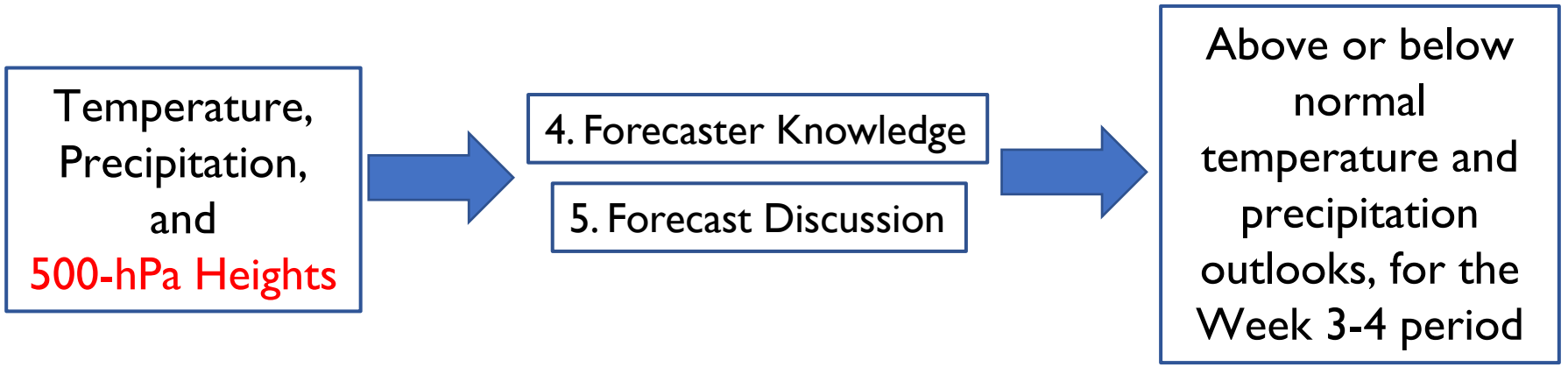
Ensemble Subsample

124-Member, Multi-Model Ensemble from the ECMWF, CFSv2, JMA, ECCC, and GEFSv12



Pattern Recognition

How do forecasters use 500-hPa heights to inform Week 3-4 temperature and precipitation outlooks?



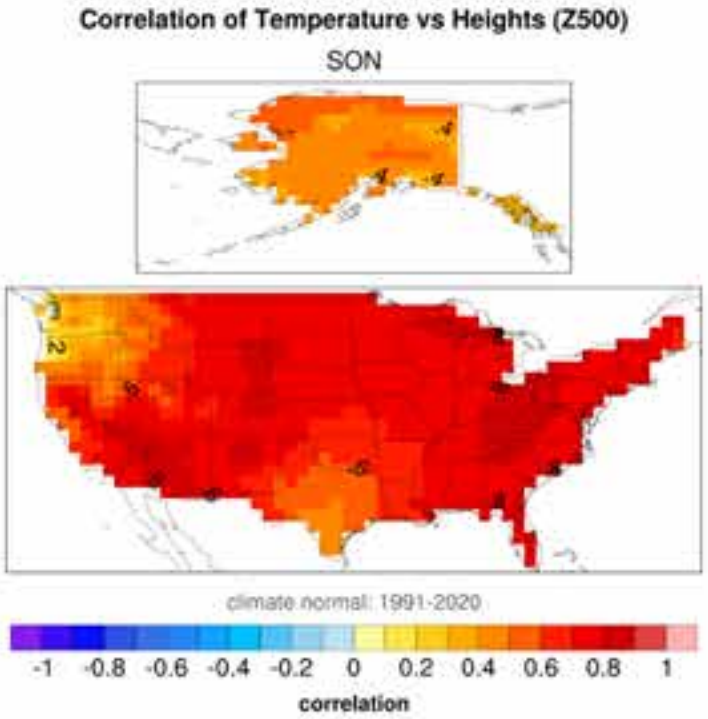
- **Pattern recognition (500-hPa heights analysis)**
  - Forecasters have a good knowledge of the relationship that anomalous temperature and precipitation have with 500-hPa heights.
  - However, incorporation of this knowledge has generally been subjective in nature.
  - Further, sometimes the finer details of the relationship, such as regional dependencies and seasonal evolution, are not always readily apparent.
  - **Thus, a new tool has been constructed to provide objective information on the relationship of 500-hPa heights to temperature and precipitation across CONUS/AK as a function of season in the form of correlations and 3 x 3 contingency tables.**

