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Compact, Low-power Nitrous Oxide Monitor for Eddy Flux Soil Emission Measurements

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Nitrous oxide, N_2O, is one of the most important greenhouse and ozone-depleting gases. The concentration of N_2O in the atmosphere has been increasing at a rate of 0.3% per year, with this rise believed to be largely due to soil emissions and agricultural practices (Park et al. 2011; Park et al. 2012). The eddy covariance technique, which requires fast ($\sim$10 Hz) measurement of mixing ratios and wind data, is perhaps the most effective technique available to quantify the exchange of gases between the atmosphere and the biosphere. It is very useful for addressing the high spatial and temporal variability of nitrous oxide emissions from soils.

Nitrous oxide monitors appropriate for eddy covariance measurements generally require large flow rates ($\sim$10 - 15 slpm) and high speed, high power vacuum pumps (500 lpm, 600 W). These requirements complicate and in some environments prevent successful field deployment. We have addressed this by developing a compact, low-power nitrous oxide monitor for eddy flux or soil chamber measurements with a dramatically reduced sample cell volume. The sample volume is reduced nearly 5 fold (from 500 to 108 cm^3) with only a two-fold reduction in optical path length (from 76 m to 36 m). The new multi-pass cell has an aluminum tube insert with a tapered internal volume that follows the mode envelope of the multi-pass spot pattern. This permits the use of a much smaller, lower power pump while still achieving high precision and fast response. Precision of 26 parts per trillion (ppt) in 1 sec was achieved with a 1/e response time of 0.14 s using a relatively low speed vacuum pump (100 lpm, 350 W). Further reductions in cell volume are planned which should permit sensitive eddy covariance measurements of nitrous oxide using an even smaller, lower power pump (60 lpm, 160 W) and modest sample flow rates ($\sim$2 slpm).

We have also recently studied the application of a standard ARI nitrous oxide monitor to measurement of N_2O isotopologues emitted into soil chambers. We measured nitrous oxide isotopologues, $^{14}N^{15}N^{16}O$ (456), $^{14}N^{14}N^{16}O$ (446), and$^{15}N^{14}N^{16}O$ (546), in the headspace of soil incubation jars. No significant interferences were observed and differences in isotopic ratios between distinctive soil samples were observed.

Park, S., P. Croteau, K. A. Boering, D. M. Etheridge, D. Ferretti, P. J. Fraser, K. R. Kim, P. B. Krummel, R. L. Langenfelds, T. D. van Ommen, L. P. Steele and C. M. Trudinger (2012). "Trends and seasonal cycles in the isotopic composition of nitrous oxide since 1940." Nature Geosci **5**(4): 261-265.

Park, S., T. Pérez, K. Boering, S. Trumbore, J. Gil, S. Marquina and S. Tyler (2011). "Can N_2O stable isotopes and isotopomers be useful tools to characterize sources and microbial pathways of N_2O production and consumption in tropical soils?" Global Biogeochemical Cycles **25**(1): GB1001.