Closure study between airborne and remote sensing measurements of vertical aerosol layering during the PEGASOS campaign in the Po Valley

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Aerosol particles influence to the energy balance of the Earth through aerosol radiation interactions (ARI). In order to quantify the ARI and to determine the influence of anthropogenic aerosols on climate, the loadings, vertical distribution and optical properties of the aerosol particles must be known. Usually, the dominant fraction of the aerosol is found in the planetary boundary layer (PBL). The vertical distribution of aerosols within the PBL typically varies in the course of the day, due to convective mixing during daytime and decoupling of vertical layers during night-time.

Ground based measurements can provide a detailed characterization of the aerosol, but only at the Earth's surface. In contrast, Lidar remote sensing provides detailed information on the vertical layering of aerosol loadings, while obtaining quantitative values is difficult. Linking the in-situ and remote sensing measurements is a challenging business (e.g. *Zieger et al.*, 2011; *Sheridan et al.*, 2012). In this study we combine ground based and airborne in-situ measurements with Lidar remote sensing for a vertically-resolved closure of the aerosol extinction coefficient.

Measurements were performed at the San Pietro Capofiume site (Po Valley, Italy) during a field experiment of the Pan-European Gas-Aerosols-climate interaction Study (PEGASOS). Data from an aethalometer (absorption coefficient), nephelometer (scattering coefficient) and/or particle size spectrometers (number size distribution) were used to infer the extinction coefficient from the in situ measurements at the ground site and on board the Zeppelin NT airship. The effect of the particulate water content at ambient RH conditions was also taken into account based on hygroscopicity measurements with a white-light humidified optical particle spectrometer (WHOPS). A ceilometer and a 532 nm Lidar were used for the remote sensing. The Lidar ratio (LR), which is required to infer the extinction coefficient from the Lidar backscatter signal, has to be assumed.

The aerosol extinction coefficients observed on 20 June 2012 are shown in Fig. 1. A distinct layering was detected in the morning (Panel 1a) with much higher concentrations in the new mixed layer compared to the residual layer above. In the early afternoon (Panel 1b), the mixed layer is fully developed, thus resulting in very small vertical variability of the aerosol loading across the whole PBL. The ground based and airborne (100 m above ground) in-situ measurements agreed well in five out of six profiles (Panel 1a shows the outlier). The airborne measurements agree within uncertainty (blue error bars) with the remote sensing results for LR=30–70 sr. This essentially means successful closure, as these LR are reasonable for the expected continental aerosol.

A more general conclusion is that the ground based measurements are often representative of the mixed layer, whereas they cannot be extrapolated to higher altitude layers such as the residual layer.

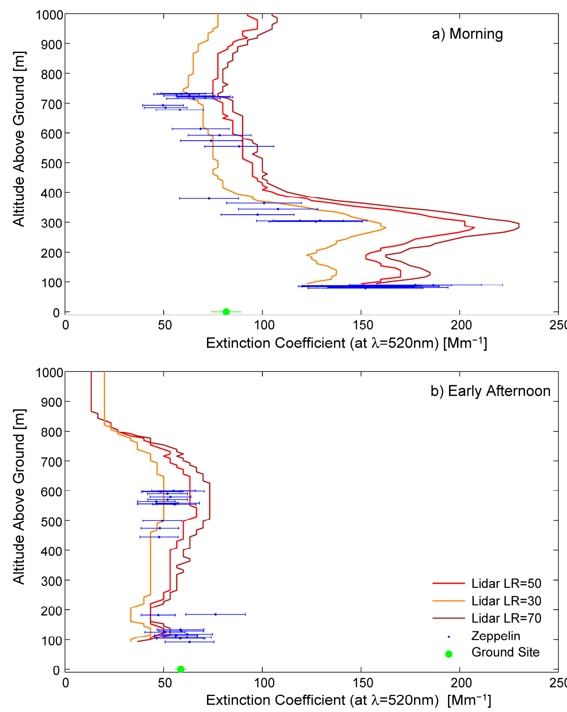

Figure 1. Comparison between in-situ (ground based and airborne) and remote sensing (Lidar) measurements.

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Sheridan et al., *Atmos. Chem. Phys.*, **12**, 11695-11721, 2012.

Zieger et al., *Atmos. Chem. Phys.*, **11**, 2603-2624, 2011.