

Fiducial Reference Measurements for Greenhouse Gases (FRM4GHG)

M. K. Sha, M. De Mazière, C. Hermans, F. Scolas: *BIRA, Belgium*

J. Notholt, C. Petri, T. Warneke: *Uni Bremen, Germany*

H. Chen, J. Hooghiem: *Uni Groningen, Netherland*

D. Griffith, N. Jones, N. Deutscher: *Uni Wollongong, Australia*

F. Hase, T. Blumenstock, Q. Tu: *KIT, Germany*

R. Kivi, P. Heikkinen: *FMI, Finland*

D. Weidmann, A. Hoffmann, M. Huebner: *RAL, Great Britain*

A. Dehn: *ESA, Italy*

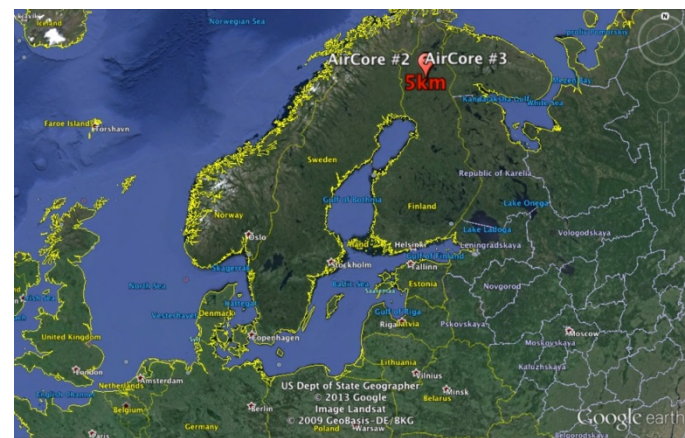
Objectives & implementation



- TCCON instrument are not portable and expensive.
- Are small, mobile, and 'cheaper' instruments able to measure GHGs (CO_2 , CH_4 , CO) with sufficient precision?



- FRM4GHG: use several different portable low-cost spectrometric instruments at a TCCON site
- Perform a detailed intercomparison
- TCCON site Sodankylä/Finland
- regular Aircore launches
- simultaneous measurements
- spring/summer/autumn 2017



