COP21 Japan Side Event
"Global Carbon Monitoring – Towards Modeling, Projection and Policy Decision"
Japan Pavilion, Paris, France, 15:15-16:45, 4 December 2015

Space-borne Atmospheric GHG Monitoring Project in Japan

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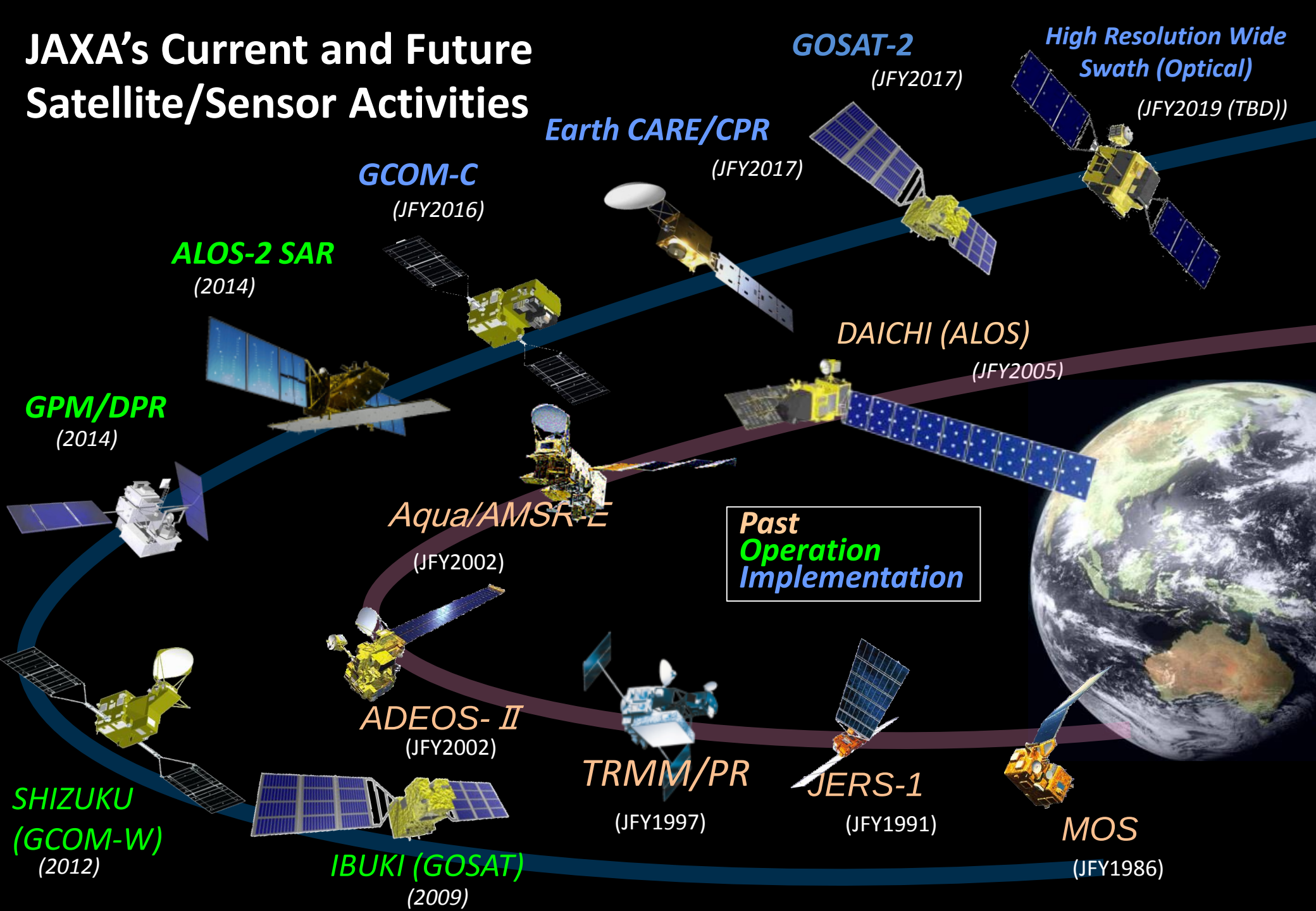
JAXA's Current and Future Satellite/Sensor Activities

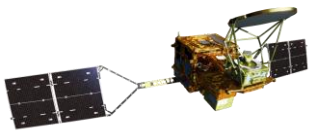


JAXA satellite programs

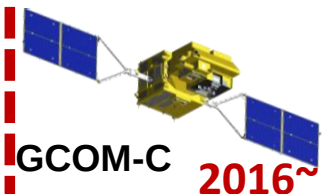
2003 (JAXA established)

Earth Observation

Climate Change/Water



Aerosol

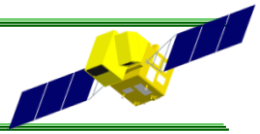


GHG, Aerosol

Global Warming

Land Use

Disaster Monitoring



Next Gene.
(optical)

