Harnessing skill from statistical and dynamical models to improve subseasonal forecasts: A Bayesian approach

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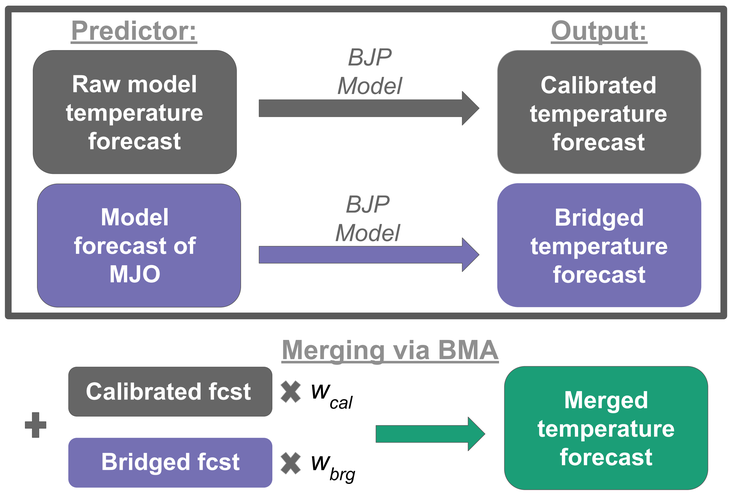
Motivation

Predicting climate at lead times of 3-4 weeks (W34) remains a challenging task. Despite recent advances, models may not optimally identify predictable signals such as those associated with the Madden-Julian Oscillation (MJO) or El Niño/Southern Oscillation (ENSO). For example, empirically-derived statistical forecasts based on ENSO, MJO and trend used at the NOAA Climate Prediction Center are in some cases more skillful than operational dynamical model forecasts. To combine information from statistical and dynamical forecasts, we apply a statistical-dynamical modeling method known as **Calibration**, **Bridging**, and **Merging** (CBaM) to data from the SubX hindcast. While the SubX models skillfully predict the MJO through week 3, the correlation with the observed RMM tends to drop below 0.6 in week 4. We attempt to use shorter lead (e.g., days 0-21) SubX MJO forecasts to predict W34 temperature over North America ("**bridging**"). The ultimate goal is to **merge** the **bridged** and **calibrated** SubX forecasts to achieve broader forecast skill. We use the three Wednesday-initialized models from the SubX dataset (EMC-GEFS, ESRL-FIMv2, and NCEP-CFSv2; i.e., the "mini-MME") to test CBaM over the hindcast period, 1999-2014.

All about CBaM (abridged)

- CBaM is a method for post-processing dynamical model forecasts using Bayesian joint probability (BJP) modeling
- We apply calibration and bridging to post-process SubX mini-MME W34 temperature forecasts for the hindcast period, 1999-2014
- Calibration and bridging models are developed using BJP modeling to represent the relationship between the SubX predictor and the observed predictand. Merging will be done using Bayesian model averaging (BMA)



Calibrated SubX Forecasts

Fig 1: BSS(Calibrated) - BSS(Raw), mini-MME

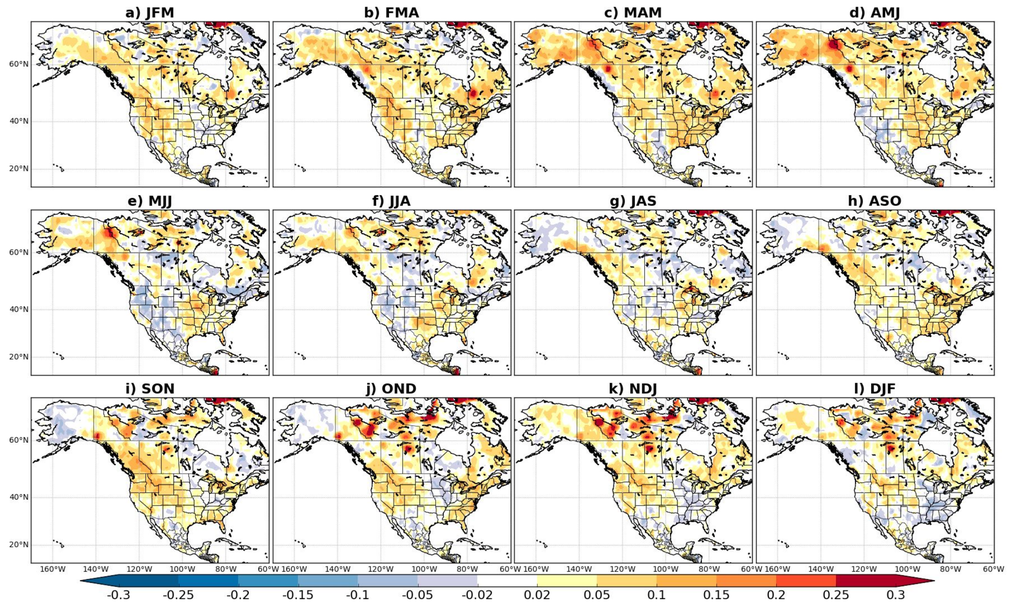


Fig. 1: Brier skill score (BSS) differences (Calibrated − Raw) from mini-MME 2-class probabilistic forecasts of above or below normal W34 2-m temperature. ***Fig. 2***: % of grids for which the differences shown in Fig. 1 are > 0.02 or < -0.02. ***Fig. 3:*** Reliability diagrams depicting the relationship between predicted probabilities (x-axis) and observed relative frequencies (y-axis) for calibrated (orange) and raw (black) mini-MME forecasts.

