Analysis of sources of carbon monoxide at Tsukuba with observed vertical profile

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Carbon monoxide (CO) is an atmospheric pollutant that is mainly produced by incomplete combustion of fossil fuels, biomass burning, and the oxidation of hydrocarbons. CO plays an important role in atmospheric chemistry by contributing to the generation of tropospheric ozone and influences on various atmospheric trace gases via its reaction with OH. As CO’ s lifetime varies from a few weeks to two months, CO show regional differences in atmospheric concentration, therefore, observation at several locations is desirable. Particularly in the Asian region, which has large impact on global CO concentrations in recent years, it is necessary to understand the behavior of CO more accurately, and observations of CO in Japan is crucial. At Tsukuba (36.05˚N, 140.12˚E), we have been observing atmospheric trace gases using a high-resolution ground-based Fourier transform infrared (FTIR) spectrometer. By utilizing high wavenumber resolution (0.0035cm-1), we can retrieve vertical distribution of CO abundances from the line shape of the observed absorption spectrum. In this study, in order to clarify the source and seasonal variation of CO over Tsukuba, we analyzed the CO source using the vertical distribution of CO and hydrogen cyanide (HCN). HCN is mainly produced by biomass burning and has lifetime of a few years. HCN was used as a tracer for biomass burning in this analysis.

For the period from April 2010 to May 2019 the vertical profiles of CO and HCN were derived from the FTIR spectra taken at Tsukuba. An inversion analysis program <SFIT4> developed based on optimal estimate method (Rodgers, 2000) was used for the analysis.
The vertical distribution of CO was decomposed into two layers, i.e. altitude ranges of 0-5 km and 5-18 km, and correlation analysis with the HCN partial column corresponding to the same date and altitude was performed. As a result of the analysis, a significant correlation was confirmed at 5-18 km altitude between the partial column of CO and HCN in autumn, and no correlation was found at 0-5km altitude From the CO / HCN ratio obtained from the correlation analysis, the ratio of biomass-burning-origin CO abundance to total CO abundance in the atmosphere was calculated for partial column at 5-18 km altitude in autumn. From September to November at altitude of 5-18 km, the proportion of biomass-burning-origin CO was estimated to be 52% on average. From this analysis, it is guessed that CO from biomass burning is dominant due to distant forest fires in upper troposphere and lower stratosphere in Tsukuba in autumn. On the other hands at lower troposphere, it is considered that CO from biomass burning is not dominant than that in upper layer because CO from combustion of fossil fuels from urban atmosphere is mixed, in addition to CO from biomass burning.

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