GOSAT results

Kei Shiomi

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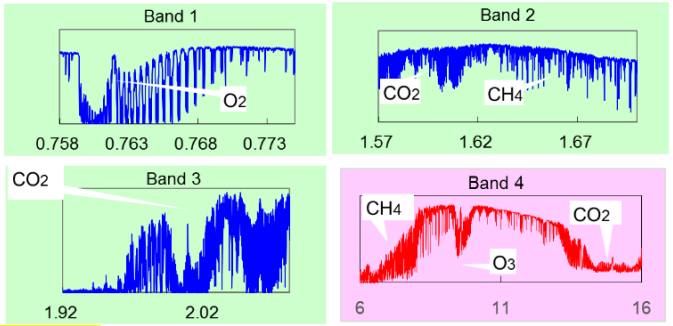
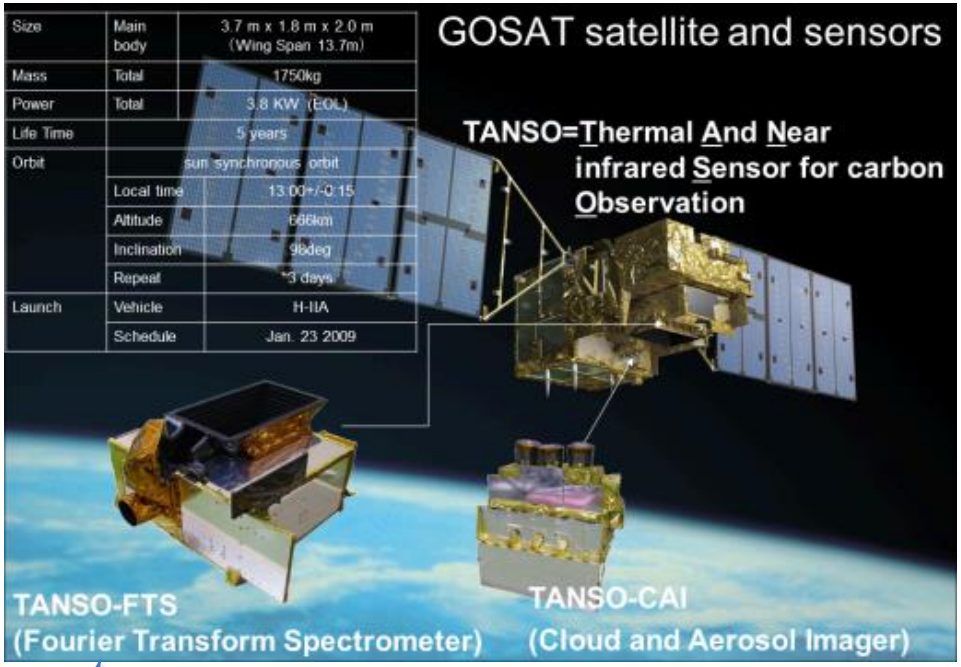
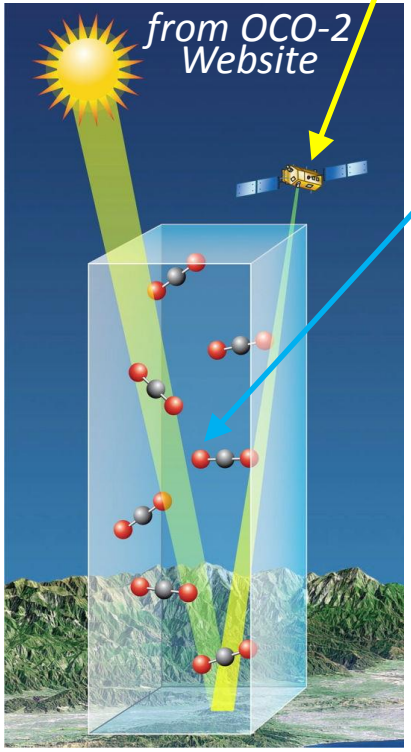
GOSAT on orbit since 2009





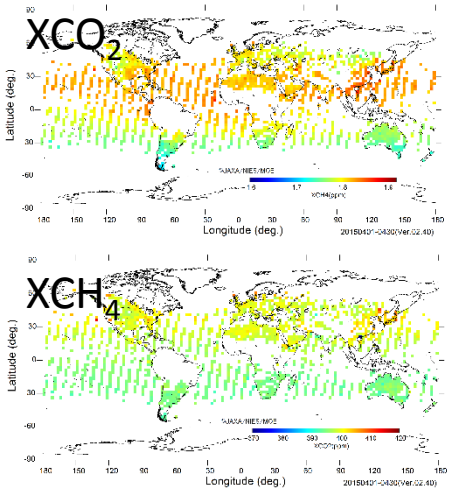
Level 1

TOA (top of atmosphere) radiance



Level 2

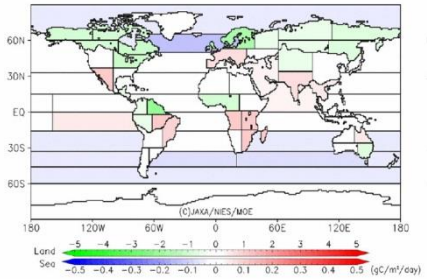
Column-averaged dry air mole fraction of CO_2 and CH_4



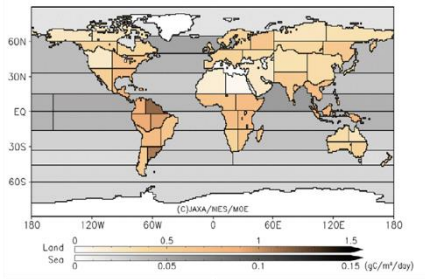
Level 4

CO_2 and CH_4 emissions and sinks

CO_2 flux (64 areas)



