P3.3

THE EXPERIMENTAL SEASONAL FORECAST AND RECENT IMPLEMENTATION OF NCEP RSM

Hann-Ming Henry Juang[1*]
Jun Wang[2]
Jongil Han[3]

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

1. INTRODUCTION

It is unclear that regional models can give a better predictability on the seasonal forecast than global models. But it is no doubt that regional models can provide higher resolution to have a mesoscale seasonal forecast. And the mesoscale features can further provide better information for the downscaling application, such as river stream forecast, local fire weather prediction etc.

This report shows the NCEP regional spectral model takes the advantage of the operational global seasonal forecast to conduct a regional seasonal forecast. The preliminary results from about one-year experiments are shown, and the recent implementations of the regional spectral model for the possible future regional seasonal forecast are presented.

2. REGIONAL SEASONAL FORECAST SYSTEM

The regional seasonal forecast system (RSF) comprises two models, one is the current operational seasonal forecast model (SFM) (Kanamitsu et al, 2002) and the other is the NCEP regional spectral model (RSM) (Juang and Kanamitsu, 1994, Juang et al 1997). Both models have the same model physics as NCEP/DOE reanalysis II with some improvements on surface physics and radiation. However, it is different from the current operational global forecast system (GFS) in terms of model physics.

RSF system requires ensemble forecasts with limited members due to computational resources. Each member of RSF run is to integrate SFM and RSM together up to four months. SFM is T62 and RSM is 60 km, and both are with 28 vertical layers. Each month, we conduct five members of forecast with five different initial conditions; last two dates of the last month and first three dates of this month. At the fourth day of each month, we conduct the hindcast for the next month. The initial condition for the hindcast is the first date of the next month, and the hindcasts are performed from year of1979 to 1999. Therefore, each month, we have five members of forecast and 21 members of hindcast ready around the fourth date of the month.

The reanalysis II is used for the model initial condition. The observed sea surface temperature (SST) is used for all members of hindcast, but the forecast SST is used for all forecasts. This may have certain inconsistency between forecasts and hindcasts. The forecast errors due to a predicted SST may give forecast different bias or errors, which are not existed in the hindcasts. The initial condition and boundary condition of RSM are all from the SFM. In this case, SFM and RSM have the same model initial, surface boundary condition and model physics.

3. DATA AND RESULTS

The RSM has been used in the RSF for experimental seasonal forecasts since October 2002. The monthly mean results are shown in the web page of http://nomad2.ncep.noaa.gov/cgi-bin/web_rsm.sh/, and can be downloaded. The results have not only monthly forecast from RSM but also from SFM, the anomalies of them are also shown in the web. The performance of the predictability is under investigation.

Fig. 1 shows an example from the web results. The anomaly of Reanalysis II is obtained by the difference between current monthly mean and 21-year monthly means of the same month, from year of 1979 to 1999. The anomaly of RSM or SFM is obtained by the difference between five-members ensemble monthly mean of current month and the one-member ensemble monthly

* *Corresponding author address*: Dr. Hann-Ming Henry Juang, W/NP2, NOAA Science Center, room 204, 5200 Auth Road, Camp Springs, MD 20746; email: henry.Juang@noaa.gov.

mean of the same month from 1979 to 1999. And the results shown in Fig. 1 are after four-month integrations. Though the anomaly is not so similar between reanalysis and model results, RSM performed close enough to SFM, which is expected.

In addition to the monthly mean or anomaly, the 6-hourly results of the model atmospheric as well as surface data, and the post processed GRIB data on pressure surfaces are all stored in NCEP IBM SP mass storage. These data can be requested by the project-related institutes for diagnosis and used for downscale applications.

4. RECENT IMPLEMENTATION

The recent activities of the NCEP RSM will be implemented into the seasonal forecast for next years. The operational version of the NCEP RSM, which supports the activities of regional short-range forecast in the operational suite, has been improved with new model physics from the operational global forecast system, and a faster version of MPI implementation. Table 1 shows the current new model physics ported from GFS to RSM. The updated physics include radiations, ozone, surface vegetations, momentum mixing in convection, and sub-grid orographic effects of gravity wave drag.

