

Science requirements for ALOS-2 for global forest and wetlands monitoring

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on behalf of
the Kyoto & Carbon (K&C) Initiative Science Team

ALOS K&C Science Panel

Established as a science advisory group to JAXA for ALOS in 2002

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ALOS – significance for forest and wetlands monitoring

What makes ALOS such a unique satellite mission?

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1. ALOS Basic Observation Scenario (BOS)

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- 1. ALOS Basic Observation Scenario (BOS)**
- 2. L-band frequency**

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- 3. HH + HV polarisation**

ALOS – significance for forest and wetlands monitoring

What makes ALOS such a unique satellite mission?

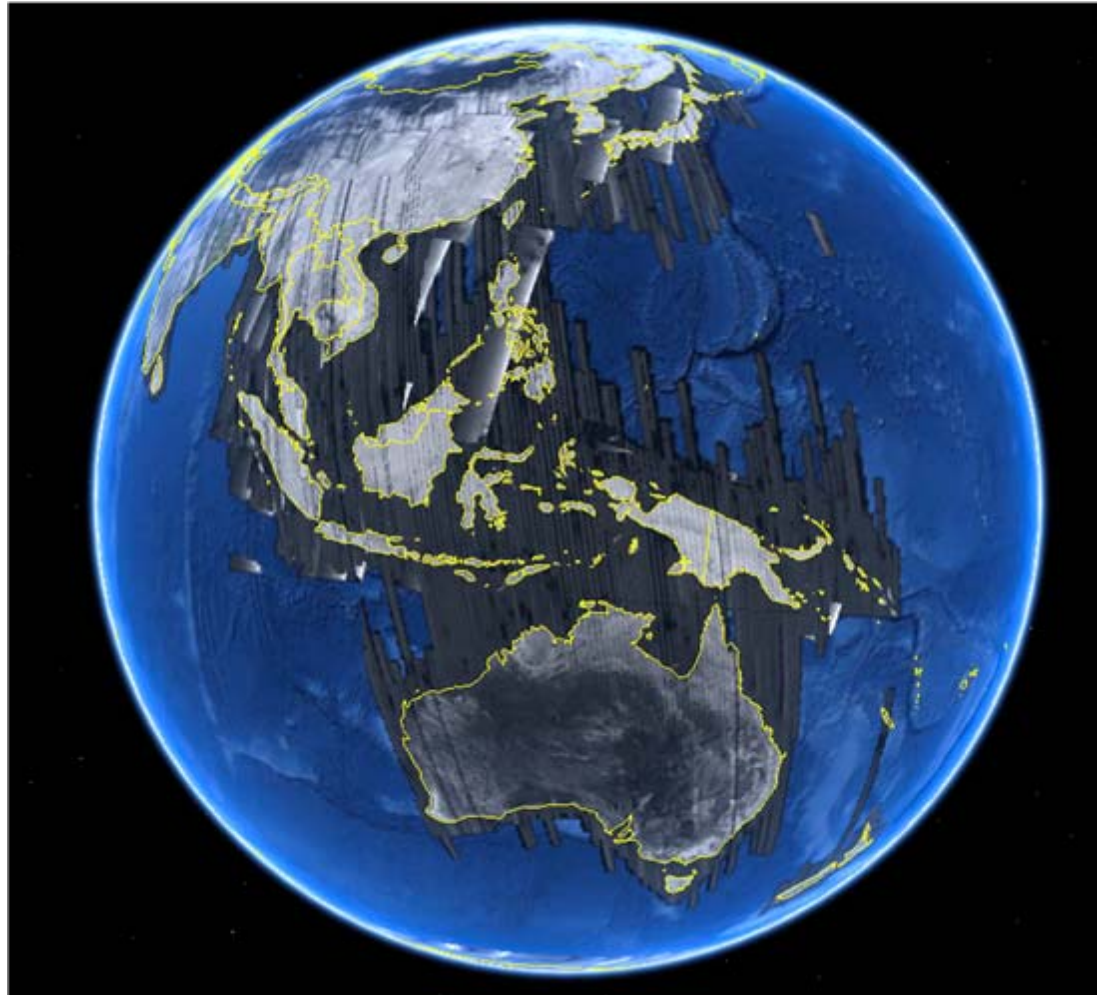
- 1. ALOS Basic Observation Scenario (BOS)**
- 2. L-band frequency**
- 3. HH + HV polarisation**
- 4. ScanSAR**

