6th Annual Meeting of the European Meteorological Society, Ljubljana, Slovenia, 4 – 8 September 2006

FINNISH METEOROLOGICAL INSTITUTE

Utilising dense observation networks in air quality episodes

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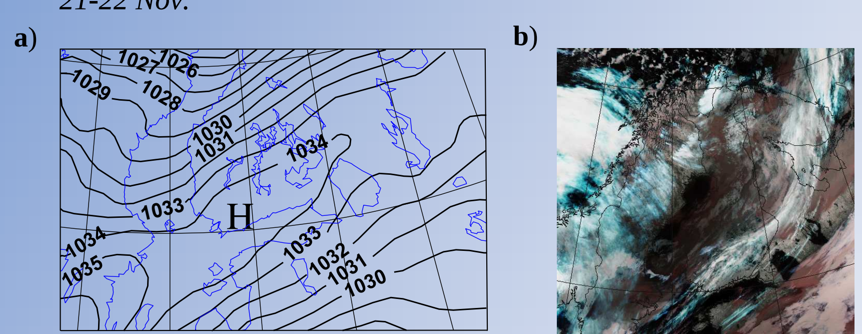
In the Helsinki metropolitan area in Finland, a dense observation network (Testbed) implemented by The Finnish Meteorological Institute (FMI) and Vaisala Oyj has been operational for a year now. We have utilised profile observation from the network in analysing two recent air quality episodes. Dense observation network gives new possibilities to develop air quality forecasting systems that use real-time and accurate observation data. It also enables a better control of air quality related phenomena in an urban environment

Figure 1. *a) ECMWF analysis: The isolines correspond to the observed atmospheric pressures (hPa) at the ground level at 00 UTC on 22 November 2005.* ***b)*** *Satellite image (NOAA/EOS) at 02UTC. Weather front moved over Finland, but only slight cloudiness reached Helsinki Metropolitan area during the night of 21-22 Nov.*



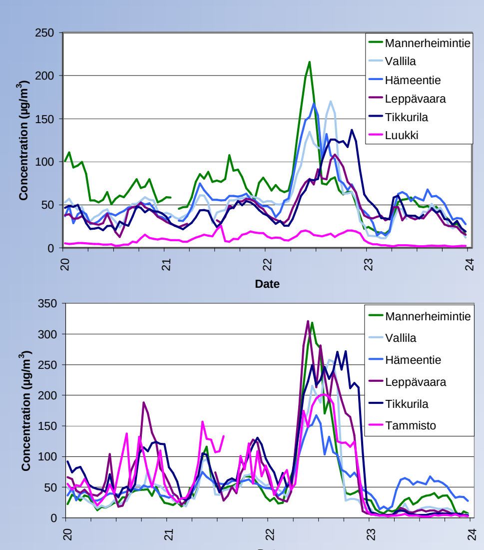


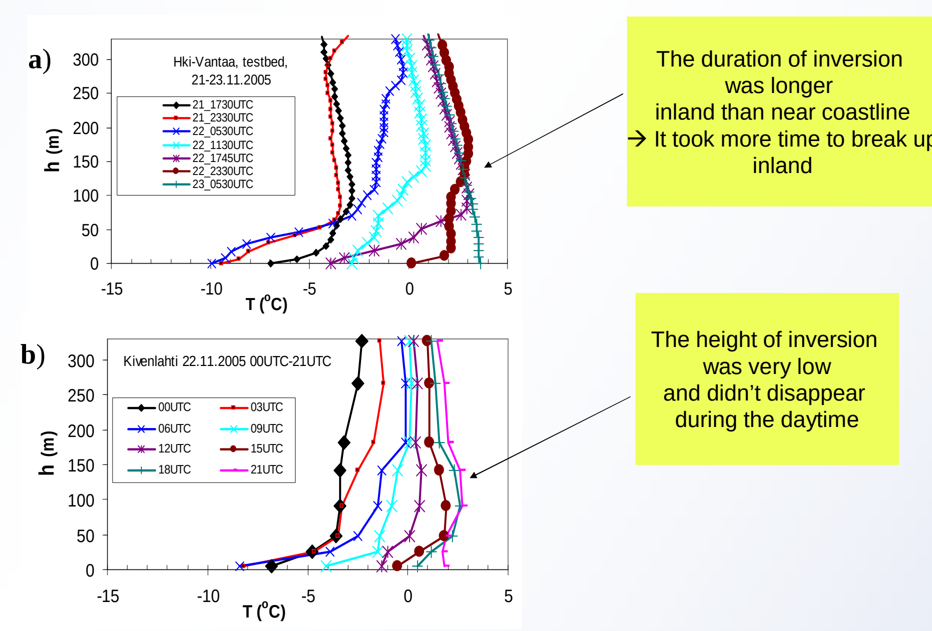
Figure 2.

