P4.34 DIAGNOSING SYSTEMATIC ERRORS IN THE ETA MODEL FORECASTS OVER SOUTH AMERICA

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1. INTRODUCTION

The Centro de Previsão de Tempo e Estudos Climáticos (CPTEC) has employed the Regional Eta Model to produce short-range forecasts on operational basis since 1997. The model has become one of the most important tools for weather forecasts over South America. However, because of the short period of operation, it is necessary to identify the systematic biases and the various parameters suitable to the conditions of this continent to achieve improved forecasts.

The purpose of this work is to perform a diagnostic analysis of some systematic errors produced by the Eta/CPTEC regional model forecasts over South America, and to assess the relative contribution of each model physics and dynamics component. The main conclusions will be used to further investigation aimed at improving the model forecast performance.

The ETA/CPTEC is a grid-point hydrostatic model with 40 km horizontal resolution and 38 vertical layers which is routinely used at CPTEC to produce 60-hours forecasts. It has a comprehensive physical package including a modified version of the Betts-Miller convective parameterization and an explicit scheme for large-scale precipitation. Turbulence is represented by the Mellor-Yamada scheme. The initial conditions are taken from the NCEP analysis and boundary conditions are provided at 6-h intervals by the COLA/CPTEC GCM. 24-hour forecasts started at 12 UTC were analyzed for the period from June to November 1998.

2. METHODOLOGY

In other to asses the relative contribution of each model component to the systematic errors, we used a methodology based on the works of Klinker and Sardeshmukh (1992) and Milton (1993), here adapted for a regional model. According to this methodology the model tendencies of a variable can be separated into dynamics (adiabatic) and physics (diabatic) components: In consequence if the model is in perfect balance, the tendencies from the dynamic and physic parameterizations should cancel exactly in a time average. However, this does not happen due to several error sources, such as model internal, data assimilation and observation errors. On the other hand Klinker and Sardershmukh showed for the ECMWF global model that *tendencies in the first time-steps show large similarity with model systematic errors* at, say, 72 hours.

In that work series of two-timesteps runs initialized with the same model analyses were performed. In the current study this integration period is chosen short enough so that no strong interaction have occurred among the model components. Otherwise it would not be possible to compare the model tendency like a simple arithmetic sum of the tendencies produced by each model parameterization scheme or part of the dynamics. On the other hand, very short integrations such as 2 time-steps is not appropriate for current model which does not produce its own analysis, therefore the predicted fields would be affected by large adjustments. After these considerations, a compromise solution of 1-hour length integrations were performed.

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3.RESULTS

Fifteen cases during the period June to November 1998 were selected and the evaluation of model systematic errors were carried out over 3 regions on the continent: NW (15S-10N, 85W-45W), NE (15S-10N, 45W-30W) and S (45S-15S, 85W-30W). NW and NE exhibits similar error pattern. In the S region the error profile depends on the synoptic conditions produced by the transient weather systems common in these latitudes. The temperature and humidity tendencies after 1 hour of integration exhibit a pattern similar of those obtained with the 24-h forecasts. This fact allow to conclude that it is possible to employ the Klinker and Sareshmukh methodology to the case of regional models and that the chosen integration-period was convenient. In spite the similarity between the 24-hr observed errors and 1-hour predicted tendencies patterns, these latter are larger in magnitude during this period of strong adjustment.

Figure 1 shows the partitioning of model temperature tendencies between the dynamics and the physics routines over tropical South America. The tendencies from the dynamics are larger than those from the parameterization schemes. In some levels both components show the same signal, for example between the eta layers 10 to 18). The humidity tendencies from the dynamics are small and almost constant with height, whereas the physics parameterizations produce strong tendencies in lower levels.

Figure 2 shows the model tendency contribution from each physic parameterization over the same region. The two major schemes in producing larger tendencies are the convection and turbulence. The first acts mainly in the middle troposphere, whereas the second acts in the first 12 layers closer to the surface. The large scale precipitation causes the smallest temperature and humidity tendencies. The radiation scheme produces a negative balance, indicating that long wave emission exceed the short wave incoming radiation. This kind of behavior was also found in the UK Met Office Unified Model (UM), but in smaller magnitude. This figure also suggests that the heat produced by the turbulent processes is not efficiently transported upwards by the convection scheme which does not produce negative tendencies in the lower levels. The convective scheme produces precipitation by relaxing the environment profile toward a reference one. The lack of evaporation from this type of precipitation may cause positive bias in the temperature tendency errors and negative in the humidity tendency errors.

Negative temperature tendencies that occur at about 19/20 eta layers (700hPa approx.) cause destabilization of the layer below. This type of error is common in the N and, specially, in the NE region. The turbulence scheme seem to produce excessively large tendencies.