ALOS Basic Observation Scenario (BOS)

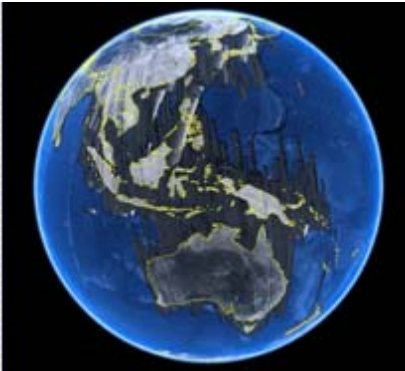
The ALOS BOS is the **SINGLE MOST IMPORTANT** feature of the ALOS mission

- **Wall-to-wall** acquisitions of the **global** land cover
- Systematic **repetition** 2 times/year (dual season: wet/dry; summer/winter)
- Pre-determined **key-modes** (FBS-34.3° FBD-34.3° WB1-HH, POL-21.5°)
- ONE mode per 46-day cycle to avoid programming conflicts and optimise acquisition success rate

ALOS Basic Observation Scenario (BOS)



PALSAR acquisitions during ONE 46-day cycle (#29: 28 Jul–11 Sep 2009)



ALOS Basic Observation Scenario (BOS)

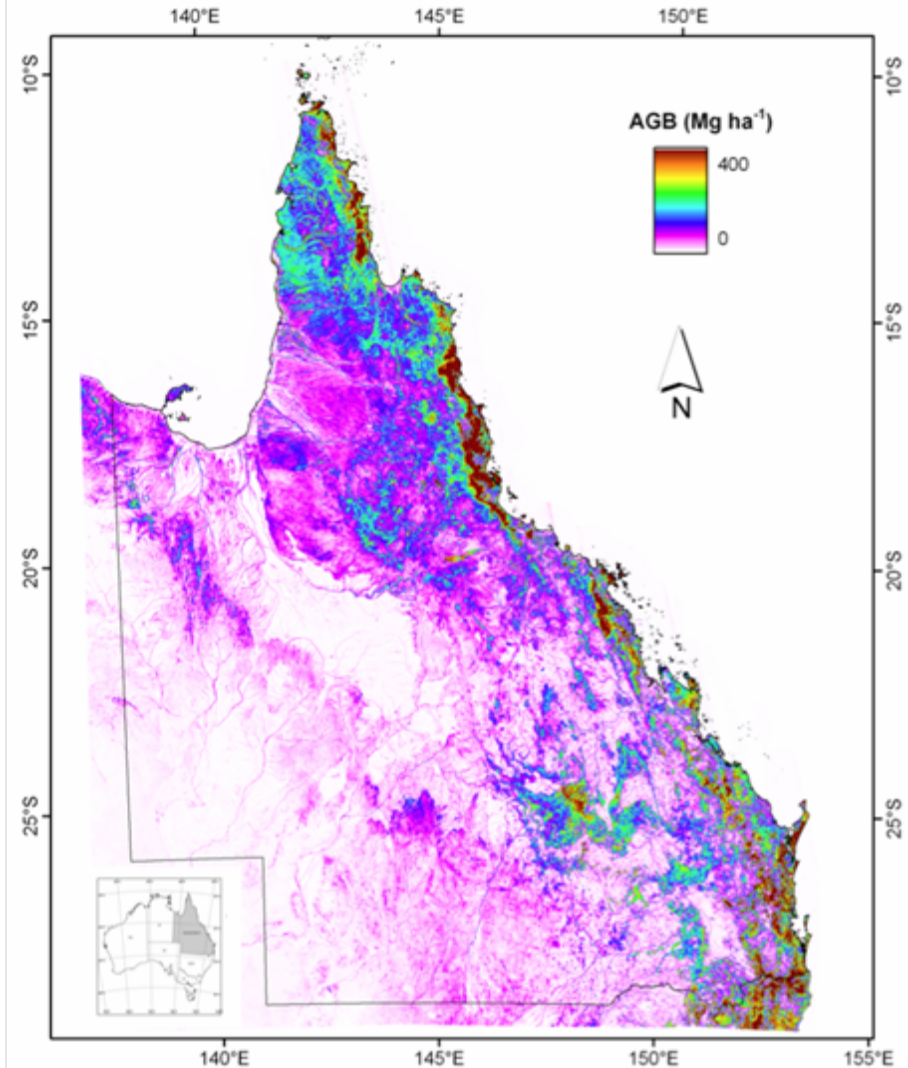
- **ONLY JAXA** : No other space agency has implemented systematic acquisitions at high resolution (previously done only with low-resolution sensors: MODIS, AVHRR). Other space agencies are now considering to do the same for future missions. But Japan is far ahead.
- **CRUCIAL FOR OUR PLANET**: Build consistent, long time-series archive of L-band SAR data fundamental requirement for assessment of climate change impact, forest carbon tracking and environmental change monitoring.
- Unique contribution from Japan to **UNFCCC, GEOSS and REDD+**

