

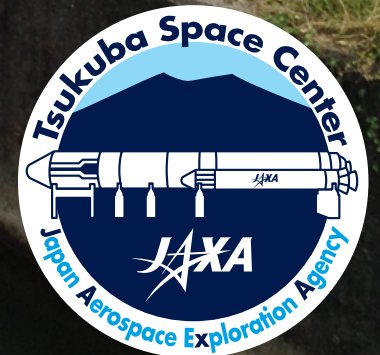
# JAXA's Mission Updates and Agricultural Applications

Kei Oyoshi<sup>1</sup>, Shinichi Sobue<sup>1</sup>, Hiroshi Miyoshi<sup>1</sup>  
on behalf of Asia-RiCE Team

<sup>1</sup> Japan Aerospace Exploration Agency (JAXA)

Land Cover/Land Use Change SARI  
International Regional Science Meeting  
in South/Southeast Asia

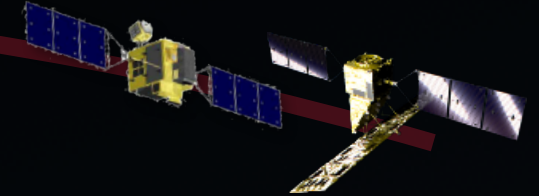
@Chiang Mai, Thailand  
17-19 July 2017



### High Resolution



ALOS-3  
High-Resolution  
Wide Swath Optical  
(2020)



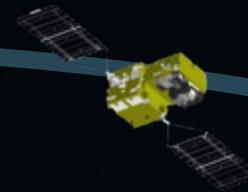
ALOS-4  
High-Resolution  
Wide Swath SAR  
(2020)

### Climate Change & Water Cycle

Aqua/AMSR-E  
(2002)



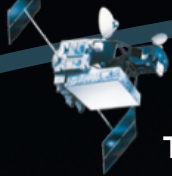
GCOM-C  
(2017)



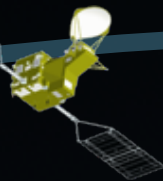
EarthCARE/CPR  
(2018)



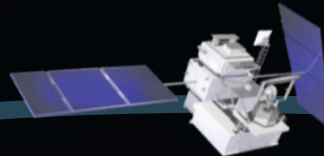
TRMM/PR  
(1997)



GCOM-W  
(2011)

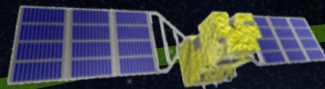


GPM/DPR  
(2013)



### GHG Monitoring

GOSAT  
(2009)



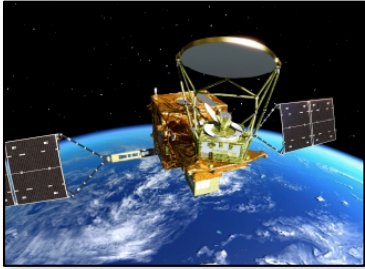
GOSAT-2  
(2018)



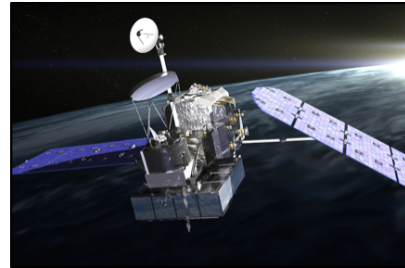
# Japanese Current and Future Missions

# Earth Observation Satellites Contribute to Agriculture

**GCOM-W1**  
(2013-)



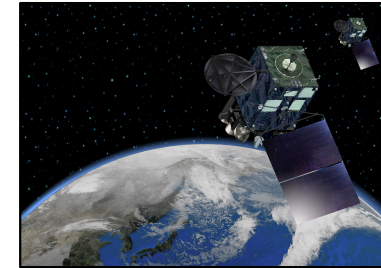
**GPM**  
(2014-)



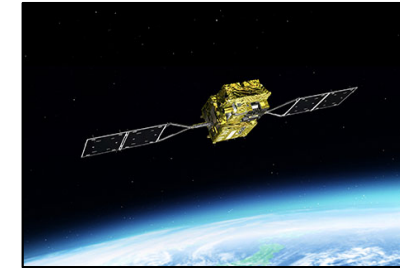
**ALOS-2**  
(2014-)



**Himawari-8**  
(2014-)

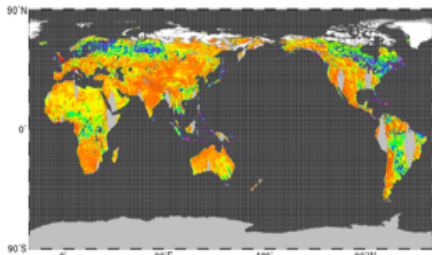


**GCOM-C**  
(2017)

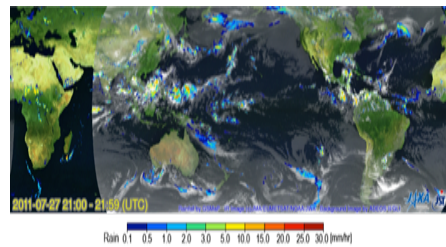


+ Other Satellites

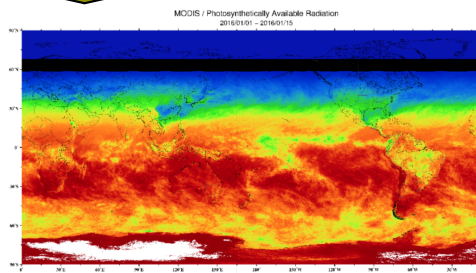
## Agriculture-Related Products



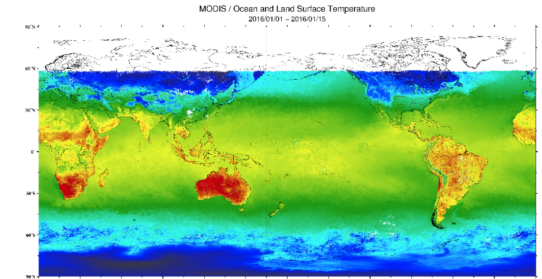
Soil Moisture



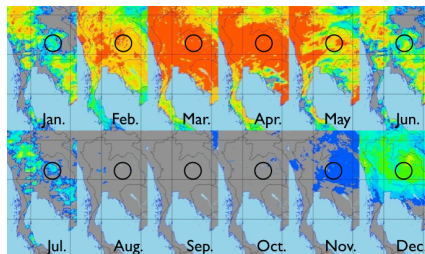
Precipitation



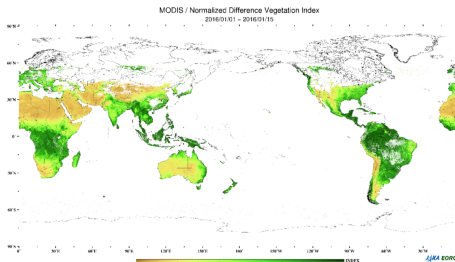
Solar Radiation (PAR)



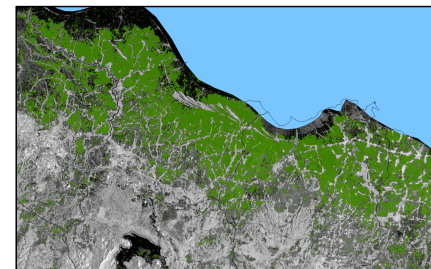
Land Surface Temperature



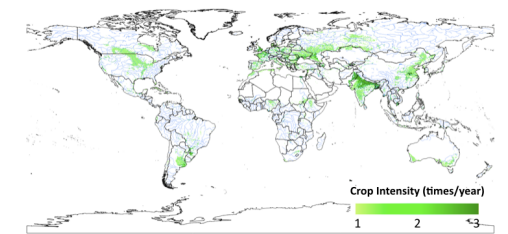
Drought Index



Vegetation Index



Planted Area



Crop Calendar

etc.

## Agriculture-related Services

Statistics

Early Warning

Damage Asses.

Farming

# Asia-RiCE for GEOGLAM (Global Agriculture Monitoring)

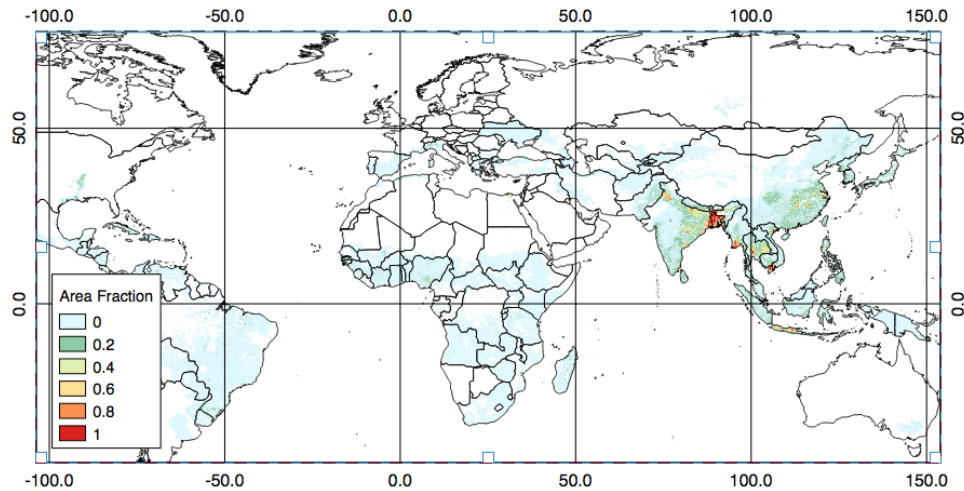
- **GEOGLAM** was endorsed by the G20 Summit, aims to enhance regional and global agricultural production (wheat, maize, soybean, and **rice**) estimates through the use of Earth observations  
[Meeting of G20 Agriculture Ministers, G20 France 2011 Summit final declaration, 2011]
- Asian agencies are implementing **Asia-RiCE (Asia Rice Crop Estimation & Monitoring)** to strengthen **rice crop** monitoring ability **by using remote sensing**, which is a component for GEOGLAM.



Asia-RiCE Website: <http://www.asia-rice.org>

# Rice Cropping System in Asia

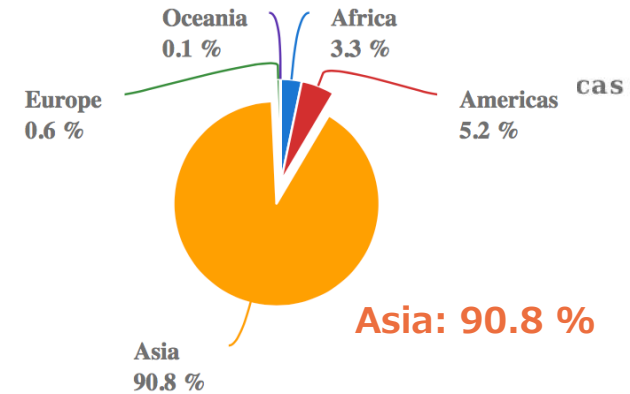
## Rice Cropping Area Fraction



[Monfreda, C., N. et al., 2008]

## Production share of Rice, paddy by region

Average 2013 - 2014



[FAO, 2017]

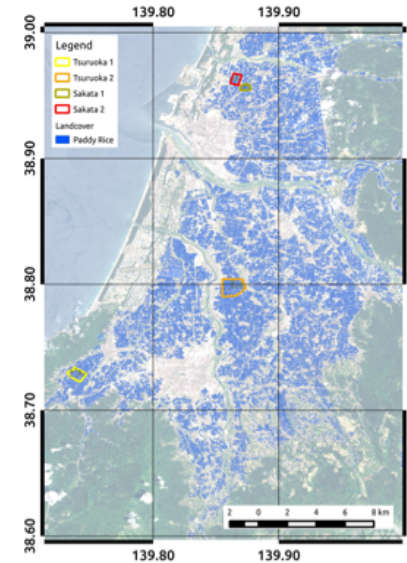
- ❖ In Asia, rice is a **staple cereal crop**, the continent accounts for about **90% of the global rice production and consumption**. [FAO, 2017]
- ❖ **High crop intensity (double or triple cropping)** and **complicated crop calendar** [Sakamoto et al., RSE, 2006]
- ❖ **Cultivated mainly in rainy season** when the utilization of optical sensor is limited, therefore **SAR can be a strong tool** [Whitcraft et al., RSE, 2015]

