WG5: AGRICULTURE AND FOOD SECURITY

JAXA's Activities for Food Security and Satellite Monitoring

Shinichi SOBUE, Ph.D.
Planning Manager

Earth Observation Research Center
Japan Aerospace Exploration Agency (JAXA)

GEOSS AP@Tokyo, Japan
03 April 2012

JAXA's Earth Observation Satellites (Sensors)

ALOS
Advanced Land
Observing Satellite

GOSAT
Greenhouse gases
Observing SATellite

TRMM PR
Tropical Rainfall Measuring
Mission Precipitation Radar

Aqua AMSR-E
Advanced Microwave Scanning
Radiometer-EOS

GPM DPR
Global Precipitation
Measurement Dual-frequency
Precipitation Radar

GCOM-W
Global Change Observation
Mission- Water

EarthCARE
Earth Cloud, Aerosol and
Radiation Explorer

ALOS-2
Advanced Land
Observing Satellite-2

ALOS-3
Advanced Land
Observing Satellite-3

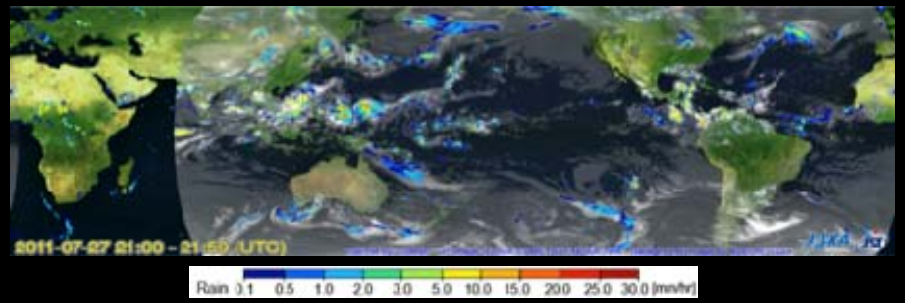
GCOM-C
Global Change Observation
Mission - Climate

JAXA Satellites (Sensors) for Agricultural Applications

TRMM

RADAR

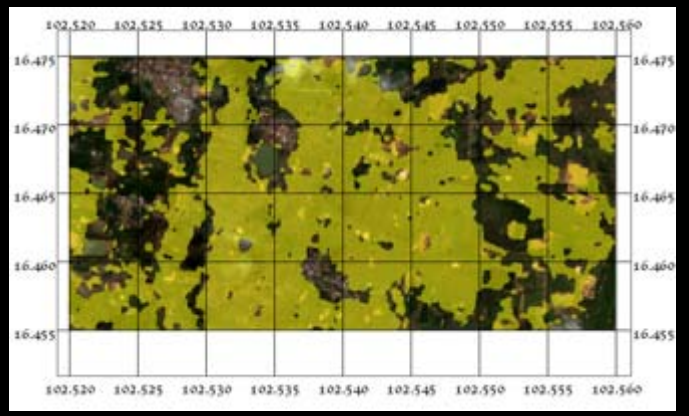
Precipitation (Yield forecast, drought)



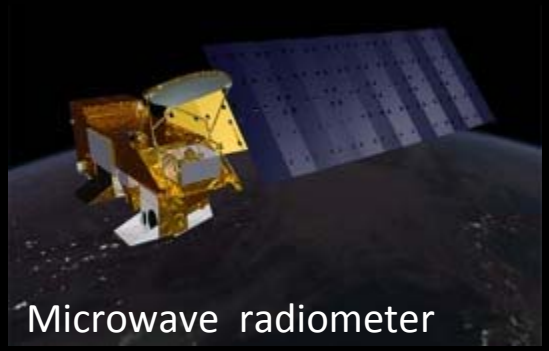
ALOS

Multispectral/SAR

Crop Area Mapping (base map)

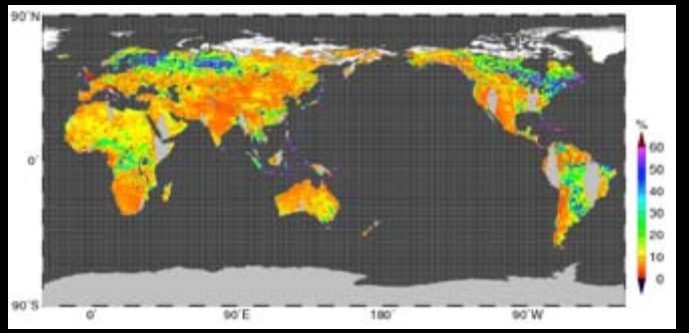


Aqua AMSR-E



Microwave radiometer

Soil Moisture (drought)



Current Agricultural Monitoring Activities

Research & Development

- Paddy Rice Field Mapping
- Crop Yield Estimation
- Drought Monitoring
- Agro-meteorological Monitoring
- Flood Damage Estimation

Japan Agricultural Geo-Monitoring Committee

[Organized by JAXA since 2009]

International Cooperation

Bilateral

- Paddy Yield Mapping and Yield Estimation (Thailand)
- Drought Monitoring (Indonesia)

Multilateral

- G20 Global Agricultural Geo-monitoring Initiative (GLAM)
- Group on Earth Observations Agriculture
- Asian Development Bank

Domestic Cooperation

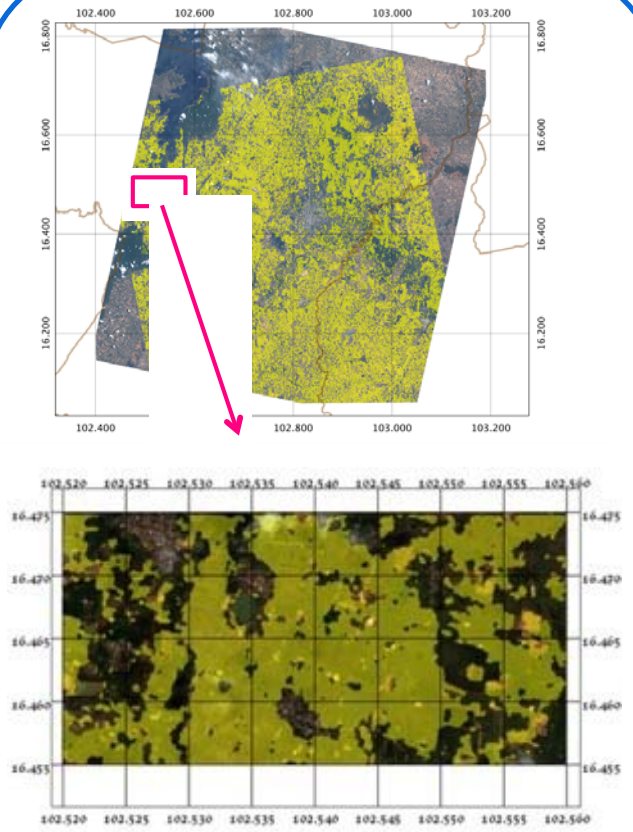
Ministry of Agriculture, Forestry and Fisheries

- Food Security Policy
- National Agricultural Statistics
- Global Drought Monitoring

