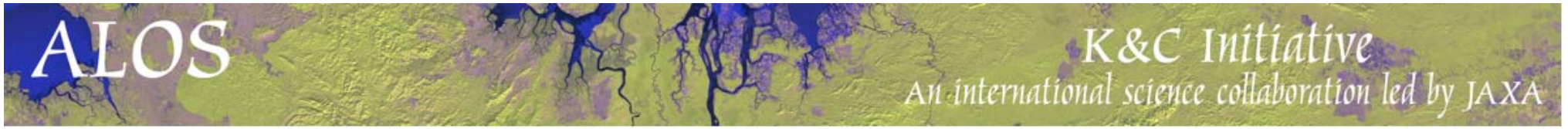


Product Delivery Report for K&C Phase 2

Laura Hess
Earth Research Institute (formerly ICESS)
University of California, Santa Barbara

Collaborators

JPL: B. Chapman, K. McDonald
Inst. de Recherche pour le Développement: L. Durieux
INPE: E. Novo, A. Affonso, E. Arraut
INPA: B. Marshall
UNESP: C. Beneditti, N. Imai

Science Team meeting #15
JAXA TKSC/RESTEC HQ, Tsukuba/Tokyo, January 24-28, 2011

Motivation: Science Questions

- **Hydrologic cycle**: What is the floodplain storage component of the water budget of the Amazon basin? What is the interannual variability of wetland inundation, how is that related to ENSO cycles, and how might climate change affect these patterns?

- **Carbon cycle**: What are the contributions of wetlands to the carbon budget of the Amazon basin, including primary productivity, emissions of CH4 and CO2? What is their role in transformation of carbon exported from upland sites (i.e, terrestrial-aquatic linkages)?

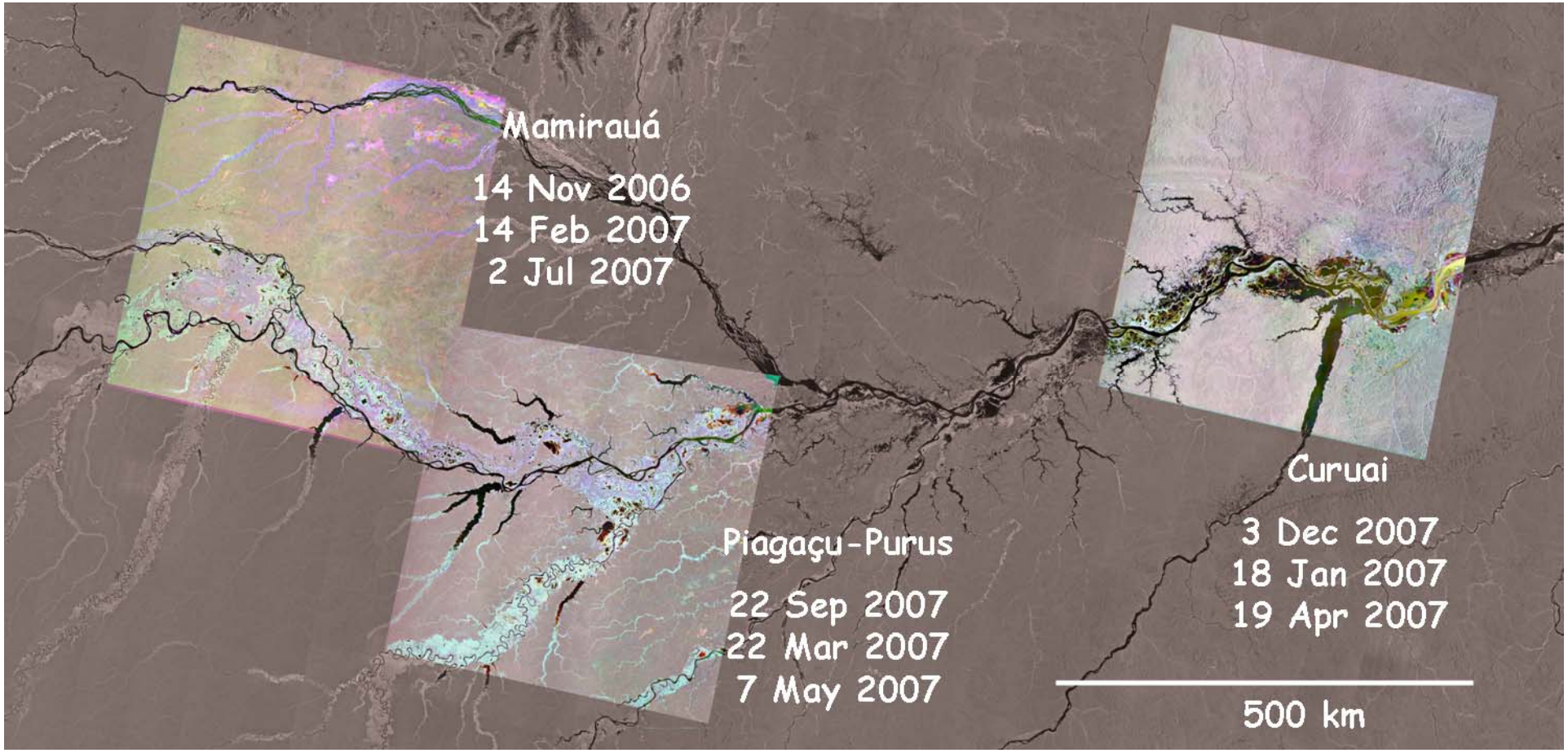
- **Ecology**: What is the spatial distribution of the major wetland vegetation types found in the Amazon? How are the distributions, life cycles, and abundance of fish, birds, mammals, and other groups related to temporal cycles of inundation and water properties?

Motivation: Management and Sustainable Development

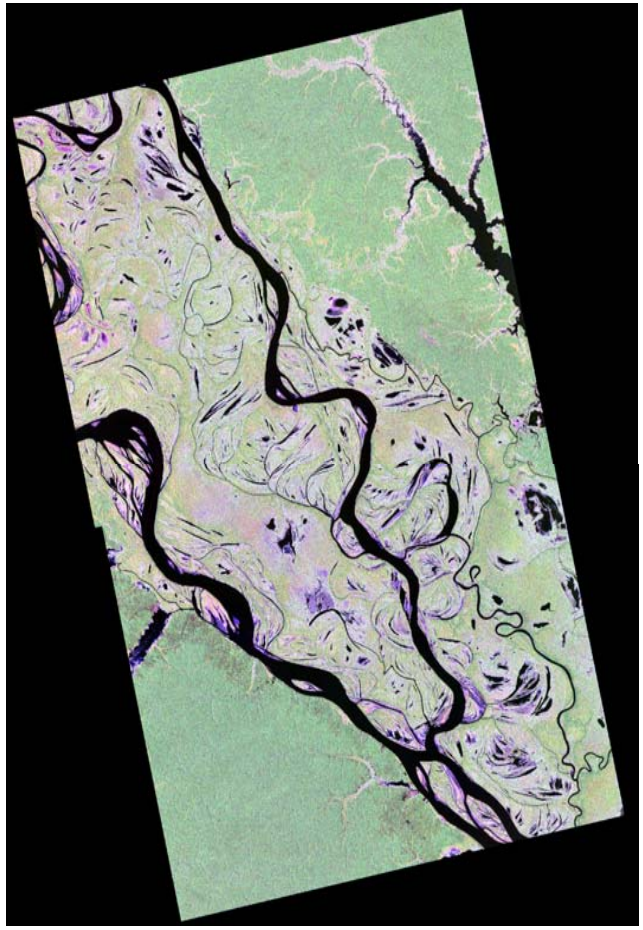
Basic information on wetland habitats is needed in order to address information requirements for:

- fisheries management
- sustainable forestry
- managing important species in traditional and commercial economies
- mapping and maintaining biodiversity
- location and management of conservation reserves, including Ramsar
- assessing human impacts on wetlands (water quality, dams, oil spills)
- modeling the role of wetlands as disease vector habitats
- documenting/predicting the effects of extreme flood and drought events on local communities

Amazon focus sites



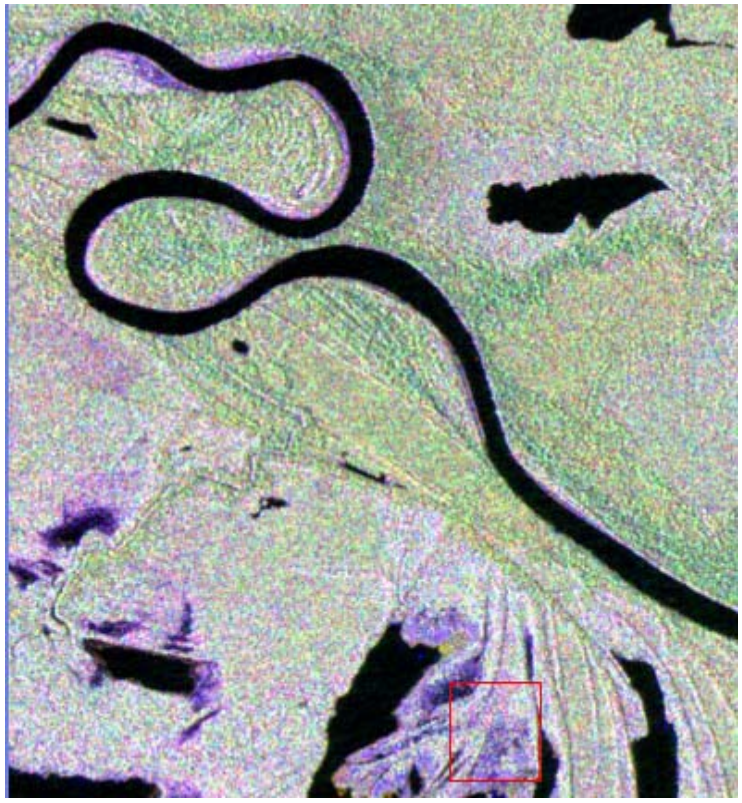
Mamirauá Fine-scale Analysis (25 m)



