



Characterising the effect of a variety of surface roughness on boundary layer wind and dynamics within the scanning Doppler lidar network in Finland

Anne Hirsikko (1), Ewan J. O'Connor (1,2), Curtis R. Wood (1), and Ville Vakkari (3)

(1) Finnish Meteorological Institute, Climate change, Helsinki, Finland (anne.hirsikko@fmi.fi), (2) University of Reading, Meteorology Department, Reading, UK, (3) University of Helsinki, Department of Physics, Helsinki, Finland

Aerosol particle and trace gas atmospheric content is controlled by natural and anthropological emissions. However, further dispersion in the atmosphere is driven by wind and dynamic mixing. Atmospheric surface and boundary layer dynamics have direct and indirect effects on weather, air quality and processes affecting climate (e.g. gas exchange between ecosystem and atmosphere). In addition to the amount of solar energy and prevailing meteorological condition, the surface topography has a strong influence on the close to surface wind field and turbulence, particularly in urban areas (e.g. Barlow and Coceal, 2009).

In order to characterise the effect of forest, urban and coastal surfaces on boundary layer wind and mixing, we have utilised the Finnish Doppler lidar network (Hirsikko et al., 2013). The network consists of five 1.5 μm Doppler lidars (HALO Photonics, Pearson et al., 2009), of which four are capable of full hemispheric scanning and are located at Helsinki (60.12°N, 25.58°E, 45 m asl.), Utö island (59.47°N, 21.23°E, 8 m asl.), SMEAR II at Hyytiälä (61.50°N, 24.17°E, 181 m asl.) and Kuopio (62.44°N, 27.32°E, 190 m asl.). The fifth lidar at Sodankylä (67.37°N, 26.63°E, 171 m asl.) is a new model designed for the Arctic environment with no external moving parts, but still retains limited scan capability.

Investigation of boundary layer wind and mixing condition can now be extended beyond vertical profiles of horizontal wind, and dissipation rate of turbulent kinetic energy (O'Connor et al., 2010) throughout the boundary layer. We have applied custom designed scanning routines for 3D-observation of the wind fields and simultaneous aerosol particle distribution continuously for over one year at Helsinki and Utö, and began similar scanning routines at Kuopio and Hyytiälä in spring 2013. In this long term project, our aims are to 1) characterise the effect of the land-sea interface and the urban environment on the wind and its turbulent nature near the surface (< 200 m above the ground) observed at our four measurement sites, 2) characterise aerosol particle spatial and temporal distribution, and 3) deploy obtained results in air quality monitoring purpose and weather models. Here, we focus on wind field characterisation. The effect of sea, land and certain buildings were clear and evident in our wind data. The results compare favourably with in-situ point observations available indicating the applicability of the 3D-measurement routines and subsequent data analysis.

Acknowledgements

This research was supported by funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant 262254, and by the Maj and Tor Nessling foundation (Dispersion of air pollution in the boundary layer – new approach with scanning Doppler lidars).

References

- Barlow J. and Coceal, O.: A review of urban roughness sublayer turbulence, Met Office Tech. Rep., Exeter, p. 68, 2009.
- Hirsikko, A., et al.: Observing aerosol particles, clouds and boundary layer wind: a new remote sensing network in Finland, in preparation for Atmos. Meas. Tech., 2013.
- O'Connor, E.J., Illingworth, A.J., Brooks, I.M., Westbrook, C.D., Hogan, R.J., Davies, F. and Brooks, B.J.: A Method for Estimating the Turbulent Kinetic Energy Dissipation Rate from a Vertically Pointing Doppler Lidar, and Independent Evaluation from Balloon-Borne In Situ Measurements, J. Atmos. Ocean. Technol., 27, 1652-1664, 2010.
- Pearson, G., Davies, F., and Collier, C.: An Analysis of the Performance of the UFAM Pulsed Doppler Lidar for Observing the Boundary Layer, J. Atmos. Ocean. Tech., 26, 240-250, 2009.

