Onset and Demise of the South American Monsoon in Two Simulations of RegCM3

Michelle S. Reboita
Instituto de Recursos Naturais
Universidade Federal de Itajubá – UNIFEI - MG

Rosmeri P. da Rocha
Departamento de Ciências Atmosféricas
Universidade de São Paulo – USP - SP
Many studies have been done to estimate the onset and demise of the South America Monsoon (SAM) using reanalyses dataset.

However, it is also important to verify if the climate models can simulate the SAM lifecycle.

Therefore, the purpose of this study is to identify the onset, demise and length of the SAM in two simulations of Regional Climate Model – version 3 (RegCM3) from 1960 to 1990.
Two simulations were carried out with RegCM3:

- one simulation was driven by output of the Hadley Centre Coupled Model (HadCM3) and

- other by global model from the Max Planck Institute for Meteorology (ECHAM5).

The simulations will be called by RegHad and RegECHAM, respectively.
Simulation Design

Domain: Cordex

Grid Points: 202 latitudes x 192 longitudes

Projection: Rotated Mercator

Horizontal Resolution: 50 km

Vertical Levels: 18

Period: 01/1959 – 01/1991
First year was considered as spin-up period.

Ocean Fluxes: Zeng et al. (1998)

Convection Scheme: Grell
Spatial patterns
DJF and JJA maps

Box Averages
Annual Cycle
RegHad simulates the South Atlantic Convergence Zone, but it displaces this zone to southward compared to the observations.
Results: Precipitation in the Summer

RegHad

RegHad - Summer (1960–1990)

RegECHAM

RegECHAM - Summer (1960–1990)

CRU

CRU - Summer (1960–1990)

U. Delaware

U.Delaware - Summer (1960–1990)

NCEP1

NCEP1 - Summer (1960–1990)

ERA-40

Era40 - Summer (1960–1990)

RegECHAM does not simulate the South Atlantic Convergence Zone and overestimates the precipitation over the northeast of Brazil.
Results: Precipitation in the Winter

RegCM3 simulations reproduce well the precipitation spatial pattern in the winter, but they underestimate the precipitation over the south of Brazil and overestimate in the south of Amazon.
RegHad $\rightarrow$ underestimates the prec from Feb to June
overestimates from Aug to Nov

RegECHAM $\rightarrow$ overestimates from Oct to Apr
similar to the observations from May to Sep

There is no a better simulation.
RegHad → underestimates the prec from Feb to June
similar from Jul to Sep
overestimates from Oct to Nov

RegECHAM → overestimates from Dec to Apr
similar to the observations from May to Sep

There is no a better simulation.

NCEP1 reproduces the annual cycle, but it underestimates the prec from Dec to May.
Both simulations have a good performance over the southeast of Brazil.

But,

they have a small underestimation from Apr to Jun.
RegHad → similar to observations

RegECHAM → underestimates slightly the prec from Mar to Jun

In this region, RegHad has a better performance.
Both simulations do not reproduce the annual cycle and underestimate the precipitation values.

Underestimation is higher in RegECHAM from Jan to Jun.
Results: Annual Cycle

**RegHad** → underestimates the prec from Feb to May
overestimates from Jun to Nov

**RegECHAM** → underestimates the prec from Jan to May
similar to Jun to Dec

RegECHAM has a better performance.
We investigated the SAM onset, demise and length in the NCEP1 and in two simulations of RegCM3. CRU and U. Delaware analysis were not included because they do not have daily data.

The SAM onset and demise were determined using a precipitation index that is defined considering the pentad mean precipitation over West-Central Brazil region (60°W-50°W and 10°S-20°S), Figure above.

The SAM onset (demise) occur when a pentad shows precipitation higher (lower) than 4 mm/day, and this value persists during at least 6 out of 8 subsequent pentads (Gan et al., 2006).
Table 1  Mean and standard deviation of the pentad of onset and demise and length of the SAM as identified by Gan et al. (2006) and in the RegCM3 simulations.

<table>
<thead>
<tr>
<th></th>
<th>GAN et al. (2006)</th>
<th>NCEP1</th>
<th>RegECHAM</th>
<th>RegHad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>58 (±3)</td>
<td>58 (±4)</td>
<td>58 (±2)</td>
<td>56 (±2)</td>
</tr>
<tr>
<td>Demise</td>
<td>22 (±2)</td>
<td>24 (±4)</td>
<td>24 (±2)</td>
<td>19 (±4)</td>
</tr>
<tr>
<td>Length</td>
<td>38</td>
<td>40</td>
<td>40</td>
<td>37</td>
</tr>
</tbody>
</table>

The SAM onset in the literature begins in the pentad number 58 that is the same of the NCEP1 and RegECHAM. In RegHad, the SAM onset occurs two pentads earlier (56).
SAM Features: Demise

Table 1 Mean and standard deviation of the pentad of onset and demise and length of the SAM as identified by Gan et al. (2006) and in the RegCM3 simulations.

<table>
<thead>
<tr>
<th></th>
<th>GAN et al. (2006)</th>
<th>NCEP1</th>
<th>RegECHAM</th>
<th>RegHad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>58 (±3)</td>
<td>58 (±4)</td>
<td>58 (±2)</td>
<td>56 (±2)</td>
</tr>
<tr>
<td>Demise</td>
<td>22 (±2)</td>
<td>24 (±4)</td>
<td>24 (±2)</td>
<td>19 (±4)</td>
</tr>
<tr>
<td>Length</td>
<td>38</td>
<td>40</td>
<td>40</td>
<td>37</td>
</tr>
</tbody>
</table>

In RegHad, the SAM demise occurs four pentads earlier (19), which is reported in Gan et al. (2006) to occur in the pentad 22. Comparing with this value, both NCEP1 and RegECHAM present a delay in the SAM demise (pentad 24).
Table 1  Mean and standard deviation of the pentad of onset and demise and length of the SAM as identified by Gan et al. (2006) and in the RegCM3 simulations.

<table>
<thead>
<tr>
<th></th>
<th>GAN et al. (2006)</th>
<th>NCEP1</th>
<th>RegECHAM</th>
<th>RegHad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>58 (±3)</td>
<td>58 (±4)</td>
<td>58 (±2)</td>
<td>56 (±2)</td>
</tr>
<tr>
<td>Demise</td>
<td>22 (±2)</td>
<td>24 (±4)</td>
<td>24 (±2)</td>
<td>19 (±4)</td>
</tr>
<tr>
<td>Length</td>
<td><strong>38</strong></td>
<td>40</td>
<td>40</td>
<td><strong>37</strong></td>
</tr>
</tbody>
</table>

Although in RegHad the SAM onset and demise is different from Gan et al. (2006) the SAM length of 37 pentads is similar (38 pentads). NCEP1 and RegECHAM present 40 pentads for SAM length.
The SAM study indicates that in RegECHAM, SAM features are more similar to the Gan et al. (2006) than in RegHad.

However, the analysis of the precipitation spatial pattern showed that RegHad simulates this better than RegECHAM. For example: South Atlantic Convergence Zone is not well defined in the RegECHAM that displaces the maximum precipitation to the northeast of Brazil.

Therefore, this study highlight that there is no a better simulation. According to the application and region of study one simulation can be more appropriated than the other.

RegCM3 reproduces the SAM features!
Thank you very much!!!