

The TanSat on-broad status, data product and future plans

Yi Liu and TanSat science team

*Institute of Atmospheric Physics,
Chinese Academy of Sciences*



Toronto 2018



Outline

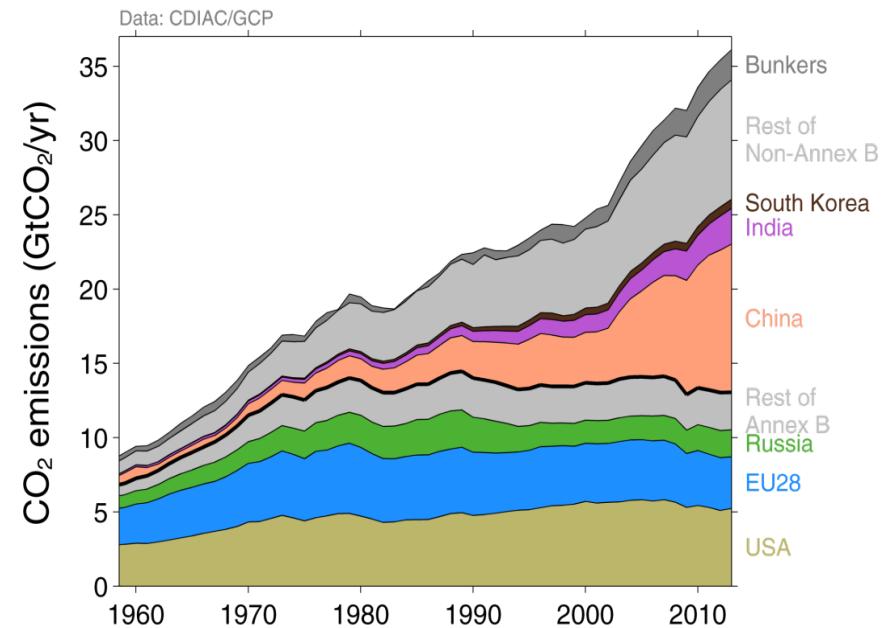
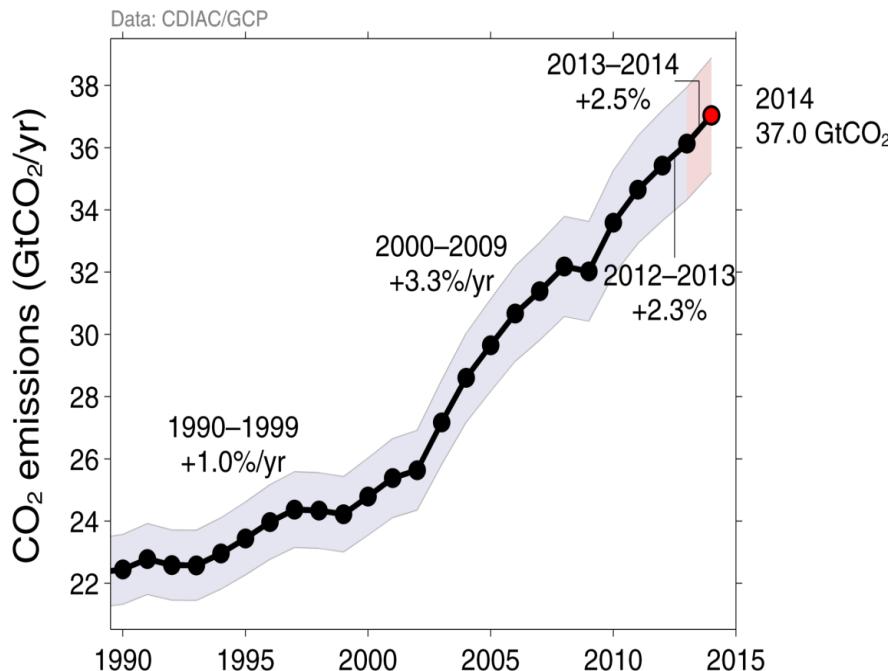
- **1 TanSat Mission**
- **2 On-broad status**
- **3 Data products**

First L2 Products: XCO₂ and SIF

- **4 Future plans**

Global Carbon Emissions

- GEO, CEOS, many organizations and projects to support the observations of continued increase of global carbon emissions which is driving climate change
- In last decade, we find a shift of emissions from USA/Europe towards countries with strong economic growth (especially **China** and India)



Credit: Global Carbon Project

China become a big number in the GHGs family

Mission	nationality	Launching	Orbit	Weight	Precision	Swath	Footprint
SCIAMACHY	EU	2002	772km	8211kg	16	1000km	32×215 km ²
GOSAT (FTS)	Japan	2009	666km	1750kg	<4	N/A (640km)	φ10.5km
OCO-2	U.S.	2014	705km	449kg	1	10.6 km	1.29×2.25 km ²
TanSat	China	2016	700km	650kg	1~4	18 km	2×2 km ²
FY-3D (FTS)	China	2017	836.4km	N/A	1~4	>100km	φ1km
GF-5 (SHS)	China	2017	708km	125kg	1~4	N/A (800km)	φ10.5km
GOSAT-2	Japan	2018	613km	2000kg	1	N/A (632km)	φ9.7km
OCO-3	U.S.	-	394km	450kg	1	16km	~4km ²
Microcarb	French	2020	650km	170kg	1	13.5km	2×2 km ²
MERLIN	EU	2021		410kg	8ppb		φ100m
GEOCARB	U.S.	2022	35400km	138kg	>2.7	—	3×6km ²

More new Chinese GHGs satellite are planning ...

Chinese GHGs satellites have increased quickly, but big challenge will be the data application

TanSat related presentations in IWGGMS-14

The TanSat on-broad status, data product and future plans Yi Liu

**Application of TanSat algorithm on GOSAT observation
-ATANGO and OCO-2 XCO₂ retrieval Lu Yao**

**The next generation of Chinese greenhouse gas monitoring satellite
mission: TanSat-2 Dongxu Yang**

**more poster presentations: Zhongdong Yang, Xingying Zhang,
Lin Qiu,**

The TanSat Mission



(1) National High Technology Research & Development Programs by Ministry of Science and Technology of China (**MOST**) (2011-2017)

(2) Strategic Priority Research Program
Climate Change: Carbon Budget and Relevant Issue
Space Science: Scientific Research Satellite
Chinese Academy of Sciences (CAS) – (2011-2016)

(3) NSMC (**CMA**) -- (2011- NOW)
Ground segment—Satellite data receive and process

Term-1(2011-2015)

Measurement Goals

XCO₂

1~4 ppmv

Monthly

500 x 500 km²

Term-2(2013-2015)