Communications

COMETS **DRTS** **WINDS**

Technology Development

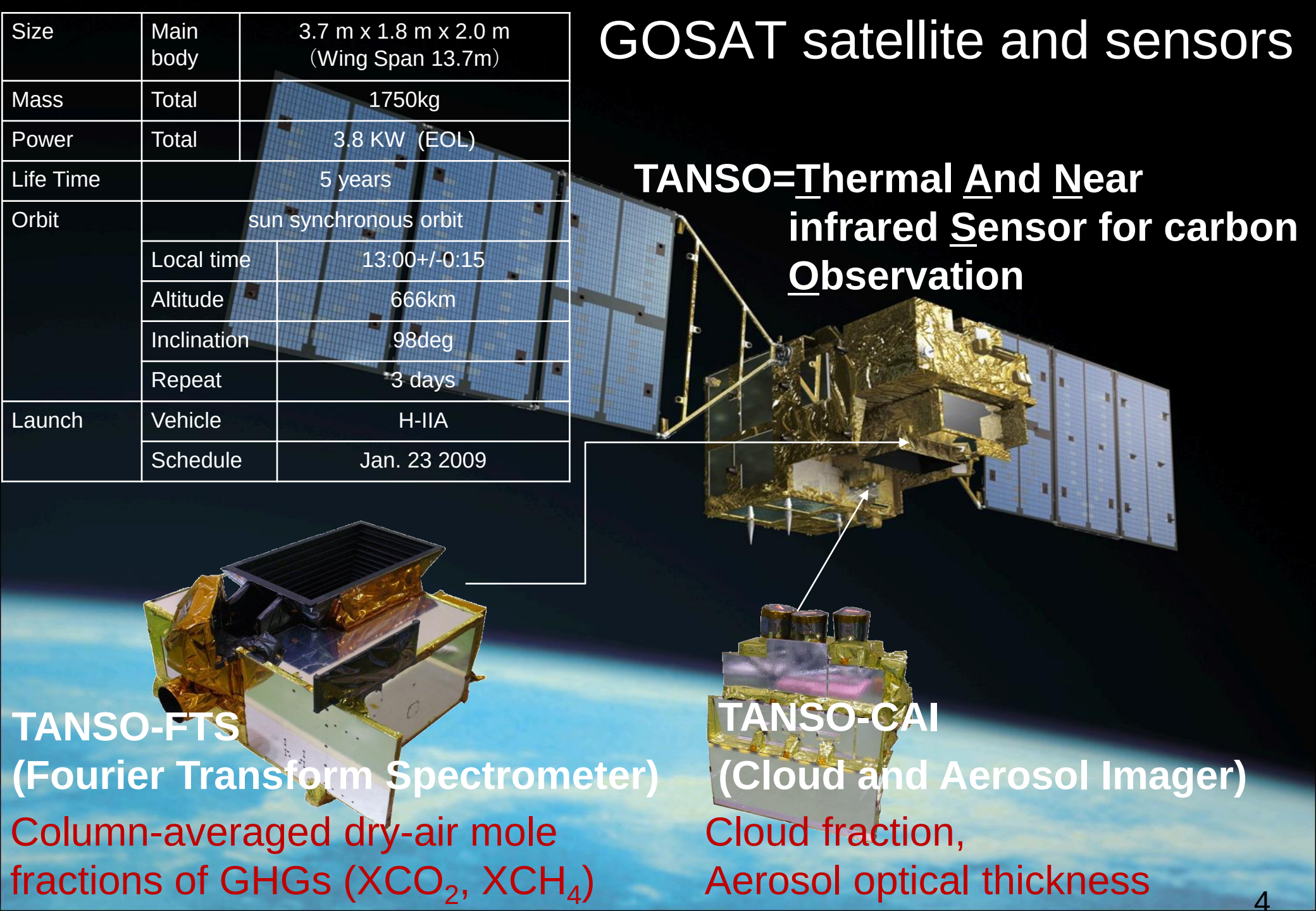
Positioning **QZSS**

ETS-Ⅵ **ETS-Ⅶ** **OICETS** **ETS-Ⅷ**

GOSAT satellite and sensors

Size	Main body	3.7 m x 1.8 m x 2.0 m (Wing Span 13.7m)
Mass	Total	1750kg
Power	Total	3.8 KW (EOL)
Life Time	5 years	
Orbit	sun synchronous orbit	
	Local time	13:00+/-0:15
	Altitude	666km
	Inclination	98deg
	Repeat	3 days
Launch	Vehicle	H-IIA
	Schedule	Jan. 23 2009

TANSO=Thermal And Near infrared Sensor for carbon Observation



TANSO-FTS
(Fourier Transform Spectrometer)

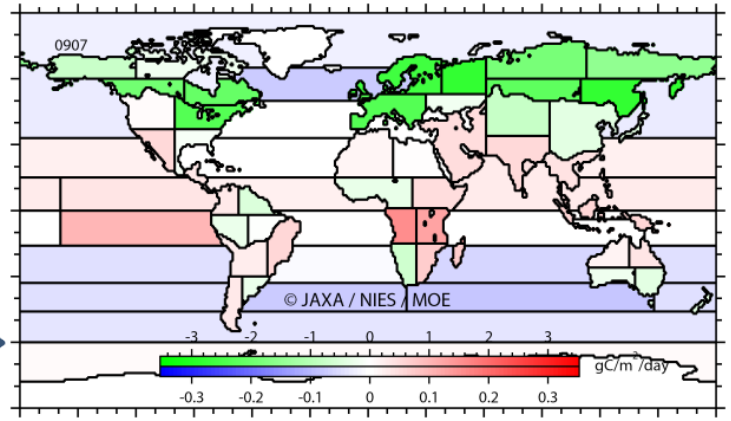
Column-averaged dry-air mole fractions of GHGs (XCO_2, XCH_4)

TANSO-CAI
(Cloud and Aerosol Imager)

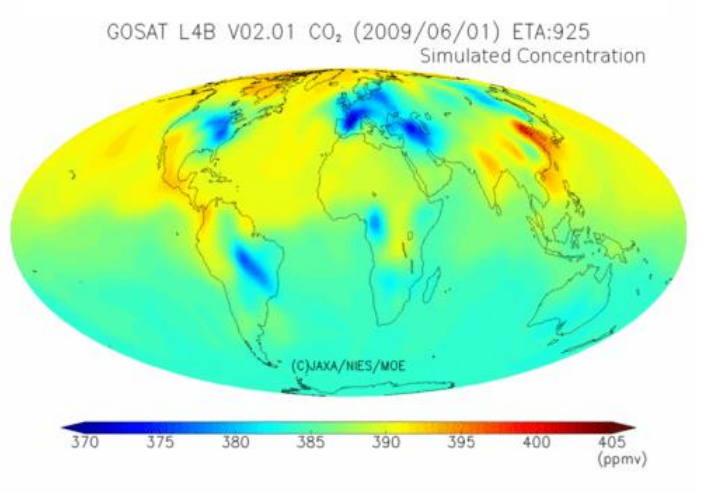
Cloud fraction,
Aerosol optical thickness

How do we use GHG satellite data?

