EGU General Assembly 2022

EGU22-1968
https://doi.org/10.5194/egusphere-egu22-1968
EGU General Assembly 2022

Characterization of size-segregated turbulent fluxes and deposition velocity by eddy correlation method in an Arctic site

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Aerosols represent a fundamental component of the atmosphere, and their behaviour in the Arctic surface layer determines deposition on snow or ice surfaces. Deposition processes lead to a decrease in the snow albedo enhancing its melting, which has major impacts on climate change in polar regions, particularly in the Arctic. Many aerosols properties have been investigated in the Arctic region, with regards to chemical composition (Quinn et al, 2009; Köllner et al, 2021), total number and mass concentrations (Croft et al, 2016), optical properties (Ferrero et al, 2019), their ability to act as cloud condensation nuclei (Bulatovic et al., 2021), their number and size distribution (Lupi et al., 2016). Relatively few cases exist of aerosol deposition measurements on snow or iced surfaces, especially by eddycorrelation (EC) method. The first example was reported by Duann et al. (1988), who analysed deposition of particles in two size ranges (0.15–0.30 and 0.5–1.0 mm) using the EC in a snow covered field in central Pennsylvania. Successively, the deposition velocity of particles larger than 10 nm in diameter over an iced surface in the Arctic (Nilsson and Rannik, 2001) and Antarctic (Contini et al, 2010) was measured using the EC method. The aim of the present work is to analyse the deposition velocity of atmospheric particles on snow surfaces at Ny-Ålesund (Svalbard Islands) in relation to local micrometeorological conditions. This work reports an analysis of the concentration, size distribution, and size segregated deposition velocity of atmospheric particles. Measurements were performed using the eddycorrelation method at the research laboratory of Gruvebadet from March to August 2021. The measurement system was based on a condensation particle counter (CPC) able to measure particles down to 5 nm in diameter with a 50% efficiency and an Optical Particle Counter (OPC) for evaluating particle size fluxes in the accumulation mode (0.25 < dp < 0.58 µm) and coarse mode (0.65 < dp < 3 µm). The average number concentration was 595 cm^{-3}, 25 cm^{-3} and 0.7 cm^{-3} for ultrafine, accumulation and coarse particles mode. Higher concentrations were observed at low wind velocities. Results gave an average deposition velocity of 3.66 mm/s for ultrafine particles. Deposition velocity was 18.89 mm/s and 52.83 mm/s for accumulation and coarse particles, respectively. Deposition increased with friction velocity. We present an overview of the results discussed in terms of average concentration, deposition velocity, and the relationship between deposition, friction velocity, and atmospheric stability.

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