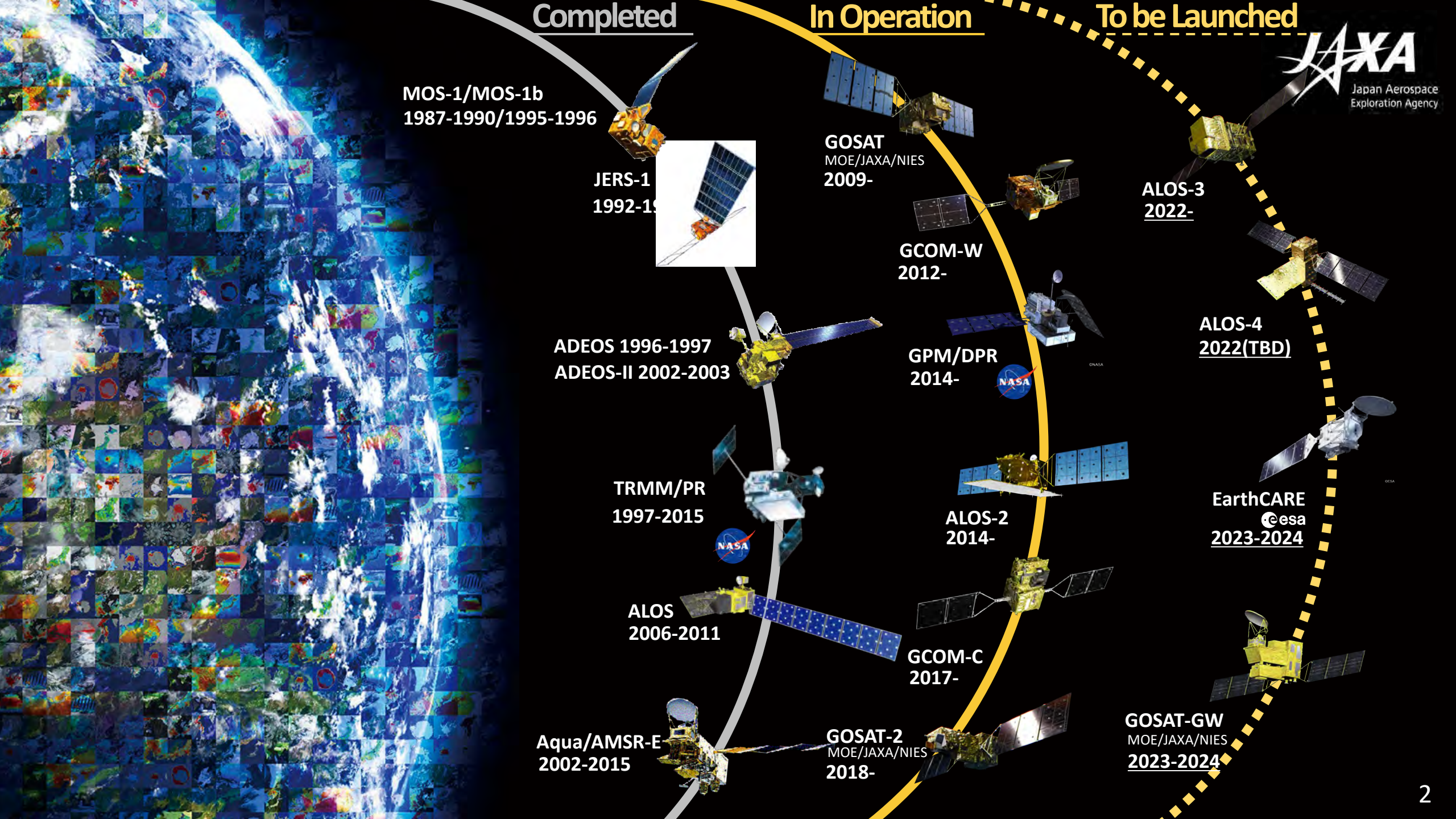
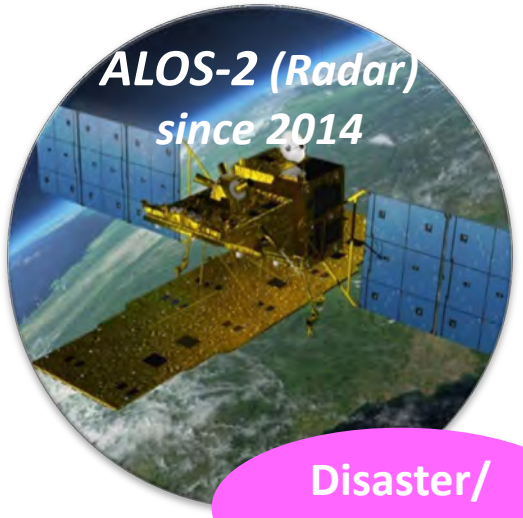
JAXA Earth Observation Satellites

Shin-ichi Sobue
Japan Aerospace Exploration Agency


Completed
In Operation
To be Launched
JAXA
Japan Aerospace Exploration Agency
MOS-1/MOS-1b
1987-1990/1995-1996
JERS-1
1992-1
GOSAT
MOE/JAXA/NIES
2009-
ALOS-3
2022-
GCOM-W
2012-
ALOS-4
2022(TBD)
ADEOS 1996-1997
ADEOS-II 2002-2003
GPM/DPR
2014-
NASA
TRMM/PR
1997-2015
NASA
ALOS-2
2014-
EarthCARE
esa
2023-2024
ALOS
2006-2011
GCOM-C
2017-
Aqua/AMSR-E
2002-2015
GOSAT-2
MOE/JAXA/NIES
2018-
GOSAT-GW
MOE/JAXA/NIES
2023-2024

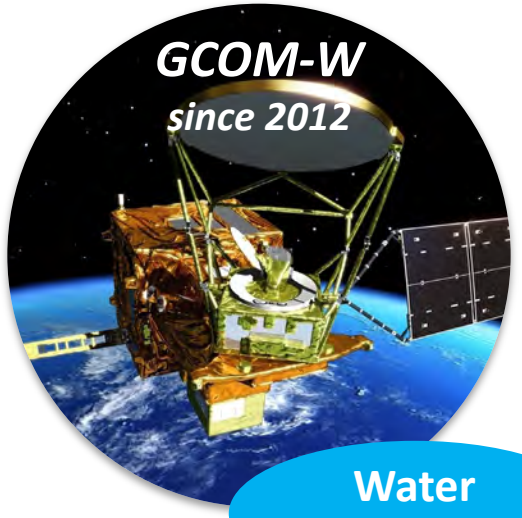
JAXA Earth Observation Missions Addressing Global Challenges



