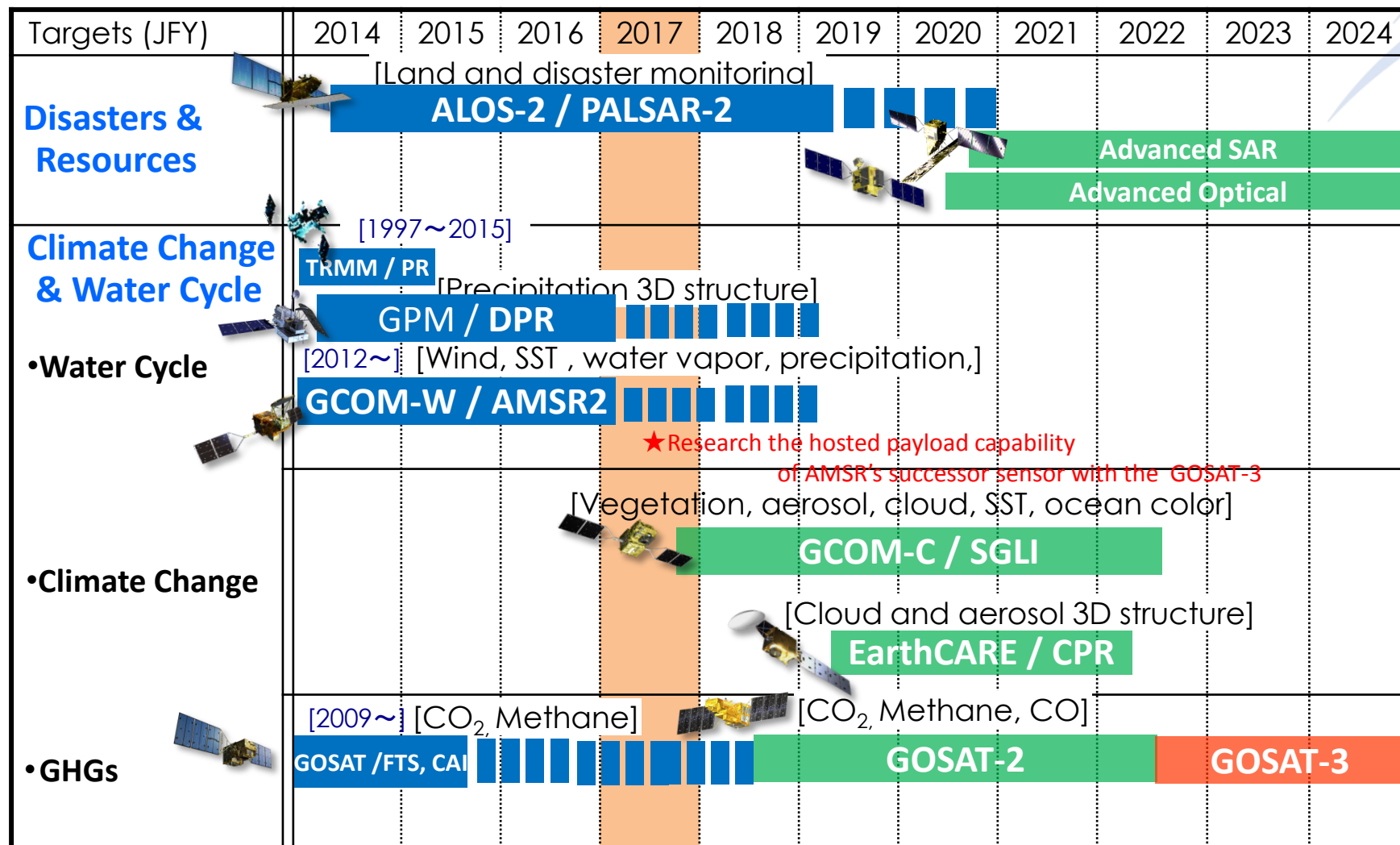


JAXA Earth Observation Satellites Program for water applications

ALOS-2 Project Manager

Shin-ichi Sobue

JAXA Earth Observation Satellites



Mission status: ■ On orbit ■ Development ■ Study



JAXA's Earth Observation Programs

JAXA's EO scenario

1. Disaster Risk Management

Crustal
Deformation
Monitoring

Flood Early
Warning

Landslide
Monitoring

2. Climate Change (Mitigation/Adaptation)

Mitigation
GHG
Monitoring

Mitigation
Forest
Monitoring

Adaptation
Prediction of
extreme
weather event

3. New Applications

Ocean

DSM

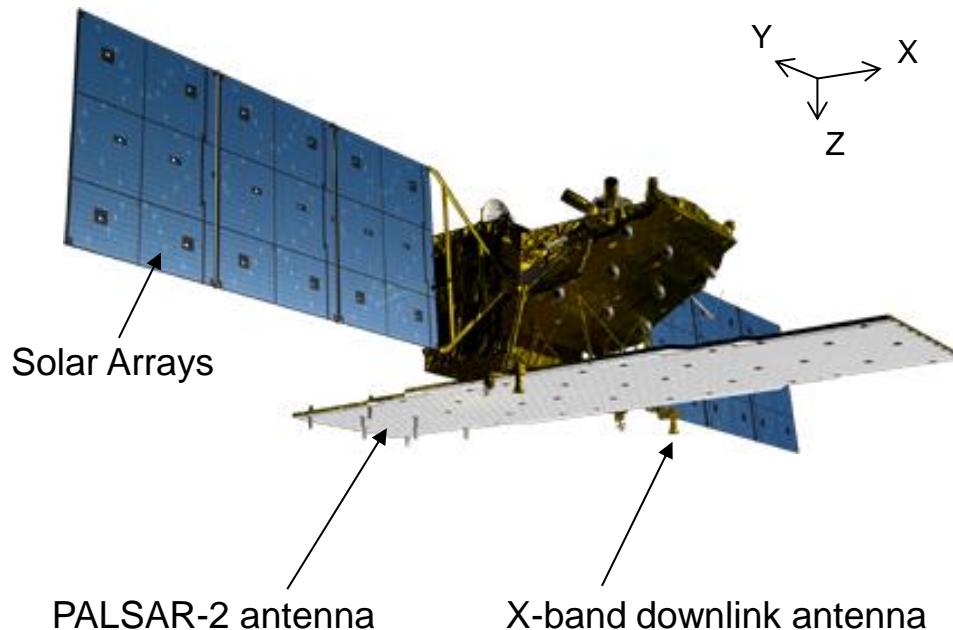
Infrastructure
Monitoring

**Geospatial Information
By Satellite Remote Sensing**

Advanced Land Observing Satellite-2 (ALOS-2)

Mission objectives

- Disaster monitoring (Earthquake, Volcano, Landslide, Flooding, ...)
- Environmental monitoring (Forest, Ice sheet, ...)
- Agriculture, natural resources, and ocean
- Technology development



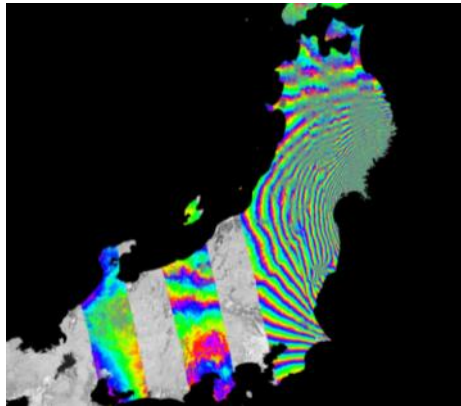
Mission sensor	PALSAR-2 (Phased Array type L-band Synthetic Aperture Radar 2)
Launch	May 24, 2014 H-IIA launch vehicle
Mass	2.1 tons
Lifetime	5 years (target: 7 years)
Orbit	Sun-synchronous, 628 km altitude, 14 days revisit, Orbit control: $\leq \pm 500$ m
Local sun time	12:00 \pm 15 min (descending) 24:00 \pm 15 min (ascending)
Mission data transmission	X-band: 800 Mbps (16 QAM), 200/400 Mbps (QPSK)

“Daichi-2” (ALOS-2)

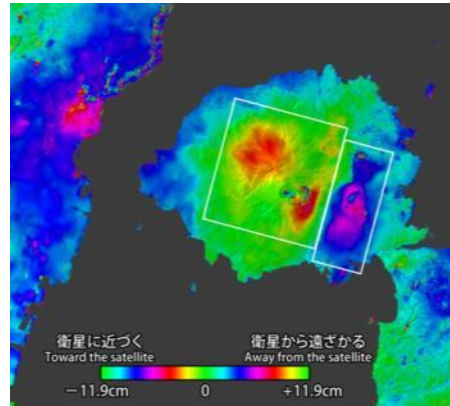
Mission Objectives:

