

The Phased Array L-Band SAR (PALSAR) Aboard the Japanese Advanced Land Observing Satellite (ALOS)

Josef Kellndorfer

Wayne Walker

Woods Hole Research Center

Masanobu Shimada, JAXA

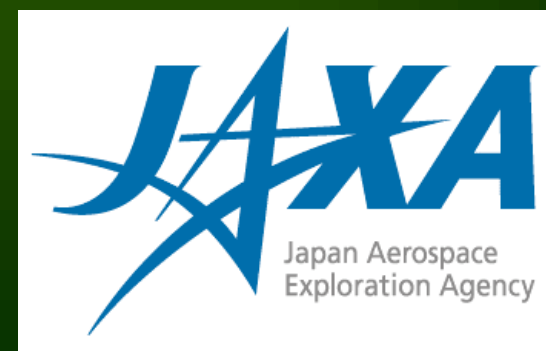
Ake Rosenqvist, EC-JRC

Veg3D Workshop, March 3-5, 2008, Charlottesville, NC

Kellndorfer, Shimada, Rosenqvist

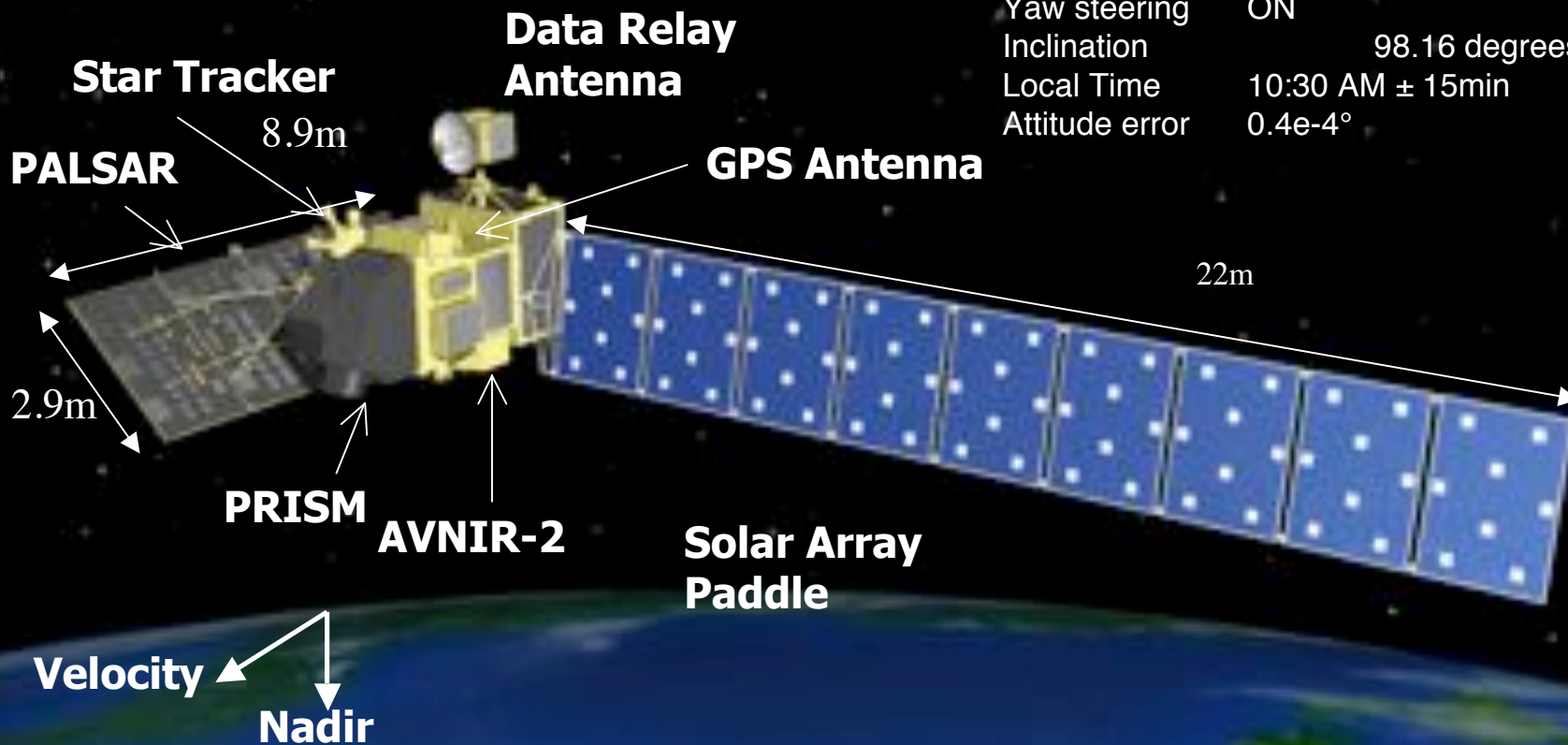
The ALOS Satellite

- ◆ Launched by JAXA January on 24th 2006
- ◆ Three sensors: PRISM, AVNIR-2 and PALSAR
- ◆ PALSAR: First polarimetric L-band sensor on free-flying Earth RS satellite (PALSAR = Phased Array L-band SAR)



ALOS Satellite System

Launch date	Jan, 24th, 2006
Launcher	H2A
Weight	4000 kg
Solar Power	~7Kw@EOL
Orbit	Sun Synchronous
Altitude	691.65 km
Revolution	14+27/46
Yaw steering	ON
Inclination	98.16 degrees
Local Time	10:30 AM ± 15min
Attitude error	0.4e-4°



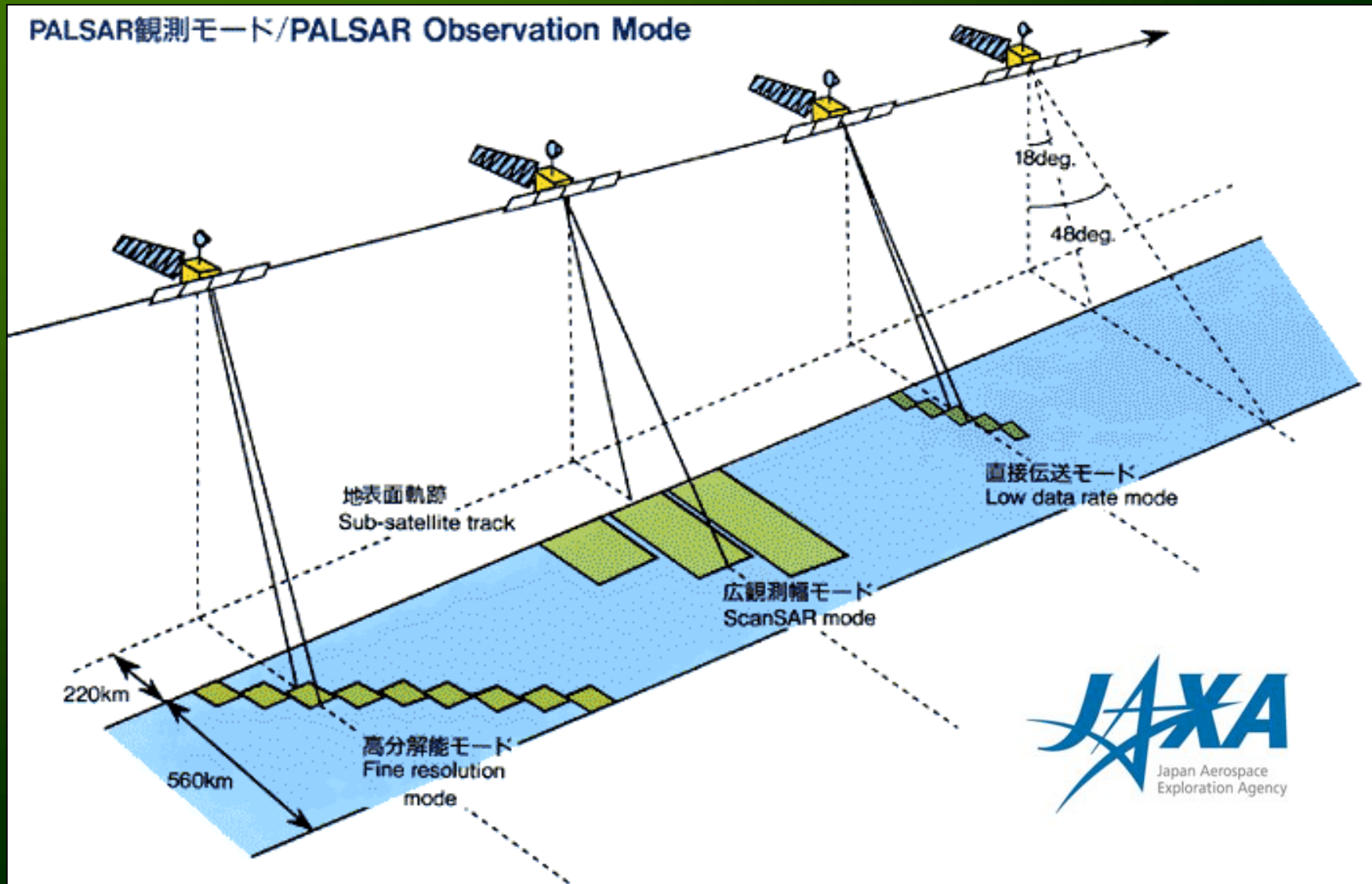
PRISM : Panchromatic Remote-sensing Instrument for Stereo Mapping
AVNIR-2: Advanced Visible and Near Infrared Radiometer type 2
PALSAR: Phased Array type L-band Synthetic Aperture Radar

PALSAR calibration results (summary)

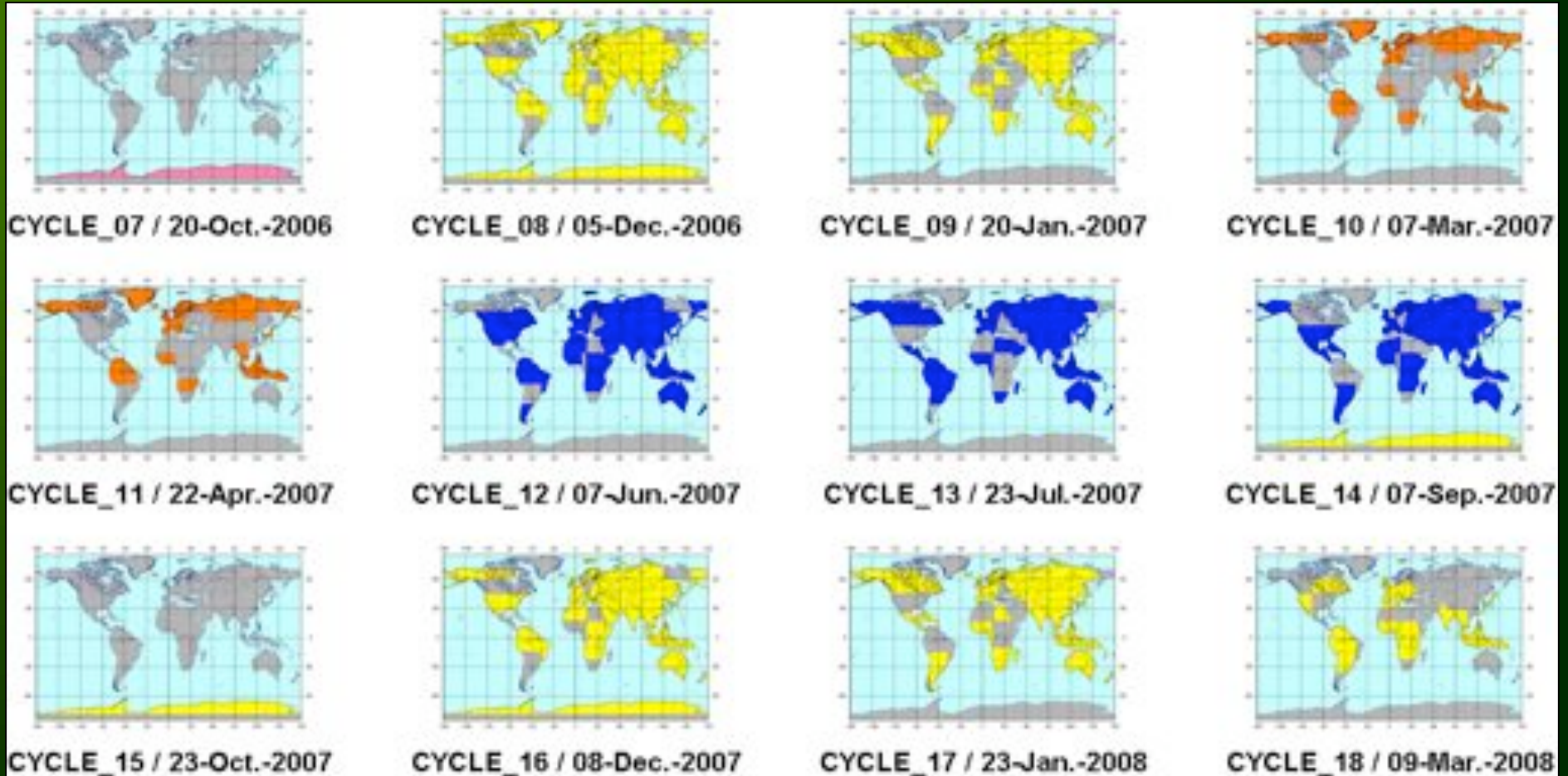
items	values	NOD	spec	remarks
geometry	9.3m(RMS:distance)***	615	100m	all modes
radiometry	0.64dB***/0.17dB*	478/16	1.5dB	all modes
polarimetry	VV/HH amp ratio(dB) : 0.02dB(0.04)	79	0.2dB	POL
	VV/HH phase diff.(deg) : 0.321(1.01)	79	5deg	
	cross talk : 31~40dB	79	30dB	
NESZ	-34dB		-23dB	all modes
resolution(m)	azimuth : 4.49m(0.1m)	478	4.5m	all modes
	range(14MHz) : 9.6m(0.1m)	478	10.7m	
	range(28MHz) : 4.7m(0.1m)	478	5.4m	
side lobe(dB)	PSLR(azimuth) : -16dB	478	-10dB	all modes
	PSLR(range) : -12.5dB	478	-10dB	
	ISLR : -8.6dB	478	-8dB	
ambiguity	azimuth : zero		16dB**	all modes
	range : ~23dB@ image end		16dB	

note)all the values are average , value in blanket is a standard deviation, * is at Sweden site.,**70km swath,***1m improved,**** : 0.1dB improved