GISTDA-JAXA Joint Research

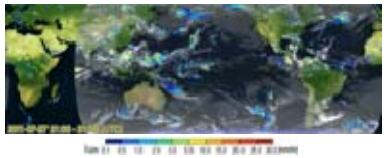
❖ Paddy Rice Mapping and Yield Estimation in Thailand

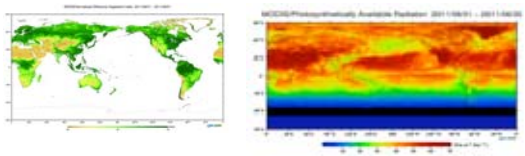
Paddy Field Mapping



Yield per Unit

Satellite Products
- Precipitation
- Temperature, Solar radiation
- NDVI, LAI, Biomass



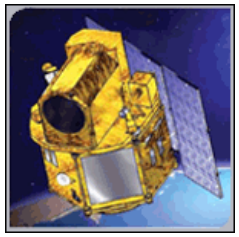


Ground Survey
- Agro-meteorological data
- Yield sampling survey

Crop Yield Map

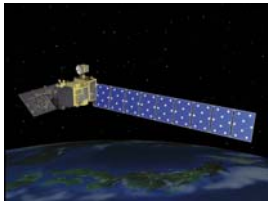
GISTDA

THEOS



JAXA Japan Aerospace Exploration Agency

ALOS



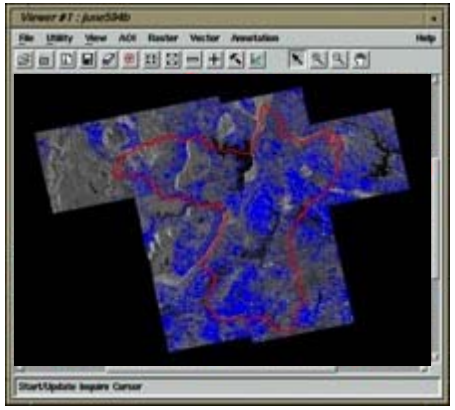
2nd Workshop@Bangkok

Rice crop acreage estimation by SAR image

❖ SAR (Synthetic Aperture RADAR) is all-weather sensor and it can identify paddy rice area even if the area is covered by clouds.

-Identifying the cultivated area size and estimating the rice crop yield.

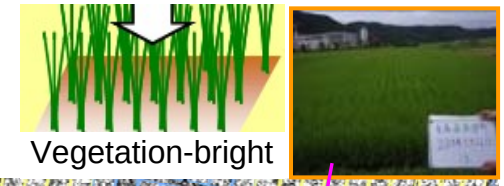
-Operating "The Thai Rice Crop Yield System" using SAR and GIS data.



Khon Kean Rain-fed paddy field by SAR data

Irrigated paddy field by SAR data

Water-dark

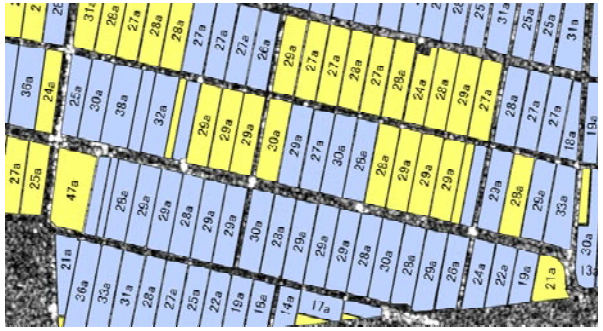


Vegetation-bright

Transplanting Season

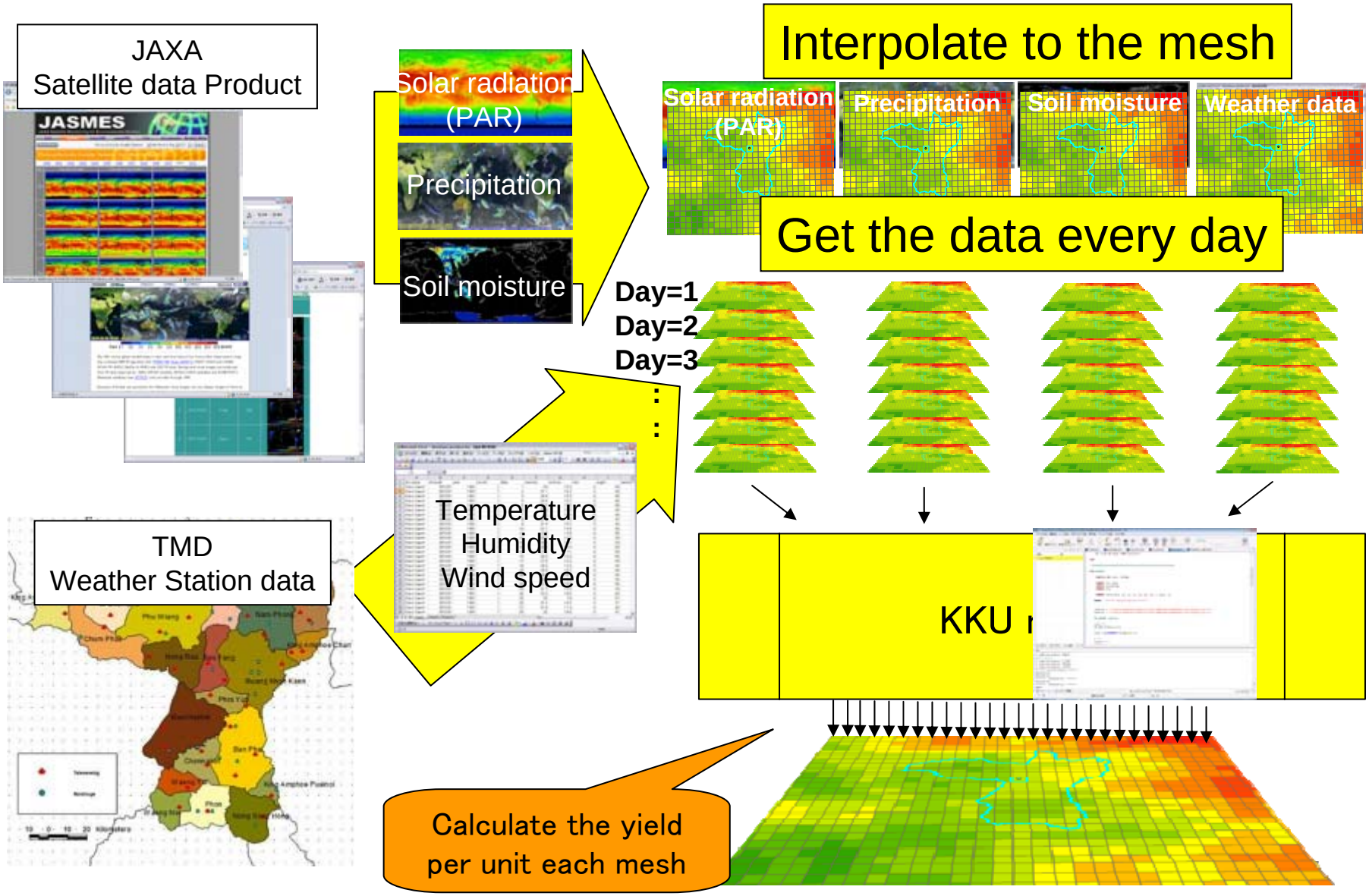
Growing Season

The data were created for the project of the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan.
Project: "Name: Feasibility Study for Wet Paddy Fields using satellite data" and JAXA-GISTDA collaboration



