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Probabilistic Forecasting with NMME

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The North American Multi-Model Ensemble (NMME, http://www.cpc.ncep.noaa.gov/products/NMME/) forecasting system has been continuously producing seasonal forecasts since August, 2011. The NMME, with its suite of diverse models, provides a valuable opportunity for characterizing forecast confidence using probabilistic forecasts. The realtime forecasts have become an important tool for NOAA Climate Prediction Center seasonal forecasters, as well as many others. This study will serve as a baseline assessment before a series of improvements are attempted for the forecast construction method.

The current experimental probabilistic forecast product (in map format, Fig. 1) presents the most likely tercile for the monthly mean value, chosen out of "above normal", "near normal", or "below normal", using a non-parametric counting method to determine the probability of each class.

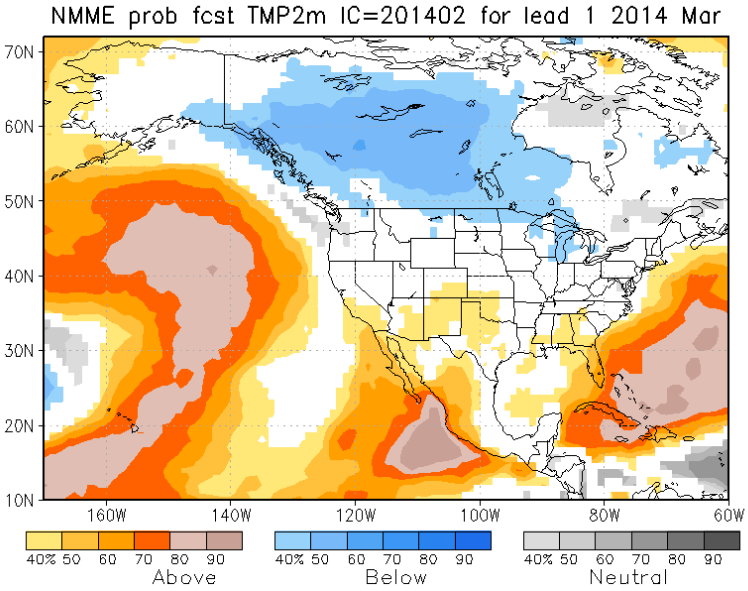

Fig. 1 Real-time 2 m surface temperature probabilistic forecast for March, 2014.

a. SST Niño 3.4 Region				
	A	**N**	**B**	**AC**
NMME	0.61	0.25	0.58	0.89
mini-NMME	0.60	0.24	0.59	0.89
CFS	0.45	0.05	0.43	0.82
6-mem CFS	0.41	-0.02	0.41	0.81

Table 1 Brier skill scores (BSS) and anomaly correlation coefficients (AC) for lead-1 forecasts from the NMME and CFSv2 of sea-surface temperature in the Niño3.4 region. Columns show BSS for forecasts in the above- (A), below- (B), and near-normal (N) categories; the last column is AC. Values are averaged over all 12 initial condition lead-1 forecasts. "Lead-1" seasonal forecast is for the first complete 3-month period following the initial month: for example, from June initial conditions, the lead-one seasonal forecast is for the July-August-September period.

A first-order bias correction is applied when the hindcast based local model climatology is removed (for each model separately) and replaced with the climatology from observations. A 2nd order bias correction is applied when forecasts are expressed in terciles derived from model hindcast data.

This study assesses the skill of the current method used to produce NMME realtime probabilistic forecasts using 29 years of cross-validated hindcasts. Probabilistic forecasts from a 6-model NMME, the full, 24-member CFSv2, a mini-NMME (4 members from each of 6 models), and a mini-CFS (6 members) are assessed using the Brier Skill Score (BSS), and the anomaly correlation of deterministic forecasts is included for comparison