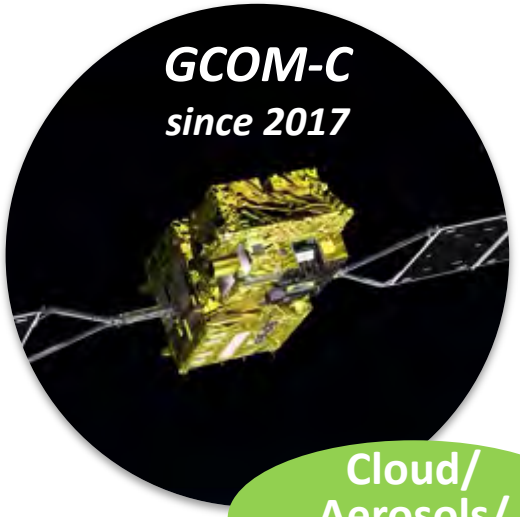
Disaster/ Forest

(NASA-JAXA joint mission)

Precipitation



Water Cycle



Cloud/ Aerosols/ Vegetation

Greenhouse gases

Greenhouse gases

UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

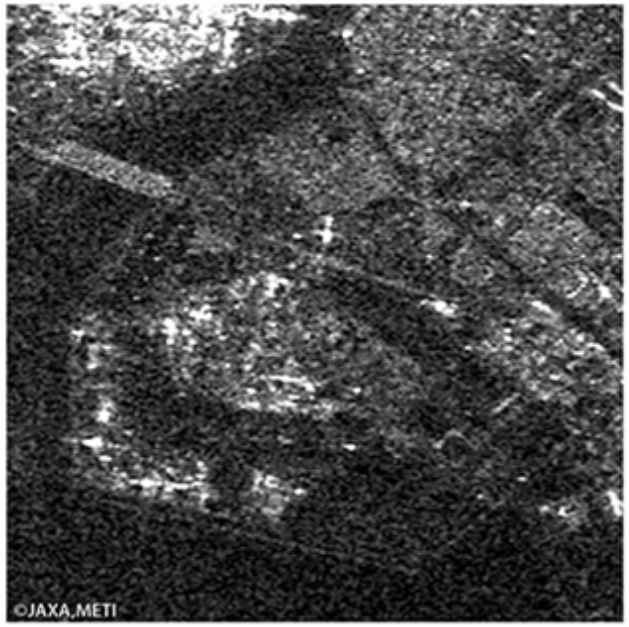
SDGs

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Japanese L-band SAR Satellites – 28-year Legacy

JERS-1

(1992-1998)

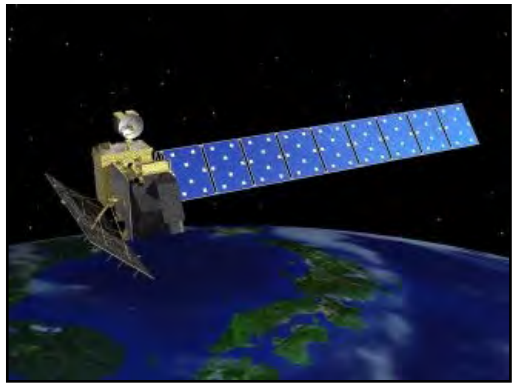


FUYO-1 SAR.
(Resolution: about 18 m)

ALOS

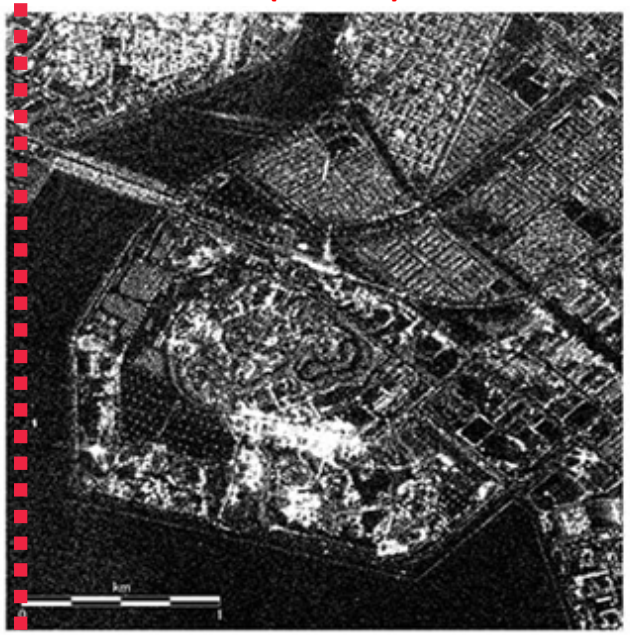
(2006-2011)

DAICHI PALSAR.
(Resolution: about 10 m)



ALOS-2

(2014-)



DAICHI-2 PALSAR-2.
(Resolution: about 3 m)

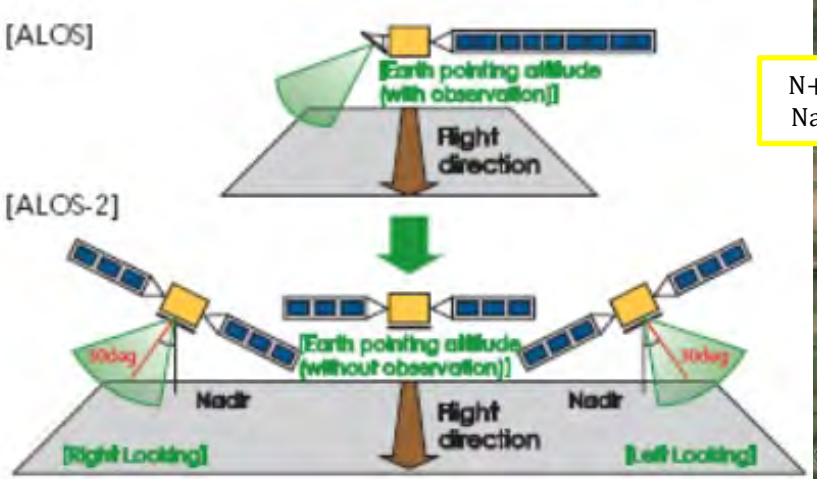
Improvement of Data Acquisition Abilities

