JAXA Remote Sensing Satellite Missions

Utilization for Earth and Environment Observation

27th June 2013

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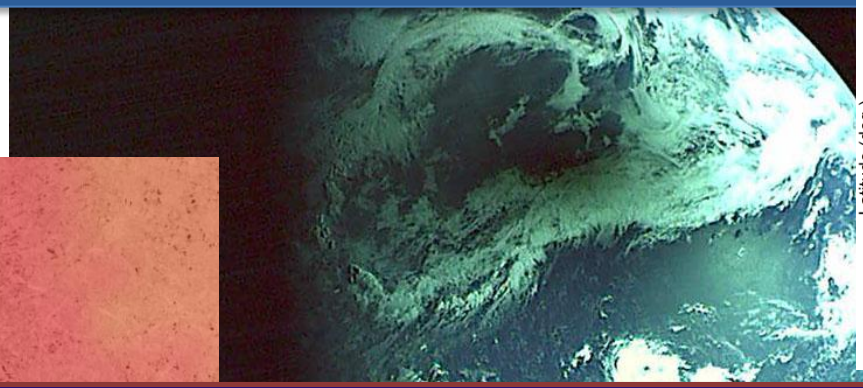
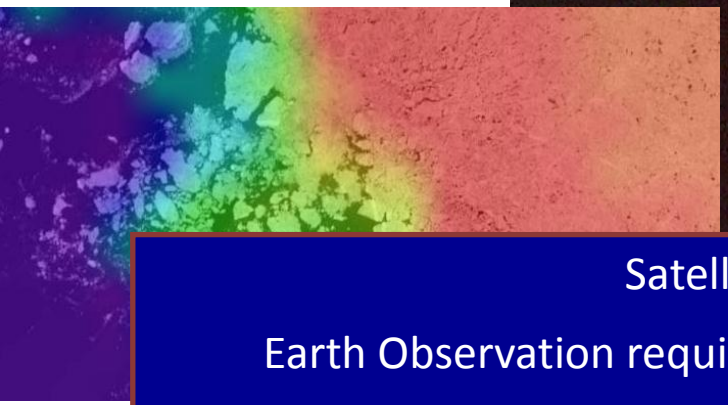
EORC/JAXA

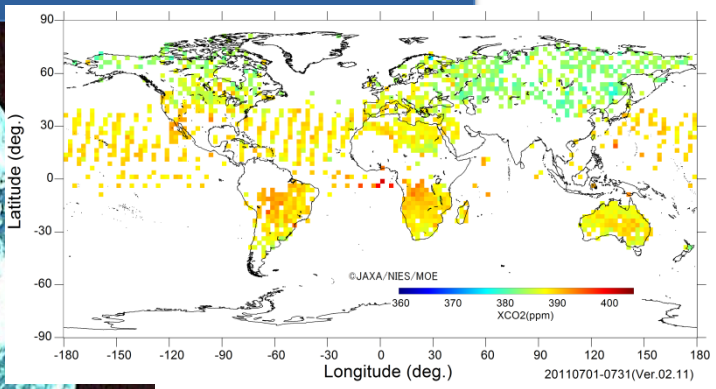
Inventory, Modeling and Climate Impacts of Greenhouse Gas emissions (GHG's) and Aerosols in the Asian Region

Earth Observation by Satellite

No doubt for necessity of Satellite Observation,
for its observation uniformity throughout the globe
and its long time record from 1960's TIROS







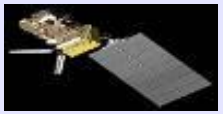
Satellite Earth Observation Common ISSUE

Earth Observation requirements are so various and wide for observation targets

and their spatial/temporal conditions.

National, Regional and Global Observation Systems

Europe/Africa

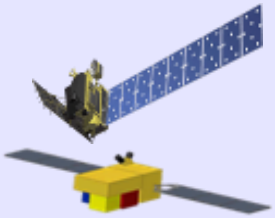
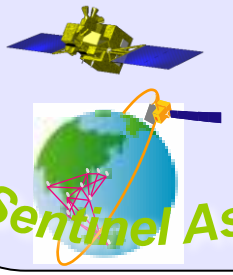

esa

cnes

DLR

Copernicus (GMES)

Asia

JAXA

CNSA

इसरो isro

Sentinel Asia

Americas



NASA

noaa

CSA ASC

USGS

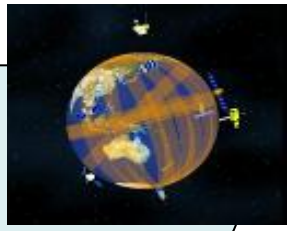
CONAE

SERVIR

CEOS

Coordination body for GEOSS space segment

27 space agencies, 21 associates



In-situ observation organizations



Requirements

GEOSS

Realization of global Earth observation system of systems within 10 years for 9 SBAs.
72 countries, EC and 52 int'l organizations


Disasters


Water


Climate


Energy


Health

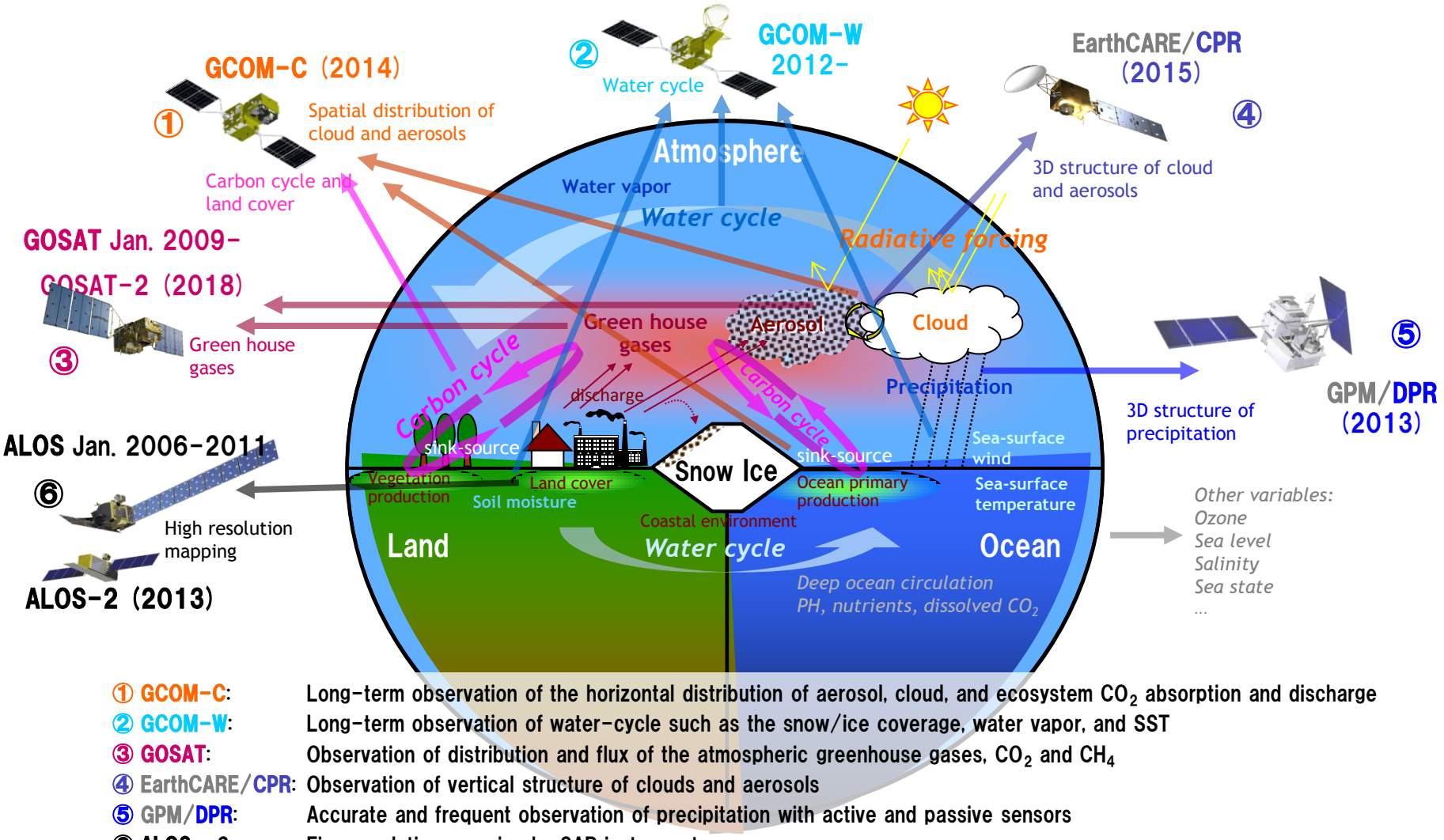

Weather


Ecosystems


Agriculture


Biodiversity

JAXA Earth Environment Observation Satellites



① **GCOM-C**: Long-term observation of the horizontal distribution of aerosol, cloud, and ecosystem CO_2 absorption and discharge

