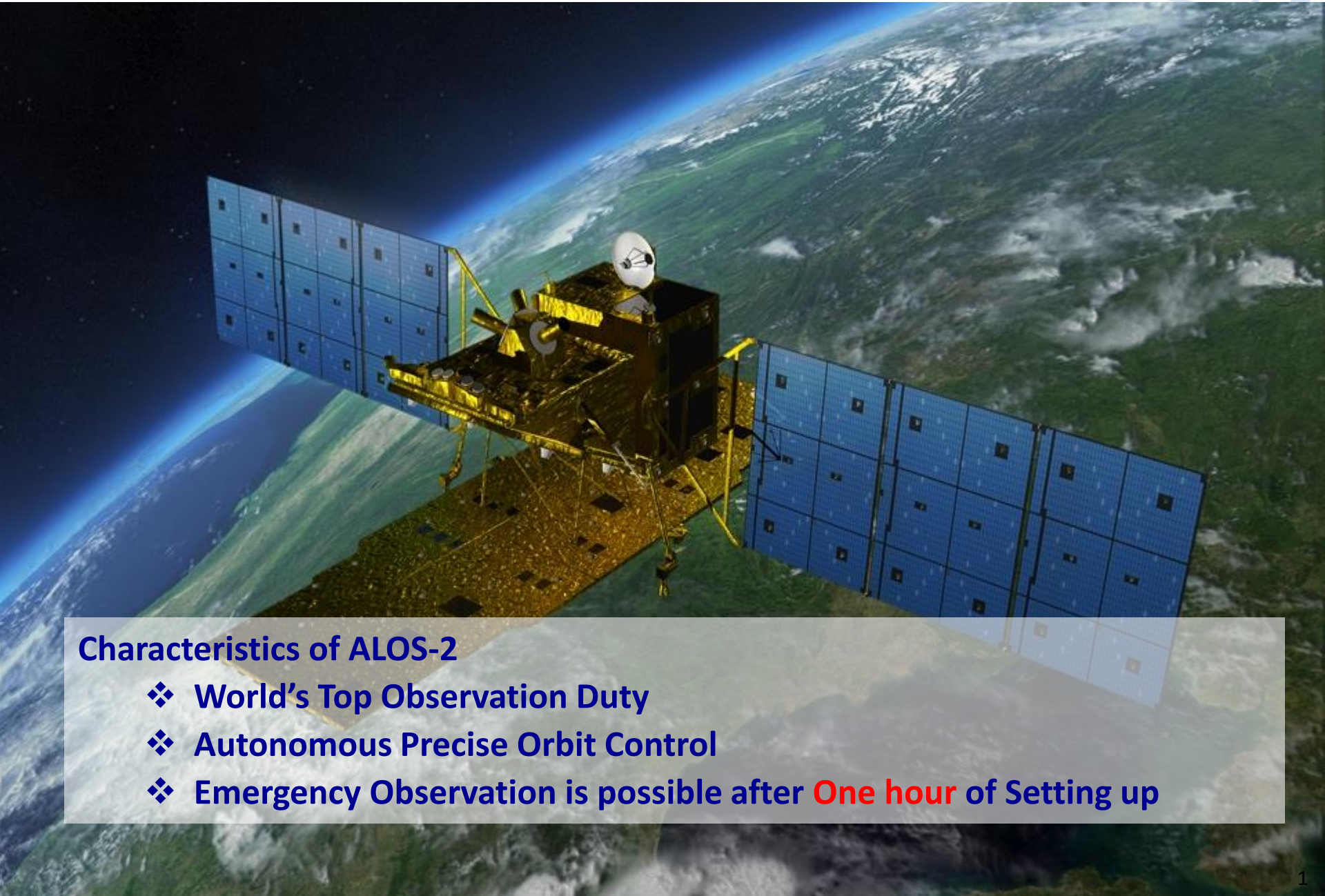
ALOS-2 Update
PALSAR-2 operation update

ALOS-2 Project Manager

Shin-ichi Sobue

January 29, 2018

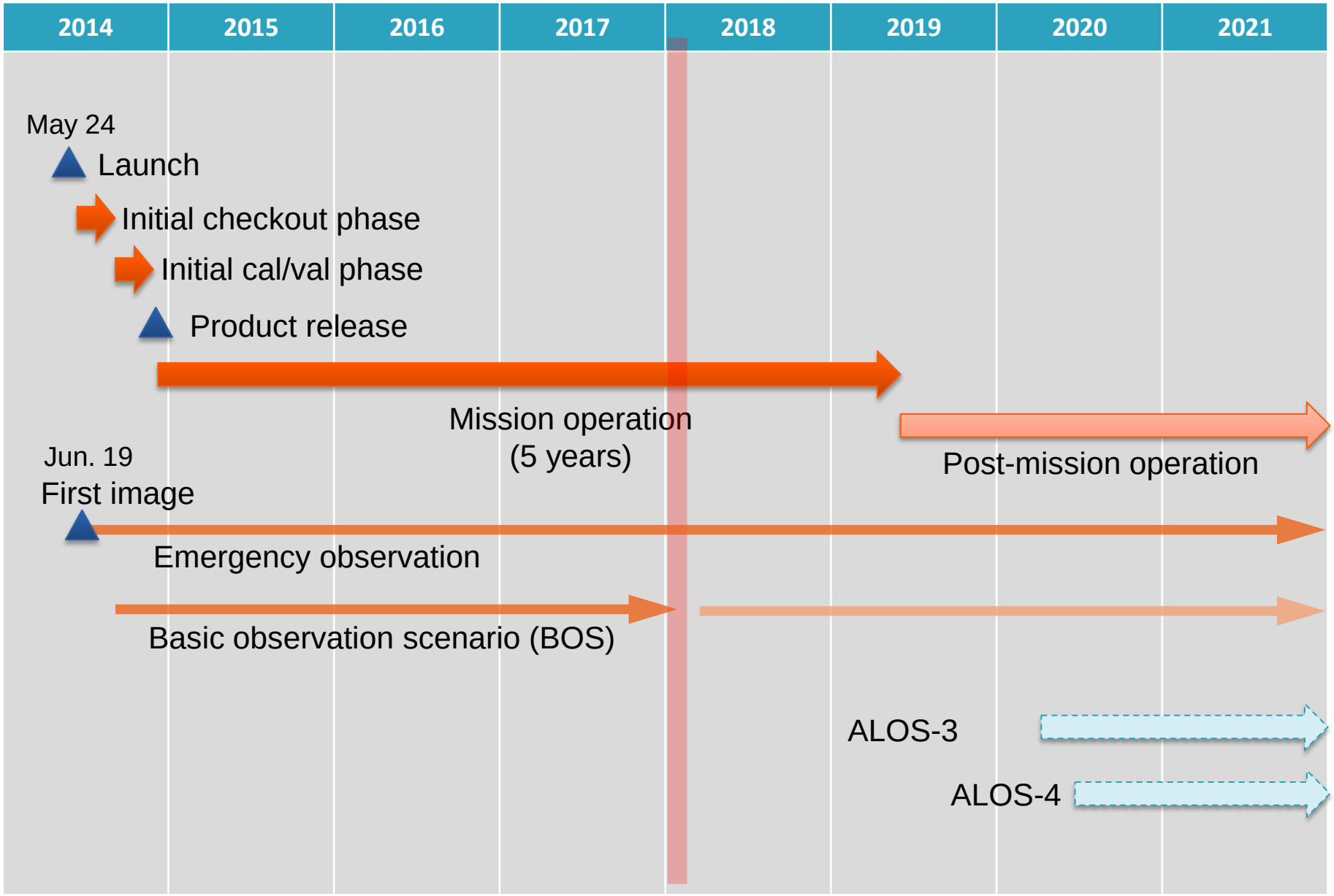
ALOS-2: Advanced Land Observing Satellite -2



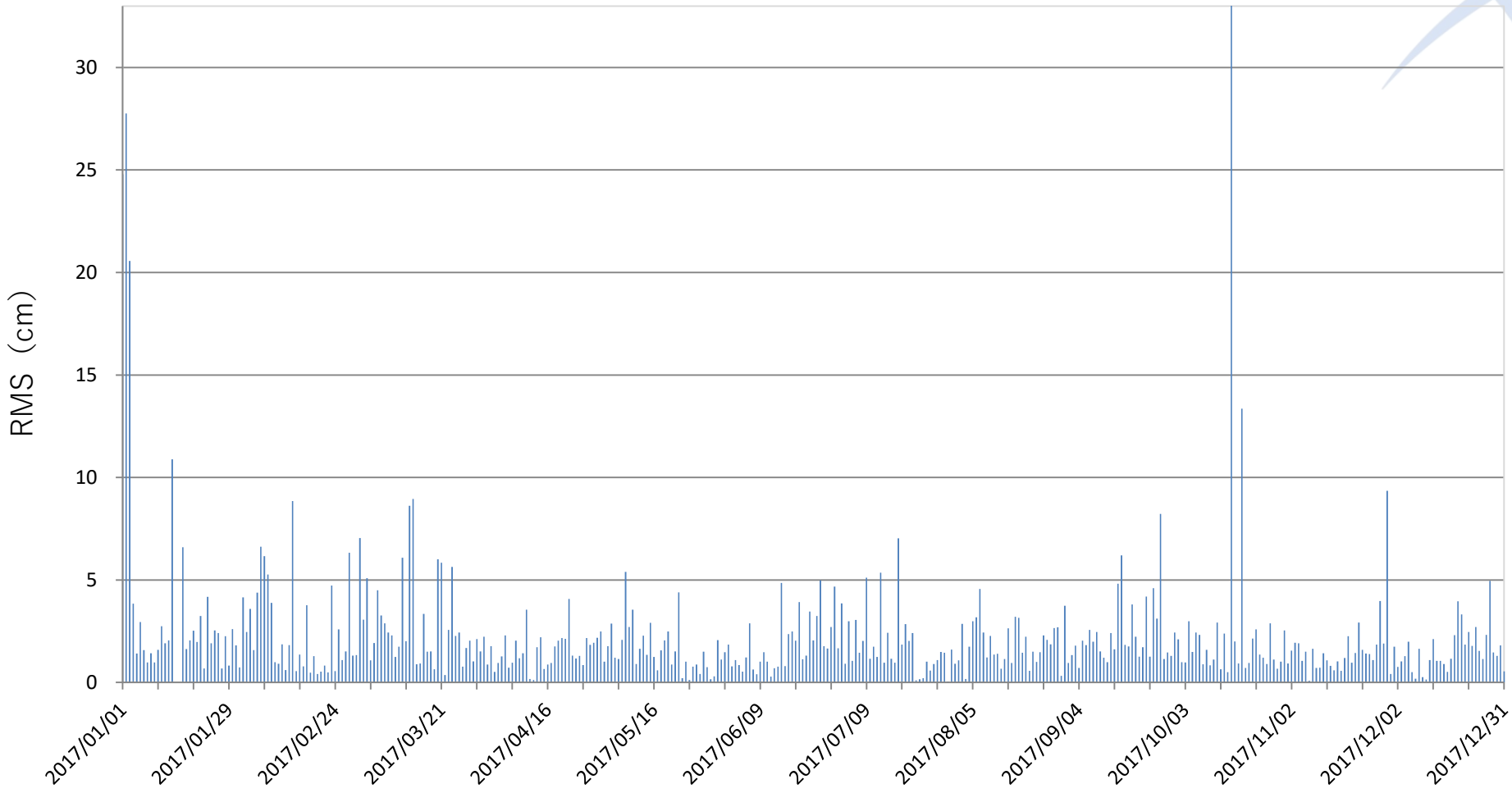
Characteristics of ALOS-2

- ❖ World's Top Observation Duty
- ❖ Autonomous Precise Orbit Control
- ❖ Emergency Observation is possible after One hour of Setting up

