University of Bern
Physikalisches Institut
Climate and Environmental Physics (CEP)

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Masters Project:

Regenerative CO_2 removal for high-precision isotopic measurement of N_2O and CH_4

Context: Trace gases make up less than 1% of the atmosphere. Despite their low abundance, they play a key role in climate, biosphere-atmosphere exchange, human and ecosystem health, and many other issues. N_2O and CH_4 are the two most important non-CO_2 greenhouse gases present in the troposphere. Understanding their sources and sinks is a critical part in the development of climate change mitigation strategies. Isotopic measurements reflect formation and destruction pathways and deliver important process information to improve our understanding of these gases and enhance our modelling capabilities.

Goals: Spectroscopic techniques are increasing in popularity for trace gas isotope measurements due to their wide applicability, simple operation and lower cost relative to isotope ratio mass spectrometry. However, interference from other trace gases – particularly CO_2 – is a major challenge (Figure 1). CO_2 is therefore commonly removed from environmental gas streams with ascarite. This is expensive and unsuited to field and long-term measurements. The aim of this project is to investigate and test several candidate CO_2 adsorbents and to develop an automated regenerative CO_2 removal device suitable for coupling with spectroscopic isotope measurement devices.

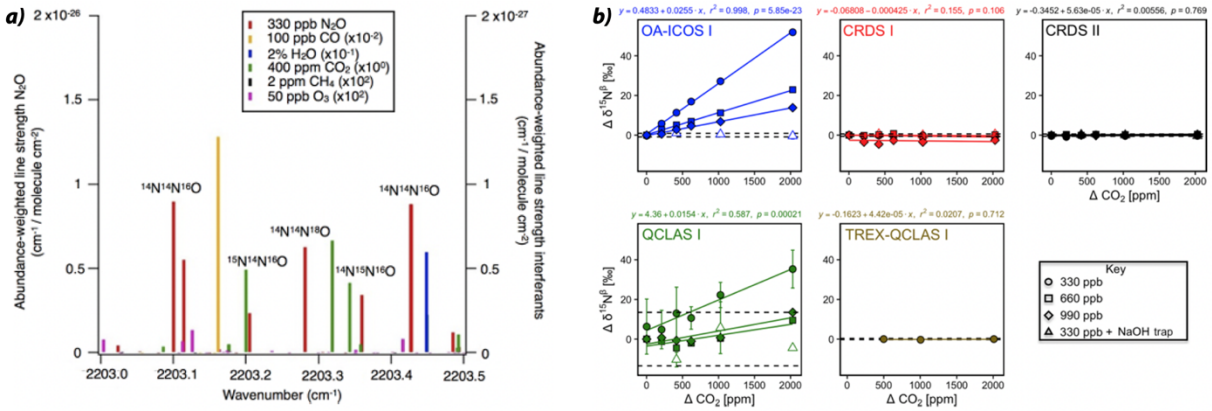

Figure 1. a) N_2O isotopocule absorption line positions and strengths in the wavenumber region used for QCLAS, showing possible spectral overlaps with other trace gases including CO_2 (shown in green). *b)* Deviations in measured isotopic values depending on changing CO2 concentration shown for different spectroscopic measurement techniques. Figure adapted from Harris et al. (2020) https://doi.org/10.5194/amt-13-2797-2020.

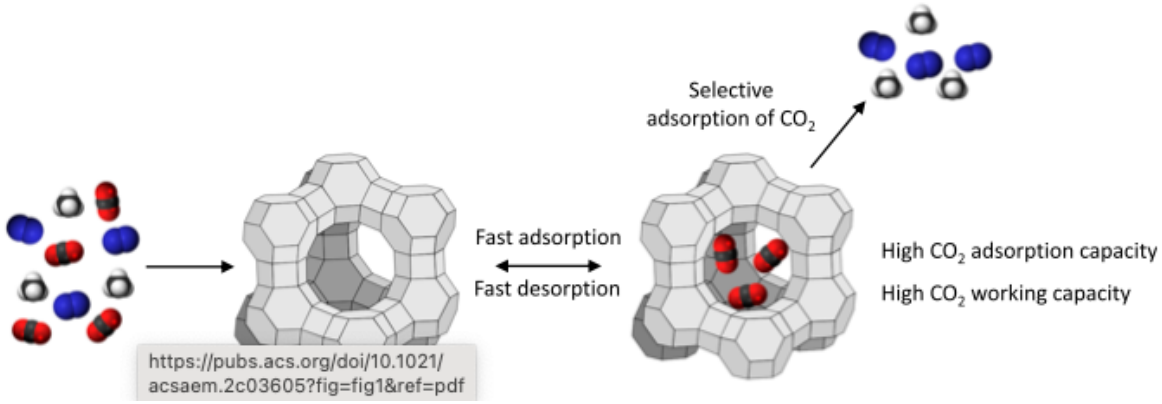

Figure 2. Schematic overview of the desirable properties of adsorbents for CO_2 capture, from Boer et al. (2023) https://doi.org/10.1021/acsaem.2c03605.

Project outline: The duration of this project is 1 year (60 ECTS), with a preferred start date between December 2024 and February 2025. Tasks will include:

- Investigate possible CO_2 adsorbent materials (e.g. Zeolite, aminopropyl-functionalized silica gel; Figure 2) for properties such as toxicity, potential secondary interferents, and ease of acquisition
- Test materials for CO_2 absorption capacity, reactivation, and impact on N_2O (and CH_4) mixing ratio and isotopic composition
- Investigate the effect of air stream humidity on absorption capacity and performance
- Automation and characterization of prototype CO_2 removal device

Your profile: We are searching for a MSc student interested in climate science, with a strong desire to gain hands on experience in applied analytical chemistry. You should bring a basic knowledge of chemistry and environmental science as well as some experience in programming in R or Python.

For further information, please contact Prof. Dr. Eliza Harris (eliza.harris@unibe.ch).