# Identification of suitable case studies for combined source apportionment

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*WP 4, Integrating in-situ, satellite and model components for improved environmental assessment*

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*Version 1*

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BAECC (Biogenic Aerosols – Effects on Cloud and Climate) Campaign (Petäjä et al. 2016b) took place in Hyytiälä, Southern Finland, at the SMEAR-II station (Station for Measuring Forest Ecosystem-Atmosphere Relations - II, see Hari and Kulmala, 2005) from January to September 2014. During the campaign the High Spectral Resolution Lidar (HSRL, see Shipley et al., 1983; Grund and Eloranta, 1991; She et al., 1992) measured vertical profiles of the backscatter and extinction coefficients at 532 nm, and depolarization from around 50 m up to 30 km in altitude. Flight campaigns with a Cessna 172 light aircraft took place in spring, summer and autumn of 2014 collecting in situ data on aerosols with an ultrafine Condensational Particle Counter (uCPC, Model 3776, TSI Inc.), a Scanning Mobility Particle Sizer (SMPS) and an Optical Particle Sizer(OPS, Model 3330, TSI Inc.). Low air speed of Cessna ensured a relatively high vertical resolution (300 m for SMPS and 80 m for OPS) during typical measurement flight of 3 hours above the SMEAR II station. The maximum flying height was 3800 m a.s.l.

Several case studies from the SMEAR II station are suitable for combined source apportionment.

## 1. 8-10 April 2014

Sequential clear-sky days with air masses arriving from the Arctic Ocean, and new particle formation events taking place each day. Besides the boundary layer, several other elevated layers can be monitored for several days in terms of development and mixing during this period. Figure 1 shows the HSRL backscatter coefficient for one of the days, 10 April. Higher values of the backscatter correspond to higher particle concentration or larger particle sizes. During clear sky days, the boundary layer in boreal forest area can be even visually recognized by the large number of aerosols. Other layers can be also distinguished by changes in the backscatter values. Changes in relative humidity profiles (left

panel, Fig.1), measured by the radiosonde (RS92, Vaisala) and Cessna, help to identify layers and agree with the layers recognized by the HSRL.

## 2. 18-20 May 2014

During this period a layer with high backscatter and depolarization values was observed above 2 km, that mixed into the boundary layer after some time (Fig. 2). Back trajectory analyses show that it was a long-range transport of Saharan dust particles to Southern Finland. This layer was also captured by Calipso satellite, which provided data for comparison. This event is quite unique as long-range transport of Saharan dust could be captured very rarely in Finland. Moreover, there is a possibility to link vertical profiles to the ground-based in situ measurements, as the layer was mixing down to the boundary layer.

## 3. 26 -27 July 2014

Interesting case with elevated backscatter values outside the boundary layer up to 10 km (Fig. 3), whereas the depolarization was very low, suggesting spherical particles. Back trajectory analyses suggest that air masses were arriving from Eastern Europe and Russia.

## References:

Grund, C. J. and Eloranta, E.W., 1991. Optical Engineering, 30(1), 6-12.

Hari, P. and Kulmala, M, 2005. Boreal Env. Res., 10, 315-322.

She, C.Y. et al., 1992. Opt. Lett., 17(7), 541-543.

Shipley, S.T. et al., 1983. Appl. Opt., 22, 3716-3724.

Petäjä, T. et al., 2016b. Bulletin of the American Meteorological Society, 97(10), 1909-1928.