Current status of ALOS-2

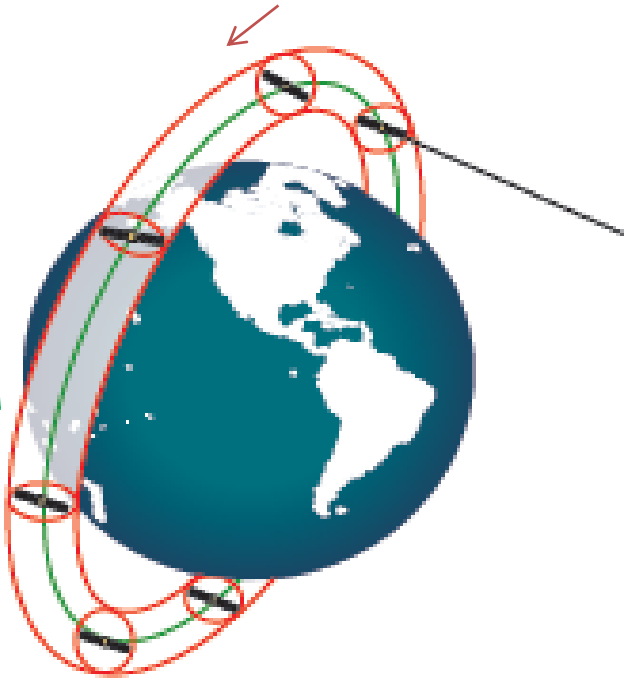


Orbit determination accuracy (relative)

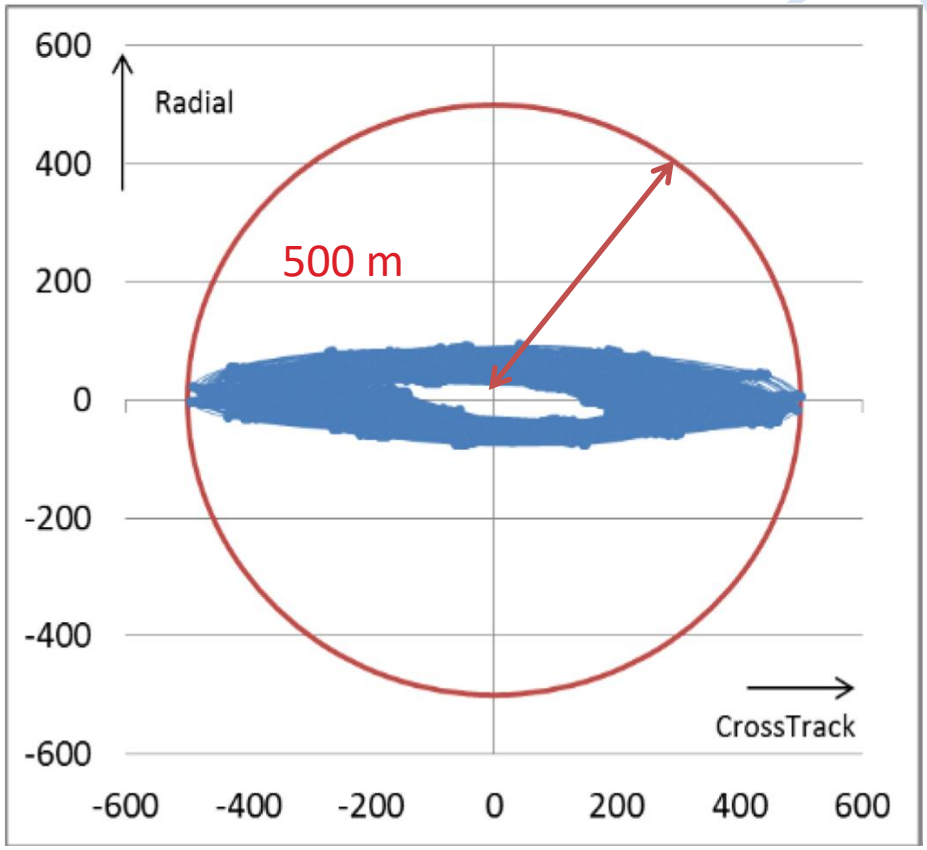


Performance of automonous orbit control

500-m radius tube



Satellite position



Orbit control (2017/11/1～2017/11/30)

Calibration and validation status

Please see Motooka-san's presentation

- PALSAR-2 keeps good condition and performance according to the built-in calibration mode every 3-months and regular cal-val activities.

Summary of validation results as of Jul. 2017

Items	Results	
Geometry (RMSE)	[Stripmap and Spotlight] **5.34 m (L1.1) / 6.73 m (L2.1)** [ScanSAR] **60.77 m (L1.1) / 29.93 m (L2.1)**	
Radiometry	RCS accuracy (1σ)	**0.56 dB (corner reflectors)** **0.77 dB (Amazonian forests)**
Polarimetry	VV-HH amplitude ratio	**1.004 (σ=0.012)**
	VV-HH phase difference	**-1.19 deg (σ=4.42)**
	Cross talk	**[HV/HH] -39.4 dB (σ=9.1)** **[VH/VV] -39.1 dB (σ=11.0)**

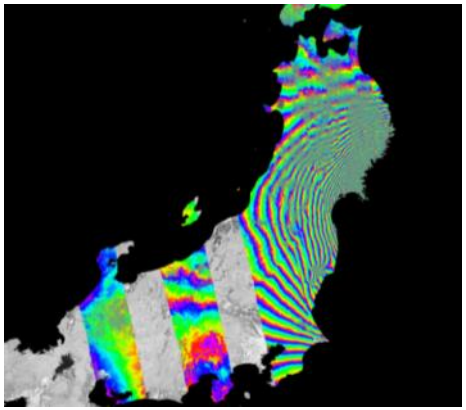
By Dr. Motoka (IGARSS2017)

“Daichi-2” (ALOS-2)

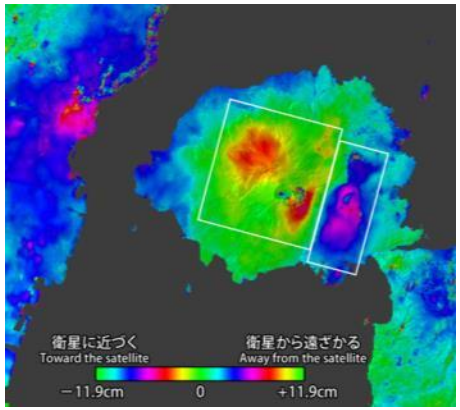
Mission Objectives:

