Evaluation of the climate simulated by INPE regional Eta model driven by the Brazilian Earth System Model

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INTRODUCTION

The National Institute for Space Research (INPE) is leading the construction of an Earth System Model as part of the Brazilian effort to develop a multidisciplinary research framework to study and understand the causes of global climate change and its effects and imapcts on society. Decadal simulations have been produced as contribution to the CMIP5 (Nobre et al 2013). Higher horizontal resolution is more suitable for impact and adaptation studies. Therefore as complementary to the development of the global model, the downscaling of these climate simulations is carried out by the Eta Model running in multidecadal mode (Chou et al 2012). The Eta Model is used operationally by INPE at the Centre for Weather Forecasts and Climate Studies (CPTEC) to produce weather forecasts over South America since 1997 and seasonal climate forecasts since 2002. The model has gone through upgrades (Mesinger et al (2012). along these years and is able to produce decadal integrations to downscale climate projections.

OBJECTIVES

To evaluate the downscaling of the present climate produced by the Eta model driven by the Brazilian Earth System Model.

The Models: Brazilian Earth System Model

BESM-OA2.3 (Nobre et al 2013) is an evolution of previous versions of the Center for Weather Forecasting and Climate Studies (CPTEC) coupled ocean-atmosphere model.
-Uses GFDL's FMS coupler to couple:
- CPTEC's Atmos global spectral model at T62L28 resolution
SSIB continental surface model
Grell cumulus convection parameterization scheme
Mellor Yamada closure scheme for PBL physics
- GFDL's MOM4p1 global ocean model at telescoping resolution from 1x1 extratropics to ¼ x 1 lat-lon equatorial, with 50 vertical levels
- ISIS ocean ice model
- Topaz ocean biogeochemistry model

The Models: Eta Regional Model

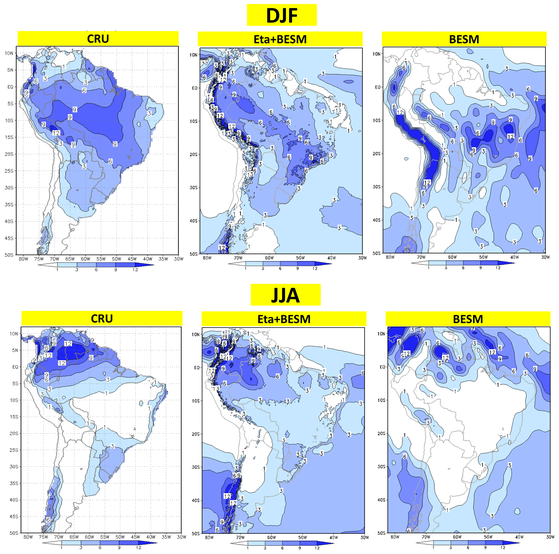
Resolution: *20km/38 layers.
Grid-point model Arakawa E grid and Lorenz grid
Eta vertical coordinate
Mesinger, 1984; added refinements in Mesinger et al (2012)
Time integration: 2 level, split-explicit
Adjustmet: forward-backward
Horizontal Advection: first forward and then centered
Vertical Advection: Piecewise linear scheme
Prognostic variables: T, q, u, v, p_s, TKE, cloud water/ice, and other hydrometeors

Convection scheme: Betts-Miller-Janjic
Cloud scheme: Zhao scheme
Turbulence: Janjic 1994 (MY 2.5), Monin-Obhukov surface layer
Radiation: GFDL package
Land surface scheme: NOAH scheme, 4 soil layers,
LBC: BESM, updt 6h/6h
Initial soil moisture: monthly climatology
Initial albedo: seasonal climatology
CO2 fixed
SST from BESM simulations

Atmospheric model initial conditions were taken from NCEP/NCAR reanalysis fields for the 00:00 GMT on 1 of December. The ocean initial states were chosen for the same dates from a spinup run of MOM4p1 with prescribed atmospheric fields of momentum, solar radiation, air temperature and fresh water .

