Geophysical Research Abstracts
Vol. 20, EGU2018-8382, 2018
EGU General Assembly 2018

A NO_2 Camera based on Gas Correlation Spectroscopy

Leon Kuhn (1), Jonas Kuhn (1,2), Ulrich Platt (1,2), and Thomas Wagner (2)

(1) Institute of Environmental Physics, Universität Heidelberg, Heidelberg, Germany (lkuhn@iup.uni-heidelberg.de), (2) Max Planck Institute for Chemistry, Mainz, Germany

Fast imaging of atmospheric trace gases becomes more and more important as the temporal and spatial scales of the observed processes of interest decrease. Conventional trace gas remote sensing techniques often use dispersive absorption spectroscopy (e.g. Differential Optical Absorption Spectroscopy, DOAS), which is very selective but due to the wavelength mapping (at moderate to high spectral resolution), is significantly limited in spatio-temporal resolution.
Several atmospheric trace gases can, however, be detected by using only a few carefully selected trace gas specific spectral channels. For this purpose, non-dispersive elements can be used for spectral filtering, maintaining the two dimensional imaging capability of the detector (both detector dimensions are used for spatial mapping). Thus, full frame trace gas images are recorded, which enhances the spatio-temporal resolution of the measurement by several orders of magnitude. While sulfur dioxide (SO_2) cameras start to be routinely used for SO_2 flux analysis at volcanoes, for other trace gases only a few examples for imaging measurements exist.
Nitrogen dioxide (NO_2) plays a major role in urban air pollution, where it is primarily emitted by point sources (power plants, vehicle internal combustion engines), before undergoing chemical conversions. The corresponding spatial gradients can neither be resolved with the established in-situ techniques nor with the widely used DOAS remote sensing method.
We propose fast imaging of spatial NO_2 distributions employing Gas Correlation Spectroscopy (GCS) in the visible wavelength range. Two spectral channels are used, one with a gas cell that is filled with a high amount of NO_2 in the light path and one without. An additional band pass filter selects a wavelength range containing structured and strong NO_2 absorption (e.g. 400 - 450 nm). The NO_2 containing gas cell serves as a NO_2 specific spectral filter, almost blocking the light at wavelengths of the strong NO_2 absorption bands within the preselected wavelength range. Absorption by atmospheric NO_2 has therefore a lower impact on the channel with gas cell in the light path compared to the channel without gas cell (where there is much more light to absorb at the NO_2 absorption band wavelengths). This difference is used to generate NO_2 images.
Compared to other proposed NO_2 Camera implementations (e.g. acousto optical tunable filter), the GCS technique has the advantages of allowing for an instrument design with a very high light throughput and large field of view. In addition, a compact, lightweight (< 1kg) and low-cost (<1000 EUR) NO_2 Camera can be implemented.
Based on simulations of the signal to noise ratio we propose optimal measurement wavelength ranges and optimal gas cell NO_2 concentrations. Moreover, we studied possible interferences by e.g. oxygen dimers (O4) and H_2O in order to ensure sufficient selectivity of the measurement. First proof of concept measurements were performed with a prototype instrument.