Disaster monitoring

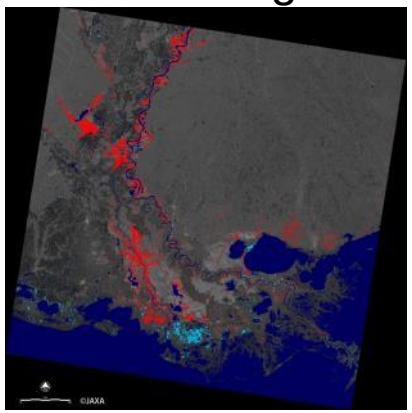
Earthquake



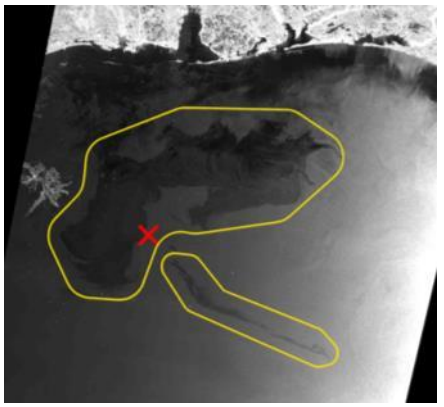
Volcano



Flooding

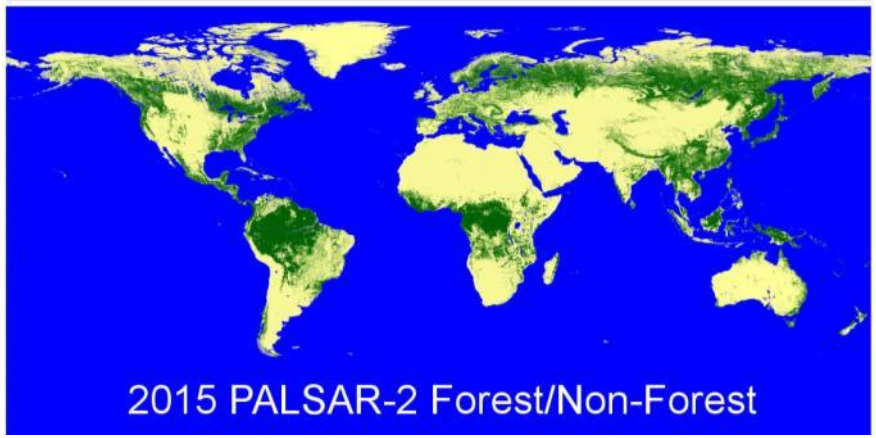


Ocean

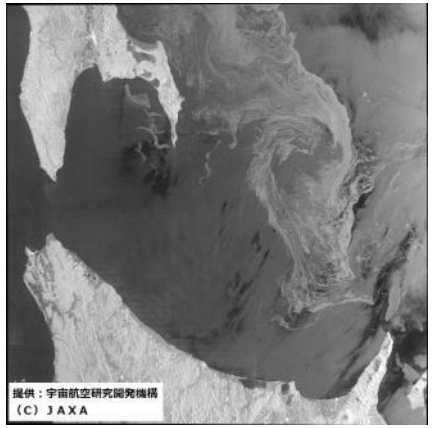


Environment and land management

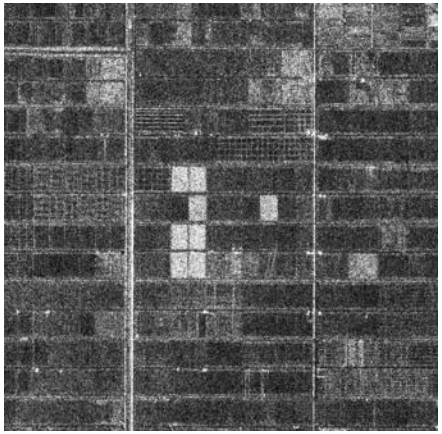
Forest and wetland



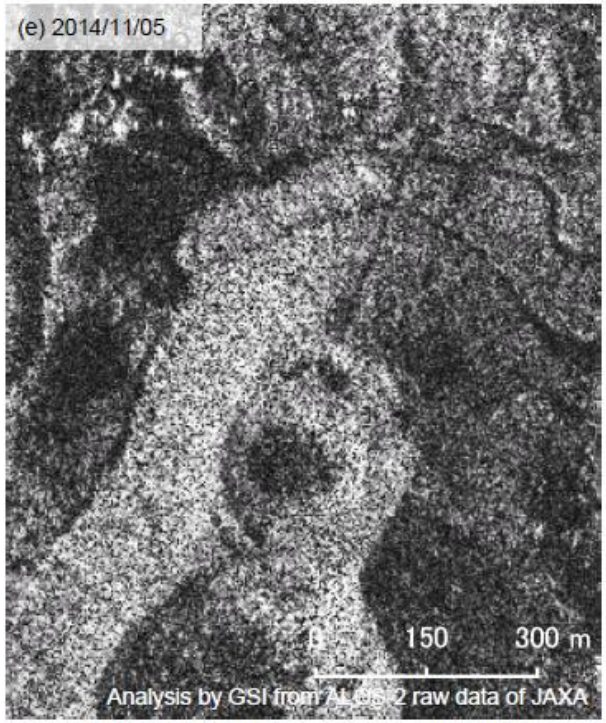
Ice

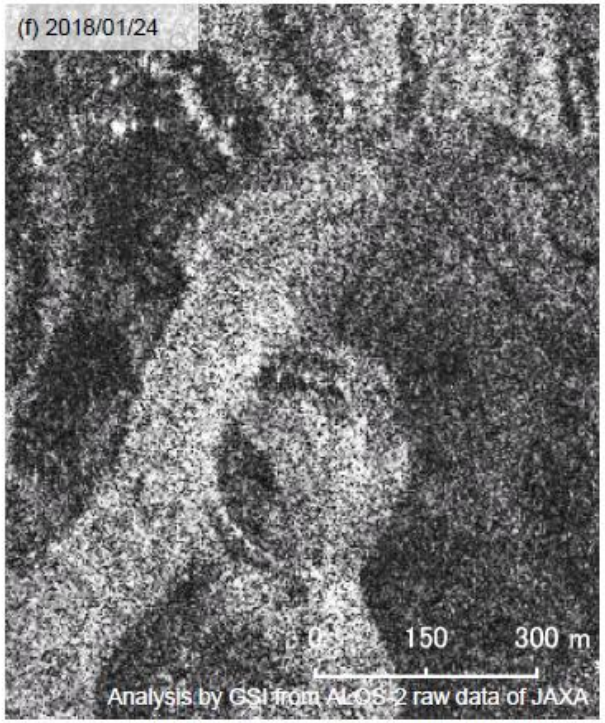


Agriculture & natural resources



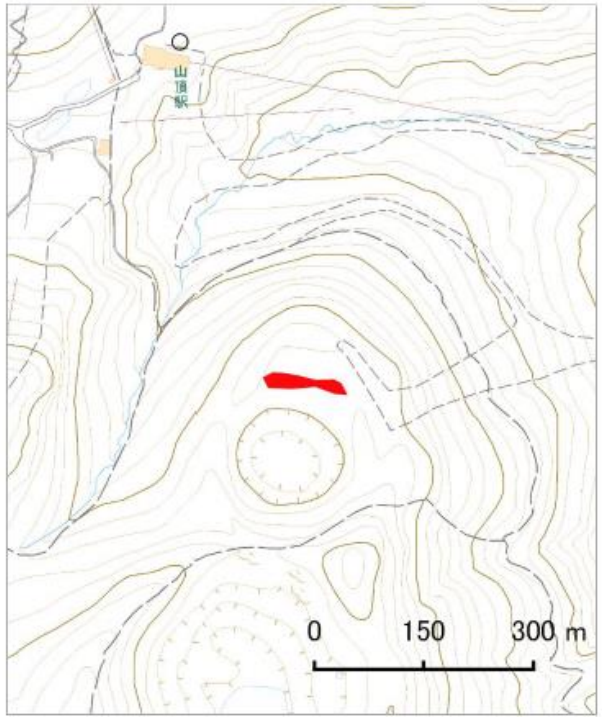
Kusatsu: Shirane Volcano





火山噴火予知連絡会拡大幹事会
資　料　①
平成30年1月26日
国土地理院

反射強度が著しく変化した箇所（赤）

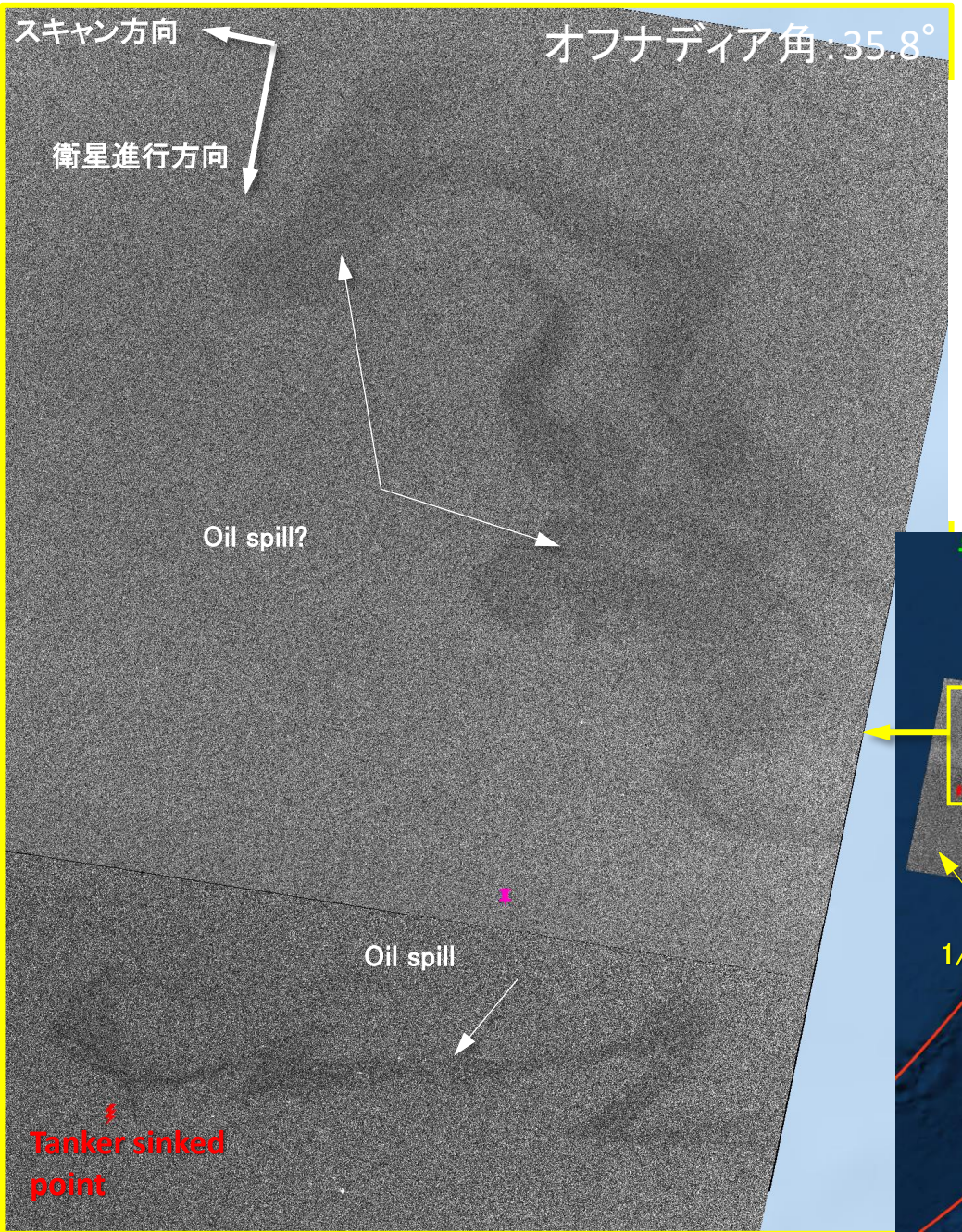


http://www.jma.go.jp/jma/press/1801/26a/yochiren180126-2.pdf

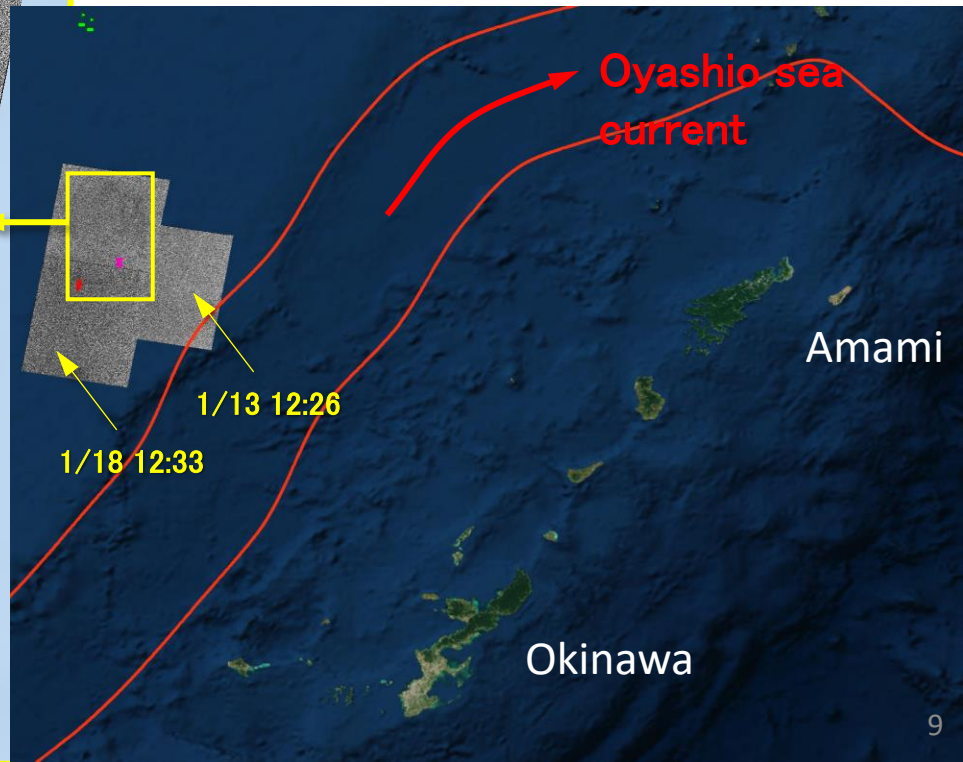
Latest ALOS-2 observation of Shirane-san (analysized by GSI)

Tanker oil spill in East China sea

January 18, 2018



- タンカーから流出した油膜は、通常の海面に比べ、なめらかになっていると考えられるので、レーダからの電波が、衛星方向に反射されず、周辺よりも暗く写る。

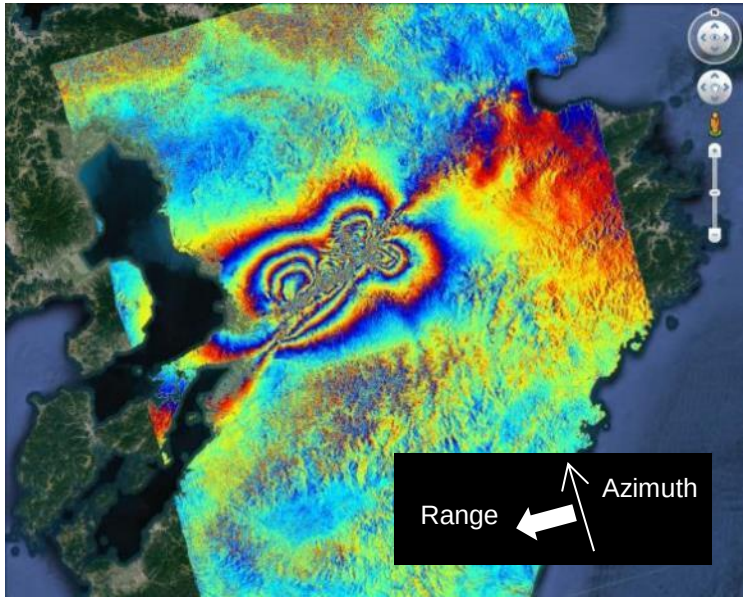


Disaster monitoring

- **Over 250 emergency observations** for earthquakes, volcanoes, flooding, landslides, and so on. The data and analysis results have been used for the assessment of damages, risks, background mechanisms, and recovery action plans.

