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IFPICS: Combining the advantages of hyperspectral imaging and filter cameras for trace gas imaging

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Imaging of atmospheric trace gases in the UV and visible wavelength range provides insight into the spatial distribution of physical and chemical processes in the atmosphere. Instruments for this purpose ideally combine a high spatio-temporal resolution with a high trace gas selectivity. In addition, they have to be built robust and compact for field measurements.

Atmospheric trace gas remote sensing by Differential Optical Absorption Spectroscopy (DOAS) is common and allows to measure several trace gases simultaneously with high selectivity and sensitivity. On the downside, image acquisition requires spatial scanning as for instance implemented in so-called hyperspectral cameras (also known as Imaging DOAS, IDOAS). This, however, results in reduced spatio-temporal resolution. Another approach to trace gas imaging is to use band pass filters, as for example in SO_2 cameras, which has the benefit of fast image acquisition combined with a high spatial resolution, but this advantage comes at the expense of low spectral sensitivity. Hence, only very high trace gas abundances can be reliably quantified, and the measurement is vulnerable to broadband interferences e.g. by aerosol.

We report an imaging technique combining the IDOAS and filter-based cameras' advantages by utilizing the periodic transmission features of a Fabry-Perot-Interferometer (FPI). The FPI is tuned to two positions, so that its transmission either correlates or anti-correlates with the approximately periodic absorption structures of the target trace gas. From the measured intensities the differential optical density and the column density of the trace gas can be obtained with a high selectivity. Compared to IDOAS (or hyperspectral cameras) we only measure two different wavelength channels, however with maximum trace gas specific information. This reduces the amount of recorded data by at least two orders of magnitude for the same measurement resolution. This can be crucial for the feasibility of field measurements.

We present a compact and field-ready Imaging-FPI-Correlation-Spectroscopy (IFPICS) prototype. The FPI settings (or different FPIs) can be adapted to detect several different trace gases, our set-ups have been optimized for sulphur dioxide (SO_2), bromine monoxide (BrO) or formaldehyde (HCHO).

We anticipate from laboratory studies using scattered skylight and HCHO cuvettes a detection limit of 4.7×10^{16} molec cm^{-2} for an image of about 90x90 pixel and an integration time of 6s. Because of

the similar absorption features of BrO we expect a detection limit of $1.6x10^{14}$ molec $cm^{\wedge-2}$. Additionally, an outlook on the application of BrO imaging in volcanic plumes is given.