EMS Annual Meeting Abstracts
Vol. 7, EMS2010-356, 2010
10th EMS / 8th ECAC

Obtaining Crosswind from Single-Aperture Optical Scintillometers

D. van Dinther (1) and O.K. Hartogensis (2)

(1) Meteorology and Air Quality, Wageningen University, The Netherlands (danielle.vandinther@wur.nl), (2) Meteorology and Air Quality, Wageningen University, The Netherlands (oscar.hartogensis@wur.nl)

A scintillometer is a device that consist of a transmitter and receiver. The receiver records intensity fluctuations of the electromagnetic beam emitted at optical or microwave wavelengths by the transmitter. These fluctuations are caused by refraction of the beam upon its passage through the turbulent surface layer.

An increasingly popular application of scintillometry is to estimate the area-averaged surface fluxes from these raw measurements following scintillometer theory (Tatarskii, 1961) relating the raw intensity measurements to the structure parameter of the refractive index, C_n^2 and Monin-Obukhov similarity theory that relates structure parameters to surface fluxes (Meijninger *et al.*, 2002).

A less known application of scintillometry is the estimation of the crosswind, i.e. the wind perpendicular to the scintillometer path. Past research on this issue focused on multiple aperture scintillometers that use the time delay between the turbulence signals of the displaced apertures to estimate the crosswind (Andreas, 2000, Poggio *et al.*, 2000 and Furger *et al.*, 2001,).

The goal of this study is to explore a method to obtain the crosswind from single aperture scintillometers through spectral analysis of the raw scintillometer signal. In theory the scintillometer spectrum shows an inflection at the transition of the refractive and absorption part of the spectrum. The transition frequency (f_{C2}) is related to the ratio of the crosswind and the diameter of the receiver and transmitter (Nieveen *et al.*, 1998) via $f_{c2} = \frac{u}{1.25D}$ where u is the crosswind speed and D the diameter of the scintillometer. Limitation of the method is that it only works properly when the crosswind is constant, i.e. with a horizontal scintillometer path, no time variation and no spatial variations of the crosswind.

The prescribed method to obtain the crosswind is examined with LITFASS-2009 (Germany) and Haarweg (The Netherlands) datasets. At LITFASS-2009 different optical and microwave scintillometers (MWS) were running along additional measurements including wind, for more detail see Beyrich *et al.* (2009). At the Haarweg a Large Aperture Scintillometer (LAS) and a Boundary Layer Scintillometer (BLS) are running along with wind measurements.

We obtain spectra of scintillometer signals with Fast Fourier Transformation (FFT). For LITFASS ten minutes averaged crosswind obtained from spectra of LAS and MWS are comparable to crosswind measured at the boundary layer station. However for short averaging times (e.g. one minute) spectra obtained with FFT become more fickle, thereby making it more difficult to obtain f_{C2}. However short averaging times are preferable, since no time variation of the crosswind are also preferable. Therefore the use of wavelets to obtain the spectra for these short averaging times ($\leq$1 minute) is investigated.

Other points we will investigate are the effects of different magnitudes of crosswind and spatial variability of the terrain height of the scintillometer path on the spectrums. We expect that a variable crosswind speed will cause a smoothing of the spectrum, thereby making it more difficult to obtain the value of f_{C2}. A variable crosswind speed can be caused by a variable terrain height, which is investigated through wind profiles.

Literature:

Andreas, E.L. (2000). ‘Obtaining surface momentum and sensible heat fluxes from crosswind scintillometers’. *Journal of atmospheric and oceanic technology* **17** 3-16.

Beyrich, F., Bange, J., Hartogensis, O., Raasch, S. (2009). Validation of scintillometer measurements over a heterogeneous landscape: The LITFASS-2009 Experiment. In: Proceedings 9th Annual Meeting of the European Meteorological Society (EMS), Toulouse, France.

Furger, M., Drobinksi, P., Prévôt, A.S.H., Weber, R.O., Graber, W.K., Neininger, B. (2001). 'Comparison of horizontal and vertical scintillometer crosswinds during strong foehn with lidar and aircraft measurements'. *Journal of atmospheric and oceanic technology* **18** 1975-1988.

Meijninger, W.M.L., Hartogensis, O.K., Kohsiek, W., Hoedjes J.C.B., Zuurbier, R.M., De Bruin, H.A.R. (2002). 'Determination of area-averaged sensible heat fluxes with a large aperture scintillometer over a heterogeneous surface – Flevoland and field experiment'. *Boundary-Layer Meteorology* **105** 37-62.

Nieveen, J.P., Green, A.E., Kohsiek, W. (1998). 'Using large-aperture scintillometer to measure absorption and refractive index fluctuations'. *Boundary-Layer Meteorology* **87** 101-116.

Poggio, L.P., Furger, M., Prévôt, A.S.H., Graber, W.K, Andreas, E.L. (2000). 'Scintillometer wind measurements over complex terrain'. *Journal of atmospheric and oceanic technology* **17** 17-26.

Tatarskii, V.I. (1961). *Wave propagation in a turbulent medium*. McGraw-Hill Book Company Inc., New York, 258 p.