Characterization of emissions from various local sources and their effects on cloud droplet formation in Puijo semi-urban site

A. Ruuskanen[1], A. Leskinen[1,2], H. Portin[1], A. Arola[1], S. Romakkaniemi[1], K. E. J. Lehtinen[1,2] and M. Komppula[1]

[1]Finnish Meteorological Institute, P.O.Box 1627, FI-70211, Kuopio, Finland
[2]University of Eastern Finland, Department of Applied Physics, P.O.Box 1627, FI-70211, Kuopio, Finland
Keywords: cloud formation, aerosol-cloud interactions, urban aerosols
Presenting author email: antti.ruuskanen@fmi.fi

Typically in urban areas there are several pollutant sources which contribute to the local air quality. The number of studies for resolving the contribution of different local sources and long range transport has been recently increasing. The local aerosol sources are of great interest due to their effects on population health, (local) air quality and radiation in the atmosphere. In this study the effect of local sources are studied by observing the physical, chemical and optical particle properties as well as gas and particle concentrations. The main aspects of the study are to identify the local sources, their emissions and how different fuels affect to the released emissions from a source, as well as the effect on cloud droplet formation.

The main measurement site of Puijo is located in Kuopio, Eastern Finland, surrounded by lake Kallavesi. The Puijo station has provided continuous data from summer 2006 (Leskinen *et al.*, 2009). The measurement station is located on top of the Puijo observation tower (306 m a.s.l, 224 m above the surrounding lake level). With total and interstitial inlets activated and not activated particles can be measured separately (Portin *et al.*, 2014). The most significant local sources are traffic on highways to north and south from Kuopio, pulp mill 5 km north-east of Puijo and local power plant 3 km south of Puijo. In the residential areas around Kuopio there are apartments and minor combustion based facilities which contribute less to the local emissions. The sector roughly from west to north from Kuopio is considered to be clean one since there are no major sources in close or intermediate range and the sector is used for comparing values from different sectors.

Preliminary results have been calculated as mean of plumes during cloud events since 2007. The plumes are categorised to correspond local sources with specific wind directions. The mean of particle size distribution during plumes is presented in Fig. 1 for paper mill, power plant and traffic. Clean sector is presented as a comparison. In Table 1 there are averages of O_3, NO, NO_2, SO_2, black carbon (BC) and total number concentration (N_{tot}). The paper mill produces larger accumulation mode particles compared to other sources with slightly elevated NO, NO_2 and SO_2 concentrations. The plumes from the power plant have very high NO, NO_2 and SO_2 concentrations, whereas traffic pollution has high NO_2, BC and nucleation mode particle concentrations.

Preliminary studies indicate that particles from the sources have differing properties in cloud droplet formation. Based on the characterization of the local sources, the effect of the each source and their fuel on cloud droplet formation and droplet population will be studied in detail.

Table 1. The average value of O_3, NO, NO_2, SO_2, BC and N_{tot} are calculated for different sources during cloud events since 2007

	Paper mill	*Power plant*	*Traffic*	*Clean*
O_3 (µg/m^3)	18.2	26.6	41.2	45.6
NO (µg/m^3)	1.21	2.64	0.34	0.99
NO_2 (µg/m^3)	4.97	9.11	12.1	1.57
SO_2 (µg/m^3)	1.7	6.9	1.2	0.4
BC (ng/m^3)	241	275	361	65.6
N_{tot} (cm^{-3})	2350	2060	3180	760

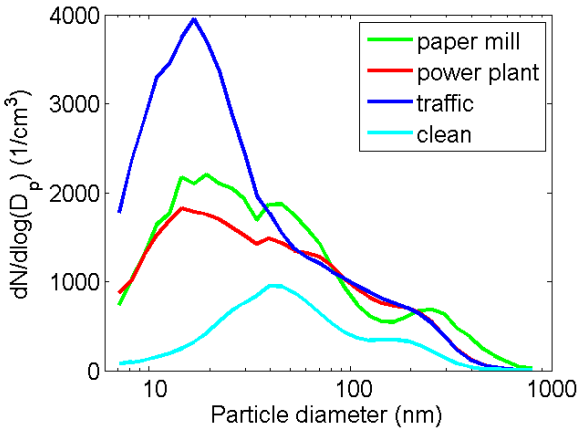

Figure 1. Average of particle number size distributions from different sources during cloud events

This work has been supported by the Maj and Tor Nessling Foundation for PhD thesis work.

Portin, H.; Leskinen, A.; Hao, L.; Kortelainen, A.; Miettinen, P.; Jaatinen, A.; Laaksonen, A.; Lehtinen, K. E. J.; Romakkaniemi, S.; Komppula, M. (2014), Atmos. Chem. Phys., 14, 6021-6034

Leskinen, A.; Portin, H.; Komppula, M.; Miettinen, P.; Arola, A.; Lihavainen, H.; Hatakka, J.; Laaksonen, A.; Lehtinen, K. E. J. (2009), Boreal Env. Res., 14, 576–590