An overview of the Japan Aerospace Exploration Agency L-band SAR programme

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on behalf of
the Japan Aerospace Exploration Agency (JAXA)

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宇宙航空研究開発機構

Outline

1. L-band SAR heritage
   - From JERS-1 to ALOS-2
   - ALOS-2 characteristics
2. Systematic acquisition strategies
   - JERS-1
   - ALOS
   - ALOS-2
3. Users – science and operations
4. The Next Generation L-band SAR

Japan and L-band SAR: 2 decades of operations

JERS-1 (1992-1998) | ALOS (2006-2011) | ALOS-2 (2014+) | Next-G (2020+?)

Trends towards

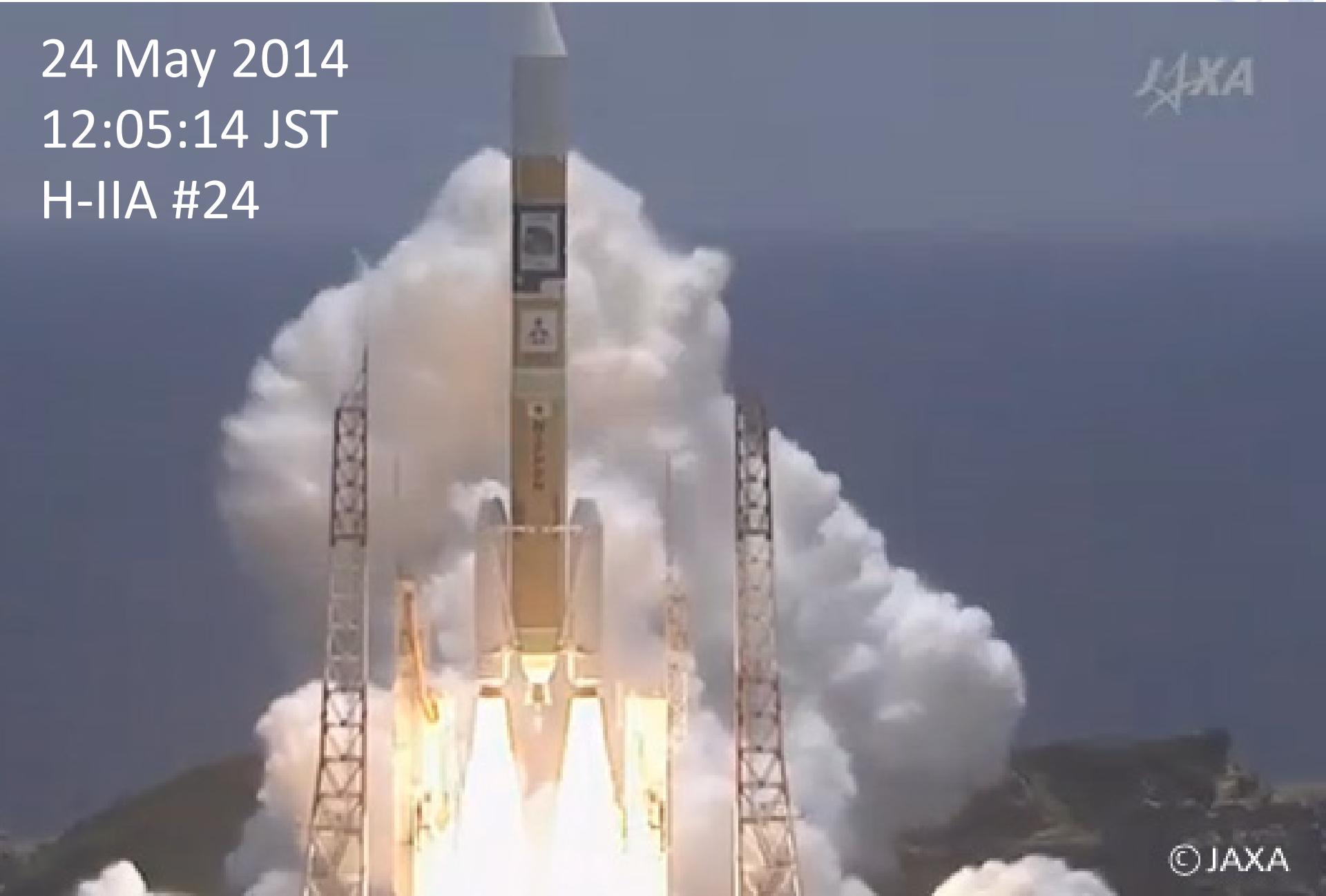
- Higher spatial resolutions
- Wider observational (access) areas
- Polarisations: SP → DP → QP
- Local → global observations