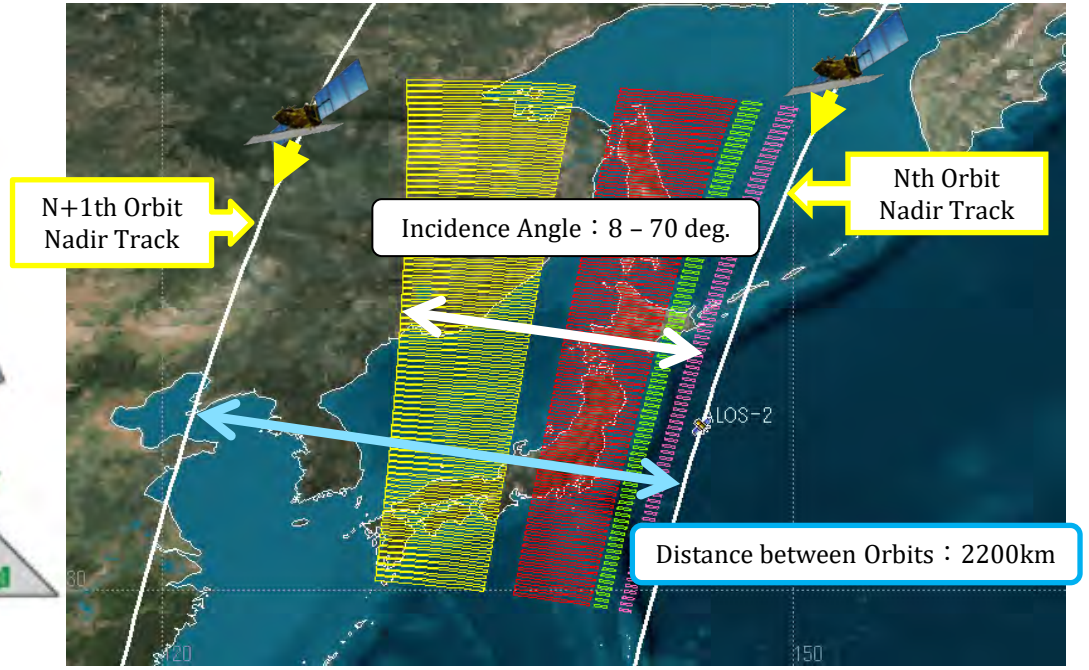
Improvements from ALOS to ALOS-2

ALOS needed 3 days (at the longest) for observation. ALOS-2 enables to observe every 12 hours.

→**<u>Wide observation</u>**: Understand entire picture of disaster in a short period for supporting initial operations by disaster related agencies and local governments.

→**<u>Repetitive observation with short intervals</u>**: Monitor recovery status.





Pink width: Swath 50km (Ultra Fine and High-sensitivity)
Green width: Swath 70km (Fine mode)
Red width: 350km (ScanSAR nominal mode)
Yellow width: 490km (ScanSAR wide mode)

