The Status of NIES GOSAT-2 Project and NIES Satellite Observation Center

# GOSAT-2 Instrument and Product Related Posters

<table>
<thead>
<tr>
<th>JAXA</th>
<th>GOSAT-2 Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poster 6</td>
<td>Makiko Hashimoto, et al. (JAXA, Japan)</td>
</tr>
<tr>
<td></td>
<td>Aerosol retrieval algorithm and aerosol properties retrieved from GOSAT/TANSO-CAI</td>
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<tr>
<td>Poster 8</td>
<td>Yu Someya, et al. (AORI/U. Tokyo, Japan)</td>
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<td>The CO2 slicing algorithm for the TIR cloud/aerosol products of TANSO-FTS2/GOSAT-2</td>
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<td>Poster 9</td>
<td>Yu Oishi, et al. (Tokai U., Japan)</td>
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<td>Primary verification of new cloud discrimination algorithm used with GOSAT TANSO-CAI in Borneo Island</td>
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<td>Poster 30</td>
<td>Isamu Morino, et al. (NIES, Japan)</td>
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<td>Towards TCCON in the Philippines: The importance of monitoring atmospheric carbon in tropical Southeast Asia</td>
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<tr>
<td>Poster 42</td>
<td>Yosuke Niwa, et al. (MRI, Japan)</td>
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<td>A 4D-Var inversion system based on the icosahedral grid model (NICAM-TM 4D-Var)</td>
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<td>Poster 54</td>
<td>Yukio Yoshida, et al. (NIES, Japan)</td>
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<td>Plan of the GOSAT-2 FTS SWIR products and its preliminary sensitivity study</td>
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<td>Poster 55</td>
<td>Ronald Glumb, et al. (Harris Space &amp; Intell. Sys., USA)</td>
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<tr>
<td></td>
<td>An Update on the TANSO-FTS-2 Instrument for GOSAT-2</td>
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</table>
Major Milestones of NIES GOSAT-2 Project in FY2015 and FY2016

FY2015
• Preliminary and critical designs of G2DPS (GOSAT-2 Data Processing System)
• Testing of a new FTS (125HR) in NIES Tsukuba Campus
• Completion of Two GOSAT-2 buildings for offices and computers
• Installation of GOSAT RCF2 (GOSAT-2 Research Computation Facility)

FY2016
• (April) Establishment of Satellite Observation Center at NIES
• (June – July) CDR of G2DPS
• (December) Shipment of FTS to the new TCCON site in Phillipines.
• Procurements of computers for G2DPS
Role Sharing in the GOSAT and GOSAT-2 Project

In GOSAT-2 Project, “Satellite development, launch, and operation “ are added to MOE’s role.
NIES Organizational Structure (April 2016)

National Institute for Environmental Studies

Director

Research Centers

Center for Global Environmental Research
- Deputy Manages / Obs. Mng. Group 2
- Global Carbon Cycle Res. Section
- Satellite Remote Sensing Section
- Biogeochem. Cycle Modeling/Analysis Sec.
- Atmospheric and Oceanic Monitoring Office
- Integration/Analysis of Global Environmental Databases Office

Center for Environmental Measurement and Analysis
- Advanced Remote Sensing Section

Research Project Collaboration Division

Satellite Observation Center 
(Director : Matsunaga)
- GOSAT Project
- GOSAT-2 Project
- GOSAT-3 Preparation Team
- Validation Team
- Ground Data System Management Team
- Ground Data System Operation Team
- Administration and Public Relations Team
- Committee for Future Satellite Missions

Science Teams
- MOE
- JAXA
- JMA
- RA PIs

Overseas / International Organizations

Director
Organizational Structure of NIES GOSAT-2 Project (as of April 2016)

NIES GOSAT Project
Leaders: Matsunaga / Yokota

GOSAT-2 Science Team
(Leader) R. Imasu
Terry Nakajima, Y. Hikosaka, Y. Honda,
Takashi Nakajima, Y. Niwa, Y. Ota,
N. Saito, H. Shimoda