a) *Nitrogen dioxide concentrations at Helsinki Metropolitan area during November 20-23.*

b) *PM_{10} concentrations at Helsinki Metropolitan area during November 20-23.*

Episode in November 22, 2005

Autumn 2005 was exceptionally warm in Finland. In Mid-November the air cooled down. On November 22 southern Finland belonged to an area of high-pressure and the winds calmed down. After a calm and cold night air pollutant concentrations rose and air quality was ‘poor’ or ‘very poor’ for the whole day mainly due to the observed strong temperature inversion. Temperature profiles obtained from radio acoustic sounding system (RASS) located at Malmi airport and frequent radio soundings combined with dense network of mast measurements made it possible to investigate the temporal evolution of the inversion layer.



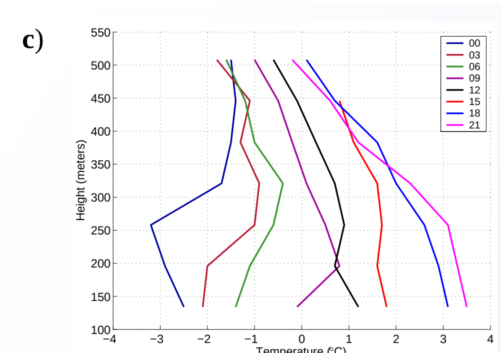
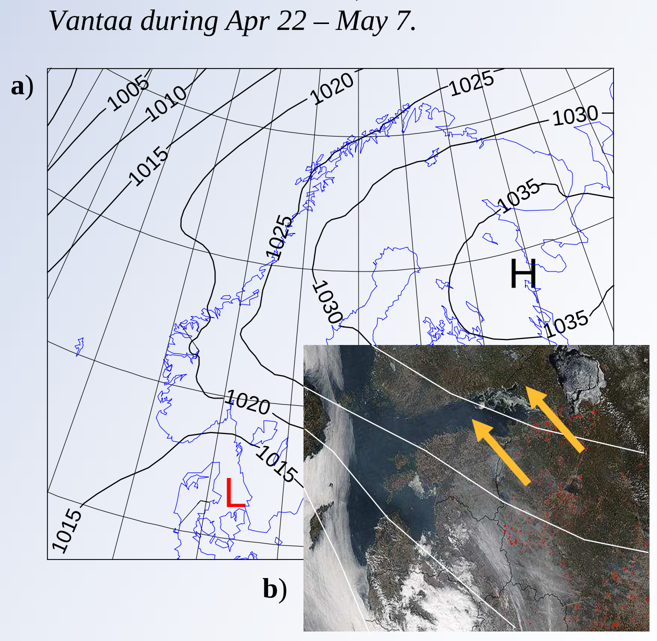
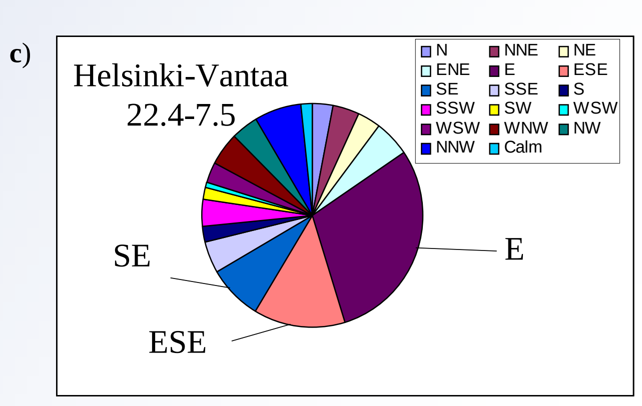