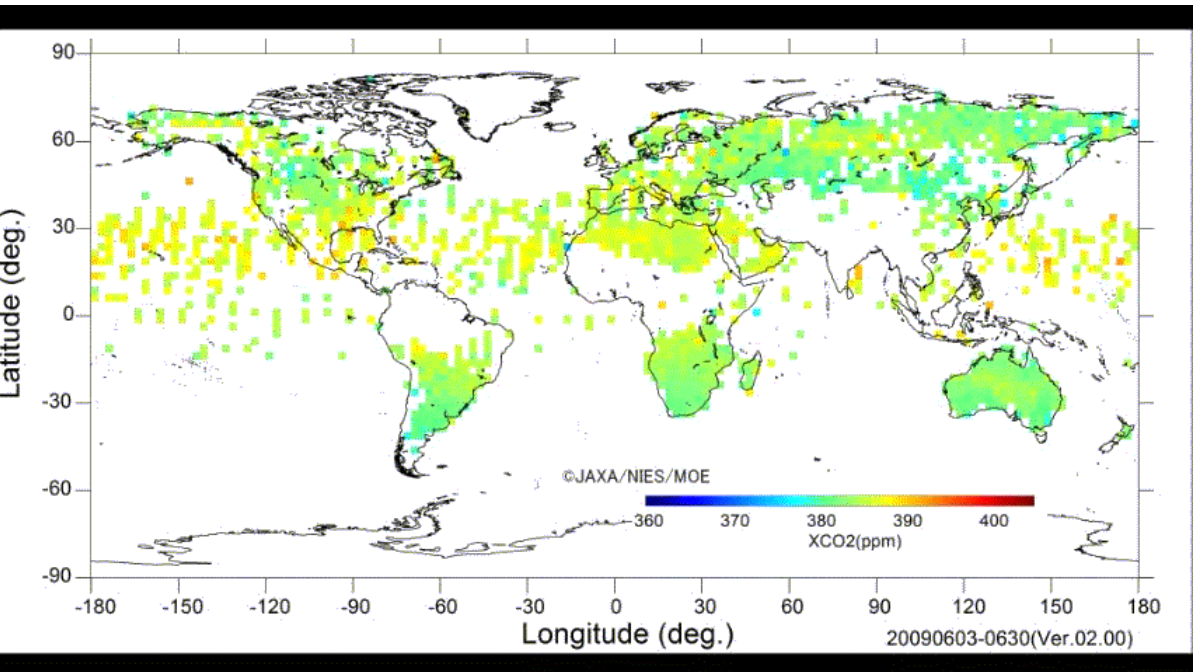
Flux estimation



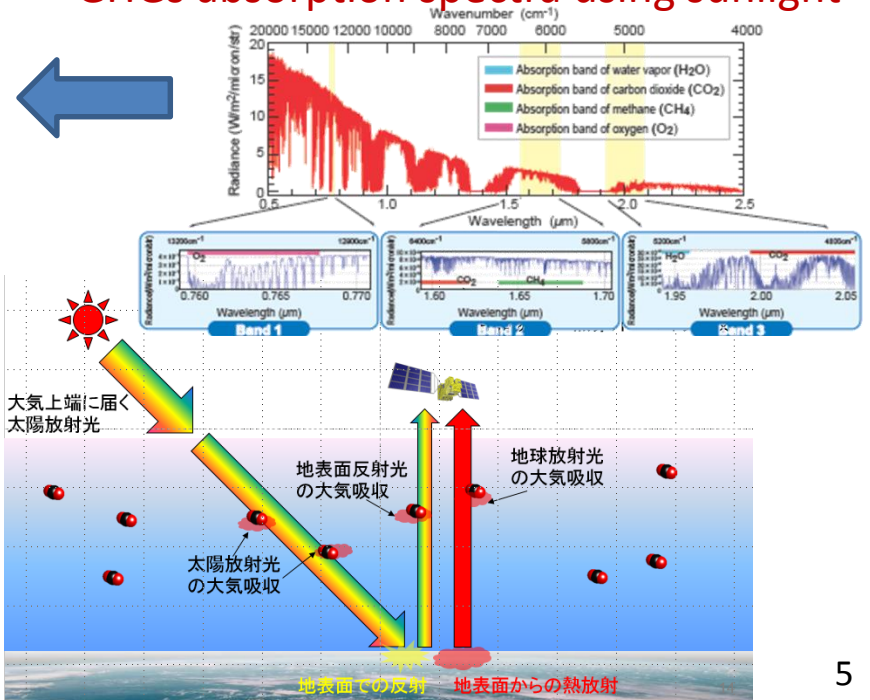
GHGs model calculation



Column-averaged dry-air mole fractions of GHGs (XCO_2, XCH_4)



GHGs absorption spectra using sunlight



Methane remote-sensing observation referred in AR5

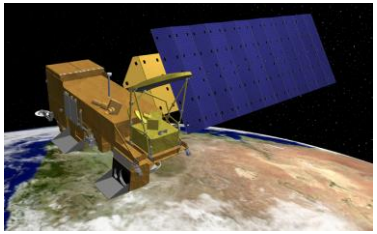
Column-averaged CH_4 with SWIR

SCIAMACHY / Envisat (2003-2012)

TANSO / GOSAT (since 2009)

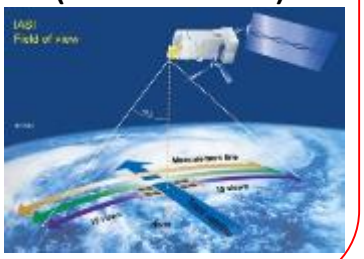
Mid/Upper-tropospheric CH_4 with TIR

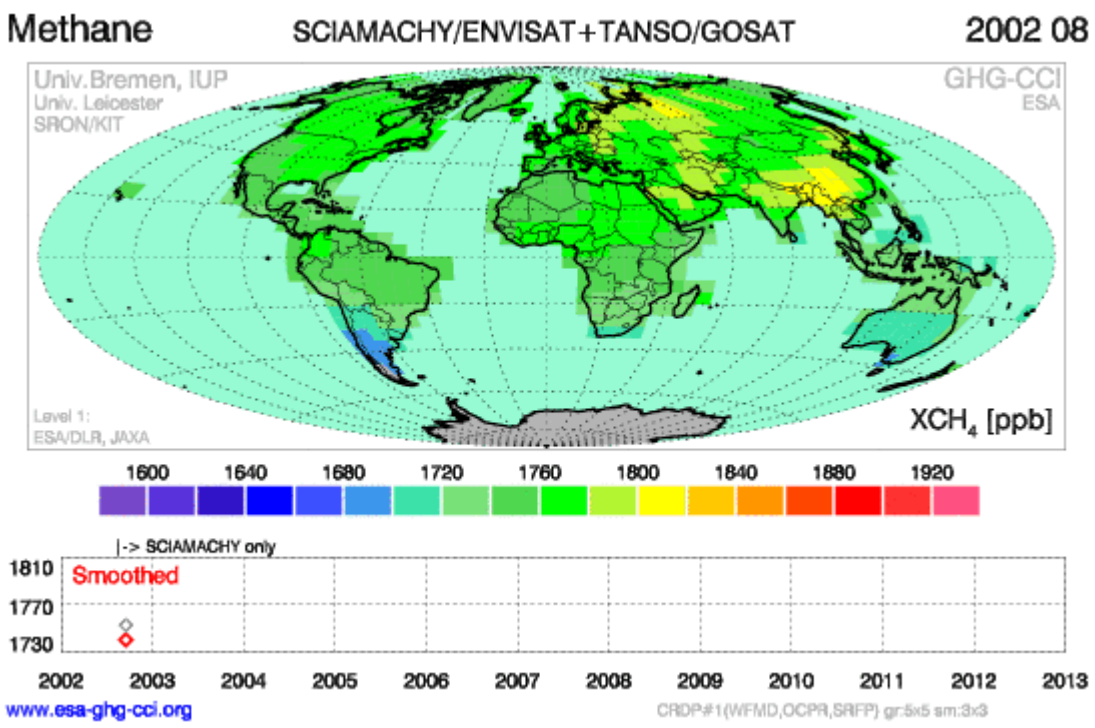
AIRS / Aqua (since 2002)