L-band + polarisation

L-band– best available frequency for forest and wetland applications

Dual-polarisation sufficient:

- HV – critical for above-ground biomass vegetation structure
- Full-pol of course nice, but half-swath yields too demanding (double) duty cycle for BOS
- Incidence angle range 28° - 45°



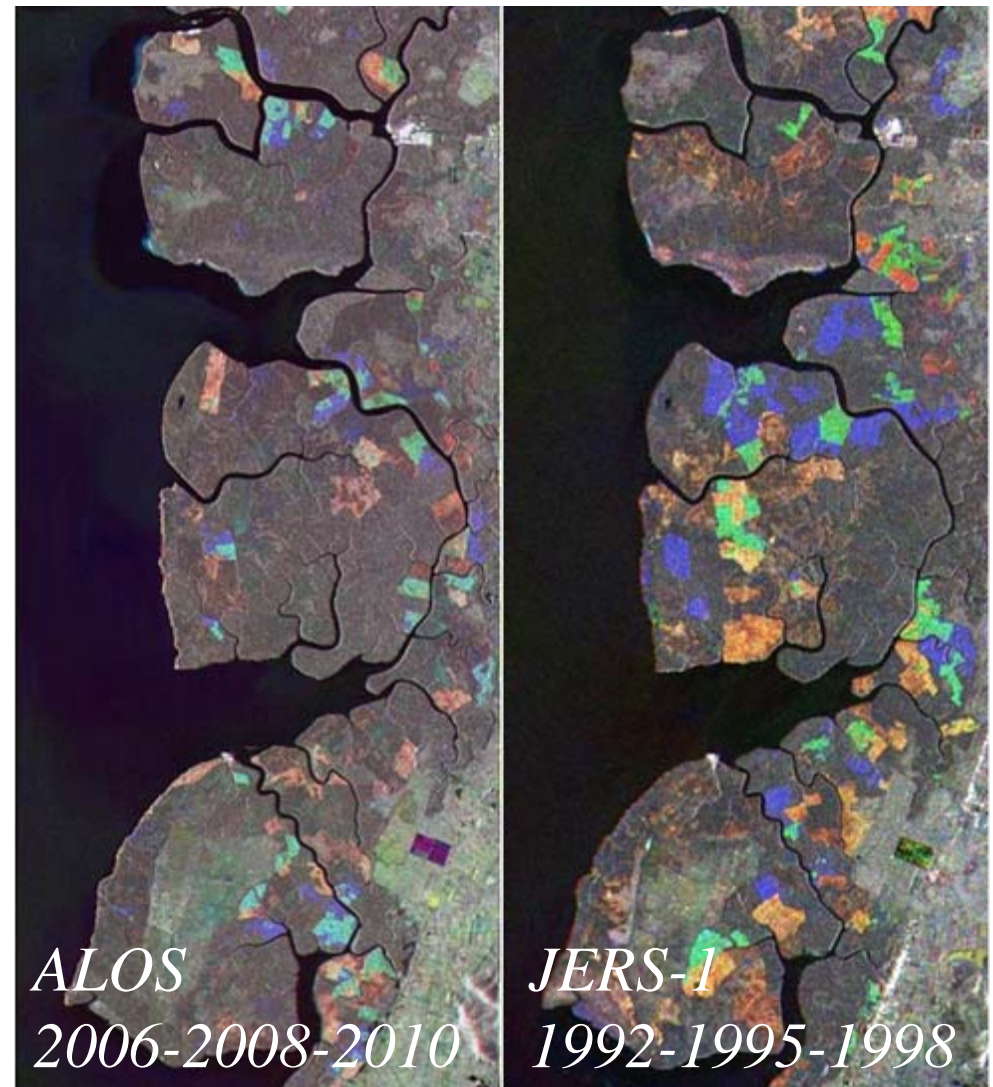
*Above-ground Biomass Map - Queensland, Australia
(Richard Lucas, Aberystwyth Univ. U.K.)*

