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How the GOSAT program has used airplane observations for its demonstration, calibration, and validation

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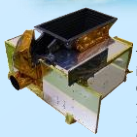
Introduction

The Greenhouse gases Observing SATellite (GOSAT) is the first satellite program designed to accurately and precisely monitor greenhouse gases (GHG) of carbon dioxide (CO_2) and methane (CH_4) from space. In-situ and remote optical measurements onboard airplanes have made GOSAT a successful mission.

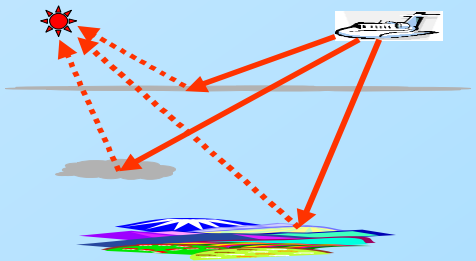


Thermal And Near infrared Sensor for carbon Observation -Fourier Transform Spectrometer (TANSO-FTS)

for DEMONSTRATION

GHG column density retrieval from solar scattered light

At the beginning of the GOSAT program, we installed a breadboard model to a high altitude airplane to acquire spectra and to detect and correct light path modifications by aerosols and clouds. We acquired high resolution spectra of O_2 A, CO_2, and CH_4 at SWIR, but validation without a simultaneous aerosol Lidar measurement was not possible.

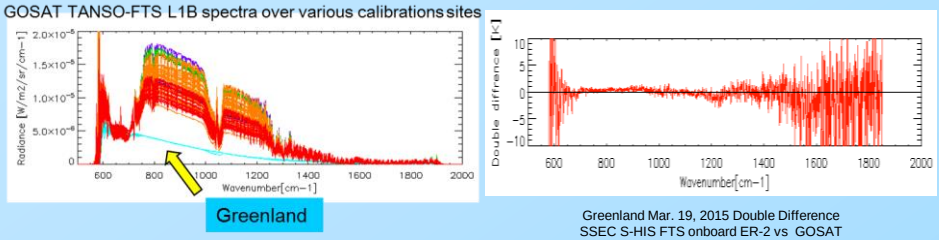


for CALIBRATION

TIR radiometric, spectroscopic and polarimetric

nasa.gov

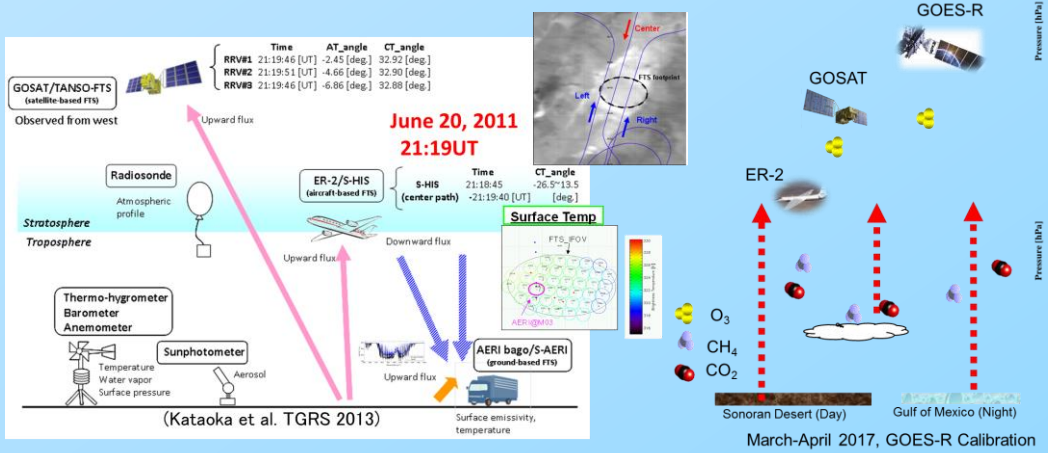
GOSAT observes wide spectral range radiation between 650 and 1800 cm^{-1} from both the surface and the atmosphere. Double difference comparison using spectra acquired by GOSAT, airplanes, and forward calculation can remove model-dependent errors. S-HIS-FTS by the University of Wisconsin onboard ER-2 at 25 km flown over the hot desert of Railroad Valley (RRV) and S-HIS and the Met Office ARIES FTS operated onboard FAAM flown over cold Greenland provided calibration data for detector non-linearity correction. Additionally, high spectral resolution data from air-borne FTSs validated spectroscopic and polarimetric calibrations.



Greenland Mar. 19, 2015 Double Difference
SSEC S-HIS FTS onboard ER-2 vs GOSAT

Cold Radiation from CO_2 and CH_4, Greenland surface and hot radiation from desert surface

$$DoubeDifference = (\tilde{R}_{OBS}^{GOSAT} - \tilde{R}_{CALC}^{GOSAT}) - (\tilde{R}_{OBS}^{SHIS} - \tilde{R}_{CALC}^{SHIS})$$

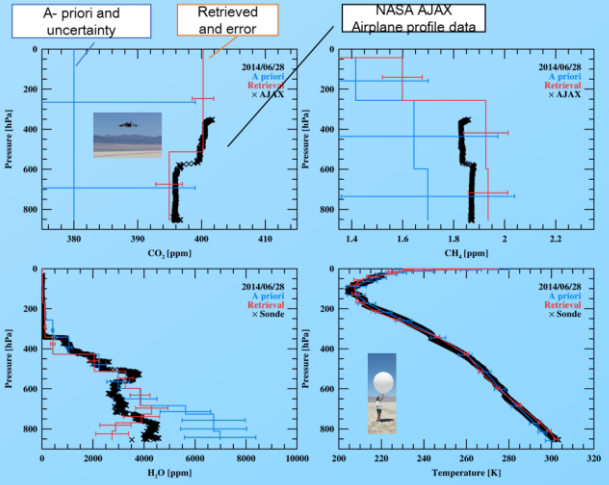


for VALIDATION

CO_2, CH_4 and H_2O vertical profile

A multiplex advantage of GOSAT-FTS can cover both sc scattered light at the SWIR band for column density and thermal radiat from the atmosphere at the TIR band for profile retrieval. NASA Ame Alpha Jet Atmospheric eXperiment (AJAX) uses a Picarro spectrometer the in-situ vertical spiral profiling of CO_2 and CH_4 from the surface to upper troposphere and coincident flight data for GOSAT over RRV.

In addition to the above applications, airplanes can provide plu emissions with a higher spatial scale to validate amount from point sourc



2-layer retrieval using both SWIR and TIR
Using RRV campaign period data
Coincident AJAX flight, radiosonde launch and GOSAT overpass

Summary: useful air–borne tools for green house gases observations

(1) LIDAR onboard high altitude airplane for demonstration: Light path modification by aerosol and thin cloud in column density retrieval. (proposing, lessons learned from prelaunch test in 2007)

(2) High spectral resolution TIR spectrometer such as FTS onboard high altitude air plane. Non–linearity correction for dynamic range of FTS application (Coincident flights in 2011, 2013, 2015, 2017)

(3) In-situ CO_2 and CH_4 measurements with spiral flight (Coincident flight since 2011 (every June).