Measurement Goals

CO₂ Flux

Relative flux error

20%

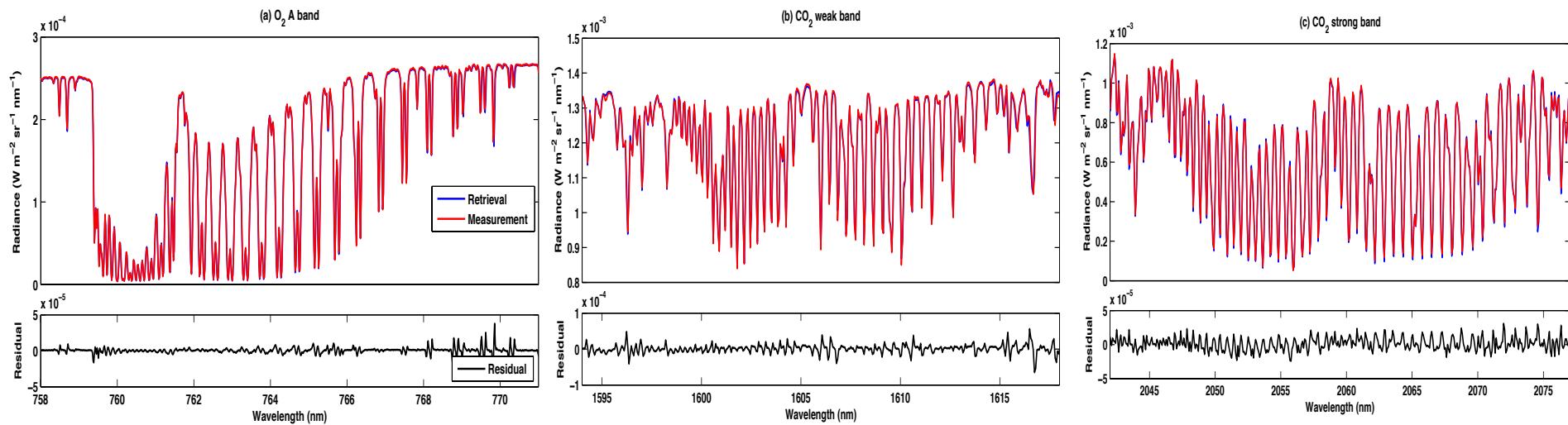
Monthly

500 x 500 km²

Instrument and performance

Carbon Dioxide Spectrometer (CDS) New name ACGS

	O ₂ -A	CO ₂ Weak	CO ₂ Strong
Spectral Range (nm)	758–778	1594–1624	2042–2082
Resolving power (nm)	0.038–0.047	0.120–0.142	0.160–0.182
Signal to Noise Ratio (SNR)	360	250	180
Footprint		2 × 2 km	
Swath		18 km	



Algorithm development

IAPCAS algorithm and application

Institute of Atmospheric Physics, Chinese Academy of Sciences

IAP Carbon Dioxide Retrieval Algorithm for Satellite Observation – IAPCAS



Application

TanSat algorithm



Similar observation characters



Other observation



OCO-2

aTanGO

Application of TanSat algorithm on GOSAT Observation

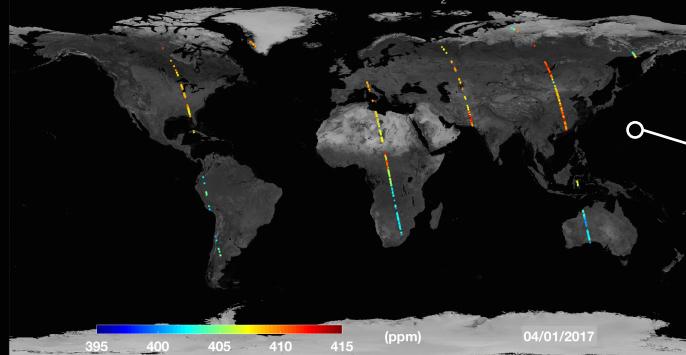
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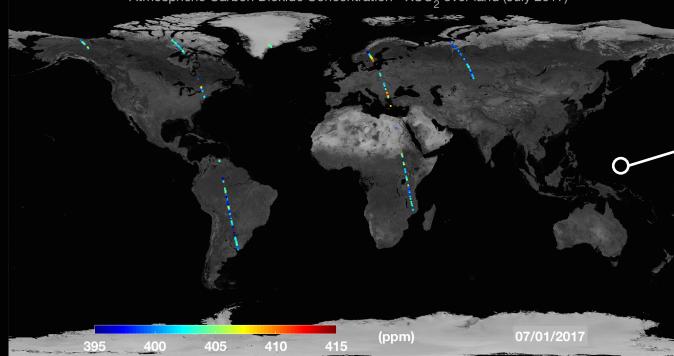
- **4 Future plans**

Chinese Carbon Dioxide Observation Satellite - TanSat
Atmospheric Carbon Dioxide Concentration - XCO_2 over land (April 2017)



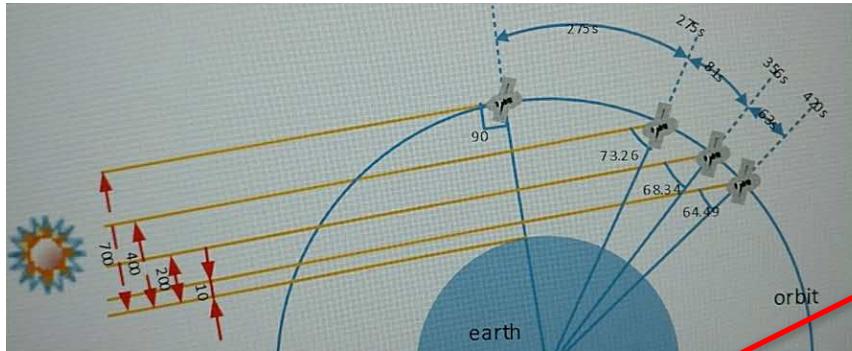
TanSat launched on 22 Dec. 2016

Chinese Carbon Dioxide Observation Satellite - TanSat
Atmospheric Carbon Dioxide Concentration - XCO_2 over land (July 2017)



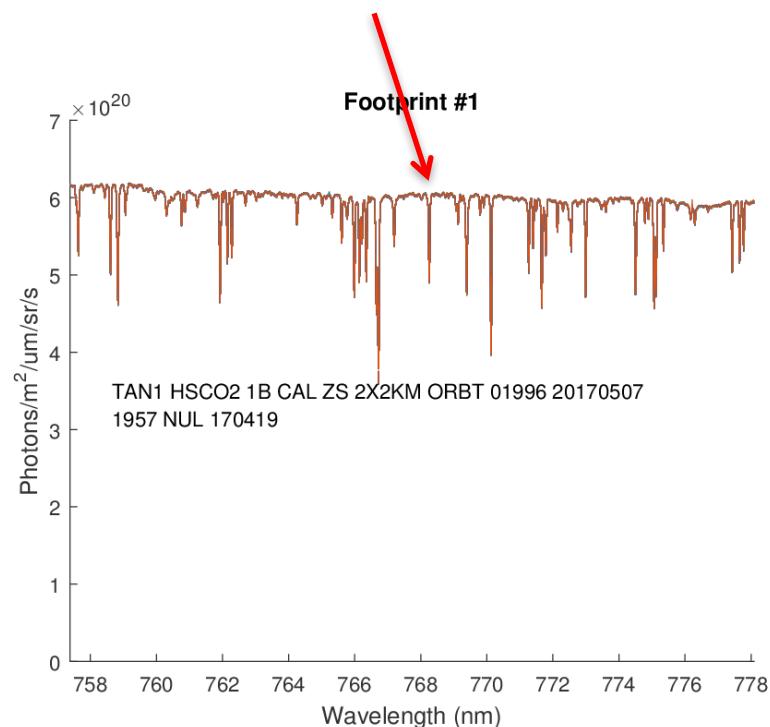
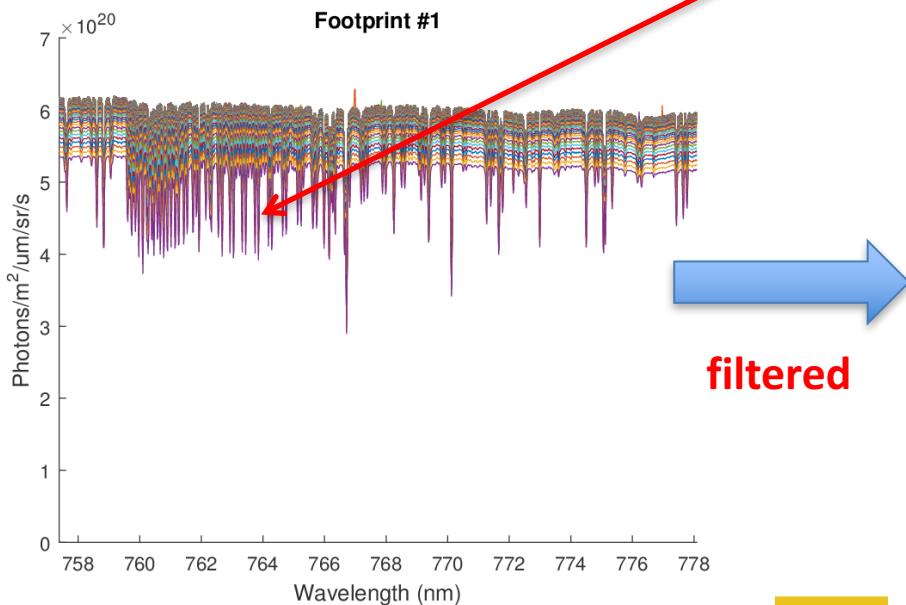
L1b data quality assessment and correction