Greatly differ from other GEOGLAM target crops (maize, soybean, wheat)

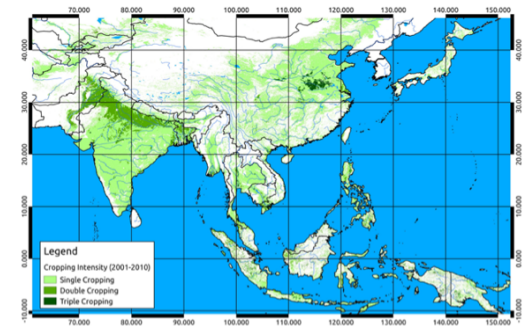
# Agriculture-related Products by Remote Sensing

ID	Product
P1	<b>Rice Planted Area Estimates and Mapping</b>
P2	<b>Crop Calendars/Crop Growth Status</b>
P3	<b>Crop Damage Assessment</b>
P4	<b>Agro-meteorological Information Products</b>
P5	<b>Yeild/Production Estimation and Forecasting</b>

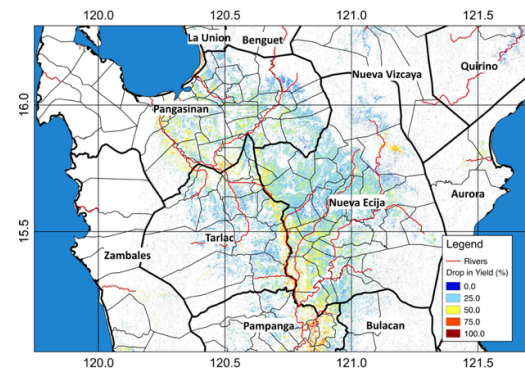
## Product Examples



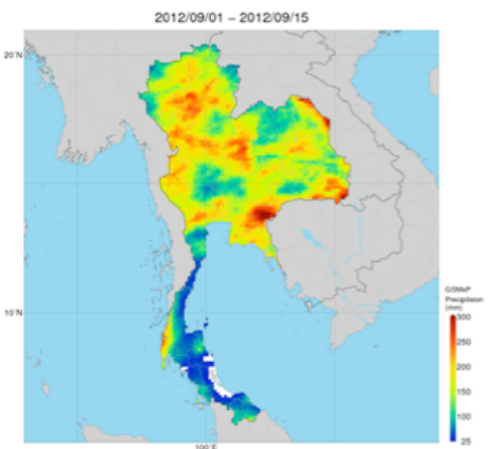
**P1: Planted Area**



**P2: Crop Calendar**



**P3: Crop Damage**



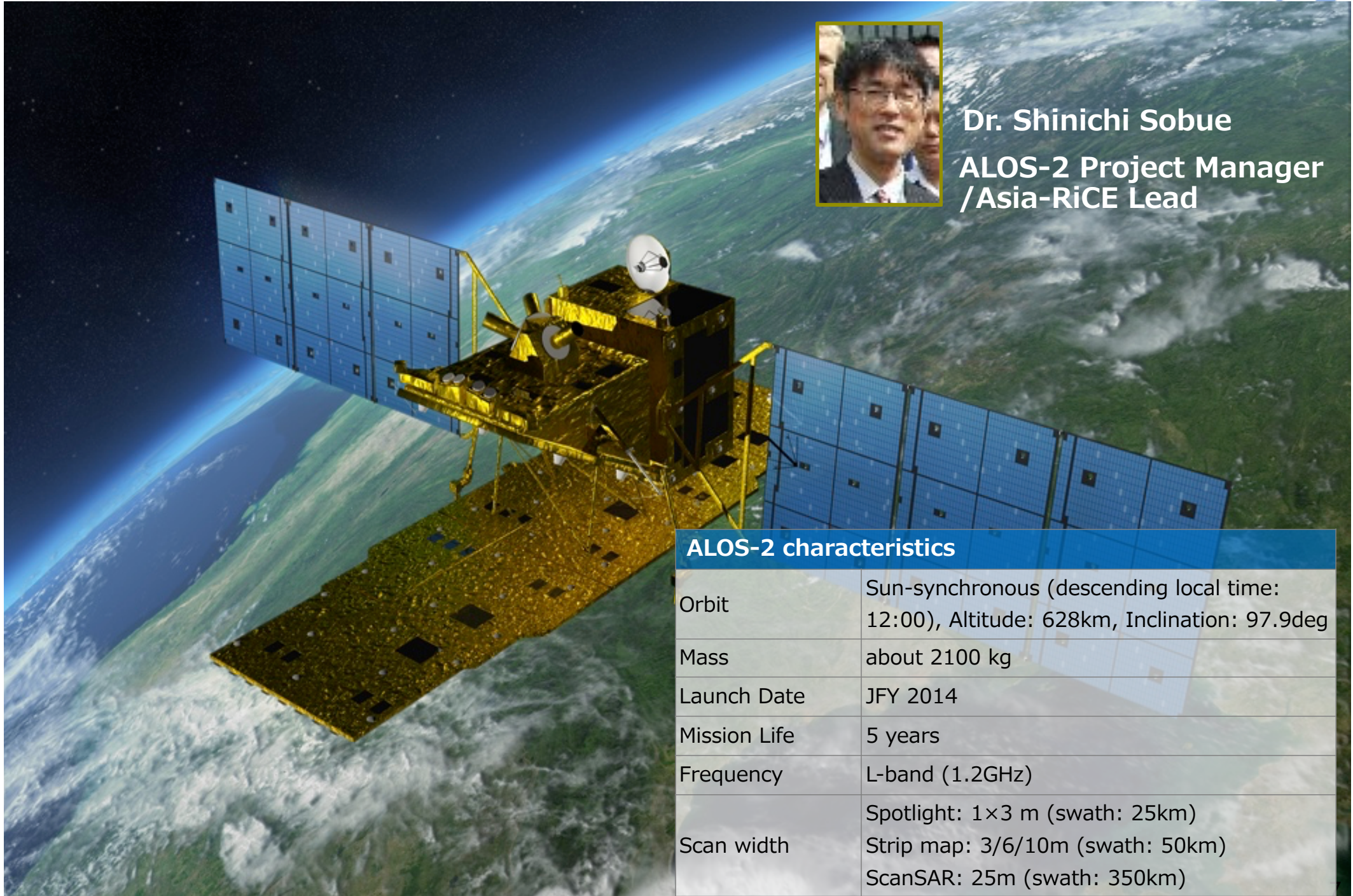
**P4: Precipitation**

[Asia-RiCE Work Plan, 2012]

# ALOS-2: Advanced Land Observing Satellite-2



**Dr. Shinichi Sobue**  
**ALOS-2 Project Manager**  
**/Asia-RiCE Lead**

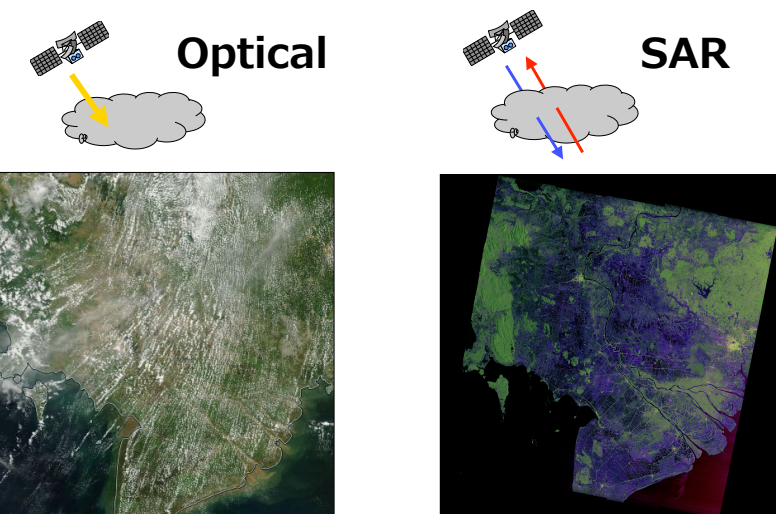


ALOS-2 characteristics	
Orbit	Sun-synchronous (descending local time: 12:00), Altitude: 628km, Inclination: 97.9deg
Mass	about 2100 kg
Launch Date	JFY 2014
Mission Life	5 years
Frequency	L-band (1.2GHz)
Scan width	Spotlight: 1×3 m (swath: 25km) Strip map: 3/6/10m (swath: 50km) ScanSAR: 25m (swath: 350km)

