

Name of research institute or organization:

**Empa, Swiss Federal Laboratories for Materials Science and Technology**

Title of project:

National Air Pollution Monitoring Network (NABEL)

Part of this programme:

EMEP, GAW, ICOS

Project leader and team:

Dr. Martin Steinbacher, Dr. Lukas Emmenegger, Dr. Christoph Hüglin (project leader)

Project description:

The National Air Pollution Monitoring Network (NABEL) is run by Empa jointly with the Swiss Federal Office for the Environment (BAFU/FOEN). The NABEL network was established in 1978 with initially 8 sites emerging from activities that started already in 1968 as contributions to international WMO and OECD observation networks. In-situ measurements by Empa at Jungfraujoch began in 1973. Early activities mainly focused on sulphur dioxide and particulate matter. In 1990/1991 the NABEL network was extended to 16 monitoring stations that are distributed all over Switzerland. The locations of these monitoring stations are representative for the most important air pollution levels ranging from the urban kerbside to remote free tropospheric background. The NABEL site at Jungfraujoch is a very low polluted site, representing a background station for the lower free troposphere in central Europe.

The current measurement programme at Jungfraujoch includes continuous *in-situ* analyses of ozone (O<sub>3</sub>), carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO<sub>2</sub>), the sum of nitrogen oxides (NO<sub>y</sub>), sulphur dioxide (SO<sub>2</sub>), methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O). These data are stored as 10-min averages. Furthermore, the concentrations of CH<sub>4</sub> and N<sub>2</sub>O are also measured semi-continuously in 24-min intervals. Molecular hydrogen (H<sub>2</sub>) is semi-continuously monitored in 30-min intervals. An extended set of halocarbons, sulphur hexafluoride (SF<sub>6</sub>) and a selection of volatile organic compounds (VOCs) (alkanes, aromatics) are measured with a time resolution of two hours. The concentrations of particulate matter < 10 µm (PM10) are determined both continuously and in 24-hour integrated samples. Daily samples are taken to quantify particulate sulphur.

With this comprehensive suite of measurements, Empa's activities at Jungfraujoch go beyond the operational setup at other NABEL stations. On the one hand this is driven by the different scientific aims at such a remote site. On the other hand this is also in response to the various international projects and programmes the observations at Jungfraujoch are embedded in. For instance, measurements at Jungfraujoch contribute to the European Monitoring and Evaluation Programme (EMEP) which is a scientifically based and policy driven programme under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP) for international co-operation to solve transboundary air pollution problems. The measurements are also part of the Global Atmosphere Watch (GAW) programme of the World Meteorological Organization (WMO). While GAW gathers data from more than 400 stations all over the globe, Jungfraujoch is also one of the currently 30 GAW global flagship stations that are appointed in recognition of their extensive measurement programme and the associated scientific analysis. The observations of the halogenated greenhouse gases (see the dedicated activity report) are part of the Advanced Global Atmospheric Gases Experiment (AGAGE) with 9 stations worldwide striving for a comprehensive picture of the composition of ozone-depleting substances and their replacement products. On the European scale, Jungfraujoch is one of the future monitoring stations of the atmospheric network of the Integrated Carbon Observation System

(ICOS) research infrastructure. ICOS aims at establishing harmonized high-precision greenhouse gas observations across Europe to understand the greenhouse gas budgets and perturbations. With an envisaged time frame of 20 years, ICOS provides the long-term observations required to understand the present state and to predict future behaviour of the

