Name of research institute or organization:

## EMPA Materials Science and Technology

Title of project:

National Air Pollution Monitoring Network (NABEL)

Project leader and team

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Project description:

The national air pollution monitoring network NABEL is a joint project of the Swiss Federal Office for the Environment (BAFU/FOEN) and EMPA. The NABEL network consists of 16 monitoring stations that are distributed all over Switzerland. The monitoring stations represent the most important air pollution levels. The NABEL site at Jungfraujoch is a very low polluted site, representing a background station for the lower free troposphere in central Europe.

The measurement programme at Jungfraujoch includes continuous *in-situ* analyses of ozone ($O_3$), carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide ($NO_2$), and the sum of nitrogen oxides ($NO_y$). In addition, an extended set of halocarbons and a selection of VOCs (alkanes, aromatics) are measured with a time resolution of four hours. Daily samples are taken for determination of gaseous $SO_2$ and for particulate sulphur. The concentrations of total suspended particles are continuously observed as well as measured as 48-hour bulk samples.

A custom-built gas chromatograph with a flame ionization detector and an electron capture detector (GC-FID/ECD) is operated since February 2005 to quasi-continuously measure $CH_4$, CO, $N_2O$, and $SF_6$. One measurement sequence takes 15 minutes and each ambient air sample is bracketed with calibration runs using real-air standards with concentrations representative for Northern Hemisphere tropospheric concentrations resulting in a time resolution of 30min. On the one hand, these measurements enable CO observations with a higher precision compared to the current commercial CO monitor based on the NDIR technique. On the other hand, the $CH_4$, $N_2O$, and $SF_6$ observations complete our extended set of non-$CO_2$ greenhouse gases so that the whole set of non-$CO_2$ greenhouse gases is now continuously monitored at the Jungfraujoch.

Figure 1 shows CO measurements for a 10-day period in summer 2005. The comparison of the CO time series measured with the two different techniques illustrates that the NDIR monitor exhibits a larger noise than the GC-FID even when considering 10-min averages. This is well visible during the last two days of the presented period when the CO mixing ratios were low and little short-term variability was observed. Whereas the measurement uncertainty of the commercial NDIR monitor is estimated to be ±5% (1σ) (Forrer *et al.*, 2000; Zellweger *et al.*, 2000) recurrent real-air standard analyses at the Jungfraujoch resulted in a standard deviation of 0.3% (at 300.9 ppb) using a 10ml sample loop for the new custom-built gas chromatograph.

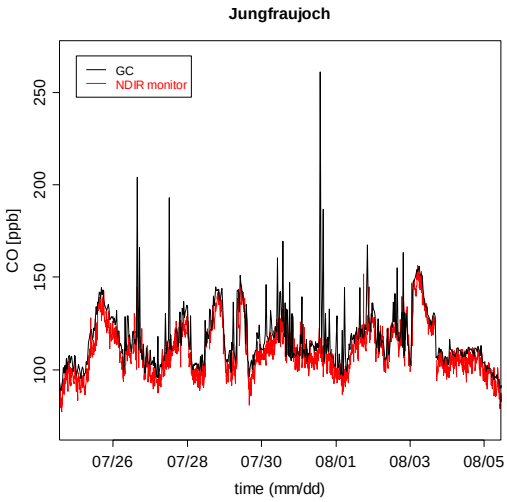


*Figure 1: Time series of in-situ measured, high time resolution (monitor 10min averages; instantaneous ambient air samples every 30 min for the GC) CO mixing ratios.*

Furthermore, short term pollution episodes can only be seen by the GC-FID as no averaging interval is needed and instantaneous concentrations are measured. The observed spikes in the CO time series might be most likely related to the transport of polluted air masses from forest fires on the Iberian Peninsula that happened at the end of July. Since short-term pollution events can now be better detected, the new measurement technique will also improve regional source allocations for Europe. The slight offset between the two techniques might be related to the different calibration standards used since the presented data are preliminary and the final corrections are not yet made.

Figure 2 illustrates the whole available dataset for $CH_4$, CO, $N_2O$, and $SF_6$. Daily averages were chosen for the sake of clarity. No distinct seasonal cycle and no positive trend were observed for $CH_4$ in agreement with other observations that recently revealed a decline of the positive trend and a high variability from year to year. Also no significant trend was observed for CO. The seasonal variation in both OH concentrations and CO emissions resulted in a slight seasonal cycle with enhanced CO levels in winter. A small seasonal cycle and a positive trend were observed for $N_2O$ in agreement with reported datasets due to annual variability in natural emissions and large-scale transport as well as human activities, respectively. $SF_6$ exhibits a positive trend on a low concentration level. However, it is an effective greenhouse gas, mostly due to its long lifetime and its high global warming potential. Some $SF_6$ data had to be excluded due to local contamination.

We conclude that the successful implementation of the new GC-FID/ECD system completes the extended data set of quasi-continuously measured non-$CO_2$ greenhouse gases and considerably improves the quality of the ambient in-situ CO determination.

