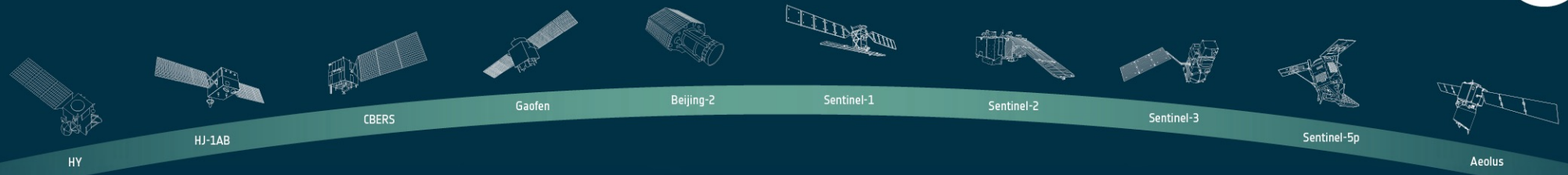
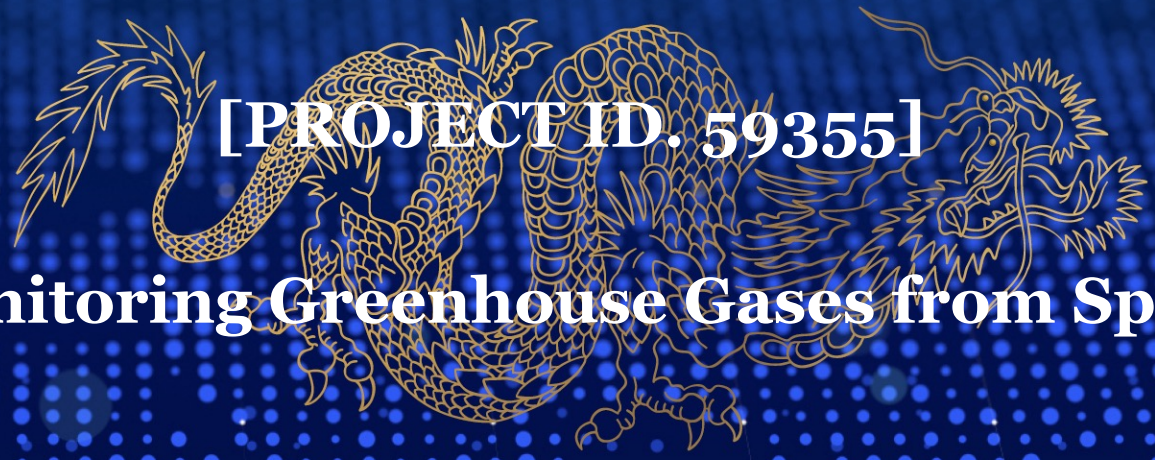


2022 DRAGON 5 SYMPOSIUM

MID-TERM RESULTS REPORTING

17-21 OCTOBER 2022



[PROJECT ID. 59355]

Monitoring Greenhouse Gases from Space

Dragon 5 Mid-term Results Project

THURSDAY, 18 OCTOBER 2022

ID. 59355

PROJECT TITLE: Monitoring Greenhouse Gases from Space

PRINCIPAL INVESTIGATORS: HARTMUT BOESCH, YI LIU

CO-AUTHORS: PAUL PALMER, LIANG FENG, ROBERT PARKER, JOHANNA TAMMINEN, HANNAKAISA LINDQVIST, ANTTI MIKKONEN, DONGXY YANG, ZHAONAN CAI, JING WANG, SIHONG ZHU

PRESENTED BY: HARTMUT BOESCH

Project Team

- University of Leicester, Leicester, UK
- University of Edinburgh, Edinburgh, UK
- Finnish Meteorological Institute, Helsinki, Finland
- Key Laboratory of the Middle Atmosphere and Global Environmental Observation, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China

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THE UNIVERSITY OF EDINBURGH

IAP CAS

FINNISH METEOROLOGICAL INSTITUTE

Project Overview

WP1: Evaluation of CO_2 and CH_4 satellite retrievals from current satellite observations (TanSat, GOSAT/-2, OCO-2/-3 and TROPOMI) using ground-based measurements

