SUB-BATS EXPERIMENTS WITH MEDIUM RESOLUTIONS FOR DIFFERENT REGIONS: PERUVIAN ANDES, THE CARIBBEAN AND EAST EUROPE

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RESUMO O principal objetivo deste trabalho é testar a habilidade do modelo climátio regional (RegCM3) para reproduzir os campos de temperatura e precipitação usando o esquema sub-BATS com resolucao media (50km) sobre diferentes regioes. Dados da reanalise NCEP/DOE foram usados como condicoes iniciais e de fronteira. Resultados preliminares dos experimentos sobre os Andes peruanos, o Caribe e o Leste europeu são discutidos.

ABSTRACT The main objective of this paper is to test the regional climate model (RegCM3) ability to reproduce the air temperature and precipitation fields with medium resolution (50km) over different regions using sub-BATS scheme. The initial and boundary conditions were taken from the NCEP/DOE reanalysis II data sets. Preliminary results of one month run experiment over the Peruvian Andes, Caribbean and East Europe region are discussed.

Palavras-chave Modelos regionais climáticos, agregação na sub-grade

INTRODUCTION

One of the limitations of the numerical models with medium resolution is their restrained ability to represent the physical processes in the surface layer in regions with complex topography, and in regions with small islands. For these cases, it would be required to run the model with high resolution, which involves a greater computacional cost. For this reason the implementation of sub-grid scheme (Giorgi et al 2003) could represent a solution to improve the ability of the regional climate model (RegCM) to reproduce regional aspects of the climate, even with a meddium resolution, for domains with sharp ocean-land contrasts or with very complex terrain. The temperature and water vapor disaggregation over the Alpes (Giorgi et al. 2003), using subgrid-scale topography and land use scheme, showed some improvement in the simulation of the precipitation and snow.

In present work, we chose three regions with different complexity: the Caribbean, for which the small islands and the ocean-land interacction is important for the weather and climate pattern; the Alps, where the RegCM usually works well, even with the medium resolution, and the central Andes (Peru) where the RegCM3 default configuration usally produces wrong output, specially in the precipitation field, generating a lot of grid point storms.

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The main objective of this paper is to test the RegCM3, using sub-BATS scheme, model ability to reproduce the monthly mean air temperature and precipitation fields with medium resolution (50 km) over different regions of the world.

DATA AND METODOLOGY

Models description

In this study we used the RegCM3 model, which is a hydrostatic limited area model, with finite-difference discretization and sigma vertical coordinate. The main characteristics of the model are described in Pal et al., (2006); Fernandez et al. (2006) and Martinez et al. (2006). The RegCM3 was applied in different studies in specific regions (Fernandez et al., 2006; Martinez et al., 2006).

Model Configuration

The Cumulus Parameterization Scheme (CPS) used was Grell with Fritsch-Chappell (Gfc) and with Arakawa-Schubert (Gas) closures; over the ocean the Zeng PBL scheme was used to calculate the near surface fluxes. The horizontal resolution was chosen as 50km, covering 71 (E-W) by 54 (N-S) grid points in Rotated Mercator projection, and 18 vertical sigma levels until 80 hPa (top of the model. Two set of simulation for each region of the world were compared: (a) the default that use BATS surface scheme; with the the model horizontal resolution of 50km; (b) the sub-BATS scheme where the near surface variables (air temperature, moisture and precipitation) were desagregated in 5 grid points, implying a 10 km horizontal resolution for the surface scheme.

Data and period of simulation

The initial and boundary conditions were taken from NCEP/DOE reanalysis II (Kanamitsu et al., 2002). Sea surface temperature was obtained by interpolating the monthly averaged values of Reynolds et al. (2002). The monthly climatology of air temperature and precipitation, developed by the Climatic Research Unit (CRU) of the University of East Anglia (New et al., 2000) and GPCP (Huffman et al., 2001) were used to verify the model results. The experements were realizad for three regions of the world: Peruvian Andes, Caribbean and East Europe (Table 1) and the periods were defined as extreme cases of drought and very rainy periods which caused some impacts in each region. The total period of simulation was one month including the model spin up.

