Vertical profiles of equivalent black carbon in the Arctic boundary layer at Ny-Ålesund (Svalbard)

Vito Vitale[1], David Cappelletti[2], Mauro Mazzola[1]

[1] Institute of Polar Science - National Research Council of Italy (CNR-ISP)

[2] Dipartimento di Chimica, Biologia e Biotecnologie, Universita` di Perugia, Italy

vito.vitale@cnr.it

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The purpose of this activity is to profile the Arctic boundary layer exploiting a tethered balloon system. A number of aerosol instrumentations were customized and deployed in a novel gondola realized in cooperation between CNR and Perugia University (Mazzola et al., 2016).

After test campaigns performed between 2014 and 2015, regular spring activities we carried our since 2016 at Ny-Ålesund (Svalbard Islands, 78°55'N, 11°56'E) from Gruvebadet observatory located at the foot of the Zeppelin mountain. Less regularly other field campaigns have been performed in summer/autumn and in winter (2019).

Tethered balloon system we have at disposal has the capability of successfully lifting up to 15 kg of scientific payload, featuring a power autonomy of about 3 h of continuous measurements with one battery.

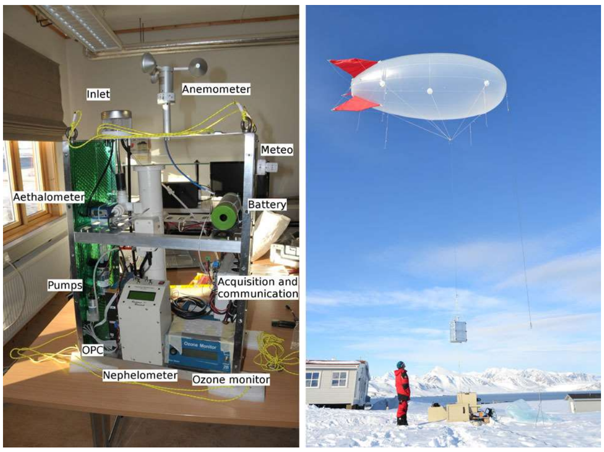

Figure 1 - *Photographs showing gondola and the tethered balloon used to measure aerosol vertical properties in Svalbard. The grey building is the Gruvebadet laboratory.*

The experimental setup integrated in the gondola for the present test campaigns included a custom optical particle counter (OPC), a nephelometer for particles scattering coefficient bs, a micro-aethalometer for black carbon (BC) content, as well as a pump-filter system for aerosol particles collection. Ozone concentration and meteorological parameters were also measured onboard.

The OPC (FAI instruments, 22 channels in the 280 nm–10 mm diameter range) has been customized to reduce as much as possible the weight. This OPC has been compared with similar instruments (Grimm 1.108 and TSI 3330), confirming excellent performances (Castellini et al. 2014).

The integrating nephelometer (Radiance Research M903) is the bulky object in the gondola, determining the final dimension of the gondola itself. This instrument measures the light scattering coefficient at a single wavelength (530 nm). The minimum value detectable by this instrument is 1 Mm^{-1}. An external pump (12 L min^{-1}) was connected to the inlet of the instrument to increase the air flux into the measurement tube and therefore improve the spatial resolution of the measurements.

BC and absorption coefficient profiles can be determined using the microAeth^{TM}AE51 (Magee Scientific). The sample was continuously deposited on the filter and the AE51 measures light attenuation at 880 nm induced by BC collected on the PTFEcoated borosilicate glass fiber filter (FiberfilmTMFilters, Pall Corporation) relative to a clean part of the filter. The precision declared by the manufacturer is 100 ng m^{-3}. This type of instrument has already been employed in the past with tethered balloon systems (e.g. Trompetter et al. 2013).

Ozone measurements are provided by a dual-beam ozone monitor (2BTech, model 205), customized for low temperature operations (rotary vane pump and lamp heater).

Aerosol sampling is activated on demand and uses quartz filters and a 20 L min^{-1} pump. All the sampling inlets were accommodated in a protected shelter on the upper panel of the gondola.

The meteorological setup includes custom temperature, humidity and pressure sensor and a wind cup anemometer. Since the humidity sensor is very sensible to light, it was shielded with a partially drilled Teflon tube.

The temperature inside the gondola during spring campaign range usually between 5 and 10 °C, higher than the external atmospheric temperature and rarely went below -5 °C.

Communications with ground were guaranteed by a radio modem transmitting at 169 MHz, which allowed also to control the switching of the aerosol sampling pump from the ground.

References

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