Geophysical Research Abstracts
Vol. 14, EGU2012-2937, 2012
EGU General Assembly 2012
© Author(s) 2012

Climate and CO_2 control on emissions and ecosystem composition of global methane sources over the last 160,000 years derived from $\delta^{13}CH_4$ in ice cores

L. Möller (1,2), T. Sowers (3), M. Bock (2,1), R. Spahni (2), M. Behrens (1), J. Schmitt (2,1), H. Miller (1), H. Fischer (2,1)

(1) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, (2) Climate and Environmental Physics, Physics Institute & Oeschger Centre for Climate Change Research, University of Bern, Switzerland, (3) PennState University, University Park, PA, USA

Reconstructions of changes in the atmospheric methane concentration in the past revealed a close connection to northern hemisphere temperature variability over the last glacial cycle and in parallel to Dansgaard-Oeschger (DO) events during Marine Isotope Stage (MIS) 3. Studying the stable carbon isotopic signature of methane ($\delta^{13}CH_4$) helps to constrain individual contributions of sources and sinks to the observed methane variations. Here we present the first ice core $\delta^{13}CH_4$ dataset covering the last 160,000 years based on a combined record from the EPICA Dronning Maud Land and the Vostok ice core.

Against previous paradigms, our data show that atmospheric CH_4 and $\delta^{13}CH_4$ most often evolve independently in time. One characteristic feature is that the strong CH_4 variations during DO events and rapid rises during the transitions leave almost no imprint in the $\delta^{13}CH_4$ record. The other pronounced feature are strong $\delta^{13}CH_4$ variations in time intervals of only minor CH_4 variation, e.g. the MIS 5/4 transition and the early deglaciation. In fact the long-term $\delta^{13}CH_4$ evolution exhibits more similarity with CO_2 than with CH_4 concentration changes. This implies that strong variations in $\delta^{13}CH_4$ (for instance during the MIS 5/4 transition, where CH_4 remained rather constant) are not dominated by a change in the source mix but rather by changes in the isotopic signature of the methane precursor material due to CO_2 and climate induced changes in C3/C4 plant composition and ecosystem structure. This conclusion has also consequences for the interpretation of the previously published 4‰ decrease in $\delta^{13}CH_4$ during termination 1 (Fischer et al., 2008). In contrast to our previous interpretation, these changes must have been at least in part caused by changes in the carbon isotopic signature of wetland CH_4 sources. Vice versa, major CH_4 fluctuations (for instance during DO events) reflect proportional emission changes in all sources amplified by variations in atmospheric lifetime. Such proportional emission changes imply that the source with the largest emission strength, the tropical wetlands, is also subject to the largest absolute change.

References

Fischer, H., Behrens, M., Bock, M., Richter, U., Schmitt, J., Loulergue, L., Chappellaz, J., Spahni, R., Blunier, T., Leuenberger, M., and Stocker, T. F. (2008), Changing boreal methane sources and constant biomass burning during the last termination, Nature, 452, 864-867.