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Fabry Perot Interferometer Correlation Spectroscopy of Formaldehyde

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Optical remote sensing in the UV and visible wavelength range of atmospheric trace gases provide insights in chemical and physical processes of the atmosphere. Especially the fast and widespread evolution of atmospheric gas distributions (e.g. volcanic plumes) can be studied entirely and on a more representative scale than by classical in-situ measurements.

Ground based remote sensing techniques (e.g. Differential Optical Absorption Spectroscopy, DOAS) mostly use dispersive spectrometers to capture spectral radiance data. Therefore, measurements are limited to a single viewing direction to at most a 1-dimensional view. The acquisition of images requires time-consuming spatial scanning (taking in the order of minutes) which results in a low spatio-temporal resolution.

The application of non-dispersive wavelength selecting elements (e.g. interference filters, interferometers, . . .) as e.g. in sulphur dioxide (SO_2) cameras for volcanic emissions introduce a technique to combine fast acquisition with high spatial resolution in two dimensions. The restriction to just two spectral channels matched to the SO_2 absorption spectrum enables the SO_2-camera to record full frame SO_2 column density images in less than a second. However, this setup is limited to relatively large SO_2 abundances and due its low spectral sensitivity, the technique can only be used under very specific measurement conditions.

We report on a novel remote sensing technique based on the periodic transmission profile of a Fabry-Perot interferometer (FPI) and its correlation to the (approximately periodically varying) target gas spectral absorbance. The possibility of tuning the FPI, yields the possibility to measure the radiance on the trace gas absorption bands (FPI transmission and trace gas absorption correlate) and between them (FPI transmission and trace gas absorption anti-correlate). These data allow to quantify the trace gas differential optical density and thus column density. FPI Correlation Spectroscopy (FPI-CS) reduces the impact of broadband spectral variations compared to band pass filter based instruments. Due to its high sensitivity and immunity to broadband extinction processes FPI-CS is not limited to SO_2 imaging but can also provide images of further species including formaldehyde (HCHO), bromine monoxide (BrO), or chlorine dioxide (OClO).

After successful application to the quantification of volcanic SO_2, we present first investigations of the FPI-CS to the detection of HCHO in the UV. Differential optical densities of HCHO of typical atmospheric column densities are lower than those of volcanic SO_2 emissions (about two orders of magnitude). Nonetheless HCHO could be detected by the FPI technique in laboratory measurements with a promising sensitivity. We give an outlook on measurements of atmospheric HCHO and the conversion of the one-pixel FPI-CS prototype to an imaging device.