Long-term Global Greenhouse Gas Observation by GOSAT and GOSAT-2 and Local Emission/Removals Observations by GOBLEU

Hiroshi Suto,
Kei Shiomi, Nobuhiro Kikuchi, Shin Ishida, Rio Kajiura,
JAXA GOSAT/GOSAT-2 team, and ANA-JAXA GOBLEU team

Japan Aerospace Exploration Agency (JAXA)
E-mail: suto.hiroshi@jaxa.jp

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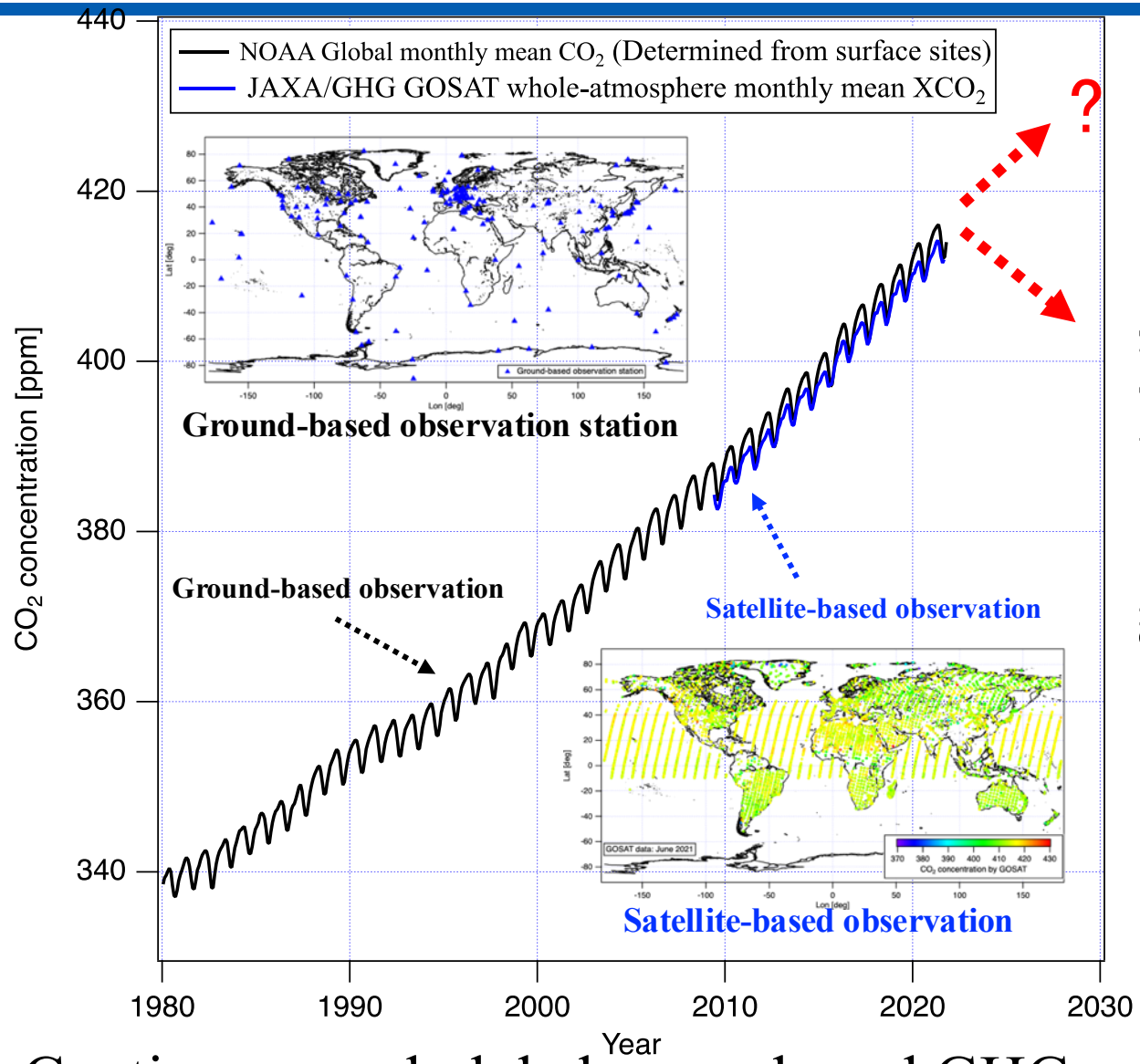
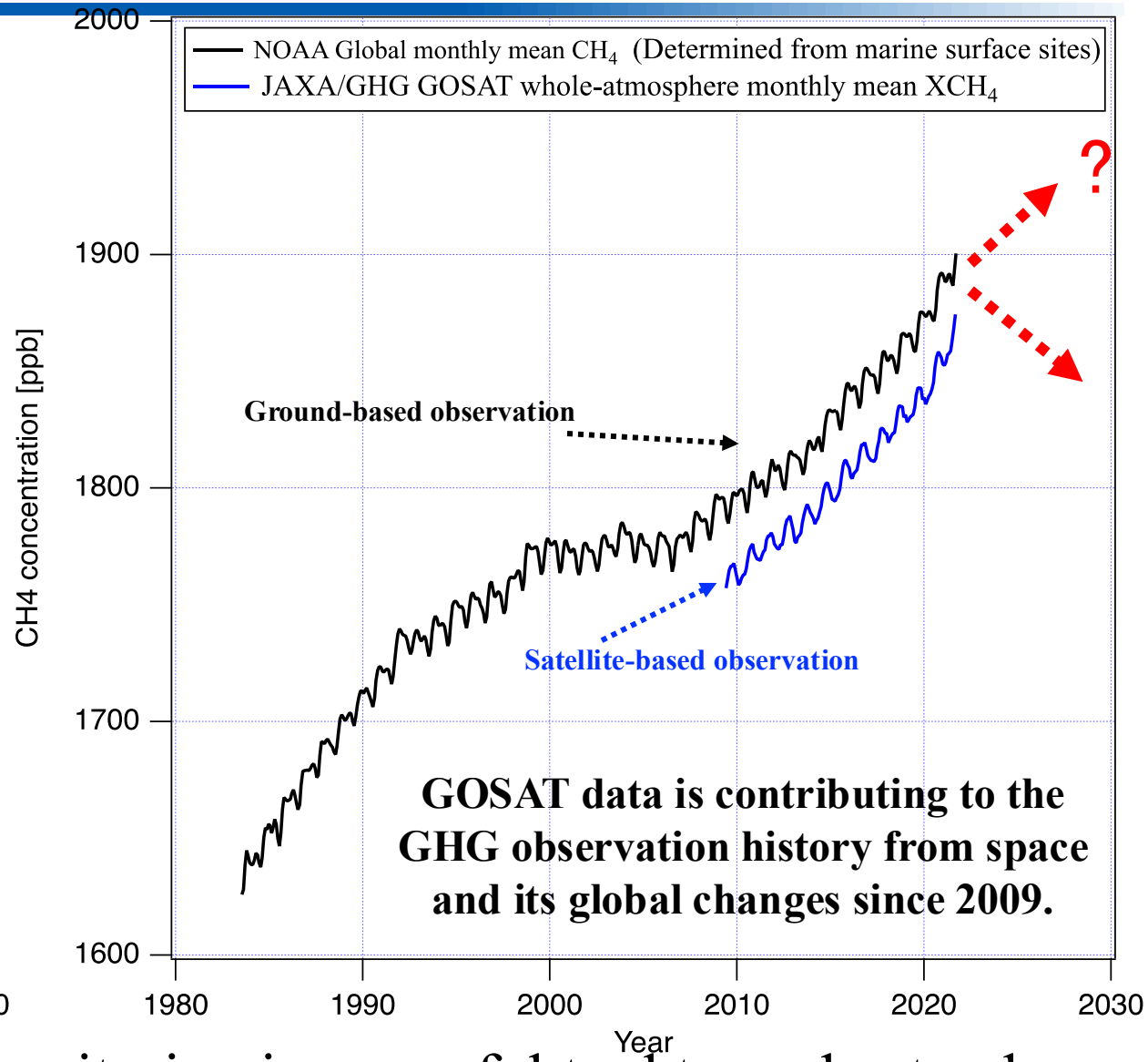
Contributing to the GHG observation history from space



