Source attribution and budget analysis of BC aerosol in Antarctica

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The observations in Antarctic area show that BC concentrations increase from winter to spring. The observed BC increase can be attributed to transport from other regions because in-situ BC emission in Antarctica is quite small. This study investigates BC transport to Antarctica from various source regions and sectors (types) during years 2005-2015 by using a global chemistry-aerosol transport model CHASER.

First, the modeled BC concentrations are validated with the BC observational data which were obtained from the Japanese research vessel “Shirase” and the Syowa Station. Then seasonality of BC concentration at Syowa station is evaluated for each emission type. It is found that BC from biomass burning peaks in spring while anthropogenic BC is high in winter. The modeledvertical distributions of BC at Syowa show that BC concentration is high and mostly constant from the surface to the middle troposphere and contributions from the neighboring regions are especially high. On the other hand, contributions from the equatorial regions and the northern hemisphere increase in the upper troposphere to the lower stratosphere showing long transport of BC at higher altitudes.

In this study, net BC inflow to south of 60S is also evaluated. BC from biomass burning areas shows the largest contribution showing an increase from winter to spring. Anthropogenic BC has low seasonality unlike BC concentration at Syowa station indicating relatively constant BC inflow throughout a year. The model also shows that BC inflow basically occurs near 180˚ while outflow is concentrated near 30˚ W. In surface layers, strong BC outflow from Antarctica is seen especially in winter and spring, suggesting that katabatic wind causes BC transport near the ground.

In addition, this study evaluates the three major BC removal process, which are wet deposition, dry deposition and outflow from 60˚S latitude. Annual mean residence time of BC in the Antarctic area is estimated at about 4-7 days with longer residence time for BC from remote regions. Monthly averaged residence time is longer in summer and fall for BC from remote regions but relatively constant throughout a year for BC from neighboring regions. It is also found that outflow is the largest contribution to removal of BC for all regions. Wet deposition is large for BC from neighboring regions, suggesting that un-aged BC from remote regions, less subjected to wet deposition, stay in the upper troposphere with longer residence time. Seasonality of residence time for BC from remote region may be caused by polar vortex, which develops on stratosphere of Antarctic area because it becomes strong in winter and weak in summer.

Keywords: BC, Syowa Station, Antarctica, removal process

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