CH_4 flux (43 areas)

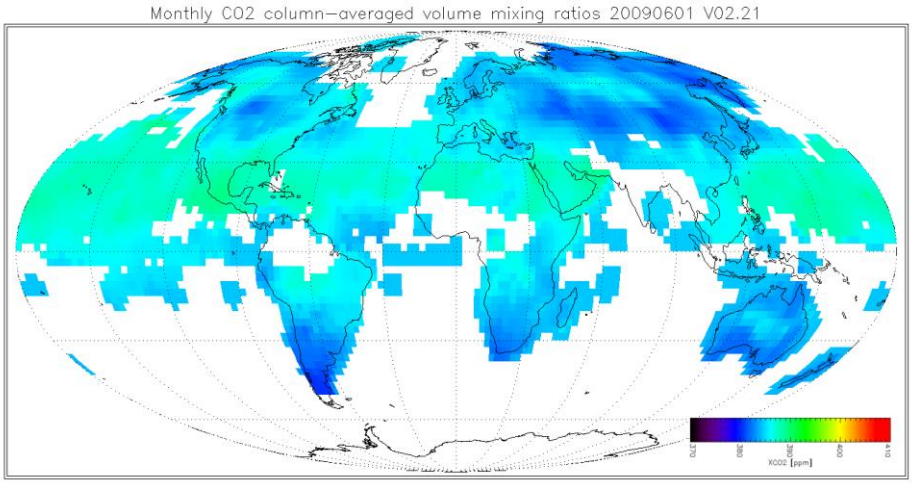


http://www.gosat.nies.go.jp/en/

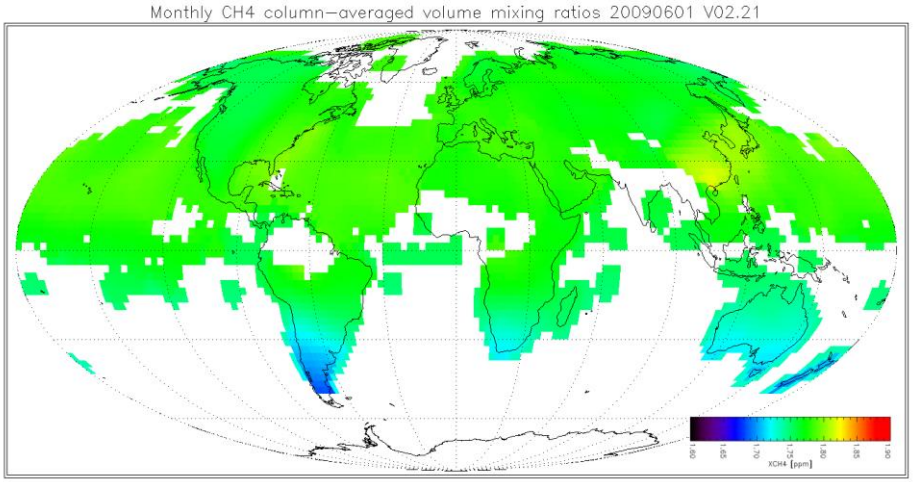
http://www.eorc.jaxa.jp/GOSAT/index.html