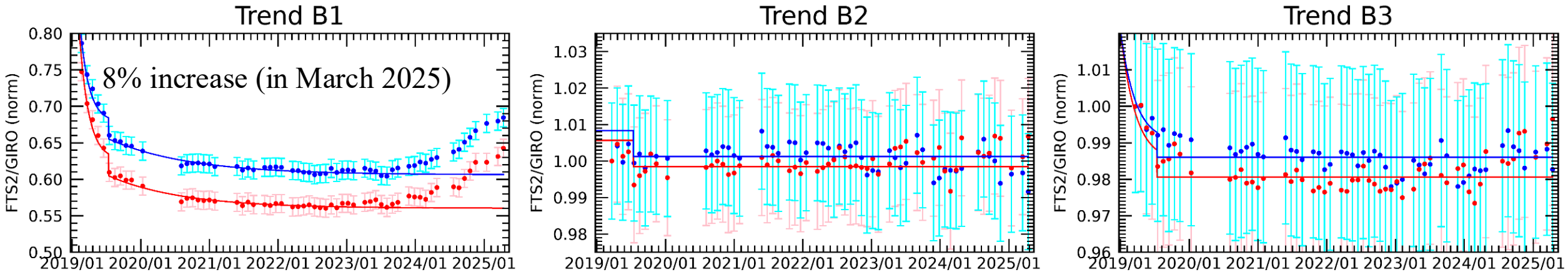


Continuous and global space-based GHG monitoring is powerful tool to understand our emission changes, and strongly requested from stakeholders.

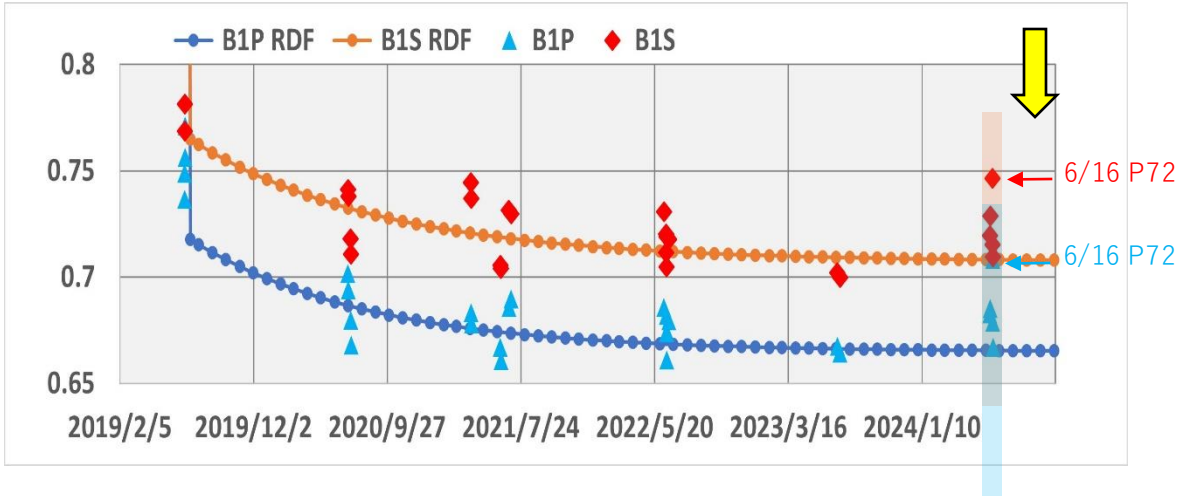
GOSAT and GOSAT-2 status

Project	GOSAT (*Kuze et al, AO, 2009*)	GOSAT-2 (*Suto et al, AMT, 2021,2022*)
Operation	**Nominal**	**Nominal**
Launch	2009/1/23 (**16 years on-orbit**)	2018/10/29 (**6 years on-orbit**)
Local observation time	13:00	13:00
Revisit time	**3** days	**6** days
Observation target	**CO_2, CH_4,** SIF(Solar-induced chlorophyll fluorescence)	**CO_2, CH_4,** CO, (N_2O) SIF(Solar-induced chlorophyll fluorescence)
Status (Since last IWGGMS)	• The observation was suspended following term: 27 Mar. 2025 – 25 Api. 2025. • The solar calibration with the back side diffuser has been suspended since Feb. 2024. After the investigation, we concluded that the rotating mechanism has anomaly and **difficult to switch the backside diffuser** for solar calibration.	• **New Level 1 was released** in public on 28 May. • **Band1 radiometric response has been changed** since Sep. 2024. The root cause and counter actions are investigating (see next page). • The observation was suspended the following periods; 19 Sep. - 25 Sep., 2024:, 21 Dec. - 25 Dec., 2024:, 12 Feb. - 15 Feb., 2025. • The maneuver operation was performed;10 May - 7 June 2024 with partially suspended observations.

