Estimation of emission source of CO from biomass burning observed with ground-based FTIR spectrometers at Tsukuba since 2010

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Carbon monoxide (CO) is mainly produced by fossil fuels burning, biomass burning, and oxidization of hydrocarbons. CO is a precursor of tropospheric ozone generation and is an extremely important substance in atmospheric chemistry because it affects the abundance of various atmospheric trace components by reacting with OH radicals. It has a lifespan of several weeks to two months in the atmosphere, and there is a large regional ununiformity in its abundance and source. In recent years, it has been found that the emission of CO from the Asian region has a great influence on the global concentration, and it is desired to improve the estimation of its source. In Tsukuba (36.1N, 140.1E), since December 1998, we have been observing atmospheric trace components using solar infrared spectra with Bruker's high-resolution Fourier transform infrared spectrometer (FTIR). In this study, in order for clarifying the source of CO measured above Tsukuba, the altitude distribution of CO and hydrogen cyanide (HCN) was derived from the infrared spectra obtained by this FTIR. In this analysis, the source of CO was estimated using CO-HCN correlation. HCN has a lifetime of several years in the atmosphere and is mainly produced by biomass combustion. In this analysis, HCN was used as a proxy for biomass combustion.

For the period from April 2010 to May 2019, the altitude distribution of CO and HCN was analyzed from the observed spectra of FTIR in Tsukuba using the inversion analysis program of SFIT4. For the obtained altitude distribution, the partial column amounts of CO and HCN in the two layers 0-5 km and 5-18 km were obtained, and the correlations between them were analyzed. As a result, a significant positive correlation was confirmed between CO and HCN column amount at 5-18 km in spring. From the CO/HCN ratio obtained from the correlation analysis, the ratio of biomass combustion-derived CO in the atmospheric CO partial column was calculated, and the average value from March to May was about 70%. In addition, the air mass observed by FTIR in this season was subjected to backward trajectory analysis using METEX. We extracted cases where those air mass trajectories passed within 100 km from the forest fire observed by the MODIS sensor onboard the satellites Terra/Aqua. At an altitude of 5-18 km in the spring, the extracted trajectories mainly originated from northeastern China to the Eurasian continent. The results suggest that the observed enhanced CO over Tsukuba may have originated from forest fires in the area of latitude 50-60 N.

Keywords: carbon monoxide, Fourier transform infrared spectrometer , hydrogen cyanide, biomass burning, trajectory analysis, FTIR

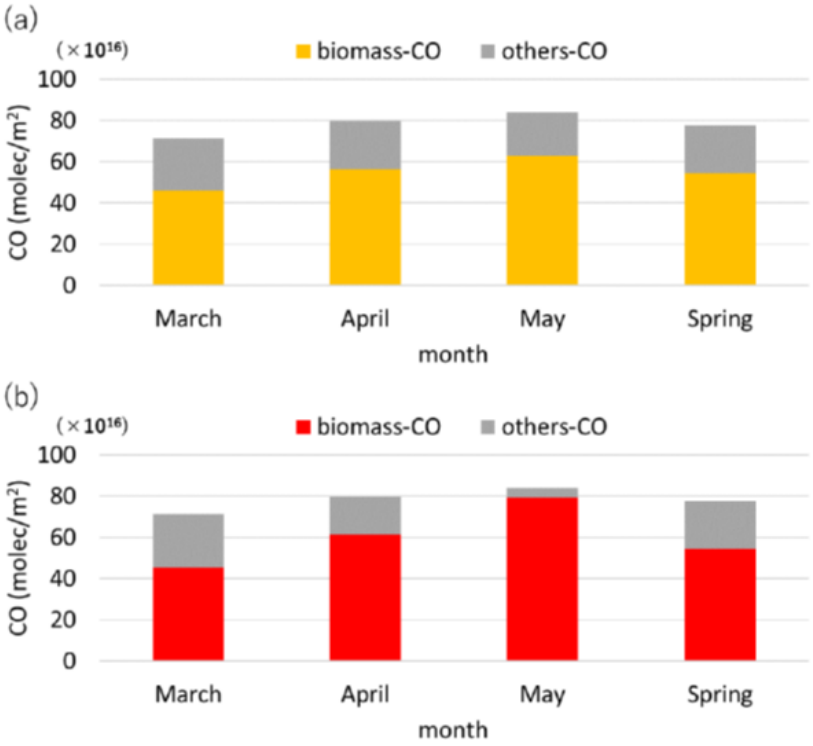

図１．高度5-18 km、バイオマス燃焼起源COのパーシャルカラム量。(a) すべての月のCO/HCN Biomass比に、春季の回帰直線の傾きの値を使用。(b) 各月のCO/HCN Biomass比に、各月の回帰直線の傾きの値を使用

Figure 1. Biomass burning-origin CO partial column for 5-18 km. (a) Calculated by annual averaged CO/HCN ratio and spring residual line's slope. (b) Calculated by monthly CO/HCN ratio and monthly residual line's slope.

