3.128 Determination of the triple oxygen isotopic compositions of tropospheric carbon dioxide.

Early Career Scientist

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Abstract:

The triple oxygen isotopic compositions ($\Delta^{17}O$) of tropospheric carbon dioxide (CO$_2$) can be a useful tracer to quantify carbon cycle in terrestrial environments. Traditionally, CO$_2$ must be converted to O$_2$ to determine $\Delta^{17}O$ precisely. However, toxic and dangerous reagents such as BrF$_5$ must be needed for the reactions to convert CO$_2$ to O$_2$. Alternative safer, more simple, and more easy techniques should be needed for the routine measurements on the $\Delta^{17}O$ of tropospheric CO$_2$. In this study, we developed an alternative new method for the high precision measurements on the $\Delta^{17}O$ of CO$_2$ using Cavity Ring-Down Spectroscopy (CRDS) for H$_2$O. First of all, atmospheric sample with CO$_2$ was introduced into pre-evacuated line and separated from atmospheric nitrogen (N$_2$), oxygen (O$_2$) and water (H$_2$O) using the differences in the boiling points. Then, N$_2$O having the similar molecular weight and the similar boiling point with CO$_2$ was separated from CO$_2$ using a Porapak PS column under -70 °C. By reacting the purified CO$_2$ with H$_2$ at 600 °C under the existence of the nickel catalysts, CO$_2$ was converted to methane (CH$_4$) and water (H$_2$O). Subsequent to purify H$_2$O from CH$_4$, $\Delta^{17}O$ of H$_2$O was measured in CRDS. The new system developed in this study has several advantages over the conventional methods, such as (1) safe and easy operations, (2) less than 50 min for the single sample analysis, and (3) comparable precisions with previous methods. By using the new system, we can determine $\Delta^{17}O$ of tropospheric CO$_2$ with precision better than 0.015 ‰ (1σ). By using the new system developed in this study, we determined the difference in the $\Delta^{17}O$ values between tropospheric CO$_2$ in Nagoya and that in car exhaust, and found that tropospheric CO$_2$ in Nagoya was 0.22‰ higher in $\Delta^{17}O$ than that in car exhaust.