GOSAT-2: Characterization of spectral radiance



Monthly lunar calibration result showed the response recovery since Sep. 2024.

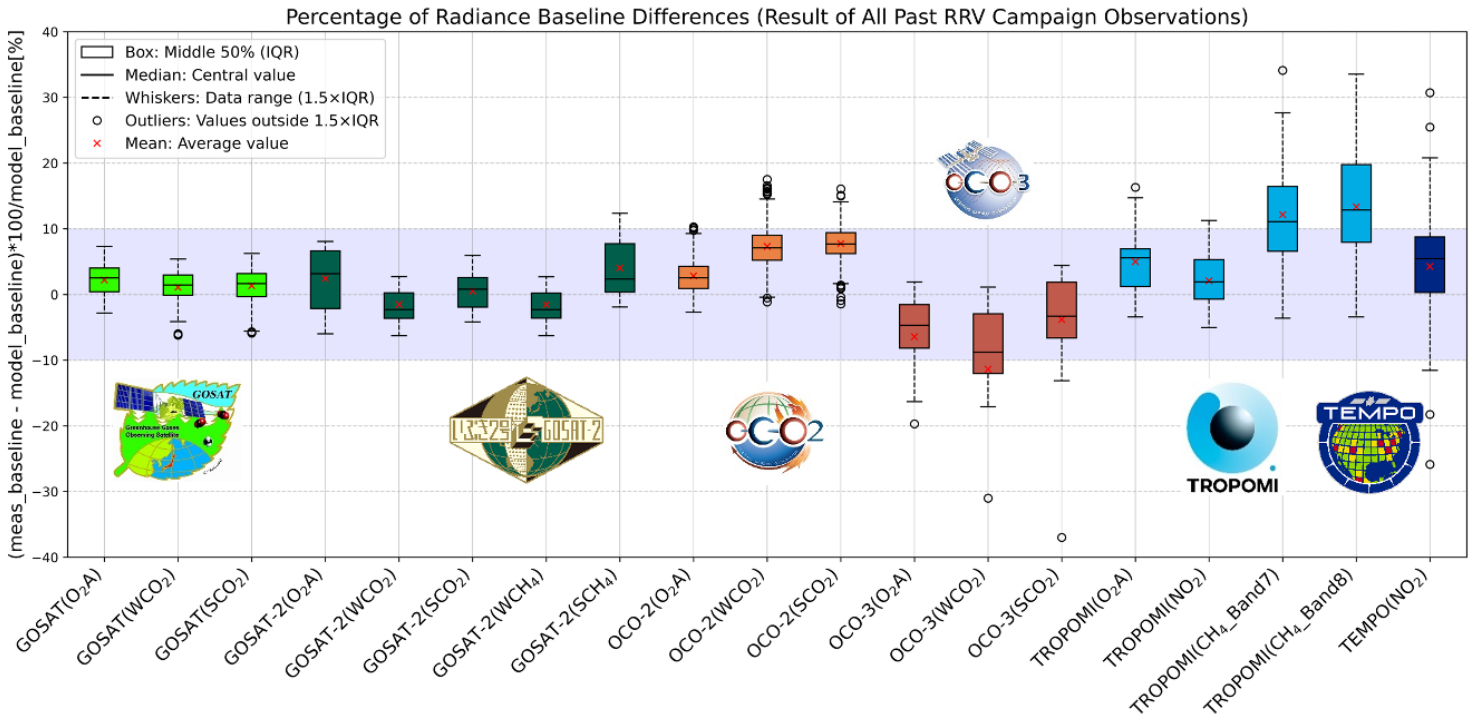


Estimation from RRV data set.

- Band1 monthly Inter-calibrations of ILS laser response, Lunar Cal. and cross-calibration with GOSAT-2 presents similar features.
- The estimation from RRV2025 will be confirmed the current response.
- The further investigation is on-going, and will be updated the Radiance Degradation Factor (RDF) and/or level-1 processing.

QA/QC for spectral radiance for multi-satellite data

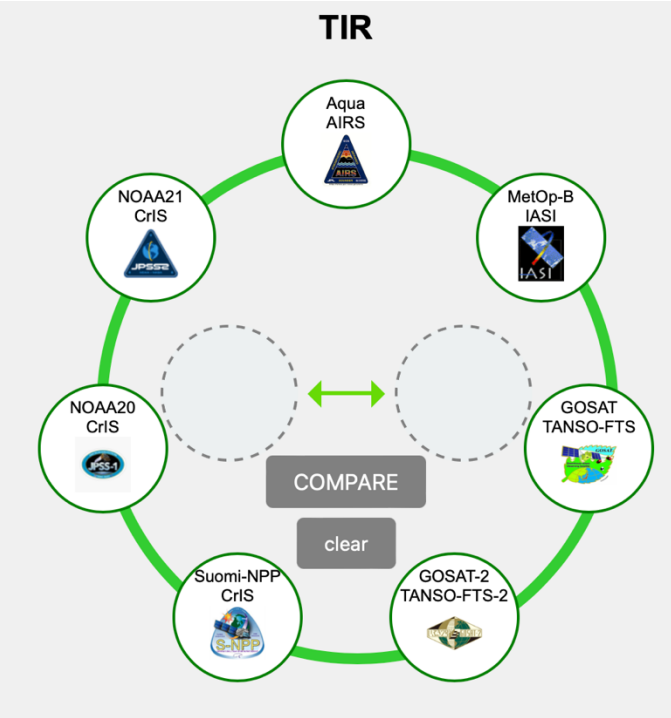
https://www.eorc.jaxa.jp/GOSAT/GHGs_Vical/index.html



