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EVALUATION OF CPTEC'S SEASONAL ENSEMBLE PREDICTIONS OF WET SEASON RAINFALL OVER NORTHEAST BRAZIL

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An evaluation of sources of errors that limit predictability in seasonal ensemble predictions for the Northeast Brazil (NEB) wet season generated by a T062L28 version of the CPTEC/COLA atmospheric general circulation model is presented. The ensemble numerical forecasts comprised 25 members initiated from consecutive analyses one day apart (from 4 to 28 December). During the simulation period (December, January and February) observed global sea surface temperatures (SST) were used as lower boundary conditions. For the forecast period (March, April and May), SST fields were prescribed as persisted February SST anomalies globally. The years 1996-2000 were chosen for this study.

It is already known that slowly varying anomalous lower boundary forcings, such as SST anomalies, are more relevant than short timescale fluctuations of the daily weather variations in determining seasonal mean atmospheric states. Therefore, potentially higher predictability is expected for regions where seasonal climate variability can be explained by variations in SST patterns . Northern NEB is one of these regions. There, the weather conditions during the wet season are mostly controlled by the Intertropical Convergence Zone (ITCZ) position and intensity. However, the region is also influenced by transients such as frontal systems, upper level cyclonic vortices, easterly waves and instabilities lines. In this work we are trying to answer the following questions: (i) can the model predict the statistical characteristics of those transient systems correctly? And, (ii) to what extent are model deficiencies in predicting the statistics of the transient systems – vis-à-vis the latitudinal ITCZ migrations – source of errors in seasonal precipitation predictions?

The results showed that when the simulated outgoing longwave radiation over the Equatorial Atlantic Ocean, representative of the ITCZ, is not well predicted, the model skill for wet season (March-April-May) rainfall over northern NEB is poor. Moreover, the model shows deficiencies to predict the correct amount of rainfall, position and intensity of upper level vortices over NEB, overestimating rainfall.

In cases where the model predicts correctly the ITCZ and there are few cases of upper level cyclonic vortices, limit of predictability will be related to the number of frontal systems penetrating into southern NEB. In some cases, the simulation of fewer cold fronts than observations is compensated by simulation of many easterly waves bringing rain from the Atlantic Ocean into the continent. Another important result is that model produces in general fewer cold fronts in comparison to the observed number of such systems reaching southern NEB, but this is compensated by intensification of the low level convergence associated with these frontal systems over southern NEB. After reaching NEB, the simulated frontal systems produce large amounts of precipitation. That, in turn, is followed by an intensified convergence and lower surface pressure. As a result, under this synoptic situation, a new cyclonic center is formed. These low level cyclonic v rtice s have no counterpart in observations, that is, they are a spurious feature of the model. It travels from north to south, counterclockwise near the Brazilian coast, producing additional rainfall. In sum, by and large the model presents a good skill in predicting precipitation in NEB during its wet season. However, there are situations when that skill is achieved, by means of wrong mechanisms.

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1. INTRODUCTION

It is already known that slowly varying anomalous lower boundary forcings, such as SST anomalies, are more relevant than short timescale fluctuations of the daily weather variations in determining seasonal mean atmospheric states (Madden, 1976; Shukla, 1984; Trenberth, 1985,). Therefore, potentially higher predictability is expected for regions where seasonal climate variability can be explained by variations in SST patterns (see review by Palmer and Anderson, 1994). Northern Northeast Brazil (NEB) is one of these regions (Moura, 1984). There, the weather conditions and mean seasonal climate during the February-May wet season are mostly controlled by the Intertropical Convergence Zone (ITCZ) position and intensity. However, the region is also influenced by transients such as frontal systems, upper level cyclonic vortices, easterly waves and sea breeze-driven instabilities lines.

In this work we make an evaluation of sources of errors that limit predictability in seasonal ensemble predictions for NEB wet season generated by a T062L28 version of the CPTEC/COLA atmospheric general circulation model. The objective is to answer the following questions: (i) can the model predict the statistical characteristics of those transient systems correctly? And, (ii) to what extent are model deficiencies in predicting the statistics of the transient systems – vis-à-vis the latitudinal ITCZ migrations – a source of errors in seasonal precipitation predictions?

2. METHODOLOGY

For each year from 1995 to 1999, a 25-member ensemble of simulations was carried out. The initial conditions for each of the ensemble member were consecutive 12Z NCEP's global model analyses one day apart (from 4 to 28 December) and the simulations were run for 6 months (December to May). During the simulation period December, January and February observed global sea surface temperatures (SST) were used as lower boundary conditions. For the forecast period (March, April and May), SST fields were prescribed as persisted February SST anomalies globally.