RGB = June HH, June HV, July HH

FBD: June 14 2007, July 30 2007

FBS: Oct 30 2007

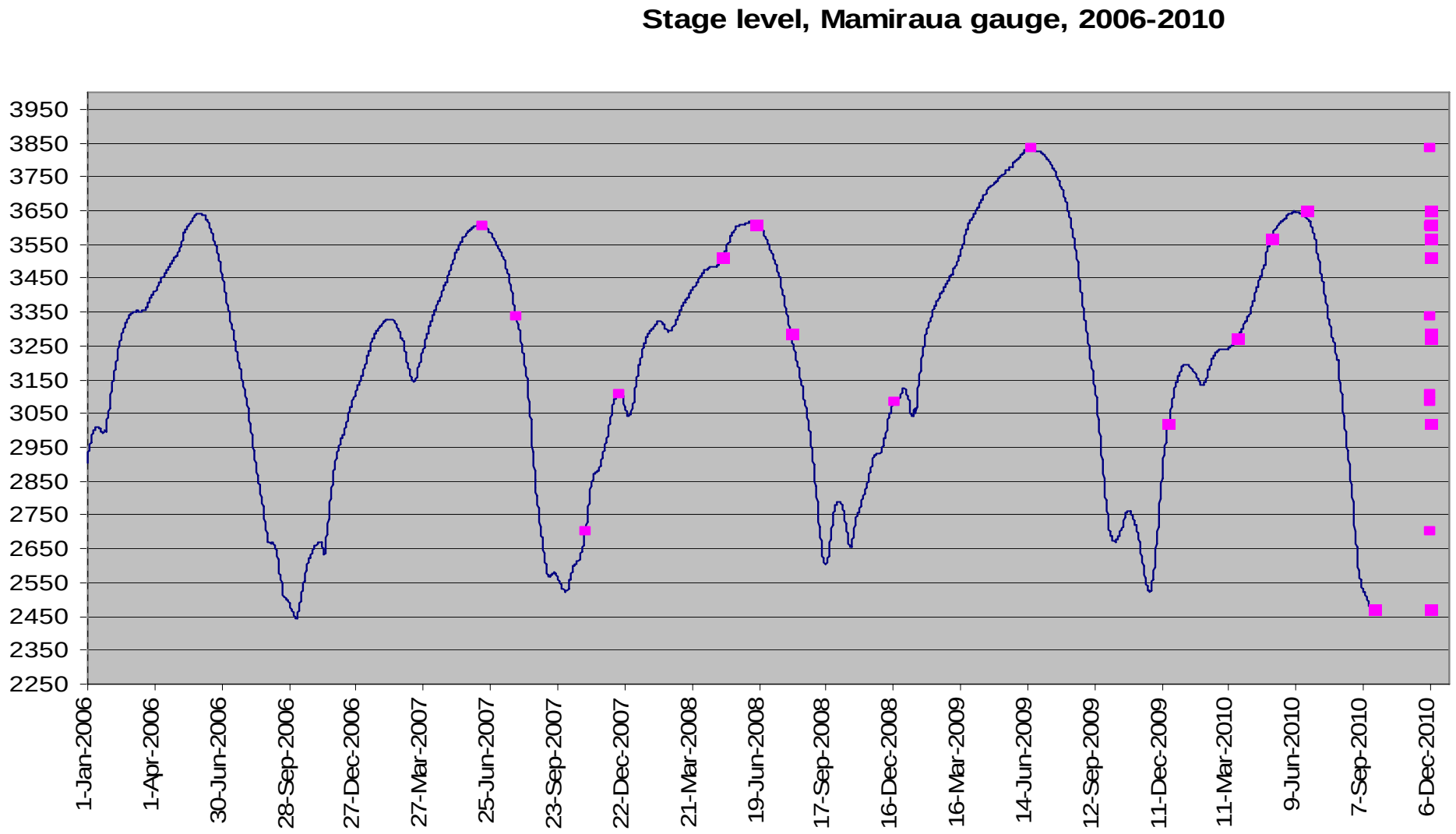


Mamirauá Reserve, Upper Amazon Floodplain, Brazil: November 2008

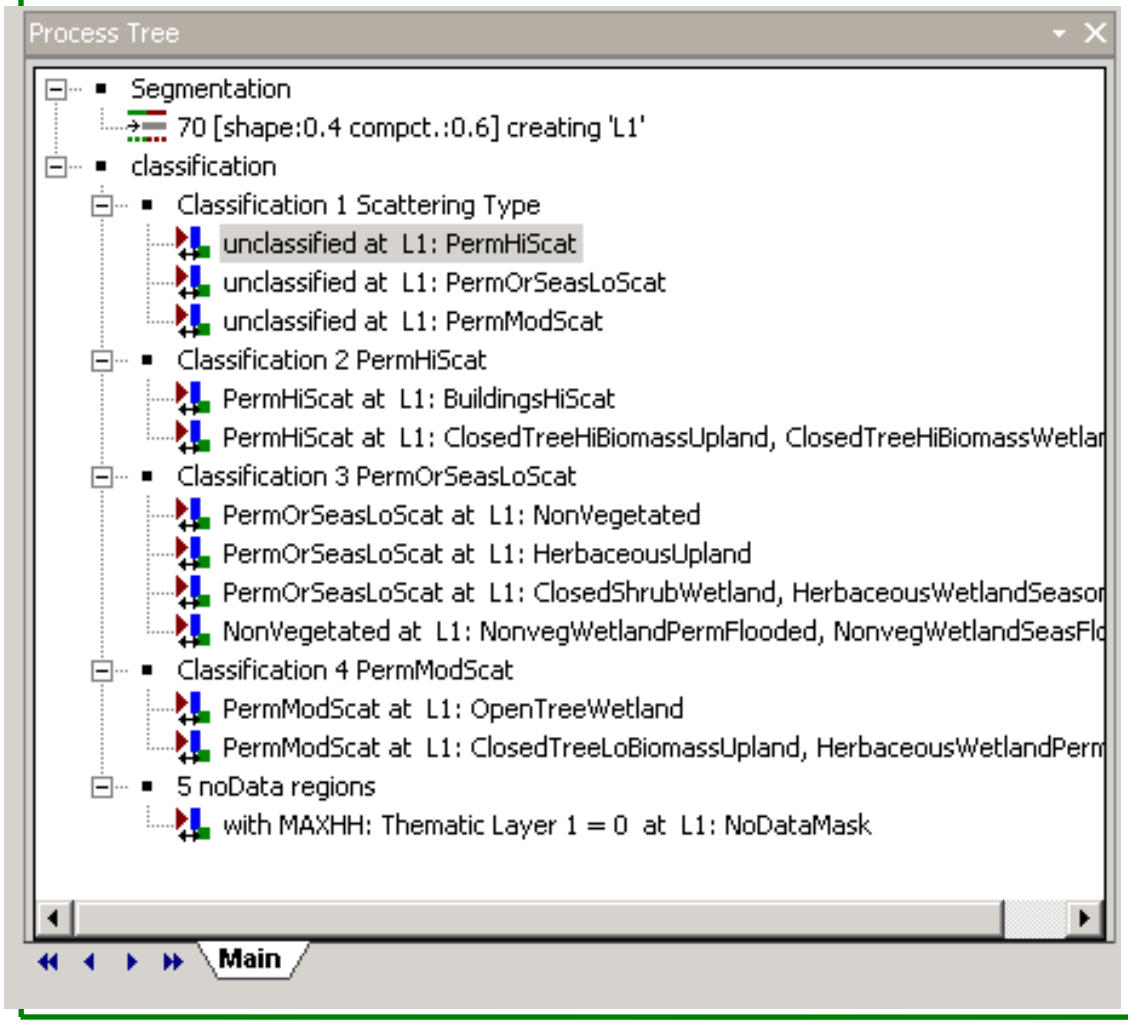
Mamirauá Reserve, Upper Amazon Floodplain, Brazil: November 2008

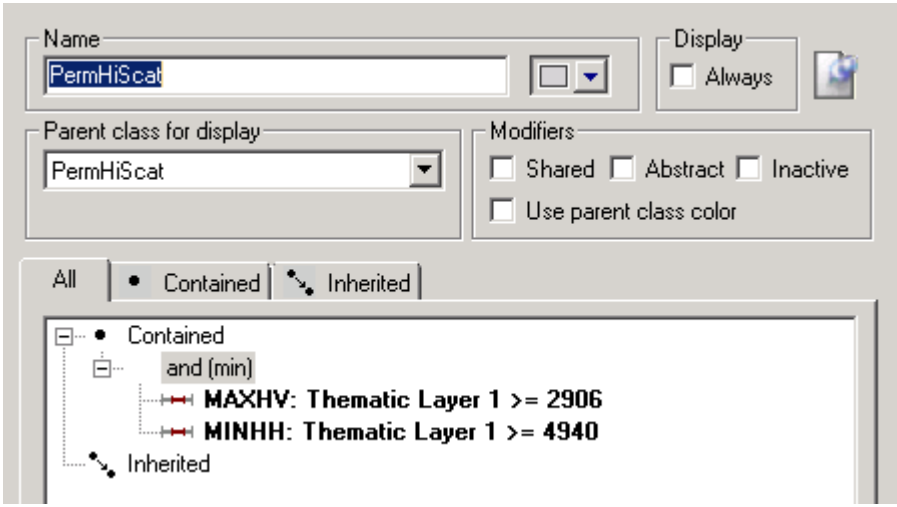
Mamirauá Reserve, Upper Amazon Floodplain, Brazil: November 2008

Fine-Beam PALSAR scene acquisition dates for Mamirauá, relative to Amazon River stage at Tefé



1. Rules-based classification of cover type using multi-temporal object statistics
2. Assignment of flooded/non-flooded for each date using HH thresholding

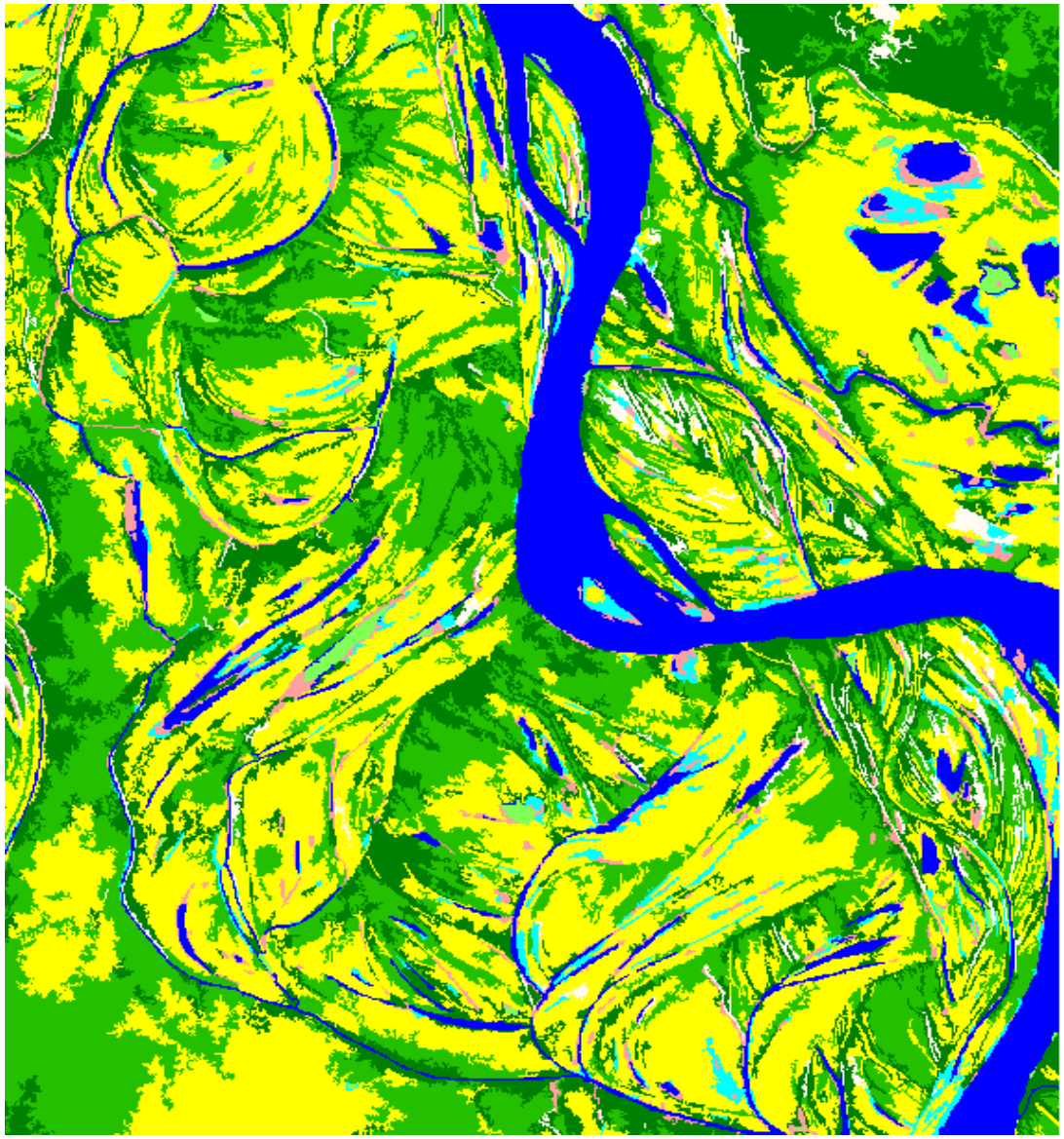




ALOS

K&C Initiative

An international science collaboration led by JAXA



Mamirauá floodplain habitats (25 m, based on 3 imaging dates)

Structure	Inundation		Local term
Woody - tall	Flooded 0-1 mo/yr		Várzea forest: high levee
Woody - tall	Flooded 1-2 mo/yr		Várzea forest: high levee
Woody - tall	Flooded 3-6 mo/yr		Várzea forest: low levee
Woody - tall	Flooded 6-12 mo/yr		Chavascal
Woody - short	Flooded 6-12 mo/yr		Chavascal
Herbaceous	Seasonally flooded		Seasonal aquatic macrophyte
Non-vegetated	Permanently flooded		Open water

Methodological issues: Image segmentation

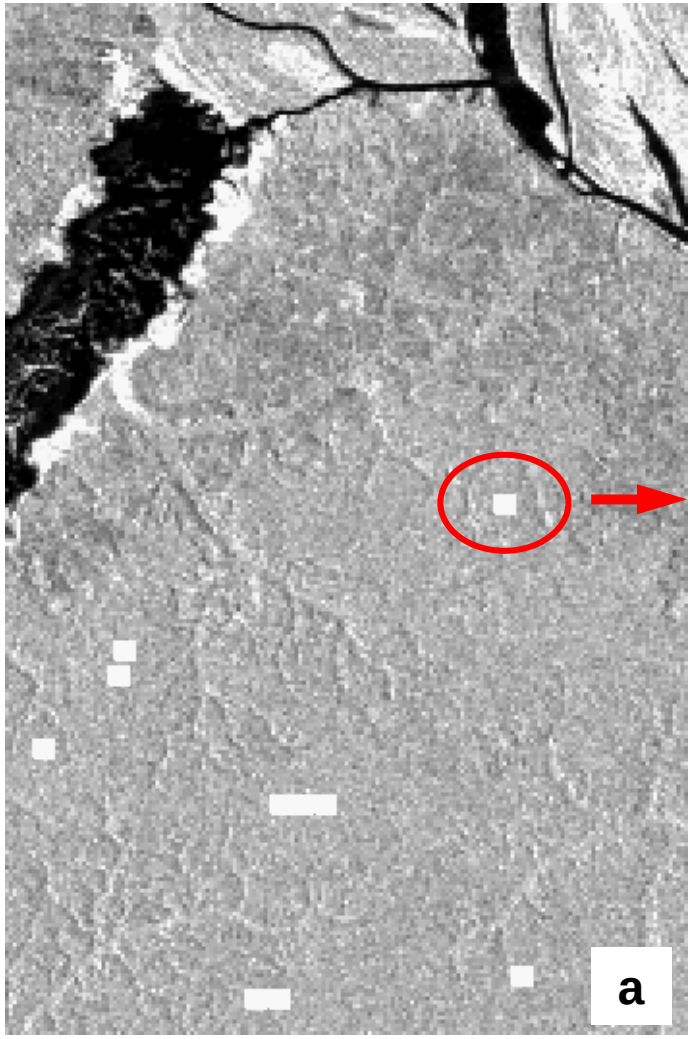
Fine-Beam (12.5 m)

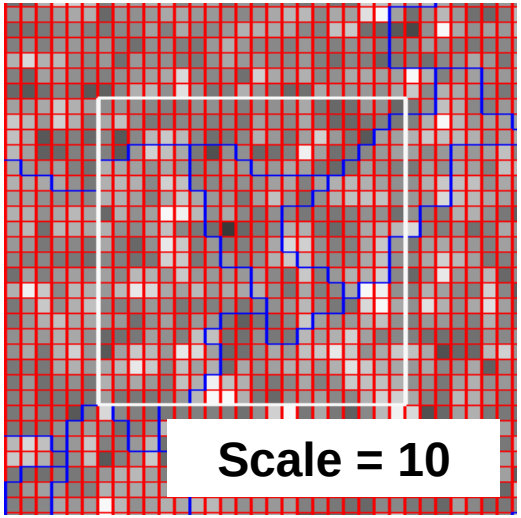
- need objective (and practical) criteria for selection of segmentation parameters

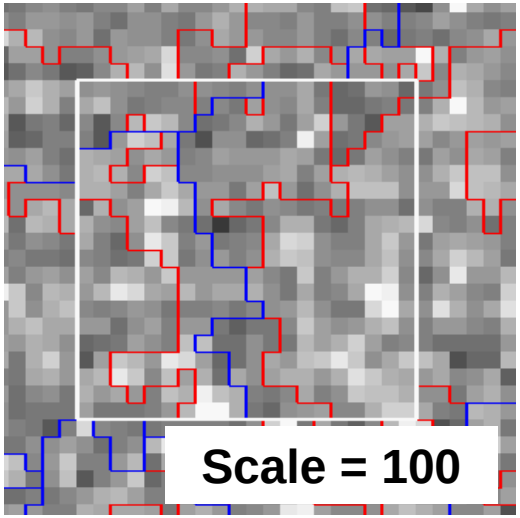
- do we fine-tune parameters for each image stack? (if we do/don't, will we have inconsistent object statistics across regions for the same cover type?)

