グリーンランド NEEM 氷床コアと南極 Dome Fuji 氷床コアから復元された完新世のメタン濃度

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Preliminary results of atmospheric CH_4 concentration during the Holocene reconstructed from the NEEM (Greenland) and Dome Fuji (East Antarctica) ice cores

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Methane (CH_4), the second most important anthropogenic greenhouse gas, has increased in the atmosphere by a factor 2.5 since the onset of the Industrial Revolution, which account for ~20% of the total increase in radiative forcing over that time. Ice cores from both polar regions preserve the past atmospheric CH_4, and thus have the potential to constrain the changes in CH_4 concentration difference between the polar regions. The inter polar difference of CH_4 gives important constraint on the evolution of CH_4 source distribution and its relationship with climate[1, 2, 3, 4]. To reconstruct the CH_4 inter polar difference during the Holocene, we have been measuring CH_4 concentrations in the NEEM (Greenland) and Dome Fuji (Antarctica) ice cores over the period from 200 to 14500 years before present (yr BP). Because most of this time period corresponds to the brittle zones in Greenland ice cores, it is challenging to reconstruct accurate CH_4 concentration during the Holocene from the NEEM ice core.

Ice samples without visible cracks were carefully selected from the Holocene section of the NEEM and Dome Fuji ice cores. We employed a newly established wet extraction system at the National Institute of Polar Research, with a typical sample size of ~80 g (ice). The air released from ice was first collected into a sample tube (electro-polished stainless steel tube with a metal-seal valve), and then it was split into two aliquots. One aliquot was measured by a gas chromatograph (Agilent 7890A) for CO_2, CH_4 and N_2O concentrations, and the other was measured by a mass spectrometer (Thermo DELTA V) for $\delta^{15}N$ of N_2, $\delta^{18}O$ of O_2, $\delta(O_2/N_2)$, $\delta(Ar/N_2)$. Air content is estimated from the inlet pressure and volume of the gas chromatograph and the volume of the sample tubes. Analytical precision of CH_4 concentration was estimated to be ±2.4 ppb from the pooled standard deviation from duplicate measurements.

We found high amplitude (30–100 ppb) CH_4 spikes in the brittle zone of the NEEM ice core. Possible causes of these high spikes are biological in-situ CH_4 production and intrusion of the present air in invisible cracks. We rejected samples with too high CH_4 concentrations after repeated analyses of the samples from the same depth for two to four times. Variations of CH_4 concentration of the NEEM ice core agree well with the most recent study[4] (covering the past 2500 years, with similar analytical precision to ours) on multi-decadal to centennial time scales, which indicates that our new record is highly reliable. Our NEEM dataset has,higher time resolution by 3–4 times and higher precision by an order of magnitude than those of previous studies covering the entire Holocene [2, 3]. With the increased precision and resolution, we find CH_4 fluctuations with centennial time scale, superimposed on long-term (millennial-scale) trends. We will discuss CH_4 variations and interpolar difference during the Holocene by incorporating the result of ongoing measurements of the Dome Fuji ice core.

References

1) Nakazawa, T., Machida, T., Tanaka, M., Fujii, Y., Aoki, S., & Watanabe, O. (1993). Differences of the atmospheric CH_4 concentration between the Arctic and Antarctic regions in pre-industrial/pre-agricultural era. *Geophysical Research Letters*, *20*(1), 943–946.

2) Brook, E. J., Sowers, T., & ORCHARDO, J. (1996). Rapid variations in atmospheric methane concentration during the past 110,000 years. *Science* (Vol. 273, pp. 1087–1091).

3) Chappellaz, J. M., Blunier, T., Kints, S., Dällenbach, A., Barnola, J.-M., Schwander, J., et al. (1997). Changes in the atmospheric CH_4 gradient between Greenland and Antarctica during the Holocene. *Journal of Geophysical Research: Atmospheres*, *102*(D), 15987–15997.

4) Mitchell, L., Brook, E., Lee, J. E., Buizert, C., & Sowers, T. (2013). Constraints on the Late Holocene Anthropogenic Contribution to the Atmospheric Methane Budget. *Science*, *342*(6161), 964–966.