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Evaluation of the National Multi-Model Ensemble System for Seasonal and Monthly Prediction

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1. Introduction

The National Multi-Model Ensemble (NMME) project supplies routine guidance to users. Phase I (experimental) ran from August 2011 to July 2012. Phase II is in operation now. This assessment focuses on the results of Phase I, and includes diagnostic verification of NMME seasonal and monthly prediction. Evaluation metrics include anomaly correlations (AC) calculated from 29 years of hindcasts (1982-2010) and Heidke skill scores (HSS) for the realtime seasonal and monthly 2 meter surface temperature (T2m) and precipitation rate (Prate) forecasts from August 2011 to July 2012 over the contiguous United States. Prediction of the winter for December-January-February (DJF) 2011/12 is used as a case study. This study is motivated by the desire to provide skill benchmarks for future improvements of the NMME seasonal and monthly prediction system.

2. The National Multi-Model Ensemble project

The NMME is a forecasting system consisting of coupled models from U.S. and Canadian modeling centers. The multi-model ensemble approach has been proven to produce better prediction quality than any single model ensemble, motivating the NMME undertaking. The environmental variables included in Phase I (Aug. 2011 – July 2012) were T2m, sea surface temperature (SST), and Prate; and realtime and archived forecast graphics from Aug. 2011 – present are available at www.cpc.ncep.noaa.gov/products/NMME. Hindcast and forecast data are archived at the International Research Institute for Climate and Society (IRI), accessible from the NMME homepage.

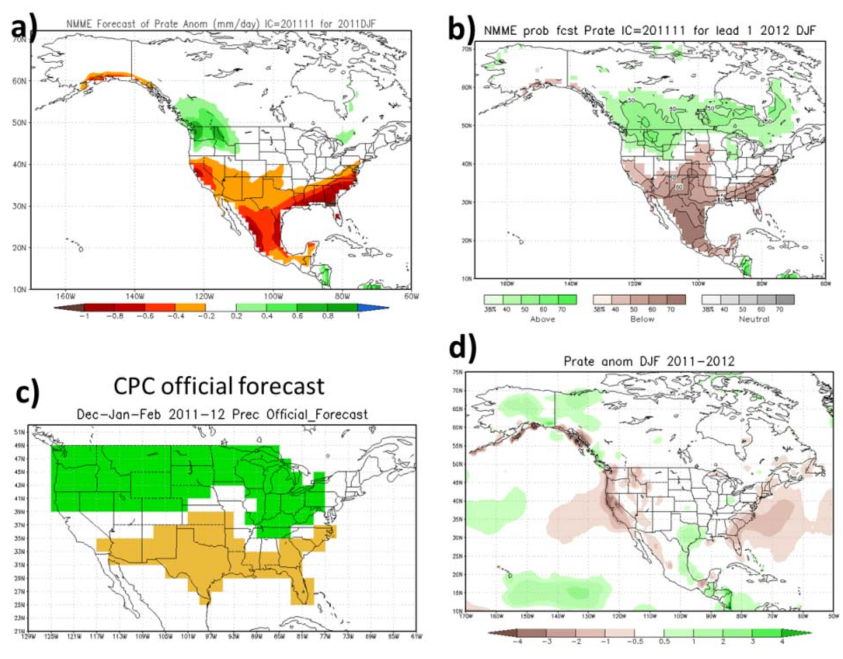

Fig. 1 NMME Prate anomaly forecast (a), probability forecast (b), Climate Prediction Center official forecast (c), and observed Prate anomaly from CPC URD (d) for DJF 2011-2012.

NMME Phase I activities included the following models:

- NCEP CFS version 1: 15 ensemble members
- NCEP CFS version 2: 24 ensemble members

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- GFDL CM2.1: 10 ensemble members
- IRI ECHAM4-f: 12 ensemble members
- IRI ECHAM4-a: 12 ensemble members
- NCAR-CCSM3.0: 6 ensemble members
- NASA: 6 ensemble members

All models have 1.0° latitude by 1.0° longitude resolution and forecast leads of 1 – 7 months. 29 years of hindcasts (1982-2010) were available for all models except CFSv1 (28 years: 1982-2009). Model forecasts are produced by the 8th of each month, and graphical forecasts are available on the 9th of each month. Phase I forecasts were all delivered on time.

