P4.5 Seasonal Climate Variability in the Version 3 of the Center for Ocean Land-Atmosphere Studies (COLA) AGCM

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1. Introduction

A new AGCM has been recently developed at the center for Ocean-Land-Atmosphere Studies (COLA) for seasonal to interannual prediction and predictability studies. The previous version (v2.2.6) which formed the skeleton for the current version of the COLA AGCM has been extensively used for climate studies in the past (Shukla et al. 2000). However v3.0 has introduced many new features with a completely revised physics package. COLA AGCM v3.0 is now run at exactly the same resolution as the NCEP reanalysis (T62L28) with identical topography. The vertical co-ordinate system is the terrain following sigma co-ordinate. The dynamical core follows from CCM3.6.6 (Kiehl et al 1998). Here, all prognostic variables except the moisture variable are treated spectrally. Moisture is advected by Semi-Lagrangian scheme. The outline of the physics of the model is presented in Table 1. Additionally we have implemented a uniform calculation of saturation vapor pressure following Marx (2002) and variation of the latent heat of phase change with temperature following Bohren and Albrecht (1998).

2. Design of Experiments

In this study we have made several dynamical seasonal prediction runs (extended to one year) using V3.0 COLA AGCM from NCEP reanalysis initial conditions of the atmosphere, soil moisture and temperature initialized with the global offline land-surface dataset (GOLD; Dirmeyer and Tan, 2001) and forced with prescribed observed weekly varying SST (Reynolds and Smith, 1994). For each experiment 10 ensemble members are run. For each ensemble member of the experiment the initial condition of the atmosphere is changed by changing the start date of the model run by a day starting from November 21, 0000UTC through November 30, 0000UTC of the year. In all 23 experiments from 1981-82 through 2002-03 have been conducted. The results will be presented from the ensemble mean.

3. Results

In Fig. 1 we have compared the model precipitation climatology from the winter (DJF) and summer (JJA) seasons with CMAP observations (Xie and Arkin, 1996). The distribution of precipitation is reasonably well captured by the model. However excessive precipitation areas in the Asian-Australian monsoon region and in the mid-latitude regions of Western Europe and mid-west North America are some of the apparent problems of the model. In Fig. 2 we show the DJF difference in the 200hPa height composite between warm and cold ENSO episodes. Here, the so called Pacific North American (PNA) pattern compares reasonably with the NCEP reanalysis. In Fig. 3 we have outlined the areas for which we have provided the interannual seasonal precipitation anomalies for their respective rainy seasons. It is seen that the model has a precipitation skill of over 0.5 in nearly all the monsoon regions of the globe except over the Indian monsoon region which seems to have the least forced signal from SST (not shown). The teleconnection pattern of Amazon River Basin (ARB) and the Maritime Northern Australia (MNA) precipitation with contemporaneous global SST for DJF is plotted in Figs. 5 and 6 respectively. It is evident from the figures that the forced signal of precipitation is very well captured by the model over both these regions in their rainy season.

	Feature	Reference	Source
1	PBL	Hong and Pan, 1996	NCEP
2	Shortwave	Collins et al. 2002	CAM2.0
3	Longwave	Collins et al. 2002	CAM2.0
4	Convection	Bacmeister et al. 2000	NSIPP
5	Horizontal diffusion		NCEP
6	Land surface	Dirmeyer and Zeng, 1997	COLA

Table1: Outline of the physics of COLA AGCM V3.0

4. Conclusions

Although a model with significant improvements in the simulation over the previous version has been developed there are further modifications in plan. The current version of the model has a bias of having thin high level clouds that trap the out going long wave radiation and reflect shortwave radiation more than the observations at the top of the atmosphere in the global tropics (not shown). Furthermore, the model also has a tendency to underestimate the low level

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clouds which results in a positive bias in the downward shortwave flux at the surface. These biases have to be confirmed in a coupled ocean-land-atmosphere setup. To ameliorate some of these biases we plan to introduce radiative forcing of aerosols and include cloud liquid water as part of the model prognostic variable. In addition we plan to increase the number of soil layers which is currently at 3 to 6 in the land surface model to overcome some sharp gradients in transpiration in the transition zones of vegetation. Additionally, fractional coverage of land, ocean and seaice in a grid box is also being considerd for implementation.

