ZONAL STATISTICS OF MONTHLY MEANS: 
A 11 YEARS CPTEC/COLA GLOBAL MODEL SIMULATION

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ABSTRACT

Global and zonal analyses of meteorological variables are performed in two sets of 
integrations of 11 years using CPTEC/COLA GCM. Monthly observed SST was applied 
as boundary condition in one set and climatological SST was used in the other set. The 
results were compared to reanalyses data. In this study, global zonal winds in both cases 
showed no trends during the period of the analyses. The interannual variability was smaller 
in the simulations than in the reanalyses. The vertical profile of the zonal wind was similar 
in both experiments and represented well the profile in the reanalyses data. The largest 
differences between the experiments and the reanalyses occurred in the middle latitudes of 
both hemispheres at high levels, and in the north tropical region at middle levels. The 
zonally averaged precipitation of both experiments were larger than the precipitation from 
the reanalyses in DJF in both hemispheres, but in JJA the simulations were larger in the 
Southern Hemisphere and similar to the reanalyses in the Northern Hemisphere. The higher 
variability observed in the tropical region showed the sensibility of the model to SST 
variability in this region.

1-Introduction

Recent climate simulations using different models were performed in the AMIP 
project. The project was an intercomparison among models and one of the tasks to analyse 
the behaviour of GCMs is to calculate the zonal global values of some variables. This kind 
of analyses shows what is the global variations during the integrations, if the model is 
conserving energy, what is the drift of the model using climatological SSTs, and other 
properties. Zonal averages can show the large scale features related to differences between 
the tropics, middle and high latitudes and it is a coarse way to compare simulations to 
observations.

In the present study, results of an integration of 11 years from the CPTEC/COLA 
atmospheric global circulation model with resolution of T42 and L28 were analysed. Two 
long range integrations were made, one using observed SST for each month of each year 
and other using the same climatological SST of each month for all years. The initial 
condition was September 14, 1985 and the analyses were made from January 1986 to 
December 1996. The variability of the simulated precipitation anomaly during this 
integration, for the Northeast Region of Brazil, compared to the observed anomalies was 
shown in Cavalcanti et al. (1998). The results showed consistent variability between 
simulation and observation.

In these analyses, global and zonal statistics of the wind field and precipitation are 
calculated for the case using observed SST and for the case using climatological SST. 
Comparisons are made with the reanalyses data of NCEP/NCAR, from 1982 to 1994.

Monthly mean climatologies were calculated from both results (observed SST and 
climatological SST). One of the purposes was to compare this two climatologies to 
investigate if there is a large change, if the control run, to get the anomalies, is taken from
the mean average of the climatological SST run or if taken from the mean average of the observed SST run. Another purpose was to show the variability of the global zonal wind, the vertical profile of the zonal wind and the zonal precipitation, compared to the reanalyses data.

2-Climatology

2.1- Definitions

During the course of the simulations monthly mean model output data were archived. Below we will use designation $X^i_j$ for this data where $i$ is number of month, and $j$ is number of year. To compare the simulated climatology for the two experiments we have given consideration to (1) globally averaged values

$$\overline{X} = \frac{1}{4\pi} \int_0^{2\pi} d\lambda \int_{-\pi/2}^{\pi/2} X \cos \varphi d\varphi ,$$

and (2) zonally averaged values

$$\overline{X} = \frac{1}{2\pi} \int_0^{2\pi} X d\lambda .$$

These values were used for estimation of the simulation climatology:

climate mean for $i$th month

$$C_i = \frac{1}{N_i} \sum_{j=1}^{N_i} X^i_j ,$$

climate variability for $i$th month

$$V_i = \sqrt{\frac{1}{N_i} \sum_{j=1}^{N_i} (X^i_j - C_i)^2} ,$$

where $N_i$ is number of simulated $i$th month. Same values were calculated for reanalyses data for 14-years period of 1982 to 1995 (Kalnay et al., 1996).

2.2- Global Climatology

In Fig.1 series of global mean wind component are shown at 500 hPa and 200 hPa levels. The simulation values are close to quasi-steady equilibrium during all period. Simulated global means have no noticeable linear trend. In both experiments, the magnitudes of oscillations are smaller than in the reanalyses data on 200 hPa level. However, for the observed SST experiment at 200 hPa, the global mean of the zonal wind component has a little more variability than for the climatological SST experiment.

2.3-Zonal Climatology

In both experiments the model was able to simulate the gross features of the latitudinal and vertical variations of meteorological variables and their variability. A comparison of the simulated climatologies from the two experiments with the reanalyses
show larger differences between the simulations and the reanalyses than between the two experiments. This differences can be related to different analysed periods in the simulations and in the reanalyses data. For example, Fig.2 shows zonally averaged seasonal (DJF) climate mean and variability for zonal wind in both simulated cases and reanalyses. Fig.3 shows differences between climate zonal wind from climatological SST experiment and observed SST experiment, and from climatological SST experiment and reanalyses. In the experiments, the principal features of climate mean and variability were captured. However, maximum differences between the two experiments for zonally averaged zonal wind is about 2 m/s while the difference between observed SST experiment and reanalyses is about 8 m/s. Fig.3b is similar to DJF mean of the zonal mean zonal wind error from Kinter et al. (1988).

Climate mean of zonally averaged total precipitation and its climate variability are shown in Fig.4. For comparison reanalyses climate means are also displayed. First of all the experimental values are more similar with each other than with the reanalyses values. In DJF the simulated precipitation using climatological SST and observed SST are larger than the reanalyses in almost all latitudes. However, in JJA, the same occurs in the Southern Hemisphere, but the values of simulations are similar to the reanalyses data in the Northern Hemisphere.

The comparison of the climate variability in both experiments shows great variability for the tropics in the observed SST experiment, mainly in DJF. This can be associated with the large precipitation shifts that are observed in many regions of the tropics which are connected to warm and cold conditions of El Niño-Southern Oscillation (ENSO) (Rasmusson and Carpenter, 1983). This result indicates that the model is able to simulate well the climate variability associated with the Sea Surface Temperature.
3-Conclusions

a. In both experiments the model was able to simulate the gross features of the latitudinal and vertical variations of meteorological variables and their variability.
b. A comparison of the simulated zonal climatologies are more similar with each other than with the reanalyses climatology. This can be related to the different periods taken for the climatology.
c. The model is able to simulate well the climate variability associated with the Sea Surface Temperature, showed by the highest variability in the tropical region.
Figure 3: Total precipitation (mm/day) for (December-February, DJF) (a) in the climate SST experiment, and (b) in observed SST experiment; and for (June-August, JJA) (c) in the climate SST experiment, and (d) in the observed SST experiment (close circle). Climate variability is indicated by bars. The open squares are used for the reanalysis climate values.

4. References

