Calibrating GEFS at medium range using short-lead MOS equations

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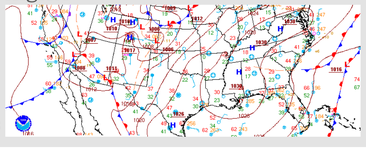
Background

- Forecasting temperature extremes in the Subseasonal to Seasonal (S2S) range is challenging
- Raw model output of max and min temperatures are often wrong even at leads less than 24 hours, due to inherent physical limitations and biases
- Understanding ensemble output at S2S leads is therefore more complicated than simply taking the raw model forecast at those leads
- Calibration of raw model forecasts is necessary
- Calibration is often done with only the variable in question (tmax for tmax, tmin for tmin, etc), but other model information, such as relative humidity or wind speed, can have a large impact as well
- Calibration at S2S leads needs to be done carefully to avoid forecasts converging to climatology, if we want a realistic range of possible outcomes

What we did

- As a proof-of-concept, focus on cold, clear nights in the southeastern CONUS, where models tend to struggle to produce low enough temperature forecasts
- Use a Model Output Statistics (MOS) methodology, to determine model variables that are most relevant
- Derive seasonally-sensitive MOS equations based on short-lead (<24 hour) Global Ensemble Forecast System (GEFS) relationships, over the period of reforecast, 2000-2019
- Apply those MOS equations to S2S leads in the realtime (2020-2024) data set for each individual GEFS ensemble member
- Investigate how the distribution of ensemble forecasts changes from raw model to MOS output for low temperatures on cold, clear nights in the southeastern US
- Compare with actual low temperatures on those nights



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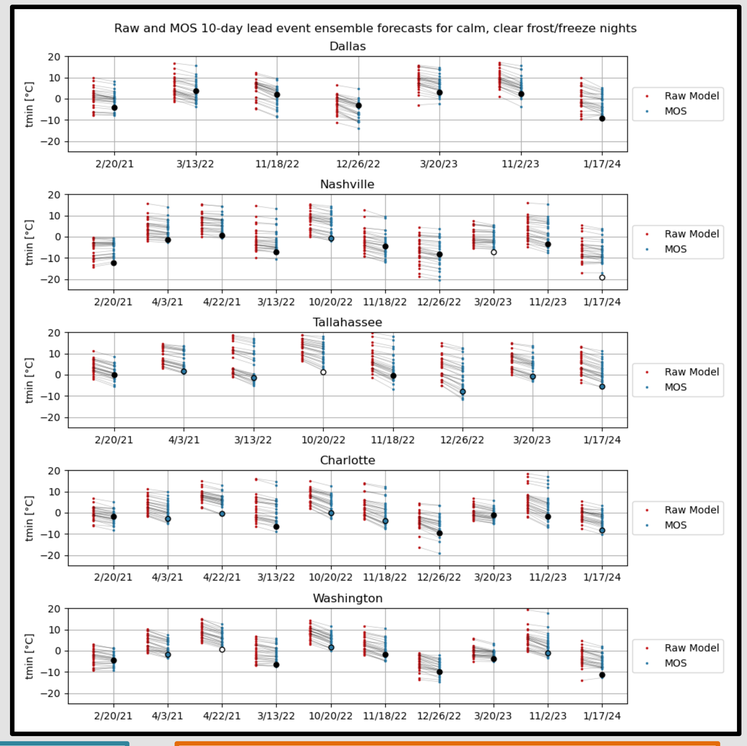
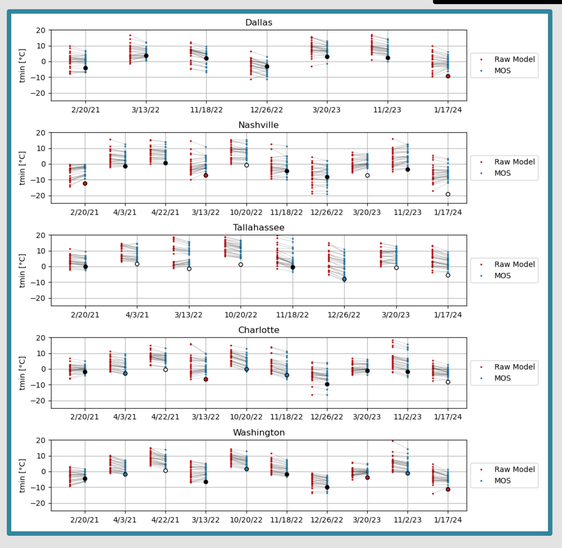
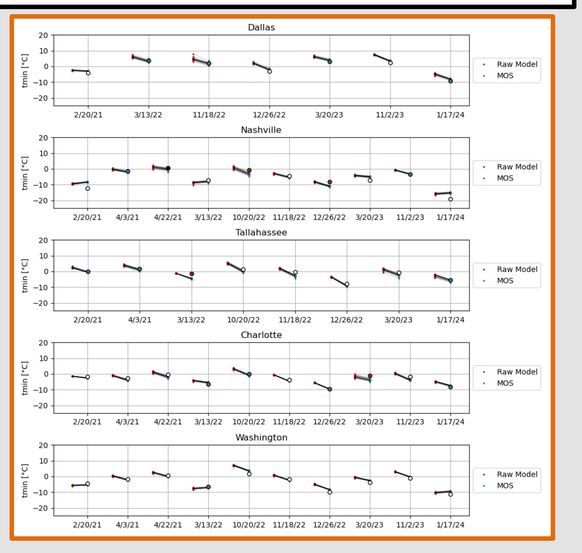
Results

- Usually, the raw ensemble forecasts (small red dots), when calibrated with MOS (small blue dots), were corrected towards the observed tmin (large filled dot)
- The raw ensemble spread often contained the true tmin at lead 10, and when it did, so did the MOS-calibrated spread. These cases are indicated with a black-filled observed tmin
- There were a few cases where neither the raw ensemble nor the MOS-calibrated ensemble captured the observed tmin, indicated with a white-filled observed tmin
- There are several cases where the raw ensemble spread did not capture the true tmin, but the MOS-calibrated spread did, indicated with a blue-filled observed tmin
- **Shown for context below are cases where we use 10-day forecasts to derive MOS equations (left), and the 0-day ensemble forecast (right)**







Conclusion

- The standard method of deriving MOS equations at longer leads from forecasts at those longer leads may lead to lower error scores overall for individual forecasts, but when assessing risk of extremes, these calibrations tend to collapse the ensemble forecast distributions towards climatology
- Calibration using the given forecast variable alone may miss critically useful information about the meteorological pattern that is available from the model output, for example, wind speed, relative humidity, 850-hPa temperatures, and more
- Using short-lead MOS equations to calibrate long-lead ensemble forecasts is shown to preserve the spread of ensemble forecasts at S2S leads, while generally correcting forecasts in the right direction, at least for tmin on cold, clear nights
- Summary statistics, such as percentage of observations above or below the median ensemble forecast, and bias of ensembles forecasts, not shown in this presentation, also indicate MOS corrections towards better forecasts

Continuing work

- We would like to further investigate summary statistics, such as reliability, to better get an idea of the success of this MOS calibration technique
- We want to compare these scores to calibration techniques already used at CPC, such as bias correction and ensemble regression
- We would also like to test other variables (such as extreme tmax days or extreme precipitation) and locations in CONUS
- Ultimately, we may want to expand this technique to all locations, all days, all variables

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