

Name of research institute or organization:

Empa, Swiss Federal Laboratories for Materials Science and Technology

Title of project:

Halogenated Greenhouse Gases at Jungfrauojoch

Project leader and team:

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Project description:

Halogenated ozone-depleting substances (ODSs) and greenhouse gases (GHGs) have been monitored at Jungfrauojoch since 2000. These measurements are combined with atmospheric transport models for identifying and quantifying national and regional emissions (Switzerland and neighboring countries). These "top-down" estimates are then used to verify "bottom-up" estimates of the international reporting agencies, which are based on industry information (import/export/manufacture). Furthermore, the measurements help to track global trends of these compounds in the "background" air. Measurements at Jungfrauojoch comprise a suite of about 50 compounds, such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), perfluorocarbons (PFCs and SF₆), hydrofluorocarbons (HFCs), and additional halogenated hydrocarbons, which are regulated under the Montreal and Kyoto Protocols.

In 2012 we implemented several instrumental and technical improvements to obtain high-quality, hourly measurements, typically with a precision < 1 % and an accuracy < 3 %. These measurements are tightly linked to the international AGAGE program (Advanced Global Atmospheric Gases Experiment).

As an example of this year's activities, results from measurements of several PFCs are presented. The figures show atmospheric abundances at Jungfrauojoch, at Mace Head (Ireland, northern hemisphere), and at Cape Grim (Tasmania, southern hemisphere). These PFCs are almost entirely of anthropogenic origin, with emissions from the semiconductor industry and from aluminium smelters (mainly CF₄ and PFC-116). All of the presented PFC concentrations are growing. With atmospheric lifetimes >3'000 yrs and continuing emissions, the detected trends are virtually irreversible over a time horizon of a few generations – a truly long-term atmospheric disturbance by humans.

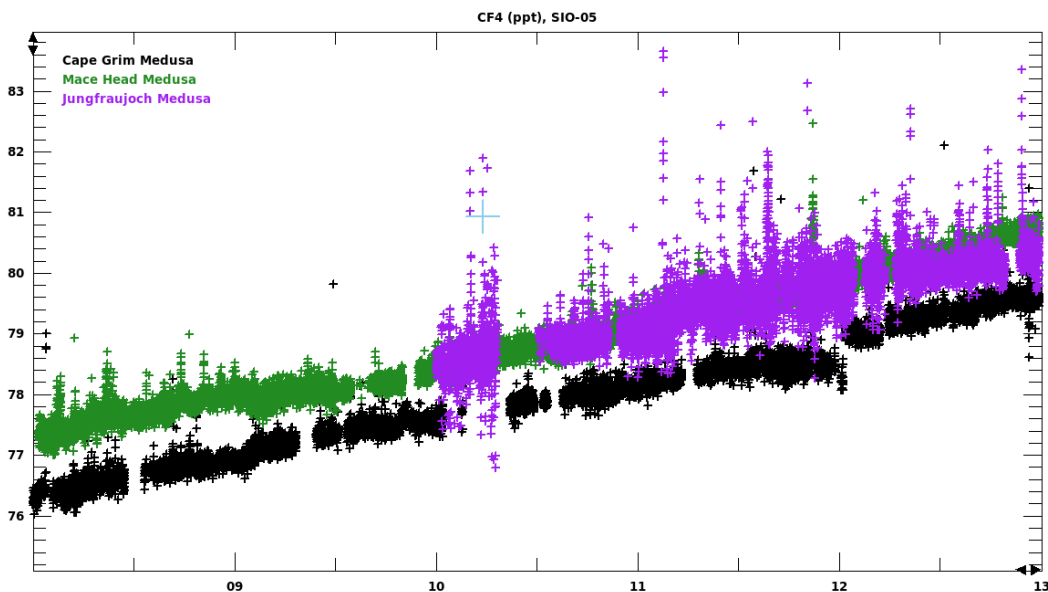


Figure 1. PFC-14 (CF_4) at three AGAGE stations for the period 2008 – 2012. The x-label defines years, the y-label dry-air mole fractions in parts per trillion (ppt). Measurements are shown for Cape Grim (southern hemisphere) in black, for Mace Head (east coast Ireland) in green, and Jungfraujoch (Switzerland) in purple. CF_4 is an extremely long-lived anthropogenic gas (50'000 – 100'000 yrs) in the atmosphere.