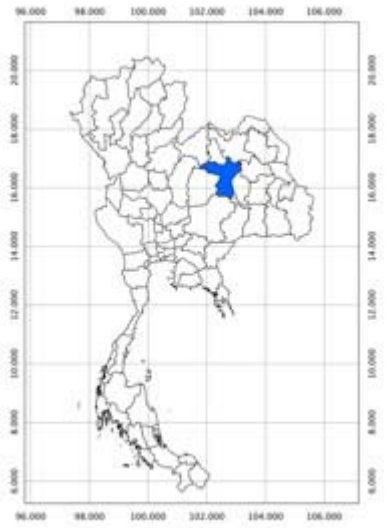
Paddy Field Classification Result

Estimation of Yield per Unit by Crop Model

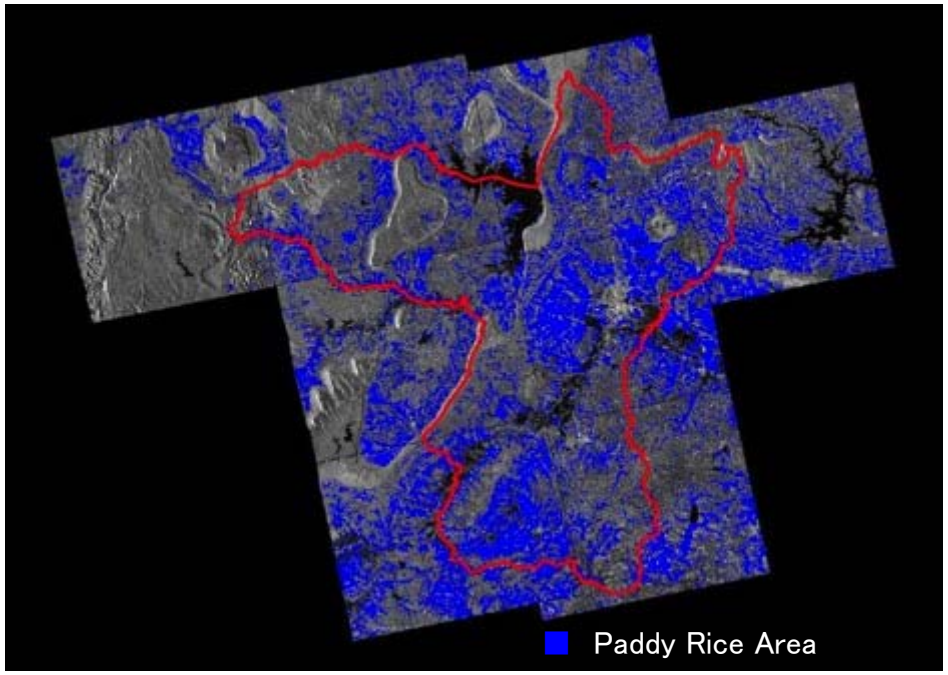


Rice Yield Estimation in Khon Kaen, Thailand

- SAR (Synthetic Aperture RADAR) is all-weather sensor and it can identify paddy rice area even if the area is covered by clouds.



Khon Kaen
Rain-fed cultivation



Result of Yield Estimation

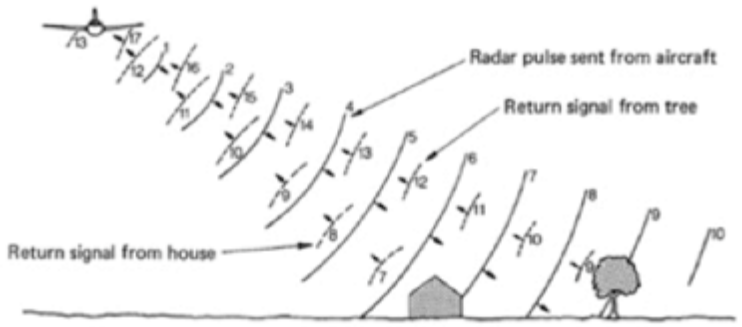
The estimated figure agree with the validation data.

	Acreage [m2]	Yield per unit [g/m2]	Yield [ton]
Result of estimation	164,405.99	203.96	33.53
Validation data by field survey	166,766.39	2.47 – 750.08	40.96
Accuracy	98.58%	–	81.87%

Pi-SAR-L

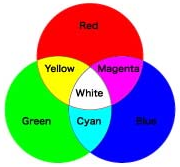
- L-band - Polarimetric and interferometry - Synthetic Aperture Radar

Aircraft : Gulfstream-II
Operated by
Diamond Air Service (DAS), Japan



[Remote Sensing and Image Interpretation,
Lillesand et al.,2008]

Frequency	1275MHz (λ =23.6cm)
Band Width	50MHz
Spatial Resolution	3m
Polarimetry	HH, HV, VH, VV
Swath Width	15km
Incident Angle	10-65 deg


Red
Yellow
Magenta
White
Green
Cyan
Blue

Flood Damage Monitoring by Airborne RADAR

❖Flood damages of paddy rice field in Suphan Buri, Thailand

Airborne RADAR
(Pi-SAR-L)

HH:HV:VV = R:G:B

27 September 2011

8 November 2011

Field Router
(automatic data
collection system)

[Courtesy Prof. Mizoguchi, U.Tokyo]


image0-webcam0-20110811208

Development of New L-Band RADAR System

- ❖ All-weather sensor, especially useful in cloudy area such as tropics.
- ❖ Easy to detect water covered area.
- ❖ Detect structural character of the vegetation.

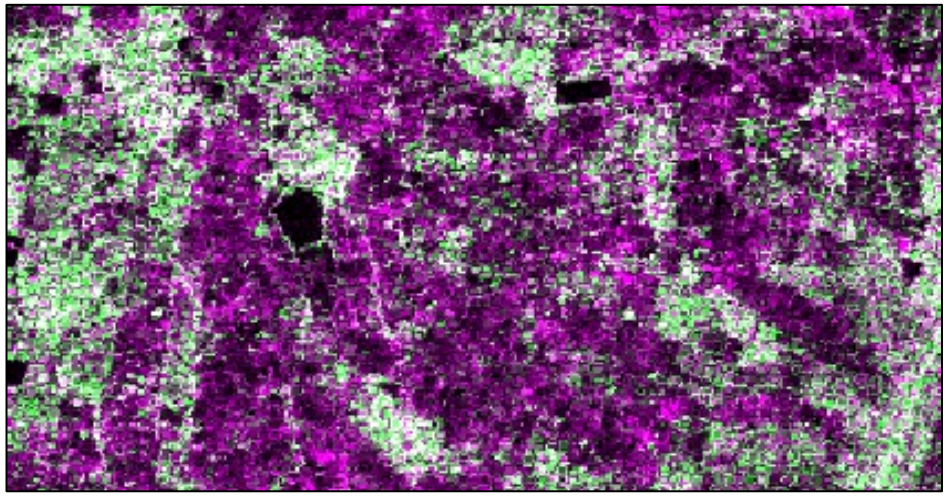
Pi-SAR-L2

- Almost completed
- Same spatial resolution with ALOS2/PALSAR-2
- Observation results will be utilized for ALOS-2 data analysis.

