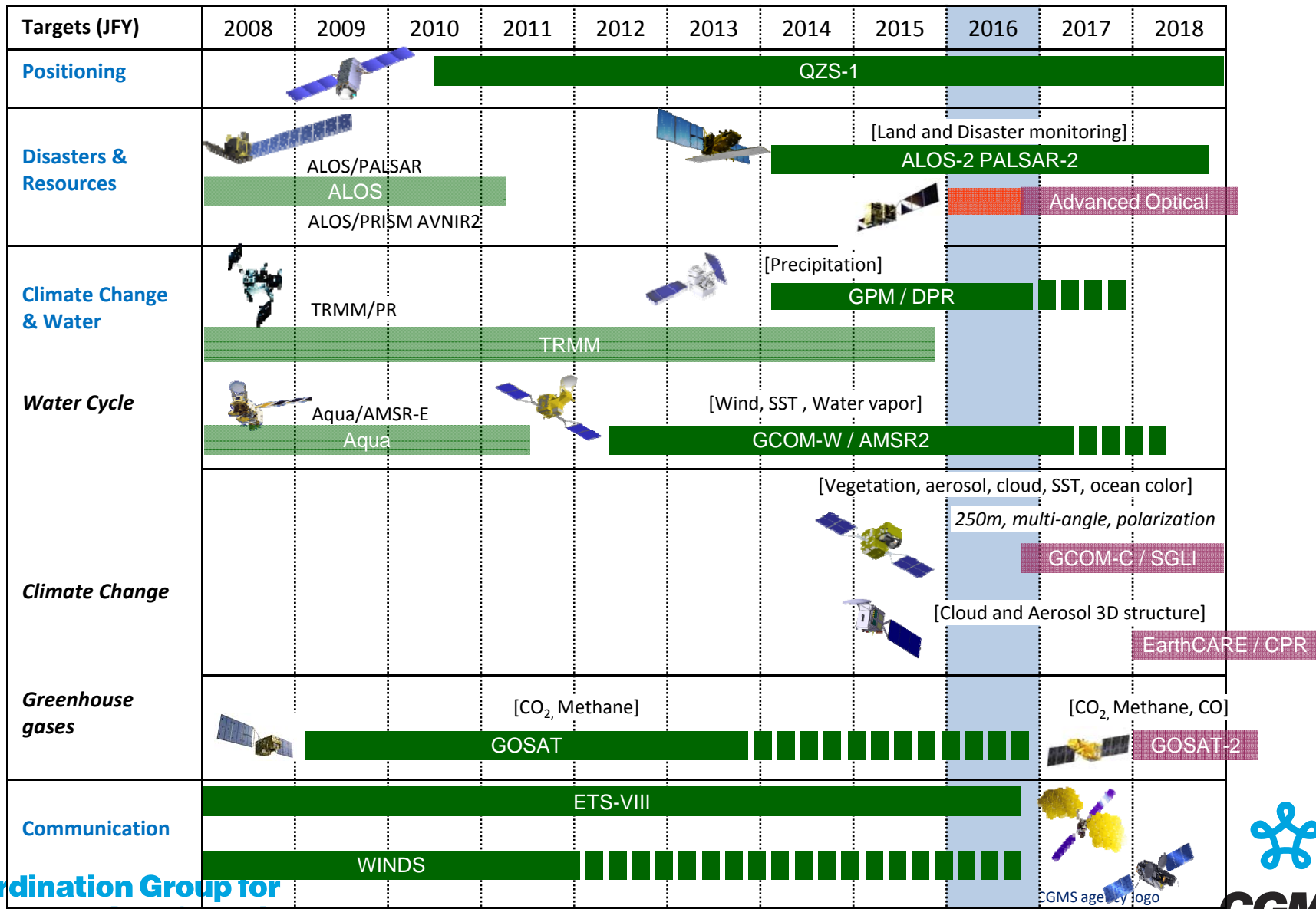


Status report on the current and future satellite systems by JAXA

Presented to CGMS-44 Plenary session, agenda item [D.2]

Coordination Group for Meteorological Satellites - CGMS

Overview - Planning of JAXA satellite systems



Coordination Group for Meteorological Satellites

On orbit

Phase C/D

CGMS agency logo here (in the slide master)

Phase A/B

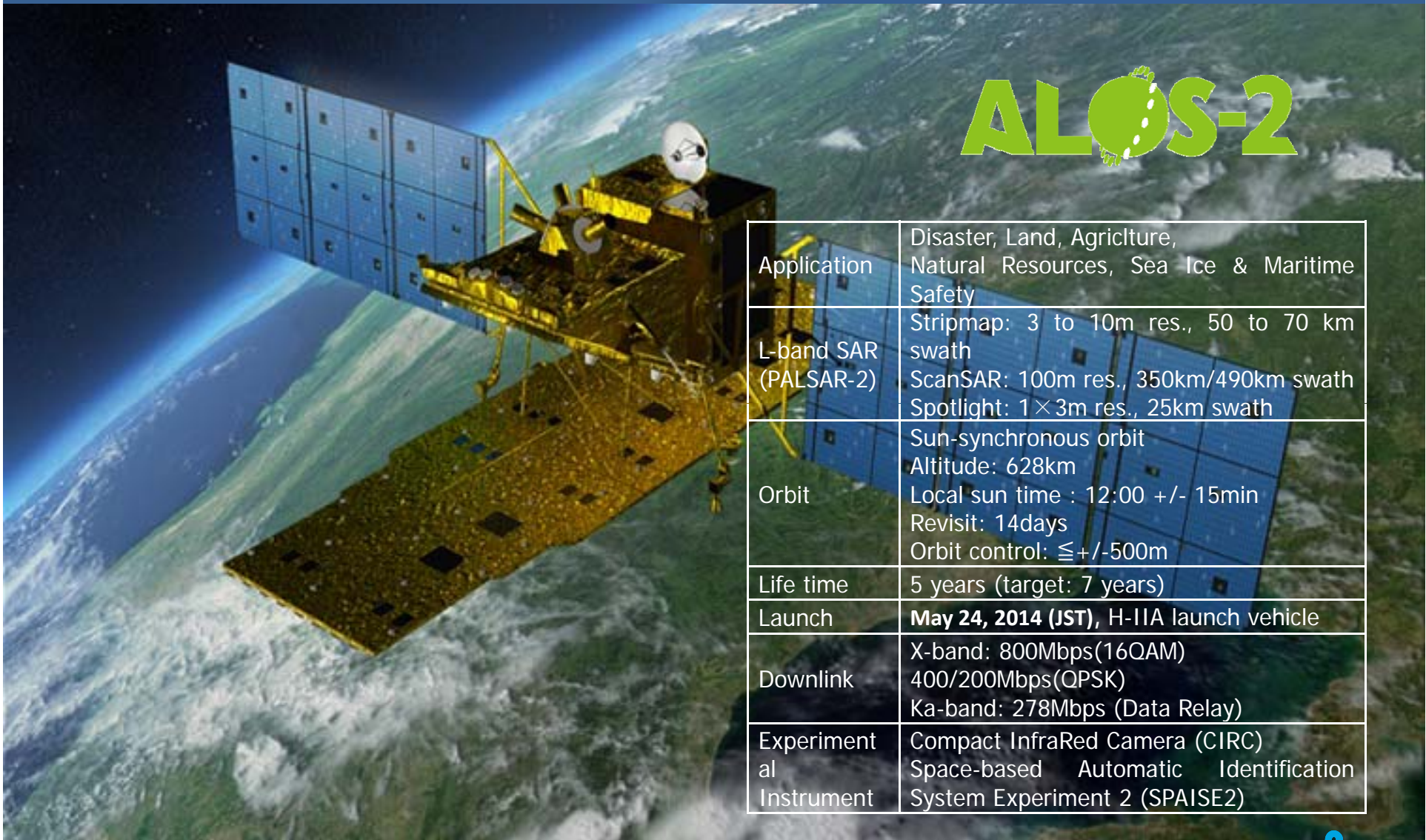


On-Orbit & Future Missions

Earth Observation

- ALOS-2
- GPM/DPR
- GCOM-W/C
- GOSAT/GOSAT-2
- EarthCARE/CPR

Coordination Group for Meteorological Satellites - CGMS



Coordination Group for Meteorological Satellites

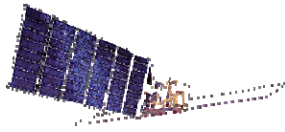
Add CGMS agency logo here (in the slide master)



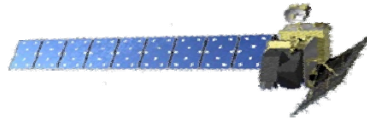
CGMS

Coordination Group for Meteorological Satellites - CGMS

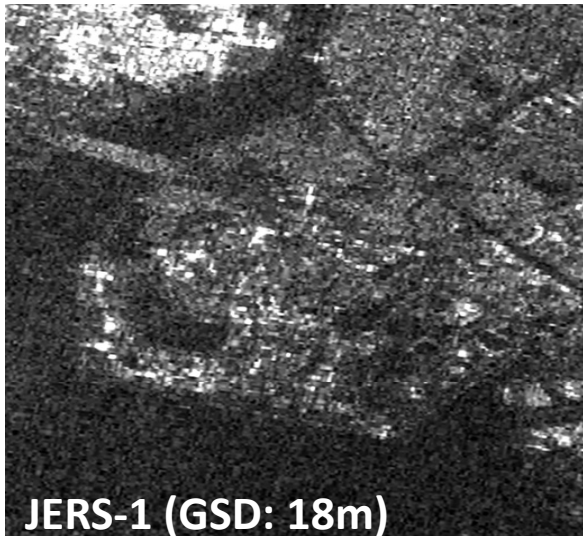
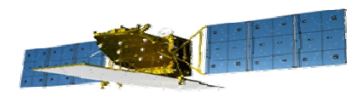
JERS-1 (1992)



ALOS (2006)



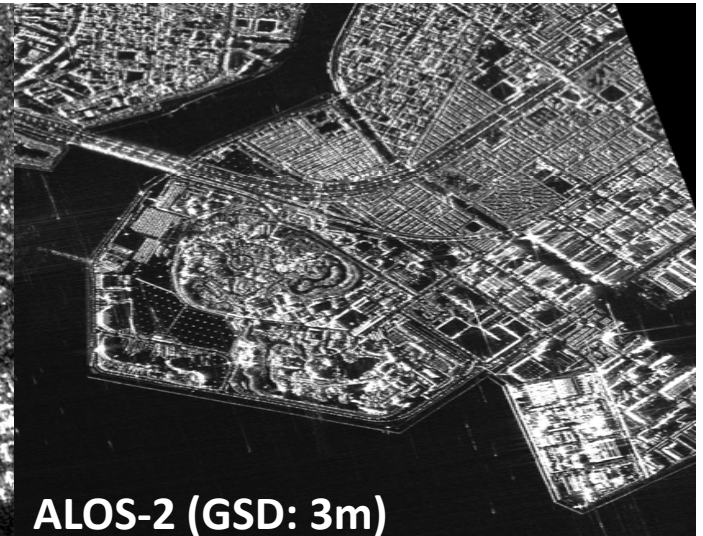
ALOS-2 (2014)



JERS-1 (GSD: 18m)



ALOS (GSD: 10m)



ALOS-2 (GSD: 3m)

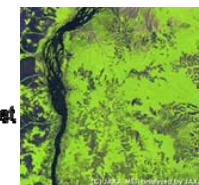
ALOS -2 contributes to climate monitoring through the environment change observation on the Earth.

