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Recent progress in development of a laser based, ultra-high precision isotope monitor for carbon dioxide

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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 general technique to help constrain source and sink strengths in GHG exchange processes is the analysis of the relative proportions of isotopic variants of GHG's. Very high precision measurements of isotopologue ratios are necessary in order to identify sources and sinks because the characteristic changes are small. The standard method of isotopologue measurement has been mass spectrometry, but this technique typically requires significant sample preparation and relatively high instrument maintenance. Laser spectroscopy has the potential to ease these burdens and also to allow easy separation of interfering isobars such as 13C-CO_2 and 17O-CO_2.

We present recent results demonstrating ultra-high precision measurements of carbon dioxide isotope ratios which have the potential to rival the accuracy of mass spectrometric measurements. These measurements were performed using Tunable Infrared Laser Direct Absorption Spectroscopy (TILDAS). We have obtained isotopic measurement precisions of $\sim$10 per meg for both 13C-CO_2 and 18O-CO_2 while measuring ambient air samples with continuous flow. We have also developed a method for analyzing air samples from canisters by alternately and rapidly trapping sample gas and reference gas in the optical cell. The ultimate goal is to create an automated, ultra-high accuracy carbon dioxide isotope monitor able to quantify small ($\sim$100 standard ml), discreet air samples. We will also discuss current instrument performance results and prospects for the measurement of the clumped isotopes of carbon dioxide in ambient air samples.