ALOS2/PALSAR-2

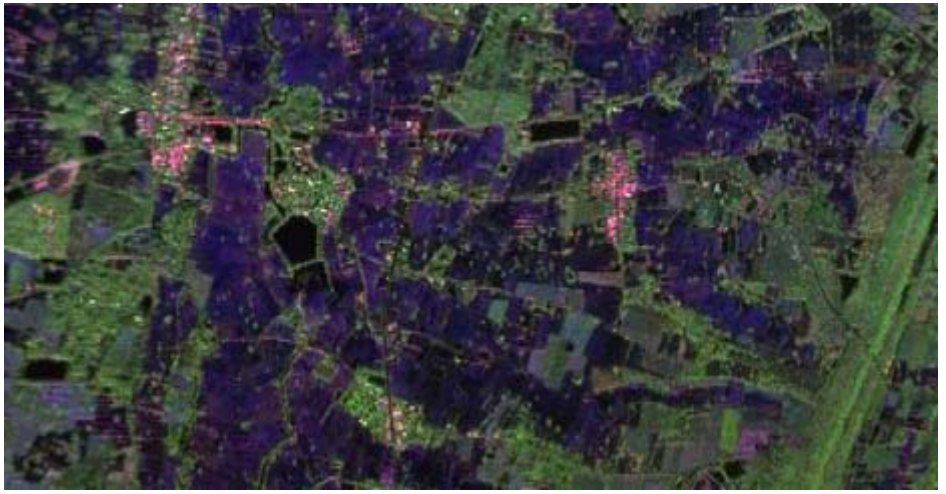
- Launched in 2013
- Improved sensor compared with ALOS PALSAR
- Wider swath compared with Pi-SAR-L2

Comparison of ALOS PALSAR and Pi-SAR-L (ALOS-2)



ALOS PALSAR (R:G:B = HH:HV:HH)
September 3, 2008

Spatial Res. 12.5m (FBD mode)



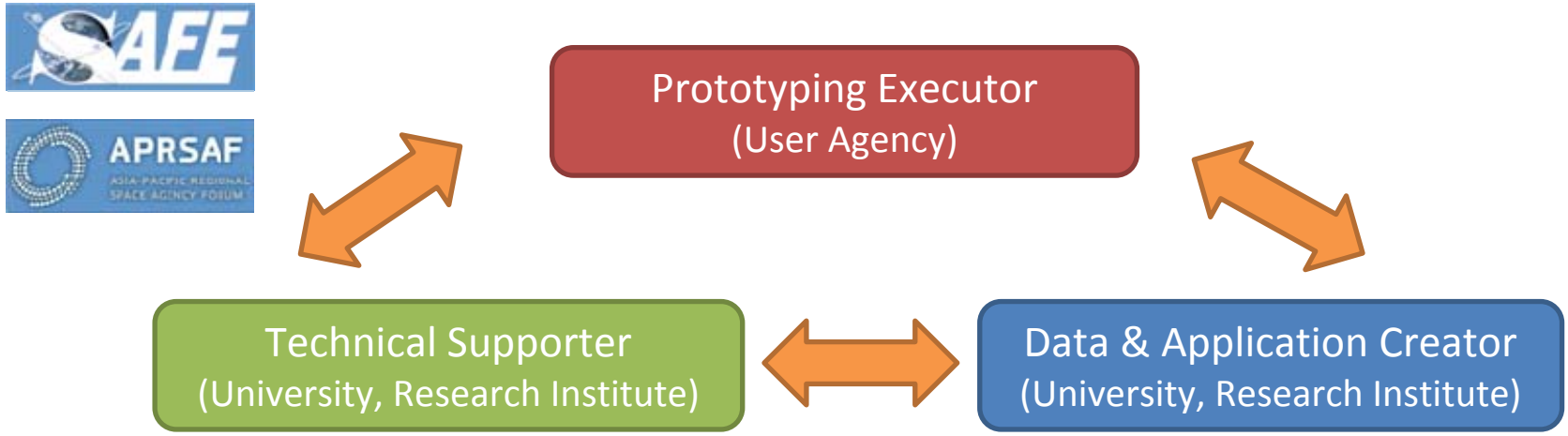
Pi-SAR-L (R:G:B = HH:HV:VV)
September 27, 2011

Spatial Res. 3.0m
(same as ALOS-2)

ALOS-2 has better spatial resolution and wider swath compared to Pi-SAR-L

Agricultural Monitoring in SAFE Initiative

- Space Applications For Environment (SAFE) is initiative under the framework of the Asia-Pacific Regional Space Agency Forum (APRSAF).
- SAFE aims to encourage environmental monitoring for climate change mitigation and adaptation studies, as well as studies on other forms of practical application, using space applications.
- SAFE is open to every agency in Asia-Pacific Region for submitting new proposal.



Framework of SAFE Implementation

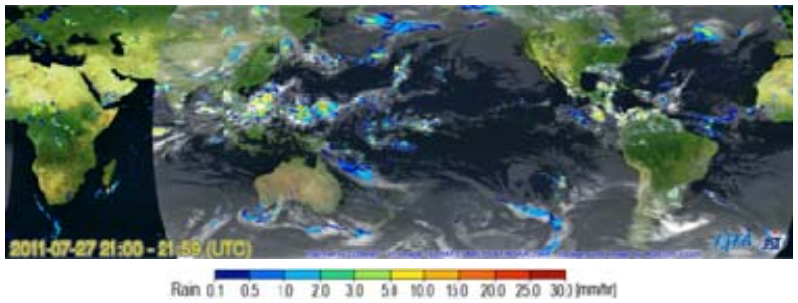
SAFE Prototyping Projects

Status	Country Executor	Theme	LAUNCH	FINAL Report
Success Story	VIETNAM FIPI,MARD	**Integrated water resource management**	May, 2008	Jun, 2010
	VIETNAM NHMS,MONRE	Forest monitoring	May, 2008	Jun, 2010
Completing	CAMBODIA MOWRAM	**Water Cycle and Agricultural Activities**	May, 2009	Jun, 2011
	LAO PDR WREA,WERI	Forest monitoring and management	May, 2009	Jun, 2011
On-Going	INDONESIA LAPAN	**Potential Drought Monitoring**	Jan, 2010	Dec, 2011
	SRI LANKA CCD	Risk of Sea Level Rise on Coastal Zone	Jan, 2010	Dec, 2011
	PAKISTAN PMD	**Monitoring Water Cycle Variations & Assessing Climate Change Impacts**	Jun, 2010	(Jun), 2012
	SRI LANKA NARA	Modeling ocean frontal zones using high resolution satellite and float data to locate tune fish aggregations	Nov, 2010	(Nov), 2012
	THAILAND DOF	Economic Fish Larvae Mapping and Monitoring	Nov, 2010	(Dec), 2012
	VIETNAM FIPI,MARD	Mangrove Forest Mapping and Carbon Stock Estimation	Nov, 2010	(Dec), 2012