Observed Correlations: Heights vs Temperature

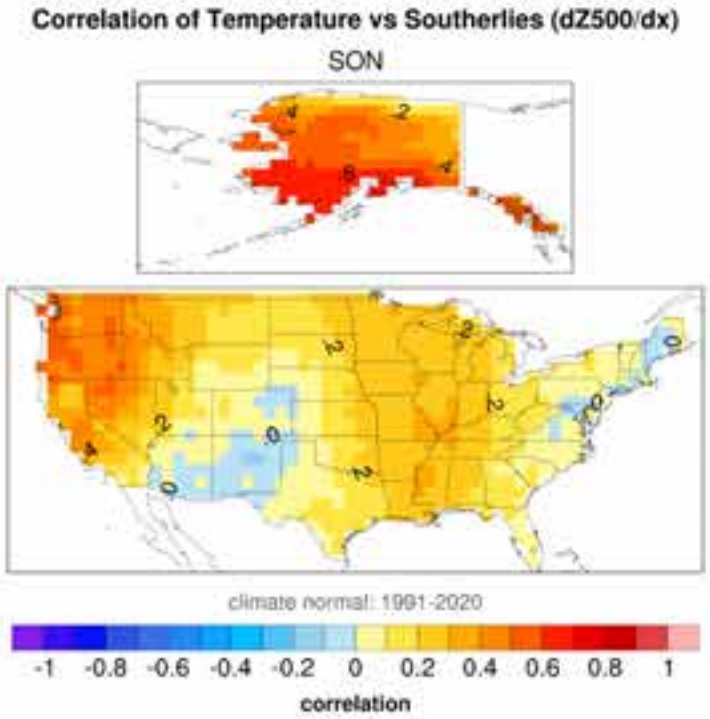
Week 3-4 Circulation

Week 3-4 Circulation: **Temperature Correlations** - Precipitation Correlations - Temperature Verifications - Precipitation Verifications - Documentation

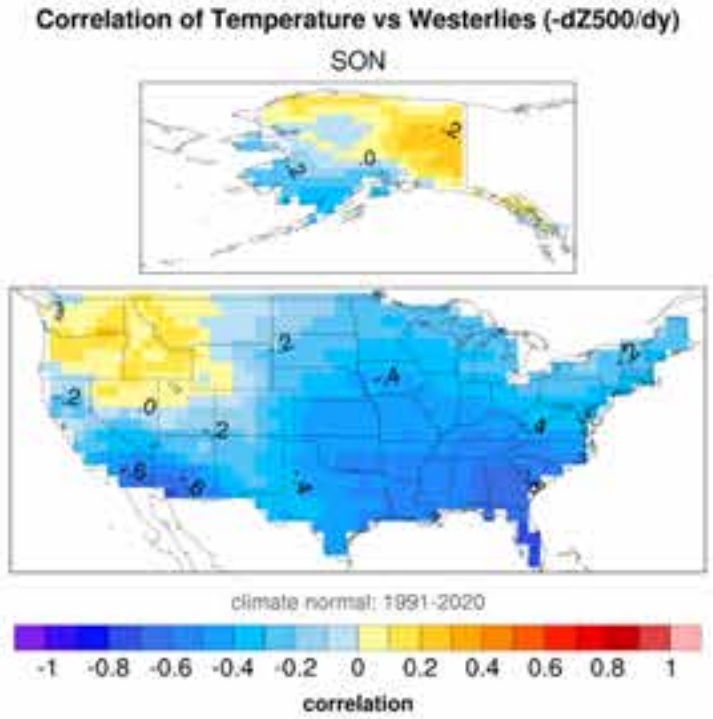
Temperature vs Heights (Z500)