JERS + ALOS + ALOS-2

Annual repetition enables long-term monitoring of deforestation.

Combination with JERS-1 systematic acquisitions (performed within GRFM) provides 10-year studies

ALOS + ALOS-2 critical for continued long-term monitoring. JAXA archive becoming as important as Landsat.

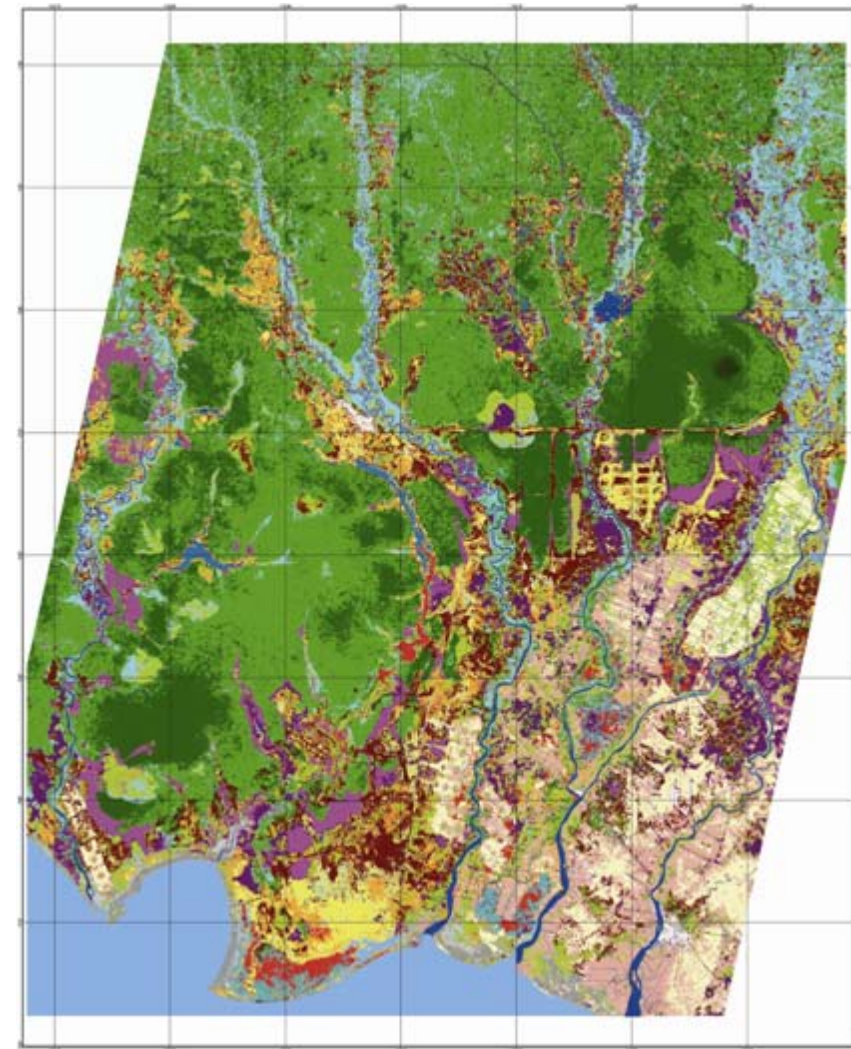
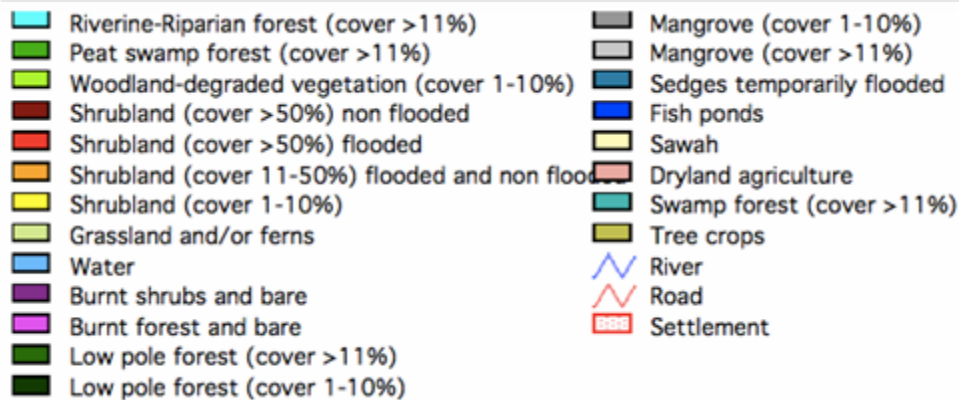