GOSAT CO_2 and CH_4 over 7.5 years

Monthly mean global CO_2 and CH_4 since 2009



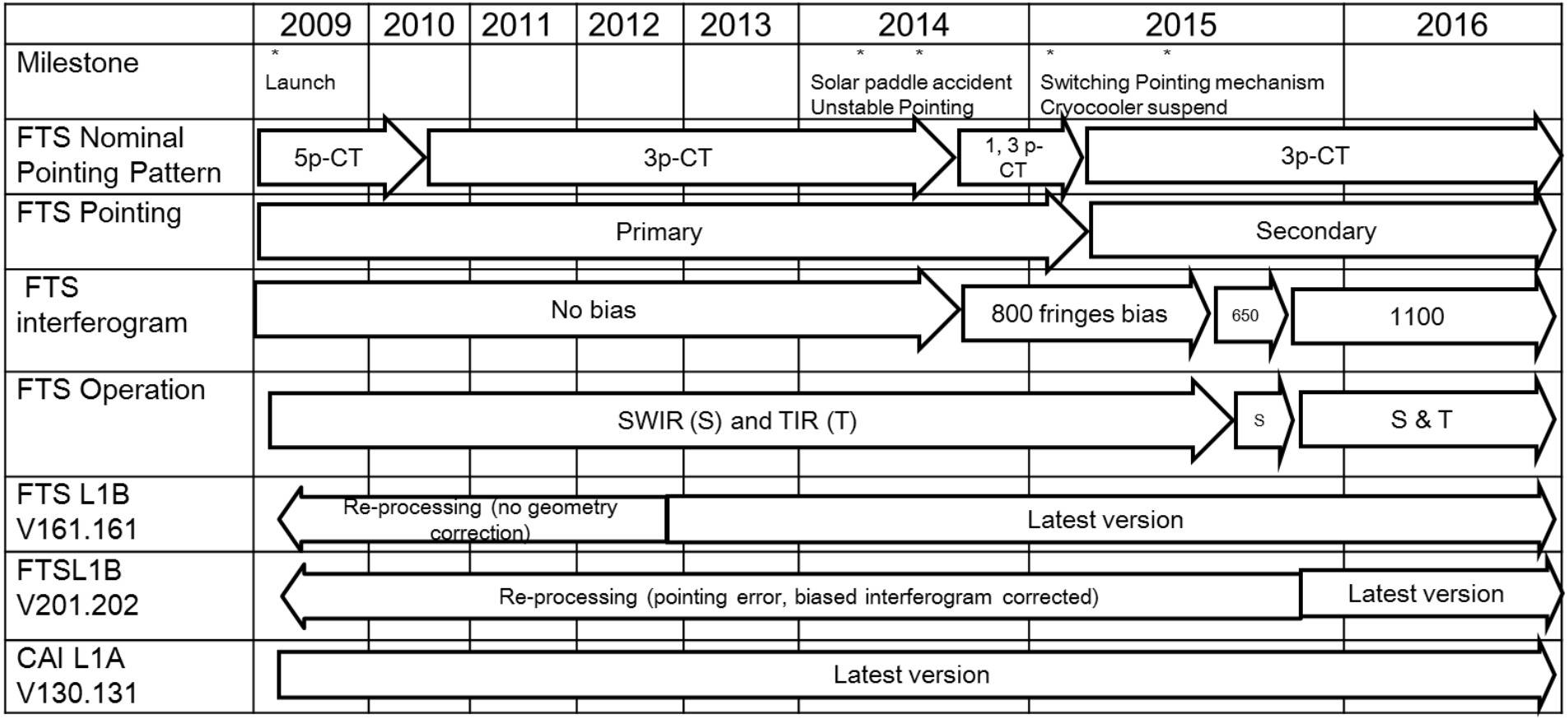
Global XCO_2 L3 map



Global XCH_4 L3 map

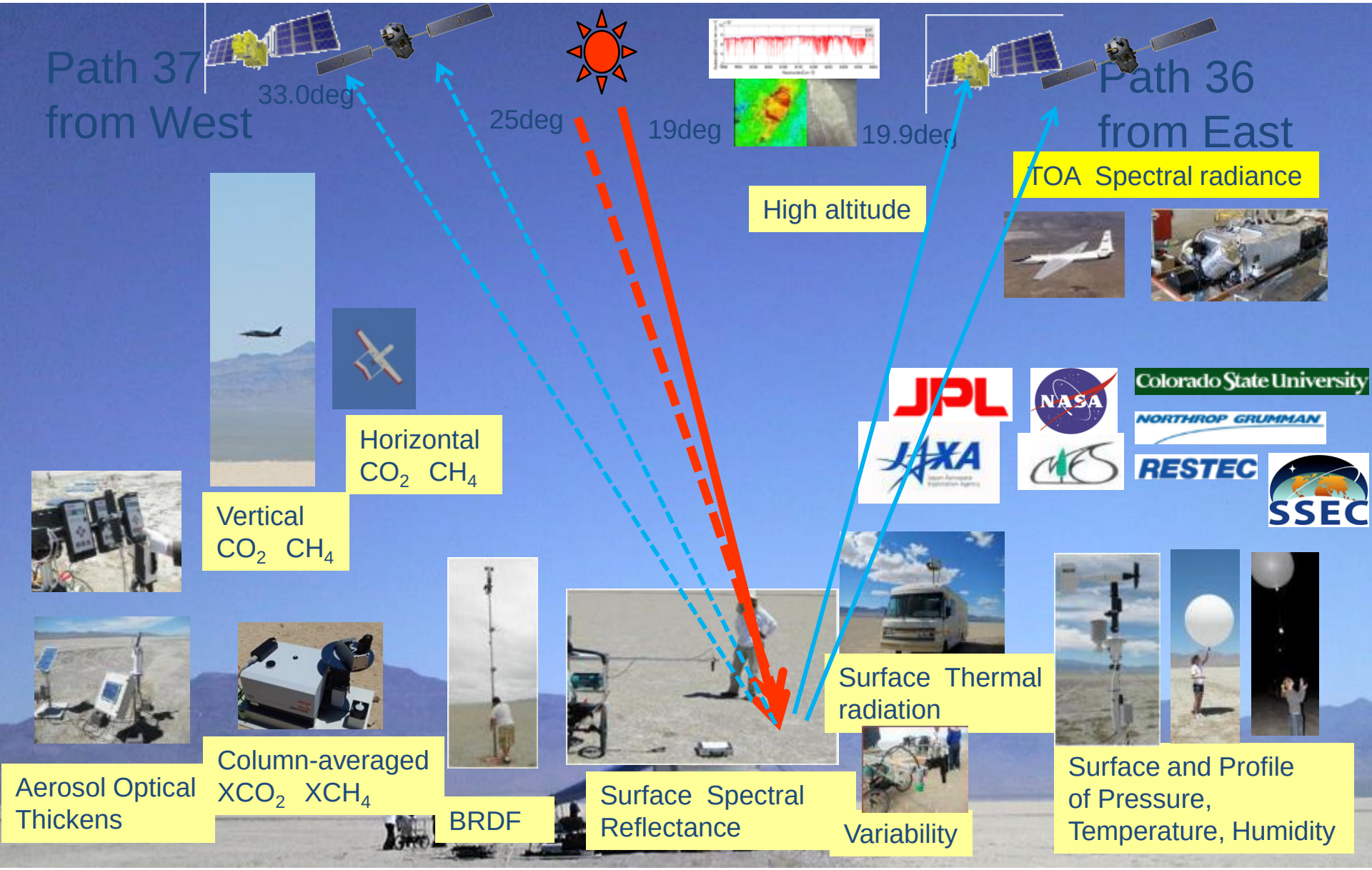
The typical accuracy of retrieved column-averaged dry air mole fractions of CO_2 and CH_4 are 2ppm or 0.5% and 13ppb or 0.7%, respectively.