② **GCOM-W**: Long-term observation of water-cycle such as the snow/ice coverage, water vapor, and SST

③ **GOSAT**: Observation of distribution and flux of the atmospheric greenhouse gases, CO_2 and CH_4

④ **EarthCARE/CPR**: Observation of vertical structure of clouds and aerosols

⑤ **GPM/DPR**: Accurate and frequent observation of precipitation with active and passive sensors

⑥ **ALOS, -2** Fine resolution mapping by SAR instruments

JAXA missions cover Essential Climate Variables (ECVs)

ECVs were identified in international science framework (GCOS). JAXA EO program covers **33** out of **41 ECVs** except *"sub-surface ECVs"*. Future JAXA mission will add more than **2 ECVs.**

Atmosphere

Upper-Air	**Cloud Properties**	Composition	**Aerosol Properties**
	Earth Radiation Budget (including Solar Irradiance)		**Carbon Dioxide**
	Temperature		**Methane and other Long-Lived Green House Gases**
	Water Vapor		**Ozone**
	Wind Speed and Direction		Precursors (supporting the Aerosols and Ozone ECVs)
Surface	**Surface Air Pressure**		
	Surface Air Temperature		
	Surface Precipitation		
	Surface Radiation Budget		
	Water Vapour (Surface humidity)		
	Near-Surface Wind Speed and Direction		

Bold under-lined parameters are covered by current JAXA EO satellite plans.
Marked even if it is only a part of requested information.

Ocean

Surface	**Carbon Dioxide Partial Pressure**
	Current
	Ocean Acidity
	Ocean Color
	Phytoplankton
	Sea Ice
	Sea Level
	Sea State
	Sea Surface Salinity
	Sea Surface Temerature

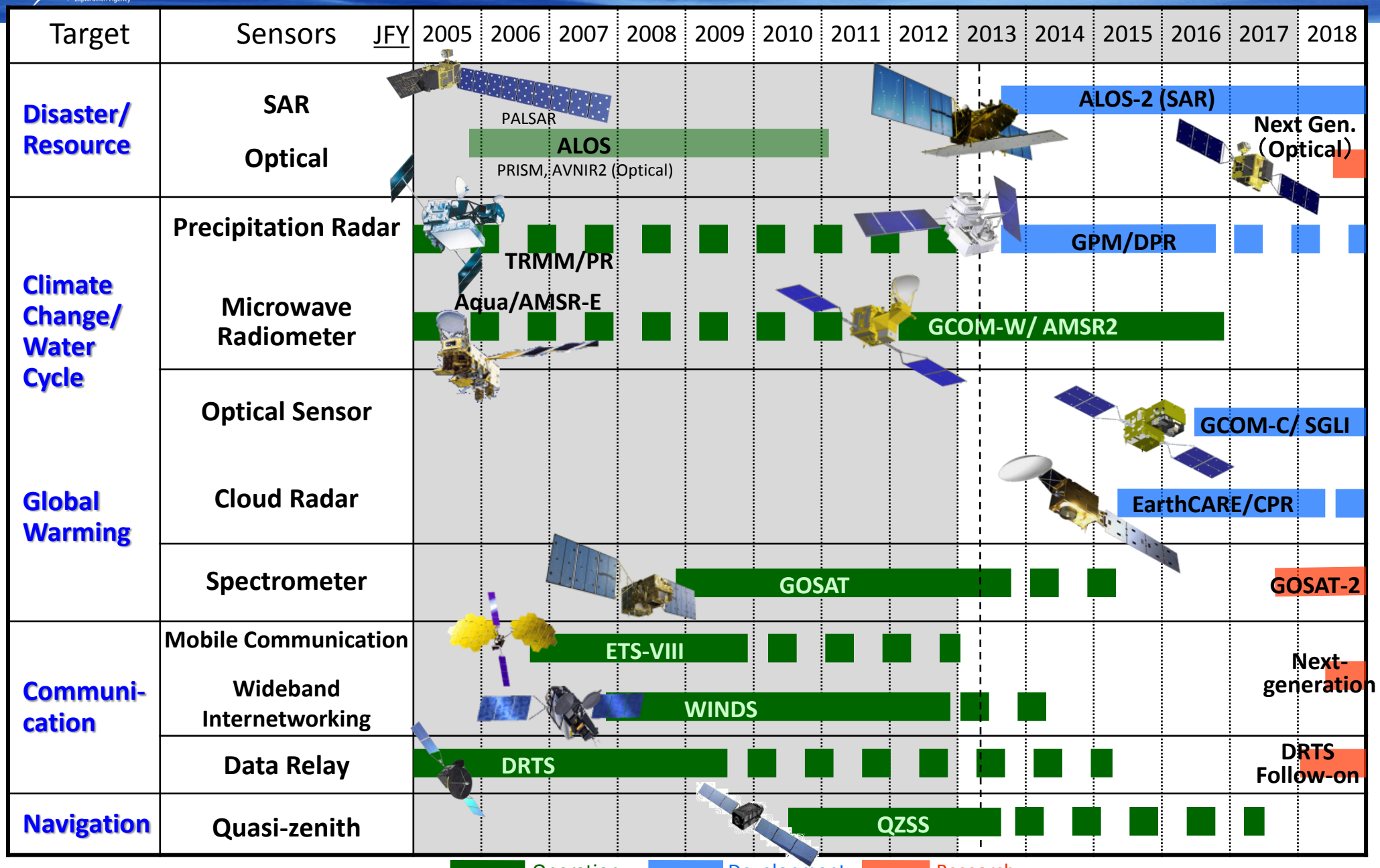
Land

River Discharge	**Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)**
Water Use	**Leaf Area Index (LAI)**
Ground Water	**Above Ground Biomass**
Lakes	**Fire Disturbance**
Snow Cover	**Soil Moisture**
Glacier and Ice Caps	Soil Carbon
Permafrost	**Ice Sheets**
Land Cover(including Vegetation Type)	

N/A for satellite observation

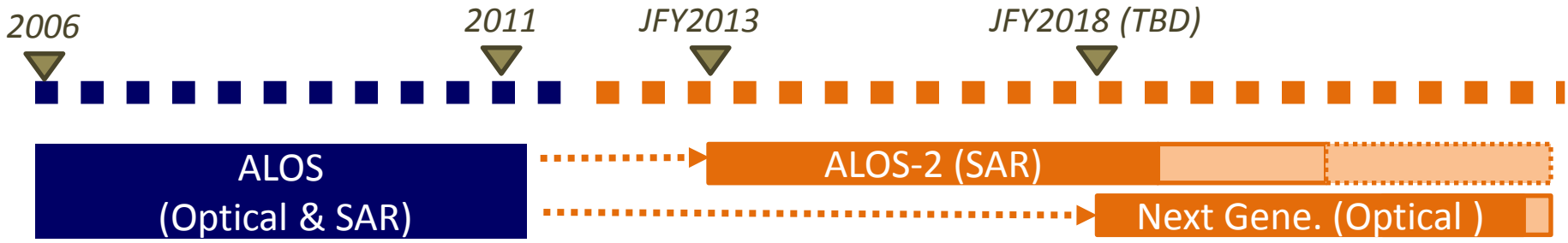
Sub-Surface	Carbon
	Current
	Nutrients
	Ocean Acidity
	Oxygen
	Salinity
	Temperature
	Tracers
	Global Ocean Heat Content

History & Current Mid-term Plan

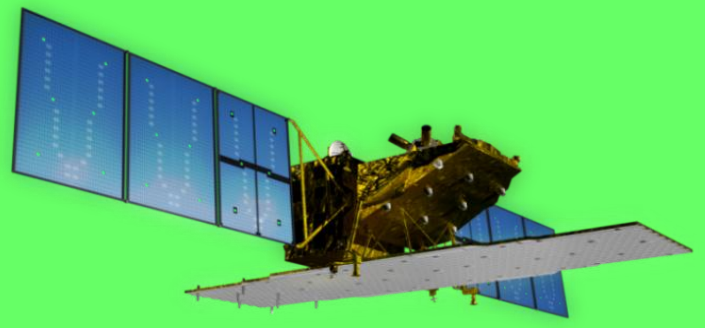


The Advanced Land Observing Satellite (ALOS) Series

- Wide-swath and high-resolution data of ALOS series to contribute to disaster monitoring, land management, global environment monitoring on Earth surface.
- To promote public-private partnership



