Flask comparison on Jungfraujoch

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1. Project description

The flask sampling for the intercomparison between Max Planck Institute Jena (MPI) and the University of Bern (UBE) was ongoing during the reporting period. For UBE, flasks were taken every week and measurements are available until the end of 2019. For MPI flasks data are updated until August 2019.
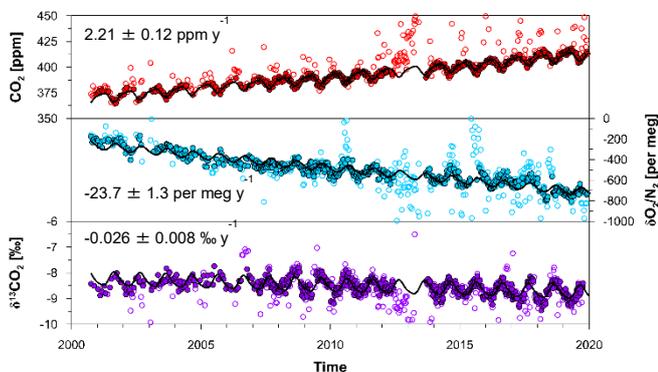

Figure 1. CO_2, O_2 and $\delta^{13}C$ values as measured by the University of Bern. Circles correspond to all measurements, filled circles are filtered values (outlier corrected). Black lines are harmonic fits. Trends are given with the corresponding uncertainties.

As obvious from Figure 1, there were increasing periods of problems associated with the flask sampling and their measurements, in particular for oxygen. These difficulties are due to the sampling itself (leaky lines, leaky cooling traps) but also to the flask measurements that were partly done with quite some delay due to instrumental failures in the laboratory at Bern as already discussed in previous activity reports. Yet the long term trend values of 2.21 ± 0.12 ppm y^{-1}, -23.7 ± 1.3 per meg y^{-1}, -0.026 ± 0.008 ‰ y^{-1} for CO_2, O_2 and $\delta^{13}C$, calculated on the filtered data (filled circles), are robust and agree well with trends of the in-situ measurements, in particular for CO_2.

Figure 2 shows the comparison between filtered values of the UBE and the MPI values. The overall agreement looks fine. But as shown in Figure 3, the differences are exceeding the compatibility goals documented in the GGMT expert recommendation, which are 0.2 ppm, 10 per meg and 0.1 ‰ for CO_2, O_2 and $\delta^{13}C$ for an extended network, i.e. flask measurements.
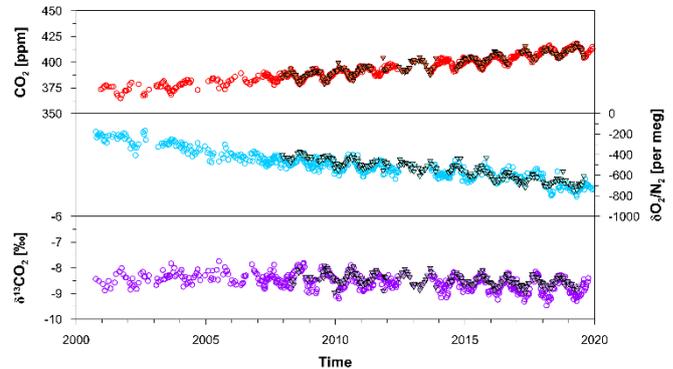

Figure 2. CO_2, O_2 and $\delta^{13}C$ values as measured by both laboratories University of Bern (circles) and MPI-BGC Jena (triangles).
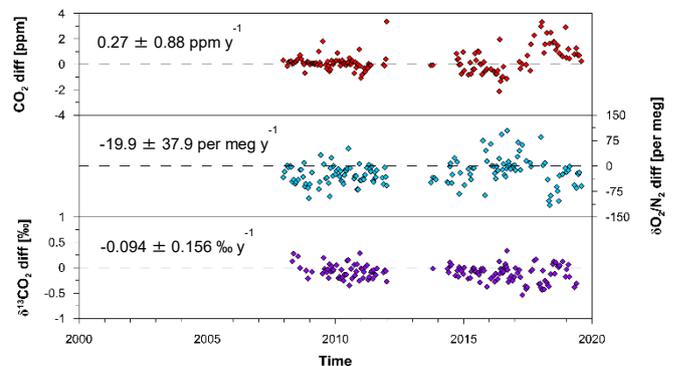

Figure 3. Differences (UBE − MPI) of CO_2, O_2 and $\delta^{13}C$ values.

Figure 4. Flask sampler for the ICOS-Station Jungfraujoch.

