crc for spatial information

DERIVING VEGETATION PARAMETERS AND FOREST STRUCTURAL INFORMATION FROM AIRBORNE RADAR SYSTEMS

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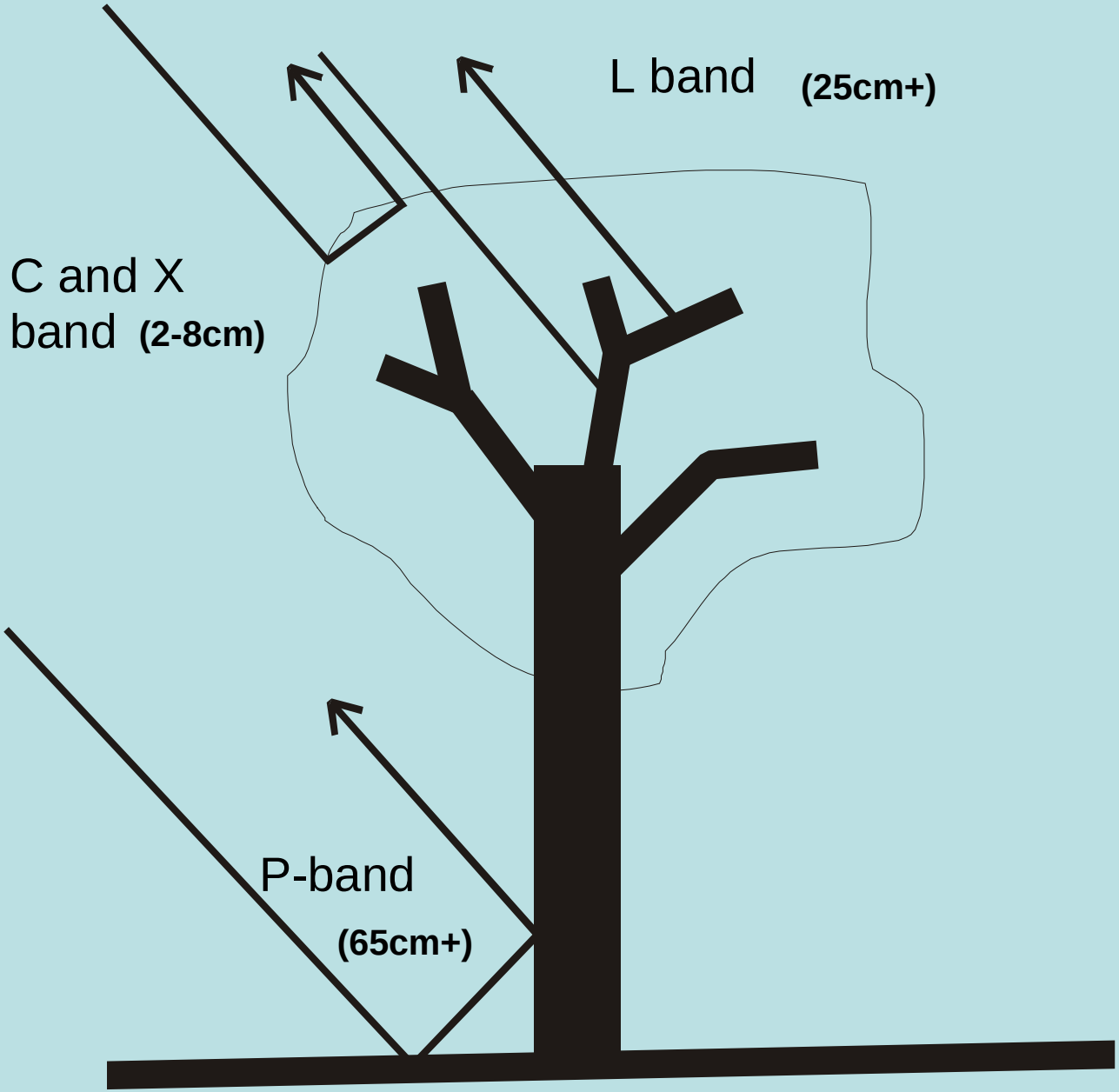
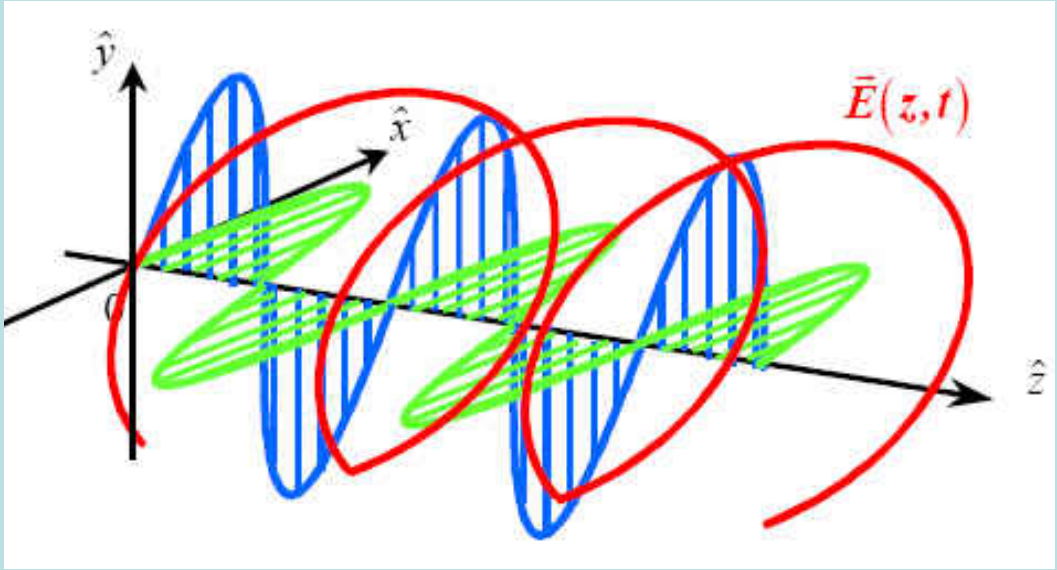
Second GEOSS Asia-Pacific Symposium:
The Role of Earth Observations in Tackling Climatic Change,
Tokyo, April 14-16, 2008

