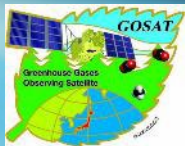


Vicarious Calibration

Kei SHIOMI,
and GOSAT Team (JAXA)



MethaneSAT

CEOS AC-VC-21, Ritsurin Garden: Commerce and Industry Promotion Hall, Takamatsu, Japan, June 13, 2025



International collaboration for GHG sensors calibration



2008 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Radiometric calibration

Prelaunch
X-CAL

Annual Vicarious Calibration at the desert playa in Nevada

CO₂ & CH₄ profile
In situ CO₂ and CH₄ on AJAX

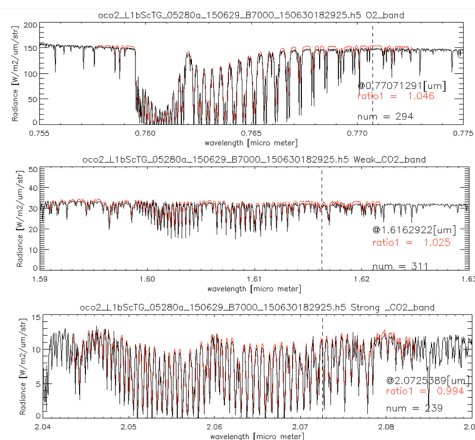
XCO₂ & XCH₄

Column with EM-27 FTS

Coincident Target

Among GHG sensors and also AQ sensors

— GOSAT OCO-2

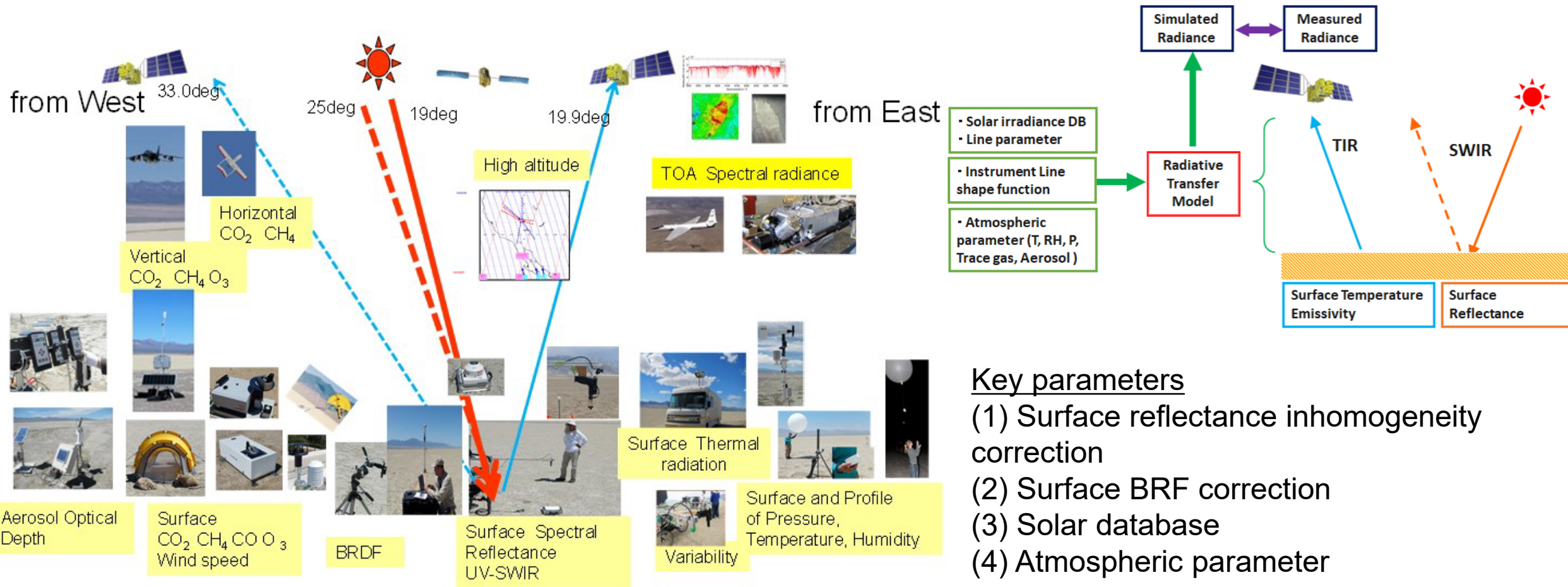


Calibrated GOSAT and OCO-2 radiance spectra agrees within 5% for all bands.