Technical Demonstrations
Local / semi-continental scales

→

Solutions (application and science)
Systematic global monitoring

Beginning of the ALOS-2 era

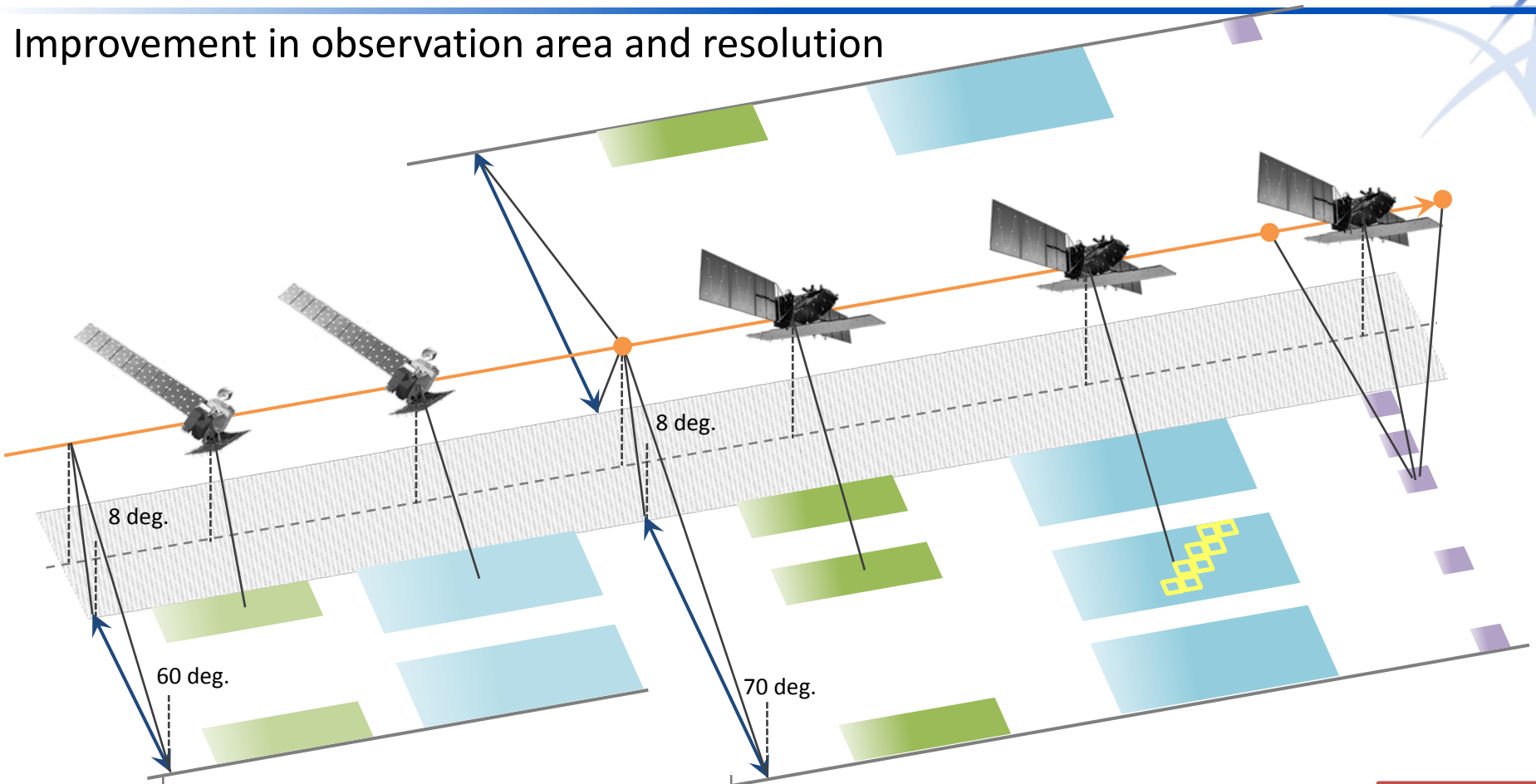


ALOS vs ALOS-2

	ALOS	ALOS-2
Orbit altitude	692 km (sun-synchronous)	628 km (sun-synchronous)
Revisit cycle	46 days	14 days
Orbital revolutions	14+27/46 rev/day 671 rev/cycle	14+11/14 rev/day 207 rev/cycle
Ground track dist. (@Equator)	60 km	194 km
Equator pass time	10:30 am/pm	12:00 am/pm
Look direction	Right	Right (nominal) + Left
Mission Data Recorder	96 GB	130 GB
Downlink capacity	120 Mbps (X-band)	800 Mbps (X-band)
	and 240 Mbps (Ka-band)	and 277 Mbps (Ka-band)
Transmission (peak) power	2.0 kW	5.1 kW
Target mission life time	3-5 years (actual: 5 yrs 3 mths)	5-7 years

ALOS vs ALOS-2

Improvement in observation area and resolution



	Observable	Stripmap	ScanSAR	Observable	Stripmap	ScanSAR	Spotlight
Swath	870 km	40 to 70 km	250 to 350 km	1160 km x 2 (right & left)	50 or 70 km	350 or 490 km	25 x 25 km
Resolution		10 m	100 m		3 to 10 m	100 m	1 x 3 m
	ALOS/PALSAR			ALOS-2/PALSAR-2			

PALSAR-2 Technical Specifications

		Spotlight	Ultra Fine	High sensitive	Fine	ScanSAR nominal		ScanSAR wide
Bandwidth		84MHz	84MHz	42MHz	28MHz	14MHz	28MHz	14MHz
Resolution		Rg × Az : 3 × 1m	3m	6m	10m	100m		60m
Swath		Rg × Az : 25 × 25km	50km	50km	70km	350km (5-scan)		490km (7-scan)
Polarization		SP	SP/DP	SP/DP/QP/CP		SP/DP		
NESZ		-24dB	-24dB	-28dB	-26dB	-26dB	-23dB	-23dB
S/A	Rg	25dB	25dB	23dB	25dB	25dB		20dB
	Az	20dB	25dB	20dB	23dB	20dB		20dB

SP : HH or VV or HV , DP : HH+HV or VV+VH , QP : HH+HV+VH+VV , CP : Compact pol (Experimental)

Main applications:

Fine beam (DP): Forest and land cover monitoring

ScanSAR (DP): Rapid deforestation / wetlands / InSAR (ScanSAR beam burst sync)

Spotlight (SP): Emergency observations

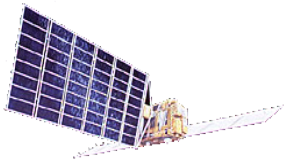
Ultra Fine (SP) : Global map, InSAR base mapping

High sensitive (QP): Global map

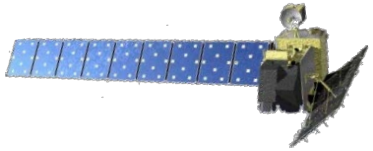
ScanSAR wide (SP) : Polar ice

ALOS-2 first image acquisitions

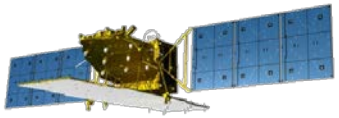
JERS-1

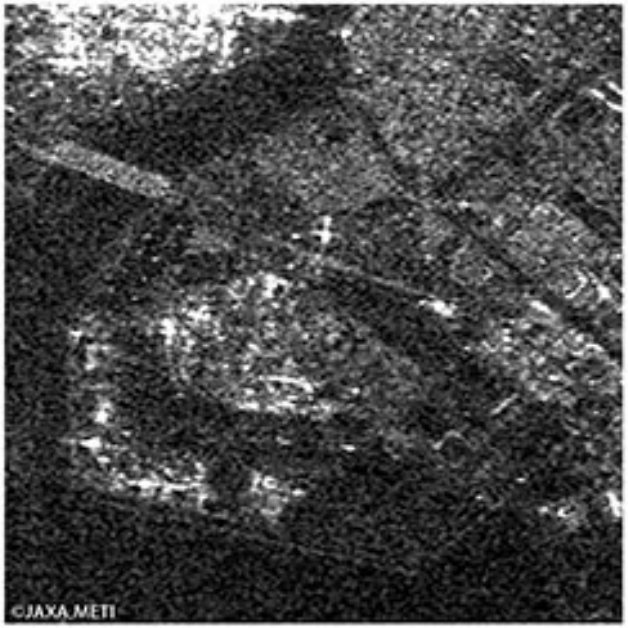


ALOS



ALOS-2



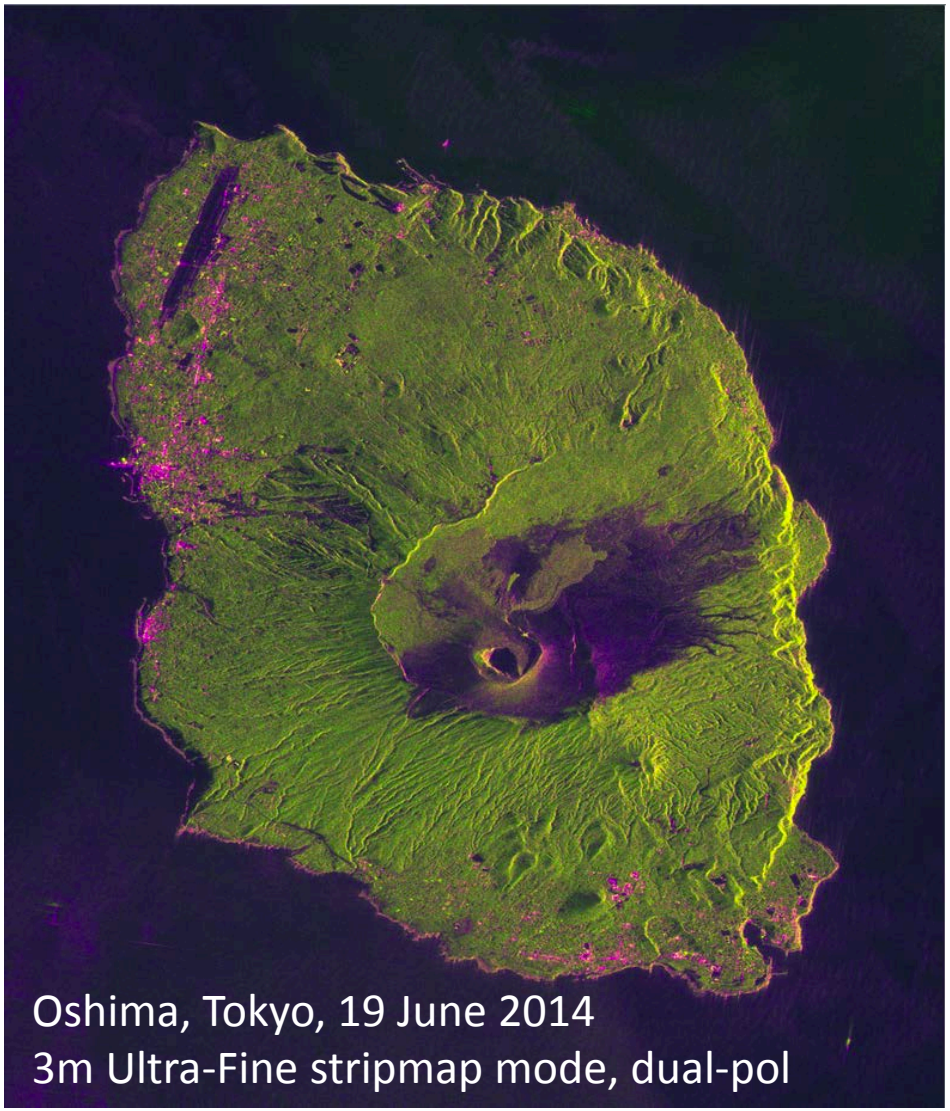


FUYO-1 SAR,
April 21, 1992,
(Resolution: about 18 m)

