Preparation status of the data processing system for GOSAT-GW/TANSO-3 in NIES

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GOSAT-GW specifications

- Launch: Japanese FY2024
- Design lifetime: > 7 years
- Sun-synchronous, Sub-recurrent orbit
- Altitude: 666km, recurrent cycle: 3days, MLTAN: 13:30, ascending

TANSO-3 (Total Anthropogenic and Natural emissions mapping SpectrOmeter-3)

- Imaging spectrometer (3-band grating)
- Spectral bands: 0.45 μm / 0.7 μm /1.6 μm
- Spectral resolution: < 0.5nm@0.45μm, < 0.05nm@0.7μm, < 0.2nm@1.6μm
- Observation mode
  - Wide-mode: 911km swath, 10km footprint, no pointing
  - Focus-mode: 90km swath, 1-3km footprint, AT/CT pointing
- Focus mode observations are carried out on request.

Products

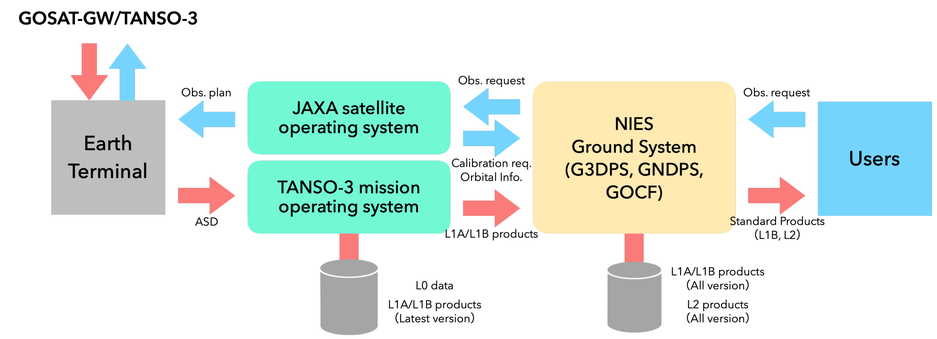
Standard Products

- **Level 1B** (geolocated and calibrated spectral radiance)
  - **Wide-mode 10km res.**: one file per cycle*
  - **Focus-mode 3km res.**: one file per scene*
- **Level 2** (atmospheric products derived from the L1B)
  - **Wide-mode 10km res. GHG**: one file per day* (including full-physics XCO_2&XCH_4, proxy XCH_4, and SIF)
  - **Wide-mode 10km res. NO_2**: one file per day*
  - **Focus-mode 3km res. GHG**: one file per scene*
  - **Focus-mode 3km res. NO_2**: one file per scene*
  - Quick delivery products are planned for focus-mode 3km res. GHG&NO_2

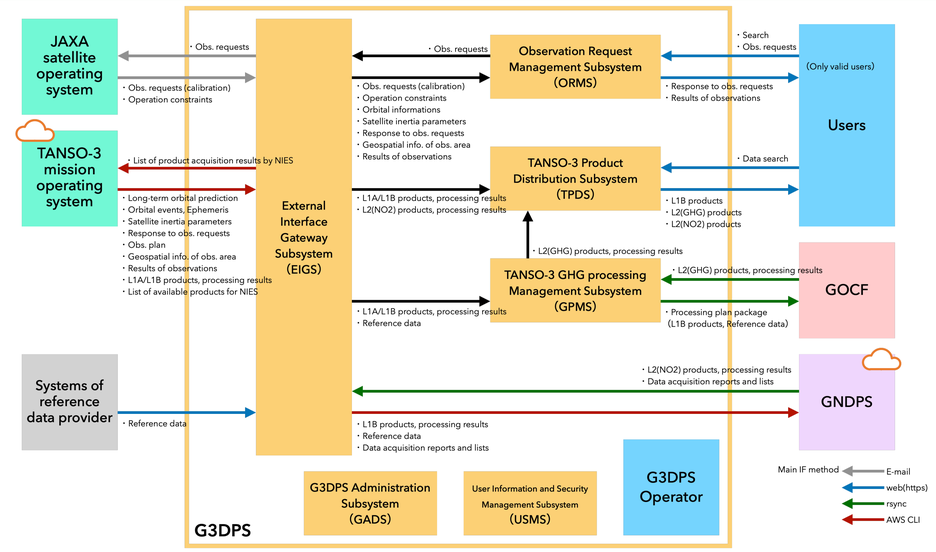
* One cycle means the orbital period between the descending point and the next descending point. The scene corresponds to each pointing request. Daily data contains 14-15 cycles.

