EGU General Assembly 2020

Climate projections in fine resolution downscaling over South America: trends and classification of cyclonic systems

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Introduction

- Cyclones developing in the eastern coast of South America impact weather and control the climate in most parts of the continent as well as over the South Atlantic Ocean.
- Current knowledge of these cyclones shows that they can have different thermal and dynamic structures along their lifecycle being classified as tropical, subtropical or extratropical.
- Over the sea, cyclones generate intense near-surface winds with major impacts on human activities and ecosystems.

Objective

- **General:** to investigate the future climatic trends of the different phases of cyclones over the southwest South Atlantic Ocean using fine resolution RegCM4 downscaling. Special emphasis will be given on the contribution of subtropical cyclones causing extreme events (rainfall and wind) in eastern Brazil.
- **In this presentation** we show preliminary results of the precipitation and of all cyclones climatology provided by the ERA-Interim evaluation simulation in the period **1979-1989.**

Data and Methods

Data

- CFSR (Saha et al., 2010) and ERA-Interim (Dee et al., 2011) reanalyses;
- Precipitation analysis from CPC (Xie et al., 2007).

Simulation

- Dynamical downscaling using RegCM4 model (Giorgi et al., 2012) over the South America CORDEX domain;
- Horizontal grid spacing: 25 km;
- Evaluation simulation nested in the ERA-Interim reanalysis.

Cyclones tracking

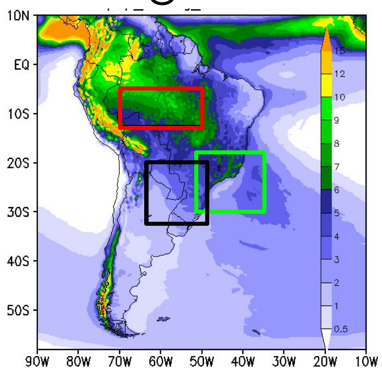
- Used an algorithm (Sugahara, 2000; Reboita et al. 2010) based on cyclonic relative vorticity at 925 hPa;
- Minimum relative vorticity less or equal than -1.5×10^{-5} s^{-1} for at least 24 hours.

- **Period: 1979-1989**

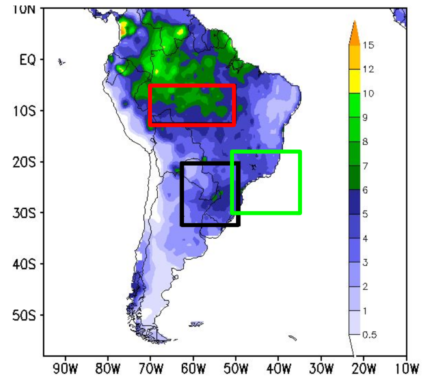
Results: simulated and observed climatologies for the period 1979-1989

Precipitation and 10-m wind

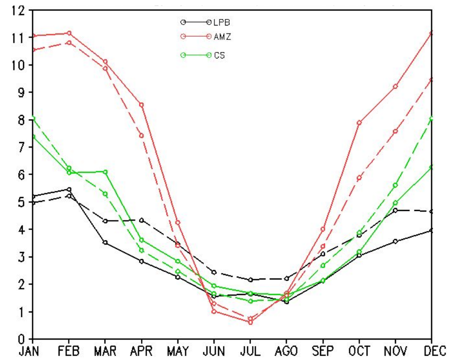
RegCM4



CPC



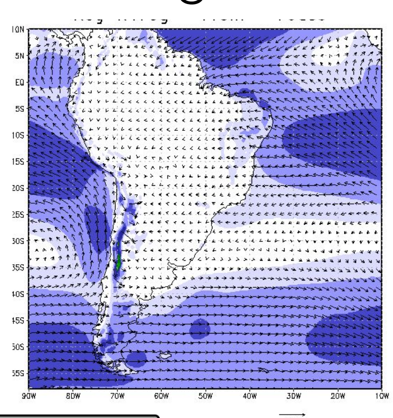
Annual cycle



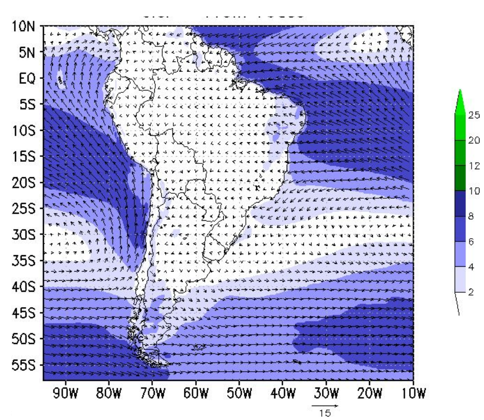
Annual precipitation (mm/day) simulated (solid lines) and observed (dashed lines); the boxes in the map represent La Plata Basin (LPB, black), Amazon (AMZ, red) and Southeast coast (CS, green).

The simulation reproduces: i) the observed (CPC) northwest/southeast rainfall band, which is more intense in the Amazon decreasing to the southeast; ii) weaker rainfall rate over La Plata Basin; iii) the winds represent quite well reanalysis, with differences in the speed near the equator and western South America; iv) the wind is slightly stronger during winter in the Amazon.

