Evaluation of the Eta Simulations Nested with two Global Climate Models to Drought Assessment of São Paulo

Heloisa Ramos Pereira[1]; Gabriel Constantino Blain[2]
[1-2]Agronomic Institute of Campinas, SP, [1]Federal University of Itajuba, MG

Abstract

This study aims at evaluating the simulations performance of a Regional Circulation Models (RCMs), nested to Global Climate Models (GCMs) - the ETA-HadGEM2-ES and ETA-MIROC5 - for calculating the Standardized Precipitation Index (SPI). For this, the indices values derived from the models will be compared with indices values calculated from ground weather stations. The selected area for this study is São Paulo state - a tropical-subtropical region of Brazil situated at the boundaries of the Capricorn tropic where both precipitation and evapotranspiration exhibit considerable variability over spatial and temporal domains. The ground data (1961 to 2005) were obtained from the Agronomic Institute of Campinas (IAC) and the simulations were obtained from the above-mentioned models. The GCMs are those described in the Intergovernmental Panel on Climate Change reports. The main goal of this study is to specify possible correction factors from the years 1991 to 2005 in order to assess the performance of the models for calculating the probabilistic drought indices.
Key-words: ETA nested model; climatological analysis; drought index.

Introduction

Droughts occur in practically all regions of the world and frequently lead to vast agricultural, economic, social and environmental damages (Chen and Sun, 2015). As described at Wilhite (2000) and Dubrovsky et al. (2009) the great number of sectors affected by drought, its temporal distribution, its geographical diversity, and the increasing demand placed on water supply by man-made systems make it difficult to develop a precise definition for drought. The scientific literature frequently recognizes four types of droughts (agricultural, meteorological, hydrological and socioeconomic), more information Wilhite (2000), Blain (2012), and others.

From the point of view of the statistical quantification of drought, the Standardized Precipitation Index (SPI) is a probability-based drought index developed to quantify precipitation departures over different time scales making them invariant in both time and space. Developed by Mckee et al. (1993), the SPI has been widely used whether in academic studies related to drought (Guttman, 1999, Dubrovsky et al., 2008, Lloyd-Hughes and Saunders, 2002, Wu et al. 2007 and Blain 2012), as well as in operational system monitoring this adversity. Considering future scenarios of drought, Global Climate Models (GCM) project changes in precipitation. significantly alter the frequency and Intensity of this climatic anomaly in several regions of the Globe (Dubrovky et al., 2008). It is important to note that due to the grid size grid size of GCM models are hundreds of kilometers, regional characteristics, such as topography for example, may not be properly represented (Chou et al., 2014a). Thus, Regional Climate Models (RCMs), which can be nested in GCM, are particularly important for evaluating the possible regional impacts of climate change on drought phenomena, since they have higher spatial resolution (Chou et al., 2014). For this, this study aims to evaluate the performance of the ETA-HadGEM2-ES and ETA-MIROC5 models in the calculation of probabilistic indices of drought and, proposing possible correction factors.

Methods and Materials

SPI Index

The SPI calculation starts by fitting a parametric "2-parameter gamma" distribution to the rainfall data that can be accumulated over a large period of time scales (usually between 1 and 12 months). The final value of the index is obtained by applying the inverse of the standard normal function to the cumulative probabilities (Guttman, 1999).

Weather stations

Monthly rainfall series, available from three weather station were chosen to show the performance of the model on simulating the climate patterns of these locations. These stations represent climatically dissimilar areas of the State of São Paulo

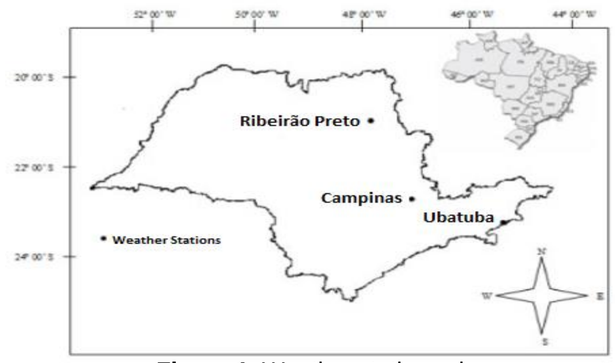

Figure 1. Weather stations chosen.

Table 1. The models description.

