

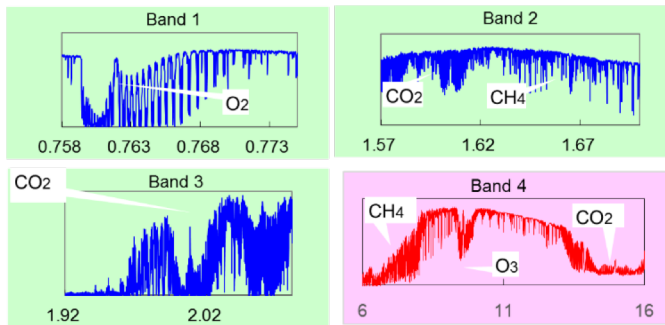
GOSAT & GOSAT-2 status

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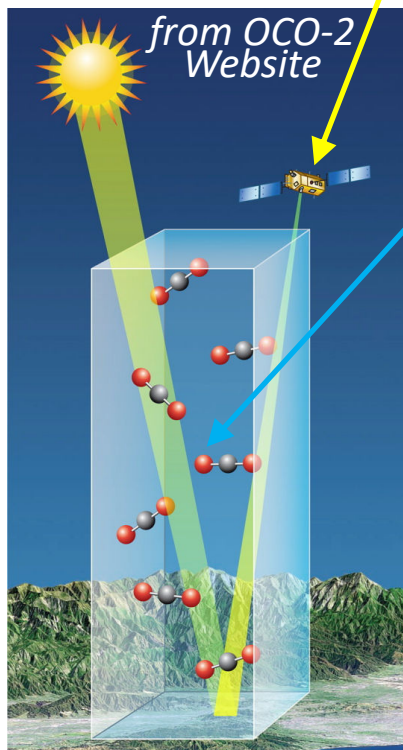


GOSAT on orbit since 2009



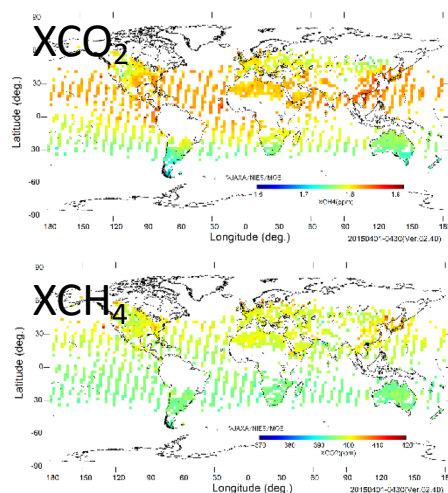
Level 1

TOA (top of atmosphere) radiance



Level 2

Column-averaged dry air mole fraction of CO₂ and CH₄



Size	Main body	3.7 m x 1.8 m x 2.0 m (Wing Span 13.7m)
Mass	Total	1750kg
Power	Total	3.8 KW (EOL)
Life Time		5 years
Orbit		sun synchronous orbit
	Local time	13:00 +/- 0.15
	Altitude	666km
	Inclination	98deg
	Repeat	3 days
Launch	Vehicle	H-IIA
	Schedule	Jan. 23 2009

GOSAT satellite and sensors

TANSO=Thermal And Near infrared Sensor for carbon Observation

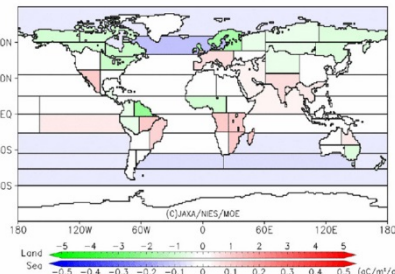
TANSO-FTS (Fourier Transform Spectrometer)

TANSO-CAI (Cloud and Aerosol Imager)

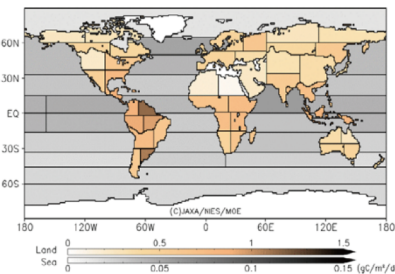
CO₂ and CH₄ emissions and sinks

Level 4

CO₂ flux (64 areas)



CH₄ flux (43 areas)