PALSAR Observation Modes

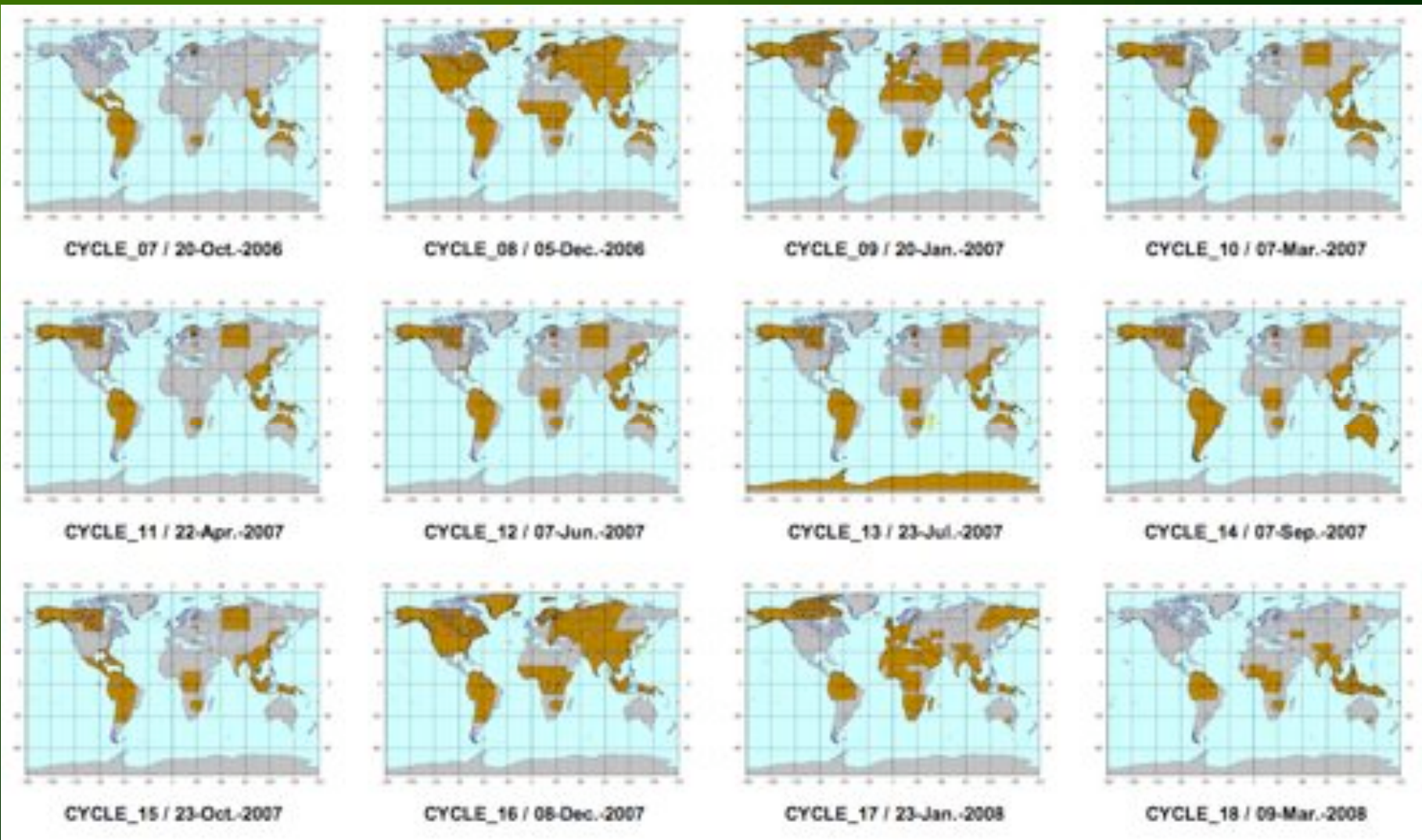


ALOS PALSAR Observation Plan Fine Beam Mode



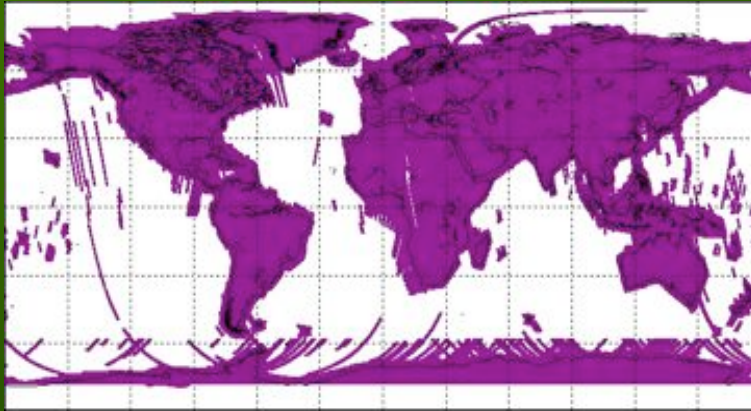
HH/HV HH Polarimetric

ALOS PALSAR Observation Plan ScanSAR Mode

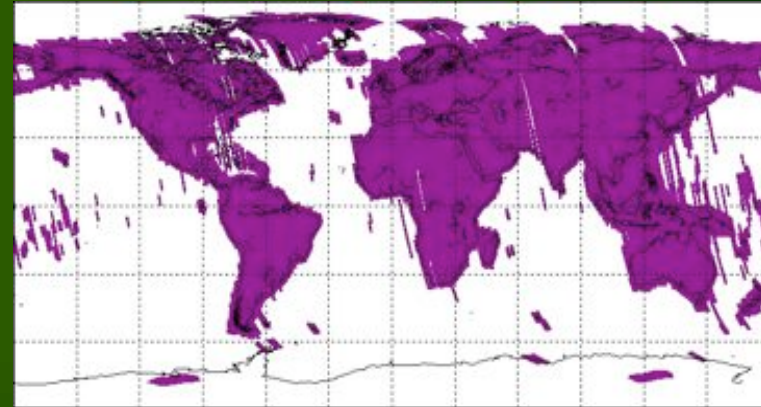


PALSAR Data acquisitions

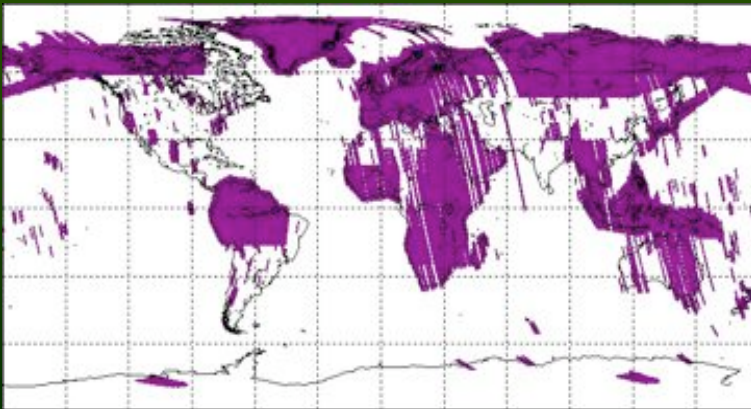
Duration : 2006/5/16 ~ 2007/10/22



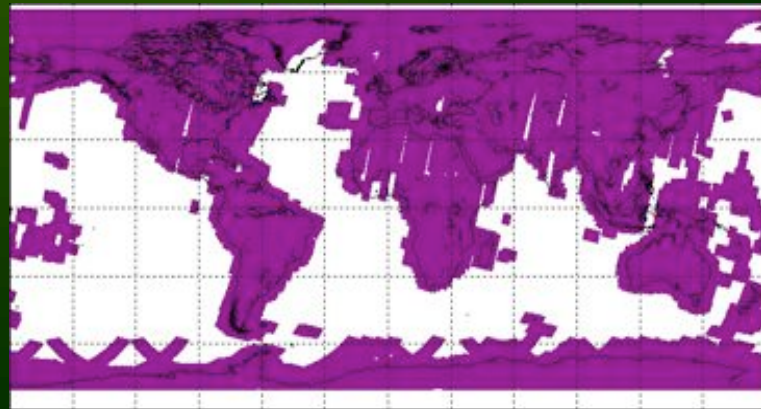
FBS



FBD



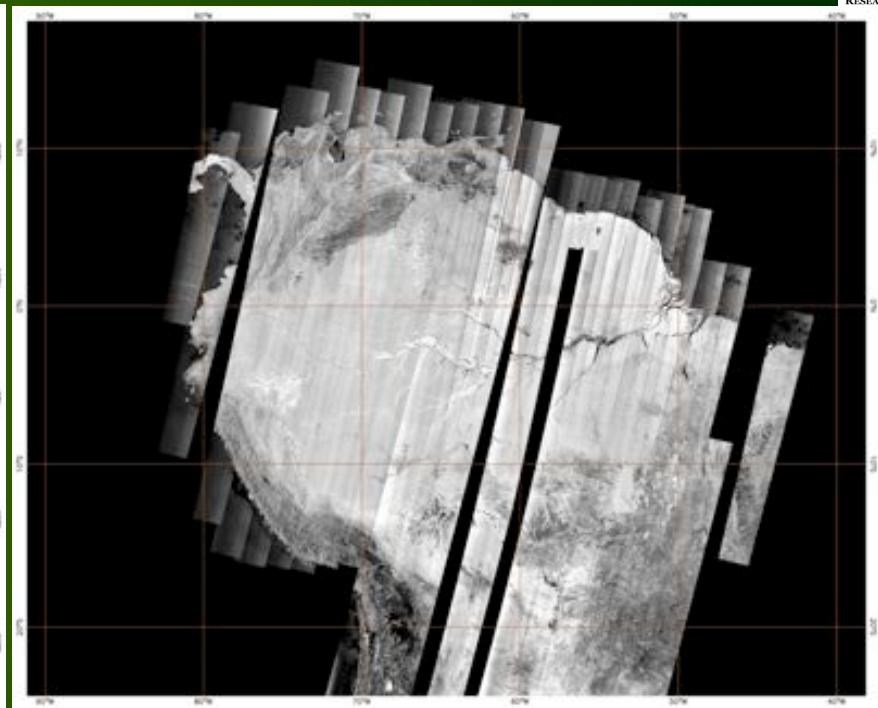
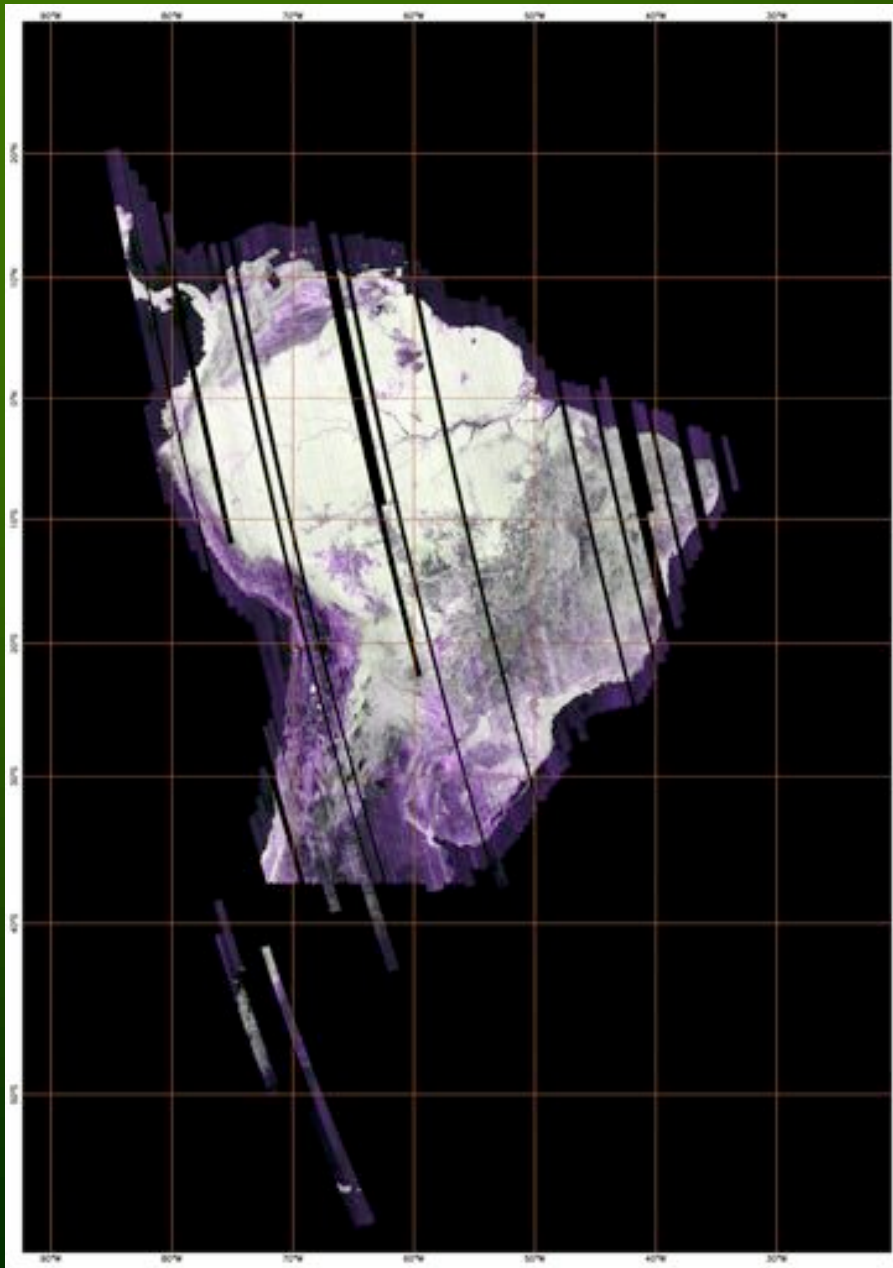
PLR



WB1

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ALOS Maps South America



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Amazon Pilot Studies



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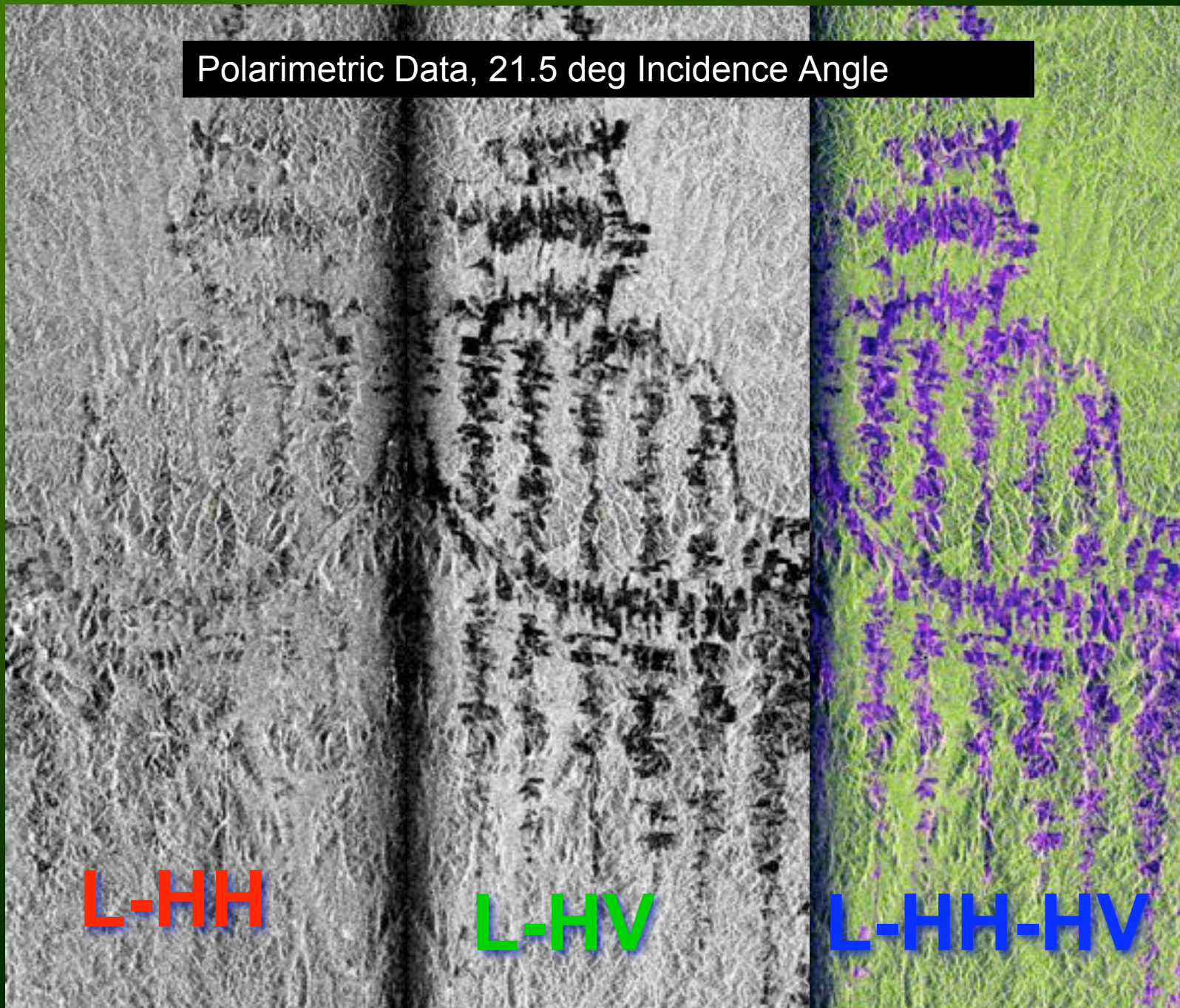
ALOS PolSAR Scene 21-Oct-2006 Trans-Amazon Highway, Rurópolis



Trans-Amazon Highway

KelIndorfer, Shimada, Rosenqvist

Polarimetric Data, 21.5 deg Incidence Angle



From Pilot to Application



Mapping 400,000 sqkm
Of the Arc of Deforestation with
ALOS/PALSAR:

The Xingu Watershed in Mato
Grosso, Brazil

Mapping 300,000 sqkm
Gabon and Equatorial Guinea

ALOS/PALSAR Dual-Pol Mosaic of the Xingu Watershed



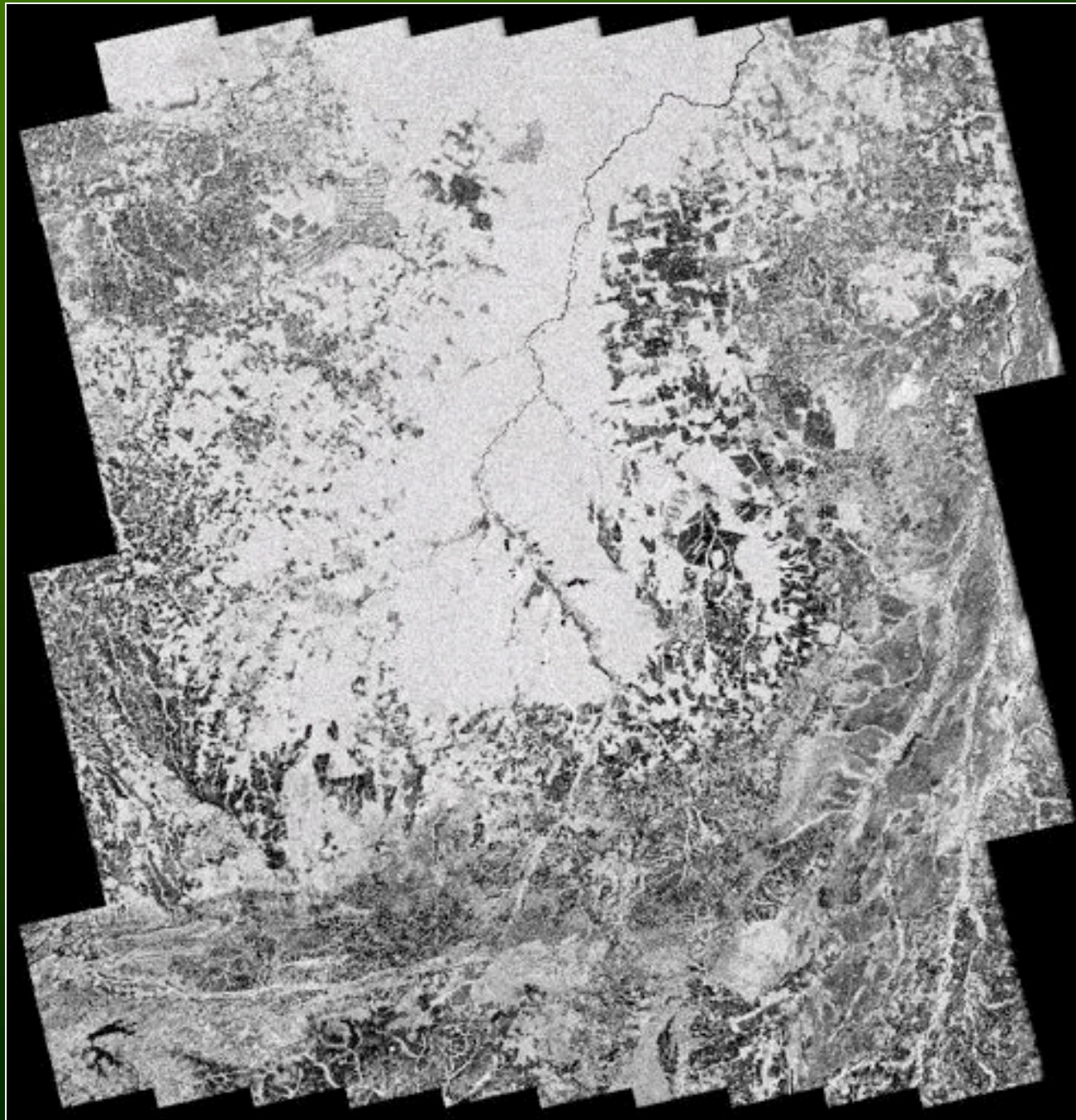
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Coverage with ALOS/PALSAR Scenes



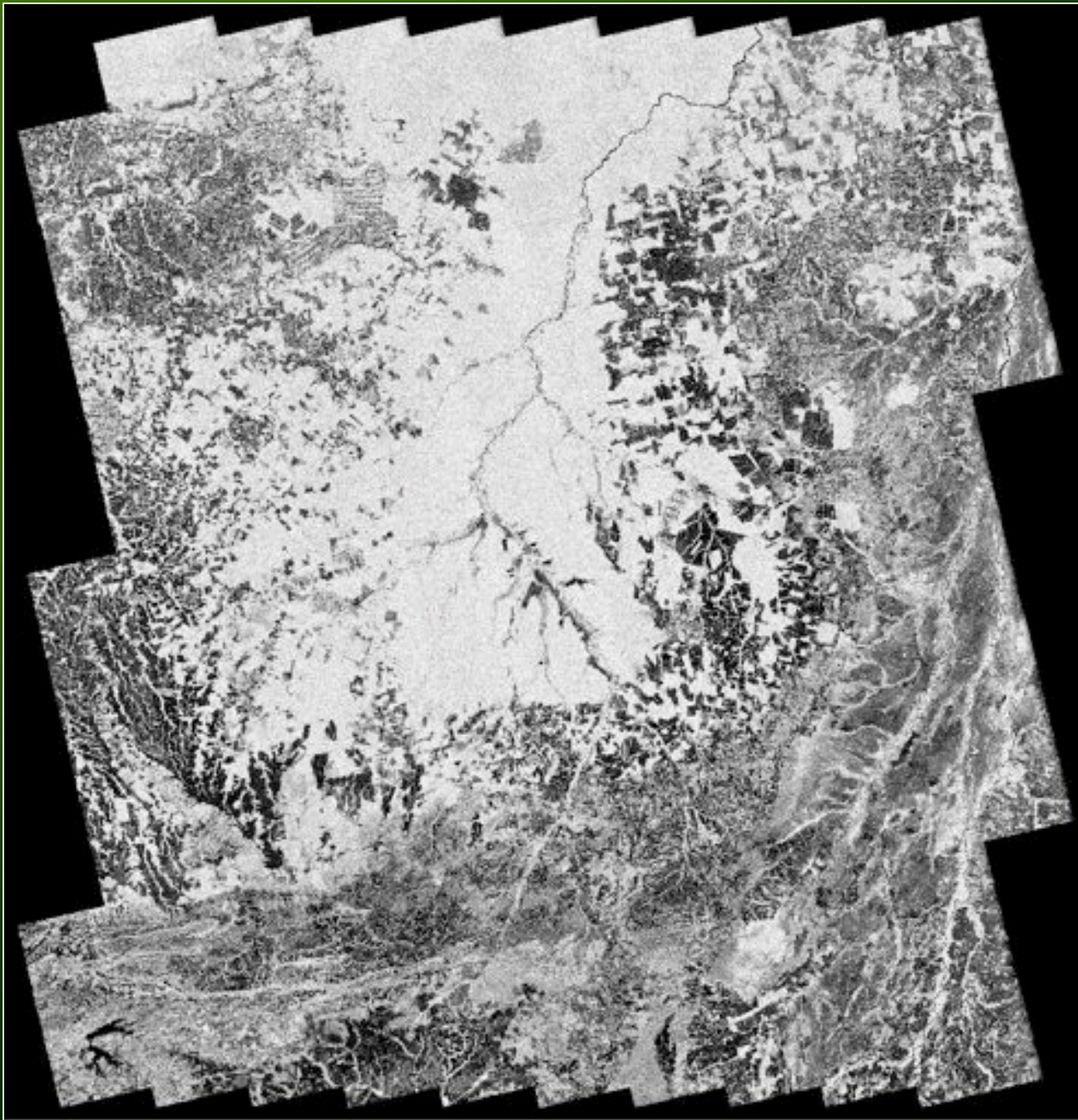
Acquisition Time Frame: June 6th to July 7th 2007
116 Scenes Selected

KelIndorfer, Shimada, Rosenqvist



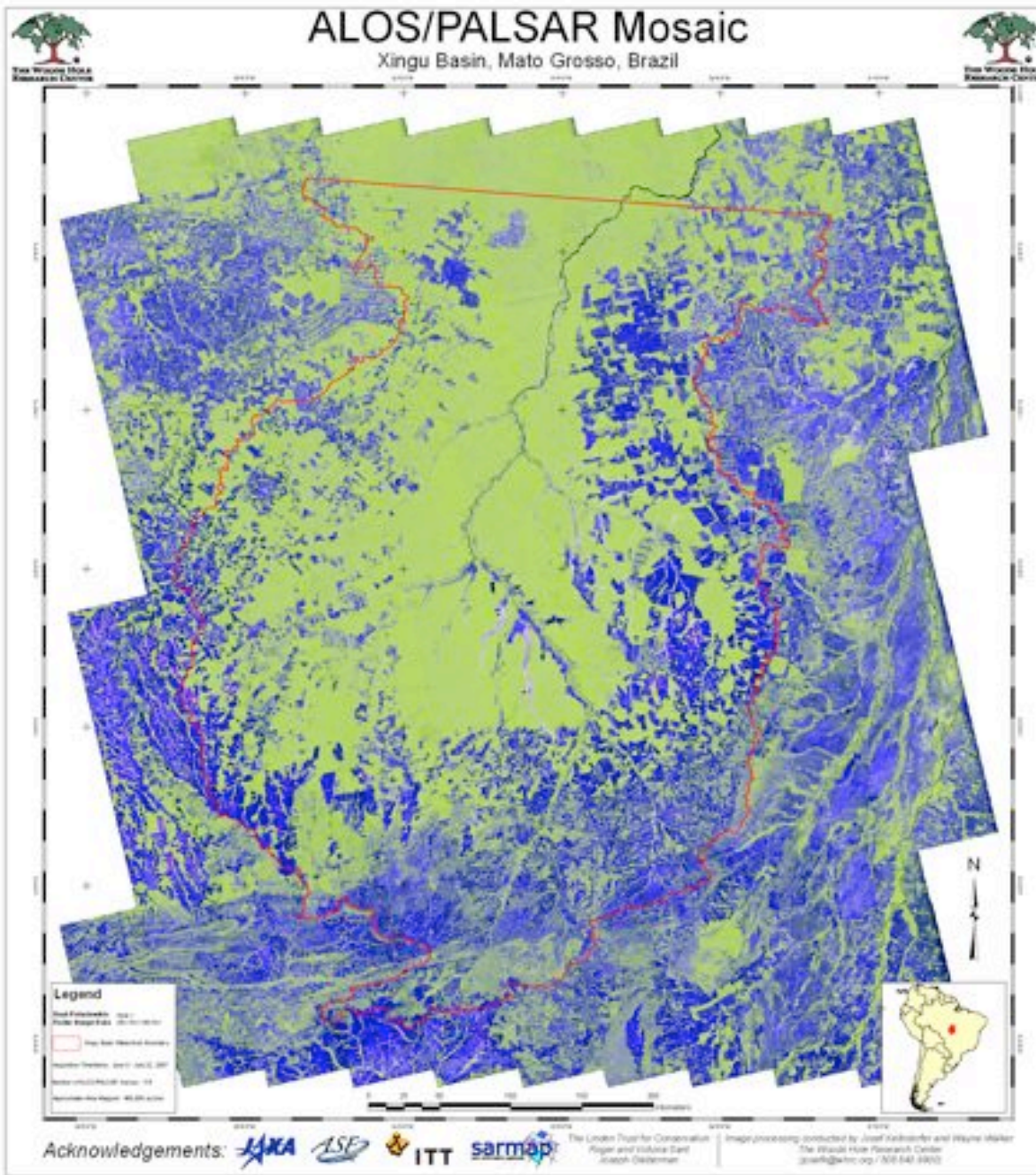
L-HH

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L-HV

KelIndorfer, Shimada, Rosenqvist



ALOS/ PALSAR Radar Image Mosaic of the Xingu Watershed

Data Acquisition:

6/8-7/22 2007

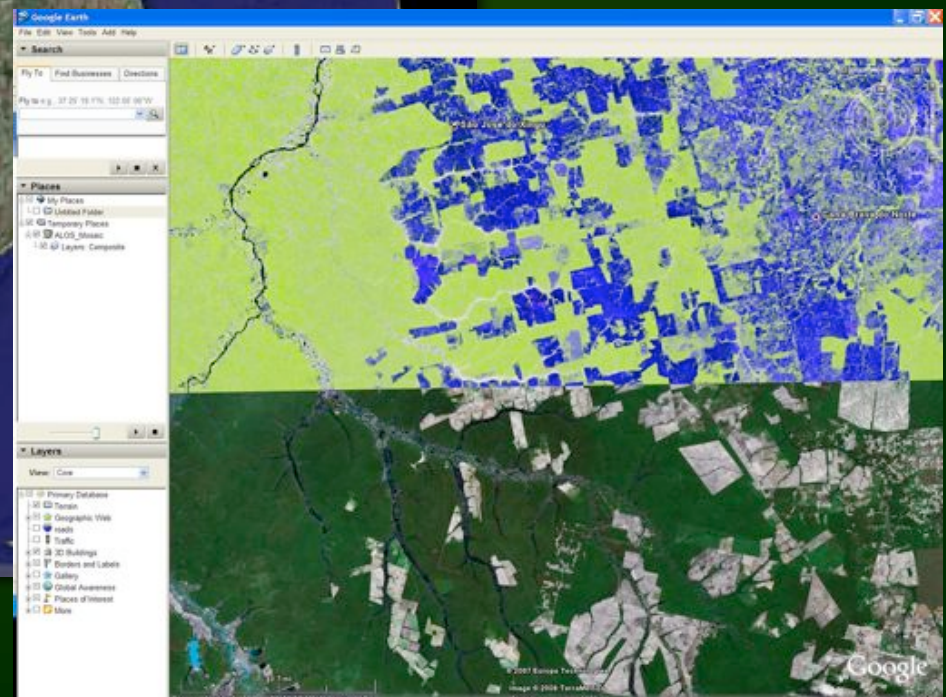
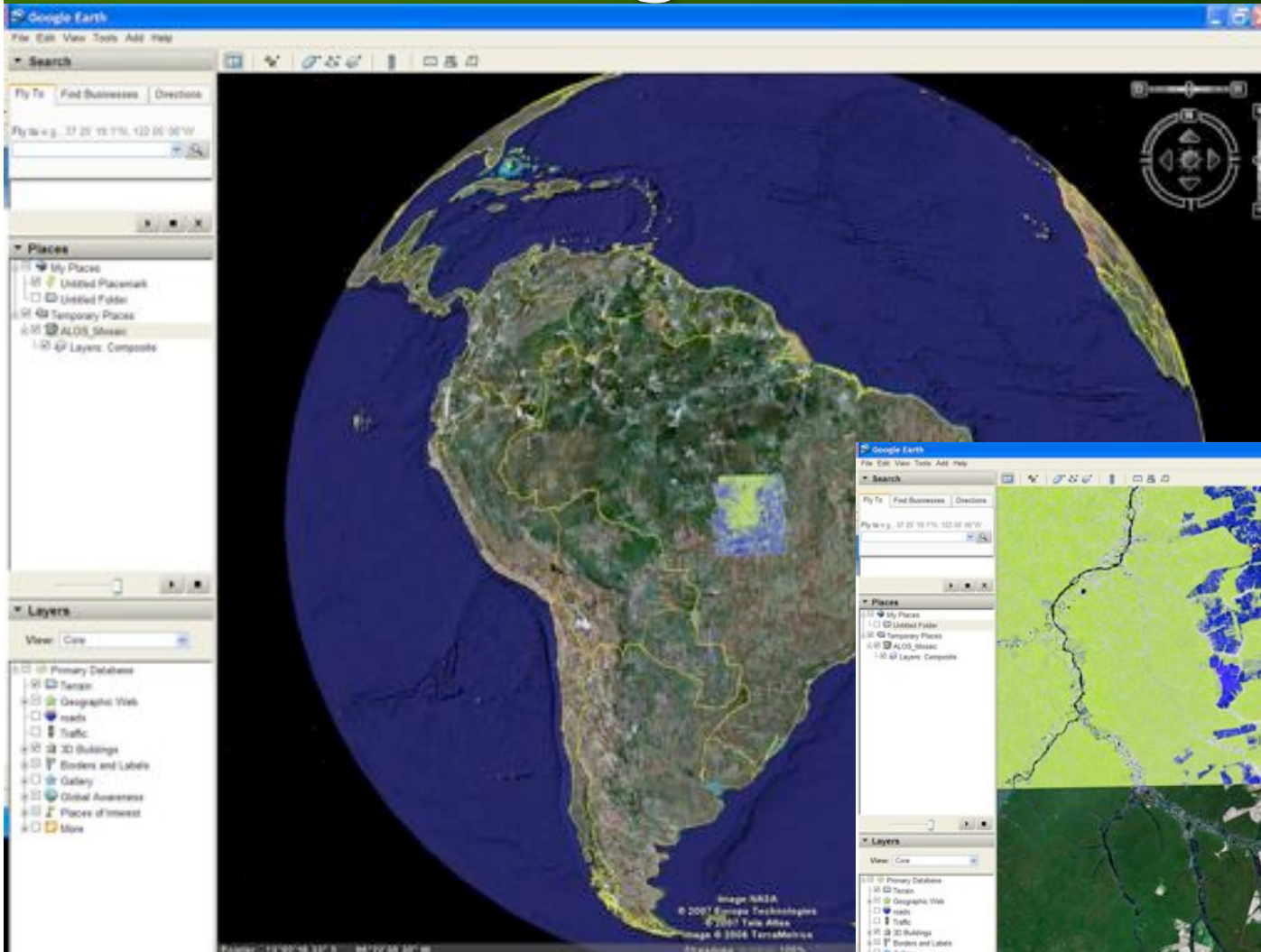
Number of Scenes:

116

Spacing: 25 m



In Google Earth ...