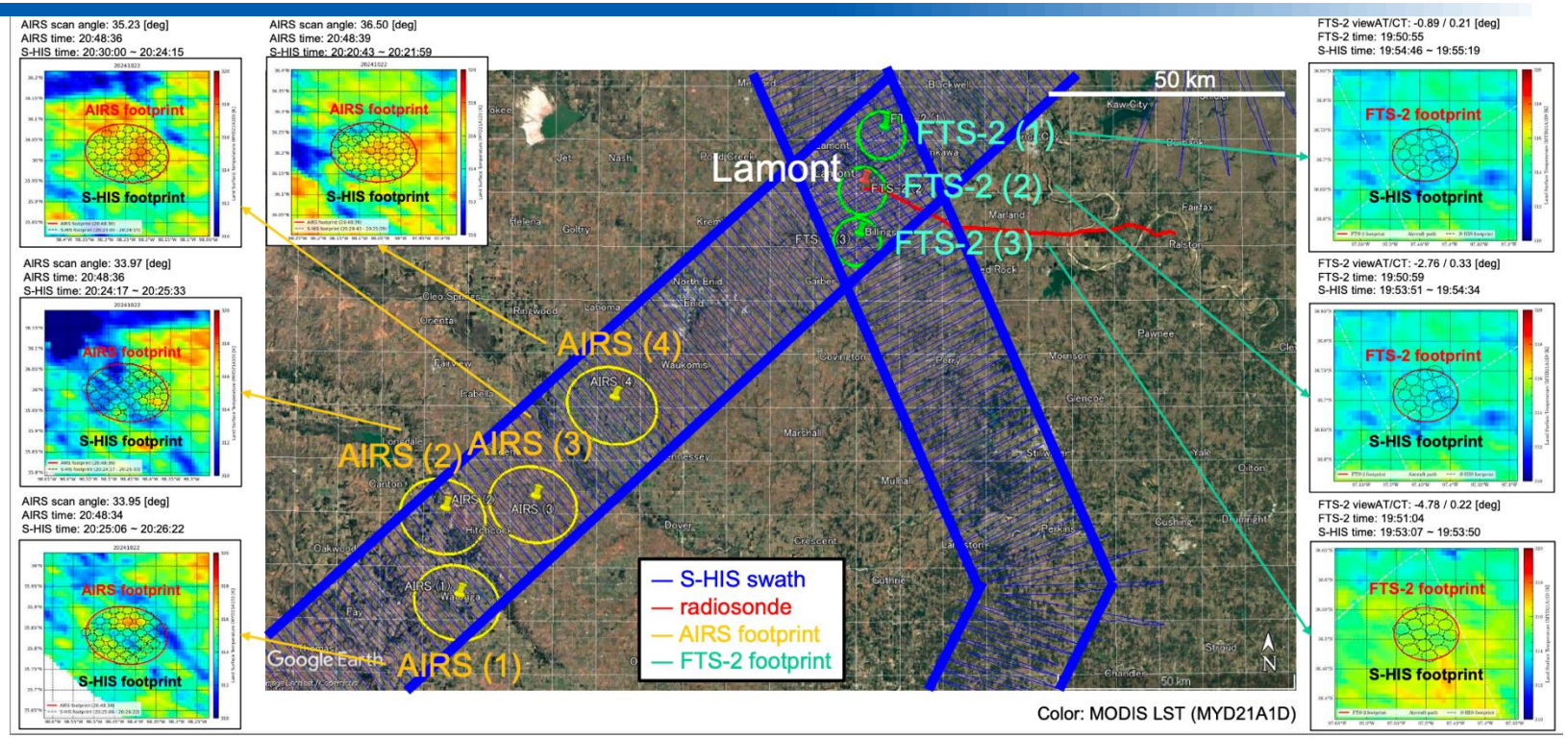
Presented by Ishida (4.08) on 10 June

- RRV2025 was successfully performed during 30 May to 5 June by JAXA, NASA and NIES.
- Previous RRV Cal/Val campaign data are released from CEOS Vicarious Calibration Site, operated by JAXA.
- Inter-comparison on spectral radiance filed are performed by JAXA and shared these results with joint team.

QA/QC for Thermal Infrared spectral radiance



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

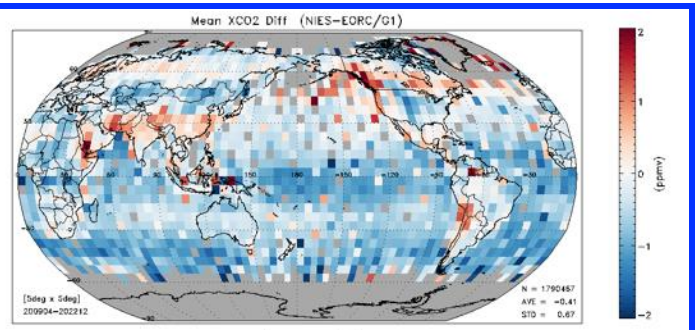


Presented by Yasuda (4.09) on 10 June

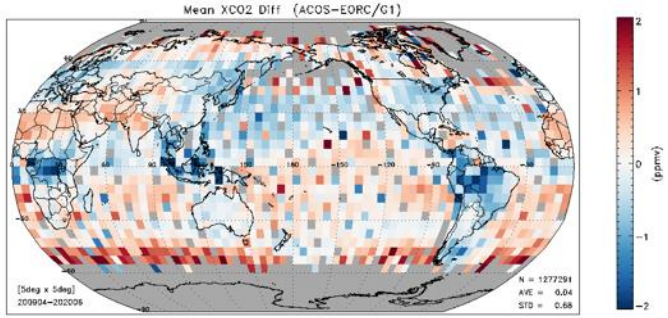
- Thermal infrared spectra observed by GOSAT and GOSAT-2 were compared and validated with conventional TIR sensers including S-HIS.

- The matchup tool both SWIR and TIR sensors (L1 and L2) were released from JAXA as part of CEOS portal sites.

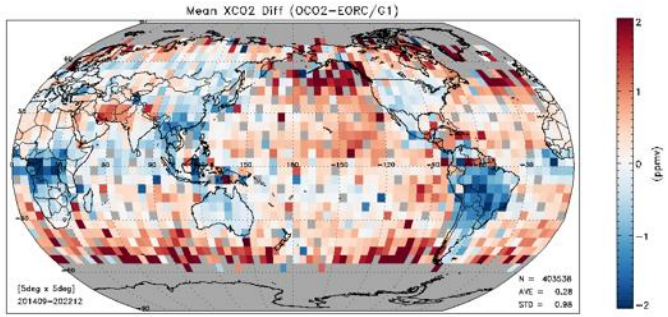
QC/QA for multi-satellite XCO2/XCH4 data



