

# Needs for satellite validation of GreenHouse (related) Gases, CO<sub>2</sub>, CH<sub>4</sub> and CO

*(focus on total column products)*

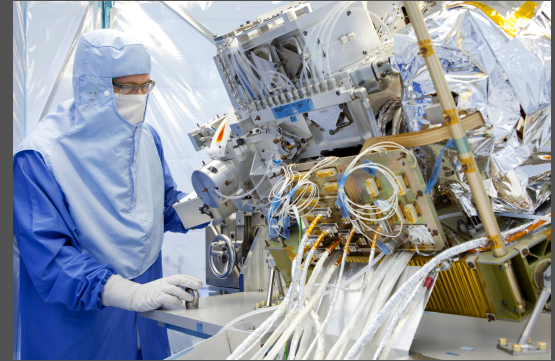
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# My background :

- Co-PI SCIAMACHY and TROPOMI/S5P (satellite instruments)  
**TROPOMI/S5P : launch 2016**, responsible for the operational CO and CH<sub>4</sub> total column products  
(P = precursor, 3x Sentinel-5 2020-2040)



- Partner of ESA's CCI project on GHGs (deliver tot. col. CO<sub>2</sub>, CH<sub>4</sub> ECV core algorithms)
- Delivery of GOSAT CH<sub>4</sub> to MACC/CAMS



esa GHG-CCI

The GHG-CCI project of ESA's Climate Change Initiative:

Michael Buchwitz,  
Institute of Environmental Physics (IUP),  
University of Bremen, Bremen, Germany  
and the GHG-CCI team

Partners: Universität Bremen, University of Leicester, SRON, DLR, LMD, KIT, European Commission, FastOpt, LSCE, EMPA, and others.

- Research on Carbon cycle (CO<sub>2</sub>, CO<sub>4</sub>, CO)

# Structural funding networks

For GHG total columns satellite validation the backbone is the TCCON network (for CO this also includes NDACC)

## **NEED for (long term) structural funding of the networks**

In fact already stations in Europe are under threat of closing down next year

‘Just keeping things running’ is not considered very sexy, therefore hard to obtain funding, most stations European PIs go from project to project funding. Not a healthy/stable basis for a network.

Main problem I see : no entity in Europe feels responsible to fund the network, although I see various stakeholders (ESA, national space agencies, CAMS, C3S?, research, EEA ?, ...) → **this needs to be solved because it blocks any discussion on additional needs wrt TCCON data in Europe**

# Rapid/fast (preliminary) data delivery

- TCCON stations guarantee delivery of data within 1 year.
- For satellite validation preferably use 1 year of data

This means that we have a first validated satellite data product after 2 years in the mission (1-2 years) (mission only lasts 5-7 yrs)

- For a number of users this is (almost) useless (unacceptable)

**NEED** : Satellite validation requires rapid delivery of (preliminary) data from the gr.based networks -in particular in the beginning of the mission- to establish asap quality of data products

Will use CAMS forecasts (or analysis) to do a first check as this is available. NOT optimal.

*(satellite data is delivered NRT(3hrs) or in few days - OFL)*



# Extension of TCCON network

- Need to measure in regions that are not/hardly sampled & critical retrieval conditions :

TROPICS, Africa, Samerica, Russia, middle East, ...high/low albedo, H<sub>2</sub>O, SZA



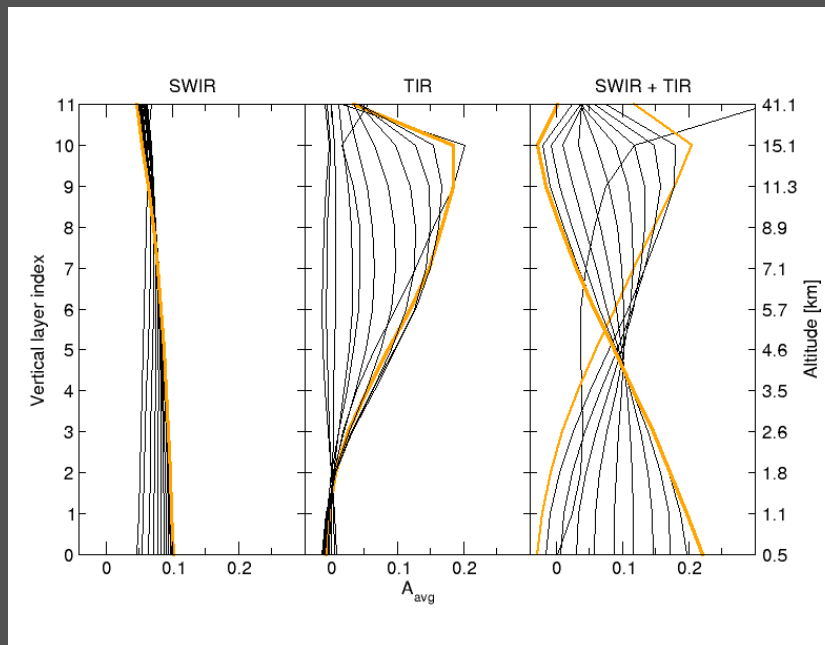
Interesting developments : smaller, cheaper, low infrastructure needs, portable low resolution spectrometers such as EM27/SUN (CH<sub>4</sub>, CO<sub>2</sub>), to be used in addition to TCCON (campaigns, remote areas, ships, traveling reference Autonomous operation ? Traceable calibration essential