- Daytime data only
- File format: HDF5 (readable by NetCDF4 library)
- Level 2 products for a month are planned to be processed within the next month
- **All the products will be distributed from "GOSAT-GW TANSO-3 Product Archive (G3PA)" site**

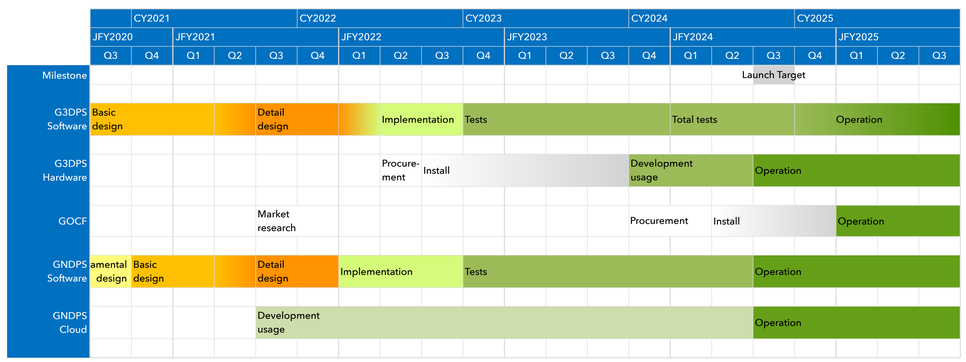
Schematic diagram of GOSAT-GW systems connecting satellites to data users



G3DPS: System for product management and user contact



Development schedule



Challenges in the NIES GOSAT-GW project

- **Focus-mode observation execution plan:** focus-mode is mainly used for observation of megacities, comparison with ground-based observations, and glint observation over the ocean. We are not able to obtain the observations of wide-mode while the focus mode is on.
- **Large computational workload:** the number of points for full-physics retrieval is expected to increase, and the computational workload will increase by more than x300 compared to GOSAT/GOSAT-2.

➡ R&D of retrieval emulation model by data-driven methods

Development of the data-driven models in GOSAT-GW project

Approach1: Building a surrogate model

- Create an emulator that simulates our radiative transfer model
- Numerous simulations using physical models are used as training data

Approach 2: Inverse estimation of GHG concentrations without using physical models

- Emulates the MAP estimation of TANSO-3 full-physics retrieval (based on e.g. Yoshida et al. 2011; 2013, Someya et al., 2022)
- Creating TANSO-3-like data for training/validation from over ten years of GOSAT spectrum/retrieval data
- Evaluation of two different machine-learning methods
  - Neural network (6-layer MLP)
  - LASSO regression
    : The method has a simpler architecture than DNN and is able to detect specific wavelength points and reference data that strongly contribute to concentration estimation
  - Preliminary results of both methods show promising results, reporting small RMSE as fairly comparable to the full-physics retrieval
- Challenges
  - Memory management and calculation time reduction when using more training data
  - Analysis of weak sensitivity to the trend/inter-annual variation of CH_4

Summary

- Development of NIES ground systems for GOSAT-GW TANSO-3 is proceeding with the aim of smooth product release under the launch schedule
- Dealing with the explosive increase in computational workload due to the increase in observation points from TANSO-3 for calculating XCO_2 and XCH_4 is one of the challenges. We plan to use "retrieval emulators" based on machine learning.