Two years of measured vertical profiles in the Arctic (Svalbard): results from 2011-2012 spring-summer campaigns

L. Ferrero[a], D. Cappelletti[b], B. Moroni[b], V. Vitale[c], R. Udisti[d], G. Sangiorgi[a], M.G. Perrone[a], M. Busetto[c], C. Lanconelli[c], M. Mazzola[c], A. Lupi[c], S. Becagli[d], R. Traversi[d], D. Frosini[d], M. Maturilli[e], R. Neuber[e], C. Ritter[e], J. Graeser[e], M. Fierz[f], G. Mocnik[g] and E. Bolzacchini[a]

[a]POLARIS research centre, DISAT, University of Milano-Bicocca, Piazza della Scienza 1, 20126, Milano, Italy.
[b]DICA, University of Perugia, Via G. Duranti 93, 06125 Perugia, Italy.
[c]ISAC CNR Viale Gobetti 101, 40129, Bologna, Italy.
[d]University of Florence, Via della Lastruccia 3, 50019, Sesto Fiorentino, Florence Italy.
[e]Alfred-Wegener Institut für Polar- und Meeresforschung (AWI), Forschungsstelle Potsdam, Telegraphenberg 43A, 14473 Potsdam, Germany.
[f]University of Applied Sciences Northwestern, Switzerland, Windisch, Switzerland.
[g]Aerosol d.o.o., Kamniska 41, SI-1000 Ljubljana, Slovenia

Keywords: Vertical profiles, Arctic, Planetary Boundary layer, Black Carbon.
Presenting author email: luca.ferrero@unimib.it

Aerosols properties (i.e. size distribution, chemical composition, Black Carbon fraction) and their load along the air column influence the climate forcing (IPCC, 2007; Corrigan et al., 2008). In order to study the effect of the Planetary Boundary Layer (PBL) dynamics on the particulate concentration, aerosol vertical profiles were conducted over Svalbard (Ny-Ålesund, Gruvebadet Station) along 2 summer (March-September) campaigns (2011 and 2012) in the framework of the CICCI program (Cooperative Investigation of Climate-Cryosphere Interaction; http://ny-niflheim.nilu.no/cicci//).
A helium-filled tethered balloon was fitted with: a miniaturized electrical nanoparticle detector (miniDiSC); a novel micro-Aethalometer (AE51, Magee Scientific) for Black Carbon (BC) absorption measurements; an Optical Particle Counter (GRIMM *1.107*; 31 size classes between 0.25 to 32 μm); a miniaturized cascade impactor (Sioutas SKC with 2 impaction stages: <1 μm, >1 μm) to collect samples of particulate matter; a meteorological station (Vaisala Tethersonde TTS 111).
In spring, 84 profiles (up to ~1 km height) were analyzed evidencing multilayered aerosol structures. Aerosol stratification heights were detected for three broadsize ranges (d_p<250 nm, 250 nm<d_p<1000 nm, d_p>1000 nm) by a gradient method; their frequency distribution is resumed in Figure 1.

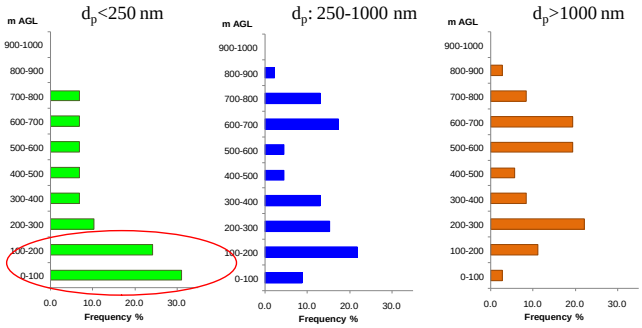

Figure 1. Frequency of aerosol stratifications along height as a function of size.

Finest particles (d_p<250 nm) were layered manily closer to the ground, where they showed higher concentration compared to accumulation mode particles (250-1000 nm; Figure 2). Often this behaviour was accompanied by a decrease of BC concentration. This behaviour was driven by the thermal structure of the lower troposphere characterized by both ground-level and high altitude thermal inversions. A case study is reported in Figure 2, as an example of the aforementioned behaviours. As a results aerosols of different sizes were layered in a different way in the lower troposphere.

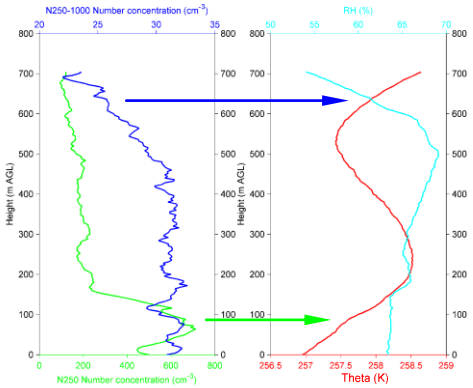

Figure 2. Vertical distribution of nanoparticles (greeen, left) accumulation mode particles (blue, left) on 6th April 2011 together with the thermal structure of the atmosphere (red, right).

In summer, 112 vertical profiles were carried out. BC and aerosol data pointed out that a total of 60 days were characterized by values 100-1000 times higher than background, due to the ship emissions in the port and in the harbour. This result demontrates that this anthropic source heavily affects the environment of the Ny Alesund area and suggesting its possible relevant role in the pollution of so critical Arctic regions.

This work was supported by the Italian National Research Council (CNR). We are also grateful for the help and logistical support to the German Alfred-Wegener-Institut (AWI).

Corrigan et al. (2008). Atmos. Chem. Phys., 8, 737–747.
IPCC: Climate Change 2007.