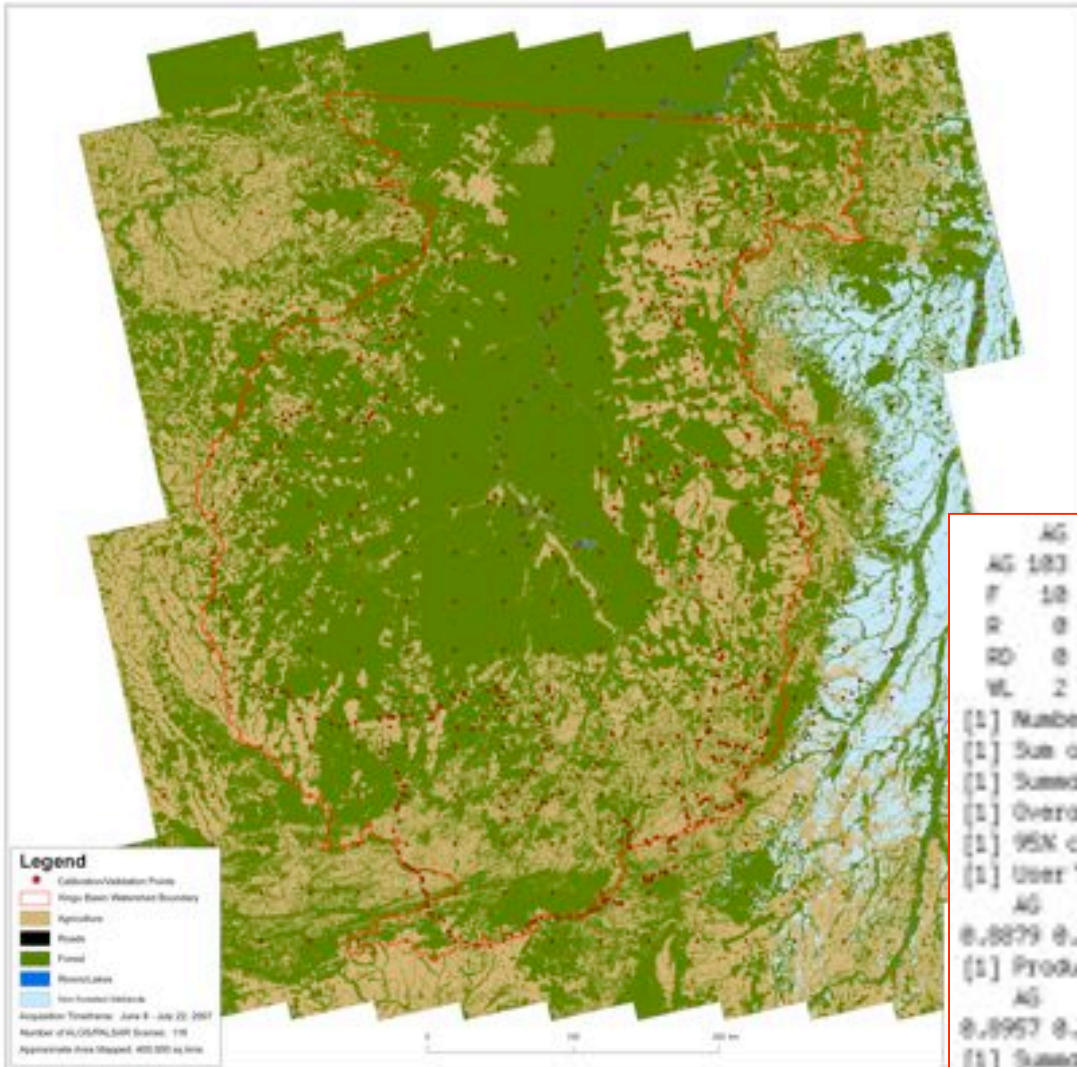


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ALOS/PALSAR Classification

Xingu Basin, Mato Grosso, Brazil



Classification Results

627 samples
30% withheld for testing

	AG	F	R	RD	WL
AG	183	18	2	0	1
F	18	124	0	0	0
R	0	0	13	0	0
RD	0	0	0	3	0
WL	2	1	0	0	6

```
[1] Number of observations: 275
[1] Sum of weighted sum of row, column weights: 1 , 1
[1] Summary of weighted naive statistics
[1] Overall accuracy, stdev, CV%: 0.9055 , 0.0176 , 1.9
[1] 95% confidence limits for accuracy:0.8691...0.9419
[1] User's weighted accuracy
AG F R RD WL
0.8879 0.9254 1.0000 1.0000 0.6667
[1] Producer's weighted reliability:
AG F R RD WL
0.8957 0.9185 0.9667 1.0000 0.6571
[1] Summary of weighted kappa statistics
[1] Overall weighted kappa, stdev, & CV%: 0.8372 , 0.0385 , 3.6
[1] 95% confidence limits for weighted kappa:0.7757...0.8988
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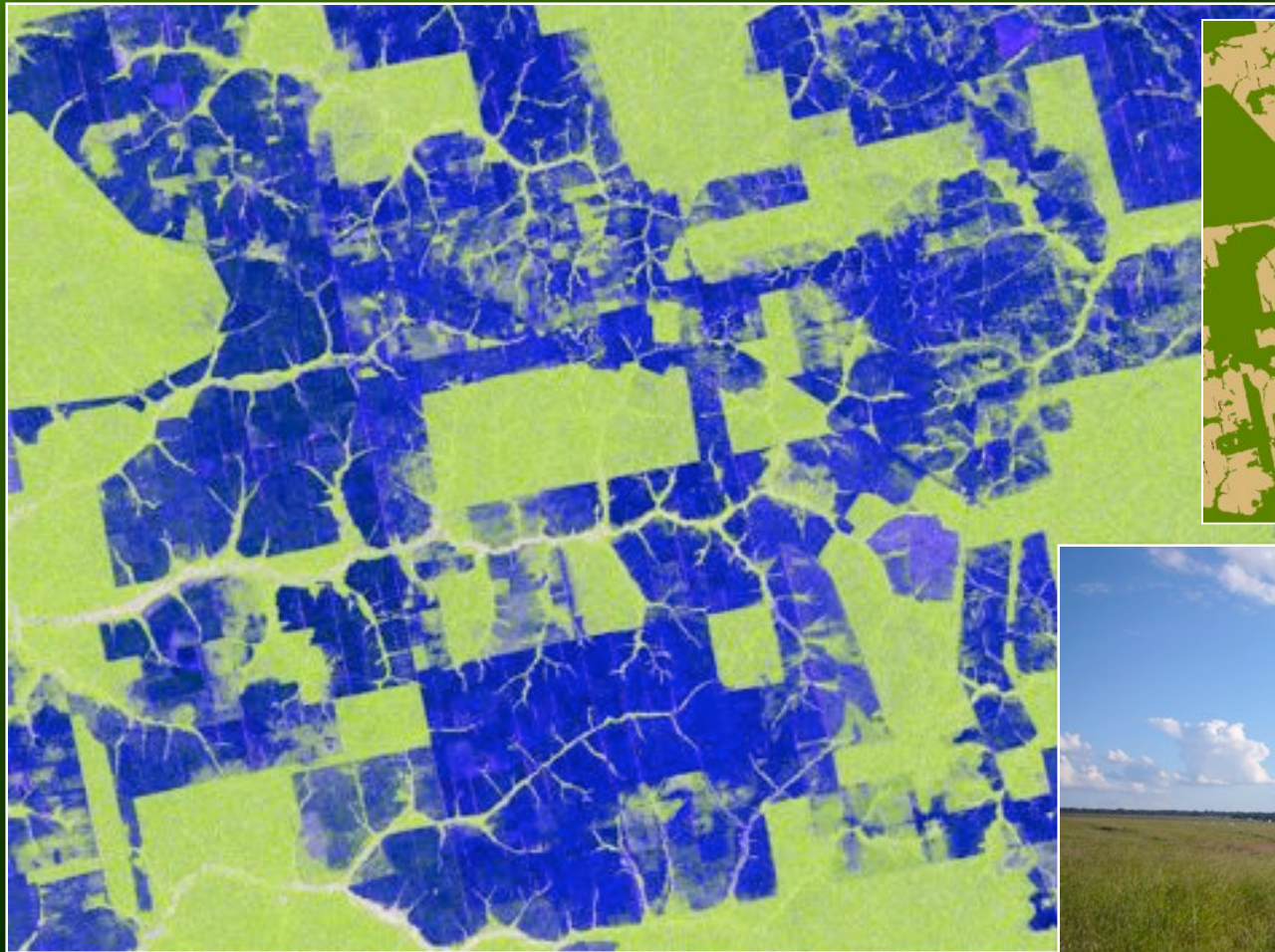
Acknowledgements:



The Linden Trust for Conservation
Roger and Victoria Sant
Joseph Gleditsman

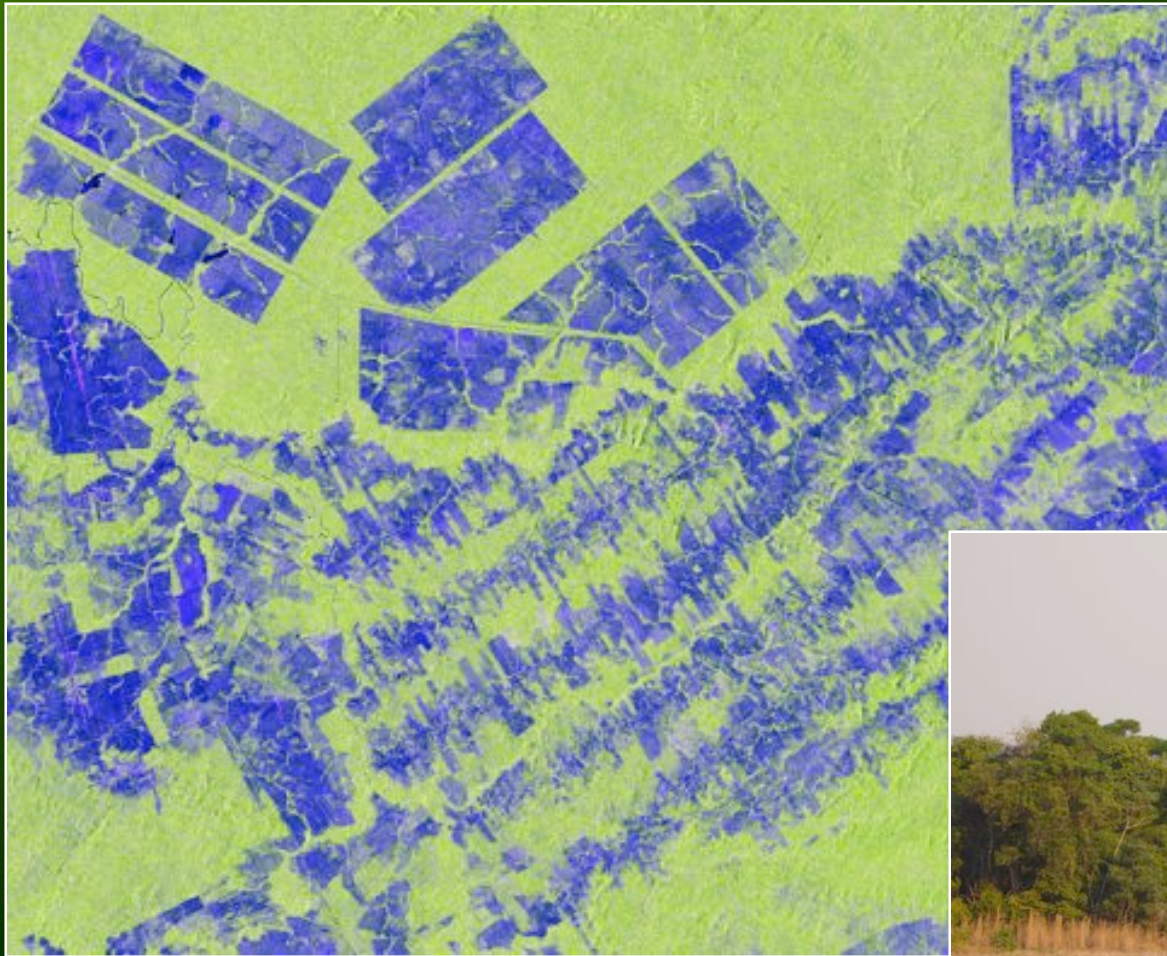
Image processing conducted by Josef
The Woods Hole Res
josef@whoi.org / 78

Large-Holder Pasture Expansion as seen by ALOS/PALSAR



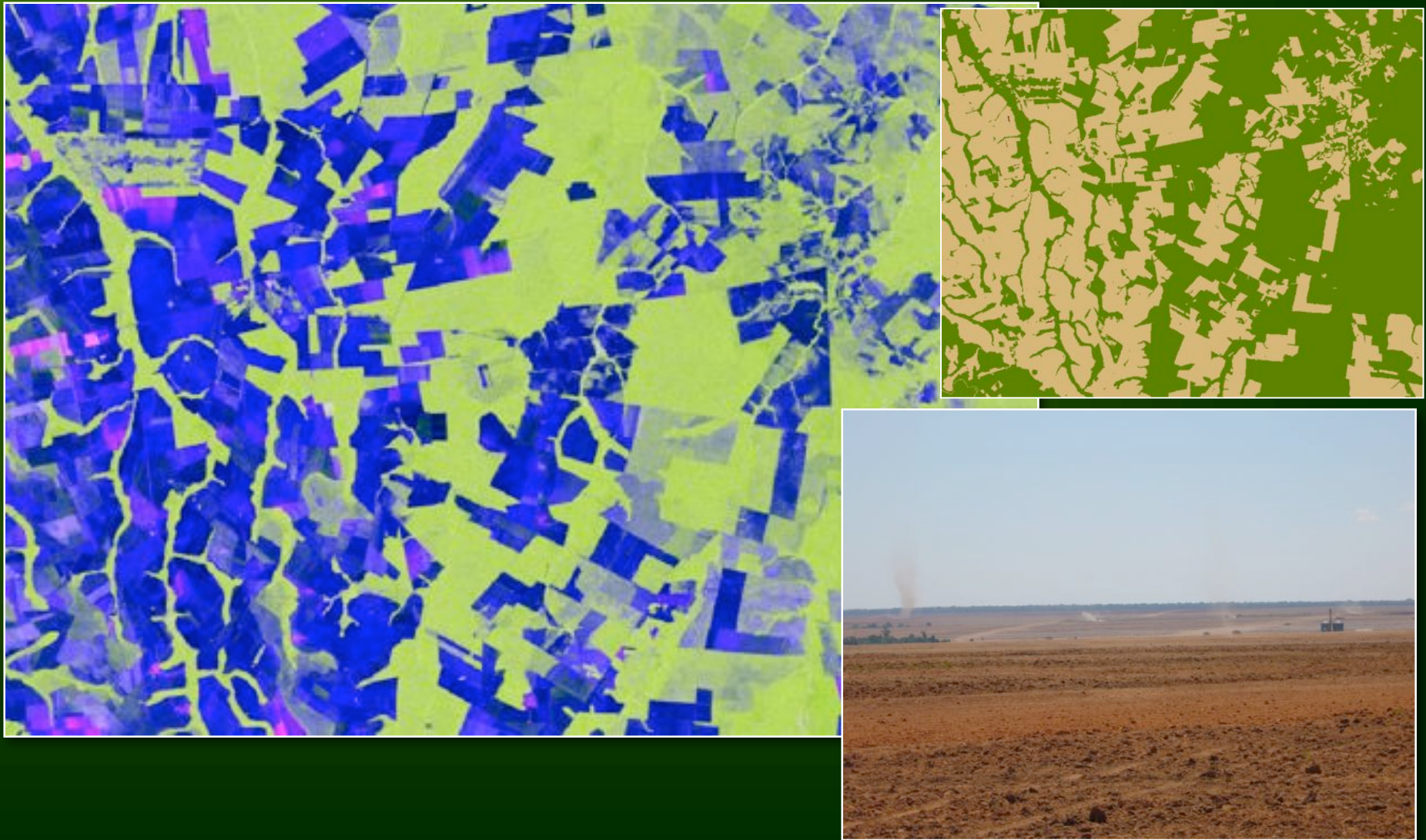
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Small-Holder meets Large-Holder as seen by ALOS/PALSAR



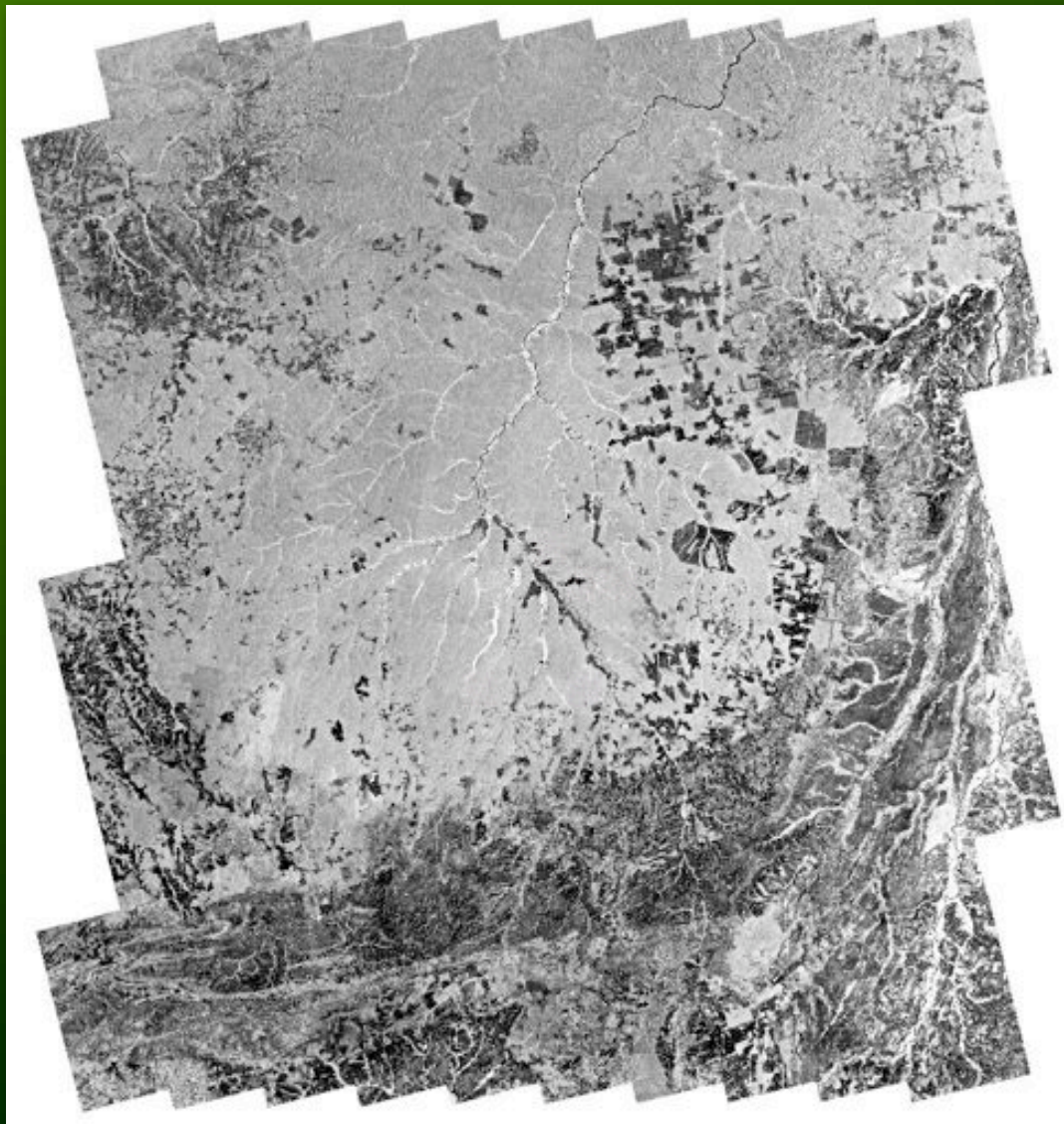
KelIndorfer, Shimada, Rosenqvist

Large-Holder Soy-Field Expansion as seen by ALOS/PALSAR



KelIndorfer, Shimada, Rosenqvist

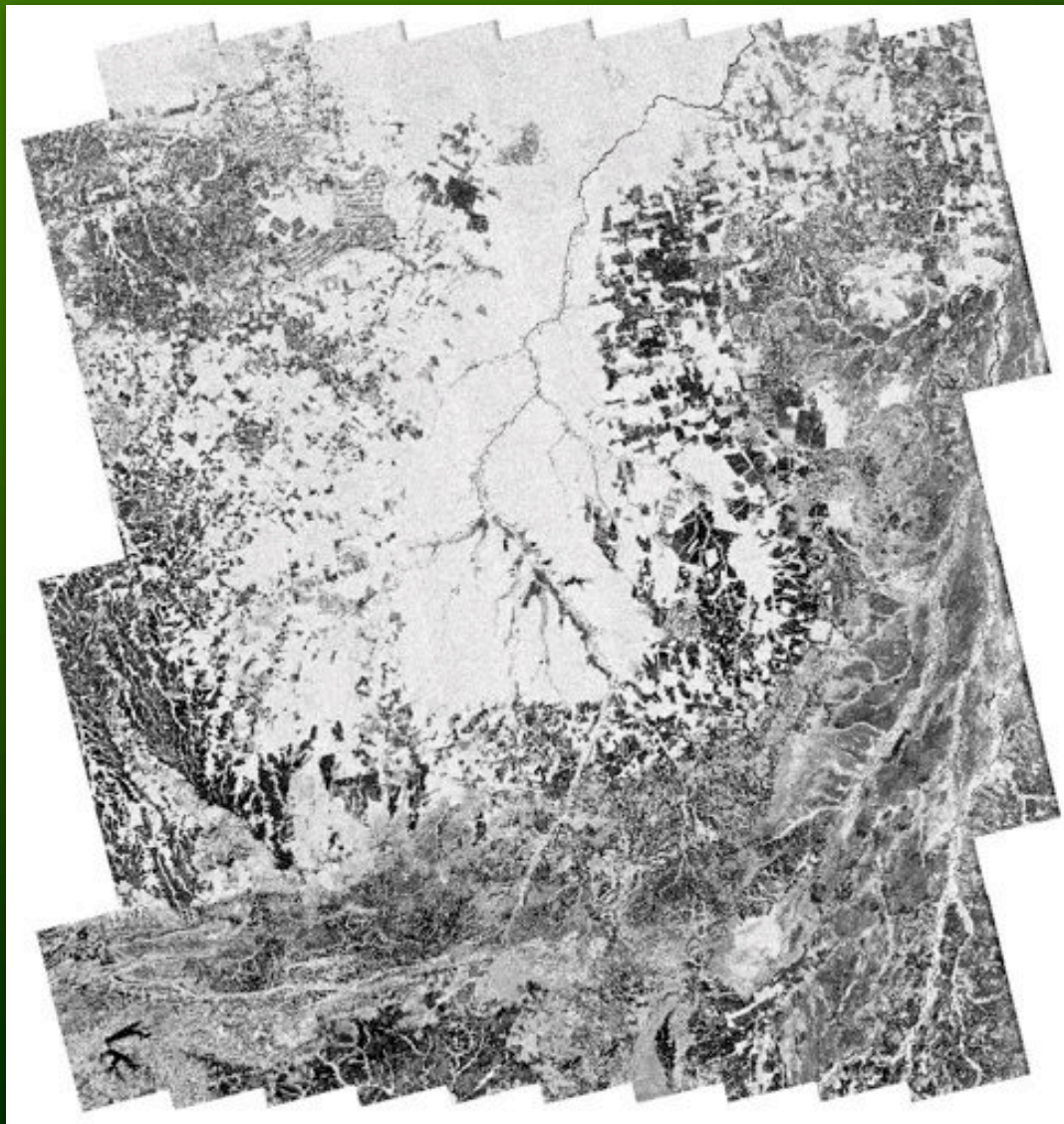
11 Year Change ...



JERS-1 GRFM data 1996

KelIndorfer, Shimada, Rosenqvist

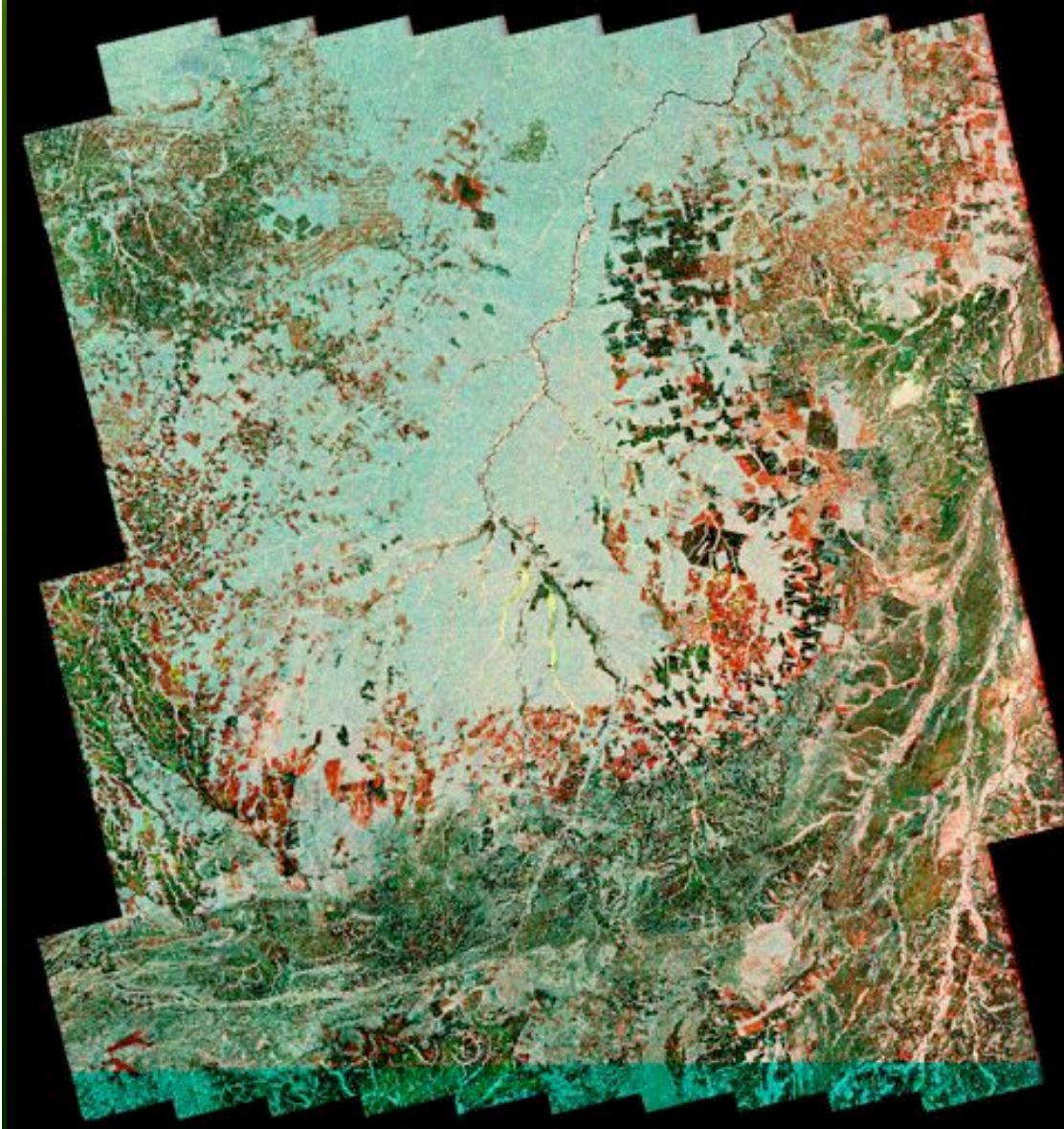
11 Year Change ...



ALOS L-HV 2007

KelIndorfer, Shimada, Rosenqvist

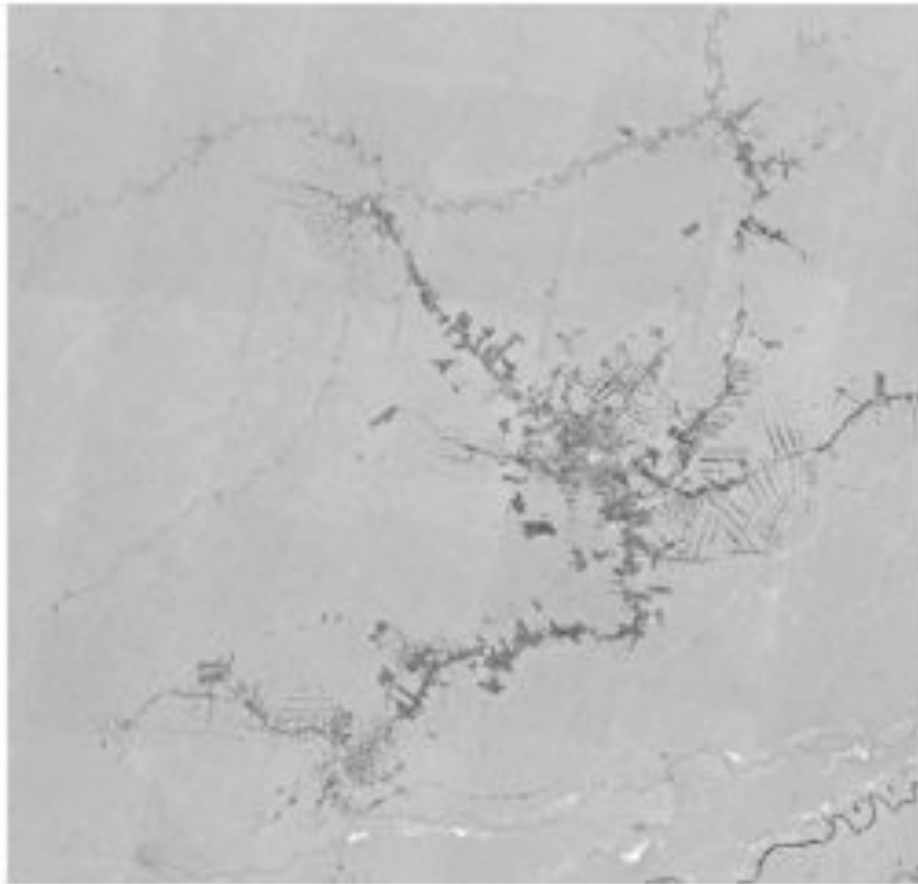
11 Year Change between JERS-1 and ALOS



