

JAXA's Mission Updates and Agricultural Applications

Ko Hamamoto¹, Shinichi Sobue¹, Kei Oyoshi¹
on behalf of Asia-RiCE Team

¹ Japan Aerospace Exploration Agency (JAXA)

Land Cover/Land Use Changes (LC/LUC) and Impacts on Environment in
South/Southeast Asia - International Regional Science Meeting

28-30th May, 2018, Philippines



- 2013

2014

2016

2018

2020 (JFY)

High Resolution



Climate Change & Water Cycle



GHG Monitoring



Japanese Current and Future Missions

Earth Observation Satellites Contribute to Agriculture

GCOM-W1
(2013-)



GPM
(2014-)

ALOS-2
(2014-)

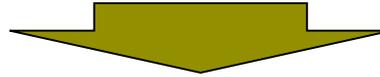


Himawari-8
(2014-)

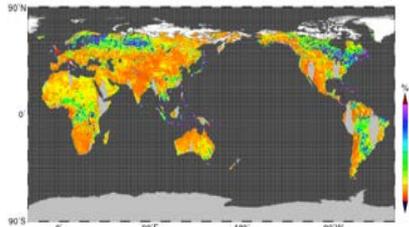
GCOM-C
(2017)



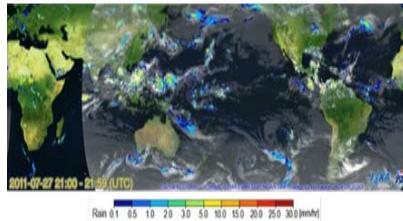
+ Other Satellites



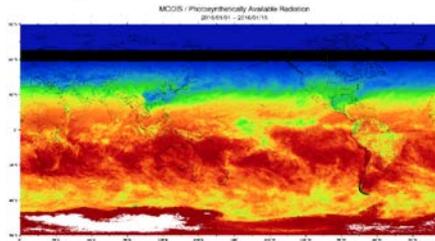
Agriculture-Related Products



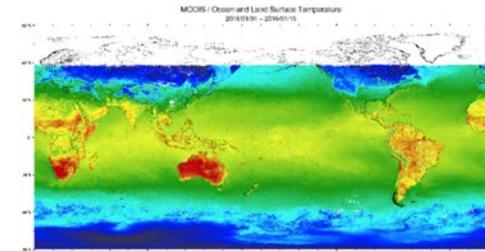
Soil Moisture



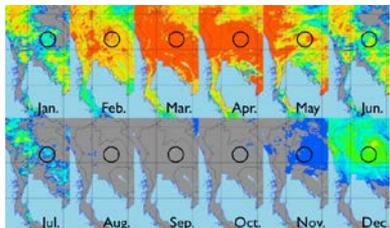
Precipitation



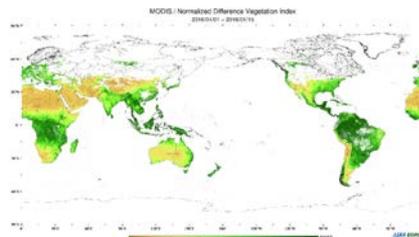
Solar Radiation (PAR)



Land Surface Temperature



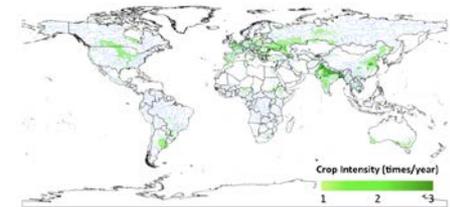
Drought Index



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.



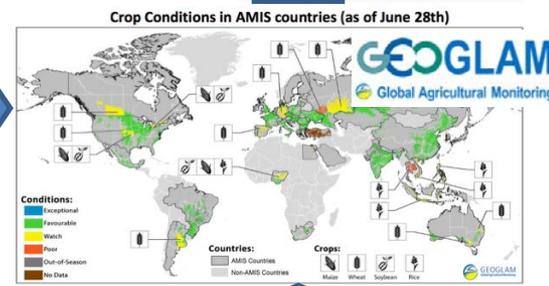
Asia-RiCE Website: <http://www.asia-rice.org>

AO-GEOSS Task 5 Agriculture and Food Security

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

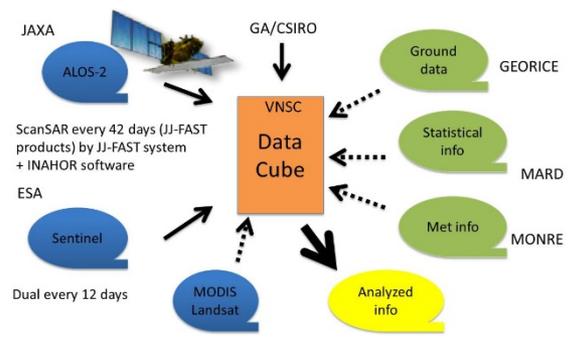


GEOGLAM was endorsed by the G20 Summit, aims to enhance regional and global agricultural production estimates through the use of Earth observations

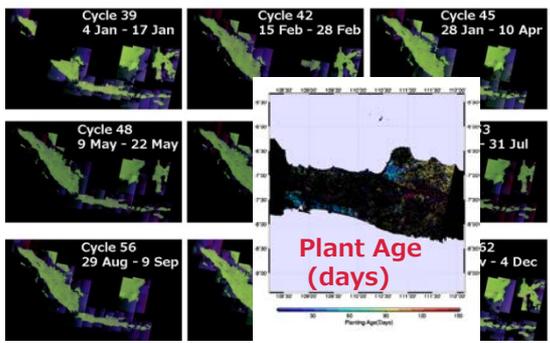


Asia-RiCE (Asia Rice Crop Estimation & Monitoring) program led by JAXA with CNES and more than 20 Asian Space agencies and Ministries of Agriculture with International organization such as ASEAN/AFSIS, UN/FAO, IRRI from 2013 to enhance rice production estimates through the use of Earth observation satellites data (POC: Sobue.shinichi@jaxa.jp, ohyoshi.kei@jaxa.jp, Thuy.letuan@cesbio.cnes.fr)

ID	Target Agricultural Products	Requirements of EO data for operational use
P1	Rice Crop Area Estimates/Maps	Wall-to-wall observation with SAR dual polarization with Optical (week - bi-weekly - monthly) : Indonesia, Vietnam/Cambodia and Thailand/Lao projects
P2	Crop Calendars/Crop Growth Status	Mid/coarse resolution optical frequent observation (MODIS, GCOM-C, Landsat, Sentinel-2, etc.) with SARs weekly
P3	Crop Damage Assessment	Very High resolution SAR and Optical timely under international disaster charter, Sentinel Asia, etc.
P4	Agro-meteorological Information Products	Daily Mid/coarse resolution optical, passive microwaver and PR with geostationary met sat frequent observation (MODIS, Sentinel, GCOM-C/W, GPM, Himawari, etc.)
P5	Production Estimation and Forecasting	Data fusion, data integration with ground base observation / statistical information and crop models



Vietnam Data Cube starting from GEOSS-AP (Hanoi, September 2017) by VNVC/VAST



Time series rice crop growth monitoring for top 10 Indonesia main rice regions by ALOS-2 with MOA