MethaneSAT

RRV vicarious calibration for GHG and AQ sensors



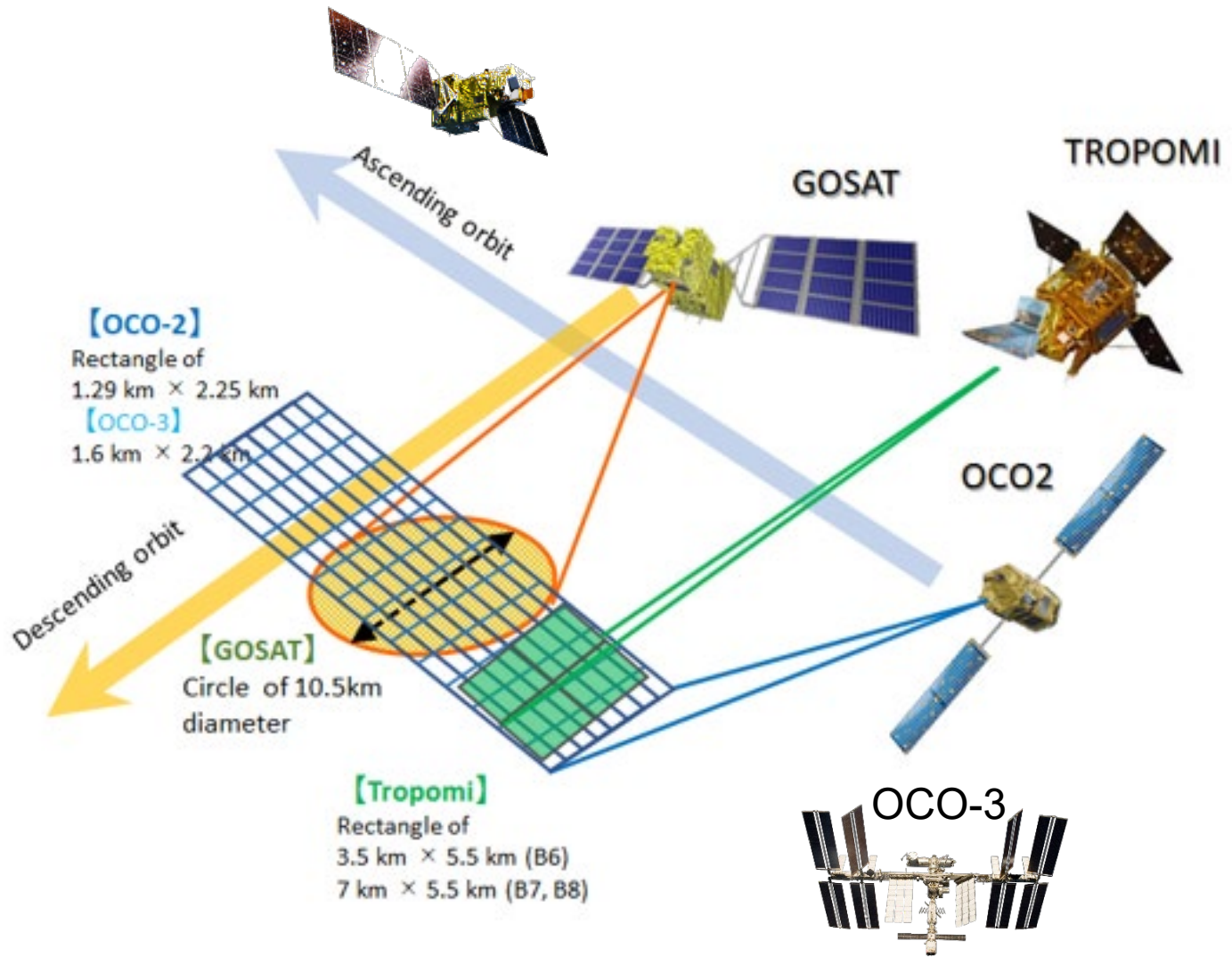
We will calculate all sensors for validating radiometric calibration accuracy by the same target.



Railroad Valley target by multiple GHG and AQ sensors



GOSAT-2



RRV 2022 Summer Campaign schedule

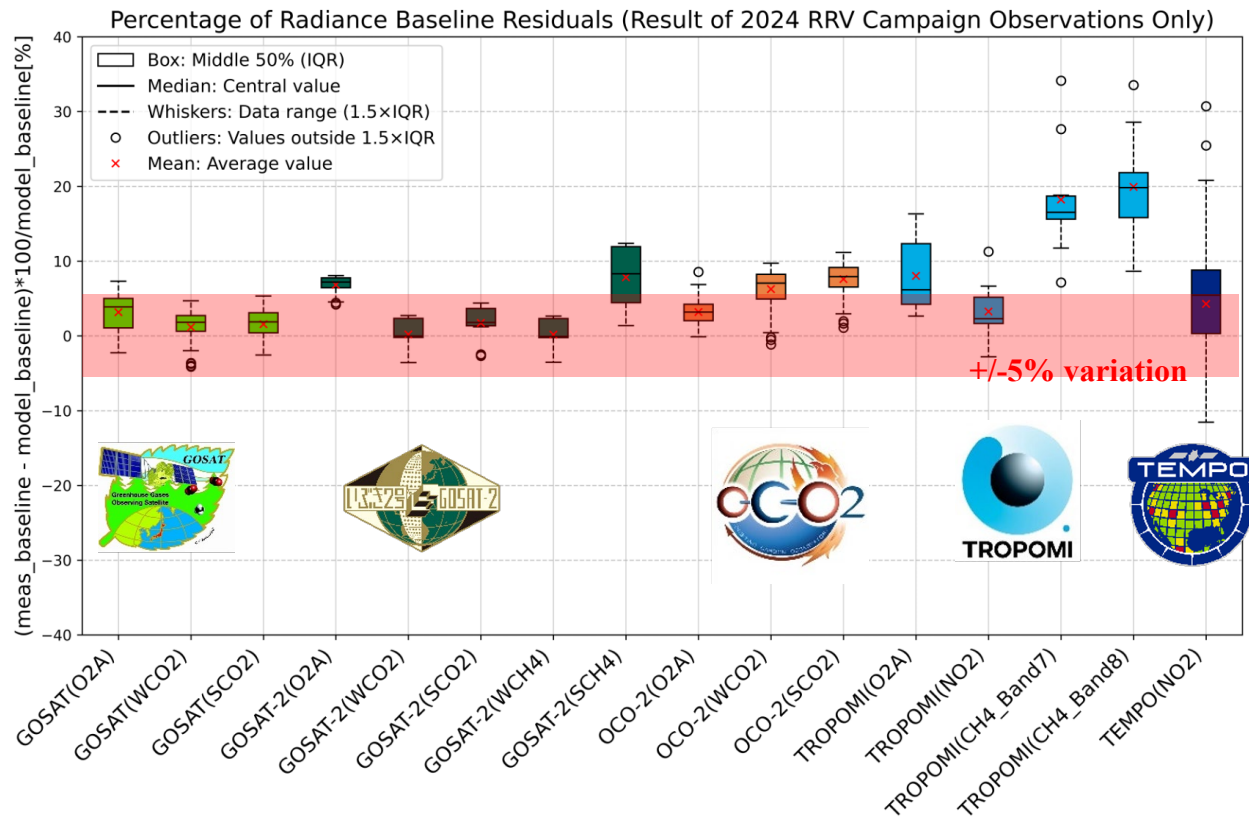
Date	DoW	OCO-2 path	GOSAT path	GOSAT-2 path	TROPOMI InstZA [deg]	
8-Jun-22	Wed		no	no	53.6	RRV
9-Jun-22	Thu	138	36	72	8.1	RRV
10-Jun-22	Fri		37	73	6.9	RRV
11-Jun-22	Sat	136	no	74	46.3	RRV
12-Jun-22	Sun		36	no	31.7	RRV
13-Jun-22	Mon		37	no	46.6	RRV

Good conditions for all sensors come every 48 days.

