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URBAN CLIMATE OBSERVATIONS IN HELSINKI

Helsinki UrBAN (Urban Boundary-layer Atmosphere Network)

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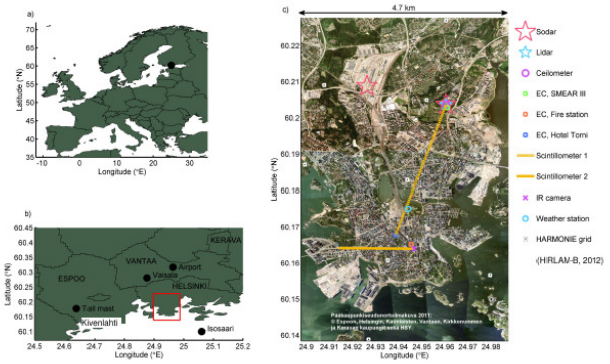
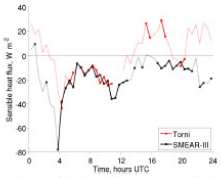
Helsinki UrBAN (http://urban.fmi.fi) is a research-grade observation network for:

- the study Helsinki's urban atmospheric boundary layer
- validation and development of numerical models of air quality and weather prediction

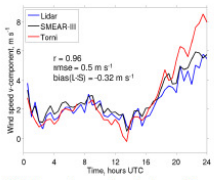


Equipment		Relevant variables (some derived)
Sodar		ABL depth, profiles of mean and variance of vertical velocity (Wood et al. 2012)
Lidar (scanning doppler)		ABL depth, profiles of vertical velocity variance and aerosol backscatter (Hirsikko et al. 2012)
Ceilometer		ABL depth, aerosol backscatter profile (Eresmaa et al. 2006)
Eddy covariance (EC)	SMEAR-III	Fluxes, turbulence statistics and mean concentrations of heat, moisture, momentum and various gases and particulates (Vesala et al. 2008, Järvi et al. 2009, Nordbo et al. 2012)
	Fire station	
	Hotel Torni	
Scintillometer 1		Structure parameter for temperature, sensible heat flux, wind speed
Scintillometer 2		
Infra-red camera		Longwave radiative emission
Profile masts (Kivenlahti, Isosaari)		Profile of temperature and wind (Suomi et al. 2011)
Doppler radar network (operational)		Wind speed and direction (Saltikoff & Nevvonen 2011)

Case study, 3rd January 2012

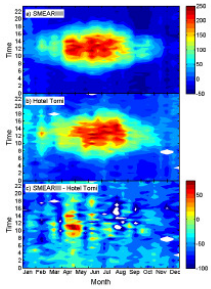


Negative sensible heat fluxes observed at two EC stations (dotted lines indicate data of low quality)

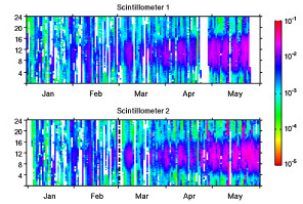


Wind speed comparison between lidar (HALO Photonics) and two EC stations

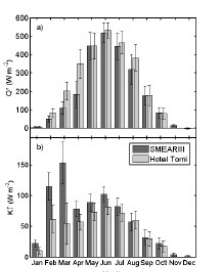
Climatology



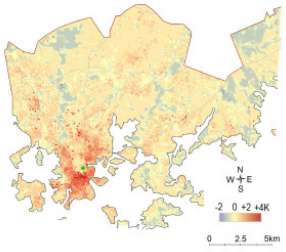
2 EC sites in 2011: (a,b) sensible heat flux (W/m²), (c) their difference



Structure parameter for temperature (1-min mean) in 2012, Scintec BLS900. Until 02-March, scint2 was located on the same path as scint1; before moving to its downtown location

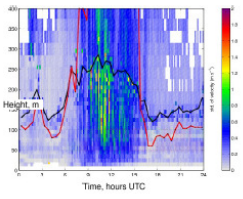


2 EC sites in 2011: (a) Net radiation, (b) upward shortwave radiation

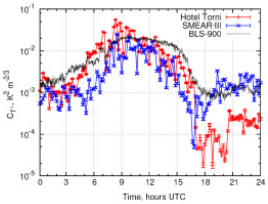


Urban heat island experiment (July09-June10): kriging map shown from 336 sites. Annual mean shown: only 46 grid points out of 38191 had a temperature difference of > 1K (referenced to Kaisaniemi weather station, in a downtown park) (Drebs 2012)

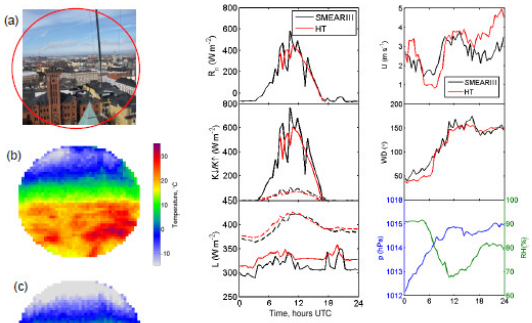
Case study, 4th September 2011



Standard deviation of vertical velocity from sodar and lidar. From sodar, velocity data up to about 200 m (black line) are reliable. Data above are from the lidar. Red line is mixing-level depth (from sodar echo power).



Structure parameter for temperature from scintillometer (BLS900) and two EC stations at each end of the beam (method in Kouznetsov and Kallistratova 2010)



Conditions at the two main EC sites (SMEAR-III and Hotel Torni): net radiation, up- and downwelling shortwave, up- and downwelling longwave, wind speed, wind direction, pressure, relative humidity

View from Elisa mast looking westwards, (a) photo; thermal camera (Omega OSXL-101) (b) daytime, (c) nightime

SUMMARY

Components of the network have been running since 2004, with substantial expansion in 2010–2012. The annual cycles show the range of stabilities across the day and year both downtown and at a suburban site: in particular the seasonal cycle is pronounced.

Results have highlighted areas of science, for example: negative sensible heat fluxes over a city centre, the applicability of urban scintillometry, the applicability of scanning Doppler lidar above a city, and the additive combination of sodar and lidar to give a fuller range of ABL depth estimates. Previous Helsinki studies have already reported many findings, such as analyses of fluxes (Vesala et al. 2008), exploitation of morphological datasets (Nordbo et al. 2012), and analysis of several years' CO_2 budgets (Järvi et al. 2012).

We anticipate that others will bring their equipment and expertise alongside ours for the development of technology, science and applications.

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