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Carbon-nitrogen-water interactions: is model parsimony fruitful?

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It is well known that carbon and nitrogen cycles are highly intertwined and both should be explained through the water balance. In fact, in water-controlled ecosystems nutrient deficit is related to this water scarcity. For this reason, the present study compares the capability of three models in reproducing the interaction between the carbon and nitrogen cycles and the water cycle.
The models are BIOME-BGCMuSo, LEACHM and a simple carbon-nitrogen model coupled to the hydrological model TETIS. Biome-BGCMuSo and LEACHM are two widely used models that reproduce the carbon and nitrogen cycles adequately. However, their main limitation is that these models are quite complex and can be too detailed for watershed studies. On the contrary, the TETIS nutrient sub-model is a conceptual model with a vertical tank distribution over the active soil depth, dividing it in two layers. Only the input of the added litter and the losses due to soil respiration, denitrification, leaching and plant uptake are considered as external fluxes. Other fluxes have been neglected.
The three models have been implemented in an experimental plot of a semi-arid catchment (La Hunde, East of Spain), mostly covered by holm oak (Quercus ilex). Plant transpiration, soil moisture and runoff have been monitored daily during nearly two years (26/10/2012 to 30/09/2014). For the same period, soil samples were collected every two months and taken to the lab in order to obtain the concentrations of dissolved organic carbon, microbial biomass carbon, ammonium and nitrate. In addition, between field trips soil samples were placed in PVC tubes with resin traps and were left incubating (in situ buried cores). Thus, mineralization and nitrification accumulated fluxes for two months, were obtained. The ammonium and nitrate leaching accumulated for two months were measured using ion-exchange resin cores. Soil respiration was also measured every field trip. Finally, water samples deriving from runoff, were collected to obtain the concentrations of dissolved organic carbon, dissolved organic nitrogen, ammonium and nitrate.
The comparison shows a better performance of the complex models reproducing carbon and nitrogen cycles. However, the TETIS nutrient sub-model, even simpler than BIOME-BGCMuSo and LEACHM, reproduces the water balance adequately and it obtains a suitable representation of the carbon and nitrogen cycles.