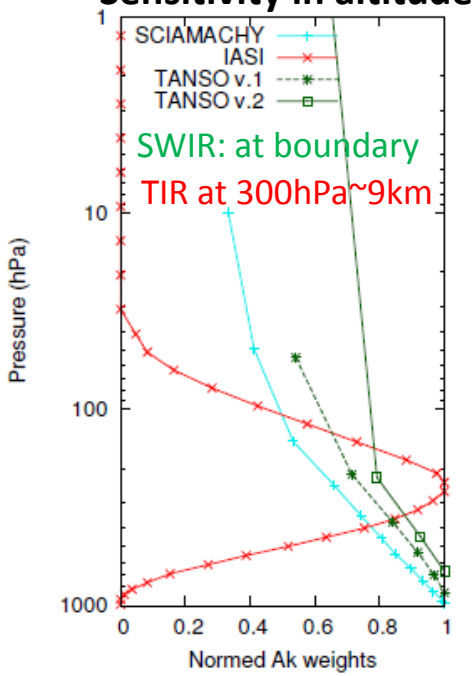
TES / Aura (since 2004)

IASI / Metop (since 2006)





Sensitivity in altitude

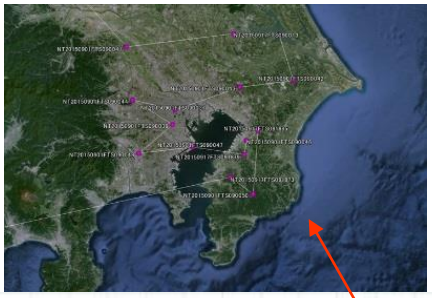


Column-averaged CH_4 with SWIR by ground-based FTS

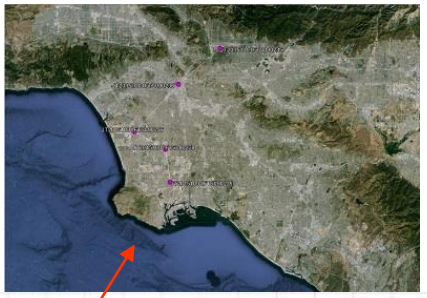
TCCON (since 2004)

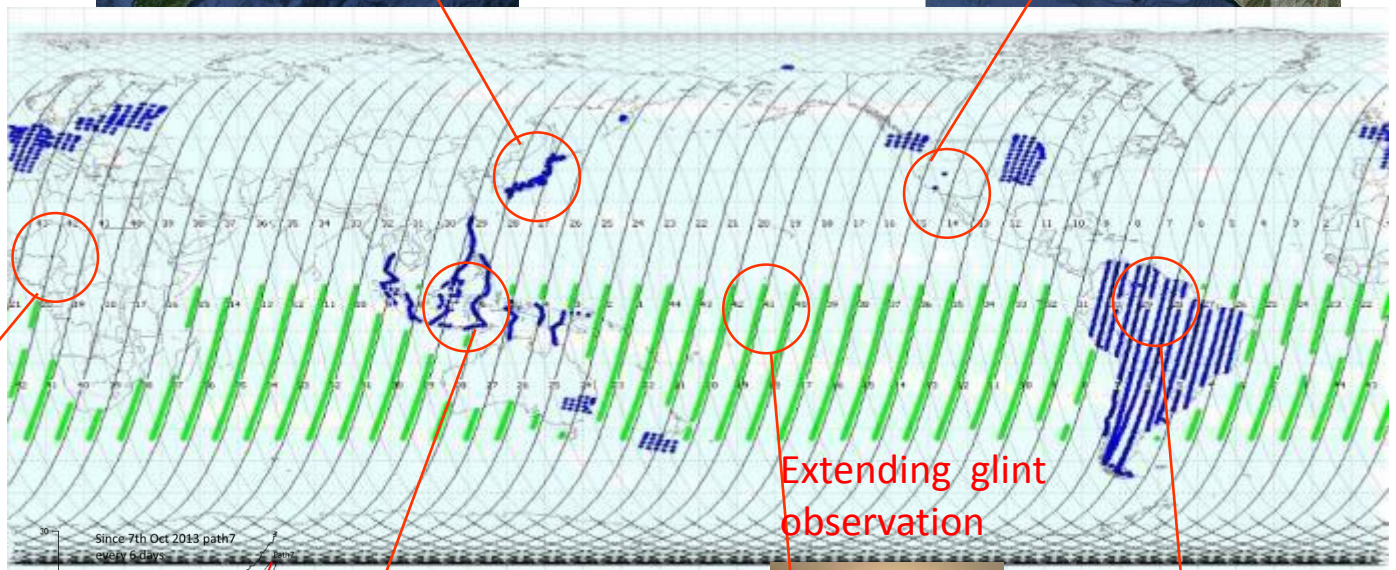
Massart et al, ACP, 2014.