Start in March 2017

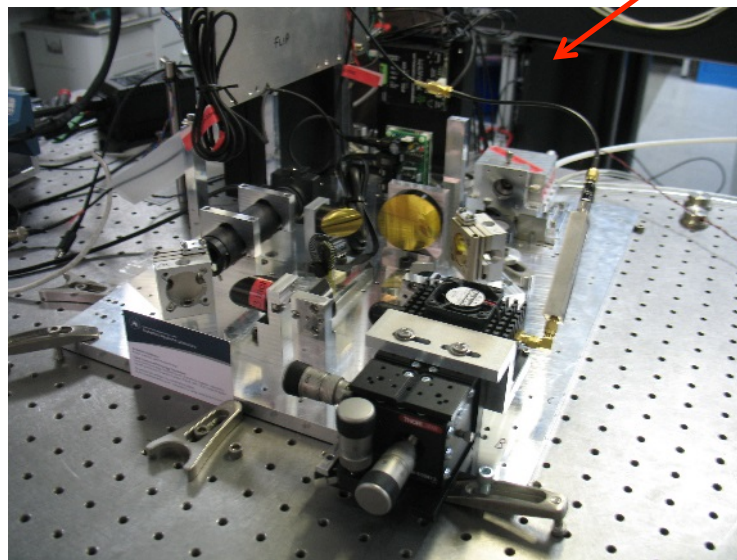
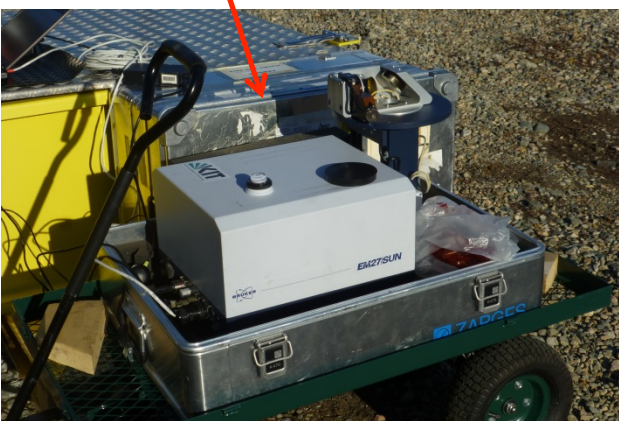
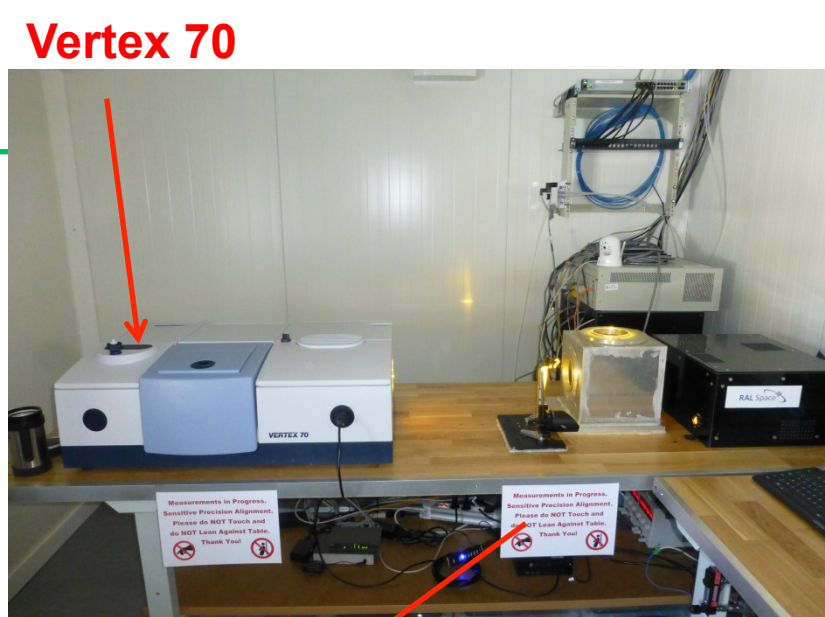
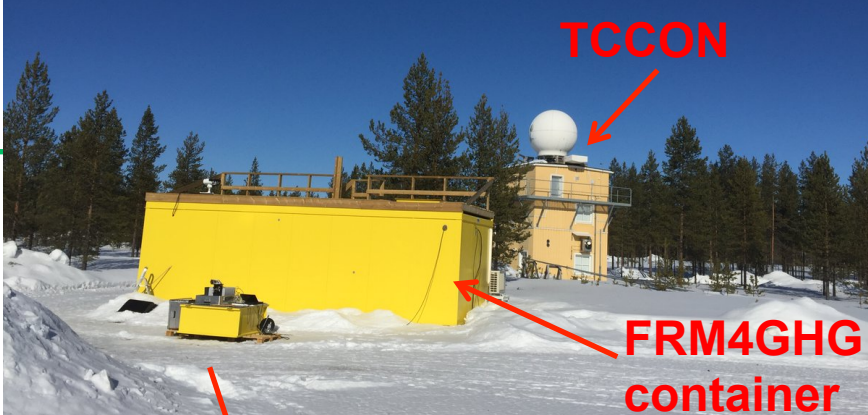


FRM4GHG team, S5PVT2 workshop at ESA/Estec 5/6 Feb 2018

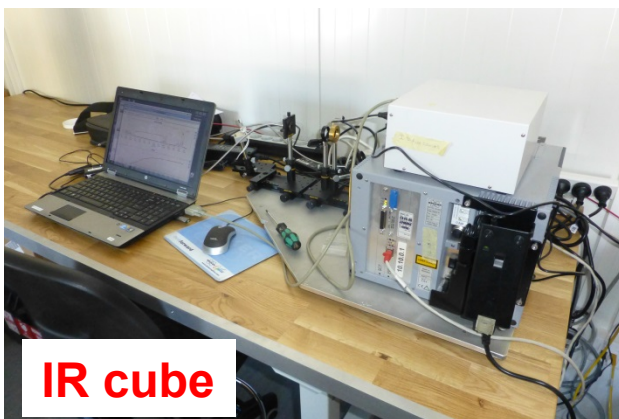
Instruments overview



Instrument	Institute	Spectral range	Resolution	Main GHGs
Bruker IFS 125HR	FMI	1800 — 15000 cm ⁻¹	0.004 cm ⁻¹	XCO ₂ , XCH ₄ , XCO @ 0.02 cm ⁻¹
Bruker Vertex 70	Uni Bremen BIRA-IASB	2500 — 15000 cm ⁻¹	0.16 cm ⁻¹	XCO ₂ , XCH ₄ , XCO
Bruker EM27/SUN	KIT	4000 — 9000 cm ⁻¹	0.5 cm ⁻¹	XCO ₂ , XCH ₄ , XCO
Bruker IR Cube	Uni Wollongong	4500—15000 cm ⁻¹	0.5 cm ⁻¹	XCO ₂ , XCH ₄
LHR (Laser Heterodyne Radiometer)	RAL	954—960 cm ⁻¹	0.002 and 0.02 cm ⁻¹	CO ₂ , H ₂ O
AirCore	Uni Groningen FMI	In-situ sampling	13.4 mbar (Amb.P. > 232 mbar)3.9 mbar (Amb.P. < 232 mbar)	CO ₂ , CH ₄ , CO vertical profiles, calibrated to WMO standards



