The Chinese GHG Satellite Status and Plan

Present by CHEN Lin

Contribution: ZHANG Lu; WANG Qian; LI Lu; PAN Yang

National Satellite Meteorological Centre,China Meteorological Administration

NSMC/CMA

IWGGMS, 2025.06.09, Takamatsu

Overview

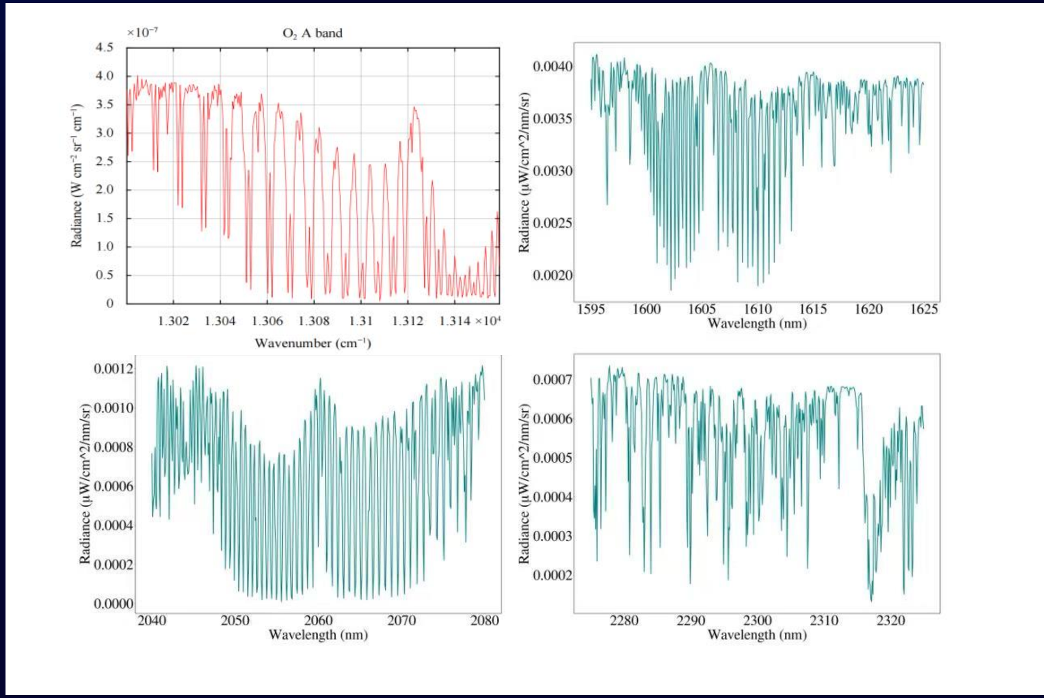
Since 2009, a series of greenhouse gas remote sensing monitoring satellites have been launched. China has also launched relevant satellite greenhouse gas programs, including the ***Fengyun series, Tansat series and DQ series.***

FY3D GAS and FY3H GAS-II

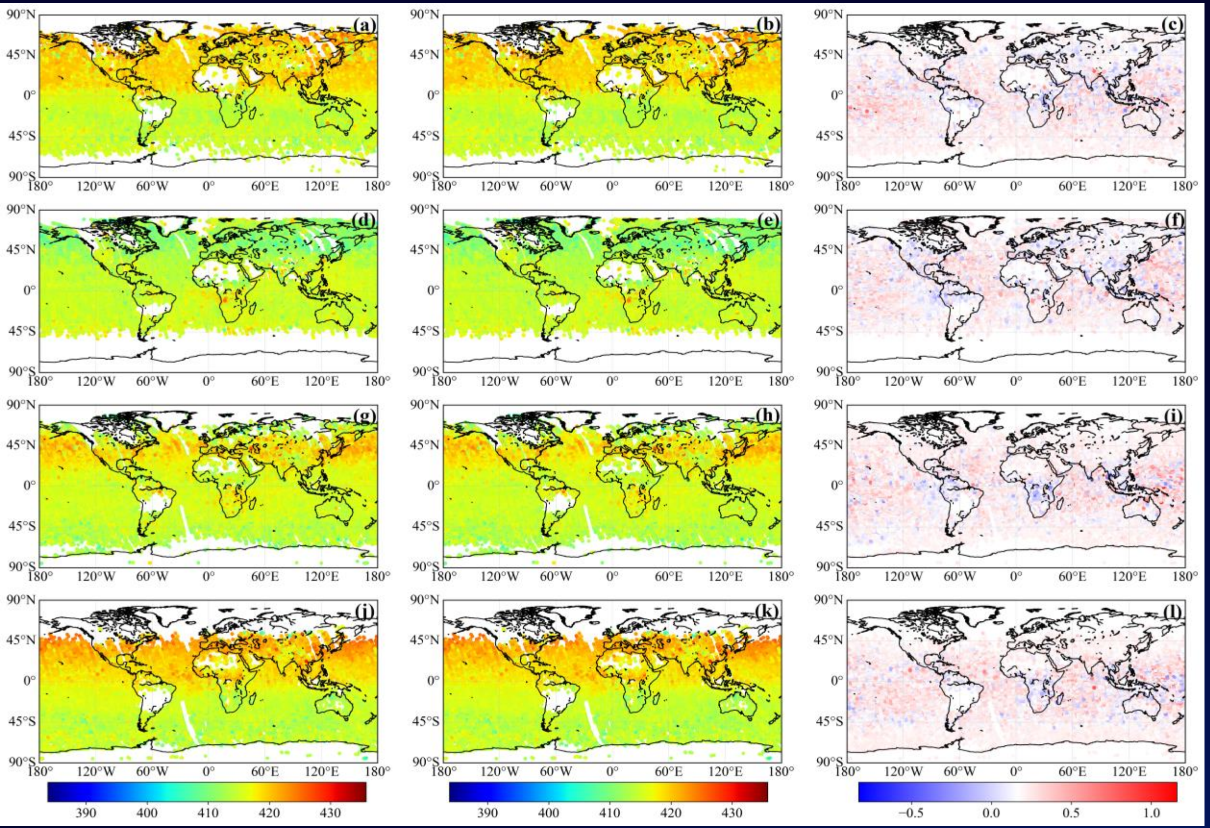
	O2-A	Weak CO2	Strong CO2	CO/CH4/N2O
FY3D GAS	Point measurements			
Aim	O2, aerosol	CO2,CH4	CO2,H2O	CO,CH4,N2O
Center wavelength	0.76μm	1.6μm	2.00μm	2.3μm
Wave range	0.75-0.77μm	1.56-1.72μm	1.92-2.08μm	2.20-2.38μm
Spectral sampling per FWHM	20nm	160nm	160nm	180nm
Spatial resolution	0.6cm-1	0.27cm-1	0.27cm-1	0.27cm-1
Coverage	--			
Spatial resolution	10km			
FY3H GAS-II	**Spatial coverage >100km with better resolution**			
Center wavelength	0.76μm	1.61μm	2.06μm	2.3μm
Spectral width	>15nm	>30nm	>40nm	>50nm
Spectral resolution	0.04nm	0.07nm	0.09nm	0.1nm
Spectral sampling per FWHM	≥3			
Coverage	>100km			
Spatial resolution	<3km			

