Name of research institute or organization:

Laboratory for Air Pollution and Environmental Technology, Empa

Title of project:

Isotopic composition of N_2O at Jungfraujoch

Project leader and team:

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Project description:

Nitrous oxide (N_2O) is a strong greenhouse gas with a global warming potential 298 times that of CO_2[1]. In addition, it is the strongest ozone depleting substance emitted in the 21st century[2]. N_2O concentrations are rising at a rate of 0.2-0.3% per year globally due to anthropogenic emissions. However, N_2O emissions from different sources are poorly constrained, which complicates efforts to develop targeted mitigation policies. High-precision measurements of the four major isotopocules of N_2O – $^{14}N^{14}N^{16}O$, $^{14}N^{15}N^{16}O$ (α), $^{15}N^{14}N^{16}O$ (β) and $^{14}N^{14}N^{18}O$ – can be combined with modelling to gain new insight into the magnitude of emissions from different sources and processes.

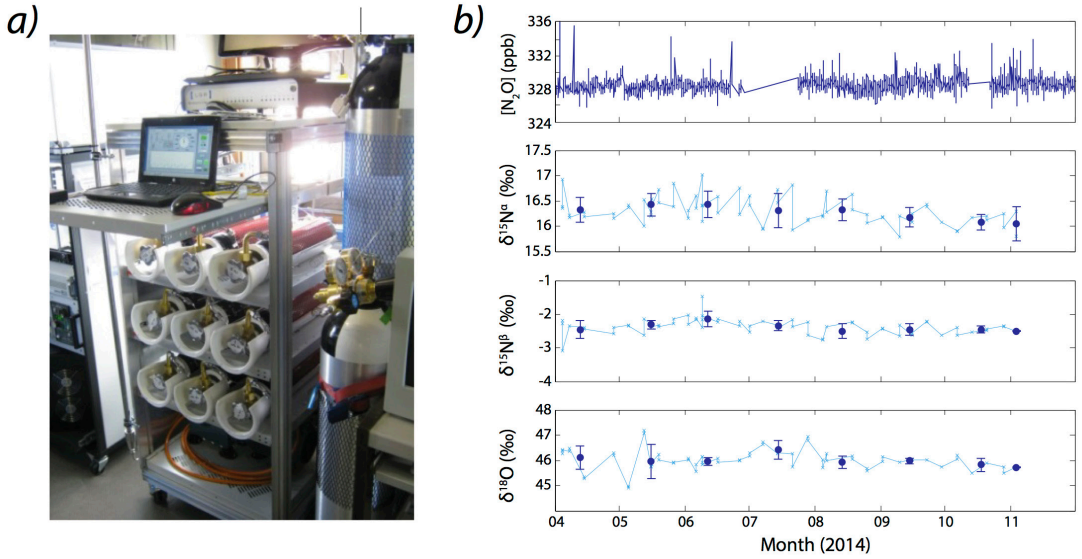

Figure 1. a) The N_2O flask sampler in the Sphinx laboratory at Jungfraujoch, b) Top panel: Continuous measurements of N_2O mole fraction made in-situ using GC-ECD (from M. Steinbacher, Empa). Lower three panels: N_2O weekly isotope data for Jungfraujoch shown in pale blue with monthly means and standard deviations in dark blue.

This project aims to monitor the mole fraction and isotopic composition of N_2O at Jungfraujoch by collecting weekly flask samples and subsequently analysing offline at Empa. The flask sampler (*Figure 1a*) was built and tested at Empa between October 2013 and March 2014 to ensure automatic sample collection with no leakage or contamination. 40 flask samples (2 L volume, pressurised to 12 bar) have been collected and measured since the 4th of April 2014, and sampling will continue into 2015. Isotopic composition and mole fraction of the samples are measured at Empa using Quantum Cascade Laser Absorption Spectroscopy (QCLAS) with preconcentration[3,4].

The results (*Figure 1b*) show that in 2014, both N_2O mole fraction and isotopic composition did not exhibit any significant temporal changes, although the summer values for $\delta^{15}N^{\beta}$ are higher than in autumn at $p = 0.20$. Our results do not support measurements by Park et al.[5], who observed a seasonal trend for the site-specific N_2O isotopic composition in the Southern Hemisphere. They reported highest $\delta^{15}N^{\alpha}$ values for June and lowest values for November with differences of around 0.8‰ and a contrary trend for $\delta^{15}N^{\beta}$; opposite to our results. In addition to monitoring for possible temporal changes in N_2O at Jungfraujoch into 2015, the data will provide an estimate of the variability in 'background' N_2O mole fraction and isotopic composition, which is critical to interpret measurements at other sites in Switzerland using inverse modelling techniques.

References:

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2. Ravishankara et al. (2009) *Science,* 326 (5949): 123-125.
3. Mohn et al. (2010) *Atmospheric Measurement Techniques*, 3: 609-618.
4. Mohn et al. (2012) *Atmospheric Measurement Techniques*, 5: 1601-1609.
5. Park et al. (2012) Nature Geoscience, 5, 261-265.

Key words:

Nitrous oxide, flask sampling, isotopic composition, seasonal variability

Scientific publications and public outreach 2014:

Conference papers

Harris, E., B. Wolf, E. Gute, S. Henne, B. Tuzson, P. Wunderlin, R. Kiese, K. Butterbach-Bahl, L. Emmenegger, and J. Mohn, Real-time measurements of N_2O isotopocules: Identifying sources and hot spots, International Symposium on non-CO2 Greenhouse Gases, Amsterdam, The Netherlands, November 5-7, 2014.

Harris, E., B. Wolf, K. Zeyer, B. Tuzson, L. Emmenegger, and J. Mohn, Development and application of spectroscopic N_2O isotope measurements at Empa, 49th meeting of scientists from AGAGE and cooperating networks, Ascona, Switzerland, April 29 – May 2, 2014.

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