RESULTS

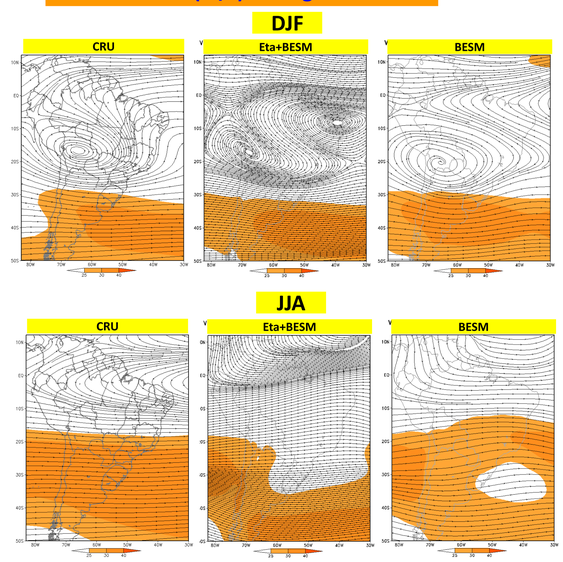
PRECIPITATION (mm/day) average 1962-1990



The South Atlantic Convergence Zone (SACZ) is the major precipitation feature during DJF (summer) season. There is precipitation in the interior of the continent in the BESM simulation, but the band feature is not clear. The downscaling produced by the Eta model improves substantially the precipitation in the SACZ region.

During JJA (winter) season, no precipitatiion occurs in the central part of the continent, which is correctly simulated by BESM. The dowsncaling however produced some overestimate.
In the southern part of Brazil, the Eta model reproduced better precipitation pattern.

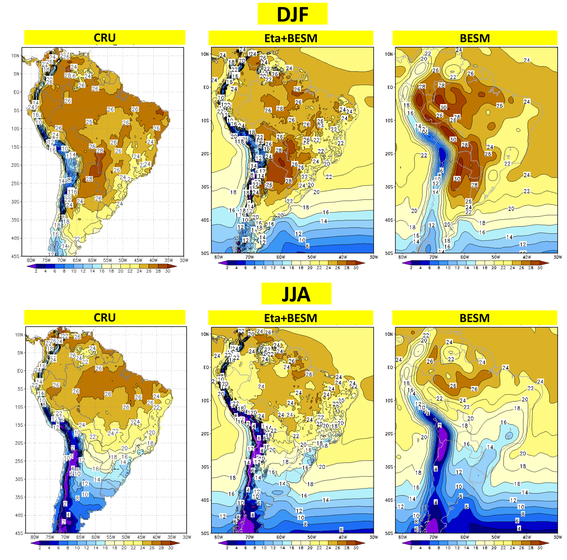
200 hPa winds (m/s) average 1962-1990



The Bolivian Anticyclone is a major feature of upper level circulation over South America during DJF (summer) season. The global model has the feature in about the correct position, but the downscaling has it displaced westward. The cyclonic circulation to the east of the continent is strong in the global model, and even stronger in the downscaling simulations.

During JJA (winter) season, the upper level flow is typically zonal. The global model simulates a weak jet and split in two latitude bands over South America. The downscaling produces also a weaker jet in Southern Brazil.

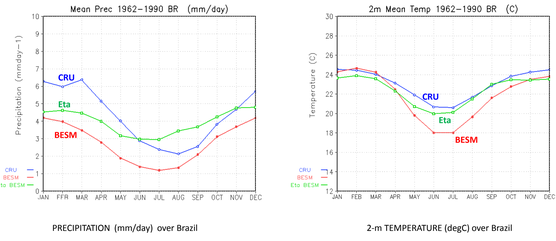
TEMPERATURE (deg Celsius) average 1962-1990



During DJF (summer) season, the global model has higher temperature in the western part of the continent and lower in the eastern part. On the other hand, the downscaling by the regional model has lower temperatures in most of the region, except over Paraguay and northern Argentina. The downcaling also has much lower temperature over the Andes Mountains.

During JJA (winter) season, both global and regional models underestimate temperatures in the tropical areas of South America.

Seasonal cycle: average 1962-1990



PRECIPITATION (mm/day) over Brazil

2-m TEMPERATURE (degC) over Brazil

The downscaling with Eta model improved the simulation of the seasonal cycle of precipitation and temperature over Brazil.
The minimum in precipitation occurs in July in both global and regional models.
The simulated curves of the temperature cycle are more in phase with the observations than the curves of precipitation.

The downscaling 29 years of present climate over South America has been carried out with the INPE regional Eta model driven by INPE's global model. The simulations show some difficulties in simulating the upper level flow, either during summer or winter seasons. The current model top of the regional model is positioned at 50hPa, raising model top should be the next task in preparing the model for longer integrations using lateral boundary conditions from the under-development Brazilian Earth System model. The Eta model driven by HadCM3 simulations (Chou et al 2012) shows different results and especially different model errors.

These are preliminary results of the Brazilian effort in the development of modelling tools to study the climate system.

Some developments are ongoing in both global and regional models, such as the inclusion of dynamic vegetation model, and the inclusion of chemical transport model. As only for the regional Eta model, it is planned the replacement of the radiation scheme, the coupling with MOM ocean model, and the coupling with flake model.

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