Rice crop monthly outlook using agro-met information and agriculture expert knowledge

National Agricultural Monitoring

Meteo
Data

EO Data

In Situ
Data

Asia-RICE seeks to contribute to National Info.System

Space Agency,
R&D entities
for
**Crop Area,
Growth,
Conditions, Yield**

**National
Agricultur
e Ministry**

Area
outlook

Area
estimate

Monthly
bulletin

Early
warning

Yield
forecast

Prod
estimate

Vulnerab.
report

Int market
report

Agriculture-related Products by Remote Sensing

ID	Target Agricultural Products	Asia-RICE Requirements of EO data for operational use
P1	Rice Crop Area Estimates/Maps	Wall-to-wall regional /national observation with SAR /Optical (bi-weekly, monthly) : Indonesia, Vietnam/Cambodia and Thailand/Lao, Myanmar
P2	Crop Calendars/ Crop Growth Status	Mid/coarse resolution optical observation (MODIS, GCOM-C, Landsat, Sentinel-2/3, etc.) with SARs weekly
P3	Crop Damage Assessment	VHR and HR SAR and Optical data timely under international disaster charter, Sentinel Asia, etc.
P4	Agro-meteo Products	Daily Mid/coarse resolution optical, passive microwave and MET sat observation (MODIS, Sentinel, GCOM-C/W, GPM, Himawari..)
P5	Rice Production Estimation and Forecasting	EO (and Met) Data and Products with In Situ data to be used in Statistical models and Agro-meteo crop growth models.

[Asia-RiCE Work Plan, 2012]

Research and Development Activities

1. Demonstration at Technical demonstration sites (TDS) (Chinese Taipei, India, Japan, Malaysia, Philippine, Thailand ,+ Cambodia and Myanmar from 2016).
2. Demonstration at Regional/National scale: wall-to-wall Vietnam , and top 10 rice production provinces in Indonesia
 - ESA-GEORICE using Sentinel-1 for Vietnam
 - ADB project using ALOS-2 (with Inahor) for Vietnam, Indonesia..
3. On going research using SARs (L/X/C) and optical (S2/Landsat/Venus/Formosat) for Rice Yield estimate and Methane Emission at TDS and JECAM site(s)

Towards operational services

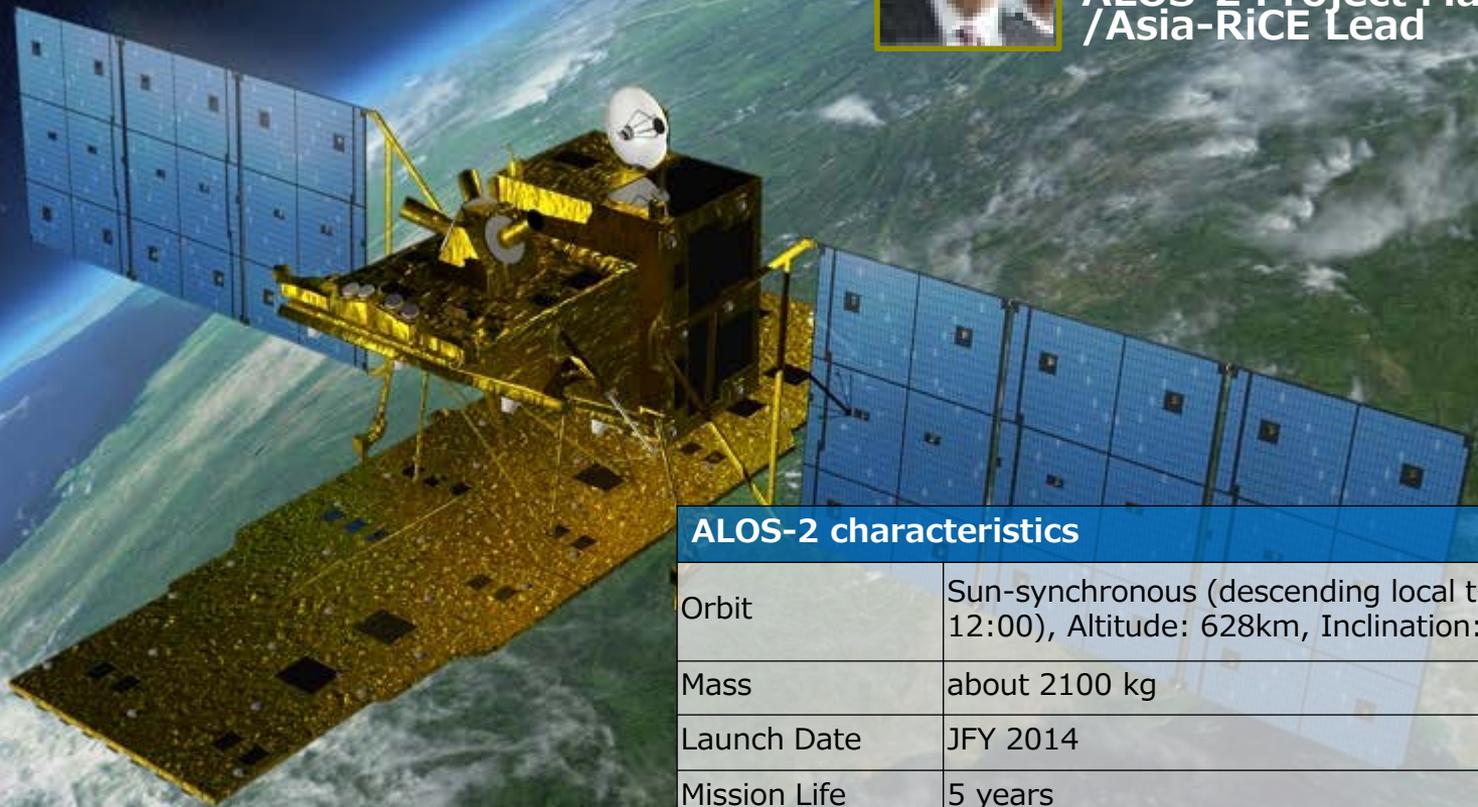
1. Start to set up pre-operational service for rice crop growing monitoring using ALOS-2 ScanSAR and Sentinel-1 and other satellites in Indonesia and Vietnam
2. Especially, for Vietnam, under the cooperation with CSIRO and VNSC, JAXA integrates ALOS-2 ScanSAR data, and CNES-CESBIO integrates Sentinel-1 SAR ARD to CEOS Vietnam Data Cube for rice monitoring.

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)

What is INAHOR-AD?