Fig. 2 shows the speed-up of an example of RSM with 241x242 grid-points and 42 vertical layers with different number of tasks. It indicates that the new MPI is two to three time faster than the old operational MPI code. The old MPI code is based on the current GFS MPI, which has decomposition in the factors of the number of model vertical layer. For 42 layers, only 2, 3, 6, 7, 12, and 21 tasks can be used in the vertical-layer-based decomposition. The new MPI is based on reproducibility (Juang and Kanamitsu 2001). In this condition, the decomposition is based on the computation. And two-dimensional decomposition with one-dimensional option is used, so it is flexible with any number of tasks, even it can be run with only one task.

This new version of RSM is based on the operational version of RSM running for short-range ensemble and daily routine operational Hawaii weather forecast at NCEP. Thus, the new improvements will be implemented into the operational suite soon after a period of parallel testing.

5. CONCLUSION

Due to the resource issues, we have only 5 members of forecast and 21 members of hindcast, and the resolution of RSM is only 60 km. The new version of RSM with higher resolution, as mentioned, contains faster MPI. If the resource allocation is enough, we will use more members. Nevertheless, the past years experimental results will provide a database for us to investigate further concerns or improvements on the regional seasonal forecast modeling.

After one year experimental regional seasonal forecast, the GFS will replace the SFM and the new RSM with current GFS model physics, flexible and faster MPI, and higher resolution as 30 km will replace the CVS version of RSM. Both new models will be used for the following years' experimental regional seasonal forecasts. Then, the improvement of the RSFM will be continuing further in addition to resources concern.

A collaborated project with CPC has some other improvements on RSM for seasonal forecast, such as physical perturbation to eliminate large-scale bias. It can be implemented into the seasonal forecast as well. And the possible modification of the RSM from mathematical perturbation to physical perturbation may be used to improve long range forecasting.

Acknowledgement: This work is supported by NOAA/OGP from IRI/ARCS regional application project.

REFERENCES

Kanamitsu, 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.

Juang, H.-M.H. and M. Kanamitsu, 2001: The computational performance of the NCEP seasonal forecast model on Fujitsu VPP5000 at ECMWF. Developments in Tera Computing, proceedings of the ninth ECMWF workshop on the use of high performance computing in Meteorology, Reading, UK, 13-17 November, 2001.

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*.

