Monitoring Global Carbon Dioxide from space: the TanSat mission Processes

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Content

1. TanSat algorithm development-XCO_2 and SIF
2. Validation technique and field campaign
3. Future plan

TanSat mission

- National High Technology Research & Development Programs by Ministry of Science and Technology of China (MOST) (2011-2017)
- Strategic Priority Research Program from Chinese Academy of Sciences
  - ➢ Climate Change: Carbon Budget and Relevant Issue
  - ➢ Space Science: Scientific Research Satellite
- NSMC (CMA) -- (2016- NOW) , Ground segment—Satellite data receive and process

TanSat mission kicked-off at 2011, launched at 2016

TanSat mission will join the ESA 3rd Party mission

Term-1

Measurement Goals

XCO2

1~4 ppmv

Monthly

500 x 500 km²

Term-2

Measurement Goals

CO2 Flux

Relative flux error

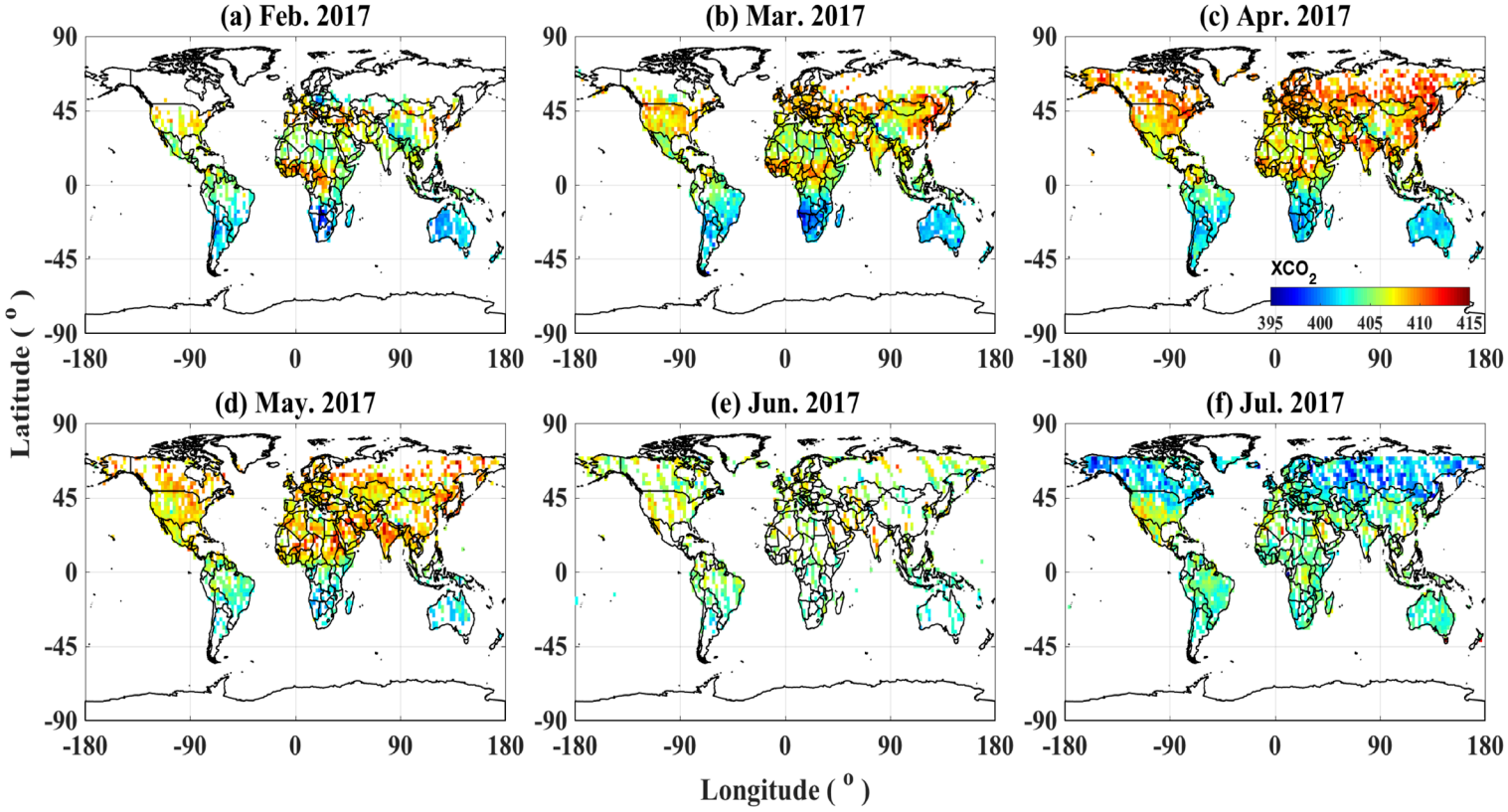
20%

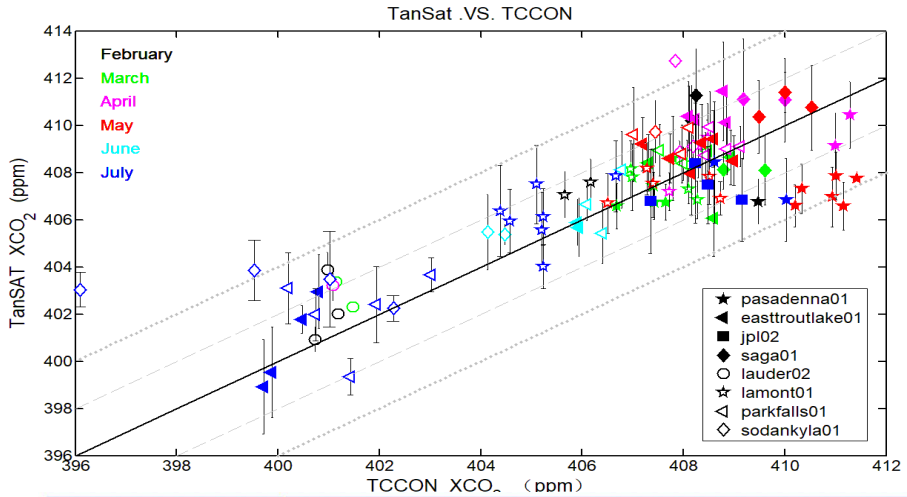
Monthly

500 x 500 km²

Preliminary results from TanSat

IWGGMS-15



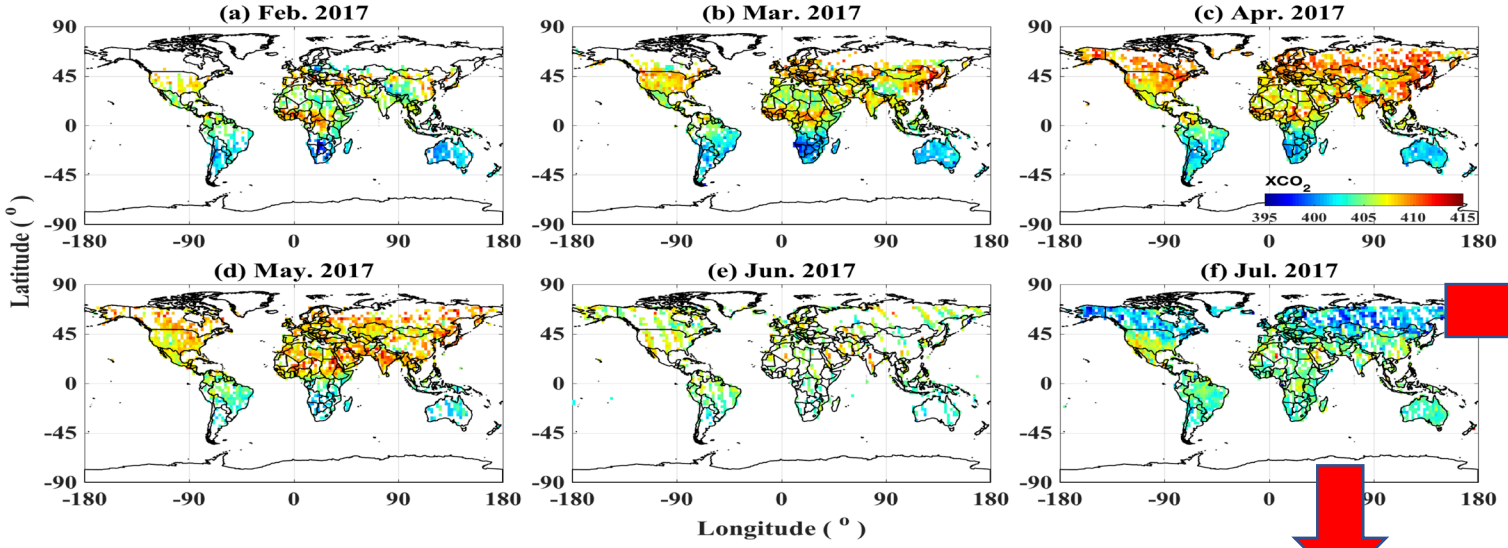


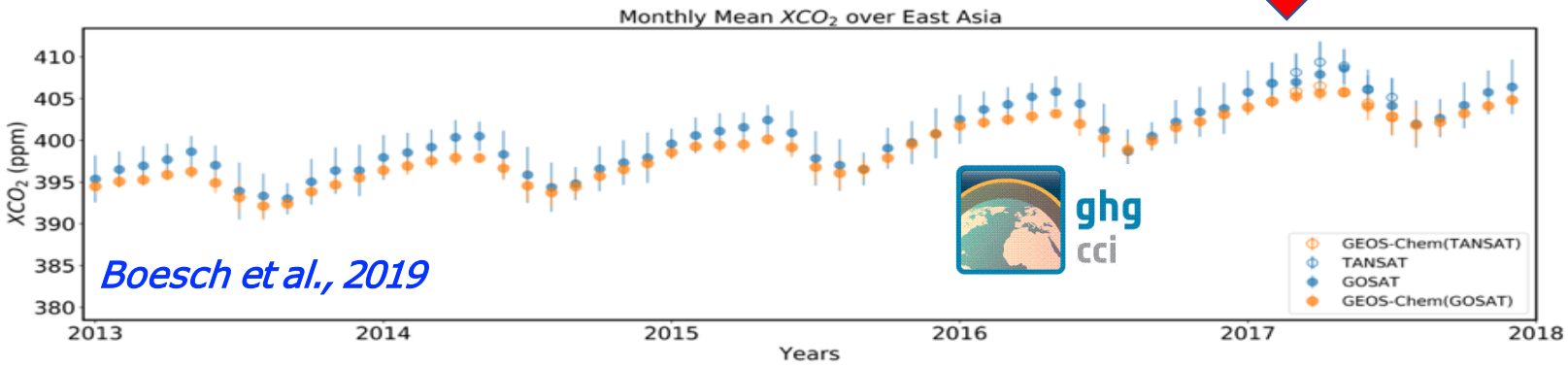
Site	Precision (ppm)					
	February	March	April	May	June	July
Pasadena, CA	2.53	13.20	1.46	3.08	--	2.27
East Trout Lake, Canada	--	0.49	2.12	0.75	0.67	1.01
Saga, Japan	4.22	1.22	1.56	0.96	--	--
Lauder, New Zealand	--	--	2.12	--	--	--
Lamont, OK, USA	0.60	1.31	0.81	0.97	--	1.49
Park Falls, WI, USA	--	0.80	0.72	0.85	1.88	1.72
Sodankyla, Finland	--	3.05	2.92	2.29	2.76	4.02
JPL	--	--	--	--	--	1.35
Average	2.45	3.35	1.67	1.48	1.77	1.98