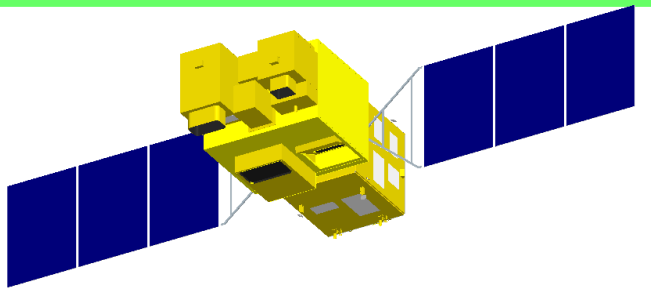
ALOS
(Optical & SAR)
(2006～2011)



ALOS-2 (SAR) (Launch: JFY2013)

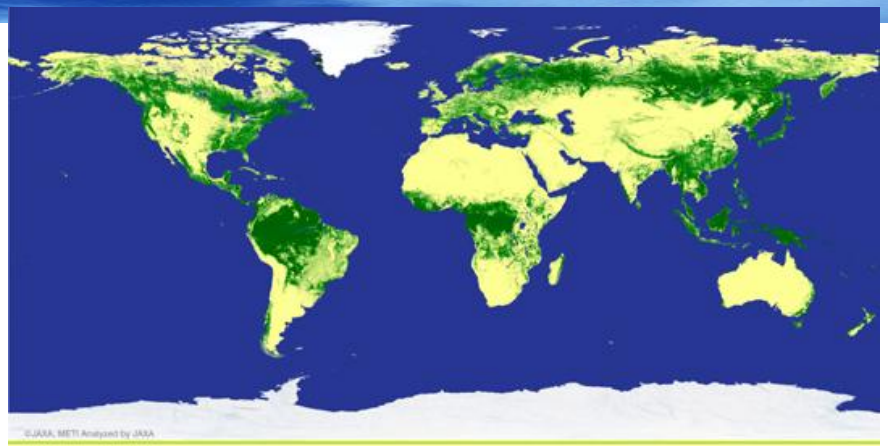
- Wide-swath (Max 490km), High-resolution (1-3m)
- L-band SAR (PALSAR-2)

- Panchromatic imager with wider swath (50km) and higher resolution (0.8m) than ALOS/PRISM
- Obtain global 3D geospatial information

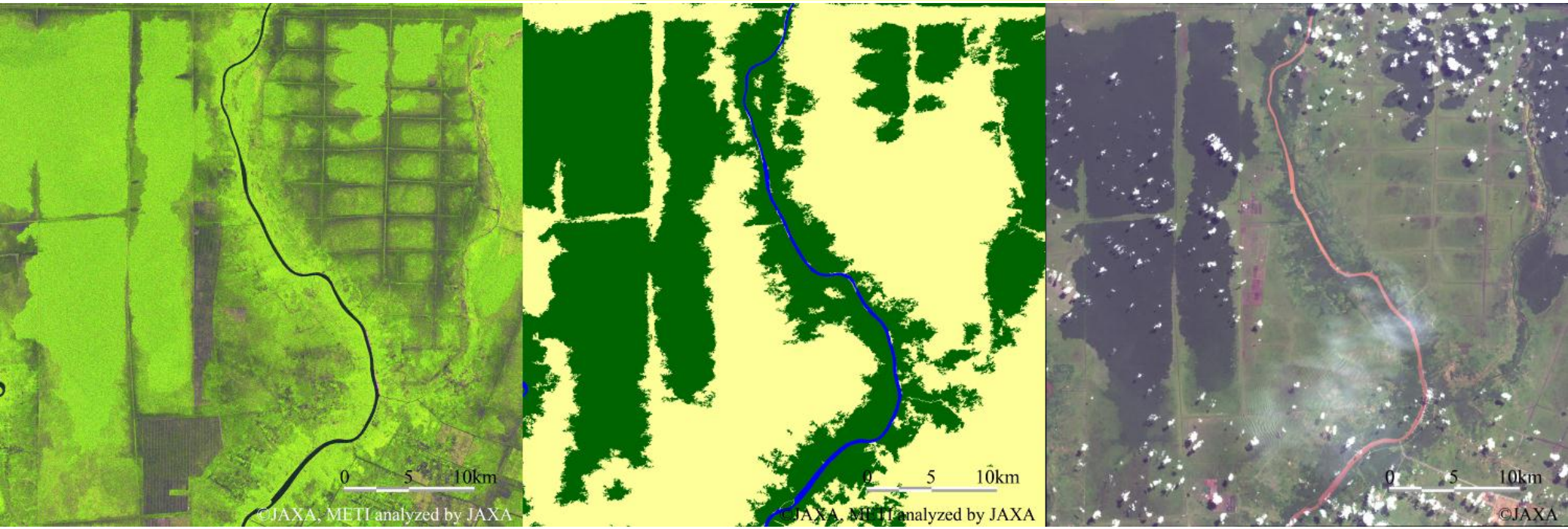


Next Gene. (Optical) (Launch: JFY2018(TBD))

