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Evolution of the planetary boundary layer in the presence of fog and plume

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Vipava valley (100 m a.s.l.), enclosed between the Trnovski gozd ridge (1500 m a.s.l.) and Karst plateau (500 m a.s.l.), is in autumn and winter months in stable weather conditions exposed to relatively large aerosol loading, often exceeding daily PM10 limit of 50 μg/m3. Using an infra-red Mie scattering lidar in the center of the valley (Ajdovščina, 45.93º N, 13.91º E) as the main detection tool, planetary boundary layer (PBL) and backscatter coefficient profiles were investigated in November and December 2015. Wind speeds in the observed period remained below 1 m/s. Backscatter coefficients were obtained using the Klett method. In this period, foggy weather, prevailing in the morning, on certain days cleared during the day. The fog was frequently mixed with aerosols, emitted from local biomass burning sources and traffic within the valley.

Fog is an indicator of constant PBL height during the day, as it generally evolves only in periods with stable weather and temperature inversion in orographically enclosed areas. We investigated the evolution of the PBL in the case of fog and plume. In the first case, PBL height remained constant at about 200 to 300 m while in the second case it followed the typical daily evolution pattern and increased during the morning. In both cases lidar backscatter coefficients within the PBL were found to be increased for a factor of 0.5 to 2 with respect to clear weather conditions.

In the periods of elevated aerosol loading in Ajdovščina observed by lidar, elevated PM10 concentrations in Nova Gorica, 20 km away along the valley, were also detected as expected, due to similar local aerosol sources throughout the valley.