Global Measurement of Nitrous Oxide and its Stable Isotopes Using Cavity Ring-down Spectroscopy

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Nitrous oxide (N_2O), a greenhouse gas ~300 times the 100 year global warming potential of CO_2, is currently increasing at a rate of 0.77 ppbv yr^{-1} (World Meteorological Organization 2010) mainly due to increased microbial production from fertilized agricultural systems (Intergovernmental Panel on Climate Change 2007). Due to the complexity of microorganism processes within soil, the spatiotemporal effects of fertilizer on N_2O production at a high resolution remain largely unconstrained. Advances in the use of intramolecular, or position-specific, stable isotope techniques (β position $^{15}N^{14}N^{16}O$ versus α position $^{14}N^{15}N^{16}O$) can be a robust tool in order to determine the biological and physical controls over N_2O emission. Picarro Instruments recently developed a wavelength-scanned cavity ring-down spectrometer coupled with a quantum cascade laser capable of the mid-infrared wavelength detection needed for N_2O. This technique allows for streamlined simultaneous and continuous measurement of N_2O concentration, $\delta^{15}N\alpha$-N_2O, and $\delta^{15}N\beta$-N_2O with measurement uncertainties of < 0.5 ppb and 1.5‰ for mole-fractions and isotopic delta values, respectively. A subset of sites from the NOAA Global Monitoring Division Cooperative Sampling Network is being measured in order to describe the global distribution of N_2O and its isotopes on a seasonal level. We expect to see a seasonal cycle in N_2O isotopomers due to stratospheric mixing in the spring of each hemisphere and heightened ocean and soil microbial activity in the summer and fall of each hemisphere.

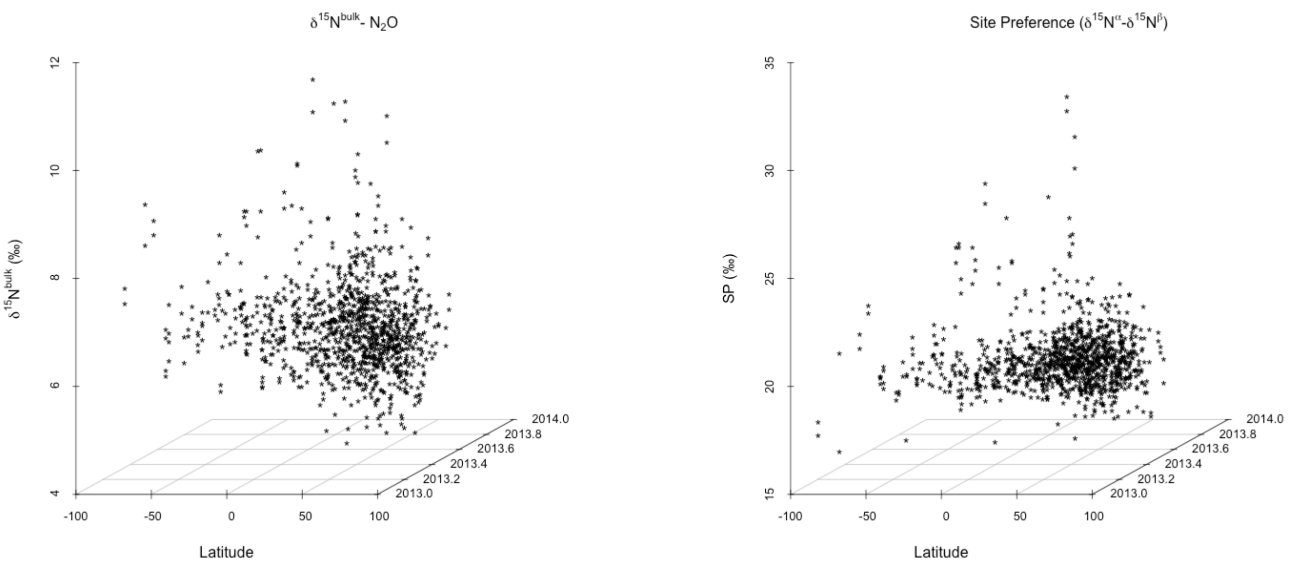

Figure 1. NOAA Cooperative Air Sampling Network N_2O isotopic measurements in 2013. Left: bulk $\delta^{15}N$-N_2O. Right: Site preference ($\delta^{15}N\alpha$-N_2O - $\delta^{15}N\beta$-N_2O).