MULTI-SCALE PROCESSES DRIVING TROPICAL CONVECTION AND INFLUENCE OF THE AEROSOL

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Brazil - USA Collaborative Research: GoAmazon – FAPESP/DOE/FAPEAM

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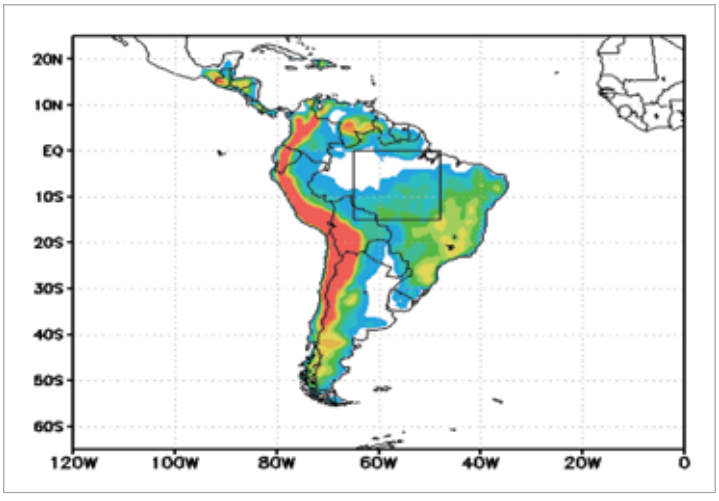

Figure 1. Shows the area over the Amazon region on the South American continent (square line) where most of the model analyses were done

This is a collaborative project between scientists in the US and Brazil and it addresses the fundamental processes that drive tropical deep convection and aerosol effects on these processes. A two-pronged approach is planned for the proposed research: (1) statistical analysis of data from the GOAmazon sites in view of properties of the atmospheric large scale environment that are relevant to convection and its interaction with aerosols, and (2) effects of aerosols on tropical precipitation for clean and polluted situations. *In situ* data collected by the GOAmazon campaign and output from a hierarchy of numerical models, ranging from general circulation models of the coupled atmosphere-ocean system to cloud resolving models will be used in the proposed research. In reference to approach (1), the effect of free tropospheric humidity and vertical shear on deep convective onset will be investigated. The intraseasonal variability in the characteristics of convection over the GOAmazon region will also studied. Approach (2) will use the results from step (1) to stratify the data from the GOAmazon sites according to aerosol information (e.g., mass loading, size distribution and chemical composition). Then the regulating effects of aerosols on selected cases of deep convection will be assessed by running simulations using a cloud resolving model (CRM) coupled with detailed spectral bin microphysics for cases of pristine and polluted conditions. The results from this project will contribute to improving the parameterizations of cloud and aerosol effects by increasing the knowledge of the processes that drive tropical convection and the aerosol influences on these processes. An important collaboration is expected among participants. The GOAmazon proposal gives both groups the opportunity to exchange knowledge and experience, with the US team learning more about the Amazon climate and the Brazil team learning more about large-scale numerical models. There is a strong confidence that the proposed scientific collaboration will be mutually beneficial in many senses.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