NIES G1 minus JAXA/GHG G1

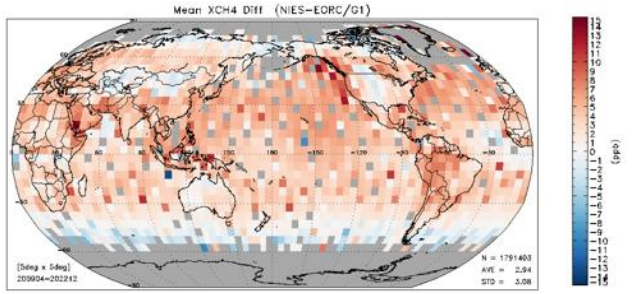


ACOS minus JAXA/GHG G1

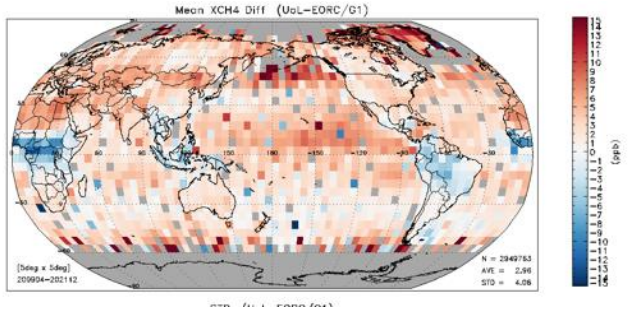


OCO2 minus JAXA/GHG G1

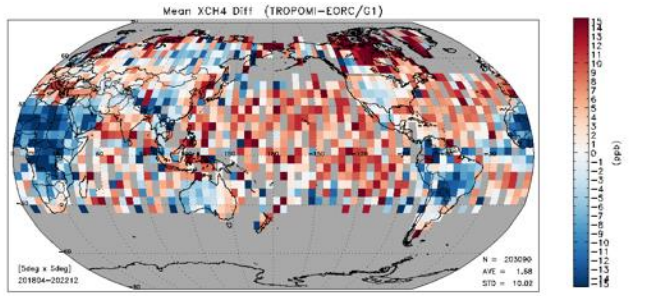
XCO_2



NIES G1 minus JAXA/GHG G1



UoL minus JAXA/GHG G1



TROPOMI minus JAXA/GHG G1

XCH_4 5° x5 ° grided mean difference during available data period

- Multi-satellite data are useful for extending observation coverage (hot spot, regional, global), when these data have same quality (bias and scatter).
- **Even though same spectral radiance** is retrieved, XCO_2 and XCH_4 in **global spatial distribution is inconsistent**. (These are well validated with TCCON, but…)
- Inter-comparison of multi-satellite dataset will be helpful to **improve QA/OC of satellite data** and improve its **global consistency**.
- To improve our knowledge for global systematic bias, JAXA is willing to continuously discuss with GHG observation communities and make our **best-practice**.

Suto et al, in prep.

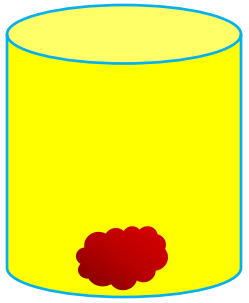
JAXA patrial column GHG product

- Use full observation advantage by GOSAT and GOSAT-2 such as simultaneous ShortWave Infrared (**SWIR**) and Thermal Infrared (**TIR**) observation as well as **2-orthogonal polarization information**.
- 2 layers in troposphere and 3 layers in stratosphere are applied for CO_2 and CH_4 vertical* concentration.

