



Committee on Earth Observation Satellites

Cross Calibration of GHG Missions

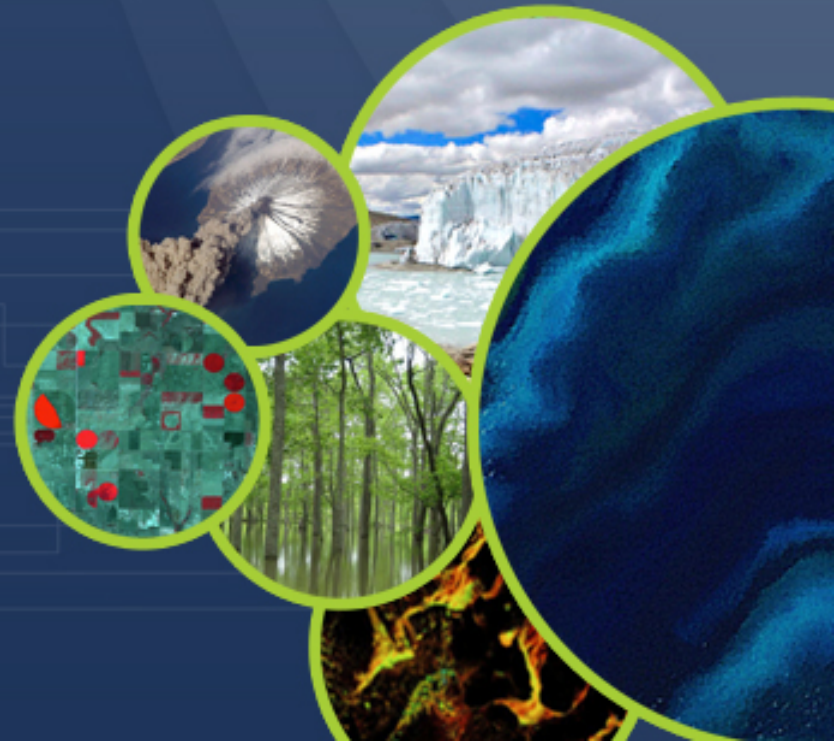
Akihiko KUZE

(Earth Observation Research Center, Japan Aerospace Exploration Agency)

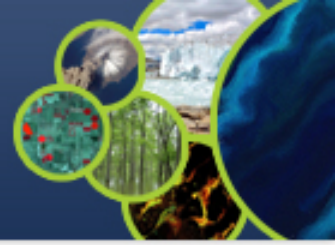
CEOS AC-VC

Nakano, Tokyo

June, 2019



Lessons learned from a decade long GOSAT operation (benefit and challenge)



<vs. SCIMACHY>

(1) Global average from different sampling strategy

<vs. OCO-2>

(2) Radiance Spectra

Radiance conversion table using prelaunch calibration

Solar spectra update after OCO-2 and GOSAT Level 1 intercomparison

(3) XCO₂

Characterize topography and surface albedo dependent bias using OCO-2 and GOSAT Level-2 intercomparison

<vs. AIRS>

(4) Radiance Entire TIR spectral range

None-linearity correction update due to wide dynamic range of FTS: cold CO₂ band

Remove step changes before and after GOSAT shutdown and thermal environment changes

Challenge: Limited number of vertical profile data

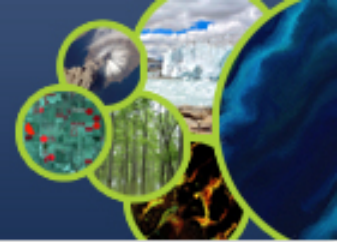
<vs. multiple sensors: + GOSAT-II, OCO-3, TROPOMI>