Disaster monitoring

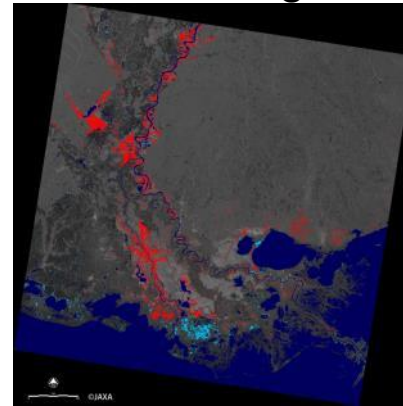
Earthquake



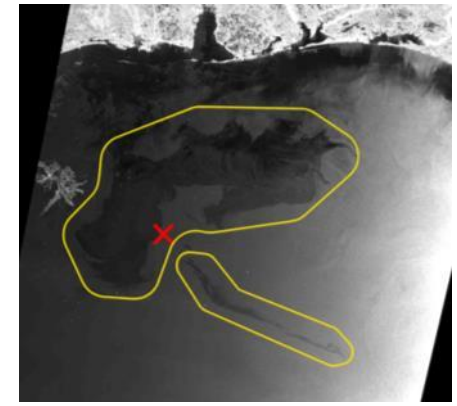
Volcano



Flooding

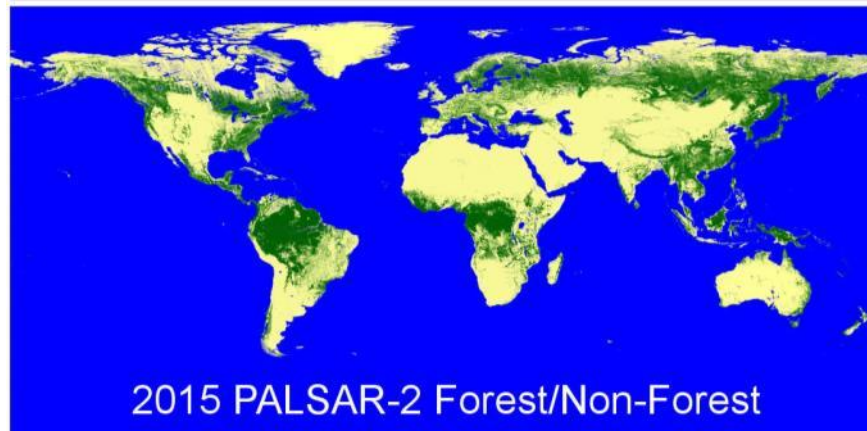


Ocean

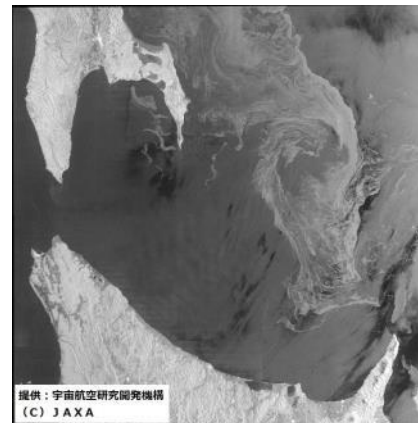


Environment and land management

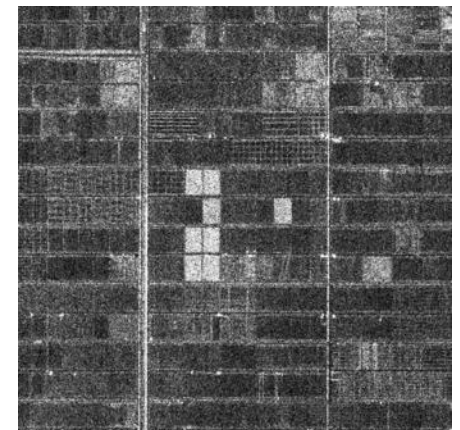
Forest and wetland



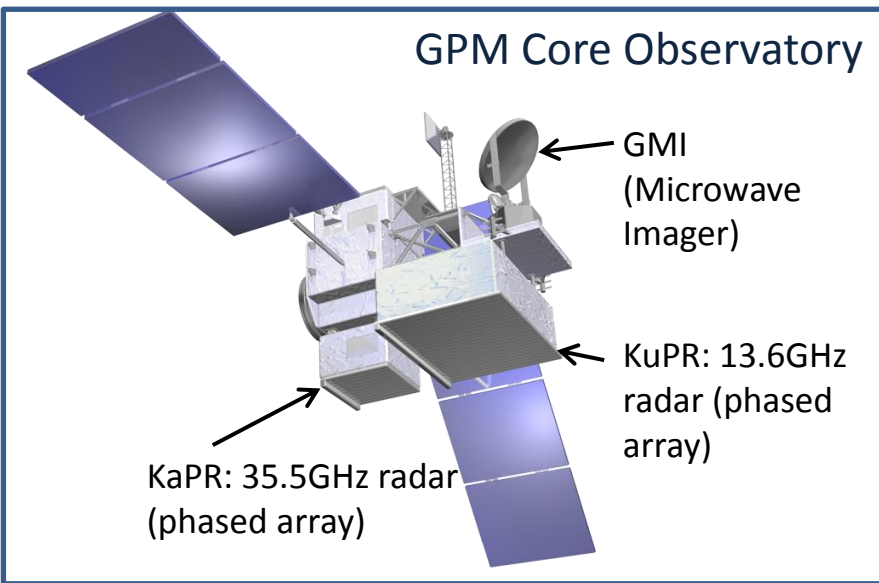
Ice



Agriculture & natural resources



Global Precipitation Measurement (GPM)



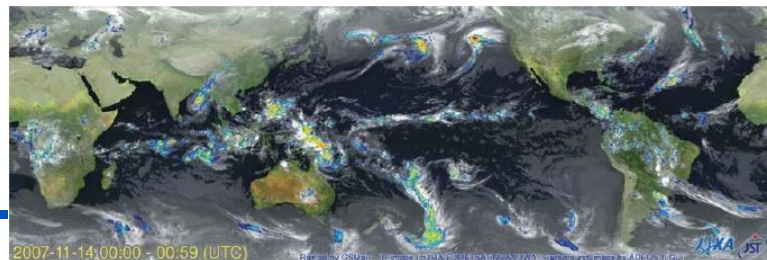
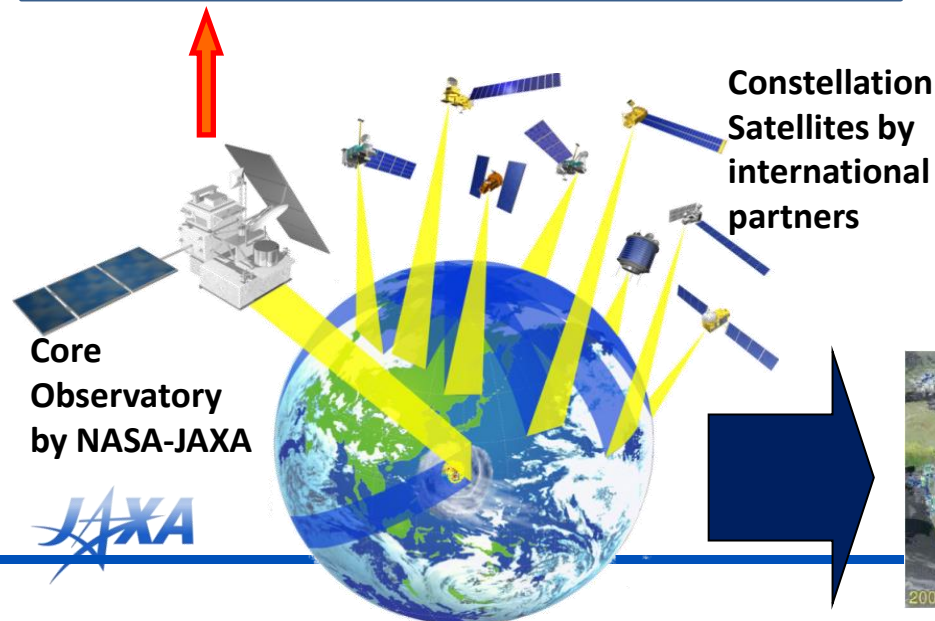
- GPM is an international mission consisting of the GPM Core Observatory and Constellation Satellites for high accurate and frequent global precipitation observation.

- Core Observatory: developed under NASA and JAXA equal partnership.
- Constellation satellites: provided by international partners (includes GCOM-W1).

■ Dual-frequency Precipitation Radar (DPR)

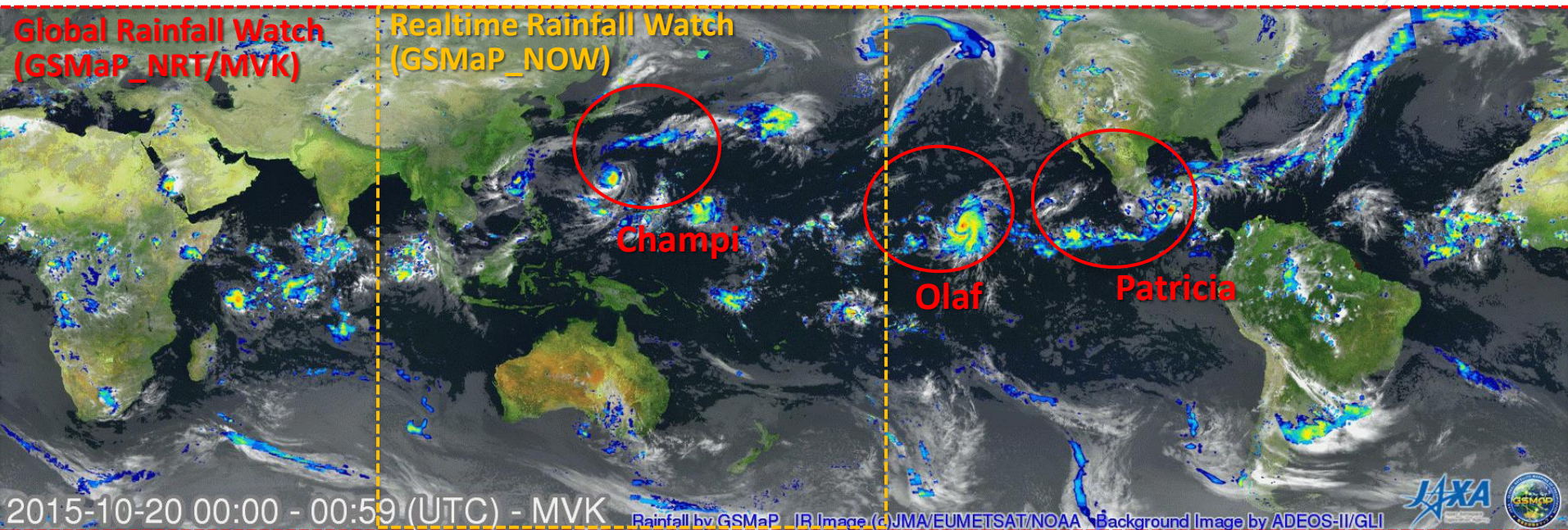
- developed by JAXA and NICT
- DPR is composed of two radars: KuPR & KaPR

- GPM Core Observatory was successfully launched **on 28 Feb. 2014 (JST)**.