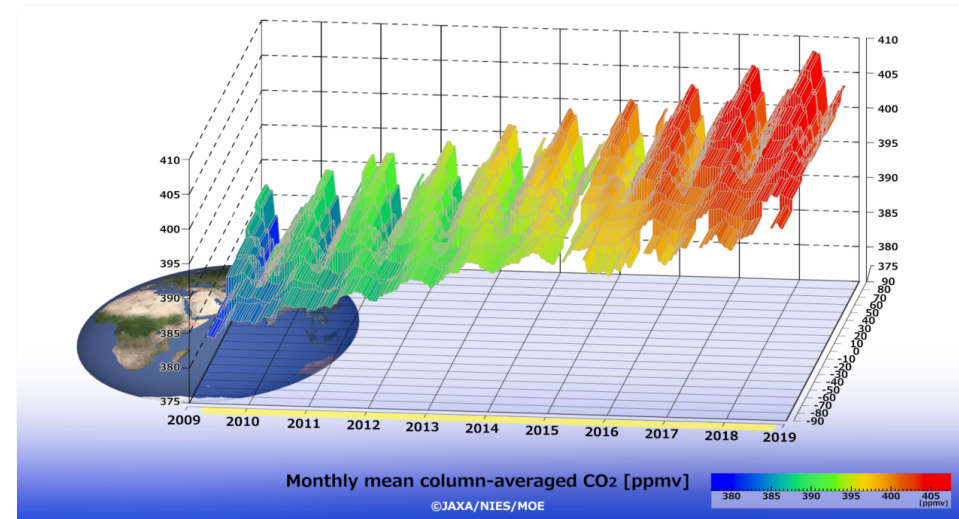


<http://www.gosat.nies.go.jp/en/>

<http://www.eorc.jaxa.jp/GOSAT/index.html>

GOSAT XCO₂ and XCH₄ over 10 years

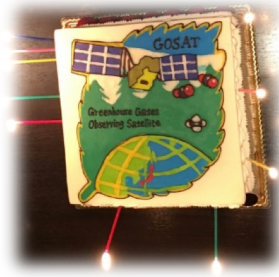
Monthly mean global CO₂ since 2009



The typical accuracy of retrieved column-averaged dry air mole fractions of CO₂ and CH₄ are 2ppm or 0.5% and 13ppb or 0.7%, respectively.

GOSAT 10-year operation

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Milestone	* Launch					* Solar paddle incident * Unstable Pointing	* Switching Pointing mechanism * Cryocooler suspend			* CDMS incident * Solar Paddle incident	
FTS Nominal Pointing Pattern	5p-CT	3p-CT				1, 3 p-CT	3p-CT				
FTS Pointing Mechanism	Primary					Secondary					
FTS interferogram	No bias					800 fringes bias	650	1100	1860	830	
FTS Operation	SWIR (S) and TIR (T)						S	S & T			
FTS L1B V161.161	Re-processing (no geometry correction)				Old version						
FTSL1B V201.202	Re-processing (pointing error, biased interferogram corrected)						Older version				Operational
FTSL1B V210.210	Re-processing (completed)										Operational
FTSL1B V220.220	Sample products now available. Official release will be soon.										
CAI L1A V130.131	Latest version										Operational



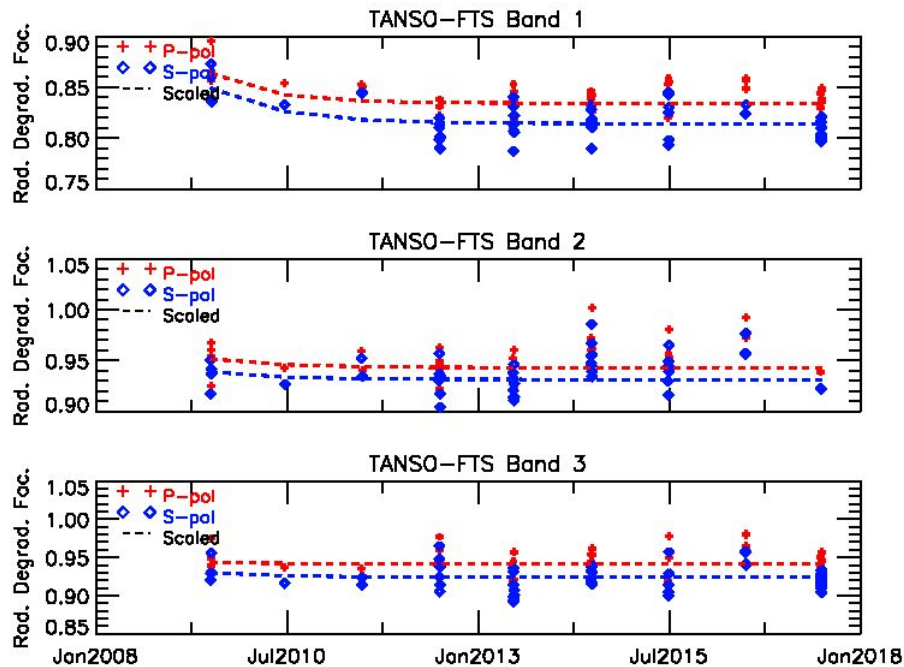
10th anniversary of GOSAT on orbit operation.

July-Aug, 2018 3rd Inclination Maneuvering control.