<Next>

Challenge: regional flux estimation using XCO₂, XCH₄ data

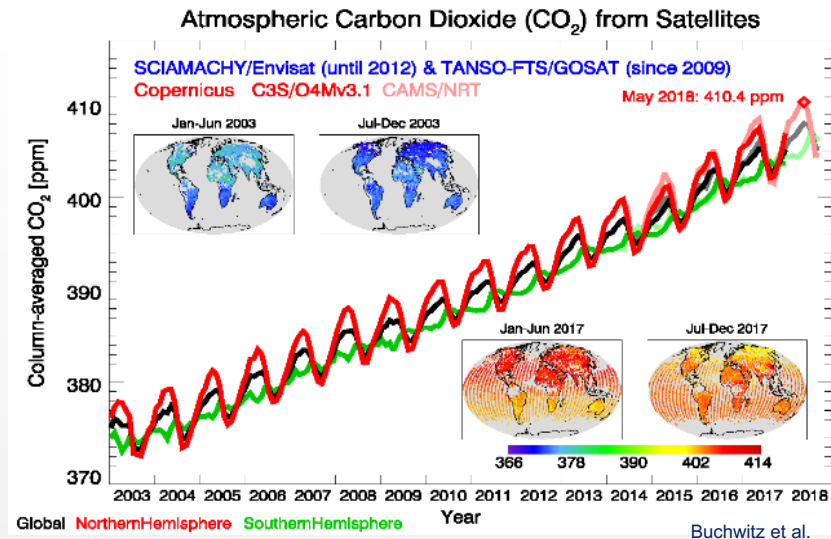
SCIAMACHY vs GOSAT

Seamless data set, Global average

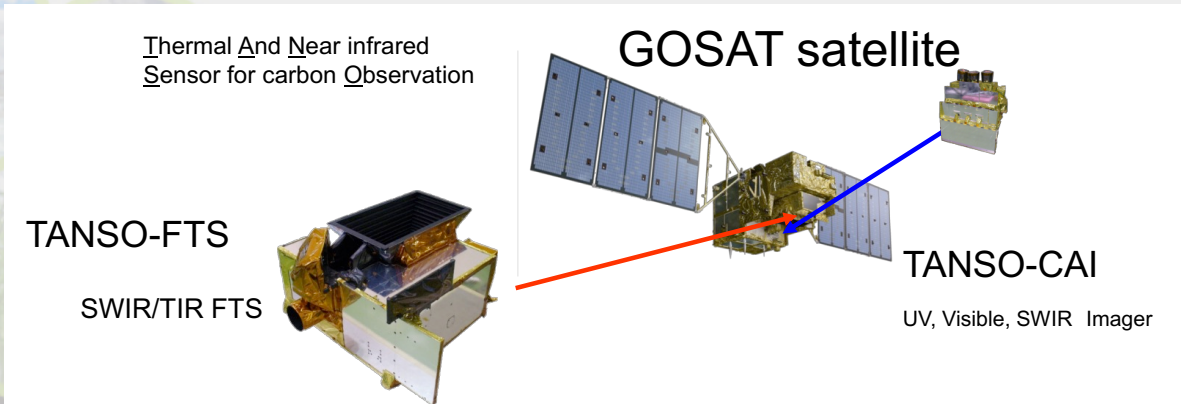


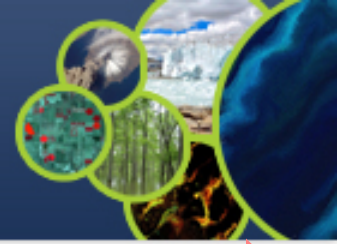
SCIAMACHY until 2002
Lower spatial and spectral resolution

GOSAT since 2009
High spectral resolution
Sparse sampling



Ensemble of SCIAMACHY-ENVISAT (until April 2012) and TANSO-FTS-GOSAT (since mid-2009) individual sensor and individual sounding (level 2) data products. (Buchwitz et al., 2019)