Figure 3.
Temperature profiles ***a)*** *from Vantaa soundings and* ***b)*** *from Kivenlahti mast* ***c)*** *the temperature profiles determined by RASS in 22 November in Malmi, Helsinki. Times are local times.*

Figure 4. ***a)*** *ECMWF analysis: The isolines correspond to the observed atmospheric pressures (hPa) at the ground level at 00 UTC on 30 April 2006.* ***b)*** *The MODIS satellite image (NASA) that shows the forest and field fires going on in Russia and the Baltic countries.* ***c)*** *Wind direction distribution at Vantaa during Apr 22 – May 7.*





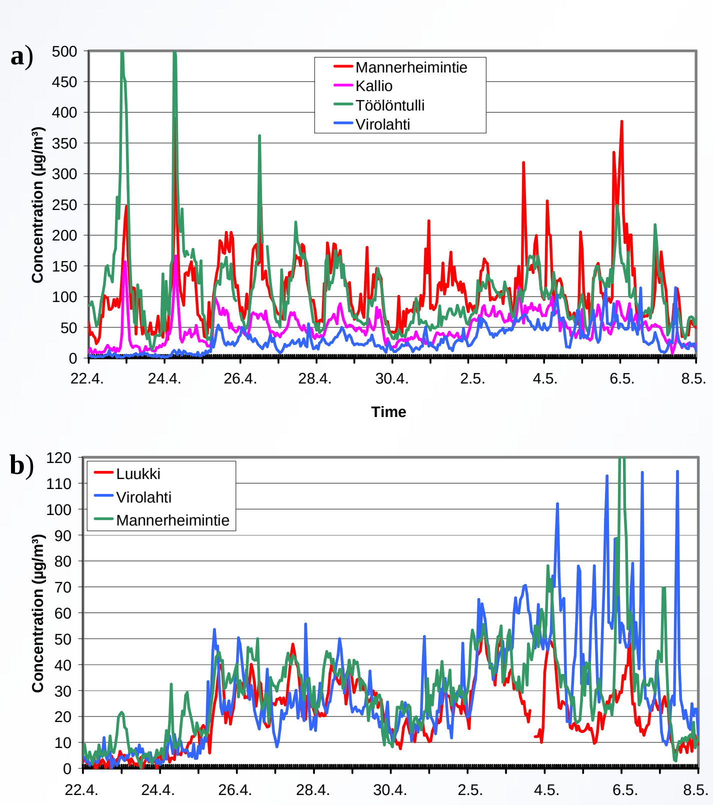


Figure 5. ***a)*** *PM_{10} and* ***b)*** *$PM_{2.5}$ concentrations during Apr 22- May 7.*

Episode from the end of April to beginning of May 2006

Particulate matter (PM) related air quality episodes are a continuous problem during springtime in Finland, because huge amounts of sand and salt are spread on the streets for reducing slipperiness during wintertime. After Mid-April the weather conditions caused a fast drying of the streets causing an immediate rise in measured PM concentrations.

The area of high-pressure remained almost still for nearly two weeks, thus causing the general airflow to come from the eastly directions for the same period. This allowed long-range transport of particles to have a significant effect on the air quality and visibility especially in southern Finland. Very high fine particle ($PM_{2.5}$) concentrations were mostly due to the forest and field fires going on in Russia and the Baltic countries. The general airflow transported the smoke and pollutants directly towards Finland. Locally the concentrations were also raised by dust from the dry streets.

In addition to the surface observations of pollutants, we also studied the aerosol profiles obtained from several ceilometers in the Helsinki Testbed network.

The mixing height is determined from the ceilometer backscattering profile using the idealised profile method. In this method an idealised backscattering profile

$$B(z) = \left[\frac{B_{SL}-B_{ML}}{2} - \frac{B_{SL}-B_{ML}}{2} * erf\left(\frac{z-MH_{SL}}{\Delta h_{SL}}\right)\right] + \left[\frac{B_{ML}+B_{U}}{2} - \frac{B_{ML}-B_{U}}{2} * erf\left(\frac{z-MH_{ML}}{\Delta h_{ML}}\right)\right]$$

is fitted to the measured profile. The footnote SL corresponds to the surface layer, the footnote ML to the mixing layer and the footnote U to the air above the mixing layer. In the fitting we have used half-hour averaged profiles.