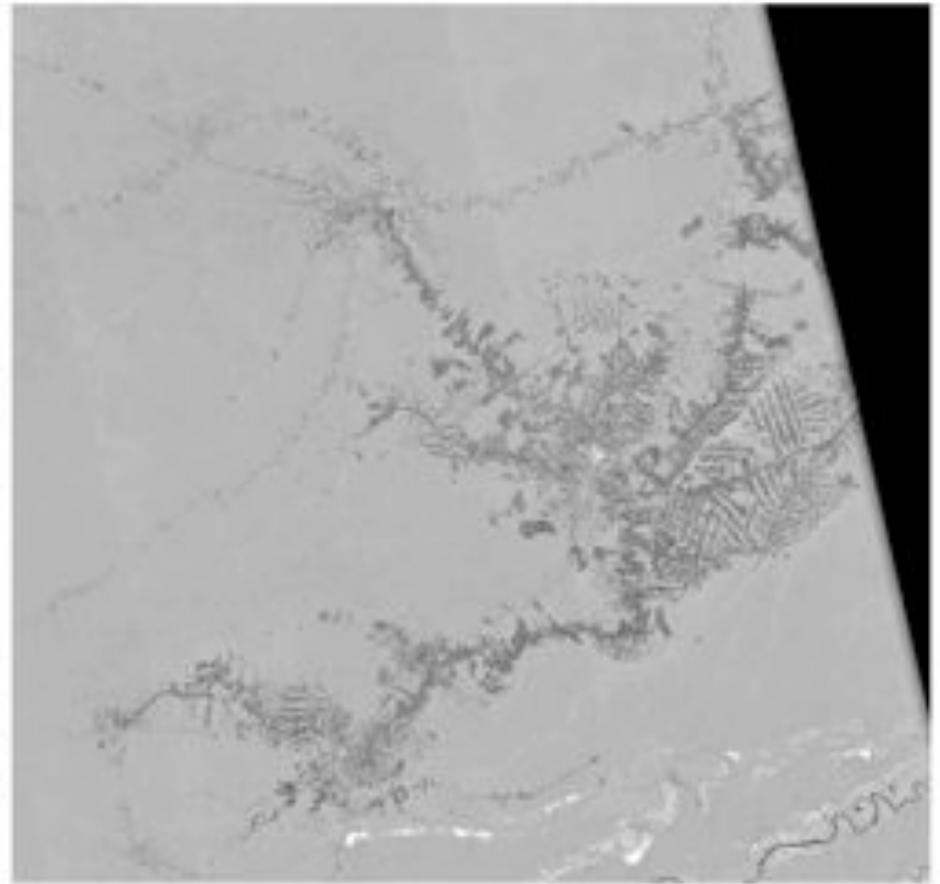
Red JERS-1 LHH
Green ALOS LHH
Blue ALOS LHV

Deforested Areas between
1996 and 2007 appear in red

Amazon Mosaic – Rondonia Area



JERS (Sep/Dec, 1995, pixel spacing=100m)



PALSAR (2006, pixel spacing=50m)

0 100km

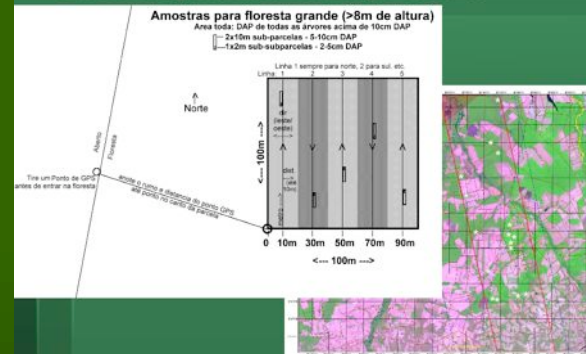
Mode : FBS41.5[deg]
Polarization : HH
Map projection : Mercator



Biomass and Degradation

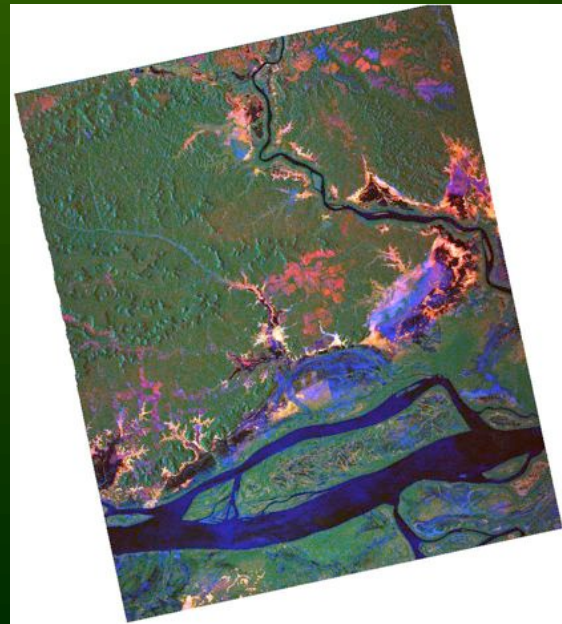
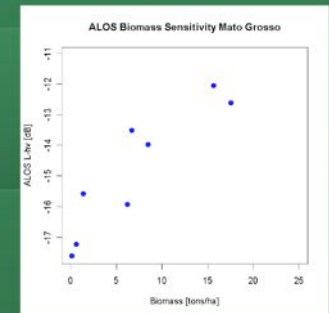
- ◆ Encouraging first results
- ◆ Need to quantify strength and limitations

Biomass Sampling in Mato Grosso, Amazonia, Brazil



ALOS Sensitivity to Forest Biomass

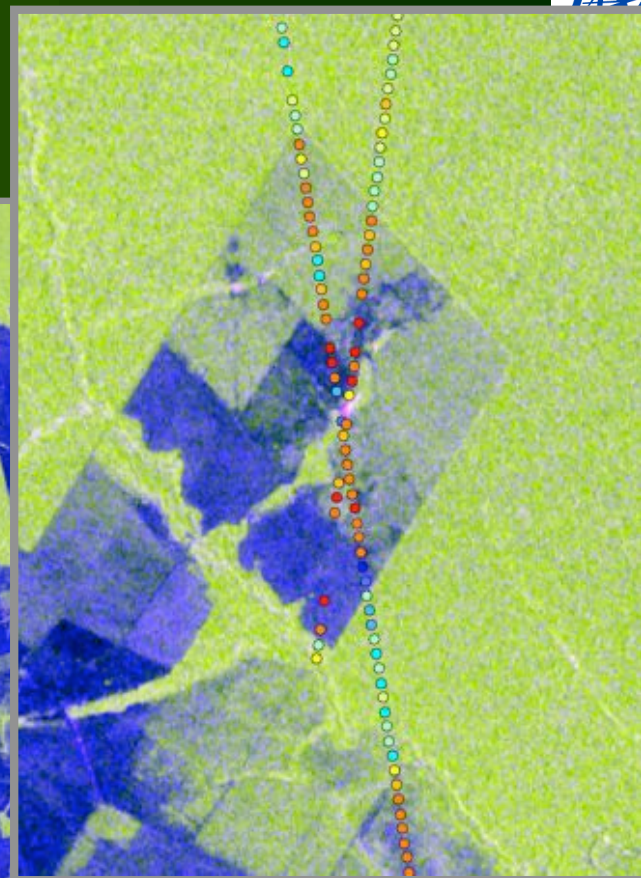
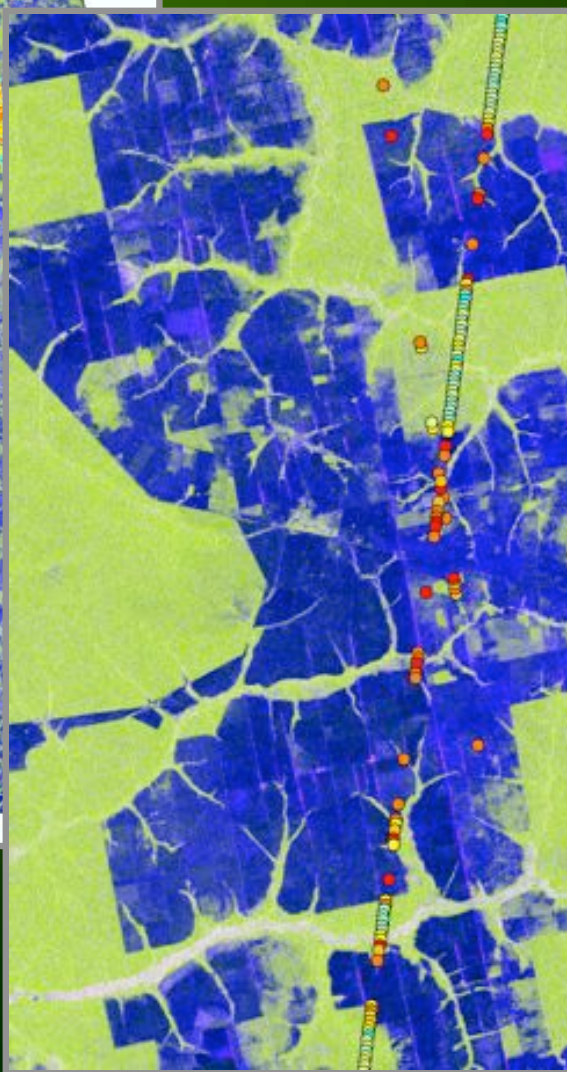
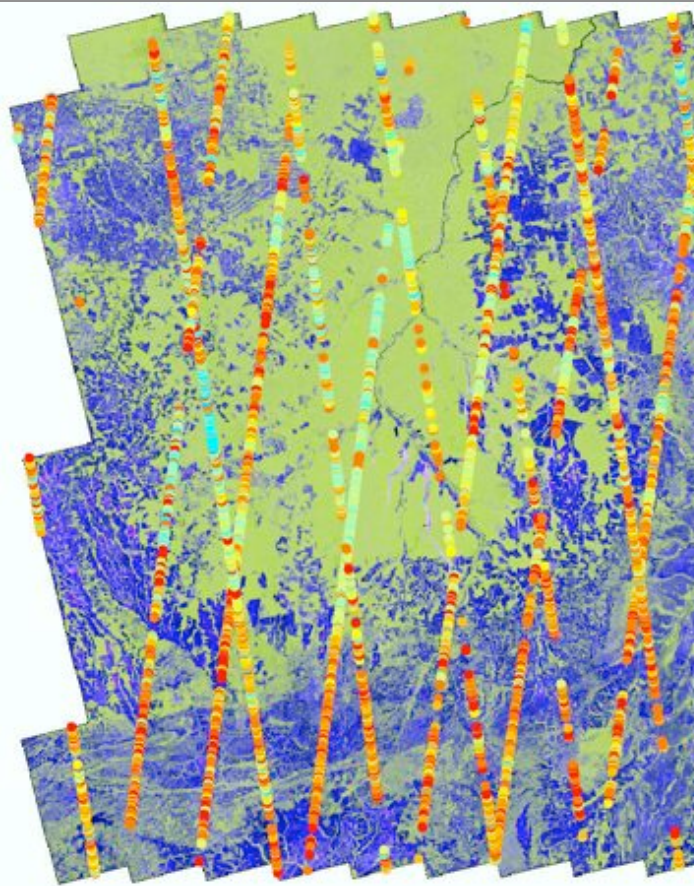
- ◆ ALOS L-HV compared to Regrowth Forest Biomass using Brown allometric Equations



Degradation Sensitivity With Repeat pass Interferometry

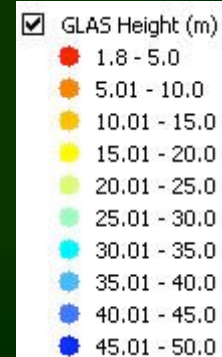
Courtesy F. Holecz

ALOS PALSAR/ICESat GLAS Synergy



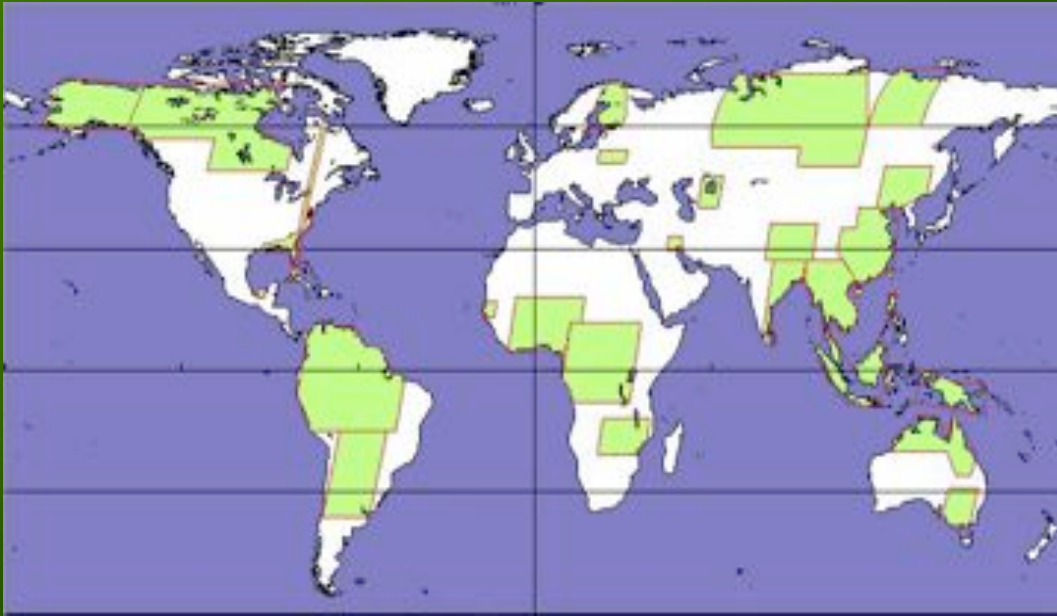
GLAS Data Processing:
Goetz, Baccini, Sun, WHRC.

ALOS Processing:
KelIndorfer, Walker, WHRC.



KelIndorfer, Shimada, Rosenqvist

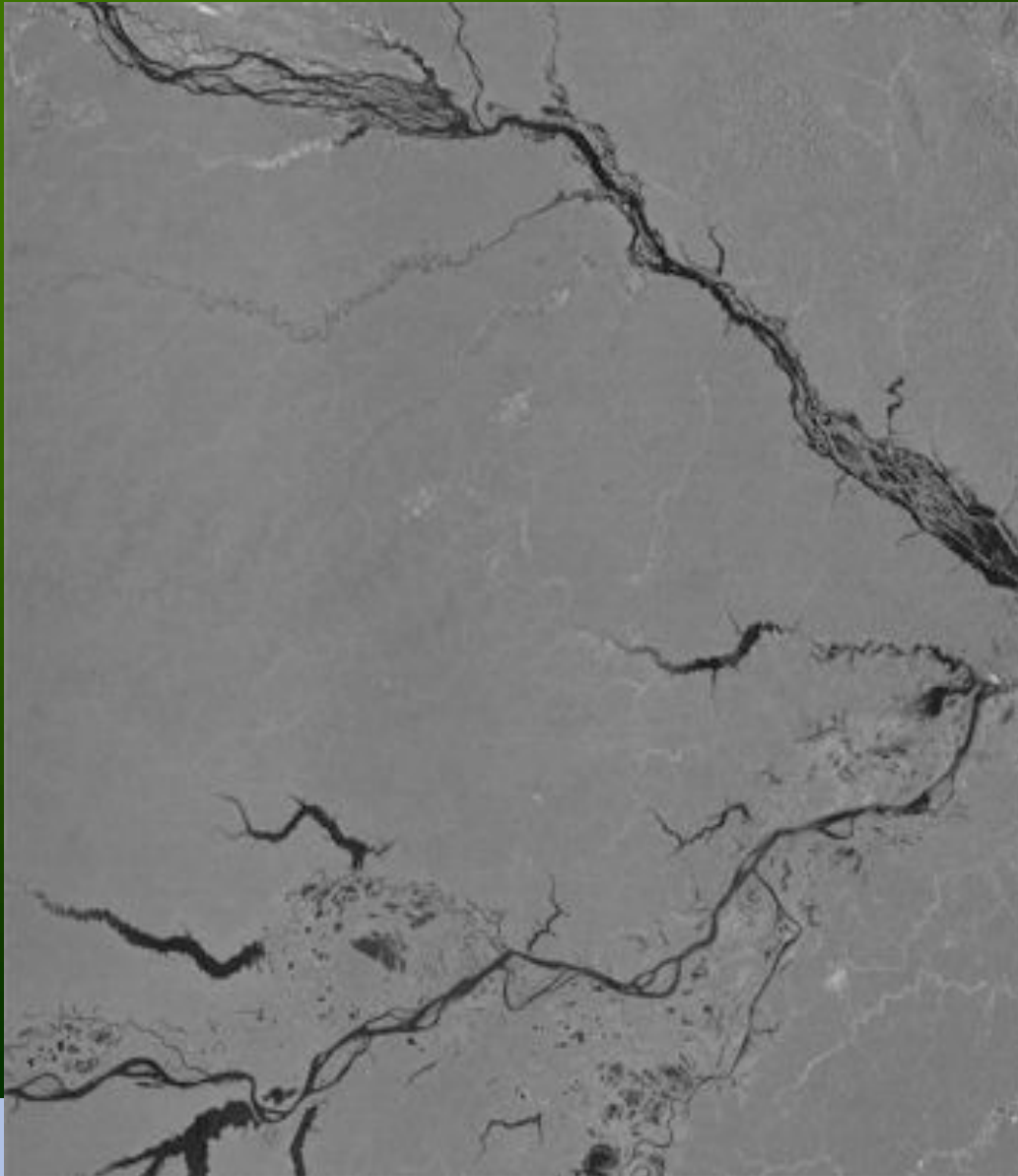
ScanSAR use for inundation monitoring



- ScanSAR will be used to for intensive monitoring of seasonal inundation dynamics in major wetlands and river basins
- Every-cycle (46-days) monitoring during 8-10 consecutive cycles

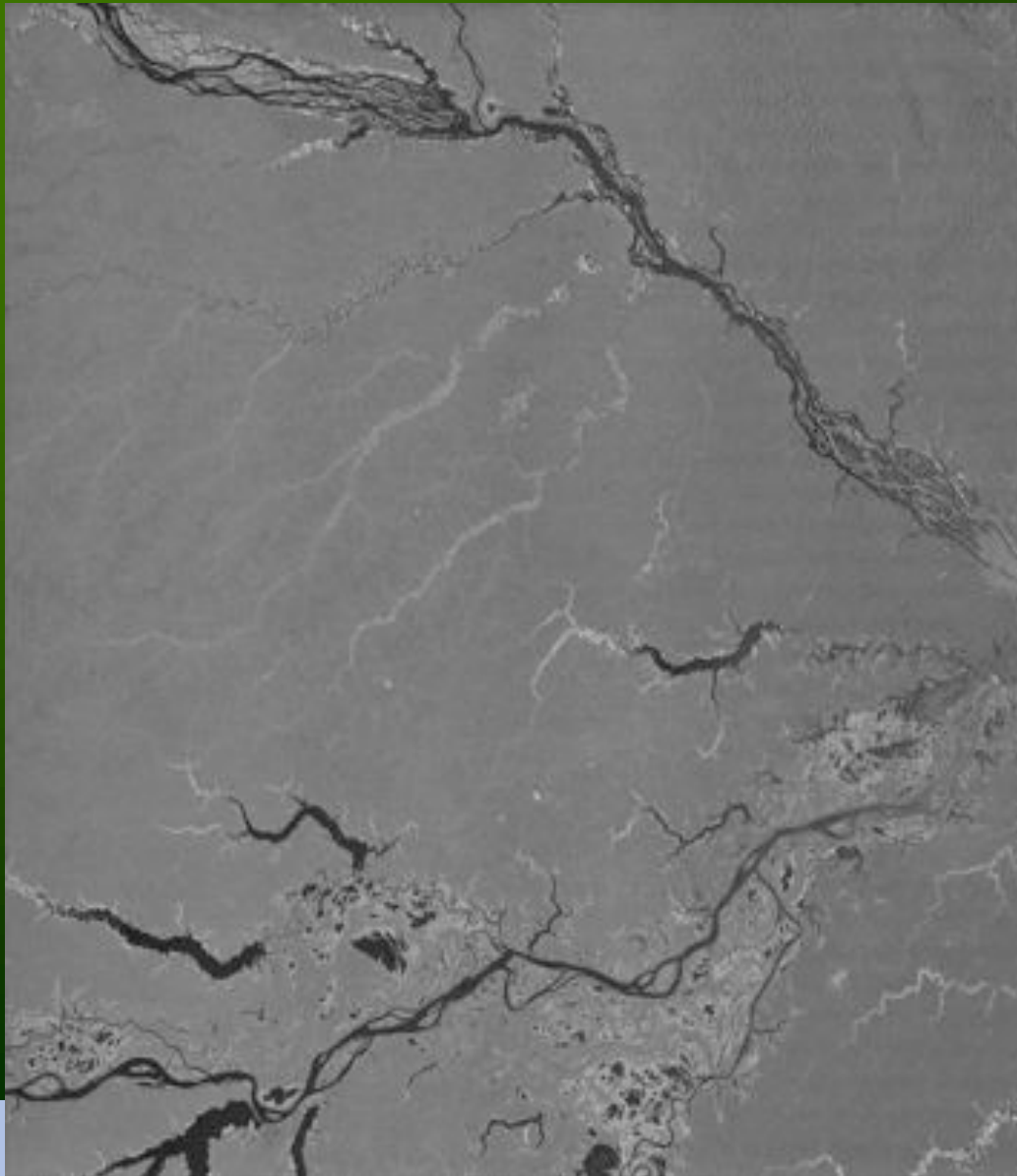
ScanSAR Wetlands Descending	2005				2006												2007									2008																													
	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11	1	2	3													
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33																										
West Siberia																																																							
Lena Delta																																																							