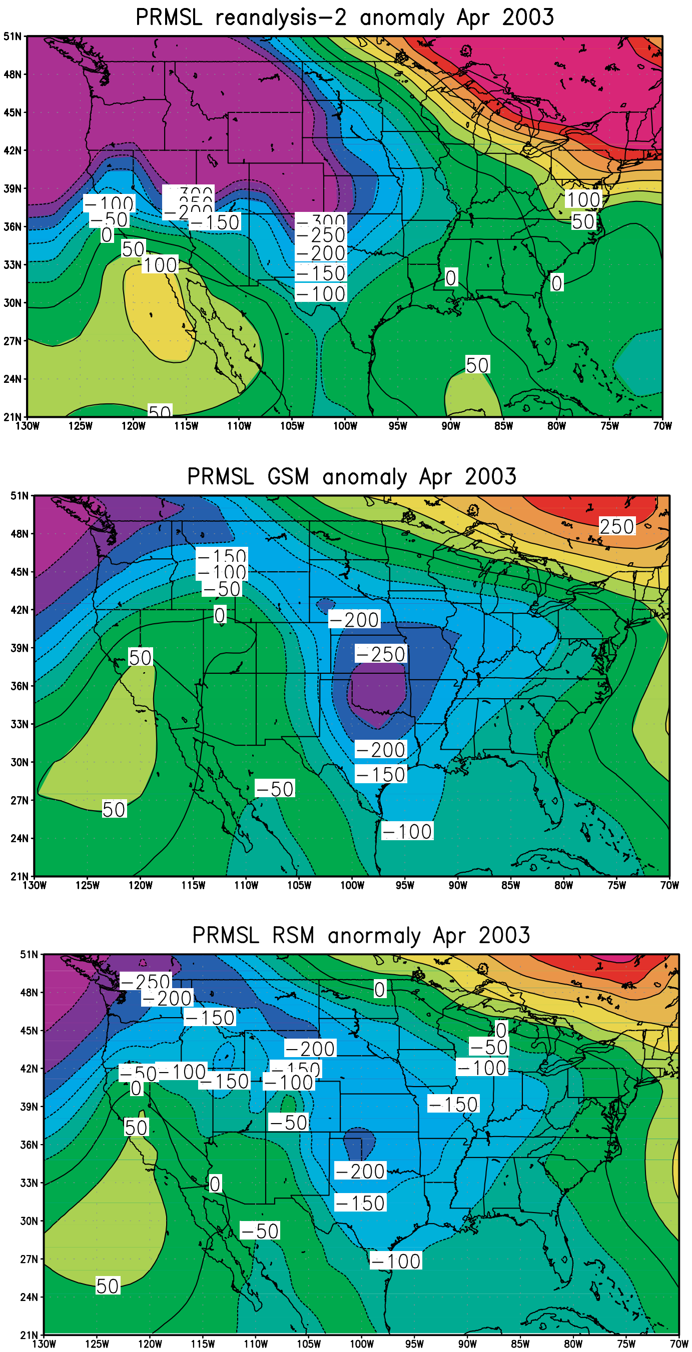

Fig. 1 The anomaly values of mean sea level pressure in Pascal for global results from reanalysis 2, global model results from SFM, and regional results from RSM.

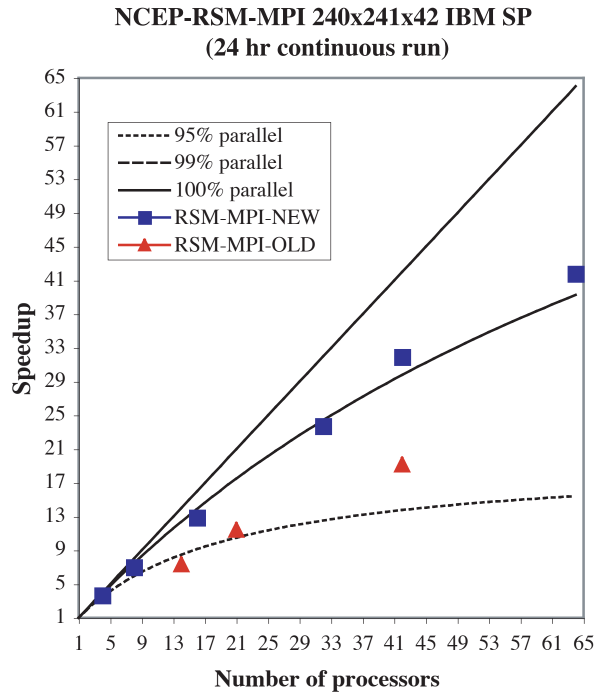

Fig. 2. The speedup related to numbers of task for the new flexible MPI (in blue) and the old MPI (in red).

Model physics used in the new NCEP RSM-MPI as of October 2003 (written in pressure coordinate)

Model physics		Description
Radiation (The parameterization uses predicted cloud condensate in the cloud-radiation interaction; it was previously based on diagnostic cloud-humidity relationships)	Longwave	Scheme: Rapid Radiative Transfer Model (RRTM; Mlawer et al., 1997)
	Shortwave	Scheme: Modified NASA model at NCEP (Hou et al., 2002)
	Aerosols	OPAC (Optical Property for Aerosols and Clouds) global climatology (Hess et al., 1998)
	Surface Albedo	Global climatology based on surface vegetation types (Hou et al., 2002)
	Ozone	Predicted using temporally and spatially varying clomatological ozone production and destruction rate
Planetary boundary layer		Nonlocal diffusion (Hong & Pan, 1996)
Land surface physics		Two-layer soil model (Mahrt & Pan, 1984); heterogeneous soil (9) and vegetation (13) types
Cumulus convection		Simplified Arakawa-Schubert Scheme (Pan and Wu 1995). Mass fluxes induced in the updraft and the downdraft are allowed to transport momentum, which helps avoid a false-alarm problem in tropical storm forecasts (Moorthi et al., 2001)
Grid-scale condensation		Prognostic cloud scheme (Zhao & Carr, 1997; Sundqvist et al., 1989; Moorthi et al., 2001). One type diagnostic cloud cover (Xu & Randall, 1996)
Shallow convection		Tiedtke (1983)
Gravity wave drag		Include the effects of subgrid orographic asymmetry and fractional area of subgrid orography larger than grid orographic height for 4 different wind directions (Kim & Arakawa, 1996) in addition to subgrid orographic variance in old version
Hydrology		Rain, Snowdeck, Runoff

Table 1. The list of the model physics used in the NCEP RSM. The model physics are the same as used in NCEP GFS.