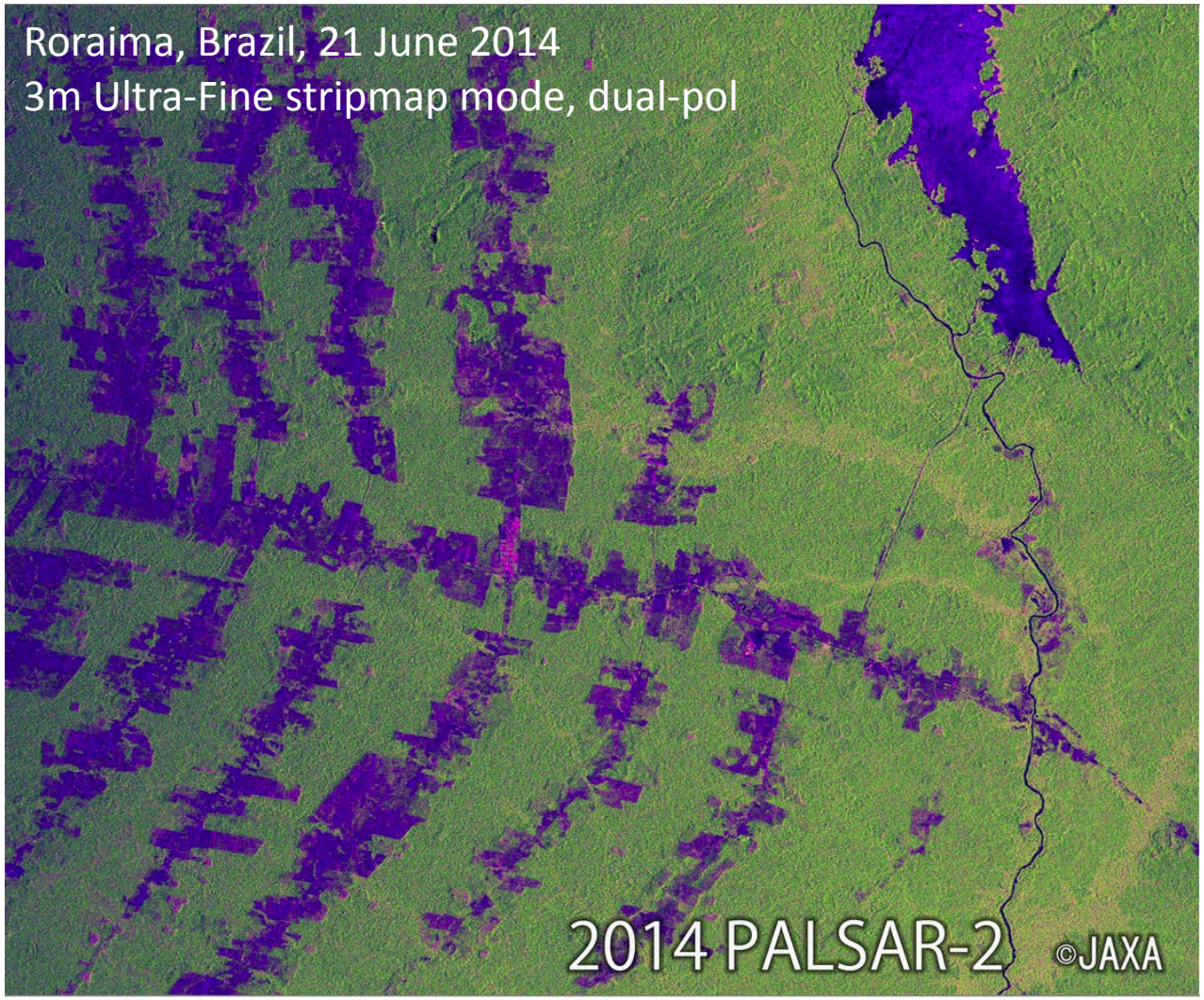
DAICHI PALSAR,
April 27, 2006,
(Resolution: about 10 m),

DAICHI-2 PALSAR-2,
June 19, 2014
(Resolution: about 3 m)

