

Name of research institute or organization:

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**Empa, Swiss Federal Laboratories for Materials Testing and Research**

Title of project:

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National Air Pollution Monitoring Network (NABEL)

Project leader and team:

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Martin Steinbacher, Beat Schwarzenbach, Christoph Hüglin (project leader)

Project description:

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The National Air Pollution Monitoring Network (NABEL) is run by Empa in joint collaboration 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 observation networks as part of WMO and OECD. In-situ measurements by Empa at Jungfraujoch started 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 monitoring stations represent the most important air pollution levels from 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 program 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>) and sulfur dioxide (SO<sub>2</sub>). The concentrations of methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), molecular hydrogen (H<sub>2</sub>), and sulfur hexafluoride (SF<sub>6</sub>) are measured in 30 min intervals. An extended set of halocarbons and a selection of volatile organic compounds (VOCs) (alkanes, aromatics) are measured with a time resolution of two hours. Daily samples are taken for determination of particulate sulfur. The concentrations of particulate matter < 10 µm (PM<sub>10</sub>) are continuously observed as well as measured as 24-hour bulk samples.

The NABEL activities have several objectives such as

- the observation of air pollution levels and comparison with air quality standards,
- the long-term measurement of air pollutants for trend determinations and the control of success of air quality reduction mechanisms,
- the contribution to international programmes like the European Monitoring and Evaluation Programme (EMEP) or the Global Atmosphere Watch Programme (GAW) of the World Meteorological Organisation (WMO),
- the provision of information to the public about present air quality, and
- acts as a research platform and user lab.

Highest quality standards have to be applied to meet these goals leading to very demanding requirements for standards, calibrations, traceability, instruments, as well as data handling and standard operational quality control procedures. Standard reference materials (primary standards) are purchased from the Netherlands Measurement Institute (NMI) and the National Institute of Standards and Technology (NIST) in the United States. These standards are kept at Empa in Duebendorf and are

used to calibrate transfer standards purchased from Swiss gas suppliers. This allows to keep the primary standards for several years (in agreement with the guaranteed stability) to minimize inhomogeneities. The transfer standards are brought to the measurement sites where they are used for automatic span checks every 23 to 49 hours along with blank measurements using on-site generated trace gas-free air. Transfer standards are re-calibrated against the primary standards at Empa before complete drainage.

All instruments undergo comprehensive instrument tests and quality check after first receipt and before being installed at the measurement sites. In operation, instruments are replaced in (instrument-specific) regular intervalls and sent to manufacturer representatives in Switzerland for service such as cleaning and replacement of wear parts. This is again followed by standard quality checks / instrument tests at Empa. Standard operating procedures exist for the instrument tests, the regular on-site maintenance and daily and monthly data processing procedures.

