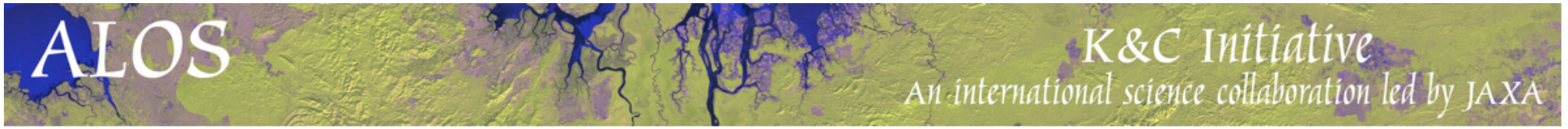
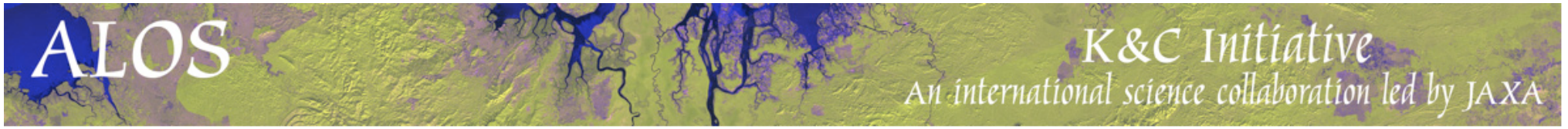


Science requirements for ALOS-2 for global forest and wetlands monitoring

Ake Rosenqvist, K&C Science Coordinator
on behalf of
the Kyoto & Carbon (K&C) Initiative Science Team

ALOS-2 User meeting
Akihabara/Tokyo, March 25, 2010



ALOS K&C Science Panel

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

Dr. Richard Lucas, Aberystwyth University, U.K.
Prof. Christiane Schmullius, FSU Jena, Germany
Dr. Bruce Chapman, NASA/JPL, USA
Dr. Dalton Valeriano, INPE, Brazil
Dr. Humberto de Mesquita, IBAMA, Brazil
Dr. Thuy Le Toan, CESBIO, France
Prof. Shaun Quegan, U. Sheffield, U.K.
Dr. Laura Hess, U. of Calif. Santa Barbara, USA
Prof. Philippe Paillou, U. Bordeaux, France
Dr. John Lowry, ERISS, Australia
Prof. Paul Siqueira, U. of Massachusetts, USA
Dr. Maurizio Santoro, Gamma RS, Switzerland
Prof. Johan Fransson, U. Agr. Sciences, Sweden
Dr. Lisa Rebelo, Int'l Water Mangm. Inst., Ethiopia

Dr. Kostas Papathanassiou, DLR, Germany
Prof. Anthony Milne, U. New South Wales, Australia
Dr. Gianfranco De Grandi, JRC, European Commission
Dr. Kyle McDonald, NASA/JPL, USA
Dr. Josef Kellndorfer, WHRC, USA
Prof. Maycira Costa, U. of Victoria, Canada
Dr. Leif Erikssson, Chalmers Inst. Tech., Sweden
Dr. Dirk Hoekman, SarVision, The Netherlands
Dr. Francesco Holecz, sarmap, Switzerland
Dr. William Salas, Applied Geosolutions, USA
Prof. Kevin Telmer, U. Victoria, Canada
Ms. Yumiko Uryu, WWF, Indonesia
Dr. Yoshiki Yamagata, NIES, Japan
Dr. Ake Rosenqvist, soloEO, Sweden

ALOS – significance for forest and wetlands monitoring

What makes ALOS such a unique satellite mission?

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What makes ALOS such a unique satellite mission?

1. ALOS Basic Observation Scenario (BOS)

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**

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**

ALOS – significance for forest and wetlands monitoring

What makes ALOS such a unique satellite mission?

