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Real time, ambient air laser monitor for rare CO_2 isotopic tracers: $\Delta^{13}C^{18}O^{16}O$ and $\Delta^{17}O$

David Nelson (1), Joanne Shorter (1), Barry McManus (1), Dylan Jervis (1), Mark Zahniser (1), and Shuhei Ono (2)

(1) Aerodyne Research, Inc., Billerica, MA, United States (ddn@aerodyne.com), (2) Earth and Planetary Sciences, MIT, Cambridge, MA, United States

Greenhouse gas (GHG) emissions are the primary drivers of global climate change and hence there is a crucial need to quantify their sources and sinks. A powerful technique to help constrain source and sink strengths in GHG exchange processes is the analysis of the relative proportions of isotopic variants of GHGs. We present a new laser isotope monitor based on Tunable Infrared Laser Direct Absorption Spectroscopy (TILDAS) to measure the primary clumped isotopologue of CO_2 ($\Delta^{13}C^{18}O^{16}O$) and to simultaneously measure the mass independent ^{17}O-CO_2 content ($\Delta^{17}O$). The instrument directly measures dried atmospheric samples without cryogenic preconcentration of CO_2.

The instrument has several novel features. The instrument's sensitivity is enhanced by employing a 400 meter optical absorption cell. Measurement drift is suppressed by using a rapid sample switching method with frequent comparison to a working reference. A new dual-pressure measurement scheme is demonstrated. This scheme solves the dynamic range challenge that arises in simultaneously measuring the main isotopologues of CO_2 together with much less abundant clumped isotopologue species.

Our initial results address measurement precision, measurement drift and calibration. We show the potential to reach 0.03 per mil repeatability with time resolution of 3 minutes and with minimal drift over an 18 hour measurement period. The instrument is sufficiently compact to be field deployed thus providing the possibility of continuous measurements of $\Delta^{13}C^{18}O^{16}O$ and $\Delta^{17}O$ rather than occasional flask samples.