FY3D GAS

O2-A band are affected by micro-vibration effect on orbit



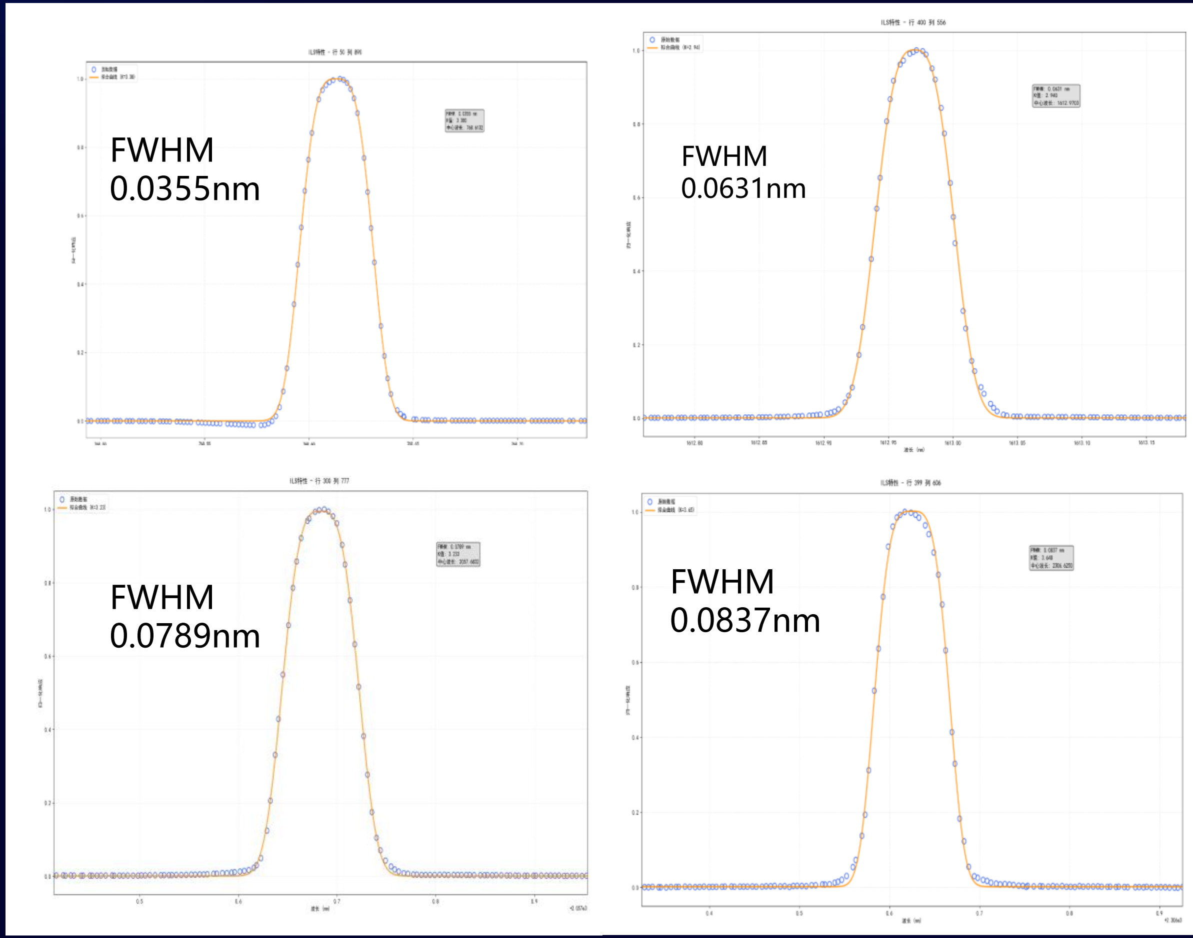
Using ERA5 instead of O2-A band, there is a 0.2 ppm difference in the retrieval of XCO2 by the two methods.