Volga Delta																																																							
Amur																																																							
East Asia paddy																																																							
India paddy																																																							
Mainland SE-Asia																																																							
Insular SE-Asia																																																							
PNG																																																							
North Australia																																																							
Pripet-Biebrza																																																							
Niber Basin																																																							
Congo Basin																																																							
Okavango-Mozambique																																																							
ASF mask																																																							
BOREAS SSA																																																							
Quebec-Everglades																																																							
Amazon Basin																																																							
Pantanal																																																							

ScanSAR for monitoring of forest inundation



2006-11-04

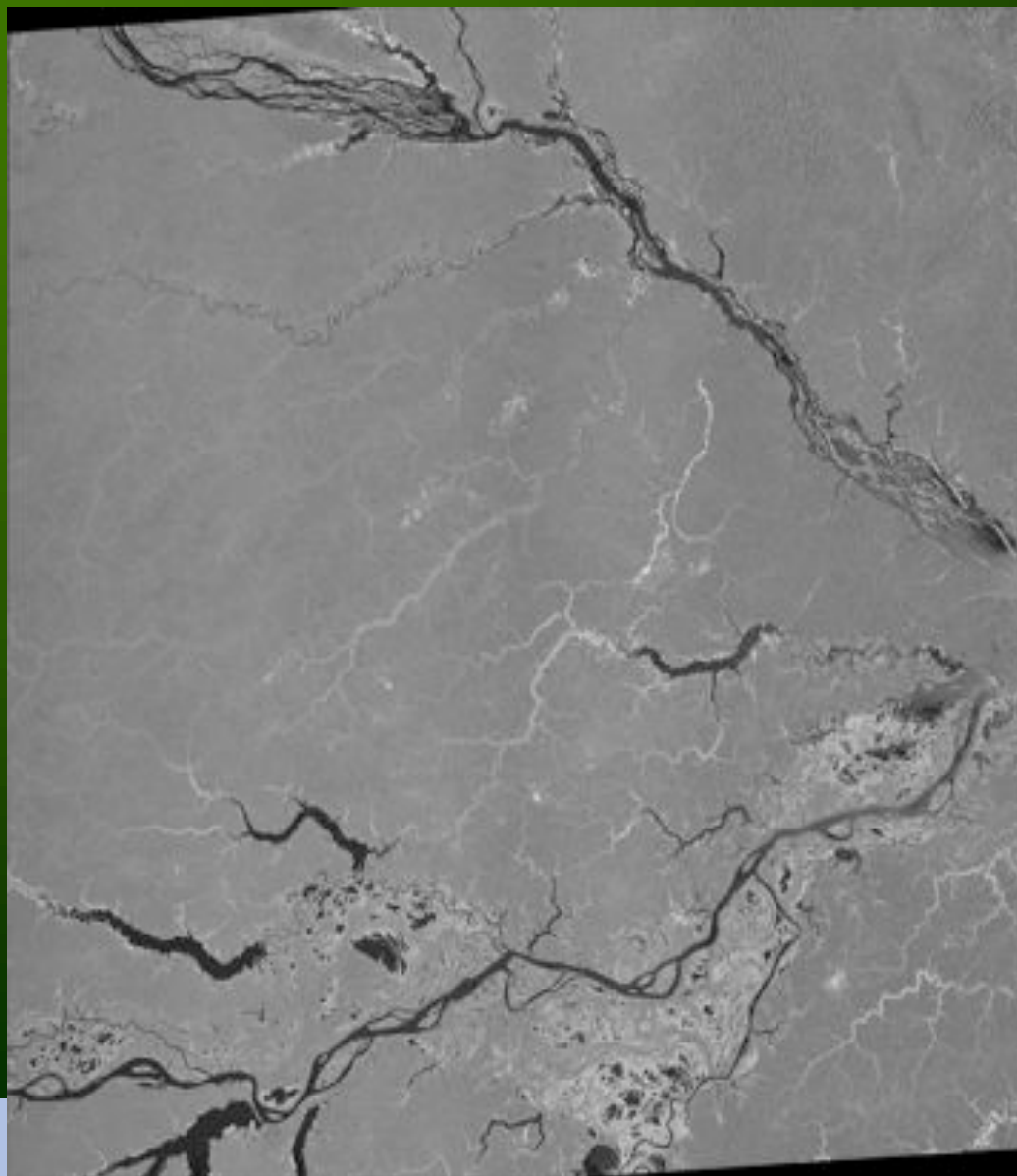
ScanSAR for monitoring of forest inundation



2006-11-04

2007-02-04 (WB2)

ScanSAR for monitoring of forest inundation

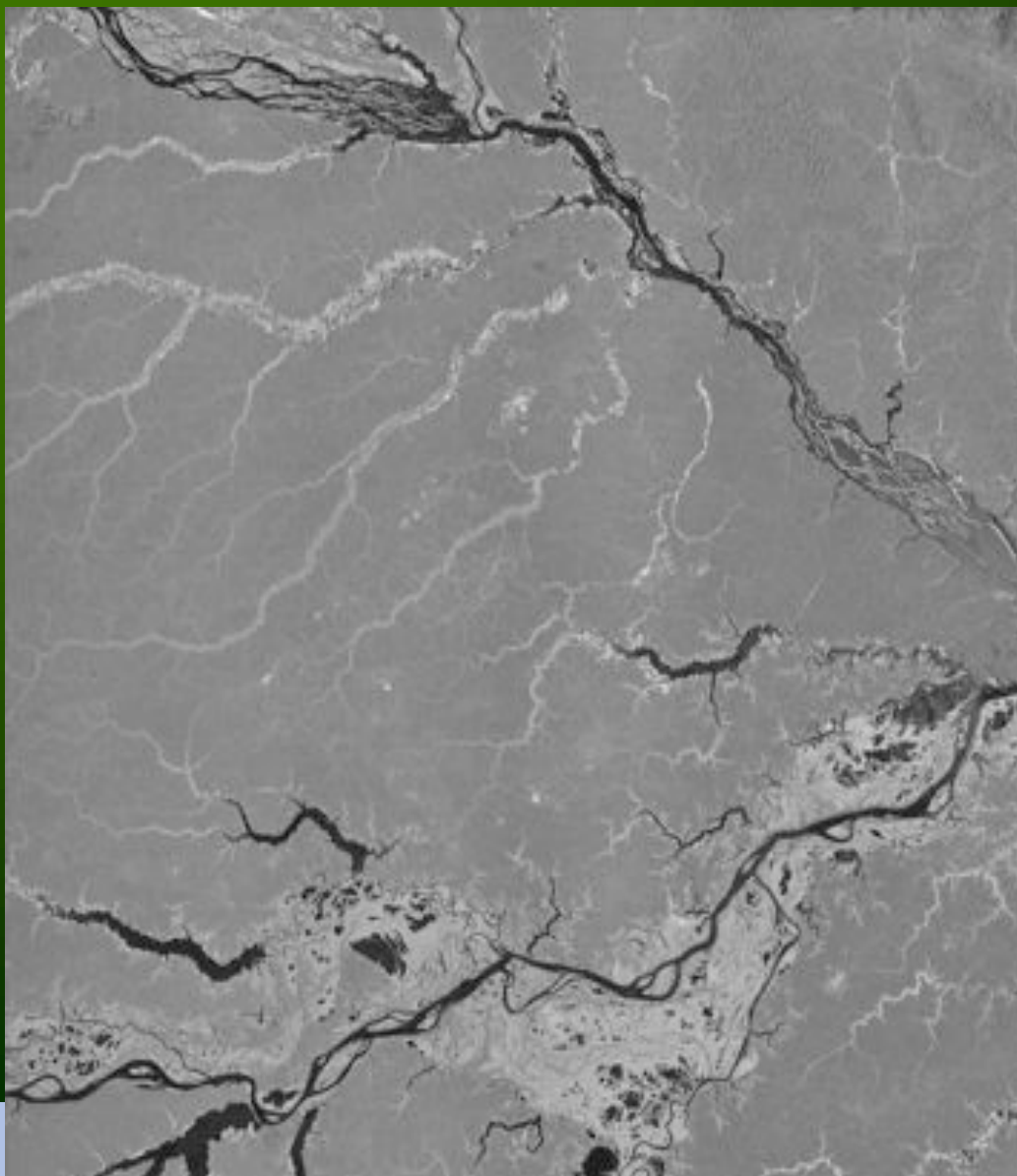


2006-11-04

2007-02-04 (WB2)

2007-03-22

ScanSAR for monitoring of forest inundation



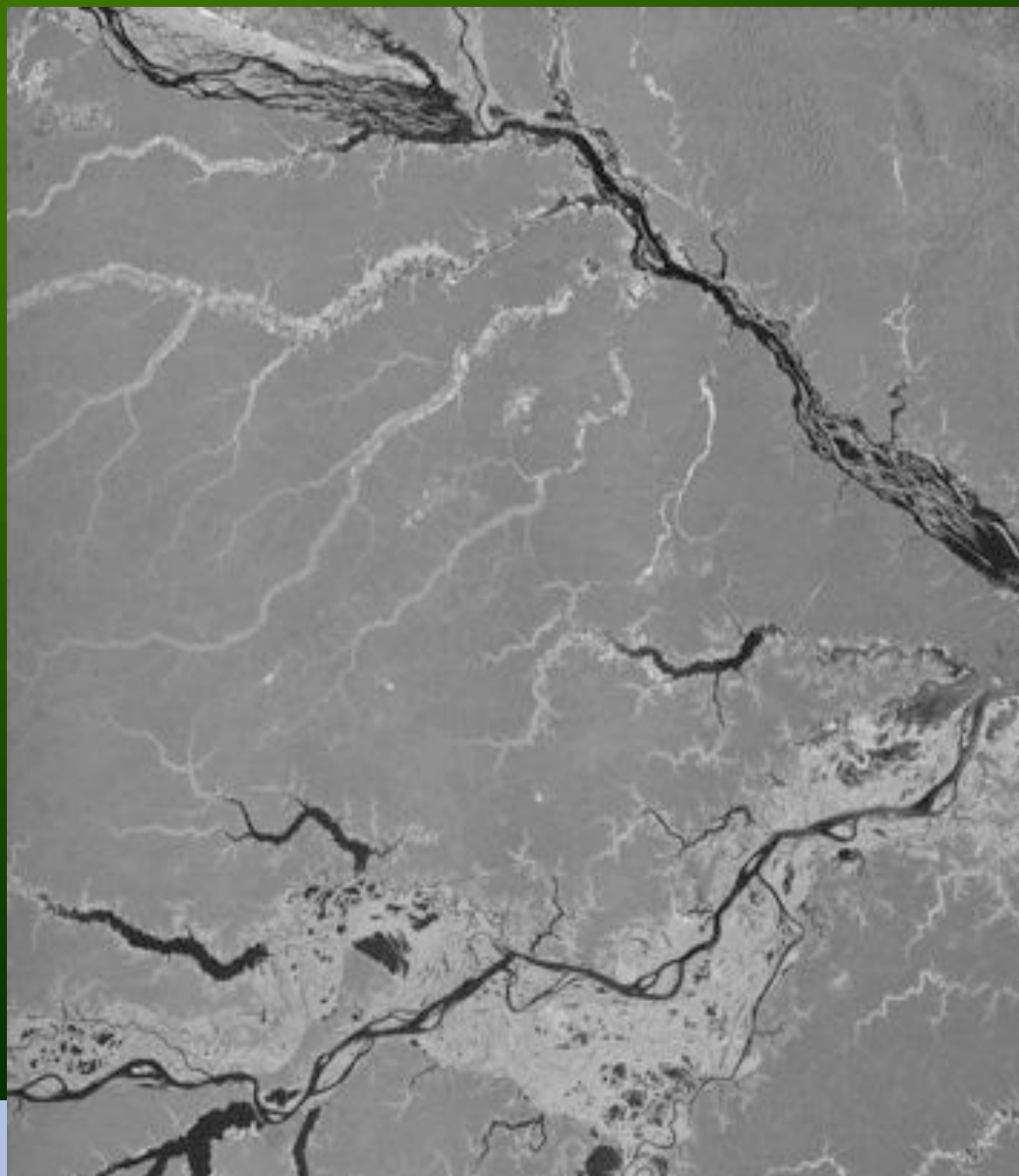
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2007-02-04 (WB2)

2007-03-22

2007-05-07

ScanSAR for monitoring of forest inundation



2006-11-04

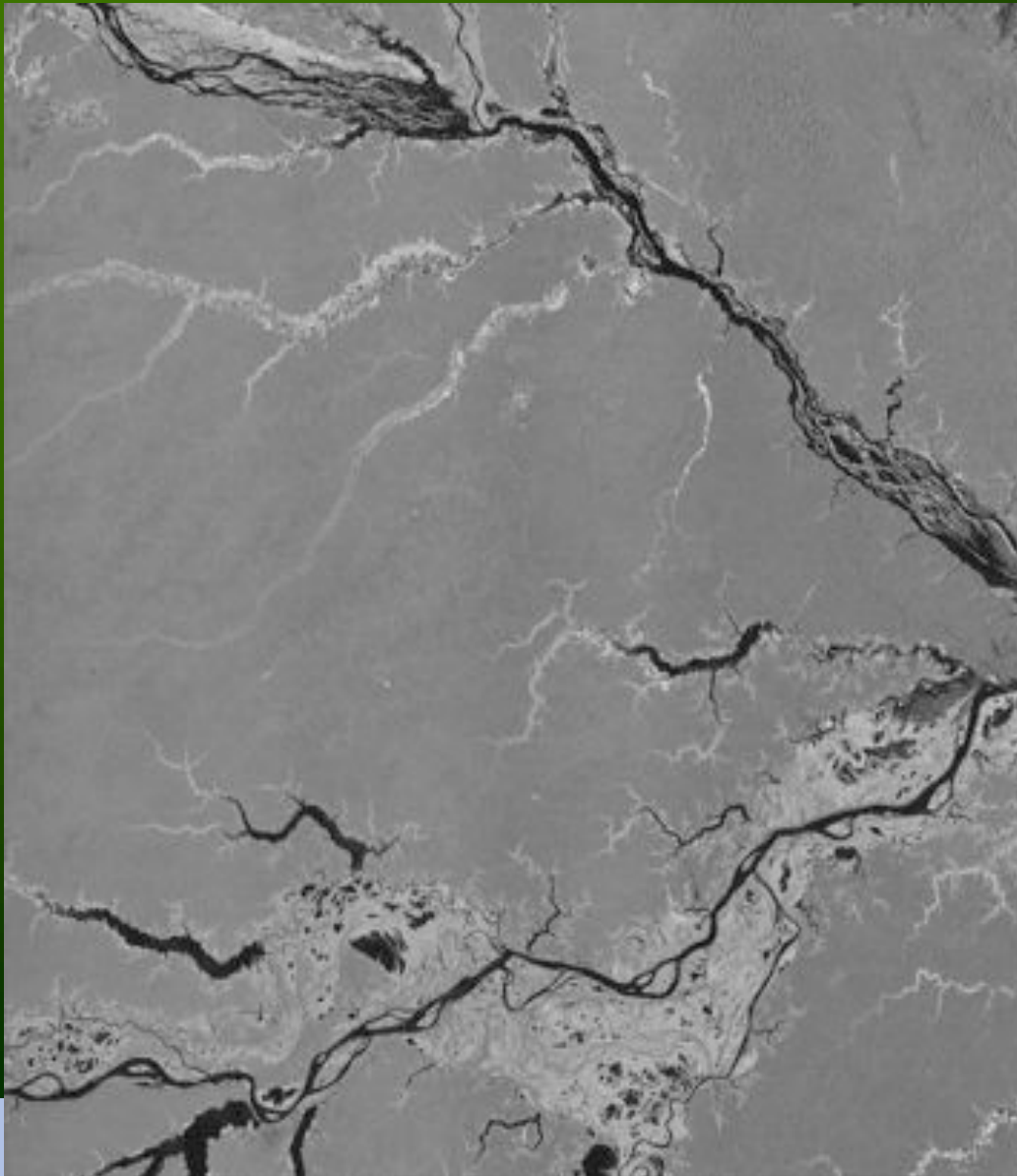
2007-02-04 (WB2)

2007-03-22

2007-05-07

2007-06-22

ScanSAR for monitoring of forest inundation



2006-11-04

2007-02-04 (WB2)

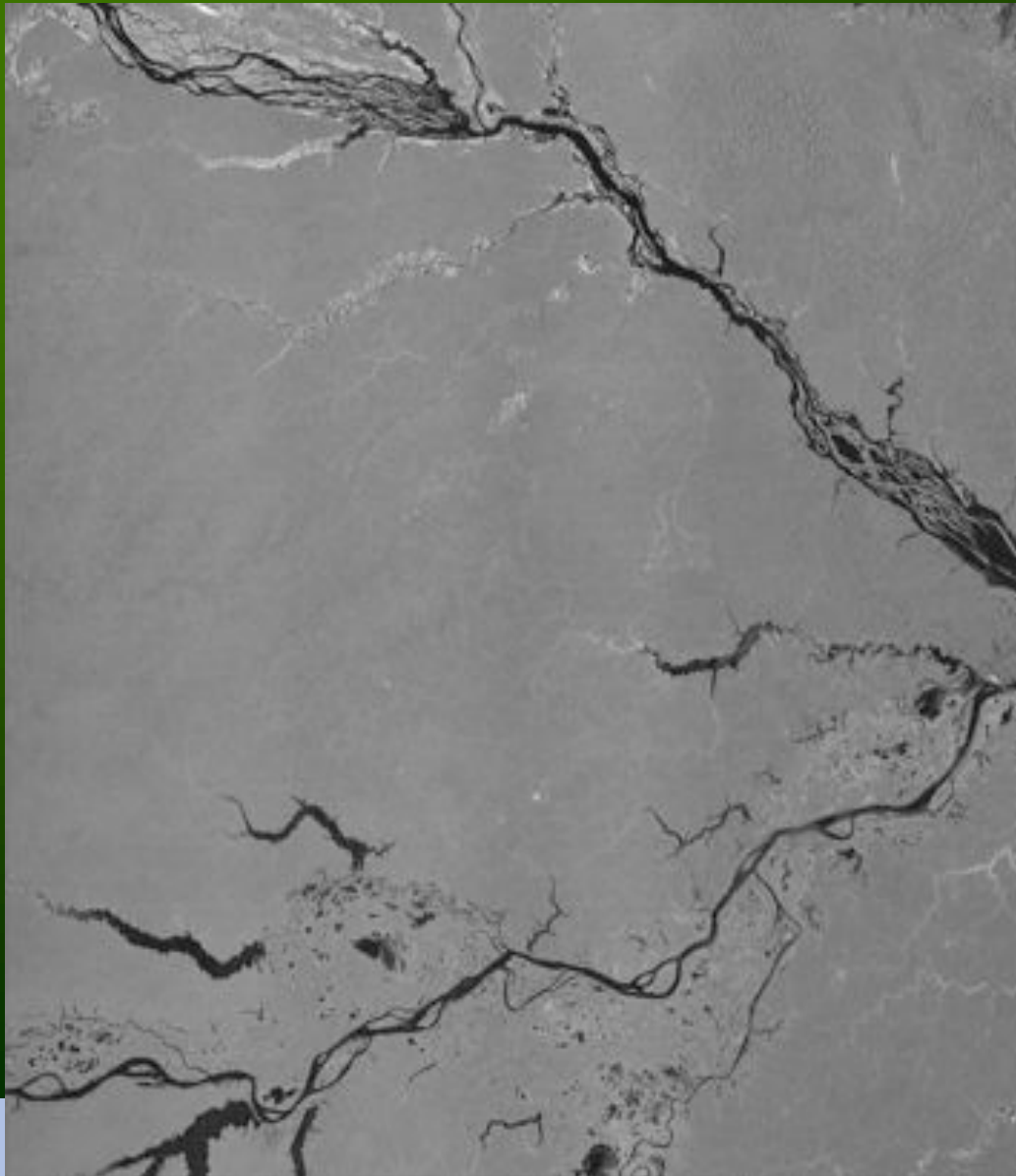