TanSat version preliminary data product
Retrieved from V1.0 L1B data by IAPCAS

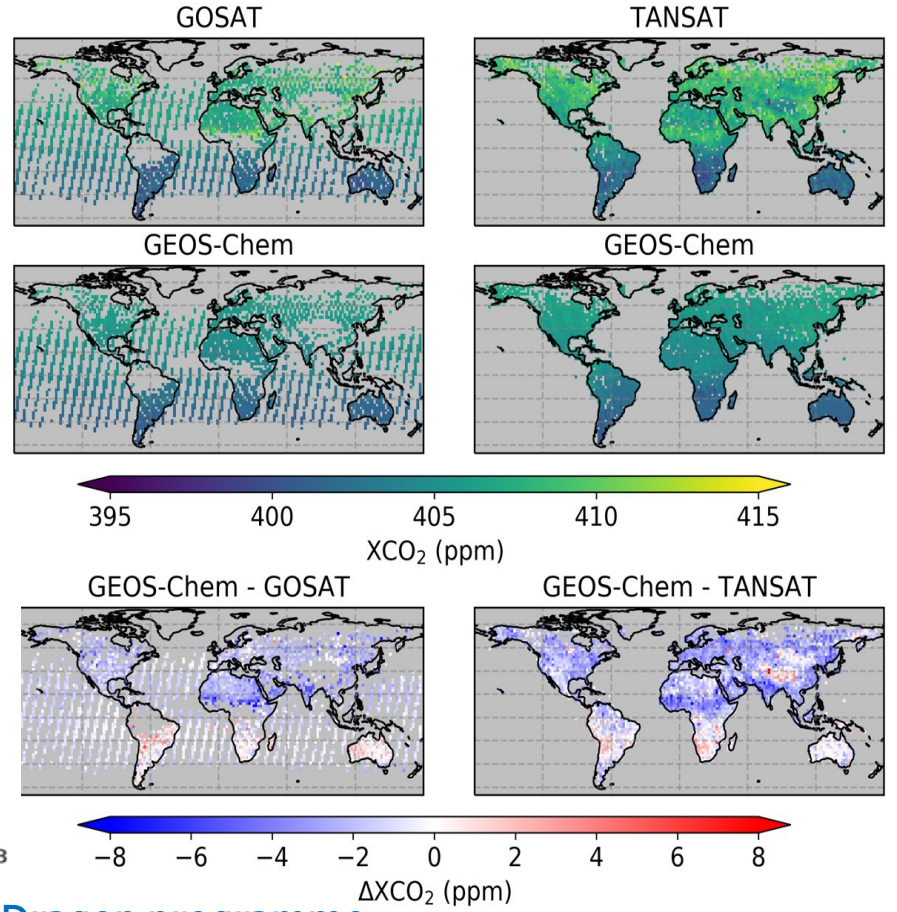
Liu et al., 2018

Model comparisons





GEOS-Chem model data from University of Edinburg

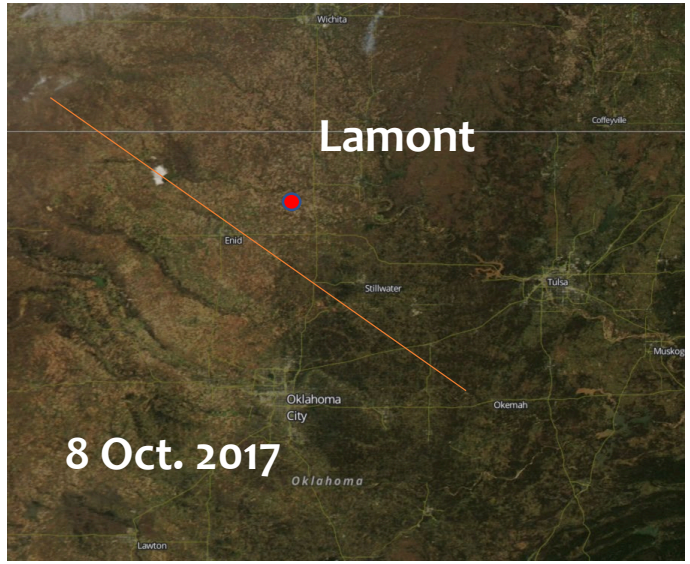


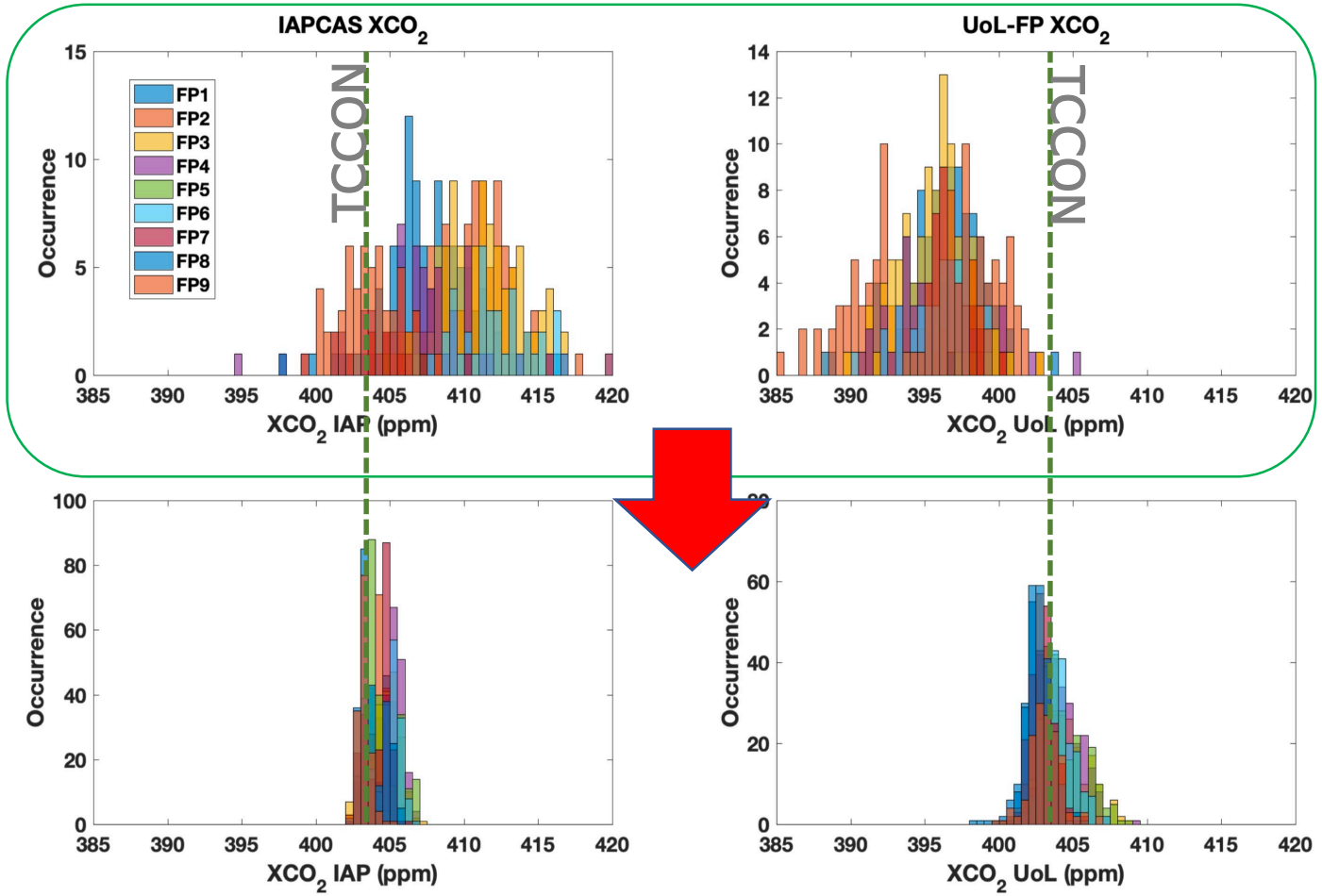
Acknowledgement: ESA-MOST Dragon programme

