Geophysical Research Abstracts
Vol. 19, EGU2017-12358, 2017
EGU General Assembly 2017

Optical and microphysical properties of aerosol vertical distribution over Vipava valley retrieved by ground-based elastic lidar and in-situ measurements

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Atmospheric aerosols influence Earth's radiation budget, visibility and air quality, as well as the cloud formation processes and precipitation. The structure of the vertical aerosol distribution, in particular that of black carbon, significantly influences the aerosol direct radiative effect, followed by feedbacks on cloud and planetary boundary layer dynamics. The knowledge on aerosol vertical distribution and properties therefore provides an important insight into many atmospheric processes.
In order to retrieve the vertical distribution of aerosol properties in the Vipava valley (Slovenia) and the influence of planetary boundary layer height on the local air quality, in-situ and LIDAR measurements were performed. In-situ methods consisted of aerosol size distribution and number concentration and black carbon concentration measurements which were performed during a one-month extensive measurement campaign in spring 2016. Aerosol size distribution (10 nm to 30 μm) was measured at the valley floor using scanning mobility particle sizer (SMPS, Grimm Aerosol Technique, Germany) and optical particle counter (OPC, Grimm Aerosol Technique, Germany). Black carbon concentrations were measured by Aethalometer AE33 (Aerosol d.o.o., Slovenia) at the valley floor (125 m a.s.l.) and at the top of the adjacent mountain ridge (951 m a.s.l.), the later representing regional background conditions. The in-situ measurements were combined with LIDAR remote sensing, where the vertical profiles of aerosol backscattering coefficients were retrieved using the Klett method. In addition, aerosol samples were analyzed by SEM-EDX to obtain aerosol morphology and chemical composition.
Two different cases with expected dominant presence of specific aerosol types were investigated in more detail. They show significantly different aerosol properties and distributions within the valley, which has an important implication for the direct radiative effect. In the first case, during a Saharan dust event on 5-6 April 2016 the prevailing aerosols were expected to be mineral dust, while in the second case, during traditional bonfires on 30 April 30 - 1 May 2016 carbonaceous aerosol from biomass burning prevailed. In the Saharan dust case, the height of the mineral dust layer decreased from 2 km to 1 km, causing the mixing of mineral dust within the planetary boundary layer, which resulted in its spreading within the valley. Increased fraction of relatively large mineral aerosols was observed (2.5-10 μm) and their identity was confirmed by SEM-EDX analysis of the collected samples. No significant increase of black carbon concentration was detected, indicating dry deposition of mineral dust and good mixing with the locally emitted black carbon. In the biomass burning case, the LIDAR backscattering coefficient gradually increased due to intensive local emissions within the valley. After 10PM the increasing wind caused the dispersion of aerosols and the total particle concentration of particles smaller than 1 μm indicates smaller sizes of black carbon aerosols in comparison to mineral dust particles.