Estimation of the CO_2 source by measuring oxygen and carbon isotopes in atmosphere

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Atmospheric carbon dioxide (CO_2) concentrations observed in urban and continental areas and the surrounding areas often show short-term elevations on a timescale from several hours to several days. These variations are considered to be attributed to the CO_2 emissions from biotic activities and burning of fossil fuels (coal, oil and natural gas). If the contribution rate from each CO_2 source is clearly determined, the uncertainty of the CO_2 emissions estimated from atmospheric inversion calculations would be reduced. In this study, we develop a method to evaluate the contribution rate from individual sources based on measurements of carbon stable isotope (^{13}C), radiocarbon (^{14}C) and O_2 concentration as well as CO_2 concentration in the atmosphere. The $-O_2:CO_2$ exchange ratios of the fossil fuel burning are different for the fuel types because the ratios are stoichiometrically related to the elemental compositions of the individual fuels. The ^{14}C measurements is useful to separate the fossil fuel emissions from the biotic emissions because the fossil fuel-derived CO_2 contain no ^{14}C. In addition, values of ^{13}C depend on source of CO_2. Therefore, the combination of CO_2 measurements with O_2, ^{13}C and ^{14}C measurements allow us to estimate the contribution rates of the individual CO_2 source.
In this presentation, we show preliminary results of the atmospheric measurements which were conducted at Tsukuba in July-August 2015 to assess the usefulness of the above method. In the experiment, the atmospheric CO_2 and O_2 concentrations were continuously measured, and the air samples were collected in the glass flasks to measure the carbon isotopes. The relations between CO_2 concentrations and $\Delta^{14}C$ for the observed CO_2 change suggest that 60-70% of the CO_2 change are attributed to the fossil fuel-derived CO_2. Taking into account of the $-O_2:CO_2$ ratio for land biotic processes of 1.1, we can obtain the $-O_2:CO_2$ ratio for the fossil fuel component of the observed changes of 1.37-1.41, which is close to the exchange ratio for oil burring (R=1.44). The relation between CO_2 and ^{13}C is also consistent with the above result.

