Geophysical Research Abstracts
Vol. 12, EGU2010-6917, 2010
EGU General Assembly 2010

Ice core δD(CH_4) record precludes clathrate CH_4 emissions at the onset of Dansgaard-Oeschger events

Michael Bock (1,2), Jochen Schmitt (1,2), Lars Möller (2), Renato Spahni (1), Thomas Blunier (3), Hubertus Fischer (1,2)

(1) Climate and Environmental Physics and Oeschger Centre for Climate Change Research, University of Bern, Switzerland, (2) Alfred Wegener Institute for Polar and Marine research, Bremerhaven, Germany, (3) Center for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Denmark

Ice core records show that CH_4 concentrations changed in concert with northern hemisphere temperature during both glacial/interglacial transitions as well as rapid climate changes (Dansgaard-Oeschger events). The stadial/interstadial changes during Marine Isotope Stage 3 (MIS 3) in atmospheric CH_4 concentrations are characterised by strong concentration jumps of 100 to 200 ppbv within a few decades. A concentration gradient with higher values in the northern versus the southern hemisphere during warm stages was reconstructed from ice core methane data from Greenland and Antarctica. This gradient indicates additional sources during warm periods located in the northern hemisphere. However, the underlying processes for theses changes are still not well understood. With tropical and boreal wetlands, biomass burning, thermokarst lakes, ruminants, termites, living biomass and marine gas hydrates (clathrates) all contributing to the natural atmospheric CH_4 level, an unambiguous source attribution remains difficult. In addition, marine methane hydrate (clathrate) destabilization events have been proposed to trigger rapid increases in atmospheric methane concentration during the last glacial cycle. Due to the distinct D/H isotopic signature of clathrate emissions, δD(CH_4) extracted from ice cores is well suited to constrain the impact of such catastrophic releases on the global atmospheric methane budget.

We developed a new extraction and gas chromatopgraphy- pyrolysis-mass spectrometry technique and measured δD of CH_4 extracted from as little as 500 g ice samples of the North Greenland Ice Core Project with high precision of $\pm 3.4‰$. Here we present clear atmospheric δD(CH_4) evidence that clathrates did not provoke atmospheric methane concentration to rise at the onset of Dansgaard- Oeschger (DO) events 7 & 8 (i.e. 34 - 40 kilo years before present). A box model for the methane cycle reveals that boreal wetlands are the dominant additional source strengthening from about 5 to 40 Tg CH_4 yr^{-1} from stadial to interstadial conditions. Modelled clathrate emissions show no increase from stadials to interstadials ($\sim$30 - 25 Tg CH_4 yr^{-1}). Tropical wetland emissions stay rather constant over these climate cycles ($\sim$90 Tg CH_4 yr^{-1}), while biomass burning emissions show a slight increase in interstadials ($\sim$60 Tg CH_4 yr^{-1}) compared to stadials ($\sim$50 Tg CH_4 yr^{-1}). Moreover, our data show a δD(CH_4) drop at the onset of DO 8 that leads the major DO warming by 500 years with boreal wetlands being the most likely explanation. Our high resolution δD(CH_4) data reveal also two centennial scale excursions to heavier values during Interstadial 8, while northern hemisphere temperature and methane concentrations were well at interstadial levels. Their origin remains obscure; however, variations in biomass burning emissions, net to gross CH_4 emissions from wetlands or clathrate contributions may explain these excursions.