Perak, Malaysia. Mangrove deforestation and regrowth.

(Ake Rosenqvist, K&C)

Multi-season

Dual-season monitoring (dry/wet season)
enables improved capacity for Land
Cover Classification



*Land Cover Classification. Kalimantan, Indonesia
(Dirk Hoekman, Wageningen Univ., NL)*

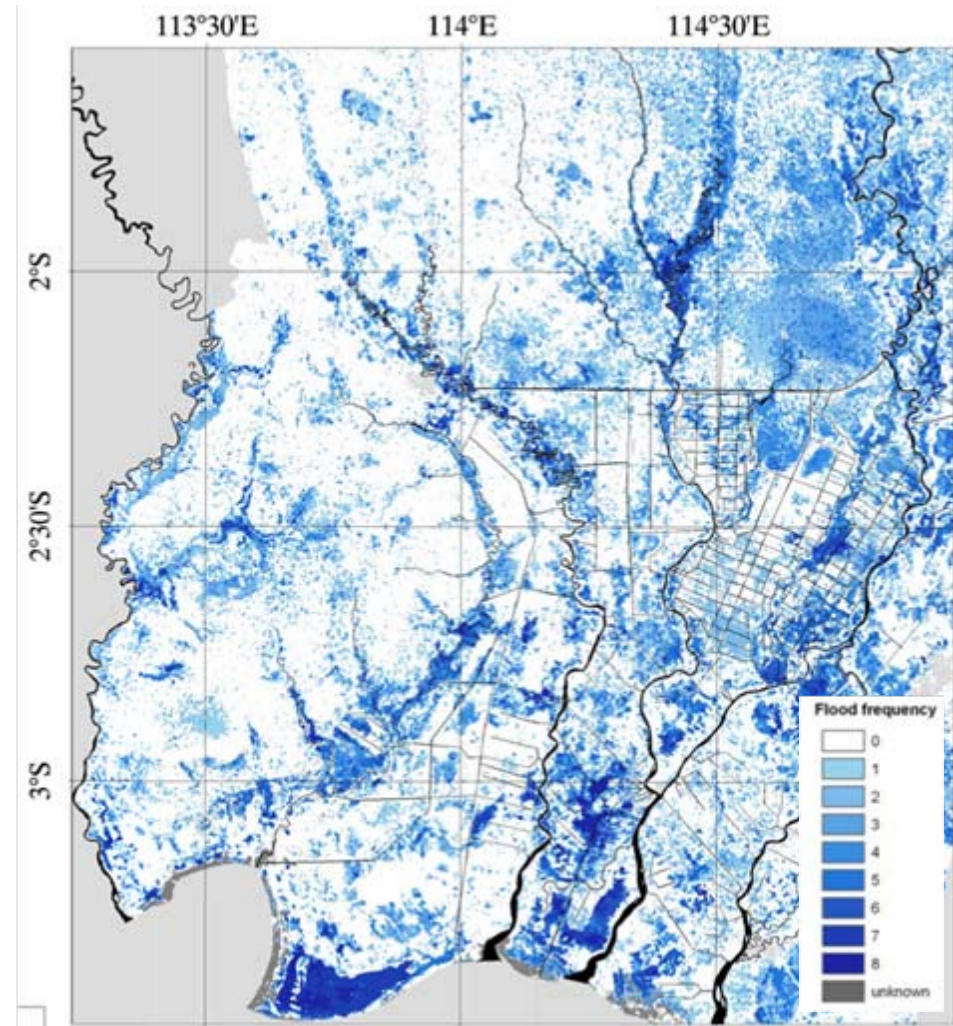
ScanSAR

Monitoring of forest and wetland flooding is a unique L-band SAR application. L-band penetration though closed forest canopy.