Challenge to optimize observation strategy

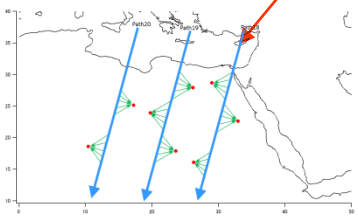


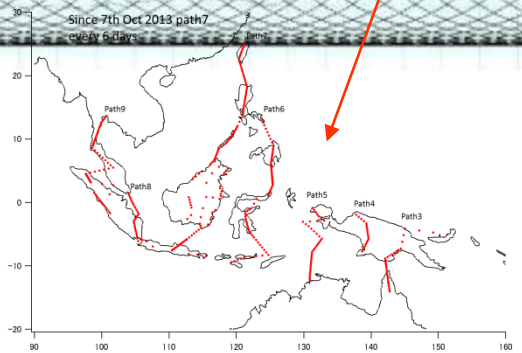
Mega-city target





Multi-angle





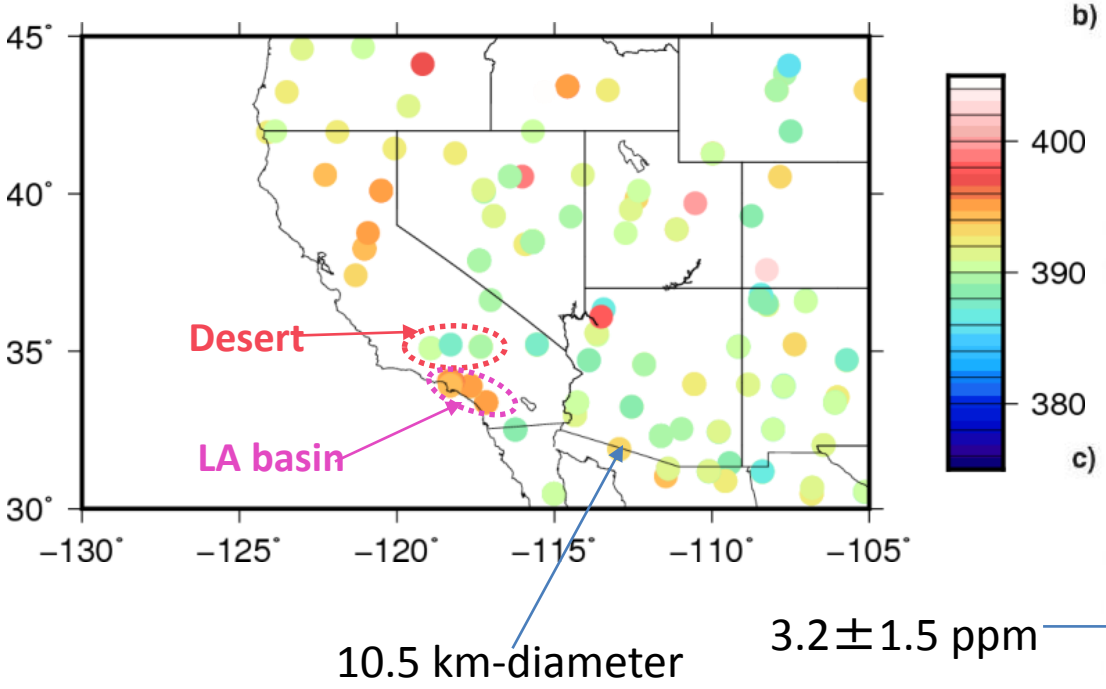
Island trace

Extending glint observation

dithering

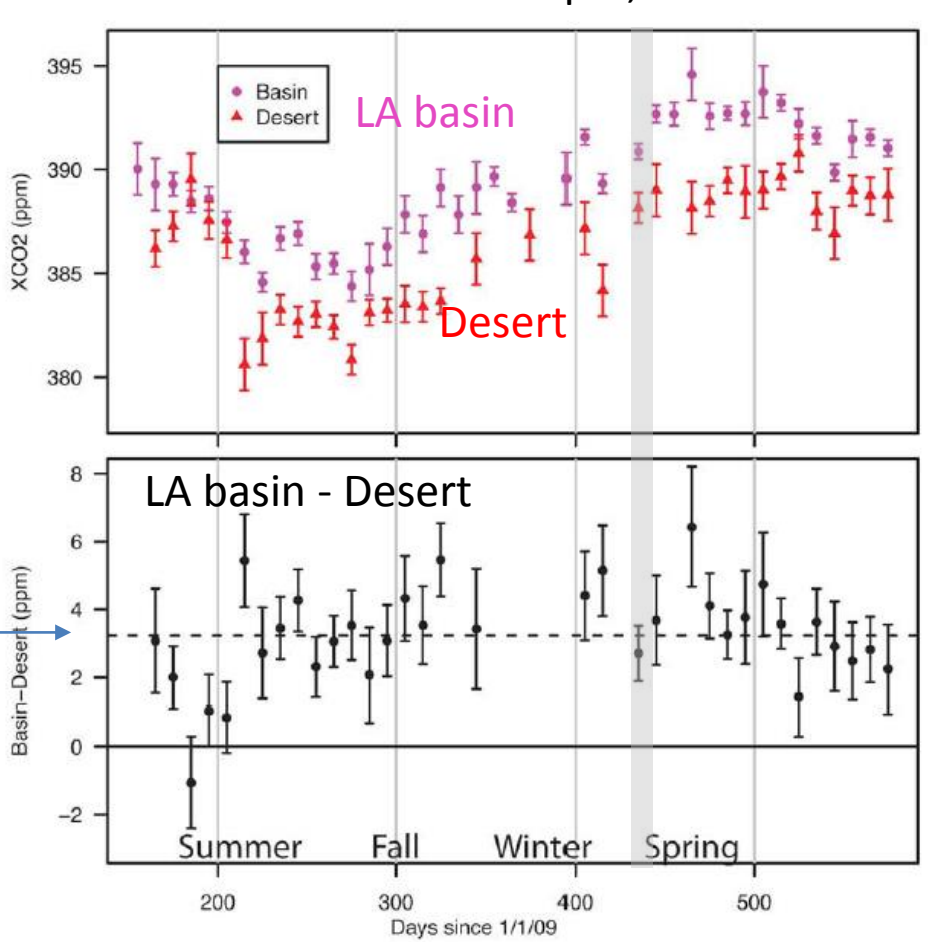
GOSAT detected mega-city CO_2 enhancement in Los Angels basin

GOSAT XCO2 in April, 2010



3.2±1.5 ppm

April, 2010



GOSAT observation uncertainty of XCO2 is currently ~ 2 ppm.
The detected enhancement in the LA basin was 3.2 ppm,
that was higher than the observation uncertainty.