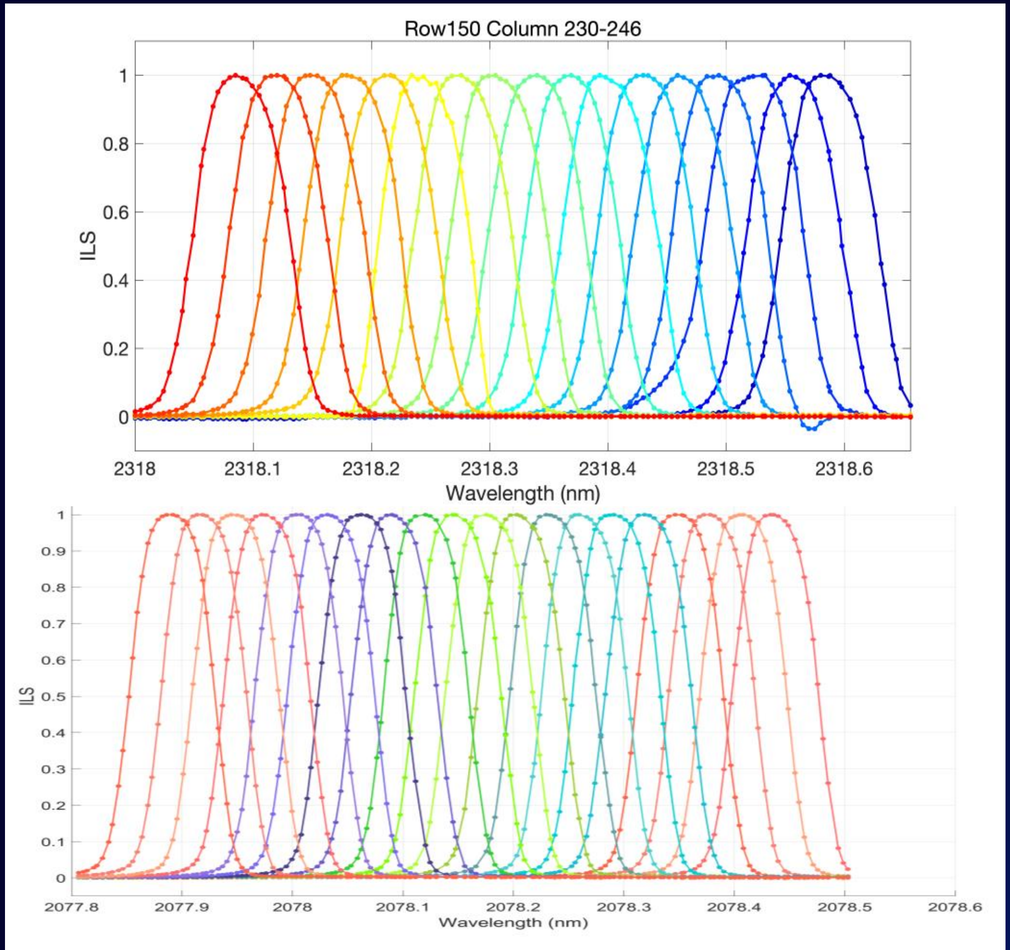


Zhang L. et al., 2025, TGRS

FY3H GAS

Pre-launch testing is underway



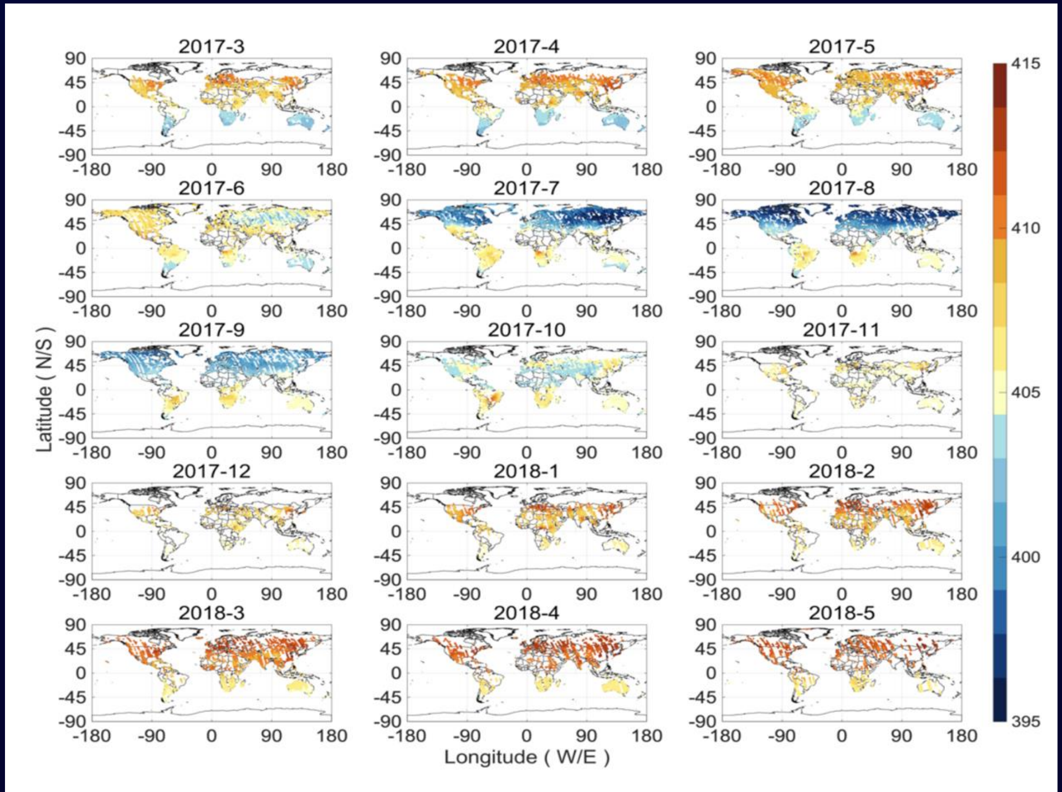


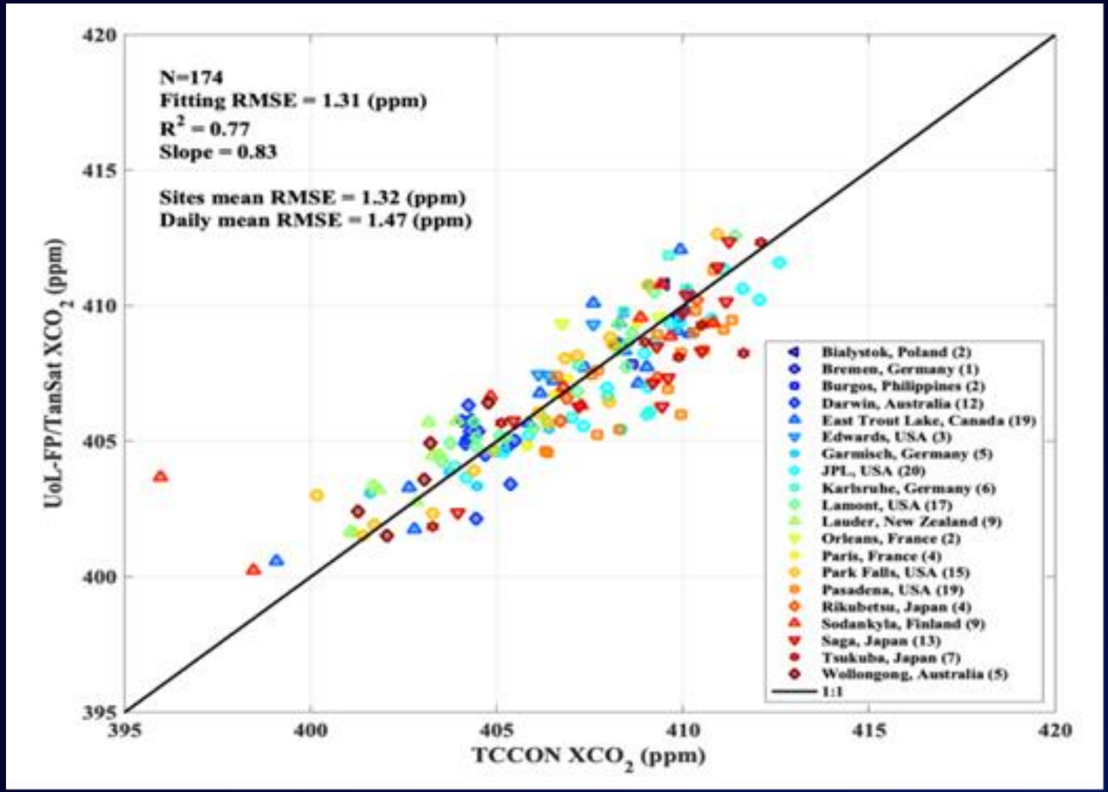
TANSat and TANSat-2

	O2A	WCO2	SCO2	CH4
TanSat				
Spectral range(nm)	758-778	1594-1634	2042-2082	
Spectral resolution(nm)	0.033-0.047	0.120-0.142	0.160-0.182	
Spectral resolving(λ/Δλ)	~19000	~12800	~12250	
SNR @ (ph/sec/m2/sr/µm)	360@5.8 X 1019	250@2.1 X 1019	180@1.1 X 1019	
Swath	**20km**			
TanSat-2	**Wide swath with better resolution, additional CH4 observation**			
Spectral range(nm)	757-771nm	1590-1620nm	2042-2082nm	1635-1670nm,
Spectral resolution(nm)	≤0.04nm	≤0.13nm	≤0.13nm	≤0.13nm
SNR @ (ph/sec/m2/sr/µm)	500:1 @ 6.4 * 1019 photo/sec/m2/sr/µm；	400:1@2.1×1019 photo/sec/m2/Sr/m；	400:1@1.8×1019 photo/sec/m2/Sr/m；	400:1@2.1×1019 photo/sec/m2/Sr/m；
Swath	**2900km**			