Calibration WG
Shimoda, Honda, Ono, Yamada, Tsuchida,
Kouyama, Moriyama

NIES GOSAT-2 Project
Leader: T. Matsunaga

Ground Data System
Y. Yoshida and M. Saito

FTS-2 SWIR L2 Algorithm
Y. Yoshida

L4 Algorithm
M. Saito and H. Noda

Terrestrial Biosphere Model
H. Noda

Validation
I. Morino

14C Measurement Y. Terao

Aerosol lidar T. Nishizawa

GOSAT-2 RA PIs

MOE and JAXA

Other NIES Scientists
H. Mukai, N. Saigusa, T. Machida

Other Organizations
JMA
Univ. Tokyo

Other Missions
OCO-2/3
TanSat
Sentinel 5p
MERLIN
Microcarb
## Timeline of Planned Total Column CO2 Observing Satellites as of June, 2016

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<td>Japan GOSAT</td>
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<td>China TanSat</td>
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<td>Japan GOSAT-2</td>
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<td>CNES MicroCarb</td>
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</tbody>
</table>

**Legend:**
- **Green:** Designed life time
- **Yellow:** Extended operation
- **Pink:** End of mission

---

**We are here.**
## GOSAT-2 Project Long-term Schedule

|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|

### Spacecraft and Instruments

<table>
<thead>
<tr>
<th>RFP</th>
<th>System PDR</th>
<th>System CDR</th>
<th>System PQR</th>
</tr>
</thead>
</table>

### GOSAT-2 Data Processing System (G2DPS) and computing facilities

<table>
<thead>
<tr>
<th>Requirement survey</th>
<th>Preliminary design</th>
<th>Critical design</th>
<th>Manufacturing</th>
<th>Testing</th>
<th>Nominal operation</th>
<th>Nominal operation</th>
<th>Nominal operation</th>
<th>Nominal operation</th>
<th>Nominal operation</th>
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</thead>
<tbody>
<tr>
<td>Design of GOSAT-2 buildings</td>
<td>Completion of GOSAT-2 buildings Installation of GOSAT RCF2</td>
<td>G2DPS computer installation</td>
<td>Nominal operation</td>
<td>Nominal operation</td>
<td>Nominal operation</td>
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<td>Nominal operation</td>
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### Validation and other experiments

<table>
<thead>
<tr>
<th>Procurement of a new FTS (125HR)</th>
<th>Modification of airborne FTS</th>
<th>Relocation of FTS to Phillipines</th>
<th>Validation of 2018 data</th>
<th>Validation of 2019 data</th>
<th>Validation of 2020 data</th>
<th>Validation of 2021 data</th>
</tr>
</thead>
</table>
## Quick Overview of GOSAT and GOSAT-2

<table>
<thead>
<tr>
<th></th>
<th>GOSAT Specifications</th>
<th>GOSAT-2 Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Launch year and life time</strong></td>
<td>Jan. 2009, 5 years</td>
<td>FY2017, 5 years</td>
</tr>
<tr>
<td><strong>Satellite</strong> (Dimension, mass, power)</td>
<td>3.7 x 1.8 x 2.0 m, 1750kg, 3.8KW (EOL)</td>
<td>5.3 x 2.0 x 2.8 m, &lt;2000kg, 5.0KW</td>
</tr>
<tr>
<td><strong>Orbit</strong> (Type, altitude, repeat cycle, equator crossing time)</td>
<td>Sun synchronous, 666 km, 3 days, 13:00</td>
<td>Sun synchronous, 613 km, 6 days, 13:00±15 min</td>
</tr>
<tr>
<td><strong>Target gases</strong></td>
<td>CO₂, CH₄, O₂, O₃, H₂O</td>
<td>CO₂, CH₄, O₂, O₃, H₂O, CO</td>
</tr>
</tbody>
</table>
| **Fourier Transform Spectrometer (FTS and FTS-2)** | Band 1 : 0.76 – 0.78 µm  
Band 2 : 1.56 – 1.72 µm  
Band 3 : 1.92 – 2.08 µm  
Band 4 : 5.6 – 14.3 µm  
IFOV = 10.5 kmφ  
Pointing = ±20° (AT), ±35° (CT)  
Polarimetry = Band 1, 2, 3 | Band 1 : 0.75 – 0.77 µm  
Band 2 : 1.56 – 1.69 µm  
Band 3 : 1.92 – 2.33 µm  
Band 4 : 5.5 – 8.4 µm  
Band 5 : 8.4 – 14.3 µm  
IFOV = 9.7 kmφ  
Pointing = ±40° (AT), ±35° (CT)  
Polarimetry = Band 1, 2, 3 |
| **Cloud and Aerosol Imager (CAI and CAI-2)** | Nadir  
B1 = 380 nm  
B2 = 674 nm  
B3 = 870 nm  
B4 = 1600 nm  
B1-B3 = 500 m / 1000 km,  
B4 = 1500 m / 750 km | B1-B5: forward (+20°), B6-10:backward(-20°)  
B1 = 343 nm  
B2 = 443 nm  
B3 = 674 nm  
B4 = 869 nm  
B5 = 1630 nm  
B1-B4, B6-B9= 460 m / 920 km  
B5, B10 = 920 m / 920 km |
| **Other new features of GOSAT-2 FTS-2** | Intelligent pointing using FTS-2 FOV camera, fully programmable (target mode) observation, and improved SNR. |
GOSAT-2’s New Capabilities / Major Improvements