*** 6 pressure levels: 0.1 hPa & (0.05, 0.1, 0.2, 0.6, 1)*Psurf**

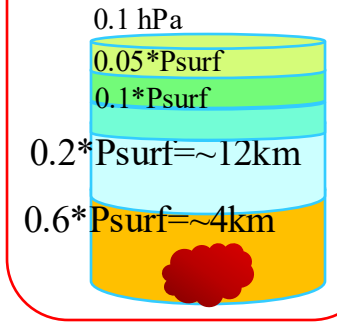
Conventional Method

Use only solar reflected light

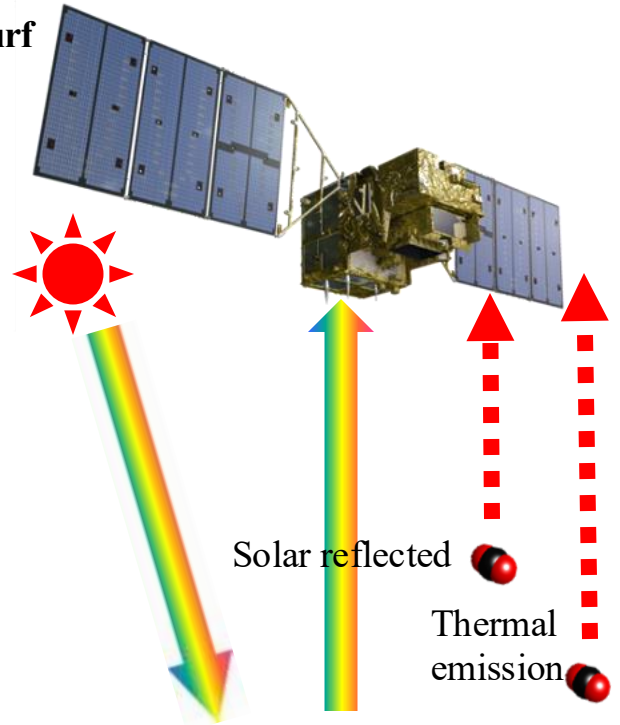


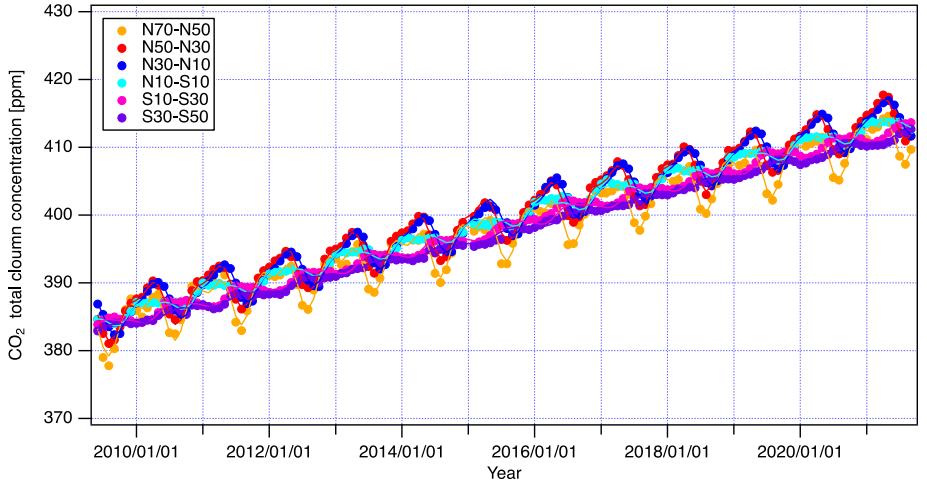
JAXA/EORC new Method

Use both solar reflected light & thermal

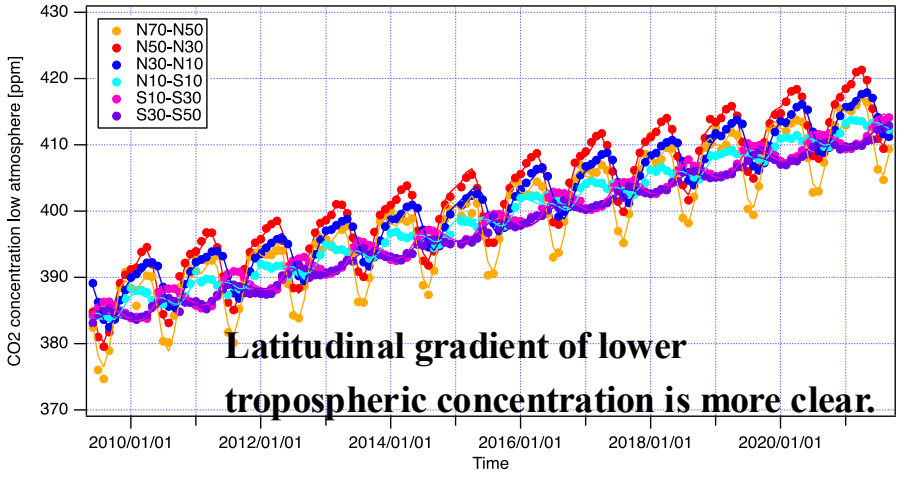


CO_2 & CH_4 emission and enhanced density of the lower troposphere





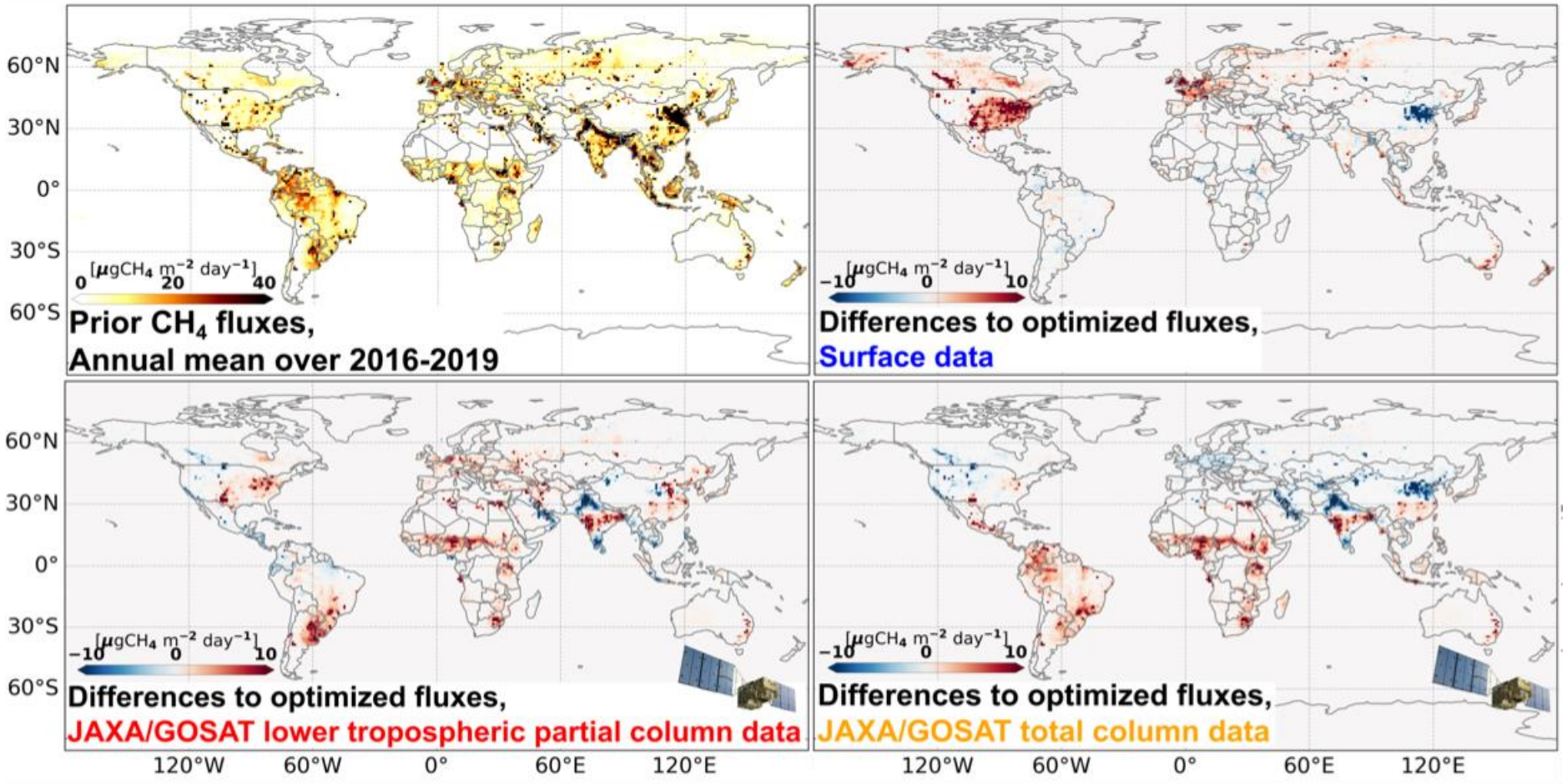
Total column concentration



Lower tropospheric concentration

Suto et al, in prep.

Application of JAXA/GHG product for emission estimate



Prior total CH_4 fluxes and their differences to optimized fluxes, averaged over 2016-2019. Positive values indicate larger fluxes after optimizations.

The Northern Hemisphere CH_4 fluxes:

- Estimates using the pXCH4_LT data (InvGLT and InvGLT_land) were similar to those using the surface observations (InvSURF), but significantly underestimated using the XCH4 data (InvGTOT).