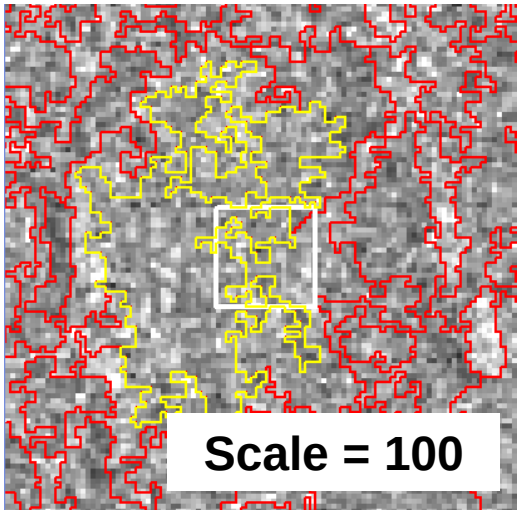
- how well do segmentation algorithms handle large numbers of dates?

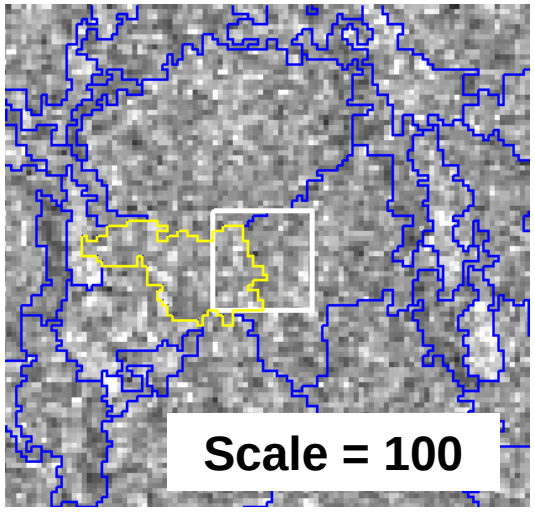
Effect of quantization level on single-date segmentation





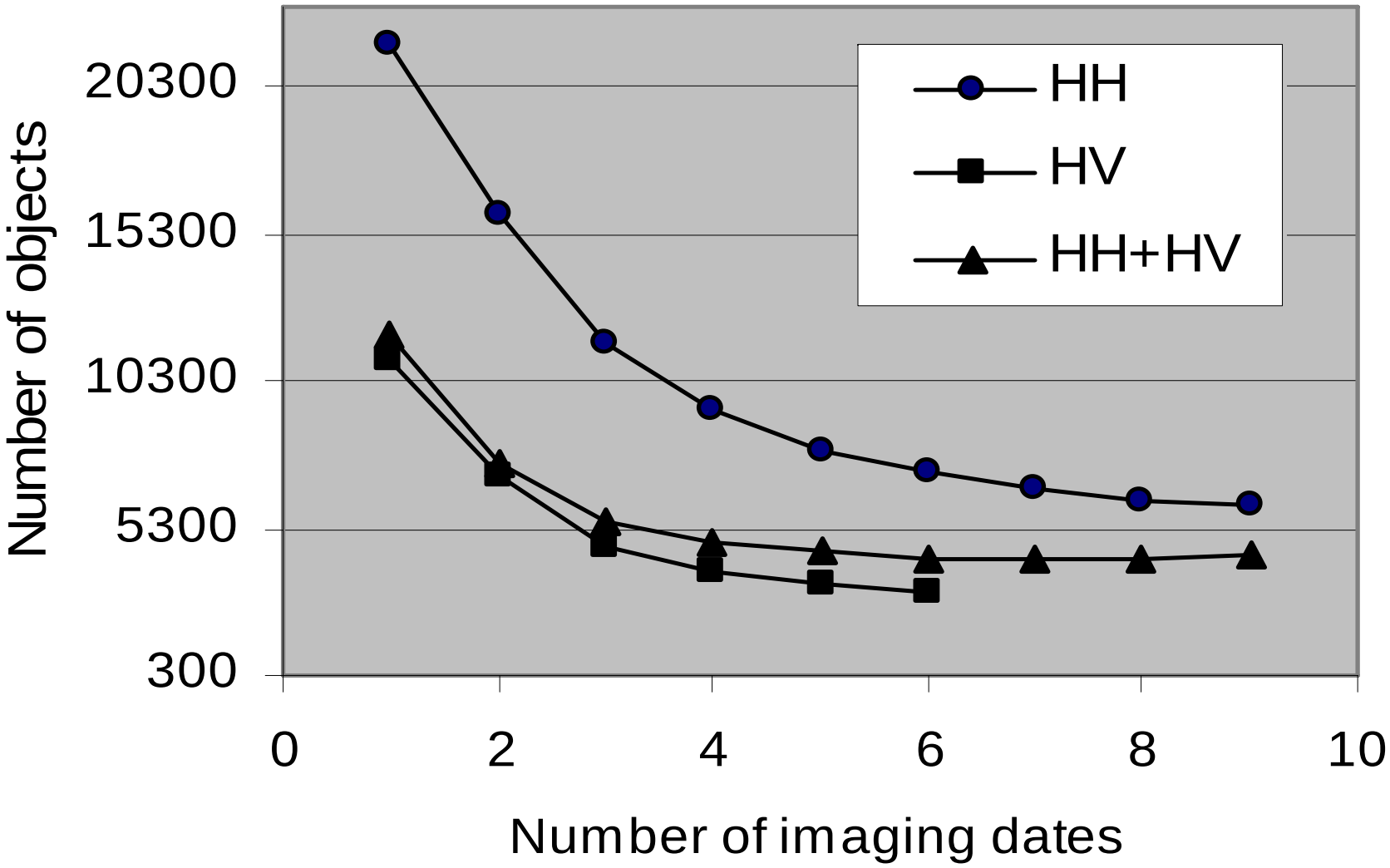


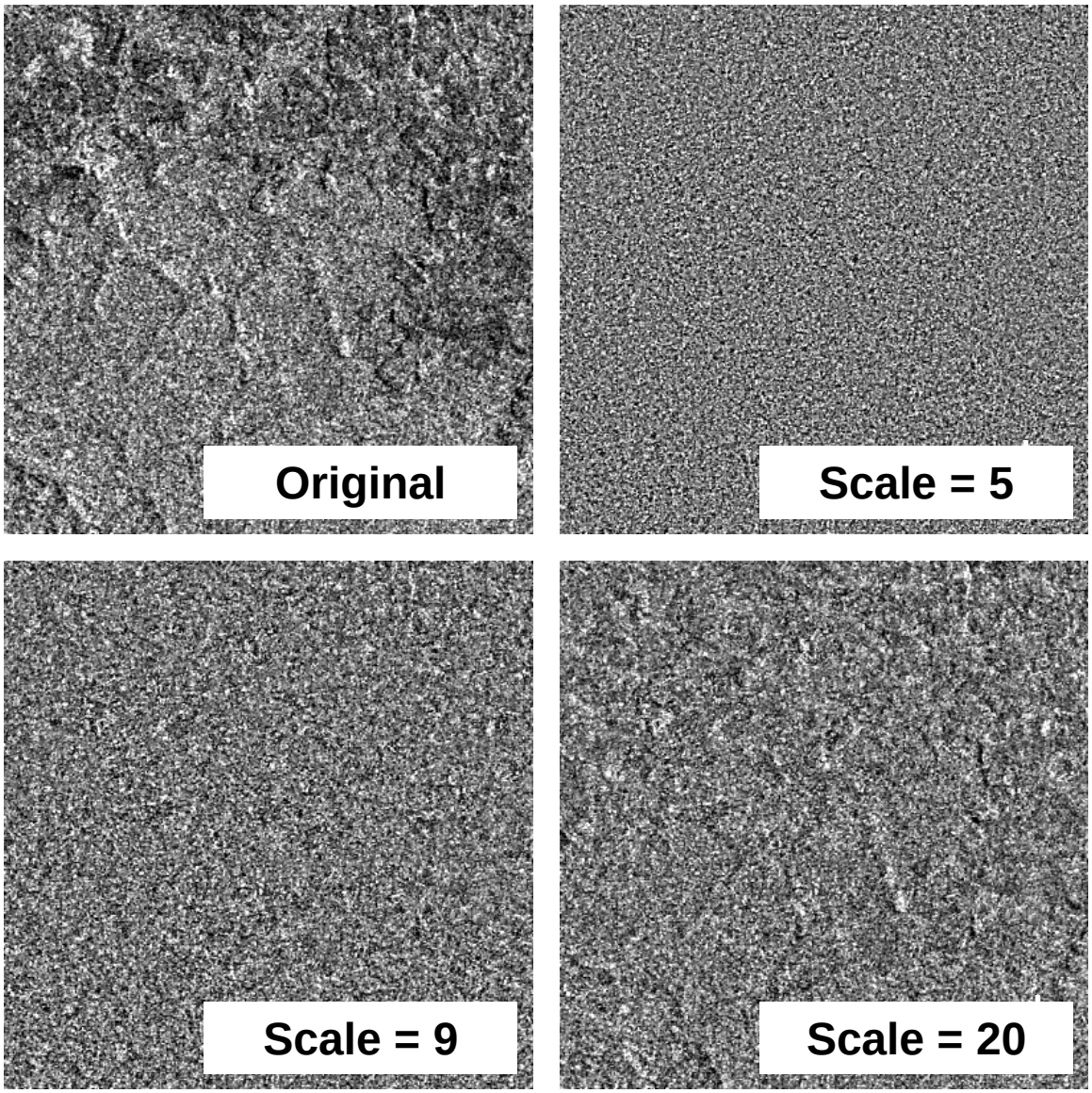




16-bit objects in red 8-bit objects in blue

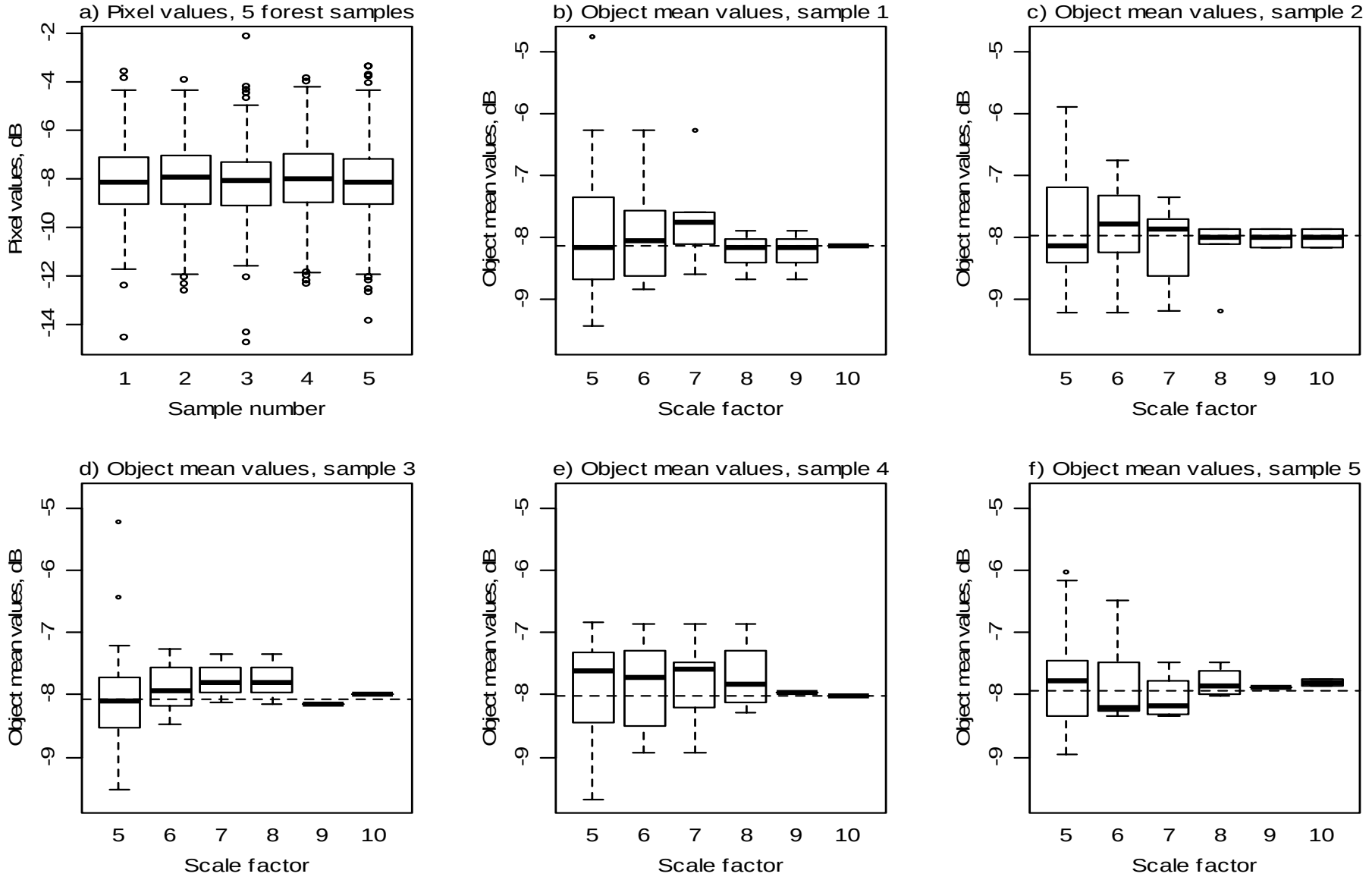
Effect of number of imaging dates on total image objects