TANSat

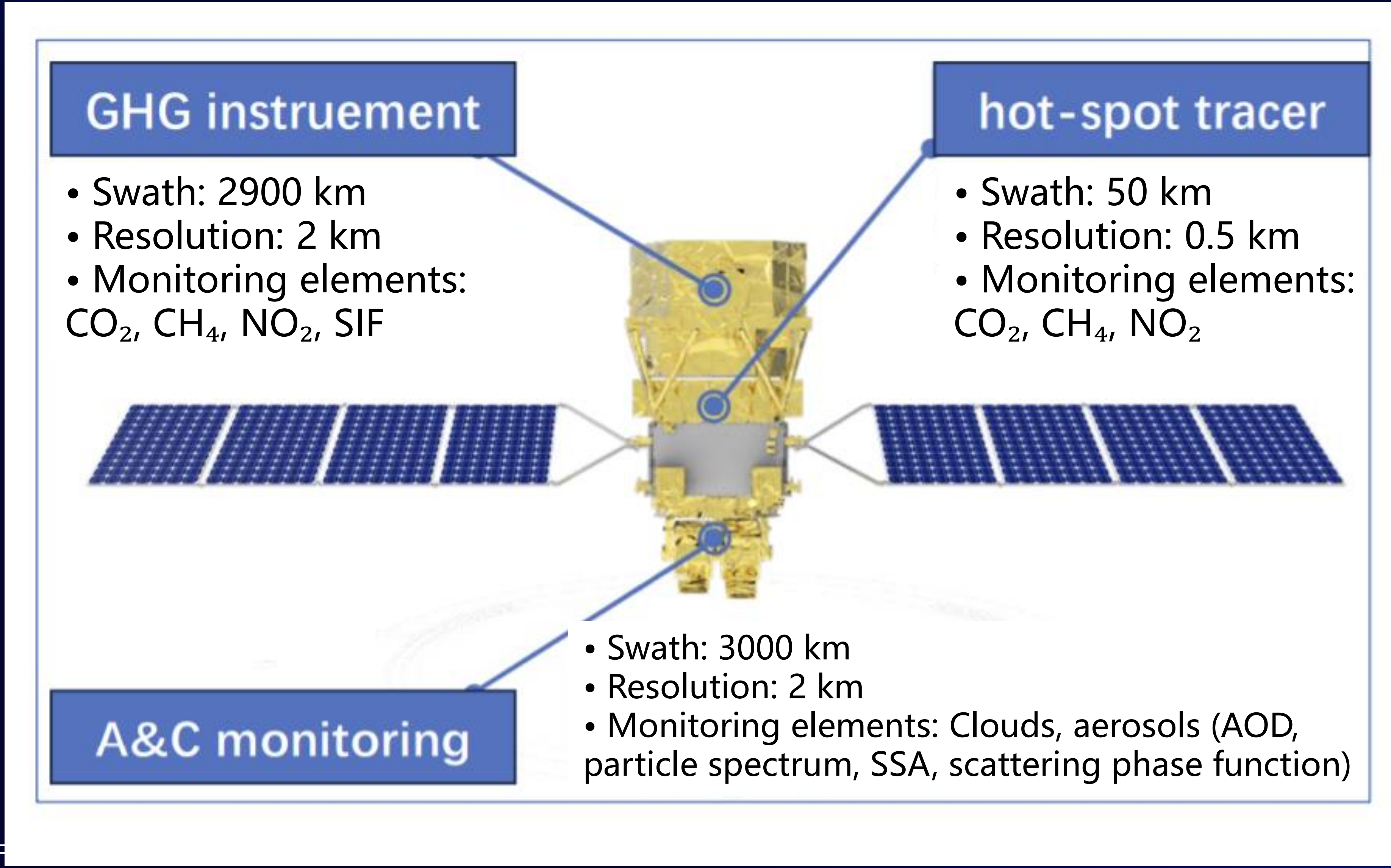
The global land surface CO_2 retrived by TANSat. The product covers the period from March 2017 to May 2018, with an inversion accuracy of 1.32 ppm comparison with TCCON.





