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Two decades of stable carbon isotope measurements in atmospheric methane - what do they tell us about global methane budget changes?

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Understanding the causes responsible for atmospheric methane growth rate changes in the last two decades is subject to ongoing scientific debate. Besides anthropogenic, also natural methane source as well as sink changes may have contributed to the observed variability. Stable isotope measurements in atmospheric and source methane, supplemented by fractionation studies of its major sink processes are potentially useful to provide additional measures on the different budget terms and their changes. However, the imprint of changing source/sink components on global atmospheric isotope trends is notoriously small; this is why only precise and highly consistent atmospheric measurements are suitable to successfully apply these isotope tools. "Historical" measurements of stable carbon isotopes in atmospheric CH_4 with the required precision are available only back to the late 1980s. These $^{13}CH_4$ measurements were made by only few laboratories world wide. One caveat of these data is, however, that their comparability is limited as dedicated standard reference material for these analyses was (and still is) not available, and each laboratory developed its own internal calibration scale based on internationally accepted IAEA CO_2 or carbonate standard reference material. Reliably combining observational records was thus only possible if ongoing comparison exercises were conducted between the respective laboratories.

In the present study we attempt to consolidate $^{13}CH_4$ observations back into the 1980s by conducting a detailed comparison of the existing long-term data sets from globally distributed background monitoring stations. We use the data from Antarctica and mid southern latitudes - where CH_4 concentration gradients are negligible - to determine $^{13}CH_4$ scale offsets between the contributing laboratories. These laboratory offsets are then applied to respective data sets from the northern hemisphere. With this method it is possible to merge the records from five different laboratories and estimate hemispheric and global $^{13}CH_4$ trends from 1988 up until 2010. An important finding is that our data do not reveal significant changes of inter-hemispheric $\delta^{13}CH_4$ differences and a global increase of less than 0.3 ‰ over the last 20 years. A simple box model of the global atmospheric methane cycle is applied to determine the contribution from natural source and sink changes of the methane budget, assuming that anthropogenic CH_4 emissions are well known.