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Scenarios of the spatiotemporal variability of precipitation for West Africa on the continental to local scale including ghg forcing and land use change

A. Krüger (1), K. Born (1), T. Brücher (2), A. Fink (1), P. Ludwig (1), H. Paeth (3), and M. Kerschgens (1)

(1) Institute of Geophysics and Meteorology, University of Cologne, Cologne, Germany (akrueger@meteo.uni-koeln.de), (2) Niels Bohr Institute, University of Copenhagen, Copenhagen, Danmark, (3) Institute for Geography, University of Würzburg, Würzburg, Germany

In the present study the influence of SST variability and land use change on the spatiotemporal rainfall variability in West Africa is investigated. The research is embedded in multidisciplinary Project IMPETUS (An integrated approach to the efficient management of scarce water resources in West Africa), which develops various decision support systems for local stakeholders to mitigate the impacts of the ongoing and projected climate change.
There is increasing evidence that in some regions, particularly in the tropics, land use changes may play an equally or even more important role in future climate change compared with enhanced greenhouse conditions. Particularly, tropical Africa appears to be a paradigm for the prominent link between land surface conditions and changes in the hydrological cycle and energy budget. Recently, complex scenarios of future land cover changes are elaborated and combined with radiative forcing according to the IPCC scenarios A1B and B1. Based on these more realistic scenarios, ensemble simulations with the regional climate model REMO are carried out, nested in global ECHAM5 simulations between 1960 and 2050 (IMPETUS model chain). The results reveal some remarkable changes in near-surface climate. In a broad band between the Guinean coast and 15°N as well as in the Congo basin annual precipitation is decreasing by 100 to 500 mm until the middle of the 21st century. At the same time, near-surface temperature increases by 2 to 5 K. The warming rate is much more pronounced in tropical Africa than in northern Africa and southern Europe, where greenhouse-gas concentrations are equally rising, and basically reflects the pattern of enhanced land degradation. The large-scale monsoon circulation and the occurrence of extreme events are affected as well. Differences between the A1B and B1 ensembles are small.
By means of the high resolution models of the IMPETUS model chain (LM and FOOT3DK) the effect of interactions between the Earth's surface and the atmosphere on fresh water availability is investigated on the local scale (the river catchment of the upper Ouémé in Benin). It is planned to use model rainfall simulations to construct a generator for future rainy seasons with a statistical-dynamical regionalisation approach for the regarded area.
For this purposes simulations with the non-hydrostatic mesoscale meteorological model FOOT3DK are conducted. First, on basis of the 3-D modelling several sensitivity studies for a certain episode of 54 hours were executed, which hint at a substantial risk of precipitation decrease in case of unfavourable land surface change i.e. the reduction of vegetation cover and/or decreasing of initial soil moisture.
In a further step accumulated precipitation for the rainy season 2002 for the HVO (Haute Vallée de l'Ouémé) was estimated with a satellite based approach for the detection of rainfall generating cloud systems (cf. Fink et al., 2006) in combination with episode simulations of FOOT3DK. The simulations with LM for 2002 are forced with analysis-data provided by the German Weather Service. The LM data serves as the input for FOOT3DK. The latter model is used for a double nesting procedure with horizontal resolutions of 9 km and 3 km. Land use is provided from other IMPETUS working groups and is mainly assessed on basis of Landsat and GLCC data. A comparison of observations and simulations leads to satisfactory results.
Finally, the entire model chain (ECHAM5-REMO-LM-FOOT3DK) is used to calculate scenario simulations with respect to the regarded IPCC scenarios. Simulations with LM are undertaken for the year 2025. Again episodes of 54 to 72 hours are calculated with FOOT3DK and an IMPETUS generated projection for the land use of 2025 to overcome the limited calculating capacity. The forty chosen dry and wet episodes shall enable the estimation of future rainy seasons (rainy season generator) by assigning them to meteorological parameters derived from REMO output.