2008 09 10 11 12 13 14 15 16 17 18 19

Radiometric calibration

Prelaunch
X-CAL



Annual Vicarious Calibration at the desert playa in Nevada



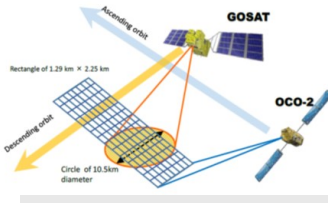
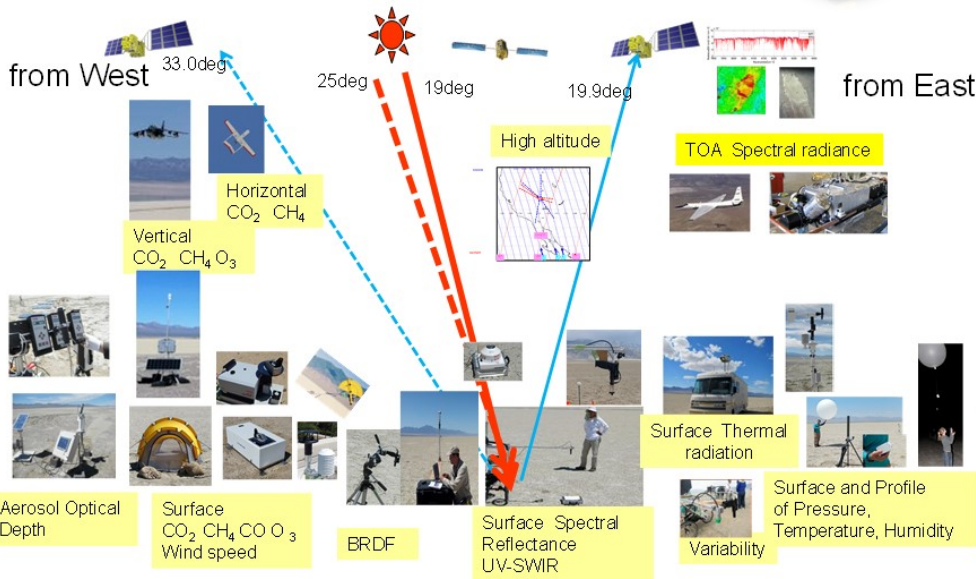
CO₂ & CH₄ profile
In situ CO₂ and CH₄ on AJAX

