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## Annual Activity Report 2018 of WCC-Empa

The Global Atmosphere Watch (GAW) programme, coordinated by the World Meteorological Organization (WMO), is a truly international endeavour driven by the need to understand and control the increasing influence of human activity on the global atmosphere. Several hundreds of registered stations contribute to the GAW programme. GAW data from all over the globe need to be consistent, traceable to common reference scales, of known and adequate quality, and require appropriate documentation. Meeting these quality objectives is essential to properly address the spatial and temporal variability of atmospheric composition in order to allow for retrieving robust averages, detecting regional gradients and long-term trends, and for verification of models and satellite retrievals.

Within GAW, an elaborate quality management framework was developed to achieve these goals. In support of the programme, central facilities responsible for quality control, scientific and technical guidance and data hosting and dissemination of the global network were established. Empa, in collaboration with MeteoSwiss, is running the World Calibration Centre for Surface Ozone, Carbon Monoxide, Methane and Carbon Dioxide (WCC-Empa) as a contribution to the GAW programme since 1996. The main task of WCC-Empa is to perform system- and performance audits at GAW stations to ensure traceability within the network, but also to provide technical and scientific support in general. This is done in close collaboration with the Quality Assurance/Science Activity Centre Switzerland (QA/SAC-CH) also hosted by Empa. This report gives an overview of the activities of WCC-Empa for the year 2018.

### 1. System- and performance audits

The following GAW stations were audited in 2018:

Mt. Cimone (CMN)	O <sub>3</sub> , CO, CH <sub>4</sub> , CO <sub>2</sub> and N <sub>2</sub> O	2 <sup>nd</sup> audit
Mace Head (MHD)	O <sub>3</sub> , CO, CH <sub>4</sub> , CO <sub>2</sub> and N <sub>2</sub> O	7 <sup>th</sup> audit

Furthermore, the following calibration and comparison activities were made in 2018 to support GAW stations and the WMO/GAW programme in general:

UBA Wien (Global GAW station Sonnblick)	O <sub>3</sub>	(calibration of O <sub>3</sub> standard)
DWD (Global GAW station Hohenpeissenberg)	O <sub>3</sub>	(calibration of O <sub>3</sub> standard)
University of Bristol, NPL (GB Regional Stations)	GHG and CO	(calibration of standards)

WCC-Empa conducted the second system- and performance audit at the global GAW station **Mt. Cimone**. The first audit by WCC-Empa in 2012 showed significant deviations in the results of several instruments and parameters, and recommendations were made to address these issues. The current audit confirmed that most of the recommendations were successfully implemented, and performance audit results significantly improved. The audit was complemented by parallel measurements for CO, CH<sub>4</sub>, and CO<sub>2</sub> over a period of one month, which revealed small differences due to different air inlet locations. Full details are given in the audit report, which can be accessed from the WCC-Empa webpage or GAW SIS.

The audit at the **Mace Head** station was made mainly due to fact that a new ozone analyser was installed. The audit confirmed the good results within the GAW data quality objectives of most parameters with the exception of CO, which remains an issue regarding calibration and stability of the instrument over time.

The above audits included a review of data series available from the corresponding World Data Centres. Furthermore, WCC-Empa requested for an update of the information available in GAWSIS. Feedback regarding some difficulties was provided to the GAWSIS management team, and issues are currently resolved.

The audits at Izaña, Ushuaia and Bukit Kototabang that were planned for 2018 could not be made in 2018 and will be postponed to 2019 due to the following reasons:

Izaña upgraded their instrumentation with a QCL instrument for N<sub>2</sub>O and CO in 2018. The new analyser had to be integrated into the operational system before the audit. Furthermore, the responsibilities in the GHG measurement programme needed to be reorganised because the PI changed position. They requested for a postponement due to the above reasons until 2019.

Bukit Kototabang purchased a new CO, CH<sub>4</sub> and CO<sub>2</sub> analyser, which was delivered and installed at the station in October 2018. This instrumentation needs to be included in the assessment by the WCC-Empa audit, which therefore had to be postponed to January 2019.

The audits at Ushuaia was not possible due to time constraints and logistical reasons and will also be postponed to 2019.

## 2. Capacity building and technical / scientific meetings

- WCC-Empa contributed to the low cost sensor statement report (Low cost sensors for the measurement of atmospheric composition: overview of topic and future applications). Empa hosted the meeting of the drafting team of 16 experts in the field of low cost sensor applications and technology to finalise the document. The recommendations were published as a WMO report (see below).
- WCC-Empa, together with QA/SAC Switzerland, trained operators of the Kenya Meteorological Department and the GAW station Mt. Kenya in ozone and greenhouse gas measurement techniques, QA/QC and data management.
- The station operators of the Mt. Cimone GAW station were trained by WCC-Empa during the on-site audits.
- WCC-Empa contributed to the following scientific meetings:
  - Meeting of the Science Advisory Group for Reactive Gases (Update on WCC-Empa activities, oral presentation).
  - GAW activities were presented during the peer review of Empa (Poster presentation).

## 3. Technical and theoretical work / publications

**Surface Ozone:** Several inter-comparisons between Standard Reference Photometers SRP#15 and #23 were made to ensure the stability of the WCC-Empa ozone reference over time. SRP#15 was also compared externally and re-certified against the Swiss ozone reference maintained by METAS.

The ozone calibration laboratory was successfully re-accredited by the Swiss Accreditation Service according to the new ISO 17025:2017 standard, and only minor non-conformities were found, which were addressed immediately.

The electronic, hardware and software upgrade of the SRP systems announced by NIST is still in a testing phase at BIPM and has not yet released by NIST. WCC-Empa will upgrade the SRPs as soon as the upgrade becomes available.

**Greenhouse Gases and Carbon Monoxide:** WCC-Empa participated in a trilateral round robin experiment with NOAA and ICOS laboratories, which confirmed traceability of the Empa laboratory to the GAW reference. Such round robin experiments are important for the GAW programme and help to understanding measurement differences between laboratories.

WCC-Empa supported the Carbosense project (low cost CO<sub>2</sub> sensors) with calibration and knowhow regarding water vapour correction.

**Publications:** As a result of the initiative of the SAG for reactive gases and the GAW Quality Assurance session of the GAW symposium (Lewis et al., 2017), recommendations regarding the use of low cost sensors were published as a WMO report (WMO, 2018) with significant contributions of WCC-Empa and the knowhow of the Laboratory for Air Pollution / Environmental Technology at Empa.

WCC-Empa prepared a paper on "Recent advances in measurement techniques for atmospheric nitrous oxide and carbon monoxide observations", to be submitted to Atmospheric Measurement Techniques. It currently is under internal review by the co-authors, and submission is foreseen before end of March 2019.

Furthermore, WCC-Empa expertise lead also to co-authorship in another scientific publication (Fiore et al., 2018).

#### 4. Storehouse

The support of the Global Environment Facility (GEF) stations with remaining funds of the GAW GEF project continued. In 2018, funds from the storehouse project were used to supply calibration standards to the GAW station Bukit Kototabang and for returning the Mt. Kenya Picarro instrument to Empa. Currently, only CHF 4261.- are remaining for future support. An overview of the activities and the budget of the Storehouse project are available from WCC-Empa on request.

Additionally, the El Tololo GAW station was supported with the delivery of two replacement pumps to ensure continuation of measurements.

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