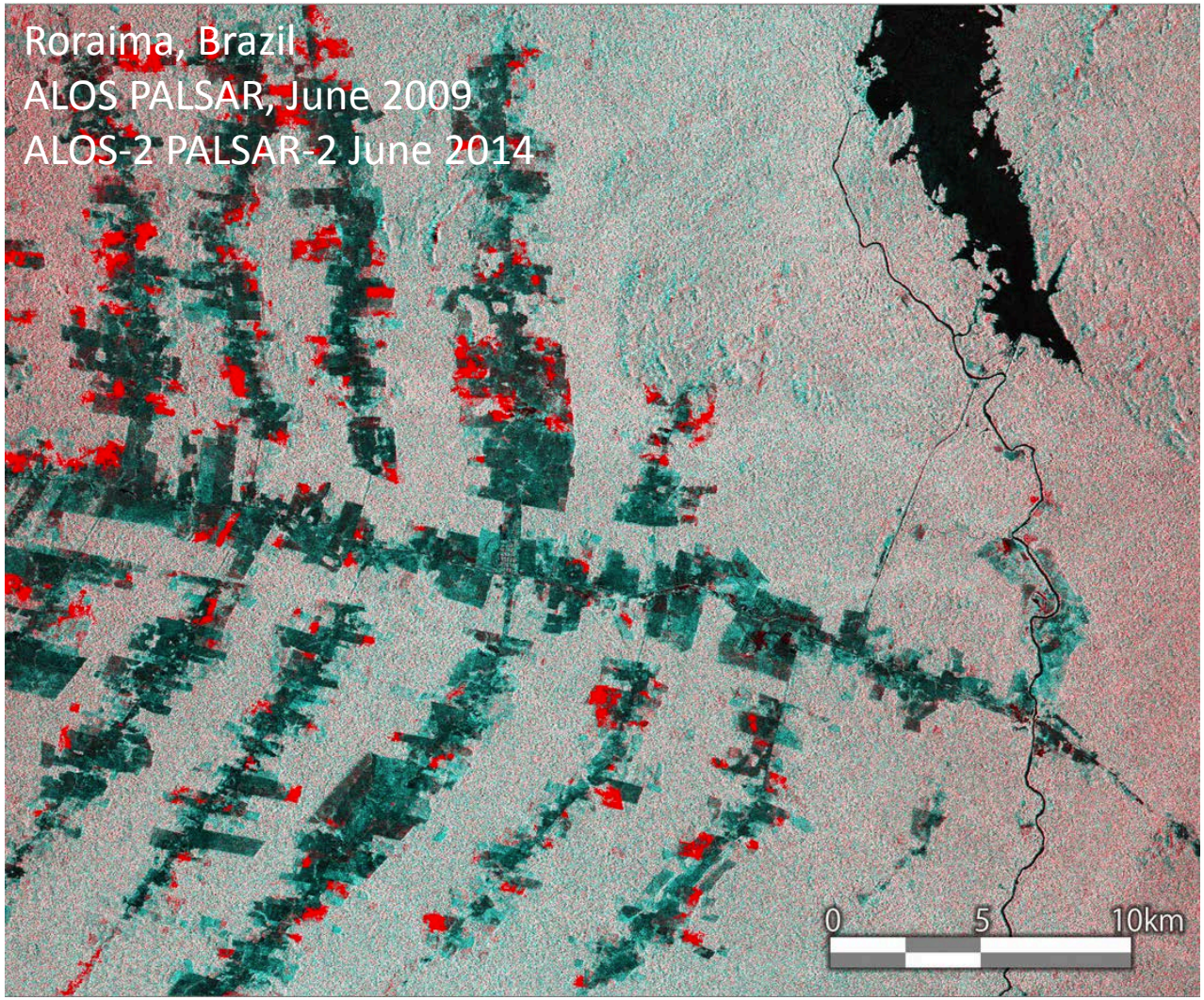
ALOS-2 first image acquisitions



ALOS-2 first image acquisitions



ALOS-2 first image acquisitions



Systematic acquisition strategies

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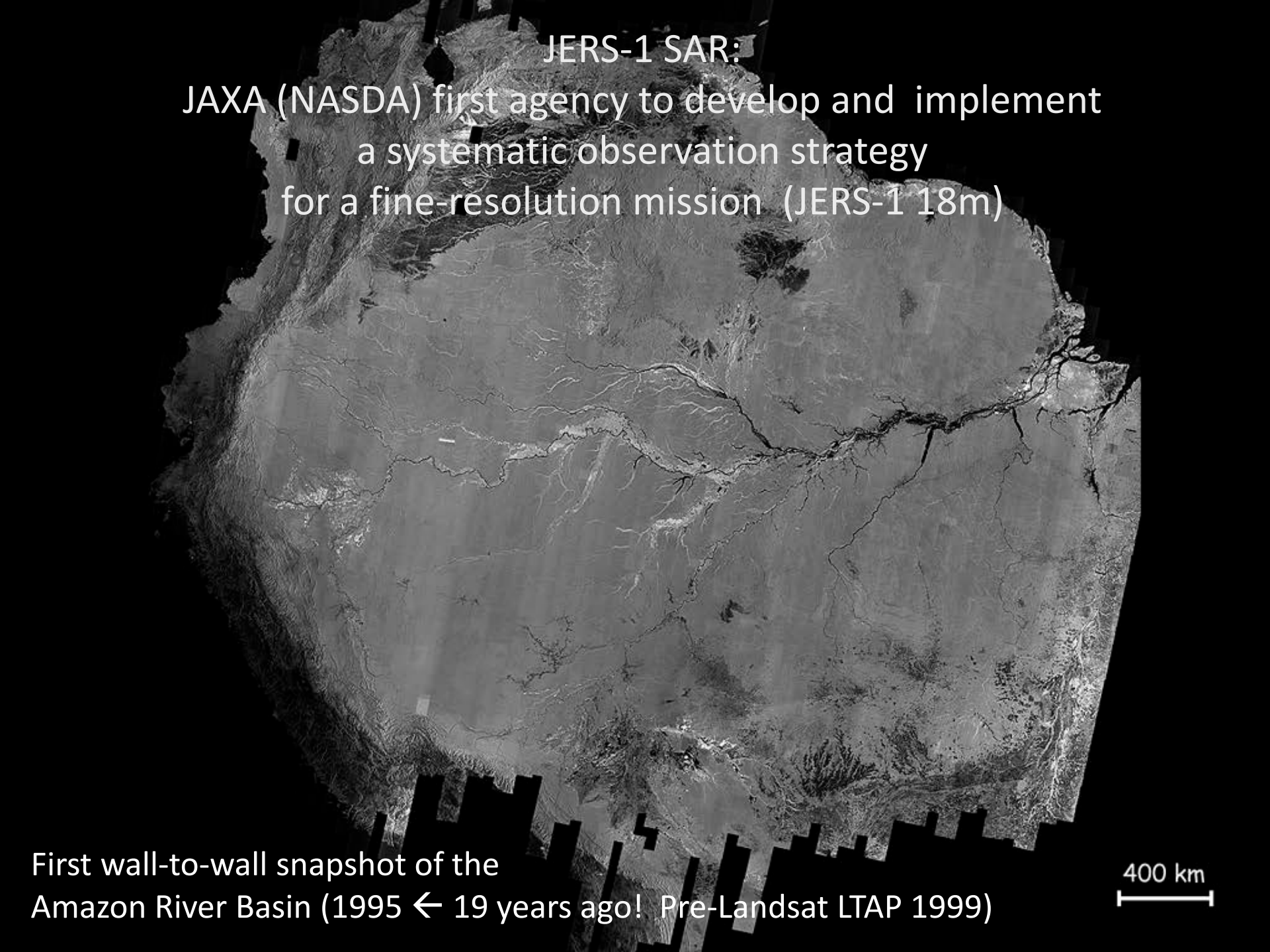
Continuation of the building of long-term L-band archives

Systematic Observation Strategies

Basic Observation Scenarios – BOS - have been developed and implemented by JAXA for 2 decades:

- JERS-1 SAR (1995-1998: **Pan-tropical, Pan-boreal**)
- ALOS PALSAR (2006-2011: **Global**)
- ALOS-2 PALSAR-2 (2014+ **Global**)
- Next Generation SAR (Key component. 2020+ **Global**)

Long-term time-series of spatially and temporally consistent satellite data of key importance for both science and operational applications, and for the development of national monitoring systems of forests, wetlands and agriculture.

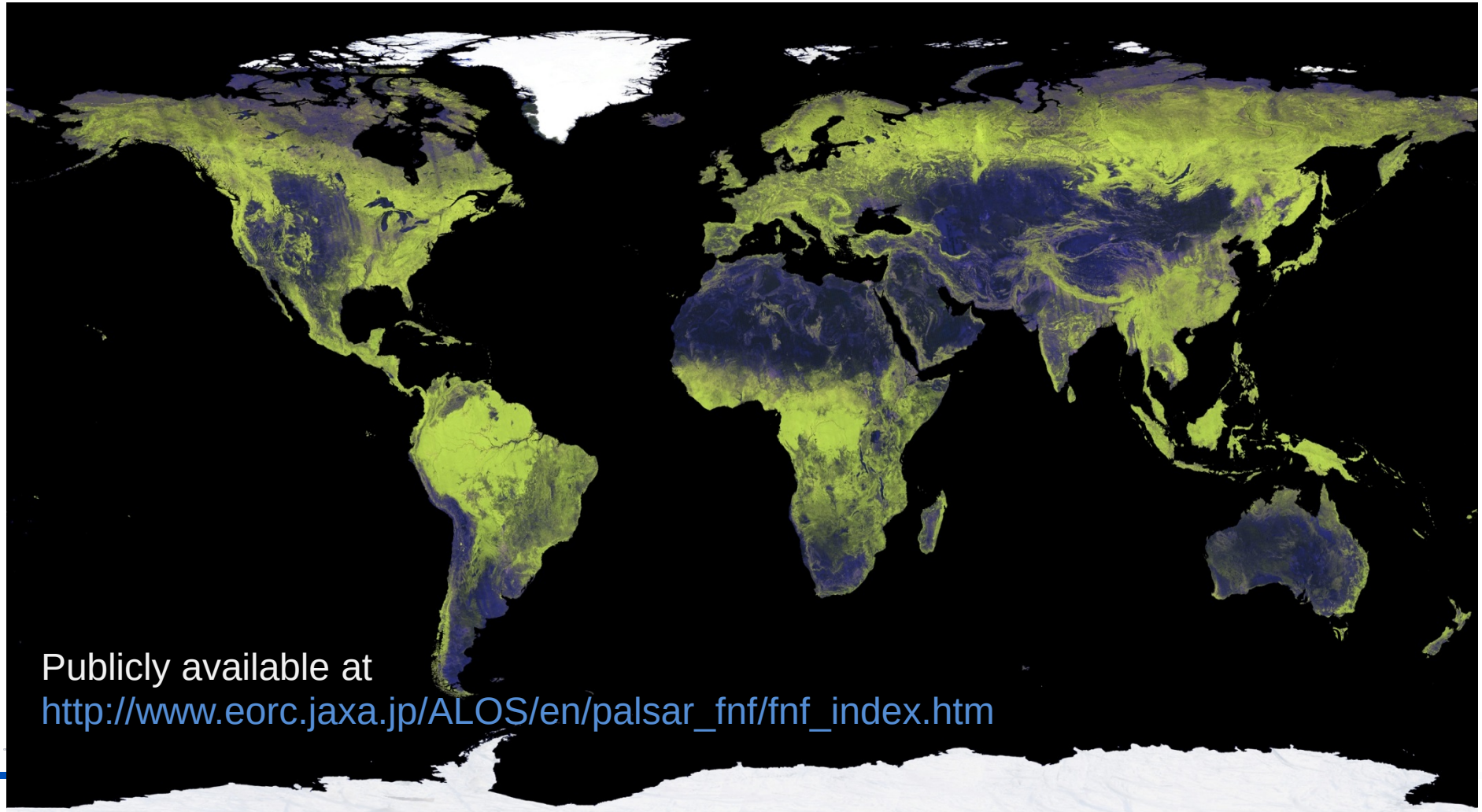

JERS-1 SAR:
JAXA (NASDA) first agency to develop and implement
a systematic observation strategy
for a fine-resolution mission (JERS-1 18m)
First wall-to-wall snapshot of the
Amazon River Basin (1995 ← 19 years ago! Pre-Landsat LTAP 1999)
400 km

ALOS Systematic Observation Strategy ("BOS")

Dual-season strategy has accommodated

global PALSAR mosaics @25m from 2007, 2008, 2009, 2010.

