Seasonal Variation of Wet Deposition of Black Carbon in Arctic Alaska

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Black carbon (BC) aerosol deposited in and onto Arctic snow increases the snow's absorption of sunlight and accelerates snowmelt. Wet removal of BC from the atmosphere plays a key role in determining its abundance in the Arctic atmosphere and in Arctic snow. However, this process is poorly understood, mainly due to the scarcity of relevant measurements. To reveal characteristic features of the wet deposition of BC, we made highly accurate measurements of mass concentrations of BC in snow and rain (C_{MBC}) and mass concentrations of BC in surface air (M_{BC}) at the Barrow Atmospheric Baseline Observatory, Alaska, from July 2013 to August 2017 and analyzed them along with routinely measured meteorological parameters from Barrow. Monthly mean M_{BC} and C_{MBC} were poorly correlated from midwinter to early spring, when C_{MBC} was close to the annual median while M_{BC} was at its annual peak. Seasonal variations in the altitude distribution of ambient BC concentration may lead to these differences in seasonal variation of M_{BC} and C_{MBC}, as may microphysical processes in mixed phase clouds. About 50% of the annual wet deposition of BC occurred in the three months of summer, associated with high values of total precipitation and BC originating from biomass burning. Size distributions of BC in snow and rain were stable throughout the year, suggesting that the size distribution of BC in the lower troposphere is similarly stable. These observations improve our understanding of the loss processes and hence the BC budget in the Arctic.

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