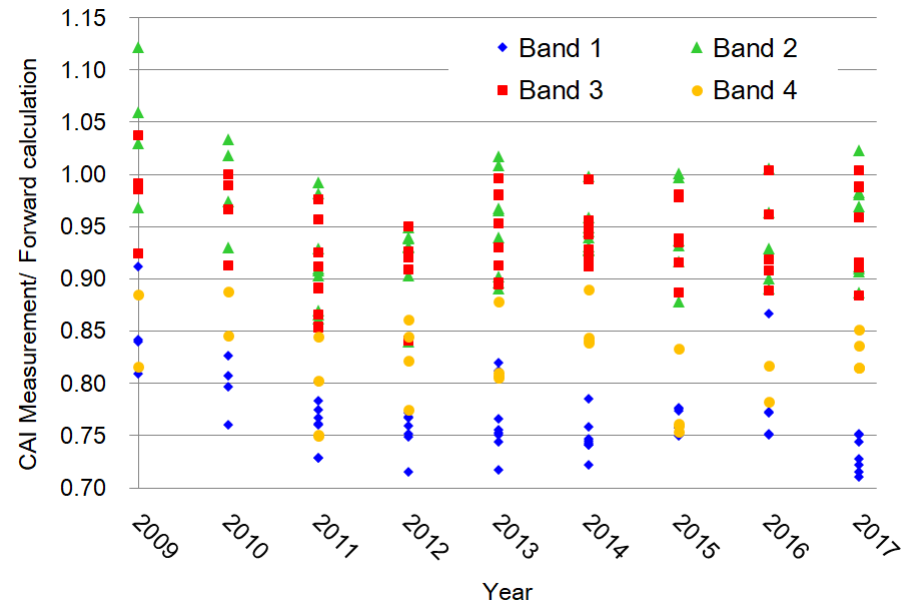
New v220.220 of L1B will be improved the TIR band and be released in soon. SWIR is applied same processing as before.

GOSAT radiance degradation

FTS radiance (0.76, 1.6, 2.0 μm)



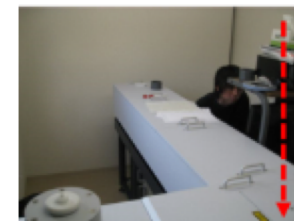
CAI radiance (0.38, 0.67, 0.87, 1.6 μm)



http://www.eorc.jaxa.jp/GOSAT/calibration_1.html

- RDF for 10 years from annual vicarious calibration campaigns. The relative curves show the model derived from the onboard solar diffuser data.
- The Latest FTS v210.210 records the best estimated radiance after degradation correction.

GOSAT XCO₂ and XCH₄ validation with TCCON stations



gbFTS@Saga

from TCCON and TCCON-wiki websites

TCCON sites (<https://tccondata.org/>)

Group	Version	XCO ₂		XCH ₄	
		Bias[ppm]	STD[ppm]	Bias[ppb]	STD[ppb]
NIES-FP	v2.21-v02.60	-0.48	2.27	-3.7	13.7
NIES-PPDF-S	V02.21-v02.40	0.73	1.83	1.4	14.1
ACOS (bias correction)	B3.5	0.1	1.7	-	-
RemoTeC-FP (bias correction)	v2.3.8	0.02	1.91	0.06	14.89
BESD	v1.02	-0.38	2.04		
U-Leicester-Proxy	CH4 v4			4.80	13.44

NIES-FP: Uchino et al., 2017

NIES-PPDF-S: Iwasaki et al., 2017,

ACOS : Lindqvist et al., ACP, 2015,

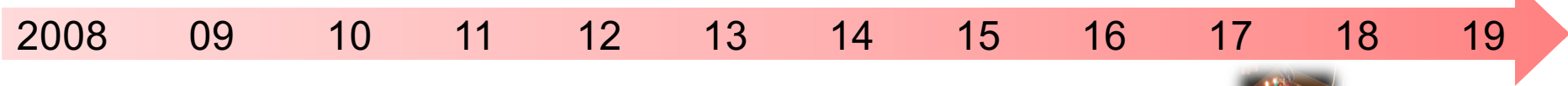
RemoTeC: ESA-CCI SVR RemoTeC, 2016

BESD: Heyman et al., 2015

Univ. Leicester: Parker, AMT, 2015

- For long-term consistency, comparison of seasonal and annual trend around TCCON sites is performed in the recent papers. (Lindqvist, ACP, 2015 etc.)

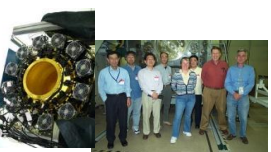
Inter-comparison between GOSAT, OCO-2 and GOSAT-2, OCO-3