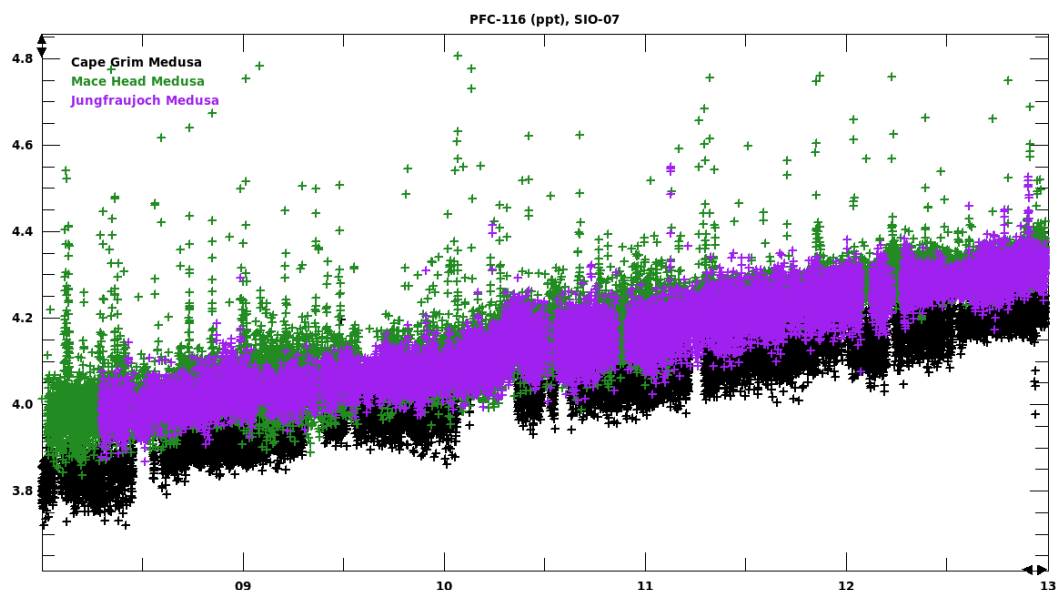


Figure 2. Same as Fig. 1 but for the long-lived PFC-116 (C_2F_6). As opposed to CF_4 (Fig. 1), there are virtually no regional emissions detected at Jungfraujoch.

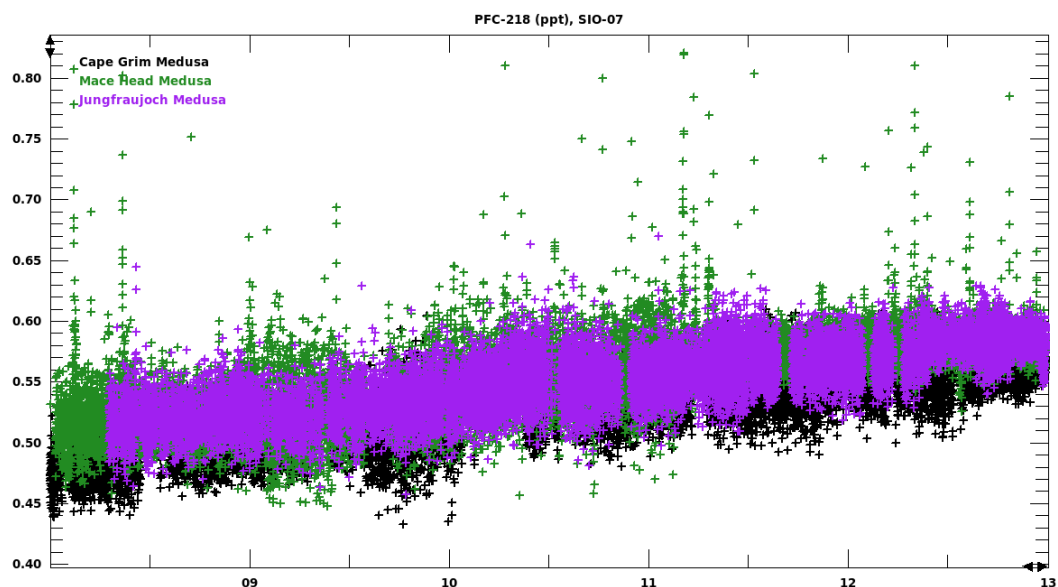


Figure 3. Same as Fig. 1 but for the long-lived PFC-218 (C_3F_8). There are virtually no regional emissions detected at Jungfraujoch. Compared to the compounds shown in Fig. 1 and 2, atmospheric growth and the inter-hemispheric gradients are small.

