Comparative analysis of regional simulations over South America: RegCM3 versus RegCM4
(and RegCM3 in the CLARIS-LPB Project)

International Conference on the Coordinated Regional Climate Downscaling Experiment – CORDEX-

Rosmeri P. da Rocha
Collaboration: S. V. Cuadra, L. F. Kruger, M. S. Reboita, M. Llopart and T. Ambrizzi
Department of Atmospheric Sciences

Universidade de São Paulo
• CLARIS-LPB project has motivated optimizations in the RegCM3 model (da Rocha et al. 2011) to improve rainfall estimation over tropical and subtropical South America;

• May 2010 – RegCM4 is made available to be used in climatic simulations;
Objective

— Comparison of RegCM3 and RegCM4 to simulate the climatology over South America;

— To present contribution of RegCM3 to the CLARIS-LPB project (status of simulations)

— USP (R. P da Rocha and T. Ambrizzi):
  • providing RegCM3 downscaling to CLARIS-LPB project
  • analyzing the relationship between extratropical/subtropical cyclogeneses in the extreme events over LPB.

— CLARIS-LPB PROJECT aims:
  predicting the regional climate change impacts on La Plata Basin (LPB) in South America
designing adaptation strategies for land-use, agriculture, rural development, hydropower production, river transportation, water resources and ecological systems in wetlands.
— 7 regional models are involved in the regional climate downscaling (SMHI-RCA, USP-RegCM3, MPI-REMO, UCLM-PROMES and INPE-Eta).
Simulation domain (CORDEX)

Includes all South America continent and adjacent oceans

Common aspects of the simulations:

Horizontal resolution = 50 km
Vertical levels = 18
Initial and boundary conditions: ERA-Interim
SST = weakly mean

Radiation, Grell convective scheme, SUBEX, Zeng scheme for surface fluxes over the sea.

From January of 1989 to
<table>
<thead>
<tr>
<th>Model</th>
<th>Simulation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>RegCM4</td>
<td>Jan 1989 to Sep 1993</td>
</tr>
<tr>
<td>RegCM3</td>
<td>Jan 1989 to Jan 2007</td>
</tr>
</tbody>
</table>
Summer: DJF 90-91 and 91-92

90-91: RegCM4 is wetter than RegCM3 over tropics and subtropics.

9192: RegCM4 simulates a excessive drying in northern Amazon.
1991 was a wet winter in South America and both RegCM3 and RegCM4 capture this characteristic, although both underestimate rainfall intensity in the:

- ITCZ
- subtropics (Southeastern of South America) ➔ rainfall associated to the transient systems
Rainfall (mm/day) time series (monthly values)

AMZ: RegCM3 and RegCM4 underestimate rainfall intensity during rainy season

- Difference of ~ 4-5 mm/day at every rainy season
- RegCM4 is similar/dryer than RegCM3

LPB: Larger similarities between RegCM3 and RegCM4 during summer;

Autumn and winter: larger underestimations of both model versions
Air temperature (°C) time series (monthly values)

**AMZ:** in the tropics RegCM3 and RegCM4 present larger monthly variability than CRU analysis:
- Warmer dry season
- RegCM4 reduces RegCM3 cold biases during rainy season, but has large month-to-month variability.

**LPB:**
RegCM4 presents a small reduction of RegCM3 cold bias during cold season
RegCM3 simulations to the CLARIS-LPB
We are using an optimized version of RegCM3 (RegCLARIS)

<table>
<thead>
<tr>
<th>INITIAL AND BOUNDARY CONDITIONS</th>
<th>ERA-Interim</th>
<th>HAdCMQ0 A1B</th>
<th>ECHAM5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERIODS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960-1990</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1989-2008</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010-2040</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2070-2100</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

We finished 6 of the 7 simulations (except the red one) and we are finishing post-processing to send the data to the CLARIS-LPB data base until end Mach-2011 (we are 1 month late).
RegCLARIS nested in ERA-Interim Climatology (1989-2008): annual rainfall (mm/day)

Over continental South America RegCLARIS simulates the main observed precipitation bands:
- Maximum in northwestern that is NW-SE oriented and decrease of intensity in SOA
- Minimum in the center Argentina and Northeast Brazil

Simulation is wetter/colder than analysis in the northwestern part of continent
RegCLARIS: climatology (1989-2008) of rainfall annual cycle and extremes

Blue: CMAP and Red: RegCLARIS

AMZ: simulated rainfall annual cycle similar to the observed (small overestimation during onset of wet season).

LPB: underestimation is larger in autumn

Precipitation pentads over South America monsoon region

RegCLARIS: reduction of weaker rain and increase the frequency of intense events (> 8 mm/day)

Time correlation: 0.80
RegCM3 nested in the HadCM3 – A1B
Climatology of annual rainfall (mm/day)

RegCM3 is showing reduction in rainfall over tropical South America (the same signal of HadCM3 driving simulation)

Present day climate obtained from RegCLARIS-HadCM3 is similar to that of RegCLARIS-ERA-Interim, except for the weaker SACZ in the South Atlantic Ocean
RegCM3 nested in the HadCM3 – A1B
Climatology of air temperature (°C)

Simulation in the tropics is colder than in CRU analysis ➔ positive feedback between rainfall and lower air temperature

Scenarios are indicating strong warming
RegCM3 nested in the ECHAM5 – A1B
2009-2040

Annual scale: could apparently be useful.
But at seasonal scales the main large/ synoptic  systems are wrongly positioned (ITCZ) or absent (SACZ) of simulation
Summer: tropical rainfall is displaced eastward and Atlantic ITCZ (?) is in the Southern Hemisphere (?)
Summary and conclusions

• RegCM3 x RegCM4
  - there are small differences in the annual cycle and monthly variability of rainfall over LPB and AMZ;
  - differences are larger for air temperature in the tropics (larger month-to-month variability in RegCM4 than RegCM3). RegCM4 reduces a little the cold bias in the tropics.
RegCM3 – CLARIS-LPB

• RegCM3- simulations will be available in the CLARIS-LPB data base soon and

• they will be used together other models (MM5, RCMI, PROMES, REMO, WRF, ...) making a multi-model ensemble to study-understand climate change in the subtropical South-America
Thank you!!