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Analyses for CO_2 source in the urban area: measurement of stable isotope ratio of CO_2 and CO_2, 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