- FTS-2 SWIR L2 carbon monoxide
- FTS-2 SWIR L2 chlorophyll fluorescence (Noda et al. [ACG10-P07])
- Improved FTS-2 signal to noise ratio
  “reduces the retrieval random error (precision) about 15% for XCO₂ and 35% for XCH₄ than those of GOSAT.” (Yoshida et al., JpGU Meeting, 2016)
- Extended FTS-2 AT pointing angle limit ⇒ More ocean sunglint data
- FTS-2 Intelligent pointing ⇒ More cloud-free FTS data
- FTS-2 Fully programmable operation ⇒ More “target-mode” data
- CAI-2 Multiple UV bands ⇒ Better land aerosol estimation
- CAI-2 forward / backward looking system ⇒ More non-glint ocean data
GOSAT-2 FTS-2 Optical Layout

FTS-2 is designed based on not GOSAT FTS but CrIS (Cross-track Infrared Sounder) onboard NASA’s Suomi NPP.

Glumb et al. IWGGMS-11, 2015
The apparent increase of the number of sunglint paths is simply due to the difference of orbit repeat cycles between GOSAT (3 days) and GOSAT-2 (6 days).

GOSAT-2 can cover the wider latitude zone than GOSAT.

The FTS sunglint data will double in number.

Kamei et al. (2015)
GOSAT-2 Data Processing Flow

- CAI-2 L1A → CAI-2 L1B
- CAI-2 L1B
- CAI-2 Surface Albedo → CAI-2 L2 Cloud
- CAI-2 L2 Cloud → CAI-2 L2 Aerosol
- FTS-2 L1A → FTS-2 L1B
- FTS-2 L1B
- FTS-2 TIR L2 Cloud and Aerosol → FTS-2 SWIR L2 Chlorophyll Fluorescence → FTS-2 SWIR L2 XCO₂, XCH₄, XH₂O, XCO
- FTS-2 TIR L2 Air temperature and Gas Concentration Profiles
- FTS-2 L4A CO₂ and CH₄ Flux
- FTS-2 L4B 3D CO₂ and CH₄ Concentration
## GOSAT-2 Product List (At-launch version)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Algorithm</th>
<th>Processing</th>
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<tbody>
<tr>
<td>TANSO-CAI-2 L1A Product</td>
<td>JAXA</td>
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<tr>
<td>TANSO-CAI-2 L1B Product</td>
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<tr>
<td>TANSO-CAI-2 L2 Cloud Discrimination Product</td>
<td>Tokai Univ.</td>
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<tr>
<td>TANSO-CAI-2 L2 Aerosol Properties Product</td>
<td>JAXA</td>
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<tr>
<td>TANSO-FTS-2 L1A Product</td>
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<td>TANSO-FTS-2 L1B Product</td>
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<tr>
<td>TANSO-FTS-2 SWIR L2 Chlorophyll Fluorescence/Proxy Method Product</td>
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<tr>
<td>TANSO-FTS-2 SWIR L2 Column Averaged Gas Concentration Product</td>
<td>NIES</td>
<td>NIES</td>
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<tr>
<td>TANSO-FTS-2 TIR L2 Cloud and Aerosol Properties Product</td>
<td>Univ. Tokyo</td>
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<td>TANSO-FTS-2 TIR L2 Air Temperature and Gas Concentration Product</td>
<td>Chiba Univ.</td>
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<td>TANSO-FTS-2 L4A Product (CO₂ and CH₄)</td>
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<tr>
<td>TANSO-FTS-2 L4B Product (CO₂ and CH₄)</td>
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<td>NIES</td>
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Thank you for your attention
matsunag@nies.go.jp