More detail : http://www.eorc.jaxa.jp/SAFE/index.html

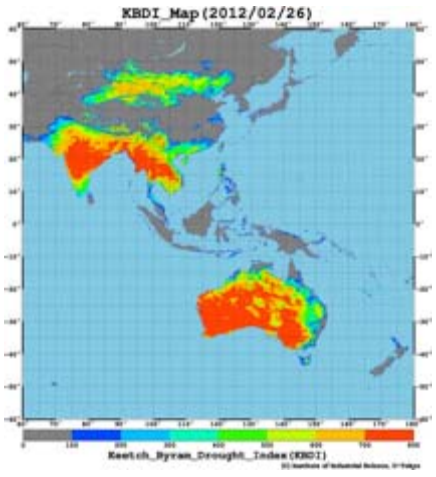
SAFE Prototyping : Drought Monitoring in Indonesia

- Keetch-Byram Drought Index (KBDI)
  Soil/dull drought index based on 20 cm soil capacity of water.
  [Keetch et. al, 1965]



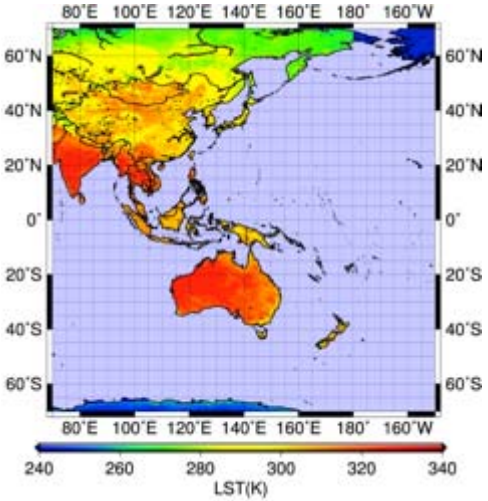
GSMaP
http://sharaku.eorc.jaxa.jp/GSMaP/index.htm

- Presently, this index is derived from satellite observations:
  - Land surface temperature (LST) from MTSAT received at IIS/U-Tokyo
  - Precipitation derived from global satellite mapping (GSMaP) provided by JAXA EORC