2007-03-22

2007-05-07

2007-06-22

2007-08-07

ScanSAR for monitoring of forest inundation



2006-11-04

2007-02-04
(WB2)

2007-03-22

2007-05-07

2007-06-22

2007-08-07

2007-09-22

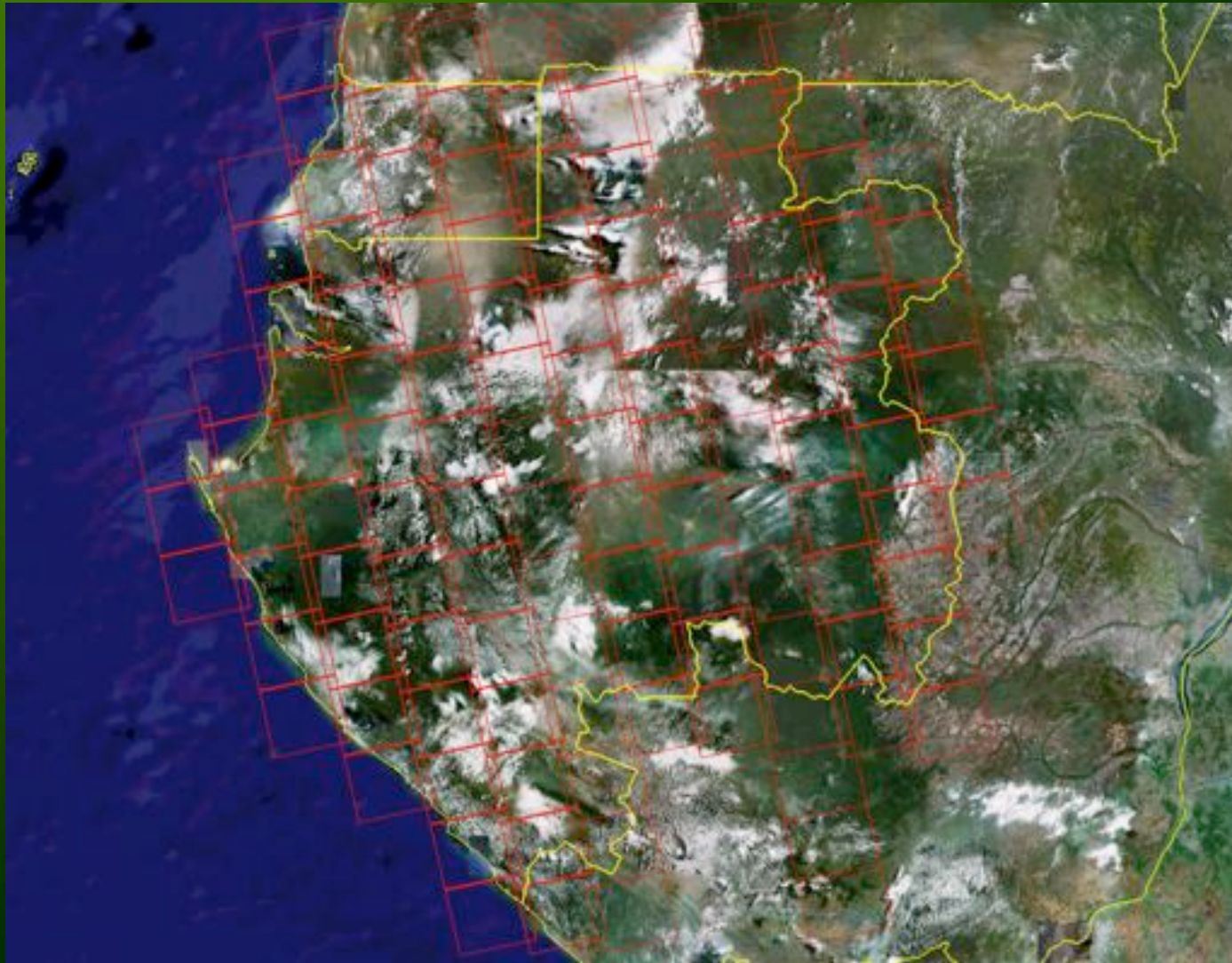
ALOS Maps Africa

ALOS/PALSAR Dual-Pol Mosaic of Gabon and Equatorial Guinea



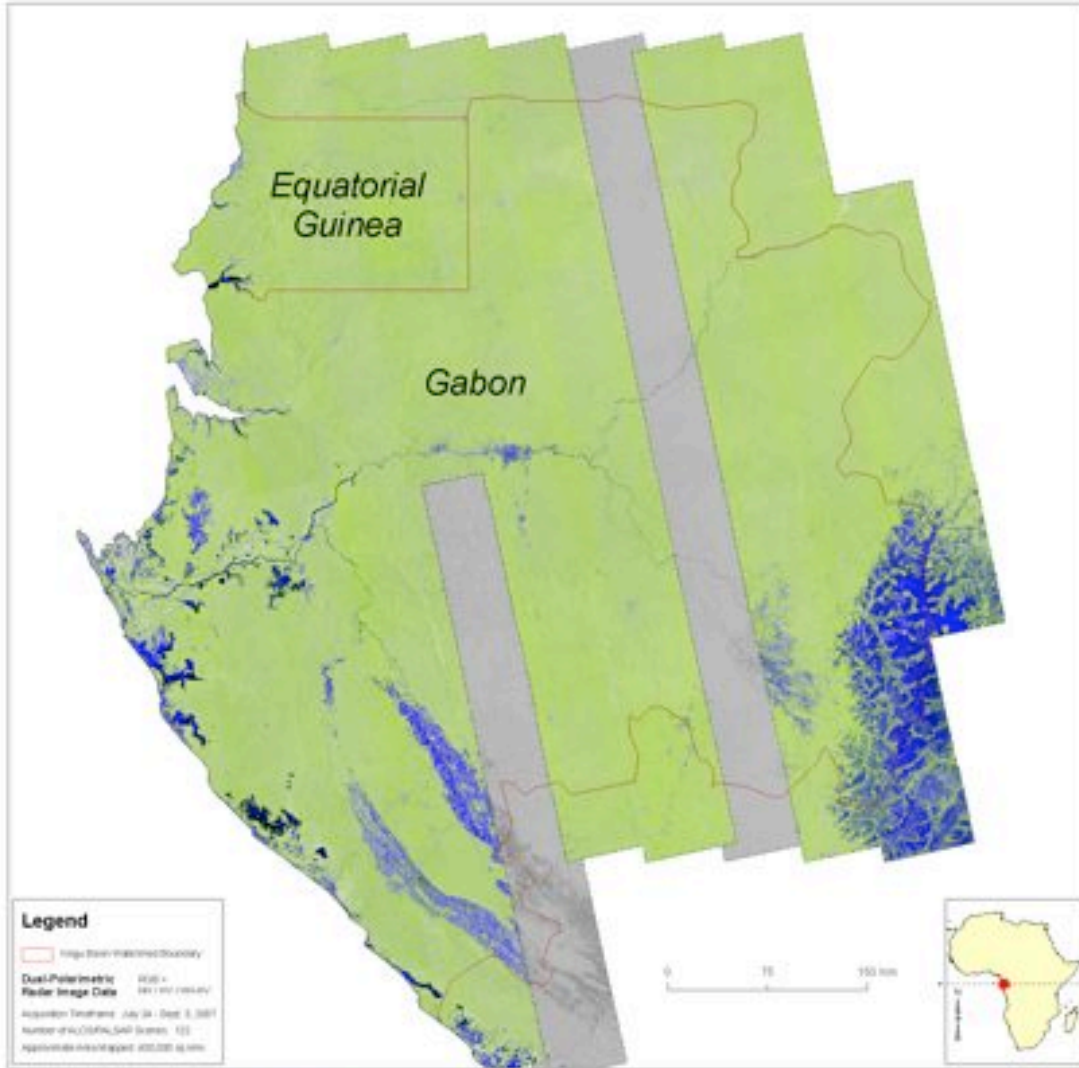
KelIndorfer, Shimada, Rosenqvist

ALOS/PALSAR Dual-Pol Mosaic of Gabon and Equatorial Guinea





ALOS/PALSAR Mosaic Gabon and Equatorial Guinea



Acknowledgements:



The Linden Trust for Conservation
Roper and Victoria Sant
Joseph Goleman

Image processing conducted by Josef Kellndorfer and Waike Walker
The Woods Hole Research Center
jkell@whoi.edu / 508 548 2872



Gabon and Equatorial Guinea as seen by ALOS/PALSAR

Acquisition Dates:

Dual-Pol (103 Scenes):

July 28 - Sep 4 2007

Single-Pol (24 Scenes):

Jan 28 - Feb 02

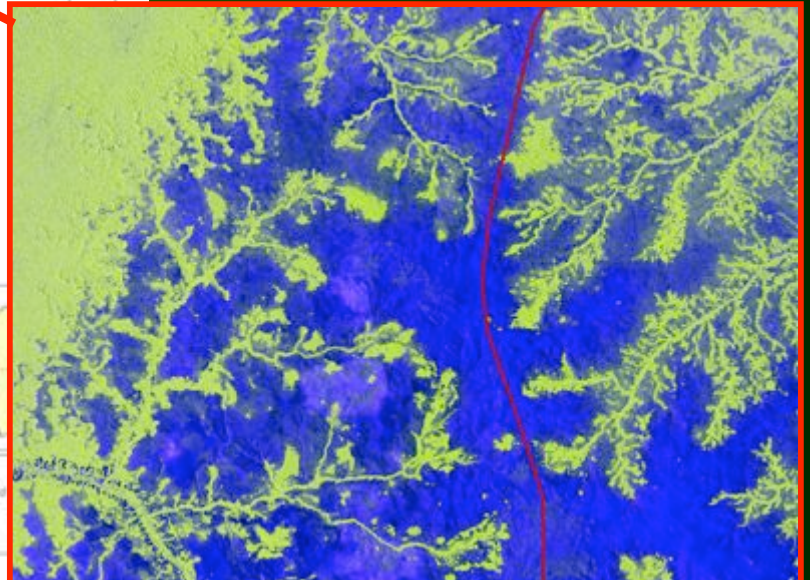
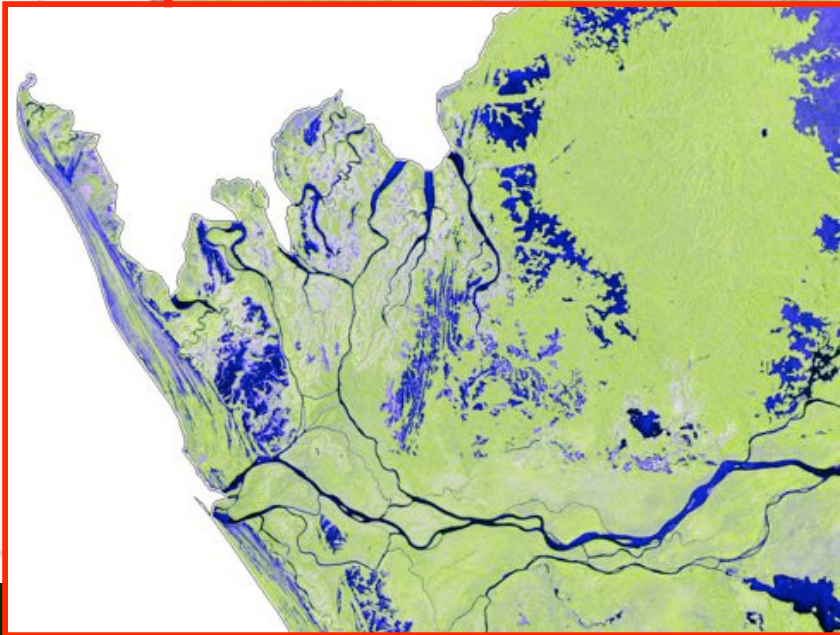


ALOS
Gat

Equatori
Guinea

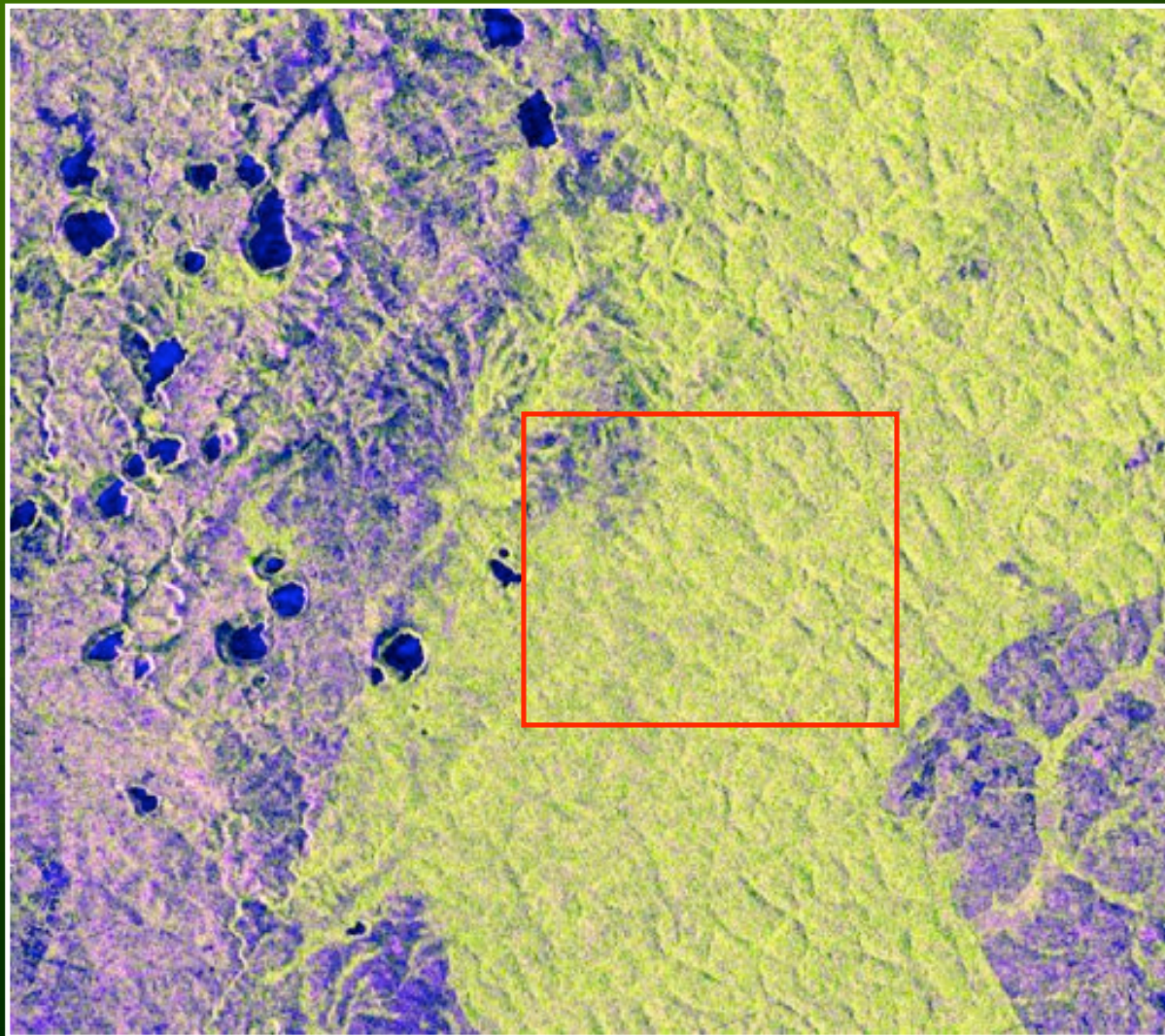


Gabon and Equatorial Guinea as seen by ALOS/PALSAR



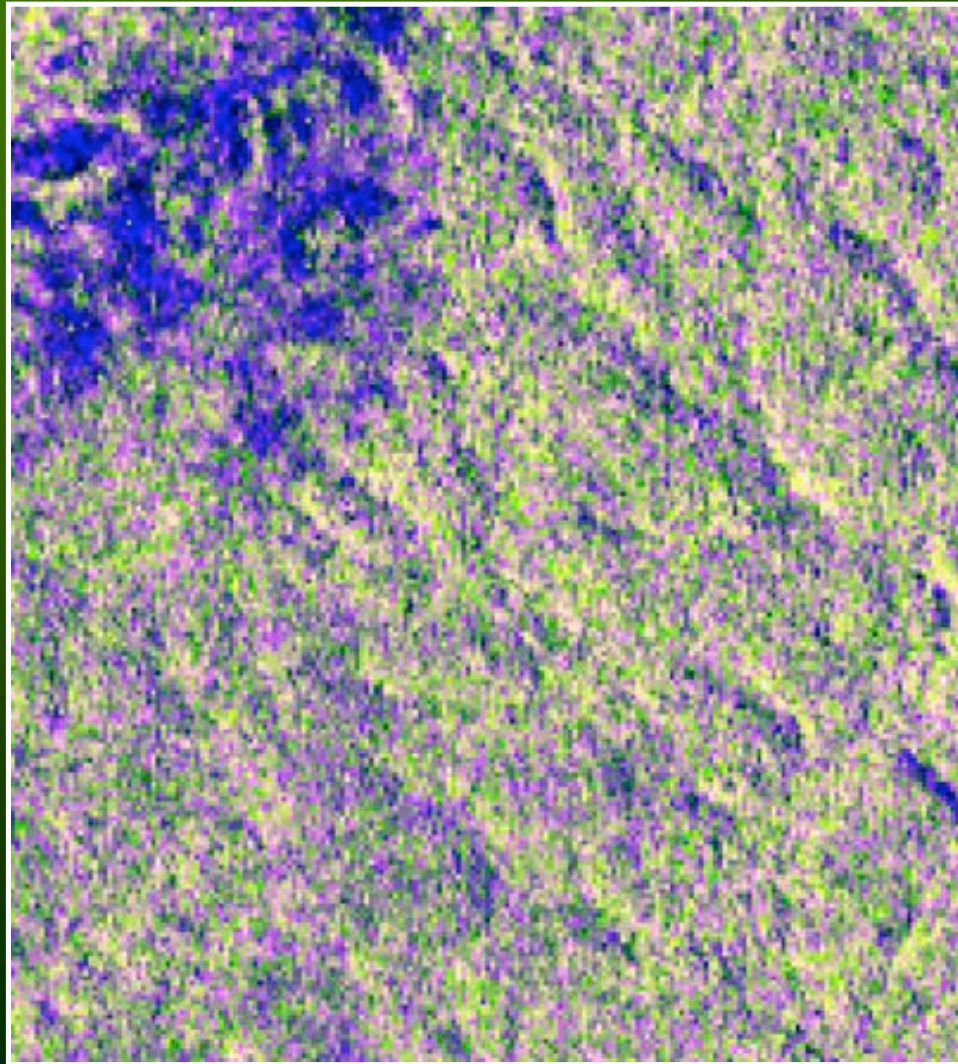
Kibale NP, Western Uganda

as seen by ASTER (2004) and ALOS/PALSAR (2007)



Kibale NP, Western Uganda

as seen by ASTER (2004) and ALOS/PALSAR (2007)



Kellndorfer, Shimada, Rosenqvist

ALOS Maps South-East Asia

All mosaics to be made available in public domain (2009) through Google Earth interface and FTP.



JAXA 2007 / ALOS Kyoto & Carbon Initiative

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© 2008 Tele Atlas
© 2008 BaseSoft

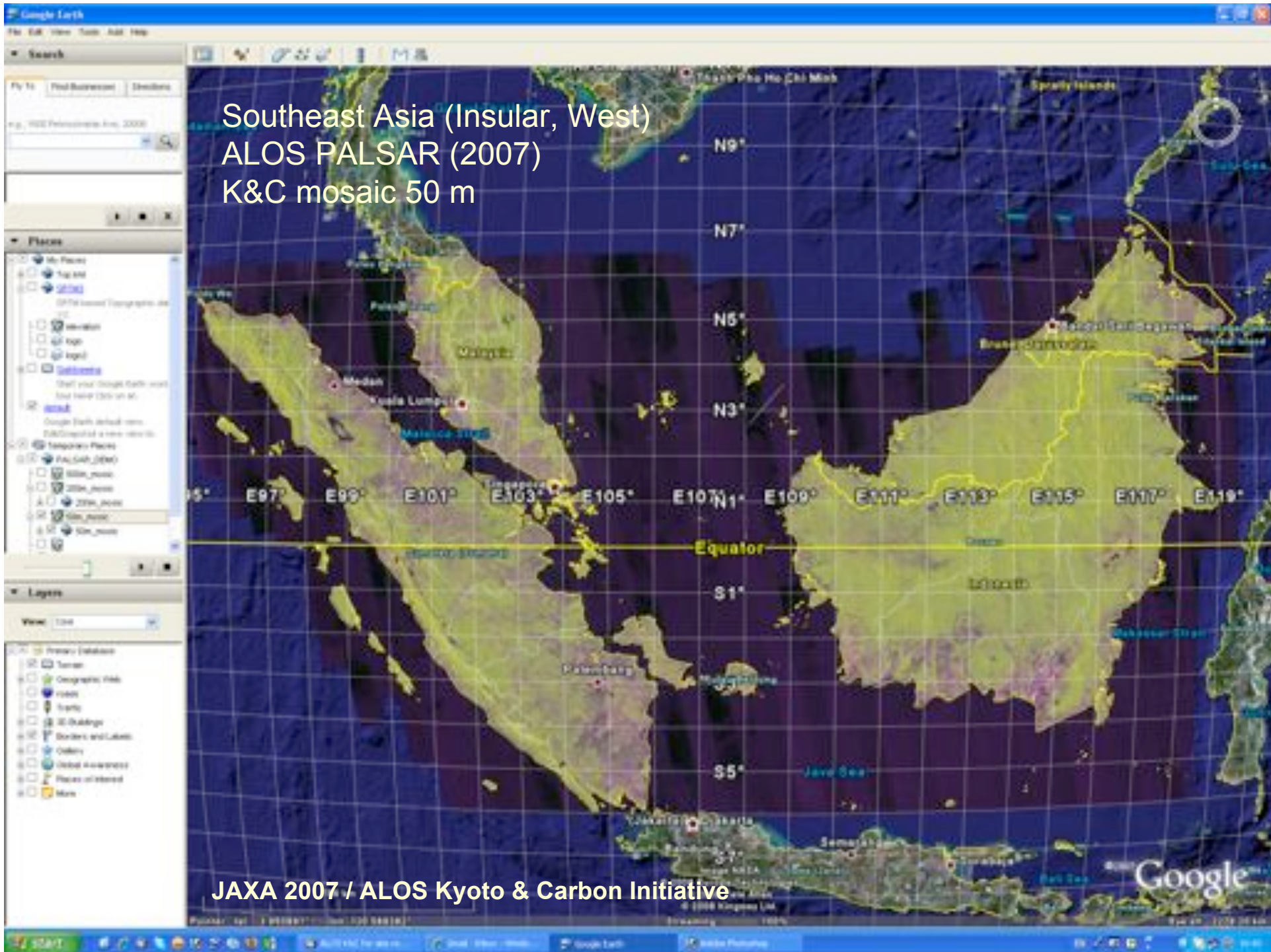
©2008 Google™

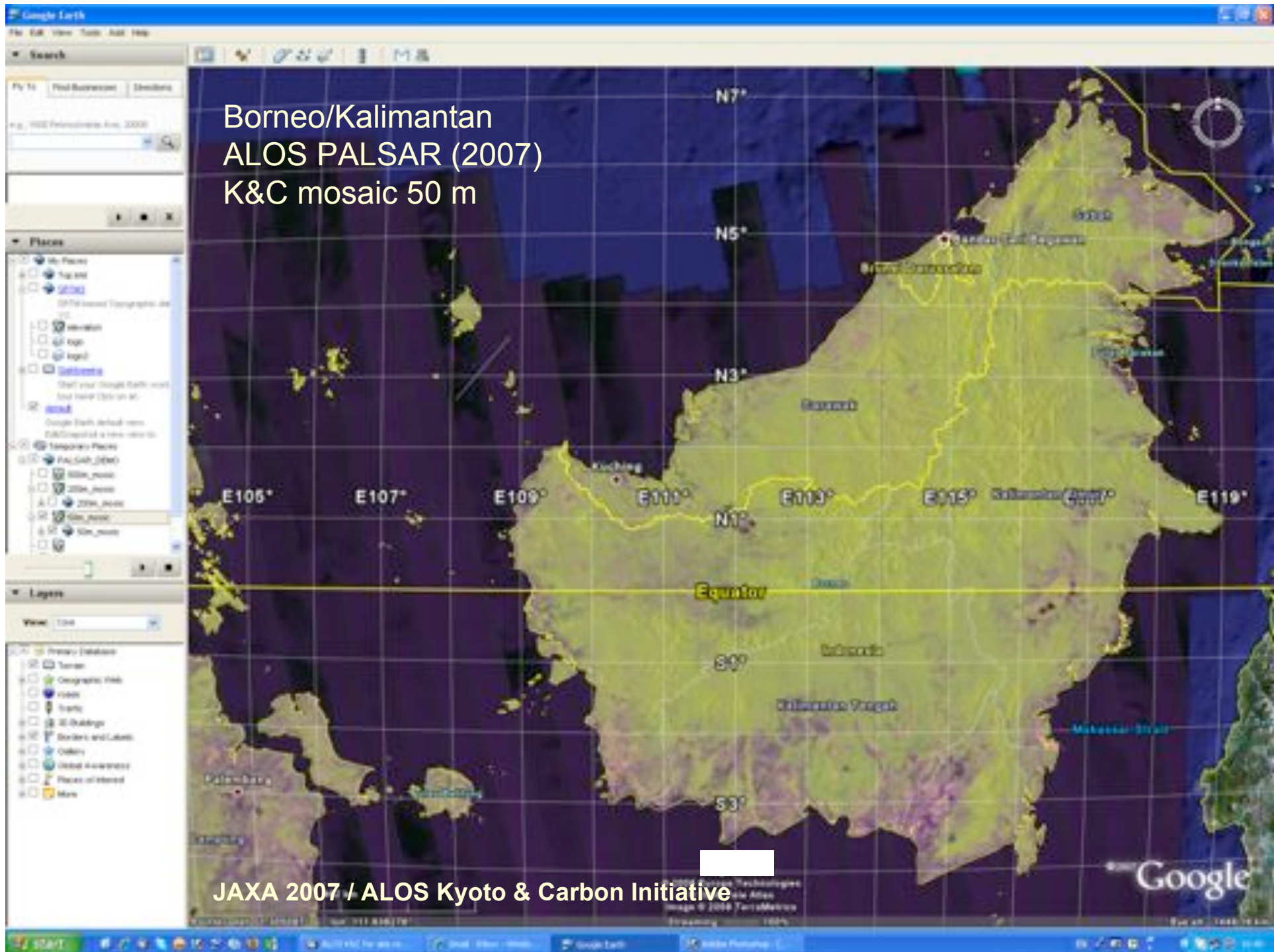
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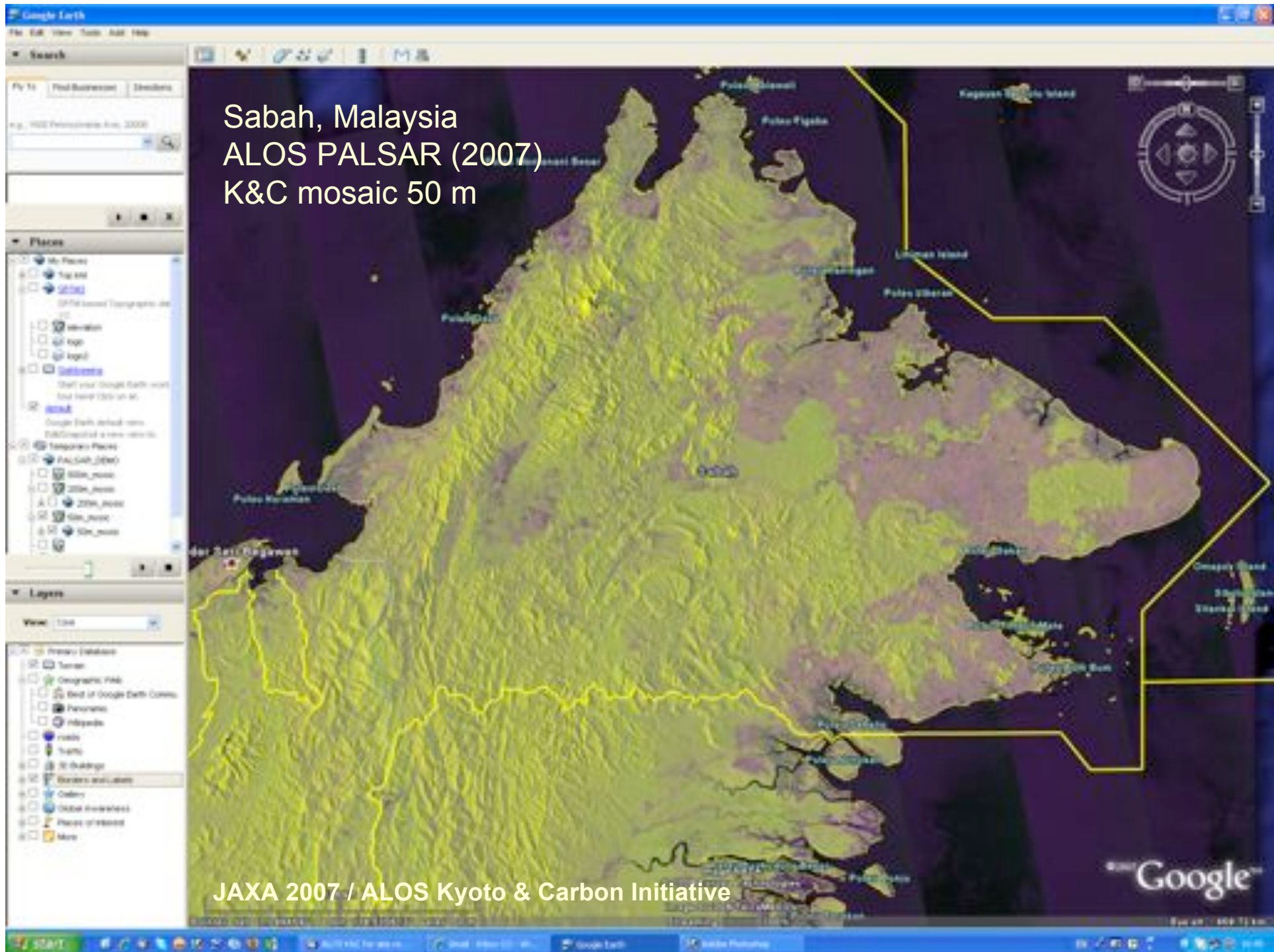
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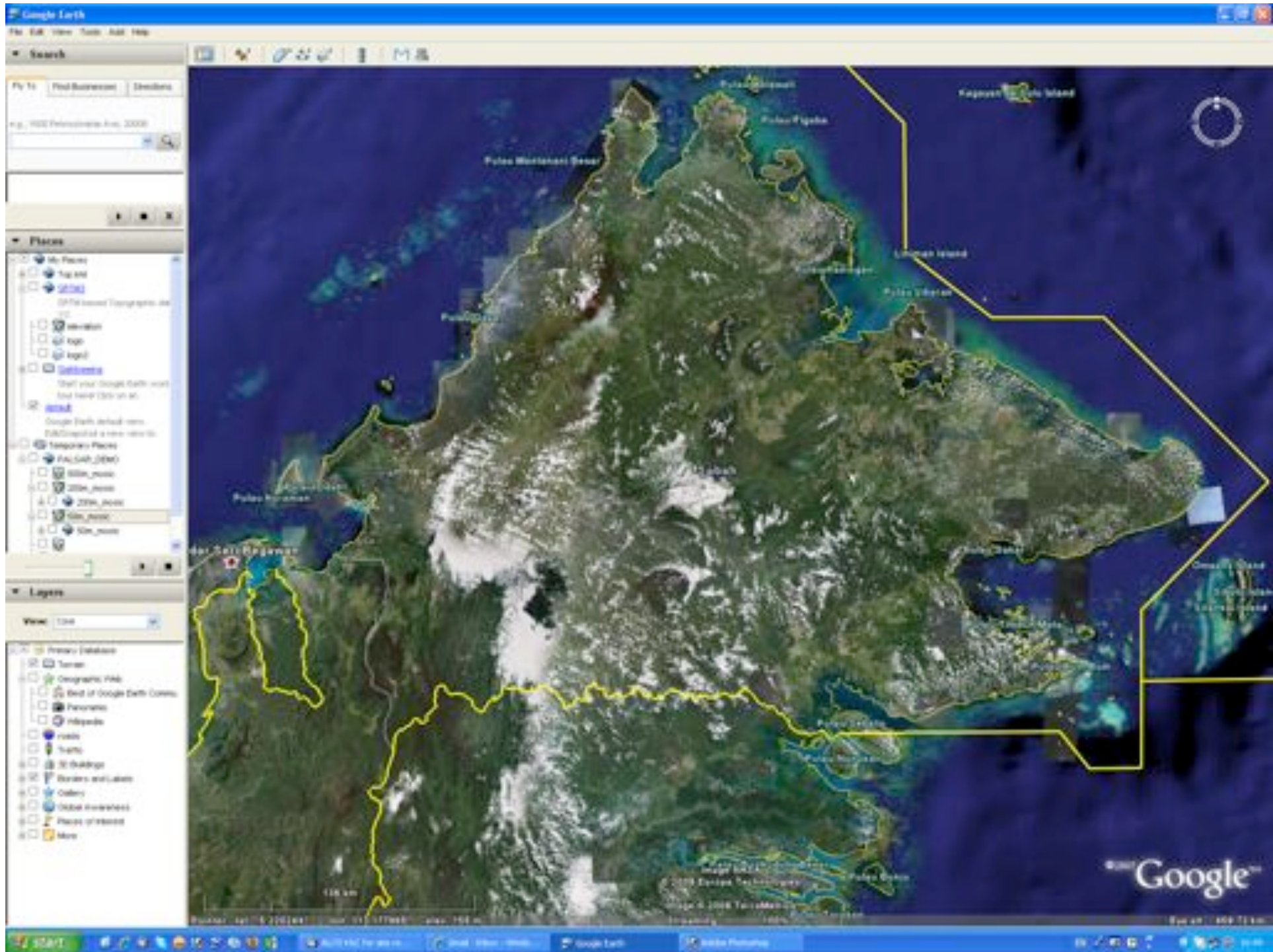
