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Reconstructing the recent methane atmospheric budget using firn air methane stable isotope analyses

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Methane is a strong greenhouse gas and large uncertainties exist concerning the future evolution of its atmospheric abundance. Analyzing methane mixing and stable isotope ratios in air trapped in polar ice sheets helps in reconstructing the evolution of its sources and sinks in the past. This is important to improve predictions of atmospheric CH4 mixing ratios in the future under the influence of a changing climate. We present an attempt to reconcile methane stable isotopes δ13C(CH4) and δD(CH4) records from 11 (for δ13C(CH4)) and 5 (for δD(CH4)) boreholes in firn from both Greenland and Antarctica to reconstruct a consistent methane atmospheric history over the last 50 years. In the firn, the atmospheric signal is altered mainly by diffusion and gravitation. These processes are taken into account by firn air transport models. We show that for δ13C(CH4) the atmospheric signal is of the same order of magnitude as the firn fractionation which, together with other uncertainties such as inter-calibration problems, complicates the reconstruction of a consistent δ13C(CH4) history from multi-site firn air data.
For δD(CH4), the atmospheric signal is about 10 times larger than firn fractionation, therefore the reconstruction is much less sensitive to firn processes. This large signal allows a very consistent reconstruction from firn air from both Antarctica and Arctic firn air data. The δD(CH4) firn air scenarios from both poles are used as input in an atmospheric inverse model to calculate the contribution of the different sources and sinks responsible for the atmospheric changes in methane observed for the past decades. Our preliminary results show that the δD(CH4) signature of the global methane source became more enriched from 1950 to the mid-1980's and started to decrease later on and we show that it is likely caused by changes in enriched sources such as: fossil or combustion sources.