Yang D et al., 2020,JGR

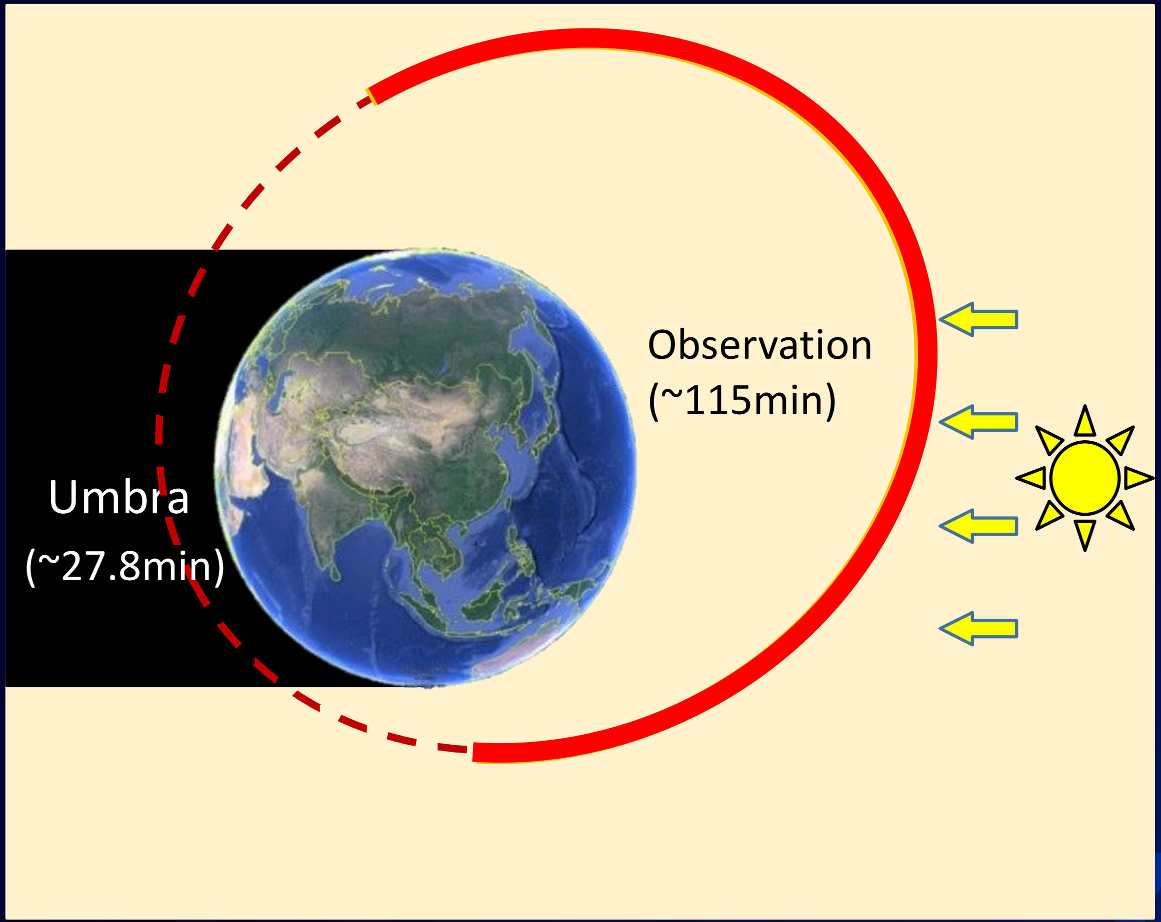
TANSat-2


GHG instruement
• Swath: 2900 km
• Resolution: 2 km
• Monitoring elements:
CO_2, CH_4, NO_2, SIF
hot-spot tracer
• Swath: 50 km
• Resolution: 0.5 km
• Monitoring elements:
CO_2, CH_4, NO_2
A&C monitoring
• Swath: 3000 km
• Resolution: 2 km
• Monitoring elements: Clouds, aerosols (AOD, particle spectrum, SSA, scattering phase function)

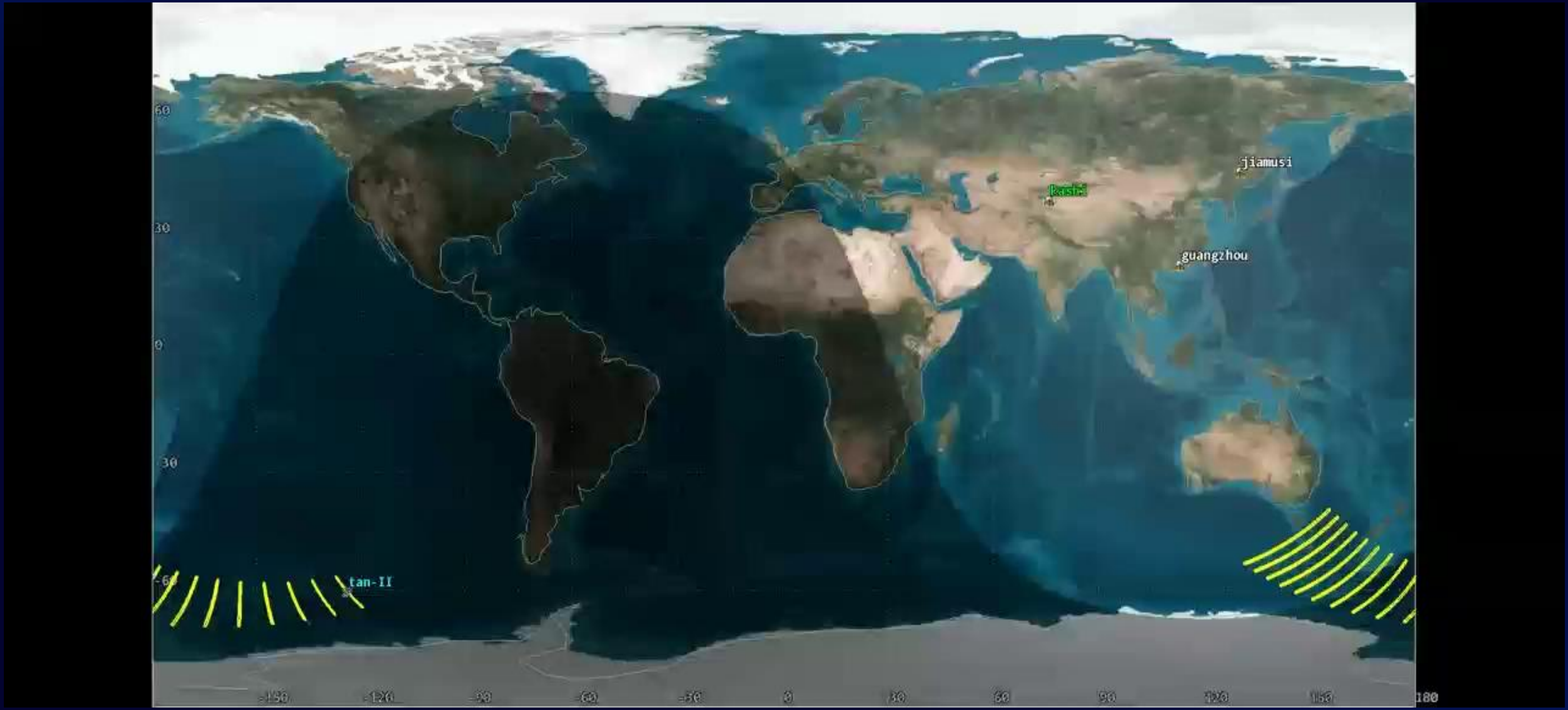
TANSat-2

Orbit type：Elliptical orbits

Parameters	Value
Perigee altitude	~522km
Apogee altitude	~7840km
Inclination	116.565°
Latitude at Apogee	35°N
Argument of Perigee	210°
Revisit Period	1 day



