Wet Deposition of Black Carbon at Ny-Ålesund, Svalbard

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Black carbon (BC) aerosol deposited in and onto Arctic snow increases the snow’s absorption of solar radiation and accelerates snowmelt. Concentrations of BC in the Arctic atmosphere and snow are controlled by wet deposition; however, details of this process are poorly understood owing to the scarcity of time-resolved measurements of BC in hydrometeors. We measured mass concentrations of BC in hydrometeors (C_{MBC}) and in air (M_{BC}) with 16% and 15% accuracies, respectively, at Ny-Ålesund, Svalbard during 2012–2019. Median monthly M_{BC} and C_{MBC} values showed similar seasonal variations, being high in winter-spring and low in summer. Median monthly BC wet deposition mass flux (F_{MBC}) was highest in winter and lowest in summer, associated with seasonal patterns of C_{MBC} and precipitation. Seasonally averaged BC size distributions in hydrometeors were similar except summer. Measurements of BC in air and hydrometeors in spring 2017 showed a size-independent removal efficiency, showing efficient activation of BC-containing particles into cloud droplets. These parameters observed at Ny-Ålesund were compared with those observed at Barrow, Alaska, during 2013–2017. The near surface M_{BC} at Ny-Ålesund and Barrow had similar seasonal patterns; however, they differed for C_{MBC} and F_{MBC}. In summer, C_{MBC} was low at Ny-Ålesund but moderate at Barrow, likely reflecting differences in M_{BC} in the lower troposphere. Seasonally averaged BC size distributions in hydrometeors were similar at both sites, suggesting similar BC size distributions in the Arctic lower troposphere, on average. Coating of BC particles at lower latitudes likely influence the BC size distributions in the Arctic.

Keywords: black carbon, wet deposition, Arctic, Seasonal variation, Laser-induced incandescence technique

