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Temporal changes in methane stable isotopes in polar ice cores: big picture and implications for ecosystem changes

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Methane (CH_4) is the third most important greenhouse gas after water vapour and carbon dioxide (CO_2). Since the industrial revolution the mixing ratio of CH_4 in the atmosphere rose to $\sim$1800 ppb, a value never reached within the last 800 000 years. Nowadays, CH_4 contributes $\sim$20% to the total radiative forcing from all of the long-lived greenhouse gases. This CH_4 increase can only be assessed in relation to natural methane changes in the past. Firn air and air enclosures in polar ice cores represent the only direct paleoatmospheric archive. The latter show that atmospheric CH_4 concentrations changed in concert with northern hemisphere temperature during both glacial/interglacial transitions as well as rapid climate changes (Dansgaard-Oeschger events), however, the sources of the methane concentration changes are still a matter of debate.

Stable isotopes of methane ($\delta^{13}CH_4$ and $\delta D(CH_4)$) may help to distinguish differences in the magnitude of source type emissions (e.g. Bock et al. 2010). However, recently we could show that it is difficult to interpret the atmospheric loading of methane by relative source mix changes alone (Möller et al. 2013). In fact it appears, that the carbon isotopic signature ($\delta^{13}CH_4$) of e.g. tropical wetlands undergoes drastic shifts connected to climate, CO_2, sea level or potentially other unknown processes.

Here we present the big picture derived from the EDML (European Project for Ice Coring in Antarctica, Dronning Maud Land) and Vostok ice cores (Möller et al. 2013) and additional new dual isotope data from 4 ice cores from both poles that cover three interglacials: the Holocene, MIS 5 and MIS 11. The contribution sheds light on our current understanding of methane biogeochemistry and discusses open questions.

References:

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