Geophysical Research Abstracts
Vol. 13, EGU2011-14097-1, 2011
EGU General Assembly 2011

Long-term observations of stable isotopes in atmospheric methane - how robust are the reported trends?

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Since more than a century, the atmospheric methane burden has been rising at variable rates, mainly due to increasing emissions associated with human activities. But also climate-related changes of natural methane sources and destruction processes most probably contributed to the observed long term variability. Disentangling the causes responsible for the observed growth rate pattern is an ongoing debate. Here, stable isotope measurements in atmospheric and source methane, backed up by fractionation studies of its major sink processes are thought to provide a valuable tool for understanding the global methane budget and its inter-annual variations. However, the imprint of changing fluxes on the isotope trends in the atmosphere are notoriously weak; therefore, precise and highly consistent atmospheric observations are required if these tools shall be successfully applied.

Only a small number of laboratories made the effort of monitoring atmospheric methane isotopes in the last two decades, and this undertaking was particularly challenging as internationally accepted standard reference material for methane isotope analyses have not been available so far. Also, only few and mostly bi-lateral comparison experiments have been conducted between the few laboratories performing these specialized methane isotope analyses, and, in most cases, also not as an ongoing effort over the last two decades. This was the main reason why it has not yet been possible to reliably combine data from different observational networks, and, the interpretation of observed trends has not always been consistent.

At this stage, we make a first attempt to compare available data sets of stable methane isotope observations (δD-CH_4 and δ^{13}C-CH_4) from the last two decades. As different laboratories performed observations at the same sites, i.e. in Alert (Arctic, 82°N), at mid northern latitudes at Niwot Ridge (40°N) or Mace Head (53°N) or in the well-mixed Southern Hemisphere at Cape Grim (Tasmania, 41°S) and Baring Head (New Zealand, 41°S), but also at the Antarctic coast (Scott Base, 78°S, and Neumayer Station, 71°S), there is even some potential to merge these different data sets. The main purpose of this study is to compare the long-term trends observed by the different laboratories: Only common trends can be assumed as robust, and will briefly be discussed in terms of deciphering changes in the sources and sinks of atmospheric methane.