# Rice Crop Monitoring using ALOS-2 ScanSAR

## SAR: Synthetic Aperture RADAR

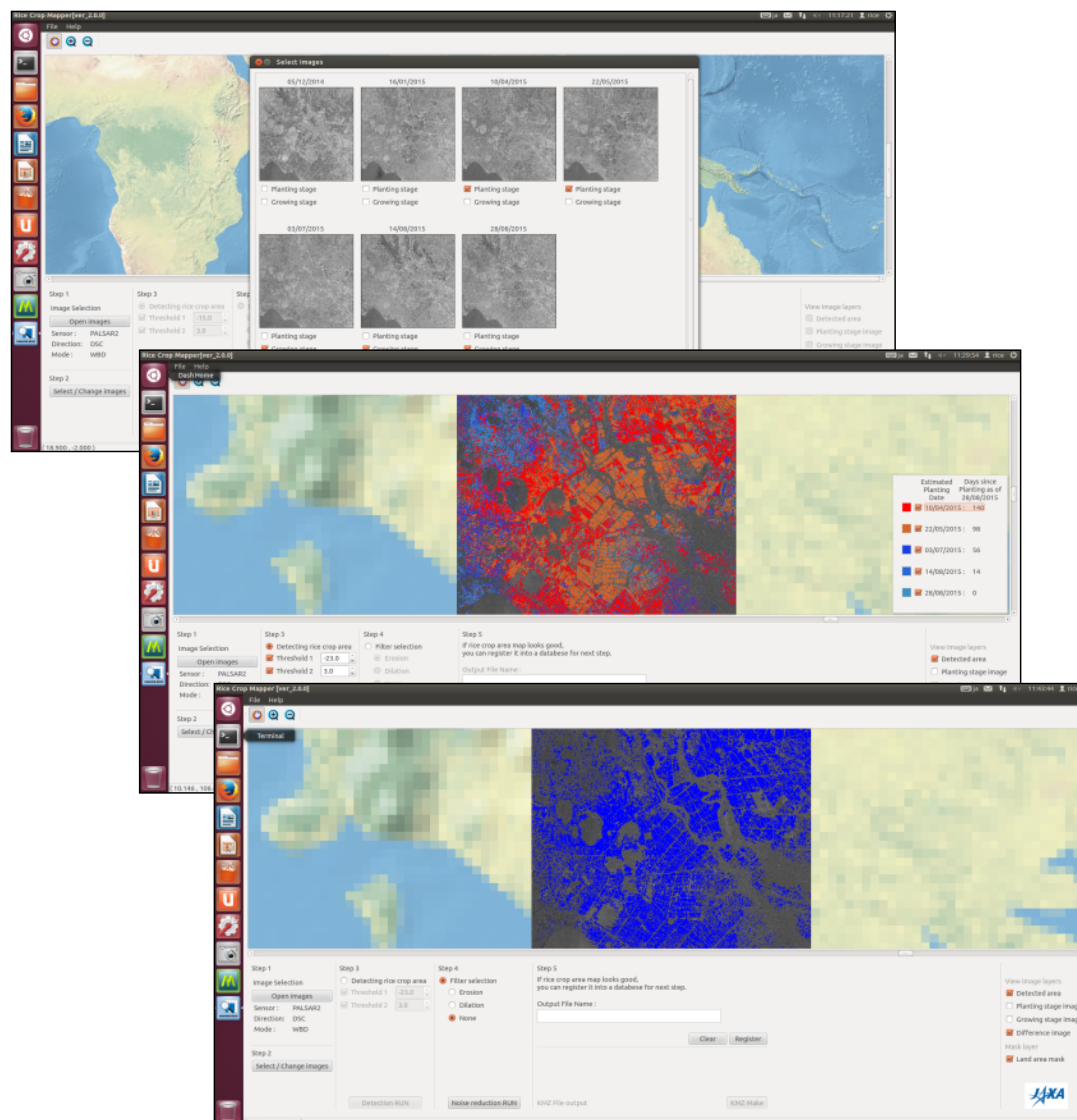
- Penetrate cloud -



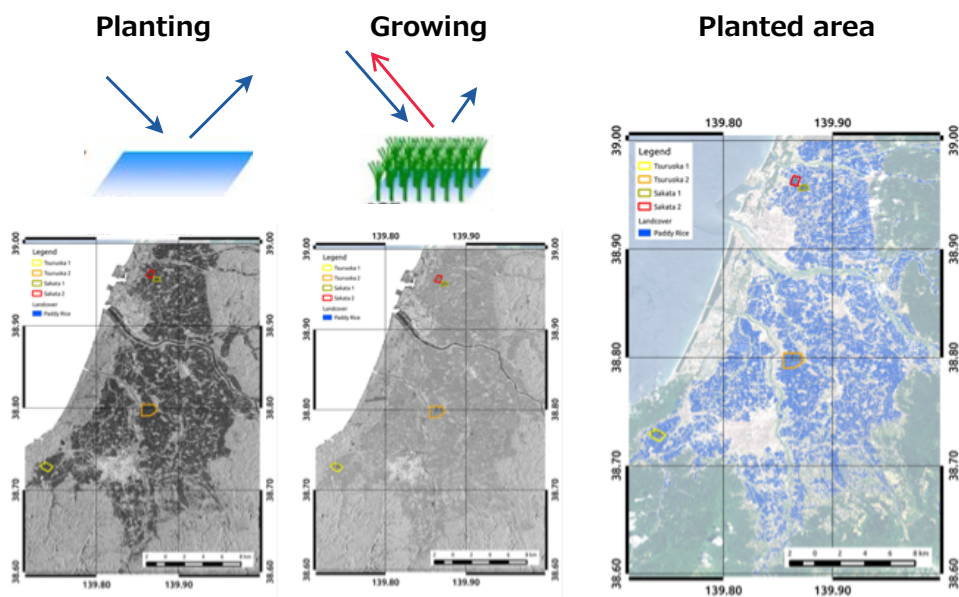
※Observed on the same day

## Rice Mapping Software (INAHOR)

- Estimate rice planted area and growing stage -



## Rice planted Area Identification





# Demonstration in Southeast Asian Countries

- 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.



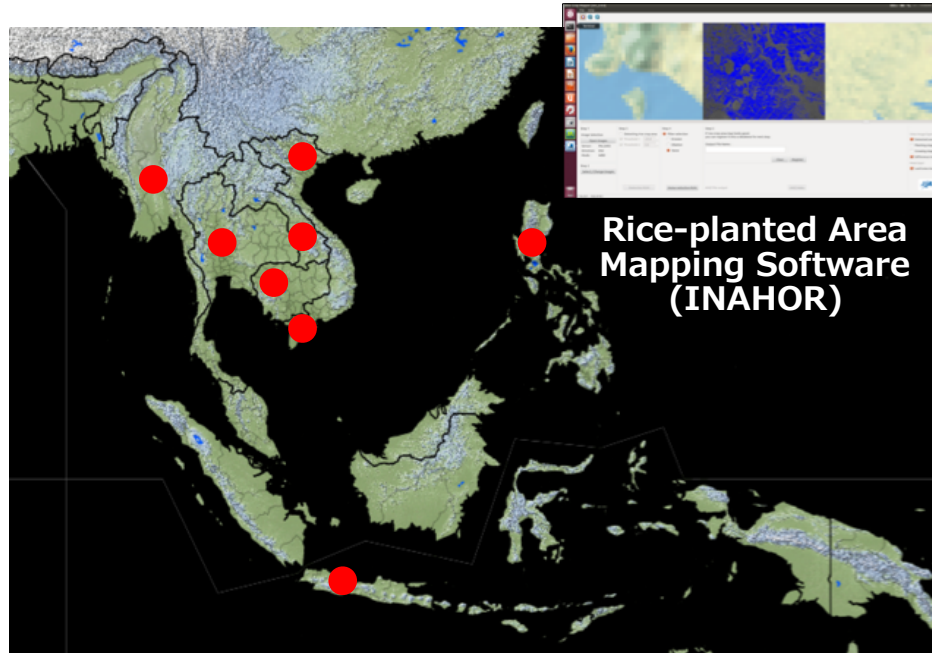
Japan  
Fund for  
Poverty  
Reduction



## ADB TA Project

- Laos
- Thailand
- Vietnam (North)
- Philippines

[2014-2016]



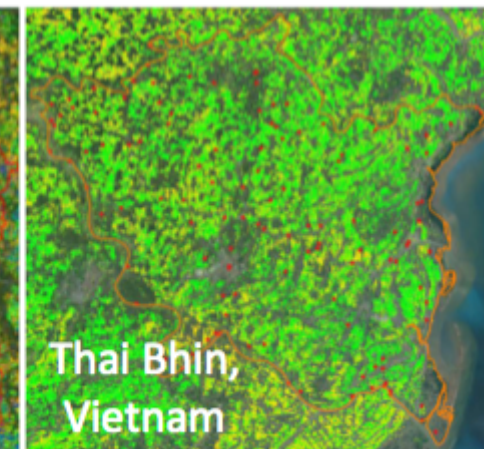
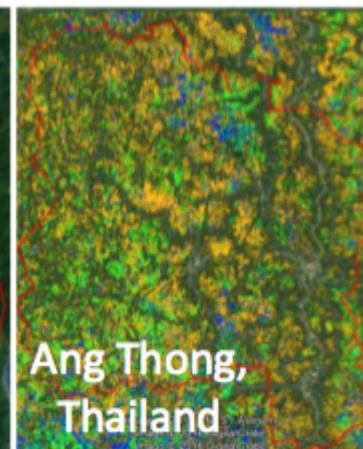
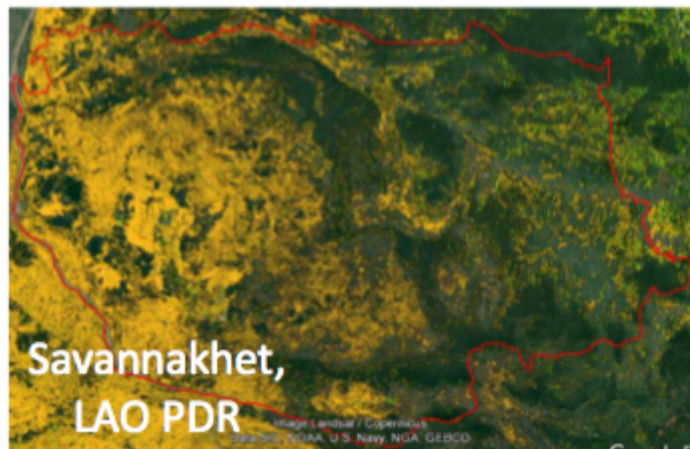
## SAFE Project (test site)

- Myanmar
  - Cambodia
- [2016-]

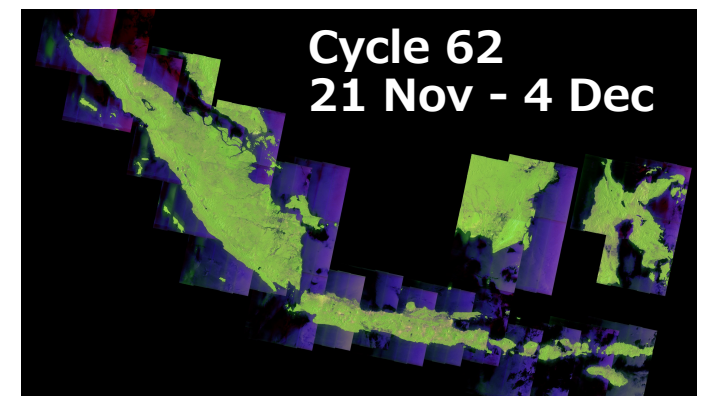
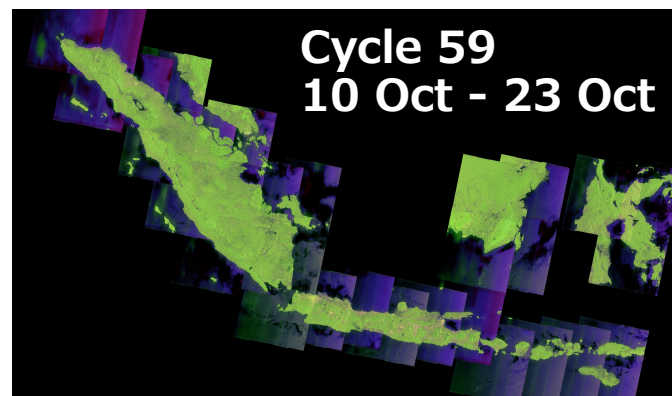
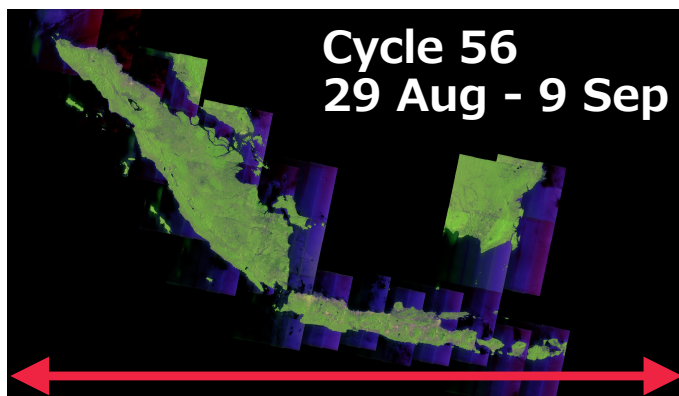
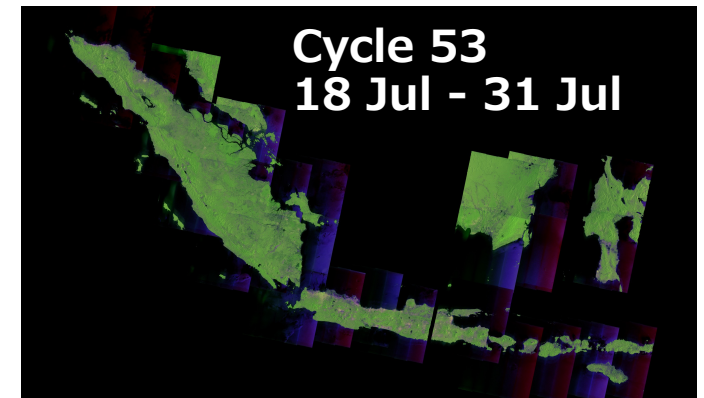
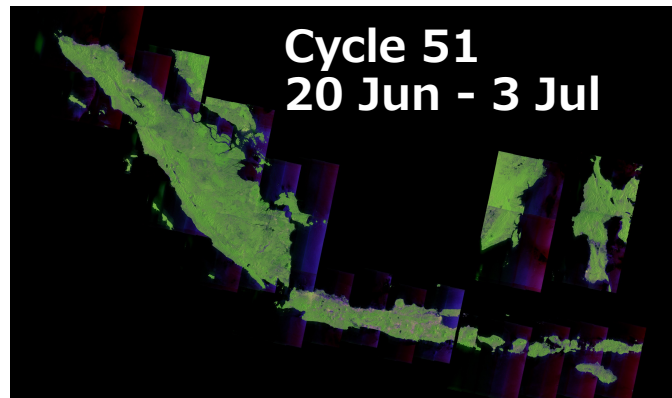
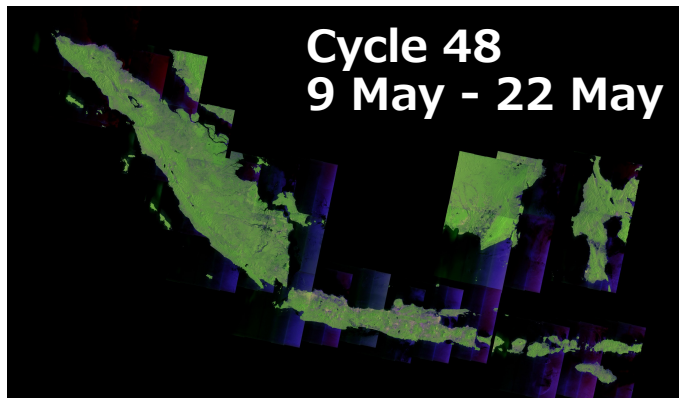
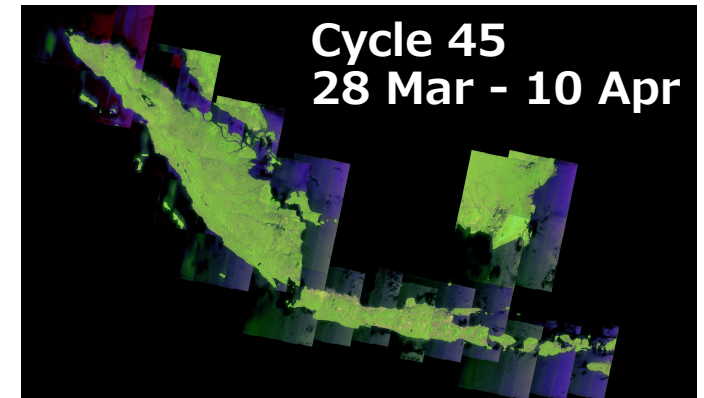
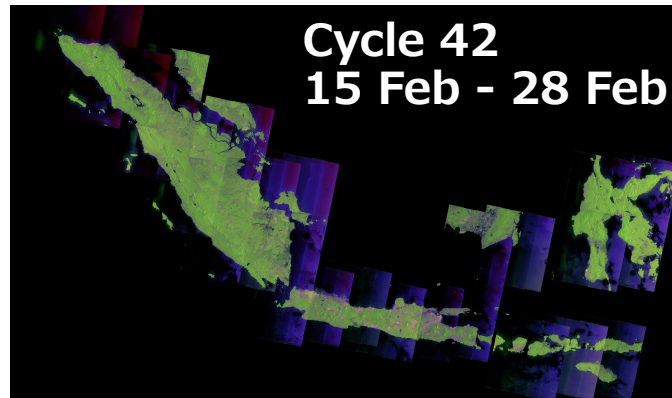
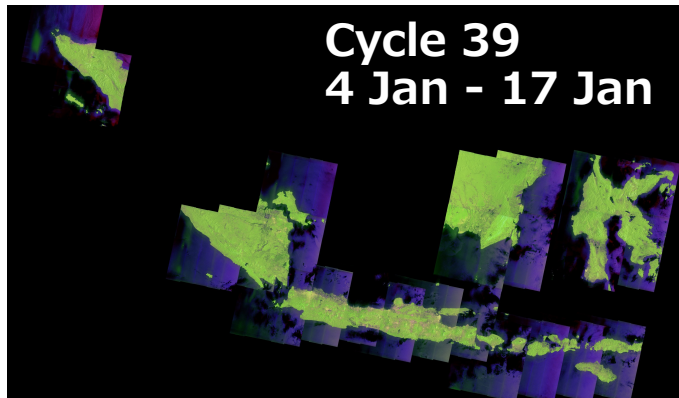
## SAFE Project (Scaling-up)