AirCore launch

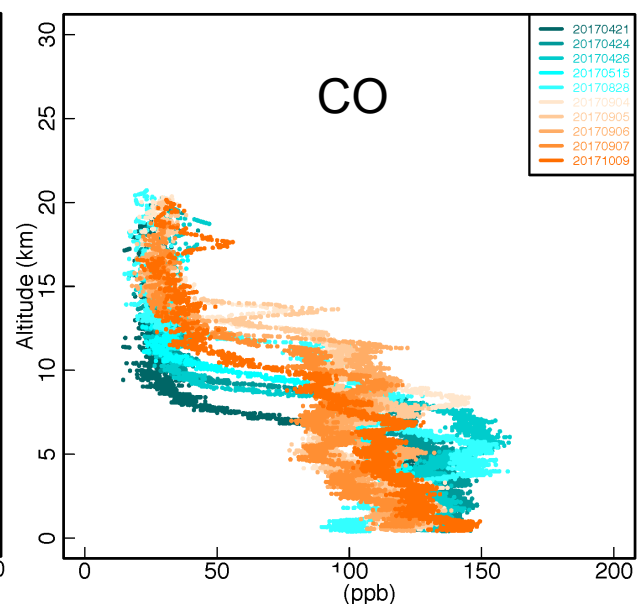
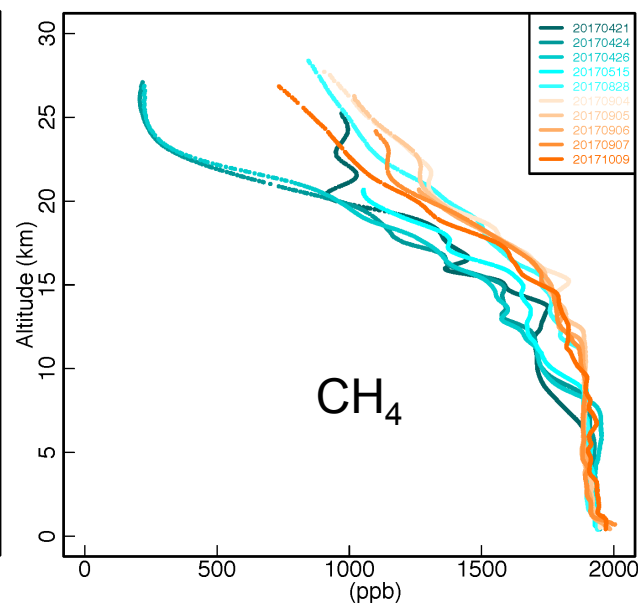
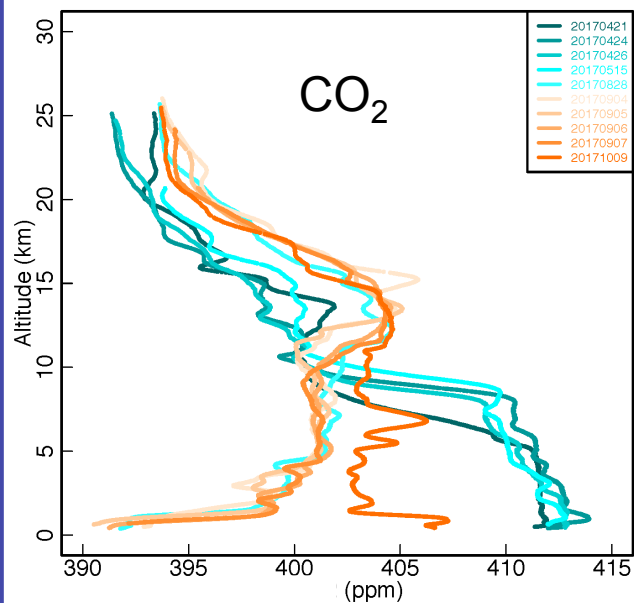


Aircore (NOAA, Karion et al., 2010)