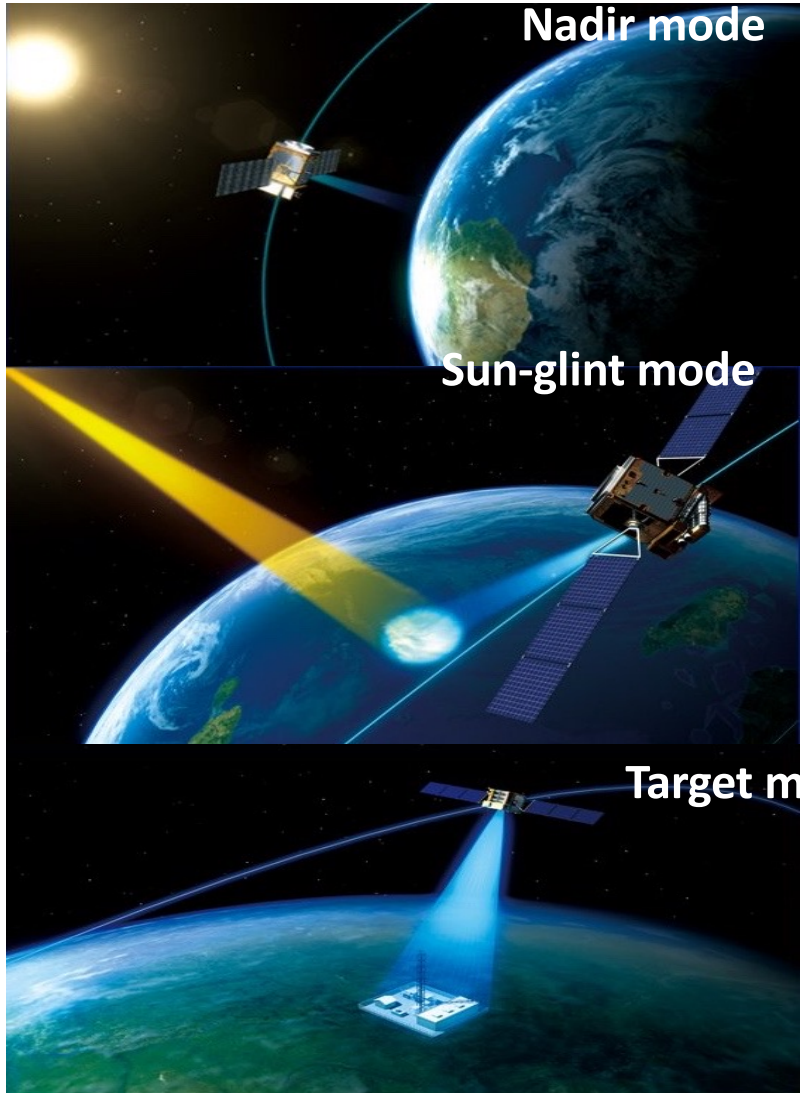
WP2: Evaluation of CO_2 and CH_4 satellite retrievals with retrieval intercomparisons and model comparisons

WP3: Flux inverse methods to assess estimates of CO_2 and CH_4 surface fluxes and emissions

Chinese Carbon Dioxide Observation Satellite (TanSat) Project

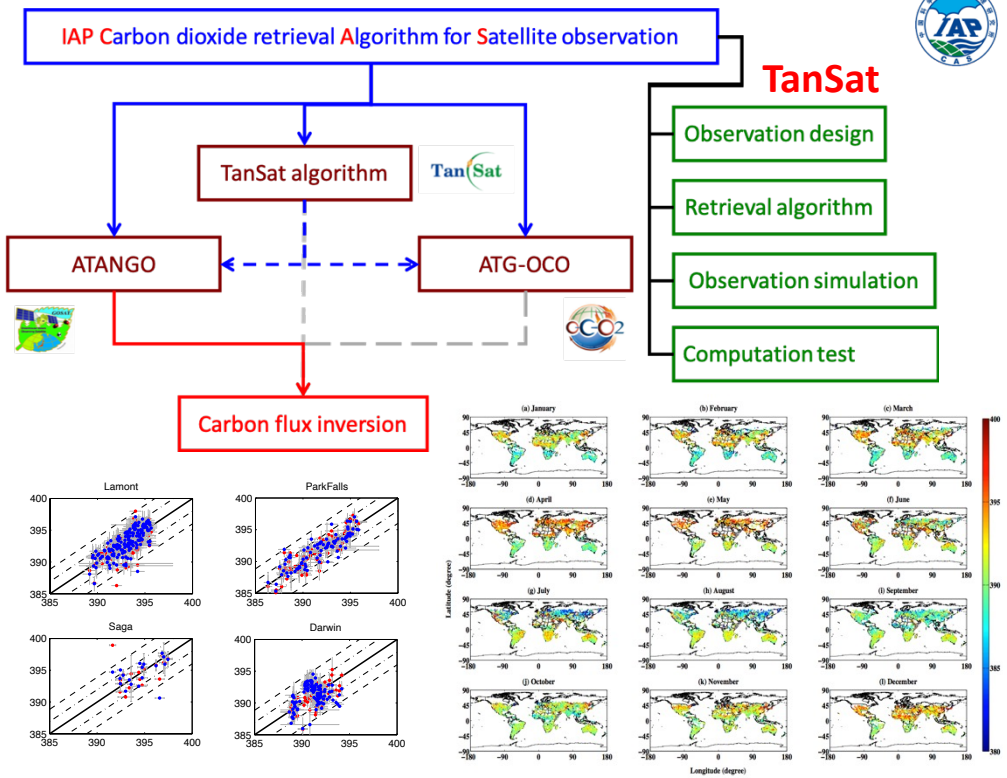
- Launched: 21 Dec 2016
- Operated until June 2018
- Goal: To measure the global Carbon Dioxide concentrations with a precision of 1 - 4 ppm on monthly scales and 500 x 500 km^2