Inter-comparison of solar measurements between TanSat, OCO-2 and solar model



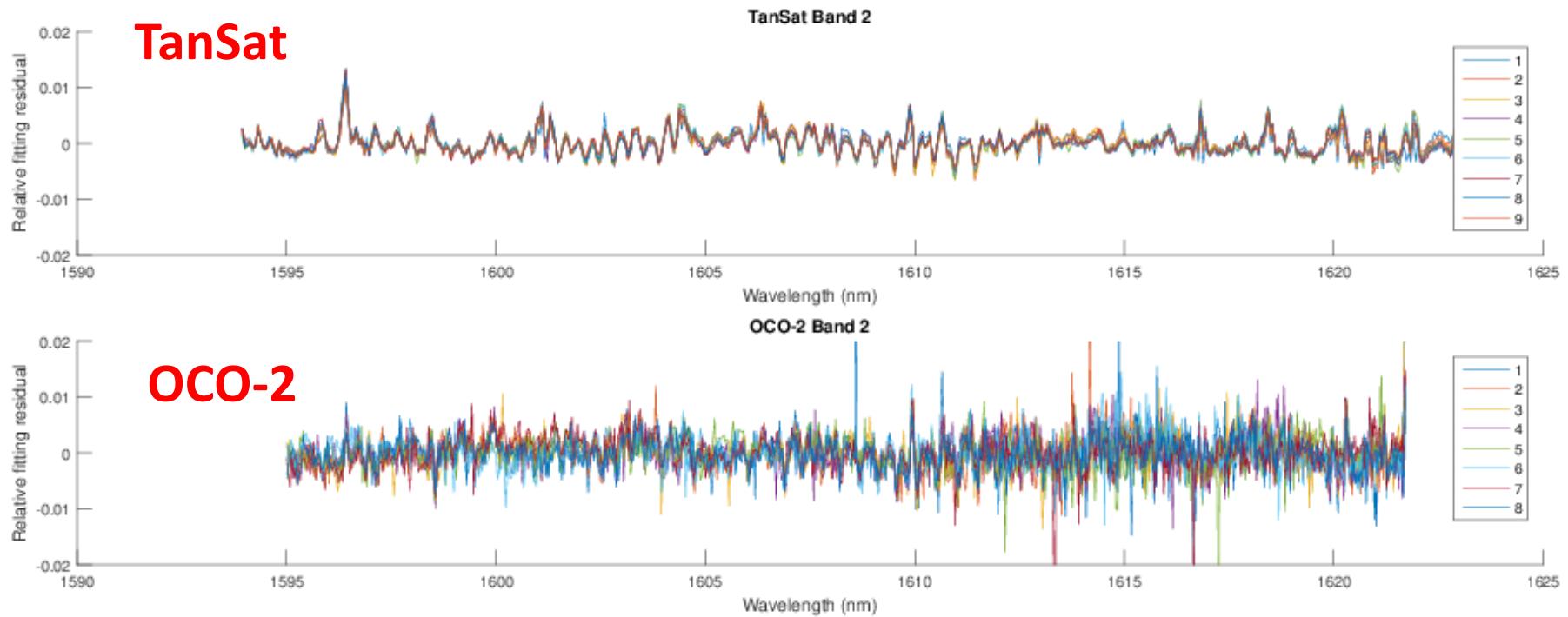
TanSat solar mode

- Typically acquired once per orbit now once per day later.
- Typically last 8 min.



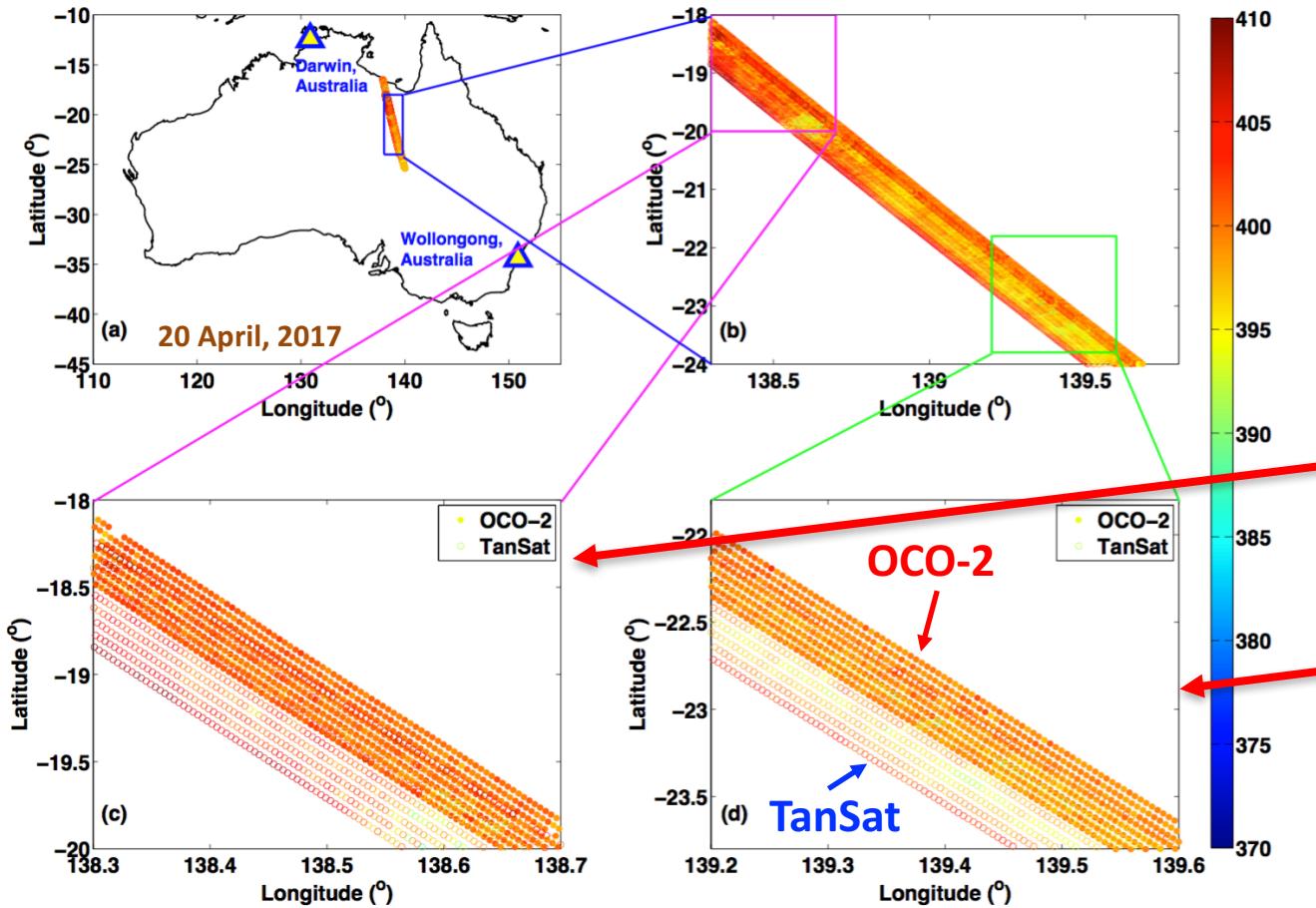
Inter-comparison of solar measurements with solar model

Fitting residual of 1.6 μm band



Inter-comparison with OCO-2

Overlap measuring with OCO-2 in Australia on 20 April, 2017
Inter-comparing with spectrum and XCO₂