Environment

Forest - Non-Forest Mapping using SAR data



- Forest
- Non-Forest
- Water



- R: HH
- G: HV
- B: HHVH

Add CGMS agency logo here (in the slide master)



CGMS

Coordination Group for Meteorological Satellites

Natural Disaster Monitoring

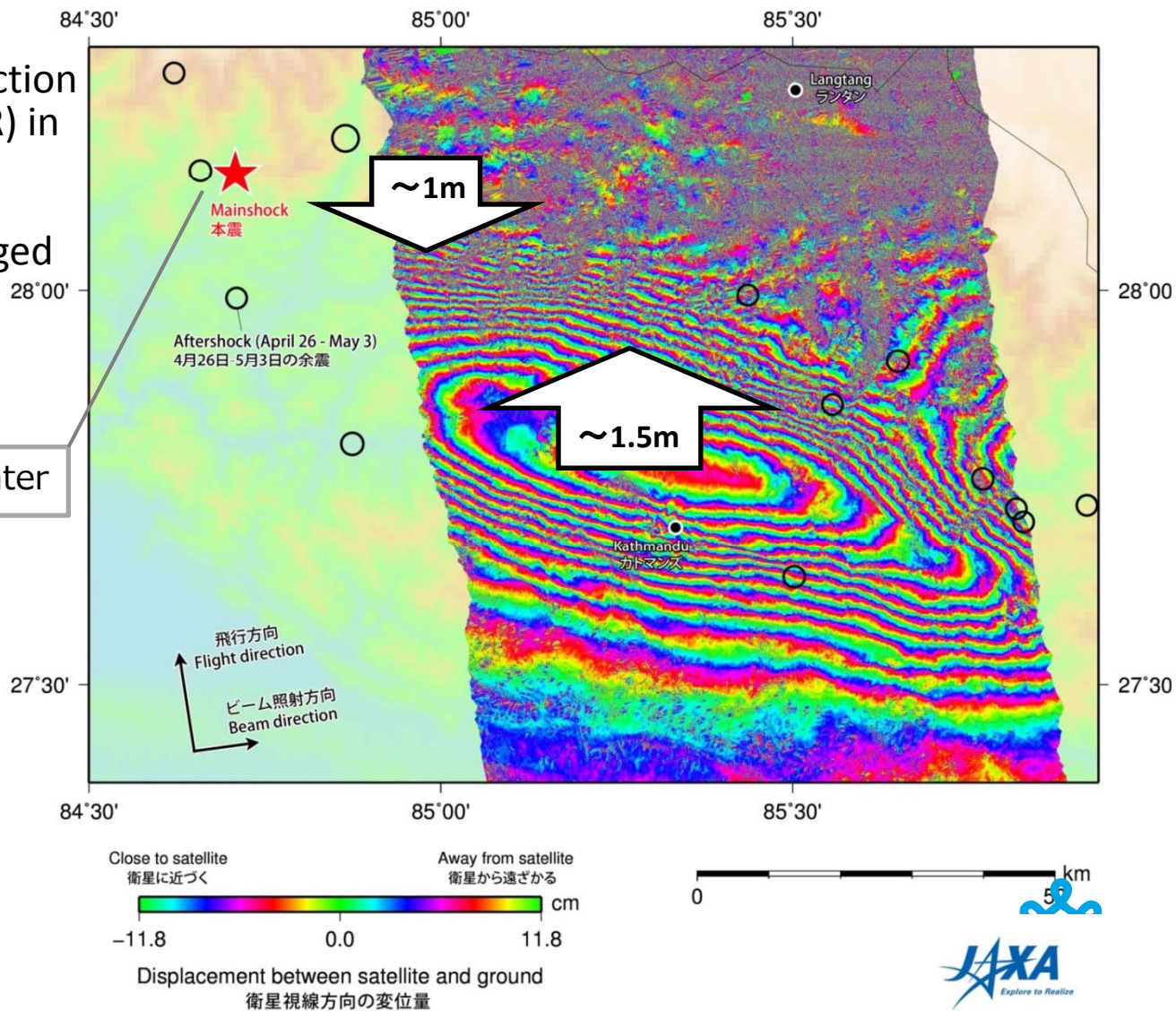
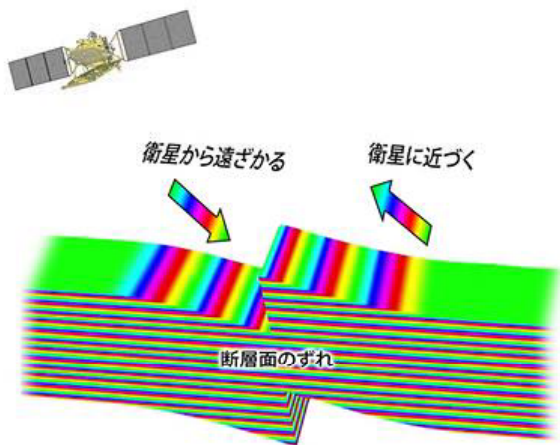
Nepal Earthquake on April 25, 2015

Land surface movement detection by SAR Interferometry (InSAR) in centimeter scales



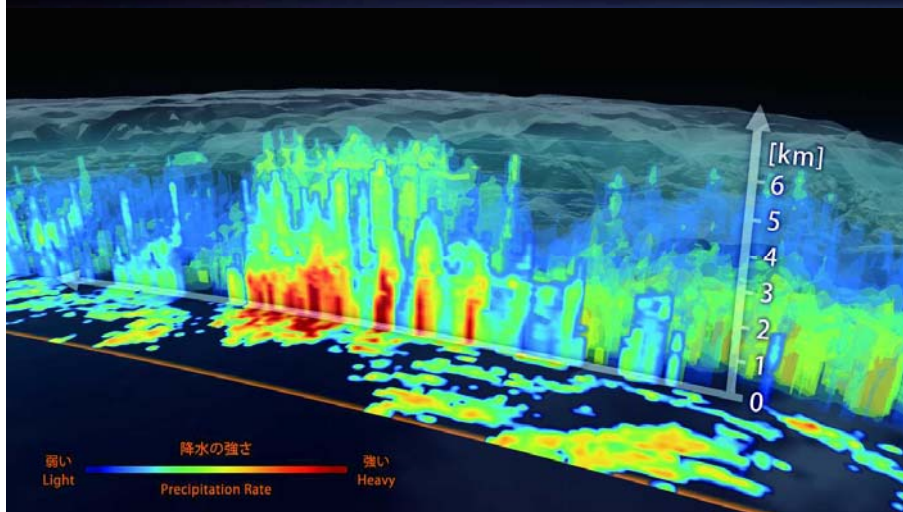
Estimation of heavily-damaged area

Not around the epicenter



Constellation Satellites (International Partners) : measuring global precipitations every 3hrs.

GPM: Global Precipitation Measurement



3D view inside an extra-tropical cyclone observed off the coast of Japan, March 10, 2014,
The vertical cross-section approx. 4.4 mi (7 km)
Image Credit: JAXA/NASA



GPM Core Observatory (JAXA&NASA) : measuring global precipitations with high precisions

Coordination Group for Meteorological Satellites

Add CGMS agency logo here (in the slide master)

