Long-term observations of $^{14}CO_2$ at Jungfraujoch

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1. Project description

Atmospheric $^{14}CO_2$ observations at Jungfraujoch started in 1986 and were continued without interruption until today. Since 2018 Jungfraujoch is an official ICOS class-1 station and therefore the responsibility was moved from Heidelberg University to the University of Bern. Therefore, the activity report was written by Markus Leuenberger. The sampling will be continued following the ICOS station specification and will be measured by the ICOS Central Radiocarbon Laboratory (CRL) at the Institute of Environmental Physics of Heidelberg University. This long-term record was in the past and is currently used for several studies of the dynamics of the regional and global carbon cycle (e.g. Levin et al., 2010, Wang et al., 2018; Major et al., 2018, Sierra, 2018), as European background reference to estimate the regional fossil fuel CO_2 component at polluted European stations (e.g. Levin et al., 2011) and as $^{14}CO_2$ reference for the free troposphere over Europe (e.g. Gavazov et al., 2018, Palonen et al., 2018, Sensula et al., 2018, McDonald et al., 2019). The current decreasing $\Delta^{14}CO_2$ trend at Jungfraujoch amounts to about 4 to 5‰ per year (Fig. 1) with a small seasonal cycle, which is partly due to the seasonal input of ^{14}C-enriched stratospheric air into the troposphere and partly to the seasonal contributions from biogenic and anthropogenic CO_2 fluxes (Levin et al., 2010).

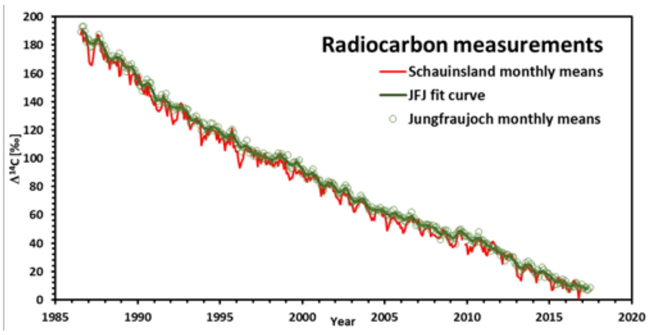

Figure 1. Atmospheric $^{14}CO_2$ observations at Jungfraujoch (green circles) in comparison to values of the Schauinsland station (red curve). The green line corresponds to a 5-months running mean of the Jungfraujoch values (data from Hammer and Levin, 2017).

Radiocarbon is decreasing due to the exchange with the other carbon-containing reservoirs such as the ocean and the land-biosphere, but since the 1990s almost exclusively due to the ongoing (global) input of ^{14}C-free fossil fuel CO_2 into the atmosphere i.e. the global Suess effect.

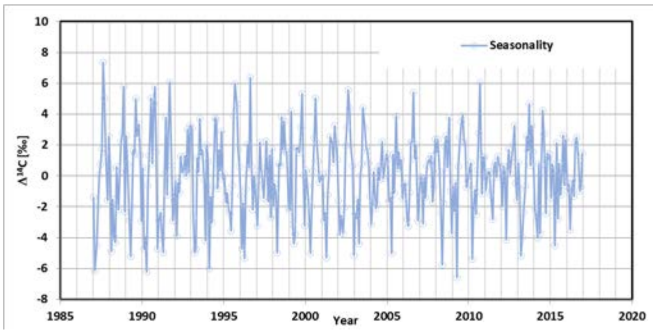

Figure 2. Seasonality of the Jungfraujoch record based on the monthly values from 1987 to 2016.

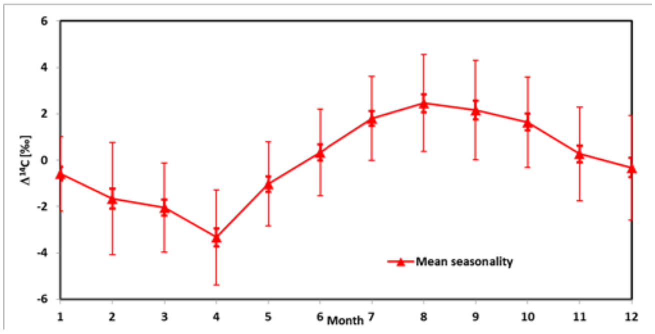

Figure 3. Mean seasonality of the Jungfraujoch record plus corresponding uncertainty (1σ, thin red) and (1σ of the mean, bold red) based on the monthly values from 1987 to 2016. January corresponds to month 1.

The seasonal behavior at Jungfraujoch shows inter-annual variability as documented in Fig. 2. The mean max-min amplitude amounts to 5‰ over the time period 1987 to 2017 (Fig. 3). The seasonality is small compared to corresponding amplitudes at other stations more exposed to direct fossil fuel emissions. The comparison of Jungfraujoch with Schauinsland data shows a clear depletion at Schauinsland, particularly during winter due to the higher fossil fuel influence with some inter-annual variability. This variability of the fossil fuel CO_2 influence at Schauinsland most probably stems from variations in vertical transport, i.e. the coupling of boundary layer air with the “free” troposphere at the mountain site. We also observe a negative trend of the difference between the two stations (Fig. 4). This negative trend indicates changes at one or the other or at both stations. Potential causes for changes are among others (i) a reduced fossil fuel emission influence at Schauinsland or (ii) an increase of this influence at Jungfraujoch. Regional model investigations are needed to understand this interesting trend.

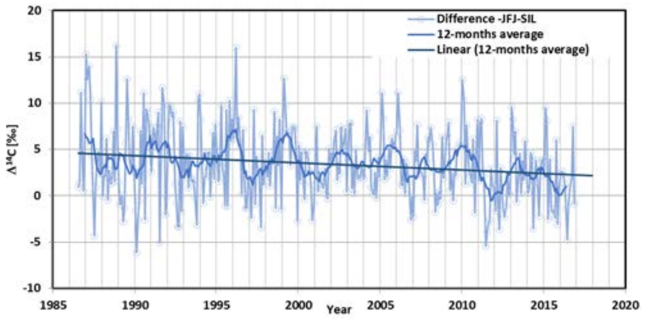

Figure 4. Differences between monthly $^{14}CO_2$ values from Jungfraujoch and Schauinsland (light blue circles). 12-months running mean (blue line) and linear trend of it (dark blue line).

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Internet data bases

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Collaborating partners / networks

International Foundation Hochalpine Forschungsstationen Jungfraujoch und Gornergrat (HFSJG)
ICOS-RI partner, ICOS-CH partners

Scientific publications and public outreach 2018

Refereed journal articles and their internet access

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