Statistics

TanSat: 400.78 ppm

OCO-2: 400.38 ppm

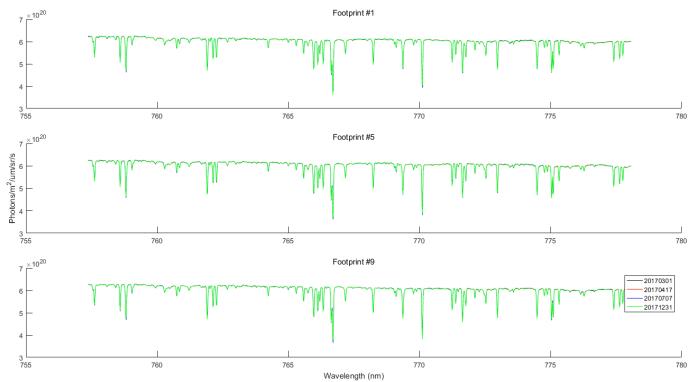
Statistics

TanSat: 397.38 ppm

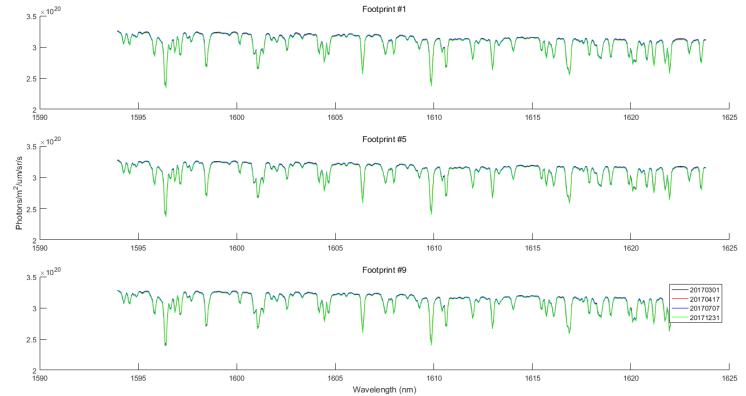
OCO-2: 399.16 ppm

L1B performance as seen from solar measurements

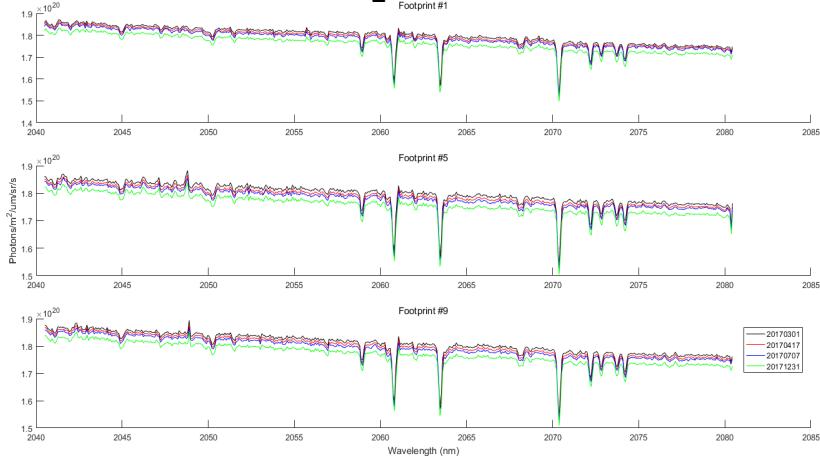
O₂-A band



WCO₂ band



SCO₂ band



O₂-A and WCO₂ bands are stable
SCO₂ band has some degradation (~1%)
2017.03 ~ 2017.12

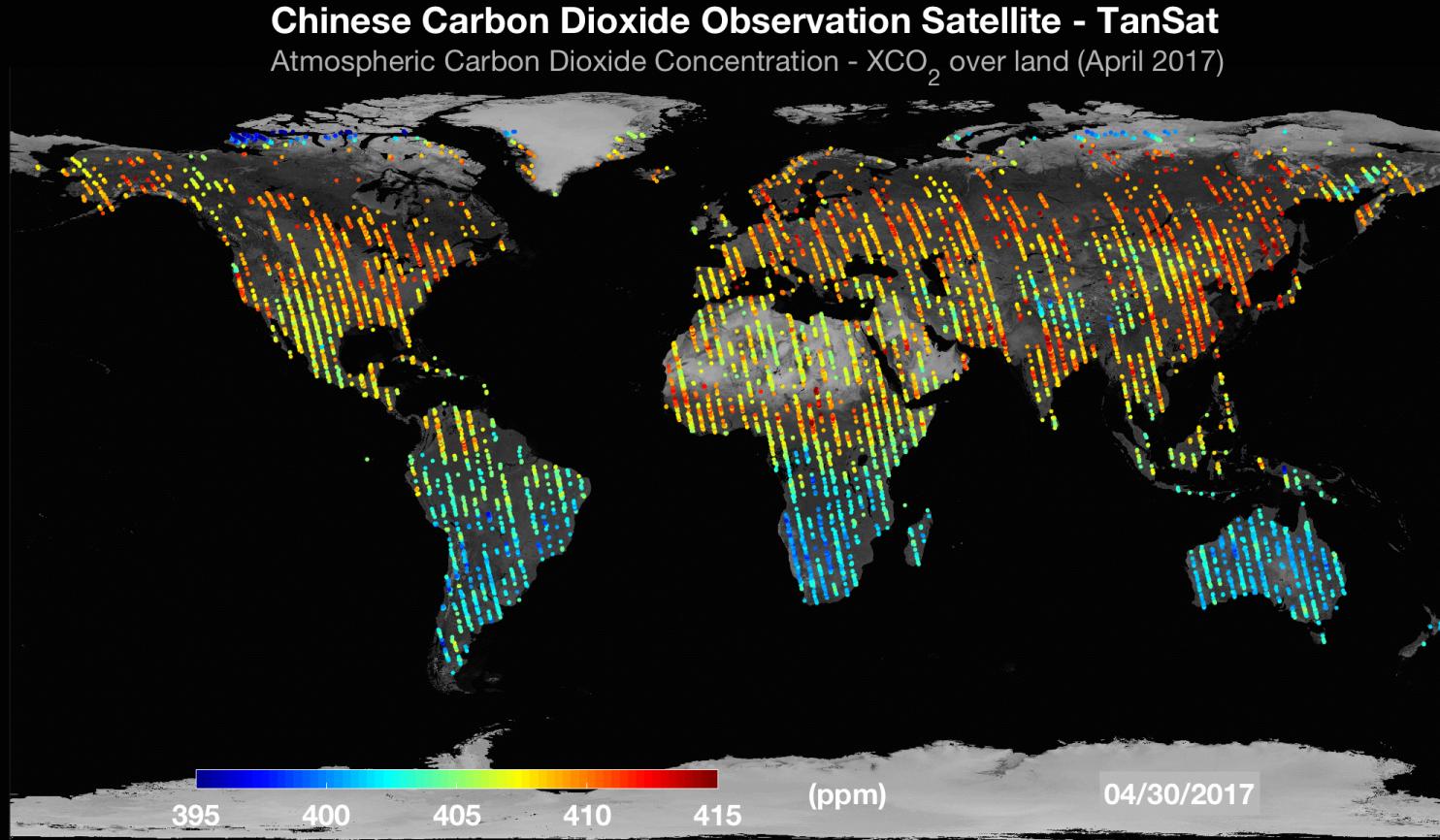
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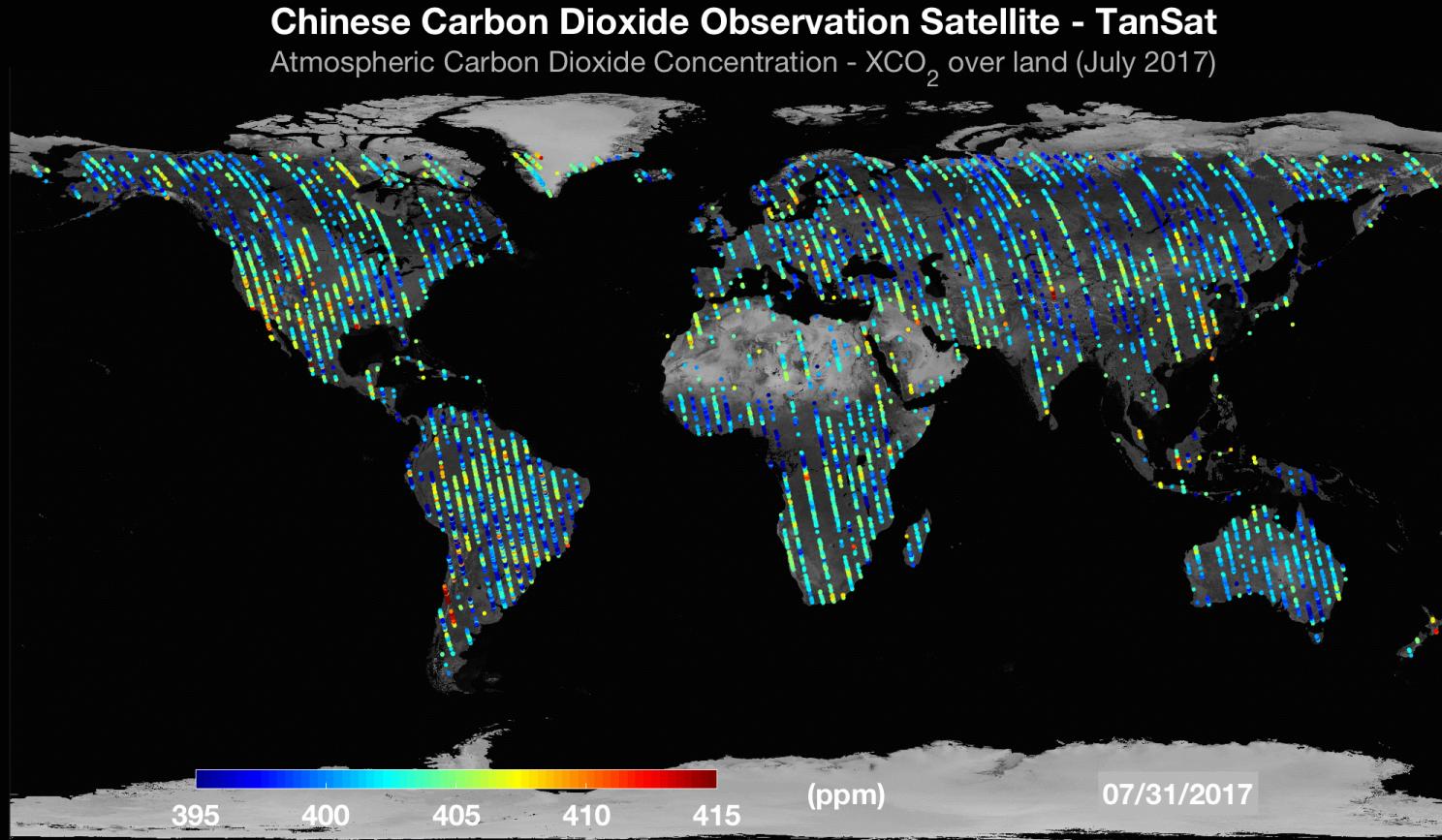
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Global distribution of XCO₂ on April 2017 --TanSat