Forest/Non-Forest map by ALOS



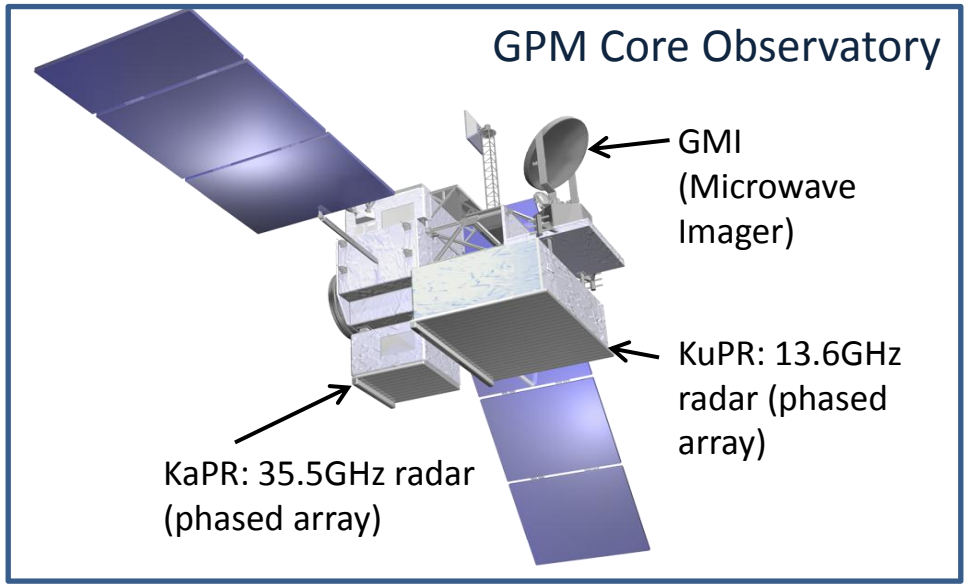
Global Forest/Non-forest Map 2009

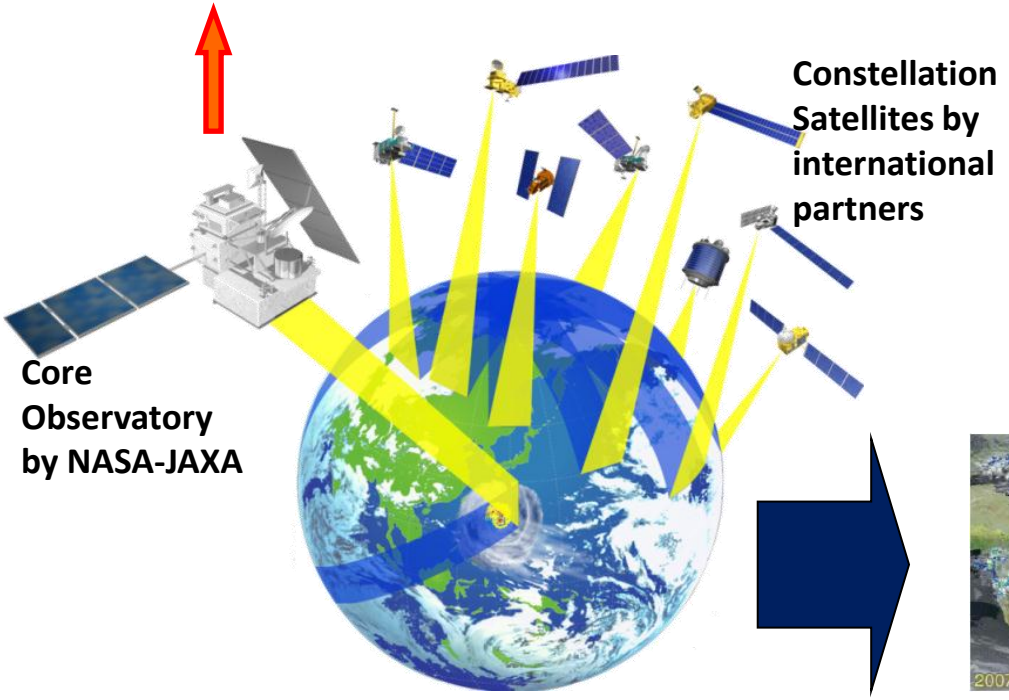


Forest/Non-forest map in a typical tropical area (Indonesia) and a 10-meter resolution SAR mosaic image of Central Kalimantan, Forest/Non-forest map, AVNIR2 image

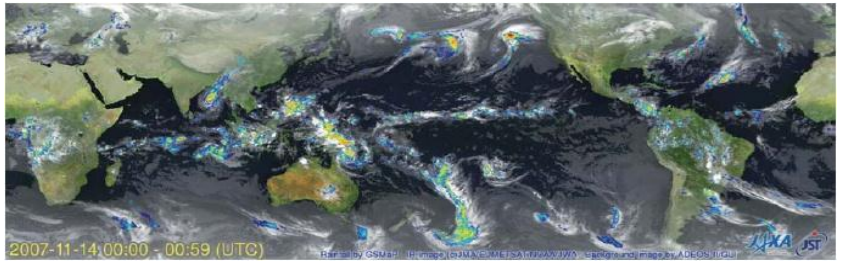
(JAXA, METI analyzed by JAXA)

Global Precipitation Measurement (GPM)/ Dual-frequency Precipitation Radar (DPR)

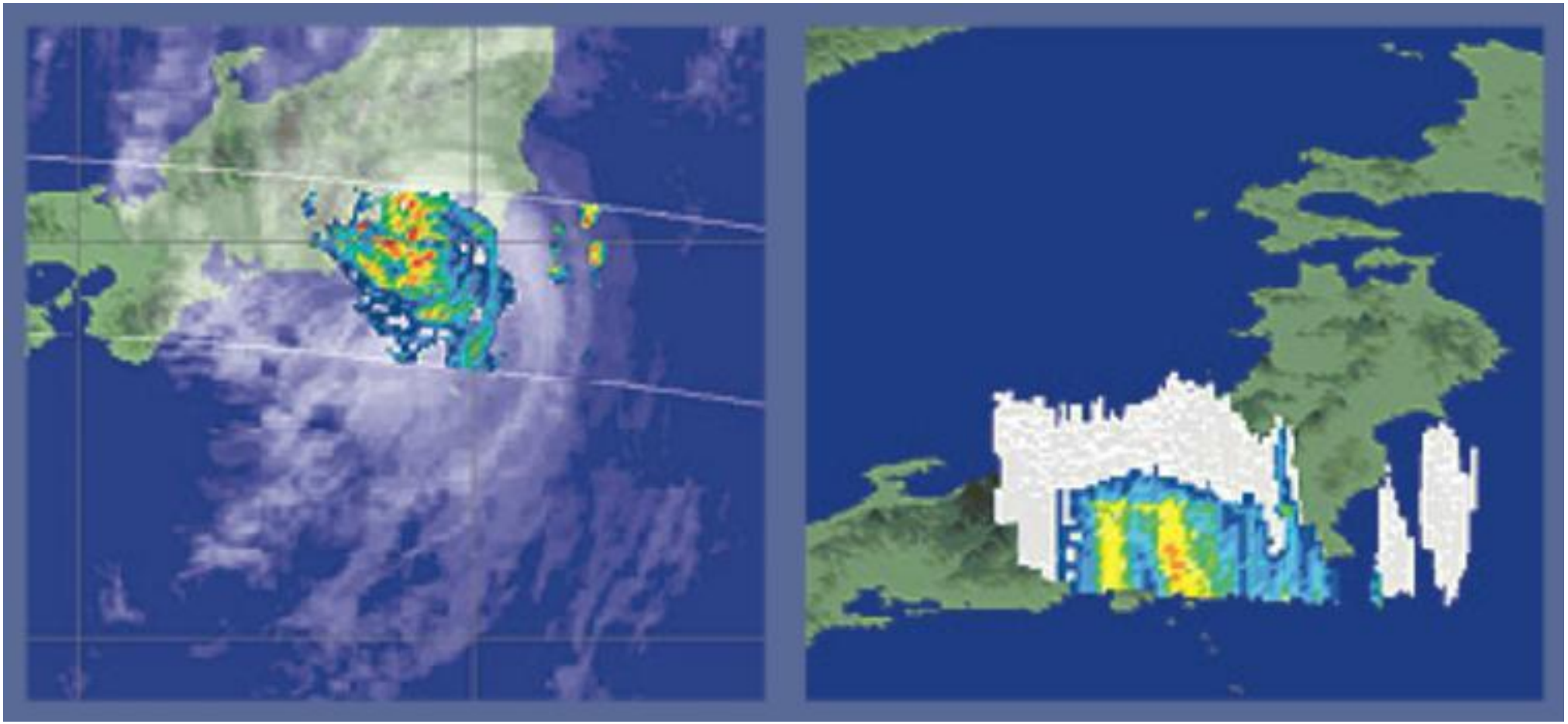




- GPM is an international mission consisting of the GPM Core Observatory and Constellation Satellites for high accurate and frequent global rainfall observation.
  - Core Observatory: developed under NASA and JAXA equal partnership.
  - Constellation satellites: provided by international partners (includes GCOM-W1).
- Dual-frequency Precipitation Radar by JAXA/NICT
  - 3D structure of rainfall
  - simultaneous dual-frequency observation to expand detectable precipitation range from weak rainfall to snowfall.
- GPM Core Observatory will be launched **in early 2014.**



Typhoon Observation by previous satellite (TRMM)

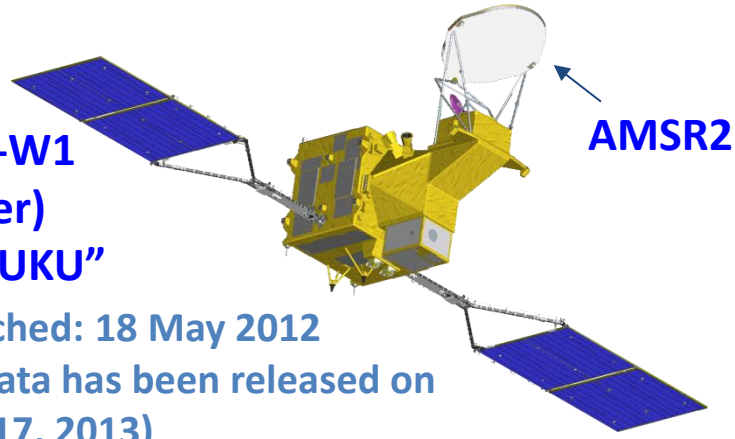


GPM expands detectable precipitation range of TRMM

Typhoon Danas 10th Sep 2001 TRMM

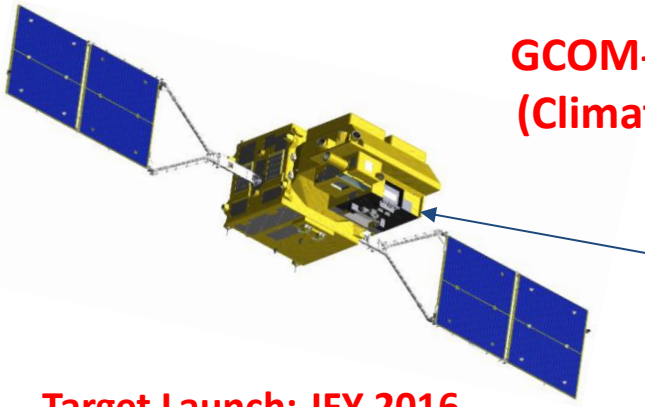
Global Change Observation Mission (GCOM)