Improvement on XCO_2 retrieval

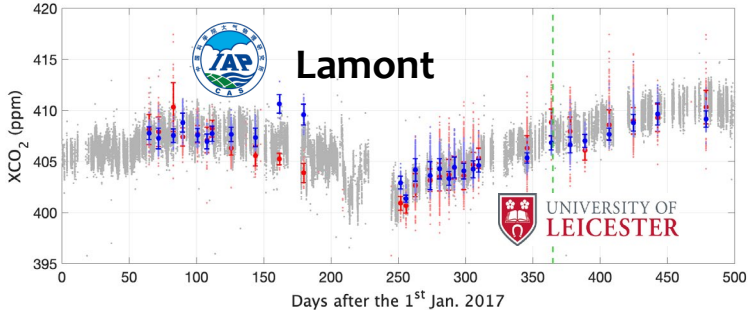
Yang et al., 2019

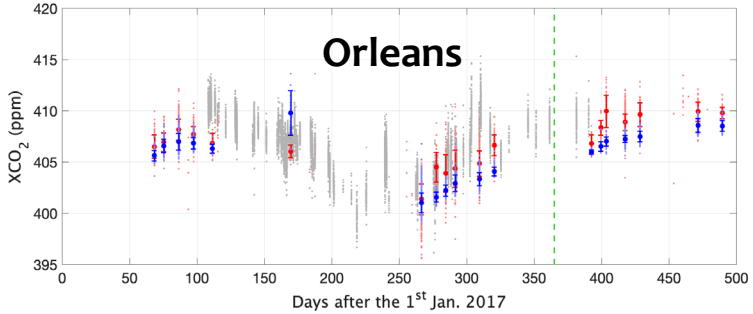
We involved innovation methods on TanSat measurement correction to improve the fitting residual and retrieval accurate and precision.