Kort et al., GRL, 2012

GOSAT suggested underestimation of US CH_4 emission inventory

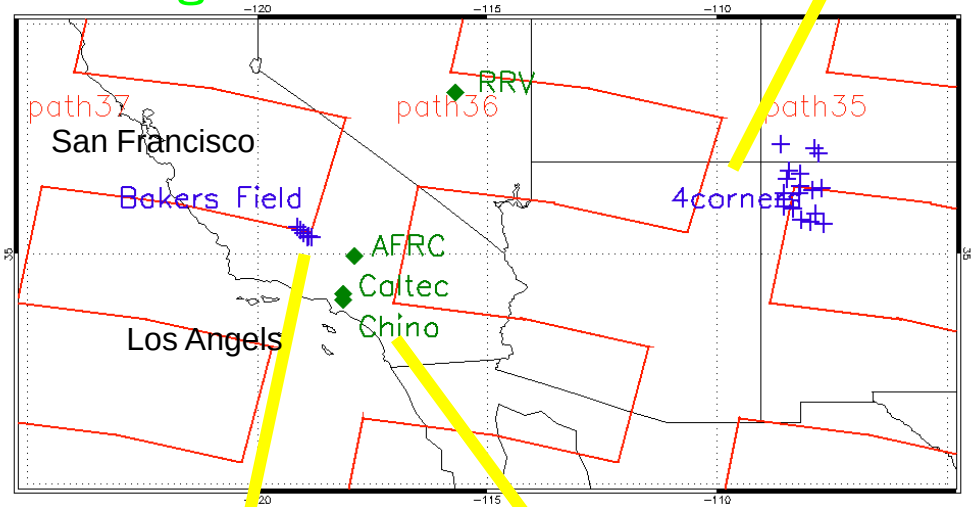
Four Corners – Power Plant

Extended operation phase

Grid observation –>

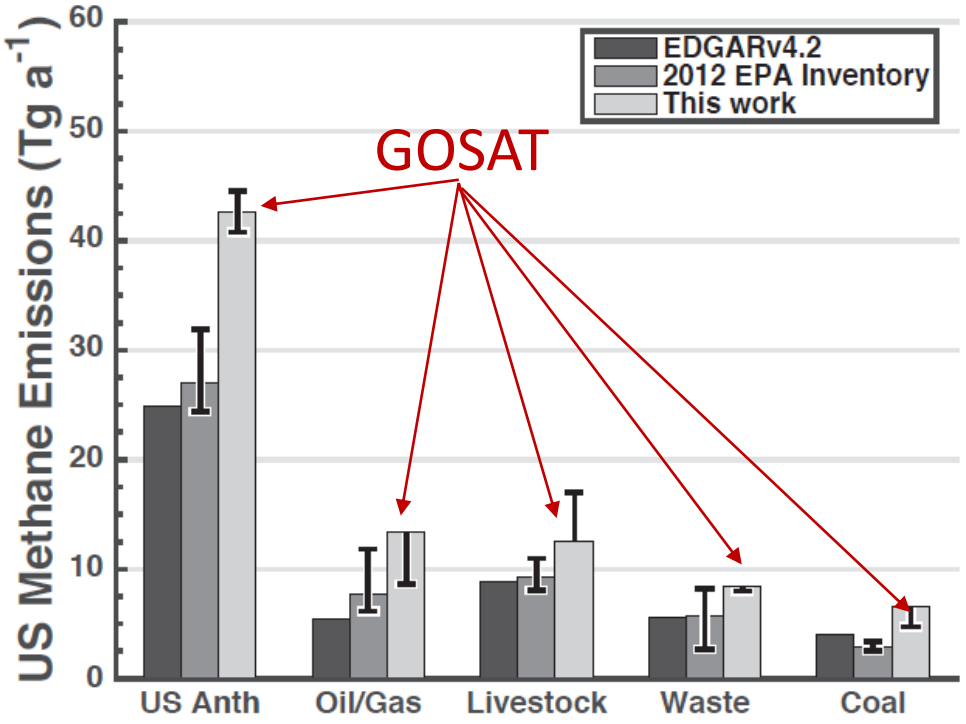
Target observation

Target observation



Bakers Field - Oil Field near LA

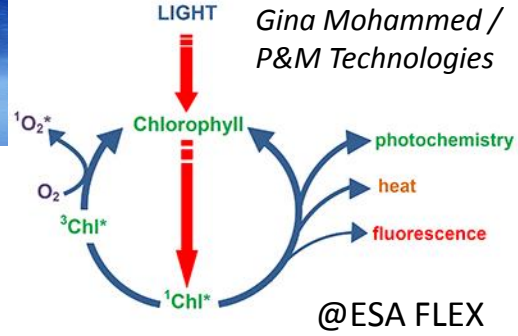
Chino - Livestock Field near LA



US CH_4 emission inventory by EPA is underestimated than GOSAT observation.

