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A new calibration system for lightweight, compact and mobile Cavity-Enhanced Differential Optical Absorption Spectroscopy instruments

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Absorption Spectroscopy has been employed for several decades now to study the earth's atmosphere. While the focus has been on remote sensing for a long time, lately there has been a renewed interest in in-situ methods, as point measurements allow an easier interpretation for highly inhomogeneous distributions of gases of interest compared to the integration approach of most remote sensing methods. One comparatively new method offering both advantages of in-situ measurements as well as being contactless is open-path Cavity-Enhanced Differential Optical Absorption Spectroscopy (CE-DOAS).
Broadband open-path CE-DOAS instruments have been used for ten years now, and in the meantime allow the measurement of numerous atmospheric trace gases (e.g. NO_2, NO_3, IO, CHOCHO, HCHO). While those instruments were bulky and not very mobile at first, recent developments resulted in relatively lightweight (< 30 kg) instruments with a relatively low power consumption allowing mobile open-path measurements at remote field locations.
An important operational issue has been the path length calibration in the field, necessary for the determination of the concentration of measured gases. Until now, often calibration gases were used with different scattering properties than air or known concentrations. However this methods has several major shortcomings, being rather inconvenient and cumbersome in the field with the need for compressed gas cylinders, as well as time consuming, preventing a quick check of the state of the instrument in the field after changing measurement locations.
Here we present a new wavelength-resolved method for broadband CE-DOAS path length calibration. A small, custom made ring-down system is employed with a pulsed LED as light source. The wavelength is then resolved by tilting a narrow band interference filter.
The system not only allows quick, automated path length calibrations without physical interaction on the instrument, but also saves weight, space and the necessity to transport compressed gas cylinders, which is a great advantage e.g. for measurements in remote coastal areas or polar regions. The technical implementation is presented and compared to other CE-DOAS calibration methods.