Radar Wavelength and Backscatter



Polarimetric SAR

Linear
HH
HH HV
VV
VV VH
Circular



Analysing the polarisation state of an electromagnetic field

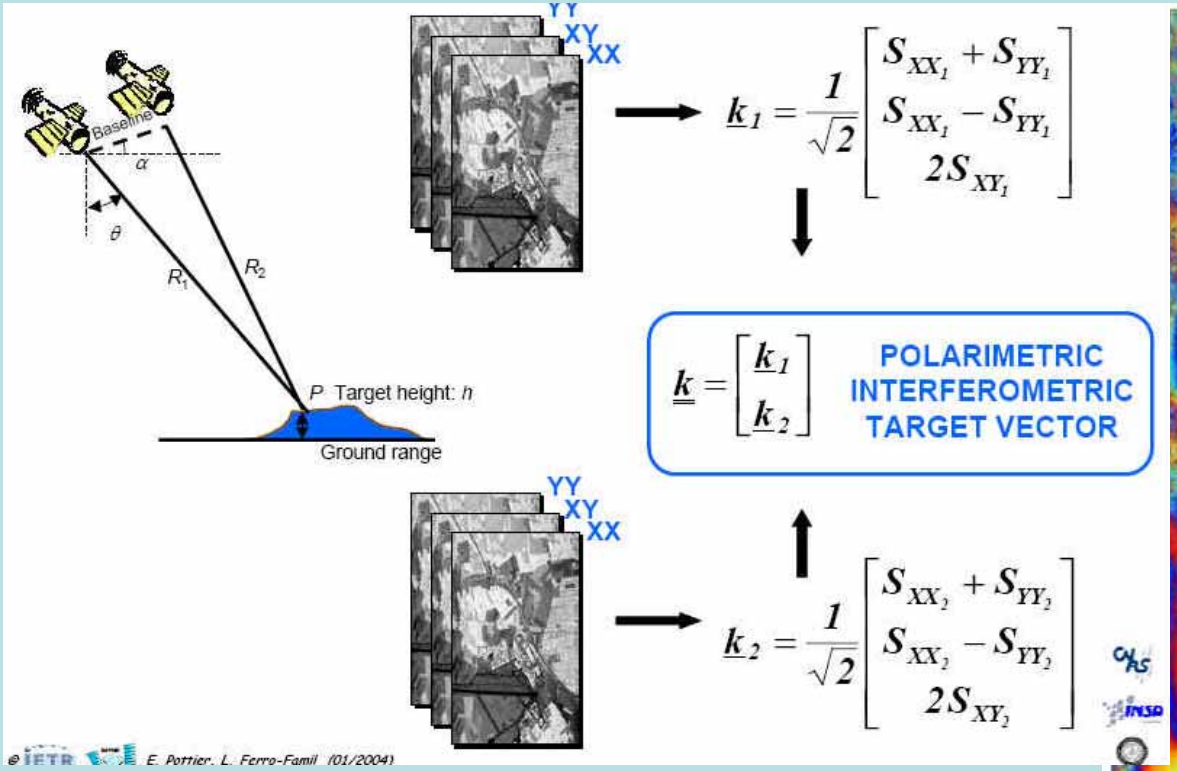
Highly related to –

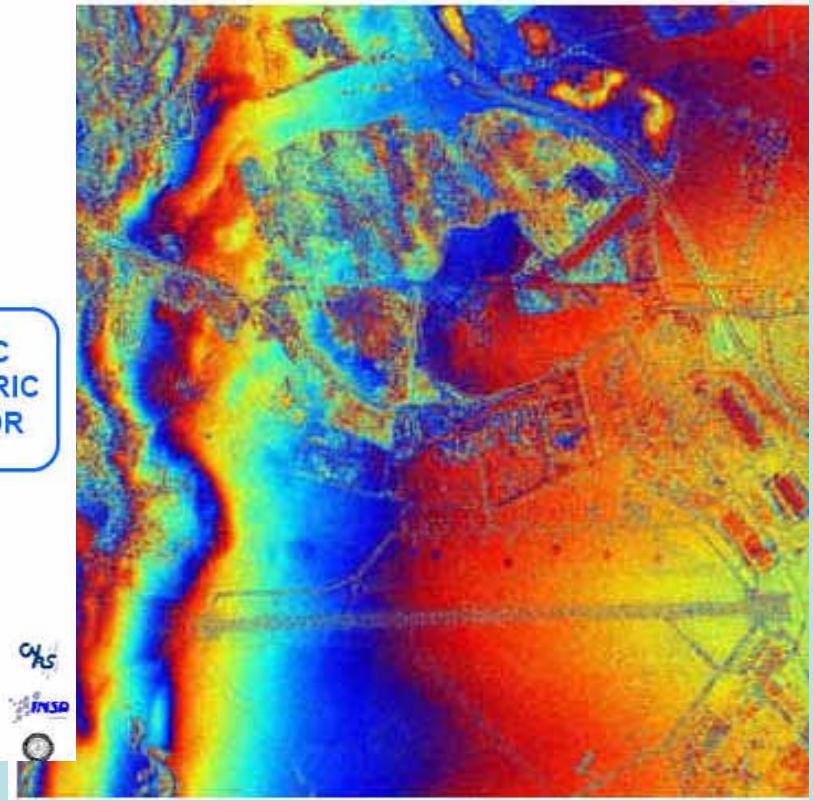
- **Geometrical shape, structure, orientation and reflecting properties, and,**
- **Geophysical properties such as surface roughness and moisture content of objects and surfaces.**

Target recognition and detection of both point and distributed objects

PolinSAR

The phase difference between two or more image data sets acquired from similar or the same SAR separated spatially by a short distance gives information on topography and with multiple datasets, changes in topography or height.





Measure height, displacement and motion

AuSAR - INGARA
D.S.T.O (Aus)
DC3 (97) KingAir 350 (00) Beach 1900C
X-Band (Quad)

POLARIMETRIC SAR SENSORS

AIRBORNE SENSORS

AES1
AeroSensing (D)

AIRSAR
NASA / JPL (USA)

DOSAR
EADS / Dornier GmbH (D)

ESAR
DLR (D)

EMISAR
DCRS (DK)

MEMPHIS / AER II-PAMIR
FGAN (D)

PHARUS
TNO - FEL (NL)

PISAR
NASDA / CRL (J)

RAMSES
ONERA (F)

RENE
UVSQ / CETP (F)

STORM
UVSQ / CETP (F)

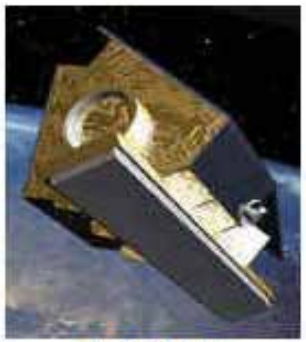
SAR580
Environnement Canada (CA)