Turner et al., ACP, 2015

Ecosystem carbon exchange



Gina Mohammed / P&M Technologies

@ESA FLEX

Chlorophyll fluorescence from GOSAT

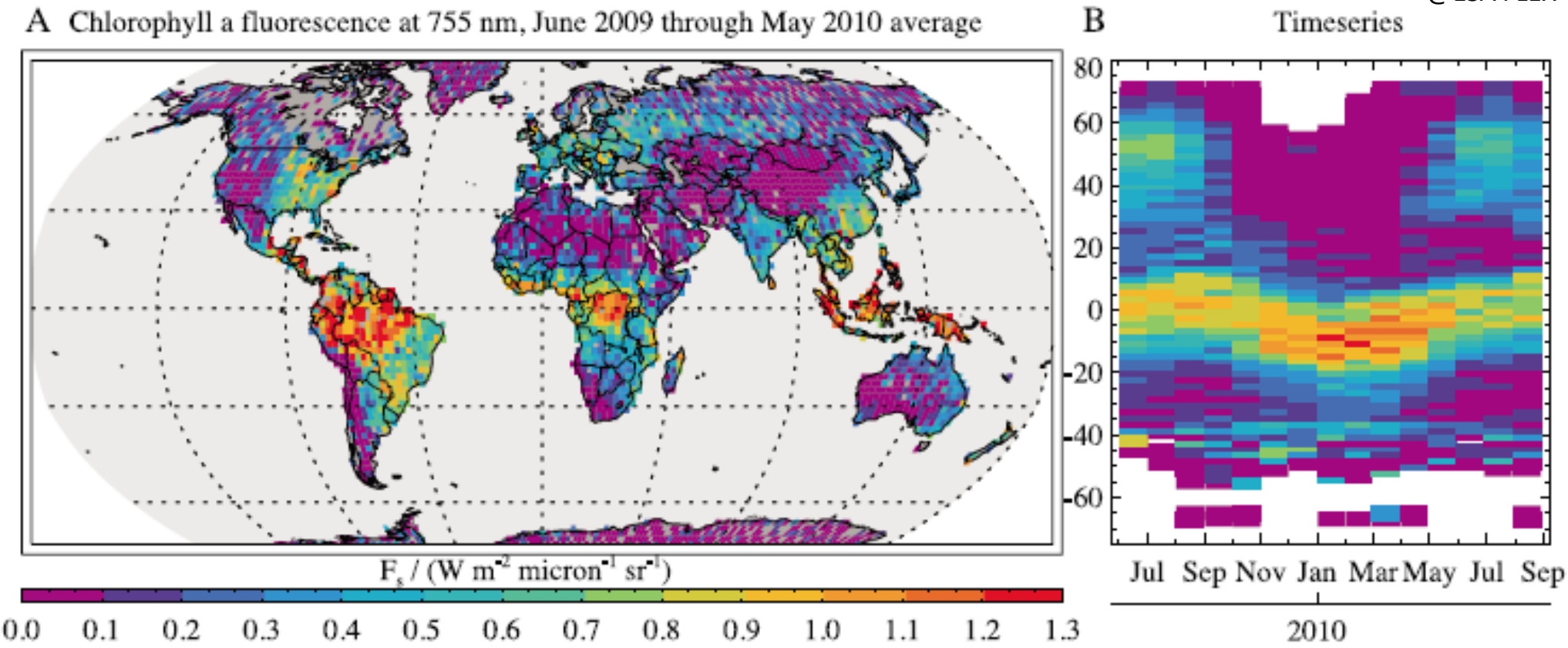


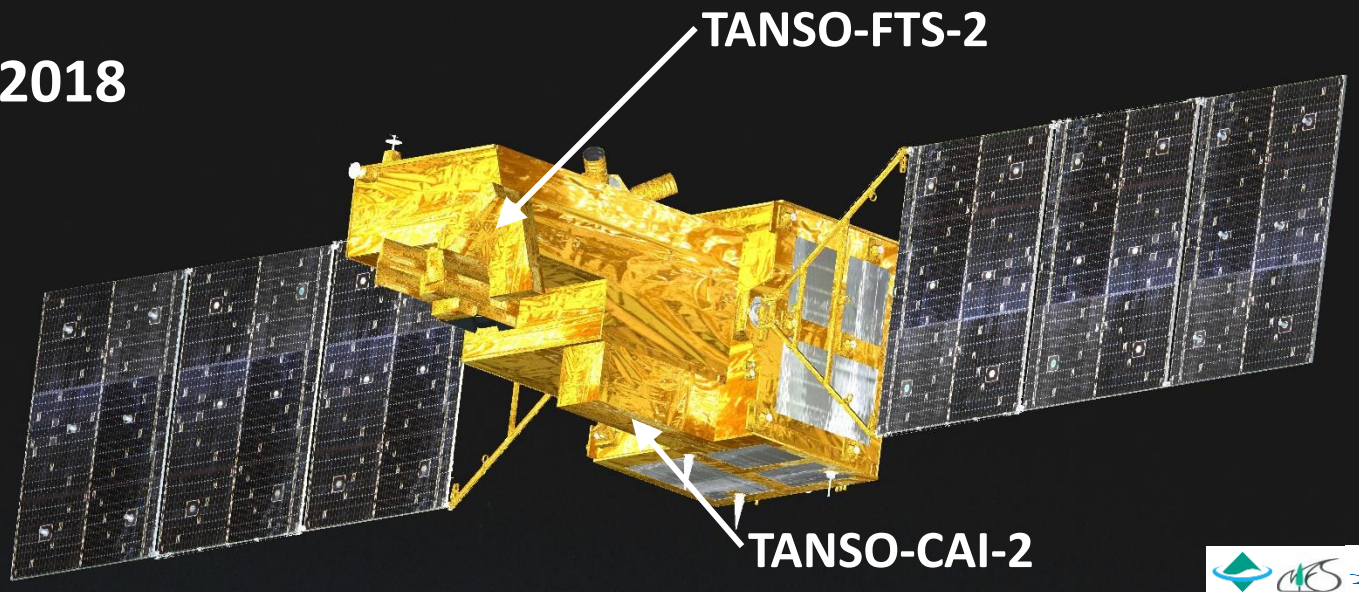
Figure 1. (a) Annual average (June 2009 through May 2010) of retrieved chlorophyll-a fluorescence at 755 nm on a 2° × 2° grid. Only grid-boxes with more than 15 soundings constituting the average are displayed. (b) Latitudinal monthly averages of chlorophyll fluorescence from June 2009 through end of August 2010.

Chlorophyll fluorescence has a potential to place constrain on Gross Primary Production (GPP).

Frankenberg et al., GRL, 2011

GOSAT-2: Successive greenhouse gas observation

Launch in early 2018 (JFY2017)



Upgrade in GOSAT-2 mission		GOSAT achievement	GOSAT target
Measurement precision	0.5 ppm for CO_2 (monthly ave.) 5 ppb for CH_4 (monthly ave.)	←2ppm for CO_2 ←12ppb for CH_4	←4 ppm for CO_2 ←32 ppb for CH_4
Flux estimation	1000km for land	←2000km in sub-continental scale	
Anthropogenic emission	CO to distinguish emission source		
Ecosystem carbon exchange	Chlorophyll fluorescence to place constrains on GPP		
Aerosol monitoring	Aerosol size distribution and its property		