- Vietnam (Mekong Delta)
- Indonesia

[2014-]



# Scaling-up Activities Towards Operational Use



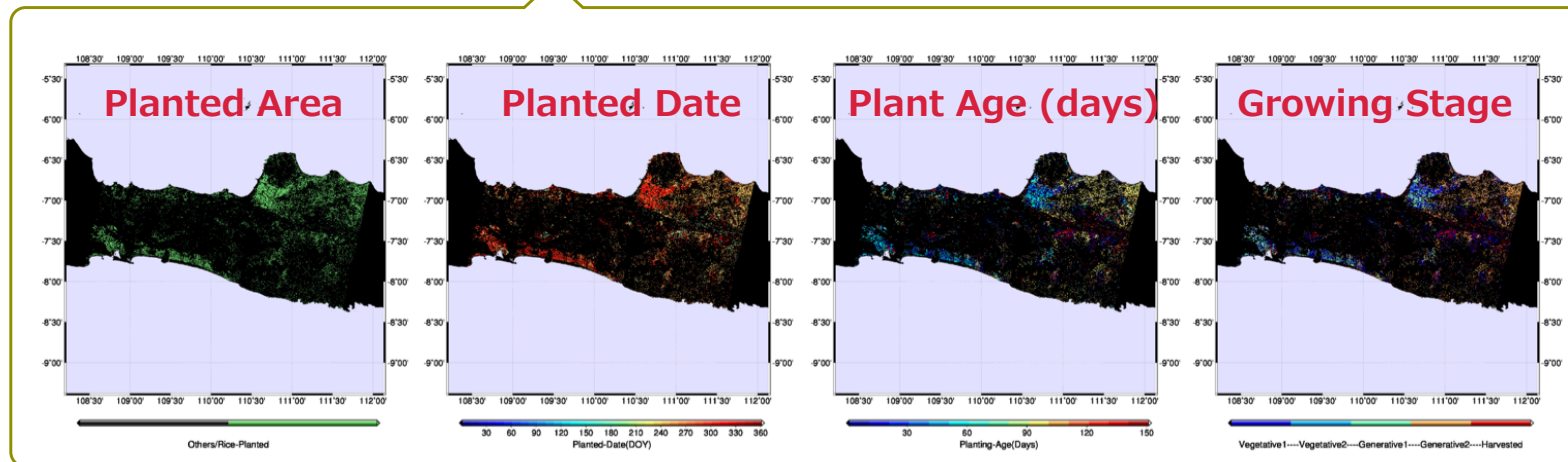
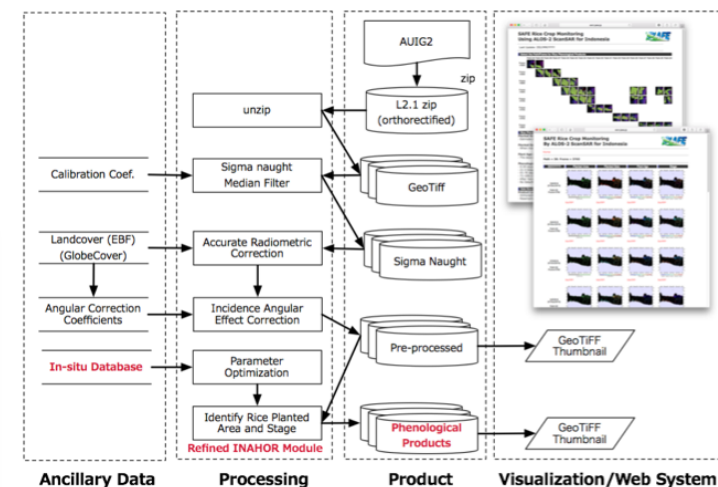
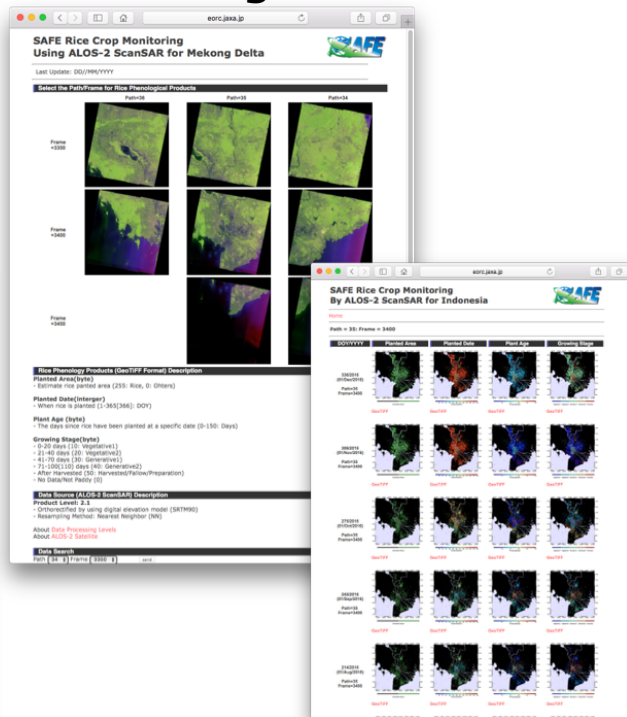
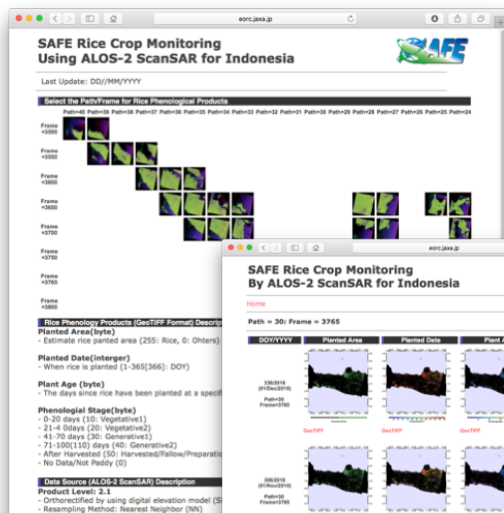
**3000 km**