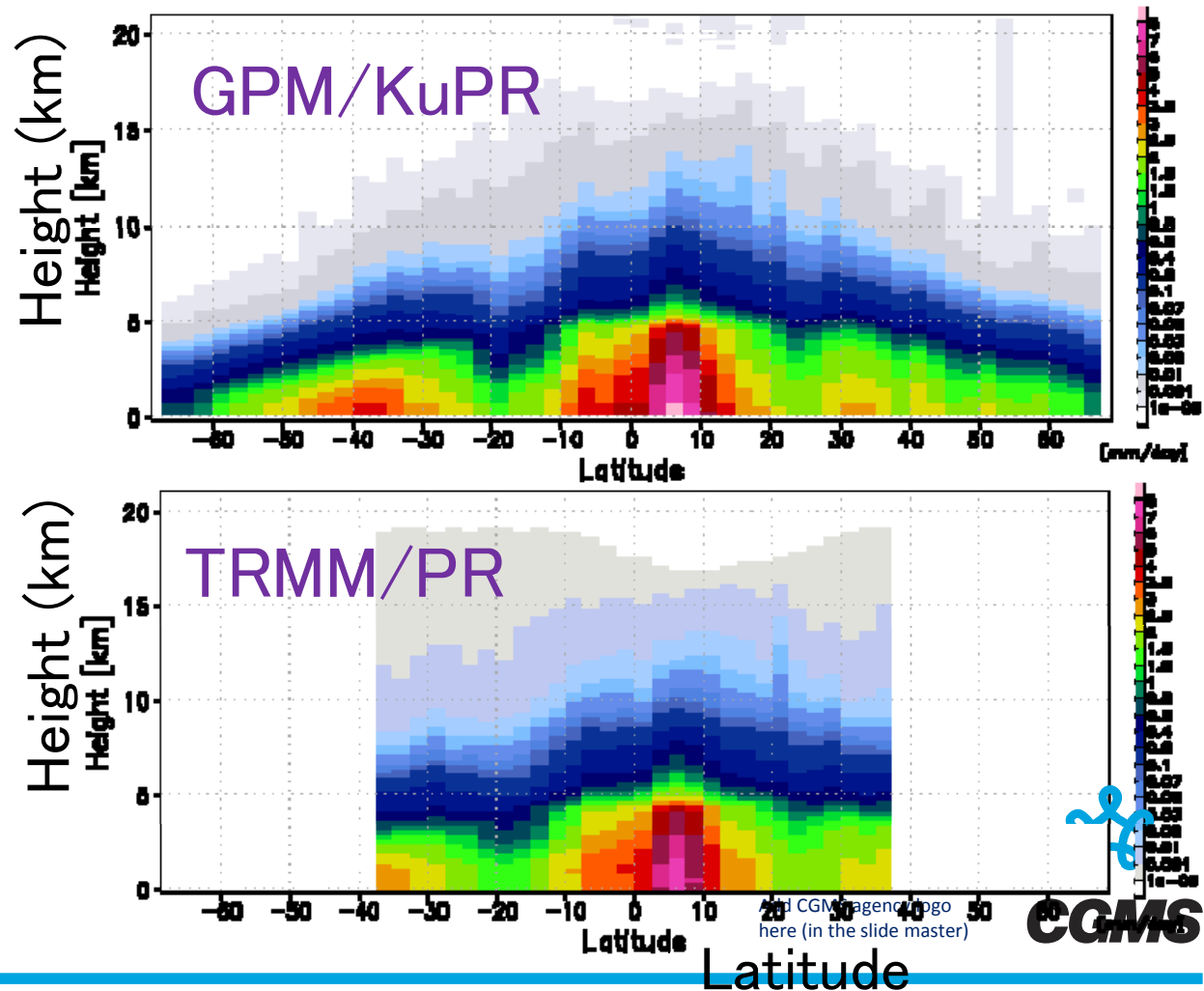


DPR observation examples

- Vertical precipitation profiles by DPR and PR

Vertical-latitude section of precipitation profiles over the ocean

Apr.-Aug. 2014
Nadir-only



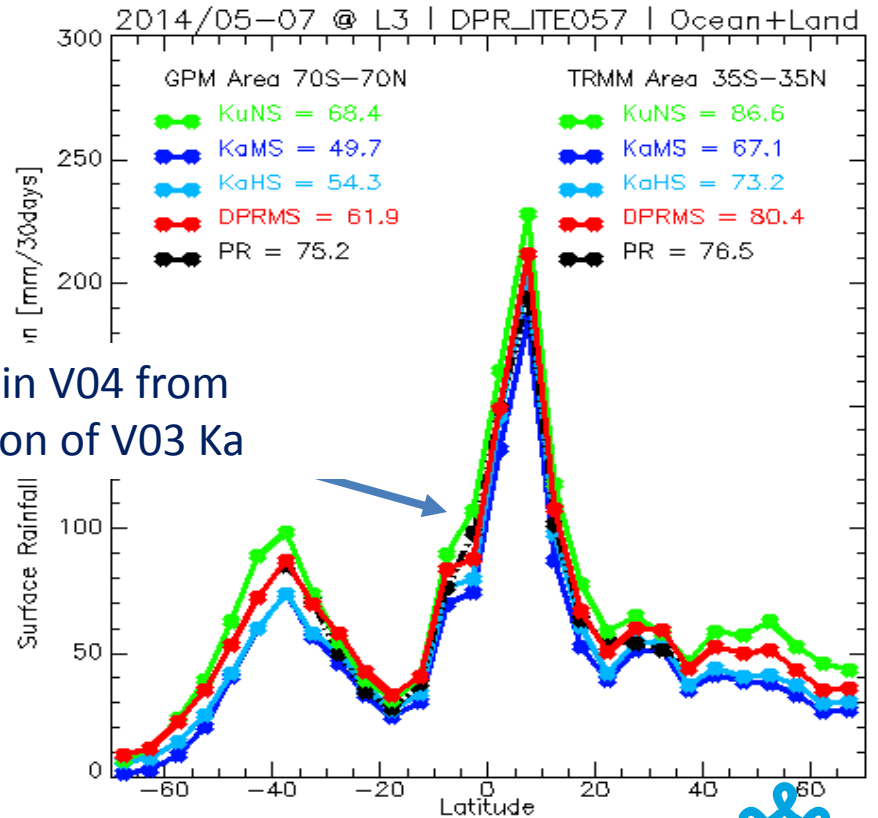
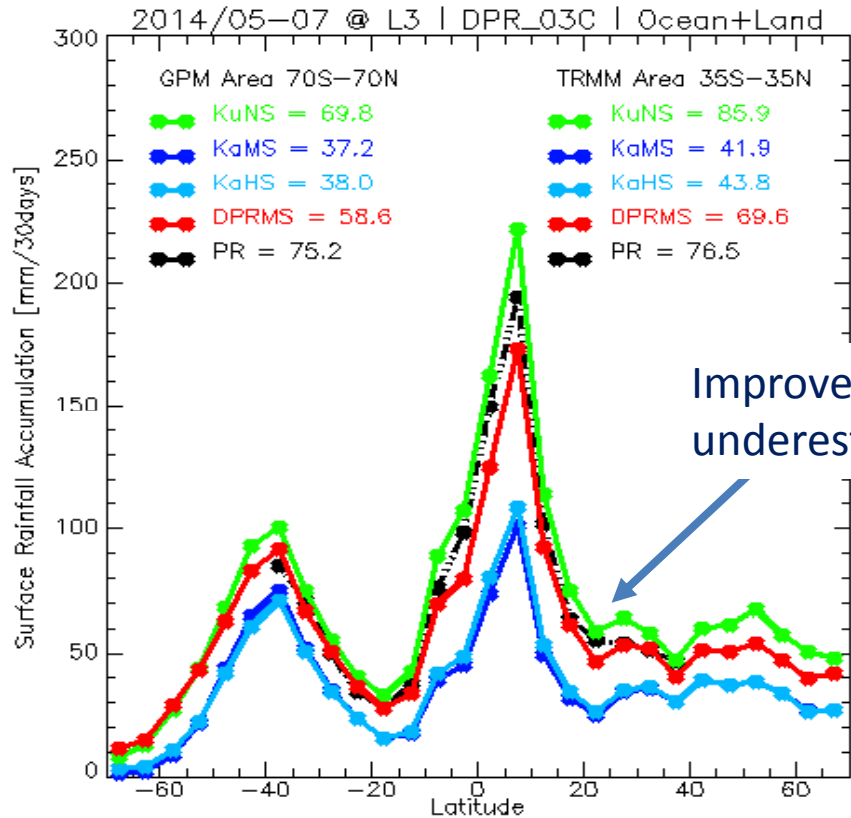
Provided by Prof. Hirose
(Meijo Univ.)
Coordination Group for
Meteorological Satellites

Version 4 DPR product released in Mar. 2014

Unconditional zonal mean of surface precipitation (May-July 2014)

V03B

V04



Improvement in V04 from underestimation of V03 Ka

DPR Data Assimilation in the JMA NWP

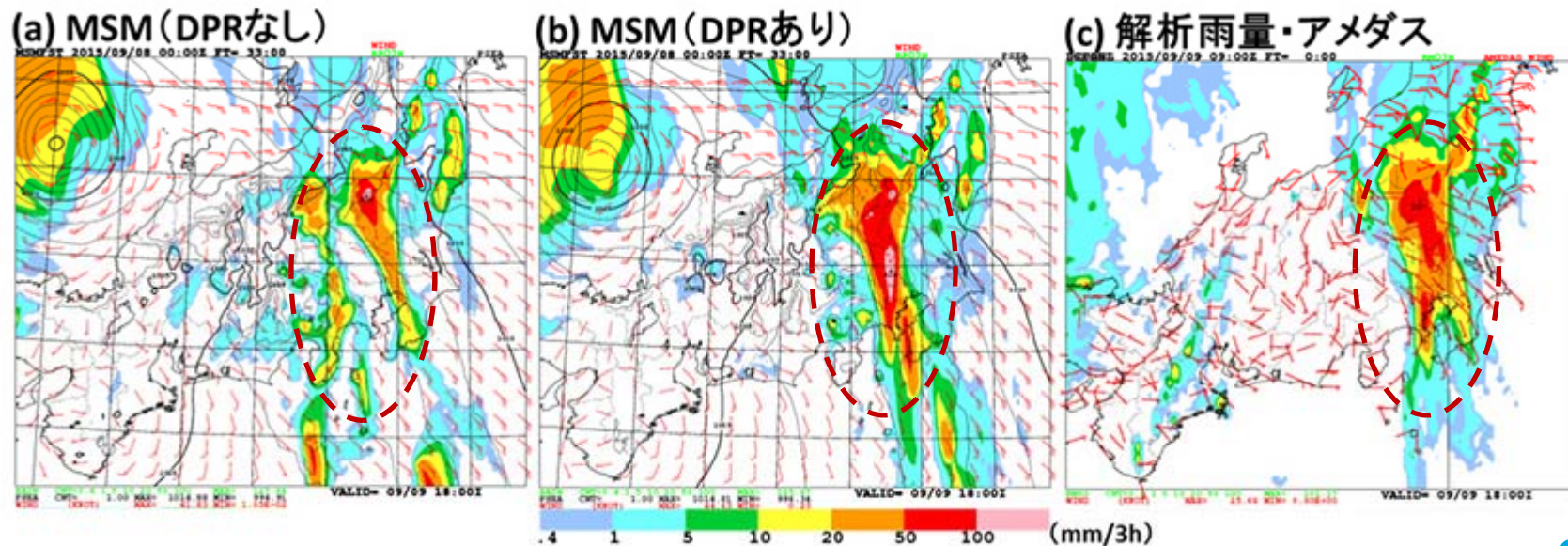
The Japan Meteorological Agency (JMA) started the DPR assimilation in the meso-NWP system on March 24 2016.

World's first "operational" assimilation of spaceborne radar data in the NWP system of meteorological agencies!

a) 33-hour prediction without the DPR

b) 33-hour prediction with the DPR

c) Observation



Example of Kanto-Tohoku Heavy Rainfall in 2015

Improvements in water vapor analysis accuracy over the ocean

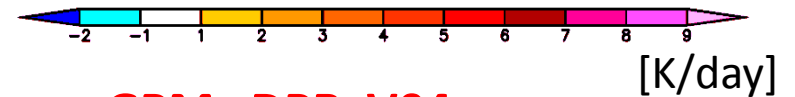
Improvements in rainfall forecast accuracy

Provided by JMA

Coordination Group for Meteorological Satellites - CGMS

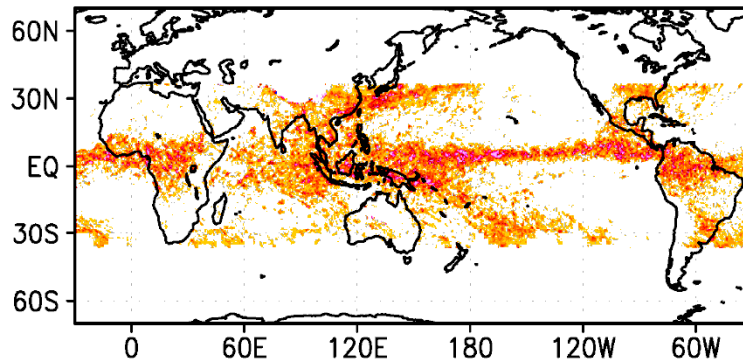
[Latent Heating] The first GPM latent heating product was released in March 2016

Comparison of latent heating products between TRMM/PR and GPM/DPR by the SLH algorithm (Shige et al. 2004) during Apr., May, Jun. 2014.



