Geophysical Research Abstracts
Vol. 12, EGU2010-674, 2010
EGU General Assembly 2010

Environmental and genetic controls on net nitrous oxide production vs. consumption during denitrification

Lisa Tiemann (1), Sharon Billings (1,2), Ford Ballantyne (1,2), Nathaniel Ostrom (3), and Patrick Dermyer (1)

(1) Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS, USA, (2) Kansas Biological Survey, Lawrence, KS, USA, (3) Department of Zoology, Michigan State University, East Lansing, MI, USA

Nitrous oxide (N2O) is a potent greenhouse gas capable of destroying stratospheric ozone, making it important to understand controls on its production and release from soils. When oxygen is limiting in soils, some microorganisms can use nitrogen-oxides as electron acceptors in the process of denitrification and release N2O. The end product of denitrification can also be N2, if N2O is consumed during complete denitrification, N2O release from soils is thus the net result of both production and consumption by soil microorganisms. To better understand the primary controls on N2O production versus consumption, we conducted experiments on soils from a mesic grassland where soil organic carbon is relatively plentiful and inorganic N concentrations and denitrification potentials are high, and developed a systems biology model of the denitrification gene regulatory network. We tested the effects of oxygen concentration, and soil moisture, carbon availability, and nitrate concentration in anaerobic conditions on N2O release in laboratory incubations. We found that nitrate concentration exerts the highest level of control on the magnitude of the measured N2O fluxes, and seems to have the greatest effect on the ratio of N2O production to consumption. Oxygen concentrations also drive the magnitude of N2O production, but seem to have little influence on ratios of N2O production versus consumption. Measurements of 15N and 18O isotopes and 15N isotopologues of N2O will help us to better define the influence of substrate availability on the denitrification gene regulatory network. The systems model we employed was developed using published regulatory pathways for the genes that code for denitrification enzymes. By fitting common biological network motifs to the denitrification regulatory system, we were able to model the effects of nitrate and oxygen concentration on gene regulation, particularly the regulation of nitrous oxide reductase, which reduces N2O to N2 and thus ultimately controls the ratio of N2O production to consumption. We verify the regulatory network model using N2O and CO2 production as well as isotope and isotopologue data from our experiments. The model we developed will enable us to predict the conditions under which production vs. consumption of N2O dominates observed net N2O fluxes.