XCO₂ & XCH₄

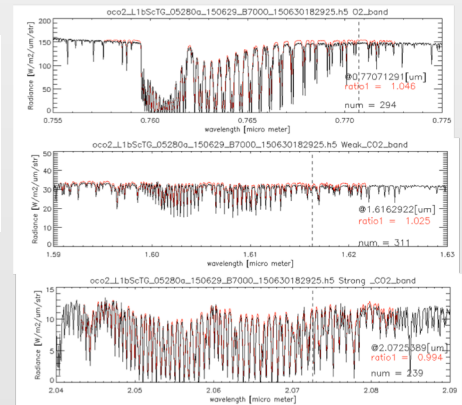
Column with EM-27 FTS

Coincident
Target

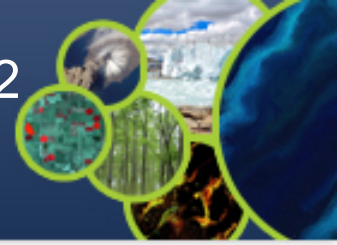
GOSAT OCO-2



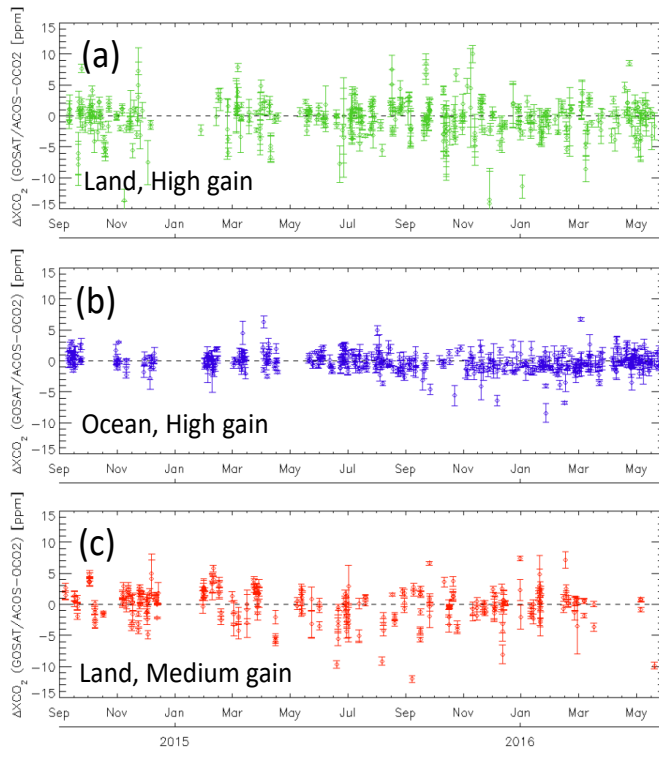
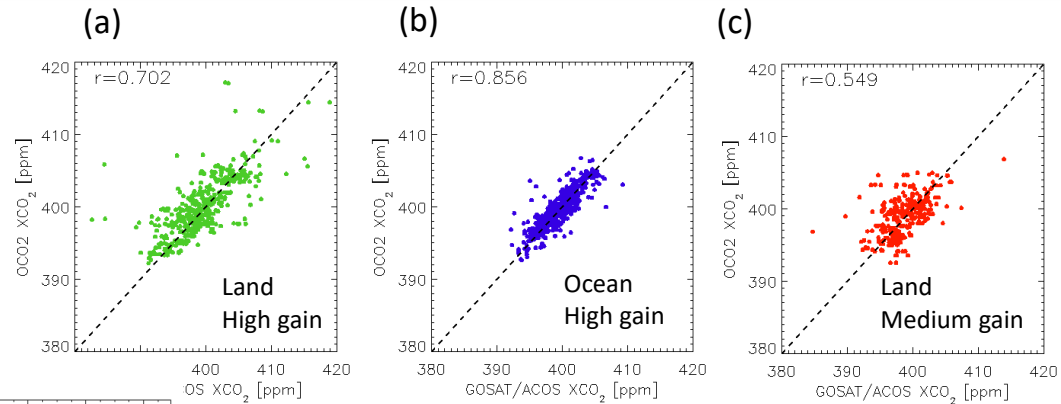
Calibrated GOSAT and OCO-2 radiance spectra agrees within 5% for all bands.



XCO₂ Scatter plots of ACOS GOSAT (B7) - OCO-2 and time dependency of their difference



- (a) ± 3.33 ppm
- (b) ± 1.48 ppm
- (c) ± 2.79 ppm

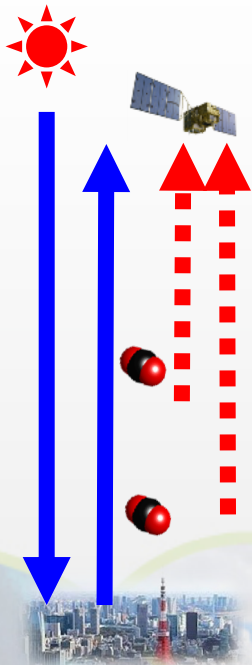
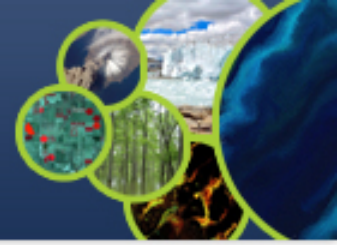


The time series of ΔX_{CO_2} from Sep. 2014

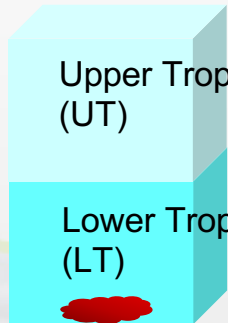
$$\Delta X_{CO_2} = \text{GOSAT/ACOS } X_{CO_2} - \text{OCO-2 } X_{CO_2}$$

2014/09 ~ 2016/05 XCO₂ Level2 matchup Agreement: (ACOS-GOSAT B7.3 vs. OCO-2 B7)

- < 0.57 ppm over Land (high gain) Error probably due to uneven Topography
- < 0.17 ppm over Ocean
- < 0.19 ppm over Land (desert)



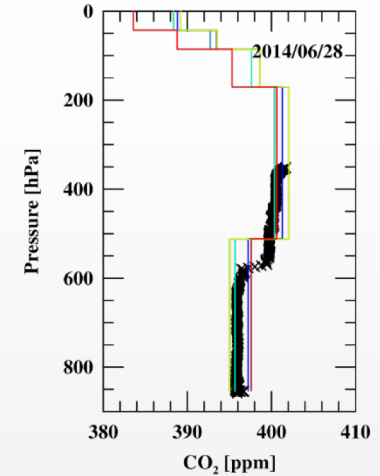
GOSAT measures both solar reflected light from the Earth's surface (SWIR) and thermal emission from the Earth's atmosphere (TIR) providing CO₂ partial-column densities of UT and LT.



