Name of research institute or organization:

Climate and Environmental Division, Physics Institute, University Bern

Title of project:

High precision carbon dioxide and oxygen measurements at Jungfraujoch

Part of this programme:

ICOS, GAW, Obspack, Globalview

Project leader and team:

Prof. Dr. Markus Leuenberger, project leader
Peter Nyfeler, Hanspeter Moret and Tesfaye Berhanu

Project description:

Combined online CO_2 and O_2 measurements at Jungfraujoch were continued. The trends were extended from the calculations done on the period 2005 to 2015 and correspond to 2.17 ± 0.09 ppm y^{-1} for the CO_2 increase rate and -24.3 ± 1.3 per meg y^{-1} for the $\delta O_2/N_2$ decrease rate, respectively (Figure 1). As can be seen from the graph, the trends did not significantly change over the last two years for both CO_2 and $\delta O_2/N_2$.

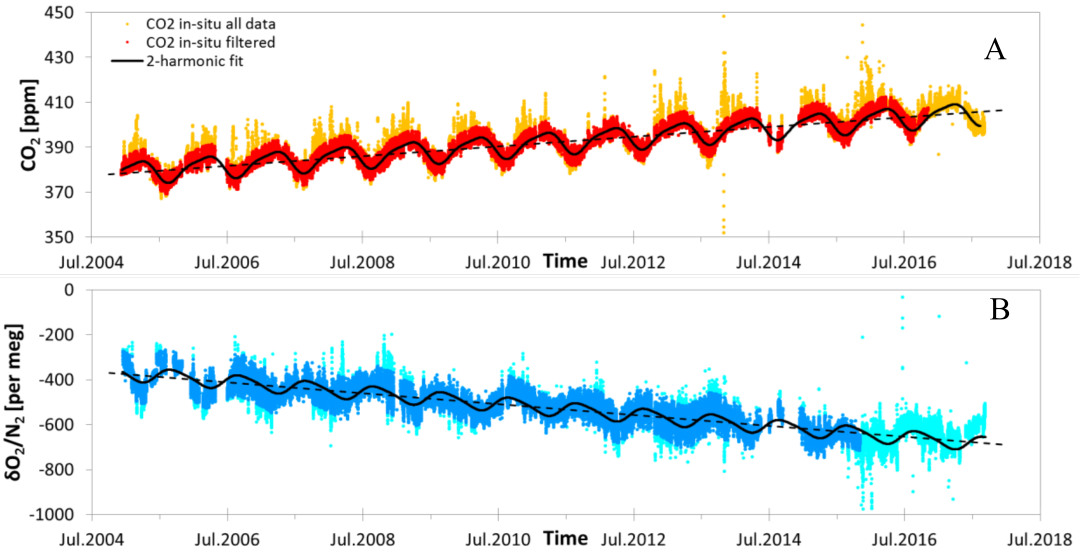

Figure 1. A: Unfiltered CO_2 in-situ measurements (orange), filtered CO_2 in-situ measurements (red), 2-harmonic fit with slope (black) as a function of time, and linear CO_2 increase (black dashed) as a function of time; B: Unfiltered $\delta O_2/N_2$ in-situ measurements (cyan), filtered O_2 in-situ measurements (blue), spline fit (black) as a function of time, and linear $\delta O_2/N_2$ decrease (black dashed) as a function of time.

Also the flask measurements were continued during 2017 but are not included in this report since we would like to focus on a comparison of CO_2 measurements at the Sphinx observatory with those at the new location East Ridge, located 130 meters above and about 1 km to the west of the Sphinx observatory. The measurements at the East Ridge commenced in December 2014. Figure 2 displays the CO_2 values for the years 2015 and 2016. The first impression of the comparison gives an excellent agreement as the seasonality as well as the short-term variability are very coherent, documenting that generally most of the variations are the same. Yet, as displayed in Figure 3, there are differences (Sphinx observatory minus East Ridge values) present between the two stations in the order of up to 10 ppm.