	Nadir footprint size
GOSAT	Circle of 10.5km diameter
GOSAT-2	Circle of 9.6km diameter
OCO-2	Rectangle of 1.3 km * 2.3 km
OCO-3	Rectangle of 1.6 km * 2.2 km
TROPOMI	Rectangle of 3.5 km * 5.5 km (B6) 7 km * 5.5 km (B7, B8)

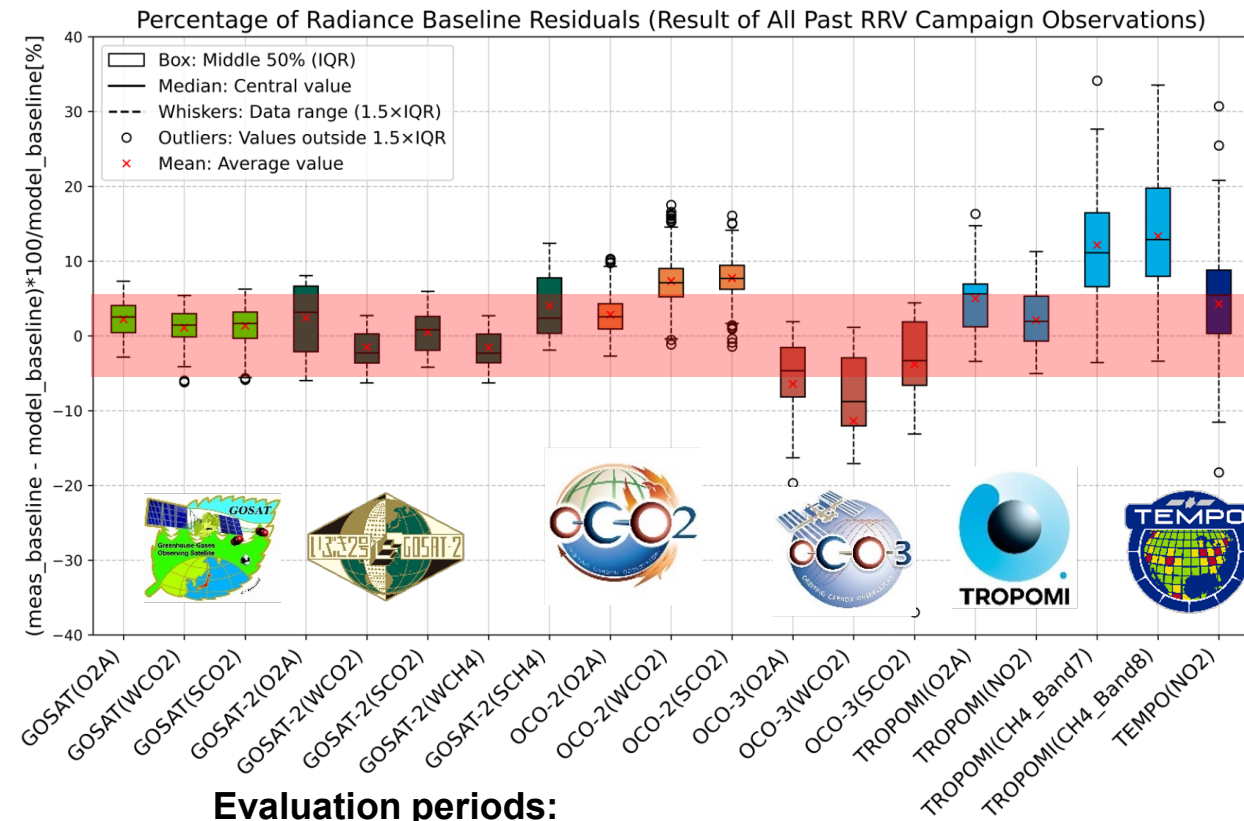


Multiple sensors VCAL results for RRV2024 and averaged all RRV campaigns



Evaluation periods: Only use 2024

- Large off-nadir conditions TROPOMI, TEMPO are challenging.
- To reduce errors, good data qualifications are needed.



Evaluation periods:

GOSAT: 2019 – 2024 (except.2020)

OCO-2: 2019 – 2024 (except.2020)

GOSAT-2: 2019 - 2024

TROPOMI: 2021 -2024

OCO-3: 2021

TEMPO: 2024



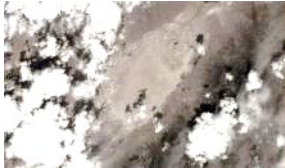



Ishida et al., AGU24

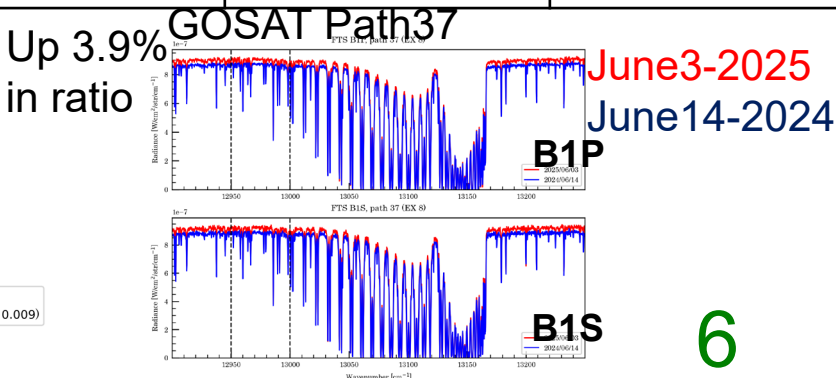
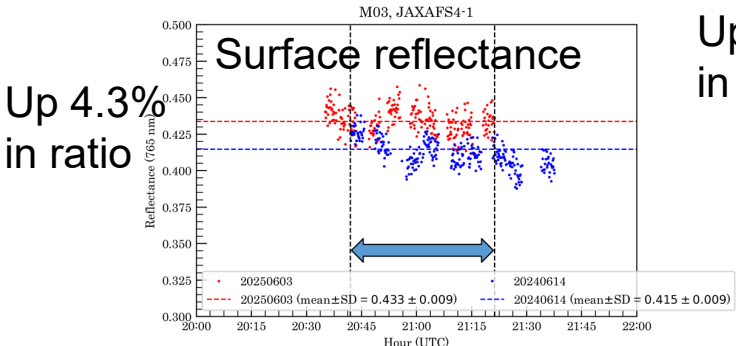


