

Name of research institute or organization:

Empa, Swiss Federal Laboratories for Materials Science and Technology

Title of project:

Continuous measurement of stable CO₂ isotopes at Jungfraujoch, Switzerland

Part of this programme:

ICOS

Project leader and team:

Dr. Lukas Emmenegger, project leader; Dr. Béla Tuzson

Project description:

Real-time and continuous isotopic composition measurements of atmospheric CO₂ deliver valuable information about the involved source- and sink processes and their dynamics at local, regional and continental scales. This is the mission of a quantum cascade laser absorption spectrometer (QCLAS) that is operated at the Jungfraujoch since 2008. The long-term CO₂ isotopologue data ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) offer, in combination with Lagrangian particle dispersion models such as FLEXPART, a world-wide unique opportunity to gain unprecedented insight into the characteristics of atmospheric CO₂. For example, using the transport model in backward mode it is possible to estimate source sensitivities (concentration footprints) for Jungfraujoch during the whole observation period (Figure 1). Hereby, 50'000 particles are artificially released at Jungfraujoch for every 3 hours interval and traced back in time for 10 days based on input data from the ECMWF-Model. A clustering of these simulated footprints facilitates the interpretation of CO₂ isotope signatures of air masses with a similar origin for selected time periods by establishing a link between anthropogenic and biogenic fluxes and the measured isotope values (Figure 2).

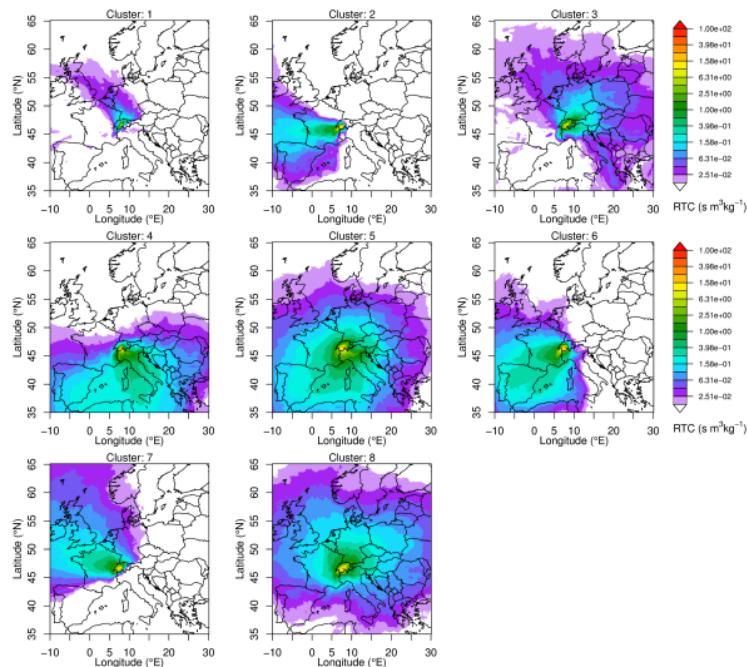


Figure 1. Average footprints for eight different transport clusters: 1) north-westerly advection with little PBL contact, 2) west advection, 3) easterly advection, 4) southerly advection, 5) weak advection (southerly), 6) south-westerly advection, 7) north-westerly advection, 8) weak advection (northerly).

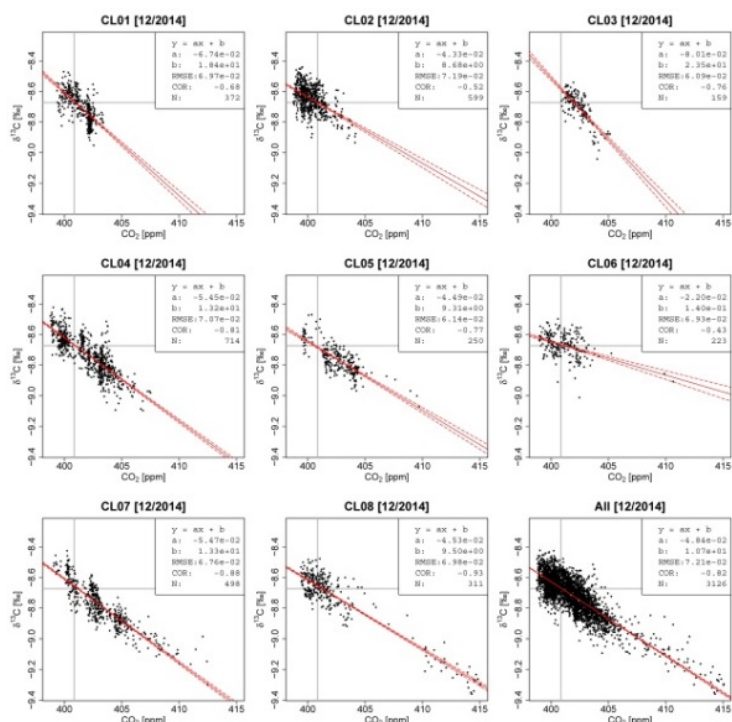


Figure 2. Scatter plots of $\delta^{13}\text{C}$ versus CO_2 for the eight transport regimes during Dec 2014.

Differences exist in the CO_2 and $\delta^{13}\text{C}$ patterns for the different clusters. Next step is the improvement of their significance by fostering measurement filtering and transport modelling. In addition, transport modelling is also employed to detect time periods when the arriving air parcels were not in contact with the planetary boundary layer (PBL) for the preceding 5 days but mainly resided in the free troposphere (FT). This yields another criterion for time series analysis. Finally, the additional trace gases simultaneously measured at the Jungfraujoch by the National Air Pollution Monitoring Network (NABEL) allow for investigating various correlations between different species within these clusters.

Key words:

Isotope ratio measurements, carbon dioxide, laser spectroscopy, quantum cascade laser

Collaborating partners/networks:

ICOS – Integrated Carbon Observation System
RINGO - Readiness of ICOS for Necessities of integrated Global Observations
GAW - Global Atmosphere Watch
Max Planck Institute for Biogeochemistry, Jena, Germany
University of Berne, Switzerland

Scientific publications and public outreach 2017:

Conference papers

Müller, M., B. Tuzson and L. Emmenegger, Analysis of high resolution isotopic signatures of CO_2 at the high altitude site Jungfraujoch in the period 2008-2016, EGU, Vienna, Austria, April 23-28, 2017.
<http://meetingorganizer.copernicus.org/EGU2017/EGU2017-12251.pdf>

Müller, M., B. Tuzson, S. Henne and L. Emmenegger, In-situ long-term record of CO_2 isotopic signatures using high-precision laser spectroscopy, 10th International Carbon Dioxide Conference, Interlaken, Switzerland, August 21-25, 2017.

Magazine and Newspapers articles

“Internationale Klimaforscher an der Empa - Fieber messen in der Atmosphäre” Empa News, August 24, 2017.
<https://www.empa.ch/web/s604/ggmt-konferenz>

Address:

Empa
Laboratory for Air Pollution and Environmental Technology
Überlandstrasse 129
CH-8600 Dübendorf

Contacts:

Dr. Lukas Emmenegger
Tel.: +41 58 765 4699
Fax: +41 58 765 6244
e-mail: lukas.emmenegger@empa.ch
URL: <http://empa.ch/web/s503/laser>