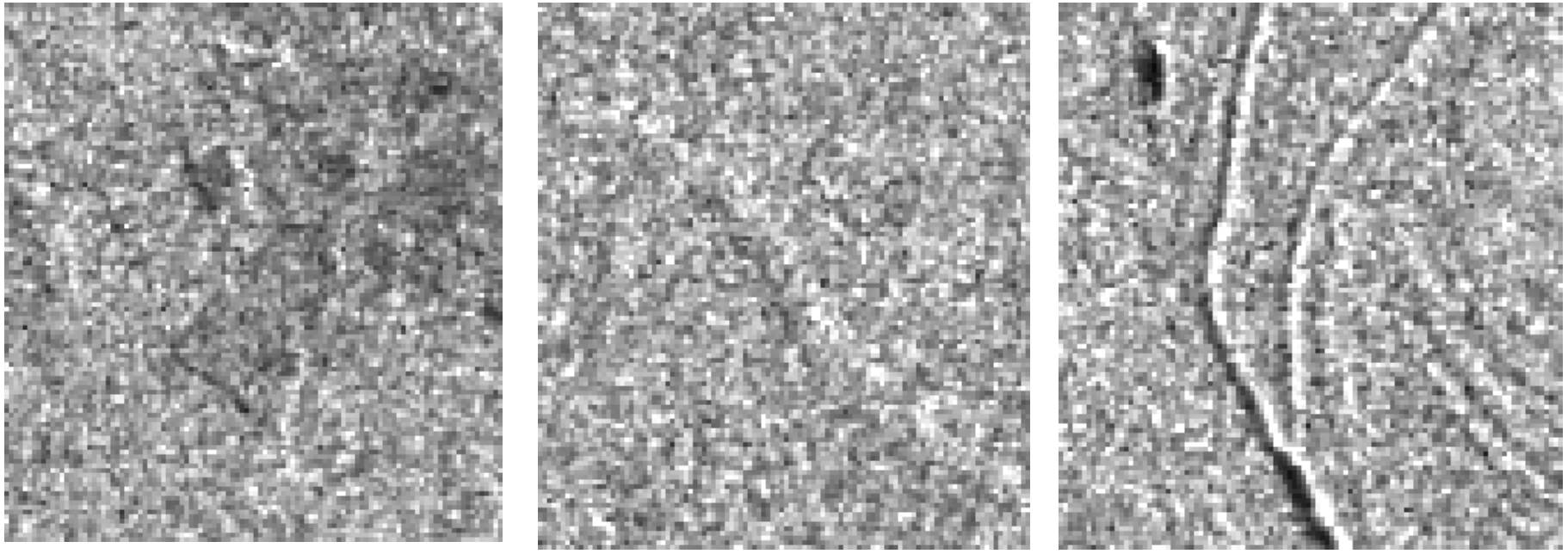
Ratio images (object means to original pixel values) for varying scale factors (using byte-quantized)

(after Oliver & Quegan)


a) Pixel values, 5 forest samples
Pixel values, dB
-2
-4
-6
-8
-10
-12
-14
1
2
3
4
5
Sample number
b) Object mean values, sample 1
Object mean values, dB
-5
-6
-7
-8
-9
5
6
7
8
9
10
Scale factor
c) Object mean values, sample 2
Object mean values, dB
-5
-6
-7
-8
-9
5
6
7
8
9
10
Scale factor
d) Object mean values, sample 3
Object mean values, dB
-5
-6
-7
-8
-9
5
6
7
8
9
10
Scale factor
e) Object mean values, sample 4
Object mean values, dB
-5
-6
-7
-8
-9
5
6
7
8
9
10
Scale factor
f) Object mean values, sample 5
Object mean values, dB
-5
-6
-7
-8
-9
5
6
7
8
9
10
Scale factor

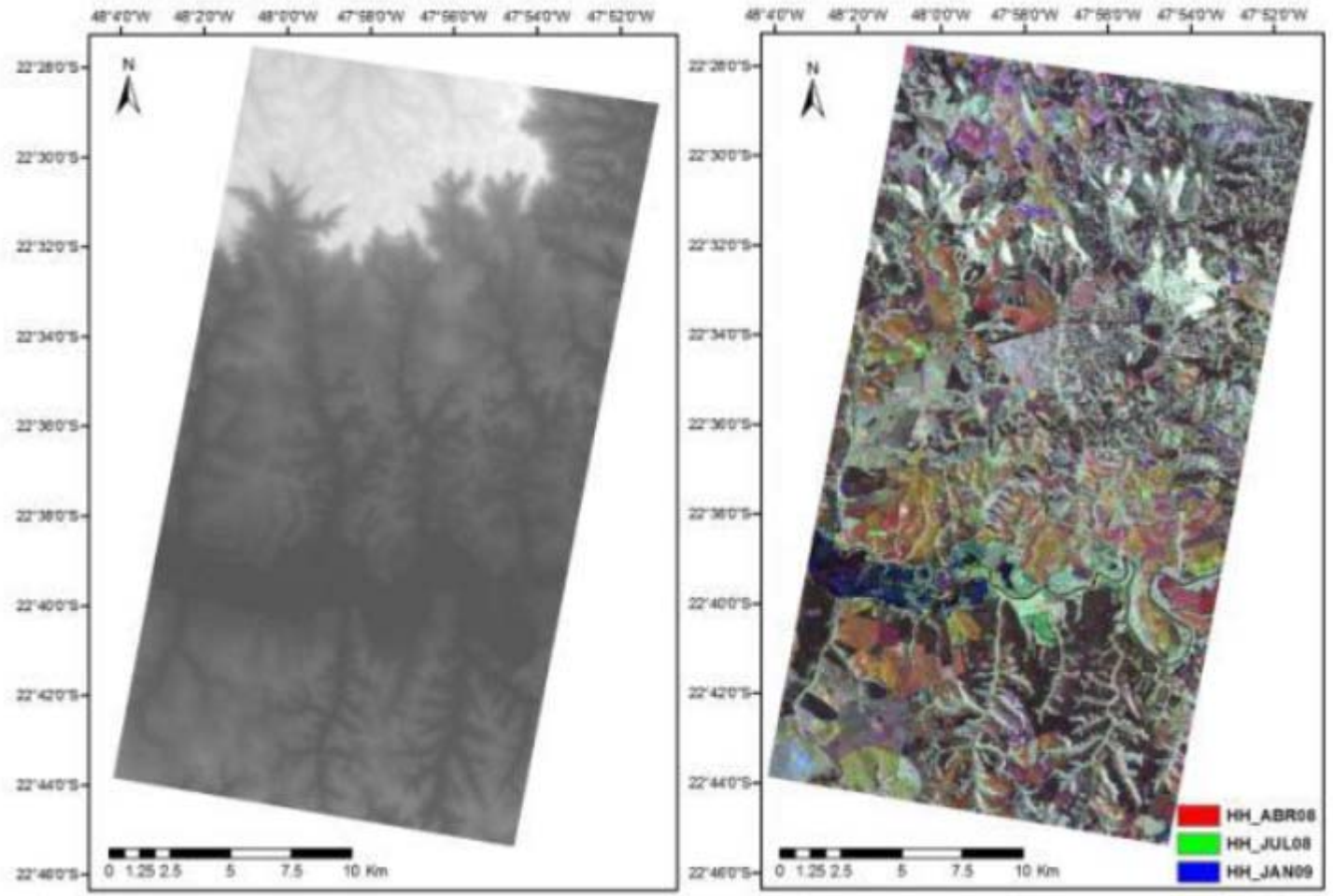
Very high resolution: the down side

Shadow and double-bounce effects using 12.5 m FBD



1 km

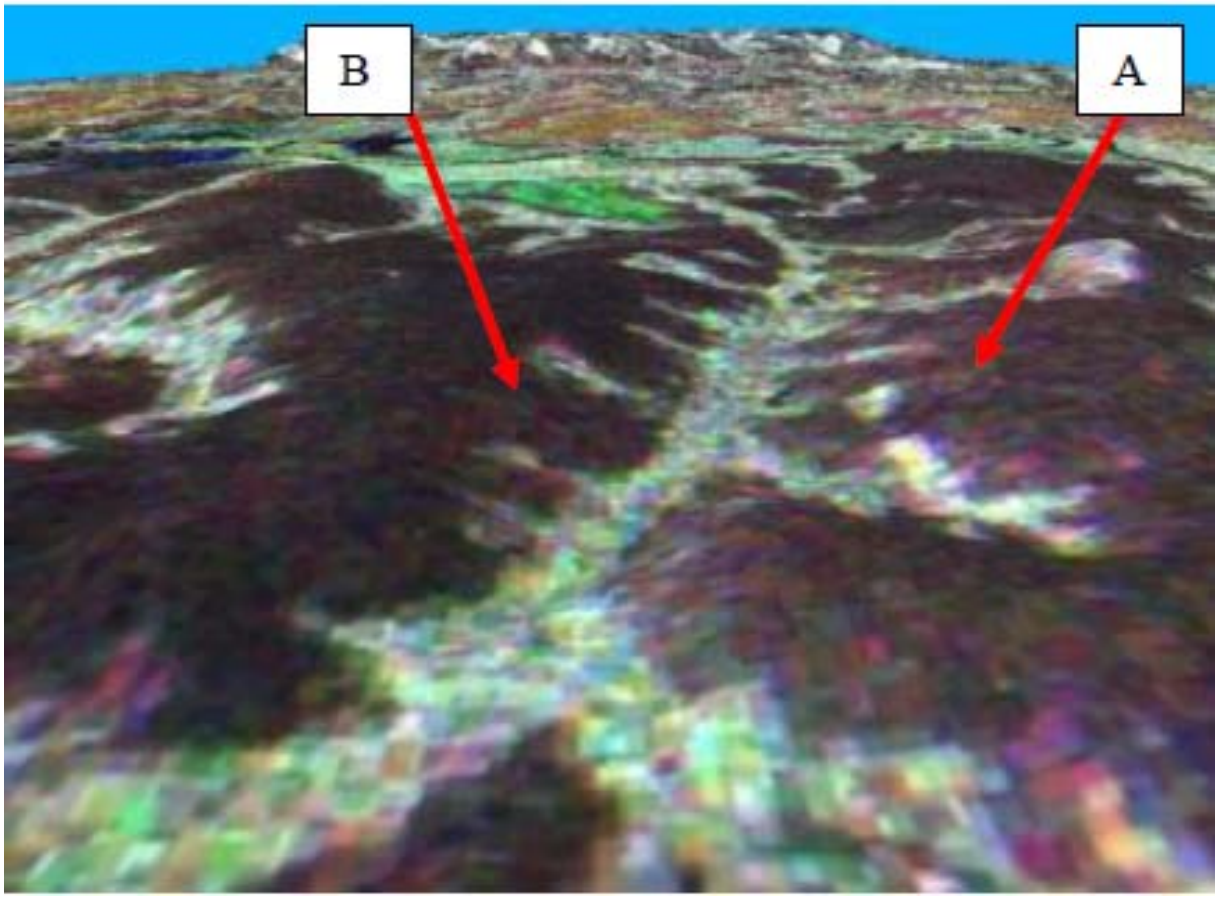
Where available (and for local scale), PRISM DEM can be used to ameliorate these effects