Summary of RRV2025 summer campaign

Surface data collected by OCO and GOSAT teams

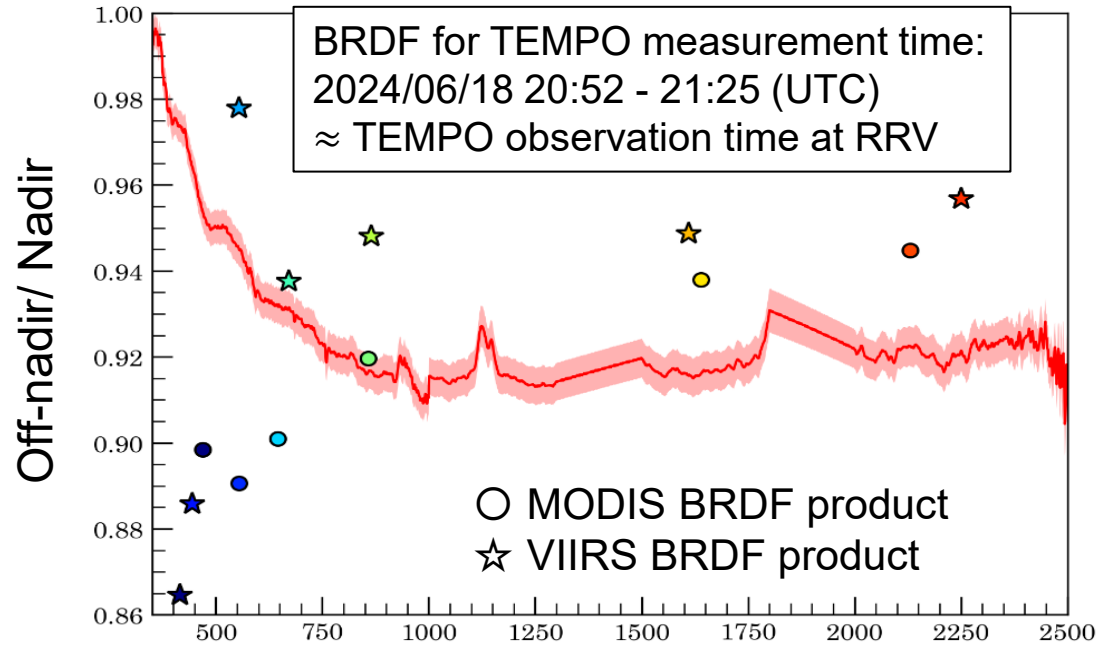


	30-May-25	31-May-25	1-Jun-25	2-Jun-25	3-Jun-25	4-Jun-25	5-Jun-25
OCO-2 path			138 (20:53UTC)		136 (20:40UTC)		
GOSAT path	36 (20:52UTC)	37 (21:24UTC)		36 (20:52UTC)	37 (21:24UTC)	No	36 (20:52UTC)
GOSAT-2 path	72 (20:54UTC)	73 (21:10UTC)	74 (21:26UTC)			No	72 (20:54UTC)
TROPOMI VZA[deg]	28deg	53.6deg	8.1deg	6.9deg	46.3deg	31.7deg	46.6deg
OCO-3			19:07UTC				17:35UTC
TEMPO		SPECIAL(21UTC)	SPECIAL(21UTC)	SPECIAL(21UTC)	SPECIAL(21UTC)		SPECIAL(21UTC)
GOSAT-1/-2 FOV camera 10km-FOV							
Weather	Clear sky (21UTC)	Clear sky (21UTC)	Clear-up just noon Clear sky for OCO-2 Cloudy for GOSAT-2 (21UTC)	Clear sky (21UTC)	Clear sky (21UTC)		Cloudy (17:35UTC) Cloudy (21UTC)

