Title: Towards a Mechanistic and Predictive Understanding of Reactive Nitrogen Oxide Fluxes to and from Soil

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BER Program: ESS

Project: University project, Early Career project

Project Abstract:

Nitrogen (N) cycle processes play a crucial role in regulating the overall abundance of oxidized inorganic nitrogen in terrestrial ecosystems, and are responsible for initiating the subsequent loss of soil N via volatilization and leaching. This poster will outline our laboratory's effort to understand the sources and sinks of reactive nitrogen oxides (NO, NO_2, HONO, and N_2O) with the goal of improving model parameterizations in chemical-transport models that include terrestrial-atmospheric interactions. The study uses a combination of field and laboratory measurements to study gas-surface exchange of these reactive gases on the landscape to the molecular level. At the landscape scale, we used soils collected from temperate forests across the eastern United States to show that microbial communities involved in nitrogen (N) cycling are structured, in large part, by the composition of overstory trees, leading to predictable N-cycling syndromes, with consequences for emissions of volatile nitrogen oxides to air. Trees associating with arbuscular mycorrhizal (AM) fungi promote soil microbial communities with higher N-cycle potential and activity, relative to microbial communities in soils dominated by trees associating with ectomycorrhizal (ECM) fungi. Metagenomic analysis and gene expression studies reveal a 5 and 3.5 times greater estimated N-cycle gene and transcript copy numbers, respectively, in AM relative to ECM soil. Furthermore, we observe a 60% linear decrease in volatile reactive nitrogen gas flux (NO_y = NO, NO_2, HONO) as ECM tree abundance increases. Currently, we are following

up on this study with in situ measurements of N_2O and CO_2 in local hardwood forests in an effort to determine whether fluxes measured in laboratory microcosm experiments are comparable to those measured in the field. Finally, results of a new study of the mechanism of HONO release from soil clay mineral surfaces at the molecular level will be presented. Specifically, the surface acidity of kaolin minerals was probed using scanning conductance ion microscopy for the first time. Steps and edges consisting of incompletely coordinated aluminum hydroxide groups were found to be likely reactive sites that are responsible for the release of nitrite as HONO to the atmosphere at soil pH well above the pK_a of nitrous acid.