GOSAT 7.5-year operation



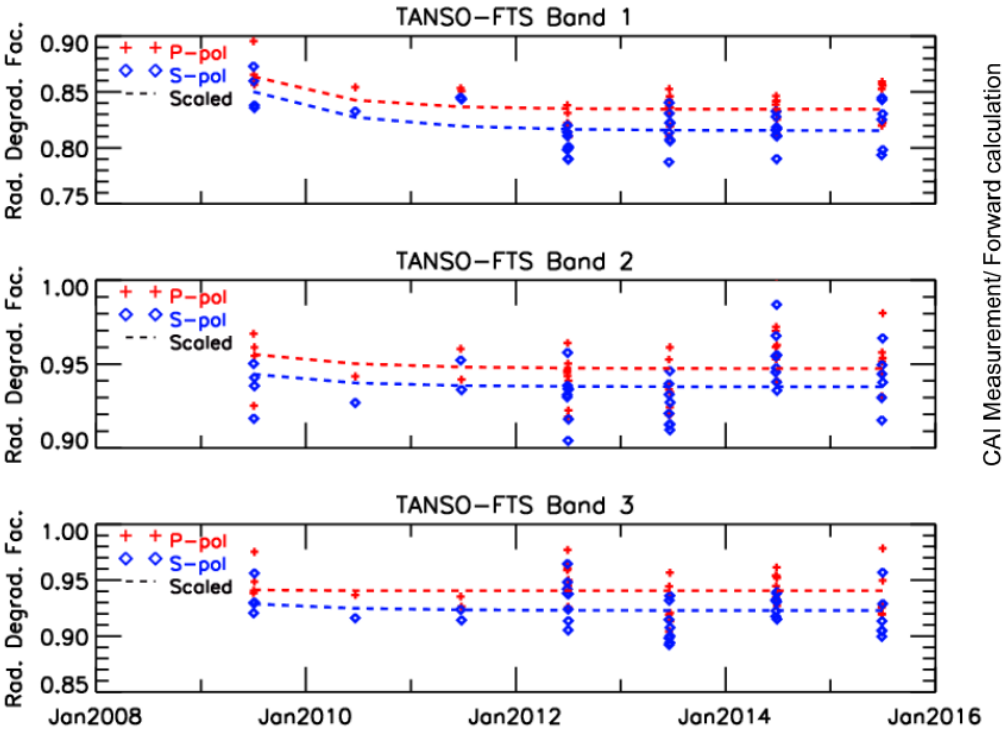
- GOSAT is currently full-operated FTS and CAI by single solar paddle power, redundant pointing mirror, and obtains center-biased double-side interferogram.
- FTS L1 v201.202 processing is improved that weighting function is applied to asymmetrical interferogram to become the same ILS and the same sampling over the whole term data.

Vicarious calibration campaign at RRV

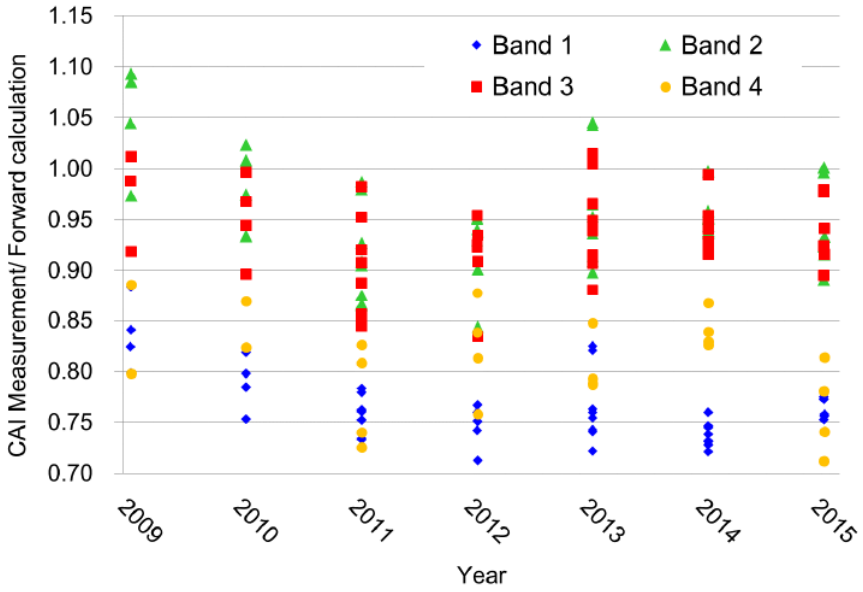


GOSAT radiance degradation

FTS radiance (0.76, 1.6. 2.0 um)



