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Study Biosphere-Atmosphere Exchange With a Field Deployable Isotope Ratio Infrared Spectrometer For Simultaneous Measurements of Carbon And Oxygen Isotopologues of CO_2

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Laser-based Isotope Ratio Infrared Spectrometers (IRIS) offer the potential to perform precise, continuous, *in-situ* monitoring of isotopologues of trace gases at ambient concentration. We are presenting a middle-infrared laser-based sensor platform that is capable of simultaneously determining both δ^{18}O and δ^{13}C isotope ratios of carbon dioxide. Specifically, we access the fundamental bands of CO_2 at 4.2 microns using a difference frequency generation (DFG) laser combined with a simple, direct absorption approach that makes use of a robust multi pass cell and a cryogen free setup.

We will present data from simulations of ambient measurements as well as real world data collected in plant chambers and greenhouse gas monitoring stations.

A simulation of ambient measurement conditions with a 75 ppm/hour change in CO_2 concentration from 350-650 ppm showed a precision of $<$0.05‰ for both δ^{18}O and δ^{13}C over 24 hours with 30 min averaging time. Comparison with Isotope Ratio Mass Spectrometer (IRMS) showed differences of 0.046 ‰ and 0.047 ‰ for δ^{13}C and δ^{18}O, respectively.

In a plant chamber simulation, the concentration ramp speed was increased up to 40 ppm/min. For 1 minute averaged samples, the precision was δ^{13}C = 0.097 ‰ and δ^{18}O = 0.121 ‰Ṫhe comparison with IRMS gave a difference of 0.032 ‰ for δ^{13}C and 0.008 ‰ for δ^{18}O.

An example of ambient air monitoring over 2 weeks shows periods of advected urban pollution with increasing CO_2 concentration as well as local photosynthetic activity that results in a draw down of the CO_2 concentration and corresponding more positive δ^{13}C.

The IRIS analyzer was also integrated into a large plant chamber experiment involving multiple instruments to study CO_2 fluxes using δ^{18}O-CO_2. Plant chamber in and out was alternatingly monitored for 5 minutes. A comparison of δ^{18}O with a TGA-200 gave a mean difference $\Delta\delta^{18}$O = -0.49 ‰ +- 0.37 ‰