2008 09 10 11 12 13 14 15 16 17 18 19

Radiometric calibration

Prelaunch X-CAL



Annual Vicarious Calibration at the desert playa in Nevada



CO₂ & CH₄ profile

In situ CO₂ and CH₄ on AJAX



XCO₂ & XCH₄

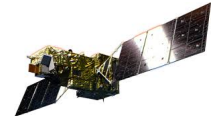
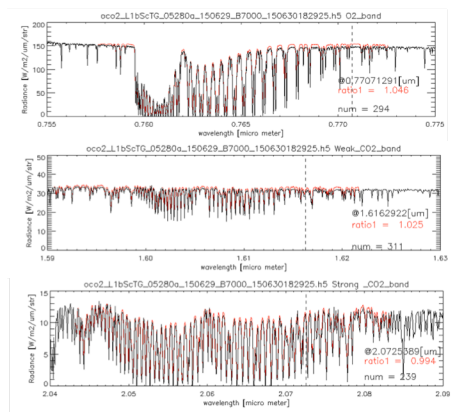
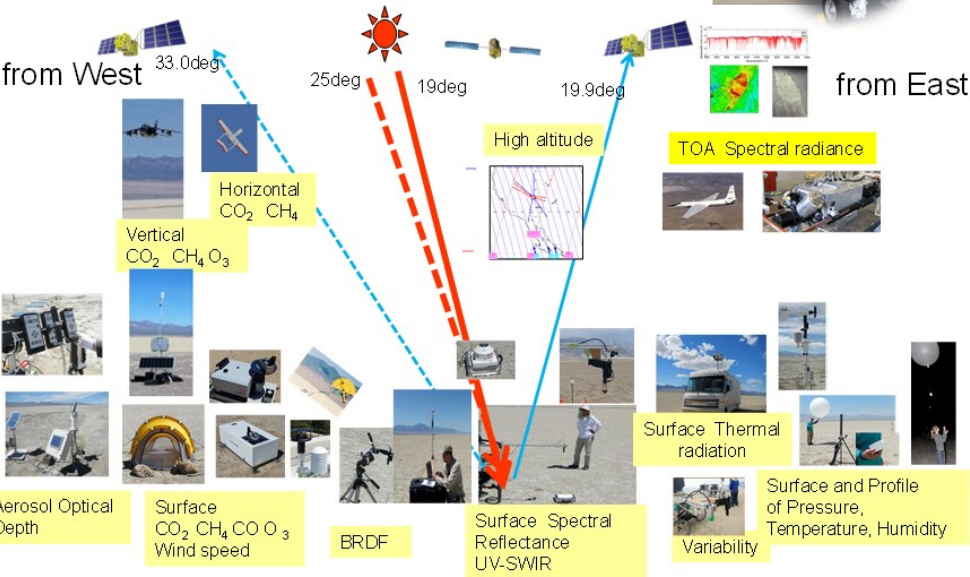


Column with EM-27 FTS

Coincident Target



GOSAT OCO-2

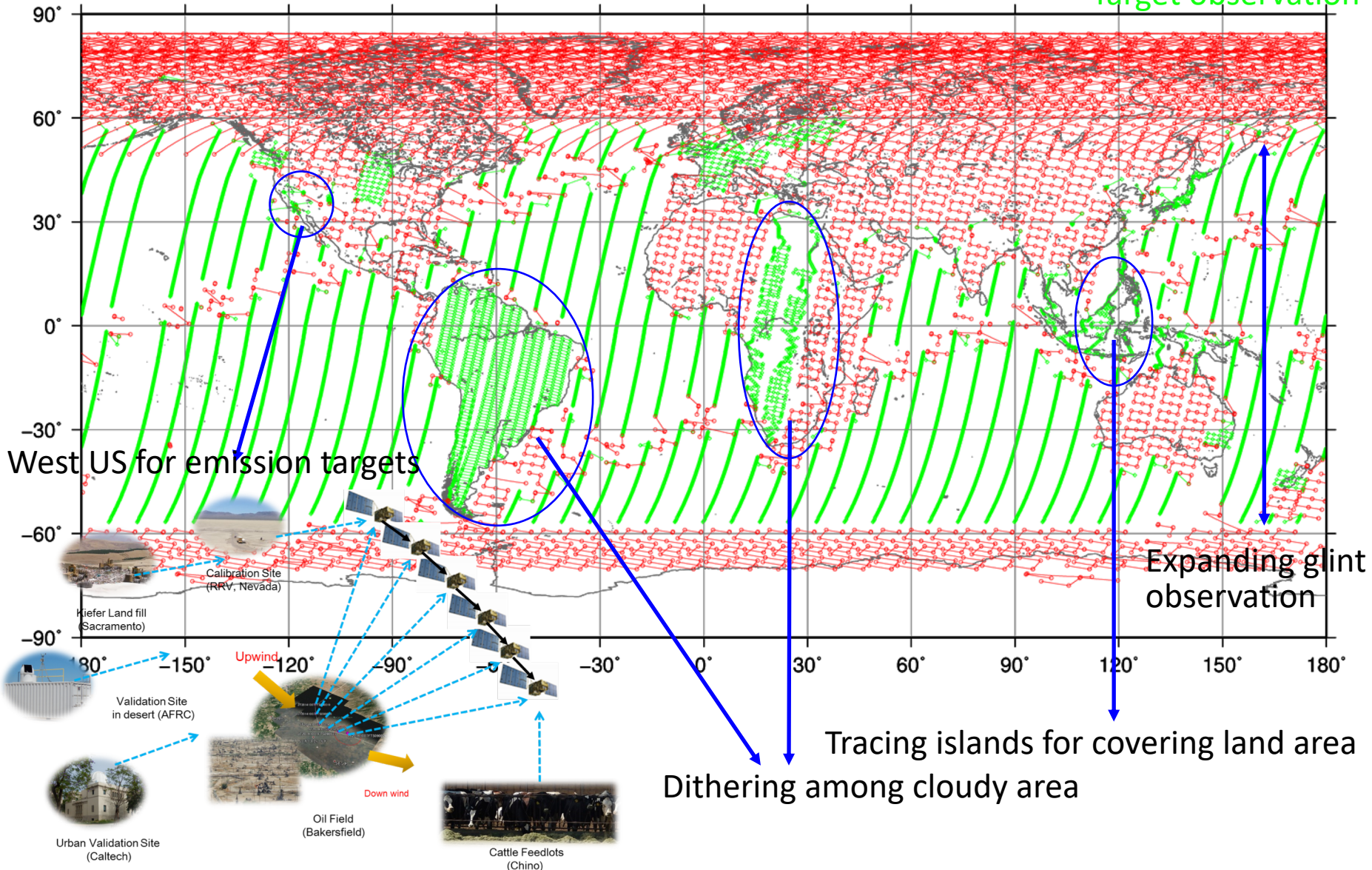


Calibrated GOSAT and OCO-2 radiance spectra agrees within 5% for all bands.