Temperature vs Southerlies (dZ500/dx)



Temperature vs Westerlies (-dZ500/dy)

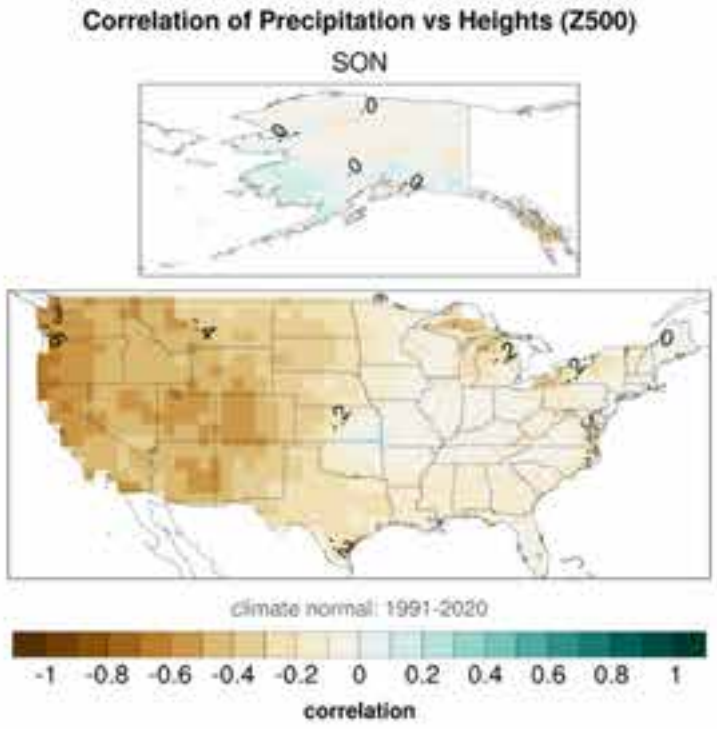


Observed Correlations: Heights versus Precipitation

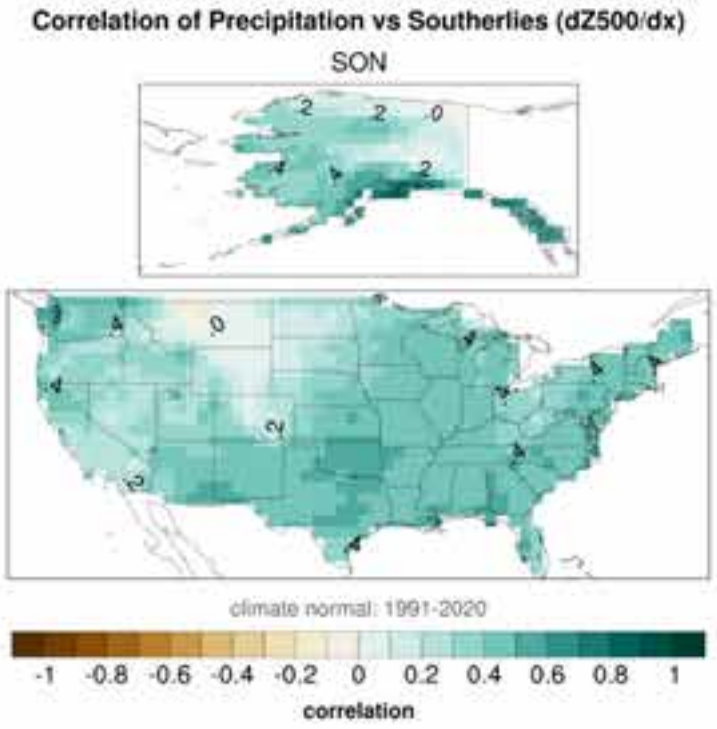
Week 3-4 Circulation

Week 3-4 Circulation: Temperature Correlations - **Precipitation Correlations** - Temperature Verifications - Precipitation Verifications - Documentation

