

Name of research institute or organization:

EMPA Materials Science and Technology

Title of project:

Monitoring of halogenated greenhouse gases

Project leader and team

Stefan Reimann, Martin Steinbacher, Martin K. Vollmer, Matthias Hill

Project description:

Long-term observations of greenhouse gases improve the understanding of the present state and the future behaviour of the atmosphere with respect to natural and anthropogenic changes and allow an assessment of their sources.

Apart from the dominating carbon dioxide (CO₂), other long-lived trace gases such as methane (CH₄), nitrous oxide (N₂O) and halocarbons (CFCs, HCFCs and HFCs) are responsible for a considerable fraction of the greenhouse effect [1].

At the Jungfraujoch halogenated greenhouse gases have been measured quasi-continuously by gas chromatography-mass spectrometry (GCMS) within the project SOGE (System for Observation of Halogenated Greenhouse Gases in Europe) since January 2000 [2]. CH₄ and N₂O have been analysed since the beginning of 2005 by gas chromatography with flame ionization/electron capture detection (GC-FID/ECD). Jungfraujoch is the highest site worldwide to host this kind of measurements.

The trends of specific greenhouse gases give important information about the global emission of these chemicals. In combination with other background sites in the Northern and Southern hemisphere the determination of the inter-hemispheric gradient for specific substances can be attained.

The measurements of the halocarbons within SOGE are characteristic for each site. As an example the HFC 134a (used as a coolant agent in air conditioners and refrigerators) is shown in Figure 1. Jungfraujoch and Monte Cimone (mountain site (2165 m asl) in the Italian Apennines) are remarkably influenced by regional sources (e.g. from the Po-Valley in Northern Italy). On the other hand, data from the stations in Mace Head (west coast of Ireland) and especially in Ny-Alesund (Spitsbergen) are more representative for the hemispheric background, showing less elevated concentrations during pollution events. Nevertheless, all sites show a simultaneous increase in the background, representing the considerable global emissions of this compound.

For CH₄ a preliminary analysis of the new measurements in 2005 shows that growth of this compound has currently stopped, which is accordance with data from other background sites. However, the reason for this behaviour is still unknown. N₂O exhibits a small but stable growth at a rate of about 0.6%, caused by emissions from agriculture and industry.

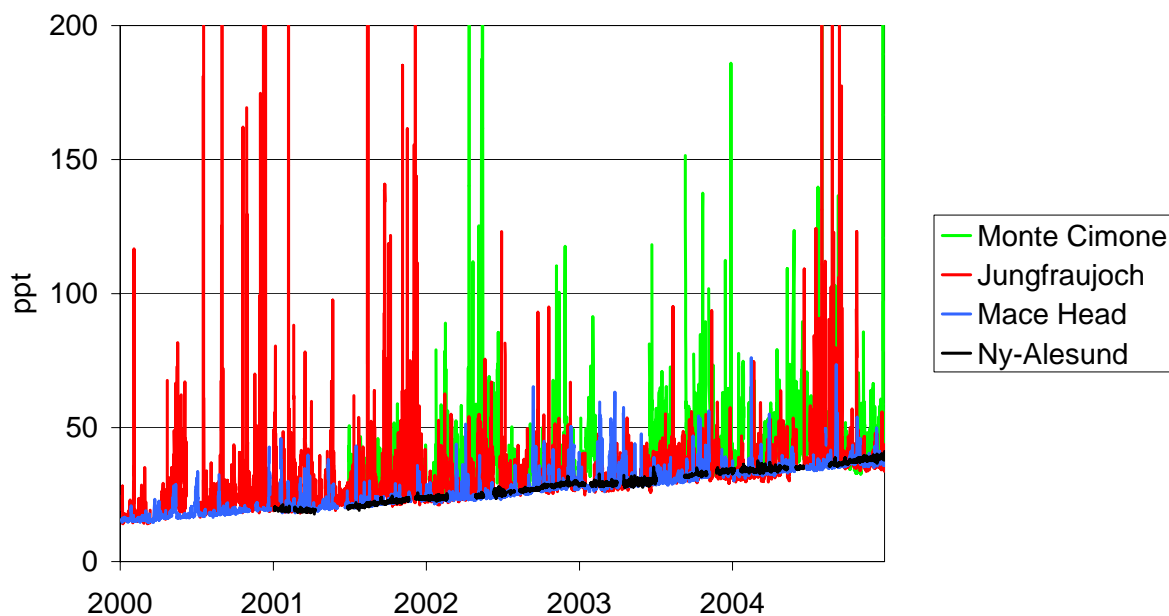


Figure 1: Time series of HFC-134a at Jungfrauoch (Switzerland), Mace Head (Ireland), Ny-Alesund (Norway) and Monte Cimone (Italy).

Detection of European sources from Jungfrauoch

During specific meteorological events (e.g. frontal transport, convective lifting during anticyclonic periods in summer) polluted boundary layer air reaches the Jungfrauoch. These periods are used to estimate emissions from the European continent. For the localisation of potent European sources of halocarbons a trajectory model was used, based on the Swiss Alpine Model [2]. The results should be regarded as indicative, showing only potential source regions. An example of the detected European emissions of the foam blowing agents HCFC-141b and HFC-152a are shown in Figure 2. Thereby, Northern Italy is seen as a source region for both of the substances, whereas only HFC-152a seems to be emitted from Germany in considerable amounts. As the use of HCFC-141b has been prohibited in Europe within the framework of the Montreal Protocol since 2003, emissions of this substance became small, in accordance with the Protocol.