JAXA's Contribution to Forecasting

“GSMaP_NOW” over “Himawari-8” area start just now! Global Satellite Mapping of Precipitation (GSMaP)



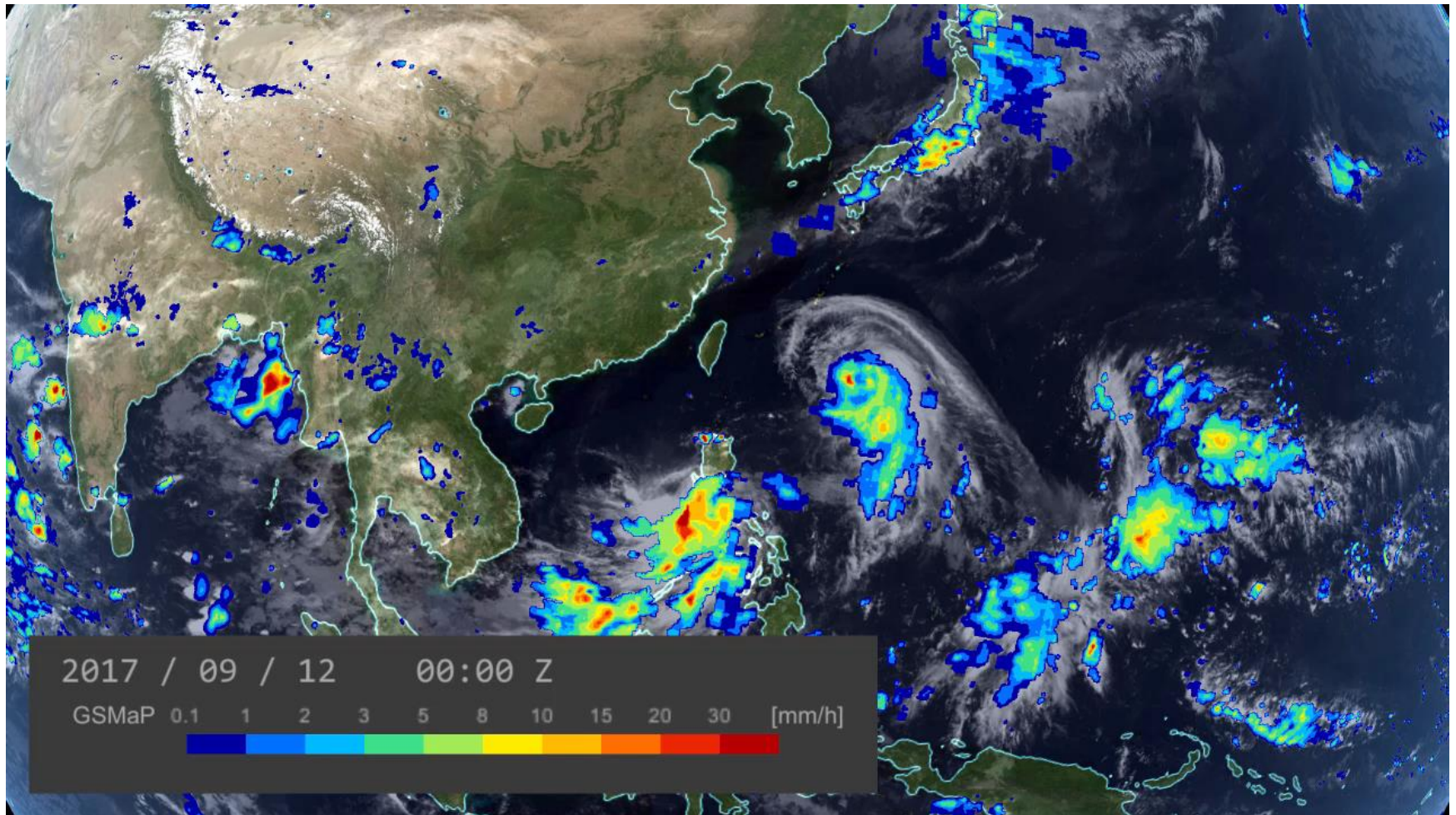
GSMaP (Global) observed Hurricane Patricia and Olaf, and Typhoon Champi: 20-24 Oct. 2015, hourly animation

- Rapidly changing precipitation phenomena need frequent observations.
- Global rainfall map merging GPM Core Observatory, polar orbiting microwave radiometer/sounders, and geostationary infrared radiometers.

JAXA Global Rainfall Watch (4-hr delay) : <http://sharaku.eorc.jaxa.jp/GSMaP>

JAXA Realtime Rainfall Watch (Himawari-area): http://sharaku.eorc.jaxa.jp/GSMaP_NOW

