Source attribution of BC in the northern Pacific and Arctic Ocean by chemistry climate model

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Black Carbon (BC) is emitted from combustion of biomass and fossil fuel into the atmosphere. BC in the atmosphere absorbs visible light and heats the atmosphere contributing to global warming. The emitted BC being originally hydrophobic with low CCN activity, is not easily scavenged by precipitation allowing long-range transport of BC to remote areas. Snow or ice surfaces, when affected by deposition of BC, decrease their albedo causing further warming in the high latitudes.
This study focuses on long-range transport of BC in the northern high latitude regions and investigates BC origins (source regions and types) with a tagged tracer simulation by a global chemistry climate model CHASER. The modeled BC concentrations are validated with the BC observational data obtained from the JAMSTEC research vessel Mirai (from August to September). The model is found to be overestimating the observed BC by a factor of 1.2 to 7 in the south of 70°N in the northern Pacific. Differences between the model and observation are relatively small near Japan, but a bit larger between 160°E to 180°E in the Pacific Ocean. For the Arctic Ocean, on the other hand, the model severely overestimates BC by a factor of 13 to 70. In the model, BC in the North Pacific and Arctic Ocean is originated mainly from Siberia, North America and China.
The overestimated BC in the model probably shows an underestimate of wet deposition by precipitation. However, it is found that CHASER tends to overestimate precipitation amount when compared to the reanalysis data as the ERA-interim. This suggests that there is an inconsistency in the BC wet deposition scheme such as underestimation of BC uptake to cloud droplets. We considered correlation between precipitation and BC wet deposition flux normalized by columnar BC mass for checking relation of precipitation and BC wet removal. The correlation coefficient is about 0.4 suggesting that BC removal by precipitation is weak in the model. In addition, the ratios of internal BC to total BC for the surface to lower troposphere are calculated for the years of 2014 to 2017. In the northern pacific and Arctic Ocean, the ratios are about 30 percent indicating that the hydrophobic type of BC is dominant in the region for which CHASER overestimates BC.
As a result, it is suggested that there is much room for improvement in the simulation of aging process of BC (hydrophobic to hydrophilic conversion) and the scheme for wet deposition of external BC. In the presentation, the results from the further improved model simulations will be introduced and discussed.

Keywords: BC, chemistry-climate model, wet deposition, Arctic Ocean, Pacific Ocean

