Three Decades of WCC-Empa Audits: Strengthening Traceability and Data Quality in the GAW Network

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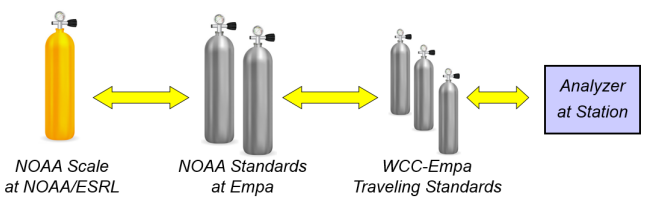
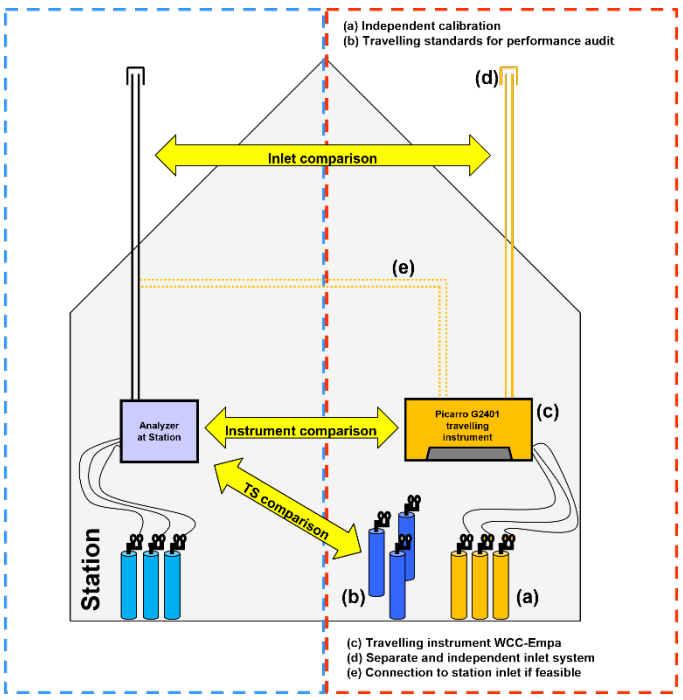
Introduction

The World Calibration Centre for Surface Ozone, Carbon Monoxide, Methane, Carbon Dioxide and Nitrous Oxide (WCC-Empa) is operated by Empa since 1996 as a Swiss contribution to the WMO/GAW programme. To date, more than 120 audits were made, mainly at global GAW stations. The aim of these audits is to ensure traceability to a common reference [1], and to increase the quality and the availability of the measured data.

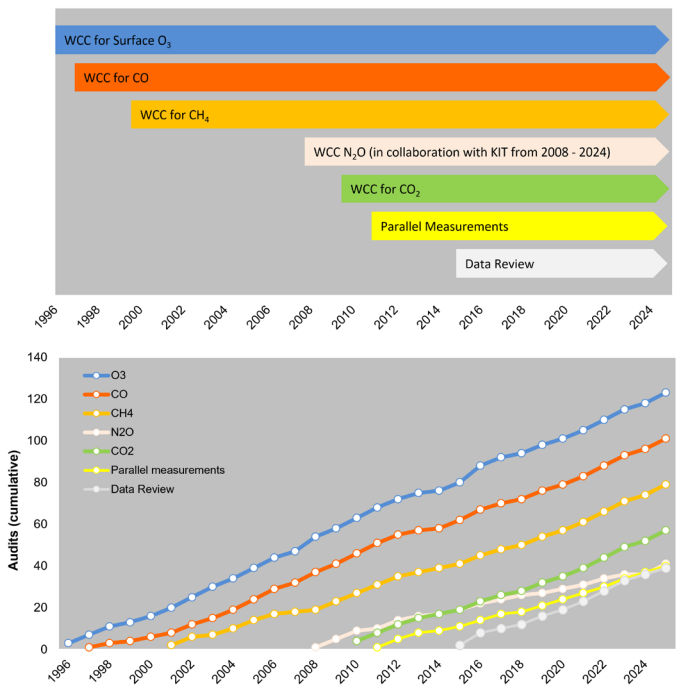


Traceability chain (schematic).

WCC-Empa collaborated with the World Calibration Centre for N_2O from 2008 – 2024, and officially became the WCC for N_2O in 2025.

