NO_2 TRACE MEASUREMENTS BY OPTICAL-FEEDBACK CAVITY-ENHANCED ABSORPTION SPECTROSCOPY

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In order to reach the sub-ppb NO_2 detection level required for environmental applications in remote areas, we develop a spectrometer based on a technique introduced a few years ago, named Optical-Feedback Cavity-Enhanced Absorption Spectroscopy (OF-CEAS) [1]. It allows very sensitive and selective measurements, together with the realization of compact and robust set-ups as was subsequently demonstrated during measurements campaigns in harsh environments [2]. OF-CEAS benefits from the optical feedback to efficiently inject a cw-laser in a V-shaped high finesse cavity (typically 10 000). Cavity-enhanced absorption spectra are acquired on a small spectral region ($\sim$1 cm^{-1}) that enables selective and quantitative measurements at a fast acquisition rate with a detection limit of several 10^{-10} cm^{-1} as reported in this work. Spectra are obtained with high spectral definition (150 MHz highly precisely spaced data points) and are self calibrated by cavity rind-down measurements regularly performed (typically every second).

NO_2 measurements are performed with a commercial extended cavity diode laser around 411 nm, spectral region where intense electronic transitions occur. We will describe the set-up developed for in-situ measurements allowing real time concentration measurements at typically 5 Hz; and then report on the measurements performed with calibrated NO_2 reference samples to evaluate the linearity of the apparatus. The minimum detectable absorption loss is estimated by considering the standard deviation of the residual of one spectrum. We achieved 2x10^{-10} cm^{-1} for a single spectrum recorded in less than 100 ms at 100 mbar. It leads to a potential detection limit of 3x10^8 molecules/cm^3, corresponding to about 150 pptv at this pressure.

[1] J. Morville, S. Kassi, M. Chenevier, and D. Romanini, Appl. Phys. B, 80, 1027 (2005).
[2] D. Romanini, M. Chenevrier, S. Kassi, M. Schmidt, C. Valant, M. Ramonet, J. Lopez, and H.-J. Jost, Appl. Phys. B, 83, 659 (2006).