Geophysical Research Abstracts, Vol. 7, 03325, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03325

Coupled Regional Climate – Hydrology Simulations for the Volta Basin (West Africa)

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The Volta Basin is a basically agriculturally dominated, climate sensitive region. Even small changes in the water balance can have a strong influence on living conditions of the people. To estimate the effect of a possible anthropogenic influence on the water balance in the Volta Basin (400,000 km^2), regional climate simulations and coupled hydrological simulations were performed.

In a first step, regional climate simulations were carried out, using the mesoscale meteorological model MM5, fully coupled to a 1D SVAT model, consisting of 4 layers up to 2m depth, to account for soil properties and soil-atmosphere feedback mechanisms. The scenario IS92a ("business as usual") of the global climate model ECHAM4 (2.5x2.5˚) was dynamically downscaled to a final resolution of 9x9 km^2 for the Volta Basin. Two 10-years time slices were simulated: The years 1991-2000 for present day climate, the years 2030-2039 for future climate.

To investigate the impact of atmospheric change on the terrestrial water balance, the distributed, physically based hydrological model WaSiM was coupled in a one-way approach to the regional climate model. For the hydrological simulations, a horizontal resolution of 1x1 km^2 was chosen, allowing detailed analysis e.g. of changes in evapotranspiration, the different runoff components (direct runoff, interflow, and baseflow), and groundwater recharge.

The regional climate simulations show an increase in annual precipitation for the whole region. The signal of precipitation change shows a strong spatial heterogeneity (-20% to +50%). Remarkably, a delay in the onset of the rainy season and a general

shortening of the rainy season could additionally be delineated. In case of temperature, a clear increase could be observed (ranging from 1˚ in the maritime South of Ghana up to 1.6˚ in the sahelian North of Burkina Faso). In case of river discharge, a nonlinear response to the precipitation input signal could be observed. Further analyses of changes in the hydrological balance are presented. Selected variables calculated by both the SVAT model (as a part of MM5) and WaSiM (e.g. evapotranspiration and surface runoff) are compared and analysed.