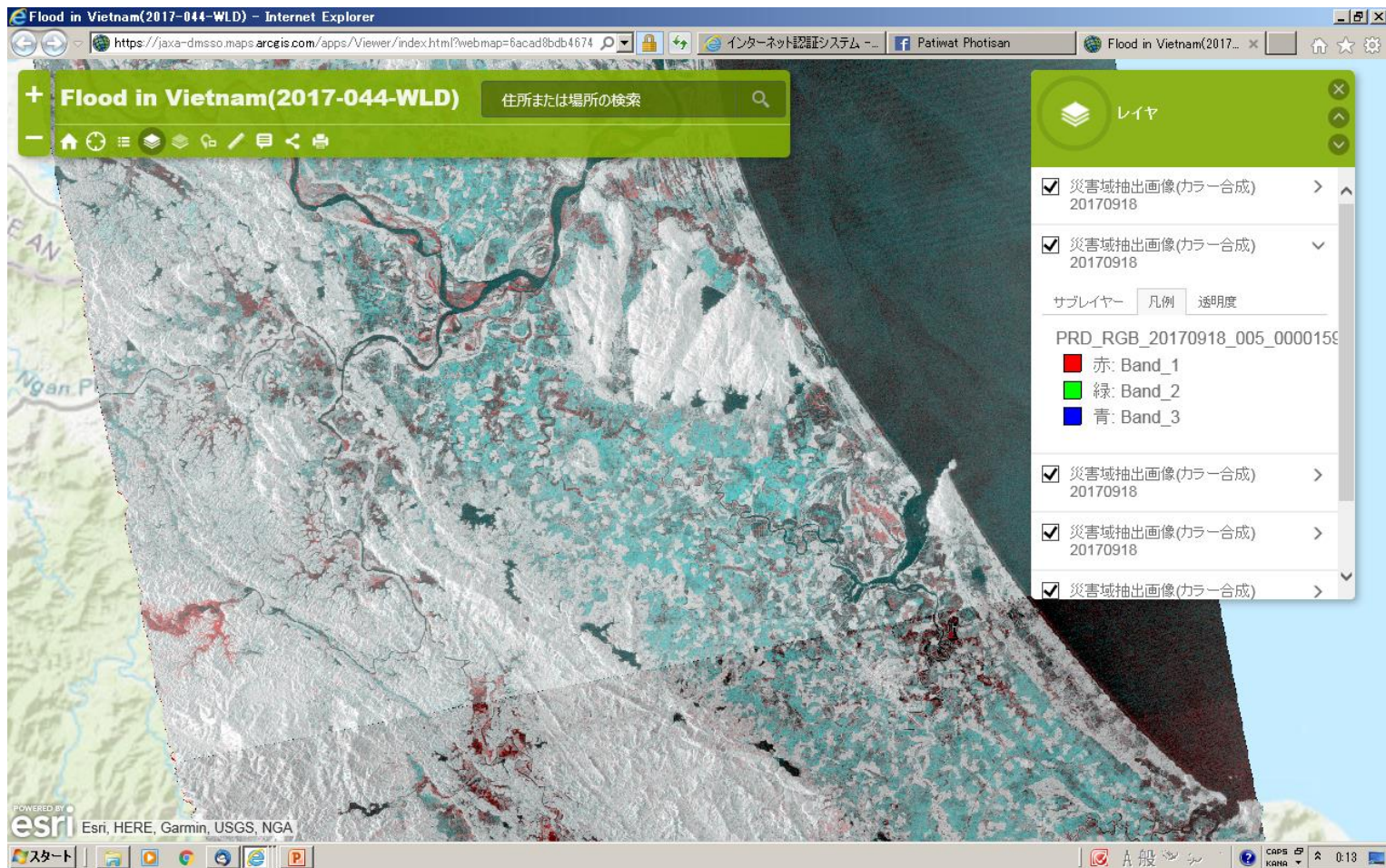
Typhoon 19 by GSMaP



Typhoon 19 by HDTV camera on JEM/ISS

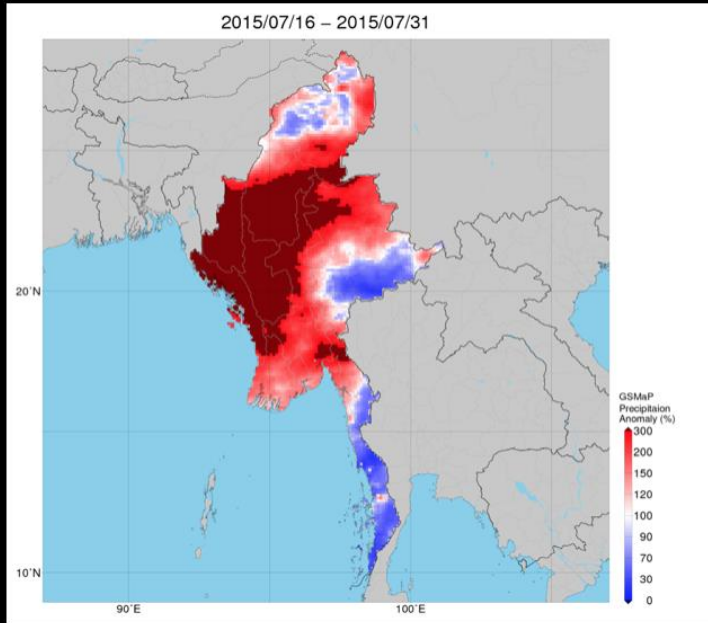


Inundation area estimation by Sentinel-Asia using ALOS-2

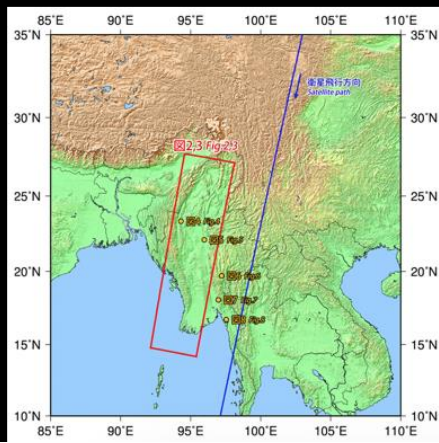


Inundated Area Detection Using RADAR Data

Rainfall Anomaly by GSMaP

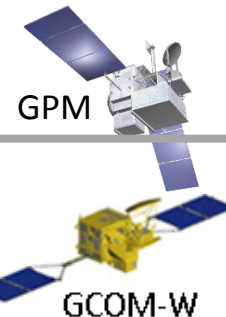


ALOS-2 ScanSAR Mode (R:G:B = HH:HV:HH/HV) 28th July 2015

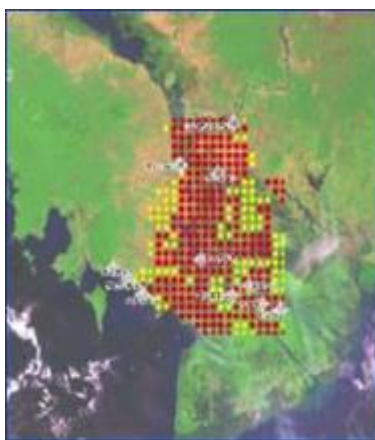
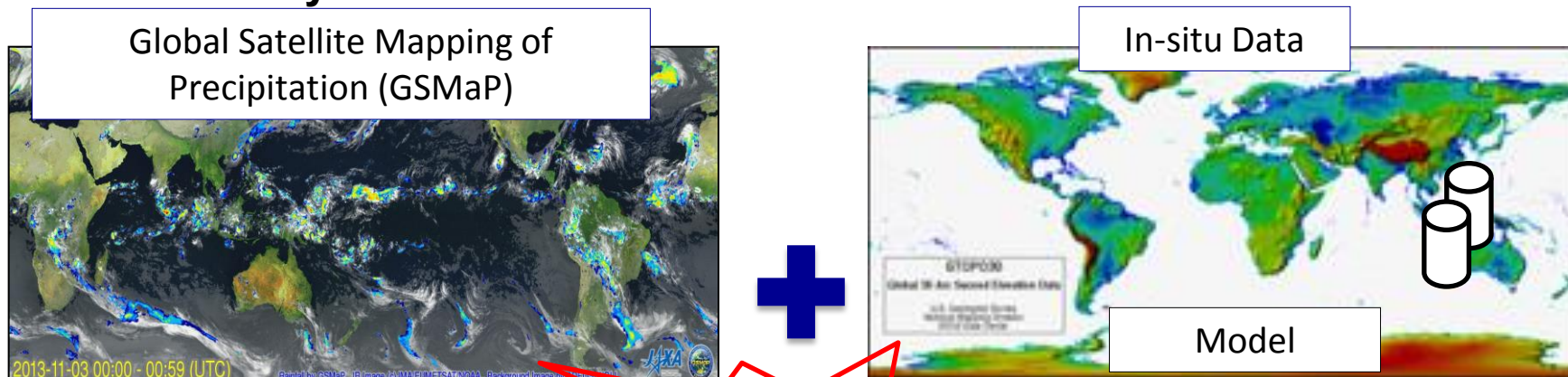


Disaster Risk Management

Flood Early Warning



- ✓ Satellite data and in-situ data are merged to predict flood of lower river region several days before.
- ✓ Based on this information, the warning and evacuation call are sent directly to residents.



Global satellite data is effective to grasp the situation on water rising of International cross-border rivers.

In Bangladesh, flood forecasting made it possible to take measures for crops in advance of damages. The farmers have a few days for harvest until flood at upper river flows down to lower areas and causes damage to the crops.

Partners



(System will be organized)



GSMaP based Landslide Warning System (GLWS)

- Pilot Study in the Philippines -

GSMaP rainfall archives are analyzed by a machine learning method (RBFN), and critical lines (CLs) of hourly rainfall and soil moisture index (SMI) are selected.

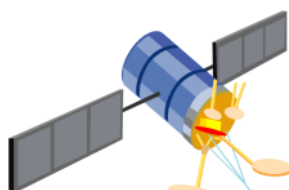
The system monitors rainfall in real-time and determines the landslide warning level.

Rainfall monitoring



AWS

Sensor network

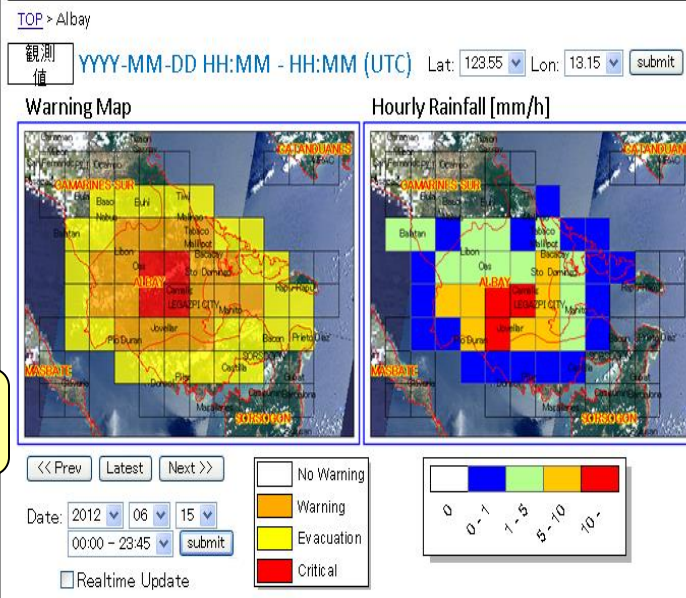


GSMaP-Now
Satellite

Automatic prediction

System

Landslide Early Warning Prototype System (Albay)



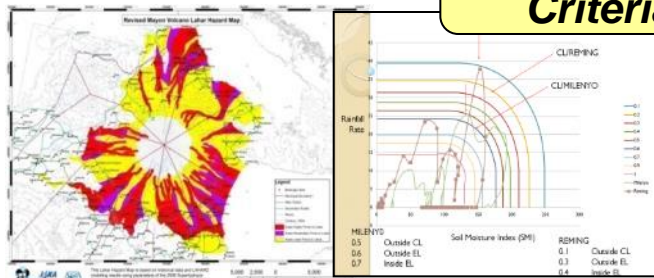
Application

Analysis /
warning



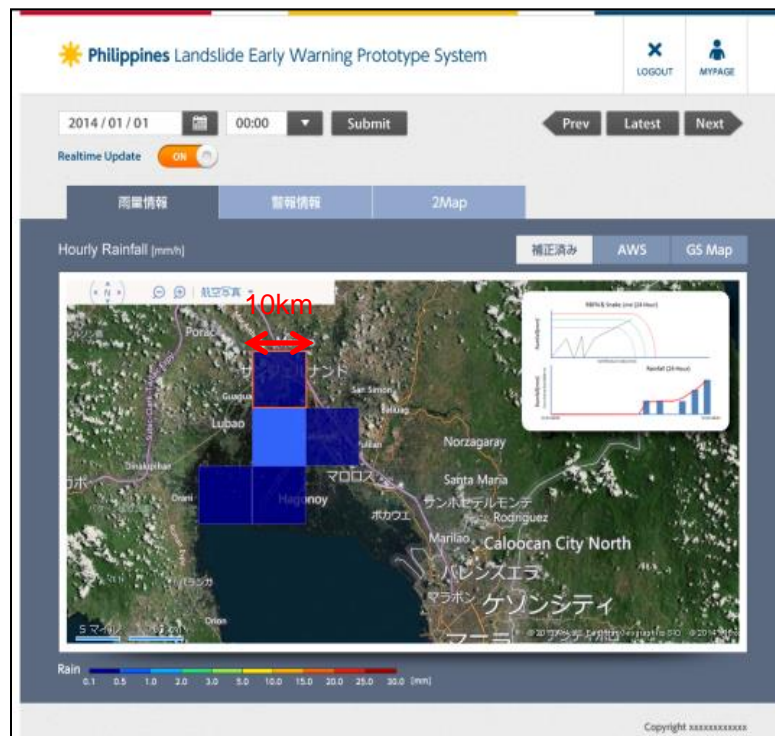
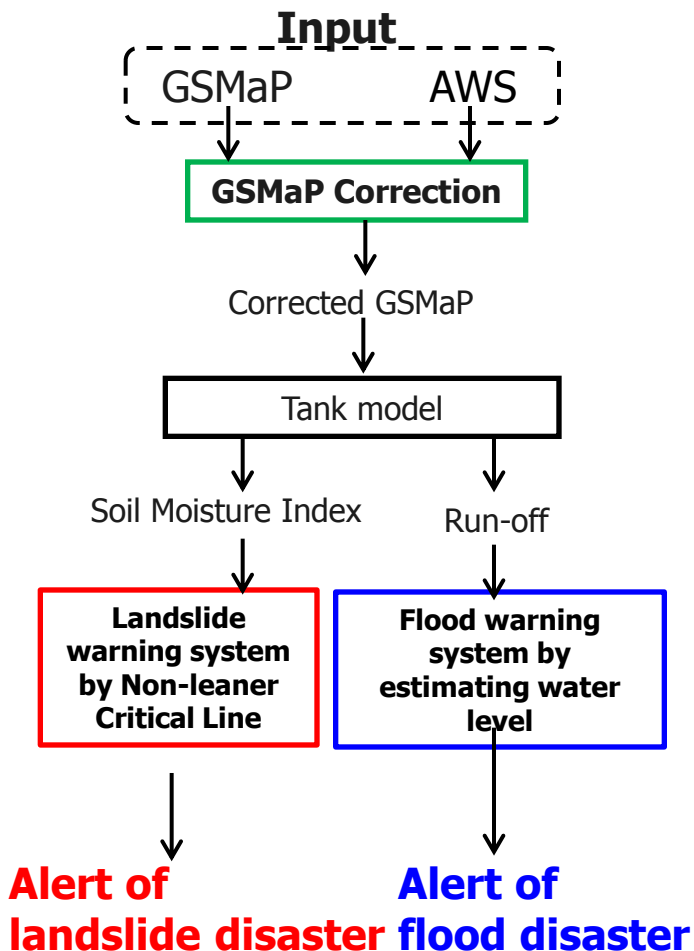
Agency /
Local gov.