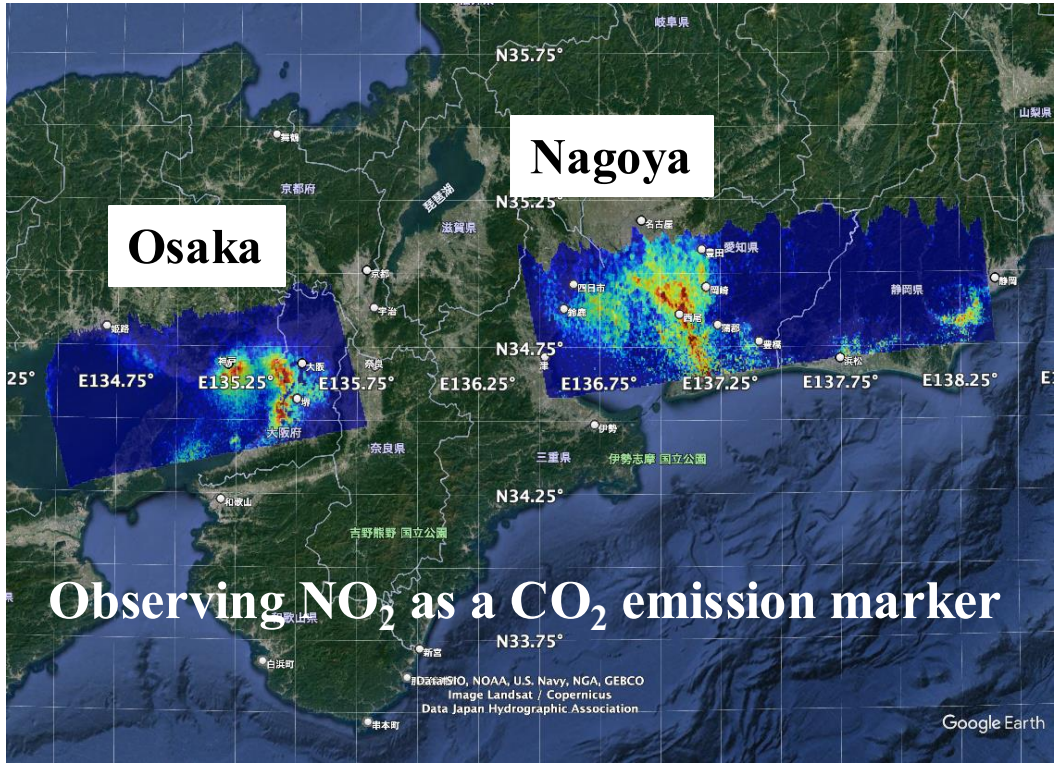
The Southern Hemisphere CH_4 fluxes:

- Both JAXA/GOSAT inversions show higher emissions than the surface inversion with stronger seasonal cycles in anthropogenic emissions.

Presented by Tsuruta (5.36) on 10 June

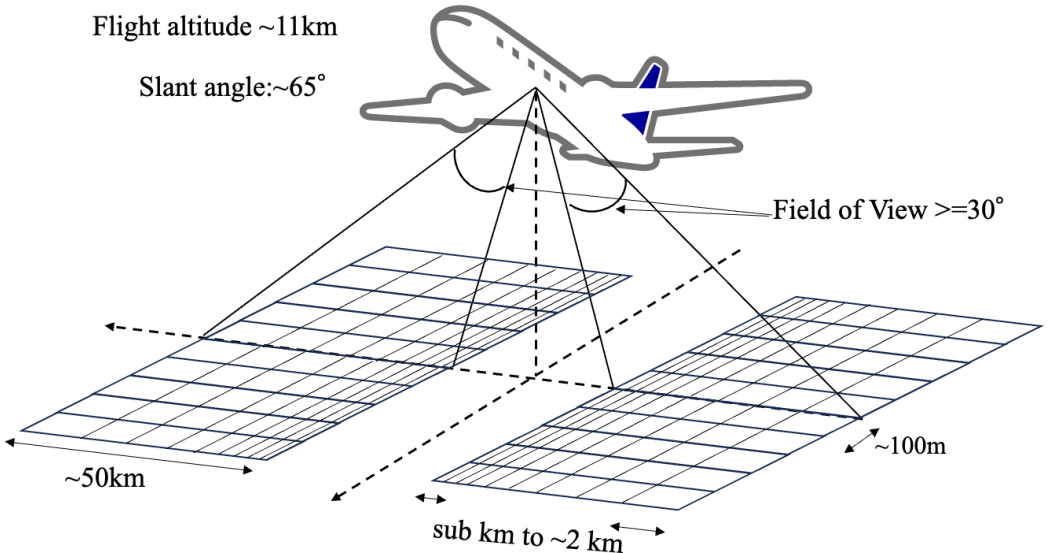
Tsuruta et al, in review.

