J5.3 THE INFLUENCE OF THE ANDES ON THE ARGENTINE-URUGUAYAN PAMPAS SUMMER CLIMATE SIMULATED BY A GENERAL CIRCULATION MODEL

Silvio N. Figueroa* and Carlos A. Nobre

Center for Weather Prediction and Climate Studies, National Institute for Space Reseach – CPTEC-INPE
São José dos Campos, São Paulo, Brazil

1. INTRODUCTION

The Pampas is an extensive plain spreading over central and eastern Argentina and Uruguay, presenting a subtropical humid climate during the summer. It constitutes one of the best areas for agriculture worldwide. Numerical experiments with and without the Andes Cordillera (AC) were performed using a general circulation model to understand the influence of AC on Argentine-Uruguayan Pampas climate during the austral summer.

2. MODEL

Except the cumulus parameterization scheme, the model used for the experiments is the operational weather and seasonal climate forecast global spectral model at the Brazilian Center for Weather Prediction and Climate Studies (CPTEC), which is a modified version of the atmosphere global circulation model (GCM) developed by Center for Ocean-Land-Atmosphere Studies (COLA). The horizontal resolution of the model is triangular 62 (T62), and vertical resolution is 28 levels (L28). The details of CPTEC-GCM version can be found in Cavalcanti et Al. (2002). The convection scheme used in the present operational GCM is Kuo-Anthes scheme. However, in our experiments we used Kuo-Geleyen scheme, which was better than Kuo-Anthes and the relaxed Arakawa-Shubert scheme for simulating precipitation in the Amazon region. It is known that the correct representation of the Amazon heat source in models is closely linked to a better simulation of large scale circulation over South America.

3. NUMERICAL RESULTS

The most important differences between AC and no-AC experiment are found on the low level circulation east of the central Andes around 5-15oS. The model with Andes reproduced northwesterly flow east of the Andes similar to observations during the austral summer (December-January-February, DJF). Conversely, without Andes, southeasterly flow is found on this region.

The northwesterly flow east of Andes is crucial to water vapor transport from the tropical region to middle-latitudes through Chaco region. The importance of atmosphere moisture transport from the tropical region to southern South America has been extensively recognized by many observational studies (eg. Mo and Higgins 1996; Wand and Paegle 1996, Nogues-Paegle and Mo 1997; Li and Treut 1999, and others).

Another interesting result from the difference AC and no-AC experiments is the existence of a weak band of precipitation, extending from southwest of Gran Chaco to the Atlantic Ocean through Uruguay and eastern Argentine Pampas. We have called this zone as Pampas Convection Zone (PAMCZ). This band is not as conspicuous during the summer climate of precipitation as the South Atlantic Convergence Zone (SACZ). Whereas the SACZ is a quasi-stationary rainfall system for 4 days or longer whose existence does not seem to depend on AC (Figueroa et al. 1995, Kodama 1999), PAMCZ seems to be just the preferred region for convection due the existence of AC.

The 500 hPa vertical velocity in the AC experiment shows three regions of subsidence: over Patagonia (around 65W-45S), southern Brazil (around 50W-30S) and Northeast Brazil (around 38W-10S), and two opposite regions over SACZ and pampas region (PAMCZ). The existence a dipole between SACZ and southern Brazil was found by Casarin and Kousky (1986) and modeled by Gandu and Silva Dias (1998). In the no-AC experiment the dipole is between two large regions, the subsidence is on most part of Argentina and upward air motion over SACZ region. Therefore, the existence of weak dipole between Patagonia and Pampas region seems to be due the existence of Andes.

* Corresponding author address: Silvio Nilo Figueroa, CPTEC/INPE, Rod Presidente Dutra km 40, Cachoeira Paulista, SP, CEP 12630-000, Brazil. Phone 55-12-5608502. Email: nilo@cptec.inpe.br

From the vertical velocity we found also that the upward air motion is more intense over Argentine pampas than Uruguayan side. This result can help to explain why frontal systems are enhanced over this region after crossing quickly the Patagonia region to the south and why it is a frontogenetic zone. For similar reason, that area is favorable for formation of squall lines and mesoscale convective systems. There are some observational evidence of the existence of preferred region for convection over Argentine Pampas (eg. Campetella and Velasco, 1995).

Two important factors are responsible for the creation of PAMCZ: the first is the existence of low level southwesterly flow east of the AC over Patagonia region and the other is the existence of northeasterly flow east of the Peruvian and Bolivian Andes which is responsible for water transport from tropical region to Chaco and Pampas regions, this feature being associated to the low level jet. The no-AC experiment shows that sensible heat fluxes is higher than latent heat fluxes, the Bowen ratio is around 2.0 and evaporation, 1 mm/day. With AC the Bowen ratio is 3.5 and the evaporation is around 2 mm/day. These results show that the Andes Cordillera has strong influence over the Pampas region summer climate. The influence seems to be greater over Argentina than the other regions of South America. The climate over central, northern and northeastern Argentina, without the Cordillera Andes would be similar to the climate of a semiarid region. It is associated to two main factors. A weak or absence of water vapor flux from tropical region to midlatitudes through Gran Chaco and the intrusion of the South Pacific Subtropical High to the continent.

4. REFERENCES

Campetella, C.M., and I. Velasco, 1995: Estudio de la tormenta ocurrida sobre territorio Argentino entre el 18 y 19 de noviembre de 1982. *Meteorológica*, **20,** 75-84.

Casarin, D. P., and V. Kousky, 1986: Anomalias de precipitacao no Sul do Brasil e variacoes na circulacao atmosferica. *Revista Brasileira de Meteorologia*, **1**, 83-90.

Cavalcanti I.F.A., and Coauthors , 2002. Global climatological features in a simulation using the CPTEC-COLA AGCM. *J. Climate*, **15**, 2965-2988.

Figueroa, S. N., P. Satyamurty and P. L. Silva Dias, 1995: Simulation of the summer circulation over the South American region with an Eta coordinate model. *J. Atmos. Sci.*, **52**, 1573-1584.

Gandu, A.W., and P.L. Silva Dias, 1998: Impact of tropical heat sources on the South American tropospheric upper circulation and subsidence. *J. Geophys. Res.*, **103**:6001-6015

Mo, K.C., and R.W. Higgins, 1996: Large-scale atmospheric moisture transport as evaluated in the NCEP/NCAR and the NASA/DAO reanalyses. *J. Climate*, **9**, 1531-1545.

Nogués - Paegle. J. and K. - C. Mo, 1997: Alternating wet and dry conditions over South America during summer. *Mon. Wea. Rev.*, **125**, 279-291.

Koddama, Y.M., 1999. Roles of the Atmospheric Heat Sources in Maintaining the Subtropical Convergence Zones: An Agua-Planet GCM study. *J. Atmos. Sci.*, **56**, 4032-4049.

Li, Z.X., and H. L. Treut, 1999. Transient behavior of the meridional moisture transport across South America and its relation to atmosphere circulation patterns. *Geophys. Res. Lett.*, **26**, 1409-1412.

Wang, M. and J. Paegle, 1996: Impact of analysis uncertainty upon regional atmospheric moisture flux. *J. Geophys. Res.*, **101,** 7291-7303.

ACKNOWLEDGEMENTS

The autors would like to thank Dr. P. Bonatti. for his useful discussions related to CPTEC/COLA Atmosphere global circulation model. This work was partially funded by the Brazilian National Council for Scientific and technological Development (CNPq) and by brazilian Science and technology foundation (FUNCATE) for the first author.