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DOWNSCALING THE SOUTH AMERICAN MONSOON SEASONAL CLIMATE

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1. Introduction

A novel technique of dynamic downscaling is proposed over South America which addresses the two grave sources of systematic errors in a regional climate model (RCM): the bias in the large scale forcing from the driving atmospheric general circulation model (AGCM) and the systematic errors generated as a result of the parameterizations in the RCM and its discrete advection and time integration schemes. Through this proposed methodology it is argued that the utility of dynamic downscaling is further enhanced.

2. Methodology

The RCM used in this study is the RSM (Juang and Kanamitsu, 1994; Misra et al. 2003). A bias correction is first adopted on the nested variables of the RCM. This step involves replacing the climatology of the driving AGCM with the corresponding climatology of the nested variables. Then a spectral damping scheme following Kanamaru and Kanamitsu (2005) is used that entails strongly damping the solution of the RCM towards the bias corrected large forcing beyond a certain wavelength (in this case 1000km). The premise of this strategy is to avoid the RCM to adjust at the largest spatial scales within the regional domain. However, it should be noted that the bias correction and spectral damping is done on vorticity, divergence and natural log of surface pressure. The thermodynamic variables of T and q are left untouched. This was done after extensive experimentation with the RSM that indicated deterioration of the seasonal mean climate of the South American monsoon when either T and or q were constrained.

3. Design of Experiments

Three January-February-March seasons of 1997, 1998 and 1999 are used to demonstrate the efficacy of this methodology. For each season five ensemble members of the RSM were generated. These ensemble members of the RSM correspond to the nesting in the ensemble members of the AGCM generated from slightly different initial conditions of the atmosphere. The SST used to force the AGCM and the RSM is the weekly varying OI SST (Reynolds and Smith, 1996).

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The AGCM is the Center for Ocean-Land-Atmosphere Studies (COLA) V2.2 (Schneider 2003). A set of 5 ensemble integrations for each season with conventional way of downscaling using RSM (CONTROL-B; Misra et al. 2003) is made. A similar set of RSM runs are made using the anomaly nesting strategy (AN_ALL; Misra and Kanamitsu 2004). The RSM seasonal integrations that involve spectral damping along with bias correction on selected nested variables are referred as EXPT.

4. Results

In Fig. 1 we show the January-February-March seasonal precipitation anomalies from the RSM runs described earlier. It is seen clearly from the figure that the EXPT run is able to best capture the dry (wet) monsoon over the Amazon river basin in 1998 (1999). Similarly the intraseasonal variance of OLR is shown in Fig. 2. Here, it is again seen that the EXPT run is able to simulate the intraseaonal variance closest to observations (Liebmann and Smith 1996) among all other RSM runs.

5. Conclusions

This study demonstrates from a small sample of seasonal RSM integrations that a combination of bias correction to large scale forcing and an empirically designed spectral damping scheme that constrains the solution of the RSM effectively raises the skill of the downscaled precipitation and intraseasonal variance over continental South America.

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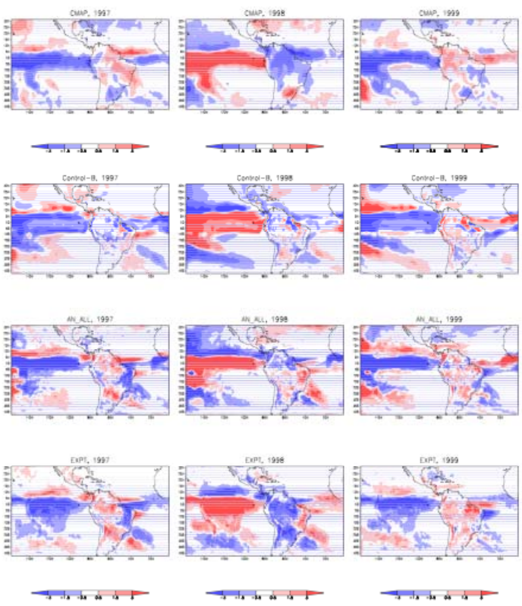

Figure 1: JFM seasonal mean precipitation anomalies. The units are in mmday .

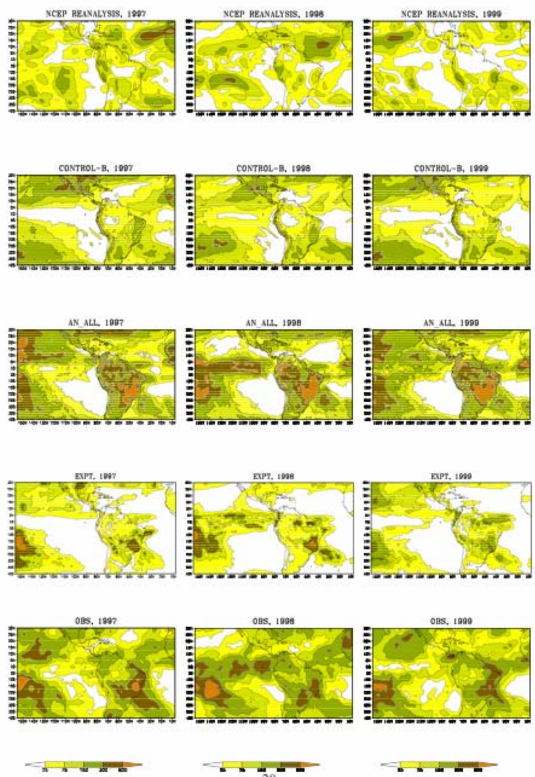

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Figure 2: The variance of filtered OLR anomalies at 20-40 days time scale for JFM season of 1997, 1998 and 1999. The units are in W^2m^{-2}.