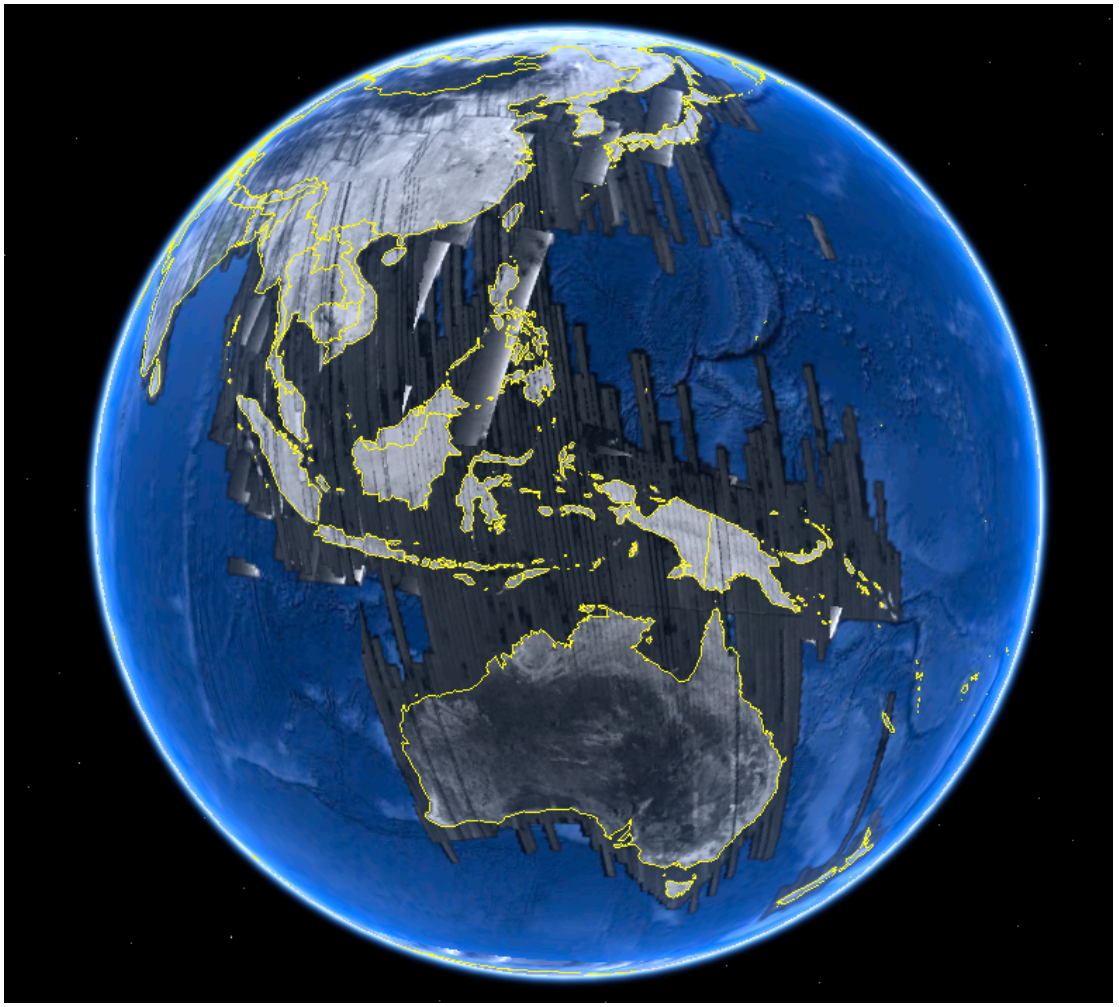
1. **ALOS Basic Observation Scenario (BOS)**
2. **L-band frequency**
3. **HH + HV polarisation**
4. **ScanSAR**

ALOS Basic Observation Scenario (BOS)

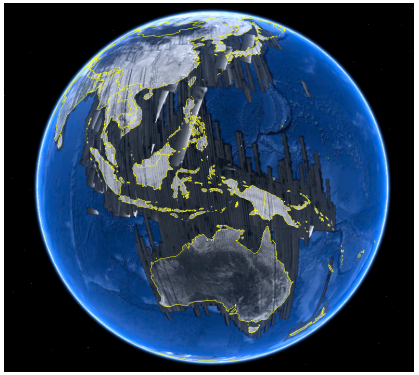
The ALOS BOS is the SINGLE MOST IMPORTANT feature of the ALOS mission

- **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.