3. RESULTS

The results showed that when the simulated minima of outgoing longwave radiation over the Equatorial Atlantic Ocean, taken here as representative of the ITCZ, is not well predicted, the model skill for wet season (March-April-May) rainfall over northern NEB is poor. Moreover, the model shows deficiencies to predict upper level vortices (ULV) over NEB. Therefore, if for a given year observations show many days with ULV's, rainfall will be below average in NEB as a consequence of subsidence associated with these systems. But, the model will not simulate well the position, intensity and duration of such vortice and, thus, simulated rainfall will be greater than observations.

In cases where the model predicts correctly the ITCZ and observations reveal few cases of upper level cyclonic vortices, limit of predictability will be related to the number of frontal systems penetrating into southern NEB. In some cases, the simulation of fewer cold fronts than observations is compensated by simulation of many easterly waves bringing rain from the Atlantic Ocean into the continent. Another important result is that model produces in general fewer cold fronts in comparison to the observed number of such systems reaching southern NEB, but this is compensated by intensification of the low level convergence associated with these frontal systems over

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southern NEB (see example for the year 1997 in Figs. 1 to 3). After reaching NEB, the simulated frontal systems produce large amounts of precipitation. That, in turn, is followed by an intensified convergence and lowering of the surface pressure. As a result, under this synoptic situation, a new cyclonic center is formed. These low level cyclonic vortices have no counterpart in observations, that is, they are a spurious feature of the model. It travels from north to south, counterclockwise near the Brazilian coast, producing additional rainfall. In sum, by and large the model presents a good skill in predicting precipitation in NEB during its wet season. However, there are situations when that skill is achieved by means of wrong mechanisms.

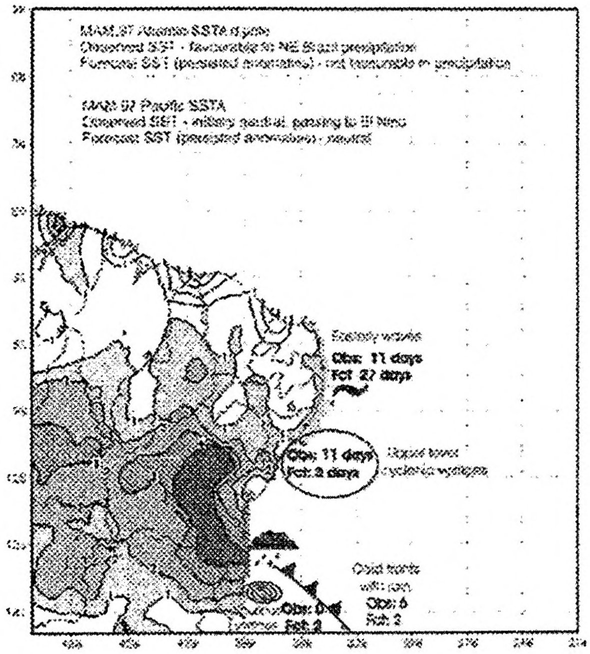

Fig. 1 – Observed and forecast meteorological systems reaching Northeast Brazil during the period March to May, 1997.

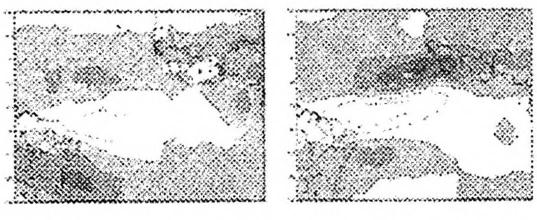

Fig. 2 – Observed (a) and forecast (b) outgoing longwave radiation anomaly (W.m^{-2}) for the period March to May, 1997.

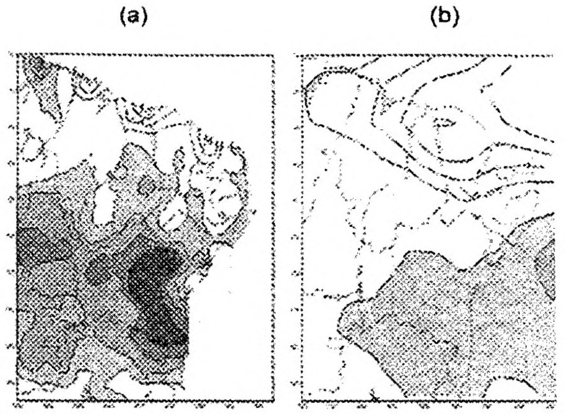

Fig. 3 – Same as Fig. 2 but for precipitation anom (mm.day^{-1}).

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