EGU2011-12865. Session CL4.4. Poster XL148.

NUMERICAL STUDY OF THE 2005 SEVERE DROUGHT IN THE AMAZON BASIN USING REGIONAL CLIMATE MODELS OVER SOUTH AMERICA

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INTRODUCTION

In 2005, large areas of the southwestern Amazon Basin experienced the most severe drought episode in the last 100 years. The drought affected the population living by the lower Amazon River and its western and southwestern tributaries the Solimões (also known as Amazon River in the other Amazon countries) and the Madeira Rivers. The causes of the drought were not related to El Niño but to (a) the anomalously warm tropical North Atlantic Ocean, (b) the reduced intensity in northeast trade wind moisture transport into southern Amazon during the peak summertime season, and (c) the weakened upward motion over this area of Amazonia, resulting in reduced convective development and rainfall. Due to the extended dry season in the region, forest fires affected part of southwestern Amazonia (MARENGO et al.,2008).

The international section of the 11 December 2005 issue of The New York Times reported that *"The drought has evaporated whole lagoons, and kindled forest fires, killed off fish and crops, stranded boats and the villagers who travel by them, brought disease and wreaked economic havoc"*.

Lake near the Amazon city of Manaquiri (left) and Barreirinha in October 2005 (right).
Source: WHRC - Woods Hole Research Center e Greenpeace.

OBJECTIVE

The aim of this work is to study the drought of Amazonia in 2005 using regional climate models to assess the skill of the models in detecting the event.

METHODOLOGY

- The models utilized in this work were Eta/INPE (PESQUERO et al., 2009; CHOU et al. 2011), MM5/CIMA (GRELL et al., 1993 and SOLMAN et al., 2008) and LMDZ/IPSL (HOURDIN et al. 2006 and LI 1999);
- The models were forced by ERA Interim reanalysis (Simmons et al., 2007) to simulate the 1989-2008 climate over South America with 50-km horizontal resolution;
- The domain used was suggested by the CORDEX (COordinated Regional climate Downscaling EXperiment) project of the WCRP (World Climate Research Programme). These simulations are contributions to the EU FP7 CLARIS LPB Project (A Europe-South America Network for Climate Change Assessment and Impact Studies in La Plata Basin) and CORDEX;
- It was used the dataset of the Global Precipitation Climatology Center (GPCC) in the spatial resolutions of 1.0° latitude X 1.0° longitude.

RESULTS

-Figure 1: DJF and MAM mean precipitation errors in 2005

- The spatial distribution of rainfall for DJF and MAM follows the expected pattern for that region. The rainy season occurs from March to May in the North and from December to February in the southern region;
- The models represent the rainy season in both regions, however, all analyzed models show errors greater than |100 mm/month| with respect to GPCC rainfall;
- The three analyzed models overestimate precipitation west of the Amazon Basin and underestimate in the Northeast compared to GPCC in the two study periods;
- The MM5/CIMA underestimates rainfall in most of the basin, in both periods.

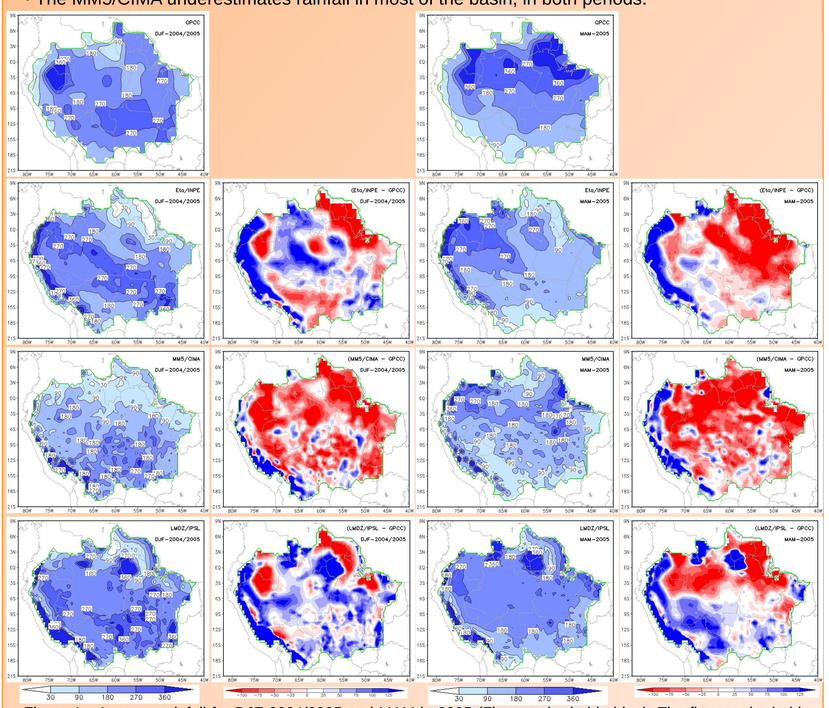

Figure 1 - Average rainfall for DJF 2004/2005 and MAM in 2005 (Figures shaded in blue). The figures shaded in blue and red represent the difference between the precipitation model and dataset of GPCC. Data in mm/month.

