Introduction

The Greenhouse gases Observing SATellite (GOSAT) is the first satellite program designed to accurately and precisely monitor greenhouse gases (GHG) of carbon dioxide (CO₂) and methane (CH₄) from space. In-situ and remote optical measurements onboard airplanes have made GOSAT a successful mission.

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 O₂A, CO₂, and CH₄ at SWIR, but validation without a simultaneous aerosol Lidar measurement was not possible.

Summary: useful airplane 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 airplane. Non-linearity correction for dynamic range of FTS application (Coincident flights in 2011, 2013, 2015, 2017)
(3) In-situ CO₂ and CH₄ measurements with spiral flight (Coincident flight since 2011 (every June))

for CALIBRATION
TIR radiometric, spectroscopic and polarimetric

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.

for VALIDATION
CO₂, CH₄ and H₂O vertical profile

A multiplex advantage of GOSAT-FTS can cover both solar scattered light at the SWIR band for column density and thermal radiation from the atmosphere at the TIR band for profile retrieval. NASA Ames Alpha Jet Atmospheric eXperiment (AJAX) uses a Picarro spectrometer and the in-situ vertical profiling of CO₂ and CH₄ from the surface to upper troposphere and coincident flight data for GOSAT over RRV.

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