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Effect of Ground Cover on Surface Fluxes of Reactive Nitrogen Oxides at a Disturbed Forest Edge

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Reactive oxides of nitrogen, such as nitric oxide (NO), nitrogen dioxide (NO_2), and nitrous acid (HONO), play a crucial role in determining the oxidative capacity of the lower atmosphere. Biogenic emissions of these reactive nitrogen species from terrestrial environments represents as much as half of the total global gaseous nitrogen budget. These emissions are driven by biotic processes related to nitrification and denitrification, or through abiotic reactions of nitrogen oxides on redox-active soil surfaces. Several of these mechanisms have been studied through laboratory studies, however their relative importance in complex environmental matrices can only be realized through field measurements. The objective of this work was to determine the relative importance of biogenic and abiotic processes driving fluxes of NO, NO_2, HONO, and N_2O from soil during a measurement campaign in the summer of 2017 at the Indiana University Research and Teaching Preserve. The site was a disturbed grassy area at the edge of a hardwood forest that is impacted by both anthropogenic and biogenic emissions of NOx. Flux measurements were made using a newly constructed continuous-flow automated chamber array connected to an array of instrumentation, including a newly developed two-wavelength chemiluminescent detector (to quantify NO, NO_2, and HONO) and a cavity ring-down spectrometer (for N_2O measurements). Chambers were placed over bare soil, lightly vegetated, or densely vegetated, as defined by plant biomass. Significant emissions of NO and N_2O were emitted from all soil types during most of the day, whereas NO_2 was consistently deposited to soil; both deposition and emission of HONO was observed over the course of the campaign. Peak emission of NO was roughly two times greater in the bare soil plot than in the densely vegetated plot and tracked solar irradiance. Peak deposition of NO_2 was identical in all three plots and occurred several hours before peak NO emission, suggesting an anthropogenic origin. Aside from temperature and soil moisture, ground coverage had the greatest impact on soil nitrogen emissions, either through plant-microbe competition for soil nitrogen or through light intensity differences associated with shading of normally photoactive soil surfaces.