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

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The Greenhouse gases Observing SATellite (GOSAT) is the first satellite program designed to accurately and precisely monitor carbon dioxide (CO_2) and methane (CH_4) from space. In-situ and remote optical measurements onboard airplanes have made GOSAT a successful mission as described below.
(1) Demonstration of 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_2A, CO_2, and CH_4 at SWIR, but validation without a simultaneous aerosol Lidar measurement was not possible.
(2) TIR radiometric, spectroscopic and polarimetric calibrations
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.
(3) Validation of GHG 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' s Alpha Jet Atmospheric eXperiment (AJAX) uses a Picarro spectrometer for the in-situ vertical spiral profiling of CO_2 and CH_4 from the surface to the 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 sources.

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