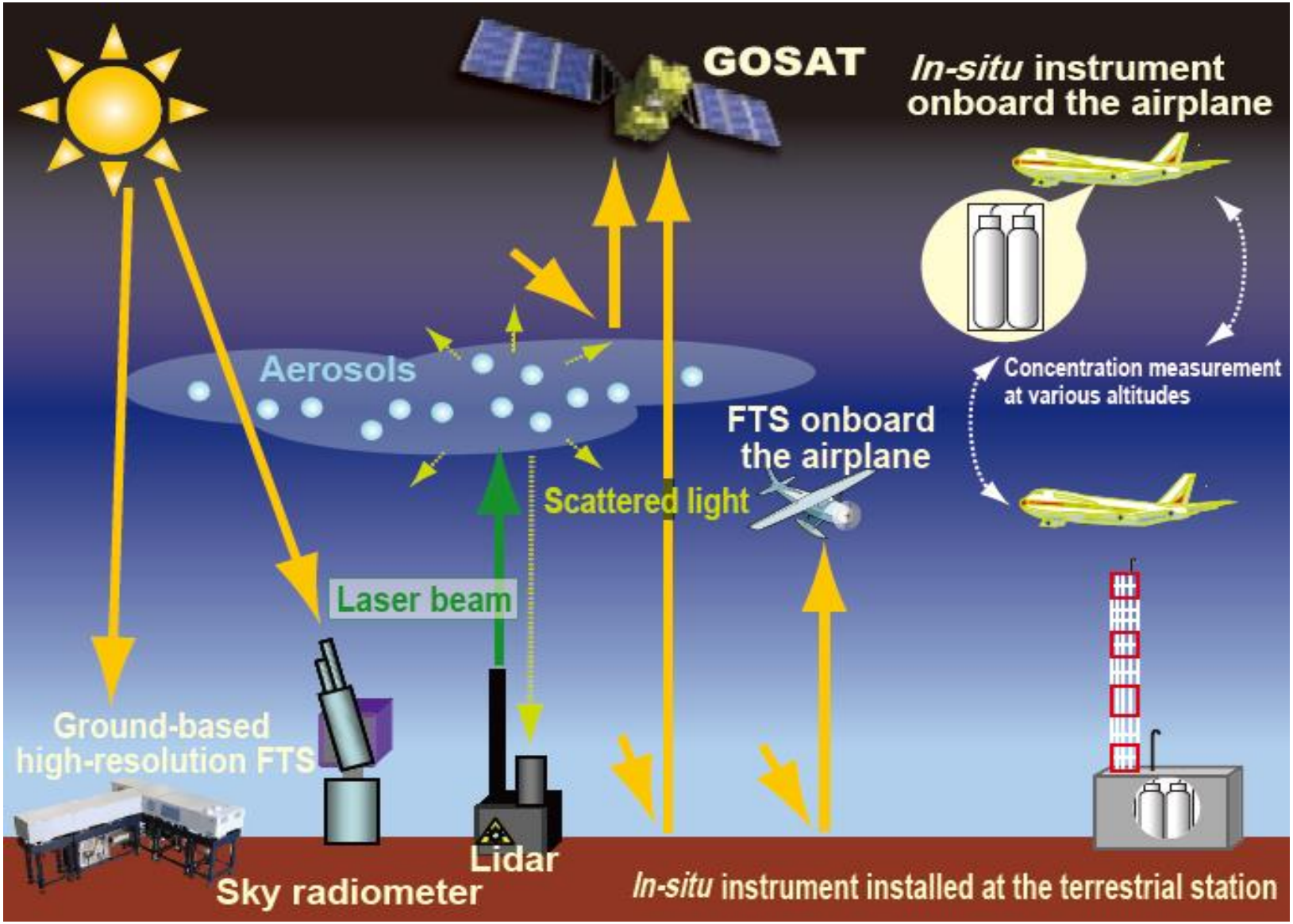
CAI radiance (0.38, 0.67, 0.87, 1.6 um)



- RDF for 6 years from seven annual vicarious calibration campaigns. The lines show the model derived from the onboard solar diffuser data.
- Latest FTS v201.202 records the best estimated radiance after degradation correction.

Kuze et al., AMT, 2016

GOSAT validation

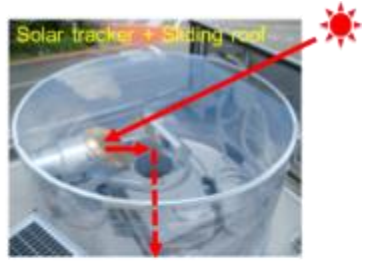


from NIES GOSAT Website

TCCON – XCO_2 and XCH_4 standards for space-based measurements

from TCCON and TCCON-wiki websites

TCCON sites (June-2013)



gbFTS@Saga

Group	Version	XCO_2		XCH_4	
		Bias[ppm]	STD[ppm]	Bias[ppb]	STD[ppb]
NIES-FP	v2.0	-1.5	2.1	-6	13
NIES-PPDF-DOAS	-	-0.43	1.8	-	-
ACOS	B3.5	0.1	1.7	-	-
RemoTeC-FP (bias correction)	v2.3.7	0.01	1.93	0.26	13.59
U-Leicester-Proxy	CH4 v4			4.80	13.44

NIES-FP: Yoshida et al., 2013, NIES-PPDF-DOAS: Oshchepkov et al.,2012, ACOS : Lindqvist et al., ACP, 2015,
KIT/SRON : ESA-CCI RemoTeC ATBD, 2015 Univ. Leicester: Parker, AMT, 2015

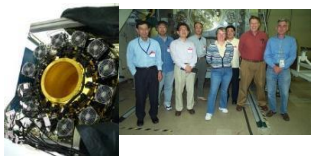
- For long-term consistency, comparison of seasonal and annual trend around TCCON sites is performed in the recent papers. (Lindqvist, ACP, 2015 etc.)