To continue with ALOS-2 from 2014



ALOS-2 Basic Observation Scenario

- Descending acquisitions (noon, ~12:00)
  - Global observations in Stripmap (3m SP) mode once per 3 years
  - Observations of Wetlands, Rapid Deforestation and Crustal Deformation in ScanSAR (350km DP) mode
  - Observations of Crustal Deformation and Forests *in Stripmap (10m DP) mode* during two successive cycles for InSAR applications ***(Super Sites)***
  - Observations of *Boreal and sub-Arctic in ScanSAR (490km DP) mode*
  - InSAR observations of *Antarctica Glaciers in Stripmap (10m DP) mode*
- Ascending acquisitions (midnight, ~24:00)
  - Global observations in Stripmap (10m DP) mode twice per year
  - Observations of polar regions in ScanSAR (350km DP) mode three times per year to cover summer/winter seasons. Antarctica will be observed in left-looking mode to cover higher latitudes.
  - Global observations in Polarimetric (6m QP) mode once per 5 years
  - Observations of special focus areas with Polarimetric (6m QP) mode annually ***(Super Sites)***
  - InSAR observations of *Greenland Glaciers with Stripmap (10m DP) mode*

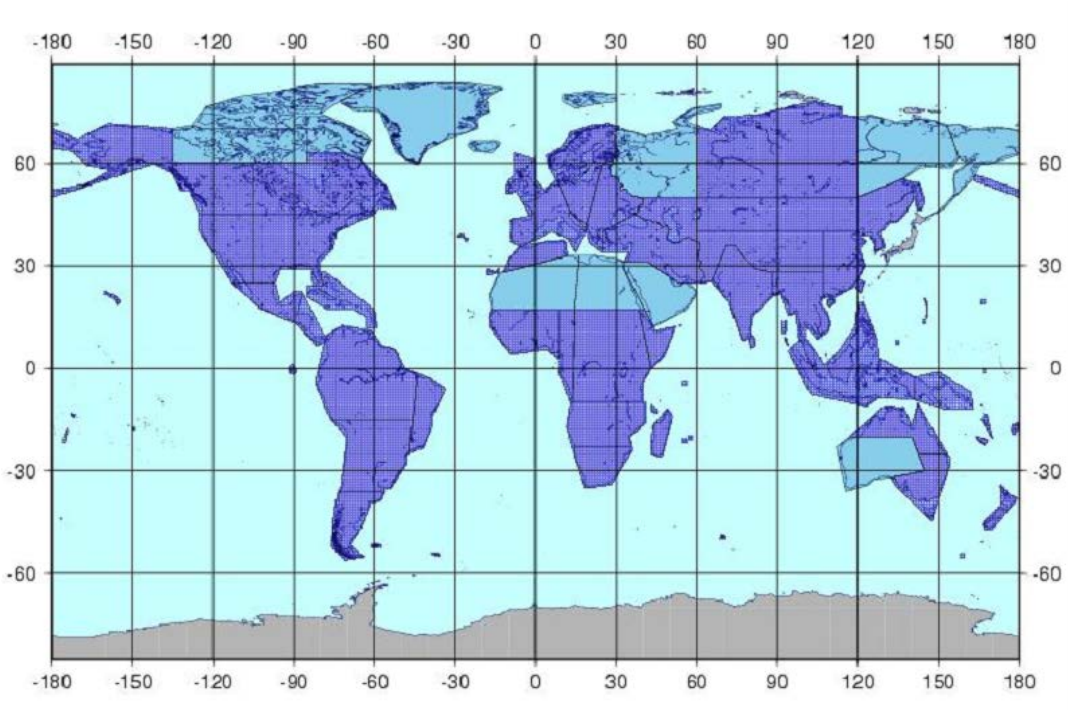
ALOS-2 Basic Observation Scenario

Global land areas – baseline mapping

Temporal repeat: 2 cov/year

GSD: 10 m (off-nadir 28.2° -36.2°)

Mode: Stripmap Dual-pol (HH+HV/28MHz)



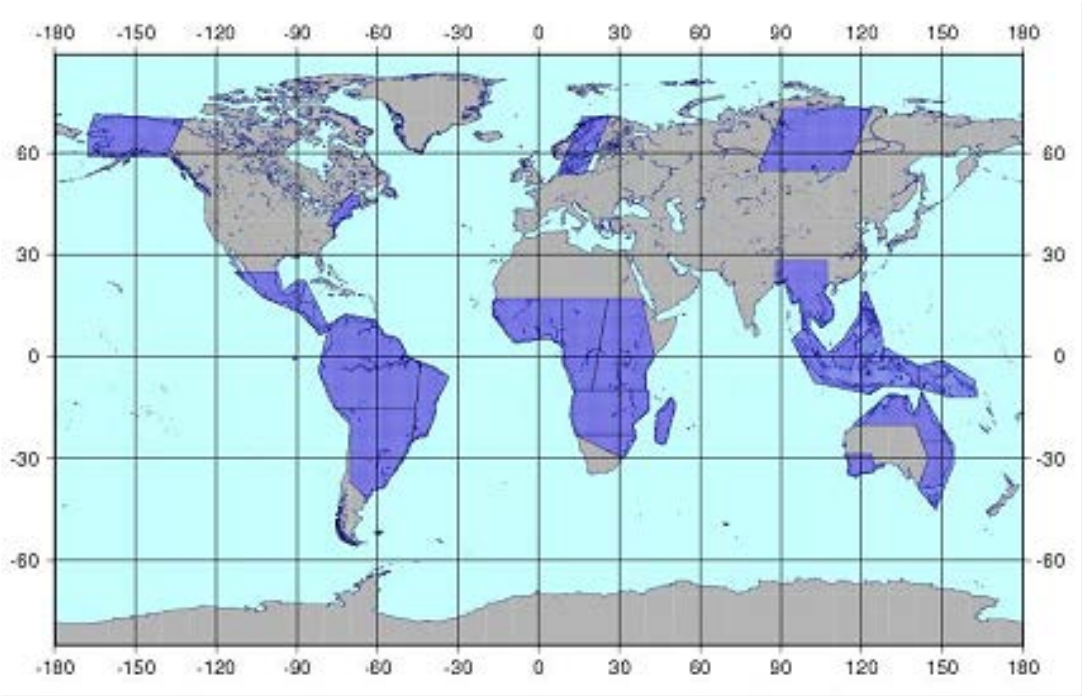
ALOS-2 Basic Observation Scenario

Forest monitoring

Temporal repeat: 2-6 cov/year (tropics 6 cov)

GSD: 10 m (off-nadir 28.2° -36.2°)

Mode: Stripmap Dual-pol (HH+HV/28MHz)



