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Anthropogenic particles in the atmospheric aerosol in the Hornsund area (southern Spitsbergen)

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The human impact on the Arctic environment is changing, due to both shifts in local activities and effects of climate change. A detailed characteristic of particulate matter in the atmosphere is a useful tool to determine the extent and source of anthropogenic atmospheric pollution. To study the aerosol particle composition in a remote part of the Arctic, we collected samples of atmospheric aerosols near the Polish Polar Station Hornsund (southern Spitsbergen) in April – May 2019, using polycarbonate membrane filters and a low volume sampler. We analysed single particle size, morphology and chemical composition in 13 samples with a field emission scanning electron microscope fitted with energy dispersive spectrometer. We distinguished natural from anthropogenic particles based on their morphology and/or chemical composition.

The analysed particles were predominately natural, of rock or soil origin (e.g. quartz, feldspars, Fe-Mg aluminosilicates, etc.) or from sea salt (particles of halite, or halite seeded on aluminosilicates). Ca-, Na- or Ca-Na-sulphates could be considered as formed in part by anthropogenic components, similarly to mixed sulphate and chloride particles.

Soot particles were relatively common and variable in morphology (lacey or compact particles). Their different morphologies may have resulted from residence time in the atmosphere and meteorological conditions. Soot may originate both locally and remotely, either from fuel combustion (biomass, coal, diesel, gasoline) or natural wildfires in continental regions. Tar balls were also relatively common and could be linked to both fuel combustion but also to wildfires. Spherical aluminosilicate particles were found, likely coming from coal fired power plants (although possibly also from household fuel combustion).

An important type of particles interpreted as anthropogenic is characterized by high content of metals, indicating their most likely origin in related to ore processing or metallurgical industry. Particles from this group were diverse: spherical Fe oxides, particles containing various proportions of Cr, Zn, Pb, Cu (often with Cl, S and O), Sn and Pb, Au, Zr, Ni (with S and O), Ni-Pt-Nb, Al-Ni (with O). The composition of anthropogenic particles highlights the importance of long range transport yet the contribution of local sources is for some types also possible.