- Long-term observation (over 10 years) for global climate change.
- Two satellite series for covering wide electromagnetic wavelength range
  - ✓ **GCOM-W :**Microwave observation with AMSR2
    focusing water cycle and other valuables by microwave observation
    (water vapor, precipitation, soil moisture, sea surface temp., wind speed, etc)
  - ✓ **GCOM-C :**Optical multi-channel observation with Polari meter with SGLI
    focusing radiation budget, carbon cycle and other valuables by optical observation
    (aerosol, clouds, ocean color, vegetation, snow ice, etc)



GCOM-W1 (Water) or "SHIZUKU"

Launched: 18 May 2012
(All data has been released on May 17, 2013)



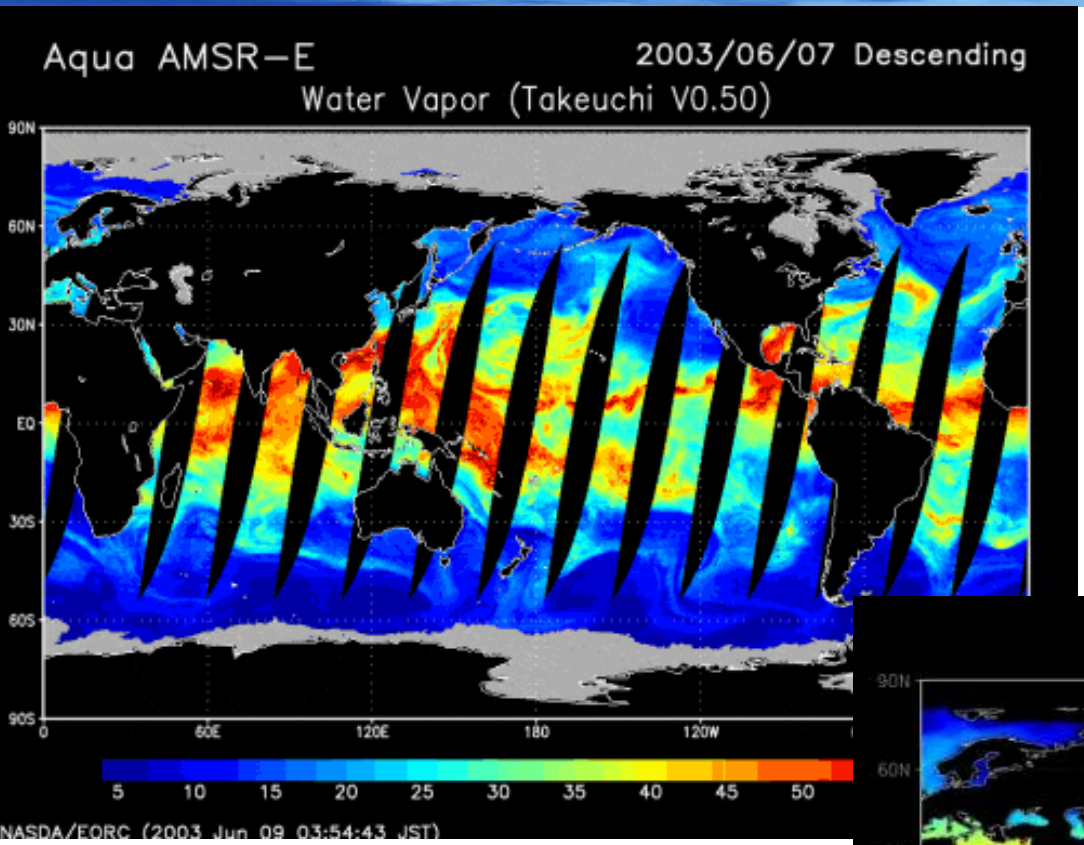
GCOM-C1 (Climate)

Target Launch: JFY 2016

Sensor	Advanced Microwave Scanning Radiometer 2 (AMSR2)
Design Life	5 years

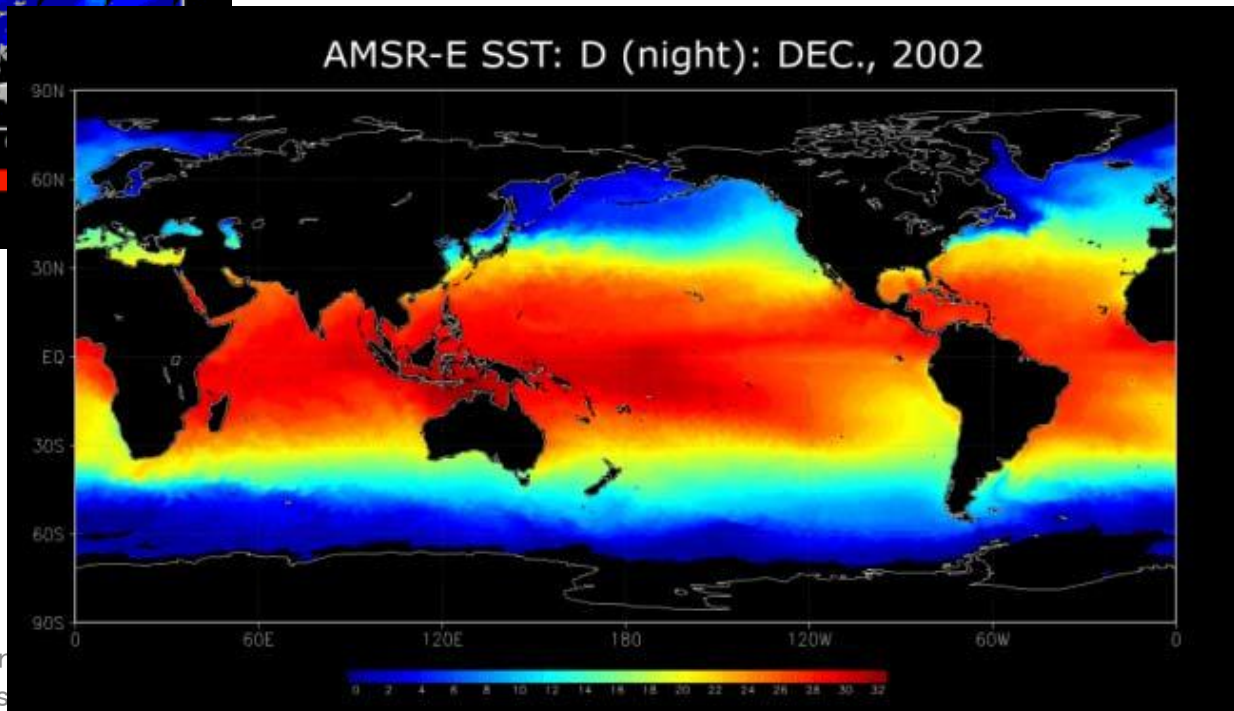
Sensor	Second generation GLobal Imager (SGLI)
Design Life	5 years

AMSR Series Observation result (by AMSR-E on Aqua)



