Geophysical Research Abstracts
Vol. 18, EGU2016-15404, 2016
EGU General Assembly 2016

Accounting for surface reflectance in the derivation of vertical column densities of NO_2 from airborne imaging DOAS

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Nitrogen oxides, NO_x (NO_x = NO + NO_2) play a key role in tropospheric chemistry. In addition to their directly harmful effects on the respiratory system of living organisms, they influence the levels of tropospheric ozone and contribute to acid rain and eutrophication of ecosystems. As they are produced in combustion processes, they can serve as an indicator for anthropogenic air pollution.

In the late summers of 2014 and 2015, two extensive measurement campaigns were conducted in Romania by several European research institutes, with financial support from ESA. The AROMAT / AROMAT-2 campaigns (Airborne ROmanian Measurements of Aerosols and Trace gases) were dedicated to measurements of air quality parameters utilizing newly developed instrumentation at state-of-the-art. The experiences gained will help to calibrate and validate the measurements taken by the upcoming Sentinel-S5p mission scheduled for launch in 2016.

The IUP Bremen contributed to these campaigns with its airborne imaging DOAS (Differential Optical Absorption Spectroscopy) instrument AirMAP (Airborne imaging DOAS instrument for Measurements of Atmospheric Pollution). AirMAP allows retrieving spatial distributions of trace gas columns densities in a stripe below the aircraft. The measurements have a high spatial resolution of approximately 30 x 80 m^2 (along x across track) at a typical flight altitude of 3000 m. Supported by the instrumental setup and the large swath, gapless maps of trace gas distributions above a large city, like Bucharest or Berlin, can be acquired within a time window of approximately two hours. These properties make AirMAP a valuable tool for the validation of trace gas measurements from space.

DOAS retrievals yield the density of absorbers integrated along the light path of the measurement. The light path is altered with a changing surface reflectance, leading to enhanced / reduced slant column densities of NO_2 depending on surface properties. This effect must be considered in the derivation of air mass factors used to convert the measurements into vertical columns. Due to the high-resolution measurements, no data product of surface reflectance with sufficient spatial resolution is available. Thus the surface reflectance is estimated from AirMAP's own spectra.

In this work the results of the research flights will be presented. The study focuses on the validation of AirMAP's measurements by comparison to other ground-based platforms like (mobile) MAX-DOAS measurements. Conclusions will be drawn on the quality of the measurements, their applicability for satellite data validation and possible improvements for future measurements.