Geophysical Research Abstracts
Vol. 20, EGU2018-2383, 2018
EGU General Assembly 2018

New process-based modeling of nitrogen biogeochemistry in forest ecosystems for the long-term simulation of nitrogen saturation

Nobuhito Ohte (1), Francesco Giannino (2), and Christian Vincenot (1)

(1) Department of Social Informatics, Kyoto University, Kyoto, Japan (nobu@bre.soc.i.kyoto-u.ac.jp), (2) Department of Agriculture, University of Naples Federico II, Napoli, Italy (giannino@unina.it)

Global environmental scientists have recently reported that excess nitrogen (N) flows and stocks have already overstepped the "tipping point" defined by the biosphere's carrying capacity (Rockstrom et al., 2009). N cycling in many terrestrial ecosystems has been affected by regional excess N cycling mainly through atmospheric depositions. Consequently, high concentration of dissolved N, eutrophication, and acidification have occurred in aquatic ecosystems in the regions subject to heavy N deposition. In temperate to tropical forested ecosystems, which often provide water resources for various human activities, many studies have traditionally focused on the effects of excess N depositions on ecosystem functions. Existing studies include several model development and simulation works, many of which are lumped style models expressing the net N transformation rates and flows, and insufficiently model the underlying mechanisms, such as microbial activities and behaviors behind the biogeochemical appearance of N transformation. The aim of the present model is to reproduce the nitrogen cycle in the soil. More specifically, the model is built to analyze related processes through three nitrogen stocks (organic N, ammonium (NH4+-N), nitrate (NO_3–N) while integrating generic plant growth processes, the carbon cycle in the soil, and environmental conditions. Thus, the model implementation is structured in four parts: 1) Nitrogen cycle in the soil; 2) Plant biomass dynamic; 3) Carbon cycle in the soil; 4) Basic hydrological processes. The latter is modified from the NASA-CASA model (Potter et al., 1993). It includes daily precipitation as well as potential evapotranspiration calculated according to Thornthwaite (1948). Nitrogen transformation in this model is expressed conceptually by microbial activity, which is regulated by carbon resources and environmental parameters, such as temperature and moisture conditions. We tested the model's verisimilitude of long-term simulations (over a few centuries with a monthly timestep) integrating plant growth. We confirmed that the model could successfully reproduce the trend in biomass growth and nitrogen storages of each form, as well as responses against nitrogen deposition increase. We discuss the mechanisms behind the linkage between carbon and nitrogen availabilities in the soil in relation to the progress of nitrogen saturation under excess atmospheric nitrogen input.