SHUTTLE / SPACEBORNE SENSORS

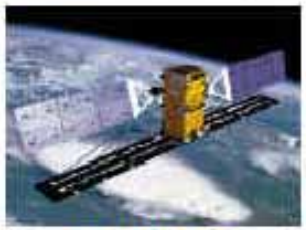
SIR-C
NASA / JPL (USA)

ENVISAT / ASAR
ESA (EU)

ALOS / PALSAR
NASDA / JAROS (J)



TERRASAR
BMBF / DLR / ASTRIUM

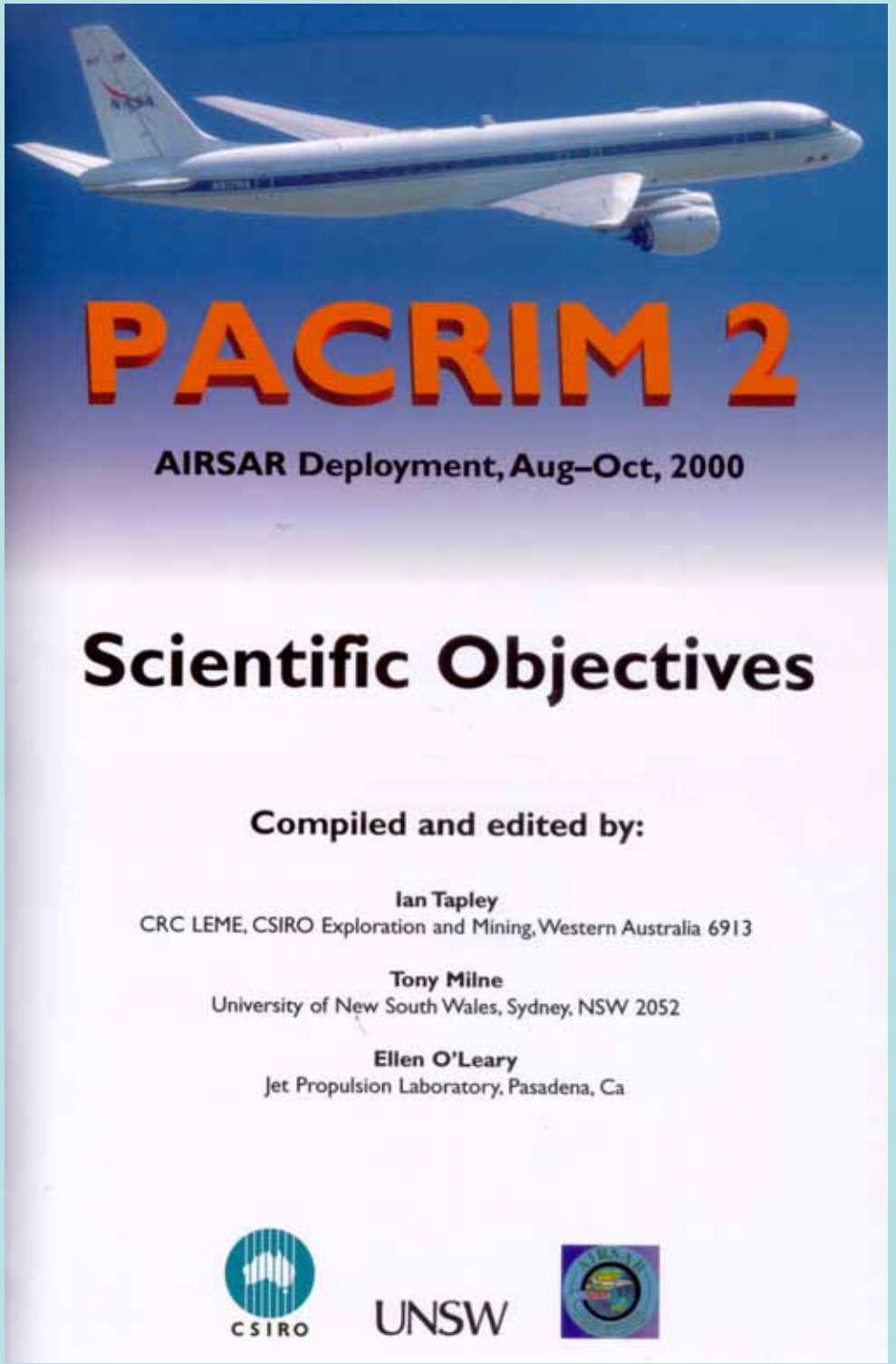


RADARSAT 2
CSA - MDA (CA)