Mw 7.3 Kumamoto earthquake, Japan (April, 2016)

ScanSAR interferometry

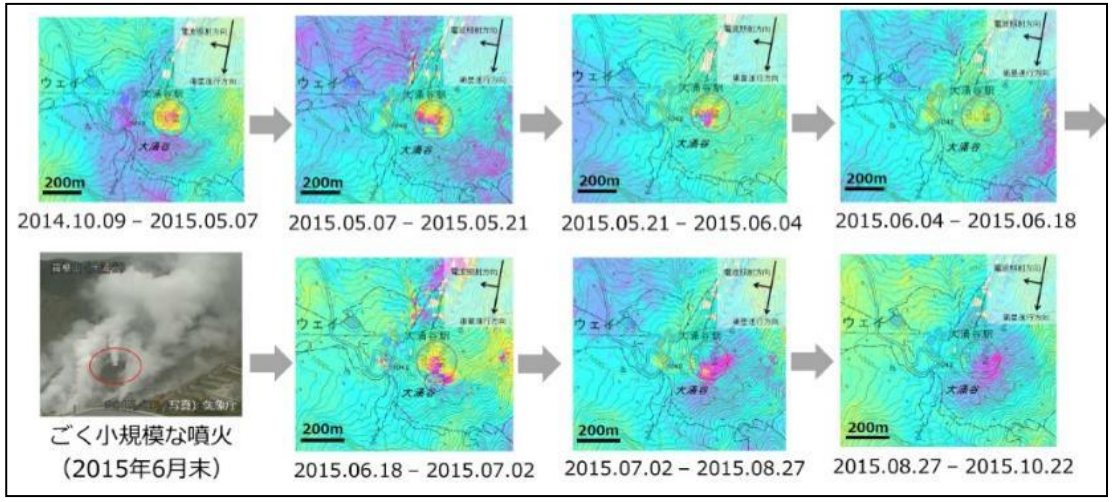


Displacement

←Toward to satellite Away from satellite→

Eruption of Mt. Hakone (May to Oct, 2015)

Small-scale deformation before the eruption detected by 14-days repeat interferometry

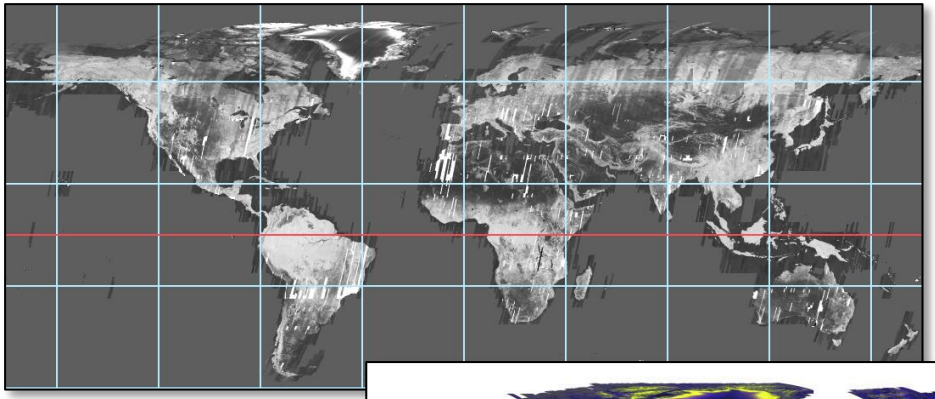


Results by Geospatial Information Authority of Japan

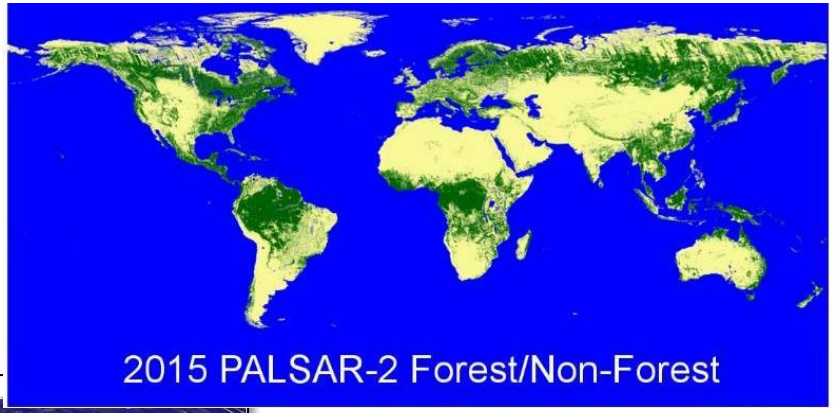
Global mosaics and forest maps

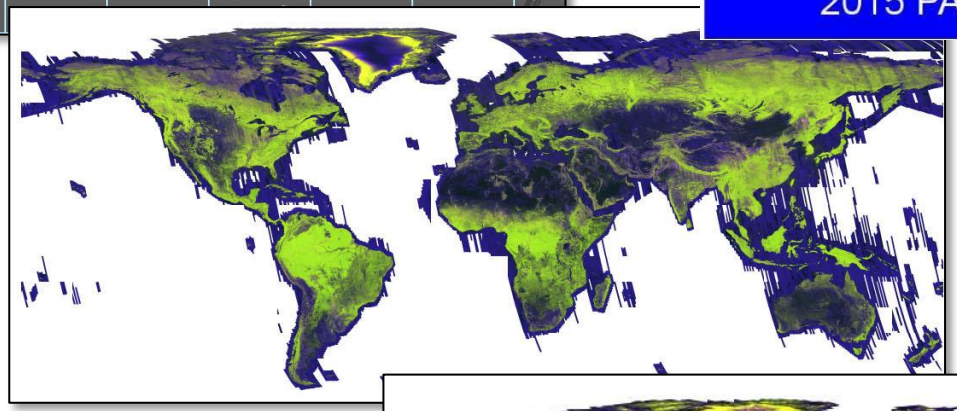
Please see Shimada-san's presentation

- JERS-1 (1996) ~ ALOS (2007-2010) ~ ALOS-2 (2014-)

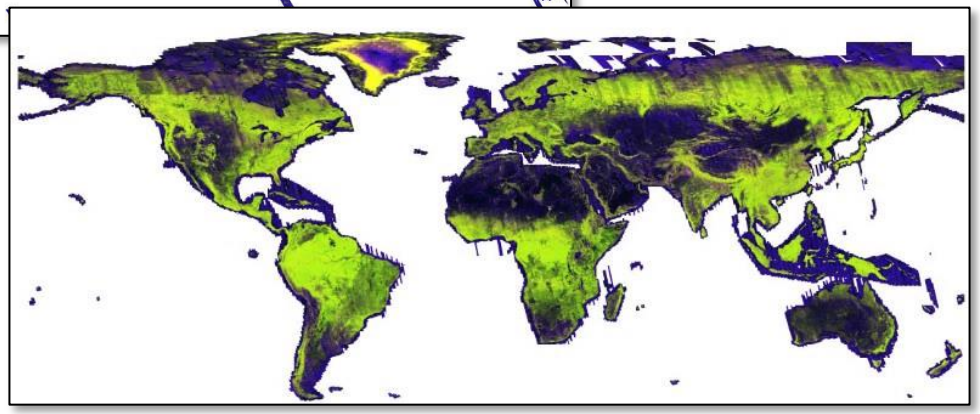


1996 JERS-1
(only HH-pol.)





2009 ALOS



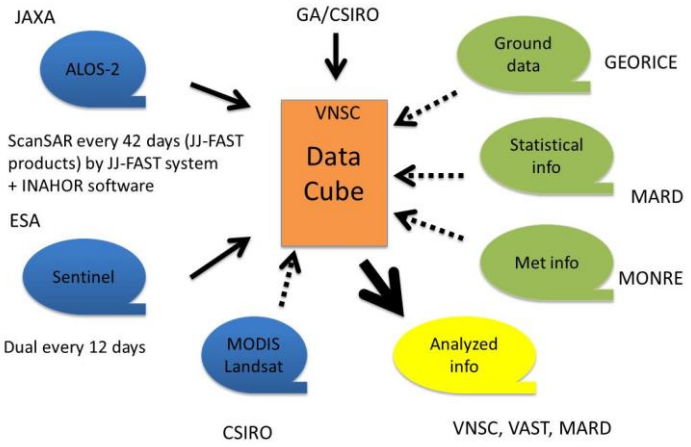
2015 ALOS-2

GEOGLAM AsiaRiCE (from demo to operation)

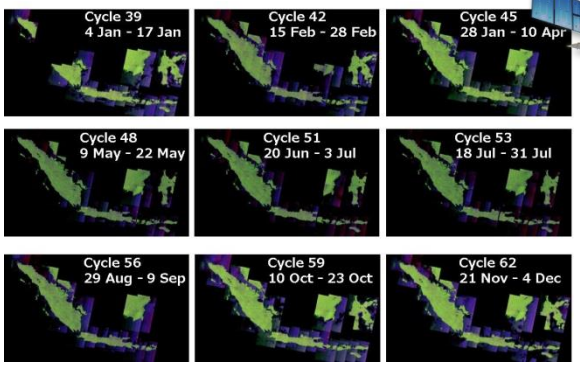
http://www.asia-rice.org

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 (POC: Sobue.shinichi@jaxa.jp, ohyoshi.kei@jaxa.jp, Thuy.letoan@cesbio.cnes.fr

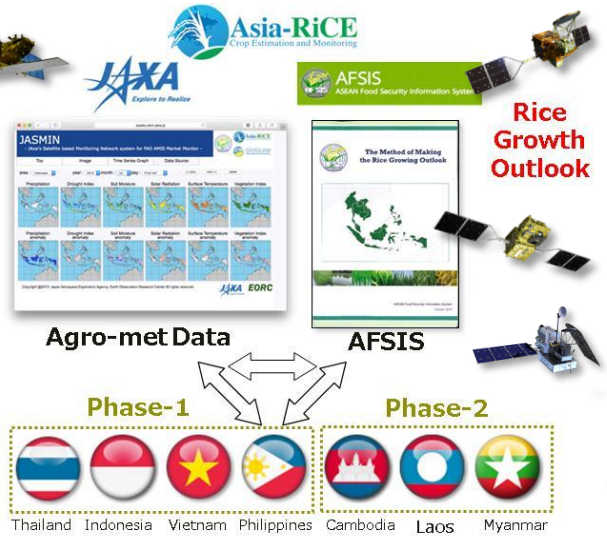
ID	Target Agricultural Products	Requirements of EO data for operational use
P1	**Rice Crop Area Estimates/Maps**	Wall-to-wall observation with SAR dual polarization with Opticals (week – bi-weekly – monthly) : Indonesia, Vietnam/Cambodia and Thailand/Lao projects
P2	**Crop Calendars/Crop Growth Status**	Mid/coarse resolution opitcal frequent observation (MODIS, GCOM-C, Landasat, Sentinel-2, etc.) with SARs weekly
P3	**Crop Damage Assessment**	Very High resolution SAR and Optical timely under international disasater charter, Sentinel Asia, etc.
P4	**Agro-meteorological Information Products**	Daily Mid/coarse resolution optical, passive microwaver and PR with geostatinary 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 / statisitcal information and crop models



Vietnam Data Cube starting from GEOSS-AP (Hanoi, September) by VNSC/VAST with CEOS



Time series observation by SAR for top 10 Indonesia main rice regions by ALOS-2 with MOA



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.

