Importance of high-quality long-term atmospheric trace gas observations within IG³IS

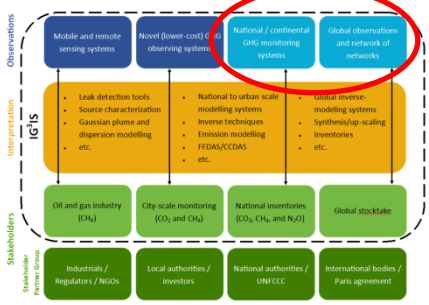
M. Steinbacher, S. Henne, D. Brunner, L. Emmenegger

Empa, Laboratory for Air Pollution / Environmental Technology, Dübendorf, Switzerland, contact: martin.steinbacher@empa.ch

The value of observations

Long-term in-situ observations of high quality will remain the backbone of greenhouse gas emission monitoring systems in the foreseeable future.

These observations provide independent information to support national emission inventory reporting to UNFCCC and Global Stocktake in agreement with the enhanced transparency framework of the Paris Agreement.

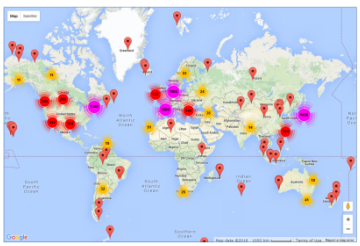


Schematic of the IG³IS framework [1].

However, data availability and accessibility varies considerably among the countries and regions.

Stations submitting CO_2 data to the World Data Centre for Greenhouse Gases [2].

The spatial inhomogeneity still exists when integrating regional or local monitoring networks, as it was done, e.g., for the Tropospheric Ozone Assessment (TOAR) [3] when data of >13'000 stations were gathered.



Map of stations in the TOAR database [4].

Augmenting the network by deploying greenhouse gas monitors at existing air quality monitoring sites can not solve the problem as most of these sites are too strongly influenced by local sources.

Tall towers have proven to be suitable platforms for providing representative observations for atmospheric inversions with atmospheric transport models [5, 6].

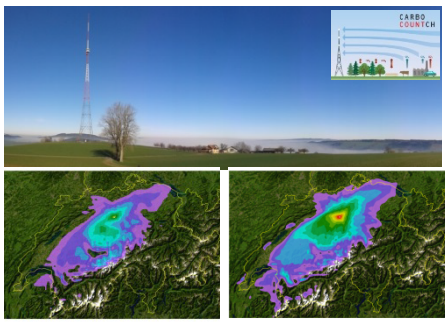
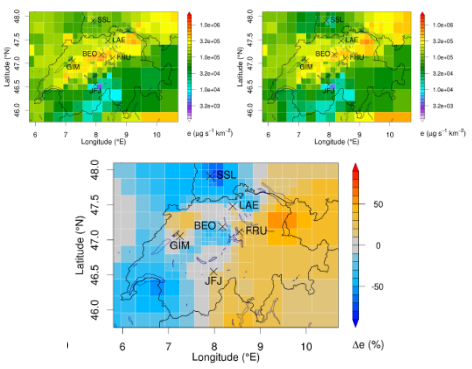


Photo of the Beromünster monitoring tower, Switzerland (top) and its annual mean footprint for a sampling height of 212 m (left) and 12 m above ground (right).

Thus, the implementation of a series of new monitoring stations will be required in many countries planning to implement the IG³IS framework.

For a small country like Switzerland, it was shown that 5 stations allow to reproduce the reported bottom-up inventory for methane, to reduce the uncertainty of the national total and to identify regions with lower or higher emissions than expected [7].



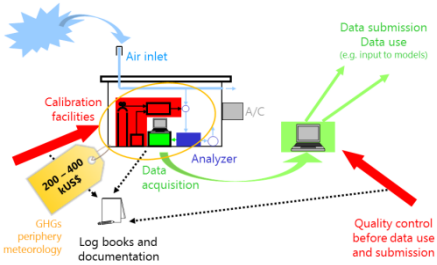
Prior (top left) and posterior (top right) CH_4 surface fluxes and the relative difference between posterior and prior (bottom). Stations providing input data for the inversions are marked with stars [7].

Required investments

Due to the long lifetime of greenhouse gases, their relative temporal and spatial variations are rather small.

Therefore, compatibility goals, understood as the scientifically-determined maximum bias among monitoring programs that can be tolerated without significantly influencing fluxes inferred by inverse modelling, are very demanding [8].

As a consequence, implemented analyzers and associated periphery need to be carefully selected, and traceability needs to be ensured through the use of calibration gases reported on common reference scales.



A schematic of an IG³IS monitoring stations including a rough estimation of investments costs for instrumentation and periphery (w/o costs for the tower and shelter).

Manpower and operational costs

Based on our experience, 6 person months per year per station of a skilled operator are needed for operation and basic data screening & processing, w/o advanced analysis.

Yearly running costs are on the order of 20'000 USD per station including instrument write-off to allow renewal of equipment every ten years.

estimated workload for station personnel

item	hours per week
station visit every other week (w/o travel)	4
trouble shooting	4
QA/QC (e.g. maintaining traceability)	4
communication (internal, external)	4
data review / flagging / analysis	4
total workload (hours per week)	20

estimated O&M cost (laser spectrometer)

item	USD per year
instrument service / pump maintenance, repair	4'500
consumables (tubing, filter, …)	500
calibration standard (1 cylinder per year)	4'000
instrument write-off	10'000
total running costs (USD per year)	19'000

Estimated manpower requirements and operating costs for an IG³IS monitoring station equipped with mature state-of-the-art instrumentation.

[1] IG3IS webpage [2] https://gaw.kishou.go.jp/ [3] http://www.igacproject.org/activities/TOAR [4] Schultz et al. (2017), Elementa, 5, http://doi.org/10.1525/elementa.244 [5] Stanley et al. (2018), Atm. Meas. Tech., 11, https://doi.org/10.5194/amt-11-1437-2018 [6] Palmer et al., (2018), Atm. Chem. Phys., 18, https://doi.org/10.5194/acp-18-11753-2018 [7] Henne et al. (2016), Atmos. Chem. Phys., 16, https://doi.org/10.5194/acp-16-3683-2016 [8] WMO/GAW (2016), report #229, https://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html.