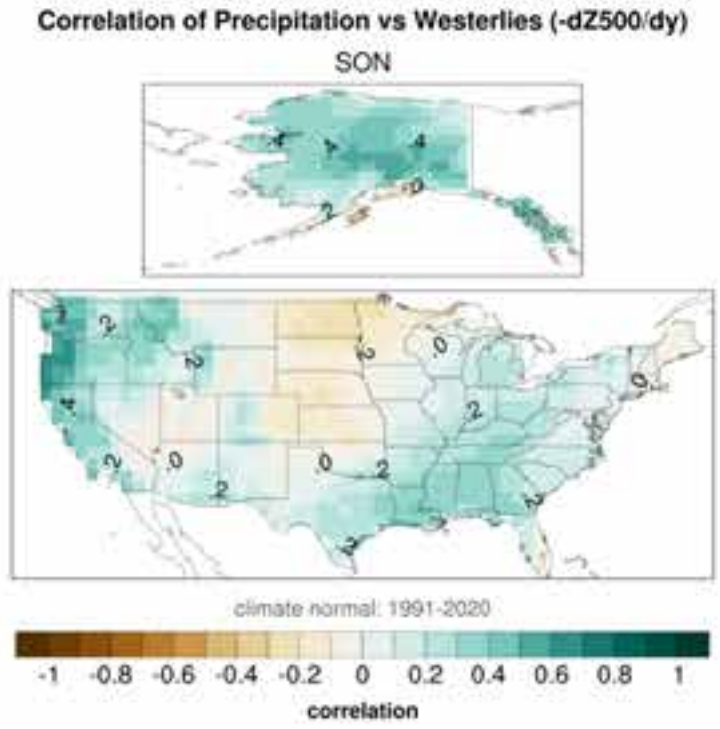
Precipitation vs Heights (Z500)



Precipitation vs Southerlies (dZ500/dx)



Precipitation vs Westerlies (-dZ500/dy)



3-Category Contingency Tables: Observed Heights vs Observed Temperature

Week 3-4 Circulation

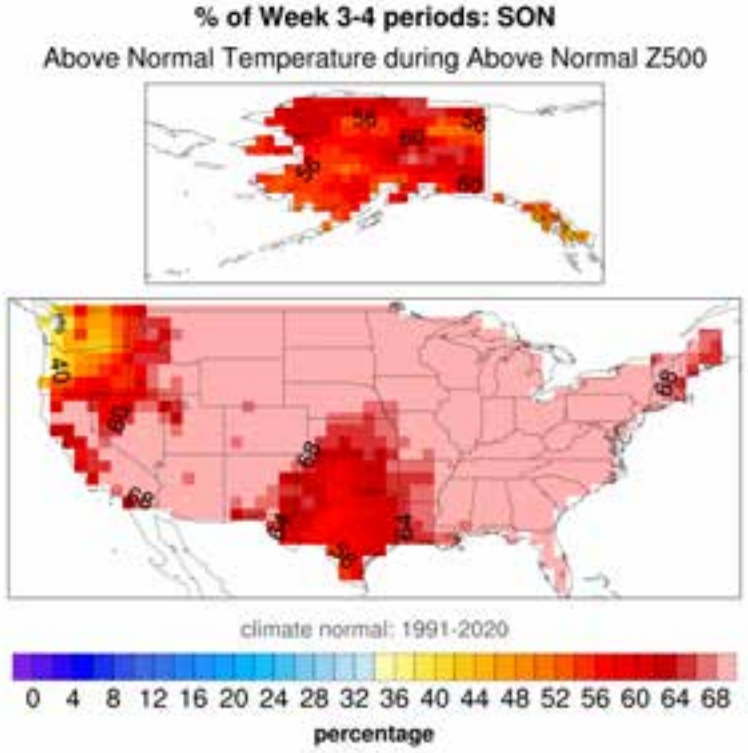
Week 3-4 Circulation: Temperature Correlations - Precipitation Correlations - **Temperature Verifications** - Precipitation Verifications - Documentation

Verification: **Observed** - ECMWF - GEFSv12 - CFSv2 - ECCC - JMA

Season: ALL - DJF - JFM - FMA - MAM - AMJ - MJJ - JJA - JAS - ASO - **SON** - OND - NDJ

Observed Above Normal Temperature

Observed Above Normal 500-hPa Heights



3-Category Contingency Tables: GEFSv12-Forecasted Heights vs Observed Temperature