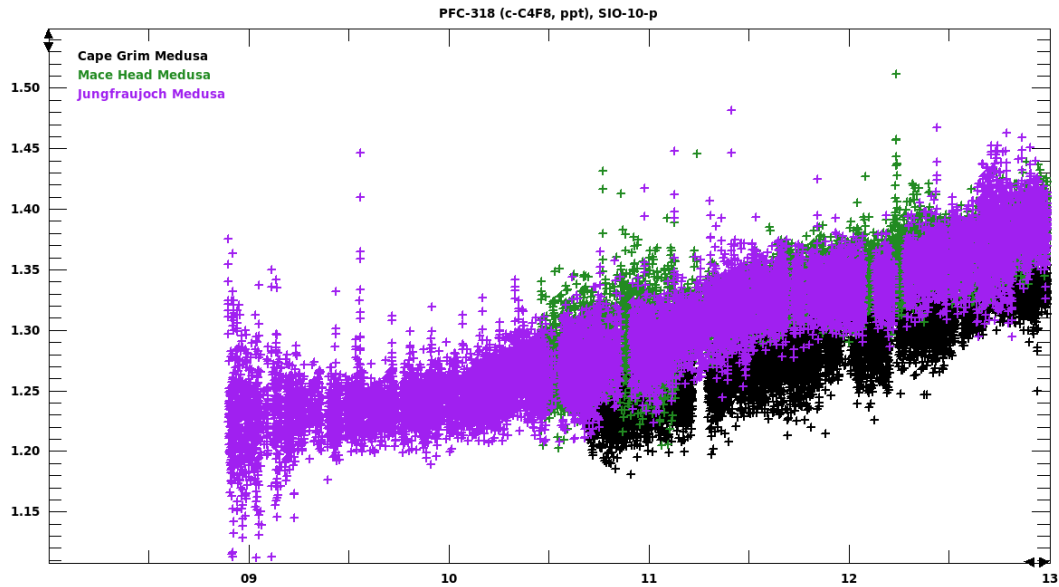


Figure 4. Same as Fig. 1 but for the long-lived PFC-318 (cyclo-C₄F₈). There are virtually no regional emissions detected at Jungfraujoch. Jungfraujoch has the longest in-situ measurement record of all the AGAGE stations. Measurements before mid-2009 were of lower precision (hence the pronounced vertical spread) due to lower atmospheric abundance and instrumental limitations.

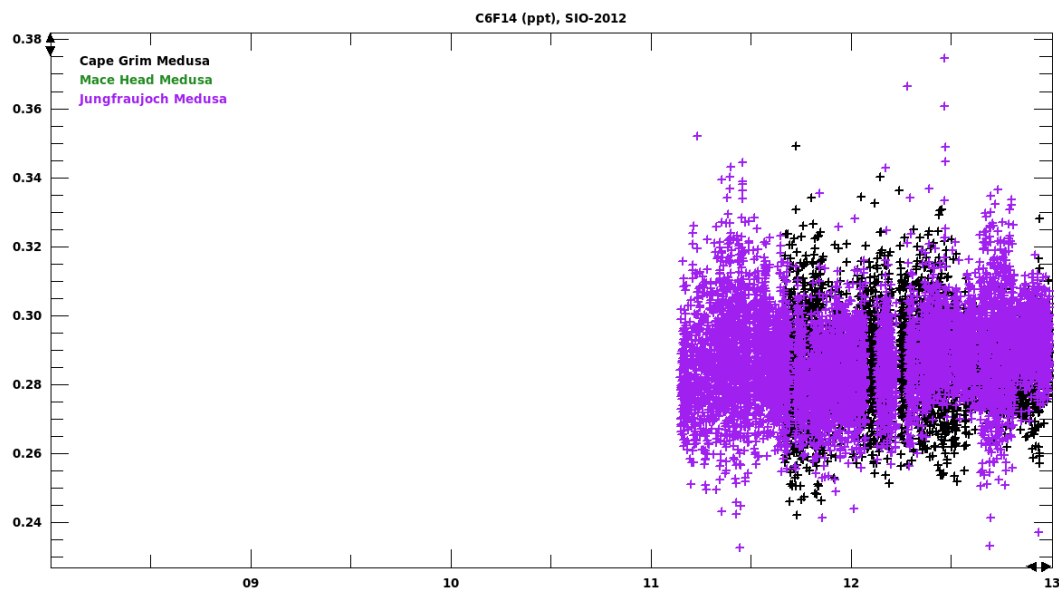


Figure 5. Same as Fig. 1 but for the long-lived C₆F₁₄. There are virtually no regional emissions detected at Jungfraujoch. So far, no significant growth and inter-hemispheric gradient can be seen.

