2.047 Tracking agricultural soil NOx and NH3 emissions variability with novel methodologies .

Early Career Scientist

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Abstract:

Agricultural production systems significantly perturb the reactive nitrogen cycle via significant atmospheric nitrogen oxides (NO_x) and ammonia (NH_3) emissions. NO_x and NH_3 serve as precursors to ozone and ammonium nitrate aerosols, linking agriculture, air quality, radiative forcing, and ecosystem health. Constraining agricultural NO_x and NH_3 emissions is critical for closing agro-ecosystem nitrogen budgets. However, fluxes are highly uncertain and lack widespread, high-resolution measurements for capturing spatially heterogeneous soil emission pulses, especially on diurnal timescales. We characterize NO_x and NH_3 fluxes and the nitrogen isotopic composition of NO_x from cropland soils across a variety of representative fertilizer and water management scenarios. A field and laboratory-verified technique for actively capturing NO_x in solution is optimized for hourly resolution soil NO_x isotopic measurements. We evaluate the ability of nitrogen isotopic enrichment factors of NO_x emissions relative to inorganic soil nitrogen substrates to distinguish emission processes. We also demonstrate a novel NH_3 flux chamber measurement method, using a portable, battery-powered, open-path quantum cascade laser-based NH_3 sensor, that accounts for adsorption losses to chamber surfaces. Ammonia detection from 50 ppbv to 50 ppmv is optimized for a large dynamic range and several minute resolution flux measurements. We present in-situ soil flux studies with soils and fertilizers representative of a sustainable cropping system of no-till and manure injection in Pennsylvania and an irrigated cropping system with conventional and no-till in Colorado. Continuous diurnal flux measurements are performed to investigate correlations of soil NO_x and NH_3 fluxes with fertilizer application, response to rainfall/irrigation, and diurnal soil temperature variations. Soil surface-applied manure resulted in order of magnitude higher NH_3 fluxes than below surface incorporation. These observations have implications for future agricultural management and mitigation strategies and are applicable for comparisons with field-scale eddy flux observations and validations of satellite NO_2 and NH_3 model inversions in agricultural emission regions.