Inter-comparison between GOSAT and OCO-2

2008 2009 2010 2011 2012 2013 2014 2015 2016

Radiometric calibration

Prelaunch X-CAL



Annual Vicarious Calibration at the desert playa in Nevada

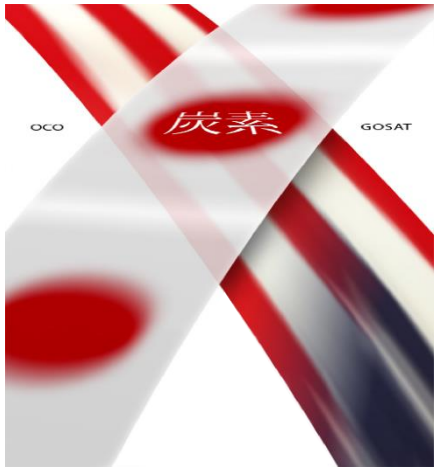
CO_2 & CH_4 profile

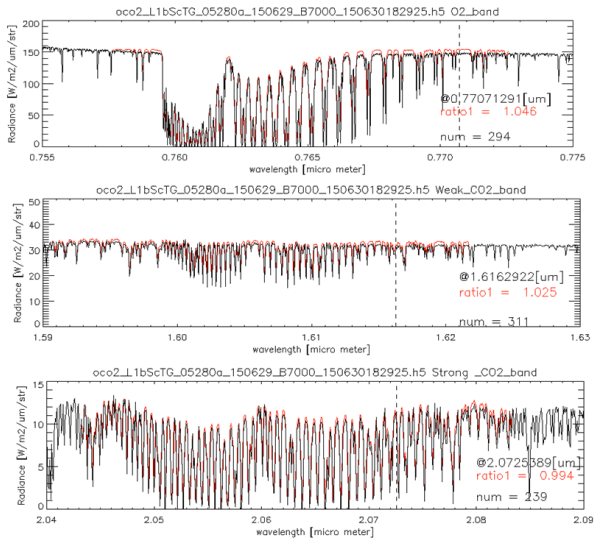
In situ CO_2 and CH_4 on AJAX

XCO_2 & XCH_4

Column with EM-27 FTS

Coincident Target





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

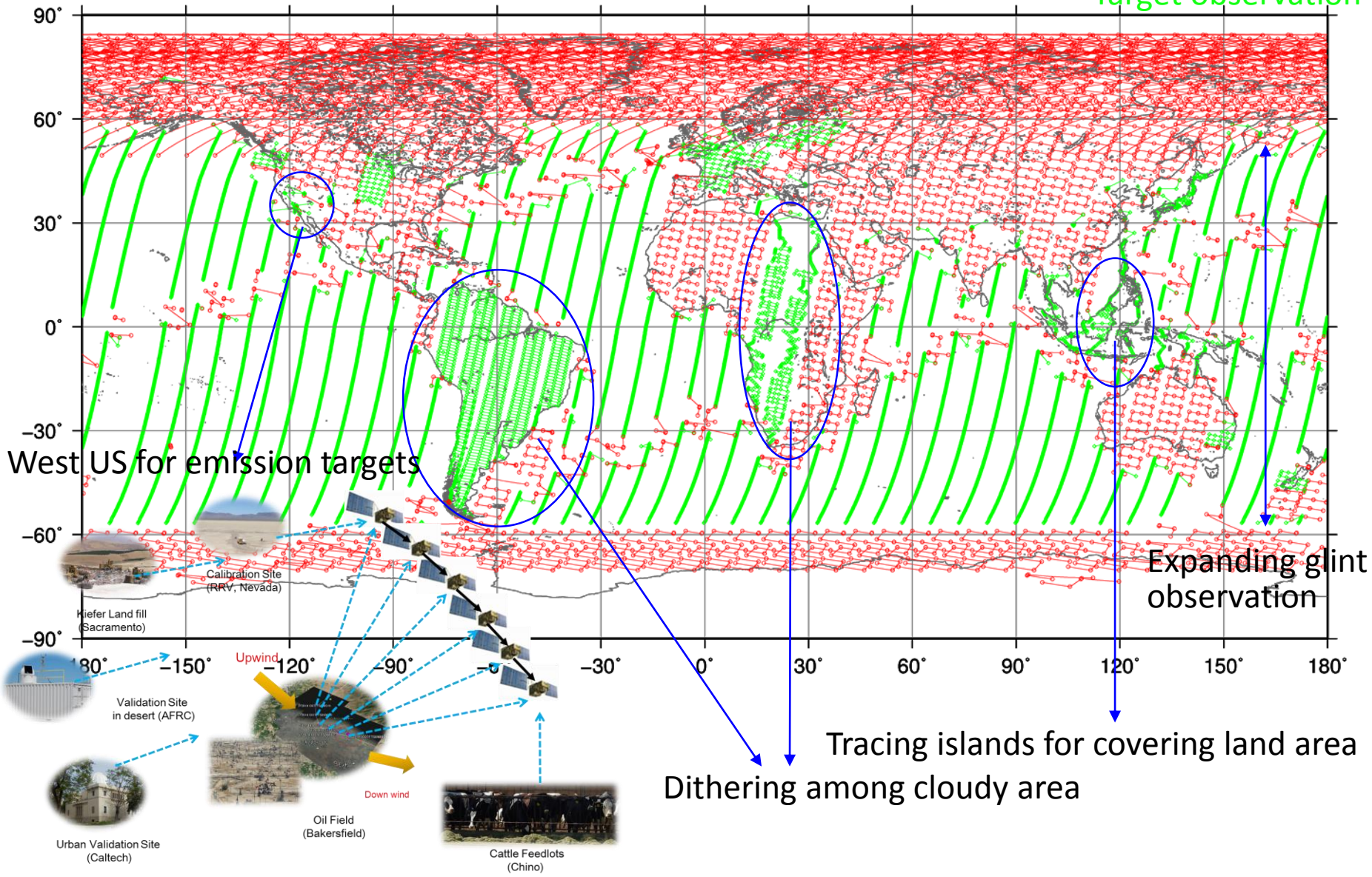
Retreived XCO_2 bias is much less than 0.5ppm over match up observations points.

