The CFS126: a dynamical system for subseasonal forecast -- challenges in predicting the MJO

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Abstract

We explore the ability of a fully coupled general circulation model to forecast tropical intraseasonal oscillations. We use the CFS126 model which is an enhancement of the Climate Forecast System (CFS) with respect to the horizontal truncation of the atmospheric model which rises from T52 to T126. We performed a series of 65-day-long retrospective forecast initialized four times daily in May, June, July and November, December, January from 2000 to 2004. We use a simple measure of the MJO, i.e., the projection of forecast anomalies of the zonal wind at 200 hPa averaged from 20S to 20N to the intraseasonal EOFs of the observed field. Using this measure, forecast of patterns during summer can be skillful for periods of up to 25 days. However, in the current system we note a predictability barrier associated to the eastward propagation of enhanced convective activity over the eastern Indian Ocean and the Maritime Continent. We explore reasons for this predictability barrier and attempt to improve forecasts of tropical intraseasonal oscillations with this dynamical system.

The observed 2000-2004 period

In order to establish a simple measure of MJO activity we use the 6-hour zonal wind at 200 hPa from the TAO array in May, June, July (Fig. 1e). This field is averaged between 20ºS and 20ºN to the intraseasonal EOFs, respectively. These PCs present a maximum lagged correlation of 0.75 at 10 days corresponding to an oscillation period of approximately 20 days. The spatial patterns describing this eastward propagation with typical MJO characteristics are shown in Figure 1c and 1d respectively. These patterns are then band pass filtered (20 to 90 days) and the spatial fields are reconstructed using the 12 PCs that explain the variance of the filtered fields (Fig. 1e). The pattern correlations shown in Figure 1b clearly indicate the presence of a high frequency activity in the western Pacific associated with the eastward propagation of enhanced convective activity.

Effects of SST on the predictability barrier

One of the reasons for the predictability barrier may be the fact that over many areas of the Maritime Continent we use climatological SST (the ocean model is not computing SST at these areas). Unphysically, SST gradients can be adverse to the realistic propagation of convection.

Effect of initial conditions on the predictability barrier

Another possible source for the predictability barrier could be incorrect initialization. In fact, CFS126 is initialized by R2 which is based on an older version of the atmospheric model. Figures 6a and 6b show persistence forecast computed using the atmospheric component of CFS126 and observed SST. The persistence forecast initialized on the 19th of May from 1995 to 2002 and the forecast initialized for May-June initializations, there is a predictability barrier associated with the crossing of the upper level divergent phase of the MJO through the Indian Ocean and the Maritime Continent. Nevertheless, this behavior can provide a prior information to forecasters.

This barrier does not appear to be related to some inherent predictability limit but rather to model deficiencies. Therefore, there are many areas of the western Pacific which are indistinguishable from the spectral characteristics of GDAS (Fig. 6c and 6g). Model formulations and the reason for the dynamics of the western Pacific will be the next investigation.

Discussion and Conclusions

- Each high and low resolution CFS run exhibit real MJO signals with the high resolution signals being slightly better.
- Depending on the phase of the phenomenon there is high skill in forecasting MJO events with the CFS126 system. However, for May-June initialization, there is a predictability barrier associated with the crossing of the upper level divergent phase of the MJO through the Indian Ocean and the Maritime Continent. Nevertheless, this behavior can provide a prior information to forecasters.
- This barrier does not appear to be related to some inherent predictability limit but rather to model deficiencies. Therefore, there is room for much improvement of the forecast skill.

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