In 2019 many different tests with the ICOS flask sampler have been performed in the laboratory at the University of Bern, using ICOS flasks that had been refurbished by the manufacturer to eliminate leaks that had been detected previously [ref. Activity Report 2018]. First of all, we had to come up with a test design of two sampling lines, with and without the flask sampler to test the filling procedures planned for ICOS. These two layouts are sketched in Figures 5 and 6.
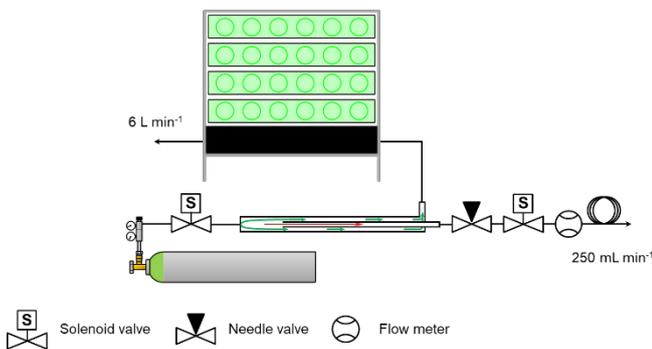

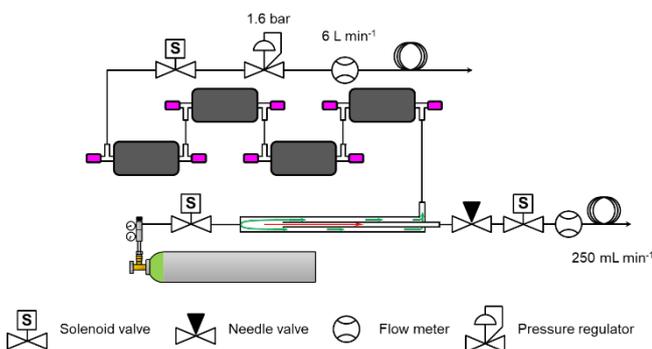*Figure 5. Setup for the ICOS-flask sampler tests.*

Figure 6. Setup for ICOS flask tests without flask sampler.

Results of the parallel sampled flasks without the flask sampler are shown in Figure 7. The values are in very good agreement with the assigned cylinder value with uncertainties below the WMO compatibility (CO_2) (or extended (O_2/N_2)) goals (see Table 1, Figure 10). Similarly, the results using the flask sampler, displayed in Figure 8 and 9, are well reproducible. Interestingly, overall uncertainties are smaller for the 1/t compared to constant flow sampling. Yet, whether the 1/t sampling is superior on the long run needs to be investigated since only a few measurements have been performed so far. It requires a robust and reliable functioning of the built-in mass flow controller of the ICOS flask sampler. Overall, the flask sampler is ready to be installed at Jungfraujoch once the final tests

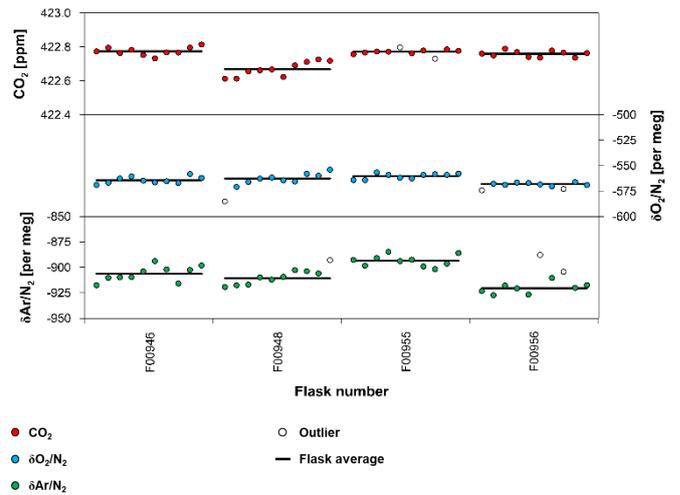with the cooling device have been passed that will be used as air drying unit.