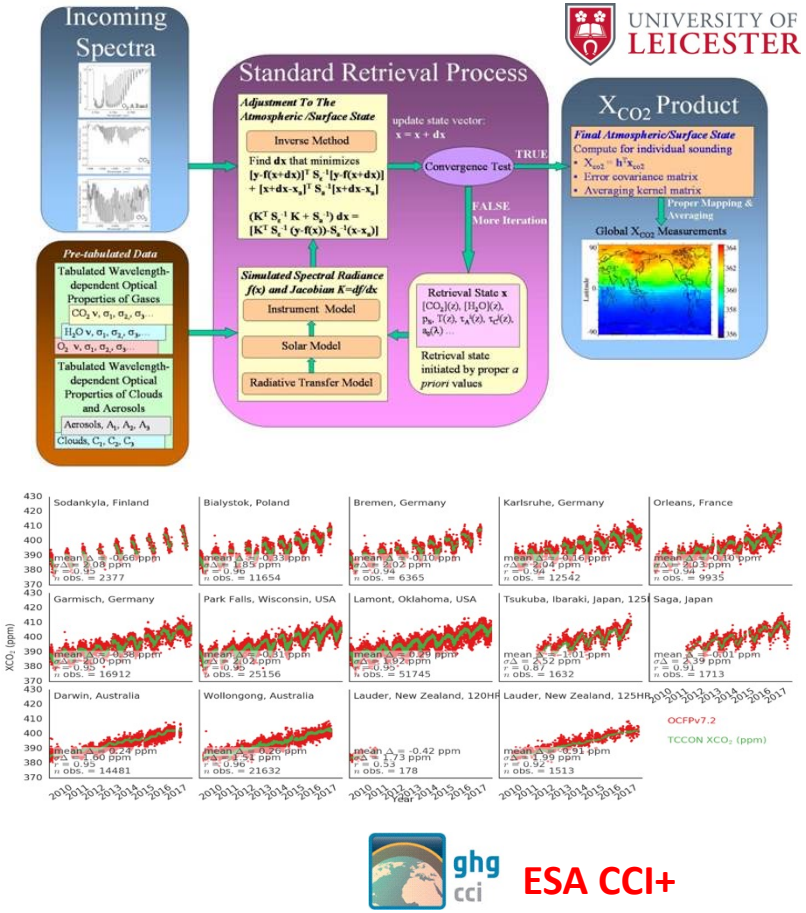
Name	Characters
Orbit type	sun-synchronous
Altitude	700 km
Inclination	98°
Local time	~ 13:30
Weight	500Kg



CO2 Retrieval Algorithms for TanSat

2 different retrieval algorithms for TanSat: IAPCAS and UoL-FP





ghg cci ESA CCI+

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CO_2 Retrieval Algorithms for TanSat

2 different retrieval algorithms for TanSat: IAPCAS and UoL-FP

ADVANCES IN ATMOSPHERIC SCIENCES, VOL. 38, JANUARY 2021, 8–11

• News & Views •

A New TanSat XCO_2 Global Product towards Climate Studies

Dongxu YANG[1,2], Yi LIU*[1,2], Hartmut BOESCH*[3,4], Lu YAO[1], Antonio DI NOIA[3,4], Zhaonan CAI[1], Naimeng LU[5], Daren LYU[1], Maohua WANG[2], Jing WANG[1], Zengshan YIN[6], and Yuquan ZHENG[7]

[1]*Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing* 100029, *China*
[2]*Shanghai Advanced Research Institute, Chinese Academy of Sciences, Shanghai* 201210, *China*
[3]*Earth Observation Science, School of Physics and Astronomy, University of Leicester, Leicestershire LE*1 7*RH, UK*
[4]*National Centre for Earth Observation, University of Leicester, Leicestershire LE*1 7*RH, UK*
[5]*National Satellite Meteorological Center, China Meteorological Administration Beijing* 100081, *China*
[6]*Shanghai Engineering Center for Microsatellites, Shanghai* 201210, *China*
[7]*Changchun Institute of Optics, Fine Mechanics and Physics, Changchun* 130033, *China*

JGR Atmospheres

Research Article | Open Access

Toward High Precision XCO_2 Retrievals From TanSat Observations: Retrieval Improvement and Validation Against TCCON Measurements

D. Yang, H. Boesch, Y. Liu, P. Somkuti, Z. Cai, X. Chen, A. Di Noia, C. Lin, N. Lu, D. Lyu, R. J. Parker, L. Tian, M. Wang, A. Webb, L. Yao, Z. Yin, Y. Zheng, N. M. Deutscher, D. W. T. Griffith ... See all authors

First published: 05 October 2020 | https://doi.org/10.1029/2020JD032794 | Citations: 9

