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Impact of Climate Change on Vegetation Dynamics in a West African River Basin

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We introduce our on-going study to develop a dynamic vegetation model (DVM) that can reproduce seasonal cycle of vegetation growth and death. A lot of studies have indicated that regional vegetation dynamics may impact local climate in West Africa and some indices of vegetation dynamics such as leaf area index (LAI) strongly correspond to land productivity there. Our DVM is characterized by an auto-calibration system using Shuffled Complex Evolution (SCE-UA) method, a consideration of detailed surface and sub-surface water runoff driven by hillslope, and an acquisition of land surface phenology using microwave remote sensing. As a demonstration of our model capacity, we show an assessment of climate change impact in a West African river basin (Volta River Basin). Future changes in terrestrial biomass distribution under climate change will have a tremendous impact on water availability, land productivity and land surface heat budget there. An eco-hydrological model that fully couples a DVM with a distributed biosphere hydrological model (WEB-DHM) that considers detailed subsurface water flow is developed. We apply the model to multi-model assessment of climate change impact on vegetation dynamics in the Volta River basin. The simple carbon cycle modeling with subsurface flow modeling shows reliable accuracy in simulating the seasonal cycle of vegetation on the river basin scale. Our future projections and sensitivity analyses show that an extension of dry season duration and high land surface temperature produced by climate change may cause a dieback of vegetation in West Africa, while an increase of atmospheric humidity has a positive impact on vegetation growth. The negative impacts of certain climate forcings sometimes overwhelm the positive impacts of the other forcings, and positive and negative impacts sometimes cancel each other. Thus, there are different magnitudes of change in biomass amount in different GCMs, although we select three GCMs whose climatologies agree well with past climate. This approach demonstrates that multi-model climate change assessment is crucial, and the sensitivity analysis developed here is useful for extracting principal environmental drivers of terrestrial biomass under a changing climate. The method in this study makes it possible to address the impact of future change of terrestrial biomass on climate and water resources on a regional scale.