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Interpolar difference of atmospheric methane around the last glacial maximum

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Reconstructions of past atmospheric methane concentrations are available from ice cores from both, Greenland and Antarctica. Caused by the asymmetric latitudinal source distribution, a difference between the two polar methane concentration levels is observed, which can be used to constrain the geographical location of the responsible methane sources.

Here we present new high resolution methane records covering Termination 1, the Last Glacial Maximum, and parts of the last glacial back to 31,000 years before present, which considerably improve the synchronization between ice cores from the northern and the southern hemisphere. For the first time, all the new data points are analysed in the same laboratory, on the same standard gases and within the same year of measurement. Critically, each measurement day we analysed both samples from Greenland and Antarctica. Due to these simultaneously analysed samples the interpolar difference of methane is determined with unprecedented precision.

We find a positive interpolar difference throughout the record with its minimum value of 3.4±0.6% between 21,200 - 21,900 years before present close to the Last Glacial Maximum. The interpolar difference becomes more positive after 21,000 before present, which is several thousand years prior to the transition into the Holocene and stays at a fairly stable level of 6.6±0.8% during Termination 1. Assuming a constant atmospheric lifetime and interhemispheric mixing time, this would imply that the source distribution did not significantly change during Termination 1.

The good correlation of the methane concentration and the monsoon record suggests that latitudinal swings in the ITCZ could be of key importance regarding the interpolar difference. Our new value of the interpolar difference during the Last Glacial Maximum is consistent with a recent bottom-up modelling study, which suggests southward shifts of the tropical and boreal sources.