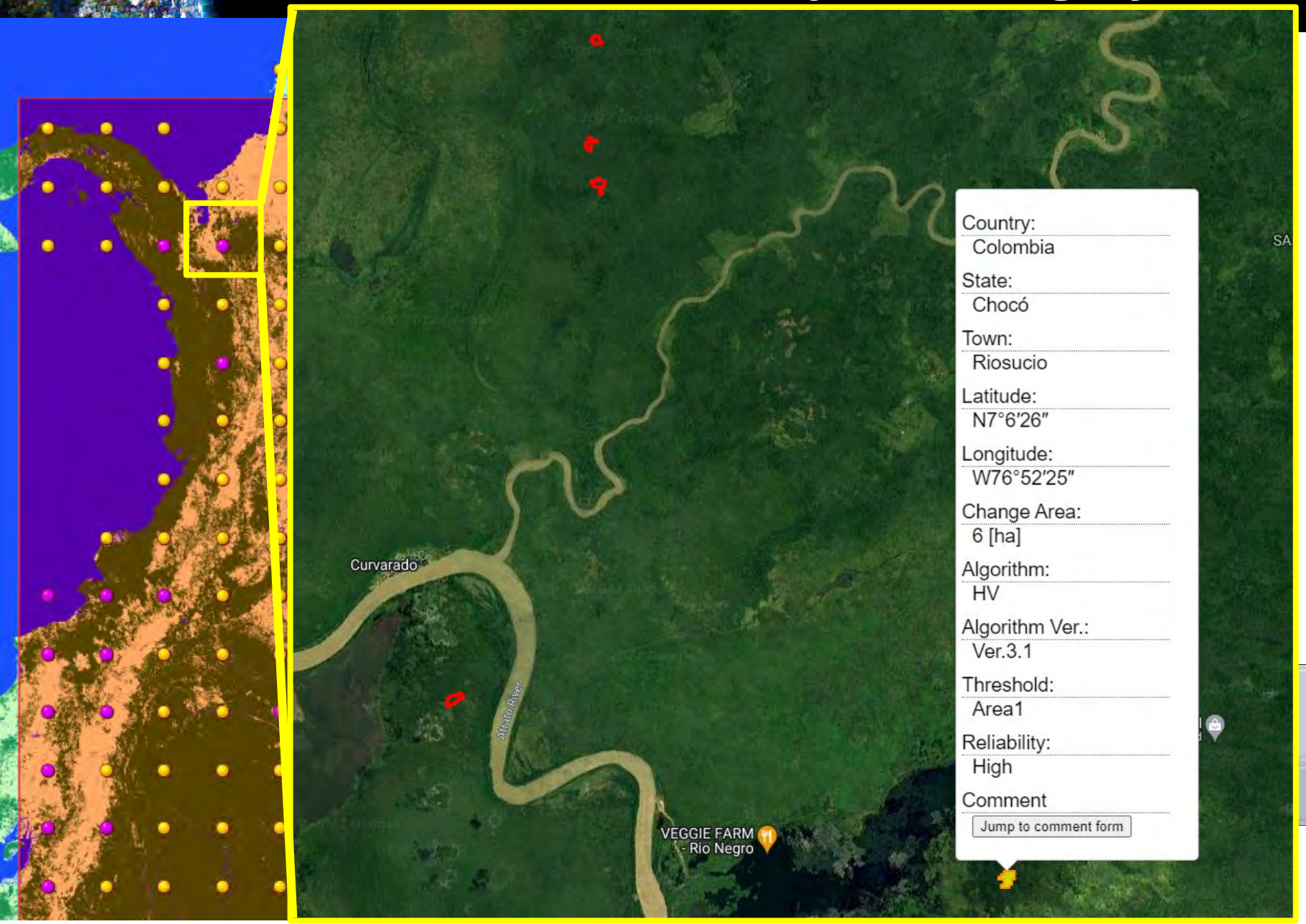
ALOS-2

Application	Disaster, Land, Agriculture, Natural Resources, Sea Ice & Maritime Safety
L-band SAR (PALSAR-2)	Stripmap: 3 to 10m res., 50 to 70 km swath ScanSAR: 100m res., 350km/490km swath Spotlight: 1× 3m res., 25km swath
Orbit	Sun-synchronous orbit Altitude: 628km Local sun time : 12:00 +/- 15min Revisit: 14days Orbit control: ≦+/-500m
Life time	5 years (target: 7 years)
Launch	May 24, 2014; H-IIA launch vehicle
Downlink	X-band: 800Mbps(16QAM) 400/200Mbps(QPSK) Ka-band: 278Mbps (Data Relay)
Experimental Instrument	Compact InfraRed Camera (CIRC) Space-based Automatic Identification System Experiment 2 (SPAISE2)

JAXA
宇宙航空研究

Deforestation Monitoring by ALOS-2

JICA-JAXA Forest Early Warning System in the Tropics



JJ-FAST

JICA-JAXA Forest Early Warning System in the Tropics

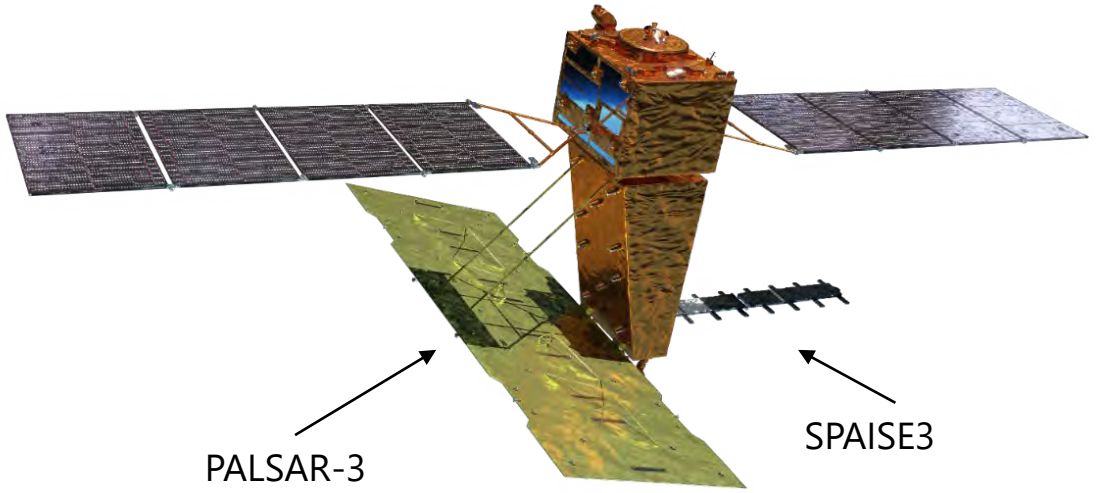
Contribute to the conservation of the world's tropical forests.

Target area	78 countries
Update	Every 1.5 months

ALOS-4

Mission objectives:

- ✓ Monitoring of **crustal and ground movement**: From "post-event monitoring" to "early detection of abnormalities".
- ✓ **Disaster monitoring** with ALOS-3 (optical system for detailed monitoring)
- ✓ **Continuation and enhancement of the ALOS-2 applications**
- ✓ **Maritime monitoring** with SAR and AIS



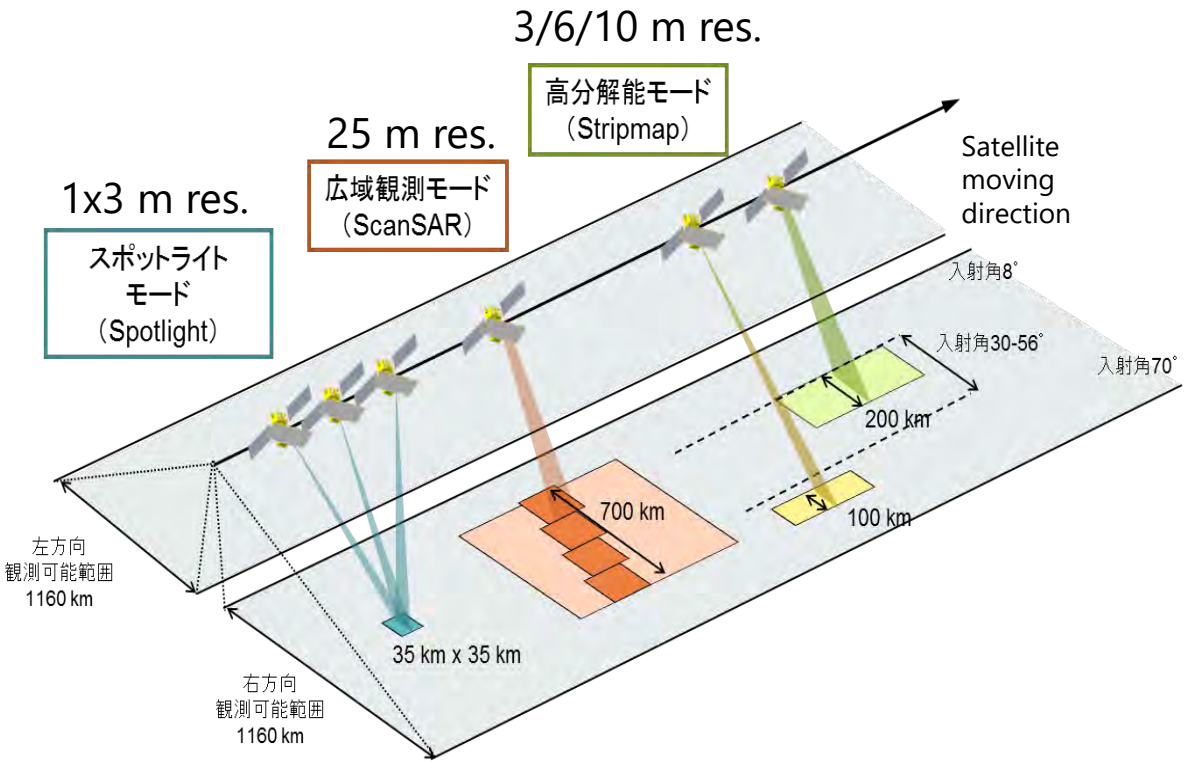
Launch	**H3 launch vehicle**
Orbit	**Same orbit as ALOS-2** ✓ Sun-synchronous sub-recurrent orbit ✓ Altitude: 628 km ✓ Inclination angle: 97.9 degree ✓ Local sun time at descending: 12:00 ± 15 min. ✓ Revisit time: 14 day (15-3/14 rev/day)
Lifetime	**7 years**
Size	X 10.0 m x Y 20.0 m x Z 6.4 m
Satellite Mass	~2,990 kg
Downlink	**1.8/3.6 Gbps** (Ka-band direct transmission and optical data relay satellite)
Mission Instruments	- **PALSAR-3** (Phased Array type L-band Synthetic Aperture Radar-3) - **SPAISE3** (SPace based AIS Experiment 3)
Prime contractor	Mitsubishi Electric Corporation