KBDI

http://webgms.iis.u-tokyo.ac.jp/KBDI/



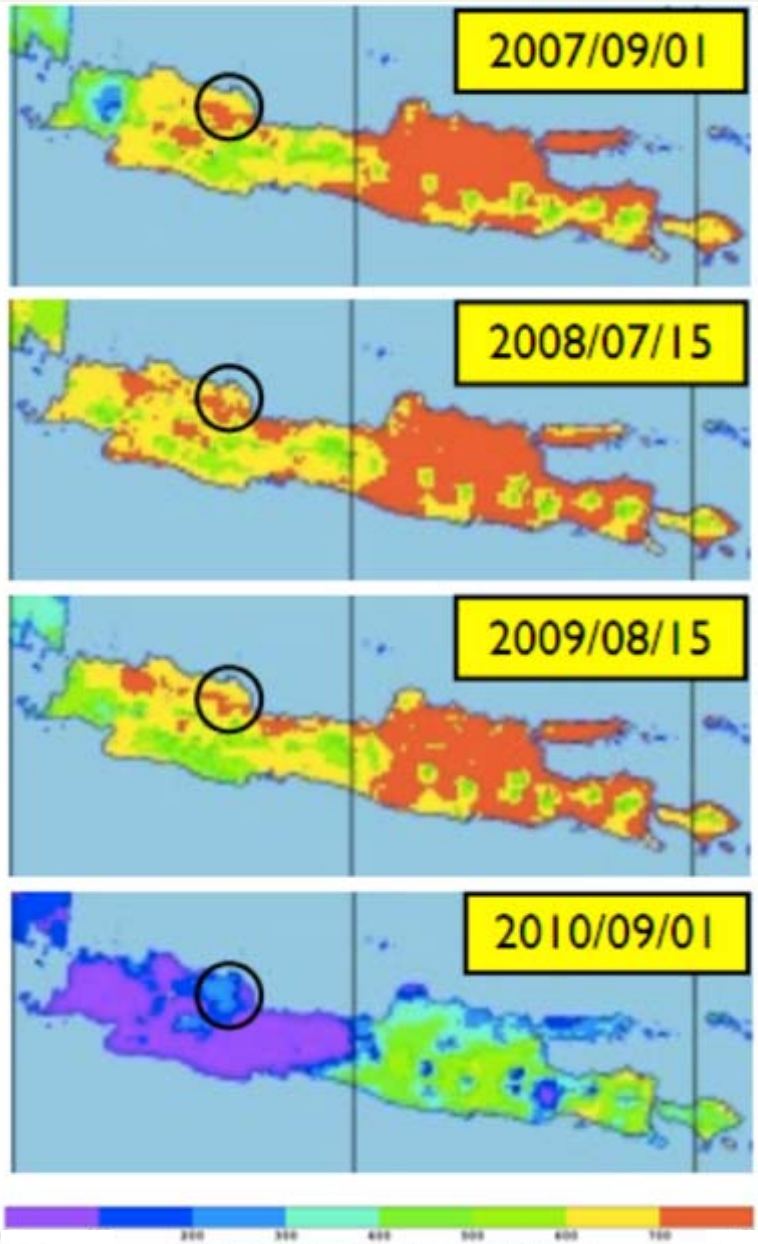
MTSAT LST

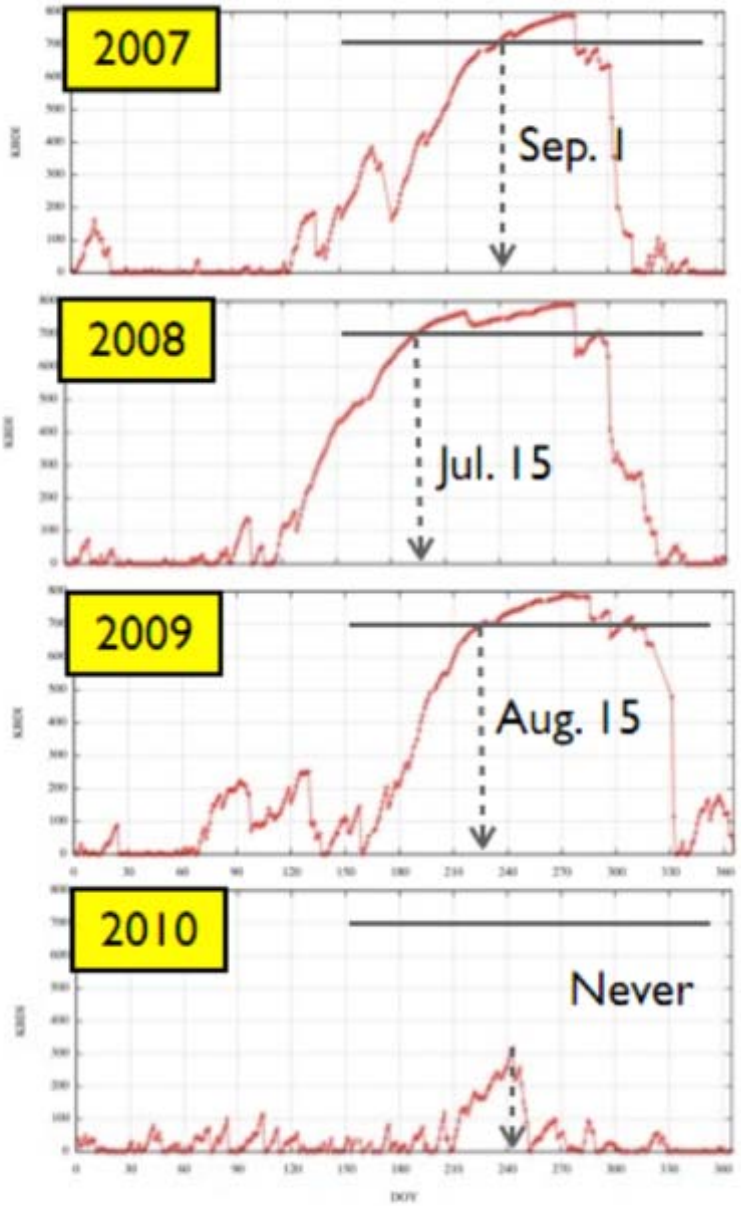
http://webgms.iis.u-tokyo.ac.jp/LST/index.php

[Prof. Takeuchi, U.Tokyo]

Onset of Drought in 2007 - 2010

KBDI based drought (Drying Soil) onset in Indramayu

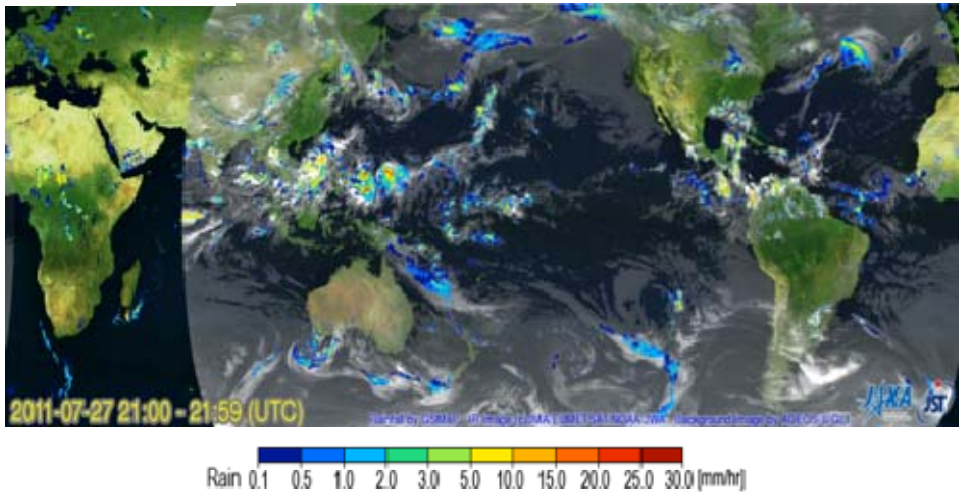




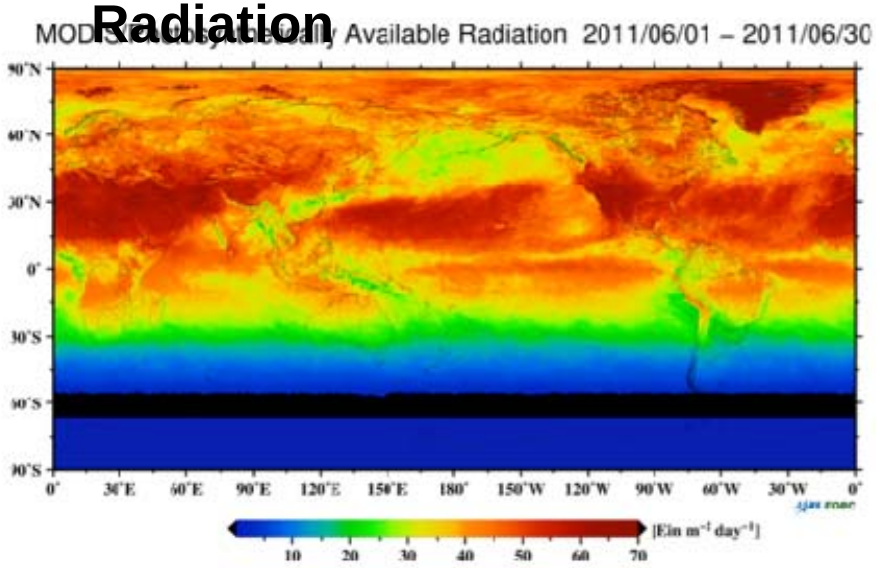
[Prof. Takeuchi, U.Tokyo]