Table 1: Region and period of experiments

Peruvian Andes (86-56ºW/21ºS-3ºN)		Caribbean (85-68º W/16-24ºN)		East Europe (4ºW-24ºE/38-54ºN)	
Dry	Wet	Dry	Wet	Dry	Wet
January 1992	January 1994	June 2004	June 1995	August 2000	July 1999

RESULTS AND DISCUSSION

For the Peruvian Andes the analysis were done for 3 subdomain: all domain, central and southern part of the domain. The Figure 1c, using sub-BATS, shows greater orography effect over the tempeature than in BATS scheme (Figure 1b), that presents a somoothed temperature field.However, in the precipitation field Sub-BATS (Figure 2c) increases the systematic errors over the Andes of the BATS (Figure 2b), and more grid point storms are genereted. Almost the same was results were obtained for the dry period (Juanuary 1992, Figure not shown).

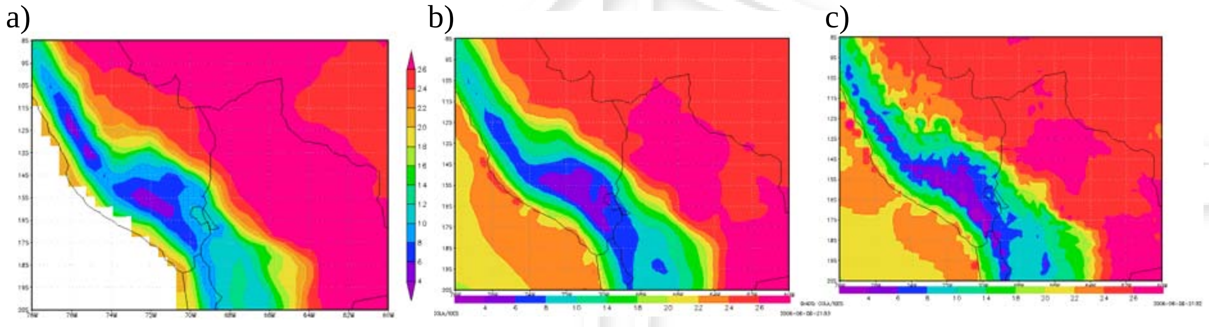

Figure 1. Monthly mean air temperature (^{o}C) for the southern peruvian Andes region for January 1994. a) CRU; b) BATS and c) Sub-BATS.

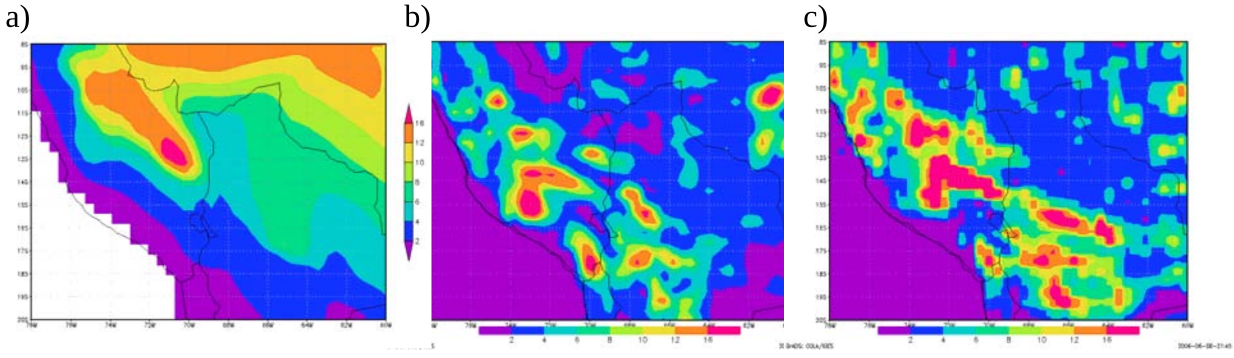

Figure 2. Same as Fig. 1, but for monthly mean precipitation (mm day $^{-1}$)