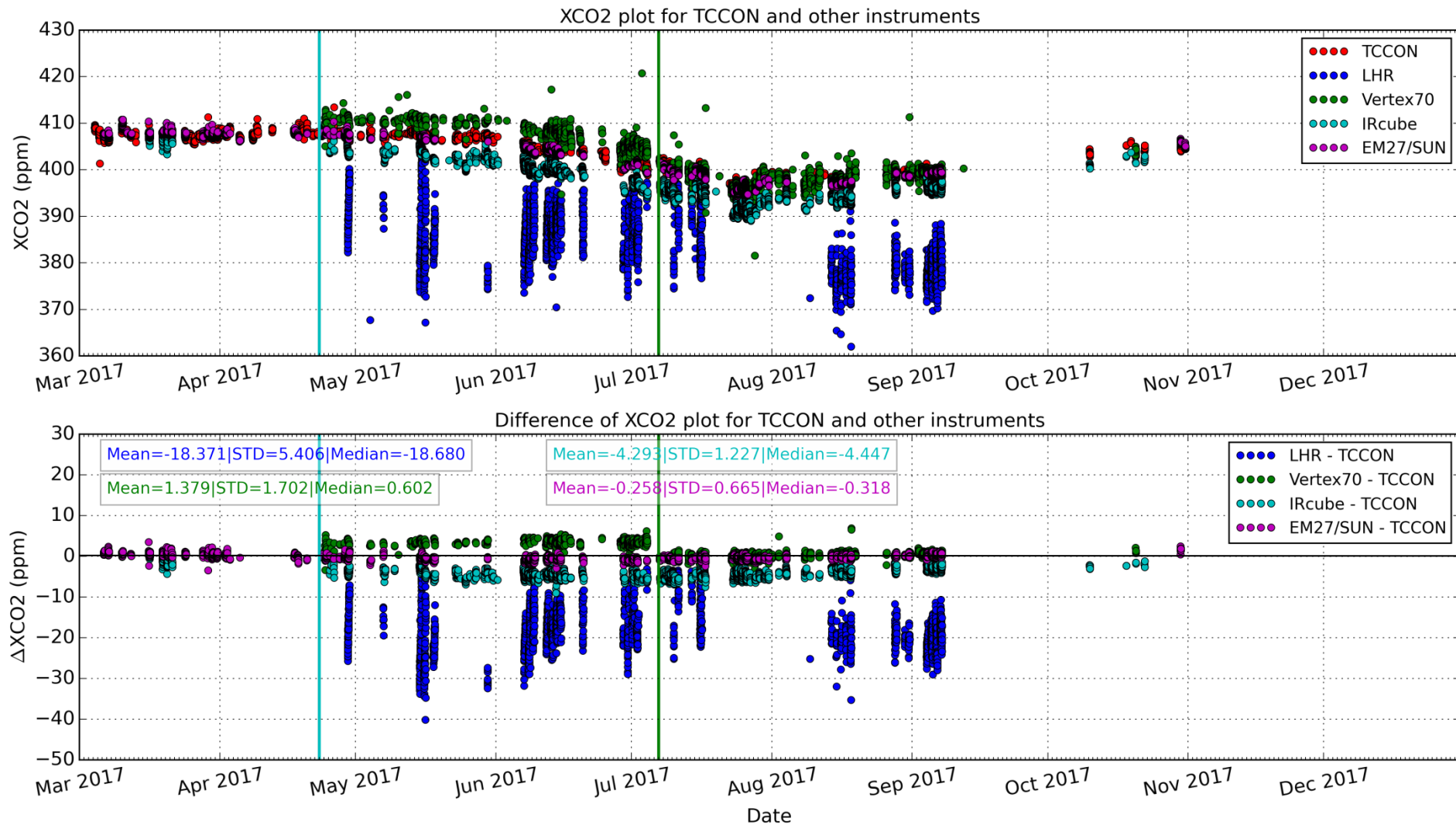


40 m (1/4" diameter) + 60 m (1/8" diameter);
coils: 2.8 kg; Total package: 3.6 kg
Up to 25 km

