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High resolution mapping of the tropospheric NO_2 distribution in three Belgian cities based on airborne APEX remote sensing

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An approach is presented to retrieve tropospheric nitrogen dioxide (NO_2) vertical column densities (VCDs) and to map the NO_2 two dimensional distribution at high resolution, based on Airborne Prism EXperiment (APEX) observations. APEX, developed by a Swiss-Belgian consortium on behalf of ESA (European Space Agency), is a pushbroom hyperspectral imager with a high spatial (approximately 3 m at 5000 m ASL), spectral (413 to 2421 nm in 533 narrow, contiguous spectral bands) and radiometric (14-bit) resolution. VCDs are derived, following a similar approach as described in the pioneering work of Popp et al. (2012), based on (1) spectral calibration and spatial binning of the observed radiance spectra in order to improve the spectral resolution and signal-to-noise ratio, (2) Differential Optical Absorption Spectroscopy (DOAS) analysis of the pre-processed spectra in the visible wavelength region, with a reference spectrum containing low NO_2 absorption, in order to quantify the abundance of NO_2 along the light path, based on its molecular absorption structures and (3) radiative transfer modeling for air mass factor calculation in order to convert slant to vertical columns.
This study will be done in the framework of the BUMBA (Belgian Urban NO_2 Monitoring Based on APEX hyperspectral data) project. Dedicated flights with APEX mounted in a Dornier DO-228 airplane, operated by Deutsches Zentrum für Luft- und Raumfahrt (DLR), are planned to be performed in Spring 2015 above the three largest and most heavily polluted Belgian cities, i.e. Brussels, Antwerp and Liège. The retrieved VCDs will be validated by comparison with correlative ground-based and car-based DOAS observations. Main objectives are (1) to assess the operational capabilities of APEX to map the NO_2 field over an urban area at high spatial and spectral resolution in a relatively short time and cost-effective way, and to characterise all aspects of the retrieval approach; (2) to use the APEX NO_2 measurements for validation and improvement of the RIO-IFDM (Immission Frequency Distribution Model) air quality model, recently developed by VITO in collaboration with IRCEL. The IFDM model is capable of modelling NO_2 concentration gradients near all major roads and local emission sources in Belgium with a resolution up to 25 m. However, due to the lack of measured small-scale patterns, the model could not be validated thoroughly up till now. The general overview of the BUMBA project and first results of the NO_2 retrieval approach will be discussed.