Model preparation



Overview of the prototype-system

The Landslide and Flood disaster Early Warning System with GSMaP



Web Browser

First user list is necessary
(User's Name and Email address)

Login:
User ID
Password

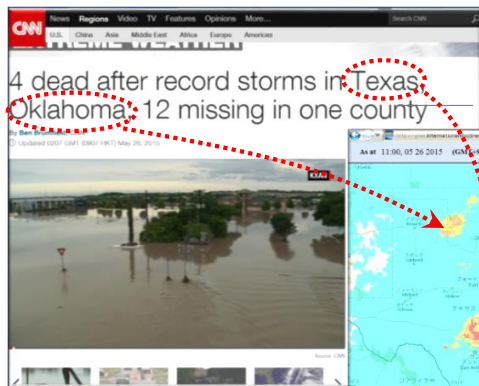


GFAS-II (Global Flood Alert System ver.2)

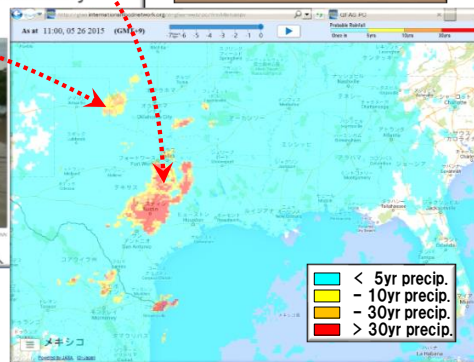


- GFAS developed by IDI is a system to apply global satellite precipitation estimates to flood forecasting. GFAS utilizes GSMaP as a means of estimation to provide “**global flood risk map**” that is display on the Internet. GFAS-II, upgraded in 2017, is **PC & Smartphone-friendly version**, and available to everyone around the world.

GFAS-II currently has the displays for 5 languages (English, Japanese, Spanish, German and Vietnamese).



Captured Image of GFAS-II web site
72 Cumulative precipitation
of 11:00, May 23-26, 2015



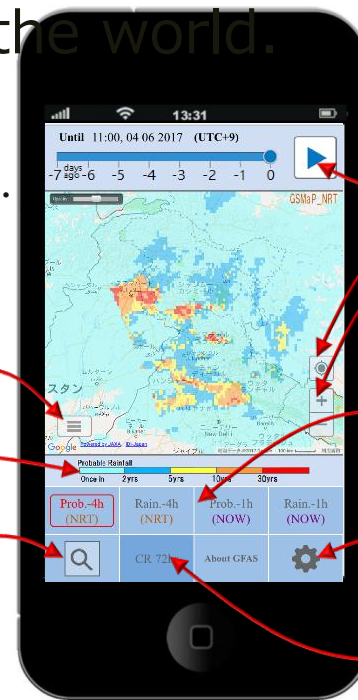
[Smart Phone]
[PC]

<http://gfes.internationalfloodnetwork.org/n-gfas-web/sp/frmMain.aspx>
<http://gfes.internationalfloodnetwork.org/n-gfas-web/pc/frmMain.aspx>

Display / Hide
of the menu

Legend

Search Location
by place name



Animation display of rain area

Jump to the Current Location
Zooming

Selection of Information
NRT or NOW
- Prob : Probable Rainfall (Risk map)
- Rain : GSMaP (Observed Rainfall)

Other Functions
- Selection of language
EN, ES, DE, VN
- Selection of layer
Map, Aerial Photo

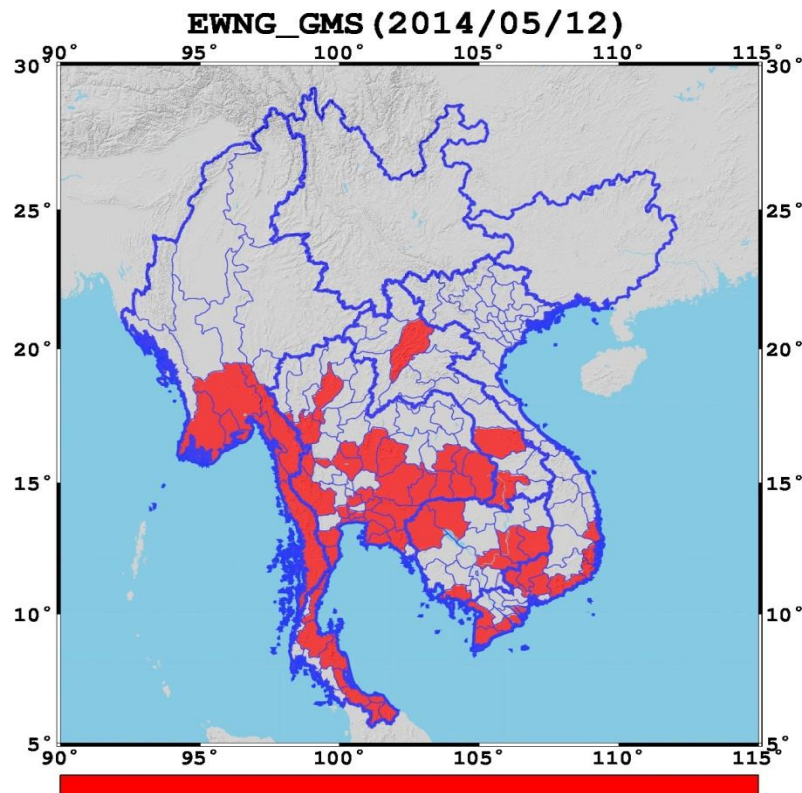
Selection Cumulative rainfall
1h, 3h, 12h, 24h, 72h



ADB Joint Project on Drought Monitoring

Target: Greater Mekong Subregion (GMS)

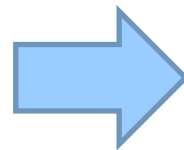
- Add free satellite-based drought information to GMS-AIN



Drought_early_warning_in_province_level

Drought Indices and alerts

-KBDI (Keetch-Byram Drought Index); daily, 10km



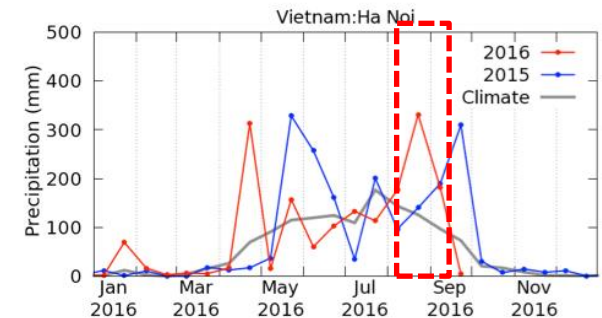
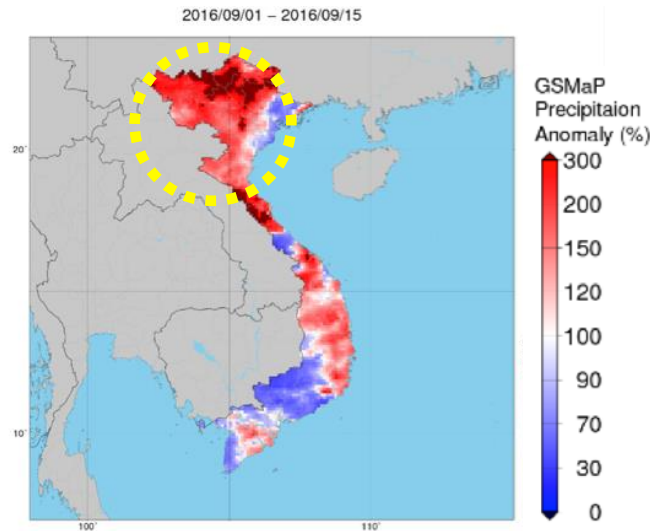
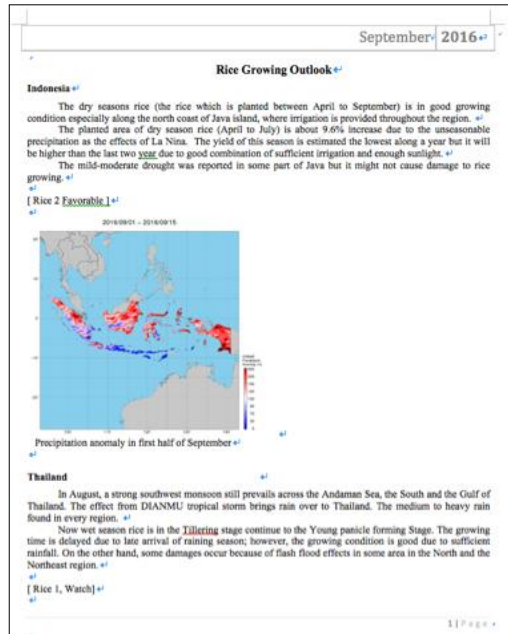
GMS-AIN (Great Mekong Subregion Agricultural Information Network)

Free data and automatically updated

-> No operational cost

Example: Rice Growth Outlook in Vietnam

Rice Growth Outlook (September 2016)