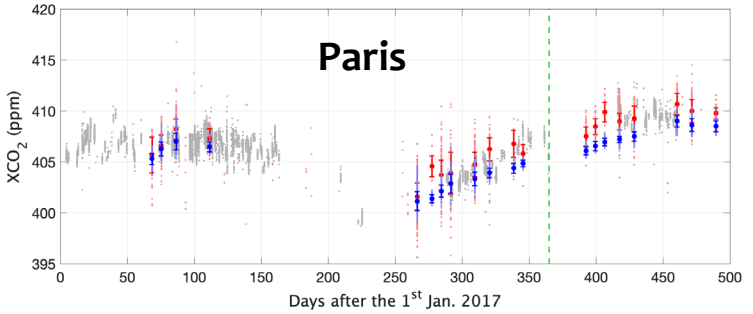


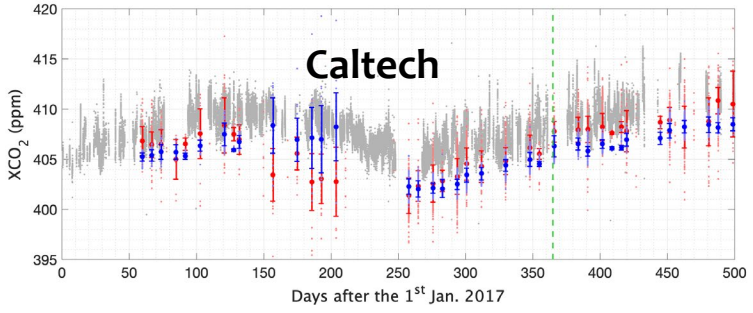


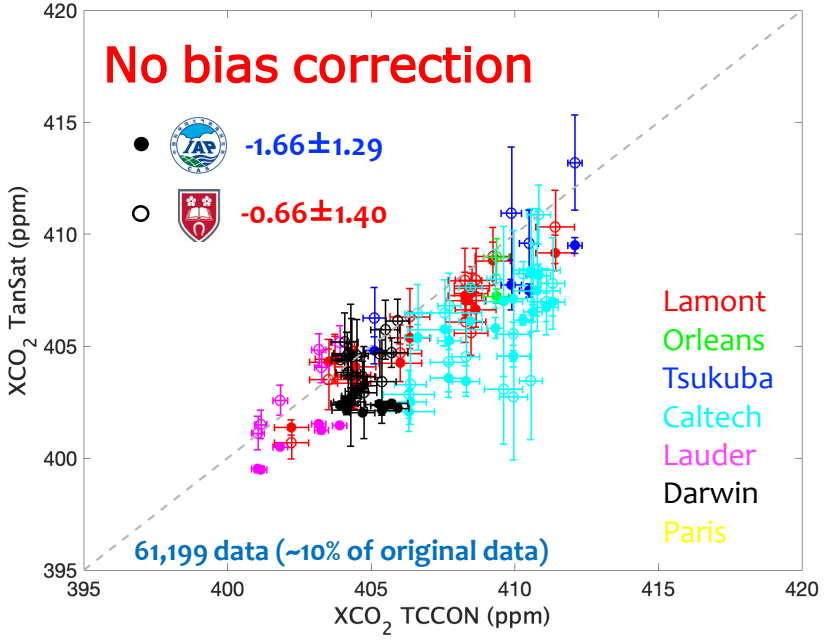
IAPCAS .VS. UoL-FP

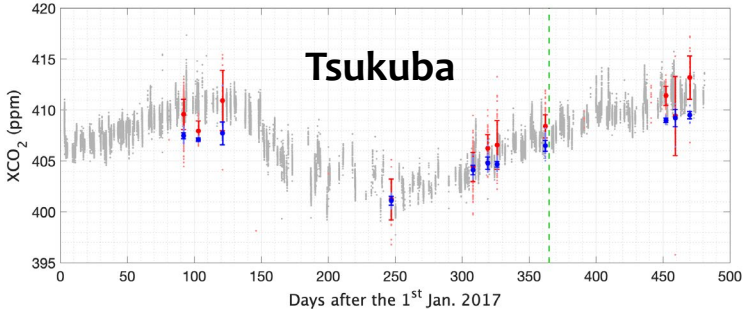


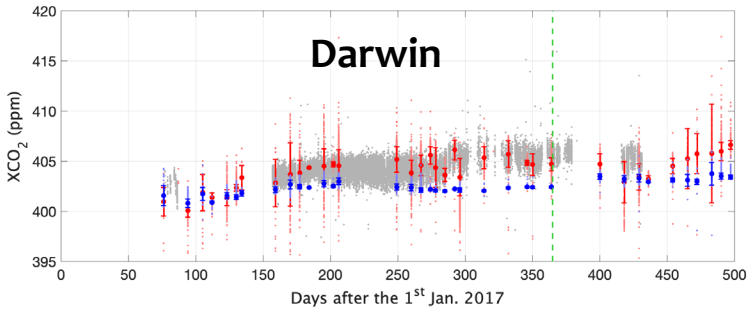


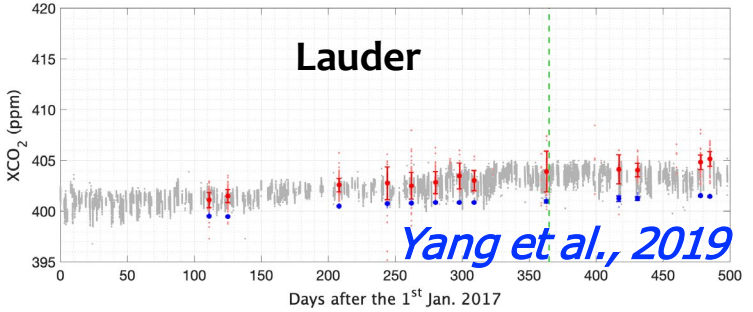












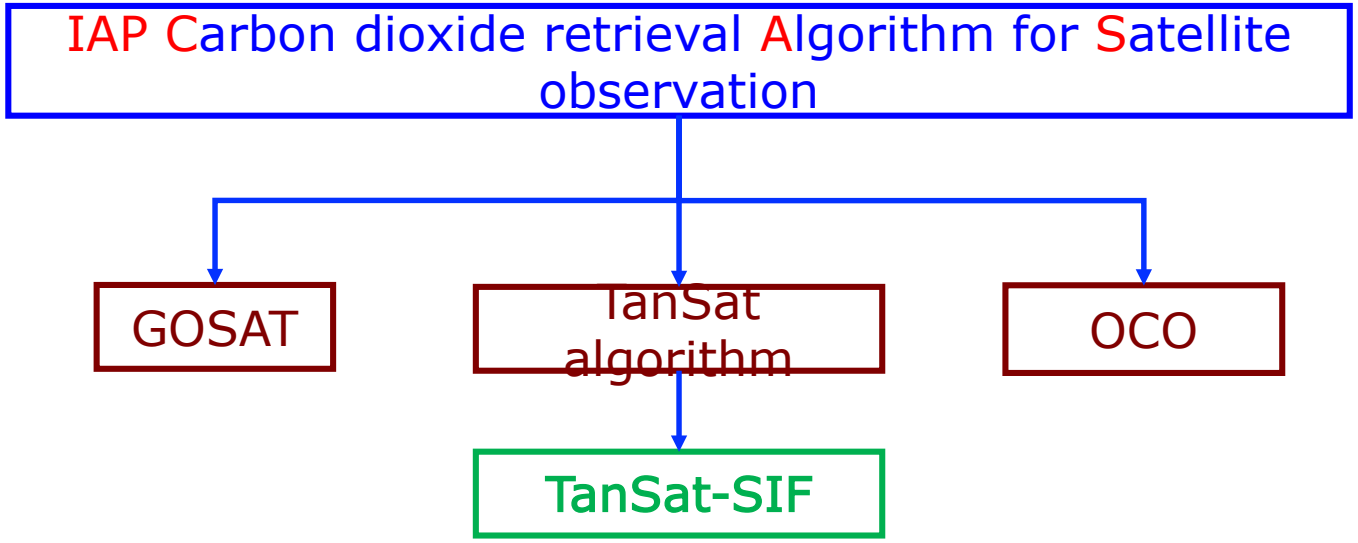
Yang et al., 2019

Preliminary validation

Sites	Bias (ppm)	Precision (ppm)	Mean RMSE (ppm)	Sampling quantity
Lamont	-0.54	1.03	0.79	11,864
	-0.84	1.33	1.17	
