IMPROVING PREDICTABILITY OF SEASONAL FORECASTING BY NCEP REGIONAL SPECTRAL MODEL

Jun Wang [1*]
Hann-Ming Henry Juang [2]

[1] Science Application International Corporation at EMC, NCEP, Washington, DC
[2] Environmental Modeling Center, NCEP, Washington, DC

1. Introduction

For a decade, regional forecast models have been implemented to produce seasonal forecasts (Dickinson, 1989; Giorgi, 1994; Cocke and Larow, 2000; Roads, 2003). These models can find regional features that are missed by the low resolution global model. However, it's still unclear that the regional climate model can provide improved predictability of seasonal forecasts than global models. This report shows that the NCEP regional seasonal forecast model nested in the operational global seasonal forecast model can improve the predictability of the global seasonal forecast. The primary results of the past year experiments are shown. And future work on regional spectral forecast model is presented.

2. Regional Seasonal Forecast Model

The NCEP regional spectral seasonal forecast system (RSF) consists of an operational seasonal forecast model (SFM) (Kanamitsu, 2002) and the NCEP regional spectral model (RSM) (Juang and Kanamitsu, 1994, Juang 1997). These two models have the same model physics. In this report, two systems are used. For the past year experiment results, the physics is as that in the global spectral model as used for NCEP/DOE reanalysis II with some improvement on surface physics and radiation. For the future, the regional seasonal forecast model physics will be same as that in the current operational global forecast system.

3. Past year experiment results

For the past year experiment, ensemble forecasts having five members, are conducted on the USA continent (lat: 21N-51N, lon: 130E ~ 65E). From Nov 2002 to Dec 2003, at the beginning of each month, each of the five members is integrated by both SFM and RSM for four months. The SFM has resolution T62 (~200km) and RSM has 60km resolution. Both models contain 28 vertical levels. The five ensemble members use different initial conditions: the last two days of the previous month and first three days of current month at 0000 UTC. For each month, 21 members of a 4 month hindcast were conducted. The initial condition is the first day of the current month in 1979 through 1999. The model initial condition uses the NCEP/DOE Reanalysis II. The observed sea surface temperature (SST) is used for all members of the hindcast. The forecast SST is used for all members of the forecast. The initial condition and boundary condition of the RSM are from the SFM.

[*] Corresponding author address: Jun Wang, NOAA Science Center, Room 209, 5200 Auth Road, Camp Springs, MD 20746; email: jun.wang@noaa.gov

The experiment starts from Nov 2002. Figure 1 shows the root mean square error (RMSE) of 500hpa Geopotential height, 850hpa temperature and precipitation with 1 month lead time from Feb 2003 to Dec 2003. Reanalysis II is used for verification for geopotential height and temperature, and observational precipitation is used for verifying the forecast rainfall. It shows that the RMSE of RSF 500hpa geopotential height is smaller than GSM from March 2003 to Oct 2003. In June and July 2003, RSME of RSF 850hpa temperature has much lower value from that of GSM. The RSME of precipitation for both RSF and GSM is larger in summer than in winter. In June, July, and Sep, RSF has significant lower value than that of GSM. Generally speaking, RSF has lower root mean square errors, especially in summer. The RMSE of all three variables with leading time of 2 months and 3 months shows the same features (Figure not shown).

Figure 2 shows the difference of anomaly correlation of 500hpa Geopotential height, 850hpa temperature and precipitation between RSM and GSM with lead time 1 month, 2 months and 3 months for Feb 2003 to Dec 2003. It shows that there is significant improvement in summer for all three variables. In Feb, Mar, Apr, Oct, Nov, Dec 2003, RSM has almost the same anomaly correlation as GSM for 500hpa geopotential height and 850hpa temperature. But for May, Jun, and Jul the RSF has higher anomaly correlation than the GSM. For precipitation, for May, Jun, Jul, Aug and Sep, RSF has better rain fall forecast than GSM.

4. Conclusion and future work

From the past year experiment results, the RSF improves global seasonal forecasts, especially in summer, by catching local small scale features which may influence summer forecast.

Recently, the NCEP Regional spectral model was updated with new model physics including a new radiation package, ozone, surface vegetation, momentum mixing in convection and a sub-grid orographic effect of gravity wave drag scheme. Those new physical schemes are used in current Global Forecast System (GFS) operations and the new version of RSM implemented with improved MPI.

Resource limitations allow for a 5 member ensemble forecast and 21 member hindcast in the past year experiment. In the future experiment the new version of the RSF with more ensemble members and lower resolution are used to explore if lower resolution RSF can catch more details in the forecast and therefore produce a better seasonal forecasts. Also experiments to investigate the predictability of seasonal forecast model with the same resolution of RSF and GFS will be conducted.

