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Linking Hydrology and Biogeochemistry to assess the impact of Lateral Nutrient Fluxes

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Until recently, it has been challenging to couple hydrologic and biogeochemical processes at the watershed scale. We have coupled two models, WTB and MEL, to simulate lateral water and nutrient fluxes and their influence on ecosystem functioning. WTB is a spatially explicit water balance model. Vertical flow was simulated using a capacitance model with lateral flow dependent on head development and the local slope of the confining layer. The Multiple Element Limitation (MEL) model is an ecosystem model, developed to examine limitation in vegetation acclimating to changes in the availability of two resources (carbon and nitrogen). MEL also incorporates the recycling of resources through the soil. In our coupled model, nutrients are treated as inert solutes and are transported vertically as well as laterally using a mixing model. Nutrients moving down the slope are repeatedly taken up, cycled through vegetation and soils, and released back into the soil solution. We are currently indentifying the possibilities for incorporating flood dynamics into the model. We evaluated the impact of adding lateral nutrient fluxes to the original MEL model using a virtual experiment. The model (coupled and MEL only) was applied to a small, well defined catchment. After a simulation period of three years, we detect a redistribution of the stock of inorganic N. A larger amount of N is present near the river than at the top of the slopes of the catchment, largely due to lateral fluxes. Comparing the coupled model to the MEL model, we also find large losses of inorganic N in the coupled model due to large vertical fluxes out of the rootzone. These vertical out-fluxes cause a smaller N uptake by plants. To detect if Carbon (C) uptake by plants is affected due to the changes in N distribution, the simulation period has to be increased due to a lagtime in the optimization of the C:N ratio in plant biomass.

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