Caltech	-3.45	1.15	0.88	21,775
	-3.03	2.04	1.65	
Darwin	-1.84	1.59	0.27	16,757
	0.13	1.66	1.30	
Tsukuba	-2.51	1.36	0.48	915
	-0.25	1.87	1.88	
Lauder	-1.86	0.34	0.09	1,558
	0.76	0.46	1.06	
Orleans	-1.09	0.78	0.55	4,796
	0.32	0.66	1.13	
Mean	-1.66	1.29	0.52	61,199
	-0.66	1.40	1.32	

New version of TanSat XCO2 will be released within 2~3 months

SIF retrieved from TanSat measurement



TanSat SIF product release approaching……

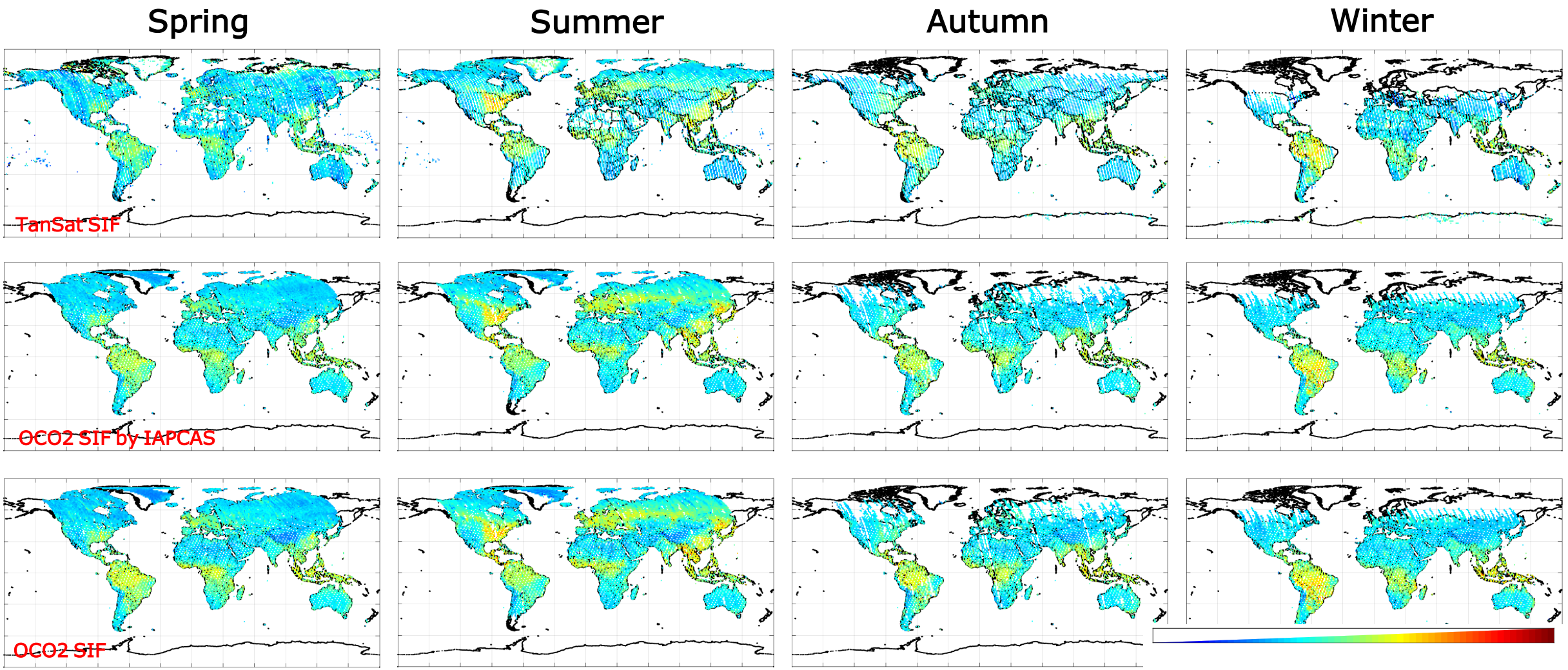
(Frankenberg et al., 2011)

