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An eddy covariance system for simultaneous flux measurements of total reactive nitrogen, ammonia, and nitrogen oxides (NO_x)

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Atmospheric reactive nitrogen exists in many forms, from highly oxidized species such as nitric acid (HNO_3), nitrogen dioxide (NO_2), and nitrate (NO_3^-) to highly reduced forms such as ammonia (NH_3), ammonium (NH_4^+) and organic amines. These species give rise to and play roles in various chemical processes such as the production of ozone, acidification of rain, particle formation and growth, and nitrogen deposition to soil and water. The resulting nitrogen products have potential impacts on the health of our atmosphere, land, and water. In particular, reactive nitrogen deposition from gas and particle phases has a direct impact on soil health, affecting agricultural productivity and sensitive ecological balances.

We present a measurement system that incorporates a dual inlet sampling system with an Aerodyne tunable infrared laser direct absorption spectrometer (TILDAS) to quantify the deposition and emission of reactive nitrogen species from soil. The instrument measures total reactive nitrogen, N_r (all N compounds except N_2 and N_2O) via one inlet, and its two largest components, ammonia and nitrogen oxides (NO_x), via the second inlet. The two sampling streams are combined to result in simultaneous detection of N_r, ammonia and NO_x.

The total reactive nitrogen measurement involves the thermal and chemical conversion of all gas and particulate nitrogen species to nitric oxide (NO). The two-step process involves the thermal conversion of nitrogen species to NO and NO_2, followed by the catalytic conversion of NO_2 to NO. We have demonstrated a conversion efficiency of $>$99% and a time response of $\sim$0.4 sec. The NH_3 and NO_x, are detected via an Aerodyne inertial inlet to achieve fast time response of NH_3. The inlet is doped with ozone to convert NO to NO_2 for a total NO_x measurement.

The resulting sampling system combines the flows of the N_r converter and the inertial inlet to pass through the Aerodyne dual laser TILDAS configured to quantify NO, NO_2, and NH_3. Simultaneous high precision, fast response detection of NO, $NO_2$and NH_3has been demonstrated. Results from laboratory demonstration of the measurement system will be presented.