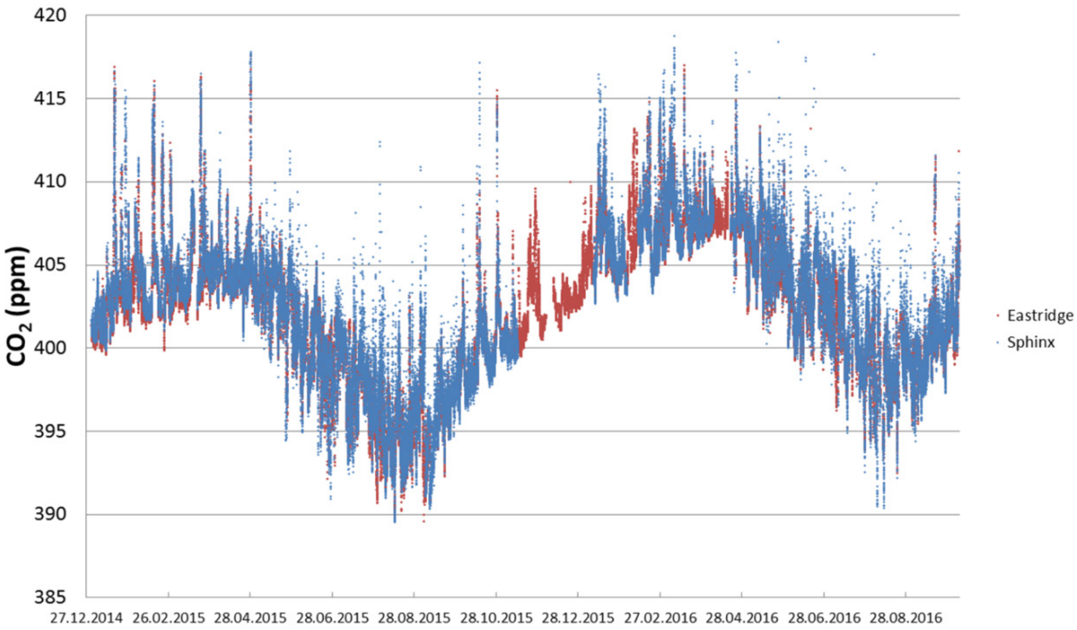

Figure 2. Comparison between CO_2 concentrations at the East Ridge (red) and the Sphinx Observatory (blue).

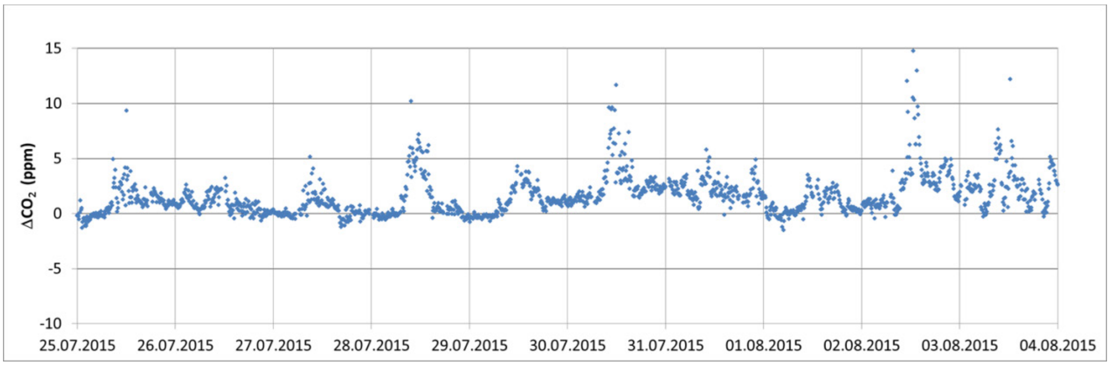

Figure 3. CO_2 differences in ppm for a 10 days period in summer 2015.

