Name of research institute or organization:

Empa – Materials Science and Technology

Title of project:

Direct and continuous measurement of NO_2, NO and NOy in ambient air using quantum cascade laser absorption spectroscopy

Project leader and team:

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Project description:

Nitrogen Dioxide (NO_2) is one of the most prominent air pollutants and highly relevant in atmospheric photochemical processes. However, chemiluminescence detection, the standard method for NO_2 measurements, requires the reduction of NO_2 to NO prior to analysis and is thus inherently influenced by other nitrogen containing species.

Laser absorption spectroscopy is a promising alternative approach because it is highly specific and sensitive. To demonstrate its potential, we have adapted a commercial (Aerodyne Research, USA) dual quantum cascade laser based analyzer (QCLAS) for high precision, continuous and interference free measurement of the NO and NO_2 in the free troposphere. In combination with an old converter, the setup also allows the detection of NOy, and thus of all oxidation states of nitrogen oxides that are routinely measured at Jungfraujoch. The instrument was installed at Jungfraujoch and operated during a three month campaign in Spring/Summer 2012 to assess its suitability for long-term monitoring of the main reactive nitrogen species under predominantly free tropospheric air conditions. A precision (1σ) of 10 ppt and 3 ppt for NO and NO_2, respectively, was achieved with 180 s averaging time under field conditions. The linear dynamic range of the QCLAS has been confirmed for both species from the detection limit to 45 ppbv. Excellent agreement was found in comparison with the chemiluminescence-based analyzer (Figure 1). This demonstrates the suitability of the laser spectroscopic approach for environmental applications, even at very low mixing ratios.

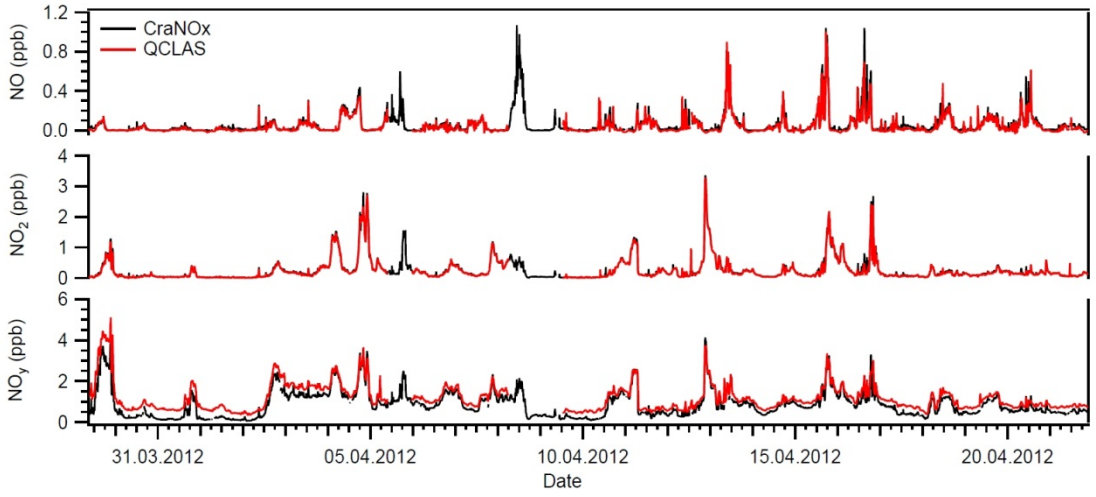

Figure 1. An exemplary sequence of NO, NO_2 and NOy time series measured at the Jungfraujoch with the two different methods. The gaps in the QCLAS data were caused by additional on-site works, such as calibration and converter investigation. The slight offset in the NOy data is due to differences in the Au-converter efficiencies.

Key words:

Nitrogen oxide, nitrogen dioxide, NOy, quantum cascade laser, absorption spectroscopy

Collaborating partners/networks:

NABEL, Switzerland
Aerodyne, USA

Scientific publications and public outreach 2012:

Refereed journal articles and their internet access

Tuzson, B., K. Zeyer, M. Steinbacher, J. B. McManus, D. D. Nelson, M. S. Zahniser, and L. Emmenegger, Selective measurements of NO, NO_2 and NOy in the free troposphere using quantum cascade laser spectroscopy, Atmos. Meas. Tech. Discuss., **5**, 1–25, doi: 10.5194/amtd-5-1-2012, 2012.

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