“International Asian Harvest mOnitoring system for Rice”

– Advanced version

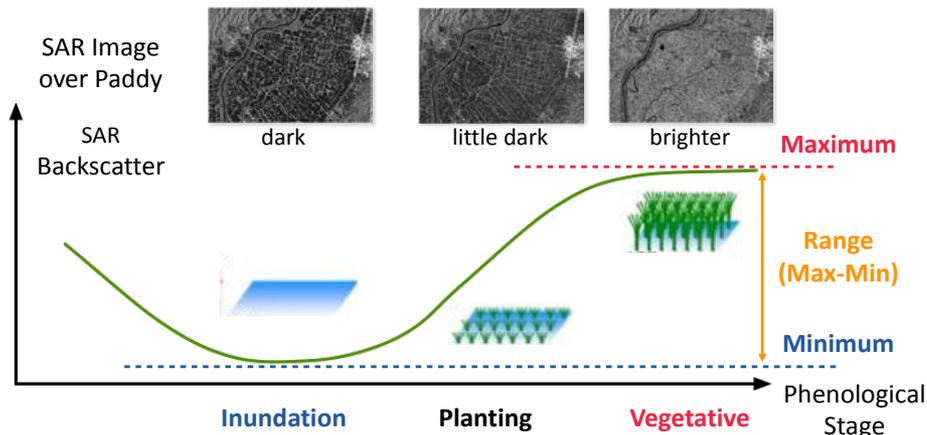
What can you expect ?

- Mapping of rice planted area
- Calculation of rice planted area
- Calculation of rice production (need yield data)



Basic Concept of Rice Planted Area Detection

- Paddy rice area has “Inundation” and “Vegetative” stages.



If (**Minimum** < Threshold1) and (**Range** > Threshold2)
(Inundation stage?) (Vegetative stage ?)



Rice Planted Area

Demonstration in Southeast Asian Countries

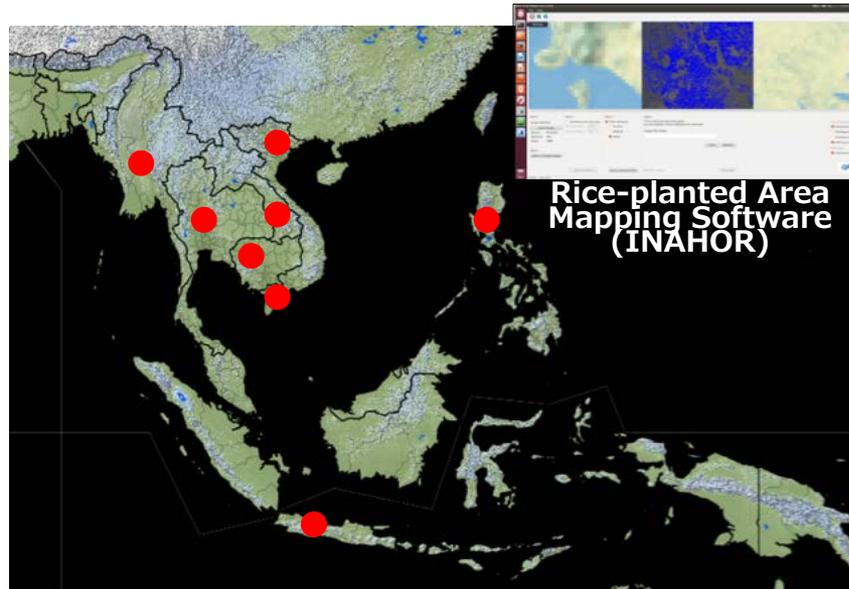
- ADB Technical Assistance project and SAFE project under the APRSAF have successfully demonstrated INAHOR using ALOS-2 with the mapping accuracy of 80-90% for the target provinces
- Scaling-up for major rice producing areas is currently demonstrated in Vietnam and Indonesia.



ADB TA Project

- Laos
- Thailand
- Vietnam (North)
- Philippines

[2014-2016]



SAFE Project (test site)

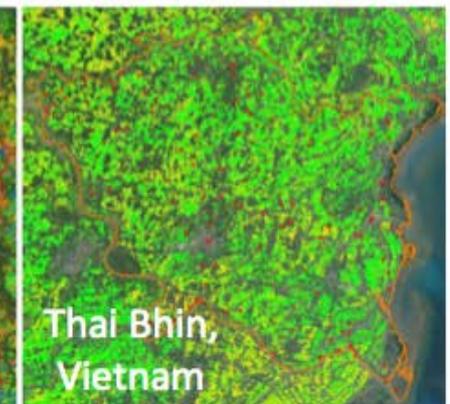
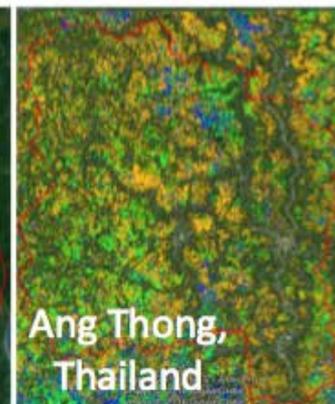
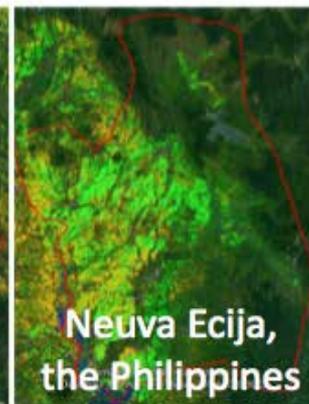
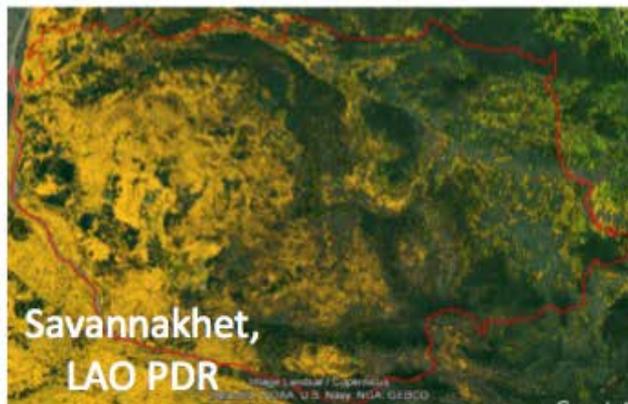
- Myanmar
- Cambodia

[2016-]

SAFE Project (Scaling-up)

- Vietnam (Mekong Delta)
- Indonesia

[2014-]

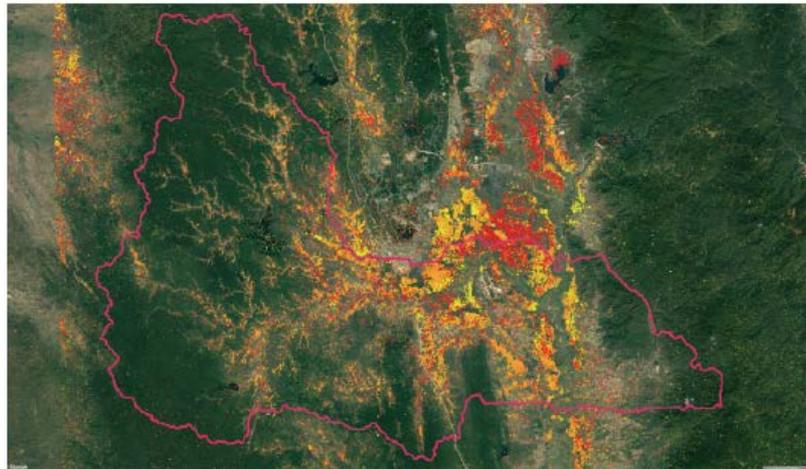


Demonstration in Southeast Asian Countries

- Rice mapping at Technical Demonstration Sites (100km x 100km – A province) using ALOS-2 and INAHOR tool in Asia Pacific Regional Space Agency Forum (APRSAF) SAFE