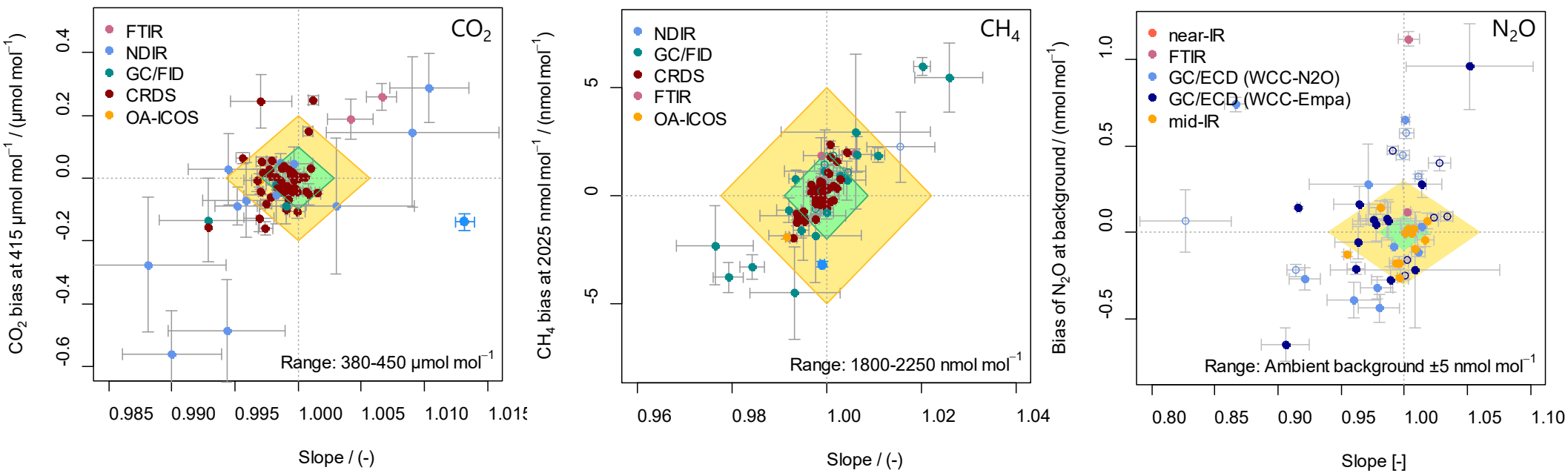


Audit setup with travelling standards and travelling analyzer.



Scope and history of WCC-Empa audits.

Selected results and achievements for GHG measurements

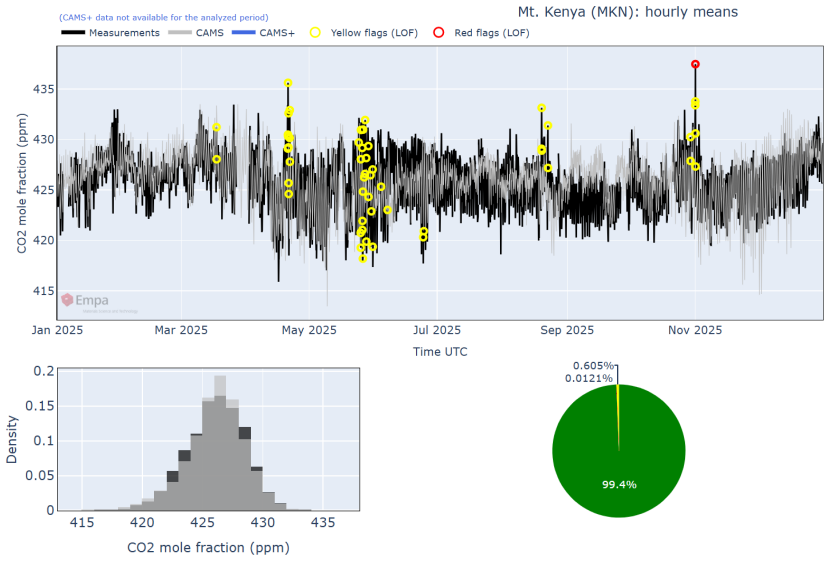


Bias in the centre of the relevant amount fraction range vs. the slope of the performance audit for individual travelling standard comparisons involving different analysers for CO_2 (left), CH_4 (middle) and N_2O (right). The dots: WCC and station measurements on the same calibration scales. Open dots: Different calibration scales. coloured areas correspond to the WMO/GAW compatibility (green) and extended compatibility (yellow) goals. Filled

- Extended dataset allows to assess network-wide performance, see summary for CO_2, CH_4 and N_2O audits above.
- The method of comparing results from different audits was developed by Zellweger et al. [2, 3].
- CO_2, CH_4 and data quality improved significantly in recent years.
- Recent laser spectroscopy based techniques show better results compared to more traditional instrumentation (NDIR for CO_2, GC/FID for CH_4).
- Reaching the WMO/GAW compatibility goals remains challenging for N_2O.
- For N_2O, progress has been made using spectroscopic techniques, but the uncertainty of standard gases is one of the limiting factors for further improvement.

Training, Capacity Building and Twinning

- WCC-Empa regularly trains station staff during audits, and it is involved in training activities together with the Quality Assurance/Scientific Activity Centre Switzerland (QA/SAC-CH).
- Training and capacity building activities help to improve the availability of greenhouse gas measurements in data sparse regions of the world.
- The example of Mount Kenya shows the success of a long-term sustainable partnership among Empa, MeteoSwiss and the Kenyan Meteorological Department.
- QA/SAC-CH and WCC-Empa are also engaged in supporting stations in Chile, Vietnam, and Kyrgyzstan.



Mt. Kenya hourly CO_2 data of 2025, checked with the GAW-QC tool (see also separate poster). The pie chart shows the fraction of normal (green) and anomalous (yellow) data.

Empa and MeteoSwiss training at Mt. Kenya in 2021

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References

[1] Buchmann, B., et al. (2009), Chimia, 63(10), 657-660.
[2] Zellweger, C., et al. (2016), Atmos. Meas. Tech., 9, 4737-4757.
[2] Zellweger, C., et al. (2019), Atmos. Meas. Tech., 12, 5863–5878.

Acknowledgements

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