JAXA : Agro-meteorological Products

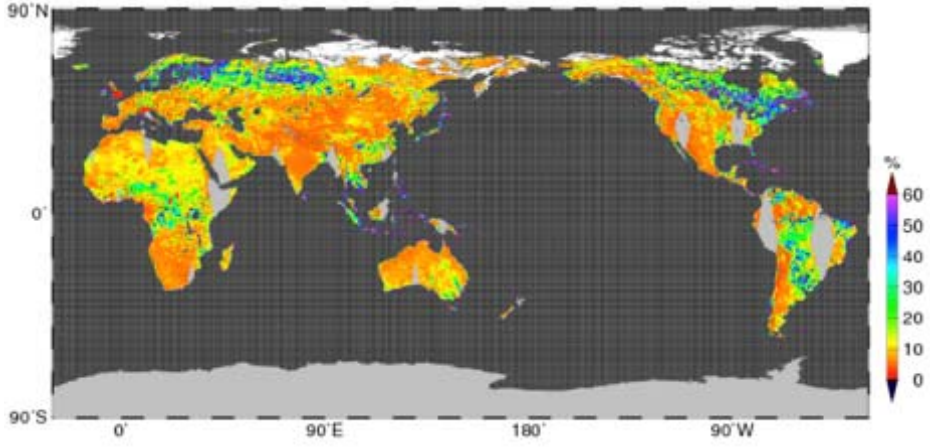
Precipitation



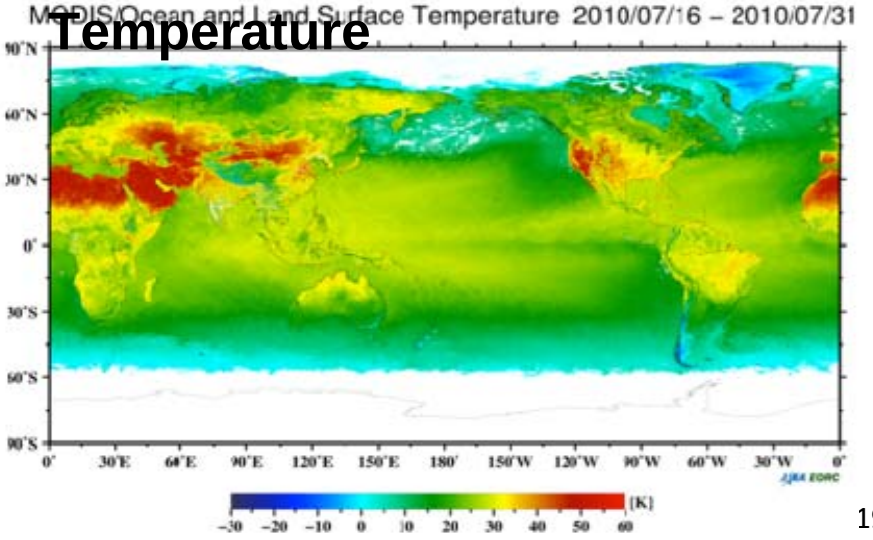
Photosynthetic Active Radiation



Soil Moisture

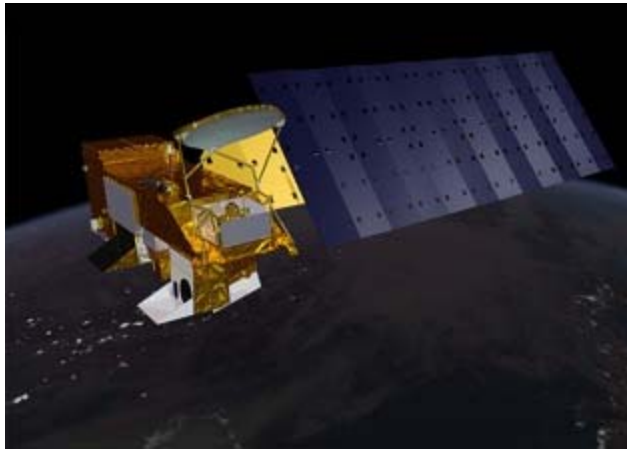


Land and Sea Surface Temperature

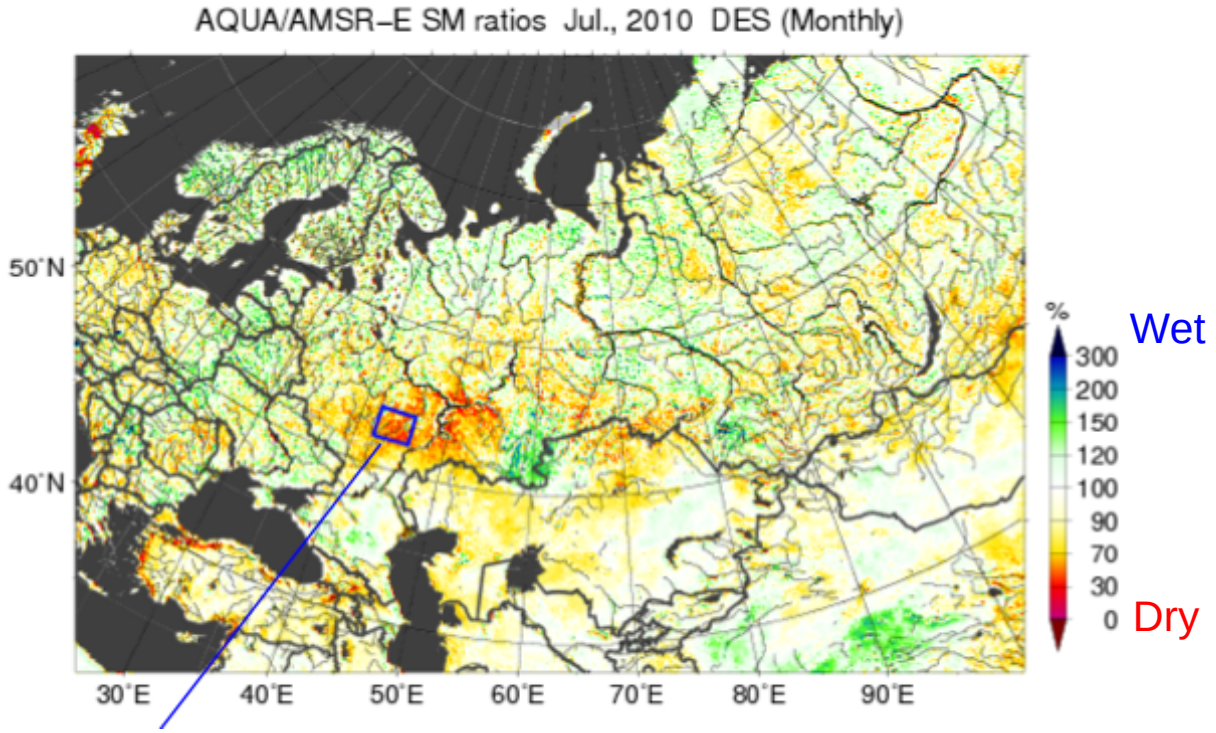


Global Drought Monitoring for Food Security

❖ Satellite derived drought information have been utilized as one of the tools for policymaking in Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan.



Aqua AMSR-E



MAFF Ministry of Agriculture, Forestry and Fisheries

JAXA Japan Aerospace Exploration Agency

GCOM-W (will be Launched on 18 May 2012 !!)

- Global Change Observation Mission - Water (GCOM-W)
- Advanced Microwave Scanning Radiometer 2 (AMSR2) onboard GCOM-W will observe precipitation, vapor amounts, wind velocity above the ocean, sea water temperature, water levels on land areas and snow depths.

GCOM-W

Pre-Flight Model (PFM)

ASEAN Food Security Information System

- Rice related statistics such as crop area or yield derived from satellite data will be useful input data to ASEAN Food Security Information System (AFSIS) by ASEAN+3 (China, Korea, Japan).
- The object of AFSIS is to strengthen food security in the region through the systematic collection, analysis and dissemination of food security related information.