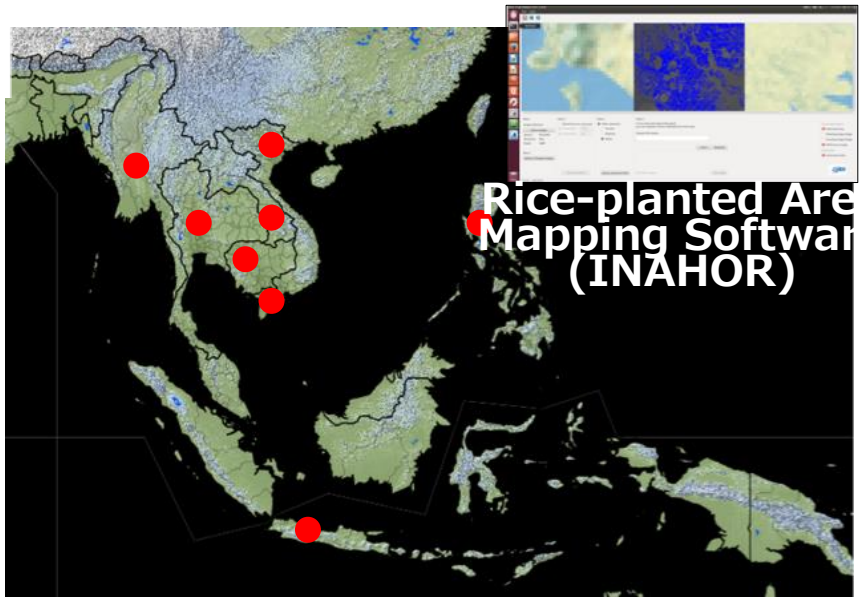
Please see Okumura-san's presentation

ADB | Japan Fund for Poverty Reduction | From the People of Japan

ADB TA Project

- Laos
- Thailand
- Vietnam (North)
- Philippines

[2014-2016]



SAFE Project (Test site)

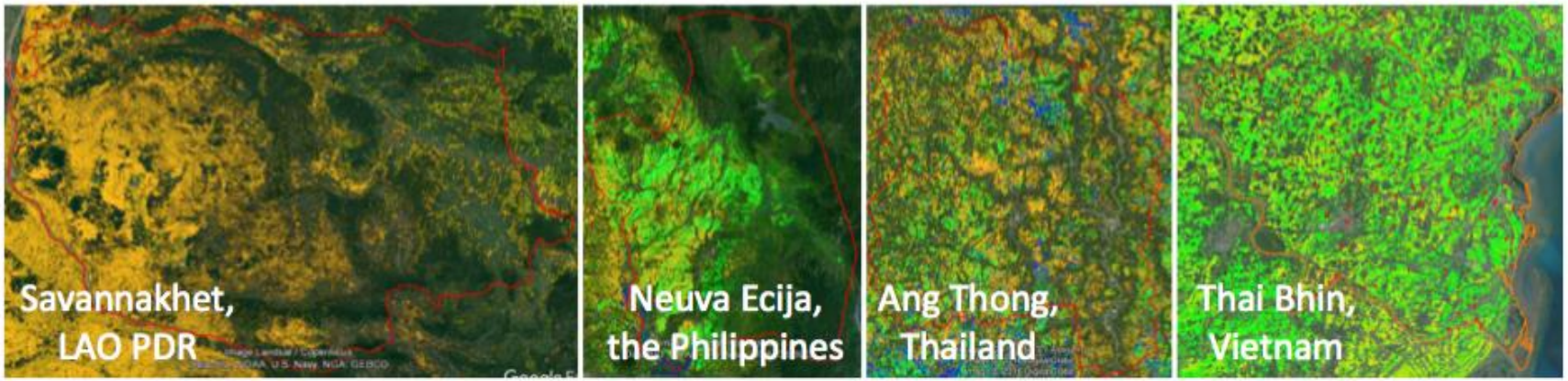
- Myanmar
- Cambodia

[2016-]

SAFE Project (Scaling-up)

- Vietnam (Mekong Delta)
- Indonesia

[2014-]



Basic Observation Scenario (ALOS-2 BOS)

- The PALSAR-2 observations are performed according to the BOS. The BOS has two separate plans for Japan and the rest of the world.
- Success rate of the BOS is 70-90 %. Missing observations are mainly due to insufficient downlink resources, conflict of observation requests, and internal calibration or orbit tuning operations.
- **Promote super sites activities with frequent observation to make a bridge to ALOS-4 operation in JFY2020 (wish to have ALOS-2 and ALOS-4 observation)**

Global BOS (4th -5th year)

1 year = 26 cycles

Please see Ake-san's presentation

■4th Year

Cycle	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100				
Year	2017											2018													
Month/Day	07/31	08/14	08/28	09/11	09/25	10/09	10/23	11/06	11/20	12/04	12/18	01/01	01/15	01/29	02/12	02/26	03/12	03/26	04/09	04/23	05/07				
Descending	Glacier Super Site	Crustal Glacier Super Site	Wetland Deforest	Glacier Super Site	Crustal Glacier Super Site	Wetland Deforest	10m (SuperSite)		Wetland Deforest	10m (SuperSite)	Crustal	Wetland Deforest 1&2	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Wetland Deforest 2	Wetland Deforest 1
		W2(2)R	W2 (2)R		W2(2)R	W2 (2)R	F2 (7)R	F2 (5)R	W2 (2)R	F2 (6)R	W2(2)R	W2 (2)R	W2(2)R	W2(2)R	W2(2)R		W2(2)R	W2(2)R		W2(2)R	W2(2)R		W2(2)R	W2(2)R	W2(2)R	W2(2)R
	F2(6)L	F2(6)L		F2(6)L	F2(6)L									W2(2)R		F2(7)R	F2(7)R		F2(5)R	F2(5)R		F2(6)R	F2(6)R			
Ascending	North Polar Crustal	Polar	World 1-1(10m)				World 2-1(10m)			Polar	South Polar	World A(10m)			GR Super Site	World B(10m)				World C(10m)			South Polar	World D(10m)		
	W2 (2)R	W2(2)R	F2 (7)R	F2 (5)R	F2 (6)R		F2 (7)R	F2 (5)R	F2 (6)R	W2(2)R	W2(2)L	F2 (7)R	F2 (5)R	F2 (6)R	F2(6)R	F2 (6)R	F2 (7)R	F2 (5)R		F2 (7)R	F2 (5)R	F2 (6)R	W2(2)L	F2 (7)R	F2 (5)R	F2 (6)R
		W2(2)L								W2(2)L															

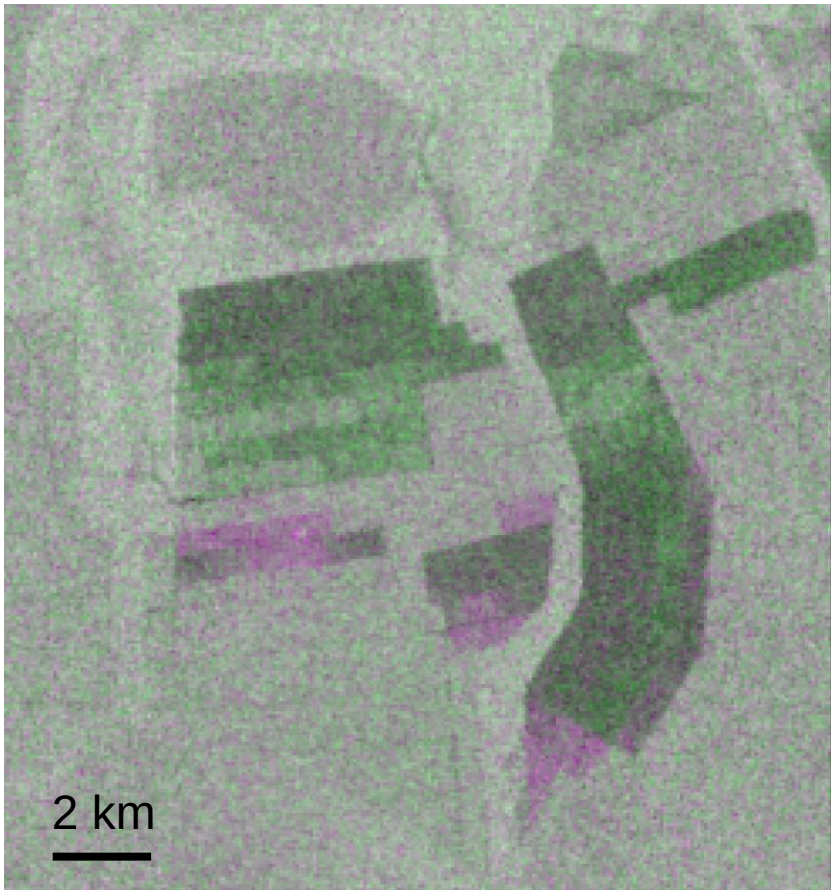
■5th Year

Cycle	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131
Year	2018											2019														
Month/Day	07/30	08/13	08/27	09/10	09/24	10/08	10/22	11/05	11/19	12/03	12/17	12/31	01/14	01/28	02/11	02/25	03/11	03/25	04/08	04/22	05/06	05/20	06/03	06/17	07/01	07/15
Descending	Glacier Super Site	Wetland Deforest 2 Glacier SuperSite	Wetland Deforest 1	Crustal 1 Glacier Super Site	Wetland Deforest 2 Crustal 2 Glacier Super	Wetland Deforest 1	Crustal 1 10m Super Site	Wetland Deforest 2 Crustal 2	Wetland Deforest 1 10m Super	Crustal 1 10m Super Site	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Crustal 1	Wetland Deforest 2 Crustal 2	Wetland Deforest 1	Wetland Deforest 2	Wetland Deforest 1
		W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R	W2(2)R		W2(2)R	W2(2)R		W2(2)R	W2(2)R		W2(2)R	W2(2)R	W2(2)R	W2(2)R
	F2(6)L	F2(6)L		F2(6)L	F2(6)L		F2(7)R		F2(5)R	F2(6)R	W2(2)R			W2(2)R		F2(7)R	F2(7)R		F2(5)R	F2(5)R		F2(6)R	F2(6)R			
Ascending	World E(10m)			North Polar Crustal	North Polar	World F(10m)					World A(10m)			Polar	GR Super Site South Polar	World B(10m)				World C(10m)				World D(10m)		
	F2 (7)R	F2 (5)R	F2 (6)R	W2 (2)R	W2(2)R	F2 (7)R	F2 (5)R	F2 (6)R			F2 (7)R	F2 (5)R	F2 (6)R	W2(2)R	F2(6)R	F2 (6)R	F2 (7)R	F2 (5)R		F2 (7)R	F2 (5)R	F2 (6)R		F2 (7)R	F2 (5)R	F2 (6)R
														W2(2)L	W2(2)L											