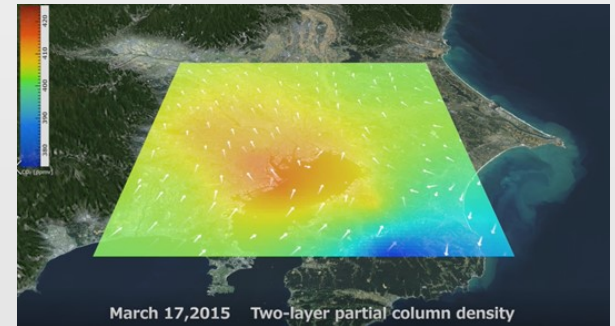
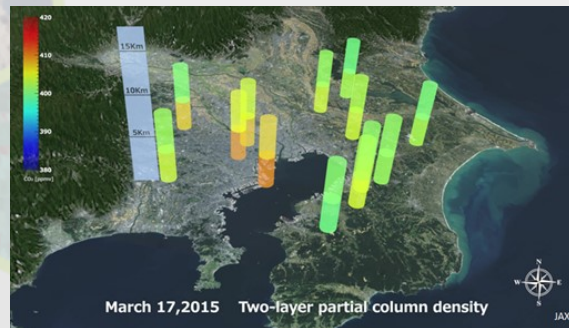
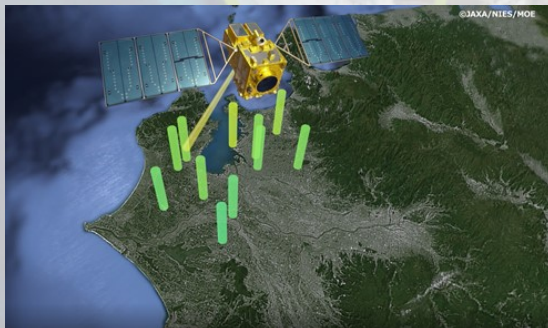
Local Emission