Figure 3 shows a longitudinal mean of temperature tendencies after 1-hour of integration. Larger values are due to the convection scheme, with positive tendencies to the north of equator occupying the whole troposphere. In other words the convection scheme acts by warming the troposphere in the region occupied by the Inter-tropical Convergence Zone, which was positioned slightly to the north of the equator during the studied period. Negative tendencies are found at midlevel, this may induce erroneous instability. The temperature tendency due to stable precipitation is one order of magnitude smaller than the convection scheme and is restricted to mid-latitudes. This type of precipitation are related to the stable part during frontal passages and acts fundamentally over the region usually affected by the South Atlantic Convergence Zone (not shown). The negative tendencies are produced by evaporation of falling rain. The latent heat released during the formation of cloud water occurs mostly in mid-latitudes and does not compensate the negative tendencies from other schemes. One can notice that cloud water presence is not limited to mid-latitudes but extends toward tropical latitudes. Radiation scheme cools almost the whole troposphere. Turbulence scheme affects the lowest model layer where turbulence is more active. This scheme tends to warm the lower troposphere, except at extra-tropical lower levels, which are affected by cold oceanic currents as Peruvian and Malvinas currents.

3. REFERENCES

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ACKNOWLEDGMENTS

Financial support was provided by Fundação de Amparo a Pesquisa do Estado de São Paulo (FAPESP) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

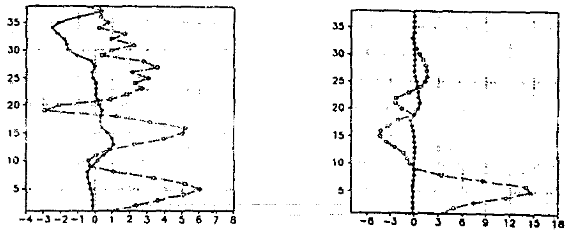

Figure 1: temperature (left) and humidity (right) tendencies (15 cases) after 1-hour of integration produced by the dynamic (dots) and the physic component (broken line). Ordinates represent eta levels

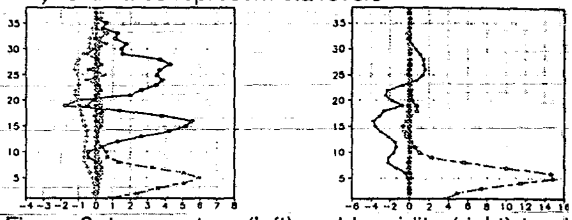

Figure 2: temperature (left) and humidity (right) tendencies (15 cases) after 1-hour of integration produced by each model parameterization: Convection (full line), turbulence (broken lines), other param. (dots)

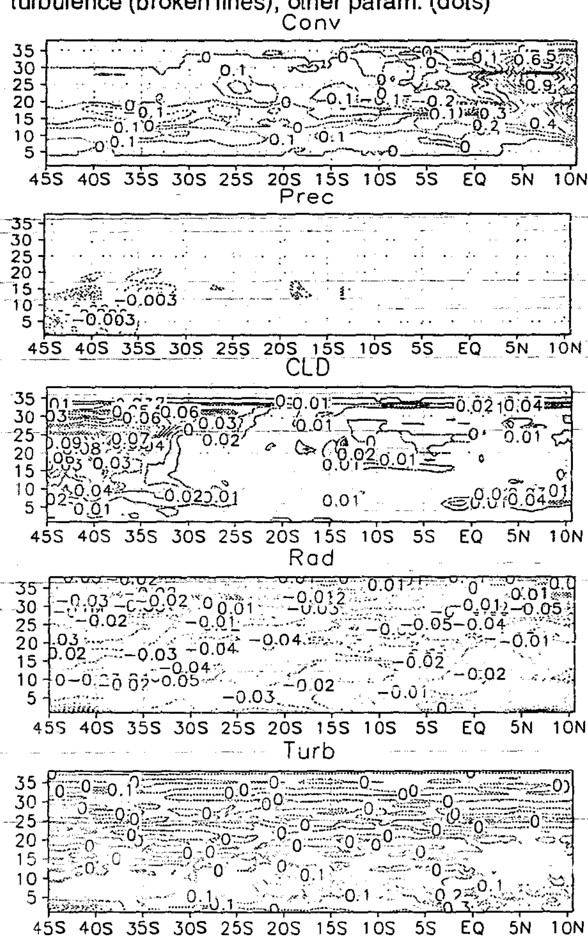

Figure 3: Longitudinal mean of temperature tendencies after 1-hr of integration generated by each parameterization scheme: Convection (Conv), large scale precipitation (Prec.), cloud water (CLD), radiation (Rad) and turbulence (Turb.) Ordinates represent eta levels.