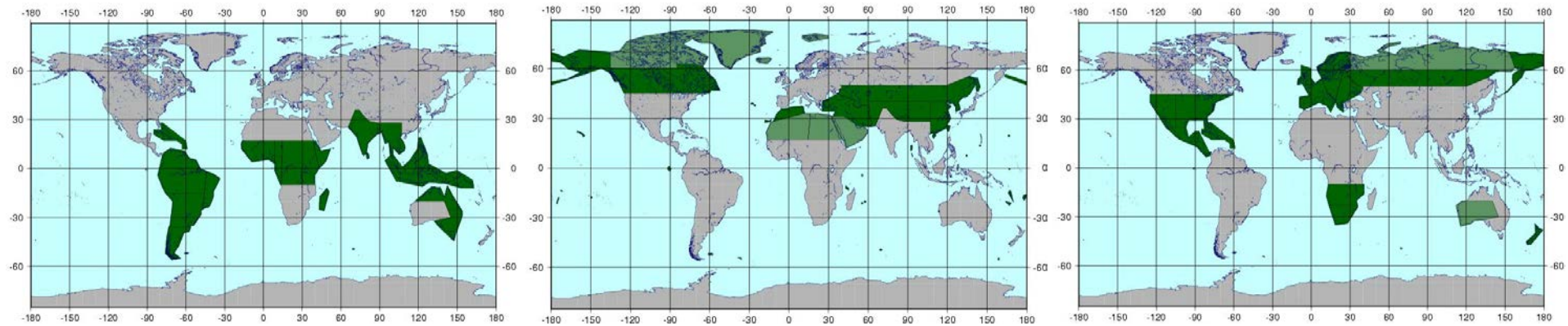
ALOS-2 Basic Observation Scenario

Global land areas – VHR baseline mapping

Temporal repeat: 1 cov/ 3 years

GSD: 3 m (off-nadir 29.1°-38.2°)

Mode: Stripmap Single-pol（HH/84MHz）



1st year　　2nd year　　3rd year

Prio 1

Prio 2

* 3 years required for global coverage in 3m mode

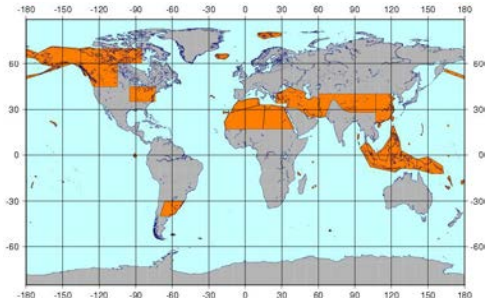
ALOS-2 Basic Observation Scenario

Global land areas – Quad-polarimetric baseline

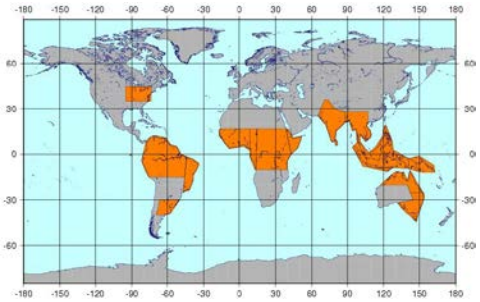
Temporal repeat: 1 cov/ 5 years

GSD: 6 m (off-nadir 25.0° -34.9°)

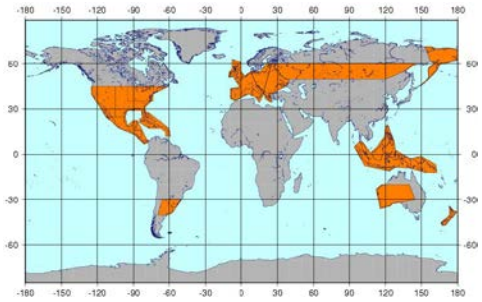
Mode: Stripmap Quad-pol (HH+HV+VV+VH/42MHz)



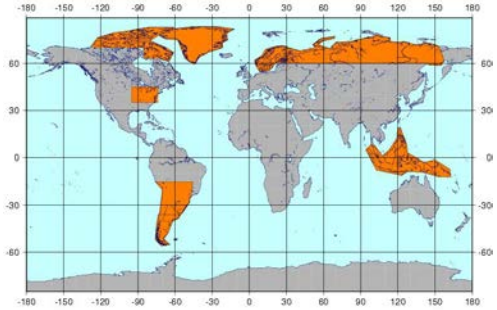
1st year



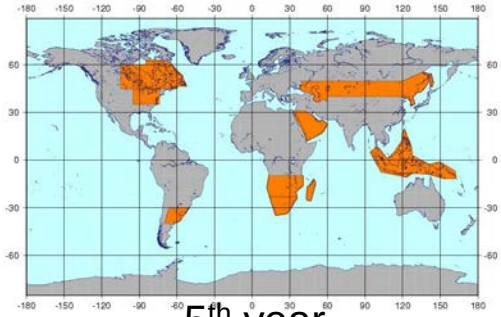
2nd year



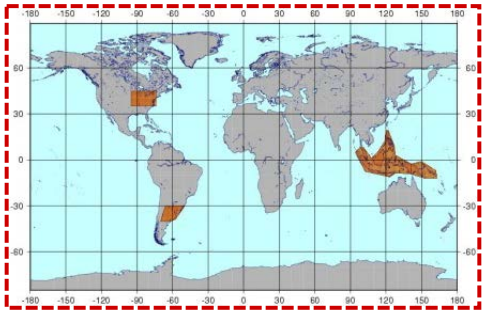
3rd year



4th year



5th year



Areas observed every year

* 5 years required for global coverage in 6m QP mode

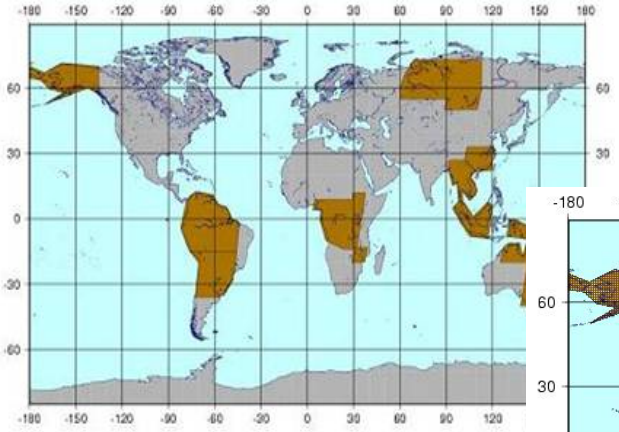
ALOS-2 Basic Observation Scenario

Wetlands & Rapid deforestation monitoring

Temporal repeat: 9 cov/year

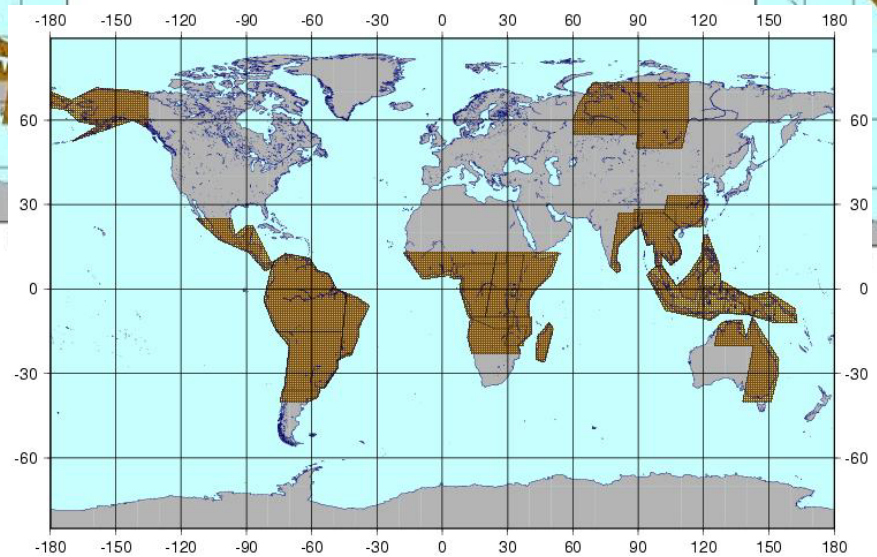
GSD: 100 m (off-nadir 26.2° -41.8°)