The hydroclimatic regime variability of the Amazon basin (AMZ) can be affected by local climate feedbacks as well as large scale climate patterns, for example associated with Sea Surface Temperature (SST) anomalies. For instance, the El-Nino Southern Oscillation (ENSO) influences the climate variability over this region. Climate change induced by increasing concentrations of greenhouse gases (GHG) affects the regional climate of the AMZ directly through modifications of the regional radiative budgets, as well as indirectly through changes in large-scale circulations patterns and changes in SST and potential for changes in ENSO events. Those changes may affect the hydroclimatology of the basin, resulting in high environmental and social impacts. According to global model projections, temperature may increase over South America (SA) by a wide range, up to ~1.0 °C to 7.0 °C, by the end of the 21st century, with the highest warming projected over the central Amazon region. The projected late 21st century precipitation changes are complex. Although ensemble average changes indicate a general drying of the Amazon, individual model projections range from a reduction of 20 to 40 % to even increase over tropical SA. Evidently, uncertainties in precipitation projections by General Circulation Models (GCMs) over SA remain high. Llopart et al (2014) analyze the local and remote impacts of climate change on the hydroclimate over the Amazon region (*Fig.1*) in an ensemble of four 21st century projections (1970-2100, RCP8.5 scenario) with a Regional Climate Model (RegCM4) driven by three global models from CMIP5 (Coupled Model Intercomparison Project Phase 5). First, they find considerable sensitivity of the precipitation change signal to both the driving global model and the RegCM4 land surface scheme, highlighting the pronounced uncertainty of regional projections over the region. However, some improvements in the simulation of the annual cycle of precipitation over the Amazon basin was found when using the RegCM4, and some consistent change signals across the experiments were simulated. *Figure 2* shows the annual cycle and simulated precipitation averaged over the AMZ region (*Fig.1*) in the reference period (1976-2005) along with the corresponding late 21st century change. The seasonal precipitation cycle over the AMZ is emphasized (*Fig.2a*). Precipitation is somewhat underestimated by all models in January-March, i.e., during the peak monsoon phase. The regional model results show a much better agreement with observations. The precipitation change (*Fig.2b*) is predominantly negative throughout the year. However it shows a noticeable seasonal variation with maximum decrease during the monsoon onset phase (August-September-October). In general the results suggest two important points: one is a tendency towards the extension of the dry season over central SA deriving from a late onset and an early retreat of the SA monsoon. The second is a dipolar response consisting of reduced precipitation over the broad Amazon region and increased precipitation over the La Plata basin and central Argentina.

MAIN PUBLICATIONS

Llopart M, Coppola E, Giorgi F, da Rocha RP, Cuandra SV. 2014. Climate change impact on precipitation for the Amazon and La Plata basins. *Climatic Change*. DOI 10.1007/s10584-014-1140-1.

Llopart MP. 2014. Soil-plant-atmosphere impact on regional climate simulations for South America. 140 pages. PhD Thesis. Institute of Astronomy, Geophysics and Atmospheric Sciences - University of São Paulo, São Paulo.

Mechoso CR, Neelin JD, Leung R, Ambrizz T. 2013. Multi-scale processes driving tropical convection and influence of the aerosol. American Geophysical Union 2013 Fall Meeting, 9-13 December. San Francisco, California, USA.

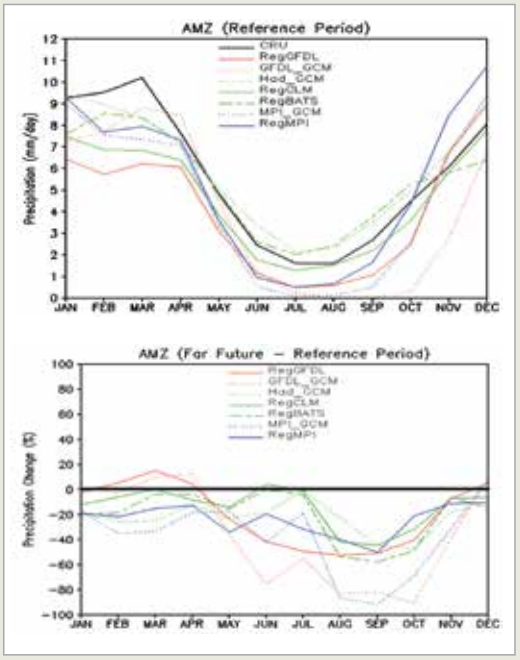

Figure 2. Annual cycle of observed and simulated precipitation averaged over the Amazon region (see Fig.1) for the reference period (1976-2005) (a) and the anomaly corresponding the to late 21st century change (2070-2099) (b). The colors correspond to the different model simulations analyzed. (Adapted from Llopart et al 2014)

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