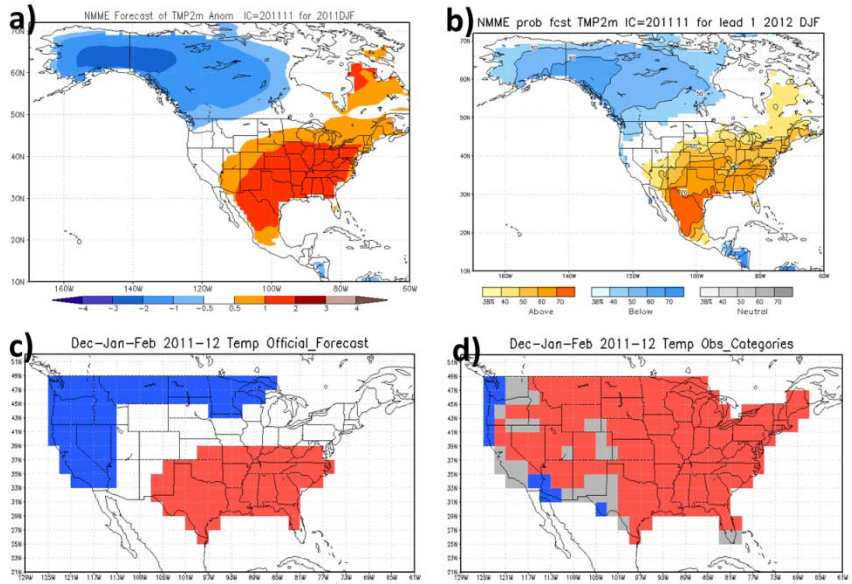

Fig. 2 NMME T2m anomaly forecast (a), probability forecast (b), Climate Prediction Center official forecast (c), and observed T2m anomaly from GHCN+CAMS (d) for DJF 2011-2012.

3. Forecast assessment metrics

Anomaly correlations (AC) were assessed for each model over the 29 years (28 for CFSv1) of hindcasts. Global maps and area averages over the Northern and Southern Hemispheres as well as the tropics were produced for T2m, Prate, and SST. Heidke skill scores (HSS) were used to assess forecast verification of Phase 1 probability forecasts. Verifying data sets used comprise GHCN+CAMS T2m, regridded to 1° x 1° (Fan and van den Dool 2008), CPC global Unified Rain-Gauge Database (URD), regridded to 1° x 1° (Xie *et al.* 2010), and OI-2 Sea-surface temperature (Reynolds *et al.* 2002), native resolution of 1° x 1°.

4. Results

Analysis of ACs (not shown) reveal that ACs for DJF seasonal forecasts at lead 1 month are higher for NMME forecasts than for individual models for all three fields. This holds for all area averaged ACs.

DJF 2011-2012 Prate anomaly forecast (Fig 1a), probability forecast (Fig 1b), CPC official forecast (Fig 1c), and observed precipitation (Fig 1d) reveal a low HSS, -04, for this season over the contiguous United States. Forecasts for T2m (Fig. 2), with a HSS of 47, were reasonably good.

	Oct 2011	Nov 2011	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012	May 2012	Jun 2012	Jul 2012
201109	-03	-02	-31	27	12	23	15			
201110		0	-16	41	12	17	11	33		
201111			-31	34	06	09	04	58	35	
201112				18	15	11	05	39	60	05
201201					20	10	14	40	54	39
201202						15	15	40	49	21
201203							13	46	53	28
201204								46	33	09
201205									32	36

Table 1 Precipitation rate Heidke skill scores over the CONUS for monthly forecasts from September 2011 – May 2012 initial conditions. Forecast initial month is in the first column; target months read across.

Winter 2012 was a difficult case for forecasting. Looking at the scores for monthly forecasts beginning with September 2011 initial conditions (lead-1 month forecast for October 2012) through May 2012 initial conditions, higher scores are found for both Prate (Table 1) and T2m (Table 2) for the January – July period, even at leads of 6-7 months. This is encouraging, as the late winter, spring and early summer of 2012 produced unusually hot and dry conditions over the CONUS.

	Oct 2011	Nov 2011	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012	May 2012	Jun 2012	Jul 2012
201109	35	17	36	85	30	65	51			
201110		24	0	83	23	64	58	59		
201111			17	69	48	70	54	64	46	
201112				62	21	58	31	12	44	39
201201					34	71	61	61	42	18
201202						76	59	61	38	61
201203							55	53	28	64
201204								49	35	40
201205									28	62

Table 2 Same as Table 1, but for T2m.

5. Summary

At lead 1 month, NMME anomaly correlations for DJF forecast are higher than those of individual models. DJF 2011-2012 was a difficult case, but lead-1 month T2m forecasts over CONUS were reasonably good; precipitation rate forecast had low skill. The very warm and dry late winter through early summer over CONUS were fairly well forecasted, even at long leads. This is a preliminary examination of the forecast verification. A full verification analysis should help to identify sources of strength and weakness.

References

Fan, Y., and H. van den Dool, 2008: A global monthly land surface 714 air temperature analysis for 1948-present. *J. Geophys. Res.*, **113**, D01103, doi:10.1029/2007JD008470.

Reynolds, R.W., N. A. Rayner, T. M. Smith, D. C. Stokes, and W. Wang, 2002: An improved in situ and satellite SST analysis for climate. *J. Climate*, **15**, 1609–1625.

Xie, P., M. Chen, and W. Shi, 2010: CPC unified gauge analysis of global daily precipitation. To be submitted to *J. Hydrometeor*.