TRMM PR V7A

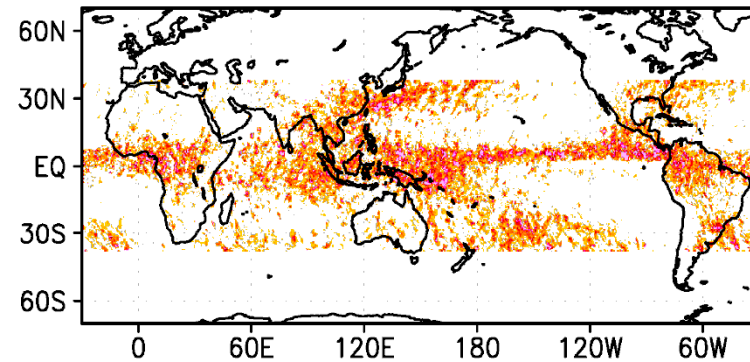
Q1R@7km Total(V7A) AMJ14



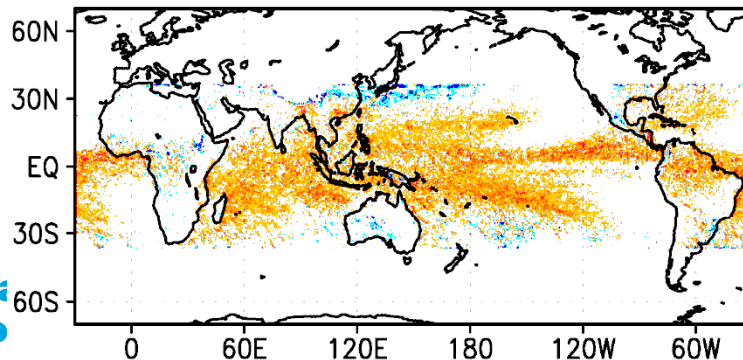
7km

GPM DPR V04

Q1R@7km Total(ITE057) AMJ14

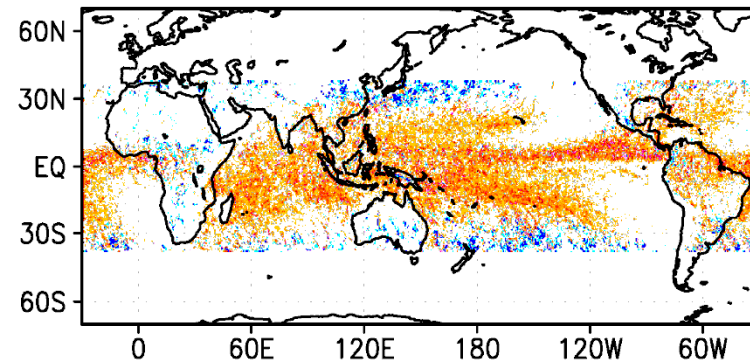


Q1R@2km Total(V7A) AMJ14



2km

Q1R@2km Total(ITE057) AMJ14

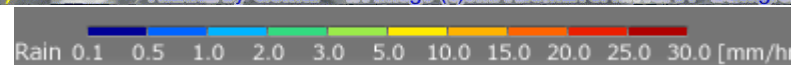
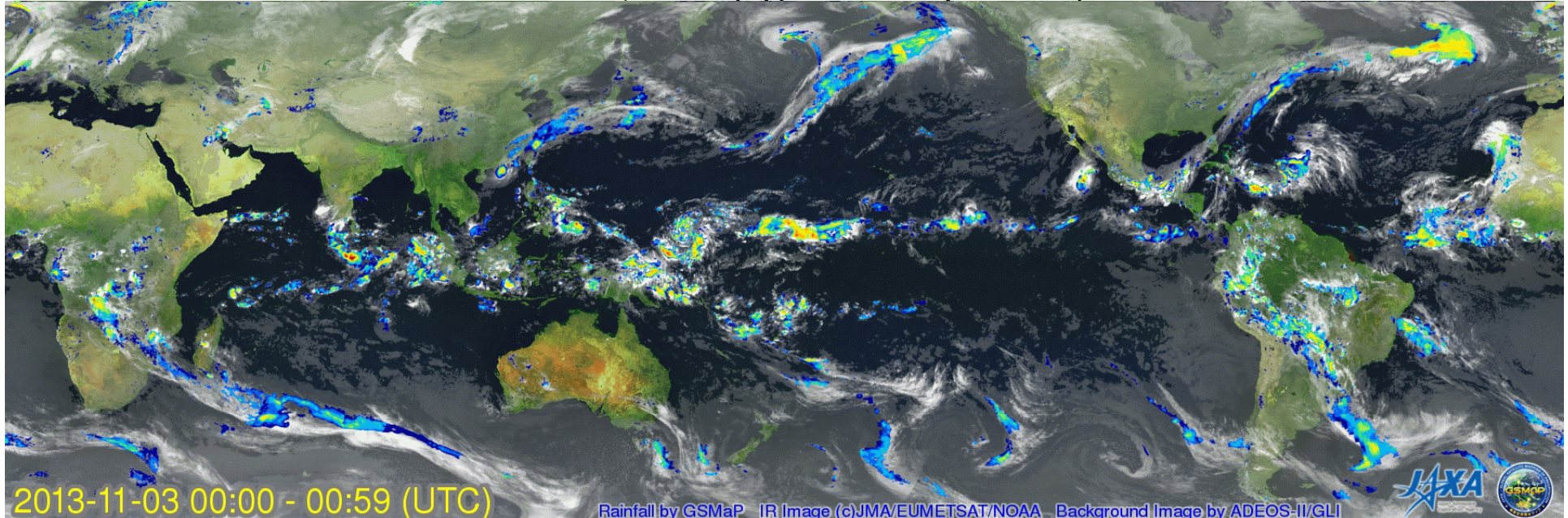


Global Satellite Mapping of Precipitation (GSMaP)



<http://sharaku.eorc.jaxa.jp/GSMaP/>

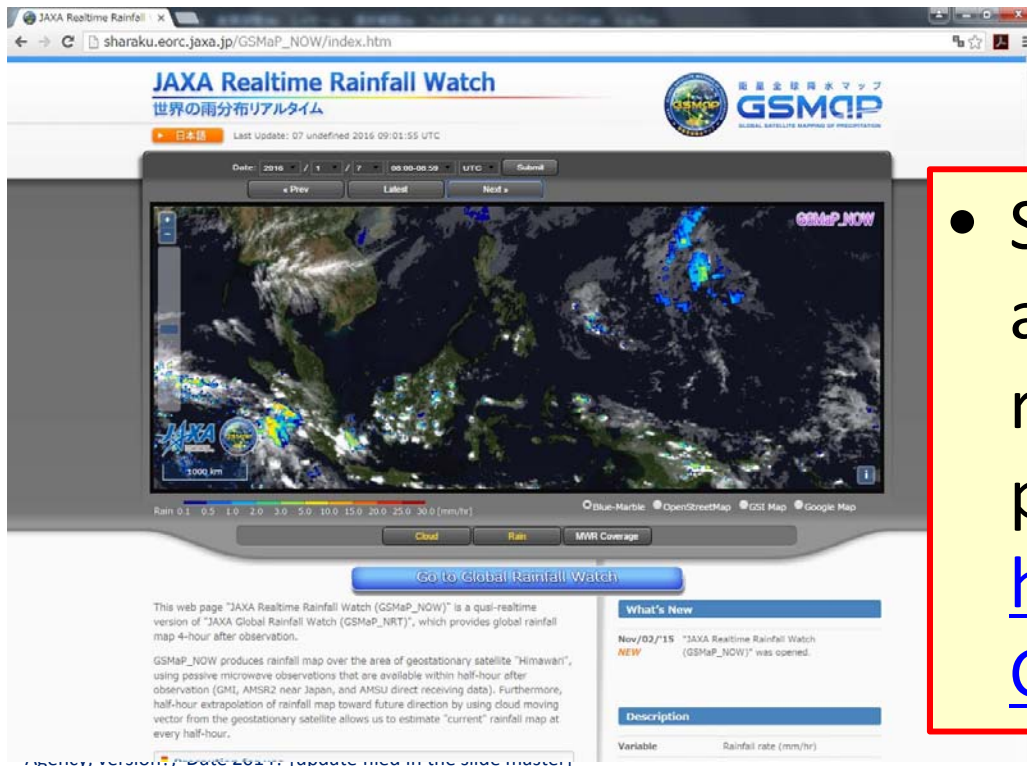
3-hourly movie from 3 to 9 November, 2013 (Typhoon Haiyan case)



- GSMaP is a blended Microwave-IR product and has been developed in Japan toward the GPM mission.
 - U.S. counterpart is “IMERG”
- Proto-type version has been in operation in JAXA since 2007
 - **“GPM-GSMaP” data were released in Sep. 2014.**
 - GPM-GSMaP data since Mar. 2000 period was reprocessing as reanalysis version (GSMaP_RNL), and was open to the public in Apr. 2016.

GSMaP real-time version(GSMaP_NOW)

- To reduce latency from 4-hr to “quasi-realtime”
 - Using data that is available within 0.5-hour (GMI, AMSR2 direct receiving data, AMSU direct receiving data and Himawari-IR) to produce GSMaP at 0.5-hr before (observation).
 - Applying 0.5-hour forward extrapolation (future direction) by cloud motion vector to produce GSMaP at current hour (just now) → “GSMaP_NOW”.

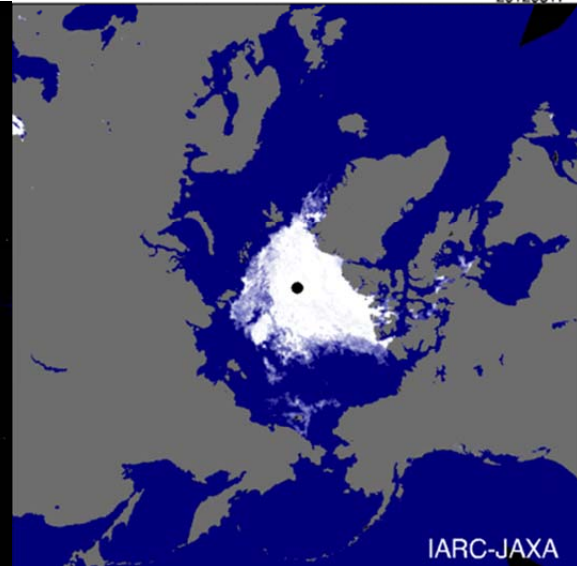


- Since Nov. 2015, web site and data (GEO-Himawari region) are open to the public from

http://sharaku.eorc.jaxa.jp/GSMaP_NOW/

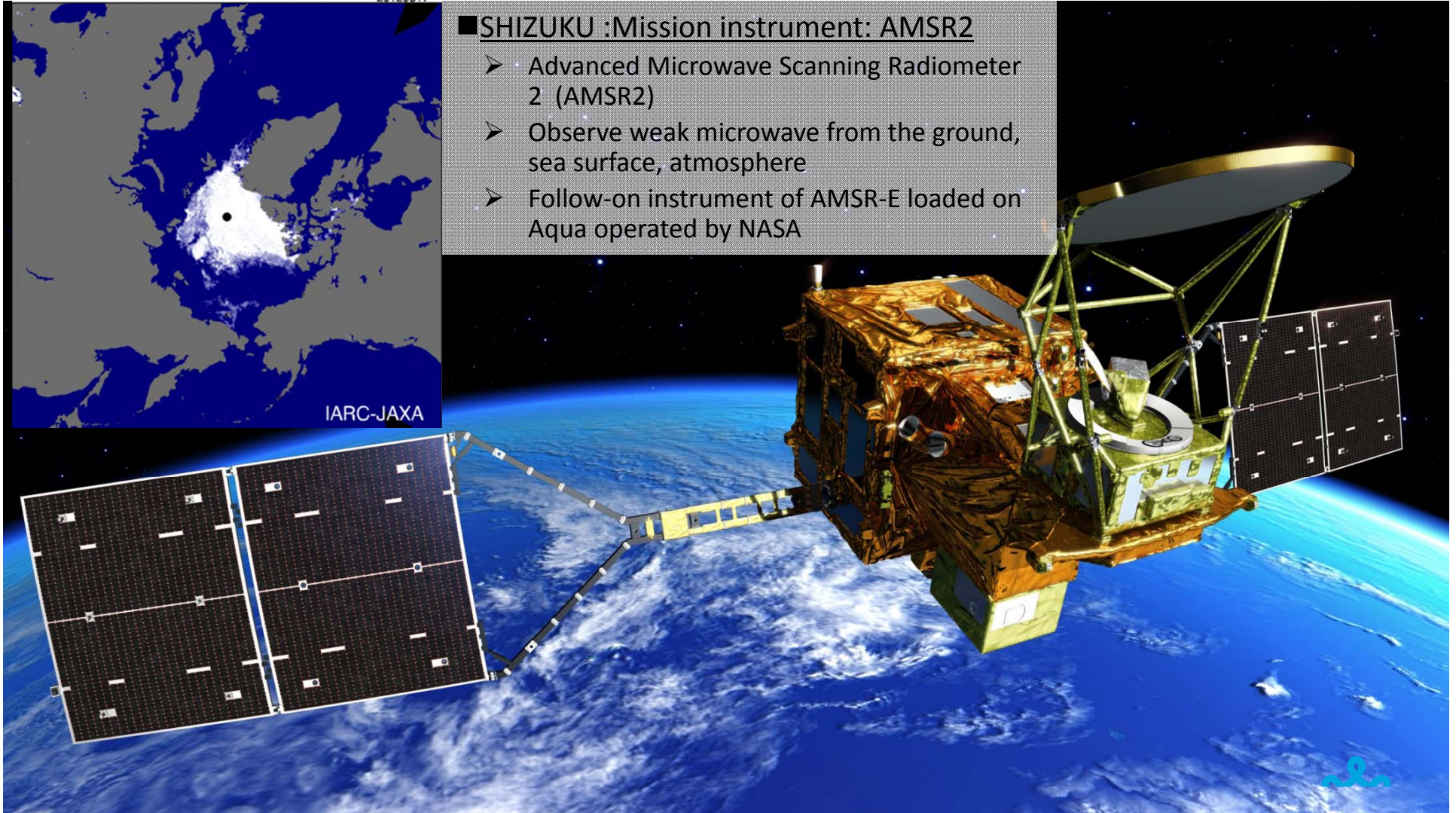
GCOM-W: Global Change Observation Mission - Water