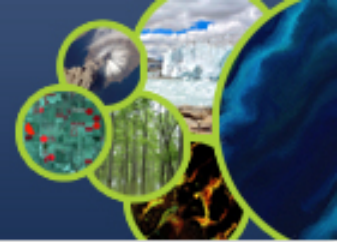


Courtesy of R. Kawa



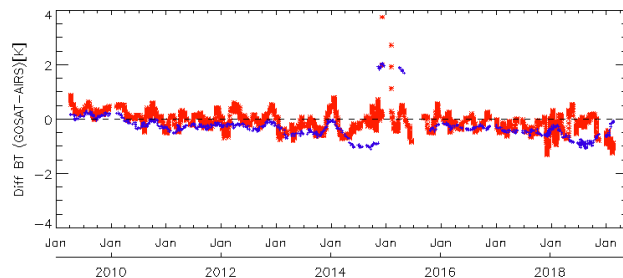
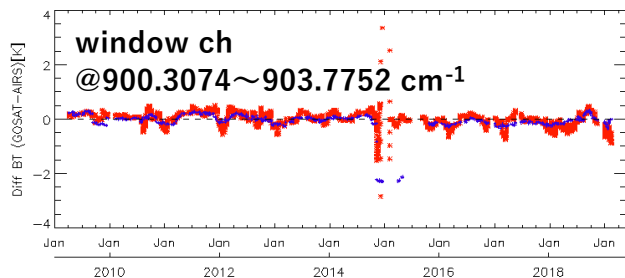
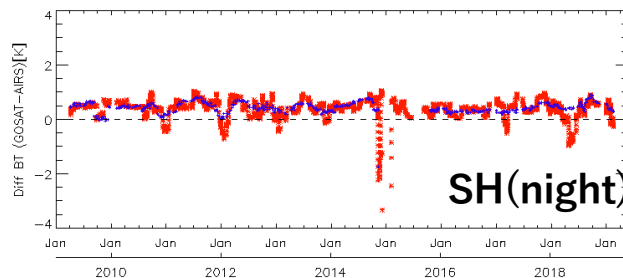
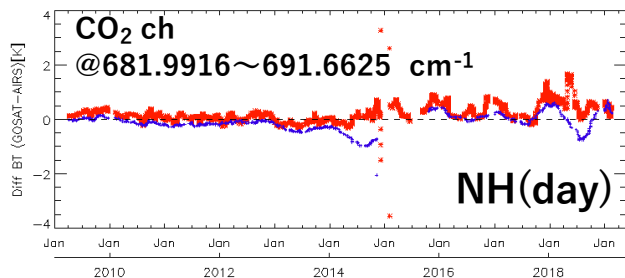
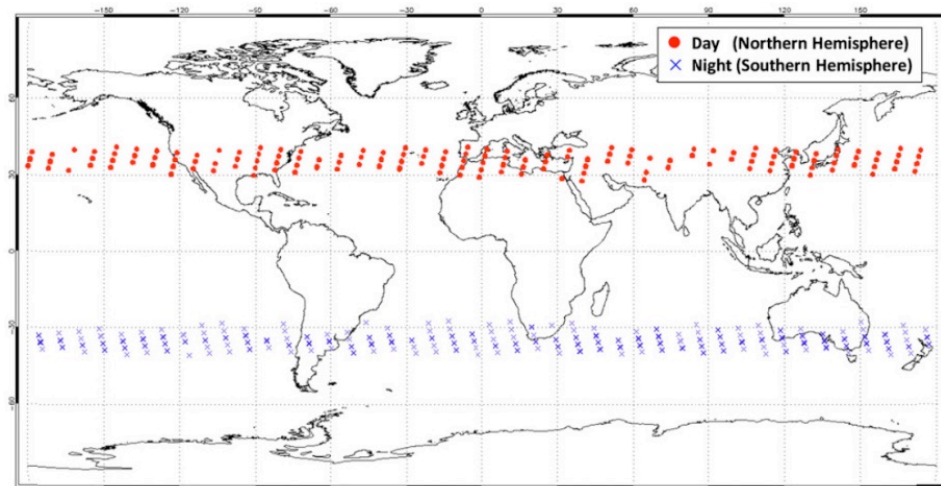
AJAXA vertical profile vs. 4 GOSAT retrieval at RRV, NV





AIRS since 2002
Cooled optics
Grating spectrometer

GOSAT since 2009
Uncooled optics
FTS

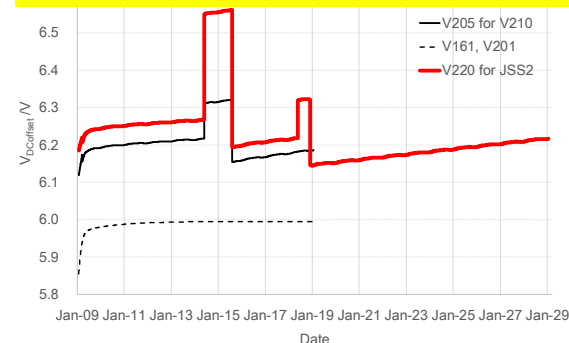


— diffBT (GOSAT_V210.210 – AIRS)
— diffBT (GOSAT_V220.220 – AIRS)

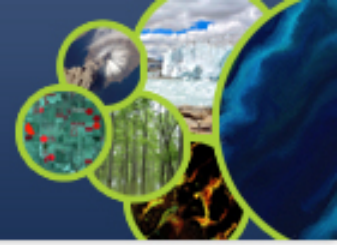
GOSAT-AIRS decade long match-up

Kataoka et al. (2019) TGRS

Entire period sample of V220 is available. (please contact JAXA)



Non-linearity Correction Parameter for GOSAT To remove step change in 2014.4, 2015.9, 2018.5, 2018.12