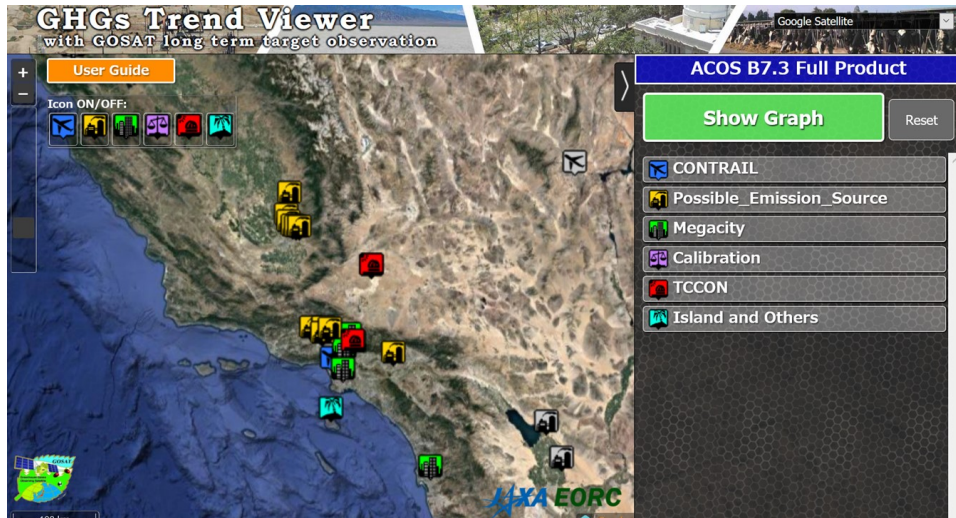
Optimization of GOSAT observation pattern

FTS observation in June 22-24, 2016

Grid observation
Target observation

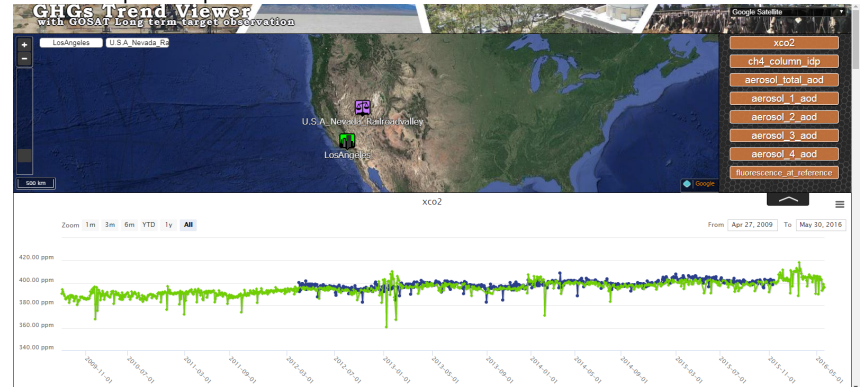


GHG trend viewer of total & 2-layer partial column



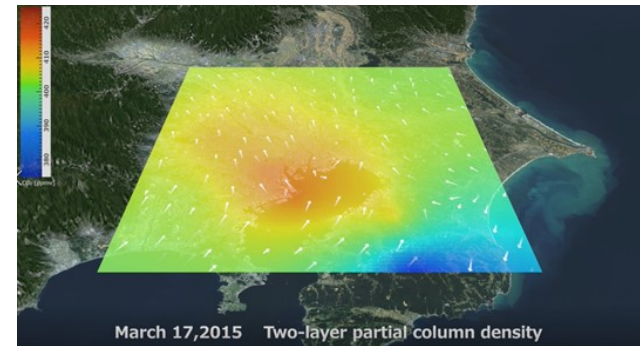
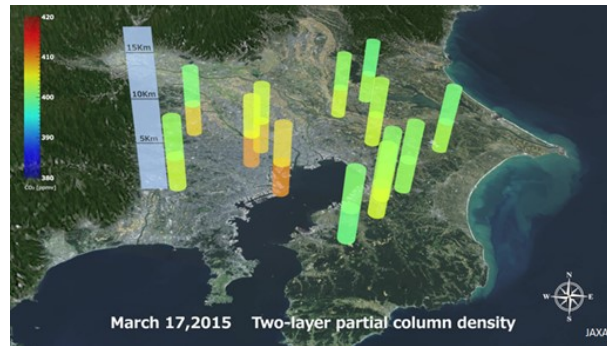
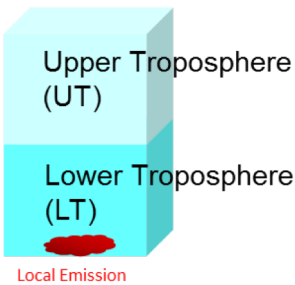
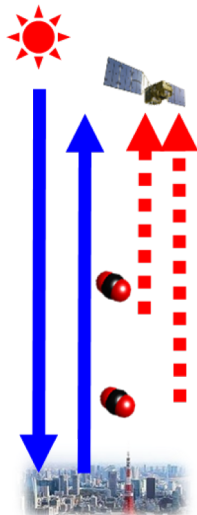
Long-term trend of ACOS, NIES, RemoTeC
CO₂, CH₄, SIF, AOD

