過去 250 年間の大気中メタンの同位体比変動の復元：フィルン空気・アイスコア測定とフィルン空気輸送モデルの適用

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Reconstruction of variations of isotopic ratios of atmospheric methane: measurements of firn air /ice core and applications of firn air transport model

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Methane (CH_4) is the second important greenhouse gas and plays an important role also in atmospheric chemistry. Atmospheric CH_4 abundance has increased over the industrial era due to enhanced anthropogenic CH_4 emissions. However, when and what types of CH_4 sources increased over the period remains as an open question. Air in porous layers above ice sheets (firn) and occluded in ice (ice core) can provide archived records of atmospheric CH_4 that cannot be traced in the worldwide systematic monitoring data of atmospheric CH_4 concentration initiated in the late 1970s. In addition, measurements of carbon and hydrogen isotopic ratios ($\delta^{13}C$ and δD) of CH_4 help to understand contributions of different types of CH_4 sources, since individual CH_4 sources are known to have characteristic $\delta^{13}C$ and δD signatures. We analyzed firn air samples collected in Antarctica (DF and YM85) and Greenland (NGRIP) as well as an Antarctic ice core (G15) for CH_4 concentration, $\delta^{13}C$ and δD. The datasets cover approximately 250 and 50 years back from the present in Antarctica and Greenland, respectively. Using a one-dimensional firn air transport model, we examine reconstructions of $\delta^{13}C$ and δD over the period of interest. Since simulated vertical profiles of isotopic ratios in the firn largely depend on atmospheric CH_4 concentration history and on diffusion effect given in the model, both of which however have substantial uncertainties, reconstructions of $\delta^{13}C$ and δD are not straightforward. In particular, reliable quantification of diffusion effect on $\delta^{13}C$ in the deep layers of firn (lock-in zone) is very challenging. In this presentation, we discuss plausible temporal changes of $\delta^{13}C$ and δD with range of uncertainties, interpolar differences and implications for the global CH_4 sources.