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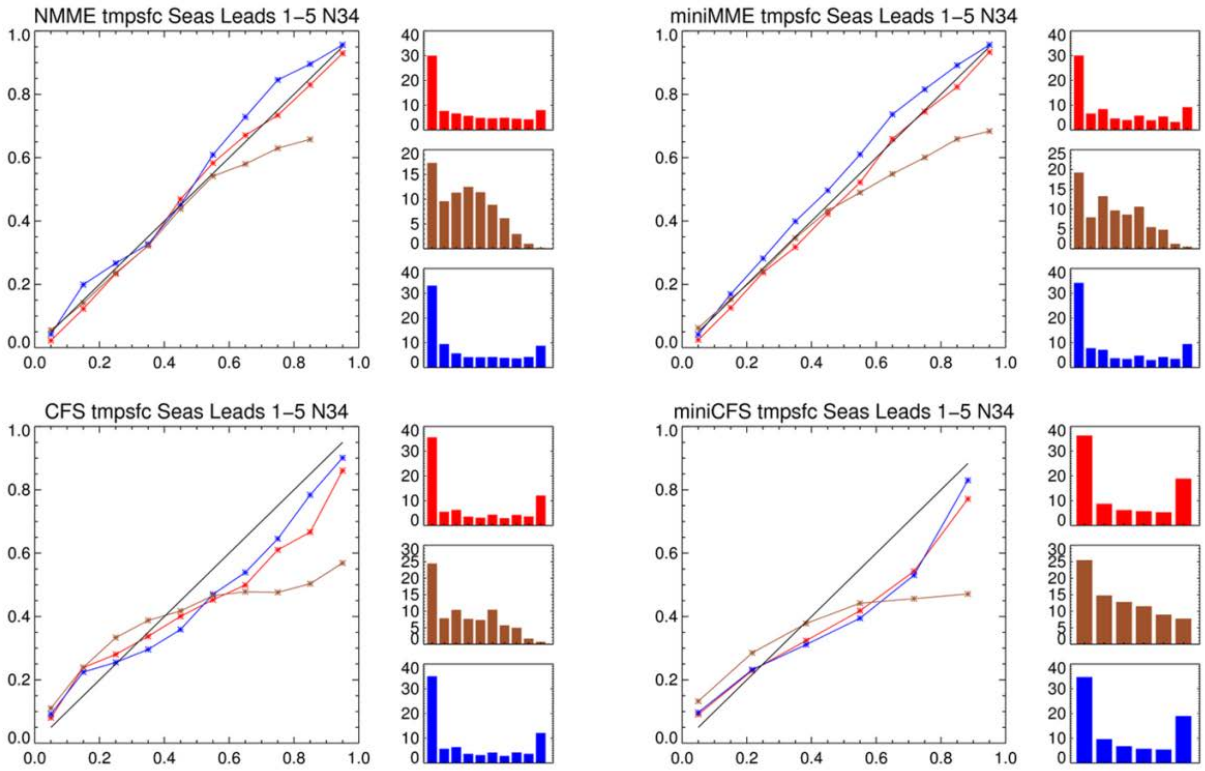

Fig. 2 Reliability diagrams for probabilistic forecasts of sea-surface temperature (SST) in the Niño3.4 region (190°E - 240°E, 5°S – 5°N) for the NMME (top L), mini-NMME (top R), CFS (lower L), and mini-CFS (lower R). Red lines indicate forecasts in the "above" tercile, blue the "below", and brown the "near-neutral". Lines closer to the black diagonal mean the observed event frequency (y-axis) is close to the forecast probability (x-axis), and therefore the forecasts are more reliable. Histograms indicate how often each forecast bin is used; numbering on the y-axis has been divided by 1000. All diagrams use 10 bins of size 0.1.

(Table 1). The hindcast assessment is employed due to the relatively short time that real-time probabilistic forecasts have been issued (less than two years.)

We also employ reliability diagrams, which allow for visual comparison of the conditional event frequency and the forecast probability; the associated "sharpness diagrams" indicate how often a given probability bin is used in the forecast. The "event" is an observation falling in a particular tercile. Probability forecasts are assigned to one of 10 bins (0 – 0.1, etc.). Reliability diagrams show the aggregated results for the lead-1 through lead-5 seasons (Fig. 2).

For all of the areas and fields (2 m land-only surface air temperature in the northern hemisphere, sea surface temperature in the Niño3.4 region and the extratropical northern hemisphere, and precipitation in the tropics) BSS for NMME forecasts are higher than those of CFSv2 forecasts. Forecasts in the near-normal tercile are near or below zero for all fields except sea surface temperature in the Niño3.4 region; BSS of the near-normal tercile is nevertheless much lower than the above and below categories. This preliminary study lends confidence that the NMME probabilistic forecasts, even as-is, provide value beyond that of the CFSv2 alone. The NMME benefits from both a higher number of ensemble members and model diversity. Further study is required to assess the sources of improved skill in the various fields and regions.

This work has been submitted to the Journal of Climate and is currently under review.