Retrieved Parameter Comparison over match up points (>200)

Optimization of observation points

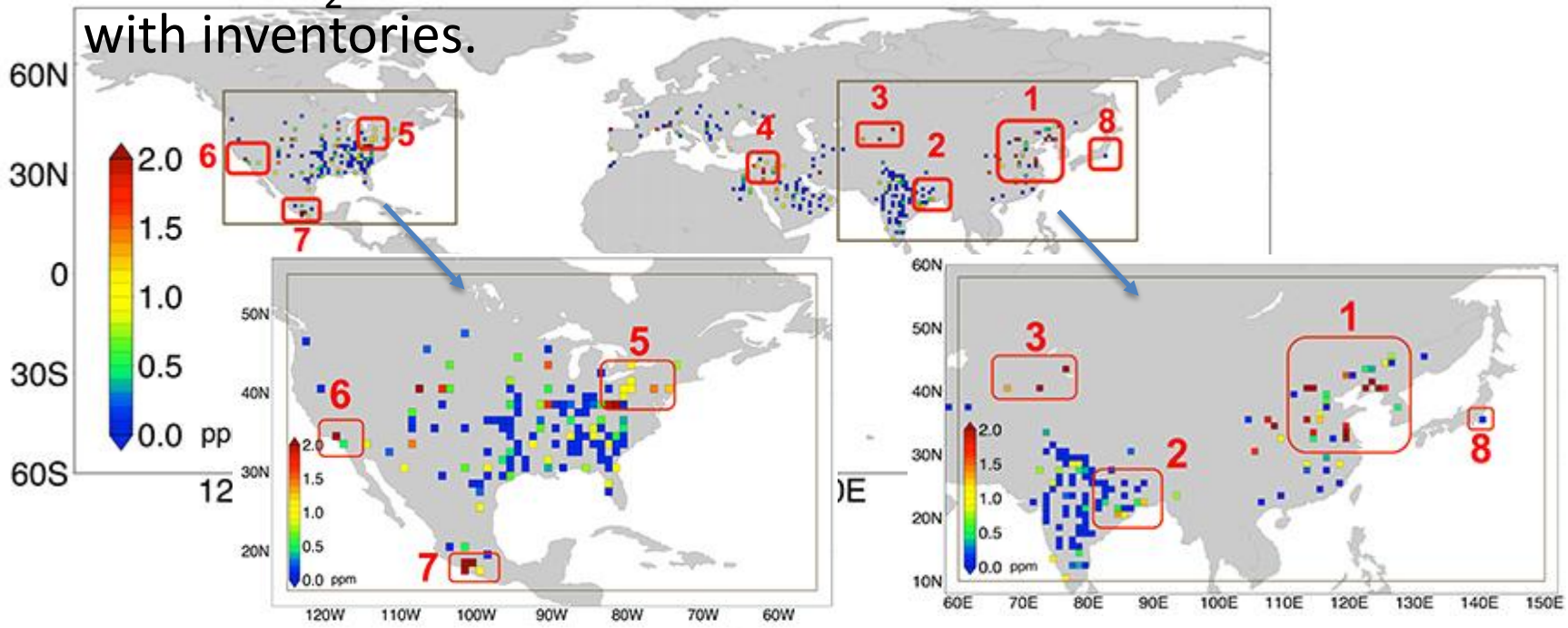
FTS observation in June 22-24, 2016

Grid observation
Target observation



GOSAT result – Anthropogenic CO_2 detection

GOSAT CO_2 observations are more enhanced than model data with inventories.



Area No.	Country / City	Max. anthropogenic CO_2
1	China / Zhangjiakou, Anshan, Harbin, Tianjin	6.2 ppm
2	India / Kolkata	2.1 ppm
3	Uzbekistan etc.	2.8 ppm
4	North Saudi Arabia, Jordan	2.1 ppm
5	US / Pittsburgh	2.1 ppm
6	US / Los Angels	3.5 ppm (1x1deg,
7	Mexico / Acapulco	2.7 ppm Jun2009-
8	Japan / Tokyo	0.5 ppm Dec2014)