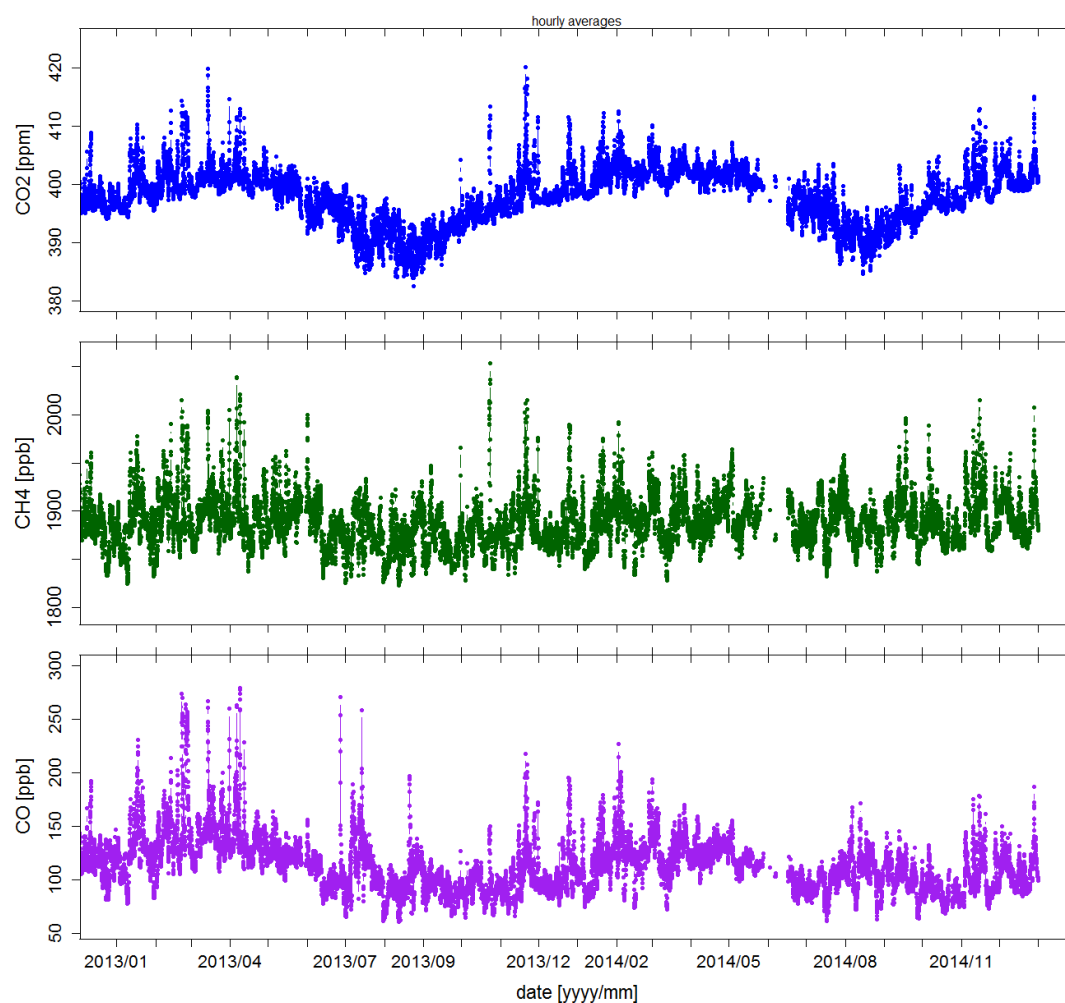


Figure 1. Time series of high-precision CO<sub>2</sub>, CH<sub>4</sub> and CO observations (hourly averages) from January 2013 to December 2014.

global carbon cycle and greenhouse gas emissions. While conclusion of the final legal framework is still pending, Empa already performs the requested high-precision CO<sub>2</sub>, CH<sub>4</sub> and CO observations in compliance with the ICOS specifications (see Figure 1). On shorter time scales, Jungfraujoch is also a prime-site in the European Commission's Seventh Framework Programme InGOS (Integrated non-CO<sub>2</sub> Greenhouse gas Observation System) and ACTRIS (Aerosol, Clouds, and Trace Gases Research Network) which both run for 4 years. A close liaison with many programmes is beneficial in various aspects: round robin intercomparisons as part of the GAW programme and the InGOS project (both for greenhouse gases) and the ACTRIS project (for nitrogen oxide) allow additional quality control activities. Side-by-side intercomparisons were promoted as Jungfraujoch was selected as one of 11 ACTRIS access to infrastructure sites as well as one of 12 InGOS access to European measurement stations. Selection of the transnational access stations was made based on infrastructure, instrumentation and expertise. Moreover, integration in international networks also promotes joint data analysis and publication, both being beneficial for quality assurance and visibility of the time series in the scientific community.

Key words:

Atmospheric chemistry, air quality, trace gases, long-term monitoring

Internet data bases:

<http://www.empa.ch/nabel>

[http://www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg\\_luft/luftbelastung/index.html](http://www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg_luft/luftbelastung/index.html)

Collaborating partners/networks:

Bundesamt für Umwelt (BAFU)/ Federal Office for the Environment (FOEN)

Global Atmosphere Watch (GAW)

Belgian Institute for Space Aeronomy, Brussels

Institut d'Astrophysique et de Géophysique, Université de Liège

Labor für Atmosphärenchemie, Paul Scherrer Institut

MeteoSchweiz

Climate and Environmental Physics, University of Bern

EMEP – European Monitoring and Evaluation Programme

ICOS – Integrated Carbon Observation System

InGOS – Integrated non-CO<sub>2</sub> Greenhouse gas Observation System

ACTRIS – Aerosol, Clouds, and Trace Gases Research Network

Scientific publications and public outreach 2014:

**Refereed journal articles and their internet access**

Bergamaschi P., M. Corazza, U. Karstens, M. Athanassiadou, R.L. Thompson, I. Pison, A.J. Manning, P. Bousquet, A. Segers, A.T. Vermeulen, G. Janssens-Maenhout, M. Schmidt, M. Ramonet, F. Meinhardt, T. Aalto, L. Haszpra, J. Moncrieff, M.E. Popa, D. Lowry, M. Steinbacher, A. Jordan, S. O'Doherty, S. Piacentino, E.J. Dlugokencky, Top-down estimates of European CH<sub>4</sub> and N<sub>2</sub>O emissions based on four different inverse models, *Atmospheric Chemistry and Physics Discussions*, **14**, 15683-15734, doi: 10.5194/acpd-14-15683-2014, 2014. <http://www.atmos-chem-phys-discuss.net/14/15683/2014/>

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<http://www.atmos-chem-phys.net/14/2625/2014/>

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Brunner, D., Lagrangian transport modeling for regional scale inverse emission estimation, Spawning the Atmosphere Measurements of Jungfraujoch, Schneefernerhaus und Sonnblick, Bern, Switzerland, January 22-23, 2014.

Steinbacher, M., GAW station Jungfraujoch – measurement programme and activities, Virtual Alpine Observatory II, Subproject I/02 Trends of climate forcing gases and aerosols and spatio-temporal deposition of persistent organic pollutants (POPs), Munich, Germany, May 12, 2014.

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Steinbacher, M., B. Schwarzenbach, NO<sub>x</sub> measurements at Jungfraujoch and Rigi, ACTRIS VOC/NO<sub>x</sub> Workshop, Juelich, Germany, November 26-28, 2014.

### **Data books and reports**

BAFU 2014: NABEL – Luftbelastung 2013. Messresultate des Nationalen Beobachtungsnetzes für Luftfremdstoffe (NABEL), pp. 130, Bundesamt für Umwelt, Bern, Umwelt-Zustand Nr. 1415, 2013.

### **Magazine and Newspapers articles**

“Lachgas heizt dem Klima ein”, *Umwelt – natürliche Ressourcen in der Schweiz*, February, 2014.

“CO<sub>2</sub> concentrations top 400 parts per million throughout northern hemisphere”, WMO press release no. 991, May, 2014.

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