Project: **759**

Project title: **Development and implementation of a hierarchical model chain for modelling regional climate variability and climate change over southern Amazonia**

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Report period: **1.1.2014 - 31.12.2015**

Introduction

The project is a subproject of the BMBF funded project **Carbiocial (Carbon sequestration, biodiversity and social structures in Southern Amazonia: models and implementation of carbon-optimized land management strategies; FKZ: 01 LL 0902 J)** and covers the crucial climate modelling part. Overreaching objective of our subproject is to analyze and model present and future atmospheric processes, boundary layer dynamics and spatiotemporal climate variations in southern Amazonia under different climate and land use scenarios. In addition the project provides climatological information for various impact studies in the Carbiocial framework. At the DKRZ high performance computer our model activities comprise the dynamical downscaling of global data sets representing the present day climate (ERA) or potential future conditions (IPCC scenarios, ECHAM5/MPI-OM). The non-hydrostatic Weather Research & Forecasting Model (WRF) is used.

During the first two years we concentrate on the downscaling of the present day climate (ERA-Interim; 2012-2013), and on the response due to potential future changes (2013) with respect to changes in greenhouse gas concentration (ECHAM; SRES A1B). During 2014 and 2015 the focus was on the impact of land use changes on the potential future (hydro)-climate variability in Southern Amazonia. In addition, the downscaling of ERA-Interim data was extended to the period 1989-2013 according to the needs of the Carbiocial project partners.

Model and setup

The Weather Research & Forecast Model (WRF) has been implemented on the DKRZ (Deutsches Klimarechenzentrum) computer architecture. A local multi domain setup for South America with special focus on the target region has finally been defined. The setup comprises a one-way nesting strategy with three nesting levels of about 60x60km (domain D1), 30x30km (D2), and 3.3x3.3km (D3), respectively for the downscaling of ERA-interim and ECHAM data. Short (24h) hindcast simulations with a 12h spin up time have been chosen for the dynamical downscaling.

The climate projections are selected according to the GLUES (Global Assessment of Land Use Dynamics, Greenhouse Gas Emissions and Ecosystem Services) project, which provides the story lines for impact studies in the Carbiocial framework. The GLUES group has selected the IPCC-AR4 SRES scenarios as the main climate input. The focus of the studies is on A1B scenario on a medium time scale (until about 2040). Here, data from the ECHAM5/MPI-OM simulations (Roeckner et al. 2006) are used to force the WRF model. Boundary driven 5-year simulations with a spin up time of 1 year are performed implementing the land use change scenarios provided by the GLUES project (Figure 1). A control simulation uses the same setup but includes no land use change.

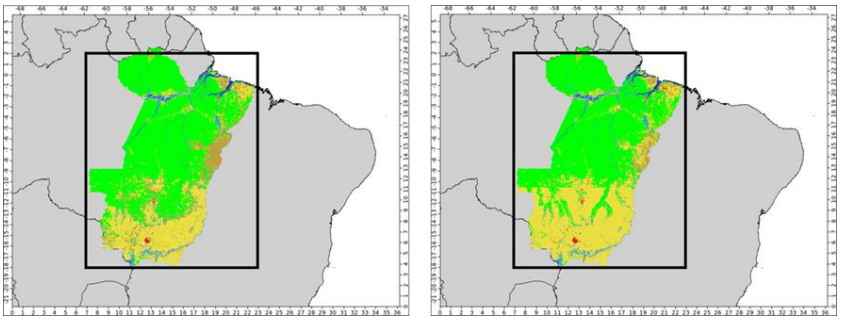

Figure 1: GLUES land use change scenarios for 2001 (left) and 2050 (right) for Mato Grosso and Para. Colors indicate particular vegetation types (e.g. yellow=crop).

Results

Downscaled ERA-Interim data have been further processed applying statistical downscaling methods to obtain output on a 900x900m grid. These data provide the input for model activities within other Carbiocial sub-projects (e.g. crop modelling). In addition they serve as a basis for the evaluation of the model chain, and for comparison between dynamical/statistical and pure statistical downscaling.

Simulations for 2001 to 2040 driven by one realization of SRES A1B by ECHAM5/MPI-OM are completed in the coarsest resolution (domain D1; 60x60km). Simulations with land use change (from GLUES) are nearly completed for 2001 to 2040 for the first and second nesting level (D1 60x60km and D2 30x30km).

Though the periods a relatively short, some preliminary results can be noted: As already seen for the ERA-Interim reanalysis data in the previous part of the project, the WRF results capture mean large scale features of the forcing data reasonably well. Overall, a warming and an increase of temperature can be seen for South America. It appears that for the Carbiocial area the relatively increase in temperature is mostly driven by global changes (i.e. changes in greenhouse gas concentration). However, land use changes may locally modulate the response due to negative or positive feedbacks. In particular, the role of soil moisture in conjunction with convective rainfall needs to be examined further.

Changes in temperature, precipitation and soil moisture imply a significant impact on the local ecology and economy (agriculture) in this region. The reasons for this particular change and the sensitivity to different land use scenarios will be one focus of future work within the project.

References

Roeckner, Erich; Lautenschlager, Michael; Schneider, Heiko (2006): IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GR1.5L40 SRESA1B run no.1: atmosphere monthly mean values MPImet/MaD Germany. World Data Center for Climate. doi:DOI:10.1594/WDCC/EH5-T63L31_OM-GR1.5L40_A1B_1_MM.

ECHAM5/MPIOM IPCC SRES A1B data used in this study/project have been provided by Max-Planck Institute for Meteorology, and have been obtained from the DKRZ data server (CERA).