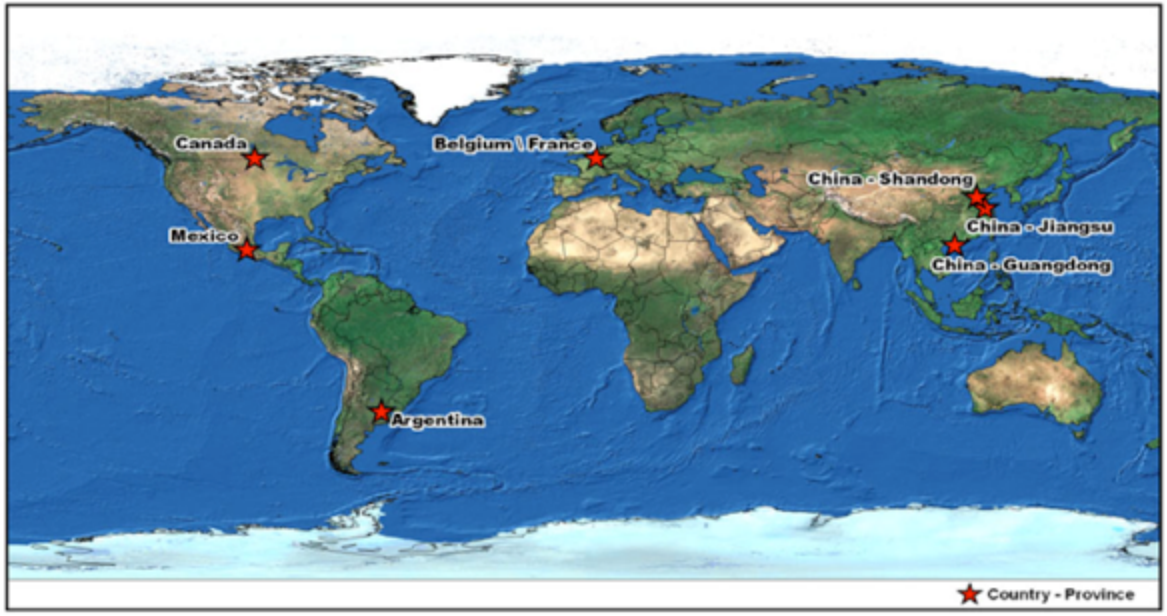
http://afsis.oae.go.th/index.php

AFSIS would be useful component for GEO GLAM/AMIS from

GEO-GLAM : Global Agriculture Monitoring Initiative

❖ **Action Plan on food price volatility and agricultu**

[G20 France 2011 Summit final declaration, 2C



GEO GROUP ON EARTH OBSERVATIONS

JECAM
Joint Experiment for Crop Assessment and Monitoring

Paddy Rice Site
- China

❖ Paddy Rice has a large variety of cropping systems:
- Single cropping, Double cropping,
- Rain-fed, Irrigated.

GEO-GLAM should include the study sites of other paddy rice

Toward a Better GEO GLAM Implementation

1. Need a review and definition phase before proposing implementation

We need to start the list of on-going and planned crop monitoring/yield and collect and characterize the requirements for GEO GLAM, building on the JECAM experience (noting this does not include rice crop for primary exporters/importers).

2. More definition around the GLAM project office arrangements and roles

- Defining its tasks, roles, membership and responsibilities should also be discussed among GEO AG task team leads and G20 representatives (and not only among JECAM and existing system players).
- It may be that a single office can undertake both functions (GFOI and GLAM) if adequately resourced and this should be explored.

3. Proposal for rice crop monitoring

JAXA is very happy to work with ISRO, GISTDA, IRRI, and others to expand the GLAM work plan and its implementation for rice crop monitoring in cooperation with ASEAN AFISS, APEC food security center, CEOS and other entities.

4. Work with regional frameworks

We should consider the collaboration with not only global and national scales, but also regional efforts for (e.g.) ASEAN AFSIS, APEC food security center, etc.

5. Justifying costing estimates for the components, data purchase and processing.

6. Clear schedule (Key dates, dependencies and phasing) should be indicated.

GEO GROUP ON EARTH OBSERVATIONS

G20 FRANCE 2011

SIT-27 DECISIONS & ACTIONS IN SUPPORT OF GEO-GLAM

Wed 28th March 2012

La Jolla

Decisions & Actions

1.CEOS agrees to participate in GEOGLAM's initial program development (SIT-27).

2.CEOS offers to GEO-GLAM to take on responsibility to further develop the space-based observations component suggested by the draft Work Plan, including development of more specific plans and schedules for the evolution of the observations activities, including data acquisitions, compilation, access and processing.
An ad-hoc team will take on this responsibility and will include Yves Crevier, John Faundeen, Brian Killough, Prasad Thenkabail, Stephen Ward (plus others?).
(SIT-27)

Decisions & Actions

3.CEOS should urge GEOGLAM (and work with GEOGLAM) to arrange a user requirements meeting with the objective of defining detailed information requirements – from which CEOS may infer observational needs. CEOS will designate appropriate representatives to participate in this meeting (June/July 2012).

4.A major component of the CEOS role will be the space data coordination activity to address the significant and sustained coverage needs anticipated of GEOGLAM. The GFOI SDCG is relatively new and developing its capacity and identity. SIT Chair will explore with SDCG the possibility of tasking (augmenting?) the group to undertake a preliminary global acquisition strategy in support of GEOGLAM needs. The acquisition strategy would follow and benefit from the process developed for GFOI and would identify the agencies, missions and sensors that can contribute to the observational requirements of GEOGLAM (From CEOS Plenary).

Decisions & Actions

5.Building upon the outcomes of the user requirements and space data coordination activities, responsible CEOS team will provide their analysis and recommendations to CEOS leadership on further steps vis-à-vis the GEOGLAM initiative – including a plan for the pre-2015 outcomes (@ CEOS SIT-28, Mar 2013).

Concluding Remarks

- Food Security is serious concern in international community.
- Earth Observation satellites can provide agricultural information such as crop area map, yield estimation and drought condition.
- JAXA is implementing R&D in agriculture and food security area.
- Ongoing JAXA's international cooperation in agriculture are:
  - GISTDA-JAXA Joint research (Thailand);
  - Agricultural projects by satellite application (SAFE)prototyping (Indonesia);
  - G20 Global Agricultural Geo-monitoring Initiative;
  - GEO Agriculture.

- Also, JAXA is developing new satellite and sensor system useful agricultural monitoring both local and global levels.
- JAXA is very happy to work with ISRO, GISTDA, IRRI, and others to expand the GLAM work plan and its implementation for rice crop monitoring in cooperation with ASEAN AFISS, APEC food security center, CEOS and other entities.

Thank You for Your Attention.

sobue.shinichi@jaxa.jp

Appendix

ALOS-2 PALSAR-2

ALOS-2

(2013)

Observation Mode

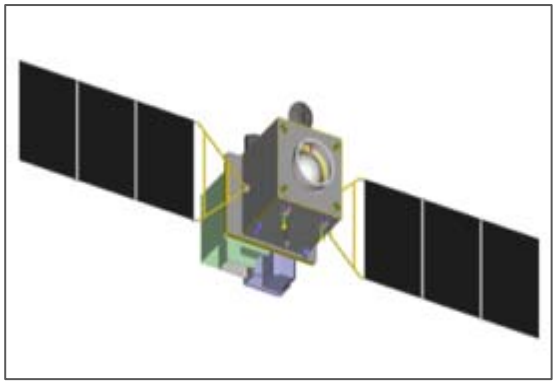
Mode	Spatial Res.	Swath
Spotlight	1-3m	25km
Strip Map	3-10m	50-70km
Scan SAR	100m	350km

Sensor Type Active Microwave (SAR)
L-band
Full polarimetry (HH,HV,VH,VV)

Future Missions : New Earth Observation Satellites

GCOM-W
(Soil moisture, Precipitation)

ALOS-2
(Crop type and damage mapping)



ALOS-3
(Detailed crop type mapping)

2012 2013 TBD

GPM DPR
(Precipitation)

GCOM-C
(Crop phenology, LST, PAR)

These Earth observation satellites can be utilized for agricultural monitoring