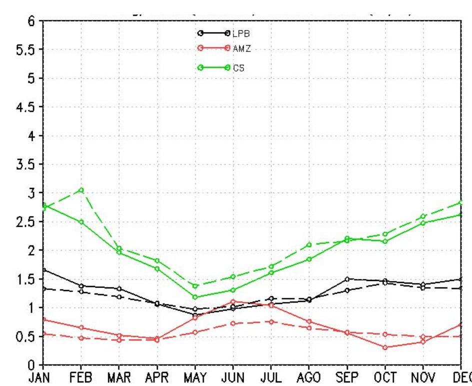
RegCM4



CFSR



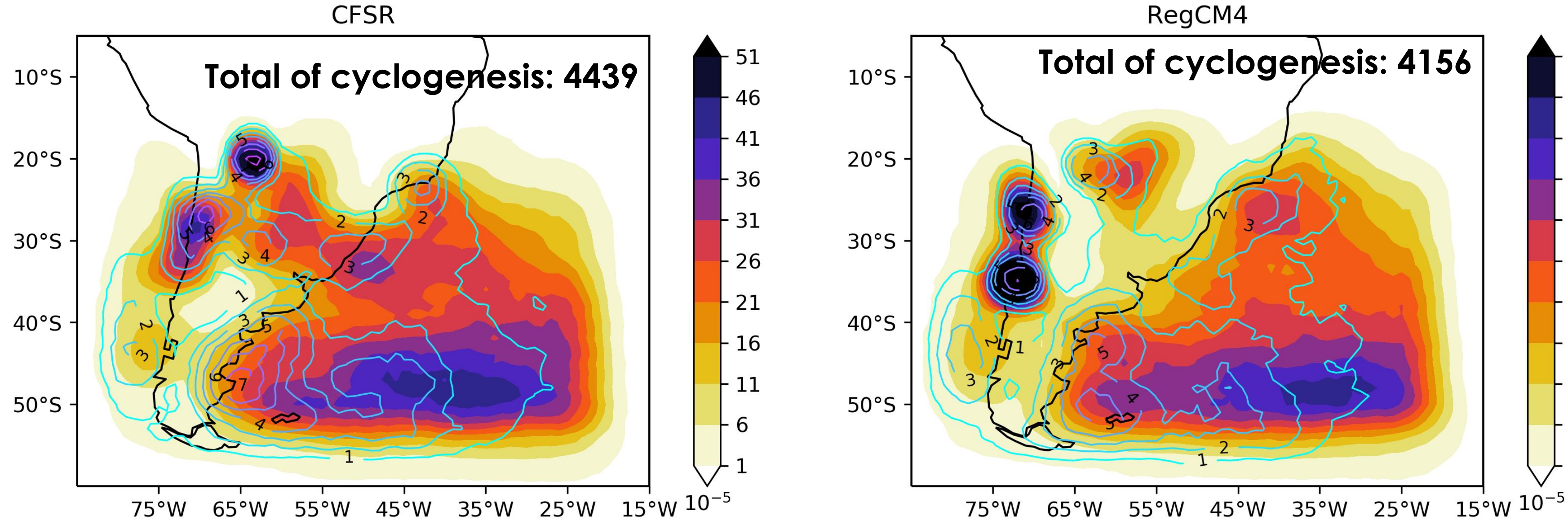
Annual cycle

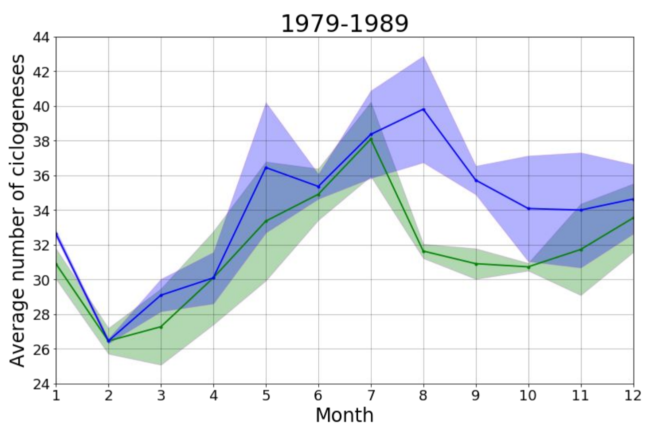


Annual mean wind at 10 m simulated (solid lines) and CFSR reanalysis (dashed lines); La Plata Basin (LPB, black), Amazon (AMZ, red) and Southeast coast (CS, green) represented by the boxes in the rainfall map.

Cyclones density climatology

Annual cyclogenesis (continuous lines) and trajectory (shaded) density





Annual cycle of cyclogenesis over the whole domain in CFSR (blue) and RegCM4 (green).

RegCM4 compared with CFSR analysis: 1) reproduces quite well the main cyclogenetic regions, however, displacing to the east the cyclogenetic regions near the eastern coast of South America; 2) underestimates a little (-6.4%) the total frequency of cyclogenesis over the tracking domain, mainly from August to November; 3) split in two the main cyclogenetic center near south Argentina.

Discussion and further work

- *RegCM4 evaluation simulation using 25 km of horizontal grid spacing presents great ability to reproduce the observed annual cycle of rainfall in most parts of South America and the near surface circulation;*

- *Important improvements - compared to previous RegCM simulations (50 km horizontal resolution): i) reduction of the dry bias over Amazon; ii) it captures the observed phase of the annual cycle of rainfall over La Plata basin;*

- *Cyclones: RegCM4 identifies correctly the main observed cyclogenetic regions in eastern coast of South America, with a small bias in the total number of cyclones (-6.4%).*

Next steps:

- *Cyclone climatology for the period 1979-2005.*
- *Cyclone classification: based on the cyclone phase space (CPS, Hart, 2003) parameters: thermal symmetry, lower and upper levels thermal winds.*
- *Scenarios simulations: RegCM4 nested in RCP4.5 and RCP8.5 of HadGEM2-ES and MPI-ES GCMs.*

Support: CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico

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