Global distribution of XCO₂ on July 2017 --TanSat

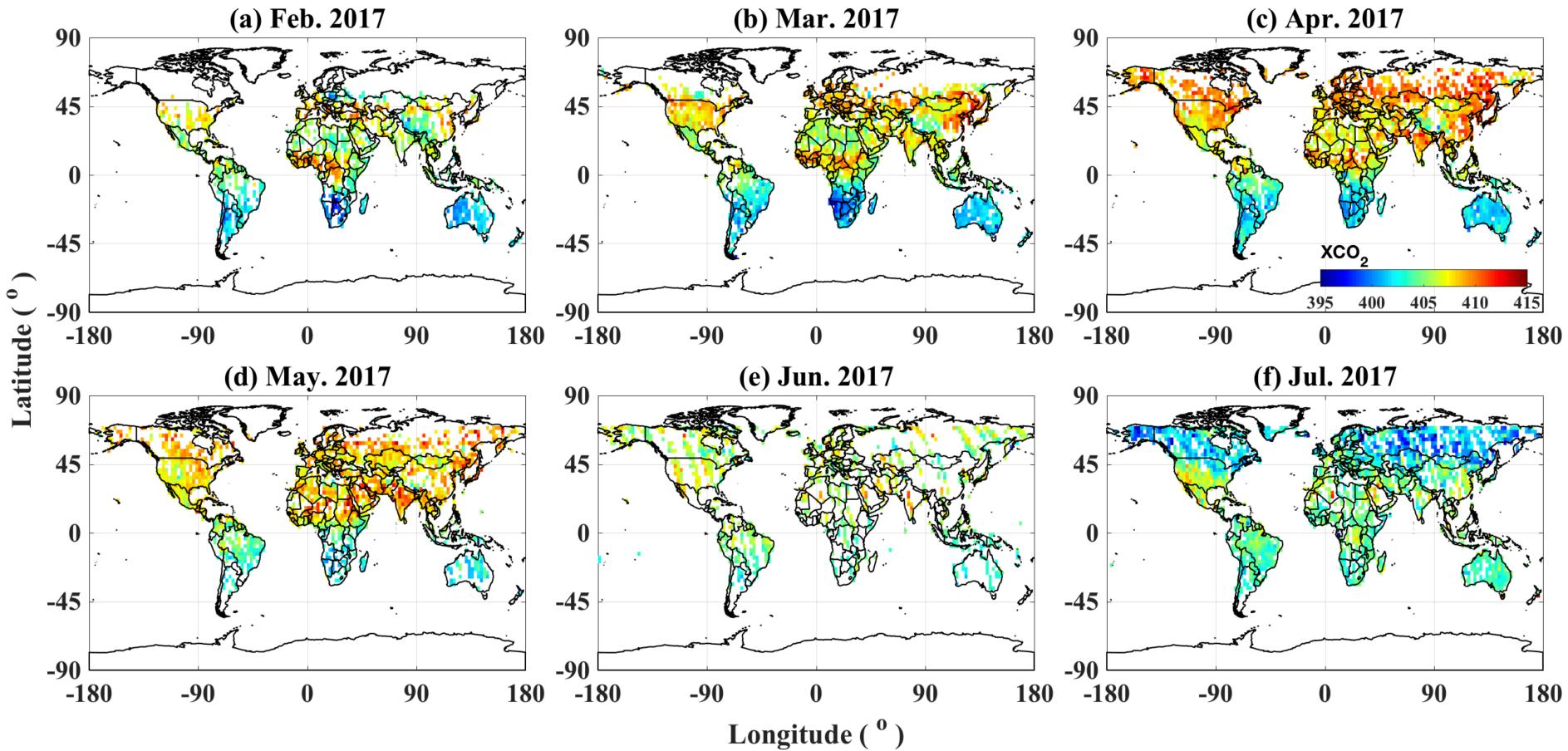


Nscc **TanSat**

microsat
上海微小卫星工程中心
Shanghai Engineering Center-Microsatellite



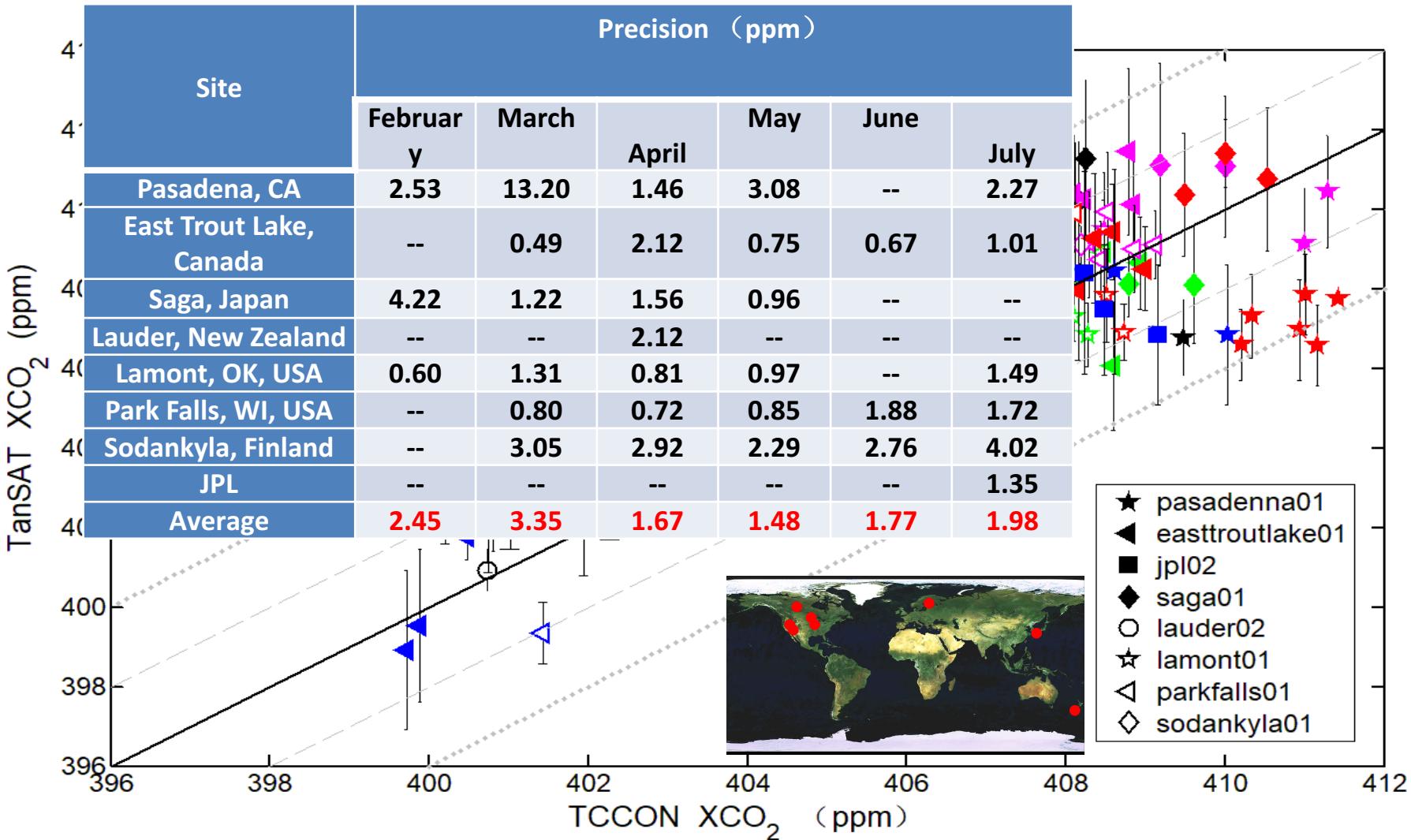
