EGU23-3470, updated on 27 Apr 2024
https://doi.org/10.5194/egusphere-egu23-3470
EGU General Assembly 2023

Artifact-Free Measurements of Isotopic Composition for Atmospheric and Planetary Gas Analysis

D. Michelle Bailey, Abneesh Srivastava, Joseph Hodges, and Adam Fleisher
National Institute of Standards and Technology, Gaithersburg, Maryland, USA (michelle.bailey@nist.gov)

The isotopic composition of gaseous species can provide critical information regarding the age and chemical or physical origin of sample material. However, the challenge of maintaining isotope abundance scales – generated by comparing sample measurements to those of a reference material having finite quantity and stability – may limit inter-laboratory agreement and consequently the uncertainty evaluation of new measurement methods. Here we will present progress towards realization of artifact-free isotope scales and rapid measurements of isotopic composition enabled by absolute SI-traceable measurement schemes.

We will discuss how cavity ring-down spectroscopy techniques, capable of highly precise and accurate measurements of transition-resolved peak areas, can be leveraged in combination with quantum chemical calculations of transition moments to enable measurement of molecular isotopologue ratios [**1**]. We will also introduce direct frequency comb spectroscopy methods for rapid and precise measurement of isotopic abundance [**2**]. This discussion will include demonstrations in the near- and mid- infrared spectral regions employing cross-dispersed spectrometers. Implications for carbon, nitrogen, and oxygen isotopic analysis will be presented.

Applications of these SI-traceable measurement approaches include accurate source apportionment and greenhouse gas inventories, radiocarbon dating, isotope forensics, with the potential for high-impact contributions to emerging advances in exoplanetary studies and astrophysics.

[1] A. J. Fleisher, H. Yi, A. Srivastava, et al., *Nat. Phys.* **2021**, 17, 889-893

[2] D. M. Bailey, G. Zhao, and A. J. Fleisher, *Anal. Chem.* **2020**, *92* (20), 13759–13766