Precipitation (Hanoi Province)

Precipitation anomaly in first half of September

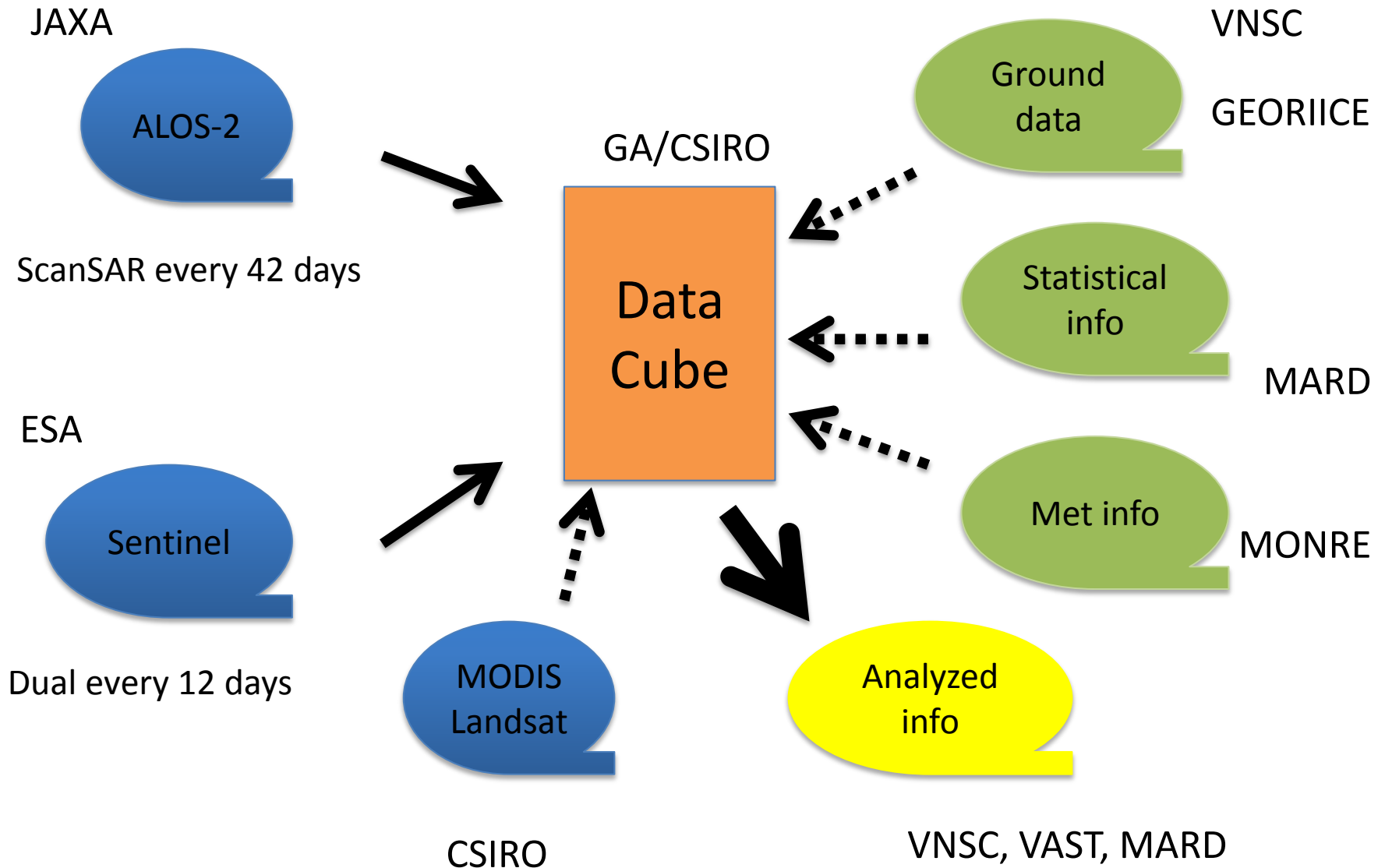
Vietnam

In the North, the seeding of autumn-winter rice (wet season rice) is completed. The sown area is around 1.1 million ha, accounting for 99.2% of the last year area. **The weather in the North is not good for paddy due to storm and flood.**

In the South, the summer-autumn rice enters a harvesting time. The harvested area is around 1.0 million ha ...

Satellite derived agro-met information can support to judge rice growth.

Vietnam Data Cube - SAR based rice crop monitoring scheme



Rice Crop Mapping in Southeast Asia

- ADB Technical Assistance project and SAFE project under the APRSAF have successfully demonstrated INAHOR using ALOS-2 with the mapping accuracy of 80-90% for the target provinces
- Scaling-up for major rice producing areas is currently demonstrated in Vietnam and Indonesia.



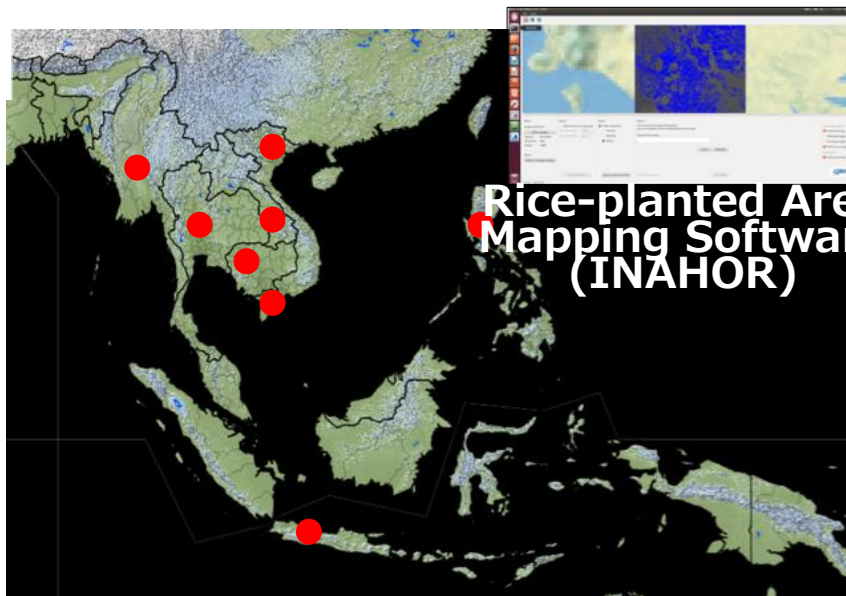
Japan
Fund for
Poverty
Reduction



ADB TA Project

- Laos
- Thailand
- Vietnam (North)
- Philippines

[2014-2016]



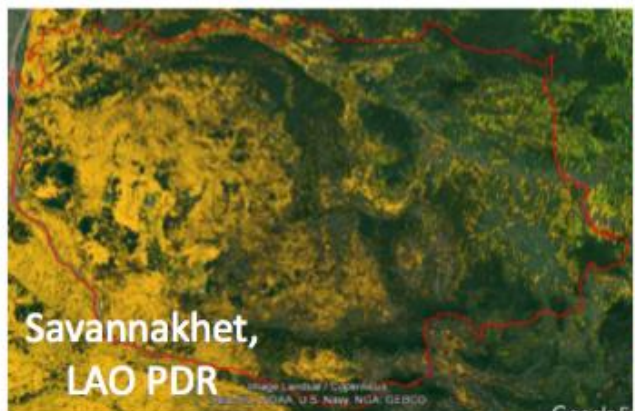
SAFE Project (Test site)

- Myanmar
- Cambodia [2016-]

SAFE Project (Scaling-up)

- Vietnam (Mekong Delta)
- Indonesia

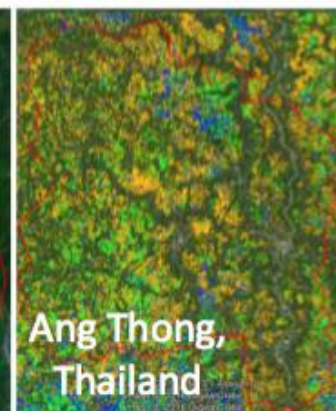
[2014-]



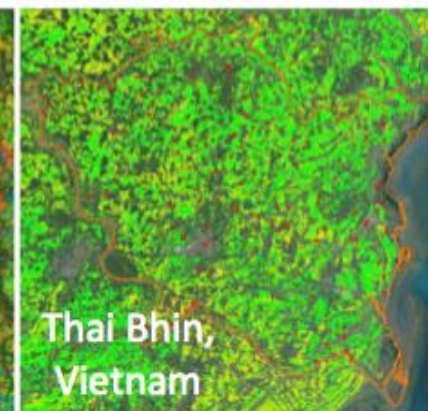
Savannakhet,
LAO PDR



Neuva Ecija,
the Philippines



Ang Thong,
Thailand

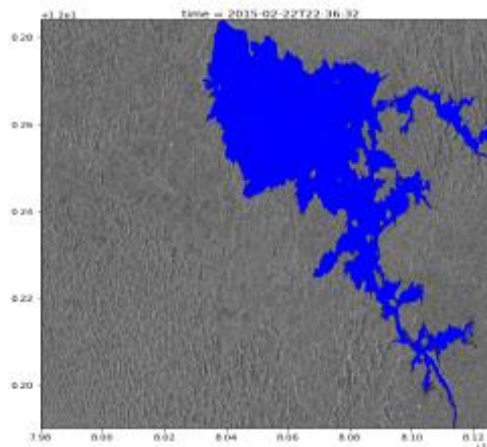


Thai Binh,
Vietnam

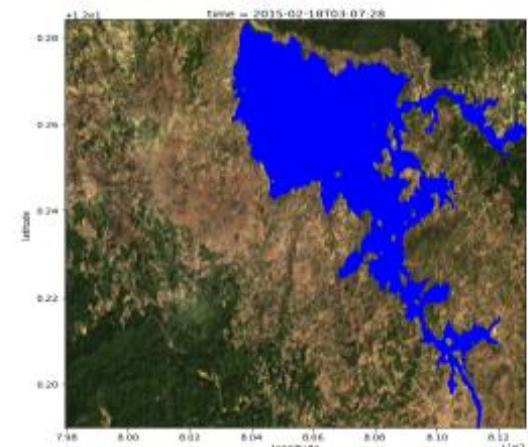


- **WASARD** (Water Across Synthetic Aperture Radar Data) is a new machine learning algorithm for water detection using radar datasets.
- The algorithm is trained using Landsat data and the Australian WOFS water detection algorithm, which has >97% accuracy.
- WASARD has shown >96% correlation with WOFS results using Sentinel-1 and ALOS datasets over Vietnam.
- WASARD produces a simple linear water classifier algorithm with the format:
 $(\text{Coefficient-1}) * (\text{Band-1}) + (\text{Coefficient-2}) * (\text{Band-2}) + \text{Bias}$

Sample water detection results for Lake Buon Tua Sarh in Vietnam. The correlation between WOFS and WASARD was 97%.