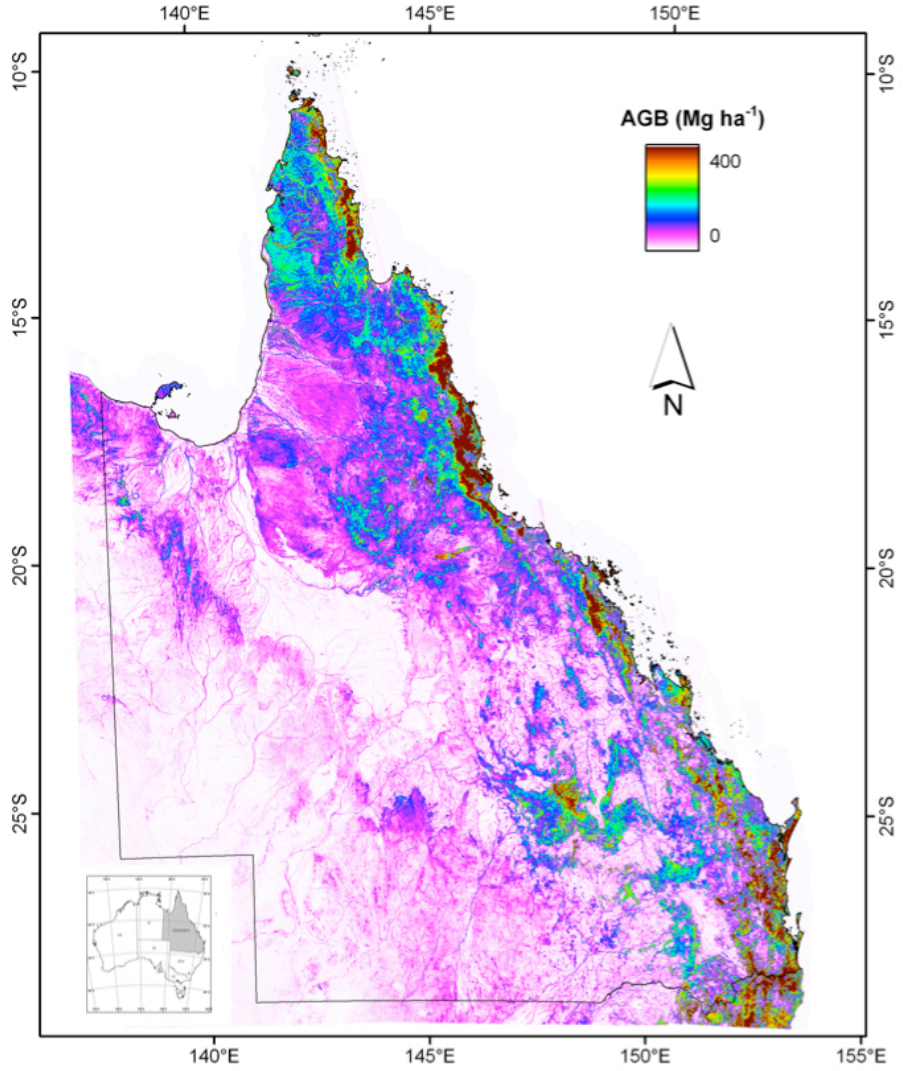
• Unique contribution from Japan to UNFCCC, GEOSS and REDD+