Myanmar



Estimated Planting Date

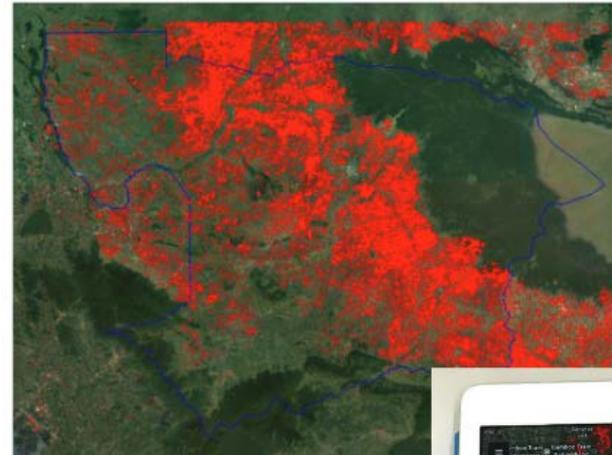
■ : 03/07/2016 ■ : 31/07/2016 ■ : 11/09/2016

Monsoon rice of Lewe Township in 2016

	Rice-Planted Area (ha)	Rice-Planted Area (acre)
Official Statistics	-	61,499
INAHOR Results	25,227	62,338

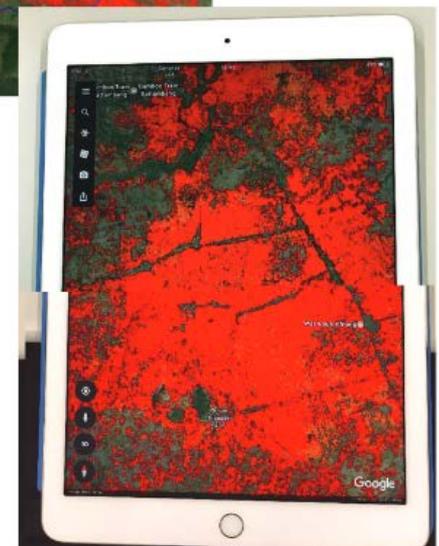
Difference (INAHOR-Official) : 839 acre
Error Ratio (INAHOR/Official) : 101.4 %

Cambodia



^ Rice planted areas from statistics were highly consistent with the INAHOR results.

> Local officers used the map function on smartphones to validate reported values during field visits.

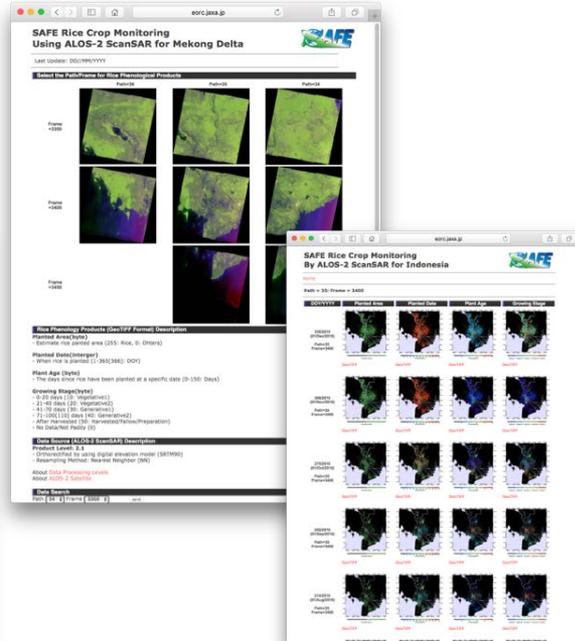


Rice Crop Monitoring System for Scaling-up

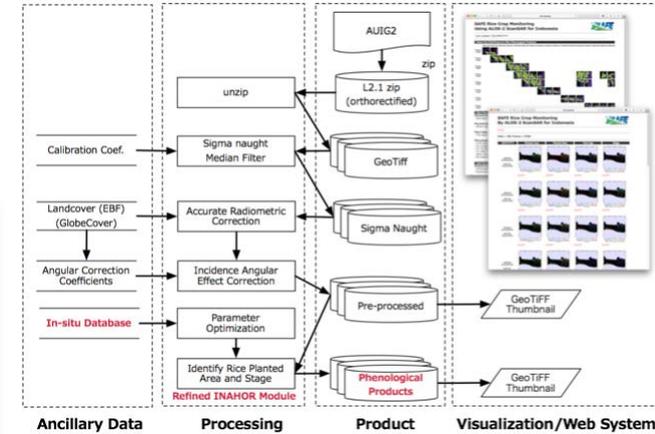
Indonesia



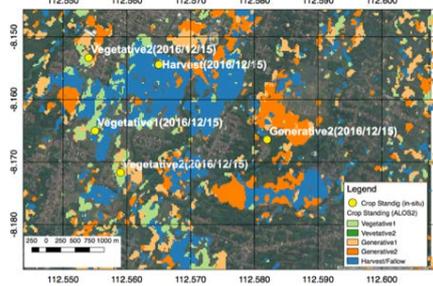
Mekong Delta



Data Processing Flow



Validation with in-situ data



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

Prototype Operational Rice Growth Monitoring System using SAR in Indonesia



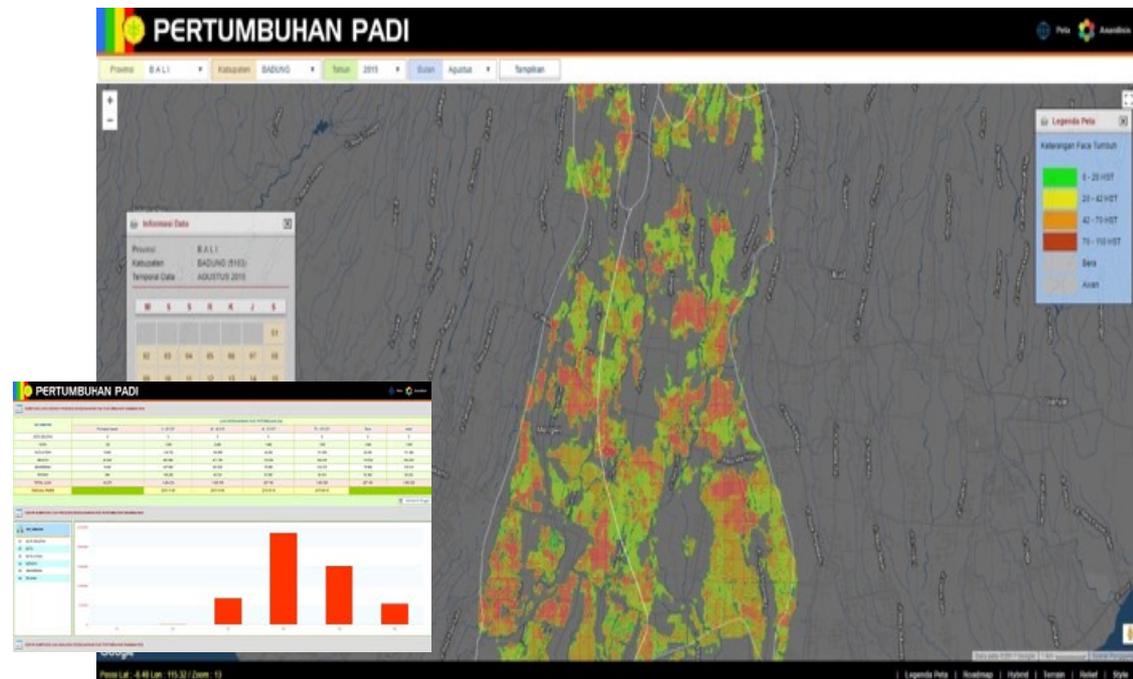
The Indonesian Center for Agricultural Land Resources Research and Development (ICALRD), the Ministry of Agriculture (MoA) developed the **prototype operational rice monitoring system using SAR (ALOS-2) data** technically supported by the National Institute of Aeronautics and Space of Indonesia (LAPAN) and JAXA.