Wavenumber: 12982~12988 cm-1

A low-order polynomial to approximate the scattering and surface reflection terms

State vector element	note
Relative SIF	Relative contribution of SIF to continuum
OD scale	Scale of O2 absorption
polynomial coefficient	Coefficient of the low-order polynomial
Wavenumber shift	Wavenumber shift caused by instrument movement

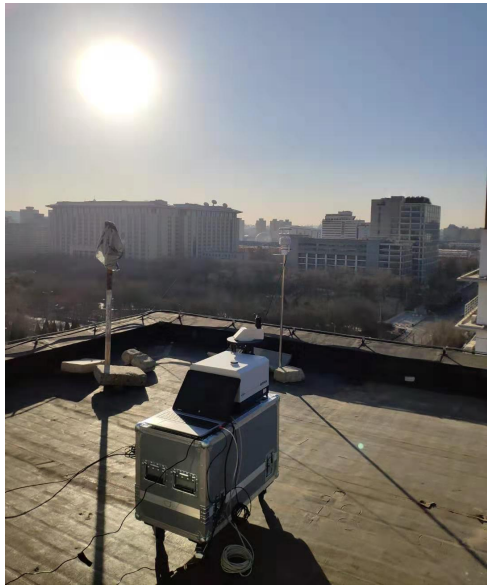
Inter-comparison and seasonal variation of SIF



- IAPCAS-SIF is developed to retrieve SIF from space measurement of high resolution spectrum in O2-A
- Inter-comparison between TanSat and OCO-2 retrieval data and official product is performed to test IAPCAS-SIF
- SIF seasonal variation and regional character is to be discussed

EM27/SUN Coordinate measurements

(a)

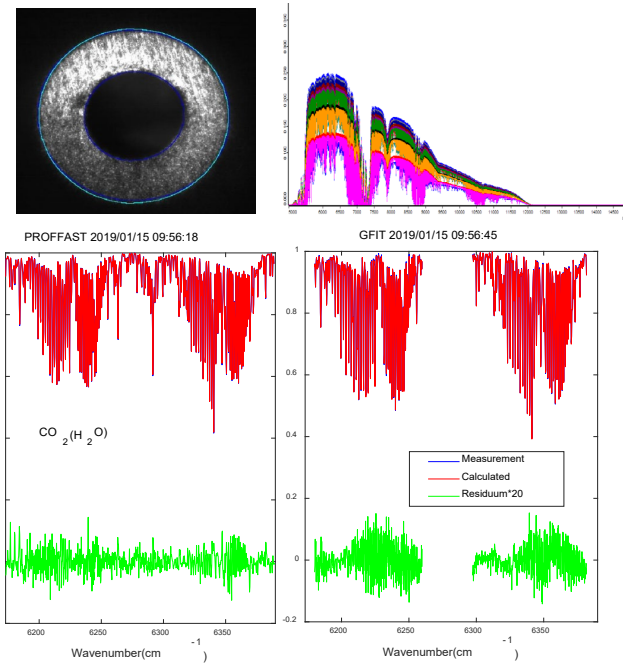


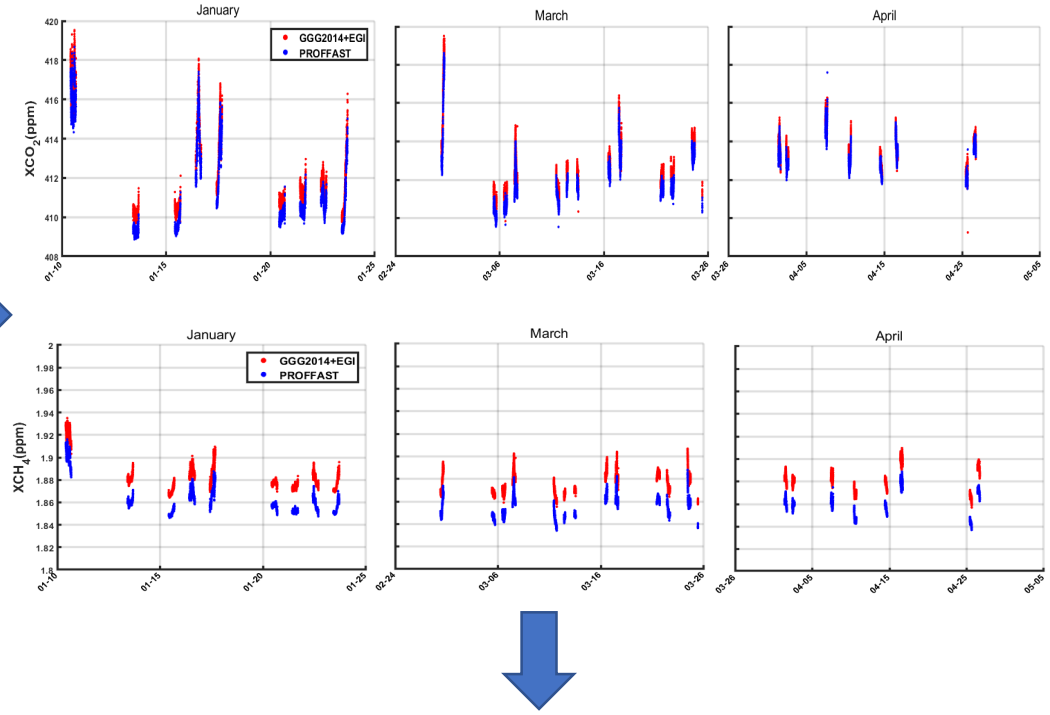
(b)