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°



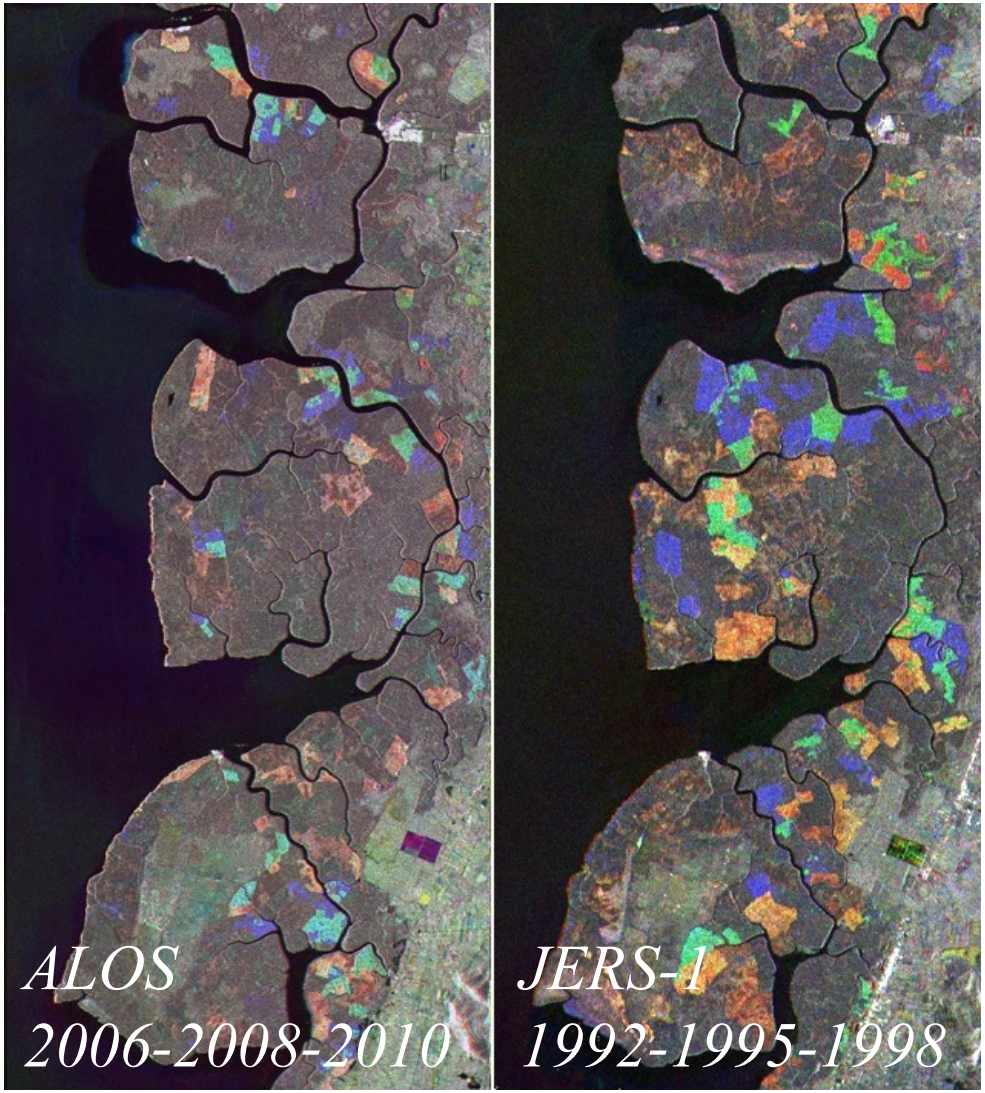
Above-ground Biomass Map - Queensland, Australia
(Richard Lucas, Aberystwyth Univ. U.K.)

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.



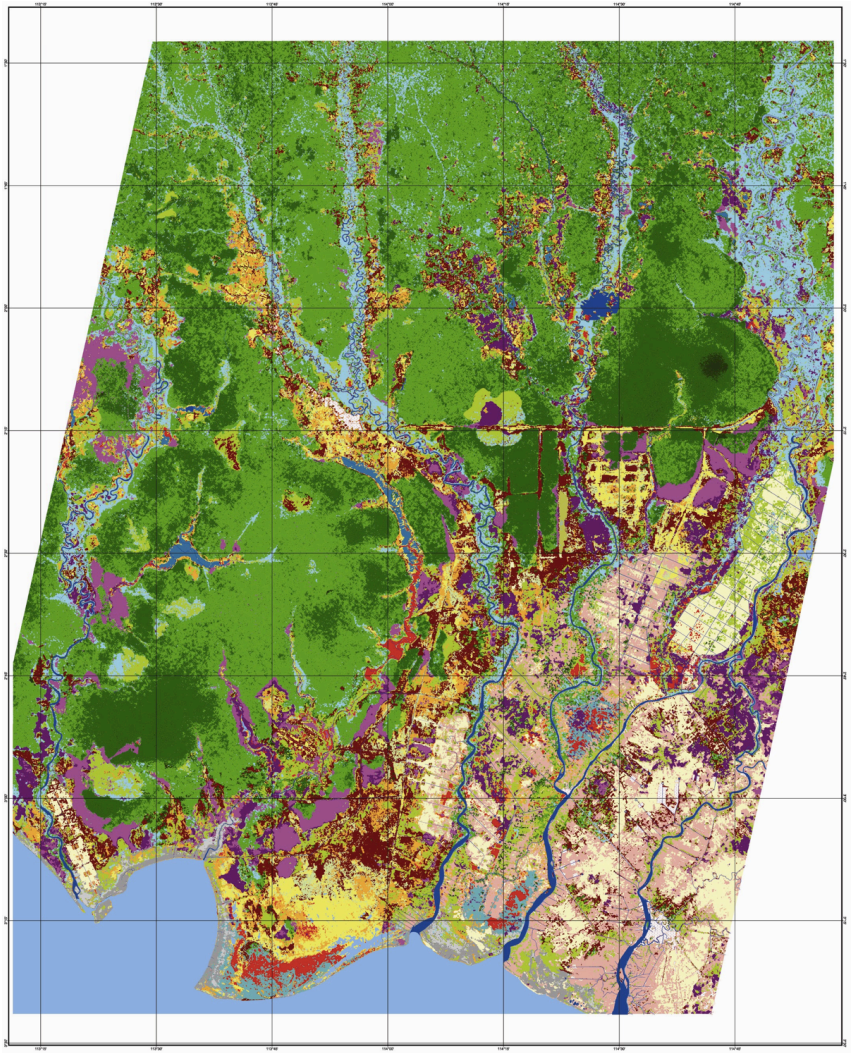
Perak, Malaysia. Mangrove deforestation and regrowth.