AMSR2 Sea Ice Concentration 20120817



■ SHIZUKU :Mission instrument: AMSR2

- Advanced Microwave Scanning Radiometer 2 (AMSR2)
- Observe weak microwave from the ground, sea surface, atmosphere
- Follow-on instrument of AMSR-E loaded on Aqua operated by NASA



List of AMSR2 Products

Standard Product

Research Product

| Standard Product | | Area | Resolution |
|------------------------|-------------------------|------------------------------|------------|
| Brightness Temperature | | Global | 5-50km |
| G E O | Precipitable Water | Global, over ocean | 15km |
| | Cloud Liquid Water | Global, over ocean | 15km |
| | Precipitation | Global, except cold latitude | 15km |
| | Sea Surface Temperature | Global, over ocean | 50km |
| | Sea Surface Wind Speed | Global, over ocean | 15km |
| | Sea Ice Concentration | Polar region, over ocean | 15km |
| | Snow Depth | Land | 30km |
| | Soil Moisture | Land | 50km |

| Research Product | | Area | Resolution |
|------------------|--|-----------------------------|------------|
| G E O | All-weather sea surface wind speed | Global, over ocean | 60 km |
| | 10-GHz sea surface temperature | Global, over ocean (>9degC) | 30 km |
| | Soil moisture and vegetation water content based on the land data assimilation | Africa, Australia | 25 km |
| | Land surface temperature | Land | 15 km |
| | Vegetation water content | Land | 10 km |
| | High resolution sea ice concentration | Ocean in high latitude | 5 km |
| | Thin ice detection | Okhotsk sea | 15 km |
| | Sea ice moving vector | Ocean in high latitude | 50 km |

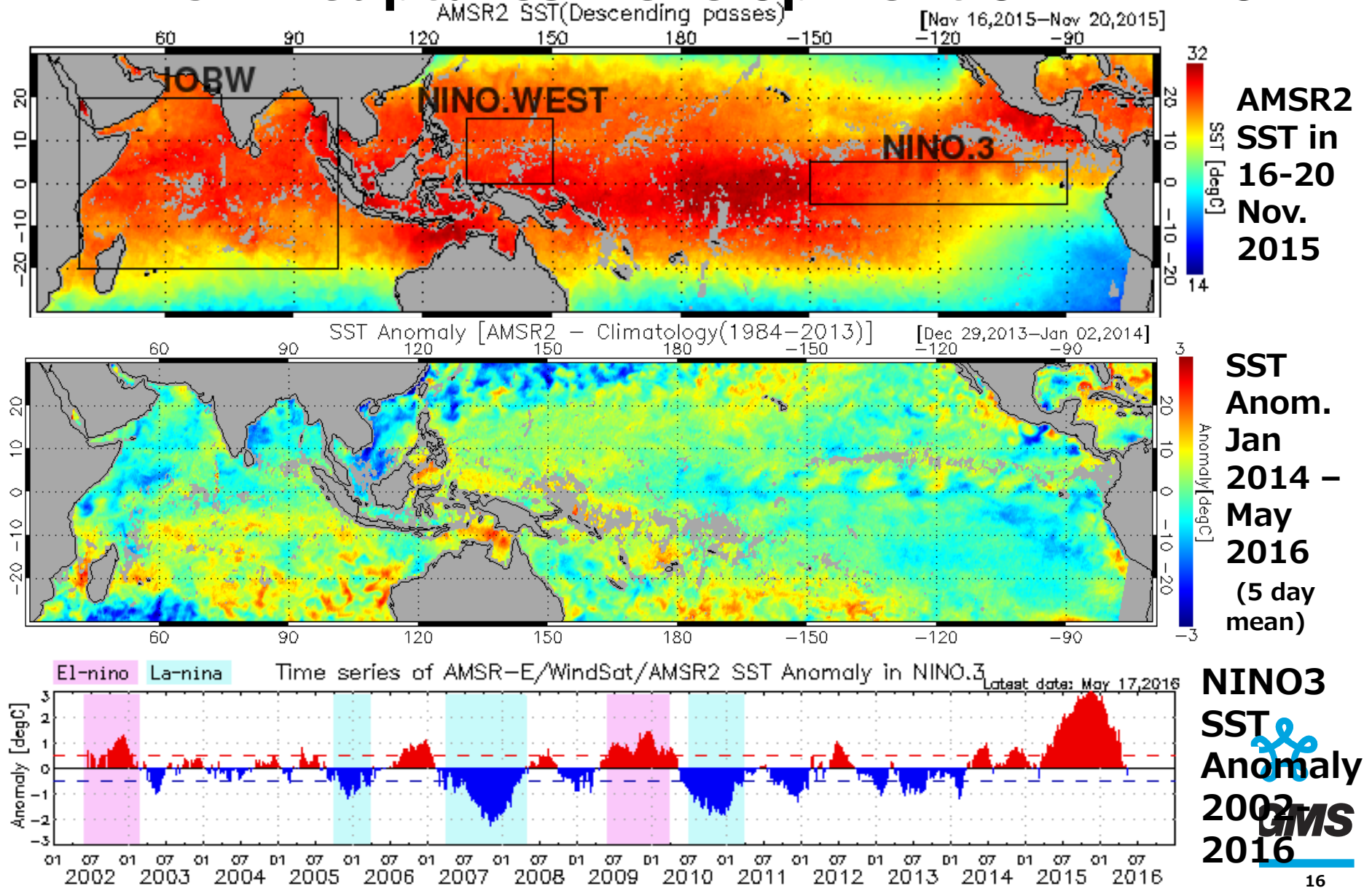
* Resolution of geophysical parameters depends on that of Level 1 channels, which used mainly in retrieval.

* Red colored products are under validation and not released (as of April 2016)



CGMS

AMSR2 Captures Development of El Niño



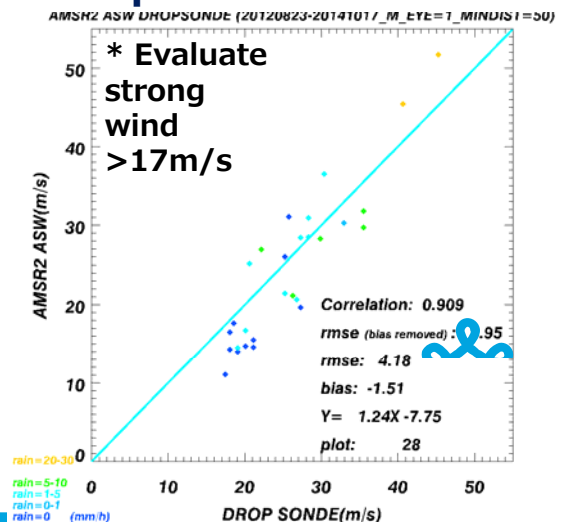
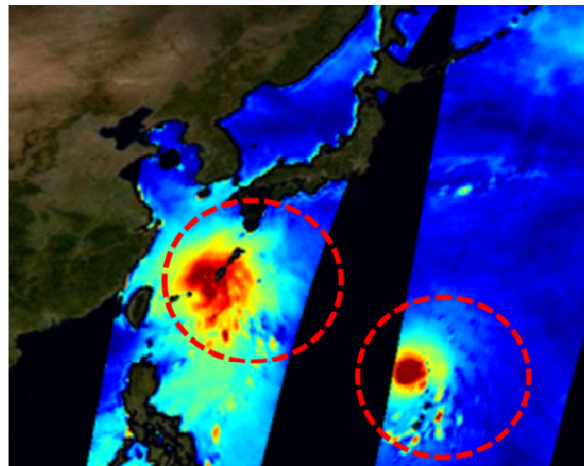
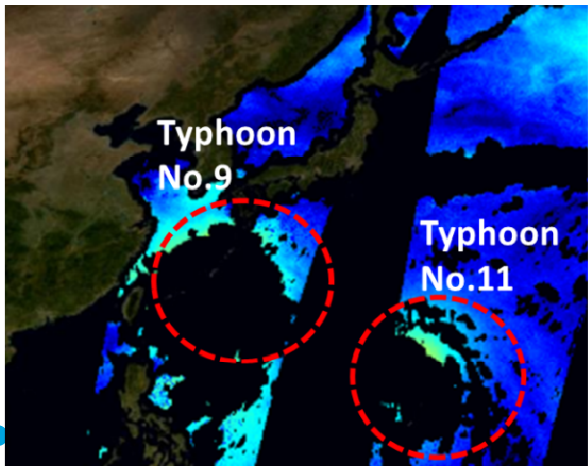
NINO3
SST
Anomaly
2002
2016

AMSR2 All-weather Sea Surface Wind Speed

- Use 6-GHz/10-GHz channels to avoid influence of rainfall (Shibata, 2006), corresponding to wind speed at best track released by JMA and NHC.
- Can capture wind speed under tropical cyclones (typhoons, hurricanes, cyclones)
- AMSR2 all-weather SSW Released to public in October 2015 after validation by using dropsonde provided by NOAA (http://suzaku.eorc.jaxa.jp/GCOM_W/research/terms.html)
- Used in JMA's operational typhoon analysis. Validation with NOAA dropsonde

AMSR2 Standard SSW

AMSR2 All-weather SSW

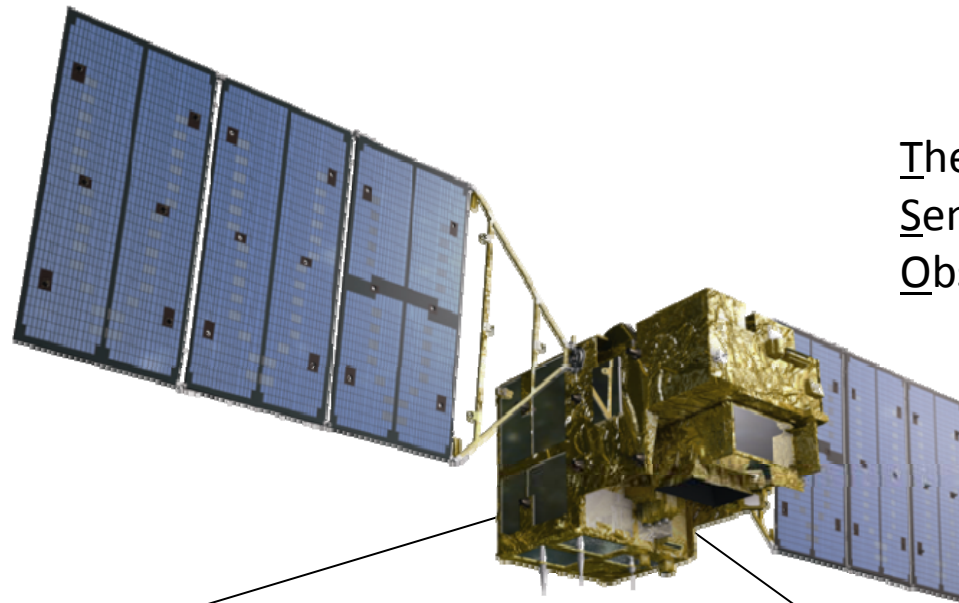


GOSAT and GOSAT-2: Greenhouse Gases Observing Satellite

- Monitoring global distribution of Greenhouse Gases from space
- GOSAT is Observing Carbon dioxide and Methane at 100-1000km spatial scale with relative accuracy of 1% (4ppm) for CO₂ and 2% (34ppb) for CH₄
- GOSAT-2 targetted 0.5ppm for CO₂ and 5ppb for CH₄
- Launch will be 2017

