Analyses for CO$_2$ source in the urban area: measurement of stable isotope ratio of CO$_2$ and CO, NO$_x$

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CO$_2$ has the most effect on the global climate change because CO$_2$ has the largest positive radiative forcing (IPCC 2007). The accurate estimation of the CO$_2$ emission and loss flux are necessary to improve the prediction of the global climate change in the future, because the variations of CO$_2$ concentration substantially contributes to the variations of the global radiative forcing. CO$_2$ concentration varies due to the emission from the gasoline and natural gas combustion, biomass burning, and ecosystem respiration, the absorption due to the photosynthesis, the absorption into ocean and emission from the ocean surface. In the urban area, the variation of CO$_2$ concentration depends on the anthropogenic emission such as the fossil fuel combustion (gasoline and natural gas) and background CO$_2$ concentration mainly.

We conducted the continuous measurement of carbon and oxygen isotope ratios of CO$_2$ (delta$^{13}$C, delta$^{18}$O) using the infrared absorption laser spectrometer. The infrared absorption laser spectrometer can continuously measure delta$^{13}$C, delta$^{18}$O in high time resolution (10 seconds). The measurement period was from July 20 to August 10, 2012 at Nagoya University. Simultaneously, we measured the concentrations of nitrogen oxides, CO, water vapor and stable isotope ratios of water vapor (deltaD and delta$^{18}$O). The variations of CO$_2$ concentrations, delta$^{13}$C and delta$^{18}$O shows the contribution of the fossil fuel combustion and ecosystem respiration to the carbon cycle in the urban area.

Measured CO$_2$ concentrations and stable isotope ratios (delta$^{13}$C, delta$^{18}$O) show the diurnal variation in the measurement period. CO$_2$ concentrations decreased in the daytime and had a peak in the nighttime. On the other hand, delta$^{13}$C and delta$^{18}$O had a peak in the daytime and decreased in the nighttime. This indicates that the variations of CO$_2$ concentration were substantially affected by the ecosystem respiration and photosynthesis in the urban area. We conducted the keeling plot analyses for delta$^{13}$C and delta$^{18}$O in the nighttime to estimate the contributions of the fossil fuel combustion, biomass burning, and ecosystem respiration. In addition of the keeling plot analyses, we estimated CO$_2$ source from the relationship between the variations of CO and CO$_2$ concentrations. CO is emitted by the fossil fuel combustion and biomass burning mainly, while, CO$_2$ generated by the fossil fuel combustion, biomass burning and ecosystem respiration. Therefore, the relationship between CO and CO$_2$ concentration shows CO$_2$ source; the lager ratios of CO to increment of CO$_2$ from the background level (delta CO$_2$) shows the contribution of the fossil fuel combustion or biomass burning, on the other hand, the smaller ratios of CO to delta CO$_2$ shows the contribution of the ecosystem respiration. We will discuss the source of CO$_2$ from the analyses of the ratios of CO to delta CO$_2$ and keeling plot.

Keywords: Carbon dioxide, Stable isotope ratio, Laser spectrometry, CO$_2$ Source estimation, Carbon monoxide