Week 3-4 Circulation

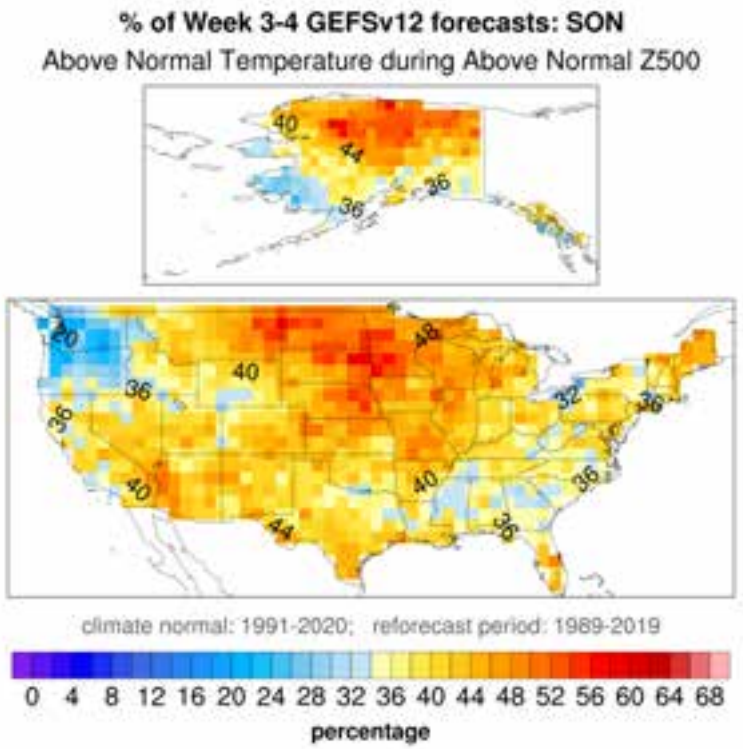
Week 3-4 Circulation: Temperature Correlations - Precipitation Correlations - **Temperature Verifications** - Precipitation Verifications - Documentation

Verification: Observed - ECMWF - **GEFSv12** - CFSv2 - ECCC - JMA

Season: ALL - DJF - JFM - FMA - MAM - AMJ - MJJ - JJA - JAS - ASO - **SON** - OND - NDJ

Observed Above Normal Temperature

GEFSv12-Forecasted Above Normal 500-hPa Heights



3-Category Contingency Tables: Observed Heights vs Observed Precipitation

Week 3-4 Circulation

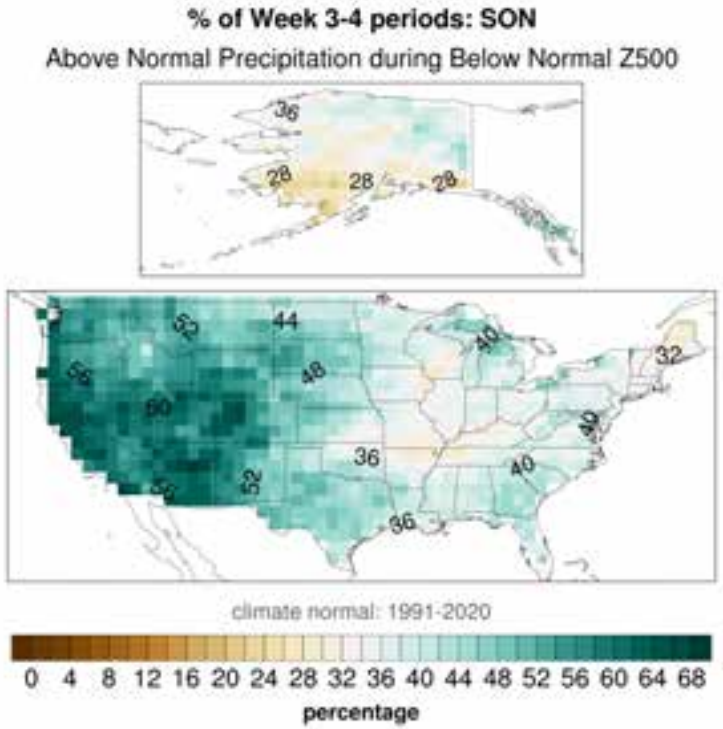
Week 3-4 Circulation: Temperature Correlations - Precipitation Correlations - Temperature Verifications - **Precipitation Verifications** - Documentation

