JpGU-AGU Joint Meeting 2018

ACG44-P05

Demonstration of greenhouse-gases flux estimation from space using an air-borne imaging spectrometer

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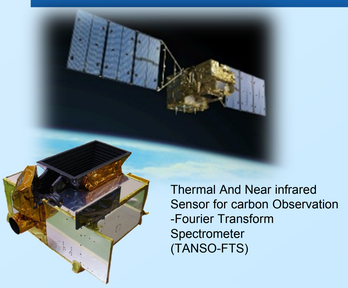
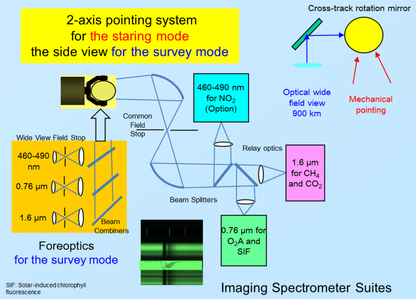
Background



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

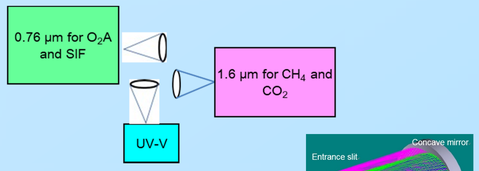
The Greenhouse gases Observing SATellite (GOSAT) is the first satellite program designed to monitor column averaged density of carbon dioxide (CO_2) and methane (CH_4) from space accurately and precisely. Local flux estimation from various emission sources using GOSAT data has large uncertainty because the GOSAT footprint of 10.5 km is large and number of sampling points per region is limited.

Our target: space-borne compact imaging spectrometer

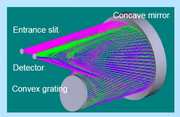


The imaging spectrometer with spectral resolution of 2 Å and spatial resolution of 1km can enhance the column averaged density and detect plume orientation. We demonstrated greenhouse-gases flux estimation from space using air-borne imaging spectrometer suites, which consist of O_2A band, CH_4 and CO_2 band at 1.6 μm and UV-visible spectrometers.

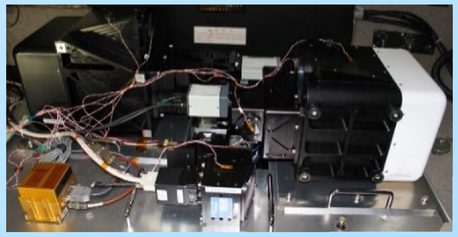
Airborne model and demonstration flight

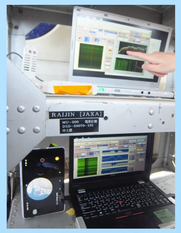


3 imaging spectrometers (1.6, 0.76 and UV)
CO_2, CH_4, O_2 (NO_2)



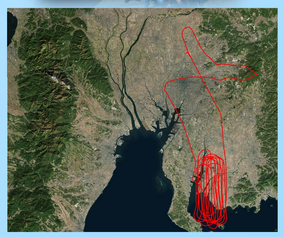
Module	Item	Value
Spectrometer module	Spectral coverage	1.56 -1.67 μm
	Speed	Faster than F = 3.5
	Spectral resolution	2 Å
	Structure	All aluminum
Detector module	InGaAs	640 pixel (Spectra) by 512 pixels (Cross track)
	Pixel size	20 μm by 20 μm
	Detector temperature	Cooled at +10℃ by thermoelectric cooler
	Integration time	1 sec (maximum)
	Spectral binning	2 pixels
	Spatial binning	16 pixels
	Lens	F=3.5, focal length 213 mm aperture 60mm
	Slit	10.24 mm by 40 micron





King air 200T/200	
Cruising altitude	2893 m
Swath	20 deg
Swath	1020 m
Cross track pixels	2018 pixels
CT size	0.506 m

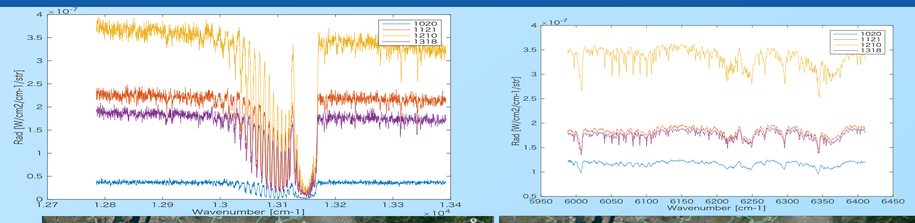
16, Feb. 2018,
Greater Nagoya over
Hekinan-city
Coal power plant
Energy manufacturing



Acknowledgement: The authors thank Shigetaka Mori and King Air flight team at Diamond Air Service Inc.
Reference: Kuze, A., and Suto, H., (2018), Imaging Spectrometer with an Agile Pointing System to Quantify Global and Regional Greenhouse Gas Fluxes and Monitor Localized Emission Sources", Trans. JSASS Aerospace Tech. Japan, 16, 147-151, DOI: 10.2322/tastj.16.147.

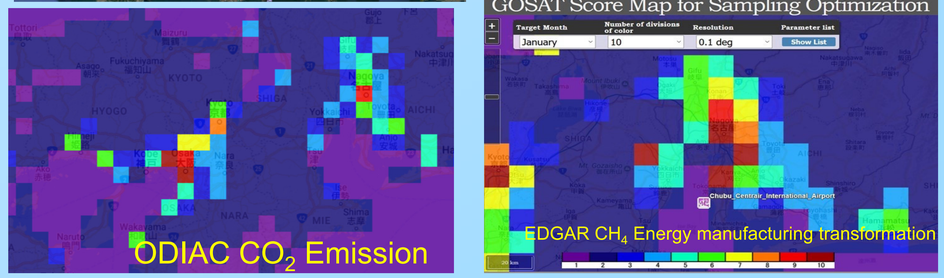
Preliminary results

Acquired spectra
(O_2A at 0.76 μm and
CO_2, CH_4 at 1.6 μm)



16 Feb. 2018
Measured
Column averaged CO_2
and CH_4

CO_2 and CH_4
Emission database Map
Power plant and population
Energy manufacturing



Next step

<Data analysis >
(1) CO_2 and CH_4 column density retrieval using full physics algorithm
(2) Light path correction using O_2 A band: using O_2 absorption instead of simple geometry with sun height and flight attitude
(3) Faster algorithm to process 4,000 times more points than GOSAT
(4) Retrieve solar induced chlorophyll fluorescence from O_2A band
(5) Short-lived NO_2 plume map for estimating wind speed and flux.
<Instrument >
(1) Improving UV spectrometer performance for NO_2 and aerosol
(2) Pointing capability to target the emission sources
(3) Fore optics to switch observation mode for both survey (wide field) and staring (high spatial resolution)
(4) Pod to install space-borne model
<Flight >
(1) Flight over various emission sources and reference (ideally background) to estimate local flux based
(2) Flight over Osaka-Kobe-Himeji to estimate flux from transportation and industry separately

Summary

- Air-borne imaging spectrometer with spectral resolution of 2 Å demonstrated the feasibility to detect enhancement from point emission sources.
- Further improvements in data analysis and instrument are needed to utilize the airborne data in order to provide the information for city-level greenhouse gases emission control.