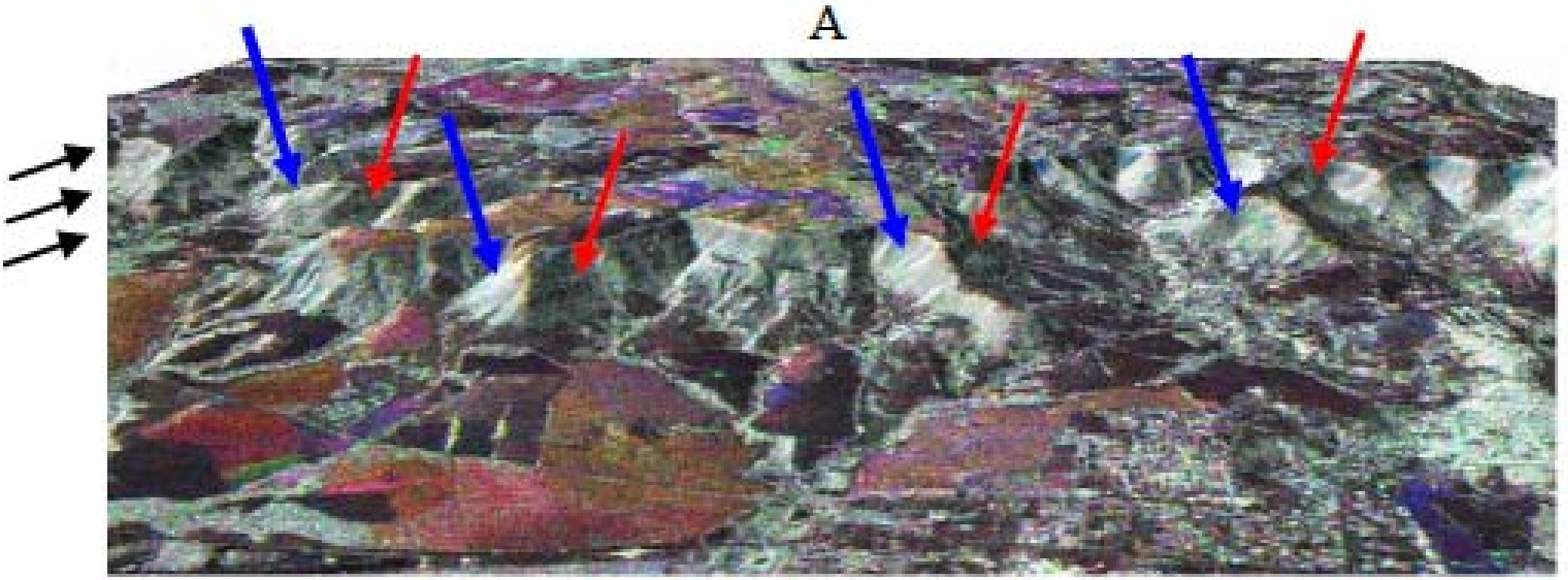
PRISM 2.5 m DEM

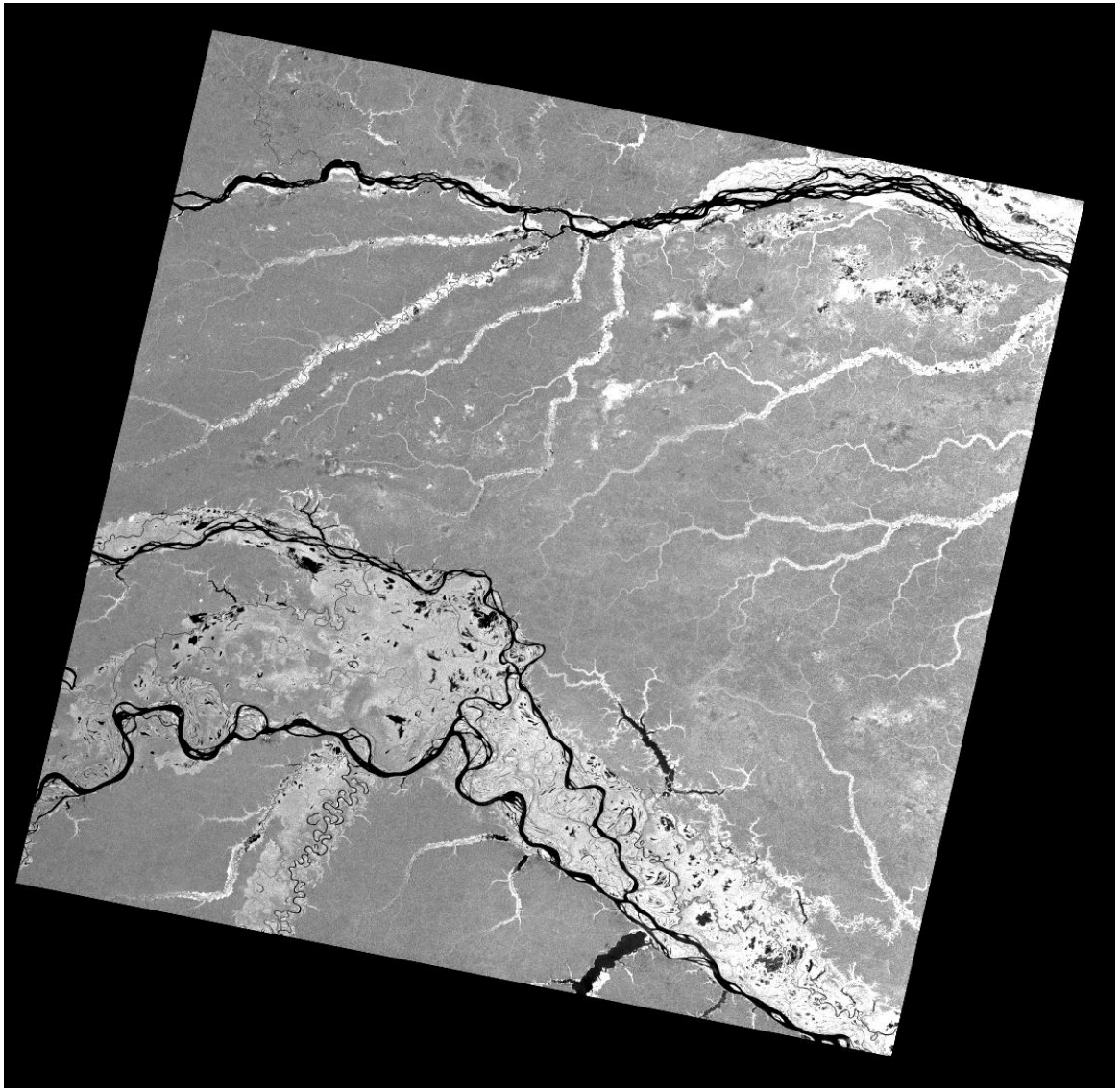
and

PALSAR 12.5 m



Beneditti 2010; PRISM DEM courtesy of T. Tadono


A



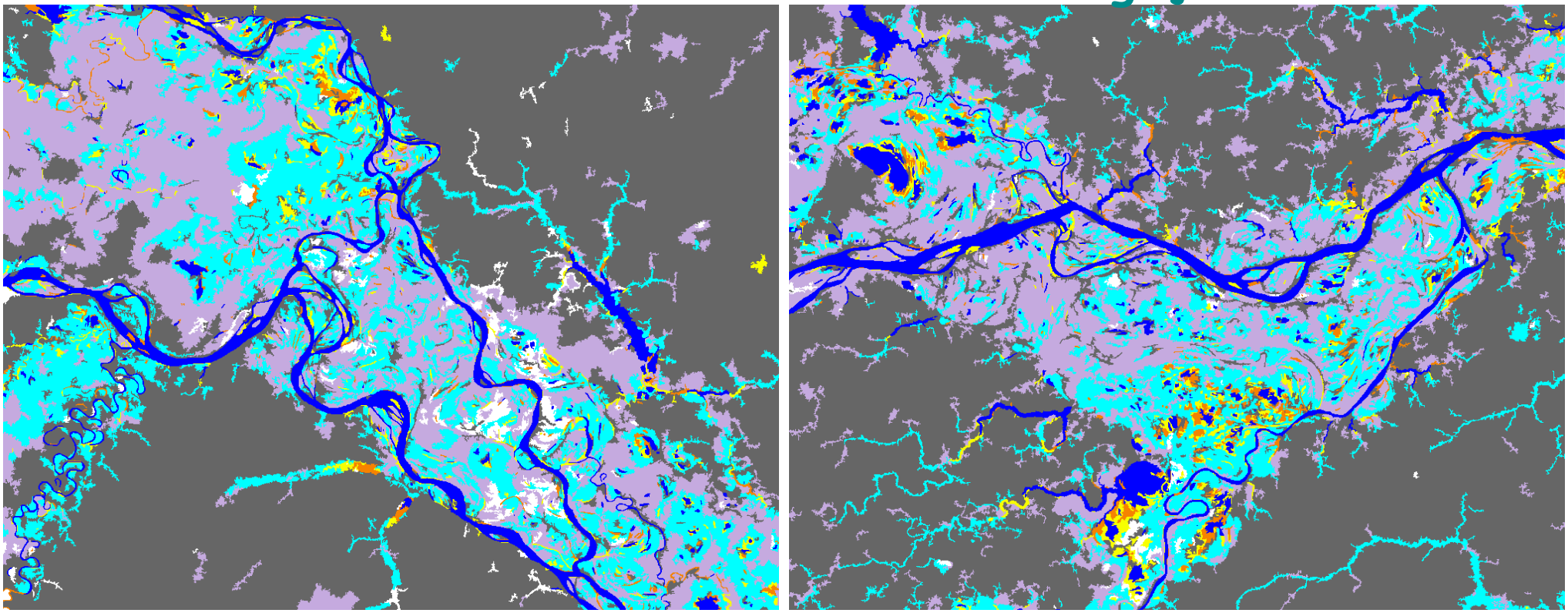
ALOS ScanSAR

19 May 2008

Classified ScanSAR (9 dates)

Mamirauá

Piagaçu-Purus



Open water

Aquatic macrophyte

Shrub

Non-wetland

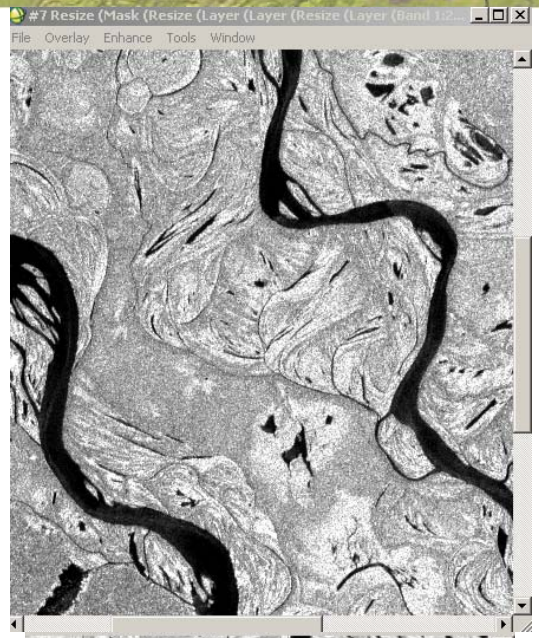
Forest, flooded 1-2 m/a

Forest, flooded 3-6 m/a

Forest, flooded > 6 m/a

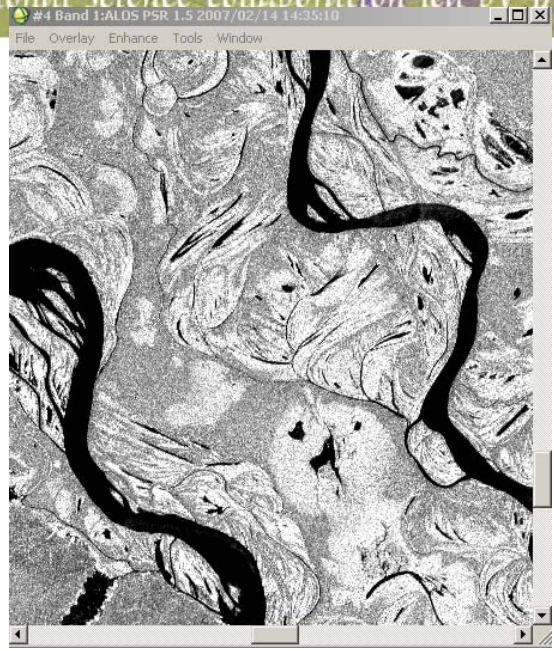
20070401

Tefé = 1044



20070214

Tefé = 1089

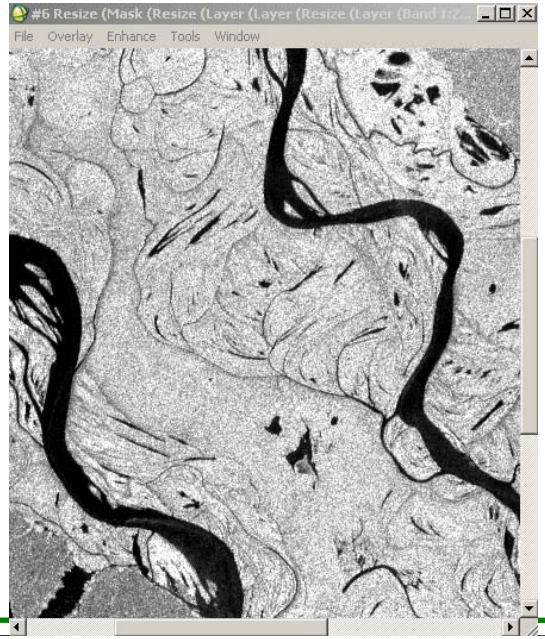


20070730

Tefé = 1109

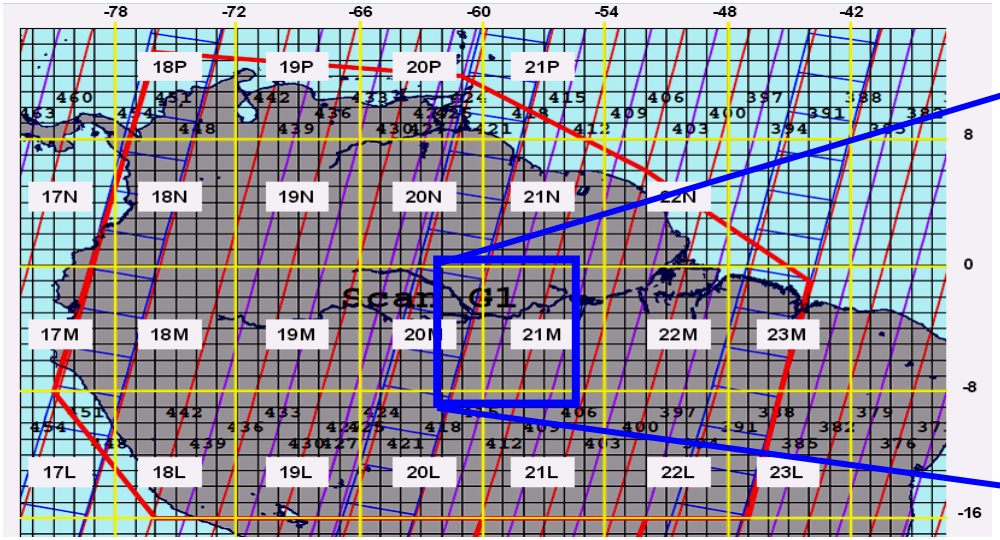
20070702

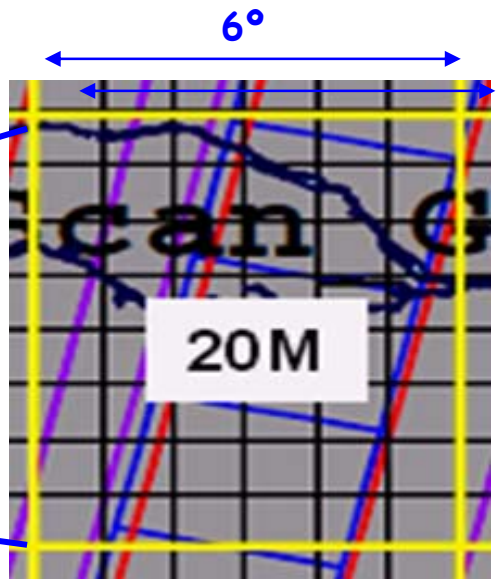
Tefé = 1293

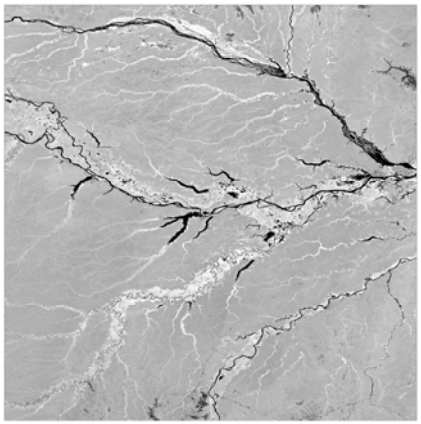


- Strips received from JAXA in KC format are processed atJPL (terrain correction, radiometric calibration, and geocoding) by UTM zone tile

- Data is provided to UCSB in multi-date path (strip) stack format (unmosaicked) for Wide-Beam (ScanSAR), and mosaicked format for Fine-Beam