TANSat-2



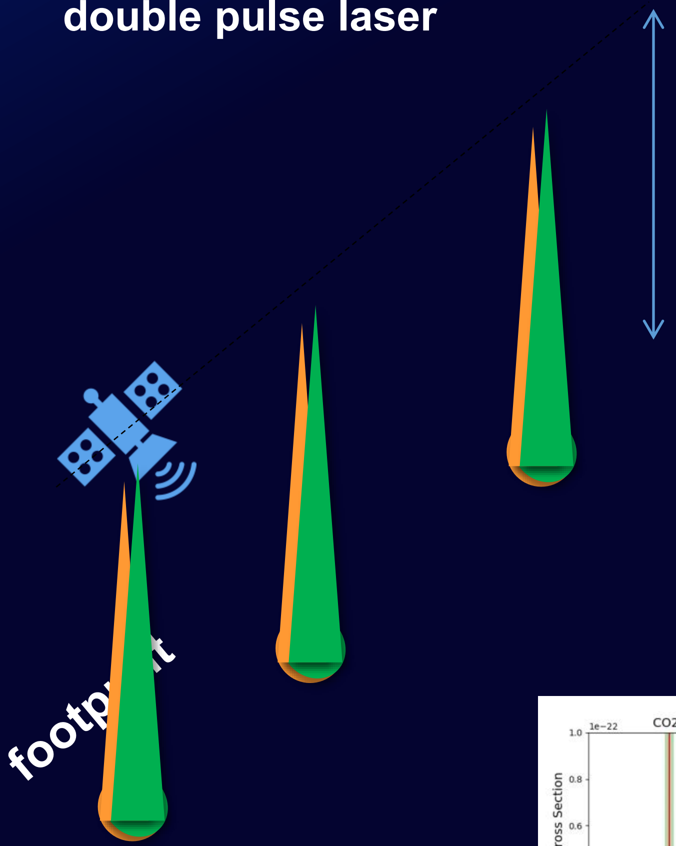
Elliptical orbits help increase observation time in the Northern Hemisphere

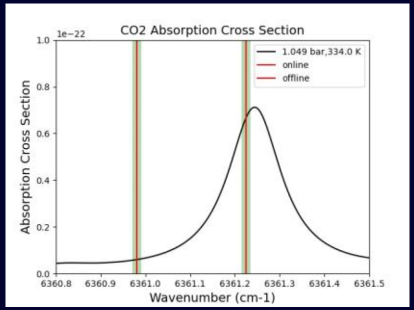
Improvment of TanSat2

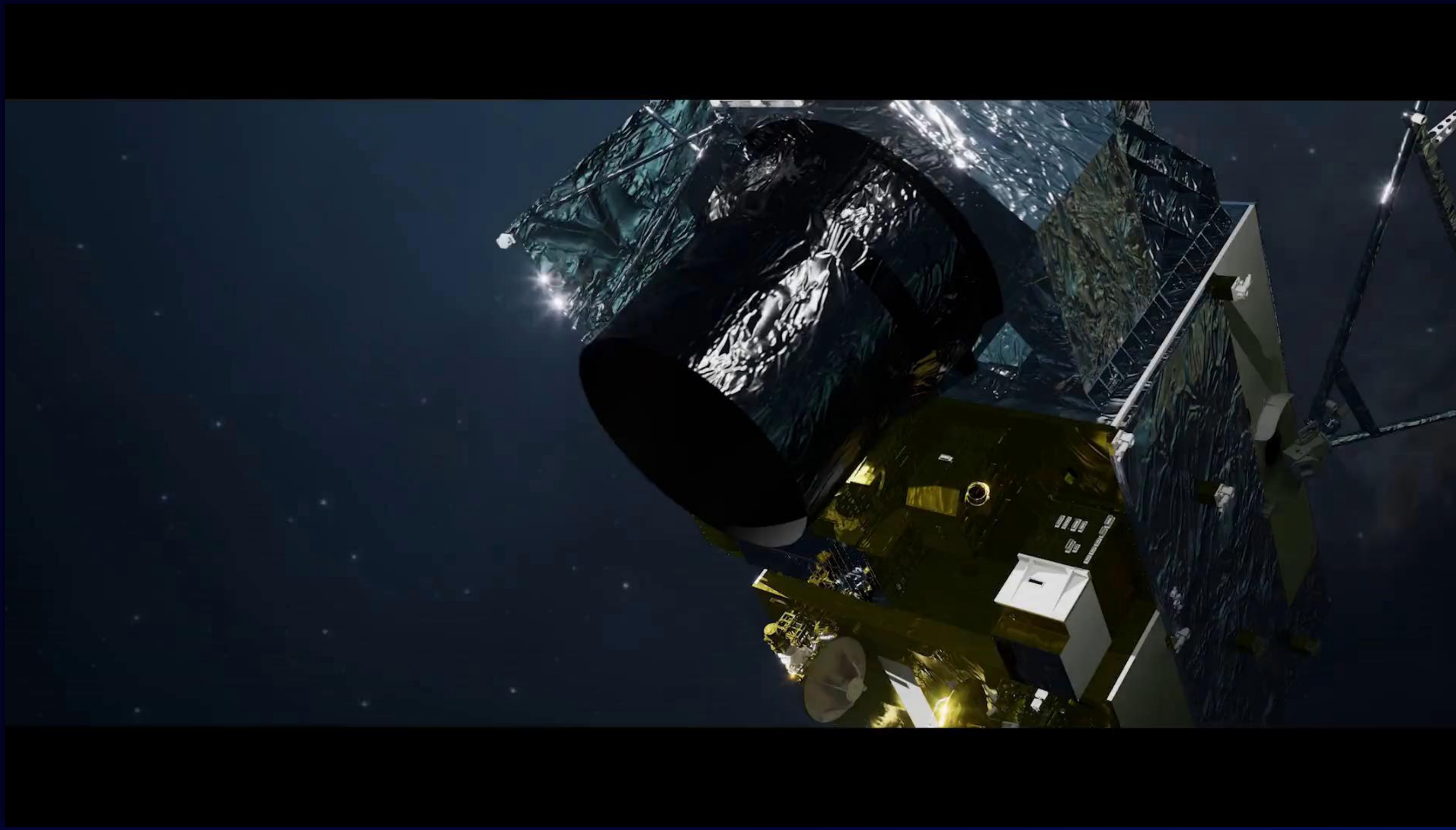
		TanSat-1	TanSat-2
Mission		CO2	Global stocktake
Approach		Inversion of Co2	Assimilation inversion of Flux, fossil CO2 emissions, Eco-Sinks
Satellite	Spatial scale	Global	Global,Cities,Hotspot
	Temporal resolution	120Days	1-3day
	Geophysical products	CO_2,SIF	CO_2,CH_4,NO_2,SIF
	Accuracy	1.47ppm	1.0ppm

