



Building a modelling framework to simulate ecosystem processes under changing climate: the long road from Biome-BGC to Biome-BGCMAg

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During the past 15 years, our research group was developing the Biome-BGCMAg (formerly known as Biome-BGCMuSo) biogeochemical model to improve its ability to simulate carbon and water cycle in different ecosystems, with options for managed croplands, grasslands, and forests. We made various model improvements based on the results of model validation and benchmarking. Our goal is to have a model that is suitable for estimating and predicting greenhouse gas fluxes of different ecosystems at various scales under changing management and climate conditions.

The current, most recent model is called Biome-BGCMAg which is a process-based, biogeochemical model that simulates the storage and flux of water, carbon, and nitrogen in the soil-plant-atmosphere system. Biome-BGCMAg was derived from the widely known Biome-BGC v4.1.1 model developed by the Numerical Terradynamic Simulation Group (NTSG), University of Montana, USA. One of the most important model developments is the implementation of a multilayer soil module with water, carbon, nitrogen, and soil organic matter profiles. We implemented drought and anoxic soil state-related plant mortality. Alternative calculation methods for various processes were implemented to support possible algorithm ensemble modelling approach. Optional dynamic allocation algorithm was introduced using predefined phenophases based on growing degree day method. We implemented optional temperature dependence of allocation and possible assimilation downregulation as a function of temperature. Nitrogen budget simulation was improved. Furthermore, human intervention modules were developed to simulate cropland management (e.g. planting, harvest, ploughing, and application of fertilizers) and forest thinning. Dynamic whole plant mortality was implemented in the model to enable more realistic simulation of forest stand development. Last (but not least) conditional management (irrigation and mowing) was introduced to analyze the effect of different management strategies in the future. We started to build a sophisticated R based software to increase the visibility of the model and enable its use by the wider scientific community.

In our first attempt to simulate national scale greenhouse gas budget with Biome-BGCMAg 2.0, we executed the model at 10 x 10 km spatial resolution for Hungary, using eco-physiological parameterization and prescribed management for maize, winter wheat, forests and grassland. The first results revealed that the spatial pattern of net primary production and crop yield is not

represented well by the model. Based on the first experiences we introduced new features within Biome-BGCMAg 2.1 that address soil water deficit related photosynthesis down-regulation. Missing stomatal conductance effect on C4 photosynthesis was also addressed by the new developments.