PALSAR-2 observation

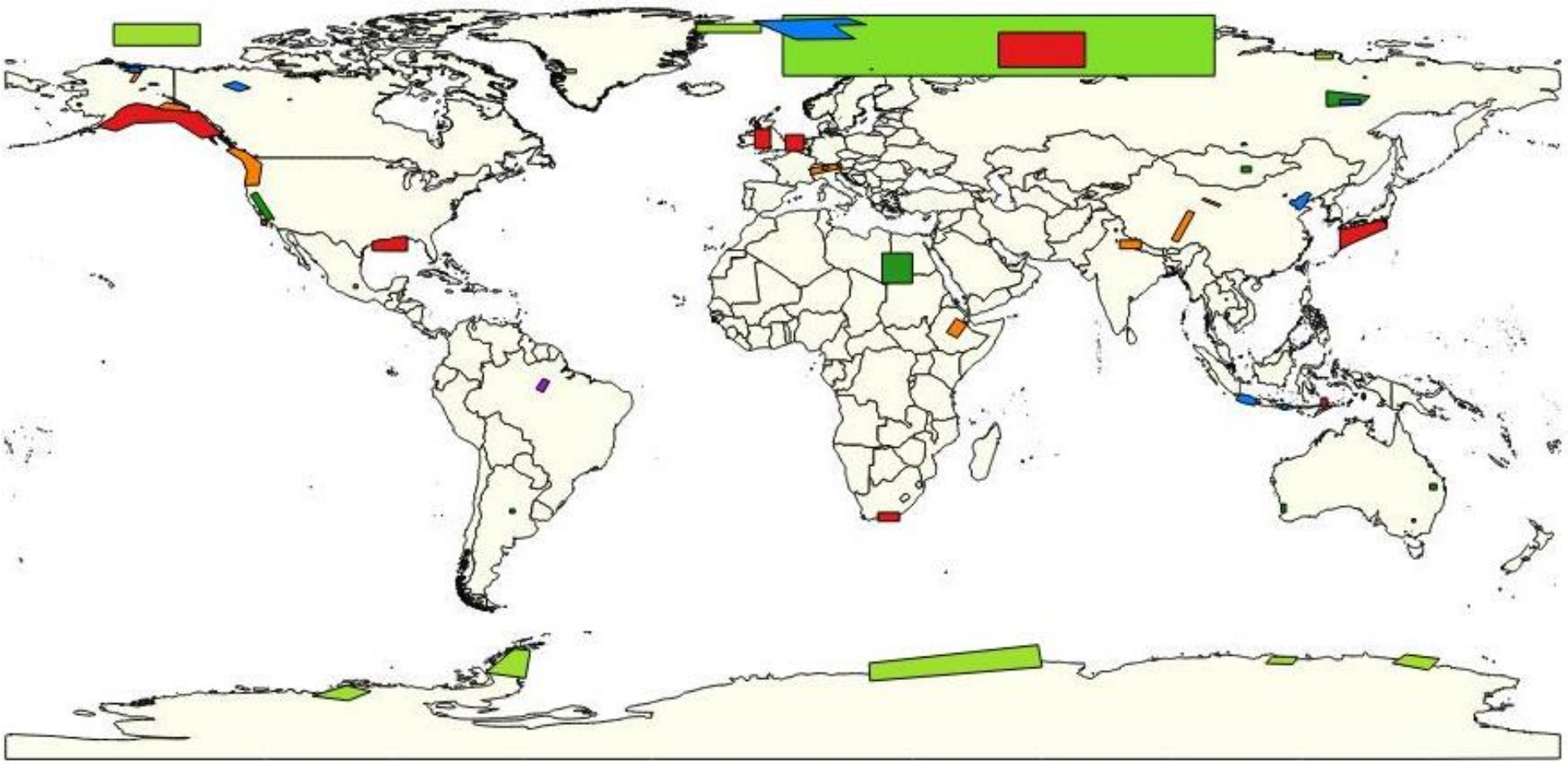
Example: tropical forests in Indonesia

ScanSAR mode
100 m resolution
~ 9 times/year in basic obs. scenario



Stripmap mode
10 m resolution
1~2 times/year in basic obs. scenario

PI Super Sites



: Polar research and Snow

: Polarimetry

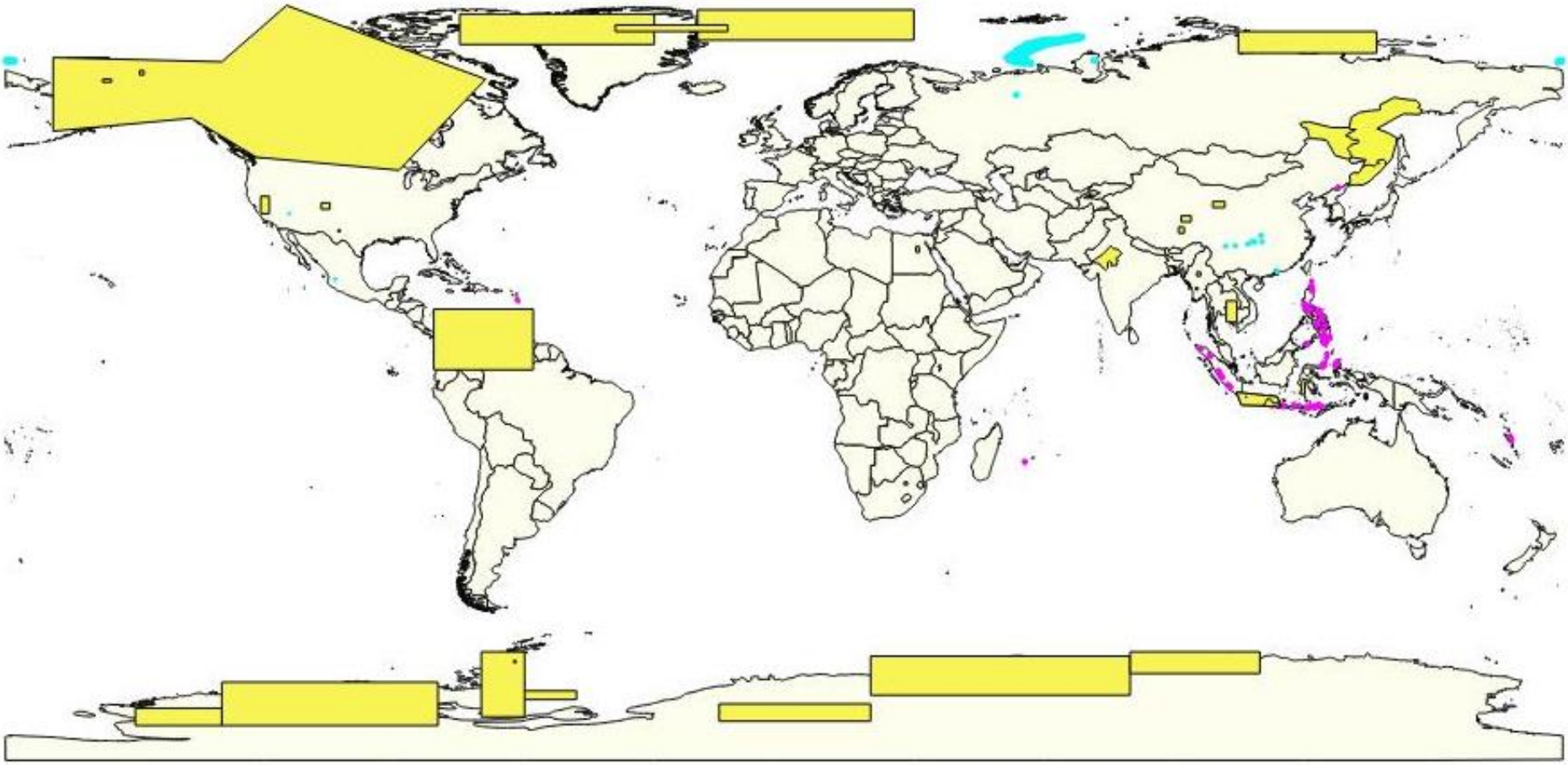
: Ocean

: Disaster

: Hydrology and Agriculture

: Land use and Forestry

New science and application priority sites



JAXA's Open and Free Data

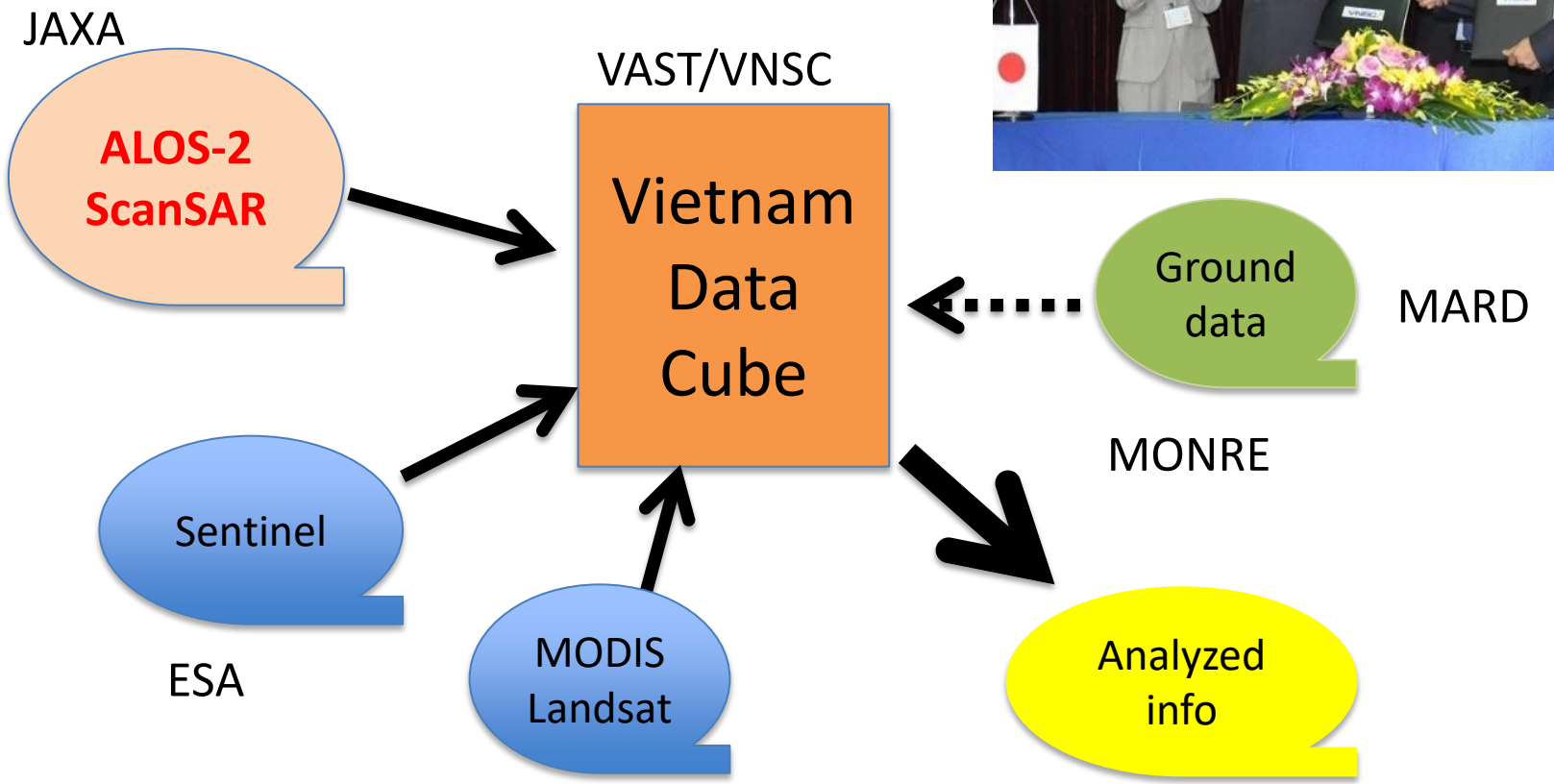
Satellite/ Sensor		Before	NOW/SOON
MOS/JERS/ADEOS/ADEOS-2/ AMSR-E/TRMM		○	○
GOSAT		○	○
GCOM-W and GCOM-C		○	○
GPM		○	○
ALOS	AVNIR-2	—	○
	PALSAR(10m)	—	○
	DSM (30m)	○	○
	Forest map / mosaic (25m)	○	○
ALOS-2	ScanSAR (100m)	—	○
	Fine mode (10m)	—	—