## Figures

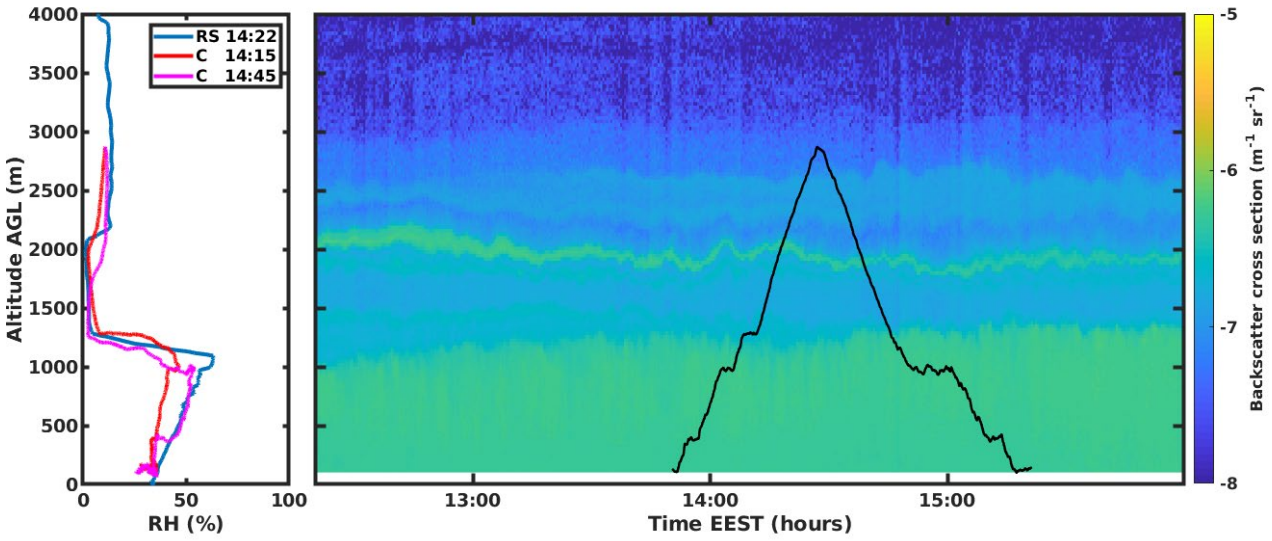


Figure 1. Left: Relative humidity profiles measured by Radiosonde and Cessna. Right: Backscatter coefficient during 10 April 2014 with Cessna flight altitude superimposed in black.

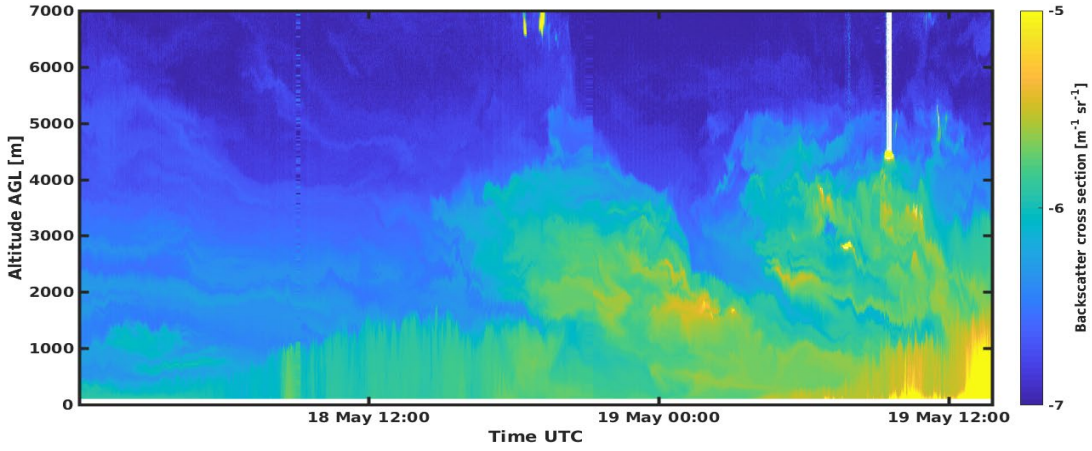


Figure 2. Backscatter coefficient during 18-19 May 2014.

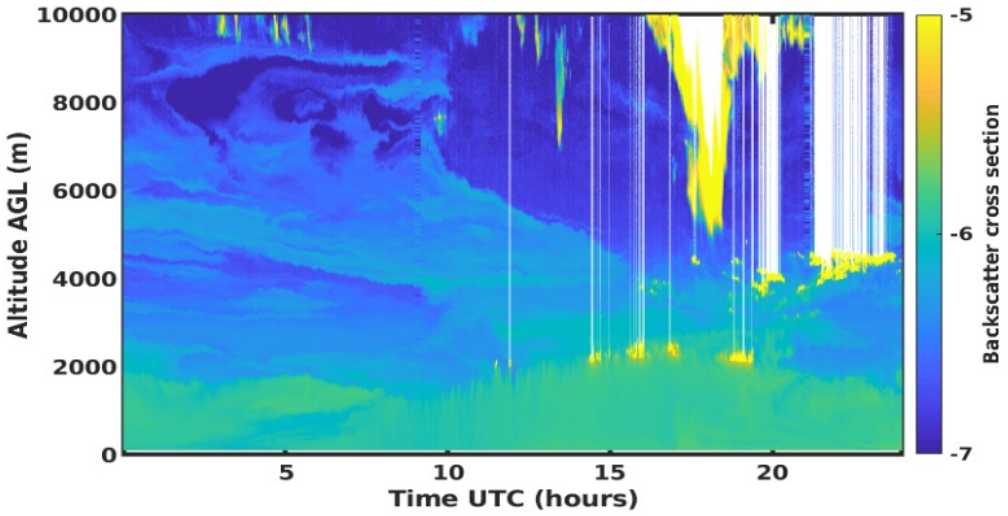


Figure 3. Backscatter coefficient during 27 July 2014.