InSAR continuity with ALOS-2

PALSAR-3 observation modes

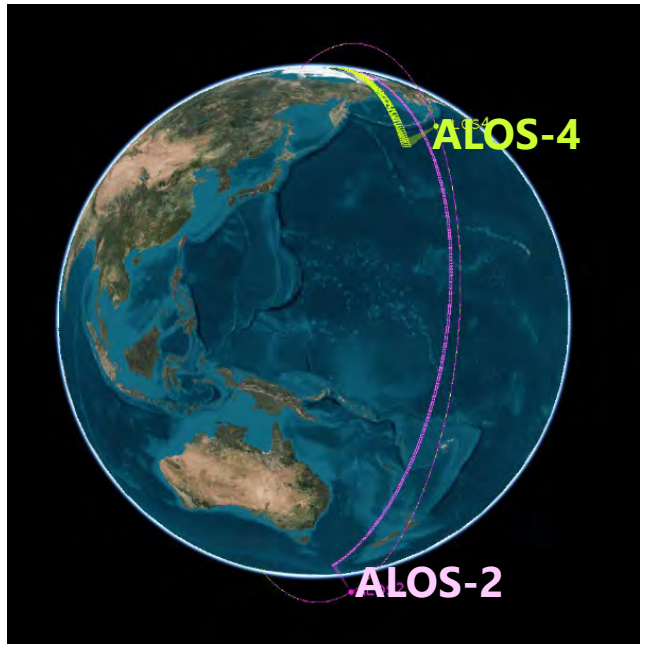
PALSAR-2/PALSAR-3 observation modes
(underlines show the updates in PALSAR-3 specifications)

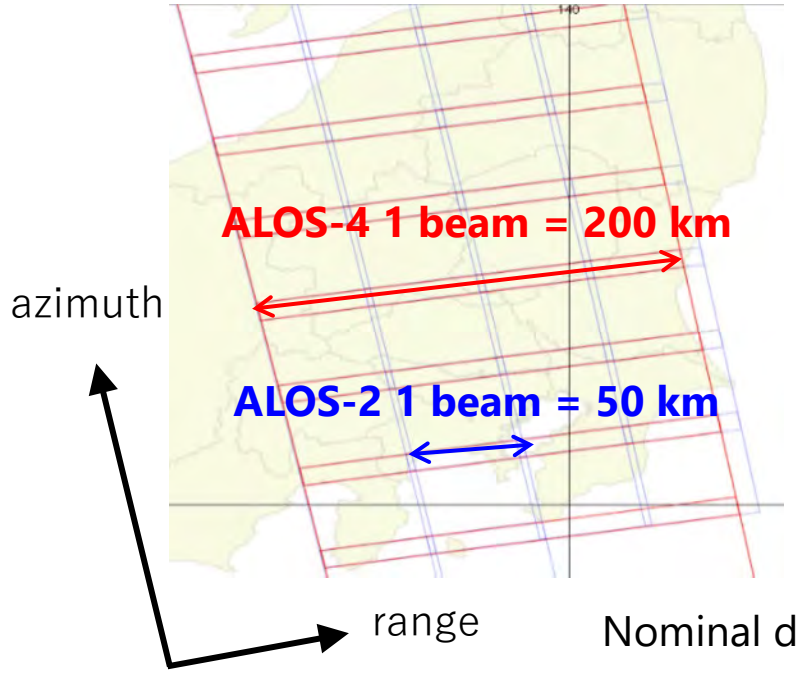
Observation mode	Spotlight	Stripmap		ScanSAR
Polarization*	Single/ **Dual**	Single/ Dual	Full	Single/ Dual
Resolution (m)	1 x 3 (Rg x Az)	3/6/10	**3**/6/10	25 (1 look)
Swath width (km)	25 x 25 →**35 x 35** **(Rg x Az)**	50/50/70 →**100-200**	40 →**100**	350/490 →**700**
NESZ (dB)	< -20	< -20	< -20	< -20
Range S/A (dB)	> 15	> 15	> 15	> 15
Azimuth S/A (dB)	> 15	> 15	> 15	> 15
Pol. X-talk (dB)	< -30	< -30	< -30	< -30
Split-band option	-	**28+10 MHz**	-	-



Continuity of ALOS-2 observations

- ALOS-2 and ALOS-4 will be in the same orbital plane, and their beam incidence angles are consistent.
- The synergy of two satellites can realize:
  - reducing emergency observation latency by half
  - frequent repeat-pass or right/left observations (alternating 6 days/8 days repeat) for selected regions (~ALOS-2 50 km swath)





