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Vertical distribution of aerosol particles over the Russian Arctic derived from in-situ aircraft measurements: the September 2020 campaign

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The Arctic is warming much faster than other regions of the globe. In 2020, temperature anomalies in the Russian Arctic reached unprecedented high levels. The atmospheric composition in this key region still remains insufficiently studied that makes difficult predicting future climate change.

In September 2020, an extensive aircraft campaign was conducted to document the tropospheric composition over the Russian Arctic. The Optik Tu-134 research aircraft was equipped with instruments to carry out in-situ measurements of trace gases and aerosols, as well as with a lidar for profiling of aerosol backscatter. The aircraft flew over a vast area from Arkhangelsk to Anadyr. Six measurement flights with changing altitudes from 0.2 to 9.0 m were conducted over the waters of the Barents, Kara, Laptev, East Siberian, Chukchi, and Bering Seas. The weather was unusually warm for this period of the year, surface air temperatures were above 0°C through the campaign.

Here, we present the results of in-situ measurements of the vertical distribution of aerosol number concentrations in a wide range of sizes. A modified diffusional particle sizer (DPS) consisted of the Novosibirsk-type eight-stage screen diffusion battery connected to the TSI condensation particle counter Model 3756 was used to determine the number size distribution of particles between 0.003 mm and 0.2 mm (20 size bins). Distribution of particles in the size range from 0.25 μm to 32 μm (31 size bins) was measured by means of the Grimm aerosol spectrometer Model 1.109.

The flights over Barents and Kara Seas were predominantly performed under clear sky or partly cloudy weather conditions. Number size distributions were wide representing particles of almost all aerosol fractions. When flying in the upper troposphere with a constant altitude over these seas, some cases of enhanced concentrations of nucleation and Aitken mode particles comparable to ones in the lower troposphere were recorded, suggesting in situ new particle formation was likely to be taking place via gas-to-particle conversion aloft.

East of the Kara Sea, flights were conducted under mostly cloudy conditions resulting in a lower median aerosol number concentration and narrower size distributions.

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