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9A.5 Dynamical downscaling of seasonal climate prediction over northern South America with NCEP's Regional Spectral Model at IRI.

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INTRODUCTION

The need for generating high-resolution regional climate forecasts and the necessity of using global domain to compute such forecasts make the task insurmountable for today's available computer resources. One way to accommodate the needs for both high resolution and global domain is to nest a high-resolution regional model on the outputs of a coarser atmospheric general circulation model.

This study presents an evaluation of seasonal climate forecasts done with the IRI's dynamical forecast system (regional model nested into an AGCM) for the northern South America region for 1998 and 1999 during the period of February to April, the rainy period over Nordeste Brazil.

METHODOLOGY

The model suite consists of the hydrostatic version of the Regional Spectral Model (RSM) from NCEP and implemented at the IRI with 80 km resolution, nested on the Marx Plank Institute's ECHAM-3 atmospheric general circulation model (AGCM) with horizontal spectral resolution T42 and 18 levels. Lateral boundary conditions and the mean state in the interior of the RSM integration domain are given at 6 hours intervals, and are extracted from the AGCM forecasts. Lower boundary conditions for the AGCM runs are forecast SSTs over the Tropical oceans during 1999 and a blend of forecast (Pacific) and persisted SST for the 1998 experiment. An ensemble of three realizations are done for the 1999 experiment, while only one integration is done for the 1998 forecast experiment.

3. RESULTS

Fig. 1 shows the FMA 1999 observed and forecast total rainfall over Nordeste Brazil. It is clearly seen in this figure that while the AGCM forecast (Fig. 1b) shows a meridional gradient of rainfall that is consistent with observations (Fig. 1a), the RSM-80 forecast (Fig1c) shows a rainfall spatial pattern that resembles observations. The reason for that can be seen in Figure 2, which shows the width of the Intertropical Convergence Zone (ITCZ) over the Tropical Atlantic as forecast by the AGCM (Fig. 2a) and the RSM-80 (Fig. 2b). Though both forecasts place the band of maxima rainfall over approximately the same latitudes, the ITCZ forecast by the AGCM is much wider than the RSM's, thus generating the excess rainfall forecast by the AGCM shown in Fig. 1b.

Other aspect of potential interest in the use the use of regional models is to forecast shifts of synoptic scale weather probability distribution on monthly and seasonal time scales. Fig. 2 shows the time series of forecast and observed area averaged daily rainfall over Nordeste (Fig. 3). This figure is suggestive that the RSM forecast the onset of the 1999 rainy season over Nordeste reasonably well. Another information of potential interest derived from the RSM-80 daily outputs is the forecast number of days with no, light, moderate, or heavy rainfall. Figure 3 shows a comparison between observed and forecast number of days without rainfall for February, March, and April 1999. The model forecasts presented good agreement with observations throughout most of the domain of integration (Fig. 4). The model also forecast reasonably well the number of days with heavy rainfall (i.e., daily rainfall greater then 15mm, figure not shown), thus suggesting the potential use of such forecasts for applications on agriculture, water resources, and civil defense.

For the period FMA 1998, the RSM-80 generated considerably better seasonal forecast over the Nordeste region then the AGCM (figures not shown). However, the overall forecast over the Amazon, and the temporal distribution of rainfall compared poorly with observations during that period. For both 1998 and 1999 the RSM forecasts generated spurious rainfall anomalies along major mountain barriers (e.g. along the Andes, fig.s not shown) which must be further investigated.

CONCLUSIONS

For the cases analyzed the regional model improved the rainfall forecast over some areas, noticeably over the Brazilian Nordeste. The width of the Intertropical Convergence Zone (ITCZ) over the Tropical Atlantic is better forecast by the RSM than by the AGCM, resulting in a better rainfall forecast over the Nordeste done by the RSM. One of the principal results of this study is the suggestion that the statistics of synoptic scale weather variability on seasonal time scales are predictable with the RSM model over the Nordeste. Diagrams of forecast and observed daily rainfall shows that the RSM ensemble forecast captured the onset of the 1999 Nordeste rainy season and the number of days without rain reasonably well.