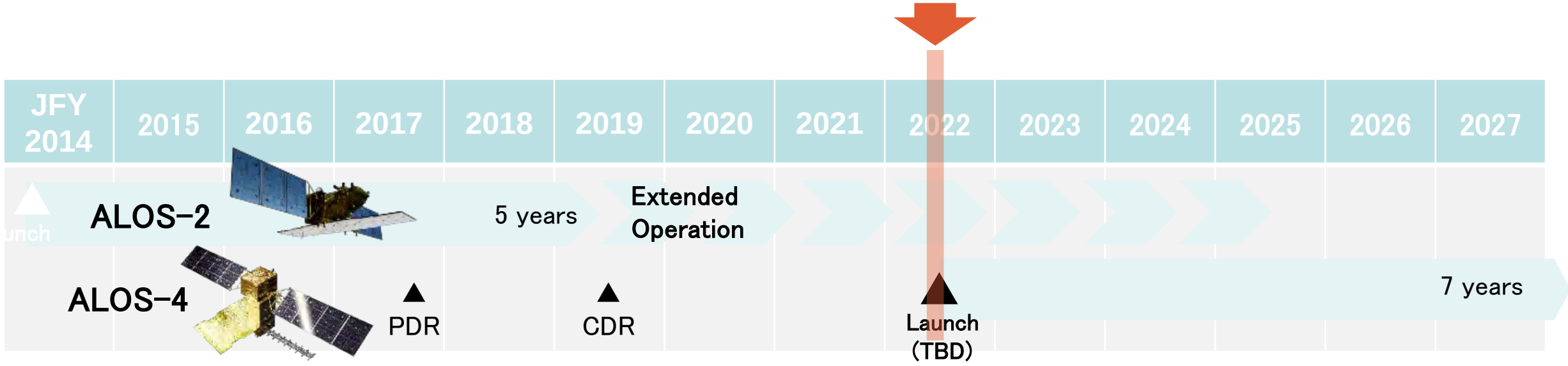
Observation beam footprint

Red: ALOS-4

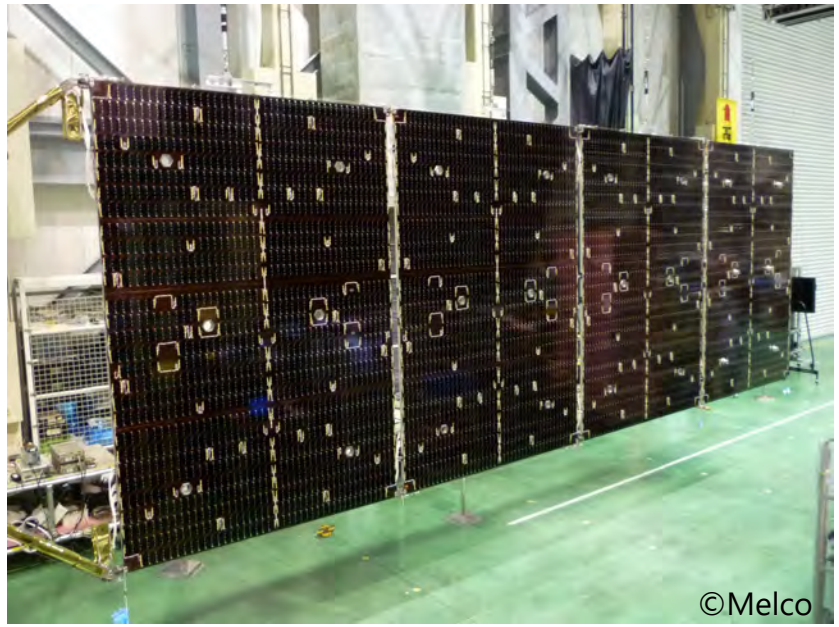
Blue: ALOS-2

ALOS-4 development status

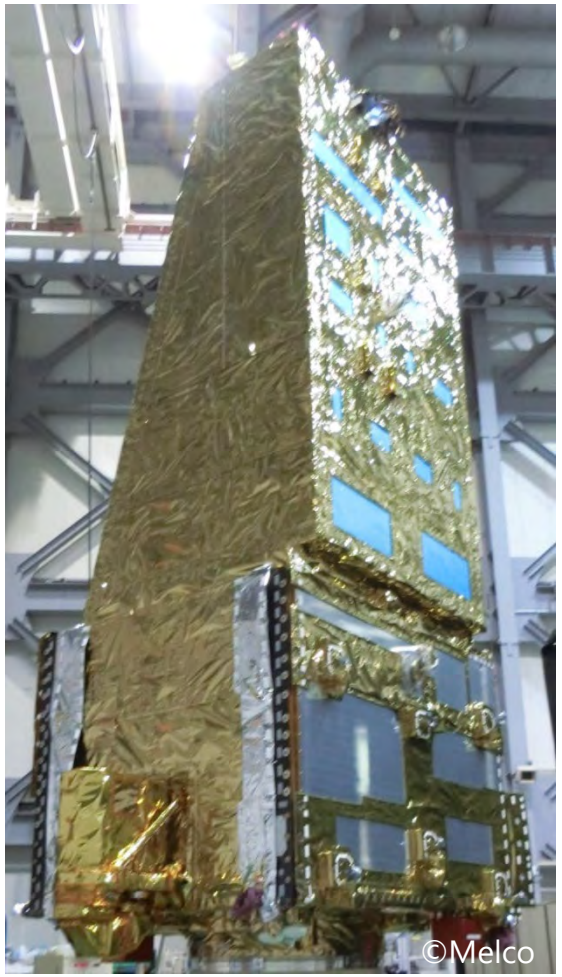
- The ALOS-4 proto-flight model is being tested. The end-to-end point target imaging test of PALSAR-3 sub-system has been completed and good results have been obtained.
- The ground system is also being tested, and a new user interface (AUIG4) that integrates ALOS-2 and ALOS-4 data is being prepared.
- The baseline of Basic Observation Scenario is defined. It will be optimized through simulations and user feedbacks before regular operation.



ALOS-4 system PFM test



ALOS-4 PFM: One of the solar array paddles



ALOS-4 PFM during micro vibration test

ALOS-4 PFM thermal vacuum test

Movies are on the website:
https://www.satnavi.jaxa.jp/ja/project/alos-4/index.html

Observation concept

- **"Basic Observation Scenario (BOS)"** is defined as a common observation scenario as in ALOS and ALOS-2 for making use of limited observation resources to achieve the ALOS-4 mission objectives.
- The current BOS has been released on the EORC ALOS website. We plan to revise it before launch based on operation simulation results and user feedback.