(Ake Rosenqvist, K&C)

Multi-season

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

- Riverine-Riparian forest (cover >11%)
- Peat swamp forest (cover >11%)
- Woodland-degraded vegetation (cover 1-10%)
- Shrubland (cover >50%) non flooded
- Shrubland (cover >50%) flooded
- Shrubland (cover 11-50%) flooded and non flood…
- Shrubland (cover 1-10%)
- Grassland and/or ferns
- Water
- Burnt shrubs and bare
- Burnt forest and bare
- Low pole forest (cover >11%)
- Low pole forest (cover 1-10%)
- Mangrove (cover 1-10%)
- Mangrove (cover >11%)
- Sedges temporarily flooded
- Fish ponds
- Sawah
- Dryland agriculture
- Swamp forest (cover >11%)
- Tree crops
- River
- Road
- Settlement



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

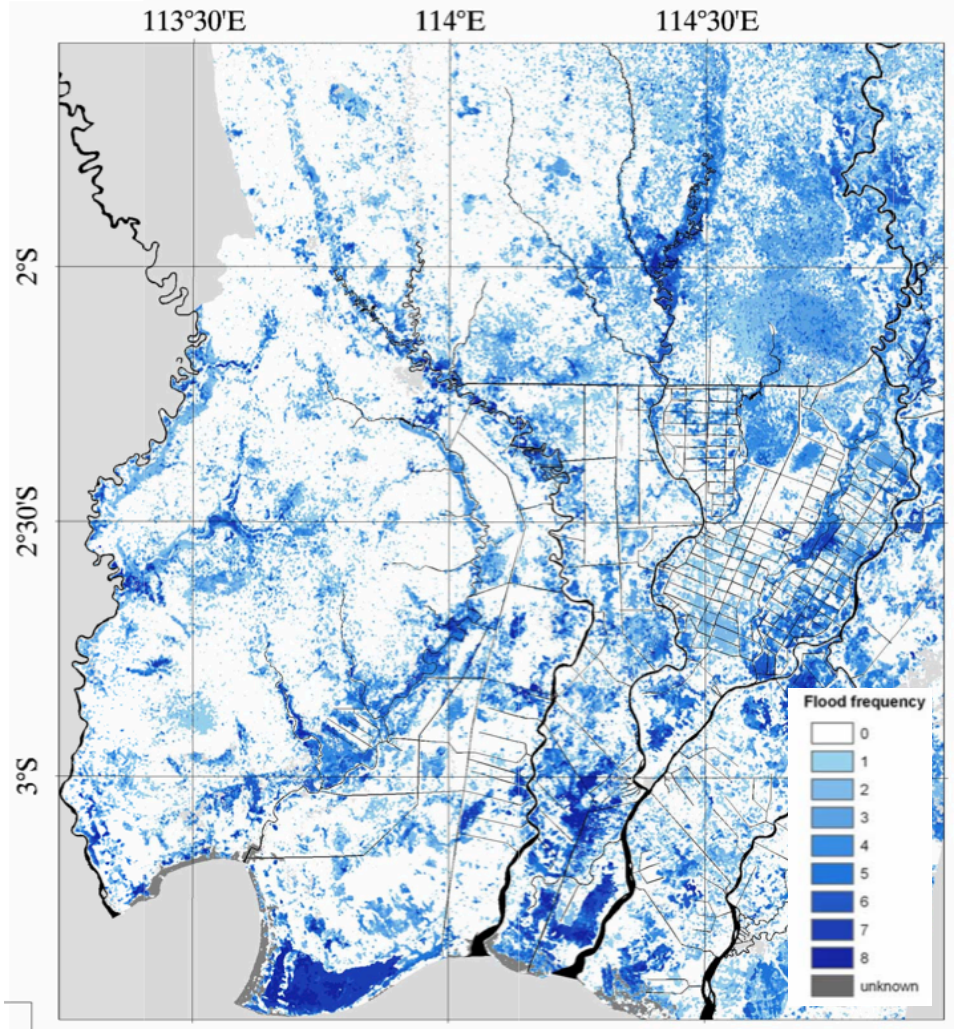
ScanSAR

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-repetivety monitoring of flooding and inundation.

WB1 mode (14 MHz) is good



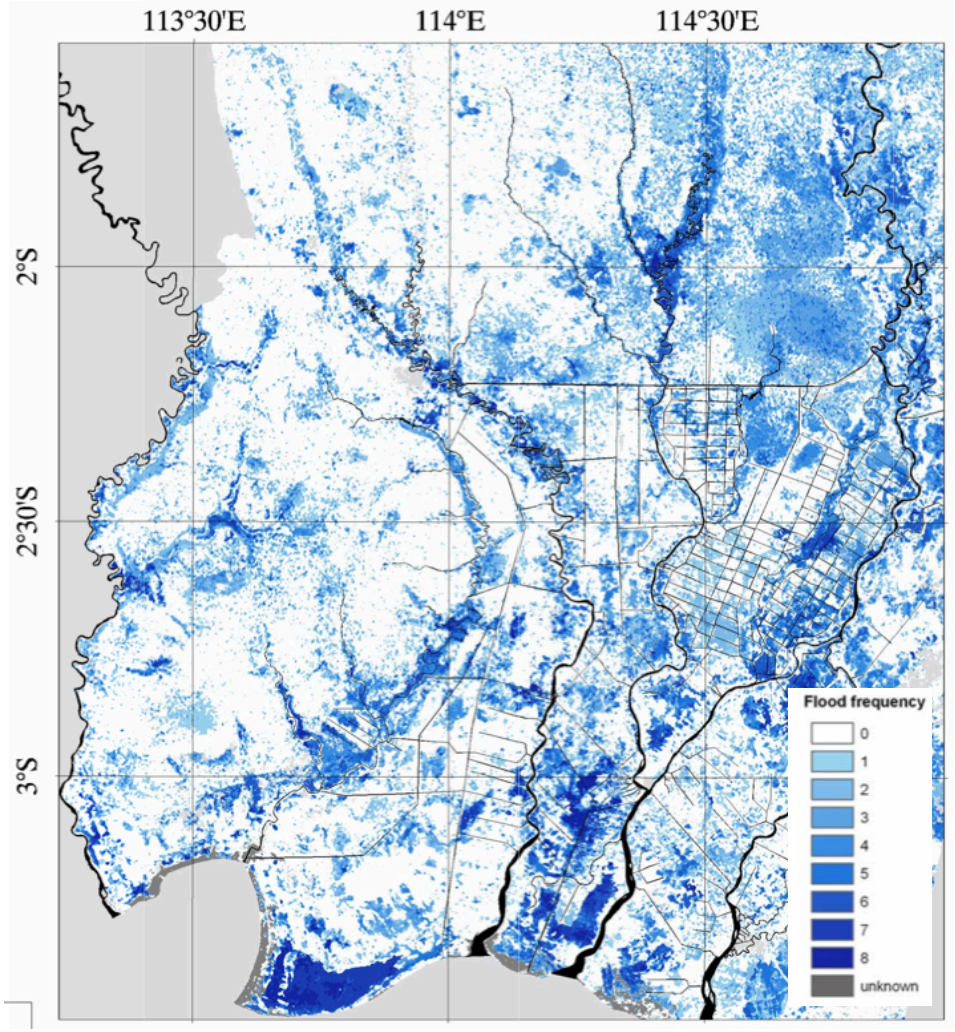
Flood duration mapping. Kalimantan, Indonesia
(Dirk Hoekman, Wageningen Univ., NL)

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 forALOS-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

M. Shimada, JAXA EORC. KC#13

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
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

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
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

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