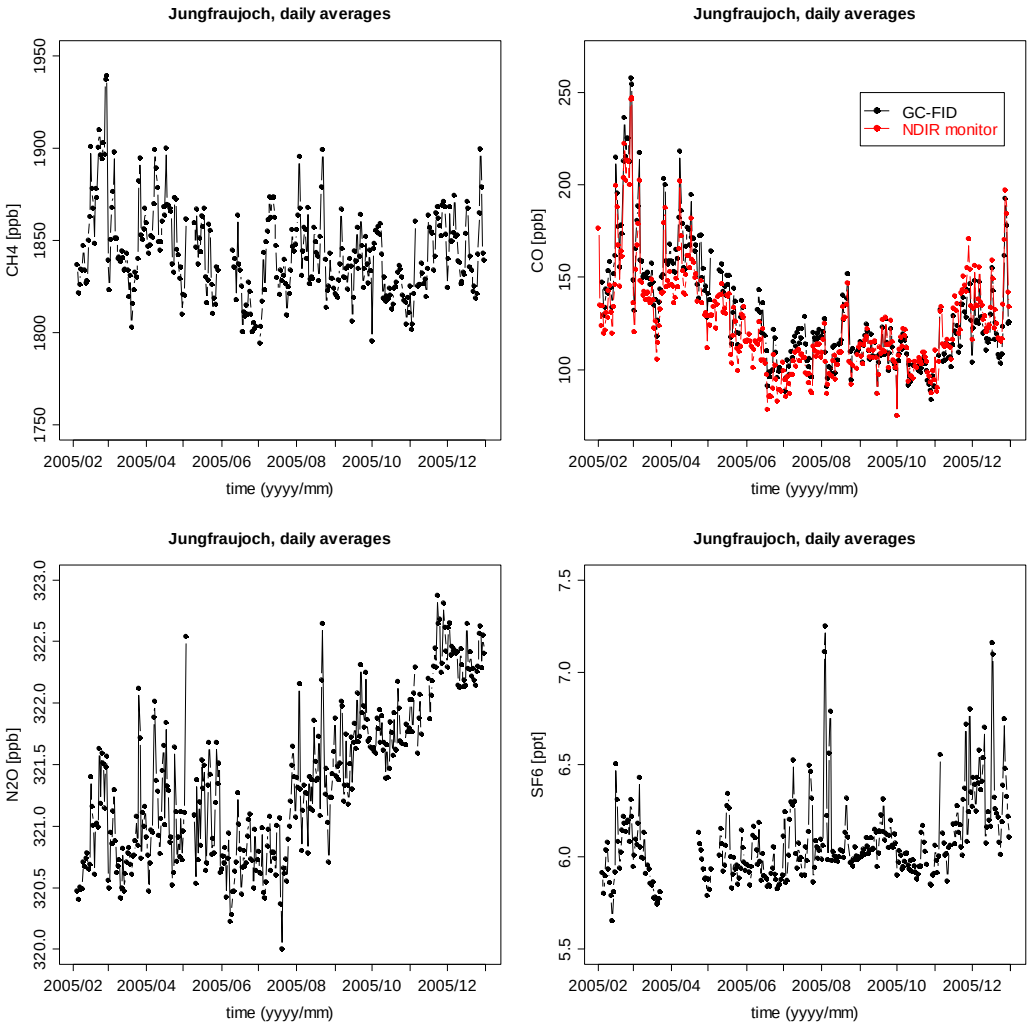


*Figure 2: Time series of daily averages from February 02 to December 31, 2005 for methane (top left), carbon monoxide (top right), nitrous oxide (bottom left), and sulphur hexafluoride (bottom right) (preliminary data).*

References

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Key words:

Air pollution, long-term measurements, methane, carbon monoxide, nitrous oxide, sulfur hexafluoride

Internet data bases:

http://www.empa.ch/nabel
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)
Labor für Atmosphärenchemie, Paul Scherrer Institut
Meteo Schweiz

Scientific publications and public outreach 2005:

**Refereed journal articles**

Li, Y., Campana, M., Reimann, S., Schaub, D., Stemmler, K., Staehelin, J. and Peter, T. (2005), Hydrocarbon concentrations at the Alpine mountain sites Jungfraujoch and Arosa, *Atmospheric Environment* 39, 1113-27.

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**Conference contributions**

Steinbacher, M., Vollmer, M. K., Stemmler, K. and Reimann, S., Global Warming Budget of non-$CO_2$ Trace Gases at the High Alpine Site Jungfraujoch, Switzerland, ACCENT Symposium 'The Changing Chemical Climate of the Atmosphere', Urbino, Italy, September 12 – 16, 2005.

**Data books and reports**

Technischer Bericht zum Nationalen Beobachtungsnetz für Luftfremdstoffe (NABEL), EMPA, 2005.

NABEL, Luftbelastung 2004, Schriftenreihe Umwelt Nr. 388 Luft, Bundesamt für Umwelt Wald und Landschaft, Bern 2005.

Buchmann, B., Reimann, S. and Hüglin, Ch., The GAW-CH Greenhouse and Reactive Gases Programme at the Jungfraujoch, Veröffentlichung Nr. 70, MeteoSchweiz (Editor), ISSN: 1422-1381, 2005.

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