Verification: **Observed** - ECMWF - GEFSv12 - CFSv2 - ECCC - JMA

Season: ALL - DJF - JFM - FMA - MAM - AMJ - MJJ - JJA - JAS - ASO - **SON** - OND - NDJ

Observed Above Normal Precipitation

Observed Below Normal 500-hPa Heights



3-Category Contingency Tables: GEFSv12-Forecasted Heights vs Observed Precipitation

Week 3-4 Circulation

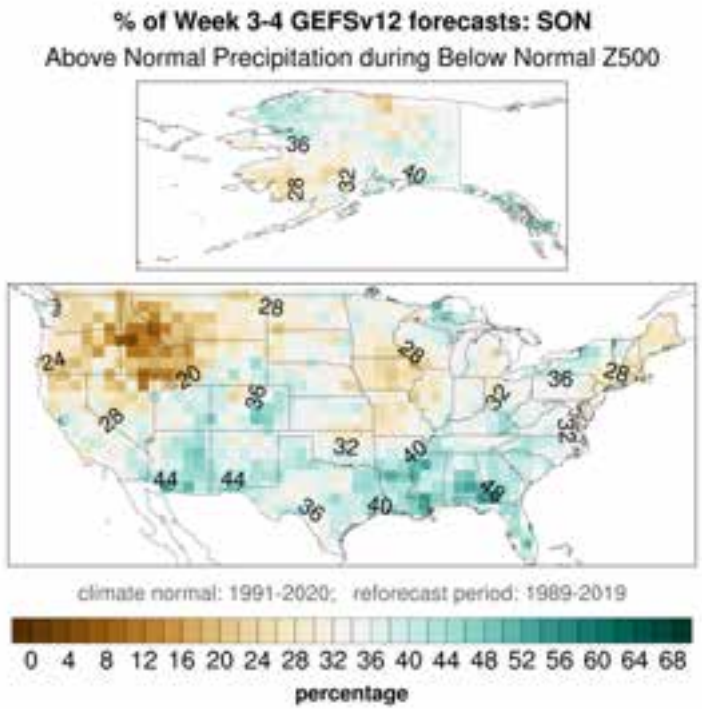
Week 3-4 Circulation: Temperature Correlations - Precipitation Correlations - Temperature Verifications - **Precipitation Verifications** - Documentation

Verification: Observed - ECMWF - **GEFSv12** - CFSv2 - ECCC - JMA

Season: ALL - DJF - JFM - FMA - MAM - AMJ - MJJ - JJA - JAS - ASO - **SON** - OND - NDJ

Observed Above Normal Precipitation

GEFSv12-Forecasted Below Normal 500-hPa Heights



Conclusions

- The tool provides a quick, objective glance of the strength of the relationship between 500-hPa Heights with temperature and precipitation over CONUS/AK across all seasons.
- The work is still experimental. We are seeking input from the forecasters and the community to make the tool as useful as possible in real-time.

Thank you! Questions?

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Extra Slides

Could we create Z500-based probabilistic forecasts of temperature and precipitation?

For example, for a given forecast issuance, we could use the individual ensemble members to derive probabilities of above, near, or below normal temperature by using reforecast information about how often above, near, or below normal temperature is observed given an individual member's forecast of above, near, or below normal Z500.

For a given forecast:

> % above normal T = % members above Z x ratio of observed above T to forecasted above Z +
> % members near Z x ratio of observed above T to forecasted near Z +
> % members below Z x ratio of observed above T to forecasted below Z
>
> And so forth for % near normal T and % below normal T

I suppose this is a sort of calibration, but it may not provide much information given that temperature and precipitation probabilities only change subtly given the GEFSv12 forecast's for Z500.