極域における温室効果気体の観測

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Observations of greenhouse gases in the polar regions

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As a part of scientific programs of the 7th term research project operated by National Institute of Polar Research, we have been measuring concentrations and isotopes of atmospheric CO_2, CH_4 and N_2O as well as their related species such as CO concentration and $\delta(O_2/N_2)$ in the arctic and antarctic regions. Since our research works cover relatively wide areas, several topics of the works to date will be presented.

To investigate global carbon cycles, measurements of atmospheric CO_2 and $\delta(O_2/N_2)$ have been made since 1982 and 2000, respectively at Syowa Station, Antarctica using grab sampling with subsequent laboratory analyses. In addition, continuous measurements of CO_2 concentration and $\delta(O_2/N_2)$ have started at Syowa Station in 1983 and 2008, respectively using in situ measurement systems. At Ny-Ålesund, Svalbard, atmospheric CO_2 and $\delta(O_2/N_2)$ have been measured since 1991 and 2001, respectively using the grab sampling method. Figure 1 shows results of these measurements. The $\delta(O_2/N_2)$ and CO_2 concentration obtained at Ny-Ålesund show clear seasonal cycles and secular trends. By using these data, the oceanic and the terrestrial biospheric sinks of anthropogenic CO_2 are estimated to be 2.6±0.7 and 1.2±0.8 GtC yr^{-1} for the period of 2001-2008.

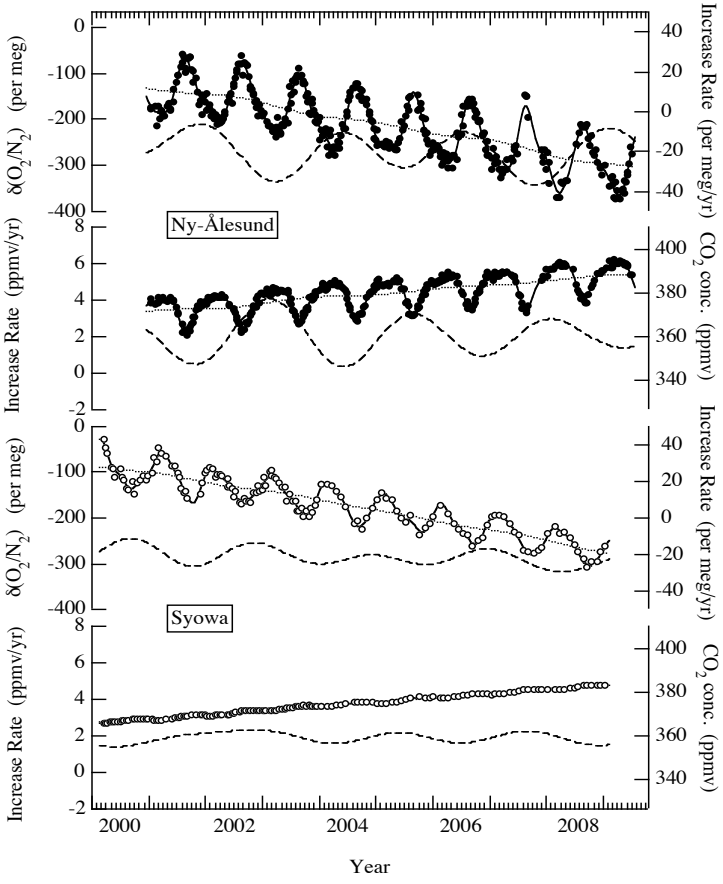

Figure 1. Variations of atmospheric $\delta(O_2/N_2)$ and CO_2 concentration observed at Ny-Ålesund, Svalbard and Syowa Station, Antarctica. Closed and open circles are observed data and thick lines are best fit curves of the observed data. Thin lines and dashed lines represent secular trends and annual increase or decrease of the trends.

Atmospheric CH_4 concentration and its carbon and hydrogen isotopic ratios have been measured at Syowa Station and Ny-Ålesund using the grab sampling method. By applying the observed data to a global CH_4 cycle model, respective emission ratios of CH_4 from biogenic, fossil and biomass burning sources are estimated to be 70, 16 and 13 %. In addition, we revealed variations of CH_4 concentration and these isotopic ratios for the last 250 years by using air samples extracted from firn and ice cores (Fig. 2). As a result of the measurements, CH_4 emission from biogenic, fossil and biomass burning sources have increased rapidly since the latter half of 19 century, since the beginning of 20 century and for the last several decades, respectively.

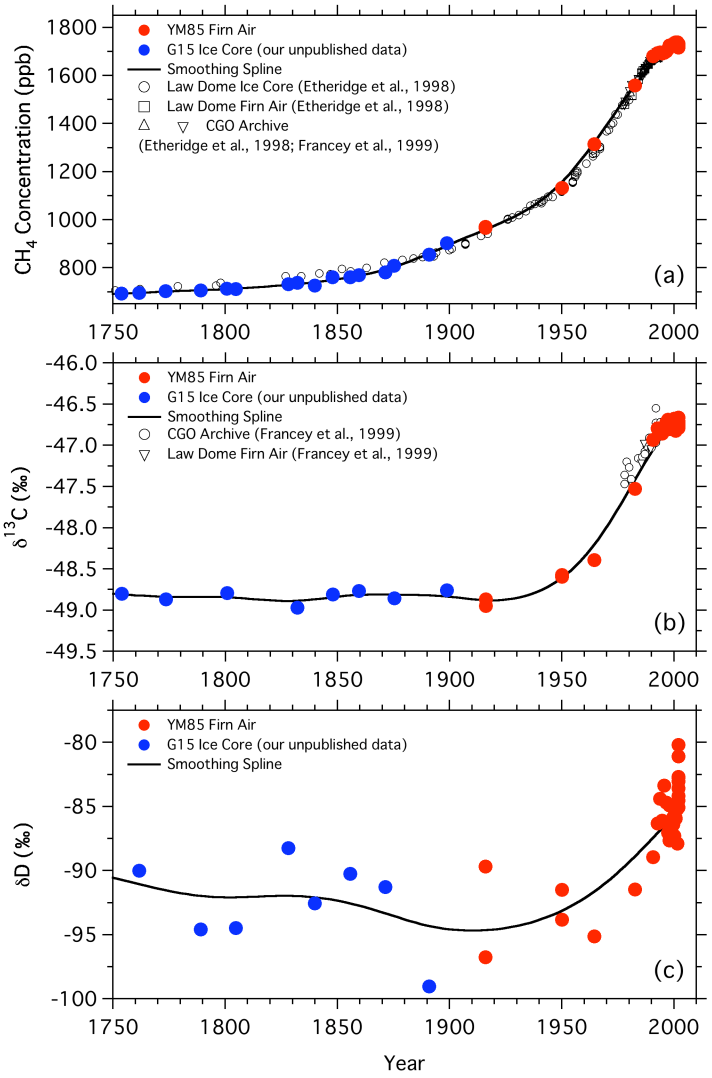

Figure 2. Past variations of (a) CH_4 concentration, (b) $\delta^{13}C$ and (c) δD reconstructed from the YM85 firn air (red solid circles) and air samples extracted from G15 ice cores (blue solid circles). Black lines are smoothing spline fit to the data. Also shown are previous measurements from archive air samples at Cape Grim Observatory, Australia, and Law Dome firn air and ice cores (open symbols). The CH_4 concentrations in previous reports are multiplied by a factor of 1.0119 to convert to the Tohoku University 1988 scale. A bias of +0.37‰ is also added to the previous $\delta^{13}C$ measurements.