The system can be used for decision makers to **plan agricultural production facilities (fertilizer, pesticide, irrigation, etc.)**.

MANTAP AGRICULTURE
Soft Launching (21 Nov 2017)

Sistem Informasi Pemantauan Tanaman Pertanian
Estimas Saprod
Informasi Kelangkaan & Bangi
Perencanaan Pengalokasian lahan pertanian yang berkualitas dan tepat sasaran

Badan Penelitian dan Pengembangan Pertanian
Kementerian Pertanian
2011



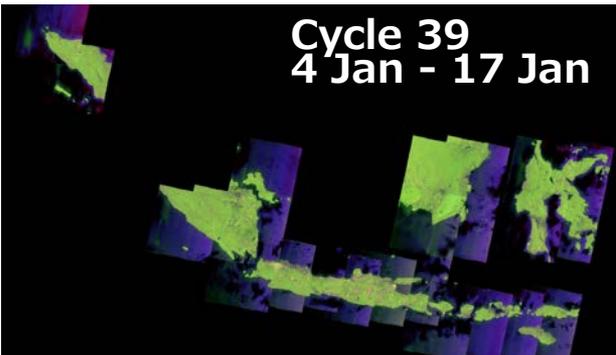
Statistics

Rice planted area and growing stage

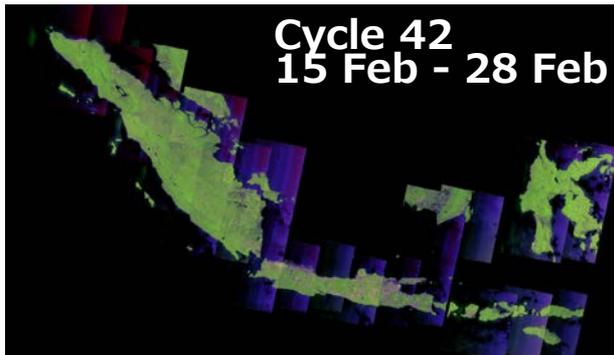
For the Improvement of accuracy, temporal and spatial resolution, integrated use of multi-frequency SAR and optical data should be investigated.