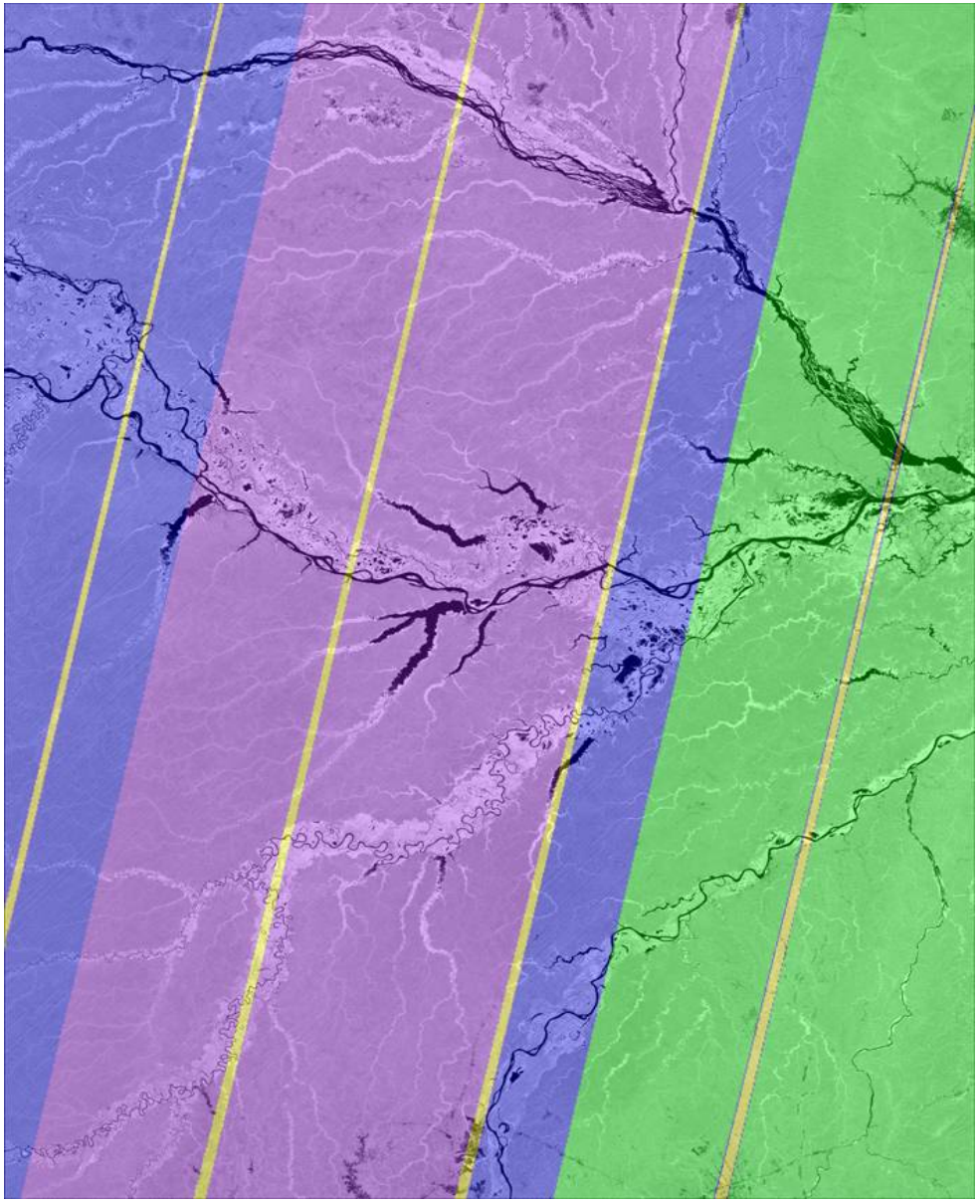


Fine-Beam mosaic of 200 scenes

- Wide-beam stack layers for each path within the tile are 1) local incidence angle (Inc), SRTM DEM, SRTM Water Bodies, and SRTM slope for each path; and 2) for each date: multi-date HH amplitude, terrain-corrected HH amplitude (HHt), and days since launch (Date)

- Fine-beam mosaic layers are local incidence angle (Inc), SRTM DEM, SRTM Water Bodies, SRTM slope, single-date terrain-corrected HH amplitude (HHt) and HV amplitude (HVt), and days since launch (Date)

ALOS ScanSAR coverage: UTM Zone 20M, 2007 (all cycles)



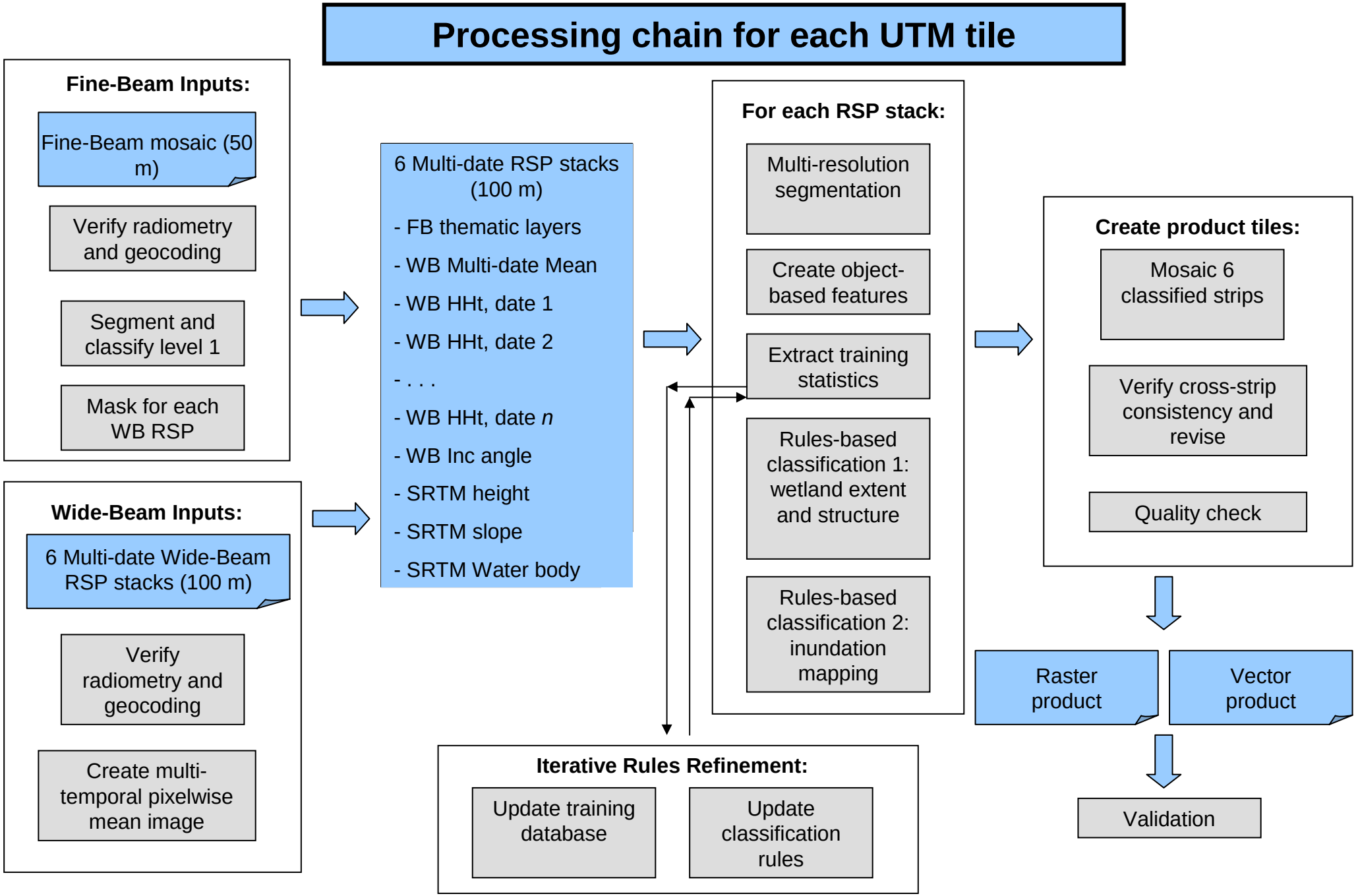
17-22

15-16

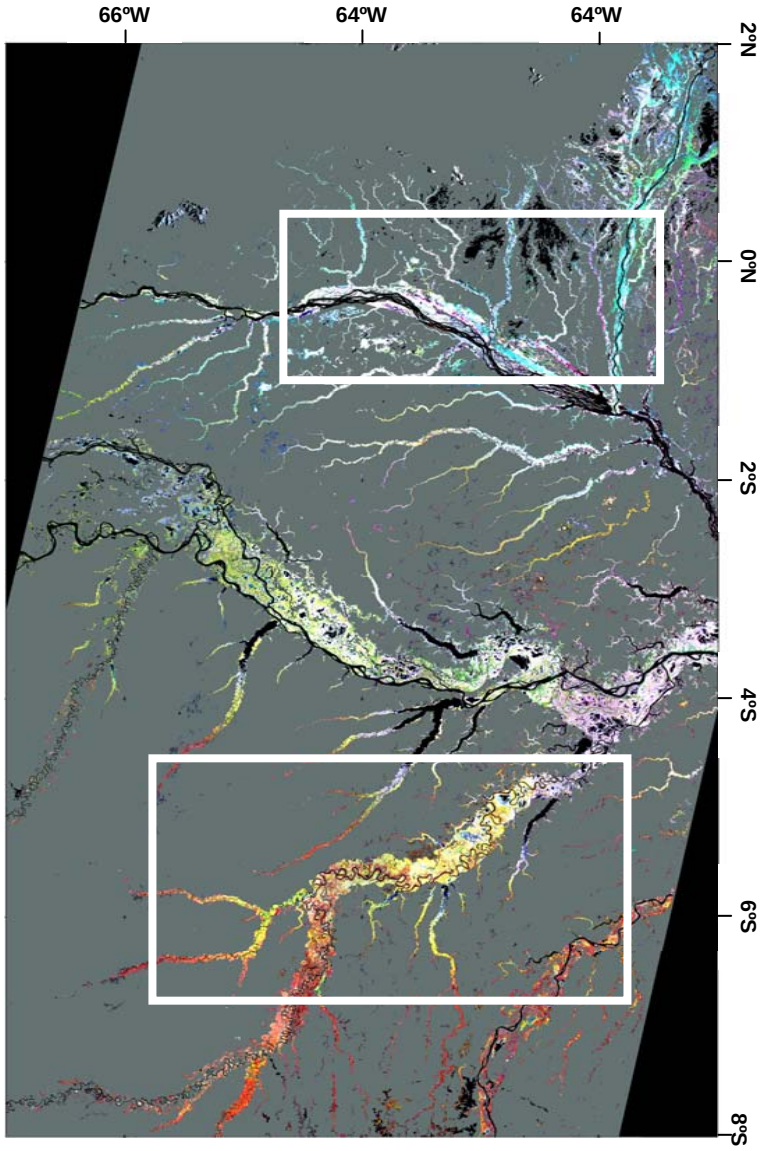
13-14

12

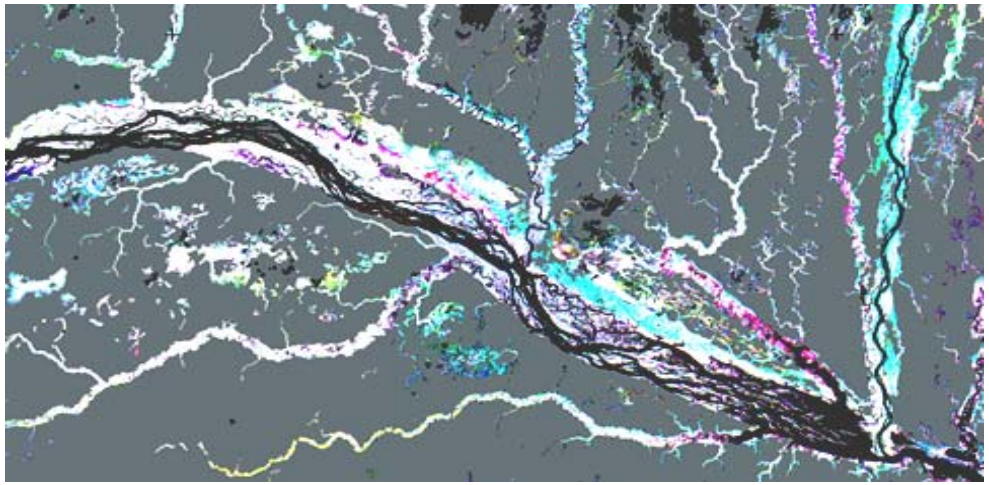
Number of coverages, 2007

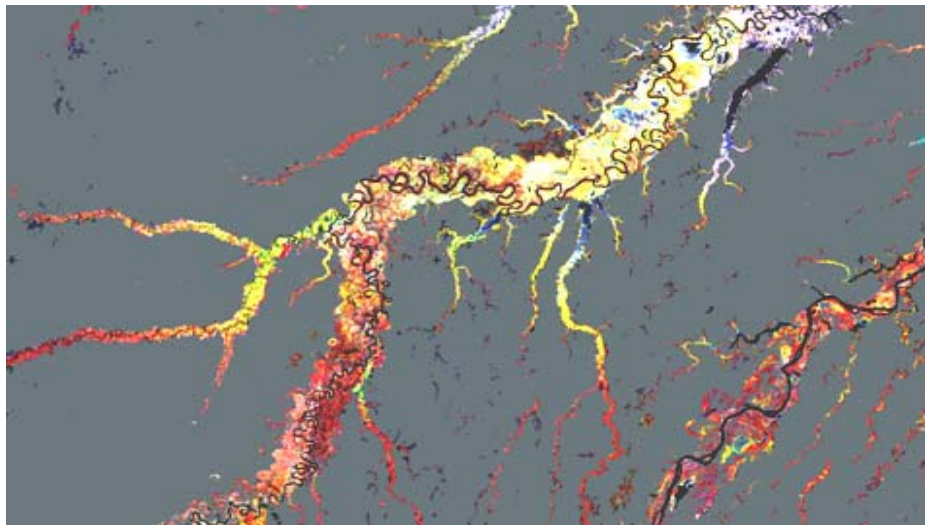

Processing chain for each UTM tile
Fine-Beam Inputs:
Fine-Beam mosaic (50 m)
Verify radiometry and geocoding
Segment and classify level 1
Mask for each WB RSP
Wide-Beam Inputs:
6 Multi-date Wide-Beam RSP stacks (100 m)
Verify radiometry and geocoding
Create multi-temporal pixelwise mean image
6 Multi-date RSP stacks (100 m)
- FB thematic layers
- WB Multi-date Mean
- WB HHt, date 1
- WB HHt, date 2
- . . .
- WB HHt, date n
- WB Inc angle
- SRTM height
- SRTM slope
- SRTM Water body
For each RSP stack:
Multi-resolution segmentation
Create object-based features
Extract training statistics
Rules-based classification 1: wetland extent and structure
Rules-based classification 2: inundation mapping
Iterative Rules Refinement:
Update training database
Update classification rules
Create product tiles:
Mosaic 6 classified strips
Verify cross-strip consistency and revise
Quality check
Raster product
Vector product
Validation

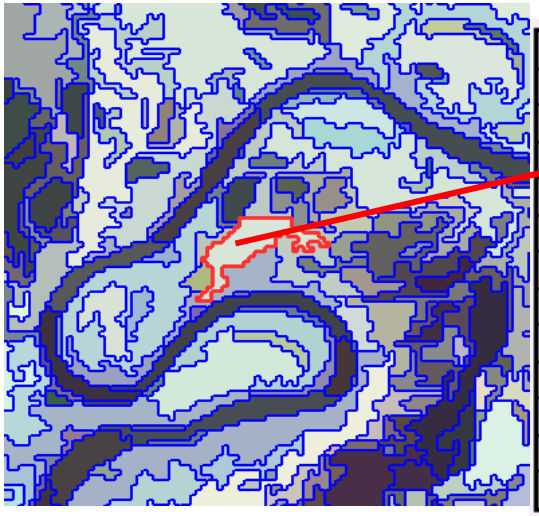
ScanSAR 3-date Mosaic (Non-wetlands masked)



