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Linking boundary layer aerosol particles and dynamics between different measurement sites with unmanned aerial systems in Ny-Ålesund

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Aerosol particles play a crucial role in the Arctic, as they may accelerate Arctic warming.
For example, the growth of aerosol particles can lead to the increased formation of cloud condensation nuclei, which ultimately leads to increased cloud cover. Further, anthropogenic emissions (like soot particles) affect the climate change caused by the absorption of solar radiation in this sensitive environment. The investigation of new particle formation (NPF) is therefore particularly important in order to understand from which sources small particles originate in the particularly clean polar region originate from. Dall'Osto et al. (2017) proposed sea ice melt for one possible cause of NPF, as the highest frequency was observed in the summer period at the Zeppelin observatory in Ny-Ålesund (Svalbard, Norway, 78°56′ N, 11°53′ E).
However, the mechanisms of NPF and mixing processes are still not well known in the polar atmospheric boundary layer (ABL) due to a lack of measurement methods. In order to link the observations of aerosol particles and meteorological parameters between different research sites in Ny-Ålesund, a four-week measurement campaign was conducted with two different types of unmanned aerial systems (UAS) between April and May in 2018. The UAS ALADINA (Bärfuss et al., 2018) is equipped with miniaturized aerosol instrumentation (condensation particle counter, optical particle counter, aethalometer) and meteorological sensors. Additional turbulence sensors are mounted on the UAS MASC 3 in order to study the possible impact of turbulent properties and the properties of the local wind field on the NPF like shown in Platis et al. (2016). Research flights were performed between the surface and a maximum altitude of 850 m AGL, thus linking the observations at Gruvebadet, an eddy-covariance station near the coast and the Zeppelin observatory (474 m AMSL). Further measurement flights were operated horizontally in constant heights above snow cover and above open water in order to capture the possible impact of biogenic activity on the NPF. NPF was observed frequently – 55% of the measurement days during the late spring campaign. Taken from 200 vertical profiles with ALADINA, NPF occurred in the whole ABL above Ny-Ålesund. The wind field surrounding Ny-Ålesund was captured with MASC 3 for these flights, so possible transport processes of aerosol particles can be analyzed.