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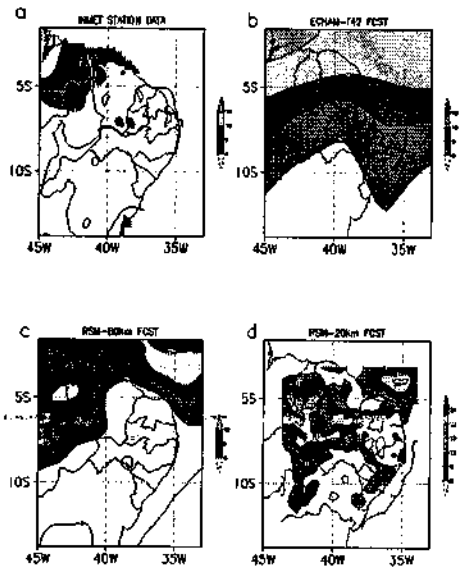

Figure 1 - February-March-April 1999 total rainfall over Nordeste Brazil: (a) Observed, (b) ECHAM3, T42L18 forecast, (c) RSM-80Km forecast, and (d) RSM-20Km forecast. Units are mm/day. Contour interval is 3 mm/day; contours greater than 6mm/day are shaded.

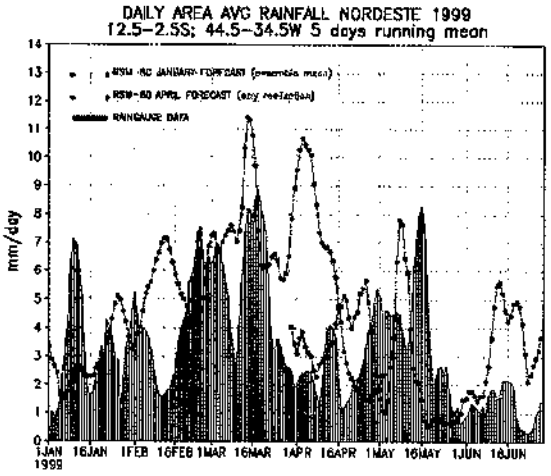

Figure 3 - Area averaged daily rainfall over Nordeste (12.5°S-2.5°S, 44.5°W-34.5°W) for observed (bars), January-April 1999 RSM-80Km ensemble mean forecast and April-Jun 1999 RSM-80Km forecast (one realization) (continuous line) Units are mm/day.

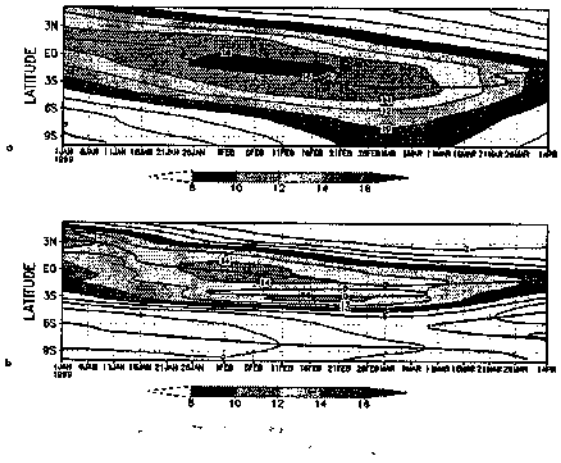

Figure 2 – Time-latitude cross section of monthly rainfall averaged for the longitude band 40°W-36°W for (a) ECHAM3, and (b) RSM-80 forecasts. Contour interval is 2 mm/day. Contours greater than 8 mm/day are shaded. The thick line represents the positions of rainfall maximum.

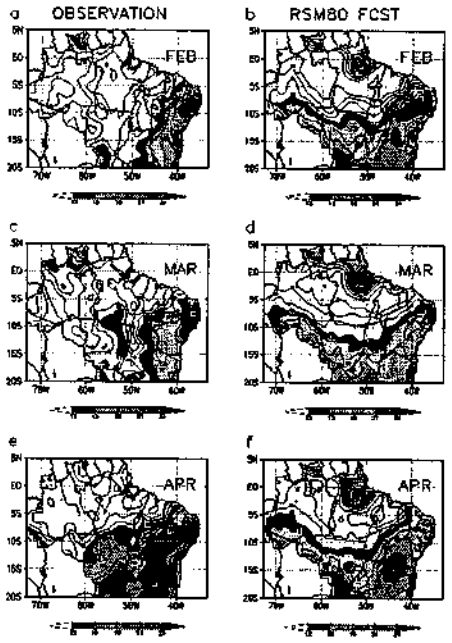

Figure 4 – Number of days without rainfall over Brazil for (a, b) February, (c, d) March, and (e, f) April 1999. Left: observations; right: RSM-80 forecast. Contour interval is 3 days. Contours greater than 12 days are shaded.