Seasonal Variation of 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 (snow and rain). We measured mass concentrations of BC in hydrometeors (C_{MBC}) and in air (M_{BC}) with high accuracy (16% and 10%, respectively) at Ny-Ålesund, Svalbard, from 2012 to 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. BC size distributions in hydrometeors changed little throughout the year, on average. Our intensive measurements in spring 2017 demonstrated the similarity of the size distributions of BC in air and hydrometeors, indicating that BC-containing particles were efficiently activated as cloud condensation nuclei. These parameters observed at Ny-Ålesund were compared with those observed at Barrow, Alaska, during 2013–2017. The M_{BC} in the planetary boundary layer 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. BC size distributions in hydrometeors were similar at both sites, suggesting that BC has similar size distributions in ambient air for the whole Arctic. Our relaible datasets of M_{BC} and F_{MBC} will be useful for constraining and testing climate models.