HH – critical for detection of flooding

ScanSAR enables high-repetivity monitoring of flooding and inundation.

WB1 mode (14 MHz) is good



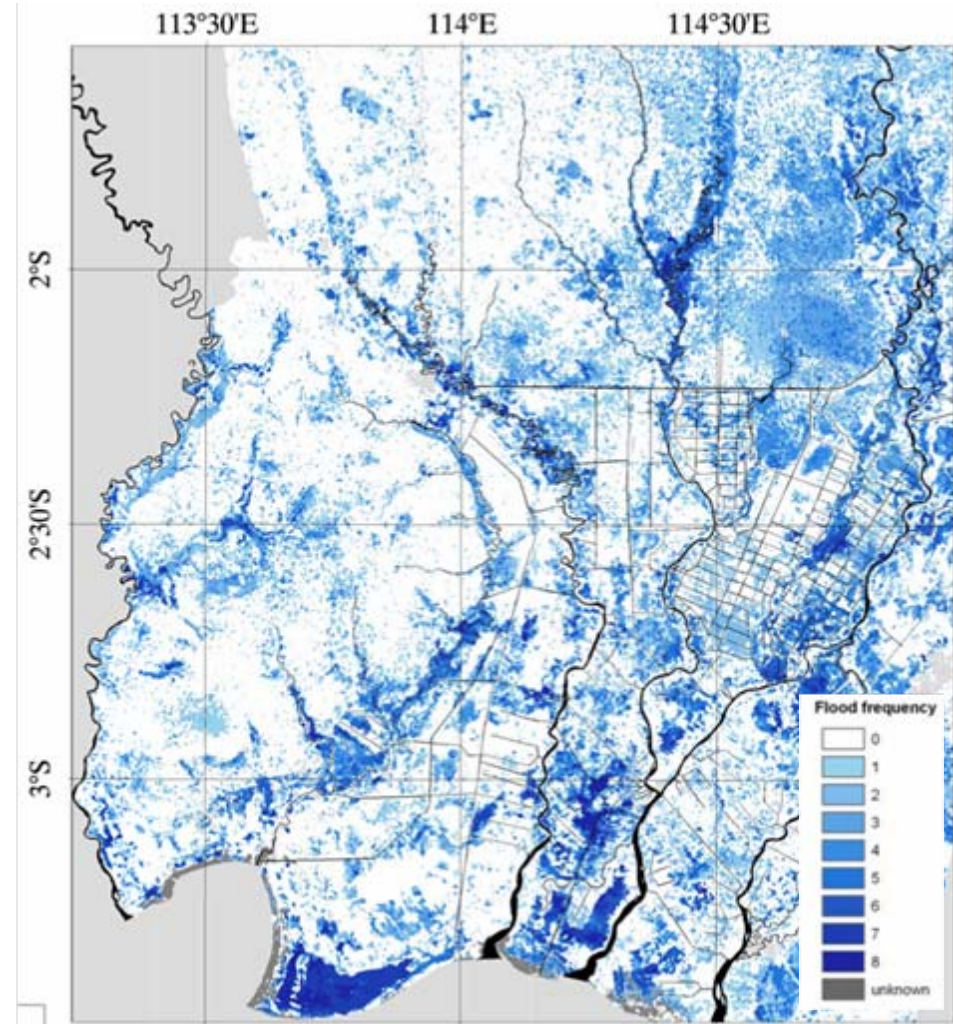
*Flood duration mapping. Kalimantan, Indonesia
(Dirk Hoekman, Wageningen Univ., NL)*

ScanSAR issues for ALOS-1

Descending acquisitions: ScanSAR-optical conflict (60-70% success rate). Missed passes serious limitation for ScanSAR use and degrading results.

46-day repeat orbit too coarse.
Especially due to low success rate.
One missed acquisition yields 3-month interruption in time series.