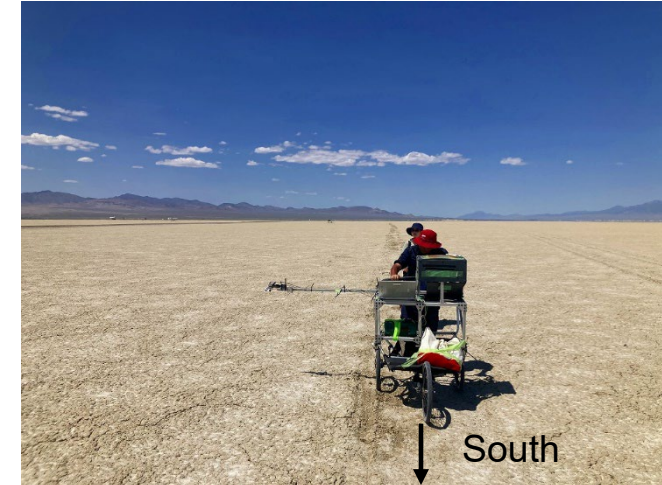
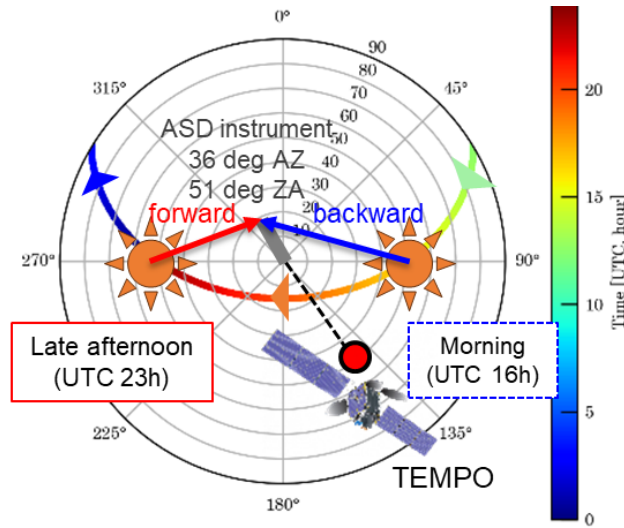
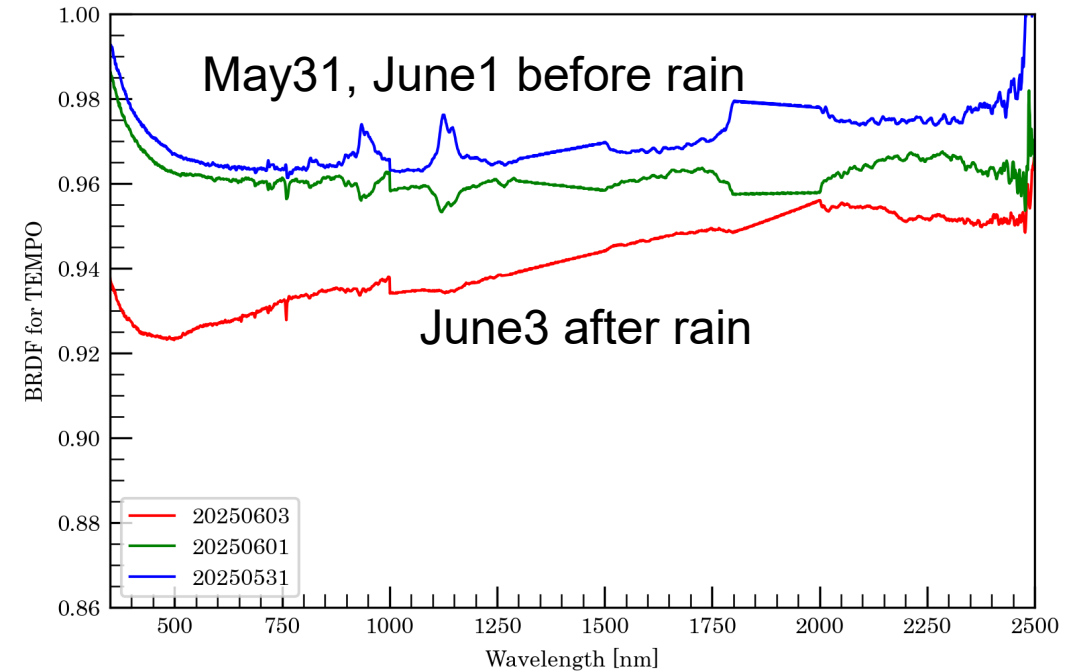


Nadir and off-nadir adjusted to the TEMPO view angle

RRV2024 TEMPO off-nadir / Nadir



RRV2025 TEMPO off-nadir / Nadir





VCAL Portal site for field data access



VCAL portal site update

Vicarious Calibration Portal for Space-borne GHGs Sensors

HOME ▾ Methodology ▾ Satellite Orbit Team Meeting Documents Gallery Links

Objectives

Campaign Data

Site feature

Campaign Data

☐ Surface reflectance (in-situ) ← Update soon

NASA JPL : Surface reflectance measured by ASD field spectrometer.

Data Link

☐ Temperature and Humidity profile (radio sonde)

JAXA : Temperature and Humidity profile measured with radio sonde.

Data Link

☐ Trace gas profile

NASA Ames : Alpha Jet Atmospheric eXperiment (AJAX)

Data Link

☐ CO2 and CH4 total column density (EM27/SUN)





JAXA: CO2 and CH4 total column density measured with ground-based portable FTS (EM27/SUN)

Data Link

☐ Weather station ← New

Railroad Valley monthly weather report

Data Link



Weather station data at RRV collected by JPL

Railroad Valley Calendar

Contents:

- FOR A MONTHLY REPORT CHOOSE A MONTH IN A GIVEN YEAR

FOR A MONTHLY REPORT CHOOSE A MONTH IN A GIVEN YEAR

[Back to List](#)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011												
2012												
2013												
2014												
2015												
2016												
2017												
2018												
2019												
2020												
2021												
2022												
2023												
2024												

Railroad Valley data for September, 2024

Contents:

- CREATED BY:
- FOR A DAILY REPORT CHOOSE A DAY IN SEPTEMBER, 2024
- AERONET DATA
- RADIOMETRIC DATA
- MOB BATTERY VOLTAGE DATA
- RSSI DATA
- SOLAR DATA
- METEOROLOGY DATA
- OZONE NOAA DATA
- OZONE RRV DATA
- REFLECTANCE DATA
- SOIL MOISTURE DATA
- LOCATION OF ANALYSIS TOOLS, DATA FILES AND REPORT

CREATED BY:

[Next](#) [Back to List](#)

Carol J. Bruegge, Wed Oct 2 14:55:17 2024

Web-site manager: Richard A. Lee@jpl.nasa.gov

https://www.eorc.jaxa.jp/GOSAT/GHG_Vical/index.html

- The Railroad Valley field data are available from VCAL portal site.
- Next Updating the re-analysis of the surface reflectance by careful screening
- Adding the weather station data collected by JPL