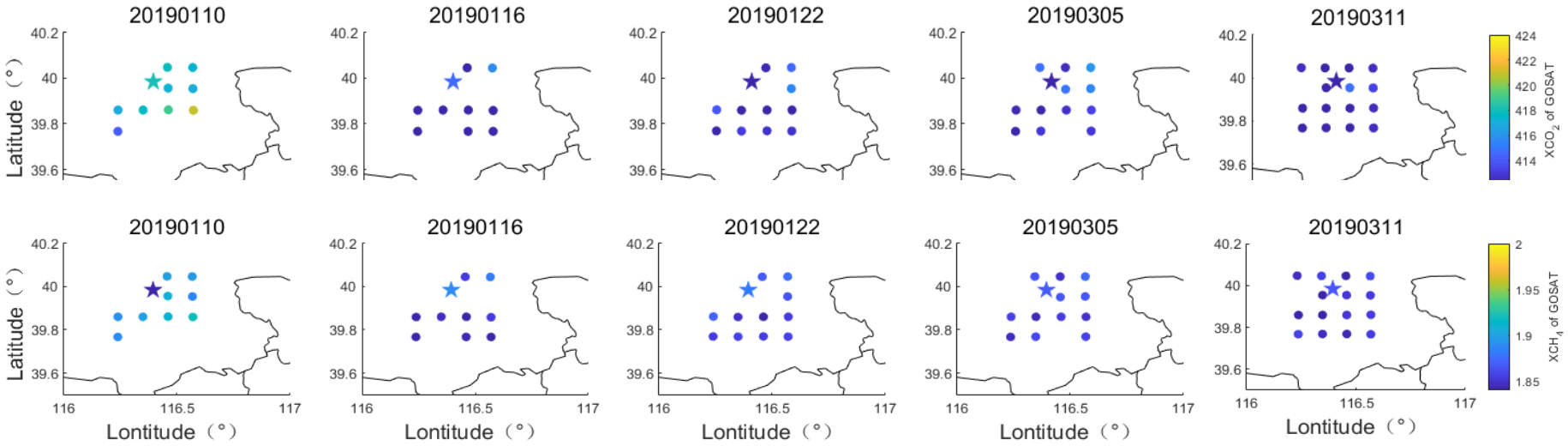
(c)

- Intercomparison measurements of X_{gas} measurements using EM27/SUN and IFS 125 HR in Xianghe
- No. 095 EM27/SUN observations on the roof terrace of IAP
- Intercomparsion measurements of four EM27/SUN (095,106,109,110)

EM27/SUN observations on the roof of IAP







Algorithm comparison (GGG2014+EGI & PROFFAST)

- Correlation coefficient : XCO_2 ~ 0.9911 XCH_4 ~ 0.9922
- Systematic differences XCO_2 ~ 0.85±0.34 ppm XCH_4 ~ 20.7±2ppb

GOSAT data comparison

- Bias: XCO_2 ~ 0.07ppm XCH_4 ~ 50ppb.