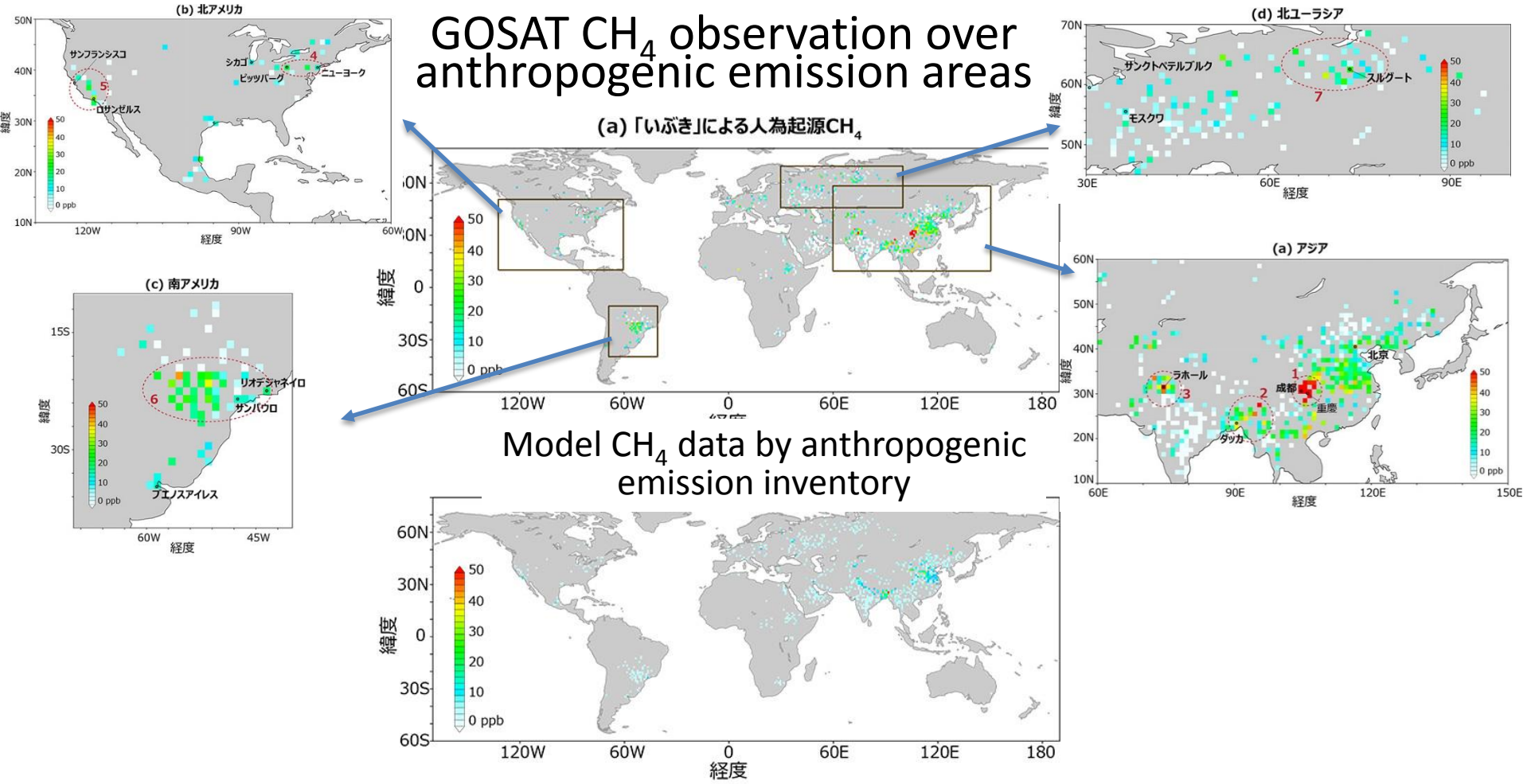
Large cities, oil fields have more emissions than a priori inventory*.

*Power plant, fossil fuel from ODIAC/CARMA
*Biomass burning from GFAS V1.2

GOSAT press release (Sep-01, 2016)

GOSAT result – Anthropogenic CH_4 detection

GOSAT CH_4 observation over anthropogenic emission areas



Model CH_4 data by anthropogenic emission inventory

GOSAT CH_4 observation at anthropogenic emission areas such as large cities, agriculture, livestock, energy development shows higher event than the a priori inventory data*.

*EDGAR v.4.2 FT2010

GOSAT press release (Nov-27, 2015)

Summary

(1) GOSAT operation
- Successful fully operation of FTS and CAI over 7.5 years since 2009

(2) GOSAT products
- Latest FTS L1 V201.202 and CAI L1 V130.131 are available in whole observation term.
- L2 XCO2 and XCH4 v02.xx are available for the previous L1 V161.161. L2 processing for L1 V201.202 has just started.
- L3 and L4 are also available corresponding to the latest L2.
- GOSAT L2 are also produced by other organization algorithms (ACOS, RemoTec, Leicester, Bremen, Yonsei etc.)

(3) Calibration, validation and inter-comparison with OCO-2
- Railroad valley campaign collaboration with OCO-2
- XCO2 and XCH4 validation with TCCON data
- Inter-comparison of GOSAT and OCO-2 in spectra and XCO2

(4) Observation points optimized by target observation
- Emission target in west US, Dithering in Amazon and Africa, Expanding sunglint observation

GHG coordination

CGMS-44:

- CMA, JAXA, and NASA reports on satellite CO_2 observation
- Recommendation of CGMS-CEOS cooperation for contribution to WMO Vision for WIGOS 2040

2016 CEOS SIT Technical WS:

- CEOS-CGMS CO_2 coordination – confirm at Plenary to write to CGMS noting AC-VC efforts and invitation to augment

- AC-VC might coordinates with CGMS in currently planned Carbon Workshop etc, not making new working group.
- Accuracy improvement is important for follow-on GHG mission progress and continuous GHG observation. GHG cal/val activities will be promoted by CEOS AC-VC and WGCV collaboration framework.

Backup

GOSAT FTS products release history

Oct. 2009	Level 1 (Observation spectra) to public
Feb. 2010	Level 2 (SWIR X_{CO2} and X_{CH4}: column averaged dry air mole fraction, v00.**) to public
Aug. 2010	Level 2 (SWIR X_{CO2} and X_{CH4}, v01.**) to public
Nov. 2010	Level 3 (SWIR X_{CO2} and X_{CH4} spatially interpolated global distribution in monthly mean) to public
Mar. 2012	Level 2 (TIR CO_2 and CH_4 density profiles) to public
Jun. 2012	Level 2 (SWIR X_{CO2} and X_{CH4}, v02.**) to public
Dec. 2012	Level 4A (CO_2 flux estimation) and Level 4B (Simulated CO_2 3-D distribution) to public.

L1 version-up many times… 1 or 2 per year

Jun. 2012	Level 2 X_{CO2} and X_{CH4} v02.** release
May 2013	Level 1 v16*.160 release
Mar. 2014	Level 4A (CH_4 flux estimation) and Level 4B (Simulated CH_4 3-D distribution) to GOSAT RA PIs (to public in this summer).
Jul. 2015	Level 1 v200.xxx release
Mar. 2016	Level 1 v201.202 release (latest version)