The first 6 month TanSat XCO₂



Yi Liu et al., 2018

TanSat XCO₂ validation against TCCON

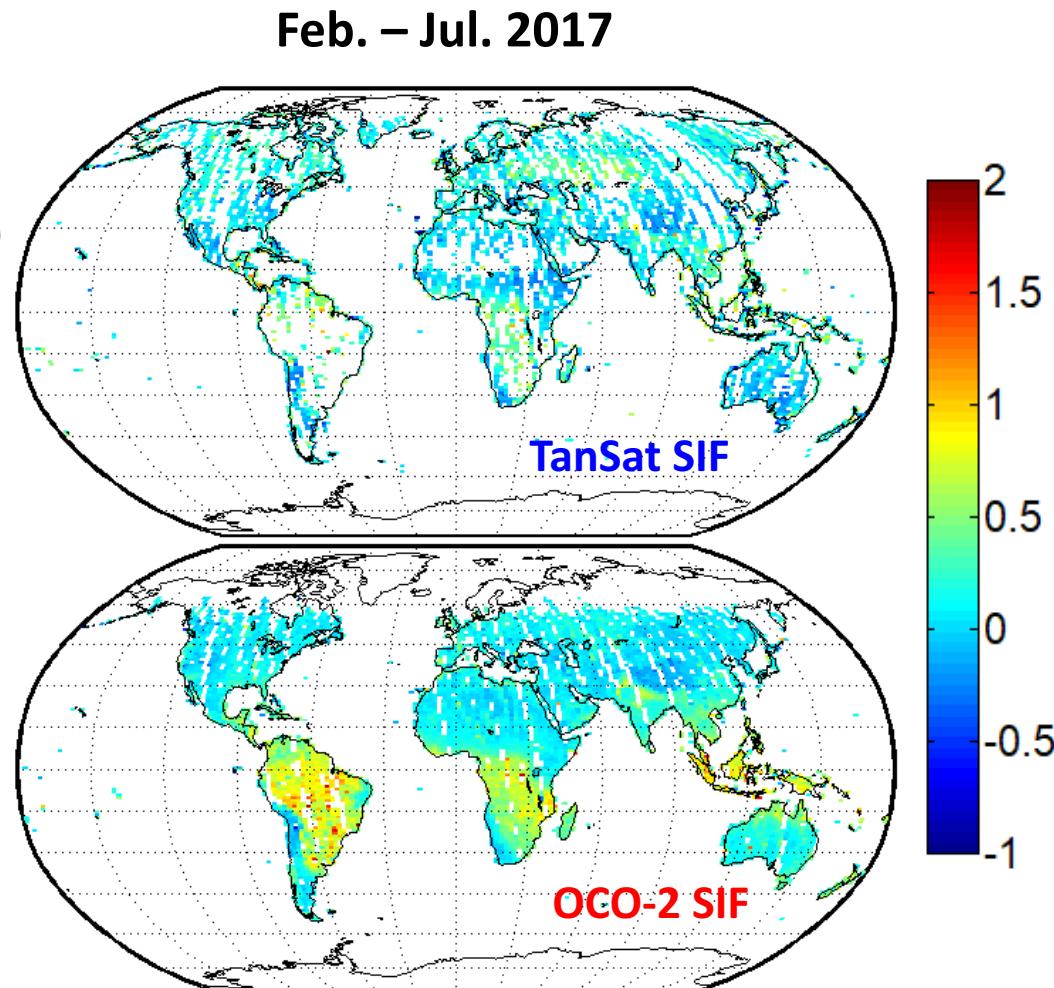
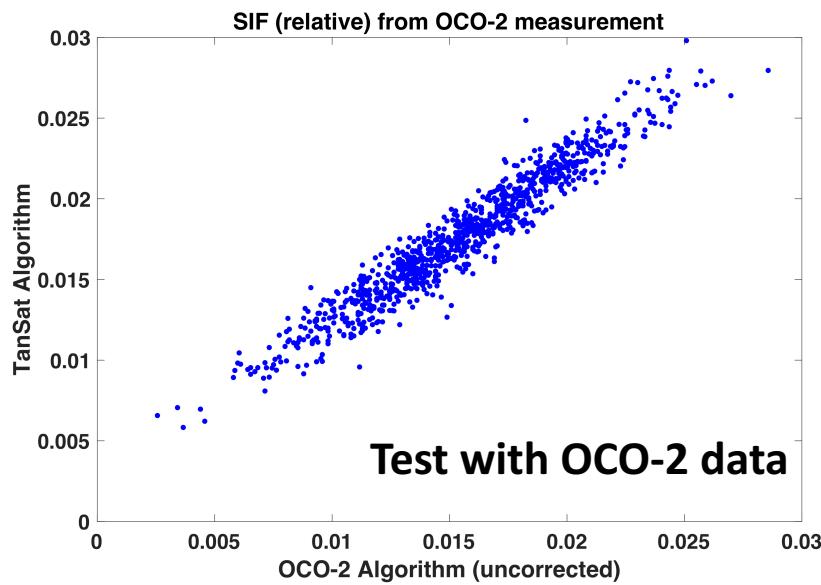
Special Thanks to TCCON data providers