Greatly improved for ALOS-2!



*Flood duration mapping. Kalimantan, Indonesia
(Dirk Hoekman, Wageningen Univ., NL)*

ALOS-2 observation modes

	Spotlight	Ultra Fine	High sensitive	new	Fine	ScanSAR	
Bandwidth	84MHz	84MHz	42MHz	14MHz	28MHz	14MHz	
Resolution	Rg × Az: 3 × 1m	3m	6m	20m	10m	100m	
Orbit determination accuracy	1m	1m	40cm	40cm	40cm	40cm	
Swath	Rg × Az: 25 × 25km	50km	50km (25km FP)	60-70 km	70km (35km FP)	350km	
Polarization	(HH or V or HV or VH)	SP/DP	SP/DP/FP/CP	FP	SP/DP/FP/CP	SP/DP	
Data rate	800Mbps	800Mbps	800Mbps		400Mbps	400Mbps	
NESZ	-24dB	-24dB	-28dB	?	-26dB	-26dB	
S/A	Rg	25dB	25dB	23dB	?	25dB	25dB
	Az	20dB	25dB	20dB	?	23dB	20dB

ALOS-2 requirement for Forest & Wetlands Monitoring

	Spotlight	Ultra Fine	High sensitive	new	Fine	ScanSAR
Coverage					Global	
Usage					Forest & LCC	
Bandwidth	84MHz	84MHz	42MHz	14MHz	28MHz	14MHz
Resolution	Rg × Az: 3 × 1m	3m	6m	20m	10m	100m
Swath	Rg × Az: 25 × 25km	50km	50km (25km FP)	60-70 km	70km (35km FP)	350km
Polarization	(HH or V or HV or VH)	SP/DP	SP/DP/FP/ CP	FP	SP/DP/FP/ CP	SP/DP
Data rate	800Mbps	800Mbps	800Mbps		400Mbps	400Mbps

Fine Beam mode, **Dual-pol (HH+HV)** at 70km swath for Global Forest monitoring (ALOS-2 “BOS mode”)

ALOS-2 requirement for Forest & Wetlands Monitoring

	Spotlight	Ultra Fine	High sensitive	new	Fine	ScanSAR
Coverage					Global	Regional
Usage					Forest & LCC	Rapid deforest. & wetlands
Bandwidth	84MHz	84MHz	42MHz	14MHz	28MHz	14MHz
Resolution	Rg × Az: 3 × 1m	3m	6m	20m	10m	100m
Swath	Rg × Az: 25 × 25km	50km	50km (25km FP)	60-70 km	70km (35km FP)	350km
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Data rate	800Mbps	800Mbps	800Mbps		400Mbps	400Mbps

ScanSAR Dual-pol (HH+HV) for Regional monitoring of wetlands and rapid deforestation (ALOS-2 “BOS mode”)

ALOS-2 requirement for Forest & Wetlands Monitoring

	Spotlight	Ultra Fine	High sensitive	new	Fine	ScanSAR
Coverage		Local	Local		Global	Regional
Usage		Logging/ degraded forest	Biomass		Forest & LCC	Rapid deforest. & wetlands
Bandwidth	84MHz	84MHz	42MHz	14MHz	28MHz	14MHz
Resolution	Rg × Az: 3 × 1m	3m	6m	20m	10m	100m
Swath	Rg × Az: 25 × 25km	50km	50km (25km FP)	60-70 km	70km (35km FP)	350km
Polarization	(HH or V or HV or VH)	SP/DP	SP/DP/FP/ CP	FP	SP/DP/FP/ CP	SP/DP
Data rate	800Mbps	800Mbps	800Mbps		400Mbps	400Mbps

Ultra Fine mode (1m) at dual-pol (HH+HV) for local-scale hotspot monitoring of forest degradation and selective logging (Not “BOS mode”)

