On Measurements and Spatial Distribution of Light Absorbing Aerosols in the Arctic

J. Backman[1], L. Schmeisser[2,3], A. Virkkula[1], J.A. Ogren[2,3], E. Asmi[1], S. Starkweather[2,4], S. Sharma[5], K. Eleftheriadis[6], T. Uttal[4], A. Jefferson[2,3], M. Bergin[7], A.P. Makshtas[8] and H. Lihavainen[1]

[1]Finnish Meteorological Institute, Helsiniki, Finland; +358-50-566-05-02, E-mail: john.backman@fmi.fi
[2]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309
[3]NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO 80305
[4]NOAA Earth System Research Laboratory, Physical Sciences Division (PSD), Boulder, CO 80305
[5]Environment and Climate Change Canada, Toronto, Ontario, Canada
[6]Institute of Nuclear and Radiological Science & Technology, Energy & Safety, Environmental Radioactivity Laboratory, National Centre of Scientific Research "Demokritos", Athens, Greece
[7]Duke University, Civil and Environmental Engineering, Durham, NC 27708
[8]Arctic and Antarctic Research Institute, St.Petersburg, Russia

A widely-used means to measure the presence of black carbon (BC) in the Arctic is using filter-based instruments that measure light absorption coefficients. Several types of filter-based instruments are in use. Here, the focus is on the aethalometer which is well-suited for unattended measurements, as is often the case in the Arctic. Results are presented based on aethalometer measurements at six Arctic stations from 2012–2014. An alternative method of post-processing the aethalometer data is presented which reduces measurement noise and lowers the detection limit of the instrument more effectively than boxcar averaging. The biggest benefit of this approach can be achieved if instrument drift is minimized. Moreover, by using an attenuation threshold criterion for data post-processing, the relative uncertainty from the electronic noise the instrument is kept constant. This approach results in a time series with a variable collection time (Δt), but with a constant relative uncertainty with regard to electronic noise in the instrument. An additional advantage of this method is that the detection limit of the instrument will be lowered at small aerosol concentrations at the expense of temporal resolution, whereas there is little to no loss in temporal resolution at high aerosol concentrations. At high aerosol concentrations, minimizing the detection limit of the instrument is less critical. The time series obtained is put into use with the Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) version 4.9. The HYSPLIT model was run 7 days back in time. The meteorological data used for the trajectories was the National Centers for Environmental Prediction Global Data Assimilation System dataset with a 1° horizontal resolution. The back-trajectory analysis was done by assigning the aerosol properties as measured at the arrival time and assigning those properties to the grid cell centers that that the trajectory-path traversed. This allows for a footprint to be constructed using the measured aerosol properties at the different receptor sites shown in Figure 1. Due to multiple receptor locations, the weights used were inverse distance travelled from the receptor point. Thus, the receptor location closest to a grid cell will weigh the grid cell the most, which is justified since the trajectory path becomes more uncertain with greater distance travelled.

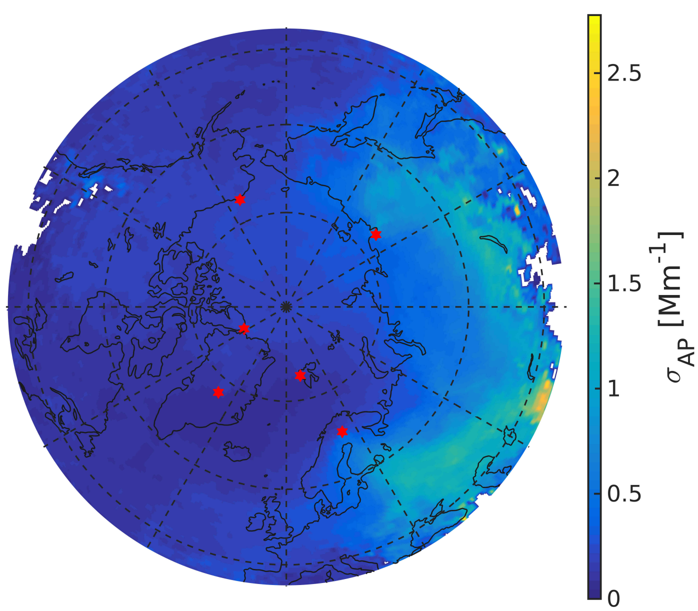

Figure 1. Footprint of light absorption coefficients using data from the six Arctic stations at a wavelength of 700 nm. The figure comprises back-trajectories where the trajectory altitude was less than 500 metres above ground level. Red stars mark the locations of the six Arctic stations.