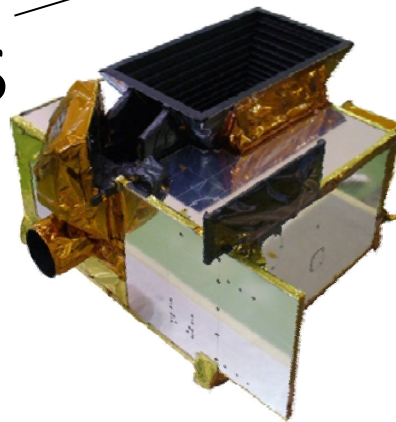


GOSAT for a decade long observation



Thermal And Near infrared
Sensor for carbon
Observation

TANSO-FTS



TANSO-CAI



SWIR/TIR FTS

**Coordination Group for
Meteorological Satellites**

UV, Visible, SWIR Imager

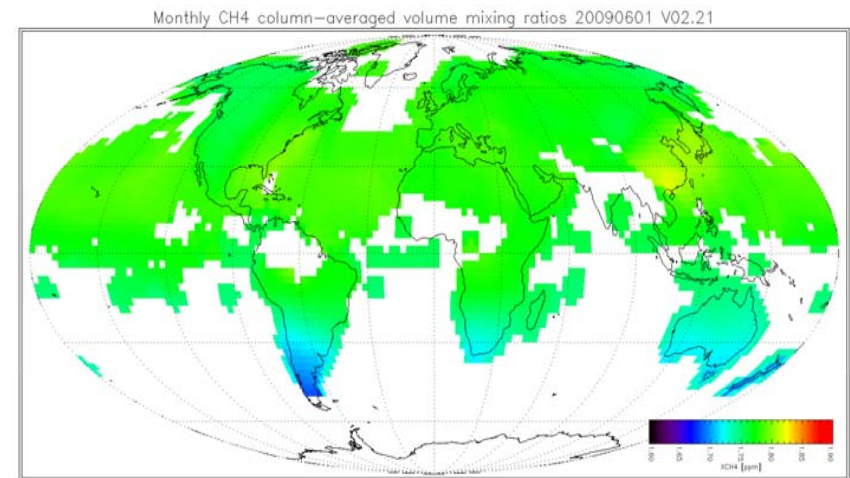
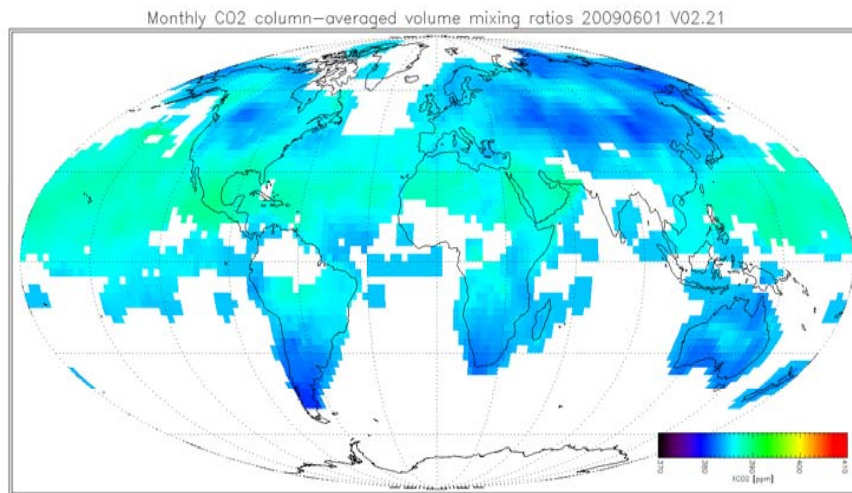
Add CGMS agency logo
here (in the slide master)



Coordination Group for Meteorological Satellites - CGMS

GOSAT TANSO-FTS in space for more than 7 years

The typical accuracy of retrieved column-averaged dry air mole fractions of CO₂ and CH₄ are 2ppm or 0.5% and 13ppb or 0.7%, respectively.



Coordination Group for
Meteorological Satellites

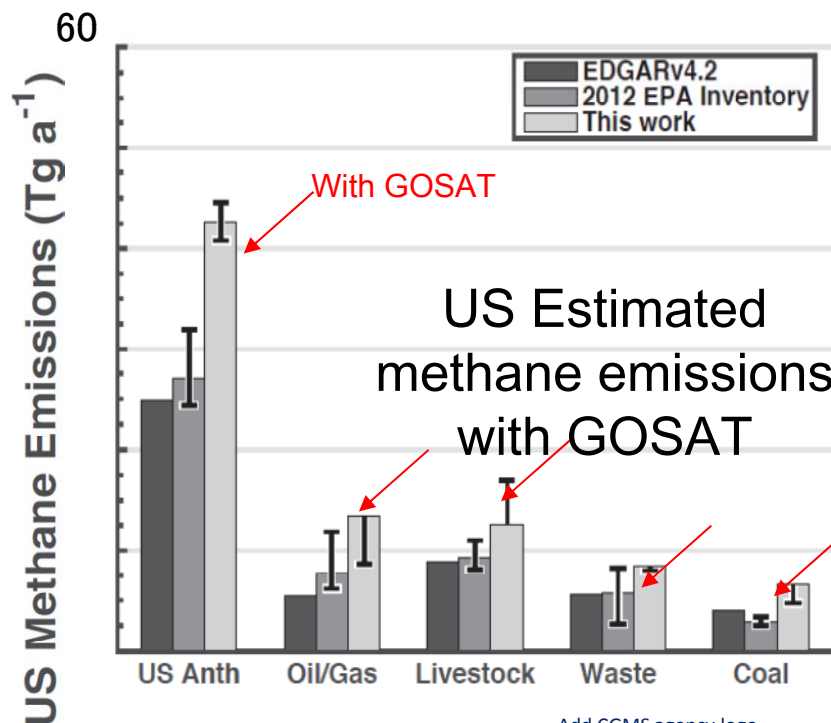
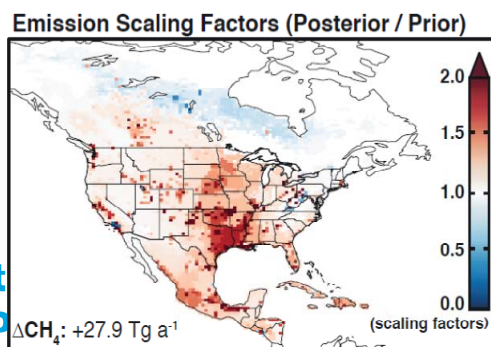
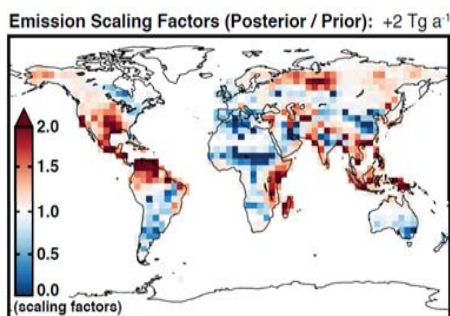
Monthly mean global CO₂ and CH₄ since 2009 GOSAT
launch

Add CGMS agency logo
here (in the slide master)



Research Highlight in 2015

Turner et al. (2015) has compared North America CH₄ emissions between the Emission Database for Global Atmospheric Research (EDGAR) v4.2 model, the 2012 US Environmental Protection Agency (EPA) inventory, and the GOSAT Level 2 products. The analytical results show that the EDGAR and EPA bottom-up inventories underestimate a US anthropogenic methane source. The emissions are highest in the south-central US, the Central Valley of California, and Florida wetlands; large isolated point sources such as the US Four Corners also contribute.



Coordination Group for Meteorological Satellites - CGMS

International collaboration to demonstrate the effectiveness of greenhouse gases monitoring from space



2008 2009 2010 2011 2012 2013 2014 2015
2016

Radiometric calibration

Prelaunch
X-CAL



Annual Vicarious Calibration at the desert playa in Nevada



CO₂ & CH₄ profile

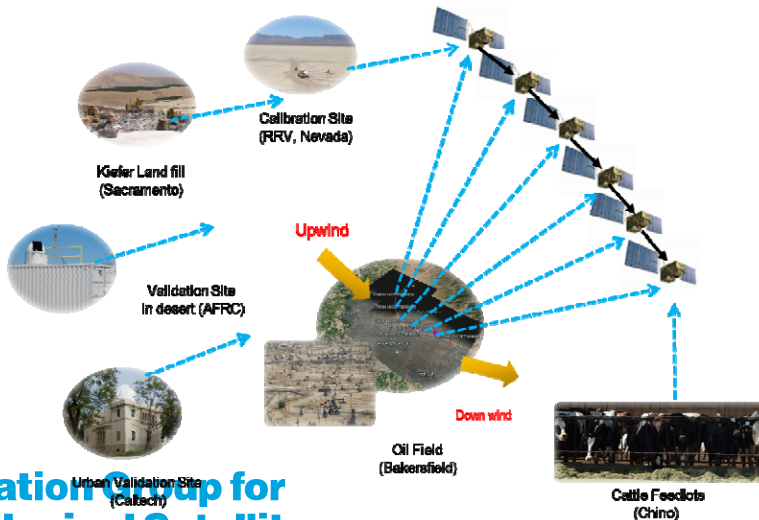
In situ CO₂ and CH₄ on AJAX airplane

XCO₂ & XCH₄

Column with a ground based FTS



Coincident
Target
(match)

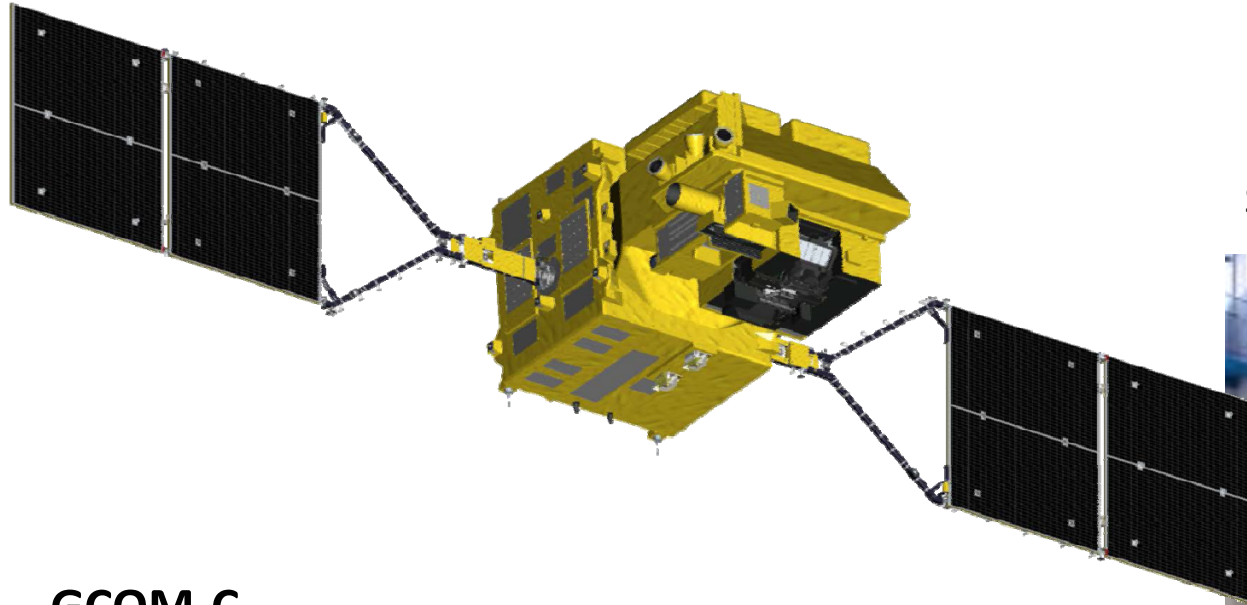


Coordination Group for Meteorological Satellites

Example of target observations over the US west coast



GCOM-C: Global Change Observation Mission - Climate



Satellite under development...