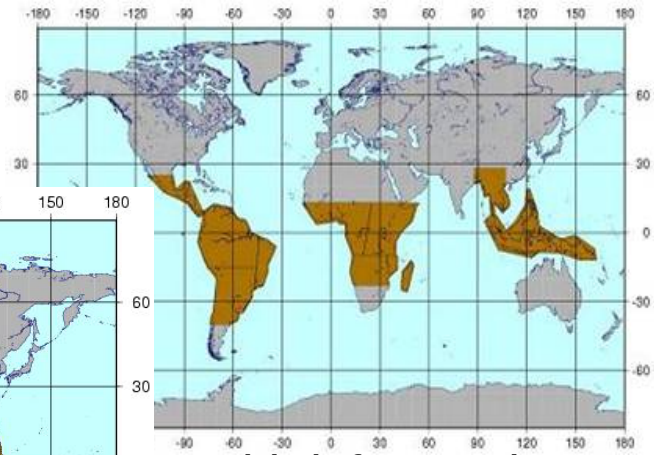
Mode: ScanSAR 350km Dual-pol (HH+HV/14MHz)



Wetlands

observed at the same time





Rapid deforestation monitoring

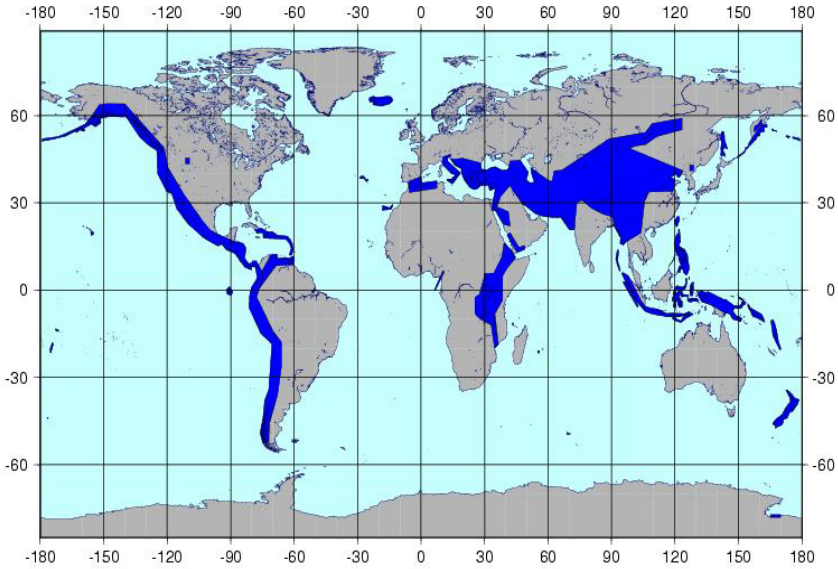
ALOS-2 Basic Observation Scenario

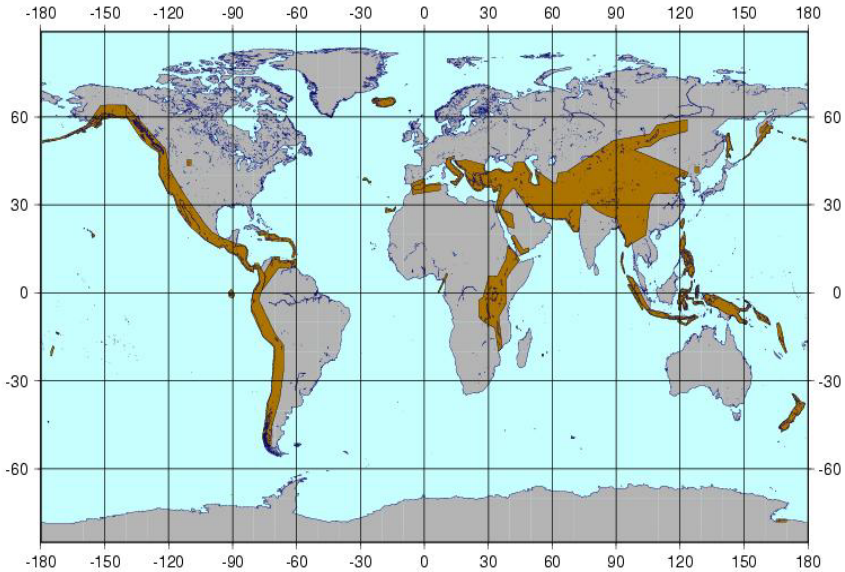
Crustal Deformation

Temporal repeat: 2-6 cov/year & 9 cov/year

GSD: 10 m (off-nadir 28.2° – 36.2°)
& 100 m (off-nadir 26.2° – 41.8°)

Mode: Stripmap Dual-pol (HH+HV/28MHz)
& ScanSAR 350km (HH+HV/14MHz)