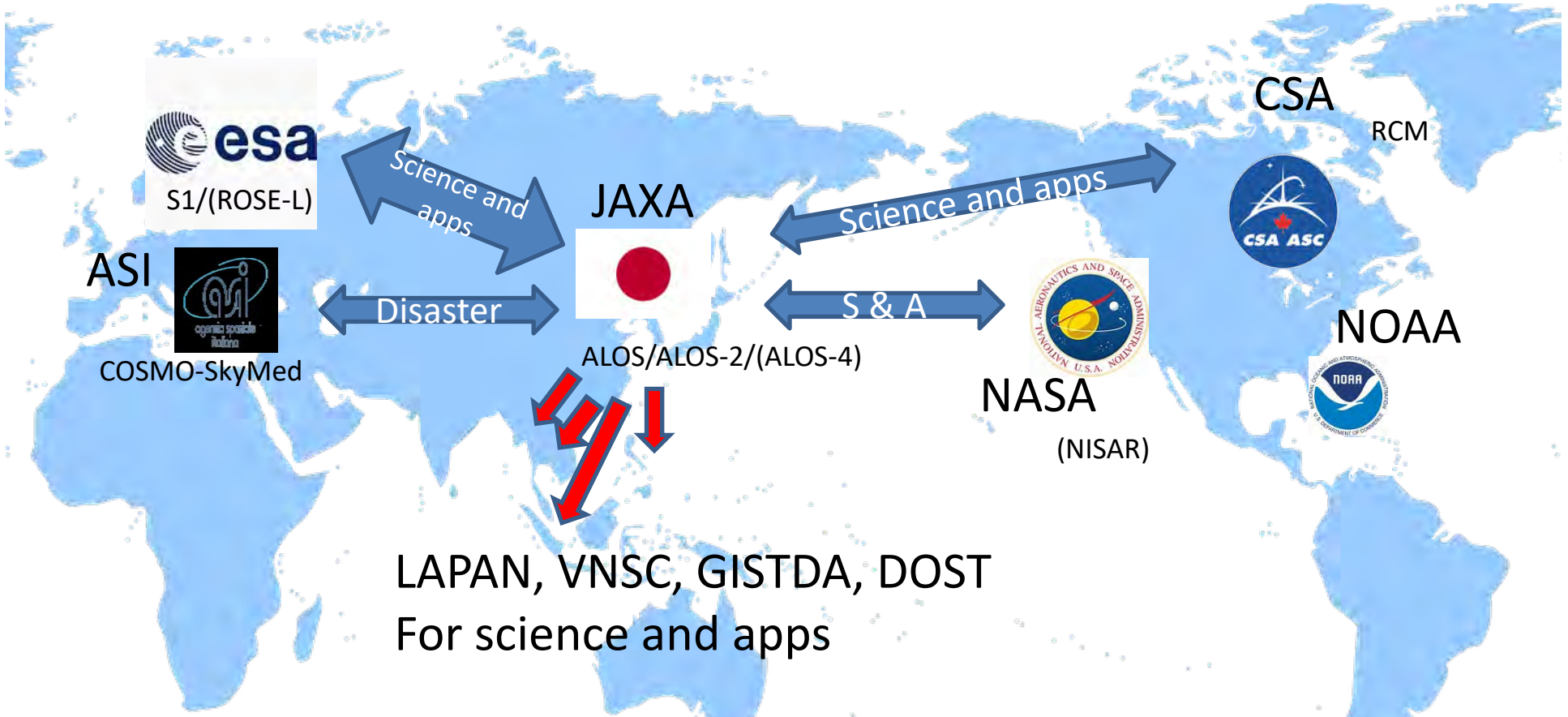
https://www.eorc.jaxa.jp/ALOS/en/alos-4/a4_observation_e.htm

Basic Observation Scenario (Global)

Theme	**Global basemap**	**Disaster basemap**	**Time-series observations**	**Polar observations**
Target areas	All land and coastal areas	About 50% of the global land areas	About 50% of the global land areas	Parts of Antarctica and Greenland
Observation modes	Stripmap 10 m 200 km swath Ionospheric correction mode (on-board split-band) for crustal movement observations.	ScanSAR 700 km swath, Stripmap 10 m 200 km swath (TBD)	Stripmap 10 m 200 km swath Ionospheric correction mode (on-board split-band) for crustal movement observations.	Stripmap 10 m 200 km swath Ionospheric correction mode (on-board split-band) (TBD)
Orbit direction	Ascending and Descending	Ascending and Descending	Ascending	Descending
Observation incidence angles	29-43 deg. (equivalent to ALOS-2 beam F2)	18-60 deg. (beam XB2), 38-55 deg. (equivalent to ALOS-2 beam F3) (TBD)	29-43 deg. (equivalent to ALOS-2 beam F2)	29-43 deg. (equivalent to ALOS-2 beam F2)
Polarization	HH+HV	HH+HV（TBD）	HH+HV	HH+HV (TBD)
Observation frequency	1 year	Once every 3 years	About 9 times/year	3 times/year (TBD)
Observation period	Avoiding the northern hemisphere snow season, October-May	Avoiding the northern hemisphere snow season, October-May	All year	Twice in summer and once in winter in the target area (TBD)

ALOS-4 BOS URL: https://www.eorc.jaxa.jp/ALOS/en/alos-4/a4_observation_e.htm

SAR international cooperation



- Science and apps: Ocean (Sea Ice, ship, oil spill), Land use (agriculture, soil moisture, SWE, crustal deformation - volcano, subsidence, LULCC, forest) with disaster response
- FS for ALOS-4 DT in international partners

Today, CSA and JAXA agree to extend our RCM-ALOS-2 cooperation

Readiness of Free and Open – ALOS-2 and ALOS data

		CY 2022				CY 2023			
		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 (10 m)**					Data Distribution (Open and Free) on less than 30% cloud on G-Portal and GEE			
						Process all AVNIR-2 1B2			
	PALSAR FBS/D(10 m), WD(100m)					Open and Free on G-Portal			
ALOS-2 	**PALSAR-2 ScanSAR (25m)**	Process CARD4L (L2.2) Asia & Africa			GEO2022 week	Open and Free on G-Portal. GEE and open repository on AWS			
		Process L1.1 Asia and Africa				Process L1.1 and L2.2 America and other area			