Scaling-up Activities Towards Operational Use

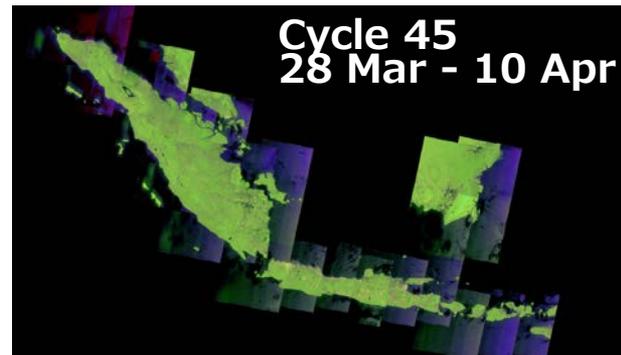
Cycle 39
4 Jan - 17 Jan



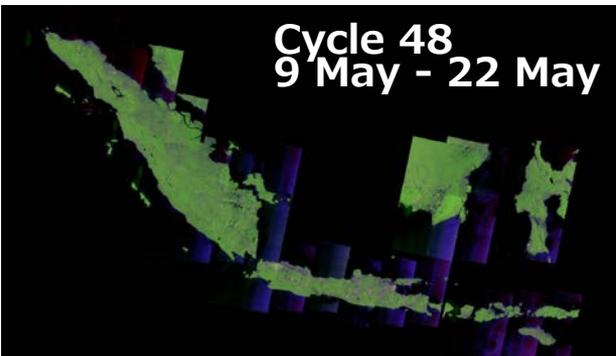
Cycle 42
15 Feb - 28 Feb



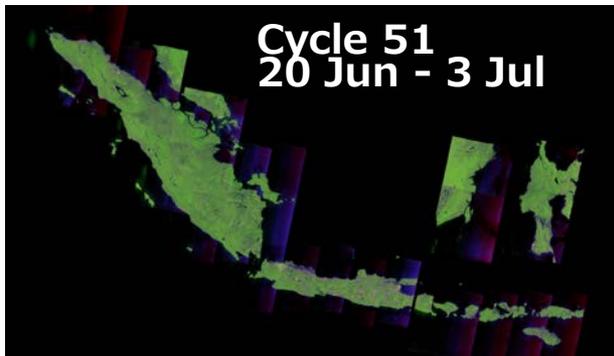
Cycle 45
28 Mar - 10 Apr



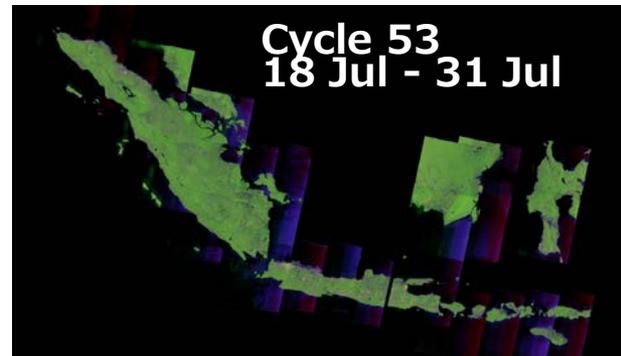
Cycle 48
9 May - 22 May



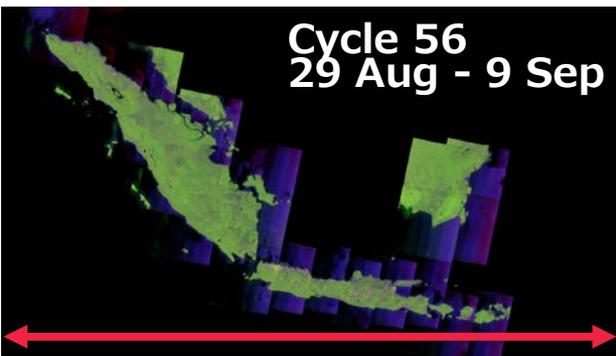
Cycle 51
20 Jun - 3 Jul



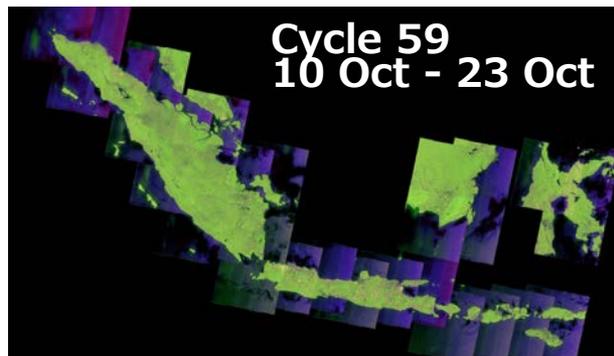
Cycle 53
18 Jul - 31 Jul



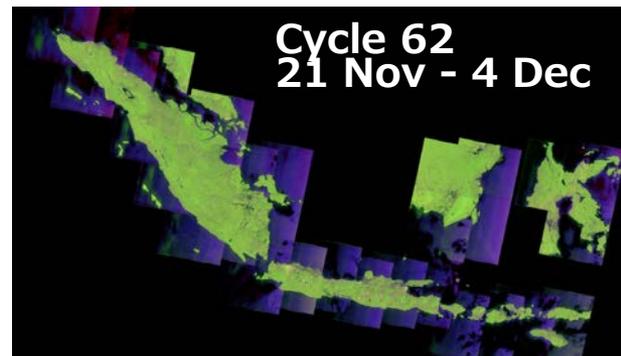
Cycle 56
29 Aug - 9 Sep



Cycle 59
10 Oct - 23 Oct



Cycle 62
21 Nov - 4 Dec



3000 km

Vietnam Data Cube official release

6 March 2018, Hanoi



CEOS support over past 18 months

ODC deployment and capacity

- Software and training (SEO, CSIRO)
- Hardware and maintenance (IMSG)
- Strategic support (Symbios)

ARD preparation and transfer to VN

- Landsat (USGS, SEO)
- ALOS-2 PALSAR-2 (JAXA)
- Sentinel-1 (SEO, CSIRO, CNES/CESBIO)
- ASTER DEM (SEO)



International partners

- ↳ CEOS SEO, CSIRO
- ↳ USGS
- ↳ JAXA, RESTEC
- ↳ CNES, CESBIO

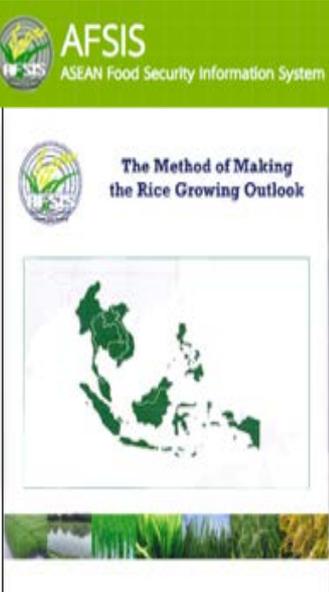
Application domains

- Forests (GFOI)
- **Rice (Asia-Rice, JAXA/RESTEC, CNES/CESBIO)**
- Water extent and quality and mangroves (Mekong, MRC)

Rice Growth Outlooks for Crop Monitor using Agro-meteorological Information

Asia-RICE continued its work with the **ASEAN Food Security Information System (AFSIS)** to provide **rice growth outlooks** using **satellite derived agro-met information** such as **precipitation (GPM, Himawari etc.)**, **NDVI, LST, and solar radiation (MODIS, GCOM-C)**, **soil moisture (GCOM-W)** to the GEOGLAM Crop Monitor for AMIS.

Integration of crop model and agro-met data are needed to provide more value-added information such as yield.

Agro-met Data

7 countries

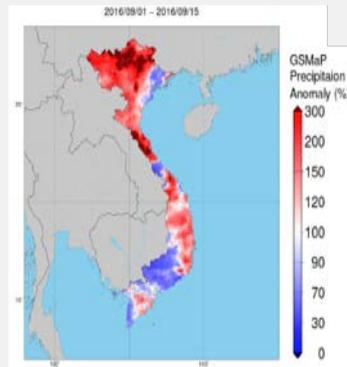


Thailand Indonesia Vietnam Philippines Cambodia Laos Myanmar

Rice Growth Outlook

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.**

(example: Vietnam, Sep 2016)



Precipitation Anomaly (GSMaP)

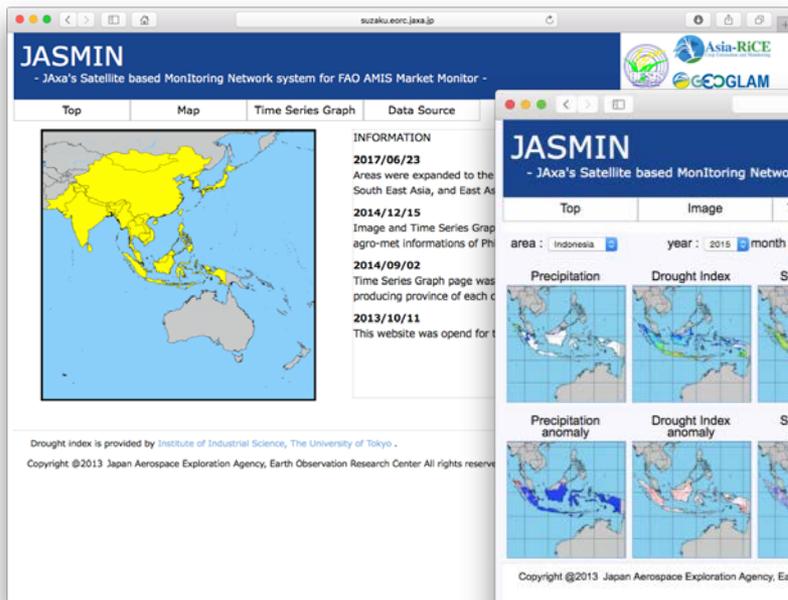
GEOGLAM



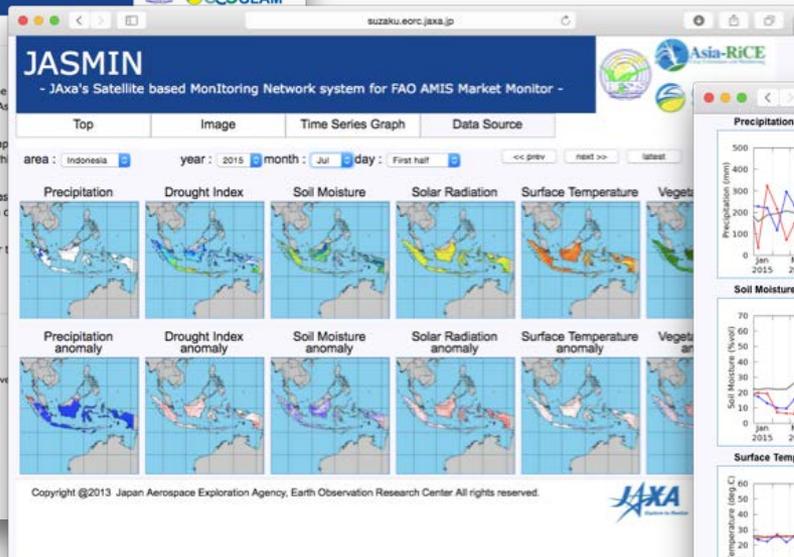
Near-real time Agro-meteorological Monitor

- ❖ **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.