Fig.2: **% of Grids for which calibration helps or hurts skill**

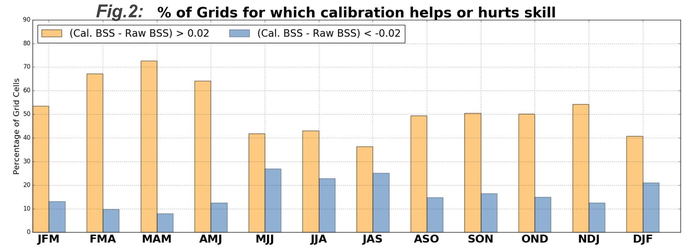
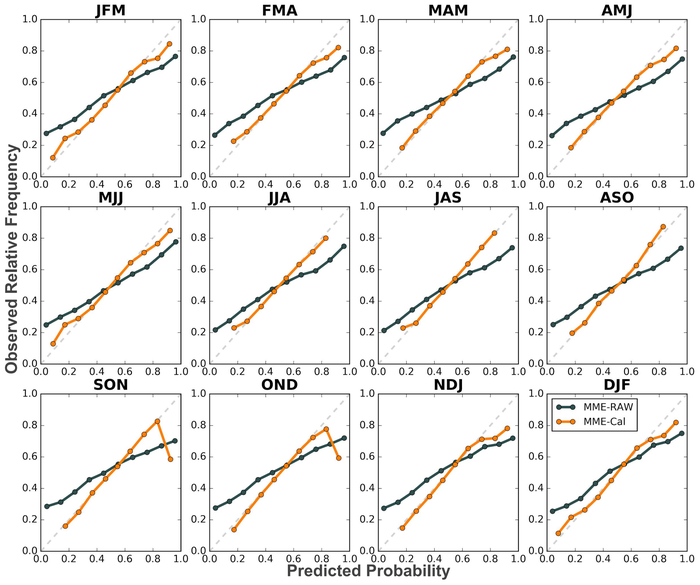


Fig.3: Reliability



Bridged (MJO) SubX Forecasts

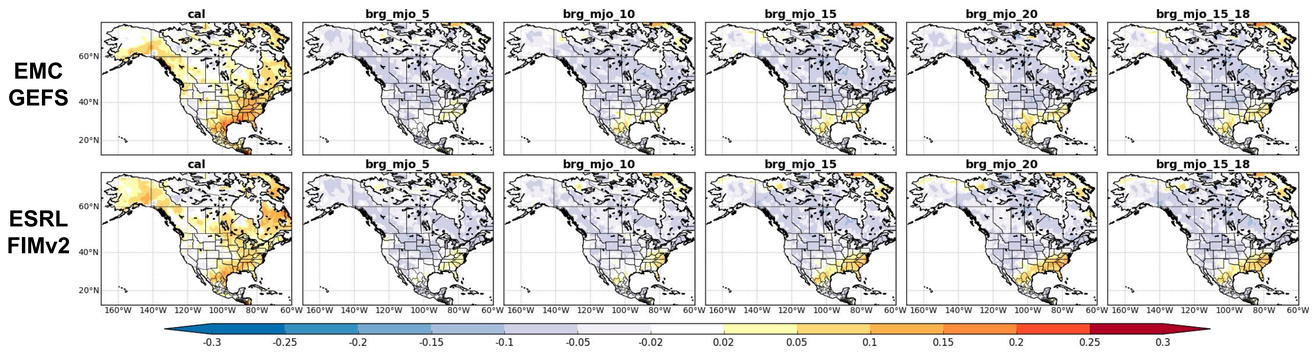


Figure 4: Mean Brier skill scores for all calibrated (left) and bridged W34 temperature forecasts initialized in DJF from the EMC-GEFS (top row) and ESRL-FIMv2 (bottom row). Bridging is done using the forecast MJO index (RMM1, RMM2) at lead times of 5, 10, 15, 20, and mean(15-18) days.

Summary & Conclusions

BJP calibration improves the reliability and, on average, the skill of the mini-MME temperature forecasts. Bridging with the MJO (RMM) teleconnection does not further enhance skill, suggesting that the MJO-temperature teleconnection over North America is already well-represented by the models. Additional interannual and intraseasonal teleconnections will be examined for bridging potential. See Schepen et al., 2015 (Monthly Weather Review) for the unabridged description of CBaM. We thank Emerson LaJoie and Kathy Pegion for providing SubX data. This work is funded by a MAPP-CPO Climate Test Bed grant.