Model	Resolution	Source
HadGEM2-ES	1.875 x 1.275/ 38 layers	Collins et al., (2011); Martin et al. (2011)
MIROC5	T85 (aprox. 156km)/ 40 layers	Watanabe et al. (2010)
ETA	40km/38 layers	Chou et al. (2014)

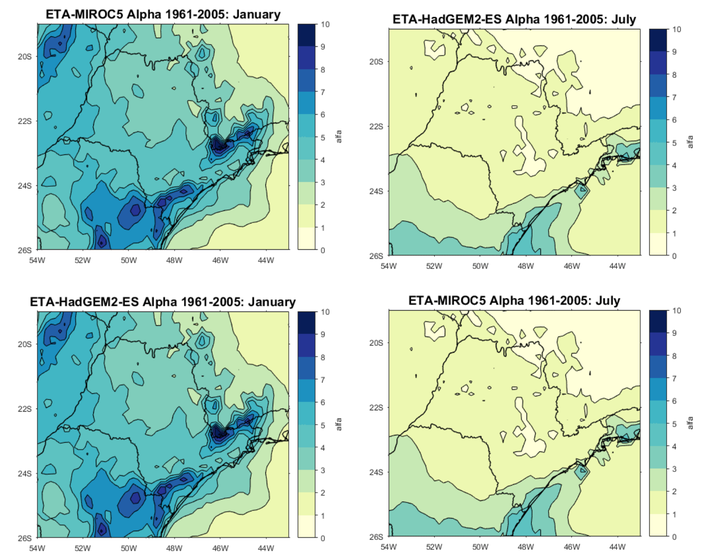

Figure 2. Alpha parameter calculated with nested ETA data.

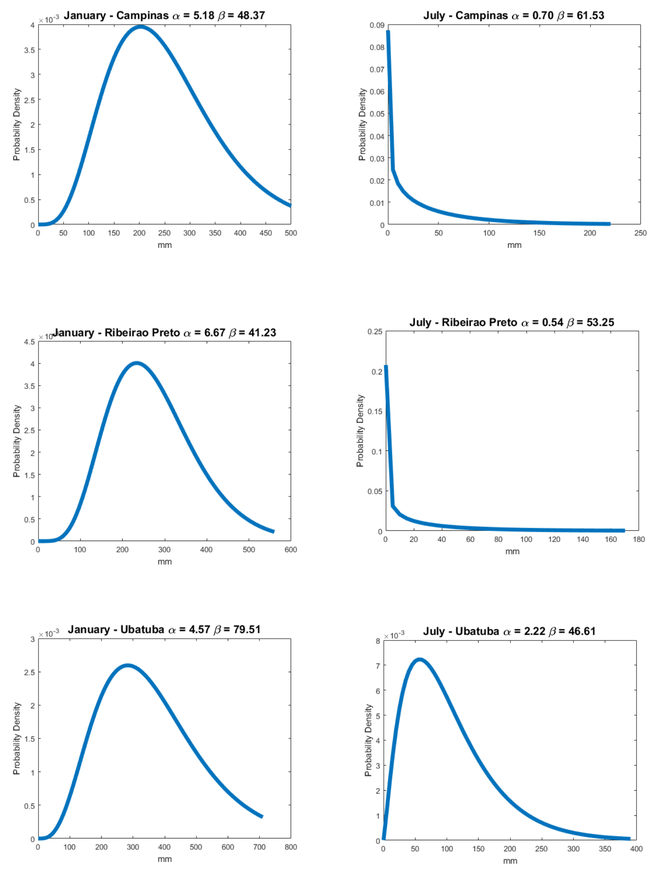

Figure 3. Probability Density calculated with observational data.

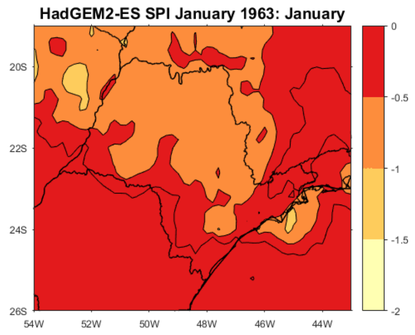

Figure 4. SPI Index calculated with HadGEM2-ES data.

Table 2. SPI values according to Mckee et al. (1993).

SPI Values	Drought Category
0 to -0.99	mild drought
-1.00 to -1.49	moderate drought
-1.5 to -1.99	severe drought
≤ -2	extreme drought

Results

The preliminary results indicated that the parameters of the Gamma distribution, obtained from the two models (ETA-HadGEM2-ES and ETA-MIROC5) properly simulated the climatology of São Paulo state. These first results demonstrate a great potential of these models on monitoring droughts in São Paulo, by using the SPI`.

Contact

Heloisa Ramos Pereira
Agronomic Institute of Campinas (IAC)
Email: heloisaramos92@gmail.com
Phone: +55 (11) 973821748