Solar-induced chlorophyll fluorescence
Aerosol optical depth



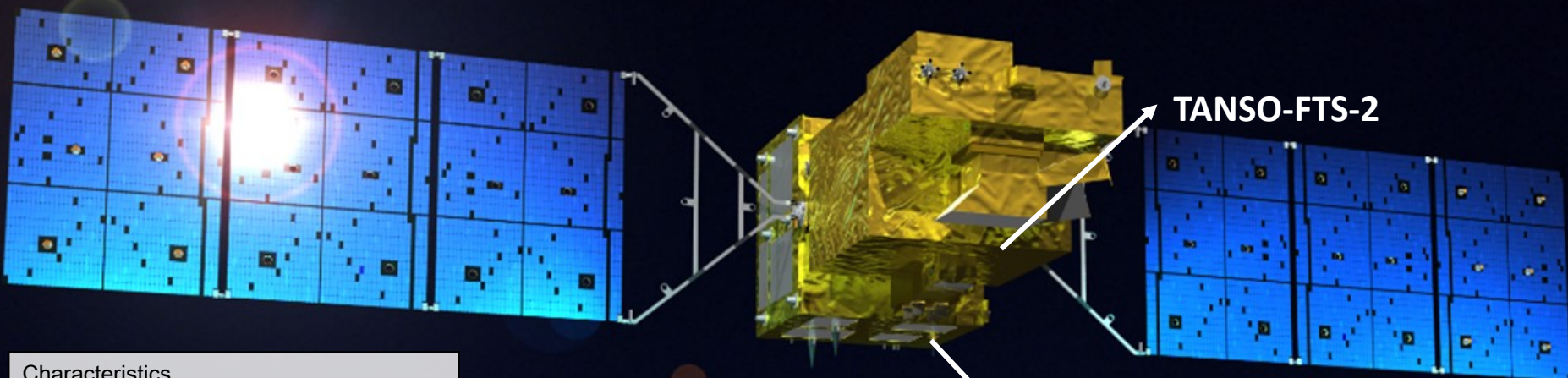
http://www.eorc.jaxa.jp/GOSAT/CO2_monitor/index_ACOS_B73.html

GOSAT measures both solar reflected light from the Earth's surface (SWIR) and thermal emission from the Earth's atmosphere (TIR) providing CO₂ partial-column densities of UT and LT.



https://www.eorc.jaxa.jp/GOSAT/CO2_monitor/index_Ver.K.html

GOSAT-2 was launched on October 29, 2018



Characteristics	
Life	5 years
Orbit	Sun-Synchronous (628km)
Mass	About 2 t
Launch	FY 2018
Observation Valuables	CO ₂ , CH ₄ and CO Accuracy: 0.5 ppm (CO ₂) and 5 ppb (CH ₄) at 500-km mesh over earth's surface

1. Simultaneous CO (carbon monoxide) measurement
2. All target mode capability
3. Cloud-avoiding pointing with onboard camera (Intelligent pointing)

TANSO-FTS-2

TANSO-CAI-2 (radiometer)

	Band 1	Band 2	Band 3	Band 4	Band 5
Target Gases	O ₂	CO ₂ , H ₂ O	CO ₂ , CH ₄ , CO, H ₂ O		
Spectral Coverage (μm)	0.75-0.77	1.56-1.69	1.92-2.33	5.5-8.4	8.4-14.3
Spectral Coverage (cm-1)	12,950 - 13,250	5,900 - 6,400	4,200 - 5,200	1,188 - 1,800	700 - 1,188
Spectral Resolution	0.2 cm ⁻¹				
Exposure	4 sec				
IFOV	9.7 km				
Pointing	±40 deg. (Along track), ±35 deg. (Cross track)				
Polarimetry	Yes (P and S channels)			No	

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Spectral Band (nm)	333 - 353	433 - 453	664 - 684	859 - 879	1585 - 1675	370 - 390	540 - 560	664 - 684	859 - 879	1585 - 1675
Tilt	+20 deg. (Forward viewing)					-20 deg. (Backward viewing)				
Spatial Resolution	460 m			920m		460 m			920m	
Swath	920 km									