DQ-1：Active aerosol and XCO2 observations

double pulse laser

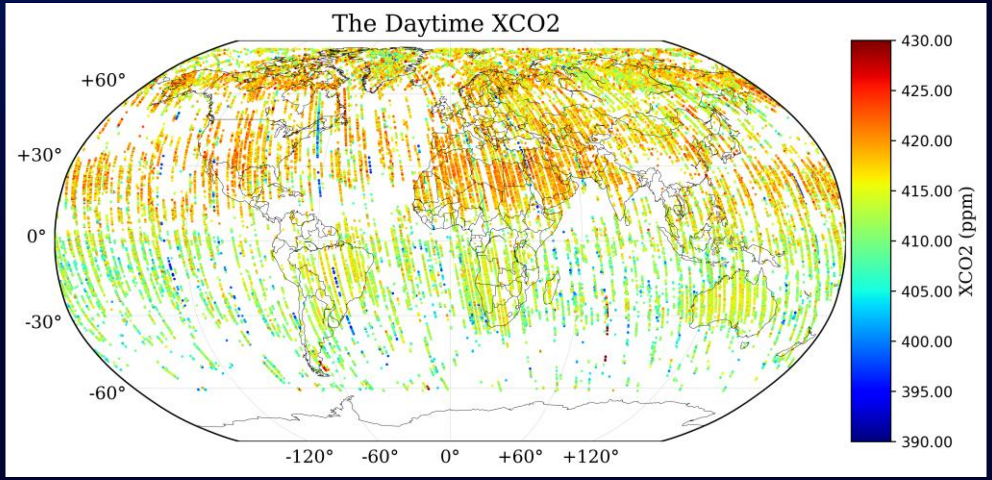


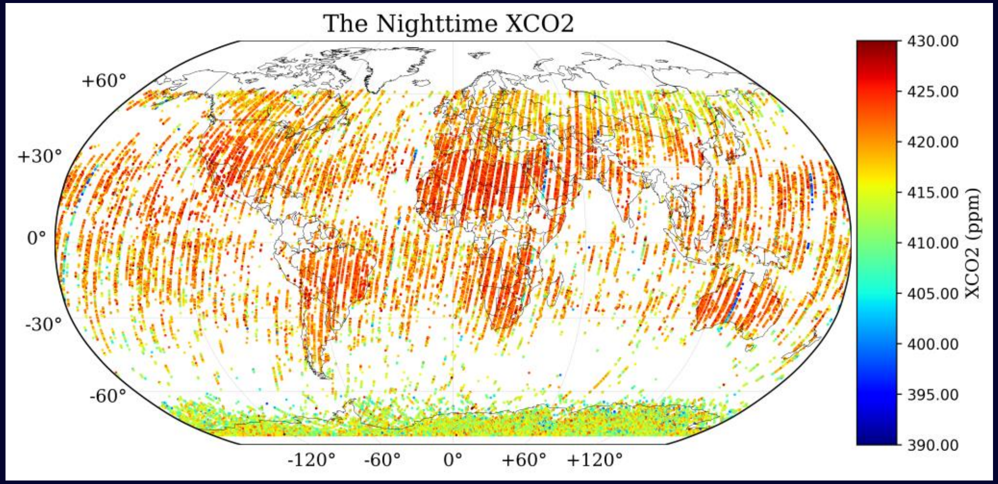




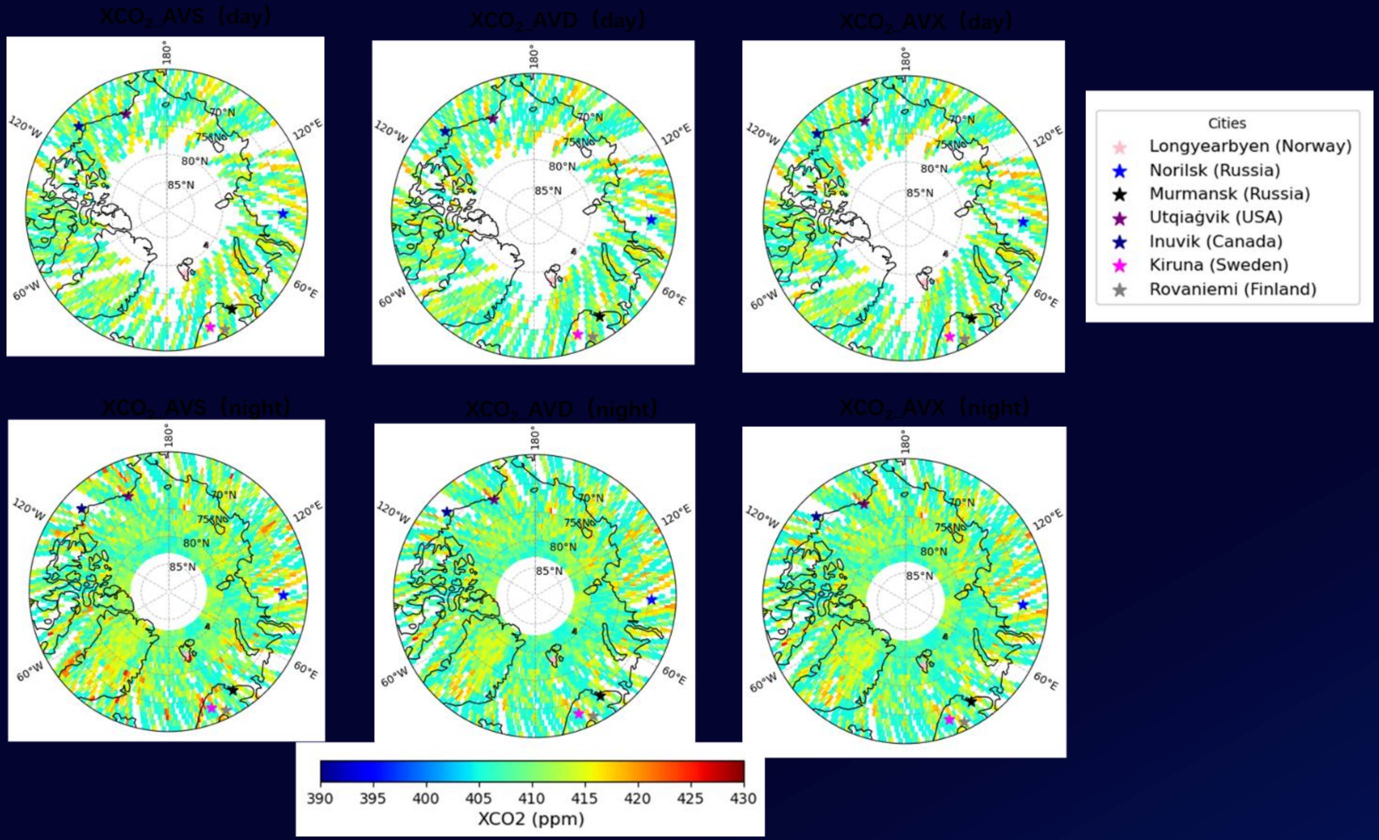
DQ1 is equipped with the world's first active LiDAR carbon dioxide instrument, simultaneously emitting two laser beams, located on the absorption and non absorption lines respectively