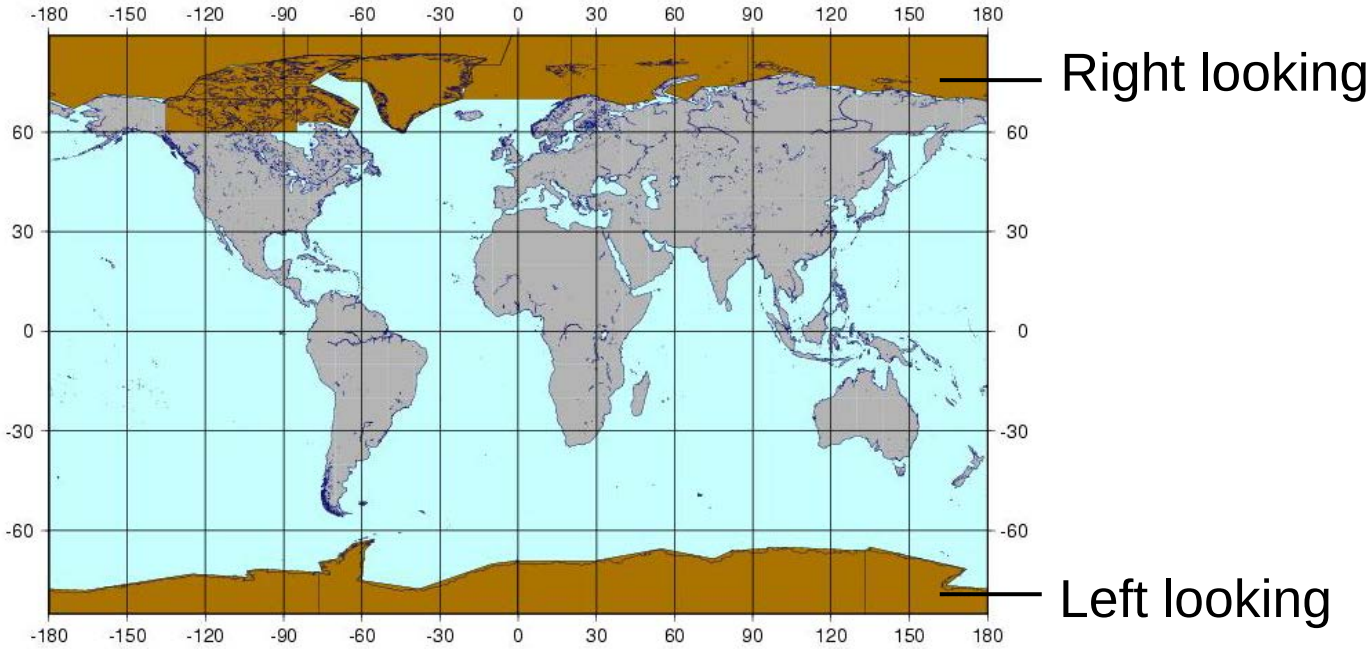
ALOS-2 Basic Observation Scenario

Polar Ice

Temporal repeat: 3 cov/year

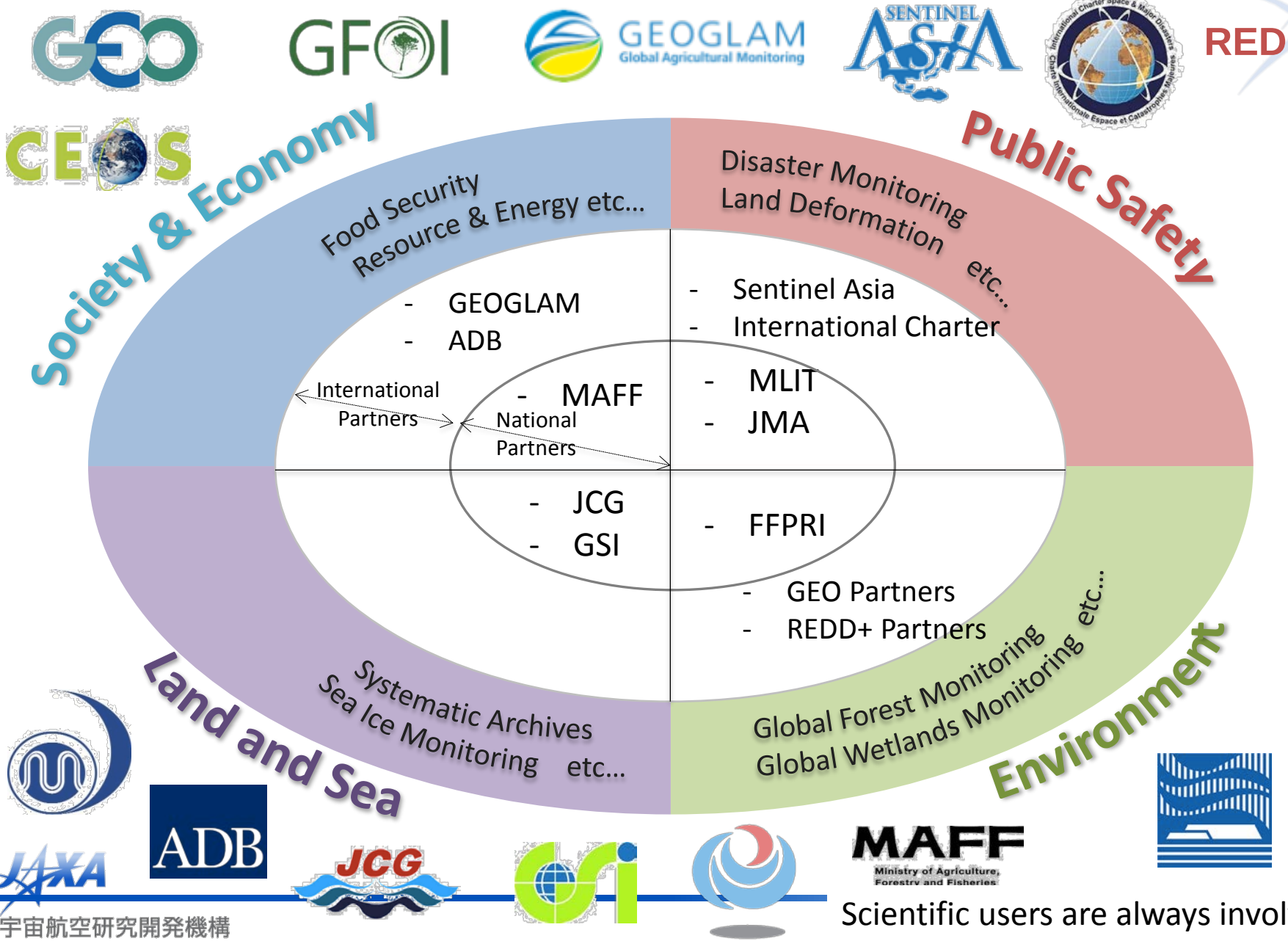
GSD: 100 m (off-nadir 26.2° – 41.8°)

Mode: ScanSAR 350km (HH+HV/14MHz)



Users – science and operations

Users – Science and Operations



Scientific users are always involved

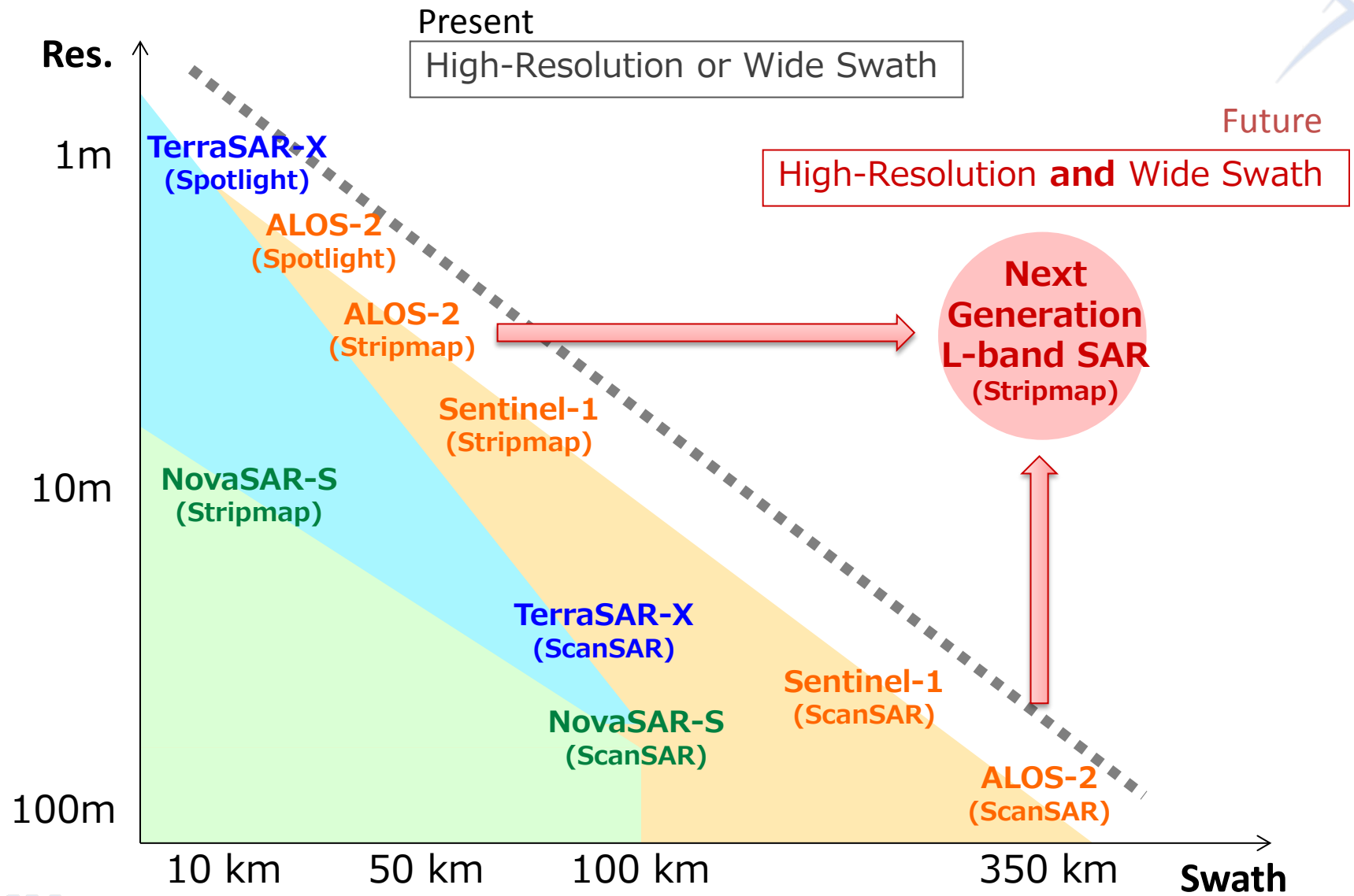
Users – Science and Operations

Long-term involvement with int'l SAR expert community

- 1996–2000: JERS-1 Global Forest Mapping (GRFM/GBFM) project science programme
- 2001–now: ALOS Kyoto & Carbon Initiative, ALOS-2 phase started
- Aim to stimulate regional-scale SAR applications development facilitated by the (J-1, A-1, A-2) systematic observations
- Some 35 user groups from 15 countries
- 30+ science meetings

The Next Generation L-band SAR

The Next Generation L-band SAR



The Next Generation L-band SAR

JAXA and DLR undertaking a study on a joint Japan/Germany mission

- L-band tandem constellation with monostatic and bistatic capacity
- Large Deployable Reflector Antenna Technology
- Digital Beam-forming to achieve wide swath at high resolution
- Global systematic observations continuity
- Launch horizon ～2020

Thank you.