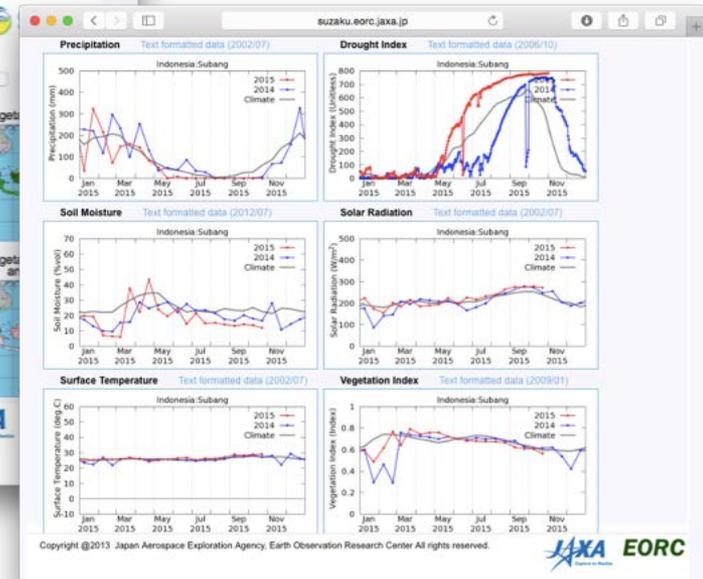
Top Page



Map



Time-series plot (each province)

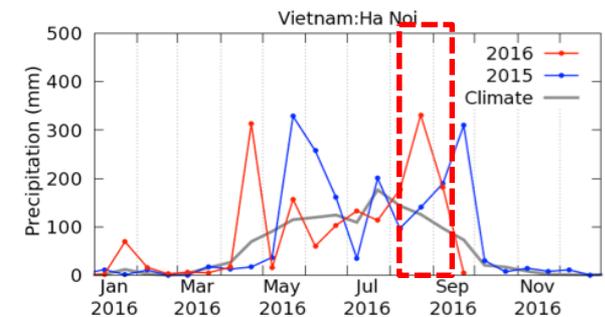
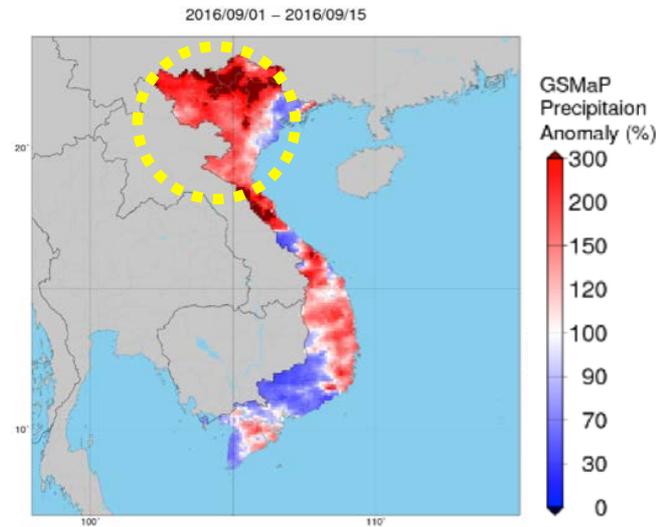
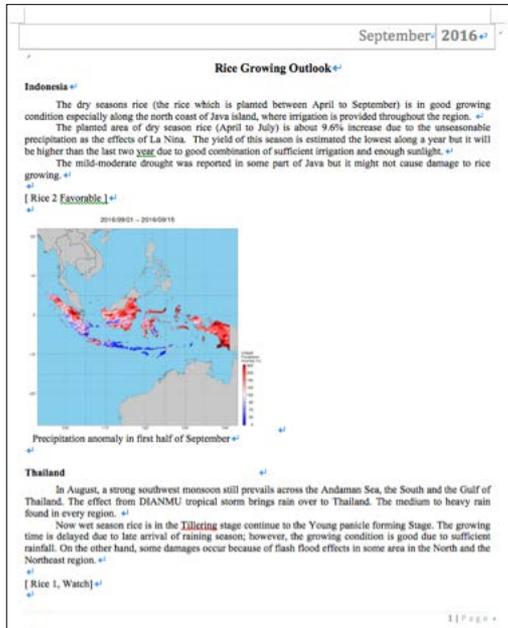


<http://suzaku.eorc.jaxa.jp/JASMIN/index.html>

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

Example: Rice Growth Outlook in Vietnam

Rice Growth Outlook (September 2016)



Precipitation anomaly in first half of September

Precipitation (Hanoi Province)

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.

Asia Rice Activity Summary

1. Rice crop area and growth monitoring

- Technical demonstration sites = one province (Chinese Taipei, India, Japan, Malaysia, Philippine, Thailand + Cambodia and Myanmar from 2016).
- Regional area (wall-to-wall): Vietnam and top 10 rice production provinces in Indonesia
- L/X/C with optical sensors (S2/Landsat/Venus/Formosat-5) integration usage study and rice growth model is going with GEOGLAM JECAM for rice to estimate rice yield
- Start to set up pre-operational service for rice crop growing monitoring using ALOS-2 ScanSAR on-line service, Sentinel and other satellites in Indonesia and Vietnam (as a successful result of wall-to-wall study by Asia Pacific Regional Space Agency Forum SAFE prototyping in Vietnam and Indonesia with ADB project). Especiall, for Vietnam, under the cooperation with CSIRO and VNSC, JAXA prepares ALOS-2 ScanSAR data on-line access as SAR ARD to CEOS Mekong Data Cube.

2. Rice crop outlook using agro-met information derived from EO satellites such as GPM, GCOM-W, MODIS, Himawari

- 5 countries (Indonesia, Philippine, Thailand, Vietnam, Japan) from 2013 + Cambodia, Laos, Myanmar in cooperation with AFSIS

3. Capacity Building and training

- Held a workshop for rice crop growth and outlook monitoring using space technology to ASEAN countries (Vietnam, Lao, Thailand, Philippine and Indonesia) in cooperation with AFSIS in March, 2017 and will discuss with ESCAP and APRSAF/ADB/ASEAN

Asia Rice Upcoming Events

- September, 2018: GEOGLA JECAM/Asia Rice meeting @ Chinese Taipei
- Oct 24-26, 2018; GEOSS-AP WG5 (agriculture and food security) @ Kyoto
- Nov, 2018; APRSAF2018@Singaporea – Space Application working group and Asia Rice side meeting
- Plan to have publishment of international journal

Thank You for Your Attention !