April – October 2017



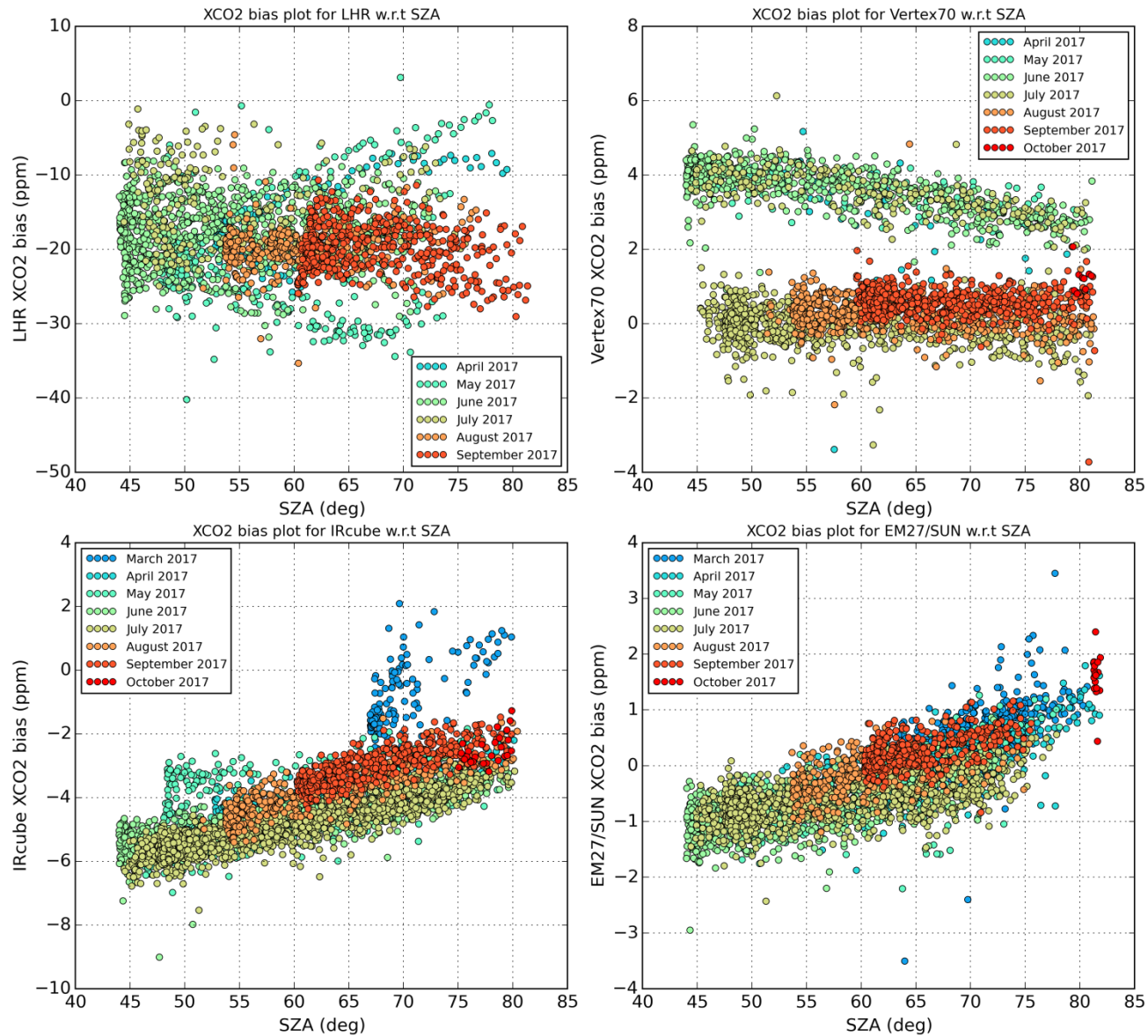
Comparison – XCO₂