# Rice Crop Monitoring System for Scaling-up

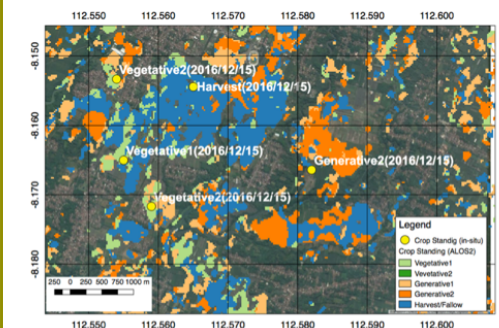
## Indonesia

## Mekong Delta

## Data Processing Flow

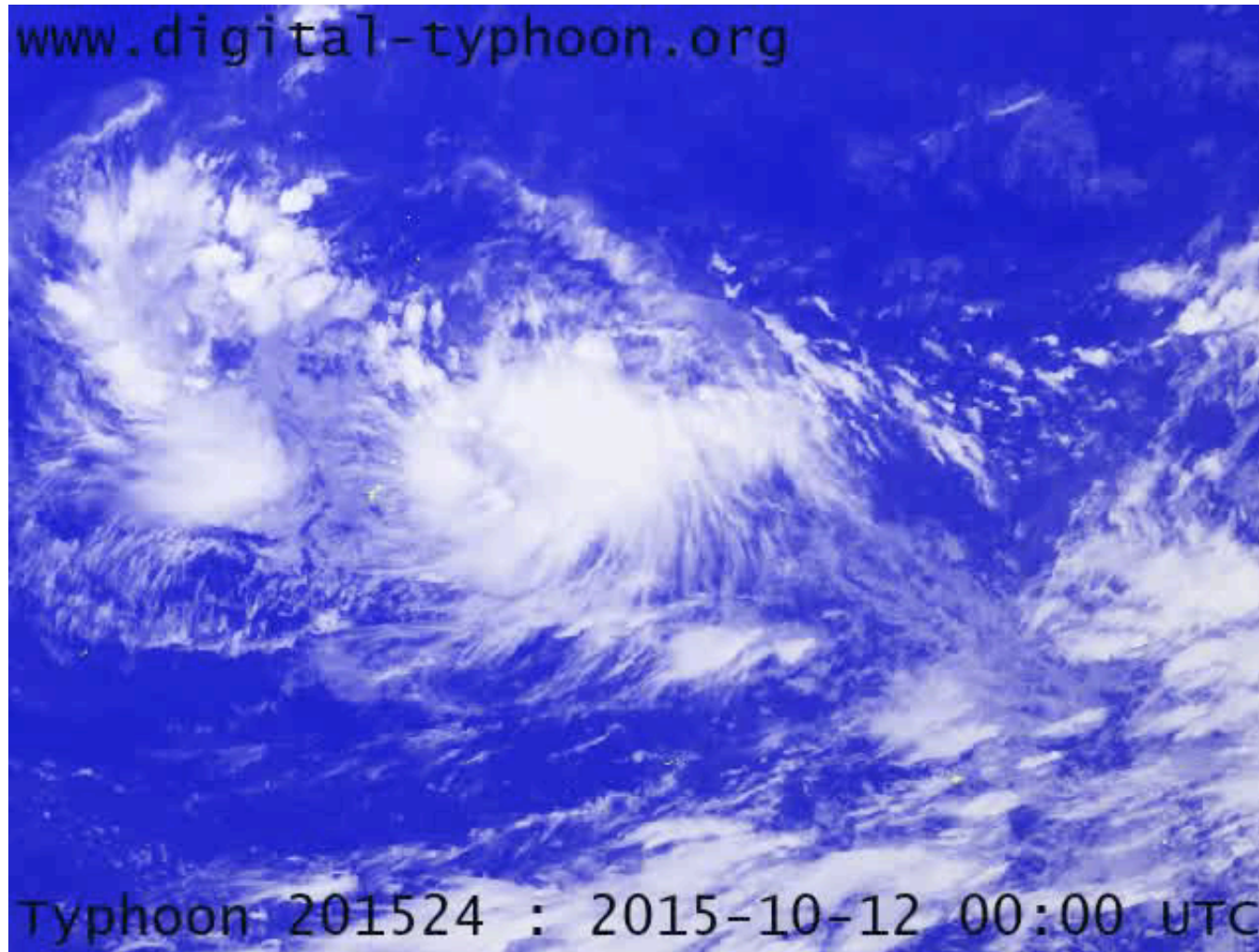


## Validation with in-situ data



Demonstrating scaling-up monitoring for rice by multi-temporal SAR data.

# Typhoon Lando hit Philippines (13-21 October 2015)



**Digital Typhoon (Prof. Kitamoto, NII, Japan)**  
**<http://agora.ex.nii.ac.jp/digital-typhoon>**

Observed by Himawari-8  
Japanese Geostationary Satellite



Japan  
Fund for  
Poverty  
Reduction

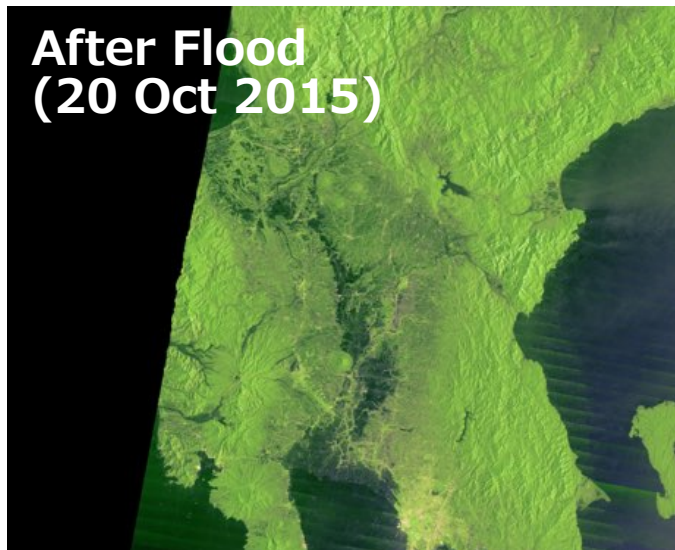
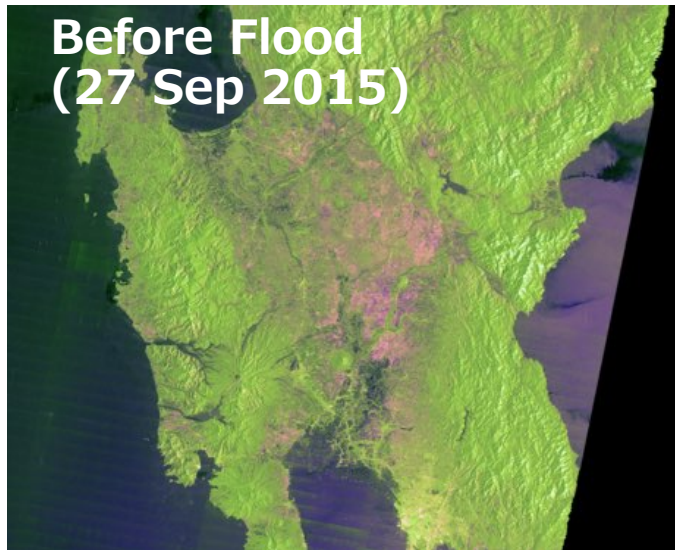


# Agricultural Damage Estimation by Multi-Temporal ALOS-2

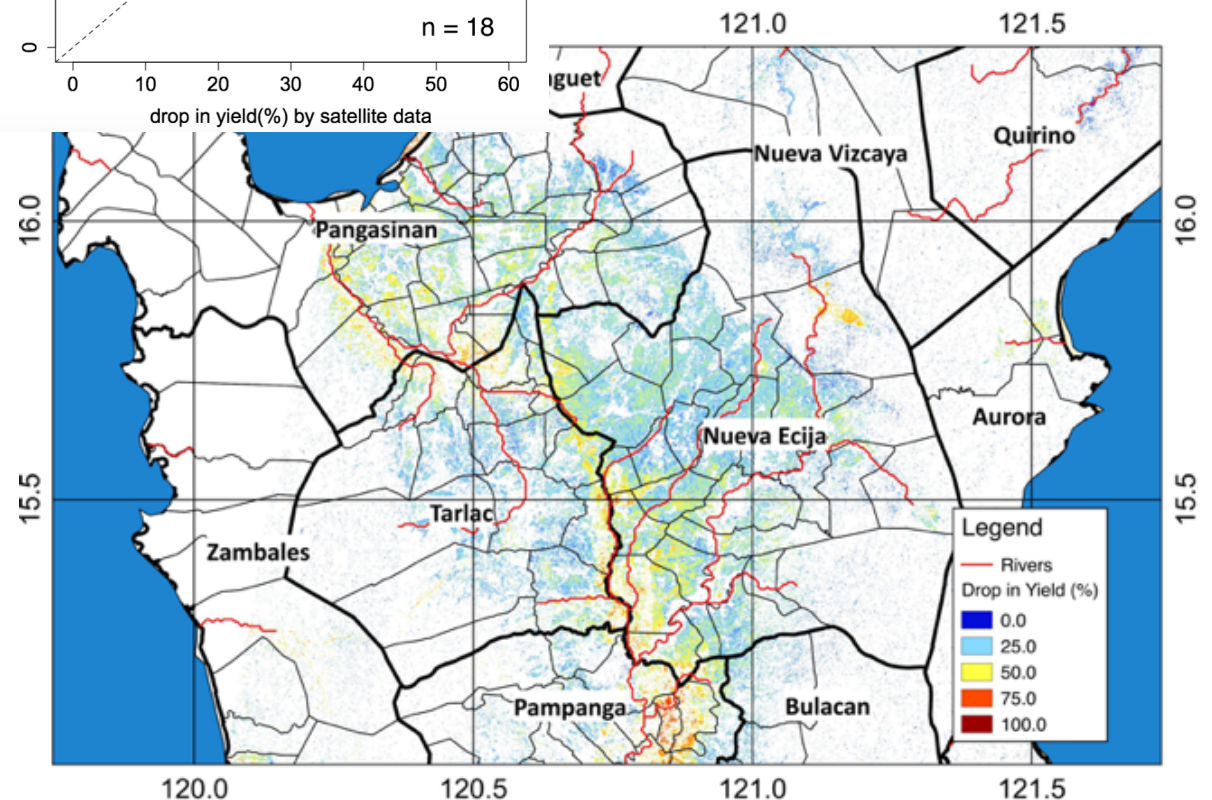
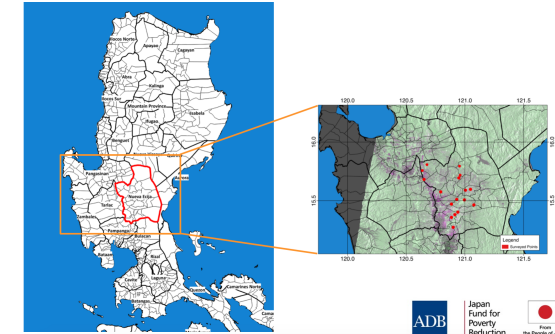
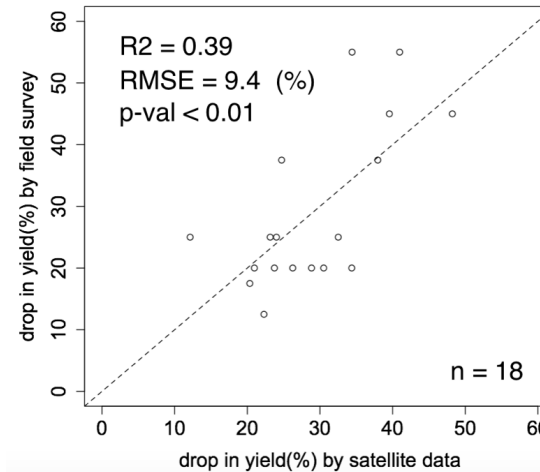
- ❖ Regression analysis result between in-situ yield drop data and ALOS-2 backscatter (before/after flooding)