AIRSAR

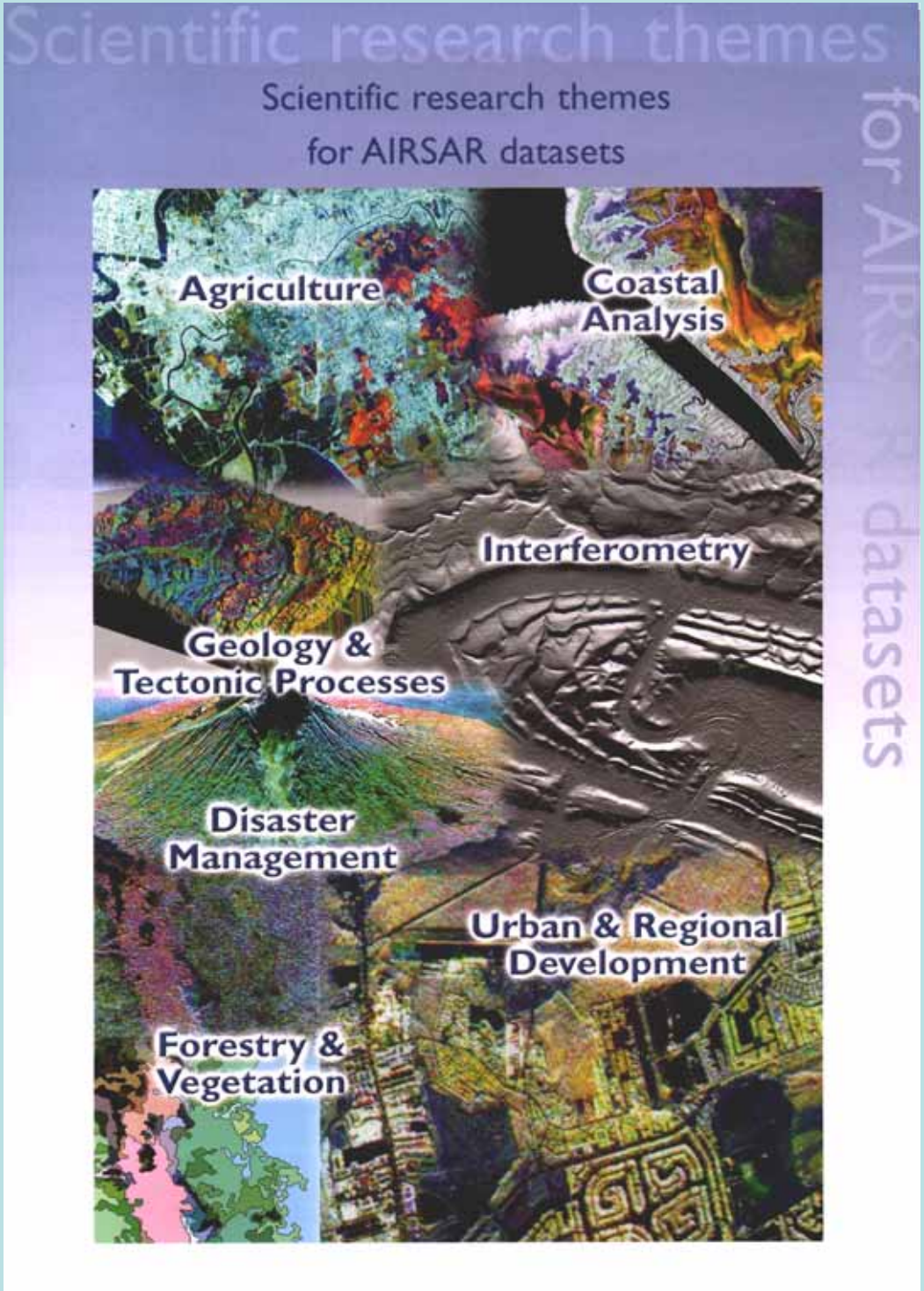
Polsar - C, L and P-band
Topsar - C and P- band

- **46 flight days over a 3-month period, 21st July to 23rd Oct.**
- **15 bases in 9 countries**
- **648 flight lines collected at 201 sites in 18 countries & territories**
- **54,623 km of flight-line data**