For the Caribbean region, Sub-BATS allows to reproduce more details in the temperature field (Figure 3b) which are associated with the orography, but it doesn't change the mean value (26,5°C for both experiments). The accuracy of the simulation must be verified using high-resolution surface network data. The sub-BATS scheme also allowed to catch the precipitation maximum over the island (Figure 4c).

a) b)

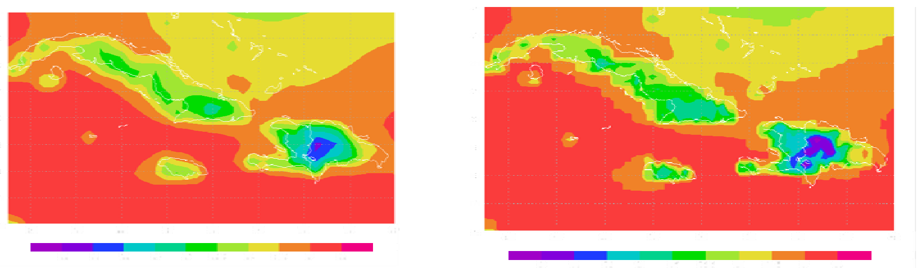

Figure 3. Monthly mean air temperature (°C) for the Caribbean region for June 2004. a) BATS and b) Sub-BATS.

a) b) c)

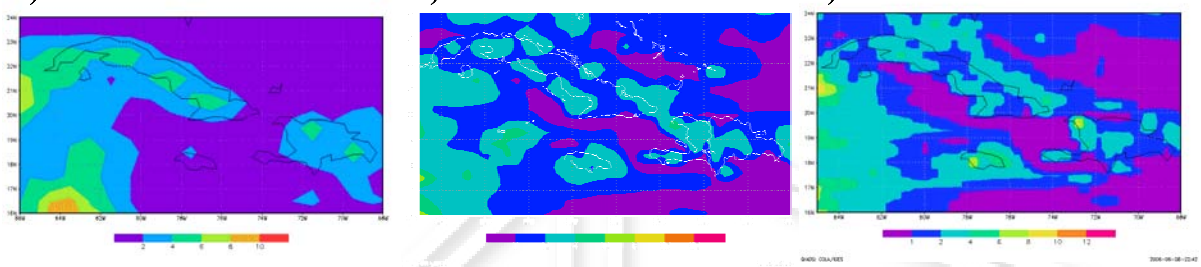

Figure 4. Same as Fig. 3, but for monthly mean precipitation (mm day $^{-1}$).

The precipitation and temperature field over the Alpes, in the European domain (Figure 5 and 6), are shown with more orographic details using sub-BATS scheme.

a) b) c)

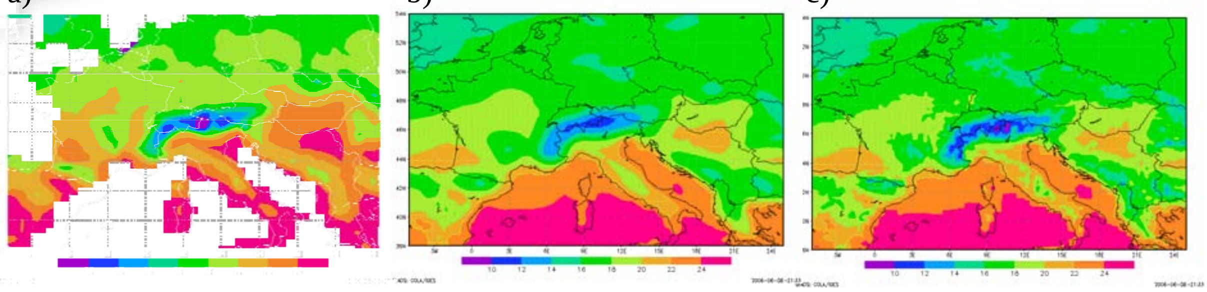

Figure 5. Monthly mean air temperature (°C) for the East Europe region for July 1999. a) CRU; b) BATS and c) Sub-BATS.