R: May 2007
G: June-July 2007
B: August 2007







No.	LCLevel4	LCLevel5	LCLevel6	LCLevel7	FIDate1	FIDate2	FIDate3
45	Woody	Tree	Closed	Tall	0	0	0
46	Woody	Tree	Closed	Tall	0	0	0
60	Woody	Tree	Closed	Tall	0	0	0
61	Woody	Tree	Closed	Tall	0	0	0
65	Woody	Tree	Closed	Tall	1	1	0
66	Woody	Tree	Closed	Tall	1	1	0
67	Woody	Tree	Closed	Tall	1	0	0
69	Woody	Tree	Closed	Tall	1	0	0
70	Woody	Tree	Closed	Tall	1	1	0
71	Woody	Tree	Closed	Tall	1	1	0
79	Woody	Tree	Closed	Tall	1	1	1
80	Woody	Tree	Closed	Tall	1	1	1

- Raster products (wetland extent, vegetation cover, and inundation period) synthesize flooding information from many dates

- Knowledge of flooding state on individual dates is important for cross-product comparison and use in models, but increases product volume by roughly 10x when presented in raster format

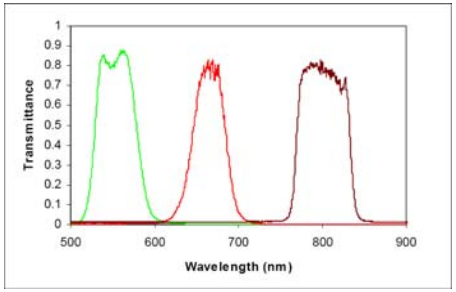
- Flooding state for specific dates is therefore additionally formatted as shapefile and attribute (dbf) file giving flooding status for all available dates for each image object

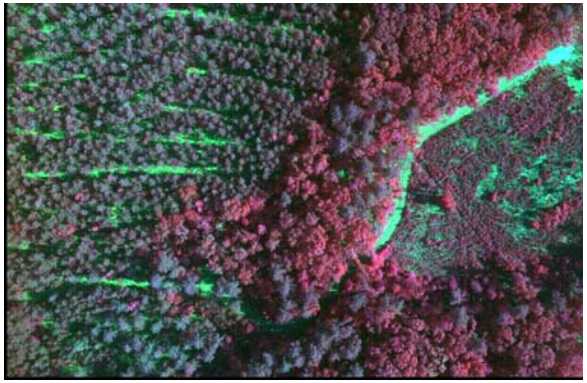
- Attribute file also includes presence/absence of seasonal aquatic macrophytes, and LCCS hierarchical classes

Validation: Câmera Multispectral e Laser para Inventário Aéreo

Dana Slaymaker

Resource Mapping

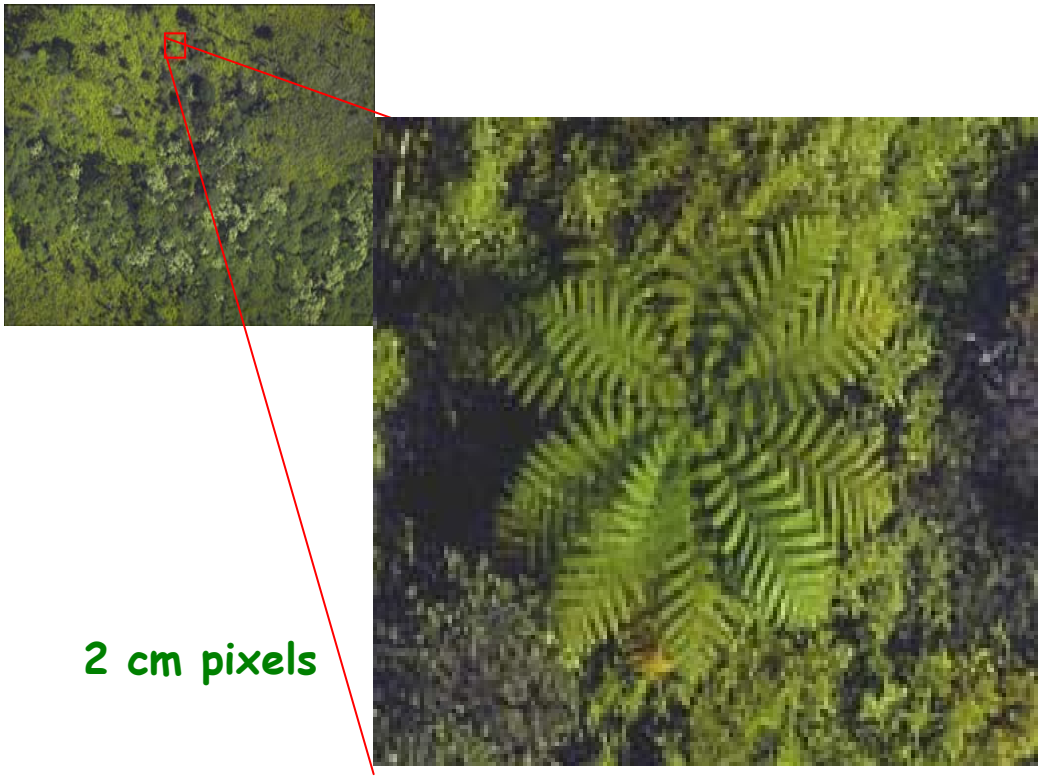




RGB = NIR, R, G

50 cm pixels

MS-4100 multispectral camera



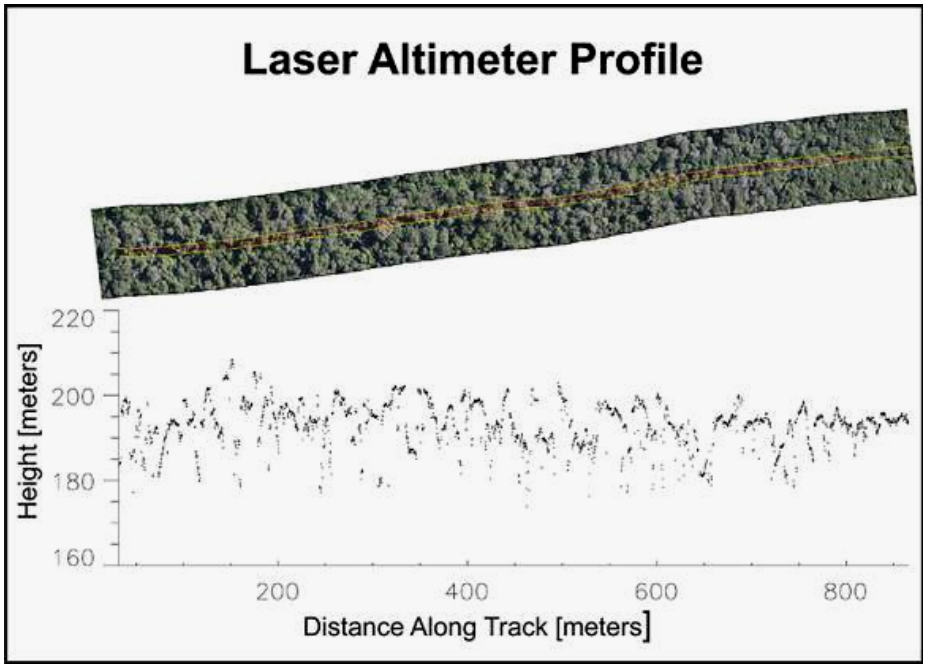
2 cm pixels

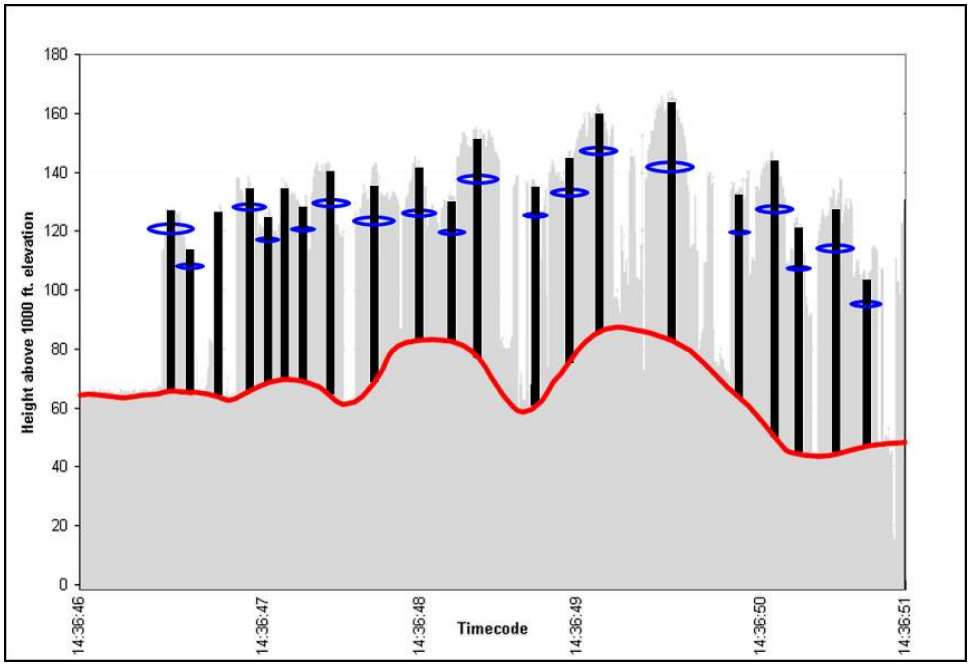
Natural color camera permits very high-resolution coverage even under low-light conditions.

Canon Mark III DS1 camera

CAMELIA:

Câmera Multispectral e Laser para Inventário Aéreo



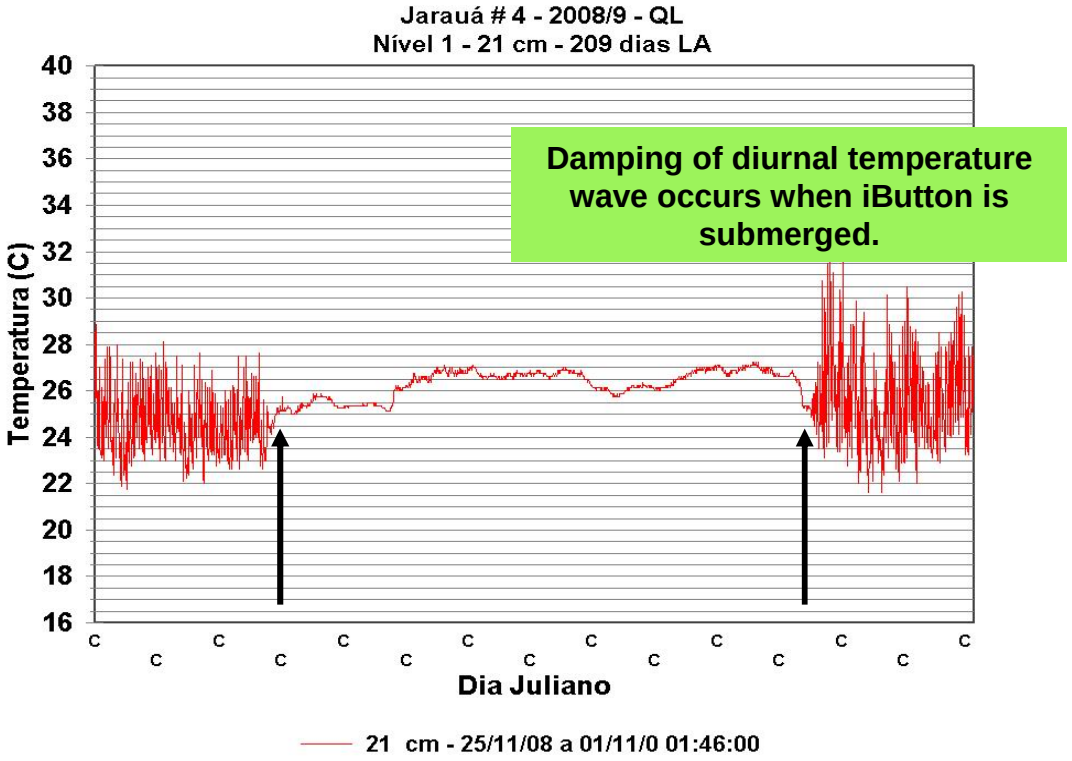


Ground and canopy surfaces are profiled using alternating first and last laser returns. Tree heights and stereo-based crown delineation can be used for biomass estimation (Brown et al. 2005).