Sentinel-1 WASARD



Landsat WOFS

ALOS-2 ScanSAR data provision

- For GEOGLAM and CEOS
 - Under GEOGLAM/Asia Rice and ALOS K&C project, JAXA provides ScanSAR data at technical demonstration sites (100km x 100km – one province) in Cambodia, Myanmar, Malaysia, Lao, India, China, Thailand and Taiwan to Asia Rice crop team members with ALOS-2 download system now.
 - Under Asia Pacific regional space agency forum (APRSAF) framework with GEOGLAM/Asia Rice, JAXA provides scale up activity for Indonesia (Top 10 rice crop production provinces) and Vietnam (Mekong)
- Proposal from JAXA
 - Under cooperation with JICA and commercial data providers, JAXA starts to prepare to provide on-line access to intermediate JJ-FAST products = ScanSAR ortho-sloped corrected DN data and/or ALOS-2 25m path ortho-sloped corrected data (gamma naught) from ALOS-2 path mosaic to selected countries for each target country data where JAXA, ADB and APRSAF countries have cooperative agreement (Indonesia, LaoPDR, Thailand, Philippines, Lower Mekong (Vietnam + Cambodia)) for governmental use in respective countries.
 - JAXA starts to prepare sample data of ScanSAR data to ingest Vietnam data cube and propose CEOS ARD of SAR (1-5 degree mesh tiled data or path ortho-sloped corrected data) in cooperation with CEOS SEO (NASA)
 - Other than ASEAN area, JAXA will discuss with commercial data distributor to have same framework of ALOS-2 ScanSAR intermediate product to target countries' governmental use if CEOS and GEO community are interested in.



Coordination status with respecting countries

1. Vietnam

- VNSC and CSIRO/GA already prepare to implement CEOS Mekong data cube by the end of this year
- VNSC and JAXA agreed to coordinate ALOS-2 ScanSAR data ingestion with rice crop area estimation software (INAHOR) to CEOS Mekong data cube
- JAXA and VNSC will finalize MOU for Vietnam data cube with ALOS-2 ScanSAR data and will have Data cube workshop as a pre-workshop of GEOSS-AP agriculture working group (WG5)

2. Indonesia

- LAPAN, MOA and JAXA agreed to coordinate coordinate ALOS-2 ScanSAR data ingestion to LAPAN data archive
- JAXA and LAPAN start to coordinate MOU to archive and use ALOS-2 ScanSAR data in Indonesia

3. Thailand

- JAXA and GISTDA start to discuss ALOS-2 ScanSAR data of Thailand and Lao provision to GISTDA

JAXA's EO Data Portals

Portal Name and URL



G-Portal

(GPM, TRMM, JERS-1, AQUA/AMSR-E....etc.)

<https://www.gportal.jaxa.jp/gp/top.html>

*Free and Open Data



GCOM-W: Global Change Observation Mission-Water

http://suzaku.eorc.jaxa.jp/GCOM_W/data/data_w_index.html

*Free and Open Data



GSMaP: Global Satellite Mapping of Precipitation

http://sharaku.eorc.jaxa.jp/GSMaP_crest/index.html

*Free and Open Data



Precise Global Digital 3D Map "ALOS World 3D" Homepage (30m resolution)

http://www.eorc.jaxa.jp/ALOS/en/aw3d/index_e.htm

*Free and Open Data

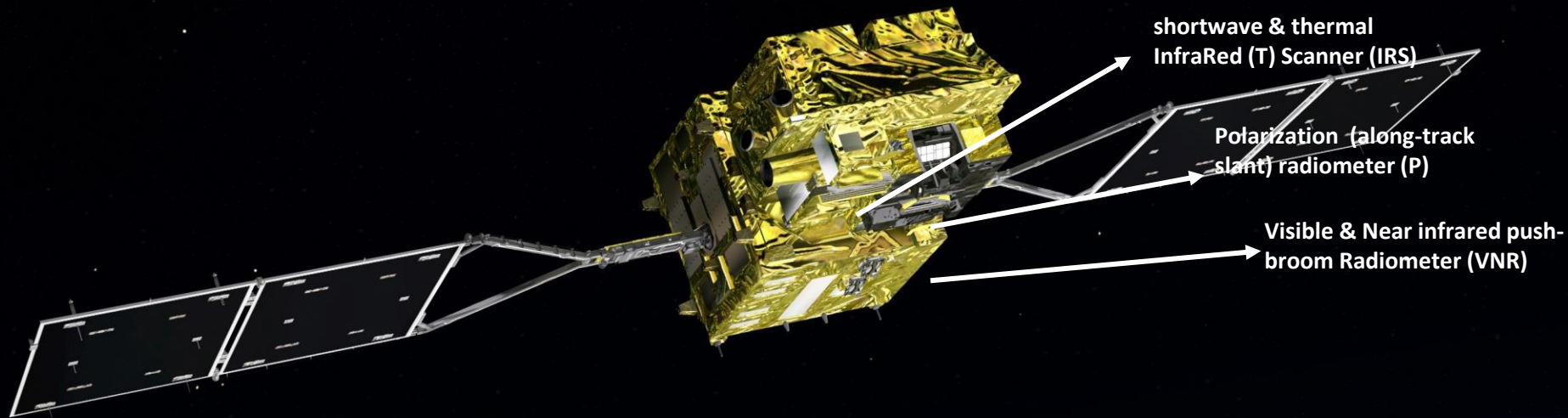
High resolution data is available through commercial distributors.

ALOS-2: PASCO (<http://en.alos-pasco.com/>)

ALOS World 3D (5m resolution): NTT DATA and RESTEC (<http://aw3d.jp/en/index.html>)

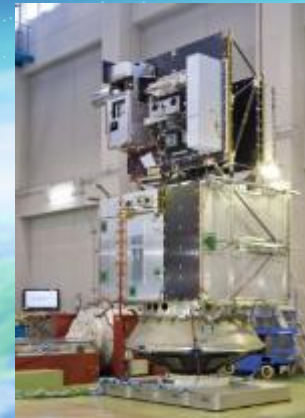
Future Missions

GCOM-C: Global Change Observation Mission- Climate

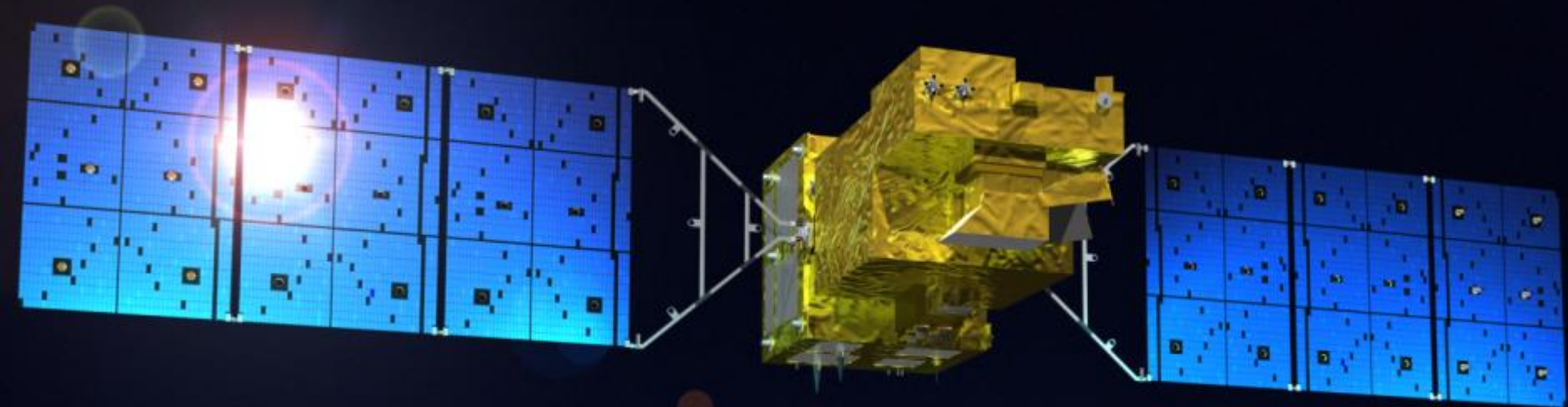


GCOM-C SGLI characteristics

Orbit	Sun-synchronous (descending local time: 10:30), Altitude: 798km, Inclination: 98.6deg
Launch Date	JFY 2017
Mission Life	5 years
Scan	Push-broom electric scan (VNR: VN & P) Wisk-broom mechanical scan (IRS: SW & T)
Scan width	1150km cross track (VNR: VN & P) 1400km cross track (IRS: SW & T)
Spatial resolution	250m (land and coastal areas), 500m, 1km
Polarization	3 polarization angles for POL
Along track tilt	Nadir for VN, SW and TIR, & +/-45 deg for P