Schedule of Data Processing

		2017				2018			
		1Q Jan Mar	2Q Apr Jun	3Q Jul Sept	4Q Oct Dec	1Q Jan Mar	2Q Apr Jun	3Q Jul Sept	4Q Oct Dec
ALOS	AVNIR-2 (10m)					±60 Degree Area Data O/F			Global Data O/F
		Global Data Processing							
	PALSAR (10m)								O/F
						Global Data Processing			
ALOS-2	ScanSAR (100m)				Asia Region Data O/F			Global Tropical Region Data O/F	

Representatives from VNSC and JAXA sign an agreement on satellite data exchange, Hanoi, September 18 (Credit: VNSC)

To support the DataCube Programme in Vietnam - a large data platform programme of the Earth's observation satellites in order to develop related applications, such as rice, forest and water quality monitoring, in addition to promoting the use of satellite data in the field of Earth observation.



ALOS-2 PALSAR-2 (ARD)

Open Data Cube

PALSAR-2

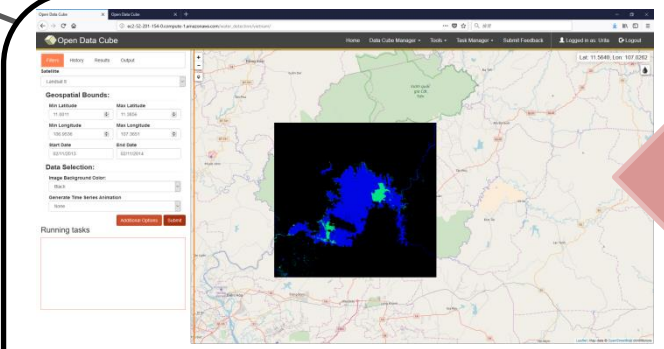
etc…

Ingest

JAXA

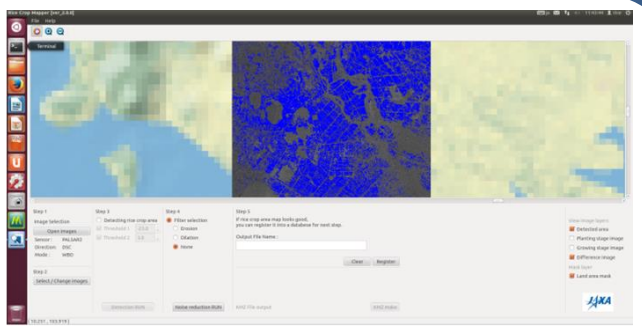
Data Archive

PALSAR-2



CEOS Data cube Interface

Python Coding



INAHOR Interface

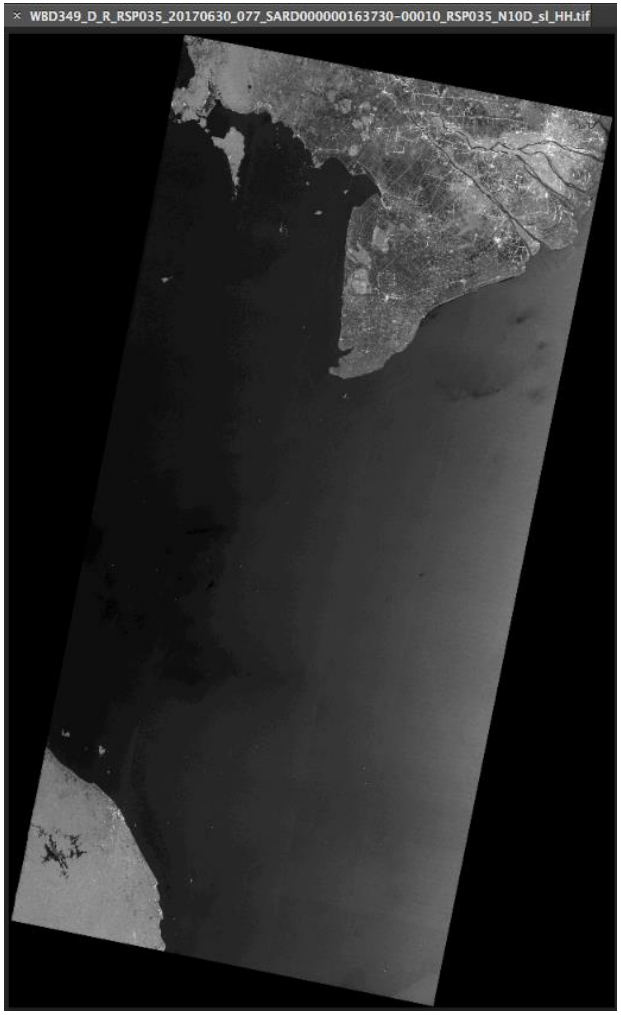
ScanSAR data provision for GFOI and other applications

Product characteristics

- Path data
- Polarisation: HH + HV
- Gamma-0
- Image size: arbitrary
- Pixel spacing: 50 m
- Image segment start & end: arbitrary
- Orho & slope correction by SRTM1
- Data type: 16 bits UInt
- File format: GeoTIFF
- Temporal resolution: 42 days
- Spatial resolution: All paths in target region

Limitations:

- ASEAN countries
- For governmental users only

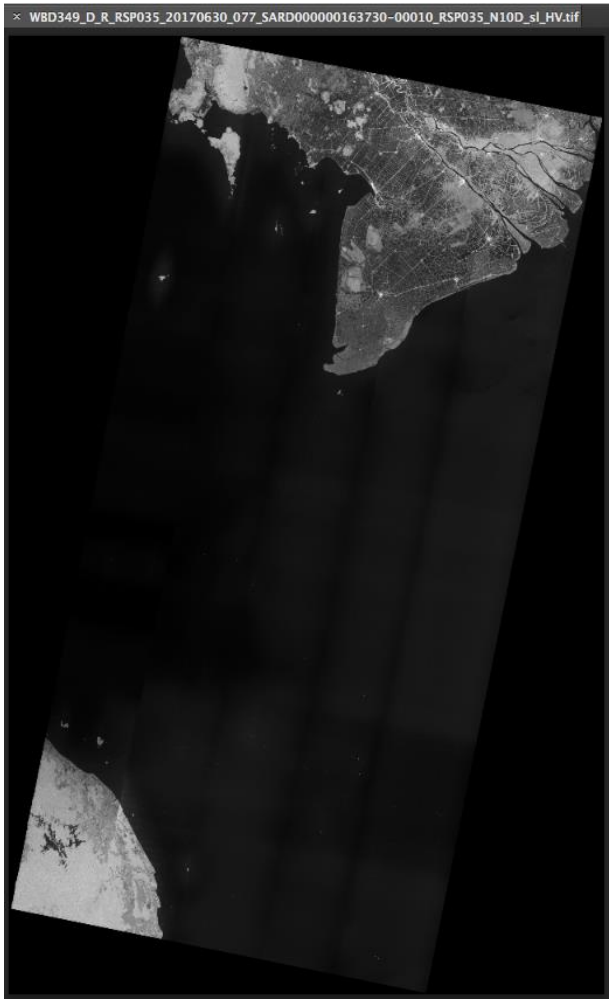


PALSAR-2 ScanSAR (HH)
30 June 2017

ScanSAR data provision for GFOI and other applications

Tag	Description
origin	Image courtesy
satellite	satellite name
instrument	instrument name
file_name	File name
product	Path or Tile
obs_date	Observation date
polarization	Types of polarization
rsp	Number of Path
cycle	Observation cycle
obs_mode	Observation Mode
off-nadir_angle	Off-nadir angle [deg]
satellite_direction	Orbit Direction D:Descending A:Ascending
look_side	Observation Direction L: Left looking R: Right looking
replay_id	Downlink ID
version	Software release and revision number
DEM	Digital Elevation Model
upper_left_latitude	Upper left latitude
upper_left_longitude	Upper left longitude
pixel	Number of pixels
line	Number of lines
data_type	UInt16:Unsigned short integer 16-bit
interleave	Permutations of dimensions in binary data BSQ - Band Sequential (X[col,row,band]) BIL - Band Interleave by Line (X[col,band,row]) BIP - Band Interleave by Pixel (X[band,col,row])
calibration_equation	The equation for convering digital number to backscattering coefficient (gamma-naught, dB)
calibration_factor(CF1)	CF1 value
calibration_info_url	ALOS-2 callibration website

Data header

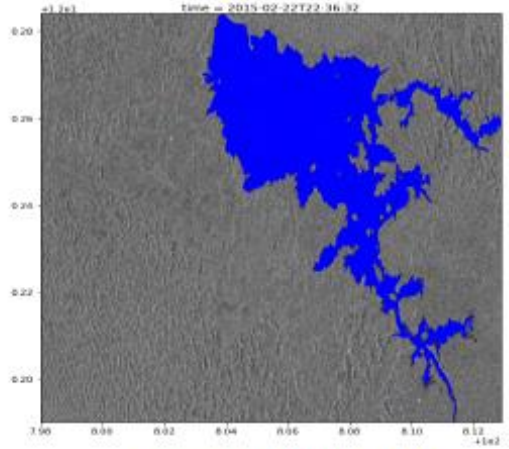


PALSAR-2 ScanSAR (HV)
30 June 2017

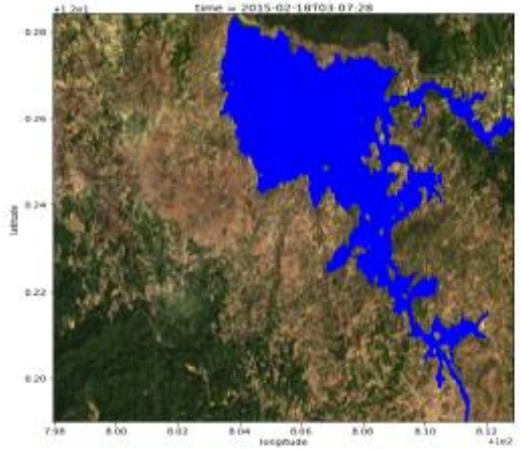
Water Detection with Radar

- **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: (Coefficient-1)*(Band-1) + (Coefficient-2)*(Band-2) + Bias