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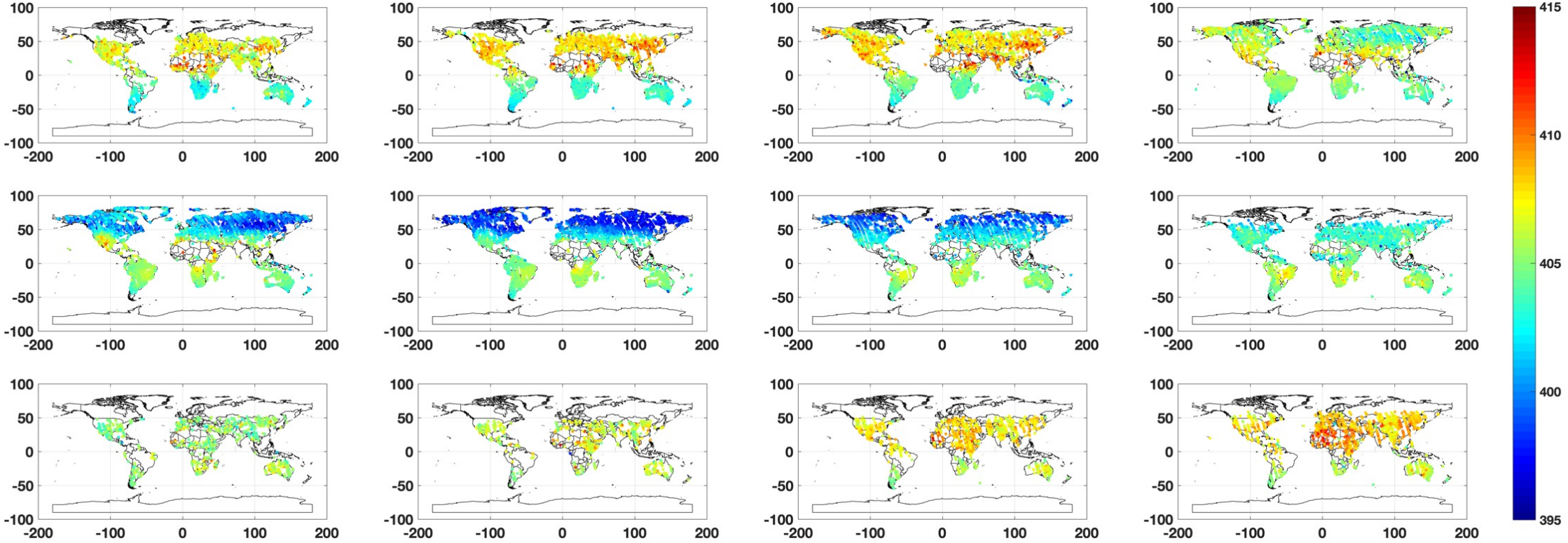
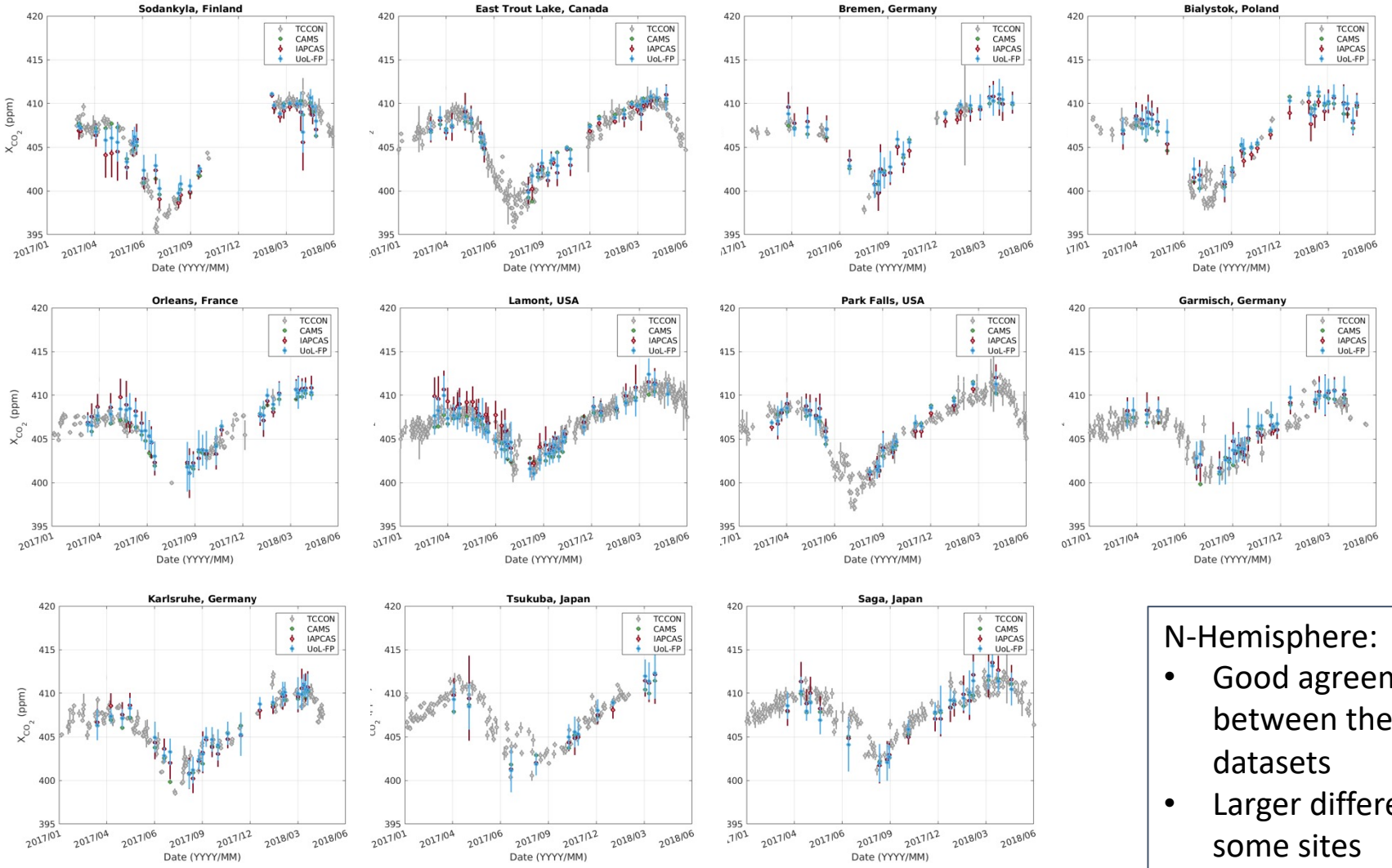
Global TanSat CO2 Data

- IAPCAS TanSat v2 data available from CASA TanSat data and science service (www.chinageoss.org/tansat)
- UoL-FP TanSat data available from ESA CCI



