Aerosol in Russian Arctic: BB/FF sources and transport impacts

O. Popovicheva[1], K.Eleftheriadis[2], A. Makshtas[3], S. Vratolis[2] ,V. Movchan[3], P. Bogorodsky[3] and T. Uttal[4]

[1]Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, 119991, Russia
[2]N.C.S.R. "Demokritos", Athens, 15310, Greece
[3]Arctic Antarctic Research Institute, St.Peterburg, 199397, Russia
[4]National Oceanic and Atmospheric Administration ETL, Boulder, Colorado
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Presenting author email: polga@mics.msu.su

During last years the Arctic climate change has brought this area to the spotlight of high level research. Black carbon (BC) is of critical importance among other climate-active species. It has a significant impact to warming by altering the albedo of snow/ice surfaces. Due to long-range transport from source regions outside the Arctic the high level of Arctic pollution is observed, relating to Arctic haze (Stock et al.,2012). Siberian wildfires supply a major source of light-absorbing aerosol on regional and global scale. Through observations of aerosol optical properties and Arctic Haze evidence of BC transport has been recorded at several Arctic monitoring sites including Barrow, Alert, and Zeppelin (Stone et al., 2014), while there are very few measurements in the Russian Arctic.

The International Observatory at the Hydrometeorological station Tiksi was founded in 2010 (71_360N; 128_530E) on the coast of Laptev Sea, and joined the International Arctic Systems for Observing the Atmosphere network (IASOA). BC has been monitored using a 7-λ Magee AE-31 aethalometer (ETL, NOOA). For the purpose of this work, data were treated to produce daily and monthly averaged BC concentrations. The advanced algorithm for the absorption coefficient estimations from both aethalometer and nephelometer data was applied in order to calculate BB and FF fractions of BC which correspond to average values derived from fossil fuel combustion and forest fire emissions. A wide BC winter maximum from November to April is relating to Arctic haze and pronounced by FF sources while the summer maximum in July is impacted by both FF and BB. With purpose to confirm the season sources the air mass back trajectories and fire map analyses were performed. The local Arctic (mostly diesel and oil flaring) sources in winter and long transport from Siberian boreal forest fires in summer were identified.

Aerosol sampling system was firstly installed on the Tiksi Observatory in September of 2014 being complementary to on-line aerosol monitoring instrumentation. Sampling and measurement campaigns were performed in autumn (September) and winter (November, March) of 2014-2015. Comprehensive characterization of aerosol chemistry and microstructure are performed by a number of analytic techniques using for FF and BB particulate emission quantification (Popovicheva et al., 2014; 2015). Carbon (OC, EC) and ion content, composition of organic/ionorganic compounds are obtained by thermal–optical transmittance (TOT), capillary electrophoresis, and FTIR spectroscopy, respectively. Cluster analysis is used to apportion the individual particles measured by EM/EDX into major characteristic groups and identify the particle types representative of combustion and natural sources.

In winter period of elevated BC concentration the carbonaceous aerosols coagulated with Na sulfates, containing up to 15% of sulfur, are dominated over regional soil dust composed from Fe oxides and aluminosilicates, Fig.1. Carbonates, nitrates, ammonium, and sulfates specify the inorganic compounds while alkanes and carbonyls determine the organic content. The ratio OC to EC and spectral absorption indicates the FF combustion source impact on aerosol composition. Analyses of boundary layer stratification confirm the impact of local urban sources.

In opposite, in autumn at very low BC concentration the aerosols are composed from marine salts and regional soil dust, Fig.1. Snow coverage of tundra strongly decreases the abundance of O- and N-containing compounds of biogenic origin. During an episode of elevated BC concentration the significant abundance of soot and sulfates, up to 46 and 17.8%, are observed, allowing the identification of pollution from local FF source.

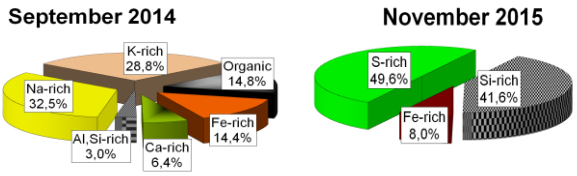

Figure 1. Aerosol grouping on Tiksi station shows the significant impact of Arctic haze on aerosol composition.

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Stock,M., Ritter,C., Herber,A., Von Hoyningen-Huene, W., Baibakov, K., et al. (2012). *Atmos.Environ.* **52**, 48-55

Stone, R. S., Sharma, S. , Herber, A. , Eleftheriadis, K. and Nelson,D.W. (2014) *Elementa: Science of the Anthropocene* **2**, doi:10.12952/journal.elementa.000027

Popovicheva O.B., Kireeva E.D., Steiner S., Rothen-Rutishauser B., et al. (2014), *AAQR*, 14,1392–1401

Popovicheva, O.B., Kozlov V.S., Engling, G., Diapouli, E. et al. (2015), *AAQR*, **15**, 117–128