Increasing Forecast Skill through Bridging of Climate Teleconnections:
A Hybrid Statistical- Dynamical Prediction System

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Calibration, Bridging, and Merging (CBaM)

**CBaM:**
- Developed by CSIRO collaborators
- Application to NMME and North America
Bayesian Joint Probability (BJP) Model

Calibration and bridging model uses **Bayesian Joint Probability (BJP)** modeling (Wang et al. 2009)

- Predictor (e.g., Niño 3.4) and predictand (e.g., 2-m T) modeled using a bivariate normal distribution, where the distribution parameters are not assumed to be fixed

- Individual **calibration** and **bridging** BJP models are developed for each NMME member mean, grid point, lead, and season

- Comparison to **Ensemble Regression (EReg) baseline** used at CPC (Unger et al. 2009)

BJP generates a statistical ensemble by sampling from the posterior distribution of the bivariate normal parameters (n = 1000)
Calibration, Bridging, and Merging (CBaM)

Raw dynamical model forecast of North American 2-m temperature

Statistical post-processing

Statistically corrected (calibrated) forecast of North American 2-m temperature
Calibration, Bridging, and Merging (CBaM)

Dynamical model forecast of a relevant climate index (e.g., Niño 3.4)

Statistical post-processing

Statistically bridged forecast of North American 2-m temperature
Calibration, Bridging, and **Merging** (CBaM)

- Statistically bridged forecast of North American 2-m temperature
- Statistically corrected (calibrated) forecast of North American 2-m temperature
- Weighted merging of forecasts based on performance in hindcast period
Differences in model & observed Nino 3.4 correlation pattern
Skill in forecasts of large-scale climate indices

<table>
<thead>
<tr>
<th></th>
<th>CFSv2</th>
<th>CMC1</th>
<th>CMC2</th>
<th>GFDL</th>
<th>FLOR</th>
<th>NASA</th>
<th>CCSM4</th>
<th>NMME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation w/obs</td>
<td>0.86</td>
<td>0.96</td>
<td>0.96</td>
<td>0.92</td>
<td>0.94</td>
<td>0.95</td>
<td>0.88</td>
<td>0.95</td>
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</table>
Objective

- **Question**: Does statistical bridging using climate indices improve forecast skill, beyond the skill of calibrated model forecasts of temperature and precipitation?
Brier Skill Score (BSS):
NMME 1-month lead calibrated forecasts of 2-m temperature for 12 overlapping seasons
BSS: Model calibrated forecasts of DJF 2-m temperature
BSS: Lead 1 **bridged** forecasts of DJF 2-m temperature
BSS: Lead 1 **merged** forecasts of DJF 2-m temperature
BSS: **NMME** calibrated, bridged, & merged forecasts
Brier Skill Score: Probabilistic forecasts of below normal US + AK 2-m Temperature (CFSv2)

Brier Skill Score: Probabilistic forecasts of below normal US + AK 2-m Temperature (CMC1)
Can lower skill of precipitation forecasts be enhanced by bridging?
Brier Skill Score Difference (Bridged – Calibrated):

1-month lead forecasts of precipitation rate

DJF

JJA
Conclusions

➢ On average, **calibrated forecasts** are greater skill relative to Nino 3.4 **bridging**.

➢ **Bridging** models provide greater skill *in particular seasons and regions*.
   - Example: Winter temperatures, over the northern United States.

➢ **Bridging** skill and enhancement of **calibrated forecasts** varies by model.

➢ **Merged** forecasts result in *the most coverage of positive skill*.
Ongoing and future work

➢ Exploring **additional climate indices** for bridging (e.g., AO/NAO)

➢ Incorporating all **ensemble members**

➢ Application to **subseasonal** forecasts
Thank you!
Extras
Reliability: Lead 1 forecasts of DJF 2-m temperature
Reliability plots: 1-month lead calibrated and bridged CFSv2 forecasts of DJF 2-m temperature
1-Month Lead DJF Pr(Below normal 2-m T)
EReg Niño 3.4 Bridging

1-Month Lead DJF Pr(Below normal 2-m T)
BJP Niño 3.4 Bridging
BJP probabilities of above/below normal temperature

Probabilities, DJF 1997/98, NMME Bridging

Probabilities, DJF 1997/98, NMME Calibration

Observed, DJF 1997/98
Brier Skill Score:
NMME 1-month lead bridged forecasts of DJF 2-m temperature