The long-term observation of black carbon and CO concentration in interior Alaska: Effect of forest fire emissions

*Takeshi Kinase[1], Masayuki Takigawa[1], Fumikazu Taketani[1], Chunmao Zhu[1], Yongwon Kim[2], Yugo Kanaya[1]

1. Japan Agency for Marine-earth Science and Technology, 2. University of Alaska Fairbanks (UAF)

The climate change in the Arctic region accelerated compared to the entire globe. Black carbon (BC) aerosol particles, which are one of the SLCFs (short-lived climate forcers) emitted from incomplete combustion processes, absorb solar radiation and have a large impact on the climate. In addition, deposited BC on snow and ice surface decreases surface albedo and contributes to snow melting and Arctic warming. However, a large spread among model estimations for BC in the Arctic remains because of the lack of observation as a constraint and differences among emission inventories.
Alaska in northern America has a large boreal forest. Forest fires in Alaska represent an important BC source for the Arctic and surrounding regions, especially for interior Alaska during the summer season. However, observation of BC in interior Alaska is not sufficient. In this presentation, we introduce our five-year-long observations of BC and CO in interior Alaska and our findings on the relationship between the BC ratio and the forest fire intensity.
BC and CO monitoring at Poker Flat Research Range (PFRR; 65.12 N, 147.43 W) started in April 2016. PFRR is located in the centre of Alaska and is surrounded by evergreen needle-leave forests. Forest fires occur occasionally in the summer season and strongly affect BC and CO concentrations in PFRR. Median BC mass concentration through the observation period was 15.2 ng/m^3 and did not show a clear seasonal variation. However, sporadically significant increases in BC were observed during summer. Comparing BC concentrations observed at PFRR with those at Denali (63.72 N, 149.0 W), Trapper creek (62.32 W, 153.15 W), and Barrow (71.32 N, 156.61 W), we found a weak correlation only for Denali (r^2=0.3), indicating different air mass transport patterns as strong separated by high mountains particularly large differences between the interior and coastal regions in Alaska were noticed. On the other hand, the CO mixing ratio showed clear seasonal variation patterns, i.e. high in spring and low in summer. The median value of the CO mixing ratio was 124.7 ppb and significant increases were observed in the same period as BC, indicating the influences from the common emission sources. The median BC/CO ratio was 1.6 ng/m^3 /ppb and did not show clear seasonal variations. Furthermore, we quantitatively estimated the source contributions of BC using FLEXPART-WRF based on GFEDv4.1 inventory. As a result, FLEXPART-WRF represented high BC concentration periods with a relatively good correlation (r^2=0.54) but underestimated approximately 17%. Source estimation by FLEXPART-WRF indicated a strong contribution of forest fires from surrounding areas during the high BC concentration periods. We compared BC/CO and Fire Radiative Power (FRP) observed in Alaska by MODIS. As a result, we found a positive relationship between these two values, indicating the increase of BC/CO with FRP (forest fire intensity). Our result suggests that the dependency of the BC and CO emission factors on the combustion intensity of forest fires should be taken into account to elaborate emission estimations from boreal forest fires.

Keywords: Black carbon, CO, Arctic, Alaska, Forest fire, Climate