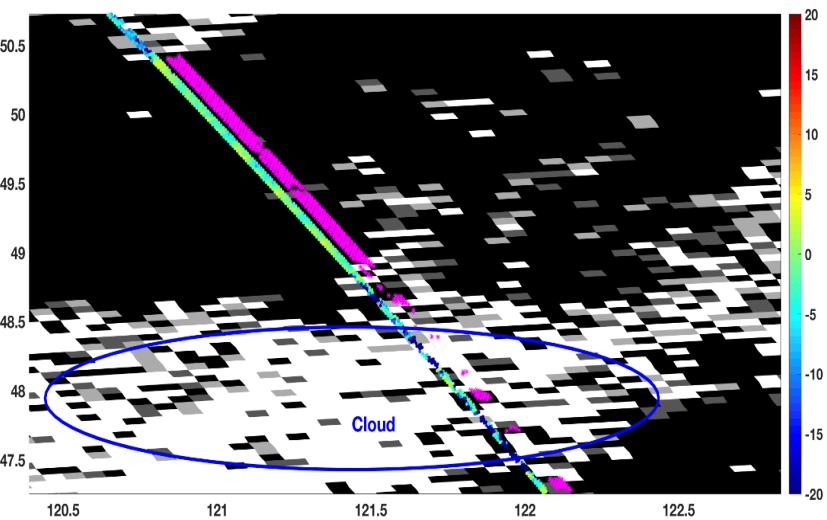
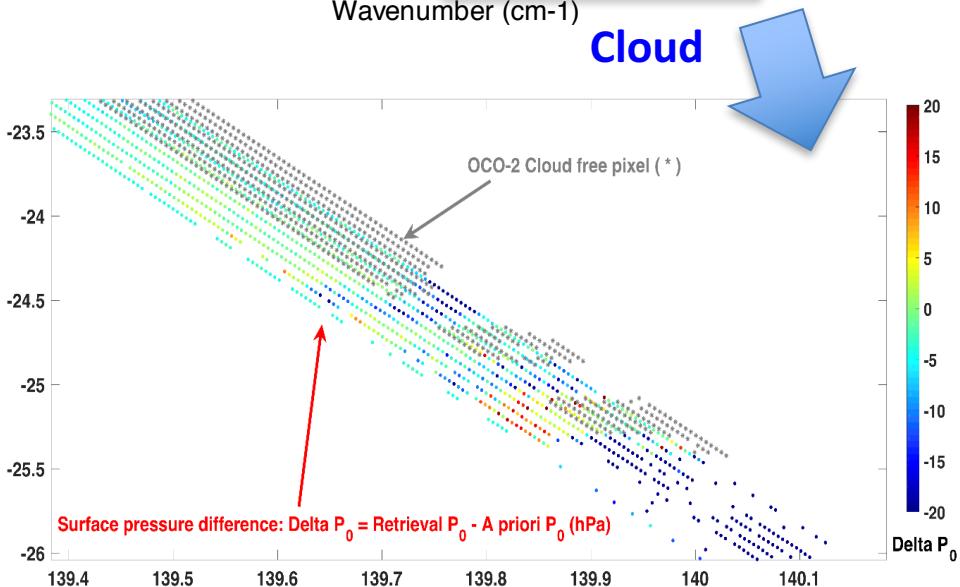
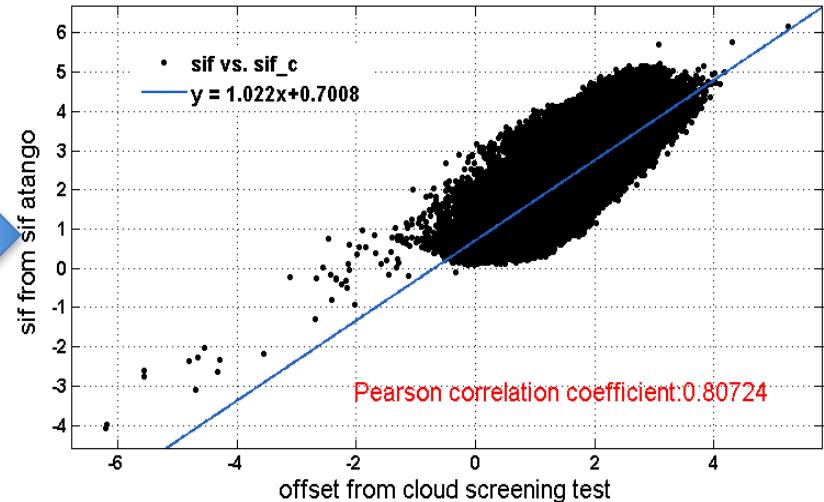
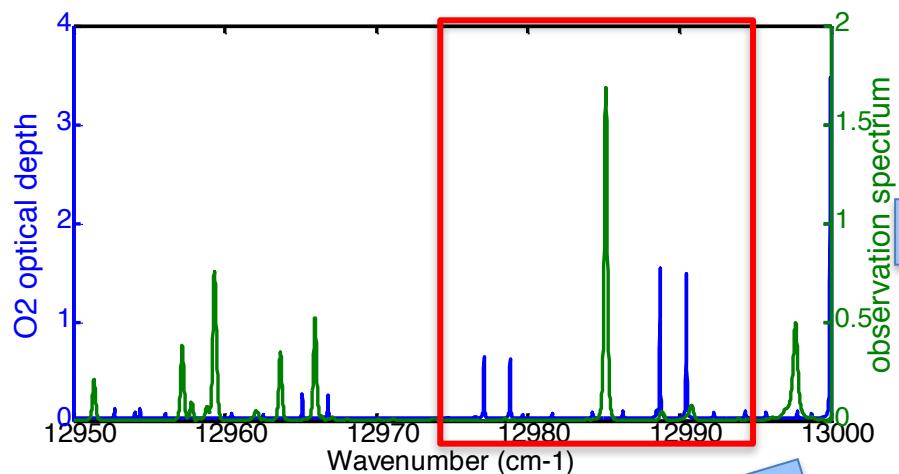
Global terrestrial SIF map from TanSat observations

$$\vec{f}(F_s^{rel}, a) = \log(\langle \vec{I}_0 + F_s^{rel} \rangle) + \sum_{i=0}^n a_i \cdot \lambda^i,$$

(Frankenberg et al., 2011)



A new cloud and SIF joint retrieval



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TanSat data distribution and joint application

