Geophysical Research Abstracts
Vol. 16, EGU2014-2941-1, 2014
EGU General Assembly 2014


# Structural development and web service based sensitivity analysis of the Biome-BGC MuSo model

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Studying the greenhouse gas exchange, mainly the carbon dioxide sink and source character of ecosystems is still a highly relevant research topic in biogeochemistry. During the past few years research focused on managed ecosystems, because human intervention has an important role in the formation of the land surface through agricultural management, land use change, and other practices. In spite of considerable developments current biogeochemical models still have uncertainties to adequately quantify greenhouse gas exchange processes of managed ecosystem. Therefore, it is an important task to develop and test process-based biogeochemical models.
Biome-BGC is a widely used, popular biogeochemical model that simulates the storage and flux of water, carbon, and nitrogen between the ecosystem and the atmosphere, and within the components of the terrestrial ecosystems. Biome-BGC was originally developed by the Numerical Terradynamic Simulation Group (NTSG) of University of Montana (http://www.ntsg.umt.edu/project/biome-bgc), and several other researchers used and modified it in the past. Our research group developed Biome-BGC version 4.1.1 to improve essentially the ability of the model to simulate carbon and water cycle in real managed ecosystems. The modifications included structural improvements of the model (e.g., implementation of multilayer soil module and drought related plant senescence; improved model phenology). Beside these improvements management modules and annually varying options were introduced and implemented (simulate mowing, grazing, planting, harvest, ploughing, application of fertilizers, forest thinning). Dynamic (annually varying) whole plant mortality was also enabled in the model to support more realistic simulation of forest stand development and natural disturbances. In the most recent model version separate pools have been defined for fruit. The model version which contains every former and new development is referred as Biome-BGC MuSo (Biome-BGC with multi-soil layer).
Within the frame of the BioVeL project (http://www.biovel.eu) an open source and domain independent scientific workflow management system (http://www.taverna.org.uk) are used to support ‘in silico’ experimentation and easy applicability of different models including Biome-BGC MuSo. Workflows can be built upon functionally linked sets of web services like retrieval of meteorological dataset and other parameters; preparation of single run or spatial run model simulation; desk top grid technology based Monte Carlo experiment with parallel processing; model sensitivity analysis, etc. The newly developed, Monte Carlo experiment based sensitivity analysis is described in this study and results are presented about differences in the sensitivity of the original and the developed Biome-BGC model.