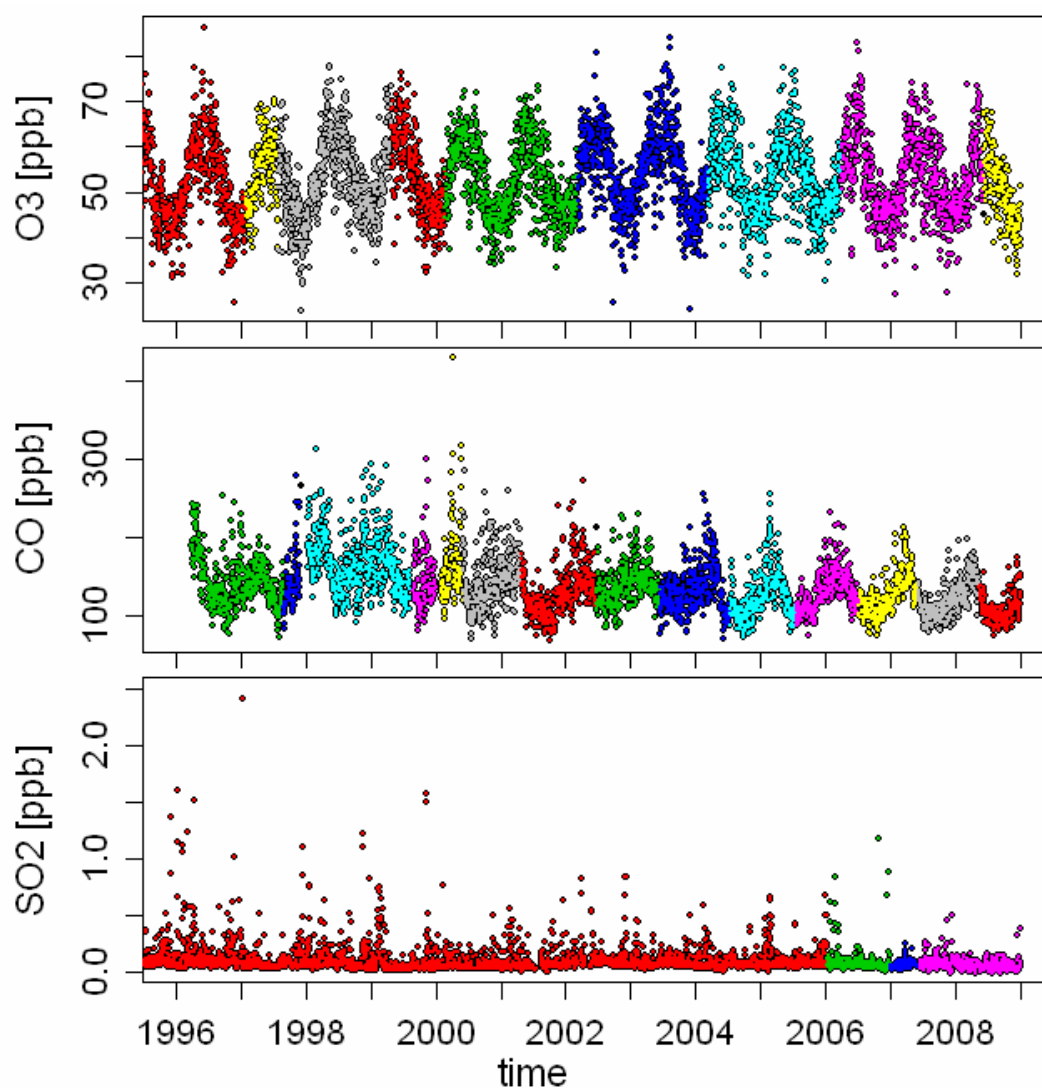


Figure 1: Long-term time series of daily averages of O<sub>3</sub> (top), CO (middle) and SO<sub>2</sub> (bottom) at Jungfrauoch. Different colors represent different instruments.

Figure 1 illustrates the regular replacement of measurement equipment at Jungfraujoch for O<sub>3</sub>, CO and SO<sub>2</sub>. Different colors represent different instruments used at the site. The same type of instrument (Thermo Environmental Instruments TEI49C) was used for O<sub>3</sub> observations since January 1997 whereas CO instruments from Horiba (APMA series) are in operation at Jungfraujoch. In June 2007, the instrument type was changed from APMA 360 to APMA 370 after comprehensive tests in the laboratory. A change of the measurement technique was applied for SO<sub>2</sub> in January 2007 after one year of collocated on-site measurements with both the old and the new technique. The previous technique of wet chemical absorption of SO<sub>2</sub> in a hydrogen peroxide solution and subsequent off-line analysis with ion chromatography only allowed 24-h bulk sample investigations. The new on-line UV fluorescence technique (Thermo Environmental Instruments TEI43C TL) allows SO<sub>2</sub> observations with higher time resolution and requires less man-power. Due to the extensive quality control activities, neither instrument replacements nor instrument updates nor measurement technique changes resulted in detectable inhomogeneities in the time series.

In regular intervals, Empa also participates in intercomparison exercises for National Air Quality Reference Laboratories at the Joint Research Centre in Ispra, Italy, in comparison studies of the Swiss Society for Air Quality Experts (Cercl'Air) and collaborates closely with the Swiss Federal Office of Metrology (METAS).

In conclusion, the Swiss Air Pollution Monitoring Network aims at achieving data sets of highest quality and continuously strives to improve precisions, detection limits etc. by choosing state-of-the-art measurement techniques and by implementation of adequate QA/QC procedures.

Key words:

Air quality, long-term monitoring, quality control

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)

Labor für Atmosphärenchemie, Paul Scherrer Institut

Meteo Schweiz

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