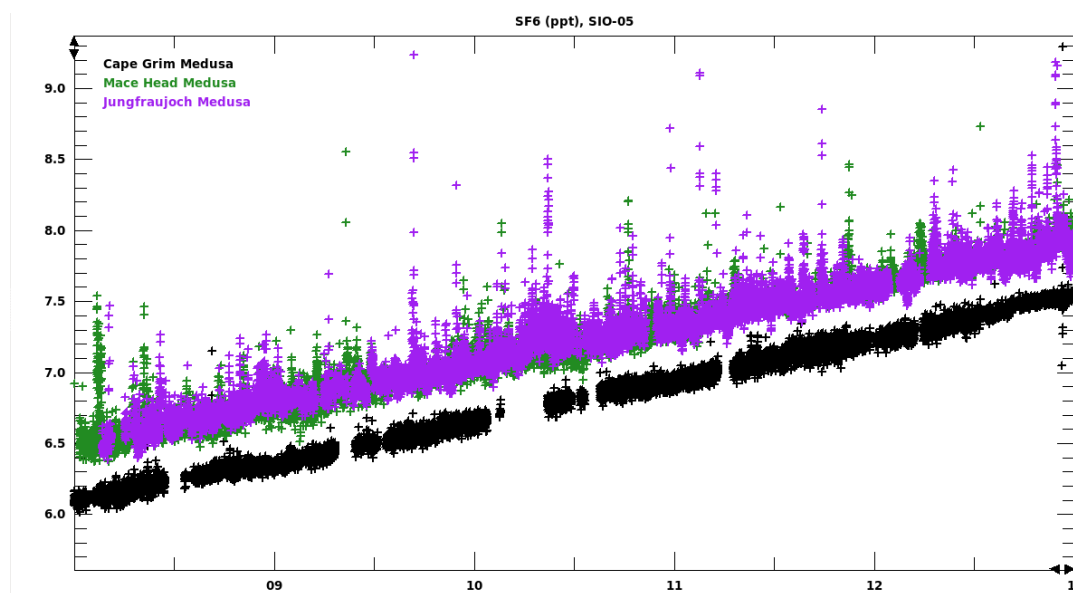


Figure 6. Same as Fig. 1 but for SF₆. The atmospheric growth rate is ~4%/yr. There is a pronounced difference between the southern and the northern hemisphere, and both Jungfraujoch and Mace Head measurements show frequent regional pollution events.

Key words:

Halogenated ozone-depletion substances (ODS), greenhouse gases (GHG), perfluorinated carbons (PFCs)

Internet data bases:

URL: <http://empa.ch/abt134>

URL: <http://agage.eas.gatech.edu>

Collaborating partners/networks:

Bundesamt für Umwelt (BAFU) / Federal Office for the Environment (FOEN)
Global Atmosphere Watch (GAW), World Meteorological Organization (WMO)
Advanced Global Atmospheric Gases Experiment (AGAGE)

Scientific publications and public outreach 2012:

Refereed journal articles and their internet access

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Conference papers

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Brunner, D., The evolution of methyl bromide and other halocarbon emissions in Europe estimated by an extended Kalman filter/2012 ACCENT-IGAC-GEIA Conference, Toulouse, France, June 11-13, 2012.

Buchmann, B., S. Reimann, Atmospheric measurements for emission estimation: Real-world Emission Verification of Halogenated Greenhouse Gases, SBSTA Science meeting, Bonn, Germany, May 13, 2012.

Reimann, S., Global and Regional F-gas emissions, SPARC-SSC meeting, Zuerich, Switzerland, February 9, 2012.

Reimann, S., Re-evaluation of lifetime of ozone-depleting substances within SPARC/ESRL/NOAA annual meeting, Boulder, USA, May 17, 2012.

Reimann, S., VOCs in AGAGE/VOC WMO expert meeting, York, UK, September 12, 2012.

Reimann, S. Evolution of Emissions of Ozone Depleting Substances in Europe, 25th Anniversary of the Montreal Protocol, WMO, Geneva, Switzerland, November 11, 2012.

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http://www.empa.ch/plugin/template/empa/*/124295

Radio and television

Interview with Stefan Reimann, SRF1, «Einstein» 21. Juni 2012 / Emissionen-Schwindel in Italien
<http://www.srf.ch/sendungen/einstein/emmissionen-schwindel-dampfer-lotti-pilzkur-fuer-himbeeren>

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