GOSAT-2 observation pattern

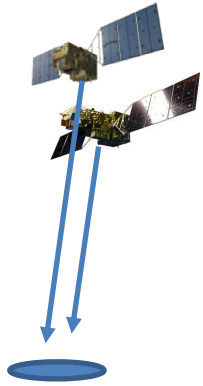
Target Date : 2019-04-08

GOSAT-2 TANSO-FTS-2 Sounding Map

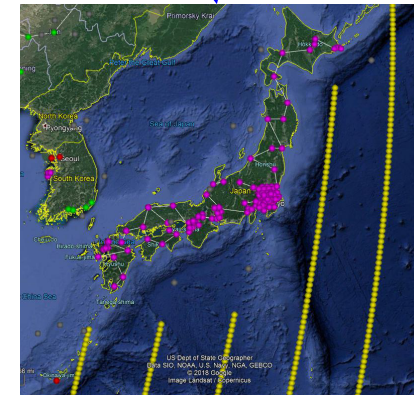
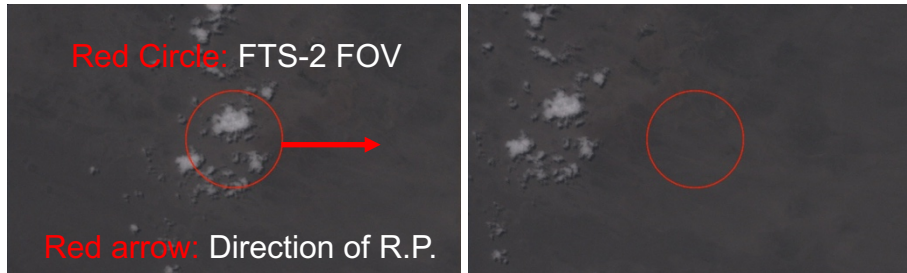
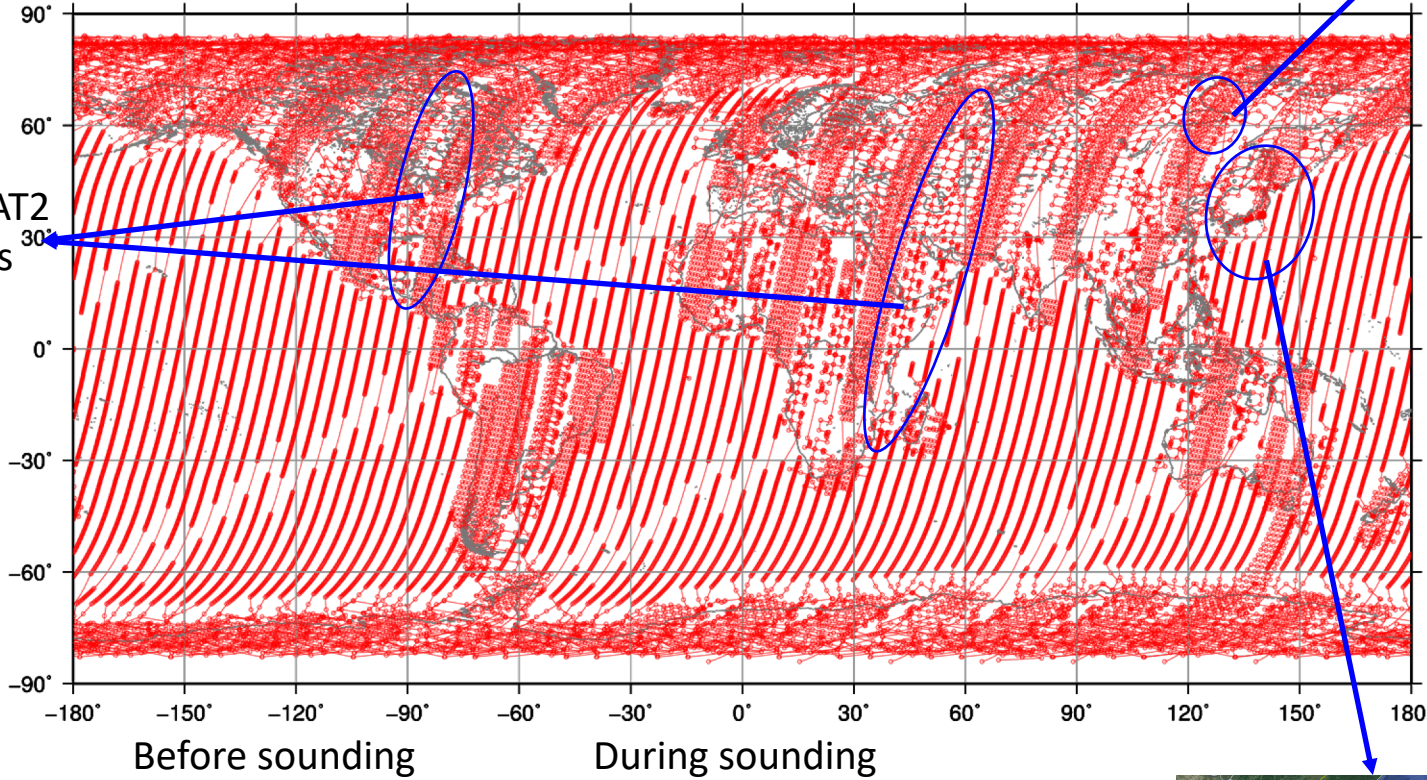
○ sounding

90km-grid observation

GOSAT – GOSAT2
coincidences



2 days out of
6 days



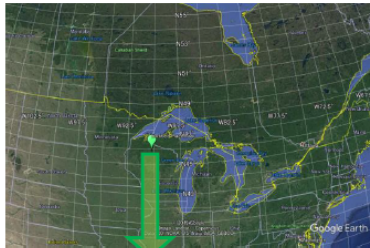
Over-land soundings are taken after re-point system toward less cloud by quick processing of on-board camera image.