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



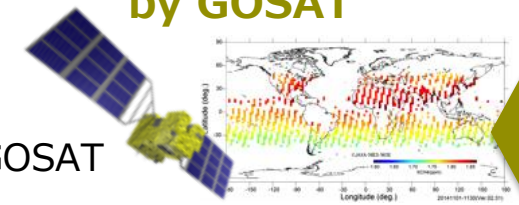
Sentinel-1 WASARD



Landsat WOFS

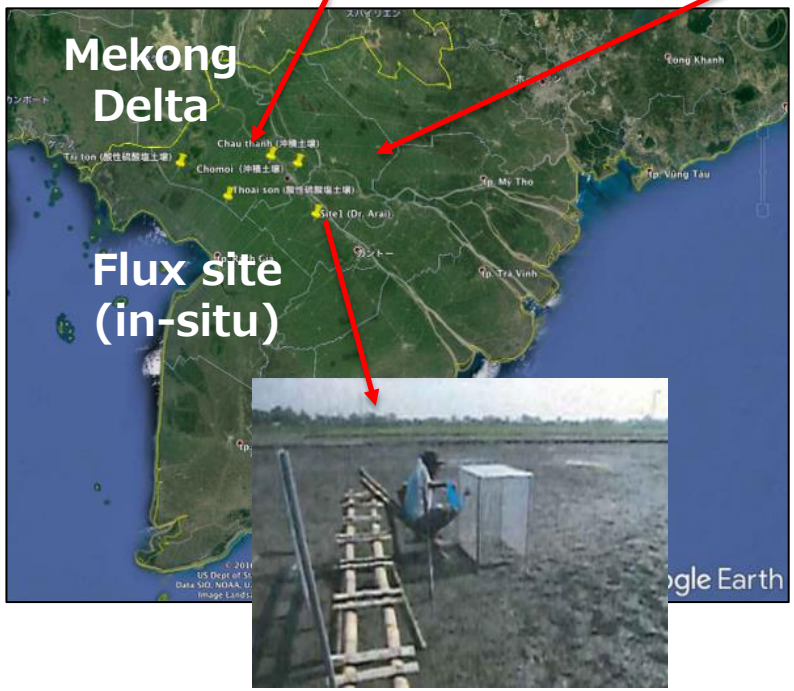
Scaling-up CH4 Measurement at a regional scale for MRV

Direct Measurement by GOSAT



GOSAT

・Point Source Obs.
（10.5kmθ）

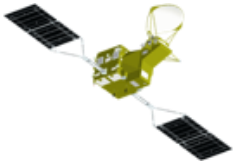


In-situ Measurement

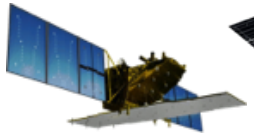
CH4 emission modeling with environmental factors

Integrate Monitoring by Opt, SAR and MWR

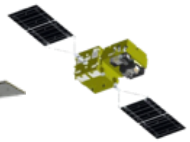
GCOM-W



ALOS-2/ Sentine-1



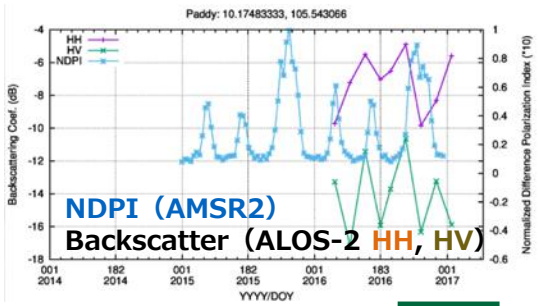
GCOM-C/ MODIS

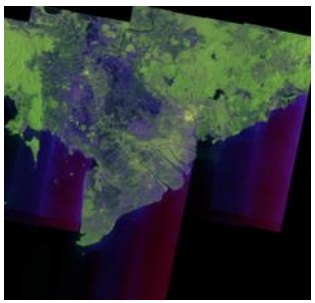


Himawari

Phenology + Water Condition

・identifying the conditions of paddy field whole rice cropping cycle including fallow season

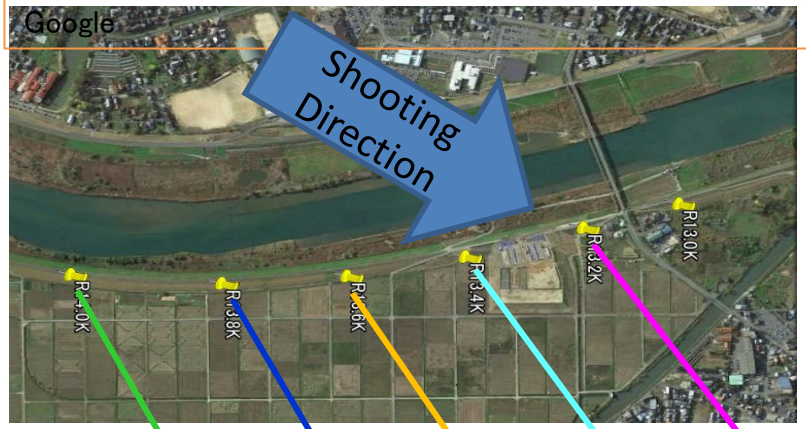


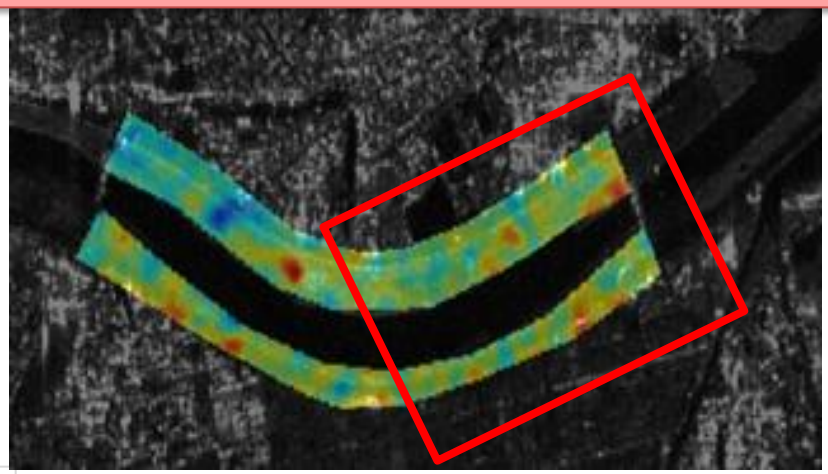


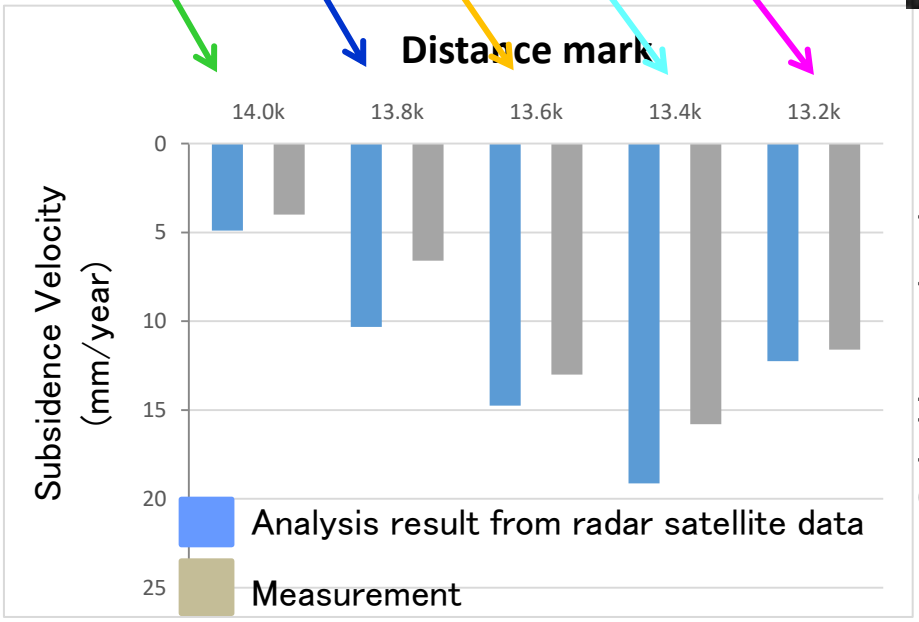
Scaling-up CH4 Emission Model / Evaluation

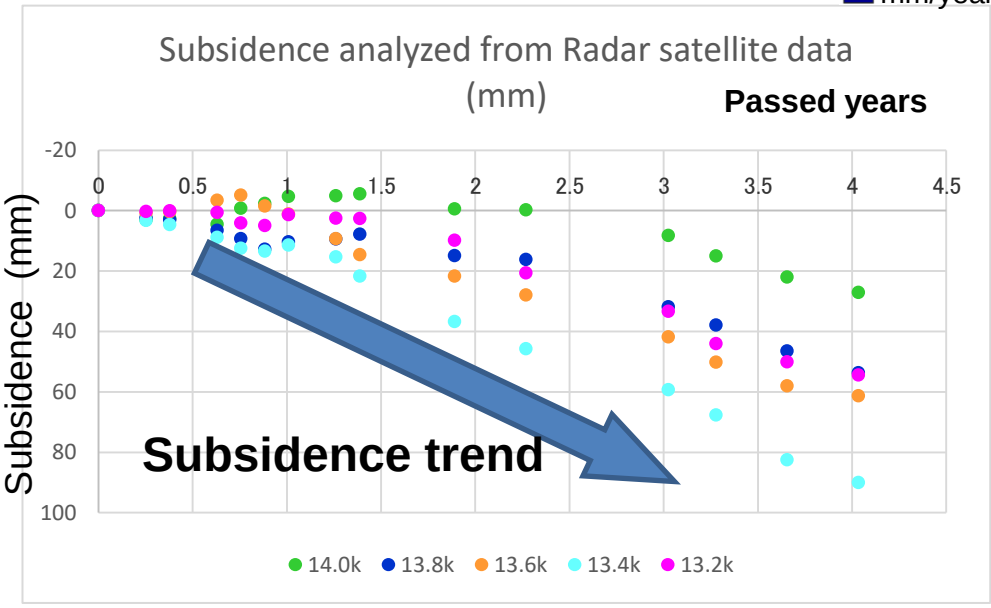
New Applications
Infrastructure Monitoring (Time Series Interferometric Analysis)

Regular monitoring to detect changes of infrastructure (subsidence) by SAR









Collaboration Project with MLIT


Thank you very much for your attention.
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JAXA
Explore to Realize