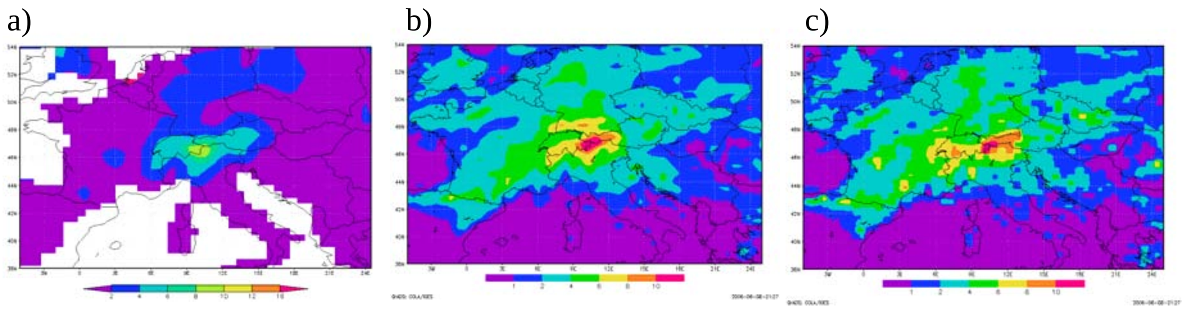

Figure 6. Same as Fig. 5, but for monthly mean precipitation (mm day $^{-1}$).

The time series for the daily precipitation, from GPCP data set, averaged over the whole domain showed that over the Europe the simulated values are very close the GPCP data, for both dry and rainy period (Figure 7a and 7b). For Caribbean region (Figure 7c) the results are satisfatory, with the model simulating well ligth precipitation (not heavy) periods. Over the Andes the simulated dialy preciptition is very different of the GPCP analysis (Figure not shown). This result might also be a consequence of the poor representation in CRU and GPCP data sets of the real precipitation pattern in this complex topography.

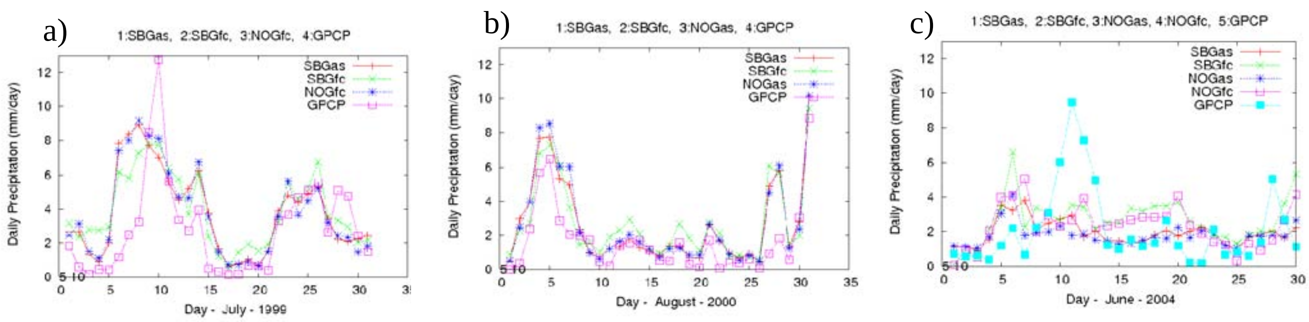

Figure 7. Time series of daily precipitation with different CPS averaged for whole domain: a) for Europe July 1999 (dry period); b) for Europe August 2000 (wet period); and c) for Caribbean for June 2004 (dry period).

The use of Sub-BATS over Europe and the Caribbean shows a small increase (~ 2-3%) in the monthly mean precipitation, while over Central and Southern Peruvian Andes, is not possible to find good results for all the domain. The spatial patterns simulated by Sub-BATS seem to show in more detail the climatic features associated to the topography and land-ocean interface, but this must be verified with local surface station data.

More specific analysis for the Andes using different cumulus and PBL parameterization schemes must be done. Problaby it will be necessary to make some changes in the sub-grid scheme to get more realistic results.

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