Water Vapor

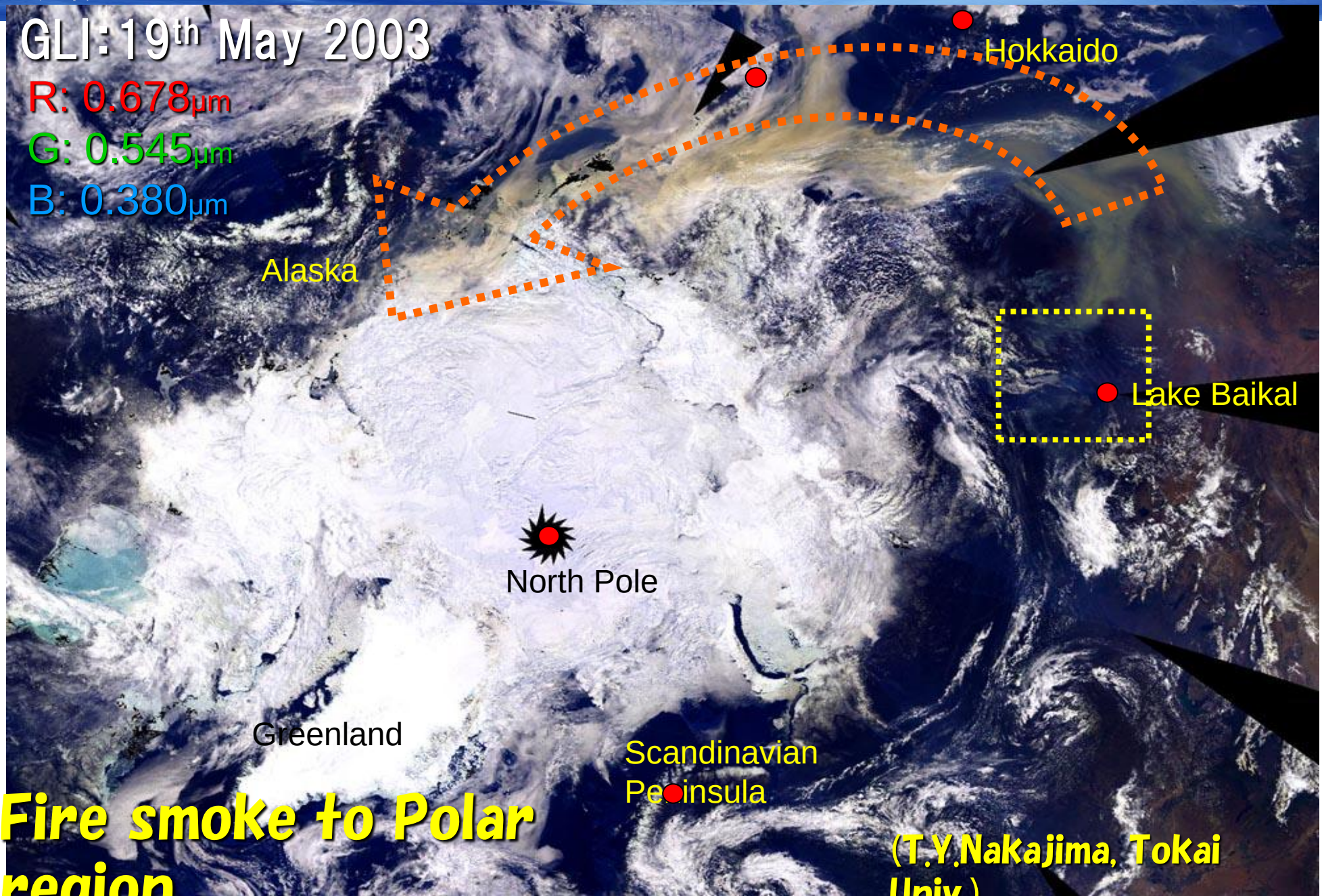
Sea Surface Temperature



AMSR-E data of 10 years will be continued by AMSR-2 on GCOM-W1

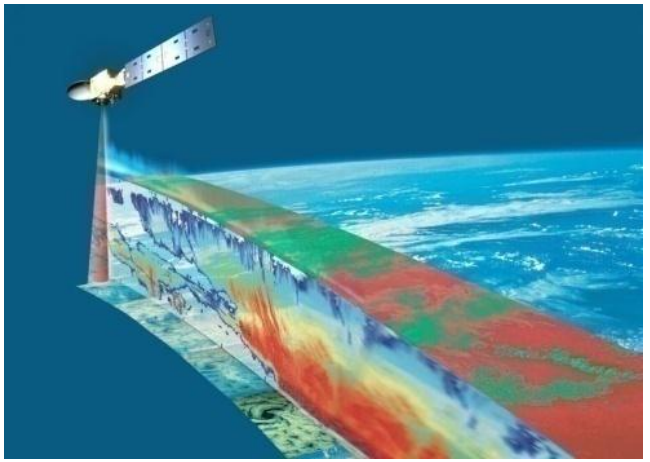
Inventory, Modeling ar
emissions (GHG's

1km Cryosphere (by Previous Sensor GLI)

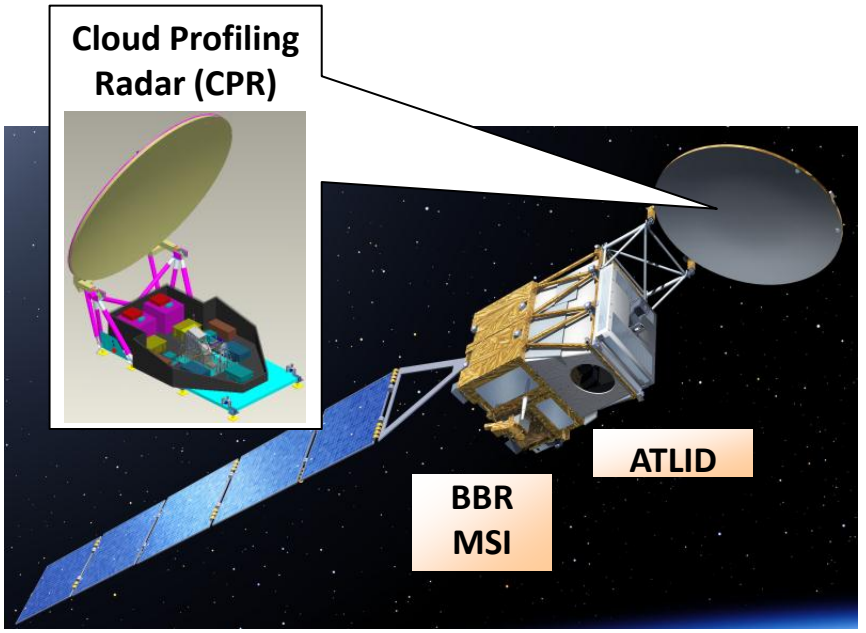


EarthCARE/Cloud Profiling Radar (CPR)

■ **Japan (JAXA/NICT)and Europe (ESA) cooperation project**



- **Mission**
  - Vertical profile of clouds, aerosol
  - Interaction between clouds and aerosol
  - Cloud stability and precipitation
- **Orbit**
  - Sun synchronous
  - Equator crossing time 14:00
  - Altitude ~400km
- **Development Responsibilities**
  - JAXA/NICT (CPR)
  - ESA (LIDAR, MSI, BBR, Spacecraft)
- **Target Launch Year**
  - JFY2015
- **Instruments**
  - CPR (Cloud Profile Radar)-JAXA/NICT
    The world's first spaceborne 94 GHz Doppler radar.
  - ATLID (Atmospheric LIDAR)
    Hyper Spectral UV Lidar (355 nm)
  - MSI (Multi-Spectral Imager)
  - BBR (Broad Band Radiometer)

