Where does the methane entrapped in Antarctic sea ice come from?

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Methane (CH4) atmospheric concentrations have increased by a factor of 2.5 since the beginning of the Industrial Era, mainly because of anthropogenic activities. However, between 1999 and 2006, CH4 growth rate declined to a near-zero level, suggesting that an equilibrium had been reached. But, from 2007 on, atmospheric concentrations underwent a renewed growth, implying major ongoing changes in the CH4 global budget (Nisbet et al., 2016). These changes challenge our understanding on the contribution of existing sources, and in particular natural sources.

Sea ice can strongly affect emissions of CH4 from the ocean, but the precise mechanisms are not well understood. Sea ice has long been considered as an inert and impermeable barrier, but recent studies have highlighted the existence of gas fluxes at the atmosphere-sea ice and sea ice-seawater interfaces (Kort et al., 2012; He et al., 2013; Zhou et al., 2014; Sapart et al., 2016). However, these fluxes are to date poorly understood and quantified. To improve future climate projections, we aim to investigate the control exerted by sea ice on the CH4 atmospheric budget.

To unravel the impacts of the Antarctic sea ice physical environment on biogeochemical cycles, the AWECS (Antarctic Winter Ecosystem Climate Study) expedition was conducted between the 8th of June and the 12th of August 2013 in the Weddell Sea. Such an expedition provides a rare opportunity to obtain insights on the behaviour of sea ice during winter. Ice cores specifically dedicated to the investigation of gas dynamics were collected at ten different stations.

In order to determine CH4 formation and removal pathways in sea ice, we used concentration and stable isotope analysis, which can help to distinguish different processes. Here, we present and discuss our first results of the isotopic composition of CH4 ($\delta^{13}C$ and δD) on sea ice cores from the Weddell Sea and the Ross Ice Shelf. This new dataset will help to determine the origin of the CH4 entrapped in Antarctic sea ice and its potential impact on the current and future atmospheric CH4 budget.

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