

FY 2015 PHASE II AWARD WINNER

FIRM: Aerodyne Research, Inc.
45 Manning Road
Billerica, MA 01821

AWARD: \$399,996.00

PHONE: 978-663-9500
E-MAIL: ddn@aerodyne.com

PRINCIPAL INVESTIGATOR: Dr. David Nelson

TITLE OF PROJECT: Ultra-High Precision Laser Isotope Monitor for $^{13}\text{CO}_2$, CO_{180} and CO_{170}

SUBTOPIC NUMBER: 8.3.1R,C

TECHNICAL ABSTRACT:

Greenhouse gas (GHG) emissions are primary drivers of global climate change. Hence there is a crucial need to quantify their sources and sinks. A powerful method to constrain source and sink strengths is the analysis of the relative proportions of isotopic variants of GHG's in atmospheric samples like those collected globally by NOAA's Cooperative Air Sampling Network. Measurements that are capable of informing climate science require extremely high precision. The standard technique, isotope ratio mass spectrometry (IRMS), is precise but is limited by laborious sample processing requirements, high capital cost, high maintenance and impracticality of field deployment. We avoid these limitations with an alternative method to measure the isotopic composition of the most important GHG: carbon dioxide. Using Tunable Infrared Laser Direct Absorption Spectroscopy (TILDAS), we demonstrate measurement precision at least as good as IRMS and exceeding that requested until Sub-Topic 8.3.1 for $\delta^{13}\text{C-CO}_2$ (0.006 vs. 0.01‰) and $\delta^{18}\text{O-CO}_2$ (0.007 vs. 0.02‰). During Phase II we will produce and demonstrate a commercial instrument meeting this standard while measuring small discreet air samples (<60 ml). We rely on two innovations: a small volume, high vacuum optical cell and a rapid sample switching method promoting long term signal averaging, without measurement drift.

SUMMARY OF ANTICIPATED RESULTS:

The proposed instrument will have an immediate technical impact in several research fields that utilize isotope ratio mass spectrometry of CO_2 : atmospheric chemistry, ecology, climate science and geochemistry. This instrument, with equivalent or better precision and lower capital and operating costs than IRMS, will increase productivity and encourage wider use of CO_2 isotope measurements, thus promoting commercialization within these research communities. Additional commercial opportunities exist in oil and gas prospecting (already in use) and in human breath analysis as a medical diagnostic. Development of this technology will also lead to additional laser isotope applications, including monitors for the clumped isotopes of CO_2 .