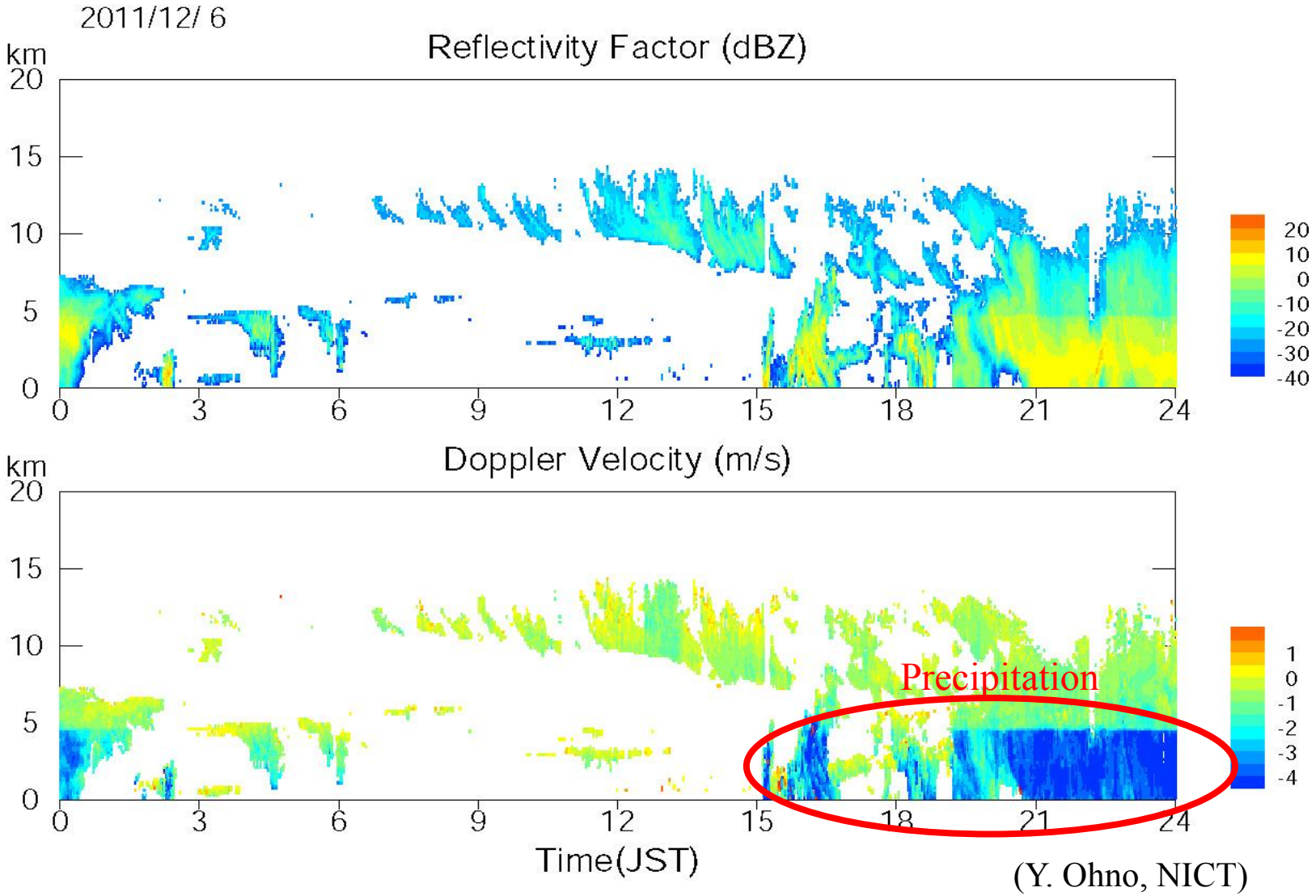


Precipitation detection using Doppler velocity

Airborne Cloud Doppler Radar demonstration by NICT

Radar reflectivity

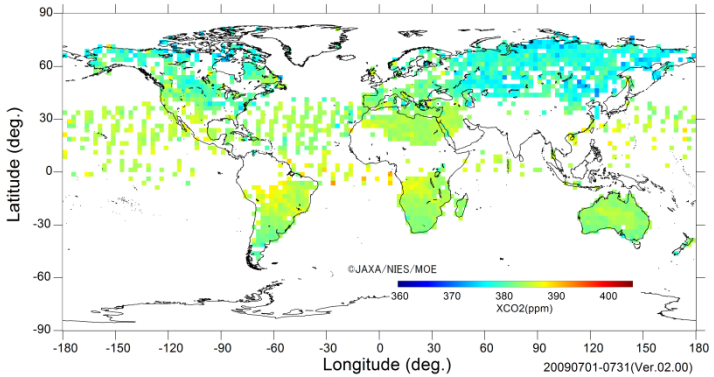
Vertical air motion (Doppler Velocity)



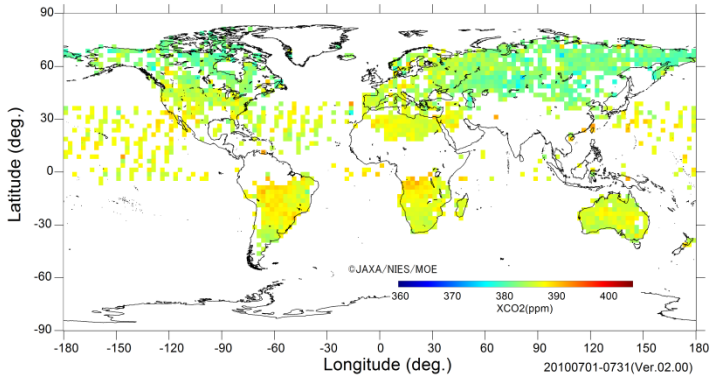
(Y. Ohno, NICT)

Greenhouse Gases Observing Satellite (GOSAT)

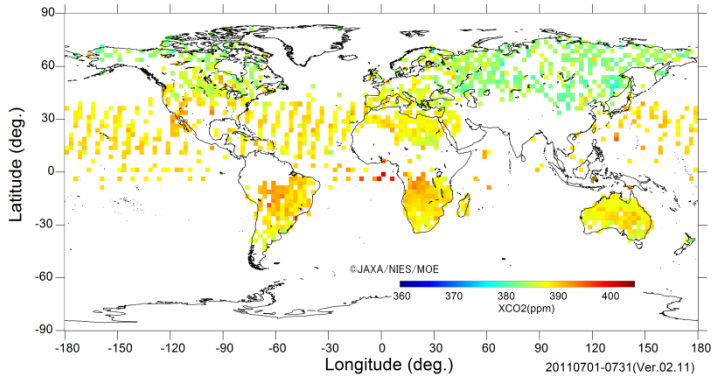
2009



2010



2011



Monthly Global Distribution Map of CO_2 (July)

FTS (Fourier Transform Spectrometer)

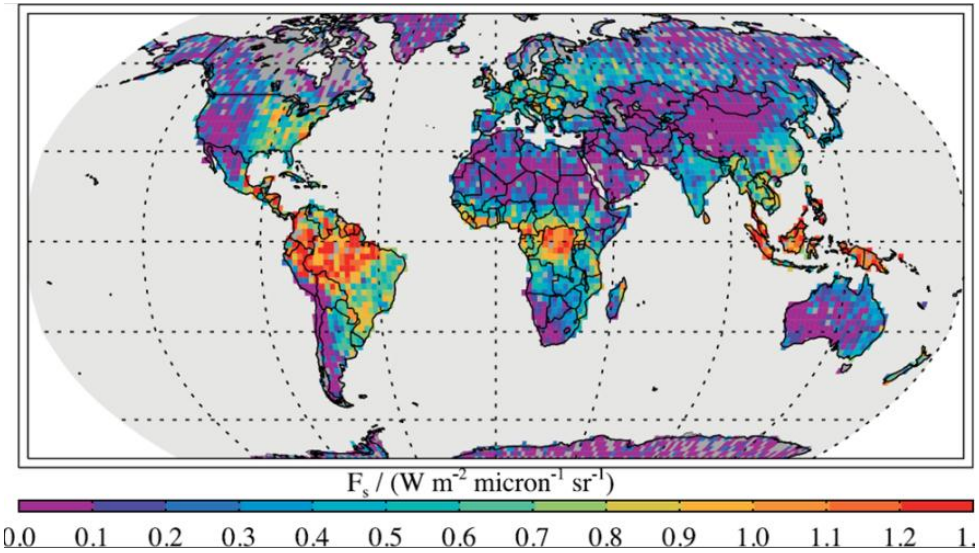
CAI (Cloud and Aerosol Imager)

Measure spectral of CO_2 and methane with highest resolution

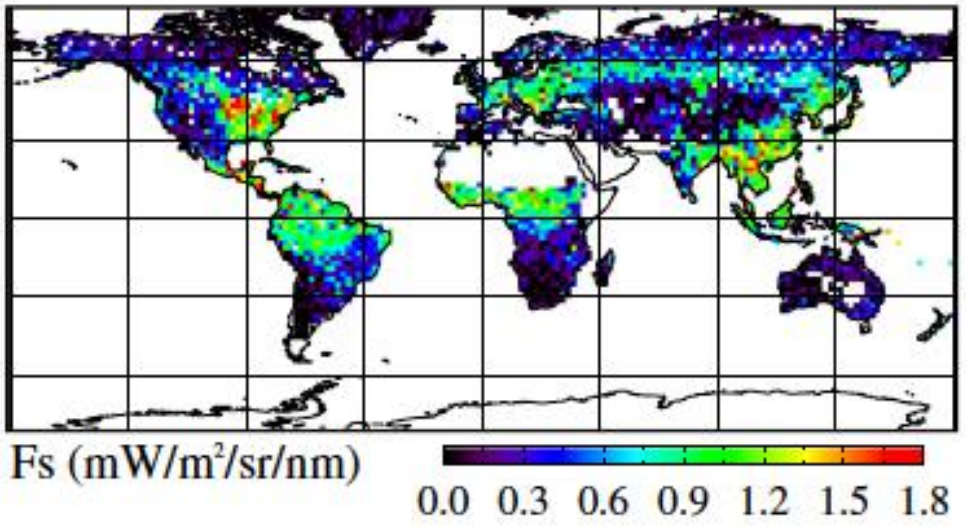
- **Measure global distribution of GHGs, to understand how the emissions can be reduced**
- **The only satellite in operation for monitoring CO_2 and methane globally**

Chlorophyll Fluorescence measurement from Space (GOSAT)

