Radiocarbon measurements of atmospheric methane

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1. Project description

We employ radiocarbon (^{14}C) measurements of atmospheric methane (CH_4) in order to determine its fractions of fossil sources (such as natural gas and fossil-fuel combustion) and contemporary sources (e.g. agriculture and wetlands) (Lassey et al., 2007). This approach benefits from the fact that ^{14}C is extinct in fossil fuels due to their old age, whereas contemporary sources show a modern radiocarbon level (Szidat, 2020). These results shall refine the understanding and quantification of individual sources of CH_4. Methane contributes substantially to global warming already today as the second most important anthropogenic greenhouse gas and may even become more relevant in the future as climate change could dramatically increase CH_4 natural emissions (Dlugokencky et al., 2011).

In 2020, we continued with the collection of grab samples (duration one hour) of ambient air at the Sphinx observatory at Jungfraujoch every second week (Fig. 1). In total 17 air samples of ~100 L (at STP) each from February/March and May to December were transferred to Bern in PE-AL-PE bags (TESSERAUX, Germany). There, CH_4 and CO_2 were extracted from the air samples using a preconcentration and purification setup that involves a gas-chromatography (GC) separation of the carbon-containing gases (Espic et al., 2019). The ^{14}C content of both gases was measured at the Laboratory for the Analysis of Radiocarbon with AMS (LARA) at the University of Bern (Szidat et al., 2014).

$^{14}CH_4$ measurements of atmospheric air from the continental background site Jungfraujoch were compared with results of two other strategic sites in Switzerland, i.e. the Beromünster tall tower as a rural background site and the Department of Chemistry, Biochemistry and Pharmaceutical Sciences of the University of Bern as an urban site. The comparison of the results from Beromünster and Jungfraujoch is of special importance, as it provides the potential of quantifying contributions of fossil and contemporary sources as well as $^{14}CH_4$ emissions of nuclear power plants in the vicinity of the rural site. Such a comparison has been performed in a similar way for the quantification of emissions of carbon dioxide (CO_2) using radiocarbon measurements (i.e. of $^{14}CO_2$) since 2012 (Berhanu et al., 2017). The $^{14}CH_4$ measurements in 2020 confirmed the results of 2019 that Jungfraujoch is well suited as continental background station for $^{14}CH_4$. The variability of the individual measurements from Jungfraujoch was again much smaller than for the rural and the urban sites.

Figure 1. Collection of air samples at Jungfraujoch. Picture: N. Arnosti.

In 2021, our activities at Jungfraujoch shall be extended within the framework of the Sinergia project "Radiocarbon Inventories of Switzerland (RICH): An integrated approach to understand the changing carbon cycle" that is funded by the Swiss National Science Foundation (SNSF). We will set up an automated sampling system at Jungfraujoch that allows a continuous collection of ambient air samples for an integrated determination of $^{14}CH_4$. This data will serve as reference for regional source apportionment of methane using ^{14}C that shall be performed at different sites in Switzerland.

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Internet data bases

https://www.14c.unibe.ch/
http://p3.snf.ch/project-193770

Collaborating partners / networks

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Scientific publications and public outreach 2020

Conference Papers

Espic, C., M. Battaglia, R. Schanda, M. Leuenberger, S. Szidat, Radiocarbon measurements of atmospheric methane, Virtual Alpine Observatory (VAO), 5th VAO-Symposium, Bern, Switzerland, February 4-6, 2020.

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