High-resolution measurements of methane concentration in the Dome Fuji ice core using Continuous Flow Analysis (CFA) system

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At National Institute Polar Research, we have developed a continuous flow analysis (CFA) system for ice core analyses, and started the measurement of the second Dome Fuji ice core. With the CFA system, we continuously melt ice core and analyze it for various species, such as water isotopes, chemical composition, dust and black carbon. We can also extract air and analyze it for methane concentration.

An advantage of the CFA system for measuring methane from ice cores is that it can generate very high-resolution data. The detail fluctuation is expected to provide new insights into the past climate variations. It would also be possible to use the methane data for correctly matching the chronology of different ice cores. For example, Buizert et al., (2015) measured methane concentration in the WAIS Divide core from Antarctica using their CFA system and matched it with a temperature proxy ($d^{18}O$) in the NGRIP core from Greenland. The high-resolution matching enabled them to deduce a centennial lag of Antarctic temperature maxima and minima behind abrupt temperature changes in Greenland. For ice cores from low-accumulation sites, such as the Dome Fuji ice core, the age difference between ice and gas is large and uncertain. The CFA methane analyses may contribute to better estimate of the age difference by comparisons with the ice and gas records from high-accumulation ice cores.

For the CFA gas analyses, a membrane degassing unit is used for extracting gas from ice-core melt. However, the gas extraction is incomplete, and thus the data must be corrected for the fractionation. The sign and magnitude of this effect can be estimated by introducing standard gases with known methane concentrations into ultrapure water, and extract and measure the gas through the CFA system. For our system, the methane concentration of the extracted standard gases through the CFA system is lower than the true value by several %.

The second Dome Fuji ice core will be analyzed by CFA from surface to 2400 m (~300 ka), and the first measurement campaign from the early Holocene to the Last Glacial Maximum has started. So far, we have completed the measurement from 300 to 314 m (7.5 to 8.0 ka). The methane concentrations after the gas extraction correction agree with the values obtained with our established, discrete measurement system within 1 %. At the presentation, we report the details of the CFA gas extraction and analyses, and the methane record from the Dome Fuji ice core measurements.

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