Anthropogenic emission source CO_2 related to CO

Adding CO band to GOSAT-2

GOSAT CO_2 and MOPITT CO

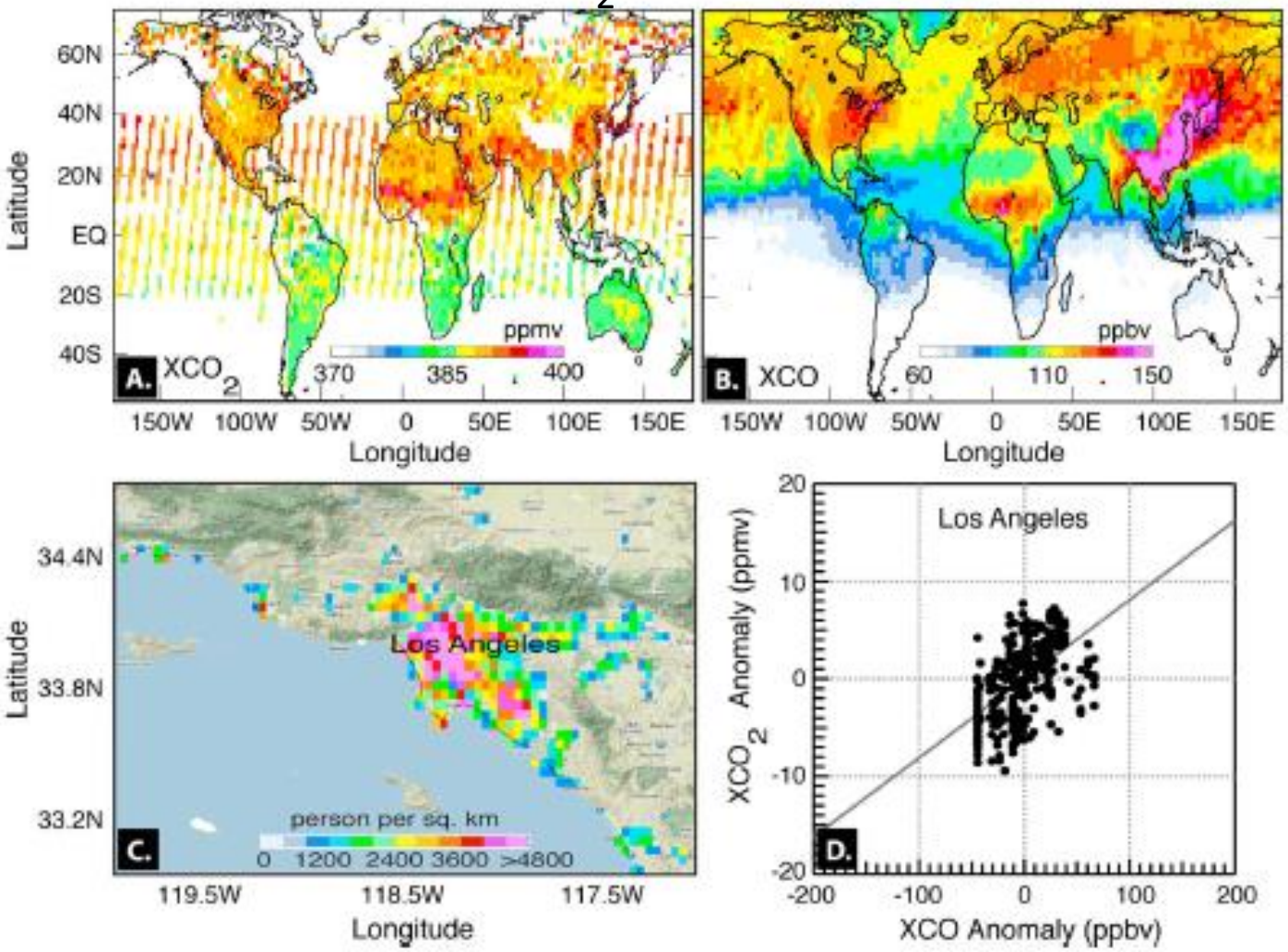
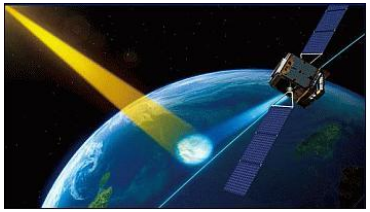
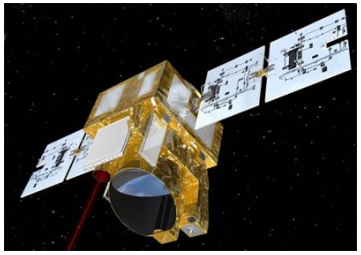
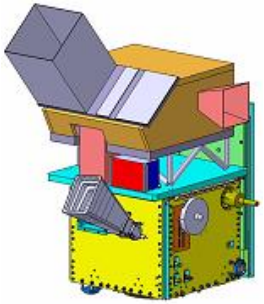
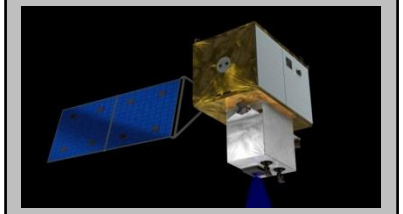
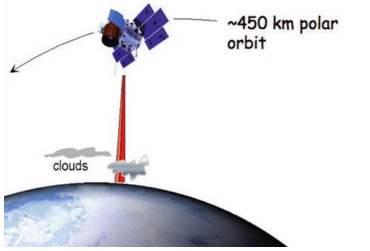


Figure 1. (a) ACOS v2.9 X_{CO_2} (in ppmv) and (b) MOPITT v5 X_{CO} (in ppbv) gridded at 2° resolution and averaged for Spring 2010. (c) A sample of megacity urban designation for Los Angeles (using population map as a proxy) is also plotted, along with (d) the X_{CO_2} and X_{CO} data points used in estimating $\Delta CO_2/\Delta CO$ for the urban region.

CO_2 and CO have a particular regional correlation affected by the anthropogenic activity.

Silva et al., GRL, 2013

Space-borne GHG monitoring with GOSAT partners

Envisat (ESA) 2003-2012 CO_2, CH_4 	GOSAT (Japan) 2009-present CO_2, CH_4 	OCO-2 (NASA) 2014-present CO_2 	TanSat (China) 2016- CO_2 	GOSAT-2 (Japan) 2018- CO_2, CH_4 
MERLIN (CNES/DLR) 2019- CH_4 	MicroCarb (CNES) 2019- CO_2 	CarbonSat (ESA) later than 2020 CO_2, CH_4 	ASCENDS (NASA) later than 2020 CO_2 	

Continuous GHG measurement from space will contribute to reveal global and regional carbon flux change.