TanSat L1b Data is available from October 23, 2017

➤ **GEO China site:**

FTP Access Service:<ftp://58.215.62.138>

➤ **CMA FY data site:**

<http://satellite.nsdc.org.cn>

TanSat L2 Data will be released soon

on the same website

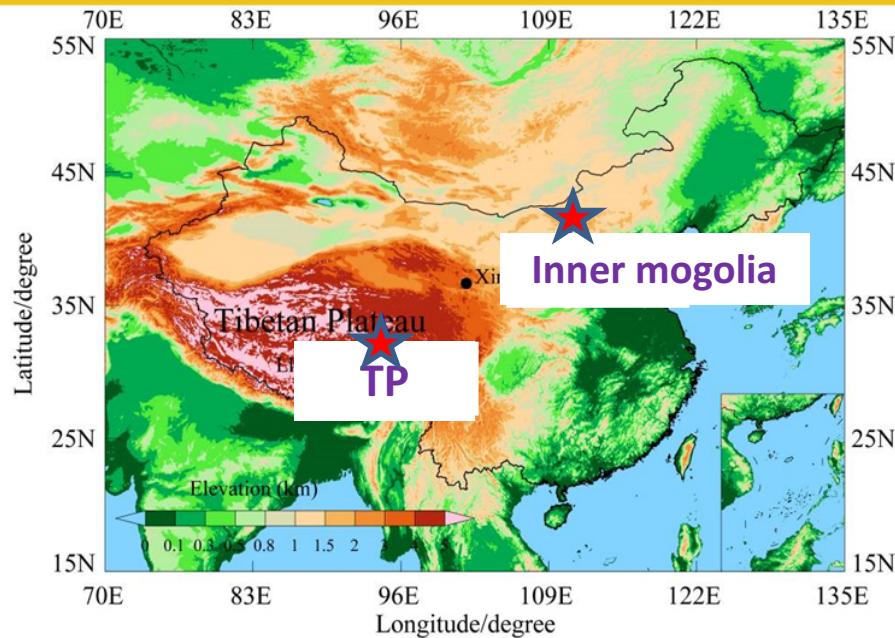
TanSat TG observation to Railroad Valley (RRV) during June 2017

Date	TanSat	OCO-2	GOSAT	RRV
25 Jun.		✓		✓
26 Jun.	✓		✓	✓
27 Jun.		✓	✓	✓
28 Jun.	✓			
29 Jun.		✓	✓	✓
30 Jun.	✓		✓	✓

We hope the RRV data will be released soon to make inter-comparison among OCO-2, GOSAT and TanSat

Validation: The STEAM campaign (2018-2022)

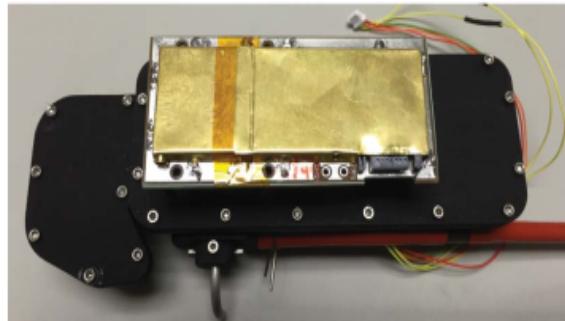
- Vertical distribution of aerosol, water vapor, CH₄, CO₂ will be obtained using research balloons
- Coincident ground-based spectrometers, such as EM-27
- The STEAM project will launch more than 40 soundings each summer, which will acquire a new dataset for the validation of satellite data, such as TropOMI, TanSat, OCO-2 and GOSAT.



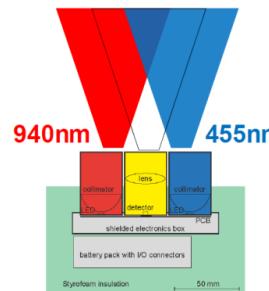
Aircore



POPS



COBALD



TanSat-2 introduction



The next generation of Chinese greenhouse gas monitoring satellite mission: TanSat-2

Dongxu Yang, Yi Liu, Zhaonan Cai

Lin Qiu, Maohua Wang

Longfei Tian, Zengshan Yin

TanSat-2 team

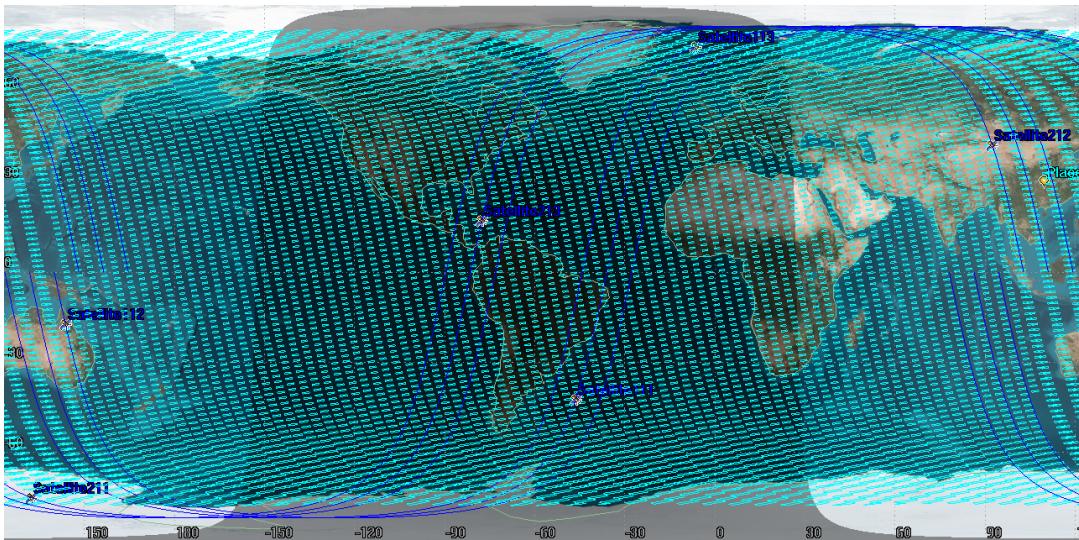
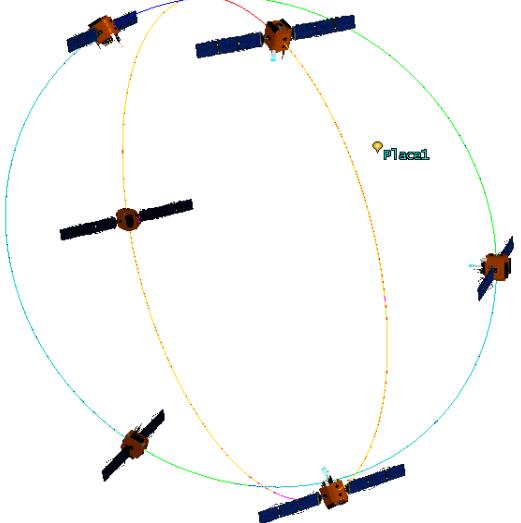
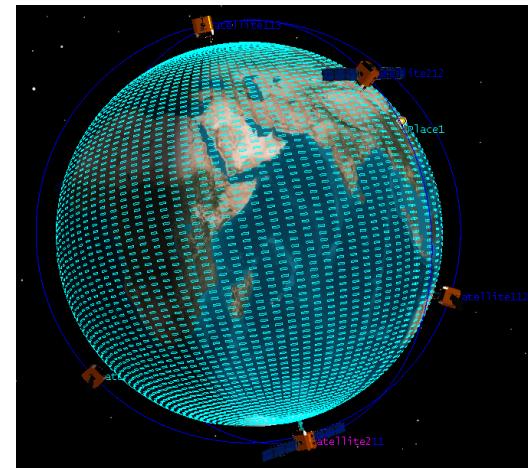
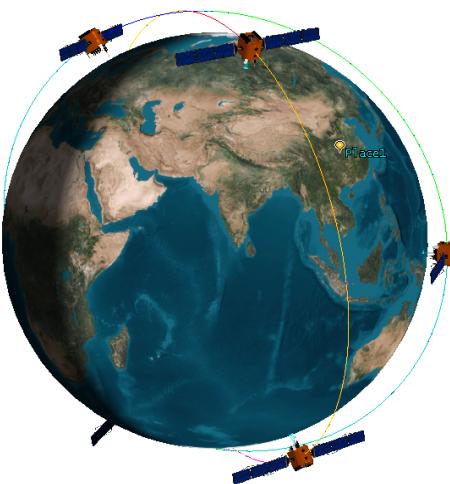
- *Institute of Atmospheric Physics, Chinese Academy of Sciences*
- *Shanghai Advanced Research Institute, Chinese Academy of Sciences*
- *MicroSat, Chinese Academy of Sciences*
- *ShanghaiTech University*



Flight orbit

□ Two orbits, 2 or 3 Satellites each

- Sun-synchronous orbit
- 590 - 610 km
- Morning 10:45
- Afternoon 13:30



Thank you!

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