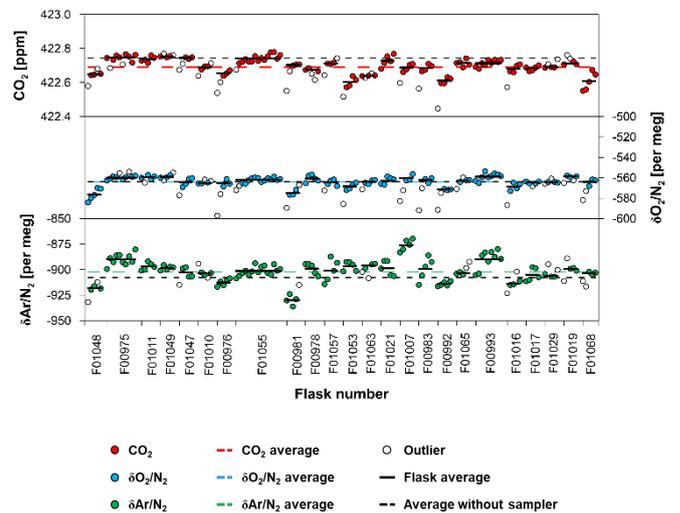*Figure 7. Results of parallel sampled flasks without flask sampler.*

Figure 8. Results of flask sampler sampling using a constant flow (10 x exchange).
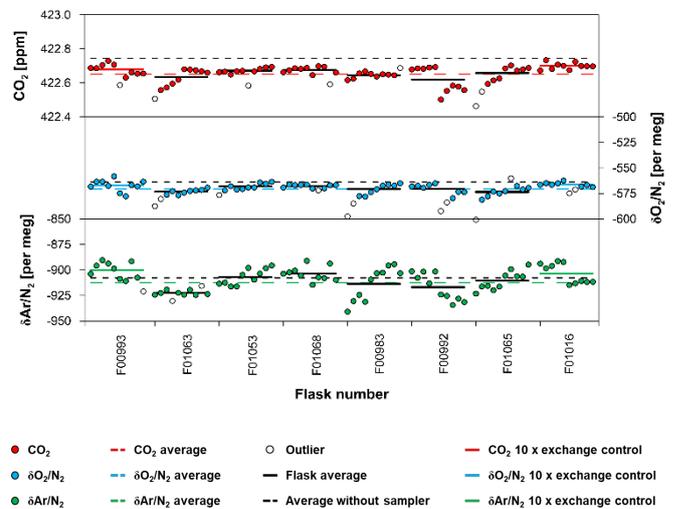

Figure 9. Results of flask sampler based on sampling with 1/t method for 15 minutes.
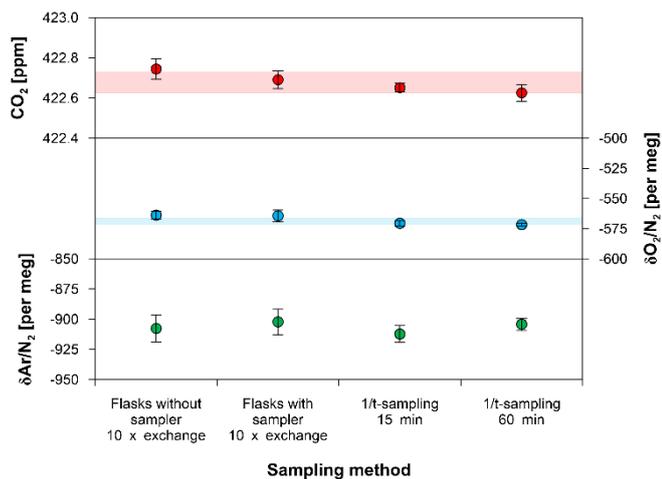
Figure 10. Summary of results.

	CO_2 [ppm]	O_2/N_2 [per meg]	Ar/N_2 [per meg]
Flasks without sampler (10 x exchange)	422.74 ± 0.05	-563.8. ± 3.2	-907.8 ± 11.1
Flasks with sampler (10 x exchange)	422.69 ± 0.04	-564.3 ± 4.8	-902.3 ± 10.5
Flasks with sampler 1/t 15 min	422.65 ± 0.02	-570.7 ± 2.4	-912.4 ± 6.9
Flasks with sampler 1/t 60 min	422.63 ± 0.04	-571.8 ± 1.3	-904.3 ± 4.9

Table 1. Summary of results of these tests. The measured values are matching or are very close to the WMO compatibility goals.

References

19th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and Related Measurement Techniques (GGMT-2017), GAW Report- No. 242, edited by A. Crotwell and M. Steinbacher, 2018.

Collaborating partners / networks

Prof. H. Chen and H. Meijer, University of Groningen
Internationale Stiftung Hochalpine Forschungsstationen Jungfraujoch und Gornergrat (HFSJG)
Oeschger Centre for Climate Change Research, University of Bern
ICOS-RI partners
ICOS-CH partners

Scientific publications and public outreach 2019

Conference Papers

Schibig, M., P. Nyfeler, M. Leuenberger, ICOS flask sampler tests in Bern, ICOS Atmospheric Monitoring Station Assembly (MSA) Meeting, CNR at Bologna, Italy, November 18-20, 2019.

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