Remote sensing from a commercial airliner: GOBLEU



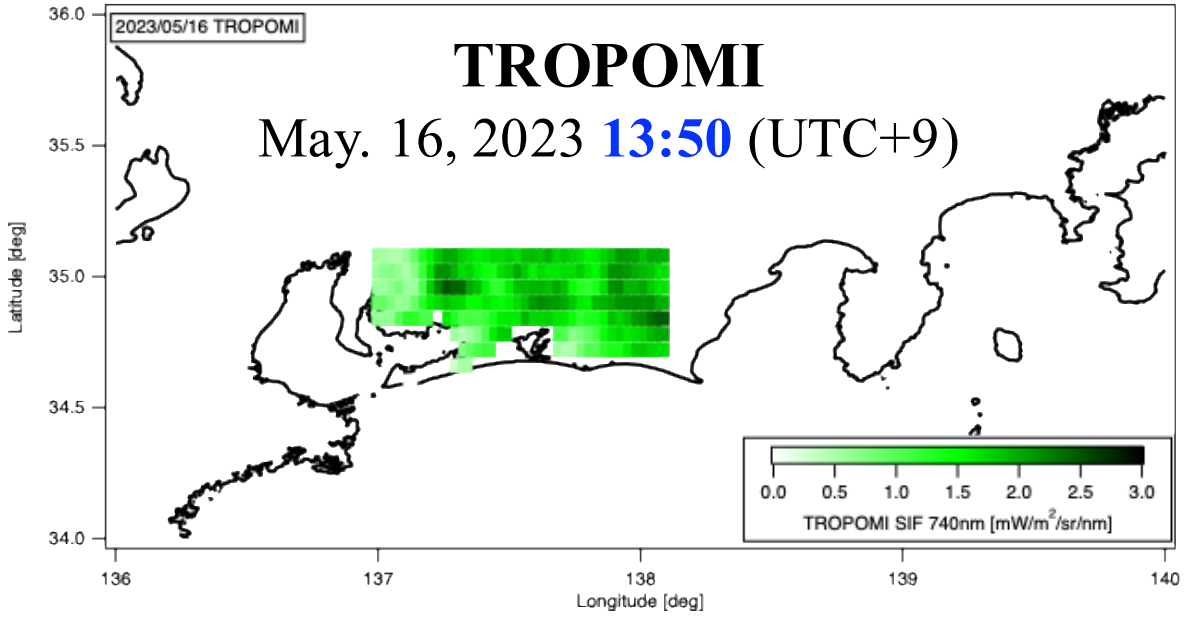
GOBLEU NO_2

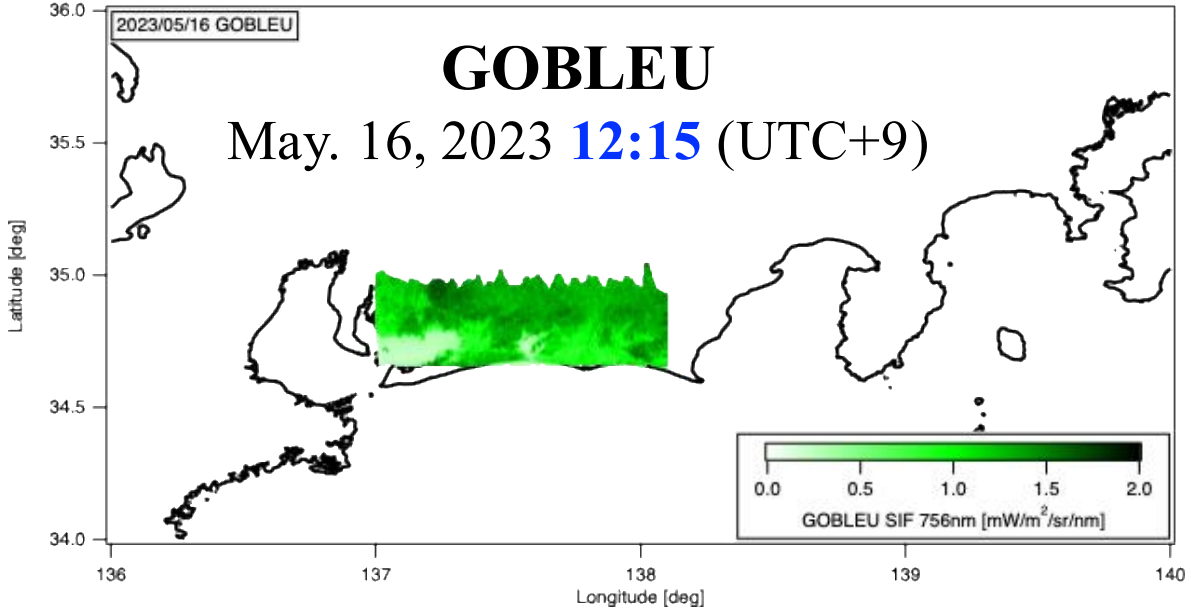
Nov. 17, 2023 **11:25** (UTC+9)

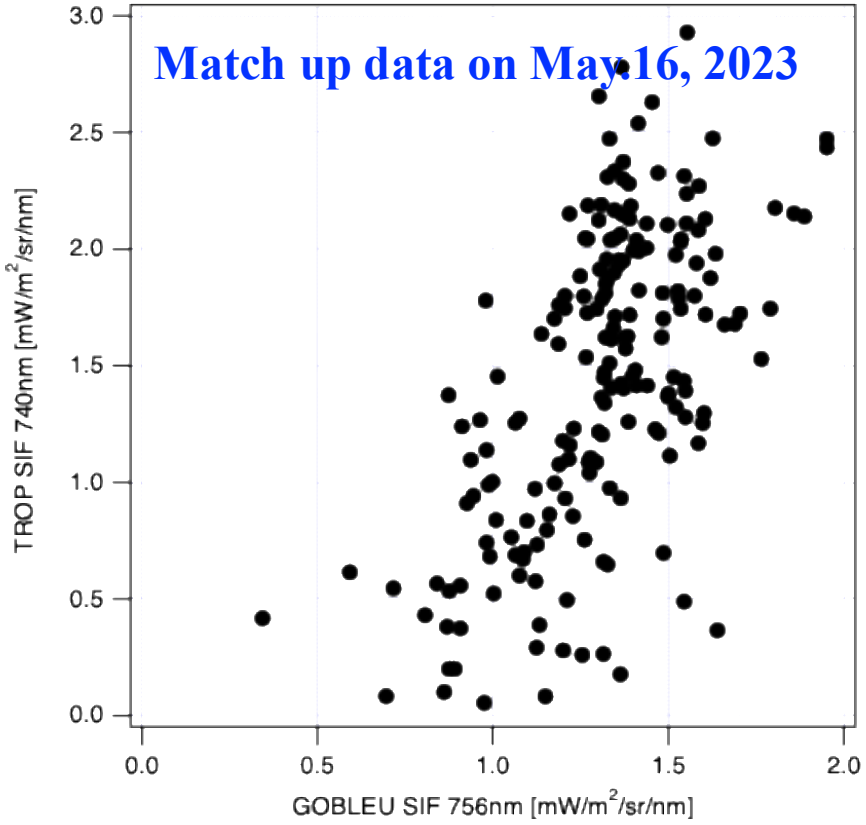


Suto *et al. Carbon Balance and Management* (2024) 19:27
https://doi.org/10.1186/s13021-024-00273-1

Observing SIF as a CO_2 removal marker







- The spatial resolution of GOBLEU-SIF is about 70 times higher than TROPOMI-SIF.
- GOBLEU-SIF data is aggregated for TROPOMI-SIF spatial resolution.
- The agreement between TROPOMI-SIF and GOBLEU-SIF is well.

Summary and Outlook

- **Both GOSAT and GOSAT-2 operation are *nominal* and systems are very *healthy.***

- **RRV2025 campaign was completed in last week with international collaboration team. The data will be processed with the common tool and the results will be shared via the portal.**

- **The latest results for spectral radiance characterization on GOSAT-2 presents the variation of best-estimated radiance. The investigation will be continued**

- **Airborne remote-sensing observation by commercial airliner is one of the powerful tool to understand the emission/removal changes on regional scale. Challenges are how to increase observation frequency.**