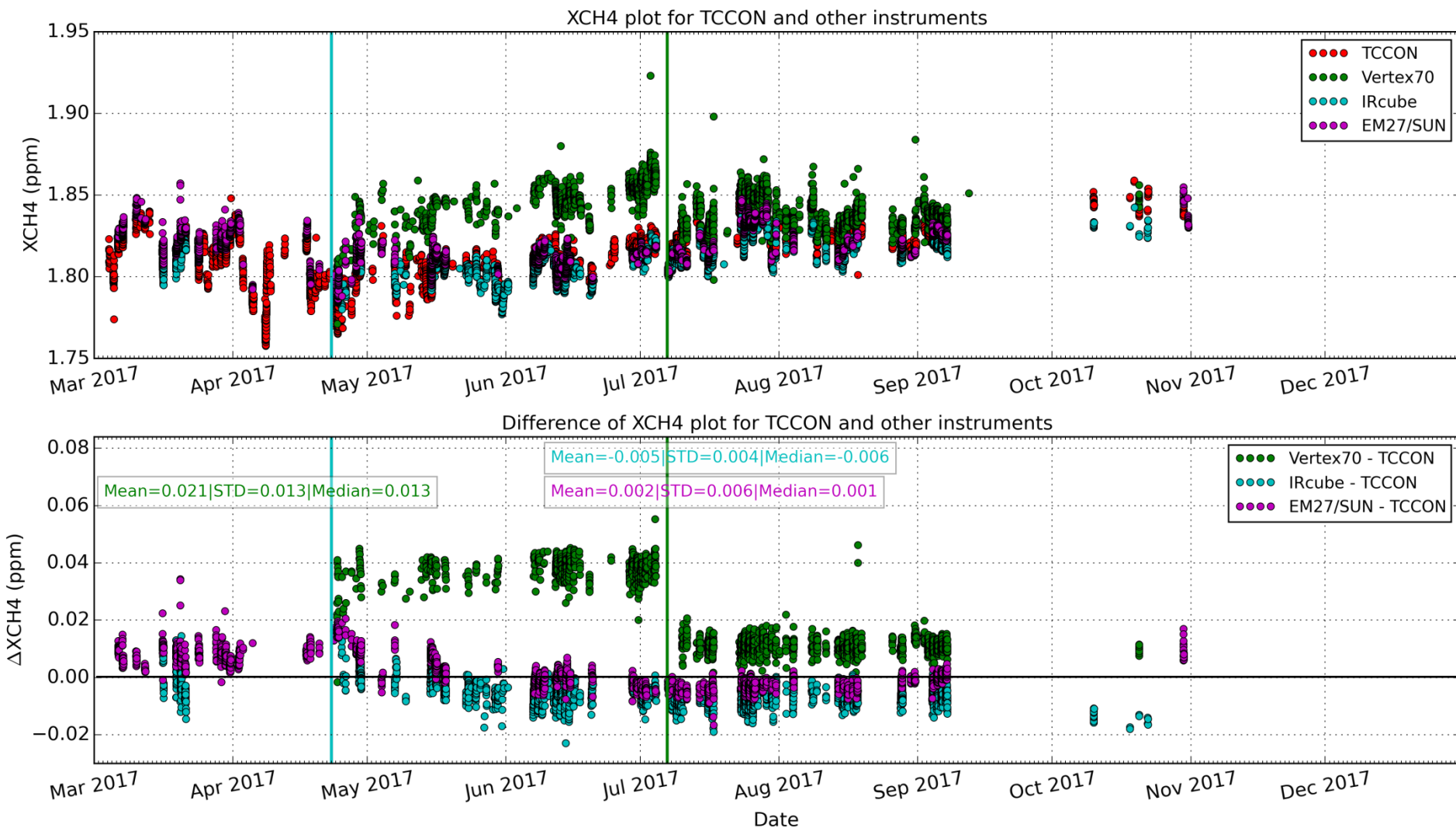
IRcube: new fiber cable installed for the solar tracker