@Tsukuba, Japan

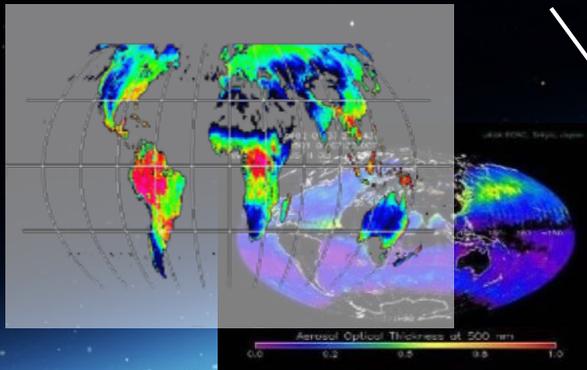
Future Missions

GCOM-C: Global Change Observation Mission- Climate

Launch in JFY2017

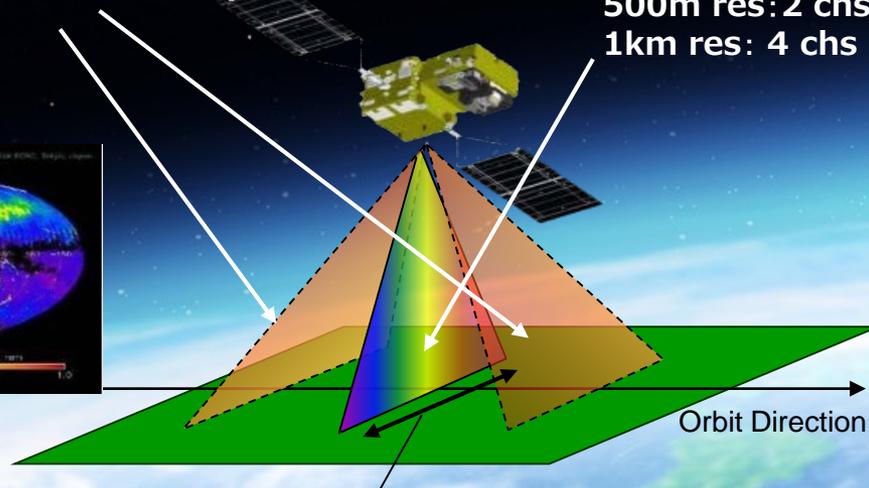


- Forward or backward polarization
- Along-track slant view (1km res: 2 chs)

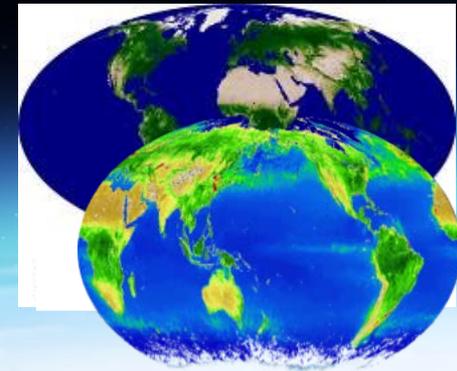


Understanding changes in biomass, aerosols and land cover

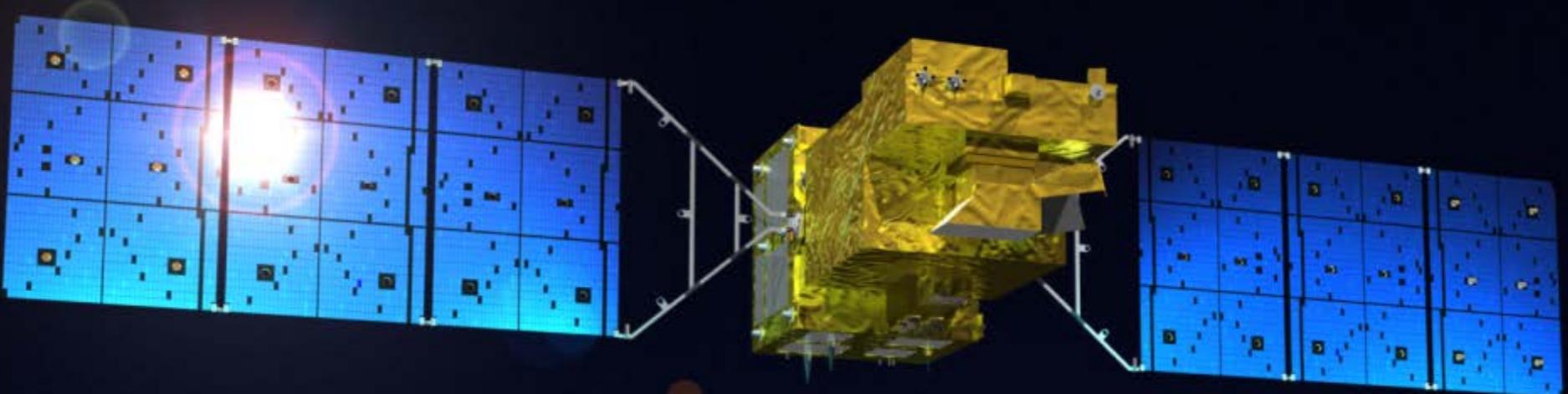
250m res : 11 chs
500m res : 2 chs
1km res : 4 chs



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



GOSAT-2 on orbit in 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		

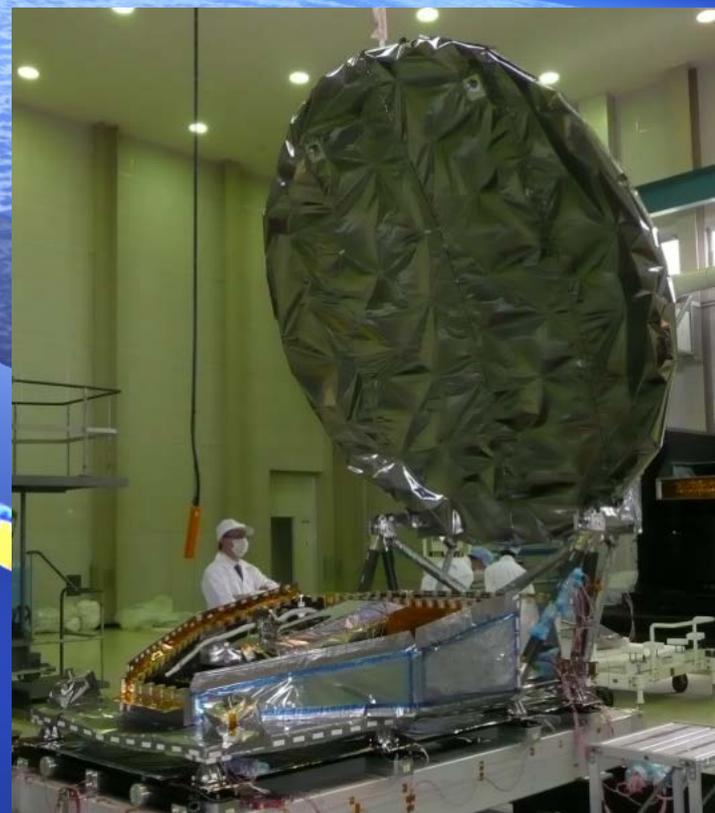
Earth Cloud, Aerosol and Radiation Explorer (EarthCARE)

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(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)