GCOM-C

- Target Launch: 2016
- Main Instrument: SGLI (Second-generation GLocal Imager)
- Observe aerosols and clouds, as well as vegetation and temperatures in the land and ocean region
- SGLI-derived phytoplankton, aerosol and vegetation activity will be used for mapping fisheries, monitoring crop growth and estimating crop yield

GCOM-C/SGLI:

SGLI 250m Visible-SWIR observation

- ✓ **250m resolution** to detect finer structure in the coastal area such as river outflow, regional blooms, small current, and red tide.

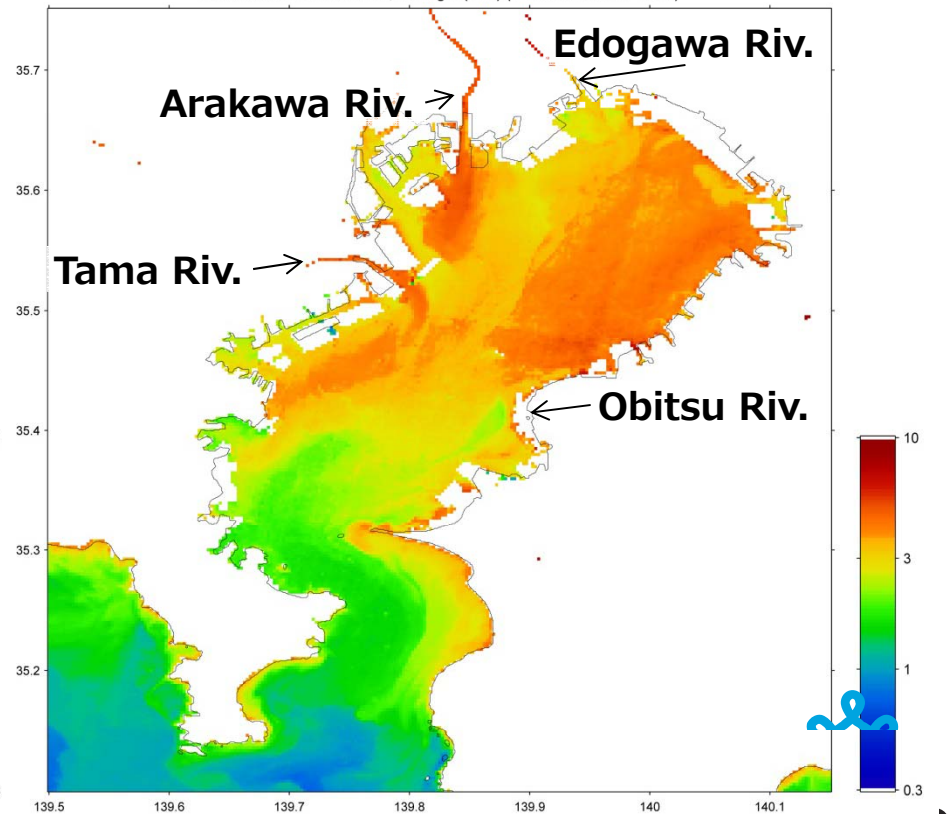
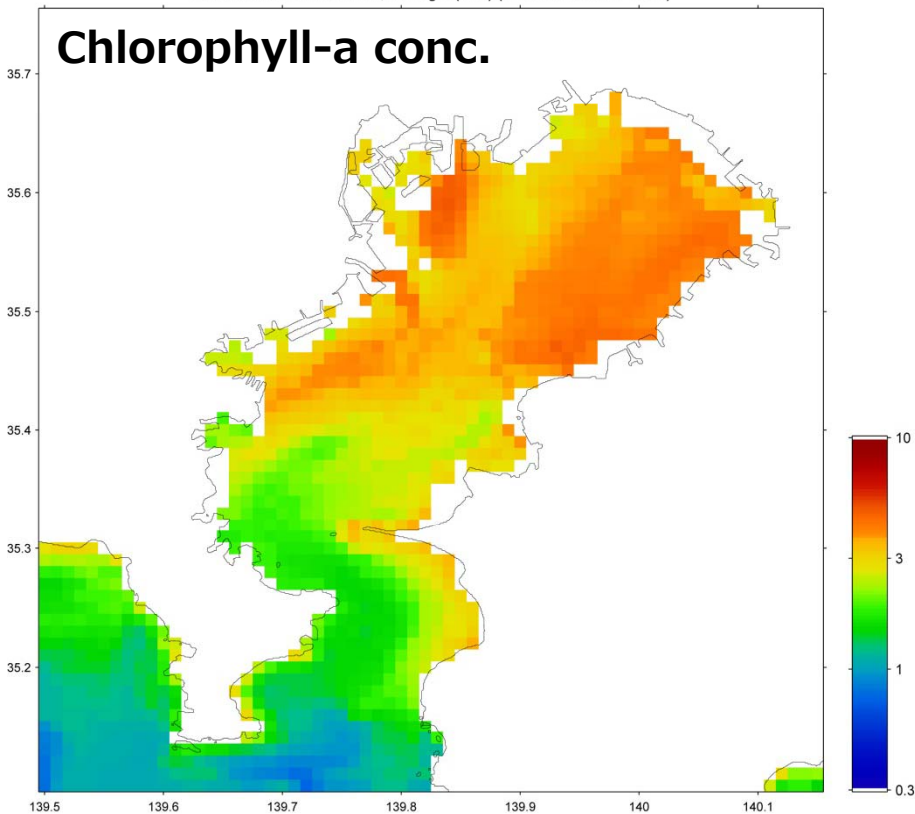
1-km resolution

250-m resolution



LC81070362013260LGN00, OC log10(chla) (2013/09/17 01:18 11.41)

LC81070362013260LGN00, OC log10(chla) (2013/09/17 01:18 11.41)



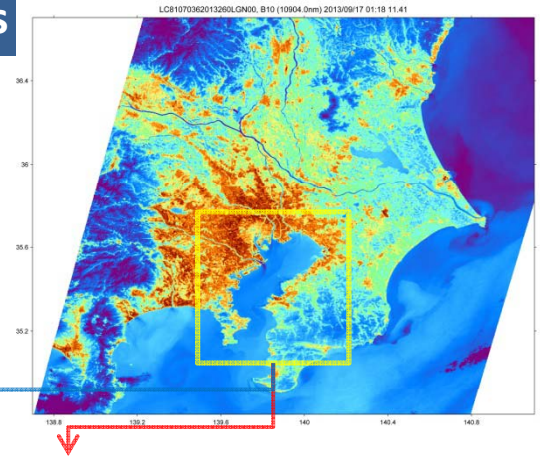
mg/m³

250m SGLI products simulated by Landsat image (Tokyo-Bay on 17 Sep 2013)

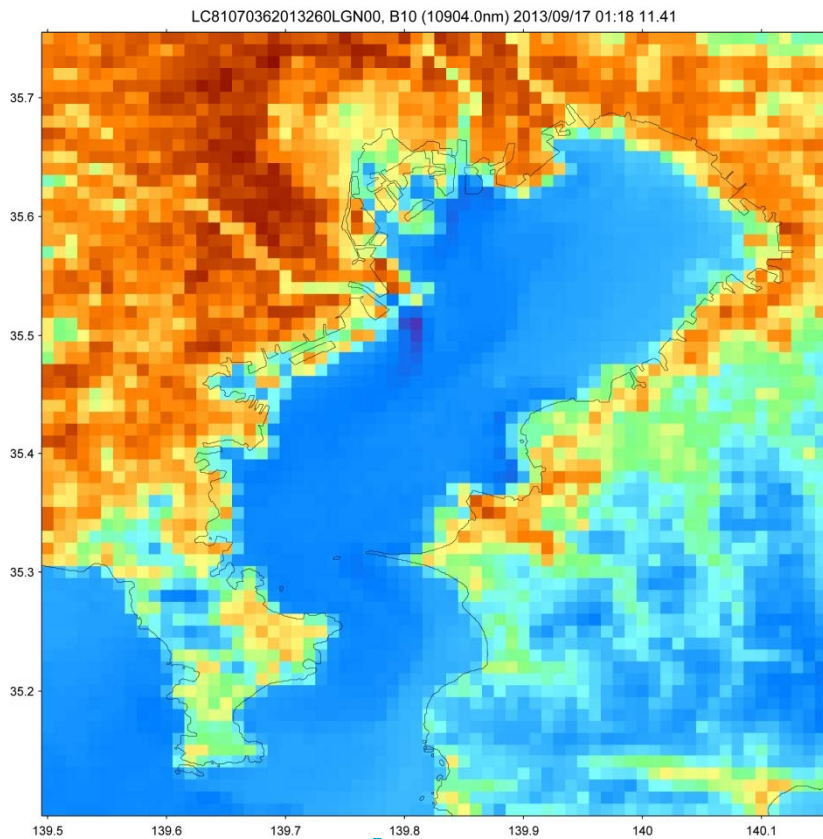
GCOM-C/SGLI:

SGLI 250m Thermal infrared observations

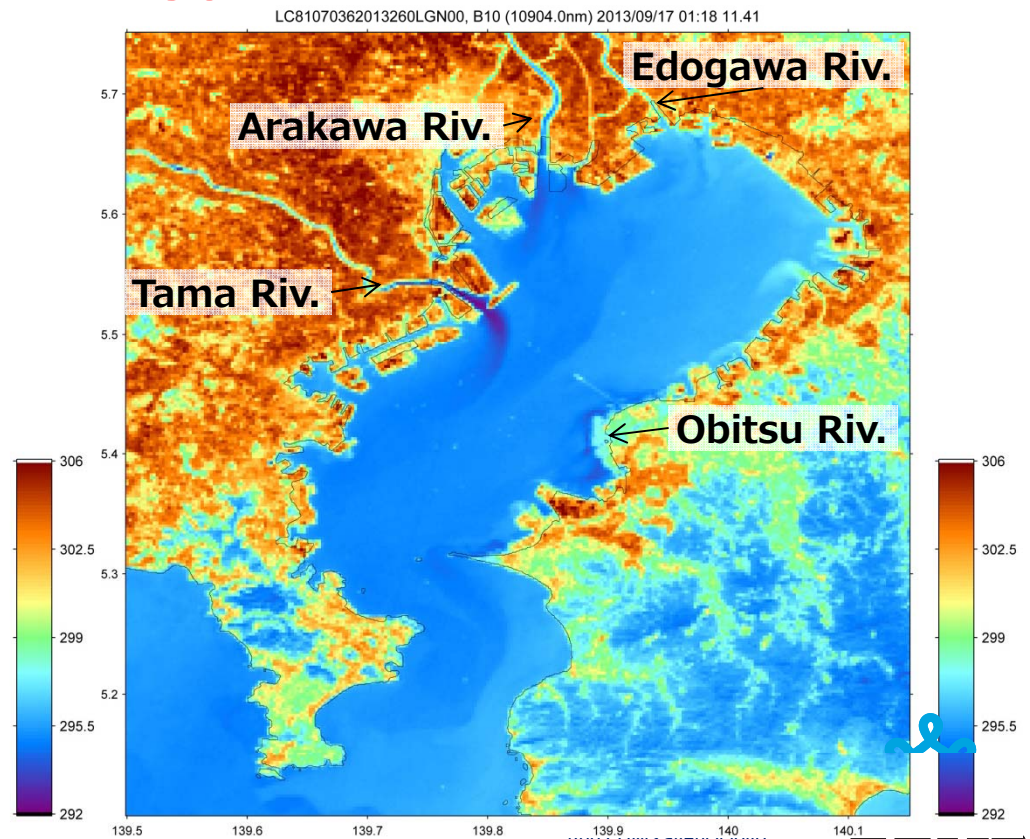
✓ **250m resolution** to detect finer structure in the coastal area such as river outflow, and influence of human activities.