Evaluation against ground-based column data

- Comparison between TanSat (UoL-FP and CAS), CAMS and TCCON over 17 sites

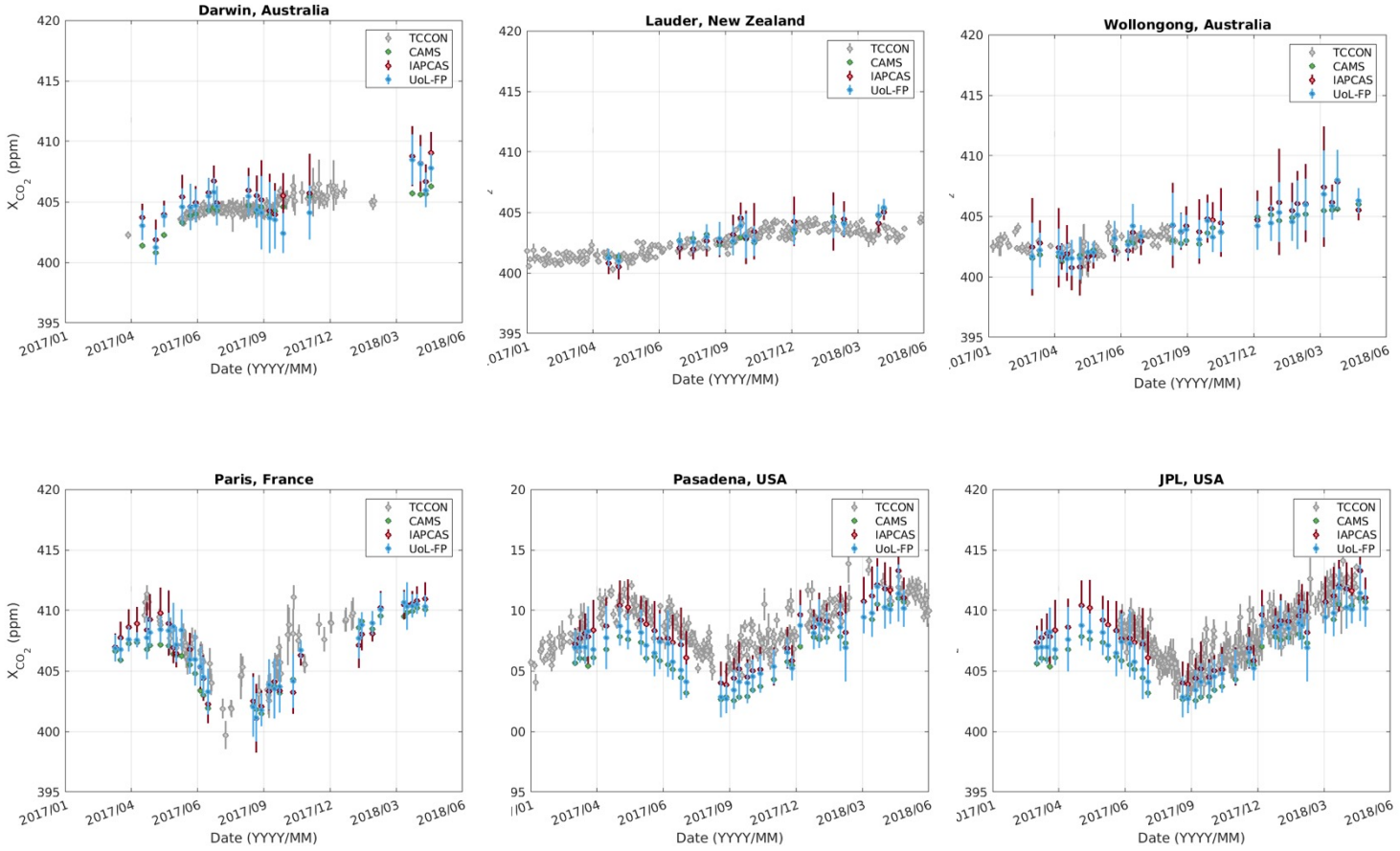


N-Hemisphere:

- Good agreement between the datasets
- Larger differences at some sites

Evaluation against ground-based column data

- Comparison between TanSat (UoL-FP and CAS), CAMS and TCCON over 17 sites



S-Hemisphere:

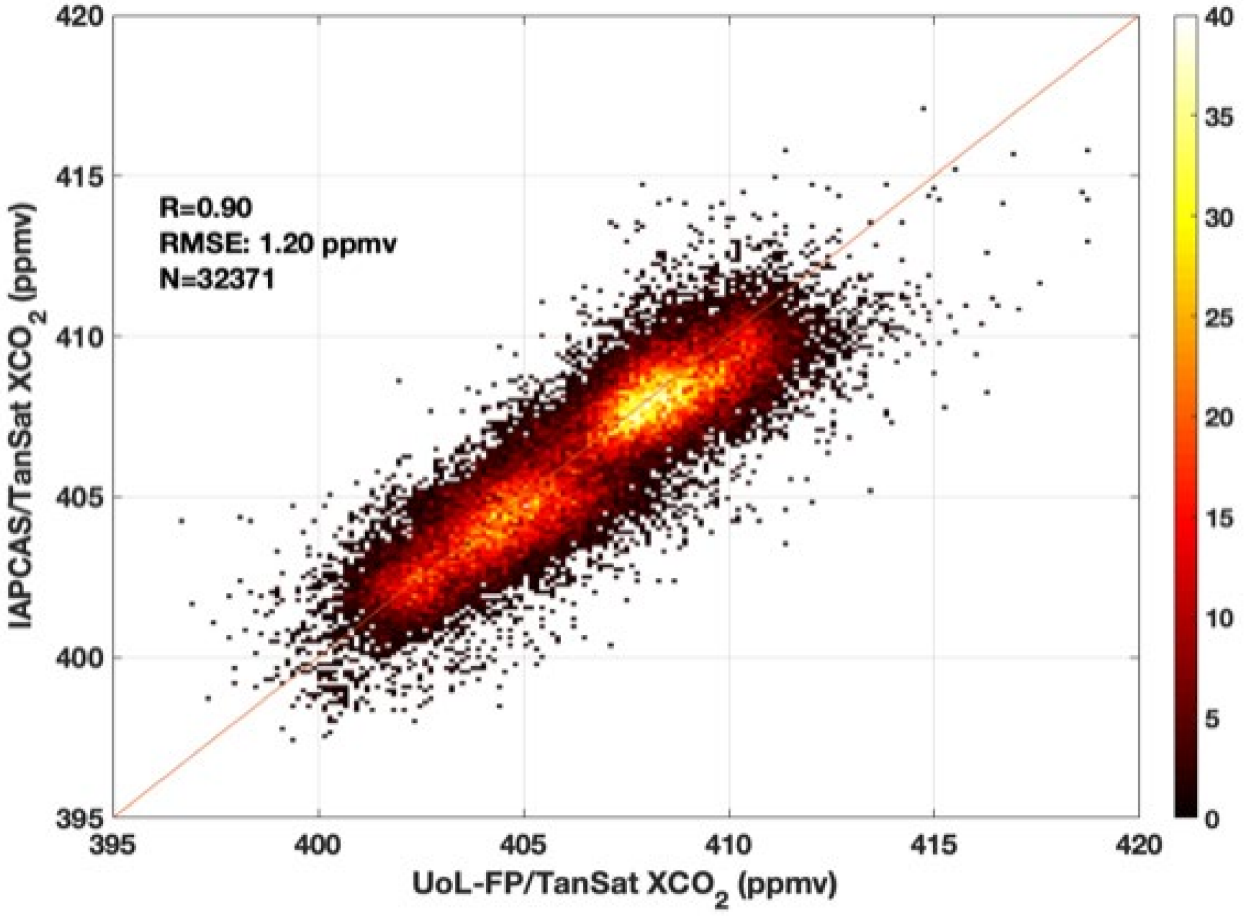
- Good agreement between the datasets
- Differences to CAMS at Darwin

Urban:

- Noticeable offset to TCCON
- Clear difference to CAMS

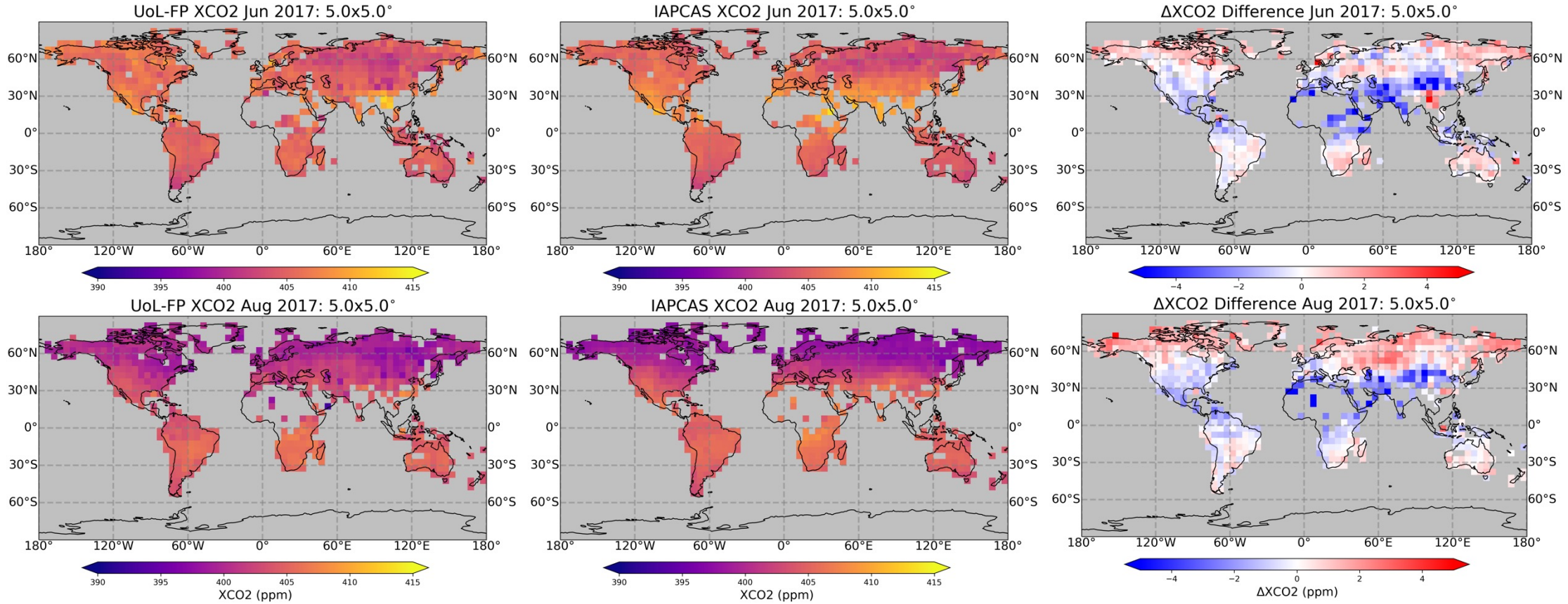
Evaluation against ground-based column data