GOSAT-2 on orbit in early 2018



Upgrade in GOSAT-2 mission

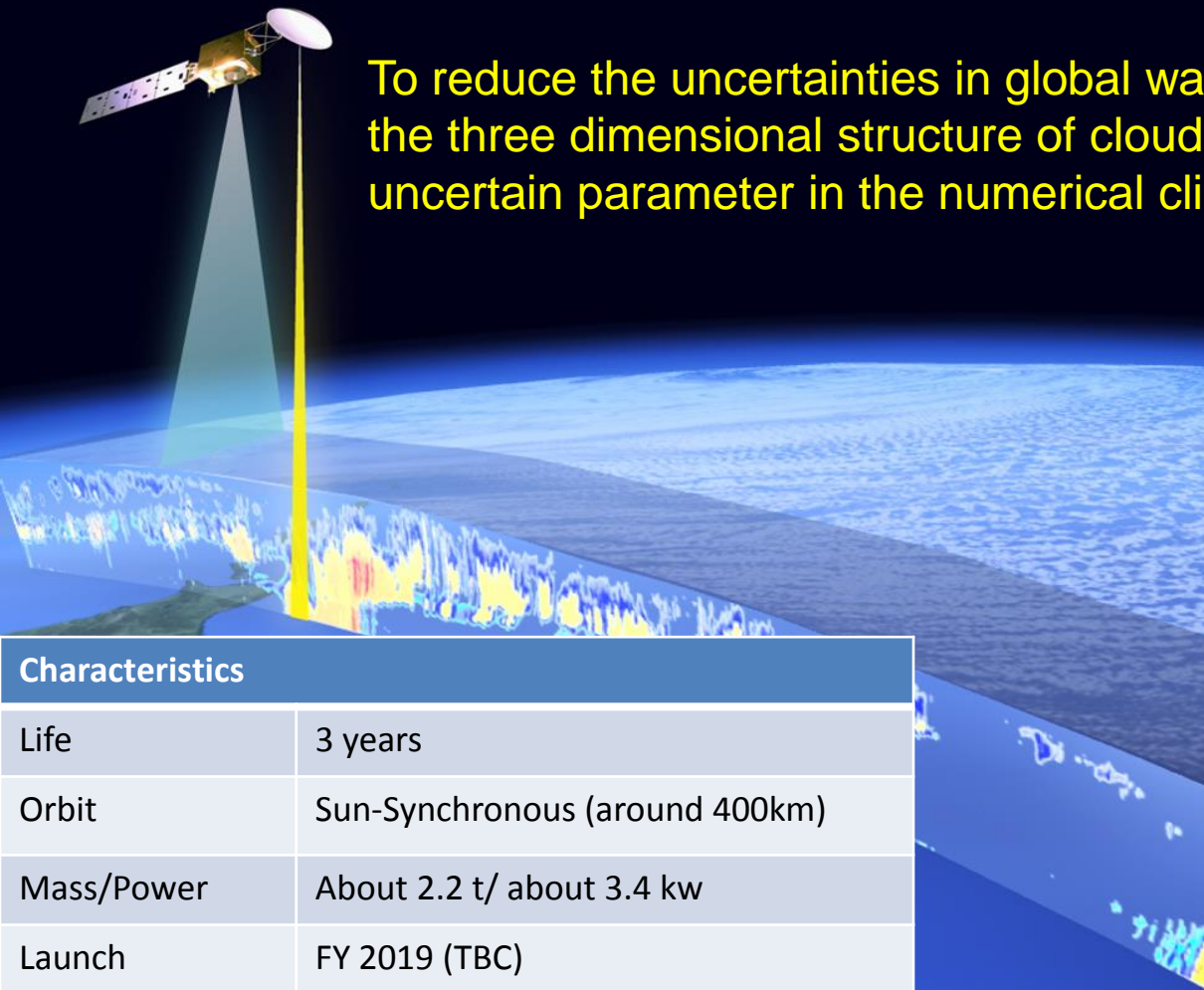
GOSAT achievement

GOSAT target

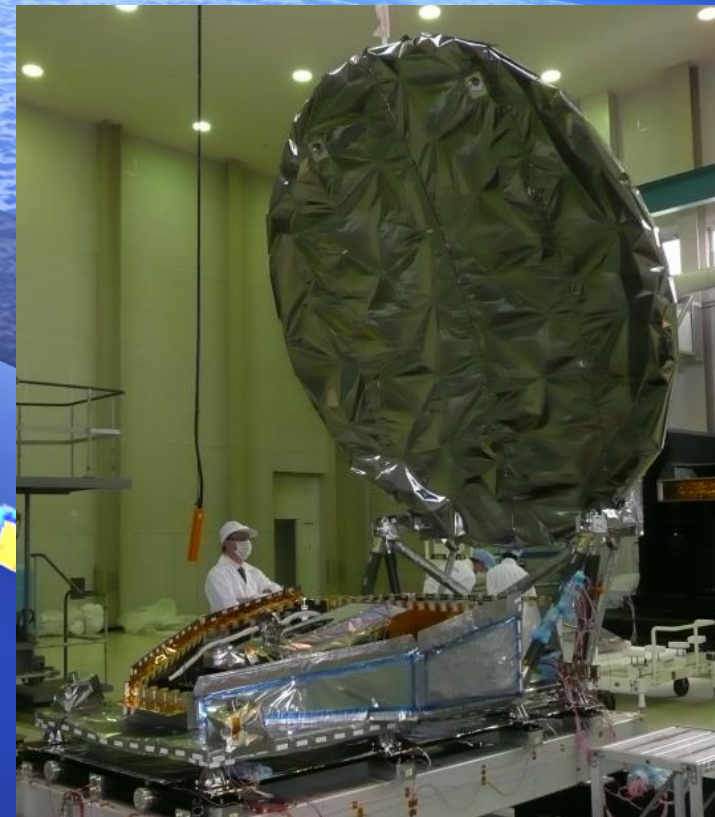
Measurement precision	0.5 ppm for CO ₂ 5 ppb for CH ₄	←2ppm for CO ₂ ←12ppb for CH ₄	←4 ppm for CO ₂ ←32 ppb for CH ₄
Flux estimation	1000km for land	←2000km in sub-continental scale	
Anthropogenic emission	CO to distinguish emission source		
Ecosystem carbon exchange	Chlorophyll fluorescence to place constrains on GPP		
Aerosol monitoring	Aerosol size distribution and its property		

Earth Cloud, Aerosol and Radiation Explorer (EarthCARE)

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.



Characteristics	
Life	3 years
Orbit	Sun-Synchronous (around 400km)
Mass/Power	About 2.2 t/ about 3.4 kw
Launch	FY 2019 (TBC)
Instruments	CPR: Cloud Profiling Radar (JAXA/NICT) ATLID: Atmospheric Lidar (ESA) MSI: Multi-Spectral Imager (ESA) BBR: Broadband Radiometer (ESA) Satellite bus: Airbus DS Satellite launch: ESA

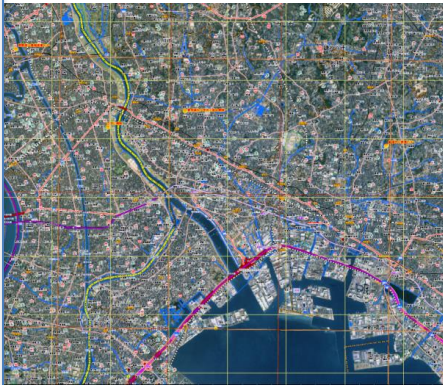


CPR (Cloud Profile Radar)

ALOS successors: Advanced Optical Satellite and Radar Satellite

Advanced Optical Satellite (ALOS-3)

Hazard Map

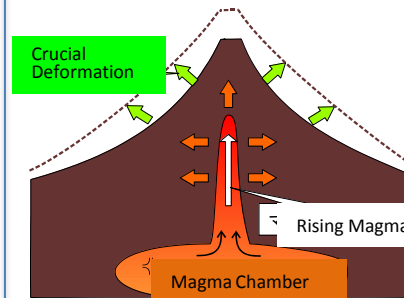
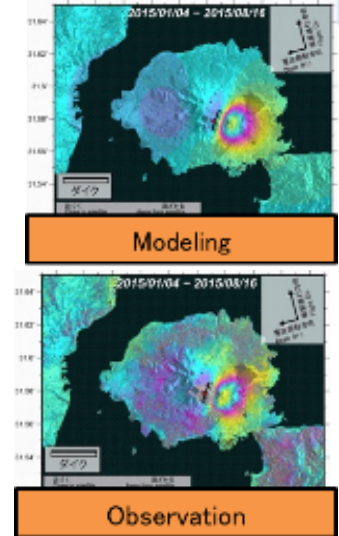
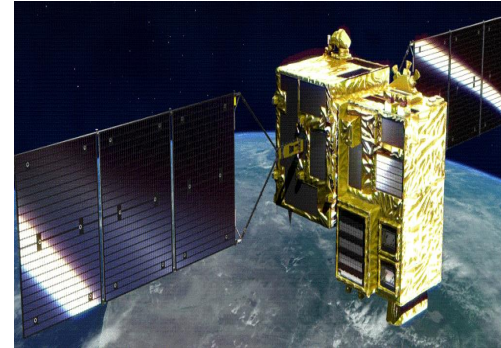


High Precision
1/25,000 Map (C) GSI

Characteristics

Life	7 years
Orbit	Sun-Synchronous (670km)
Mass	About 2.7 t
Launch	FY 2020
Resolution	Panchromatic : 0.8m (swath: 70km) Multi: 3.2m (swath: 70km)

Advanced Radar Satellite (ALOS-4)



Estimate situation of magma
chamber under the ground
and faulting

Take a decision for evacuation

Characteristics

Life	7 years
Orbit	Sun-Synchronous (628km)
Mass	About 3 t
Launch	FY 2020
Resolution	<u>Spotlight</u> 1 × 3 m (swath: 35km) <u>Strip map</u> 3/6/10m (swath: 200km) <u>ScanSAR</u> 25m (swath: 700km)

Thank you very much for your attention.

sobue.shinichi@jaxa.jp

@Tsuruoka, Yamagata Pref.
TDS Site in Japan