Intercomparison of GHG sensors simultaneous measurements at RRV

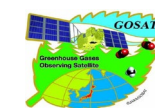
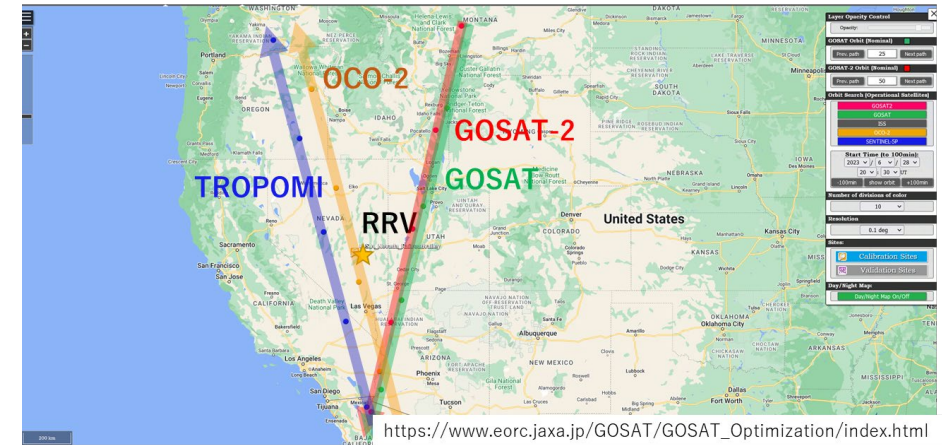
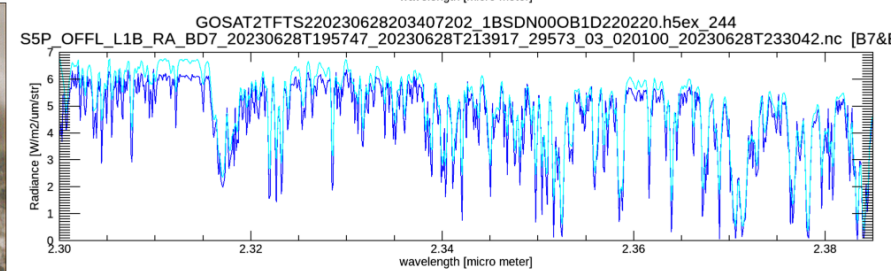
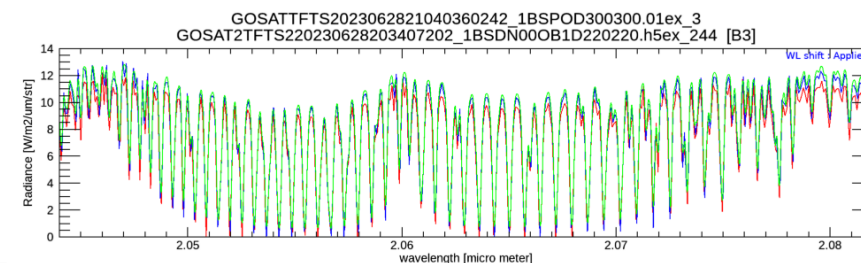
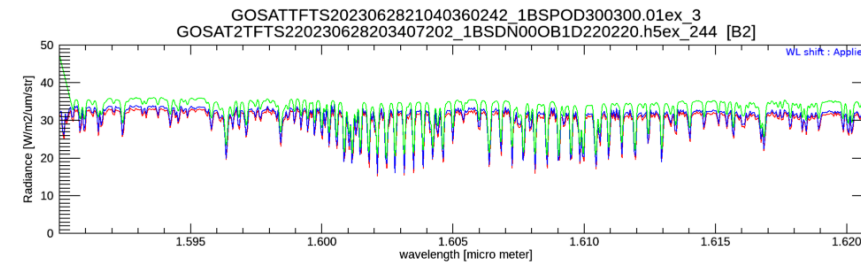
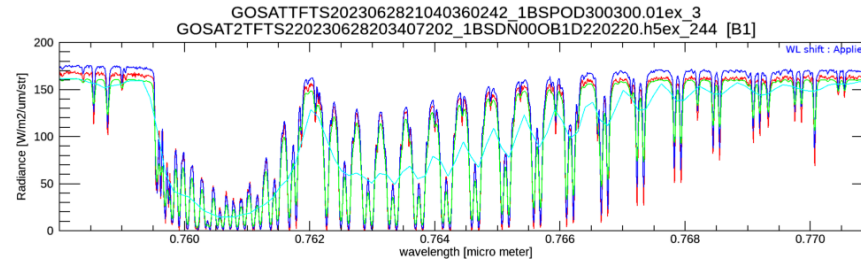
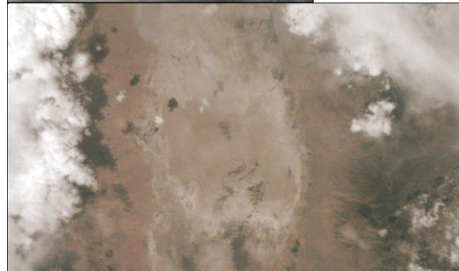
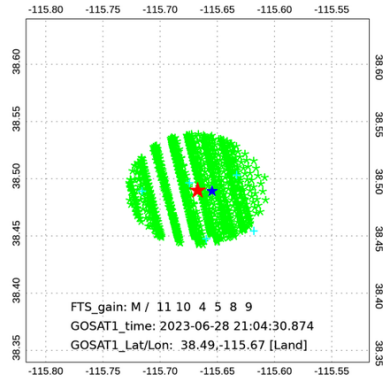


GOSATTFTS2023062821040360242_1BSP0D300300.01_ex3 / GOSAT2TFTS220230628203407202_1BSDN000B1D220220.h5_ex244
 SensorZn [deg.]: 21.923 / 21.212 SensorAz [deg.]: 91.376 / 94.360 Cloud check: 3 / 0.001022
 SolarZn [deg.]: 22.615 / 21.073 SolarAz [deg.]: 233.347 / 228.663 BT(892-905[cm-1]) Average [K]: 313.707 / 315.237
 Matchup_time [min.]: 10.199 Matchup_dist [km]: 1.095 QualityFlag: 000000 / Good