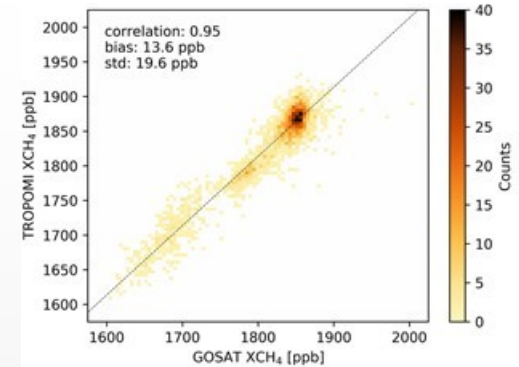
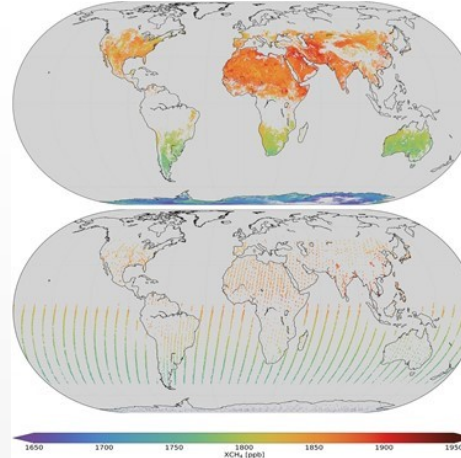


Using different bands:
GOSAT CH₄ at 1.6μm and
TROPOMI at 2.3μm

June 30-July 5
11th annual vicarious calibration **and**
X-CAL campaign at Railroad Valley, NV,
U.S.A.

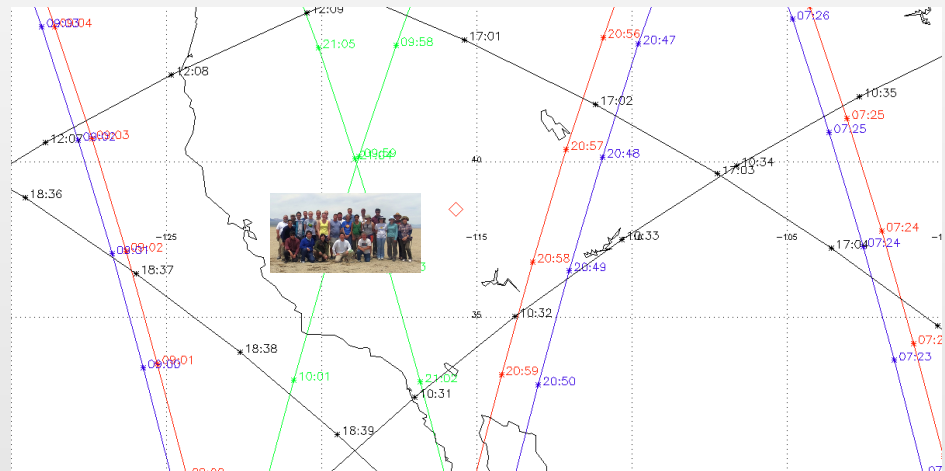
Over paths
3 GOSAT, 3 GOSAT-2,
2 OCO-2, 3 OCO-3

Surface Albedo
AOD
XCO₂, XCH₄, XCO by EM27 FTS

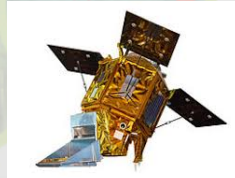


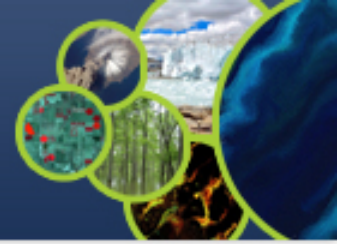
Hu et al. (2018) GRL

TROPOMI (upper) GOSAT (lower)



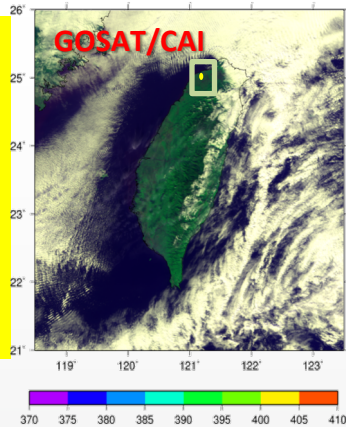
OCO-2, OCO-3, GOSAT, GOSAT-2
+ Sentinel 5P (July 1)