Eye alt: 11784.92 km

... ..ist





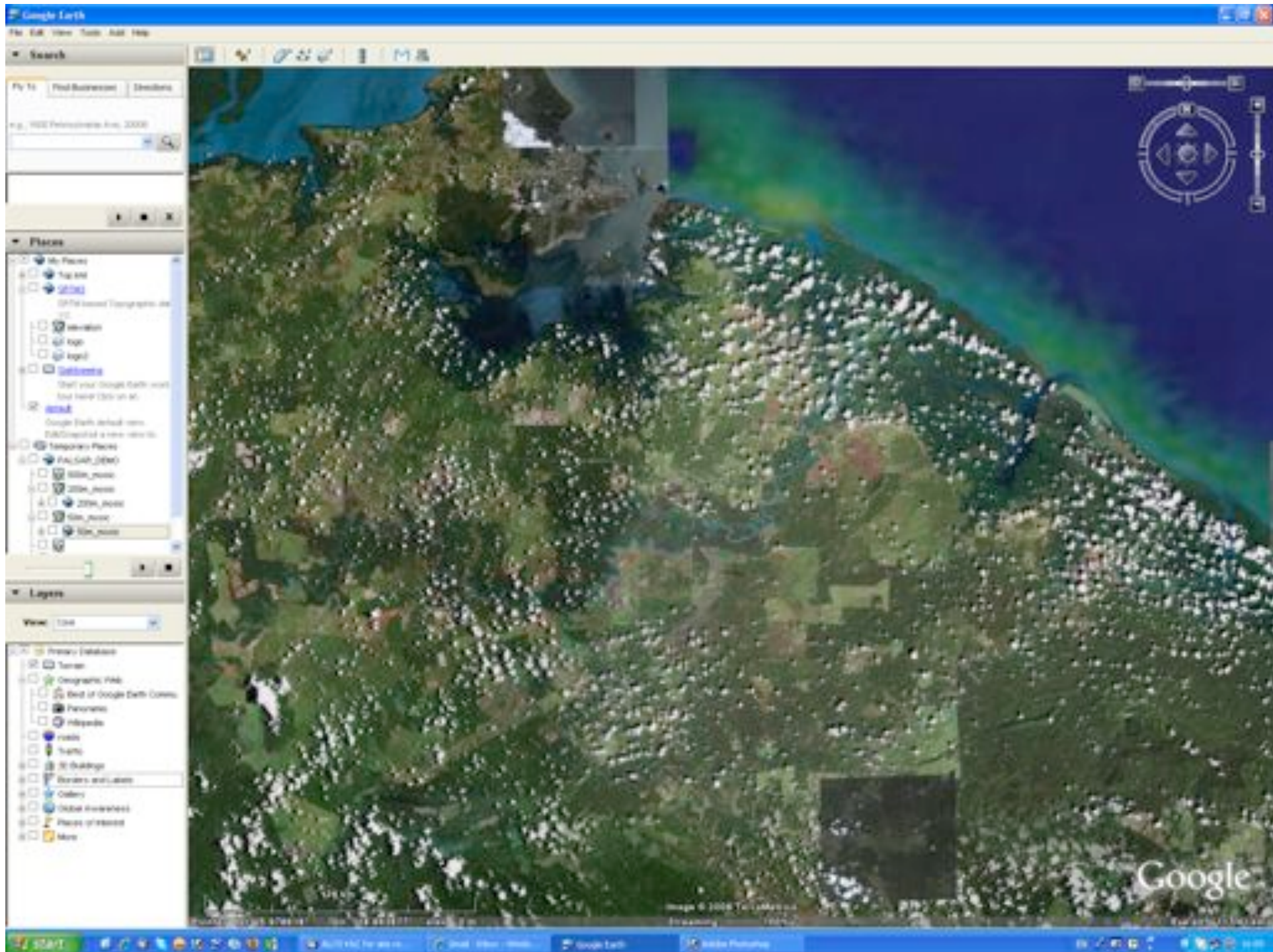


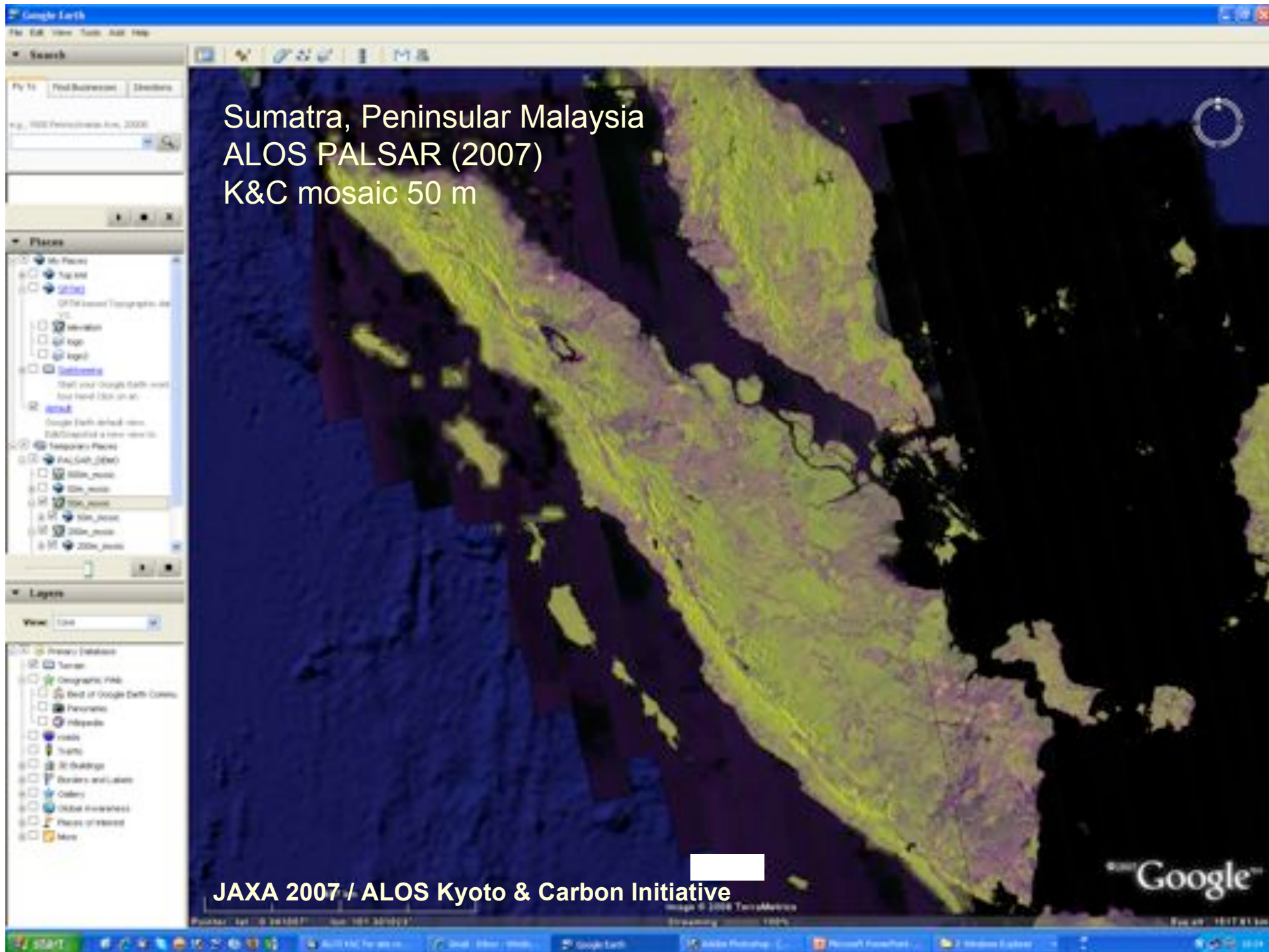




Sabah, Malaysia
ALOS PALSAR (2007)
K&C mosaic 50 m

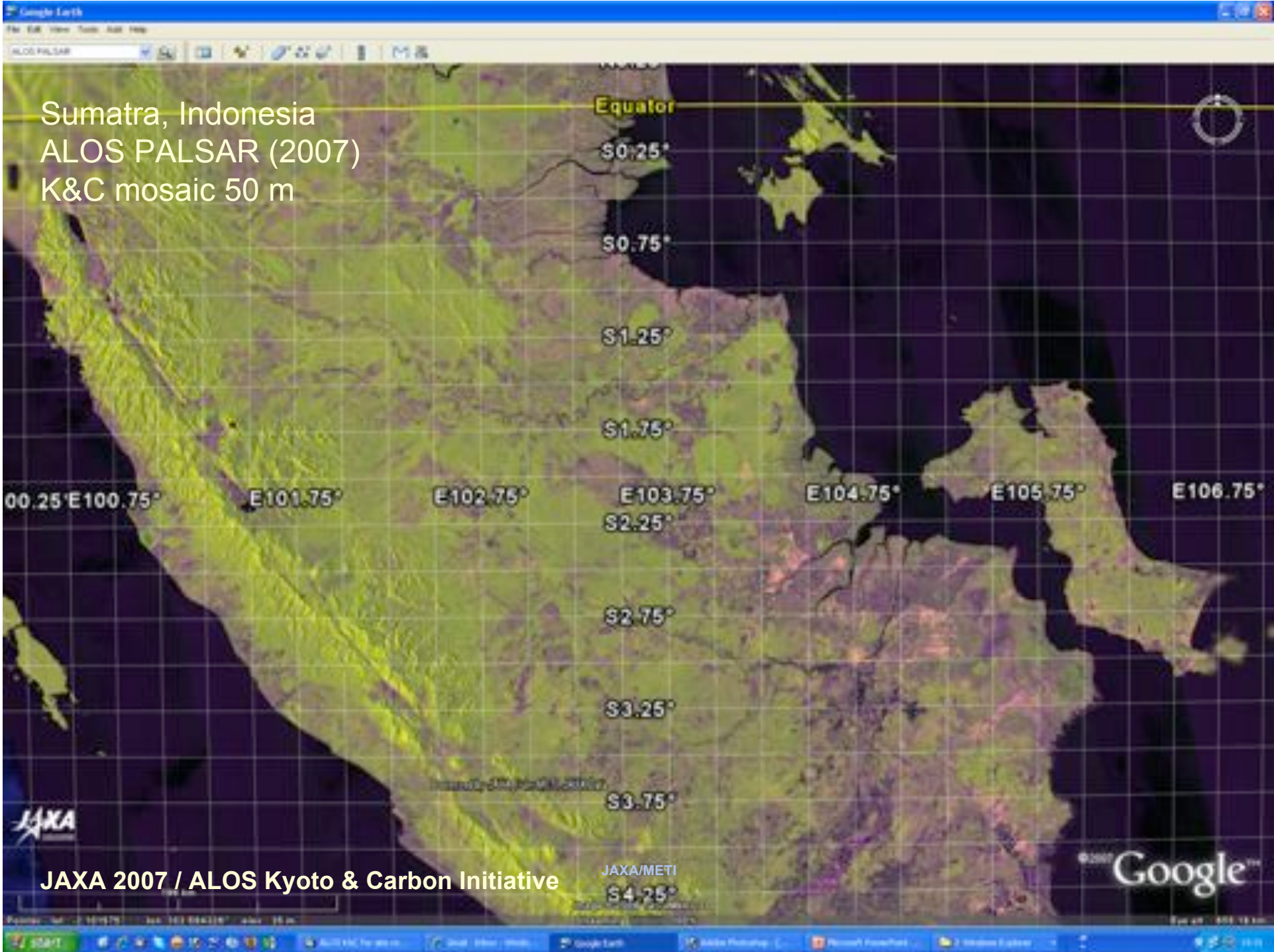
JAXA 2007 / ALOS Kyoto & Carbon Initiative

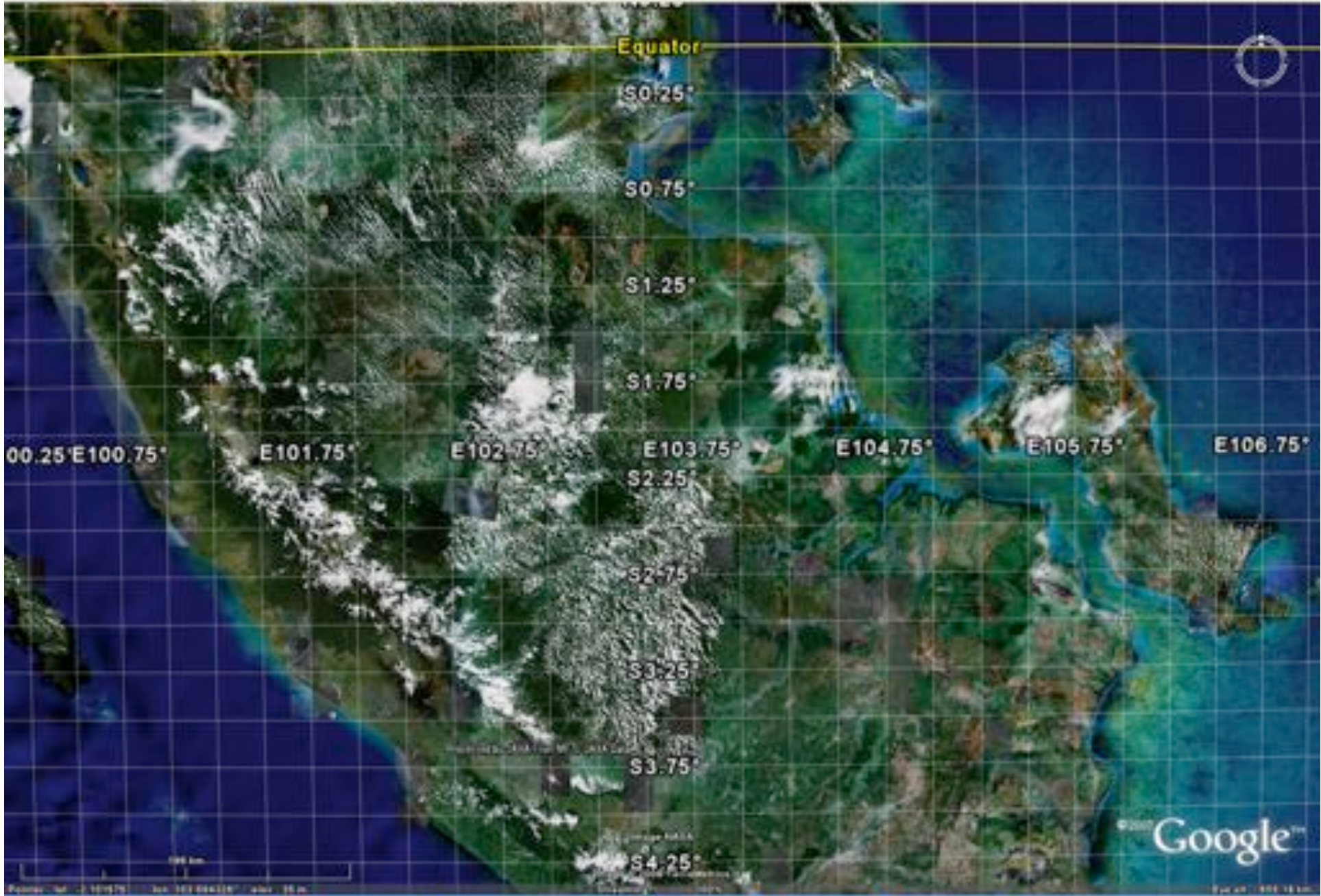




Sumatra, Peninsular Malaysia
ALOS PALSAR (2007)
K&C mosaic 50 m

JAXA 2007 / ALOS Kyoto & Carbon Initiative



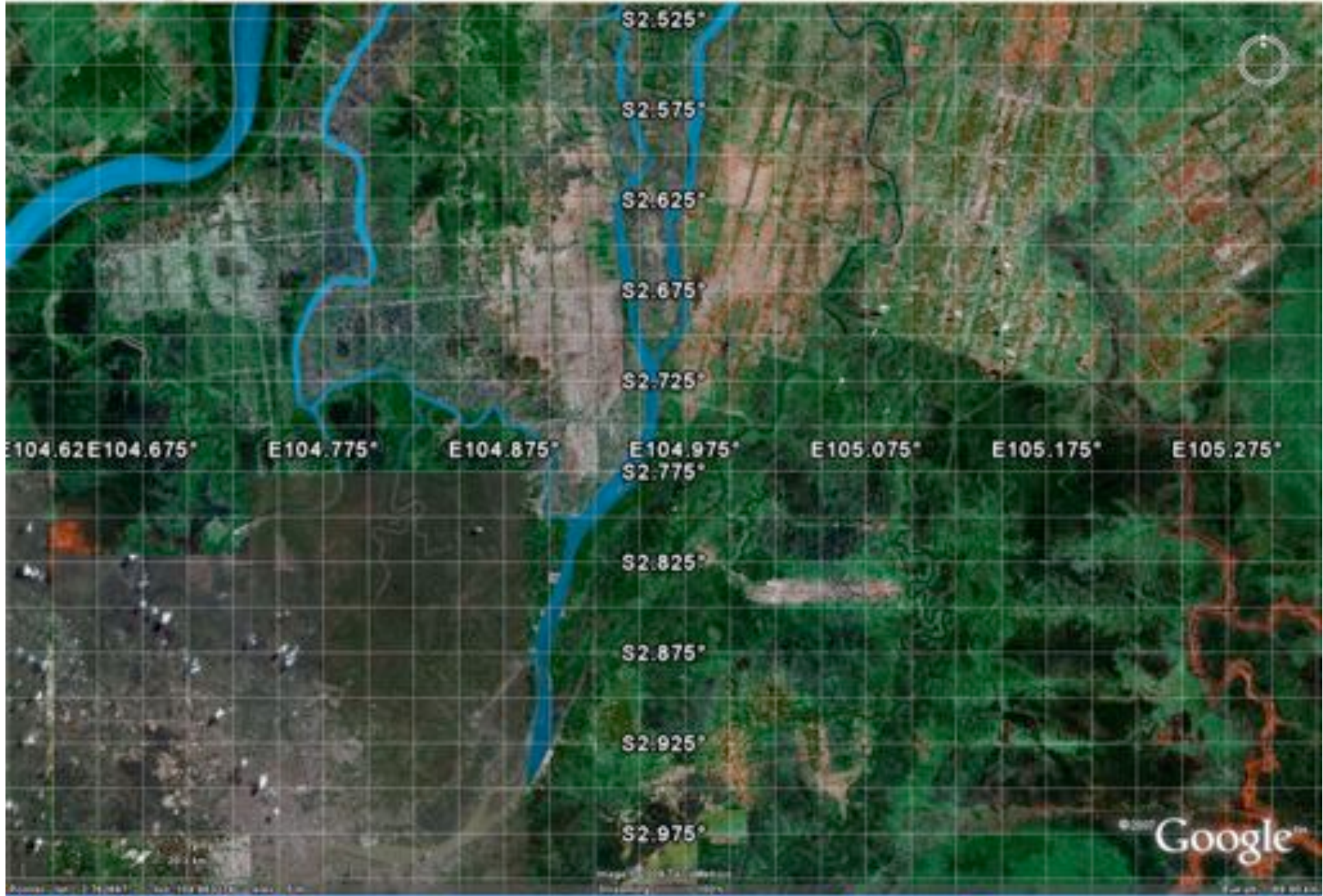




Riau, Indonesia
ALOS PALSAR (2007)
K&C mosaic 50 m

JAXA 2007 / ALOS Kyoto & Carbon Initiative

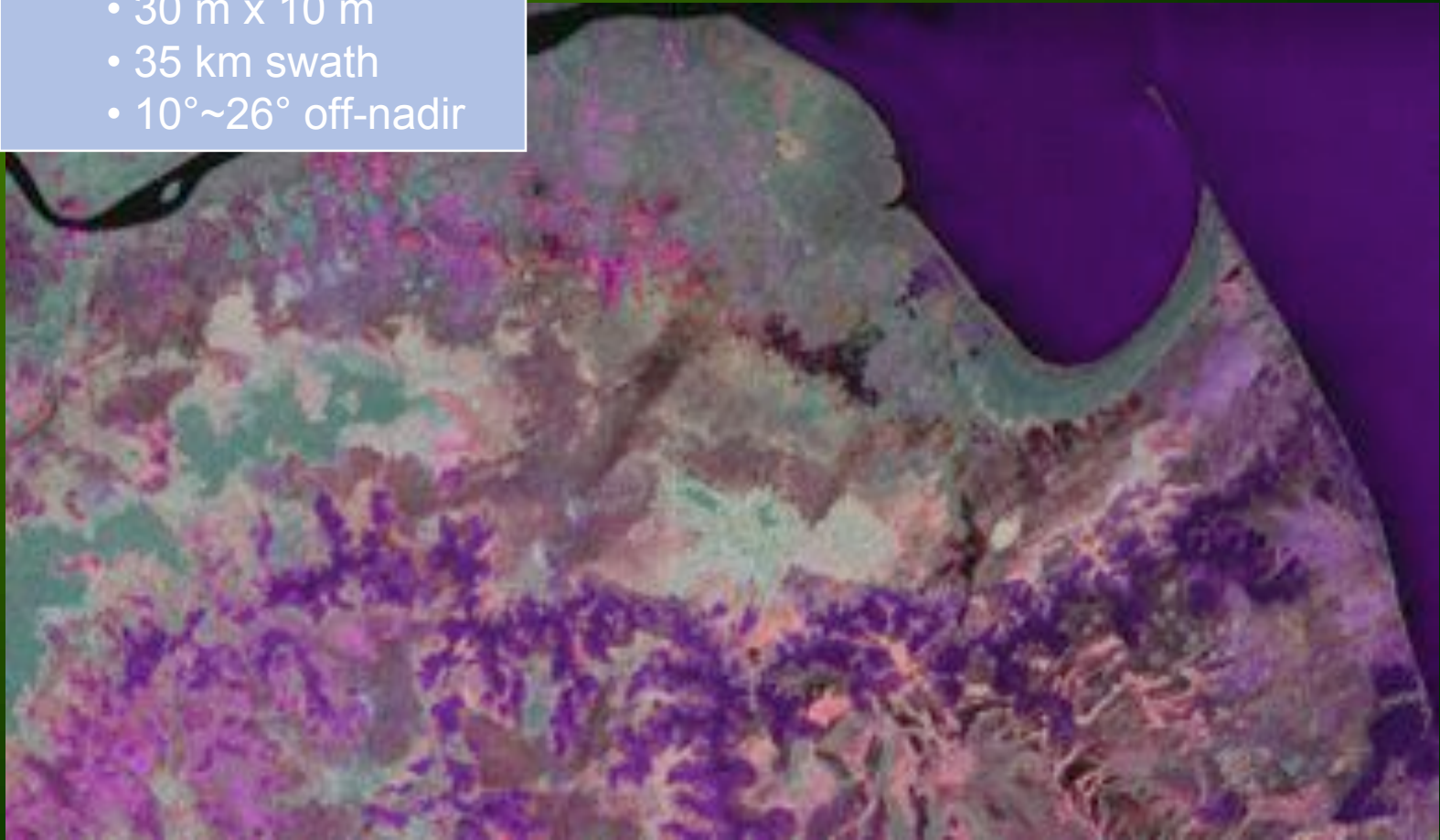
JAXA/METI



Full polarisation

- HH+HV+VV+VH
- 30 m x 10 m
- 35 km swath
- 10°~26° off-nadir

Polarimetric mode



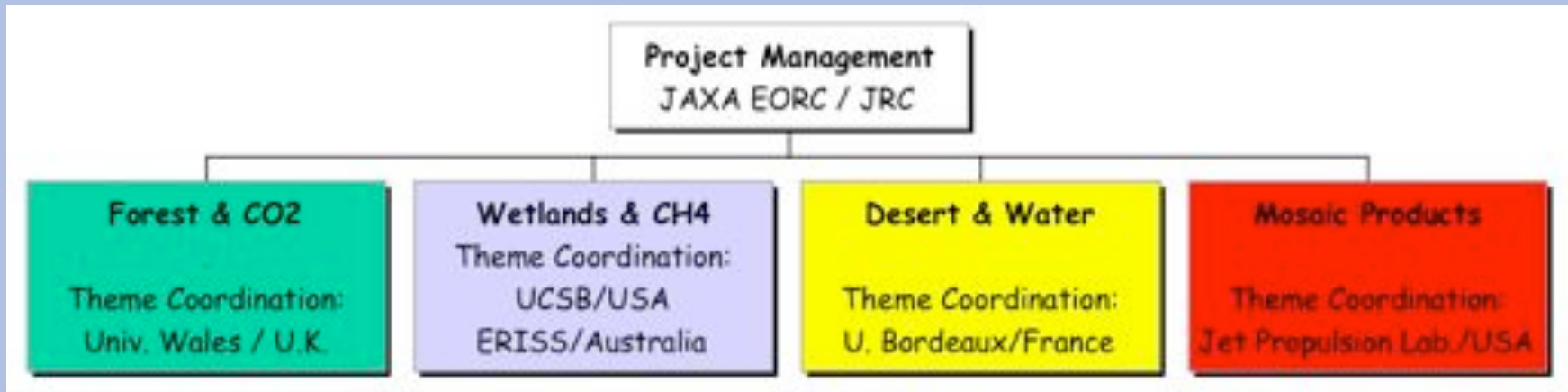
South Kalimantan, Indonesia, 22 March, 2007
PALSAR full-pol mode. **HH**; **HV**; **VV**

Summary



- ◆ Results from cal/val phase through October 2006:
 - ◆ Excellent geolocation accuracy (9.3m)
 - ◆ Excellent radiometric resolution
 - ◆ Stable system
 - ◆ Life expectancy 10 years (planned 3 years)
- ◆ Dedicated observation plan to establish time series of fine-beam (dual and single pol) and ScanSAR data

ALOS Kyoto & Carbon Project Organization & Science Team



K&C Science Team (23/15):

JAXA EORC (Japan)

Joint Research Centre (E.U.)

Jet Propulsion Laboratory (USA)

INPE (Brazil)

IBAMA (Brazil)

DLR (Germany)

Wetlands International

Int'l Water Management Inst (Sri Lanka)

CESBIO (France)

BOS Foundation (Indonesia)

Sarmap (Switzerland)

Woods Hole Research Center

FSU-Jena (Germany)

U-Sheffield (U.K.)

SLU (Sweden)

U-Wales Aberystwyth (U.K.)

UCSB (USA)

U-Victoria (Canada)

UNSW (Australia)

U-Helsinki (Finland)

U-Bordeaux (France)

U-Massachusetts (USA)

AGS (USA)

Gamma (Switzerland)

ALOS and SRTM Synergy



BALI, Indonesia
Host to UNFCCC
COP13

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