BRDF applied

2023/06/28

- GOSAT (21:04) V300
- GOSAT-2 (20:54) V200
- OCO-2 (20:53) B11r
- OCO-3
- TROPOMI(20:51)
- All sensors SatZA=20-23deg**





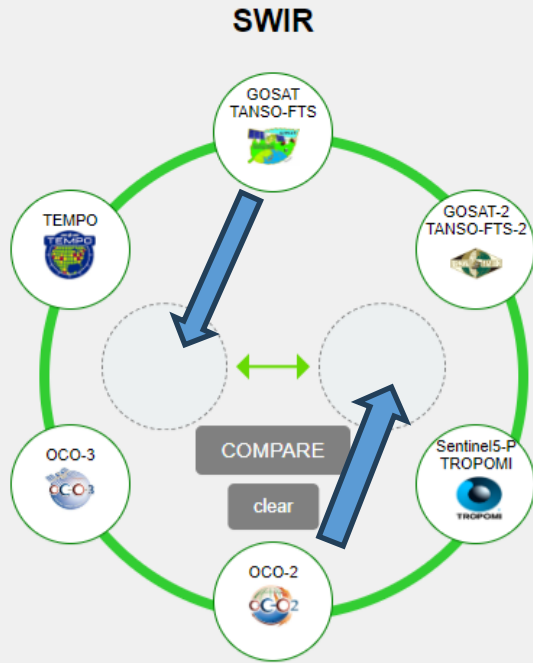
Match-up data viewer of GHG sensors L1 and L2



To harmonize the multiple GHG data, inter-comparisons of the sensor radiances or gas densities are important to confirm the biases in spatial and temporal variations

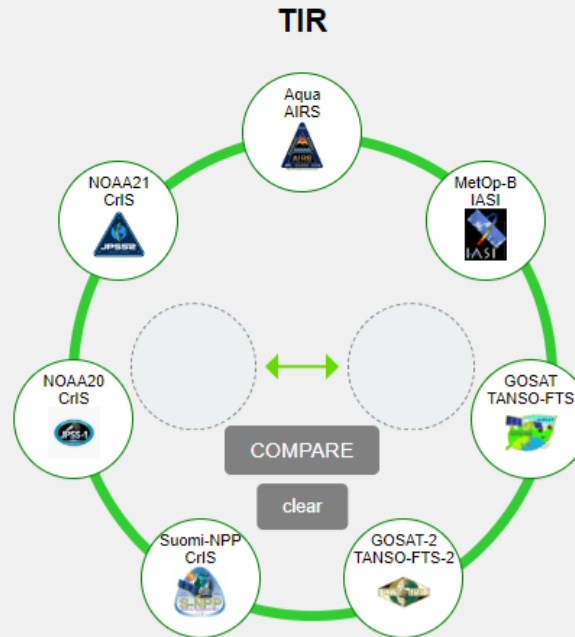
Level 1 ☐ Level 2 ☒

Select two sensors and click on the [COMPARE] button



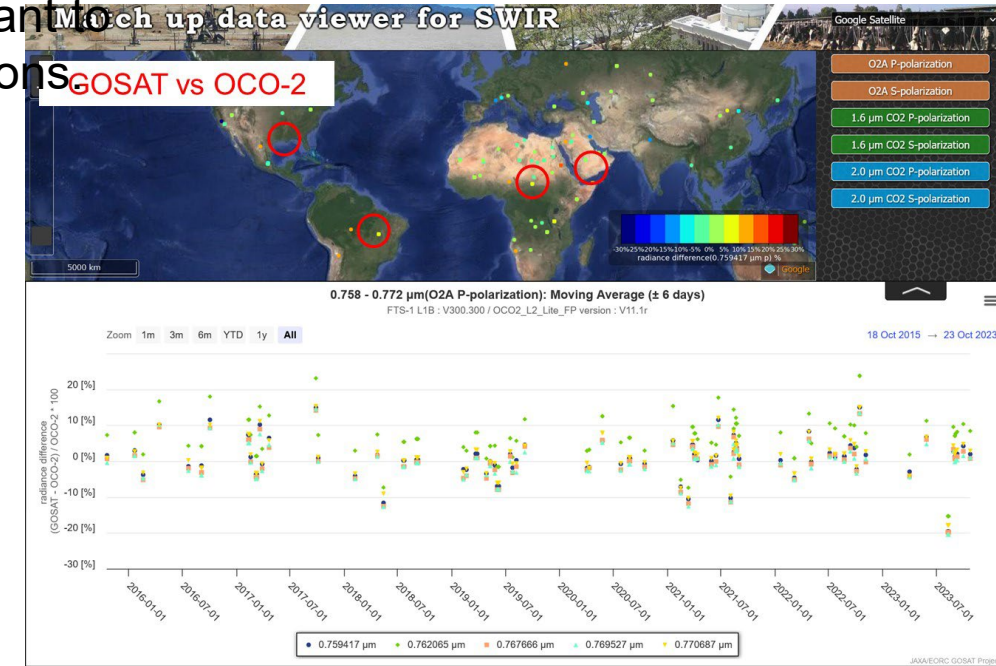
SWIR

Calibrated radiance
XCO₂, XCH₄, SIF, AOT



TIR

Calibrated radiance
Brightness temperature



GOSAT vs OCO-2 O2A radiance spectra
Degradation corrected
Cloud screened (successful L2)
Most of the data agree within 10% for all three bands except for over forest.