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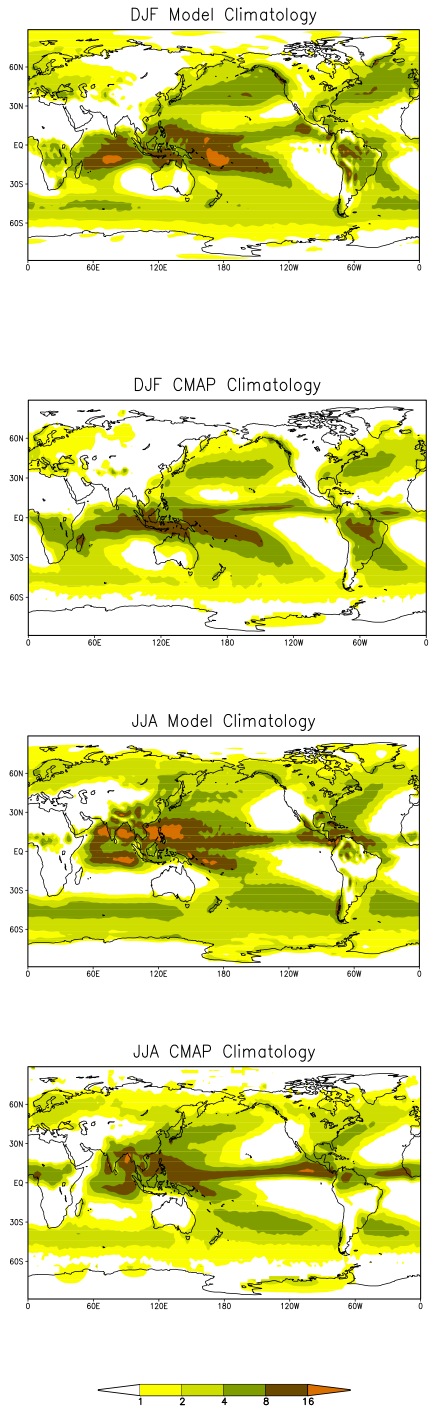


Figure 1: Precipitation Climatology. The units are in mmday^{1}. .

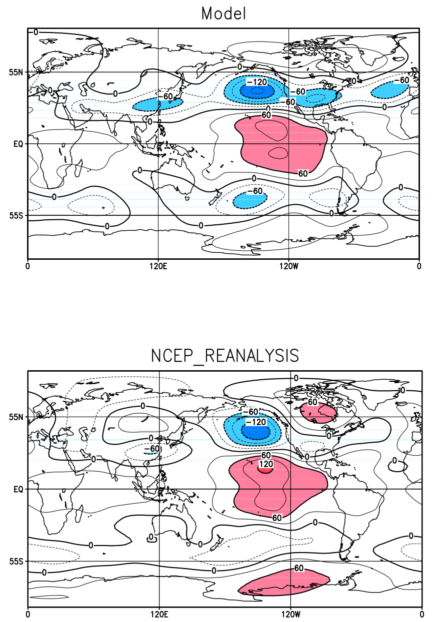


Figure 2: The mean DJF 200 hPa height difference between warm (83, 87, 88, 92, 95, 98, 03) and cold (84, 85, 89, 96, 99, 00, 01) ENSO years.

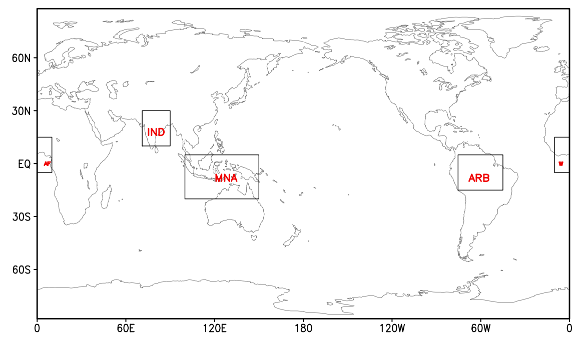
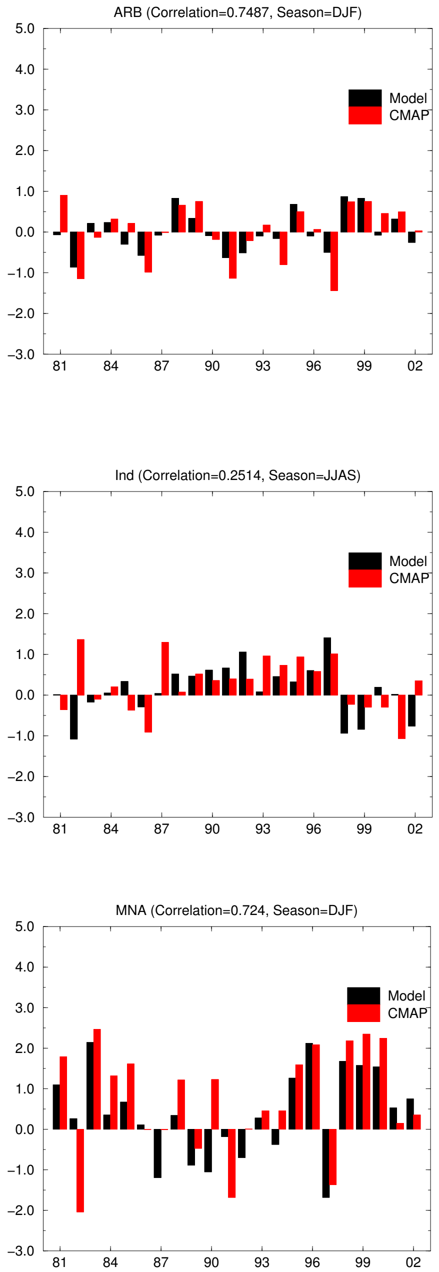