1-km



250-m



Meteorological Satellites

Agency, version?, Date 2014? [update filed in the slide master]

Simulated by LANDSAT-8/TIRS 11 μ m 100m data on 17 Sep. 2013

CGMS
Kelvin

EarthCARE/CPR – Cooperation with ESA

To reduce the uncertainties in global warming prediction by measuring the three dimensional structure of clouds and aerosols, which are most uncertain parameter in the numerical climate models.



Instrument

CPR (Cloud Profile Radar)

ATLID (Atmospheric LIDAR)

MSI (Multi-Spectral Imager)

BBR (Broad Band Radiometer)

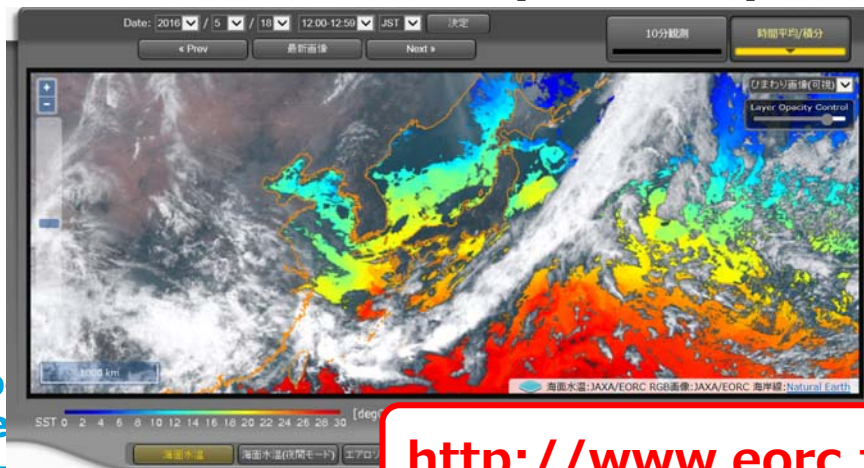
- Joint Mission by Europe and Japan
- Launch in 2018
- 3 years lifetime
- 400 km altitude
- Sun-synchronous orbit (Local time: 14:00)



Ocean Environment Monitoring

- Developed Himawari-8 Ocean products based on the GCOM-C/SGLI algorithms (Kurihara et al., 2016)
- Himawari Ocean Products
 - NetCDF-CF format
 - Sea Surface Temperature (2km res., 10-min/1-hr ave.)
 - Night-time SST (2km res., 1-hr ave.)
 - Ocean Color (Chlorophyll-a) (5km (full-disk)/1km (near Japan) res., 1-hr ave.)
 - Short Wave Radiation & Photosynthetically Available Radiation (PAR) (5km (full-disk)/1km (near Japan) res., 10-min/1-hr ave.)

Himawari-8 SST (1-hr ave)



Himawari-8 Chl-a (1-hr ave)



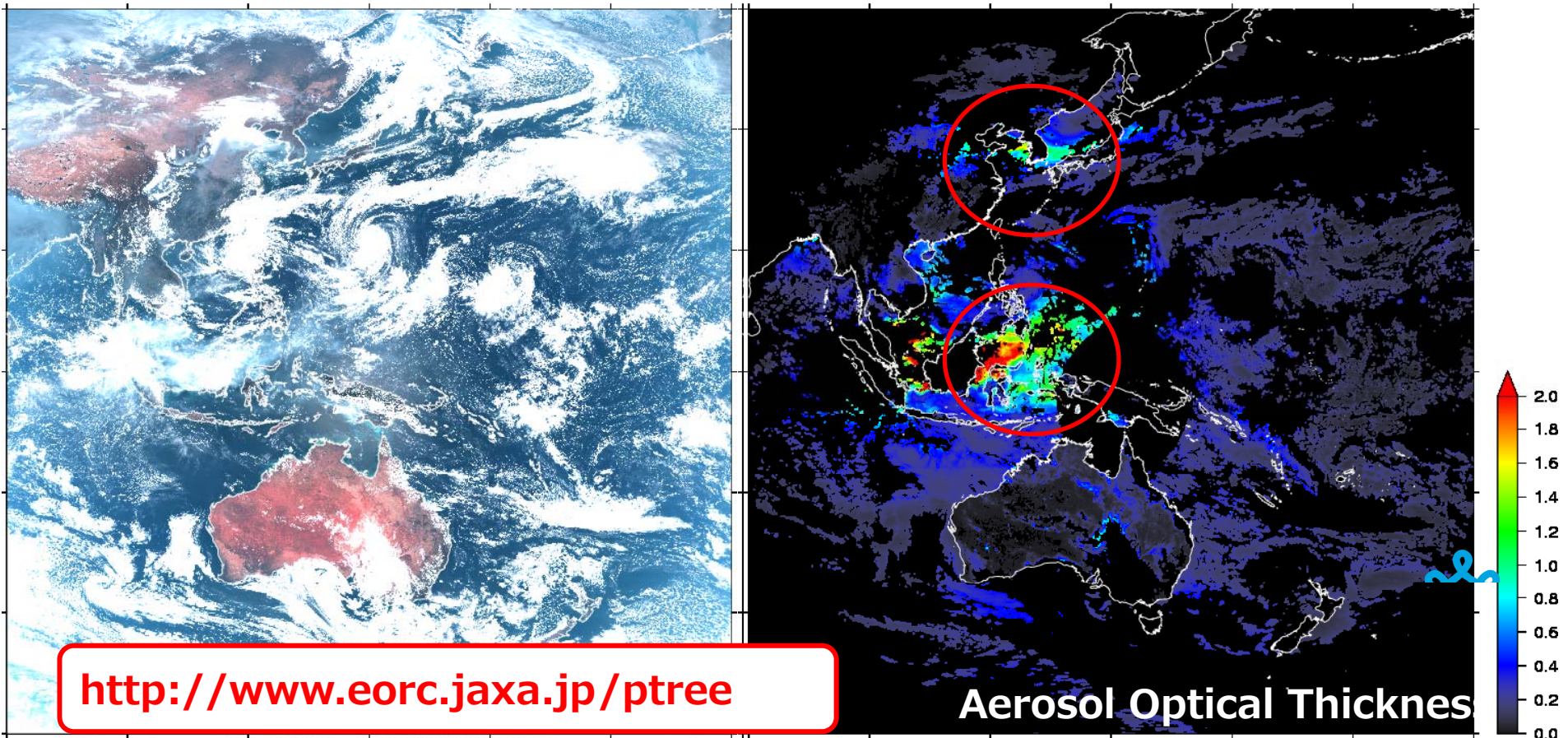
<http://www.eorc.jaxa.jp/ptree>

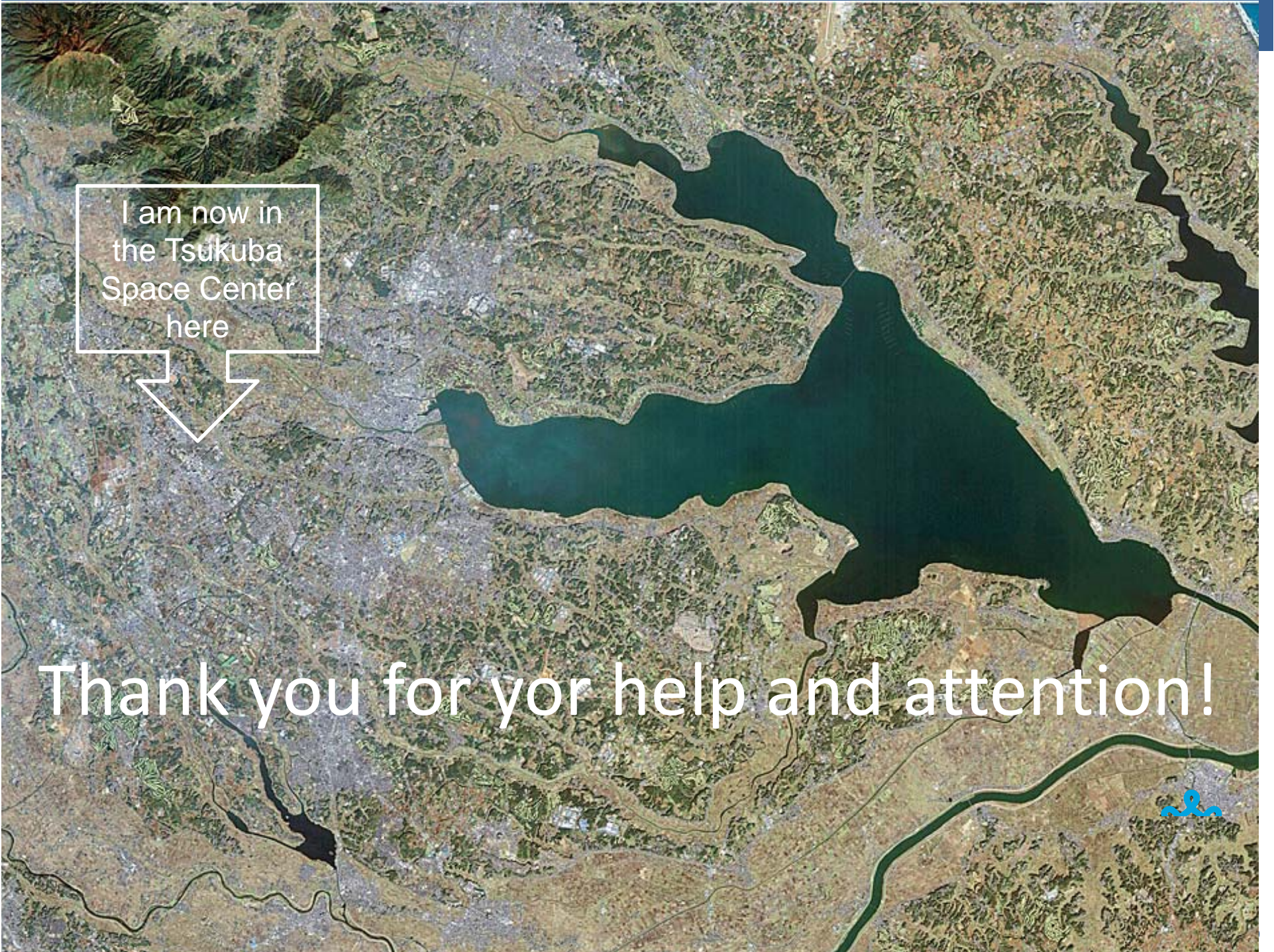
Air Pollutant Monitoring

- Developed Himawari-8 Aerosol products based on the GCOM-C/SG1 algorithms (Higurashi and Nakajima, 1999, 2002; Fukuda et al. 2013)
- Air pollutant flows originated from wildfire in Indonesia and China can be detected.

NC_H08_20151020_0230_R21_FLDK.02401_02401.nc

AOT1H H08_20151020_0230_1H_ARPbet_FLDK.02401_02401.nc



A satellite-style map of Tsukuba, Japan, showing a large reservoir in the center and surrounding urban and forested areas. A white callout box with a downward-pointing arrow is located in the upper left quadrant. The text inside the box reads: "I am now in the Tsukuba Space Center here".

I am now in
the Tsukuba
Space Center
here

Thank you for yor help and attention!

A small, stylized blue logo consisting of three wavy lines, resembling a signature or a brand mark, located in the bottom right corner of the map.