- Comparison of UoL-FP and IAPCAS TanSat retrievals over TCCON sites



Global Comparison

- Largest differences in Tropics and Sub-Tropics (few validation sites exit)



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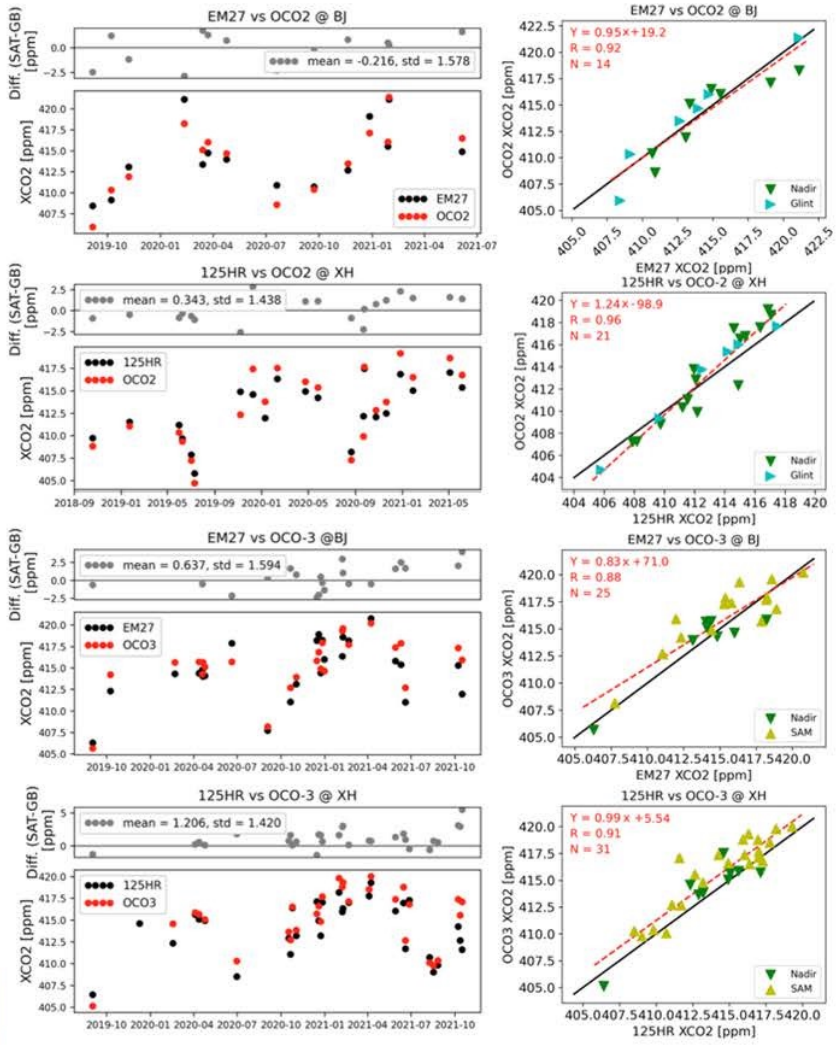
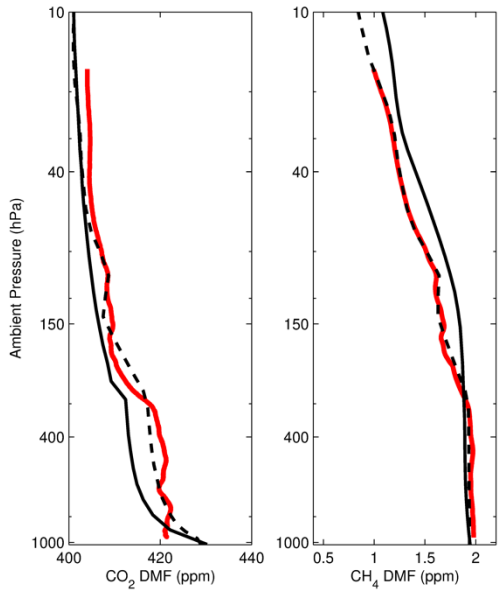
OCO-2/3 Evaluation over Beijing



Zhou, M.; Ni, Q.; Cai, Z.; Langerock, B.; Nan, W.; Yang, Y.; Che, K.; Yang, D.; Wang, T.; Liu, Y.; Wang, P. CO_2 in Beijing and Xianghe Observed by Ground-Based FTIR Column Measurements and Validation to OCO-2/3 Satellite Observations. *Remote Sens.* **2022**, *14*, 3769. https://doi.org/10.3390/rs14153769

Advances in satellite validation at the FMI Arctic Space Centre in Sodankylä, Finland

- Satellite retrieval accuracy at high latitudes is important for quantifying the boreal carbon cycle but also for constraining global fluxes.
- Seasonal coverage of observations over Sodankylä is limited by snow cover and large solar zenith angles → challenges for retrievals and therefore a suitable location for validation. (See also Dragon Young Scientist poster by Antti Mikkonen et al.)
- Planned space missions in the 20^{s} require new types of validation (e.g., SIF, emissions) but also heavily rely on the continuing support of the established validation network (TCCON, COCCON, AirCore).



