Evaluation of strategies for assessing CO_2 inter-laboratory offsets

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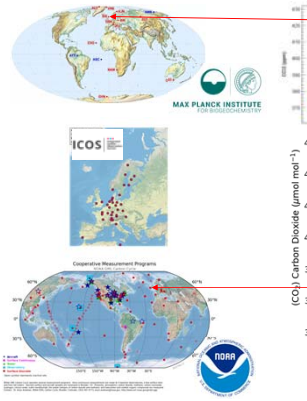
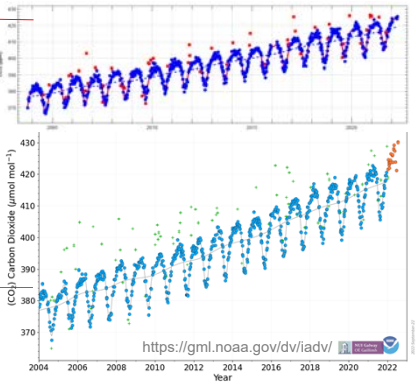
Integrated Carbon Observation System – Research Infrastructure (ICOS-RI)

Background

Several laboratories contribute to global monitoring of greenhouse gases. These are used by inverse models to understand the global carbon cycle. The quality of the outcome of such inverse models depends on the spatial and temporal density of such data series such that combined data sets are needed. This requires good compatibility of the different data. A compatibility target of 0.1 µmol/mol has been set for the NH. The success of achieving this target needs to be proven by comparison measurements.



Subset of networks for CO_2 observations



CO_2 records of Shetland Isles and Mace Head from MPI-BGC and NOAA-GML

Comparison Approaches

Common comparison methods used are:

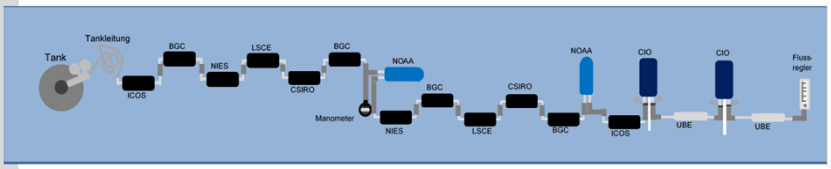
- Round Robins using high pressure cylinders
- Shared flasks from individual sites
- co-located sampling at shared sites

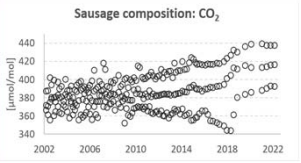
These vary in frequency, their validity in representing flask measurement offsets of the entire network and the number of comparison partners involved.

The "Sausage" flask intercomparison aims at providing such representative offset information over several decades.

„Sausage" Flask Comparison

Comparison Sample Preparation





Characteristics of the Sausage Comparison:

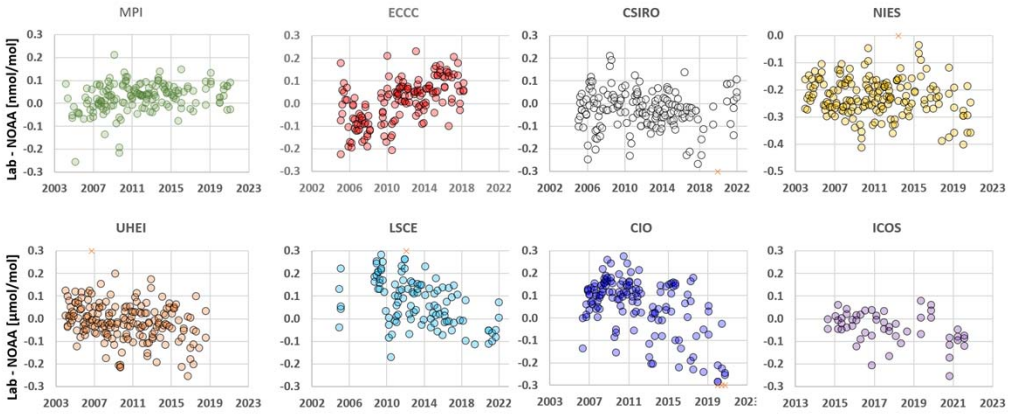
- row of connected glass flasks as used in the different sampling networks
- fill gas: cylinder of dried natural air, adjusted in GHG mole fractions flushed through row
- interval: initially bi-monthly; minimum annual; 3 levels spanning the atmospheric range
- 3 pressure levels according to the needs of the individual laboratories
- homogeneity of Sausage verified @ MPI by comparison last – first flask result
- results reported to ftp site for comparison

Participating Laboratories between 2002 - 2022

	participation period	CO_2 analyzer
Univ. Heidelberg	2002 - 2019	GC-FID
MPI BGC	2002 - 2022	GC-FID
LSCE	2002 - 2022	GC-FID/CRDS
CSIRO	2002 – 2022	GC-FID
NIES	2002 – 2022	NDIR
NOAA	2005 – 2022	NDIR / CRDS
ECCC	2005 – 2018	GC-FID
RUG-CIO	2007 – 2022	GC-FID
Univ. Bern	2007 – 2022	MS
ICOS-FCL	2014 – 2022	GC-FID

Results of Sausage CO_2 comparison

lab	mean CO_2 offset $_{lab - NOAA}$
MPI	+ 0.02 ± 0.07 µmol/mol
UHEI	- 0.01 ± 0.09 µmol/mol
CSIRO	- 0.03 ± 0.10 µmol/mol
LSCE	+ 0.08 ± 0.11 µmol/mol
NIES	- 0.23 ± 0.07 µmol/mol
ECCC	+ 0.01 ± 0.10 µmol/mol
CIO	+ 0.05 ± 0.14 µmol/mol
ICOS	- 0.04 ± 0.07 µmol/mol



Time series of CO_2 measurement offset in Sausage sample results of participant laboratories and NOAA-GML

NIES data on NIES-09 calibration scale; all other laboratories: WMO-CO_2 X2019

Conclusion

- good agreement over two decades
- valuable tool to identify lab problems
- for resolving < 0.1 ppm offsets careful assessment of experimental artefacts of comparison set-up required
- offsets in Sausage data and round robins may show small systematic differences
- mole fraction dependency of offset apparent in some records for limited periods

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