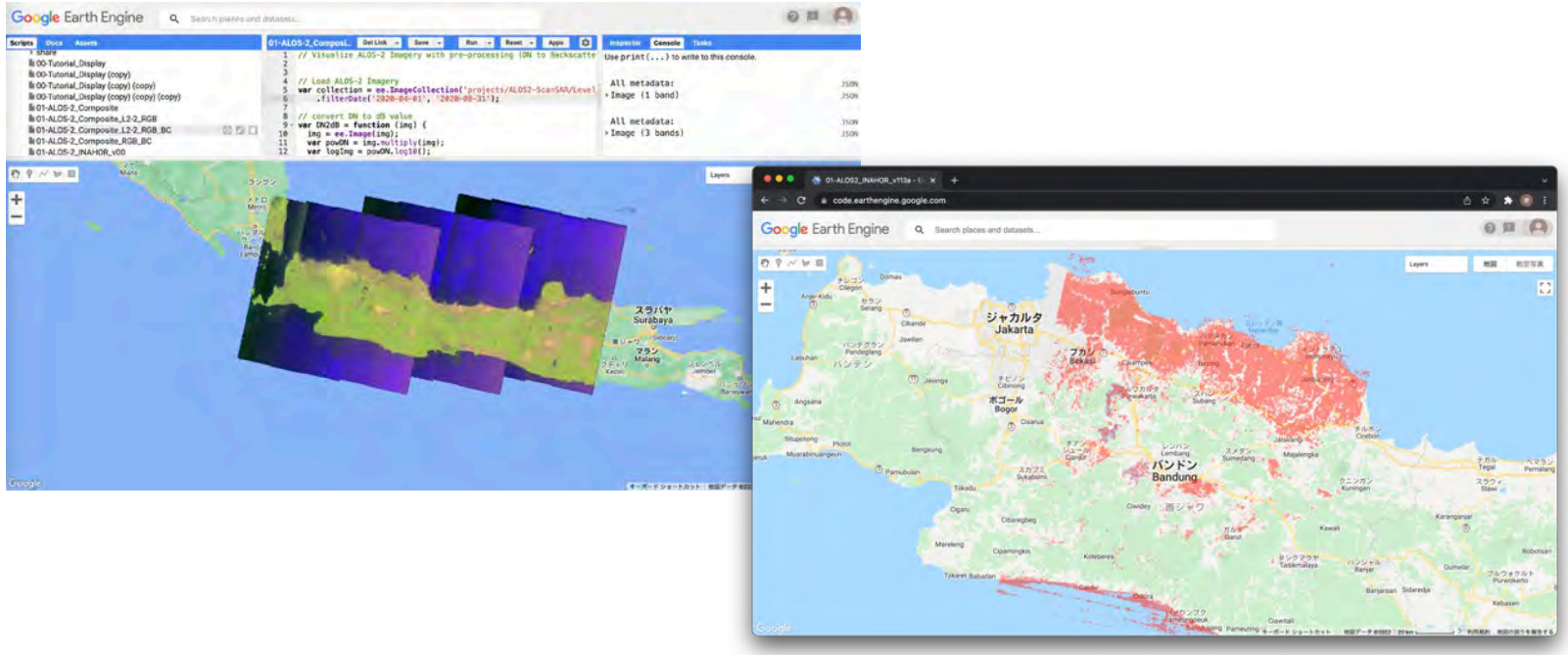
JAXA G-portal: https://gportal.jaxa.jp/gpr/?lang=en

AVNIR-2 EORC HP(Japan area): https://www.eorc.jaxa.jp/ALOS/en/dataset/ori_e.htm

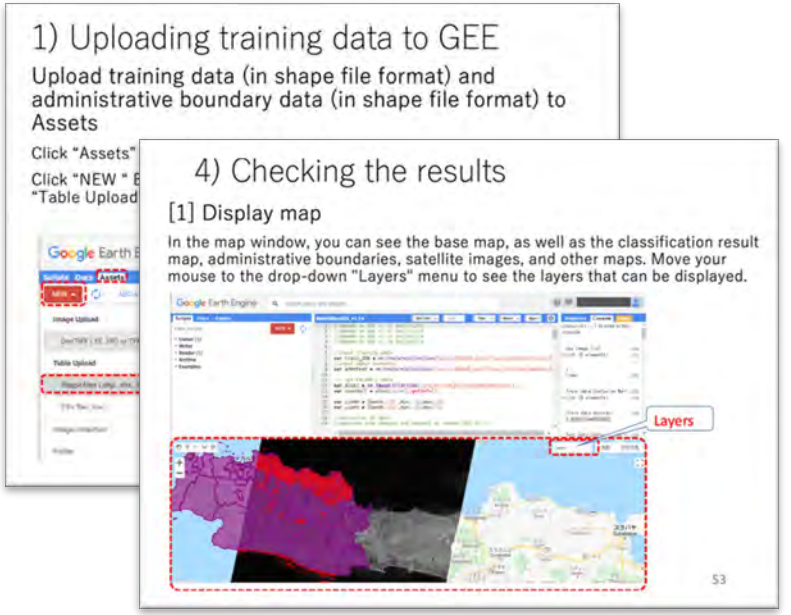
Data/Tool Sharing: Google Earth Engine with ALOS-2

- ALOS-2 ScanSAR L2.2 (CARD4L) will be ingested into GEE in collaboration with Google to facilitate rice monitoring related activities in the Asian region in this October.
- JAXA's rice mapping tool (INAHOR) is also available on Google Earth Engine (GEE) and tutorial material (document and video) is currently preparing (will be used training for the agricultural statistician) and JAXA plans to host tutorial session at APRSAF in Hanoi.

Visualization of ALOS-2 ScanSAR Imageries on GEE and detected rice planted area by INAHOR



Tutorial material



JAXA

Contributing to Society through Space-based Earth Observations

Human activity has expanded to a level today that likely affects the entire global environment. We must find a way to mitigate and adapt to climate change linked to global warming. This will require a series of actions that include gaining an accurate understanding of the current state of the Earth and human activity, predicting what will become of the Earth in the coming years, taking appropriate measures based on this prediction, and adjusting these measures after evaluating the results. Space-based Earth observation is anticipated to be a superior method for repeatedly observing the entire planet with consistent precision. The Earth Observation Research Center (EORC) was established under the Japan Aerospace Exploration Agency (JAXA) in April 1995 as Japan's core organization for Earth observation satellite data processing, analyzing, calibration/validation, and archiving. By continuing to carry out these activities using space-based Earth observation technology, we hope to assist humankind in its adaptation to climate change.

https://earth.jaxa.jp/en/

For more information

https://earth.jaxa.jp/en/

Thank you for your attention.

For next generation under international OJT in CANADA