DQ-1: Active aerosol and XCO2 observations



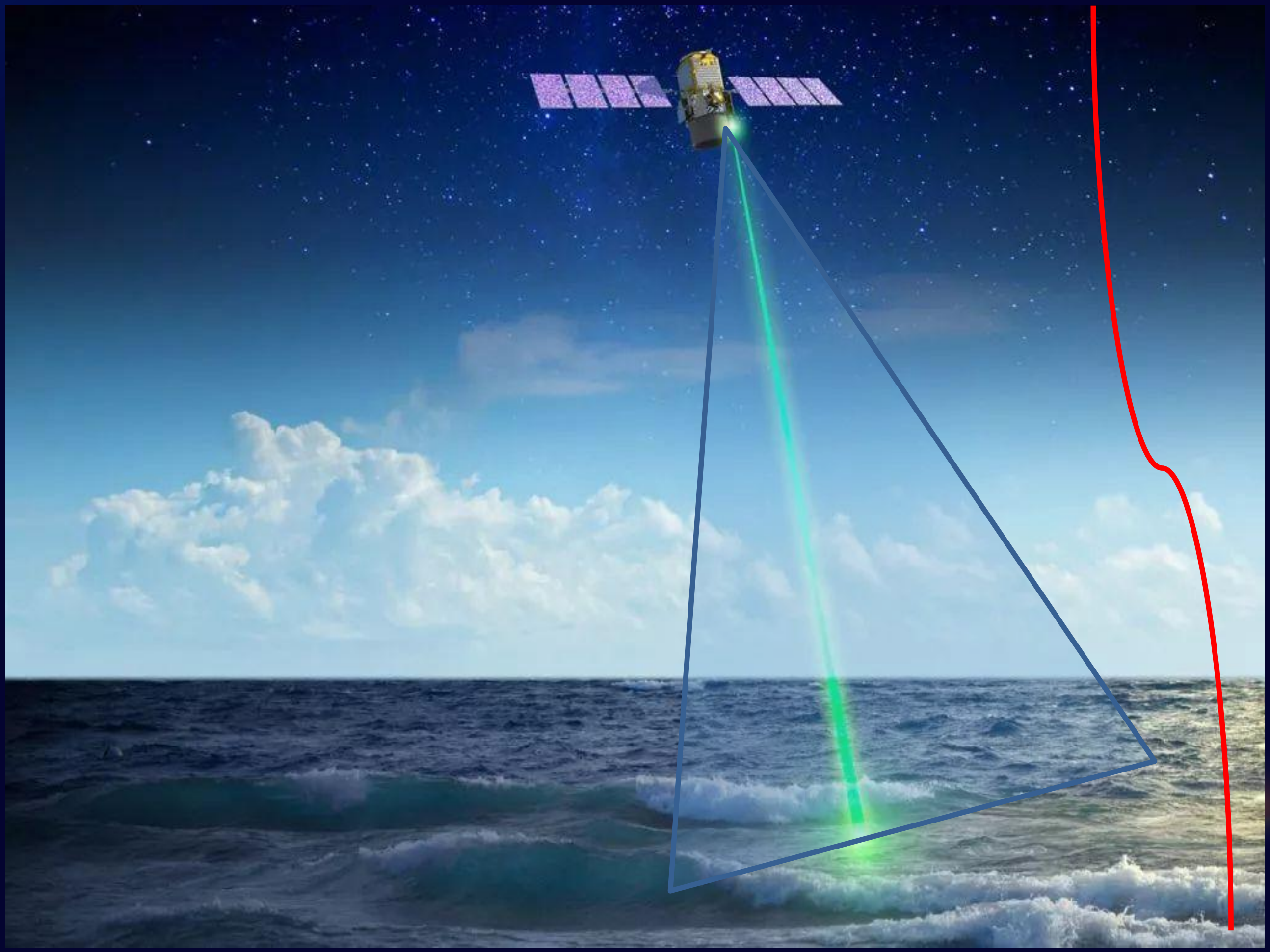


Zhang L. et al., in preparation



Compared with passive detection, active carbon dioxide lidar can detect surface reflectance at high latitudes and high altitudes such as polar regions, as well as carbon dioxide at night.

DQ-2: Active and passive collaborative XCO2 measurements



The instrument onboard DQ-2

- ACDL LIDAR for XCO2
- SWIR for XCO2
- IR for profile of CO2

DQ-1 and DQ-2 instruments parameters

	ACDL IPDA lidar	Passive instruments		
DQ-1 (no passive for CO2 but for clouds and aerosols)				
Repetition frequency	20 Hz	POSP	Center wavelength/nm	380,410,443,490,670,865,1 380,1610 ,2250
Wavelength1	150mJ@532nm	DPC	Wave range/nm	433~453, 480~500(P), 555~575, 660~680(P), 758~768, 745~785, 845~885 (P), 900~920
Wavelength2	110mJ@1064nm			
Online wavelength	75mJ@1572.024 nm	EMI	Wave range/nm	240~315, 315~403, 403~550, 550~710
Offline wavelength	75mJ@1572.085nm	WSI	Center wavelength/nm	0.415,0.443,0.47,0.49,0.555,0.659,0.681,0.753,0.8, 0.865,0.936,0.94,1.375,1.64,2.13,3.8,3.8,7.325,8.55 ,10.8,12.0
DQ-2 (similar with DQ-1 + GAS-II/HIRAS of FY3H)				
Repetition frequency	20 Hz	The parameters are consistent with GAS-II of FY3H, except that the orbital altitude is 750km	Spectral Range (cm-1)	648.75~1169.375 1167.5~1921.25 1919.375~2551.25
Wavelength1	150mJ@532nm		Spectral Resolving (cm-1)	0.625 0.625 0.625
Wavelength2	110mJ@1064nm			
Online wavelength	75mJ@1572.024 nm			

Summary

- Status of China’ s greenhouse gas missions are summarized , including
  - TanSat1 has stopped operation
  - FY3D/GAS is operating normally, but data abnormally
  - DQ-1 is operating normally

- The new generation GHG satellites/sensors are coming up, including
  - FY-3H/GAS-II (passive) will launch in October 2025, undergoing pre-launch ground test
  - DQ-2 (active-passive combined) will launch in 2026
  - TanSat-2 (passive) will launch 2026, undergoing instrument test

Summary

- It is difficult for any satellite to meet the growing demand for greenhouse gas monitoring by itself. Therefore, greenhouse gas satellites could be formed as a virtual constellation, or at least establish data standards to facilitate data cross validation and fusion.

- The scarcity of high-quality ground-based data for calibration and validation necessitates the establishment of a cooperative group for data sharing.

Thank you