References

Dickinson, R.E., R.M. Errico, F. Giorgi, and G.T. Bates, 1989: A regional climate model for the western United States, *Clim. Change* 15, 383-422

Giorgi, F., C.S. Bordeur and G.T. Bates, 1994: Regional climate change scenarios over the United States produced with a nested regional climate model, *J. Climate* 7, 375-399

Cocke, S. and T.E. Larow, 2000: Seasonal predictions using a regional spectral model embedded within a coupled ocean-atmosphere model, *Mon. Wea. Rev.* 128, 689-708

Hong, S.-Y. And A. Leetmaa, 1998: An evaluation of the NCEP RSM for regional climate modeling. *J. Climate* 12, 592-609

Juang, H.-M.H. and M. Kanamitsu, 1994: The NMC nested regional spectral model. *Mon. Wea. Rev*. 122, 3-26

Juang, H.-M.H., S.-Y. Hong and M. Kanamitsu, 1997: The NCEP regional spectral model: an update. *Bulletin Amer. Metero. Soc*. 78, 2125-2143

Kanamistu, M., A. Kumar, H.-M.H. Juang, J.K. Schemm, W. Wu, F. Yang, S.-Y. Hong, P. Peng, W. Chen, S. Moorthi, and M. Ji, 2002: NCEP Dynamical seasonal forecast system 2000. *Bulletin Amer. Metero. Soc*. 83, 1019-1037

Roads, J., S.-C. Chen, M. Kanamistu, 2003: U.S. regional climate simulations and seasonal forecasts, *J. Geophys Res* 108(D16), 8608 dio:10.1029/2002JD002232

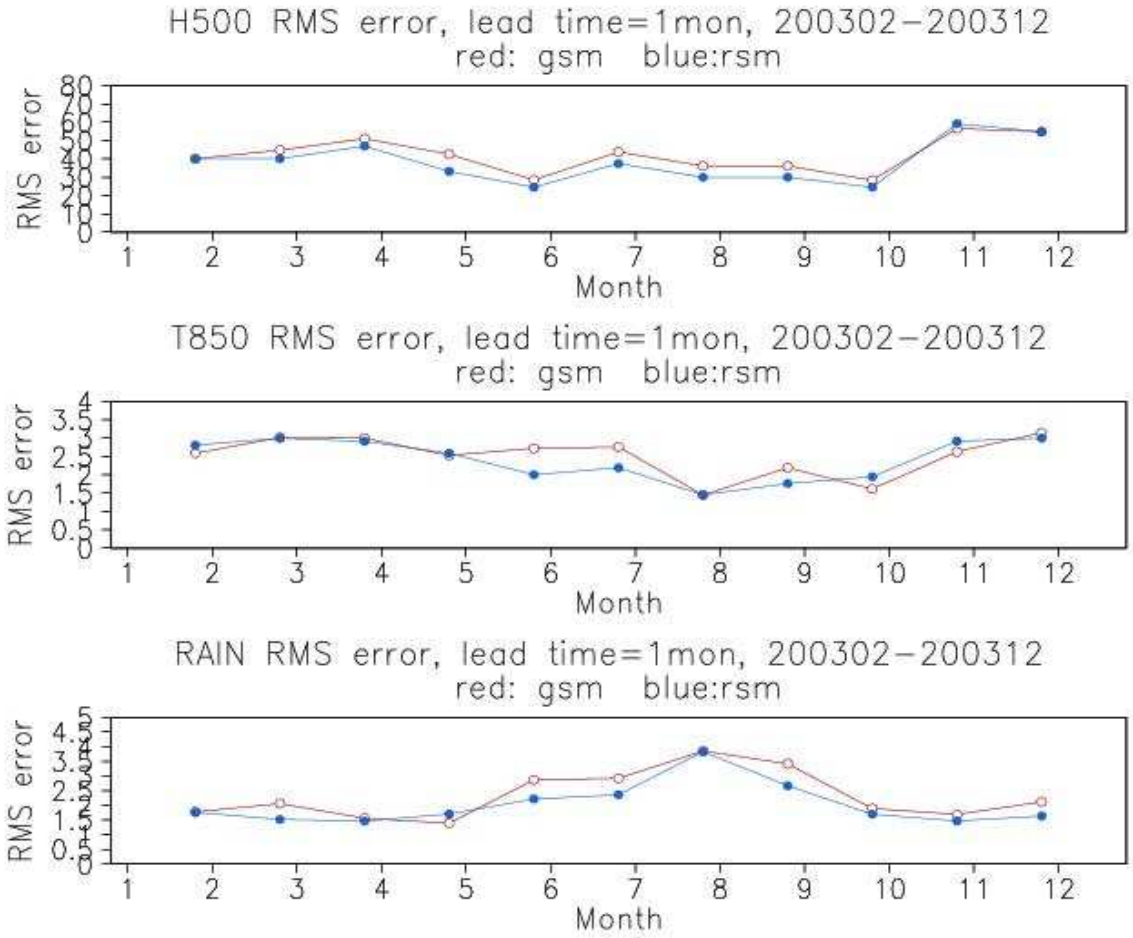

Fig. 1 The root mean square error of 500Hpa geopotential height, 850hpa temperature and precipitation from global model and regional spectral model. Verification is reanalysis II for geopotential height and temperature and observational rainfall for precipitation.