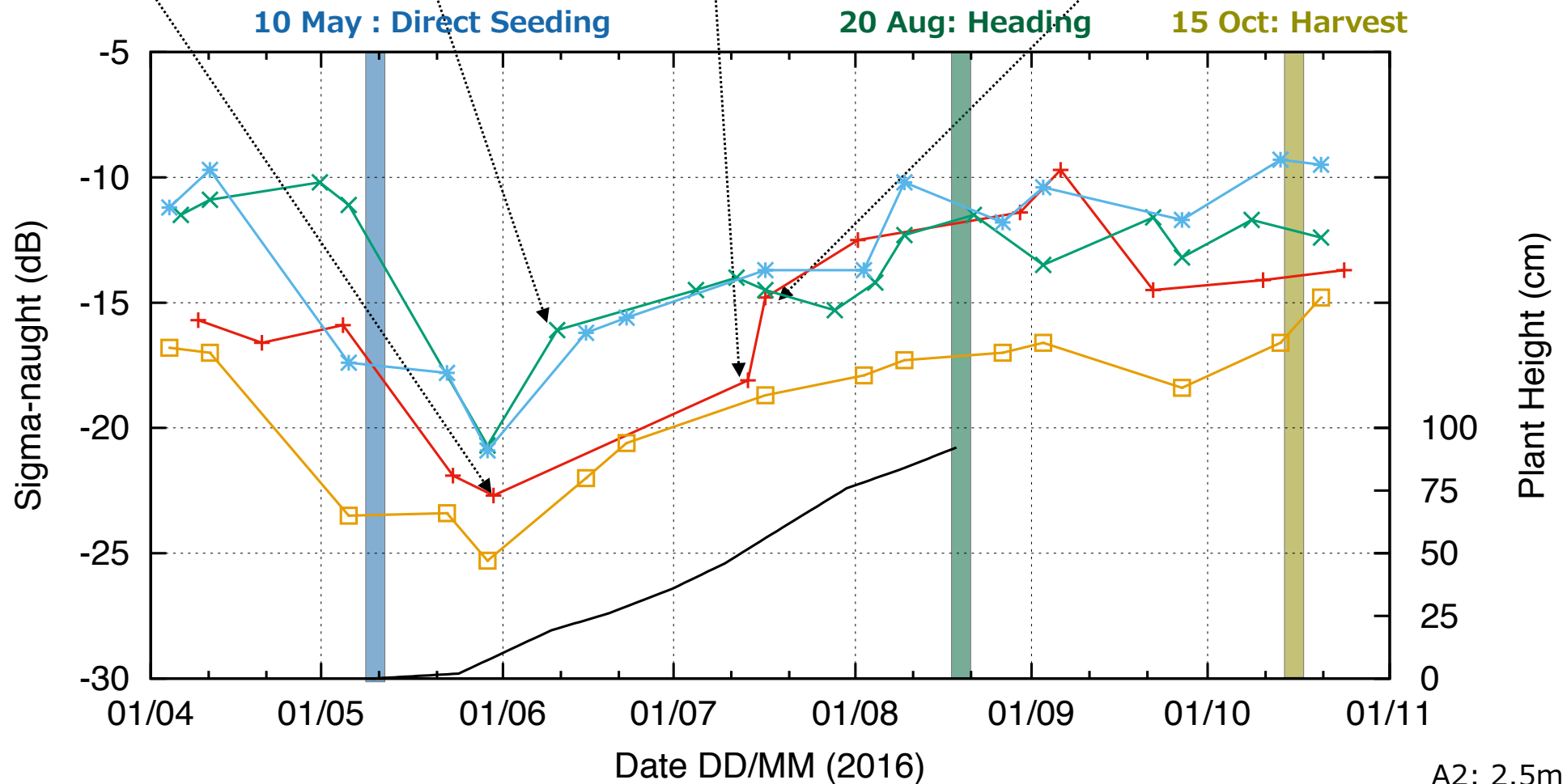
Japan  
Fund for  
Poverty  
Reduction



Field survey vs Estimation by ALOS-2



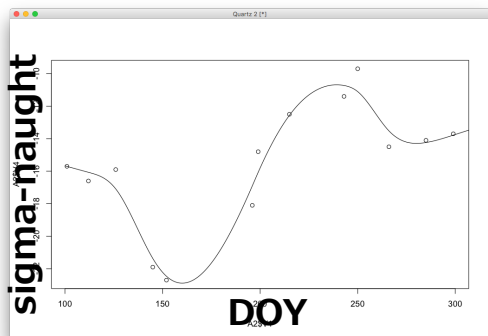
# Multi-frequency SAR Comparison, Tsuruoka, Japan



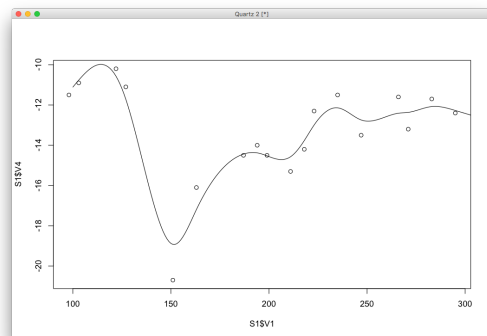
ALOS-2 HH    +    RADARSAT-2 VV    \*    Plant Height    —    A2: 2.5m  
 Sentinel-1 VV    x    RADARSAT-2 VH    □    S1: 10m  
 R2: 8m    14

# Sensitivity Analysis of L/C band at Each Plant Height

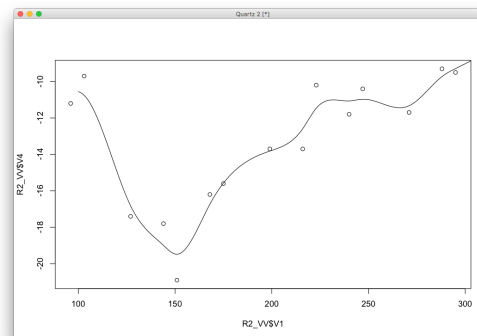
❖ Sensitivities were calculated after applying spline interpolation to backscatter