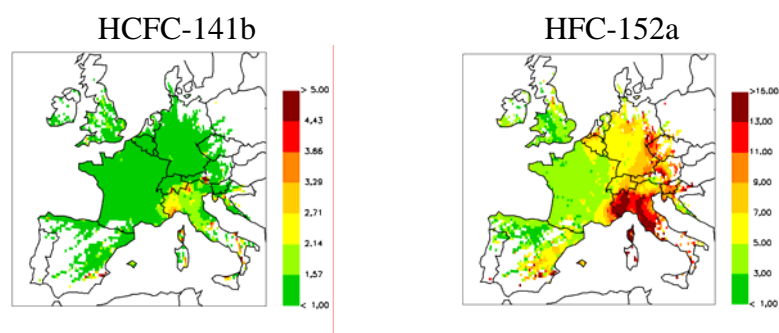


Figure 2: Source regions resulting from trajectory statistics for HCFC-141b and for HFC-152a in 2004 seen at Jungfrauoch. Units indicate averaged excursions above the baseline, linked to trajectories that passed over the respective grid cell.

Future plans

In the future the long-time data series for the non-CO₂ greenhouse gases will be used to assess European emissions down to a regional level. This will be achieved by expanding the already existing analyses of the data from Jungfraujoch by merging the data with that of other stations in the SOGE network. This work will be in assistance of the Kyoto Protocol and the verification of greenhouse gas emissions declared by European countries.

1. IPCC, *Climate Change 2001: The Scientific Basis*, ed. J. T. Houghton. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp., 2001.
2. Reimann, S., et al., *Halogenated greenhouse gases at the Swiss High Alpine Site of Jungfraujoch (3580 m asl): Continuous measurements and their use for regional European source allocation*. *Journal of Geophysical Research-Atmospheres*, 2004. 109(D5): art. no.-D05307.

Key words:

Air pollution, long-term measurements, halocarbons, Kyoto Protocol, Montreal Protocol

Internet data bases:

http://www.empa.ch/climate_gases
<http://www.nilu.no/soge/>

Collaborating partners/networks:

Bundesamt für Umwelt (BAFU)/ Federal Office for the Environment (FOEN)
Global Atmosphere Watch (GAW)
SOGE (System for observation of halogenated greenhouse gases in Europe)
AGAGE (<http://agage.eas.gatech.edu/home.htm>)

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Scientific publications and public outreach 2006:

Refereed journal articles

Vollmer, M. K., Reimann, S., Folini, D., Porter, L. W. and Steele, L. P. (2006). First appearance and rapid growth of anthropogenic HFC-245fa (CHF₂CH₂CF₃) in the atmosphere. *Geophysical Research Letters* 33 L20806 doi:10.1029/2006GL026763.

Conference contributions

Steinbacher M., Vollmer M. K., Reimann S. - Radiative forcing budget of non-CO₂ trace gases at the high-Alpine site Jungfraujoch, Switzerland; Joint CACGP/IGAC/WMO symposium 'Atmospheric Chemistry at the Interfaces'; Cape Town, South Africa, September 17 – 22, 2006.

Steinbacher M., Vollmer M. K., Reimann S. - Radiative forcing budget of non-CO₂ trace gases at the high-Alpine site Jungfraujoch; International conference in

celebration of the 75th anniversary of the High Altitude Research Station Jungfrauoch Research at Jungfrauoch "Top of Science" Interlaken, Switzerland, September 11-14, 2006.

Steinbacher M., Vollmer M. K., Reimann S. - Quasi-continuous CH₄, N₂O, and SF₆ measurements at the high Alpine site Jungfrauoch: influence of transport processes and emissions estimates; GEIA 2006 conference; Paris, France, November 29 – December 01, 2006.

Reimann, S. Vollmer, M. K. and Folini, D. Top-down assessment of European emissions of halocarbons, poster presented at the GEIA 2006 conference; Paris, France, November 29 – December 01, 2006.

Rodolphe Zander, R. and Reimann, S. Long-Term Monitoring of Greenhouse and Ozone-Depleting Gases at Jungfrauoch, presentation at the International conference in celebration of the 75th anniversary of the High Altitude Research Station Jungfrauoch Research at Jungfrauoch "Top of Science" Interlaken, Switzerland, September 11-14, 2006.

M. K. Vollmer, M.K., Reimann, S., Steinbacher, M., Porter, L. W., Steele, L. P., Krummel, P. B., Fraser, P. J., O'Doherty, S., Grealley, B. R., Simmonds, P. G., Miller, B. R., J. Mühle, J., Weiss, R. F., Wang, R. H. J., Cunnold, D. M., Prinn, R. G. First appearance and rapid growth of new hydrofluorocarbons (HFCs) in the atmosphere: Their potential as interhemispheric transport tracer, poster presented at the International conference in celebration of the 75th anniversary of the High Altitude Research Station Jungfrauoch Research at Jungfrauoch "Top of Science" Interlaken, Switzerland, September 11-14, 2006.

Address:

EMPA

Laboratory for Air Pollution/Environmental Technology

Ueberlandstrasse 129

CH-8600 Dübendorf

Contacts

Stefan Reimann

Tel.: +41 1 823 4654

Fax: +41 1 821 6244

e-mail: stefan.reimann@empa.ch

URL: http://www.empa.ch/climate_gases