- Figure 2: 2005 DJF and MAM precipitation anomaly

- The dataset of GPCC shows for the period DJF (rainy season in Southern Amazon) a deficiency of precipitation over most of the Basin, with high deficit in the central region. In the MAM (rainy season in Northern Amazon) rainfall deficiency persists in the West and South Amazon;
- The Eta/INPE model identified only a few locations with precipitation below average. In the central region for the period DJF, the model showed positive anomalies, while data from the GPCC shows a marked deficit of precipitation;
- The models MM5/CIMA and LMDZ/IPSL showed a spatial distribution of negative anomalies similar to that found in dataset of GPCC.

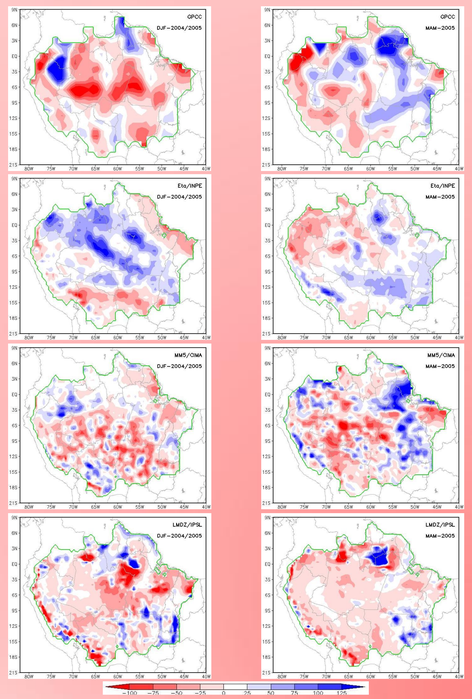

Figure 2 - Rainfall anomalies for DJF 2004/2005 and MAM in 2005. Anomalies are calculated with respect to the 1990-2008 baseline period, for each dataset (mm/month).

-Figure 3: Precipitation time series between 1991-2008, South and North Amazon Basins

- In the rainy season of the northern region (MAM), the area average of GPCC rainfall shows values above average for the period studied, while in the rainy season of the southern region (DJF), rainfall is below the average. The southern region was the most affected by the drought;
- In the southern region, LMDZ/IPSL and MM5/CIMA models show precipitation below the average for the period simulated, as was found in the GPCC, although the magnitude of the anomaly was smaller;
- Differently from other models and observation, the Eta model shows a positive anomaly in the South;
- The three models show the deficit of rainfall for the drought of 1998. This event was related to an El Niño episode.

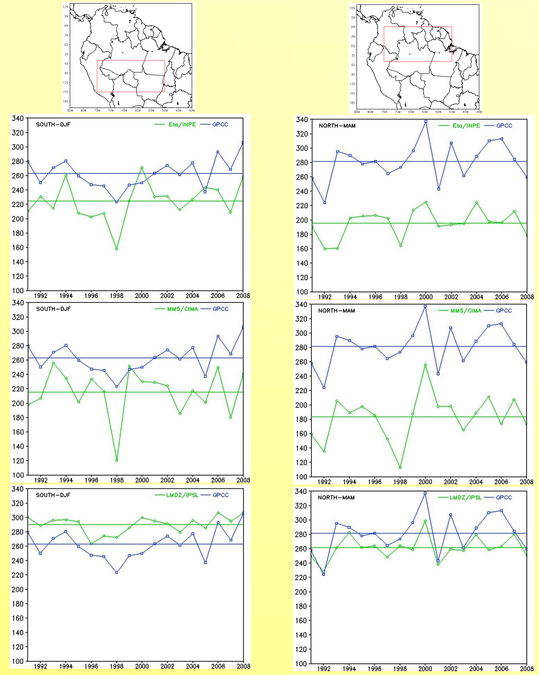

Figure 3 - Time series of average rainfall (mm/month) for the northern region (MAM) and southern Amazonia (DJF) from 1991 to 2008. These seasons correspond to the peak of the rainy season in the sections of the Amazon basin represented by the red square. The straight line without mark represents the average of each dataset.

CONCLUSIONS

1. All models show precipitation errors of magnitude larger than 100mm/month;
2. The MM5/CIMA and LMDZ/IPSL simulations captured the negative precipitation anomaly of the 2005 drought in the southwestern Amazon;
3. The drought of 1998, related to El Niño, was captured by all models, whereas the drought of 2005, related to warmer tropical North Atlantic ocean, was missed only by the Eta Model;
4. Internal nudging maybe an advantage of the other two models over the Eta Model in favouring the simulation of the 2005 drought conditions;

   This is a preliminary study, and more regional climate models will be included in this work.

ACKNOWLEDGMENTS

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement Nº 212492 (CLARIS LPB. A Europe-South America Network for Climate Change Assessmen and Impact Studies in La Plata Basin). The first author is sponsored by CNPq.

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