Aircore campaign 2018 in Inner Mongoria

13th – 14th June

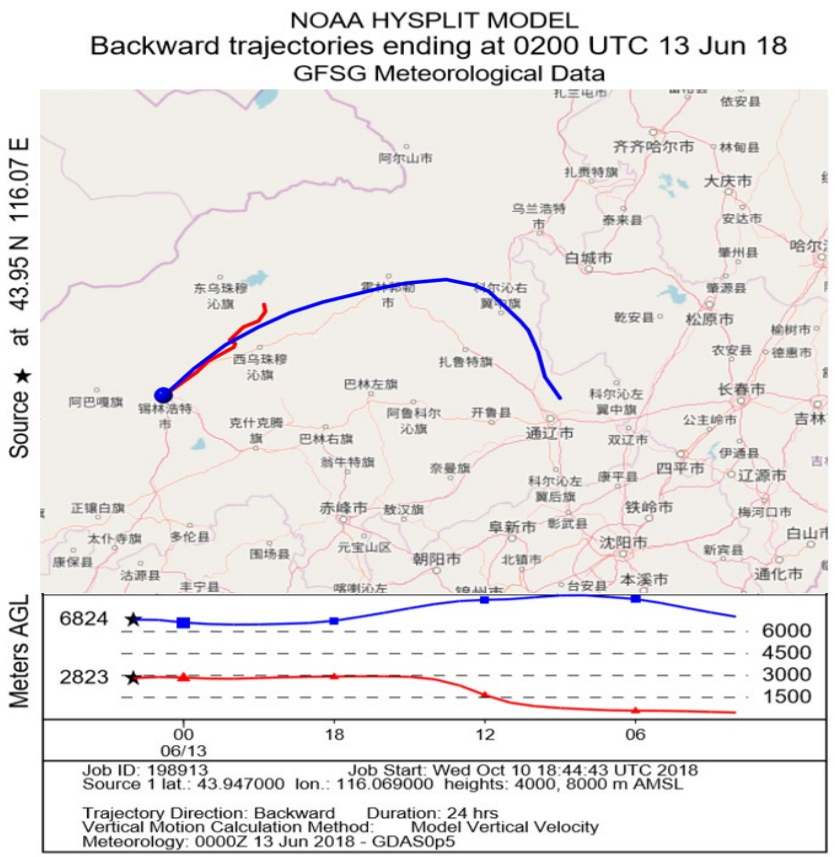
Xilin Hot
（116E, 43.9N, 1004m）

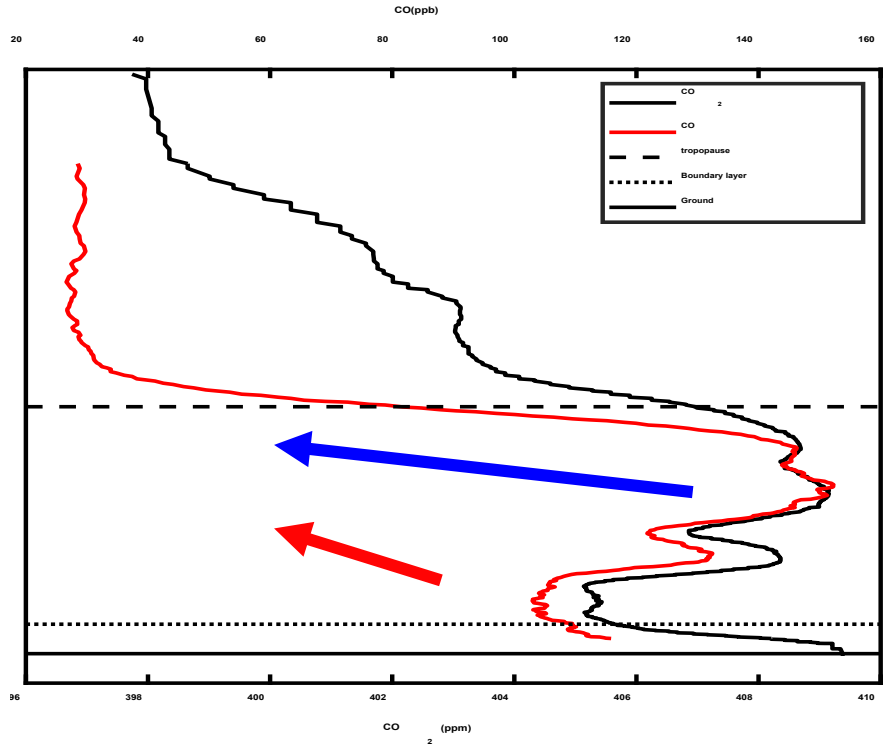
12th – 13th November

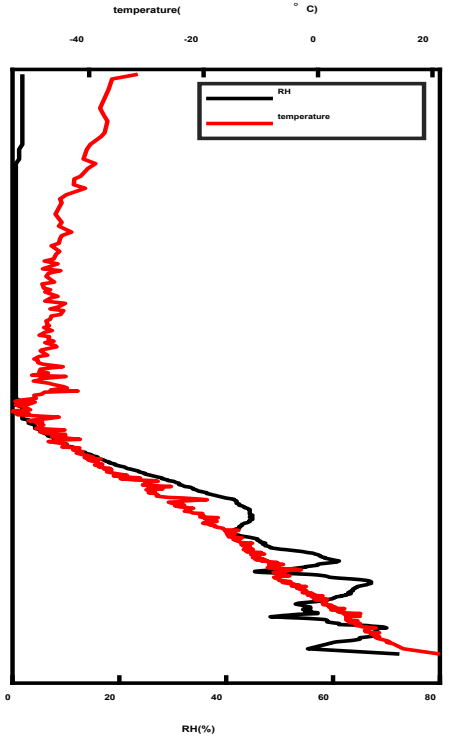
Urad Middle Banner
（108.5E, 41.59N, 1300m）

Profiles

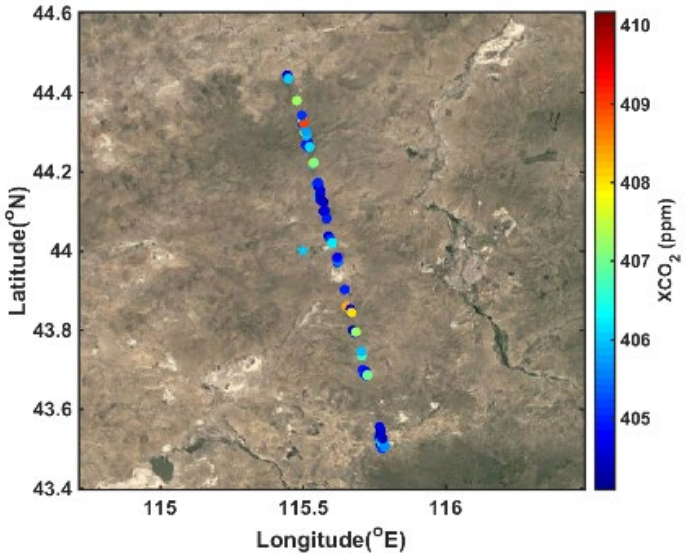
13th June



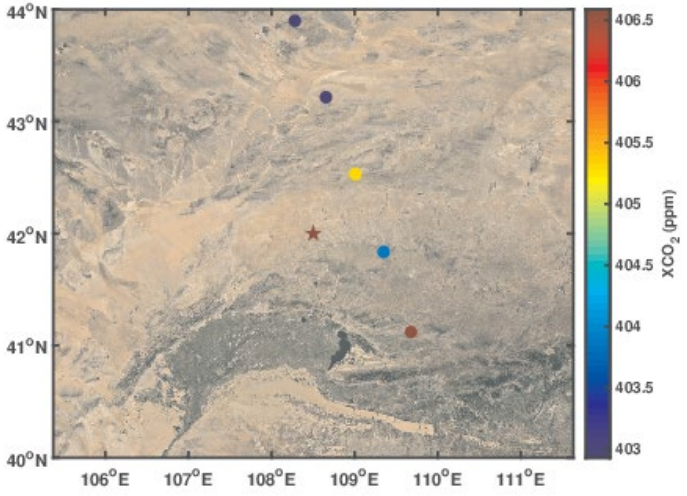




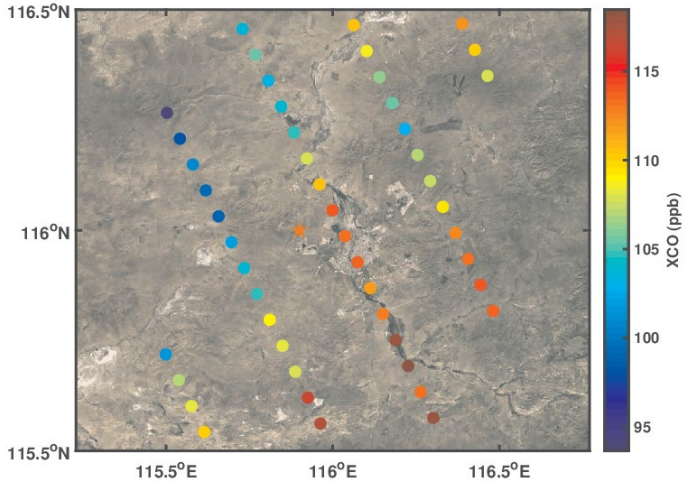
Comparison with OCO-2 \ GOSAT \ TROPOMI



Aircore vs. OCO-2 on 13th



Aircore vs. GOSAT on 12th November



Aircore vs. TROPOMI on 13th June

	CO_2	CO
June campaign		
Aircore	406 ppm	113 ppb
Satellite	405.6 ppm ± 0.6 ppm (OCO-2)	118 ppb ± 1.89 ppb (TROPOMI)
November campaign		
Aircore	406 ppm	82 ppb
Satellite	404.3 ppm (GOSAT)	\

Summary and future plan

1. The L2 data have been retrieved by the IAPCAS algorithm and new global data of XCO2 and SIF will be released within 2-3 months.
2. The TanSat validation campaign have been conducted and data will be applied to GOSAT, OCO and TROPOMI products validation,
3. Validation campaign will be achieved in China in 2019 and more international cooperation will be promoted.

Thank you for attention!

Special Acknowledgement
ESA 3rd party mission & CCI+ project
GOSAT and OCO teams for data and cooperation