Left: Sodankylä TCCON PI Dr. Rigel Kivi presenting an AirCore tubing. Right: AirCore (red line) comparisons to TCCON GGG2014 priors (black solid line) and GGG2020 priors (dashed) show that new priors are more realistic at high latitudes. Figs: R. Kivi, FMI

Table: GHG satellite biases against the Sodankylä TCCON FTS (XCO_2 in ppm, XCH_4 in ppb). Time series figures and more detailed estimates are available from H. Lindqvist, FMI.

GOSAT ACOS v9 XCO_2	GOSAT NIES v02.95 XCO_2	GOSAT NIES v02.95 XCH_4	OCO-2 ACOS B10 XCO_2	TanSat IAPCAS XCO_2	TanSat OC-FP XCO_2	TROPOMI OPER v02.02.xx XCH_4	TROPOMI WFMD v1.5 XCH_4
0.85±1.56	0.28±1.94	4.1±10.9	0.36±1.5	-0.87±2.1	-0.30±2.4	-15.0 ±19.0	-7.4±17.8
0.21 %	0.07 %	0.22 %	0.09 %	-0.21 %	0.07 %	-0.81 %	-0.4 %

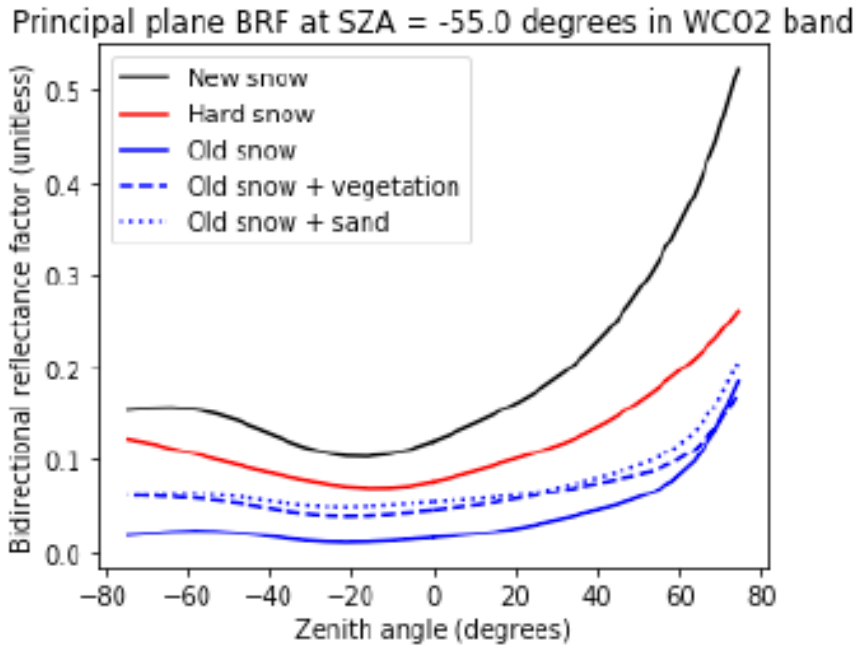
Ongoing and recent campaign activities in Sodankylä include:

- ESA SNOWITE
- ESA FRM4GHG 2.0
- ESA WIFVOS and WIFVOS-CCN
- ESA Land Carbon Constellation
- Academy of Finland WINMET

Poster: Simulations of improved carbon dioxide observation over snow

- Measurement-based surface BRDFs of different snow types and their effect on top-of-atmosphere radiances in the CO2 observation bands is presented.
- Part of a larger ESA feasibility study of improving satellite-based remote sensing of atmospheric CO2 in the northern high latitudes.

Mikkonen et al.: Simulations of improved carbon dioxide observation over snow (Submission 164, P.1.1: Climate Change-Atmos-CAL/VAL Conference Time: Wednesday, 19/Oct/2022: 8:30am - 10:30am)



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TanSat Special Issue in Remote Sensing

Special Issue "China's First Dedicated Carbon Satellite Mission (TanSat)"

A special issue of ***Remote Sensing*** (ISSN 2072-4292). This special issue belongs to the section "**Satellite Missions for Earth and Planetary Exploration**".

Deadline for manuscript submissions: **22 December 2022** | Viewed by 1080

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Interests: principal scientist on TanSat data applications

EO Data Delivery

Data access (list all missions and issues if any). NB. in the tables please insert cumulative figures (since July 2020) for no. of scenes of high bit rate data (e.g. S1 100 scenes). If data delivery is low bit rate by ftp, insert “ftp”

ESA Third Party Missions	No. Scenes
1. TROPOMI	
2.	
3.	
4.	
5.	
6.	
Total:	
Issues:	

ESA Third Party Missions	No. Scenes
1. GOSAT	
2.	
3.	
4.	
5.	
6.	
Total:	
Issues:	

Chinese EO data	No. Scenes
1. TANSAT	
2.	
3.	
4.	
5.	
6.	
Total:	
Issues:	

European Young scientists contributions in Dragon 5

Name	Institution	Poster title	Contribution
Antti Mikkonen	FMI	Simulations of Improved Carbon Dioxide Observations over Snow	Analysis of satellite retrievals over snow

Outlook

- Continued exchange on satellite retrieval methodology for greenhouse retrievals
- Validation of current satellites against ground-based observations with focus on China and high latitudes
- Surface flux inversion from TROPOMI and OCO2 to infer fluxes over China
- Consideration of upcoming systems for emission monitoring such as CO2M and Tansat-2