Geophysical Research Abstracts
Vol. 16, EGU2014-9033-1, 2014
EGU General Assembly 2014

Modelling the Congo basin ecosystems with a dynamic vegetation model

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The scarcity of field observations in some parts of the world makes difficult a deep understanding of some ecosystems such as humid tropical forests in Central Africa. Therefore, modelling tools are interesting alternatives to study those regions even if the lack of data often prevents sharp calibration and validation of the model projections. Dynamic vegetation models (DVMs) are process-based models that simulate shifts in potential vegetation and its associated biogeochemical and hydrological cycles in response to climate. Initially run at the global scale, DVMs can be run at any spatial scale provided that climate and soil data are available. In the framework of the BIOSERF project ("Sustainability of tropical forest biodiversity and services under climate and human pressure"), we use and adapt the CARAIB dynamic vegetation model (Dury et al., iForest - Biogeosciences and Forestry, 4:82-99, 2011) to study the Congo basin vegetation dynamics. The field campaigns have notably allowed the refinement of the vegetation representation from plant functional types (PFTs) to individual species through the collection of parameters such as the specific leaf area or the leaf C:N ratio of common tropical tree species and the location of their present-day occurrences from literature and available database.

Here, we test the model ability to reproduce the present spatial and temporal variations of carbon stocks (e.g. biomass, soil carbon) and fluxes (e.g. gross and net primary productivities (GPP and NPP), net ecosystem production (NEP)) as well as the observed distribution of the studied species over the Congo basin. In the lack of abundant and long-term measurements, we compare model results with time series of remote sensing products (e.g. vegetation leaf area index (LAI), GPP and NPP). Several sensitivity tests are presented: we assess consecutively the impacts of the level at which the vegetation is simulated (PFTs or species), the spatial resolution and the initial land cover (potential or human-induced). First, we show simulations over the whole Congo basin at a 0.5° spatial resolution. Then, we present high-resolution simulations (1 km) carried out over different areas of the Congo basin, notably the DRC part of the WWF Lake Tele – Lake Tumba Landscape. Studied in the BIOSERF project, this area is characterized by a forest-savannah mosaic but also by swamp and flooded forest.

In addition, forward transient projections of the model driven with the outputs of about thirty global climate models (GCMs) from the new Coupled Model Intercomparison Project Phase 5 (CMIP5) will permit to outline the likely response of carbon pools to changing climate over the Congo basin during the 21th century.