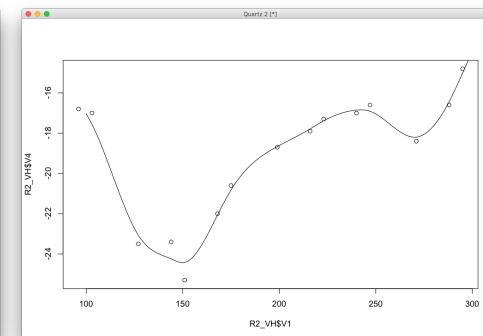
ALOS-2 VV



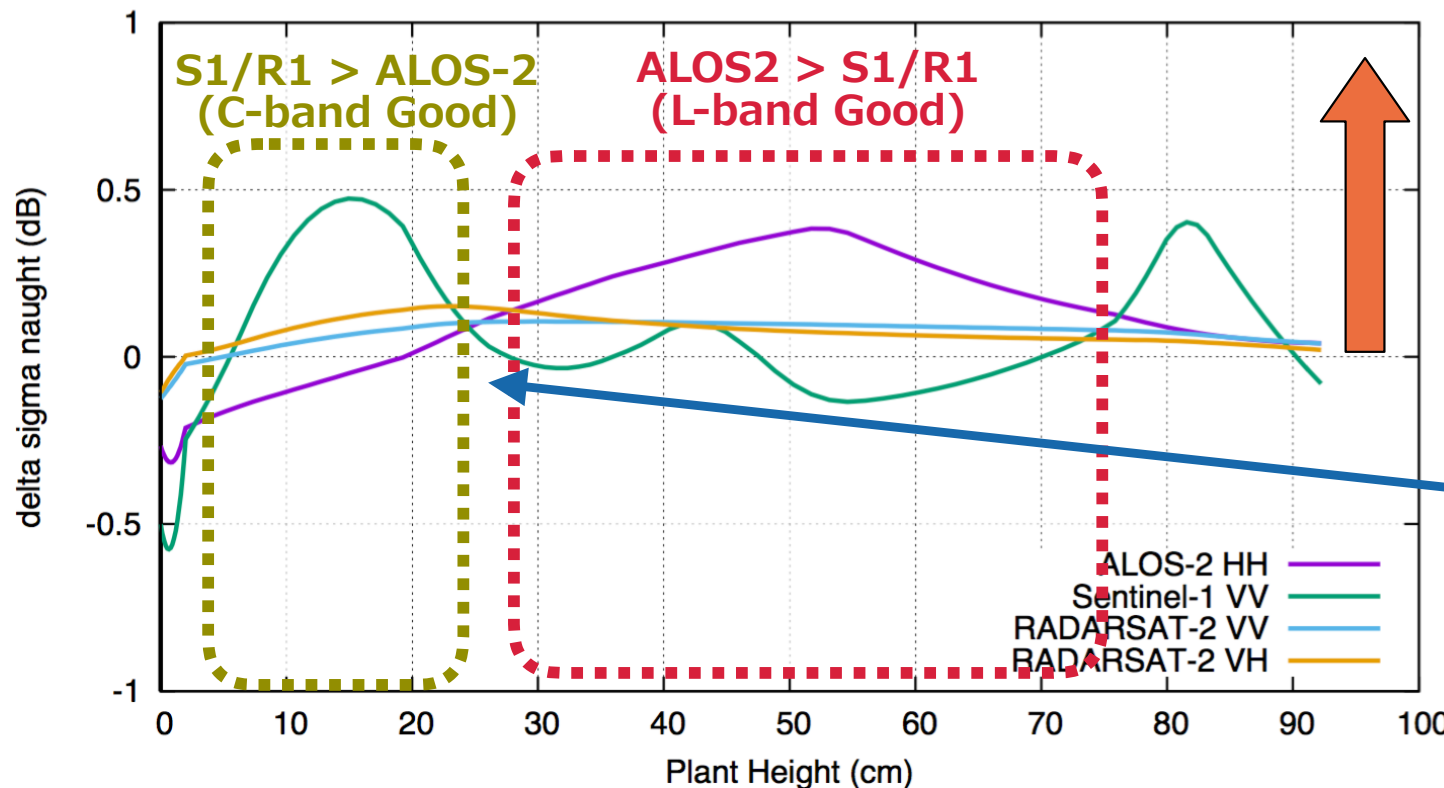
Sentinel-1 VV



Radarsat-2 VV



Radarsat-2 VH



High Sensitivity



ALOS-2 Wavelength  
23.4 cm

Plant Height: 25cm

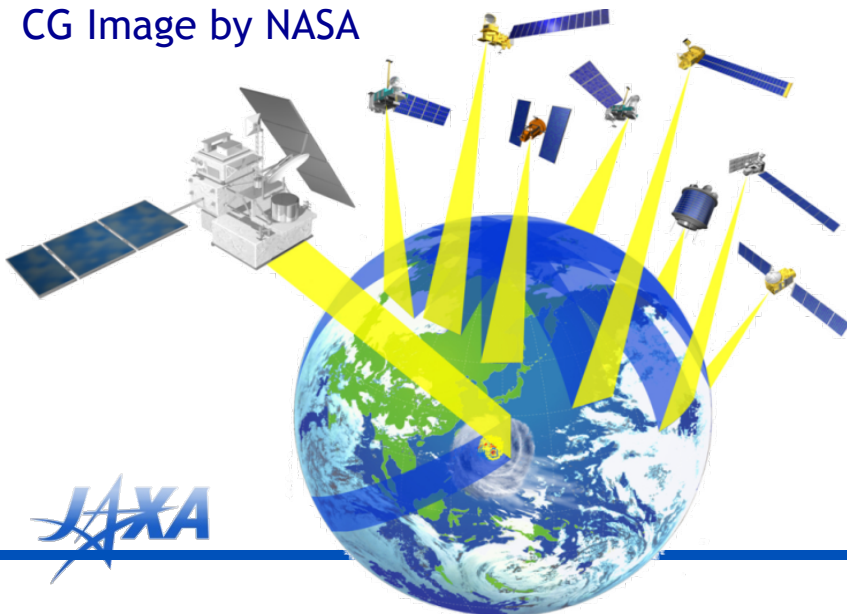


# GPM and GCOM-W for Water Cycle Monitoring

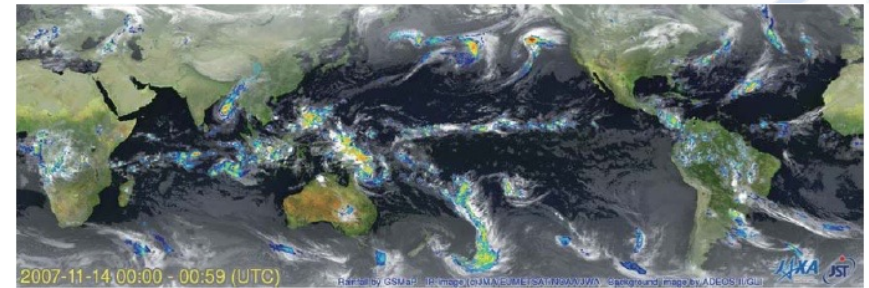
## GPM Core Observatory by NASA-JAXA



CG Image by NASA



## Global Satellite Mapping of Precipitation (GSMaP)



0.1° grid  
Hourly data with 4hr delay



## GCOM-W: Global Change Observation Mission- Water

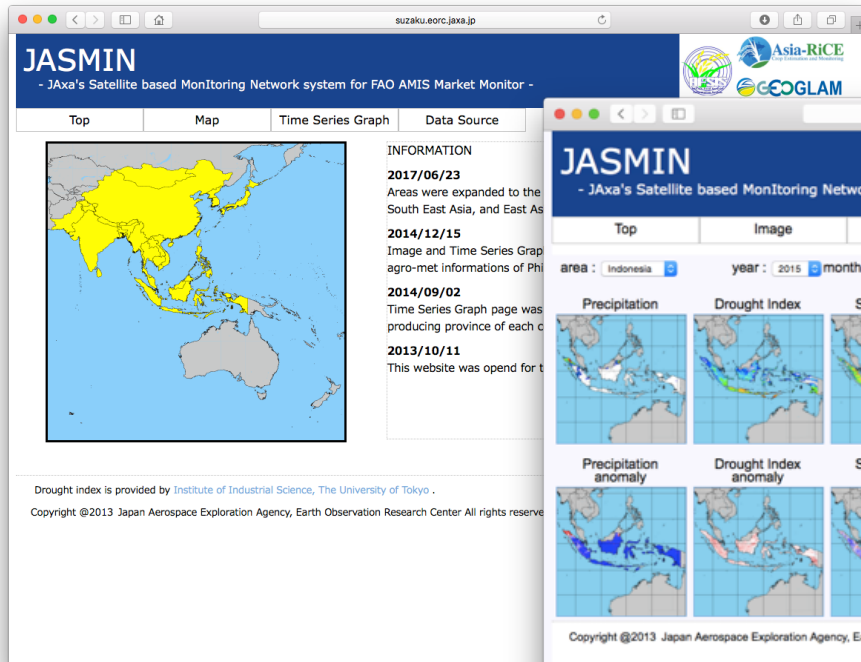




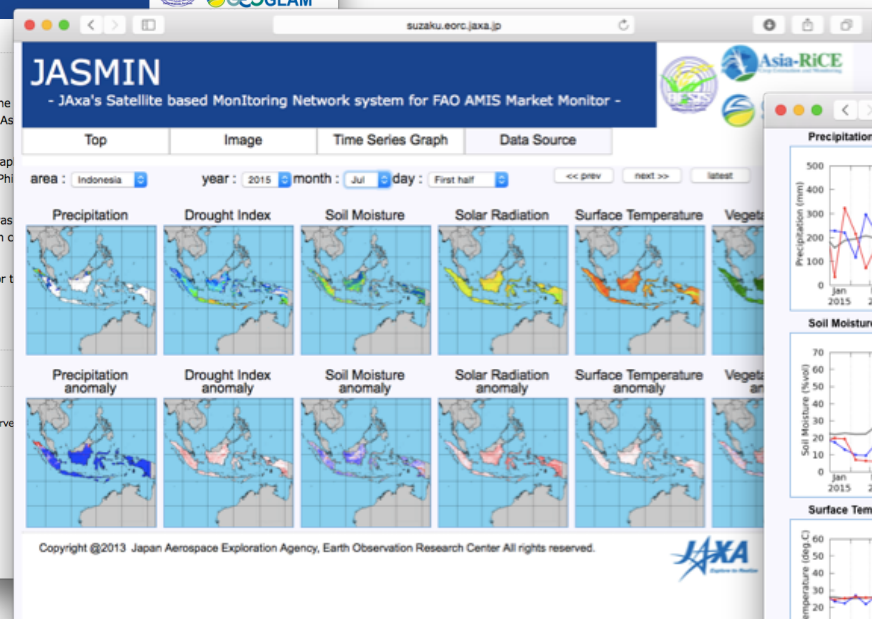
# Near-real time Agro-meteorological Monitor

- ❖ **JASMIN** provides satellite-based rainfall (GSMaP), drought index, solar radiation, land surface temperature, soil moisture, and vegetation index.
- ❖ These data are updated twice a month and utilized for the assessment of rice growth in GEOGLAM/Asia-RiCE activity.

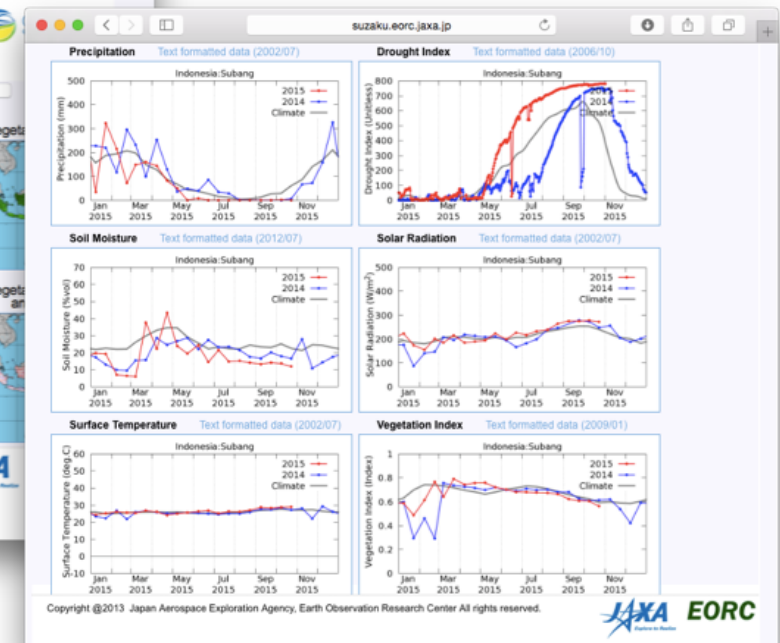
## Top Page



## Map



## Time-series plot (each province)

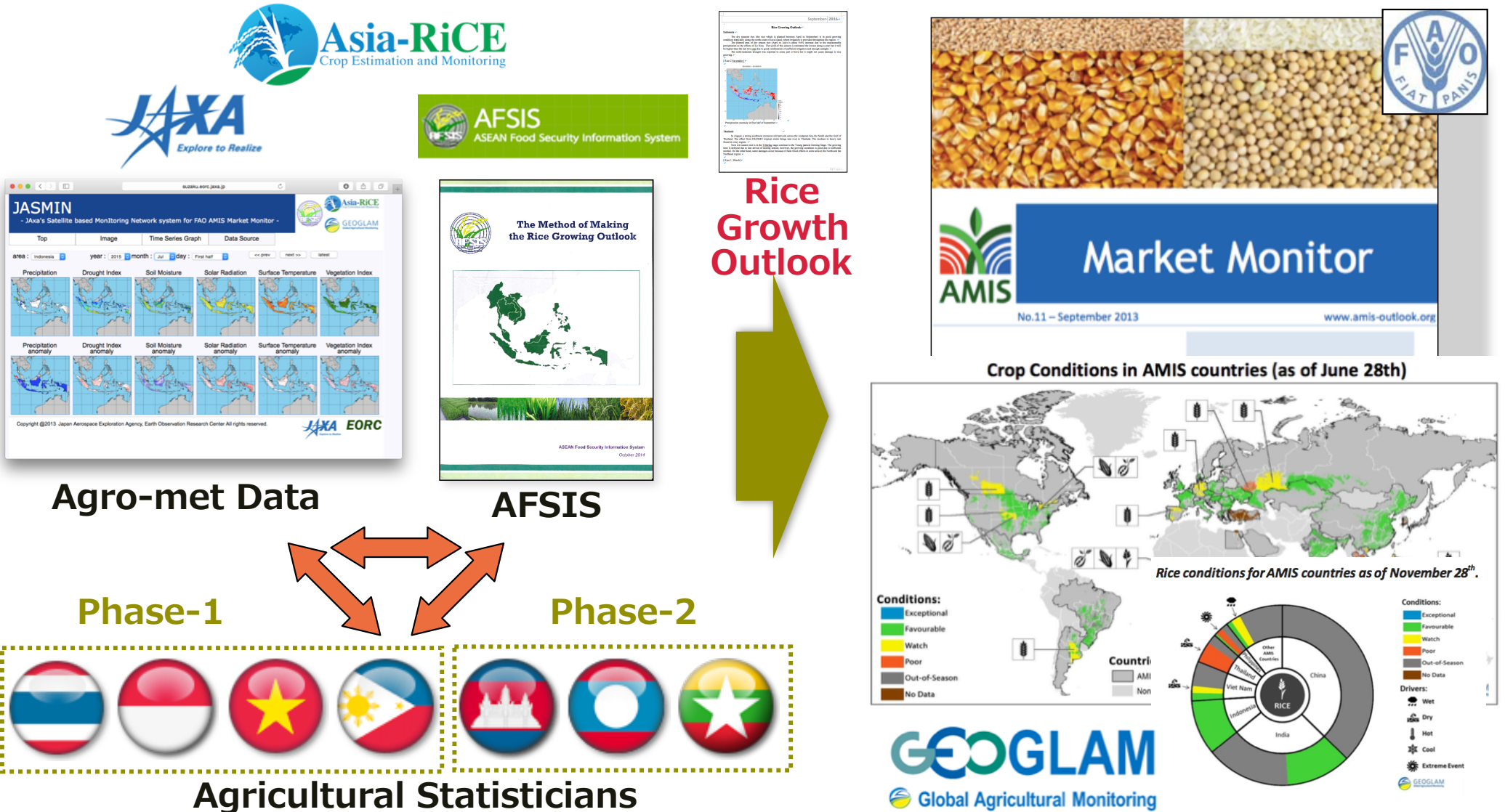


<http://suzaku.eorc.jaxa.jp/JASMIN/index.html>

Target areas were expanded to whole Southeast, South, and East Asia.

# Rice Growth Outlook to GEOGLAM for FAO AMIS

**Market Monitor** is published by **FAO** on monthly basis to assess international agricultural market situation and outlook of **wheat, maize, rice, and soybeans**.



Monthly Rice Growth Outlook is reported to GEOGLAM for FAO/AMIS



# Future Missions

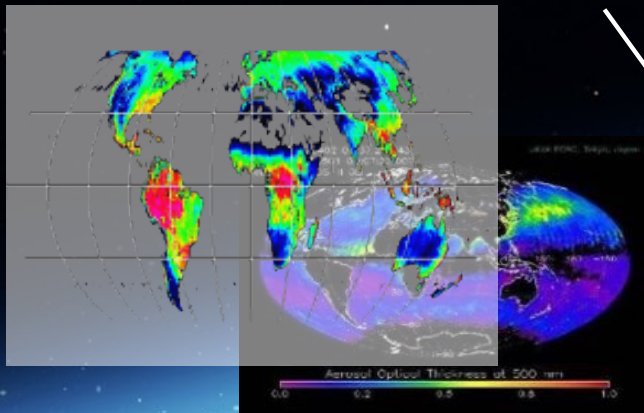
# GCOM-C: Global Change Observation Mission- Climate

Launch in JFY2017

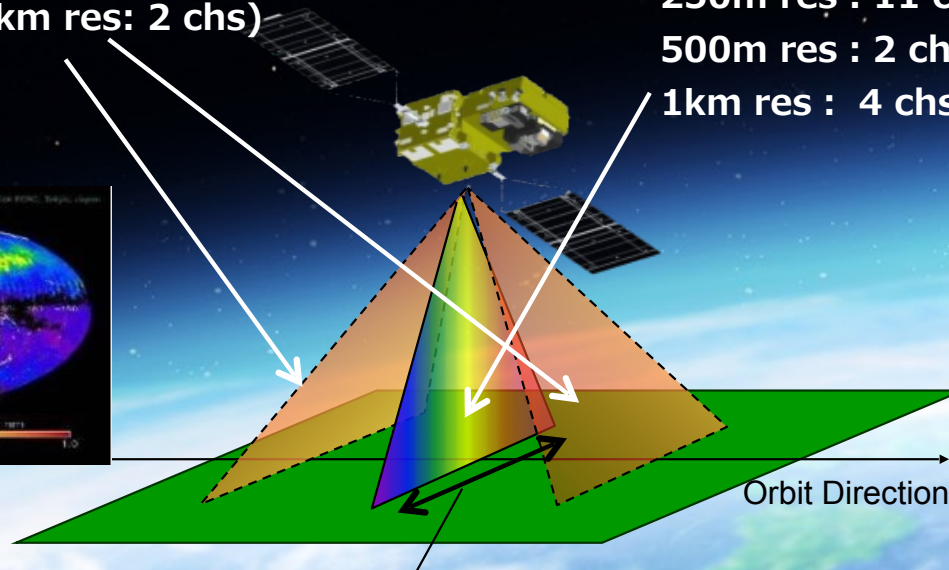


- Forward or backward polarization
- Along-track slant view (1km res: 2 chs)

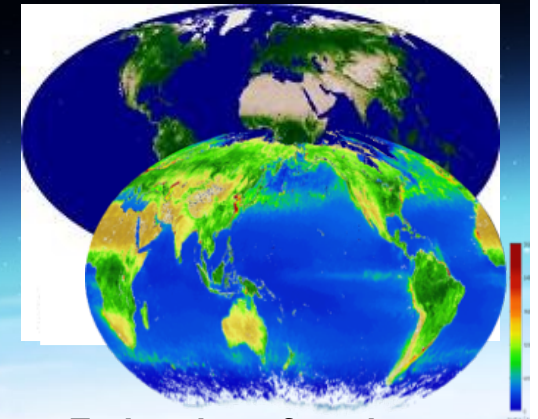
250m res : 11 chs  
500m res : 2 chs  
1km res : 4 chs