*Hase et al.*

# Vertical profiles

- So far total columns, but TIR measurements provide height sensitive information (free troposphere)
- Moreover, aim is to combine total column meas. with TIR to get more information on the lower parts of the atmosphere (like MOPITT for CO, GOSAT, S5P/Cris, IASI NG/S5, ....)
- **Need : high vertical resolution measurements for validation (limited data available – aircrafts)**



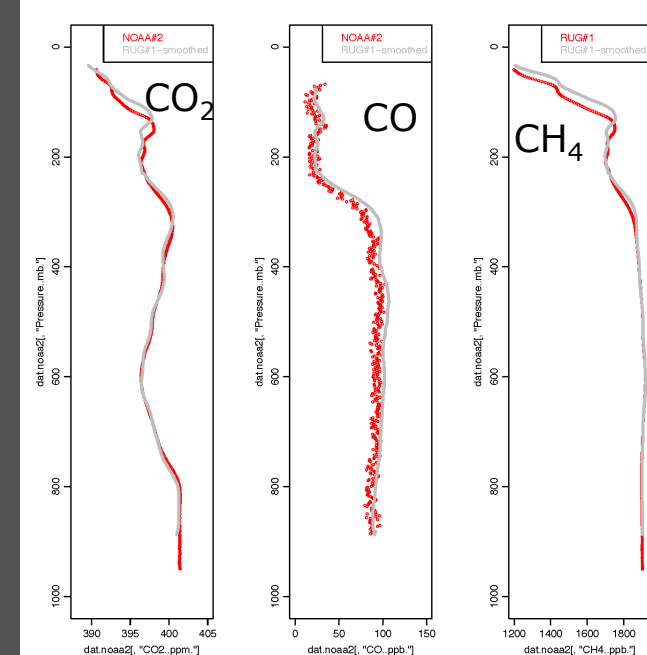
# New promising development : AIRCORE



*Karion et al, 2010*



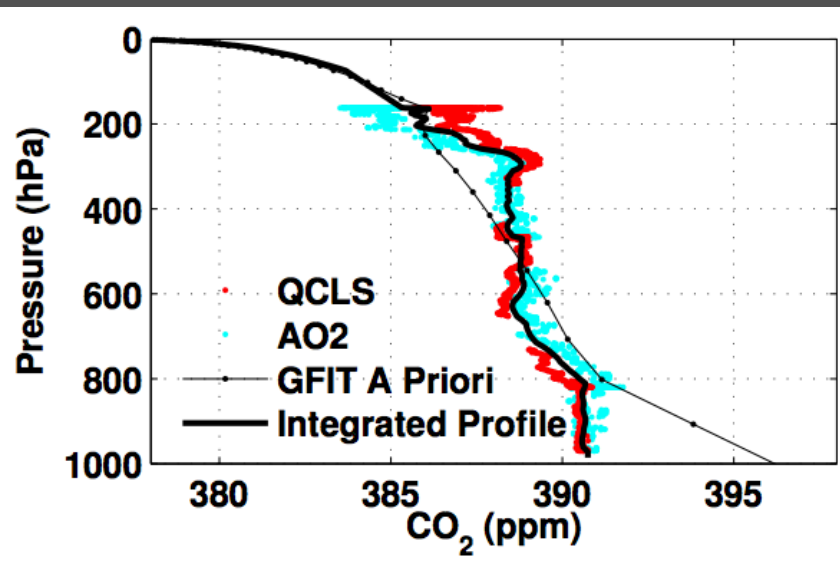
*Chen et al.*



- AIRCORE is a **promising** new development (cheap, good accuracy), but needs 1) further technical developments (lightweight, glider, ...), 2) extensive validation, 3) publication of results (traceability)

# Absolute calibration of TCCON (and NDACC)

- **Need for regular absolute calibration of individual TCCON stations** (to link to WMO standards)



*Wunch et al., 2010*

In-situ aircraft measurements are used to link TCCON to the WMO-standards. (to overcome a.o. spectroscopic errors)

Aircraft only to certain height → largest error source, in particular for CH<sub>4</sub>.

Aircraft measurements costly (not often)

AIRCORE can measure higher up in stratosphere (and lower down), and because of lower cost more often.

Moreover : More vertical profile measurements at TCCON locations would further improve accuracy validation satellite total columns with TCCON



## additional (data) needs

- ECMWF : easy access to ECMWF meteo data (in particular analysis data, so not only reanalysis after 3-5 months) to research institutes (available, TBC)
- Absolute traceable calibration of NDACC CO is lacking, and intercomparisons TCCON and NDACC CO columns needed to link the networks. More locations, but mostly extend long historic dataset of CO measurements (TCCON only started in 2004).
- Validation of emissions at city level with (upcoming) high spatial resolution satellite measurements (network of low resolution spectrometers well suited, *Hase et al, 2015*)

## Summary needs :

- (long term) structural funding TCCON (and NDACC) stations - action urgently needed
- **Rapid/fast data delivery of (preliminary) TCCON data crucial for early satellite validation**
- Extension of TCCON network (geographically, retrieval critical)
- Much more vertical profile measurements for TIR (and other vertical sensitive satellite measurements)
- More regular absolute calibration of TCCON (and NDACC) and at all stations
- User friendly access to analysis ECMWF data (tbc)
- Validation of emissions at city scale (satellite spatial resol. higher)
- **Promising new developments** : AIRCORE and cheaper/portable lower resolution spectrometers (such as EM27/SUN CH<sub>4</sub>, CO<sub>2</sub>)