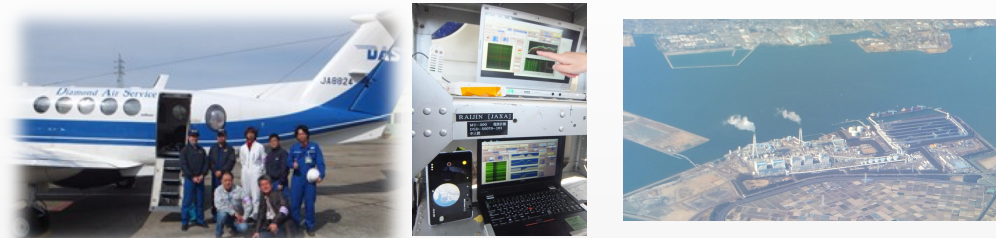


To estimate local flux

Cities
Taiwan



Near Coal Power plant
OCO-2 detected enhancement
GOSAT: below detection level

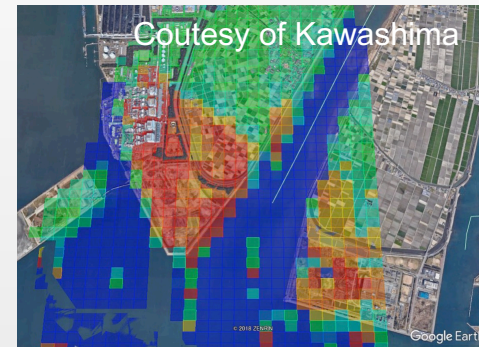
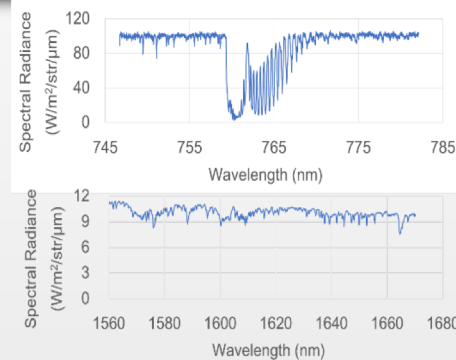
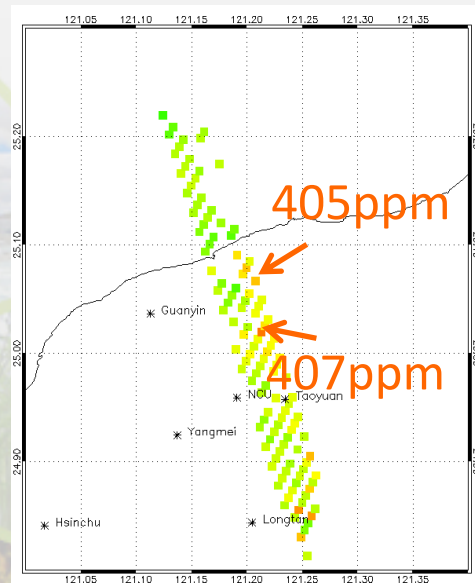
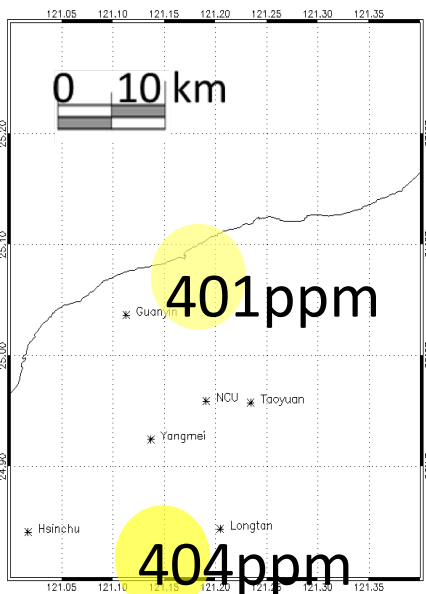


GOSAT XCO₂

OCO₂ XCO₂

2016/01/01 05:00 UT

2016/01/01 05:05 UT



Toward next generation instrument

Imaging spectrometer suites adding NO₂