Figure 3: Outline of the areas for which interannual precipitation anomalies of the rainy season are computed.



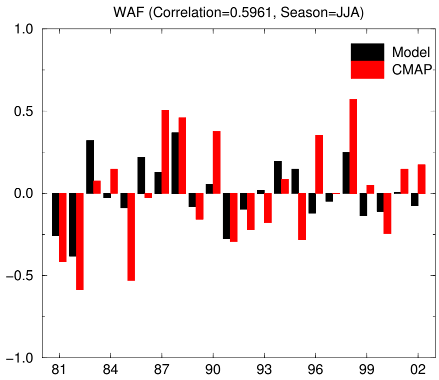


Figure 4: Interannual precipitation anomalies for the rainy season of the regions outlined in Fig. 3.

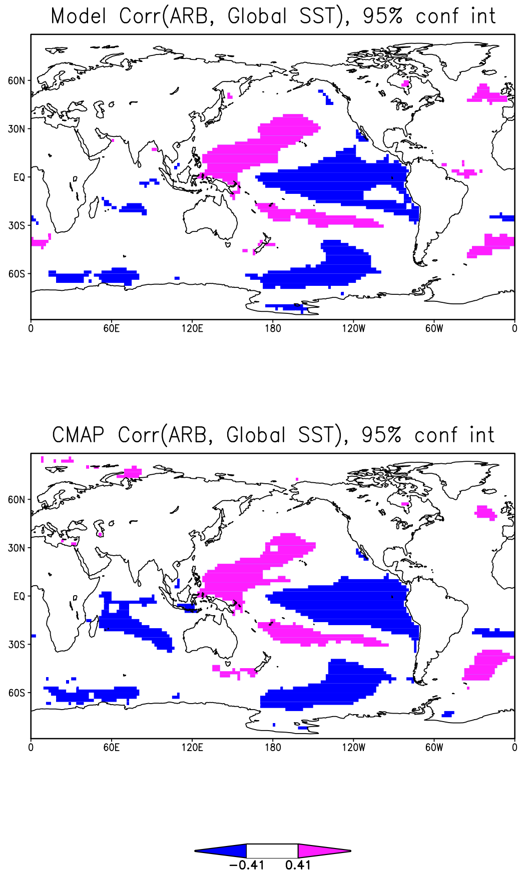


Figure 5: Global teleconnection pattern between Amazon River Basin (ARB) precipitation from model and CMAP observations with contemporaneous observed SST for DJF. Significant correlations are shaded.

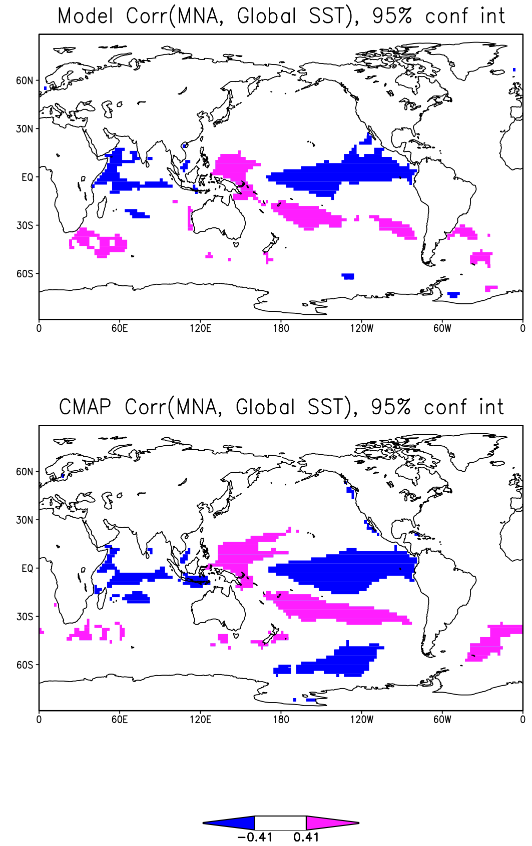


Figure 6: Same as Fig. 5 but for the Maritime and Northern Australia (MNA) region.