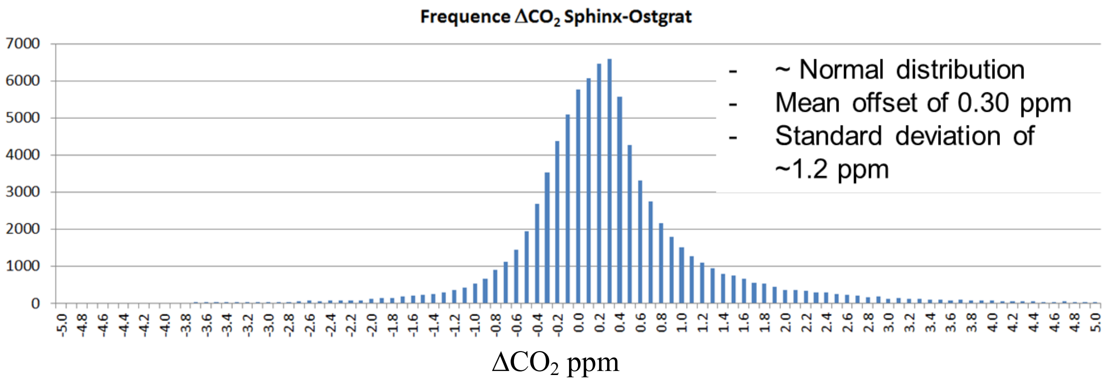

Figure 4. Frequency distribution of the CO_2 differences given in ppm.

The mean difference is only 0.3 ppm but with a standard deviation of about 1.2 ppm as shown in the frequency distribution (Figure 4). When plotting the differences versus day hours (Figure 5) then a clear diurnal signal is obtained that is already visible in Figure 3.

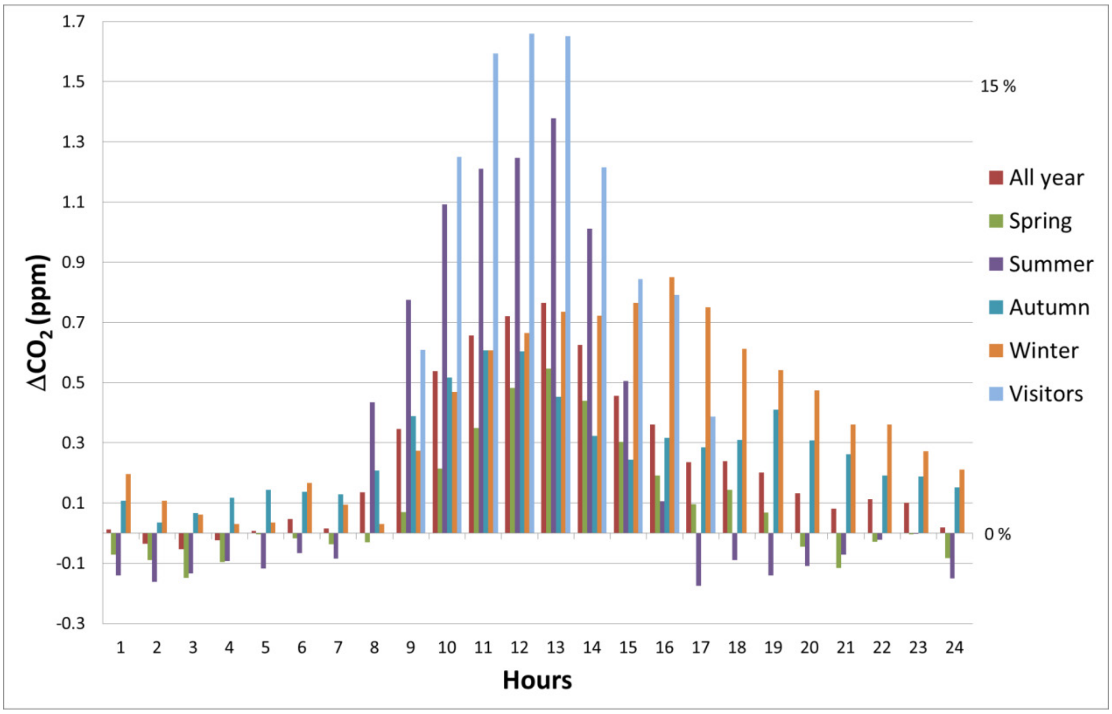

Figure 5. CO_2 differences given in ppm versus day hours.

