Geophysical Research Abstracts
Vol. 12, EGU2010-8698, 2010
EGU General Assembly 2010

Quantifying gross fluxes of nitrous oxide and dinitrogen gas using a novel isotope pool dilution technique

Yit Arn Teh (1), Wendy Yang (2), and Whendee L. Silver (2)

(1) Environmental Change Research Group, University of St Andrews, School of Geography & Geosciences, St Andrews, United Kingdom (yat@st-andrews.ac.uk), (2) Department of Environmental Science, Policy & Management, University of California, Berkeley, California, USA

One of the existing challenges in trace gas biogeochemistry lies in understanding the environmental controls on the net and gross fluxes of soil-derived compounds. This is because gross production and consumption fluxes of these gases often occur simultaneously or in close spatial proximity, making it difficult to make inferences about the effects of environmental variables (e.g. temperature, soil water content, porosity, redox, etc.) on gross fluxes based on bulk concentration measurements alone. One novel approach for quantifying gross fluxes of N_2O and N_2 is “stable isotope pool dilution;” a technique that has been successfully applied to study bidirectional fluxes of other biogenic compounds, such as CH_4 and halocarbons. To evaluate the efficacy of this method for quantifying gross N_2O and N_2 fluxes, we conducted a combined field and laboratory test of the pool dilution technique along side conventional measures of nitrification and denitrification. Experiments were conducted in a N-rich managed peatland pasture in the Sacramento-San Joaquin Delta, California, USA. Field and laboratory measurements were performed in a broad range of microforms and microtopes spanning a range of hydrologic and environmental conditions. Field experiments focussed on gross fluxes of N_2O and N_2 in upper soil horizons; the soil layers that exchange most rapidly with the atmosphere. Laboratory experiments indicated that ^{15}N pool dilution compares favourably with more conventional measures of N_2O and N_2 flux, such as acetylene inhibition or the $^{15}NO_3^-$ pulse-trace approach. Gross N_2O fluxes greatly exceeded N_2 fluxes by as much as an order of magnitude or more, and averaged 6.1 ± 2.2 mg N m^{-2} d^{-1}, with a range from 0.06 to 63.13 mg N m^{-2} d^{-1}. N_2O:N_2 emissions ratios generally exceeded 1 except along slopes, with an overall range of 0.2 to 30.9. NH_4^+ concentrations and denitrifying enzyme activity were the best predictors of gross N_2O fluxes in the field ($r^2 = 0.65$). Net N_2O production rates explained 53 percent of the variability in gross N_2 fluxes, whereas N_2O:N_2 ratios were best predicted by the combination of water-filled pore space and mineral N concentration ($r^2 = 0.44$). This research highlights the potential of the pool dilution approach for quantifying gross fluxes of N_2O and N_2 from surface soils under both field and laboratory conditions. Future experiments will couple these measures of soil surface fluxes with push-pull methods for determining gross N_2O and N_2 fluxes at depth, and natural abundance isotopomer measurements to determine sources of N_2O.