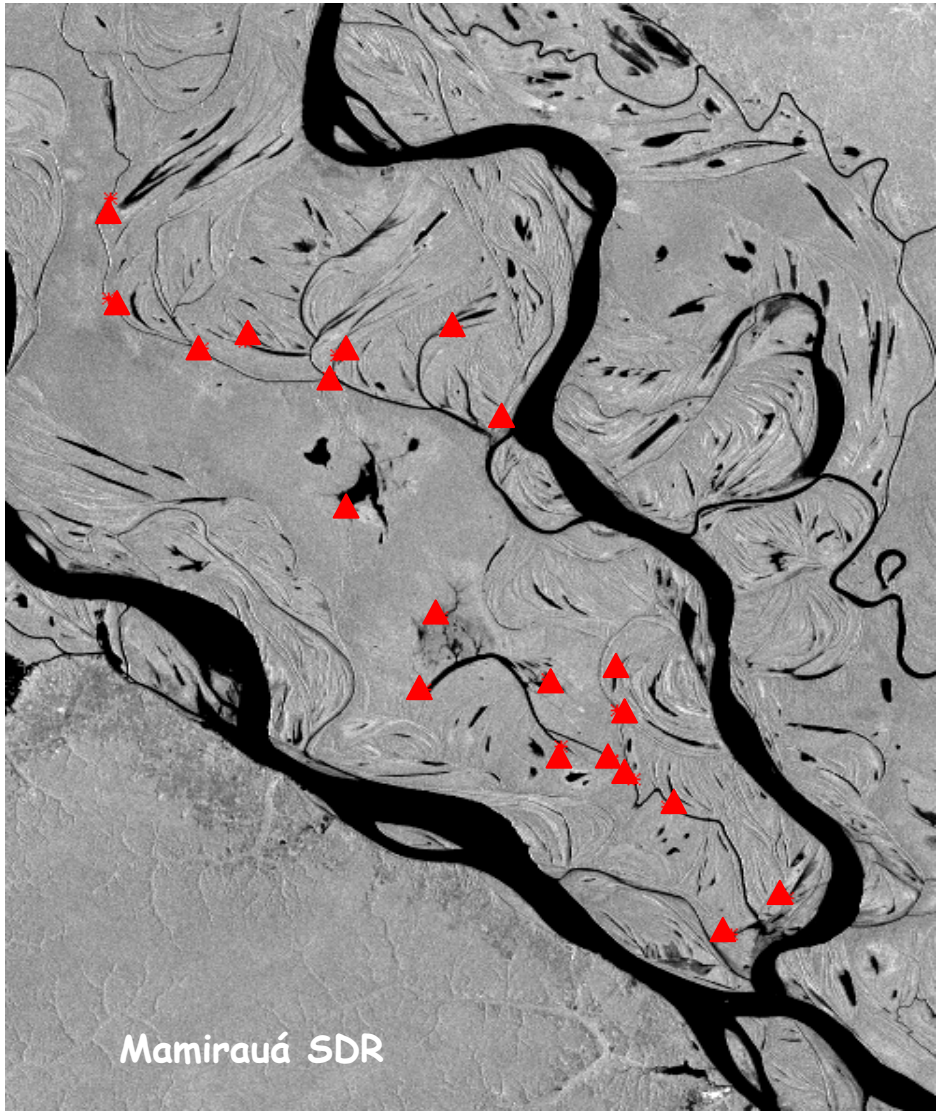
Proof-of-Concept Field Experiment: Low-Cost Distributed Network of Water Level Gauges at the Mamirauá and Piagaçu Reserves

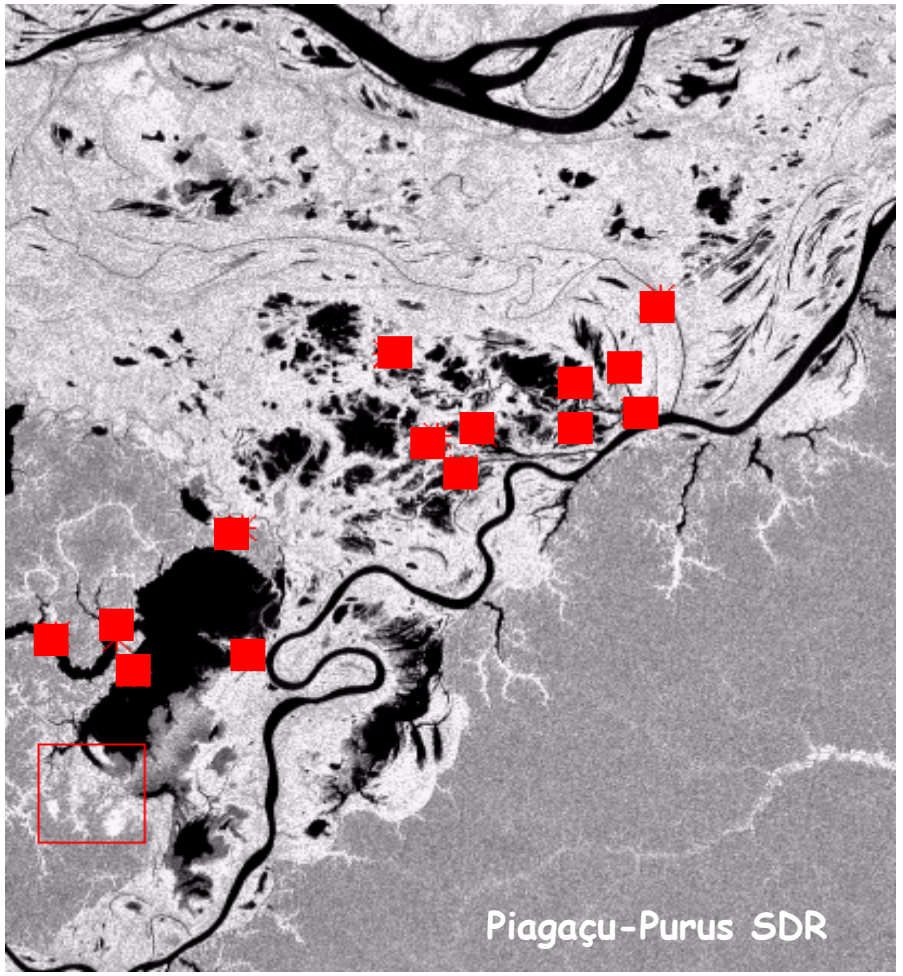
L. Hess, E. Arraut, R. Gielow, E. Novo, A. Affonso

Thermochron iButton and tree "gauge"

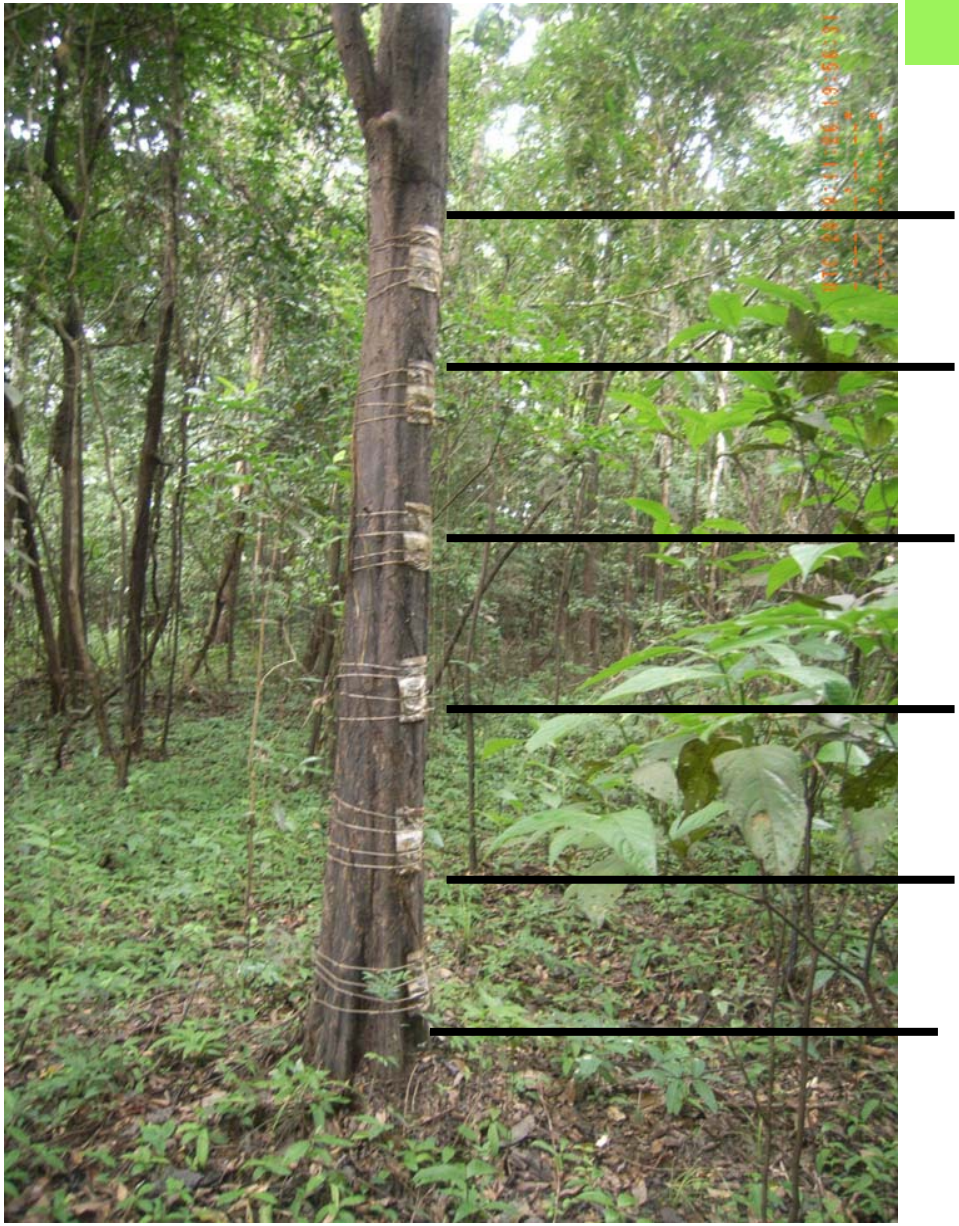


Damping of diurnal temperature wave occurs when iButton is submerged.

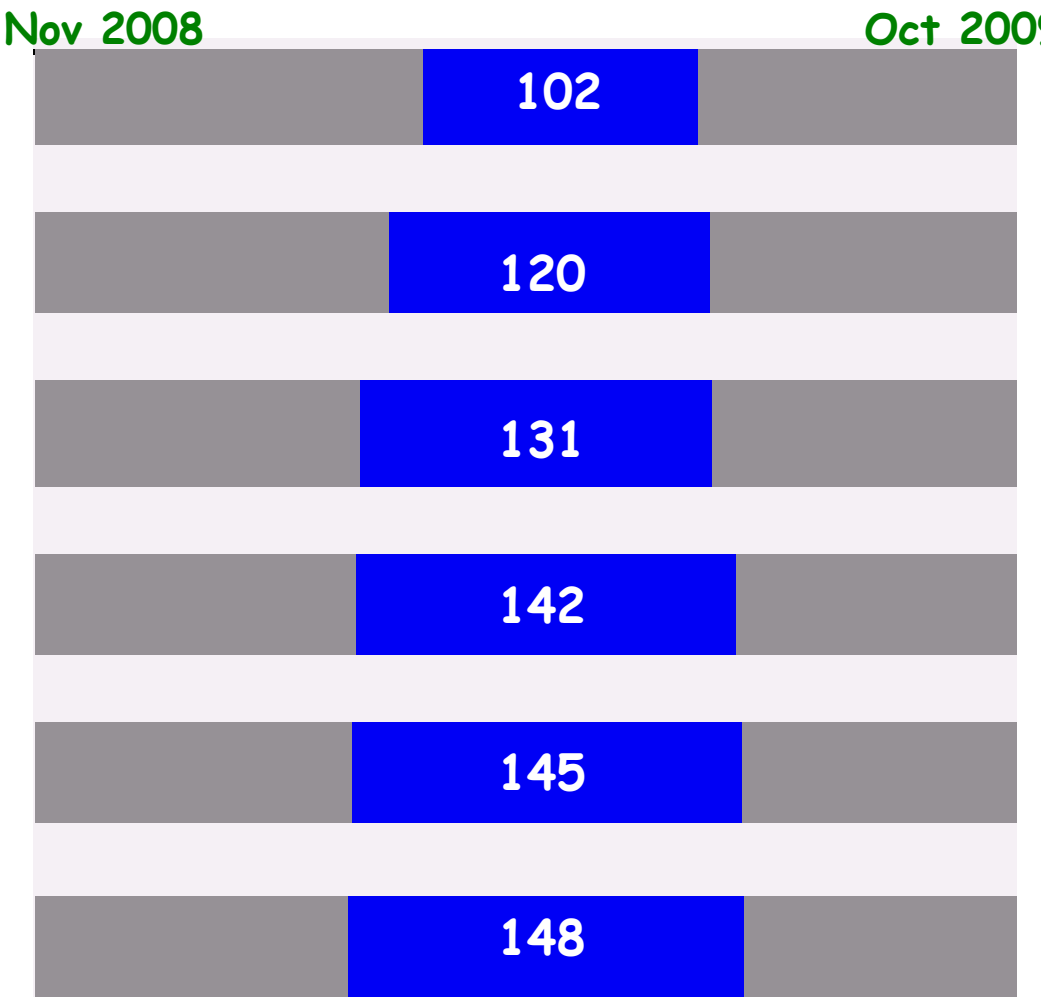




iButton gauge locations, 2008-2009



Inundation period (days), 2008-2009 flood



K&C deliverables

Papers and Reports

1. Published

- K&C Phase-1 report; Phase-2 report by Feb. 7
- 2 contributions to K&C Booklet
- Cristina Aparecida Beneditti, 2010. *Object-based analysis of ALOS PALSAR imagery for land cover discrimination.* Master's thesis (in Portuguese), State University of São Paulo, Presidente Prudente.
- J. Lowry, L. Hess, and A. Rosenqvist, 2009. Mapping and monitoring wetlands around the world using ALOS PALSAR: the ALOS Kyoto and Carbon Initiative Wetlands Products. pp. 105-20 in *Innovations in Remote Sensing and Photogrammetry,* ed. S. Jones and Karin Reinke.
- L. Hess, E.M. Novo, L. Durieux, A. Affonso, E. Arraut, B. Marshall, B.D. Chapman, and K.C. McDonald, 2010. Multi-scale mapping of Amazonian wetlands with ALOS PALSAR. *Eos Trans. AGU* 91(26), *Meet. Am. Suppl.*

K&C deliverables
Papers and Reports

2. Submitted/in preparation

- PALSAR-based mapping of floodplain habitats at a Brazilian Ramsar site. *To be submitted to ??.*
- Backscattering characteristics of woody vegetation of Amazonian wetlands: *RSE special issue*
- Inundation mapping of central Amazonian wetlands with ALOS ScanSAR: *RSE special issue? or possibly Earth Interactions*

K&C deliverables

Data sets and Thematic products

2. Completed, but not yet delivered

- *Fine-scale vegetation structure and inundation period mapping, Mamirauá Sustainable Development Reserve, Brazil (Ramsar site)*
- *ScanSAR-based vegetation structure and inundation mapping, upper Solimões floodplain*
- *KC strip-based mapping for UTM 20M (6 x 8 degrees), reduced resolution (6 arcsec)*
- *Very high resolution geocoded mosaics from aerial overflights*
- *Training/test polygons and statistics*
- *Field photos*
- *(iButton data files?)*

THANK YOU JAXA!

AND MANY THANKS TO:

INPE

IRD
Institut de recherche pour le développement

FAPESP

Projeto geoma

Mamirauá
INSTITUTO DE DESENVOLVIMENTO SUSTENTÁVEL MAMIRAUÁ

INSTITUTOPIAGACU