The diurnal signal seems to scale with the number of visitors at the Sphinx location. During night time hours no difference is seen within the WMO target accuracy of 0.1 ppm. As expected the highest differences are observed during summer when the number of visitors is high, but interestingly also during winter rather high differences are seen especially during afternoon and evening hours. Therefore, we might experience additional sources for the excess CO_2 at the Sphinx location.

Key words:

Greenhouse gas, climate change, CO_2 emissions

Internet data bases:

The Jungfraujoch data can be downloaded from our homepage (http://www.climate.unibe.ch/?L1=research&L2=atm_gases) or from the WMO GAW: World Data Centre for Greenhouse Gases (http://ds.data.jma.go.jp/gmd/wdcgg/cgi-bin/wdcgg/accessdata.cgi?index=JFJ646N00-KUP&select=inventory)

Collaborating partners/networks:

ICOS partners, Globalview, Obspack, Swiss GCOS office, EMPA, University of Groningen, the Netherlands, MPI BGC Jena, Germany

Scientific publications and public outreach 2017:

Refereed journal articles and their internet access

Berhanu, T. A., S. Szidat, D. Brunner, E. Satar, R. Schanda, P. Nyfeler, M. Battaglia, M. Steinbacher, S. Hammer, M. Leuenberger, Estimation of the fossil fuel component in atmospheric CO_2 based on radiocarbon measurements at the Beromünster tall tower, Switzerland, Atmos. Chem. Phys., **17**, 10753-10766, https://doi.org/10.5194/acp-17-10753-2017, 2017.

Oney, B., N. Gruber, S. Henne, M. Leuenberger, D. Brunner, A CO-based method to determine the regional biospheric signal in atmospheric CO2, Tellus Series B – Chemical and Physical Meteorology, **69**, doi: 10.1080/16000889.2017.1353388, 2017. http://www.tandfonline.com/doi/full/10.1080/16000889.2017.1353388

Yuan, Y., L. Ries, H. Petermeier, M. Steinbacher, A.J. Gomez-Pelaez, M.C. Leuenberger, M. Schumacher, T. Trickl, C. Couret, F. Meinhardt, A. Menzel, Adaptive Baseline Finder, a statistical data selection strategy to identify atmospheric CO2 baseline levels and its application to European elevated mountain stations, Atmospheric Measurement Techniques Discussion, https://doi.org/10.5194/amt-2017-316, 2017.

Conference papers

Affolter, S., M. Steinbacher, J. Lauper, M. Leuenberger, M. Schibig, T. Berhanu, High altitude CO_2 measurements at the Jungfraujoch (Switzerland): Comparison between the Sphinx (3570 m a.s.l.) and East Ridge (3690 m a.s.l.), 10th International Carbon Dioxide Conference, Interlaken, Switzerland, August 21-24, 2017.

Berhanu, T.A., S. Szidat, D. Brunner, E. Satar, R. Schanda, P. Nyfeler, M. Battaglia, M. Steinbacher, S. Hammer, M. Leuenberger, Estimation of the fossil-fuel component in atmospheric CO2 based on radiocarbon measurements at the Beromünster tall tower, Switzerland, Abstract Volume 15th Swiss Geoscience Meeting, Davos, Switzerland, November 17-18, 2017.

Berhanu, T.A., S. Szidat, D. Brunner, E. Satar, M. Battaglia, M. Steinbacher, S. Hammer, M. Leuenberger, Estimation of the fossil-fuel component in atmospheric CO2 based on radiocarbon measurements at the Beromünster tall tower, Switzerland, 10th International Carbon Dioxide Conference, Interlaken, Switzerland, August 21-25, 2017.

Leuenberger, M., M. Schibig, U. Carstens, C. Rödenbeck, T. Berhanu, 10-years of combined CO_2 and O_2 measurements at two remote sites of Jungfraujoch, Switzerland and Puy de Dôme, France, 10th International Carbon Dioxide Conference, Interlaken, Switzerland, August 21-25, 2017.

Data books and reports

Leuenberger, M., WMO World Data Centre for Greenhouse Gases, c/o Japan Meteorological Agency 1-3-4, Otemachi, Chiyoda-kuTokyo 100-8122, Japan, CO_2 Data from Jungfraujoch, 2017.

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