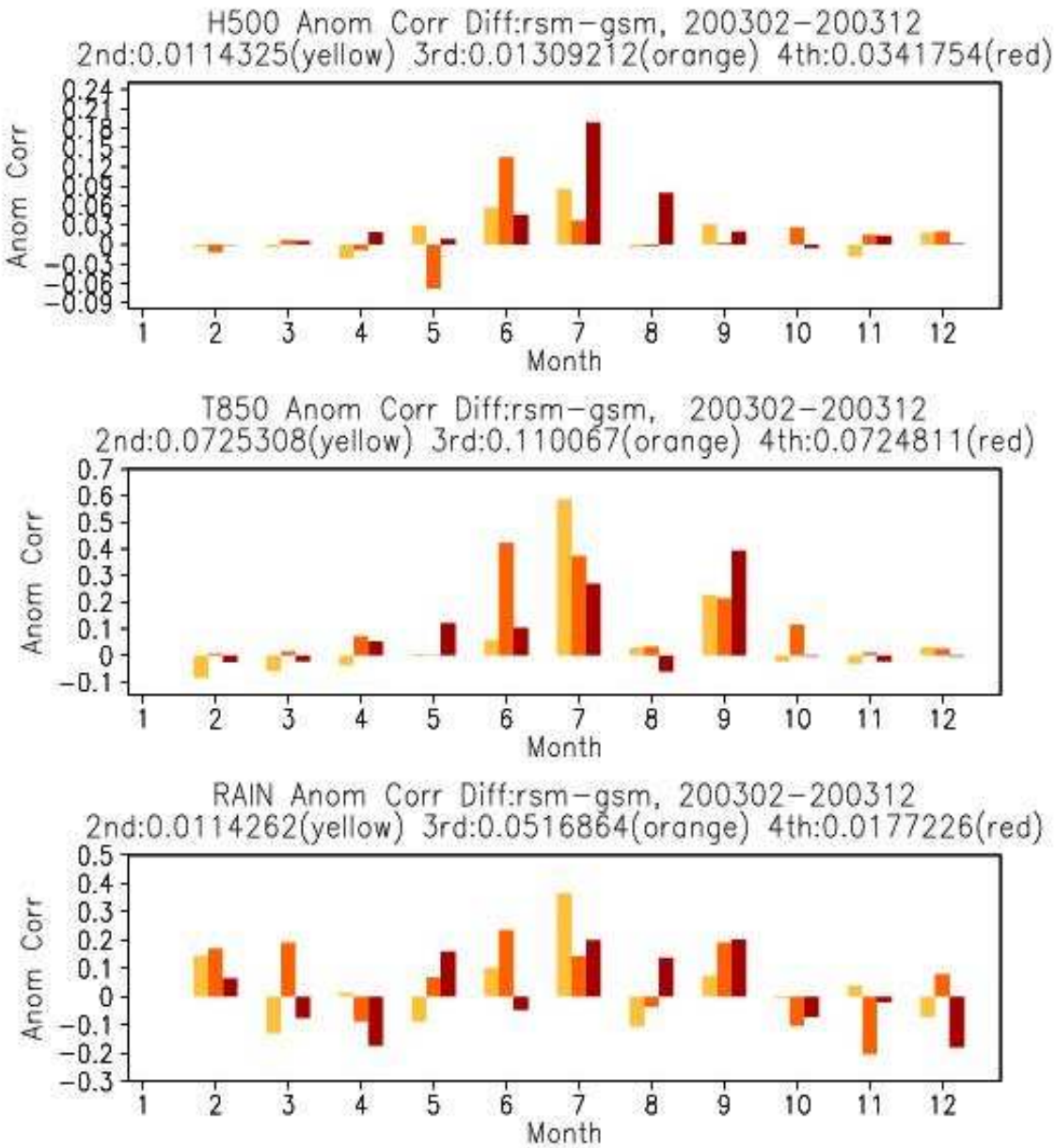

Fig. 2 The anomaly correlation of 500Hpa geopotential height, 850hpa temperature and precipitation from global model and regional spectral model. Verification is reanalysis II for geopotential height and temperature and observational rainfall for precipitation.