Inter-comparison of GOSAT, GOSAT2 and OCO2

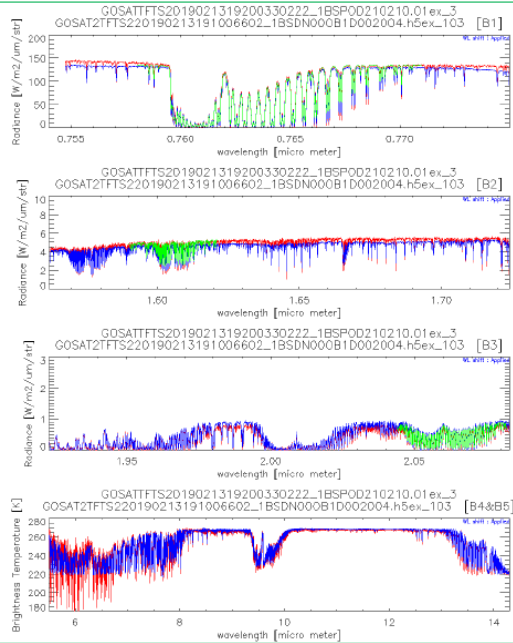
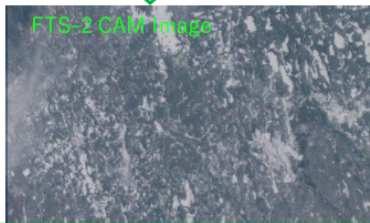
GOSAT-GOSAT2-OCO2 Spectra comparison

Feb13,2019
Park Falls/USA

— GOSAT
— GOSAT-2
— OCO-2



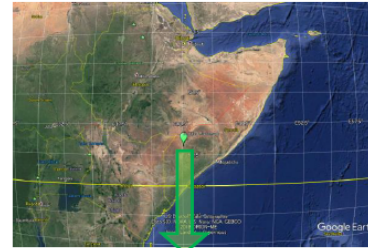
FTS-2 CAM Image



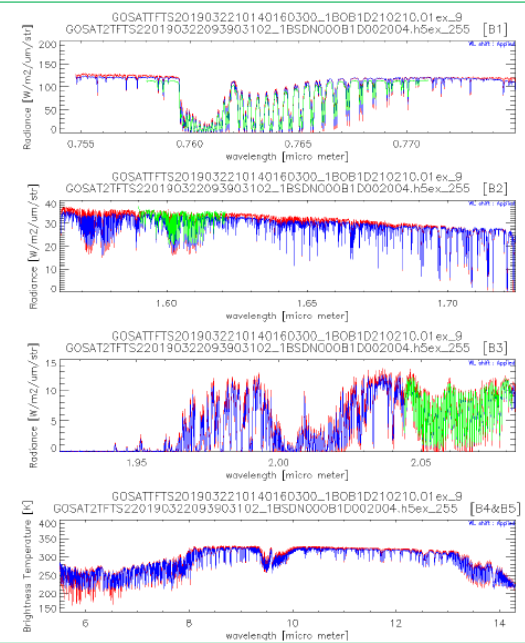
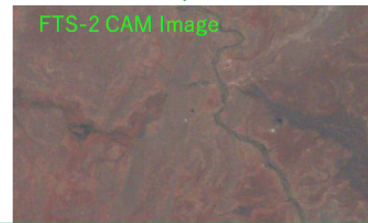
GOSAT-GOSAT2-OCO2 Spectra comparison

Mar23,2019
Somalia/Africa

— GOSAT
— GOSAT-2
— OCO-2



FTS-2 CAM Image



Summary

(1) GOSAT operation

- Successful fully operation of FTS and CAI over 10 years since 2009

(2) GOSAT products

- Latest FTS L1 V210.210 and CAI L1 V130.131 are available in whole observation term.
- NIES L2 XCO₂ and XCH₄ v02.80 are available for the latest L1 V210.210.
- NIES L3 and L4 are also available corresponding to the latest L2.
- GOSAT L2 are also produced by other organization algorithms (ACOS, RemoTeC, BESD, Leicester, Yonsei etc.)

(3) Calibration, validation and inter-comparison with GOSAT, GOSAT-2 and OCO-2

- Railroad valley campaign collaboration with OCO-2
- XCO₂ and XCH₄ long-term validation with TCCON data
- Inter-comparison of GOSAT, GOSAT-2 and OCO-2 in spectra and XCO₂

(4) GOSAT-2 operation

- GOSAT-2 was launched on 29 October, 2019 and is now operated in cal/val phase.
- Adding CO channel and aerosol UV imager