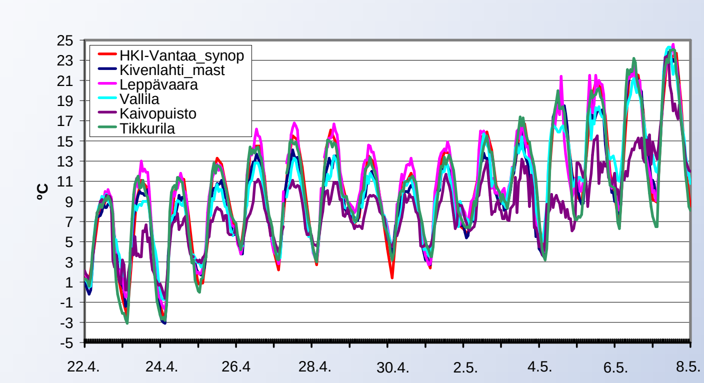


Figure 6. *Temperature series 22 April – 7 May in Helsinki Metropolitan area. Diurnal variation is quite large.*

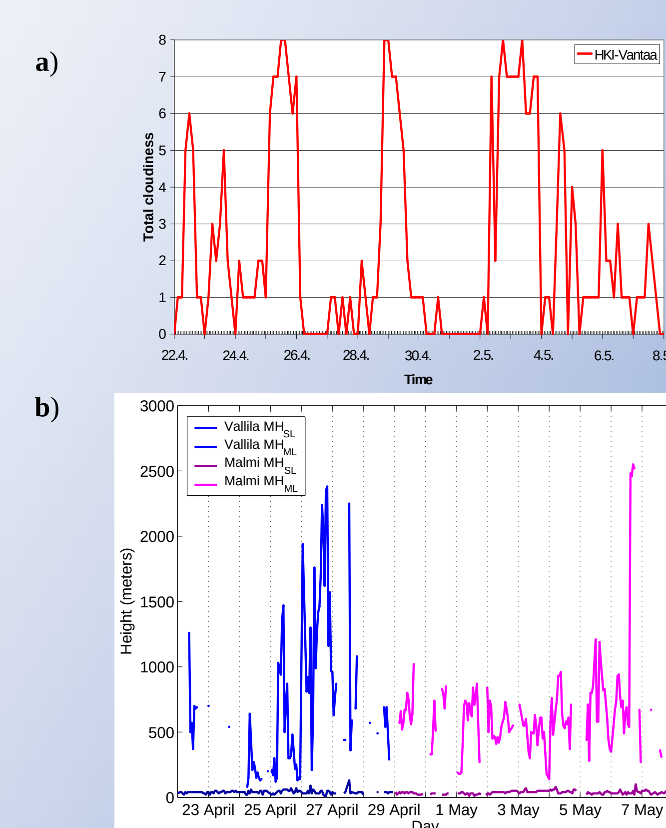


Figure 7. ***a)*** *Total cloudiness in one-eights at Vantaa* ***b)*** *Mixing height determined by ceilometer during the episode of 22 April – 7 May in Vallila (blue lines) and Malmi (magenta lines), Helsinki*

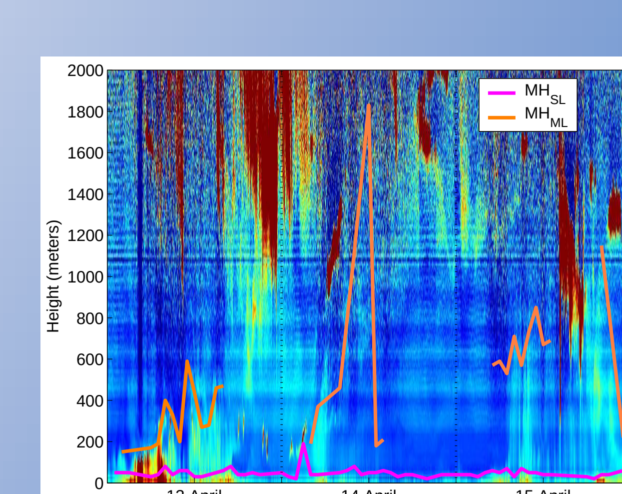


Figure 8. *Mixing height determined by ceilometer during the episode of 13 – 15 April in Vallila, Helsinki.*