Vertex 70: additional aperture in the parallel beam

Comparison – XCO₂



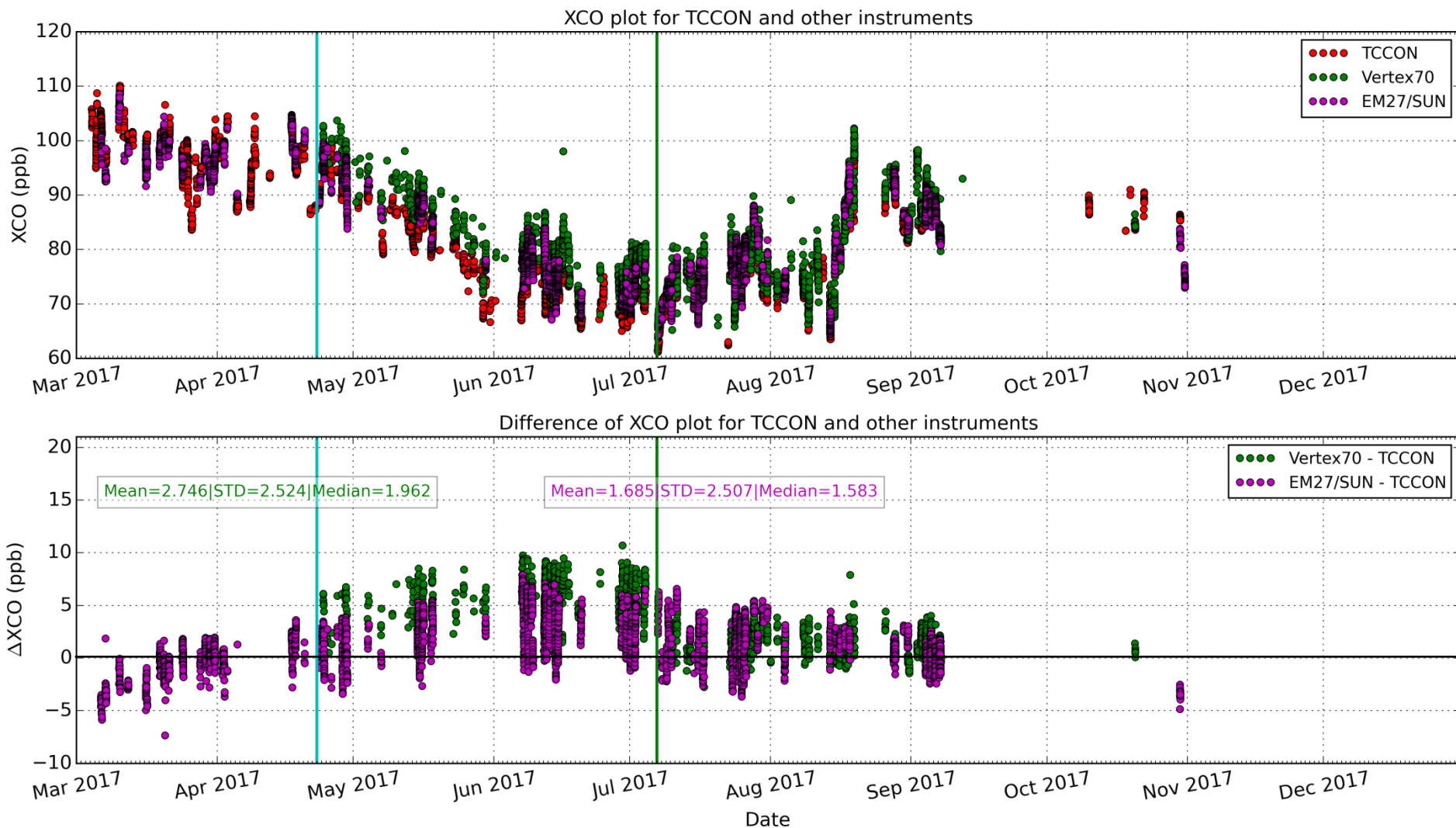
Comparison – XCH₄



IRcube: new fiber cable installed for the solar tracker

Vertex 70: installation of additional aperture in the parallel beam

Comparison – XCO

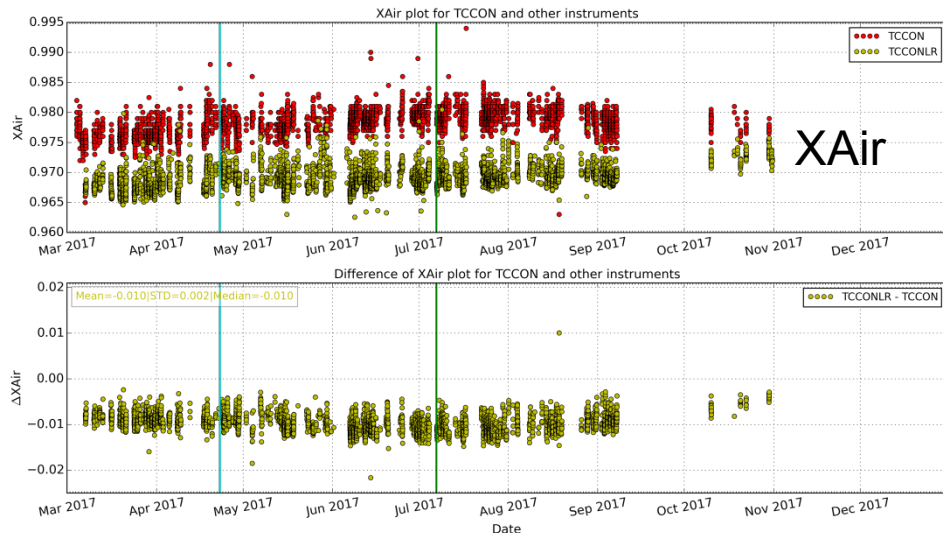
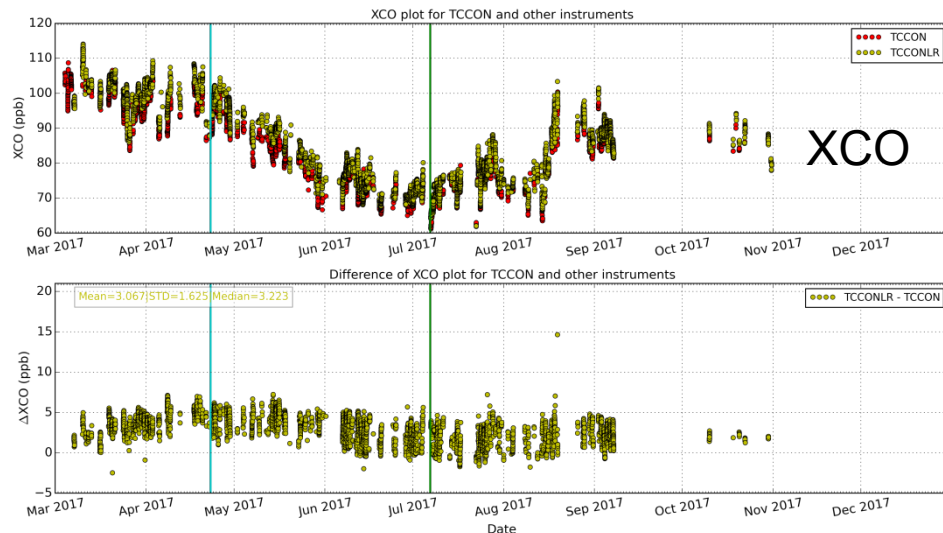
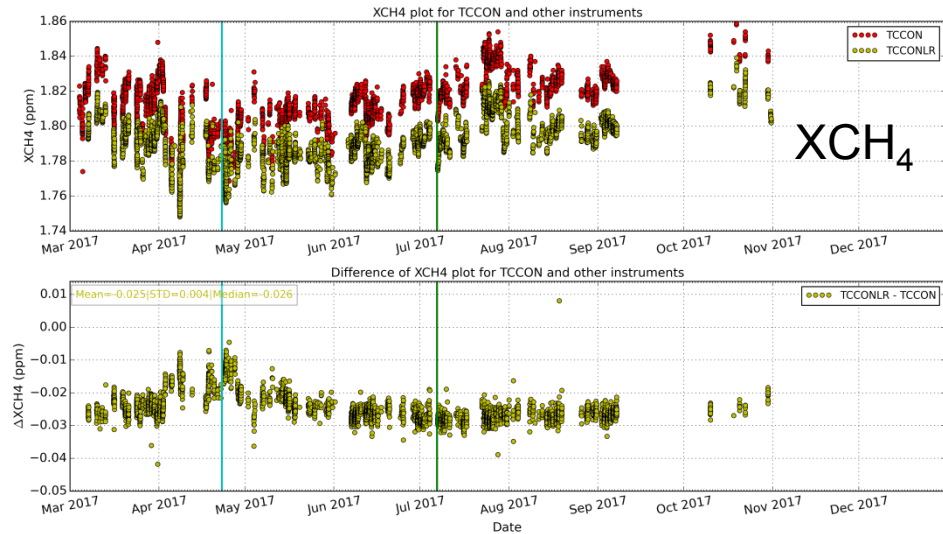
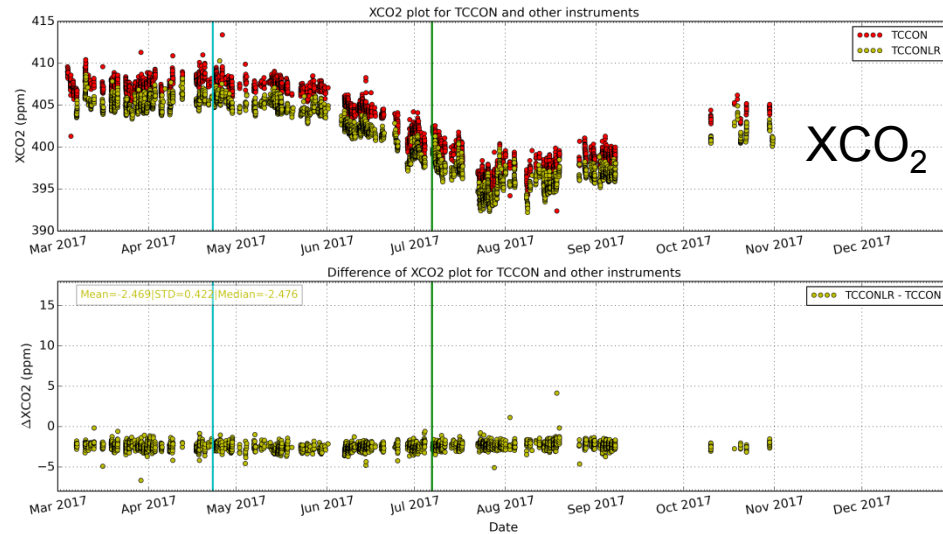


Comparison – Xair

$$XCO_2 = \frac{CO_2}{X_{air}(O_2)}$$



Comparison – TCCON vs TCCON-Low Res



- ESA-funded project FRM4GHG to intercompare several low-resolution instruments besides TCCON instrument together with Aircore launches in Sodankyla/Finland in 2017
- Instrumental setup has been improved during the campaign
- Differences exist
- Overall: Portable FTIR instruments are well suitable for satellite validation
- Phase 2 of FRM4GHG
 - campaign in 2018 (March to October) in Sodankyla/Finland
 - continue and extend the measurements
 - understand (and solve) the differences
 - provide a guideline for further development of new observation sites to complement the TCCON network
 - Add more species (N_2O , CH_2O)
 - S5P/Tropomi validation

Access to information, data and results



<http://frm4ghg.aeronomie.be>

Twitter: #frm4ghg



Poster on FRM4GHG (M. K. Sha, et al.)

Poster on S5P validation (T. Blumenstock, et al.)

Poster on COCCON (F. Hase, et al.)

Poster on TCCON fast retrieval (R. Sussmann, et al.)

Poster on TCCON4S5P (M. K. Sha, et al.)