Understanding changes in biomass, aerosols and land cover

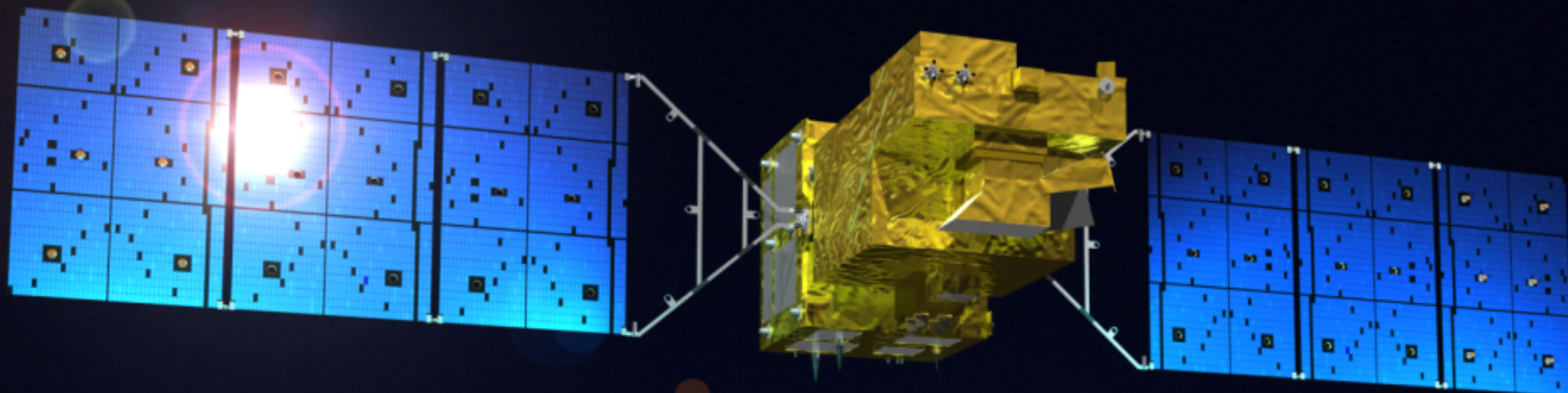


Swath : 1150km (Visible · Near-infrared, Polarization)  
1400km (Short-wavelength infrared · Thermal infrared)



Estimation of marine production, Obs. of vegetation, clouds, water flow, or ocean currents

# GOSAT-2 on orbit in 2018



## Upgrade in GOSAT-2 mission

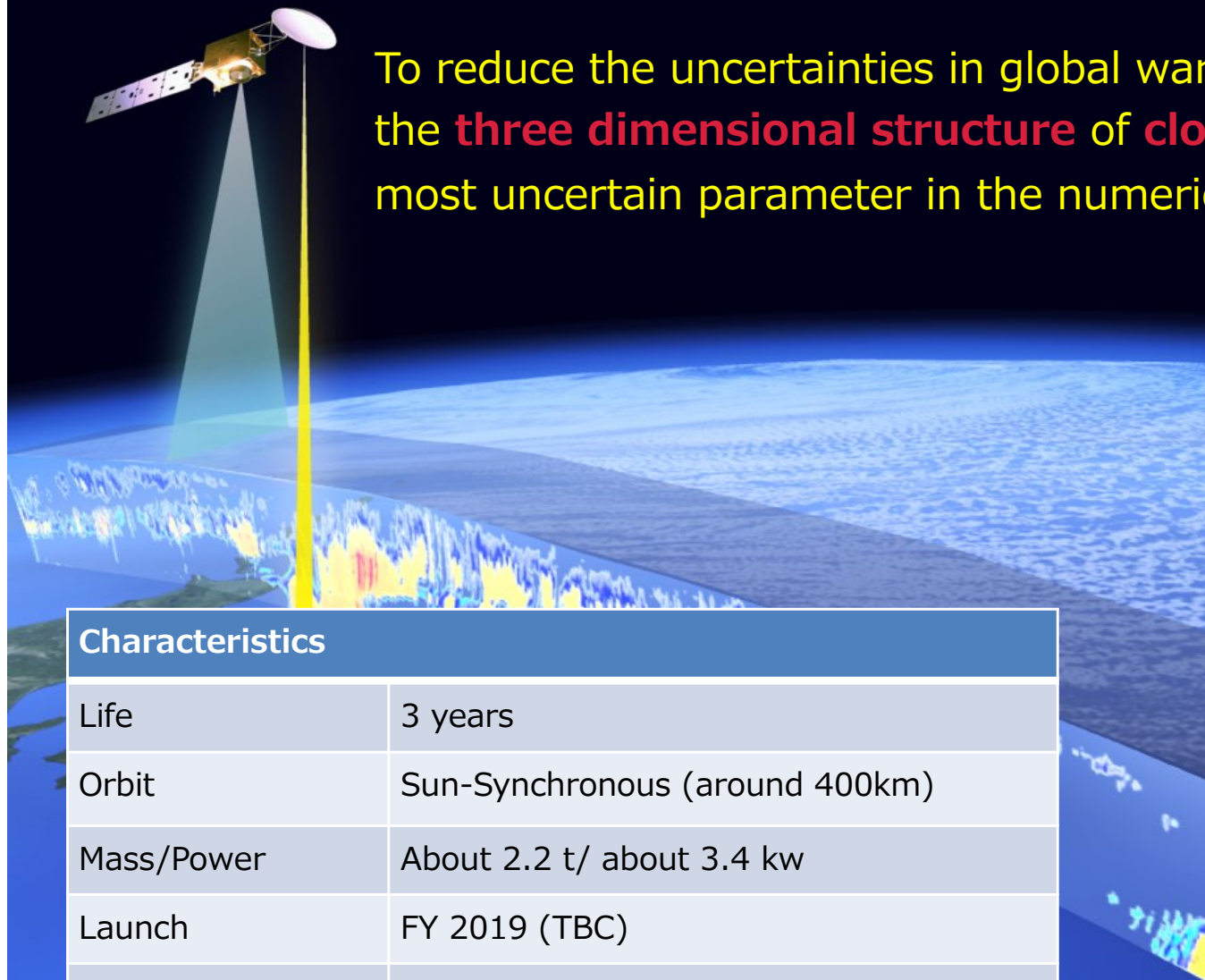
## GOSAT achievement

## GOSAT target

Measurement precision	0.5 ppm for CO <sub>2</sub> 5 ppb for CH <sub>4</sub>	←2ppm for CO <sub>2</sub> ←12ppb for CH <sub>4</sub>	←4 ppm for CO <sub>2</sub> ←32 ppb for CH <sub>4</sub>
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		

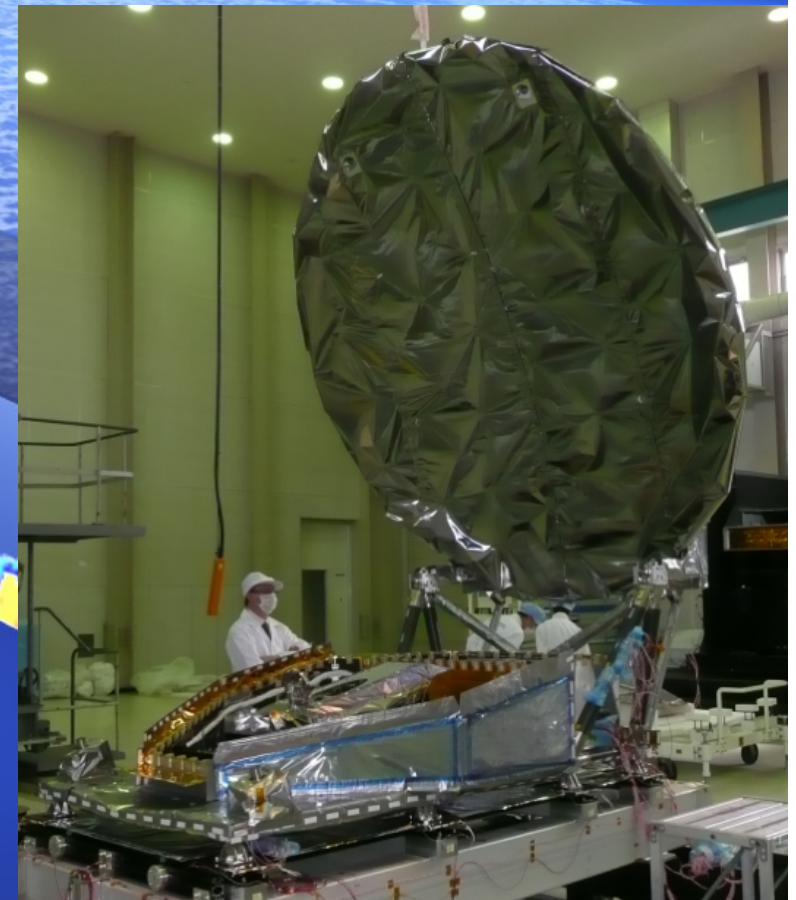
# Earth Cloud, Aerosol and Radiation Explorer (EarthCARE)

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

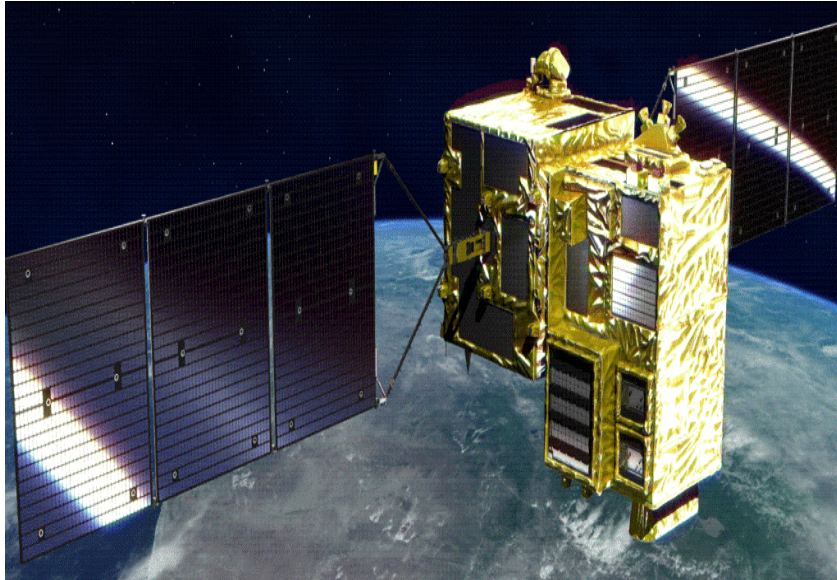
Life	3 years
Orbit	Sun-Synchronous (around 400km)
Mass/Power	About 2.2 t/ about 3.4 kw
Launch	FY 2019 (TBC)
Instruments	CPR: Cloud Profiling Radar (JAXA/NICT) ATLID: Atmospheric Lidar (ESA) MSI: Multi-Spectral Imager (ESA) BBR: Broadband Radiometer (ESA) Satellite bus: Airbus DS Satellite launch: ESA



CPR (Cloud Profile Radar)

# ALOS Successors: Advanced Optical Satellite(ALOS-3) and Radar Satellite(ALOS-4)

## Advanced Optical Satellite (ALOS-3)



### Characteristics

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

## Advanced Radar Satellite (ALOS-4)



### Characteristics

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

# Summary

- ❖ Asia-RiCE is implementing by Asian space/agriculture agencies
  - ▶ Expanding rice monitoring by SAR from provincial-level to country/region-level estimates for the operational use in enduser agency (e.g. Ministry of Agriculture)
  - ▶ Preparing rice growth outlooks using satellite-derived agro-meteorological data and provide them to AMIS via GEOGLAM
  
- ❖ JAXA's current missions (SAR, rain RADAR, MWR) contributes to rice monitoring in Asia for rice plated area mapping, agro-meteorological monitoring, and agricultural damage assessment etc.
  
- ❖ New missions will also enhance our ability to monitor rice and other crops.



# Thank You for Your Attention !

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