ALOS-2 requirement for Forest & Wetlands Monitoring

	Spotlight	Ultra Fine	High sensitive	new	Fine	ScanSAR
Coverage		Local	Local		Global	Regional
Usage		Logging/ degraded forest	Biomass		Forest & LCC	Rapid deforest. & wetlands
Bandwidth	84MHz	84MHz	42MHz	14MHz	28MHz	14MHz
Resolution	Rg × Az: 3 × 1m	3m	6m	20m	10m	100m
Swath	Rg × Az: 25 × 25km	50km	50km (25km FP)	60-70 km	70km (35km FP)	350km
Polarization	(HH or V or HV or VH)	SP/DP	SP/DP/FP/ CP	FP	SP/DP/FP/ CP	SP/DP
Data rate	800Mbps	800Mbps	800Mbps		400Mbps	400Mbps

High sensitive mode (6m) at Full polarisation
for local-scale mapping of biomass (Not “BOS mode”)

ALOS-2 requirement for Forest & Wetlands Monitoring

	Spotlight	Ultra Fine	High sensitive	new	Fine	ScanSAR
Coverage		Local	Local		Global	Regional
Usage	Not useful	Logging/ degraded forest	Biomass	Not useful	Forest & LCC	Rapid deforest. & wetlands
Bandwidth	84MHz	84MHz	42MHz	14MHz	28MHz	14MHz
Resolution	Rg × Az: 3 × 1m	3m	6m	20m	10m	100m
Swath	Rg × Az: 25 × 25km	50km	50km (25km FP)	60-70 km	70km (35km FP)	350km
Polarization	(HH or V or HV or VH)	SP/DP	SP/DP/FP/ CP	FP	SP/DP/FP/ CP	SP/DP
Data rate	800Mbps	800Mbps	800Mbps		400Mbps	400Mbps

Spotlight mode not useful - stamp-type acquisitions only
 “New mode” (20m res not considered necessary)

ALOS-2 requirement for Forest & Wetlands Monitoring

	Spotlight	Ultra Fine	High sensitive	new	Fine	ScanSAR
Coverage		Local	Local		Global	Regional
Priority	x	2	2	x	1 (BOS)	1 (BOS)
Usage	Not useful	Logging/ degraded forest	Biomass	Not useful	Forest & LCC	Rapid deforest. & wetlands
Bandwidth	84MHz	84MHz	42MHz	14MHz	28MHz	14MHz
Resolution	Rg × Az: 3 × 1m	3m	6m	20m	10m	100m
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Polarization	(HH or V or HV or VH)	SP/DP	SP/DP/FP/ CP	FP	SP/DP/FP/ CP	SP/DP
Data rate	800Mbps	800Mbps	800Mbps		400Mbps	400Mbps

Mode Priorities

Recommendations for ALOS-2 (1/3)

Critical importance – ALOS-1 and ALOS-2 BOS:

- Implementation of a mission-long **global systematic observation strategy for ALOS-2 (ALOS-2 BOS)** that is consistent with the FBS/FBD and WB1 strategy of the ALOS-1 BOS.
- **Continue BOS for ALOS-1** during whole mission life. Time series, coverage and continuity over several missions (JERS/ALOS/ALOS-2) are key points for Climate Change monitoring
- Japan is world leader in acquisition planning – please keep on this legacy on support to UNFCCC, GEOSS and REDD+

Recommendations for ALOS-2 (2/3)

Key modes:

- **Fine-Beam HH+HV** (Global monitoring BOS mode)
2 global coverages/year at wet/dry (winter/summer) seasons (=ALOS-1 BOS)
The above including 1 InSAR coverage/year (new)
- **ScanSAR HH+HV** (Regional monitoring BOS mode)
Every second cycle (28 days) monitoring over key regions (=ALOS-1 BOS)
- **High-sensitive Full-pol** (Hot-spot monitoring)
On-demand as required
- **Ultra-fine Dual-pol** (Hot-spot monitoring)
On-demand as required

Recommendations for ALOS-2 (3/3)

- Consider Coherence as standard product level for FB and ScanSAR
- Enable of multi-pass ScanSAR-to-ScanSAR interferometry (through orbit control and timing of scan bursts)
- Dimension of on-board data storage capacity to cope with global data collection
- In addition to DRTS, consider high speed playback and downlink capacity to a network of global ground stations. Relying on ONLY DRTS for downlink (like present ALOS) is considered very risky
- Consideration of placing the second SAR satellite in tandem orbit during a part of the mission for collection of global non-repeat pass interferometric baseline data sets.

On behalf of
the ALOS K&C Initiative Science Team:

Thank you