NO₂ TRACE MEASUREMENTS BY OPTICAL-FEEDBACK CAVITY-ENHANCED ABSORPTION SPECTROSCOPY

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In order to reach the sub-ppb NO₂ 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 (∼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 ring-down measurements regularly performed (typically every second).

NO₂ 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 NO₂ 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 3x10⁹ molecules/cm³, corresponding to about 150 pptv at this pressure.