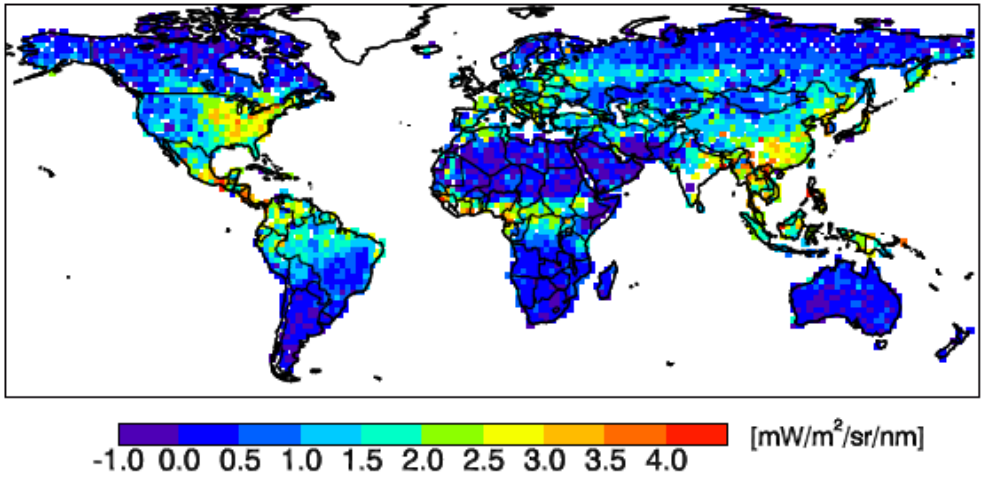
Annual average (June 2009 through May 2010)
Frankenberg et al., 2011



Monthly average for July 2009
Joiner et al., 2011

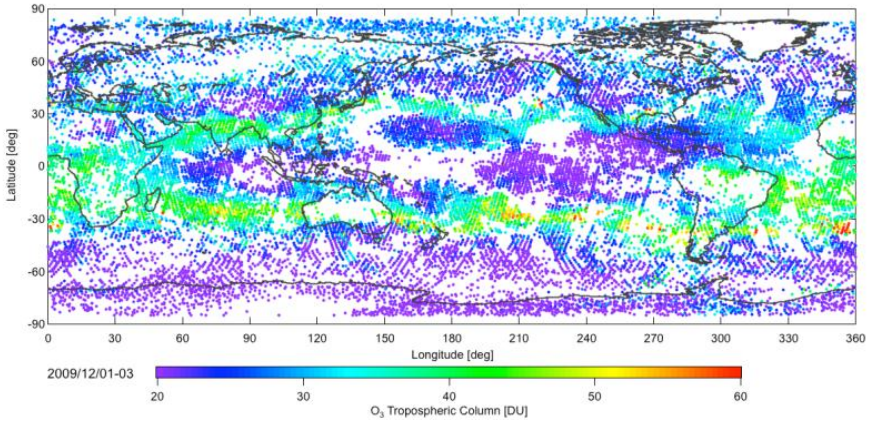


Monthly average for July 2009, Guanter et al., 2012

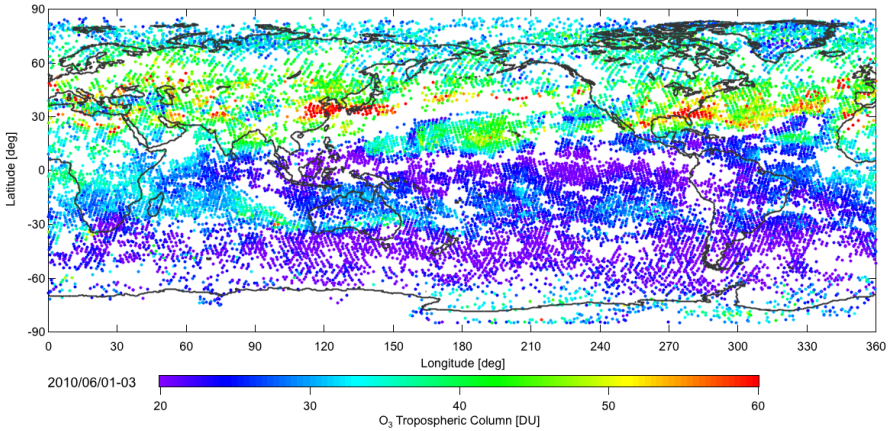


Seasonal variation of tropospheric ozone column averaged between 120-150°E

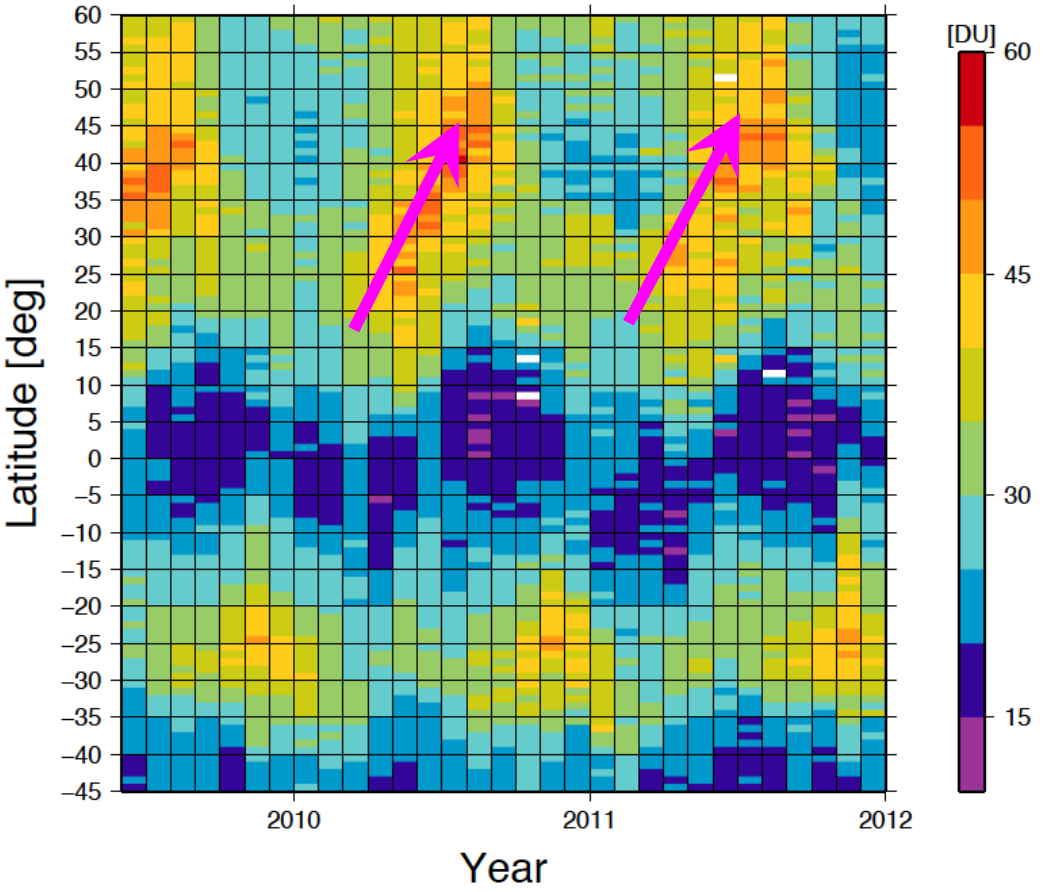
December 2009



June 2010



Average every 1.0° latitude



NH: High ozone belt moves toward higher latitude during spring and summer

SH: High ozone arises periodically

(H. Ohyama JAXA)

Future works

Next missions are under study

- X-band SAR for ocean altimetry

- Lidar for accurate biomass measurement

- UV to MW spectrometers system for air pollution measurement

- Next generation L-band SAR for wider swath using extra large deployable antenna

- Future advanced Geostationary satellite mission

- Super Low orbit satellite system for future mission, such as active instruments, gravity measurement as a challenge for sub-surface remote sensing by satellite

Summary

- Earth Observation Satellite for Environment is now getting matured under international cooperation. Full spectral observation will start from around 2016 in Japan.

- JAXA's current Satellite plan is going to cover most of Essential Climate Valuables which is internationally discussed and agreed.

- New observation results are emerging with new satellite observation technologies, such as GOSAT, and CPR, SGLI for near future. Fruitful results from long-term observation are expected from some missions, such as PALSAR-series, PR-series, AMSR-series. And new observation technologies are in study phase.

- JAXA is making efforts to keep these satellite observation system and contributes to GEOSS; Global Earth Observation system of systems. Also JAXA is pursing future operational social infra-structure using such observation satellites and sensor technologies.