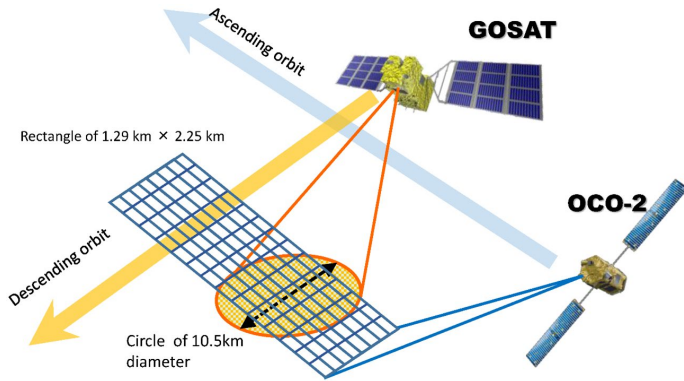
https://www.eorc.jaxa.jp/GOSAT/Matchup_forCal/top_matchup_viewer.html



L2 XCO₂ inter-comparison (OCO2-GOSAT)

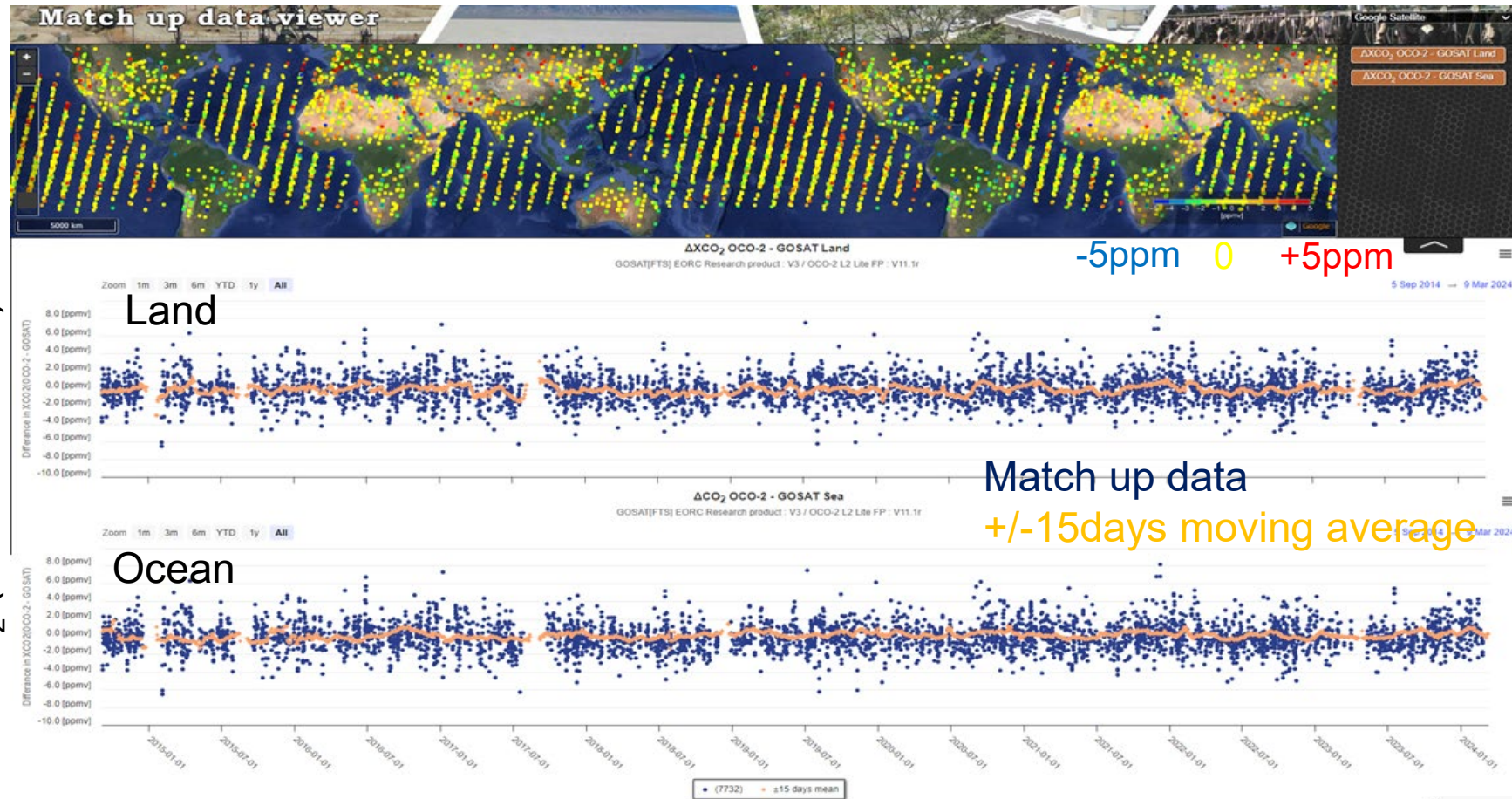


OCO2-GOSAT
XCO₂



GOSAT: JAXA GHG product V3
OCO2: OCO2_L2_Lite_FP V11.1r

ΔXCO_2 (OCO2-GOSAT)



- Retrieved parameters are different between the L2 algorithms over Land and Ocean. Ocean glint measurement methods are slightly different between GOSAT and OCO-2. Bias might be also different.
- OCO-2 and GOSAT XCO₂ are in good agreement < 0.5ppm. OCO-2 has low bias than GOSAT over forest area of Amazon and Africa.



Summary



- VCAL campaign at Railroad Valley has conducted since 2009 over 17 years
 - Target by 5 GHG sensors (GOSAT, OCO-2, TROPOMI, GOSAT-2, OCO-3) + AQ (TEMPO) + New space (MethaneSAT...) + future GOSAT-GW, CO2M, MicroCarb
 - Validate multiple sensors radiometric accuracies by the common VCAL method
 - RRV2025 summer campaign was conducted successfully from May 30 to June 5.
 - VCAL portal site (https://www.eorc.jaxa.jp/GOSAT/GHGs_Vical/index.html)
- Inter-comparison between GHG sensors
 - L1 radiance in both SWIR and TIR and L2 XCO₂, XCH₄, AOD
 - Match-up data viewer site (https://www.eorc.jaxa.jp/GOSAT/Matchup_forCal/top_matchup_viewer.html)
- Next schedule
 - Next VCAL team meeting: 12-13UTC, September 12, before the fall campaign
 - RRV2025 fall campaign: tentatively October 4 – 9, good for OCO-3 target, GOSAT-GW in the early calibration phase