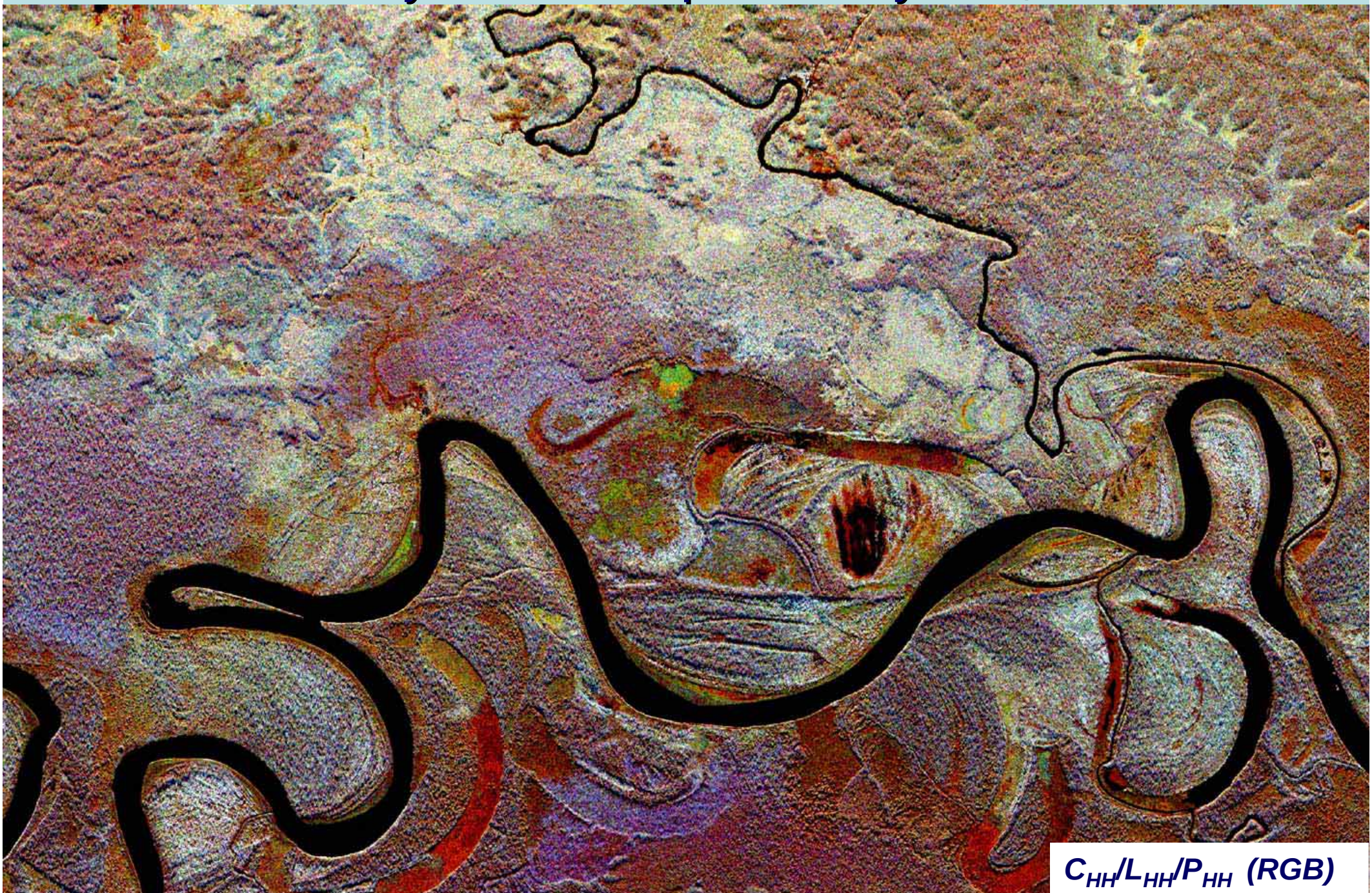


AIRSAR data provided to >400 PI's from 20 PacRim countries in 3 missions

- Forestry and vegetation
- Agriculture
- Coastal analysis
- Geology & tectonic processes
- Interferometry
- Disaster management
- Urban & regional development



Define the impact of mine waste dispersions on the biodiversity of the Fly River flood-plain ecosystem, PNG



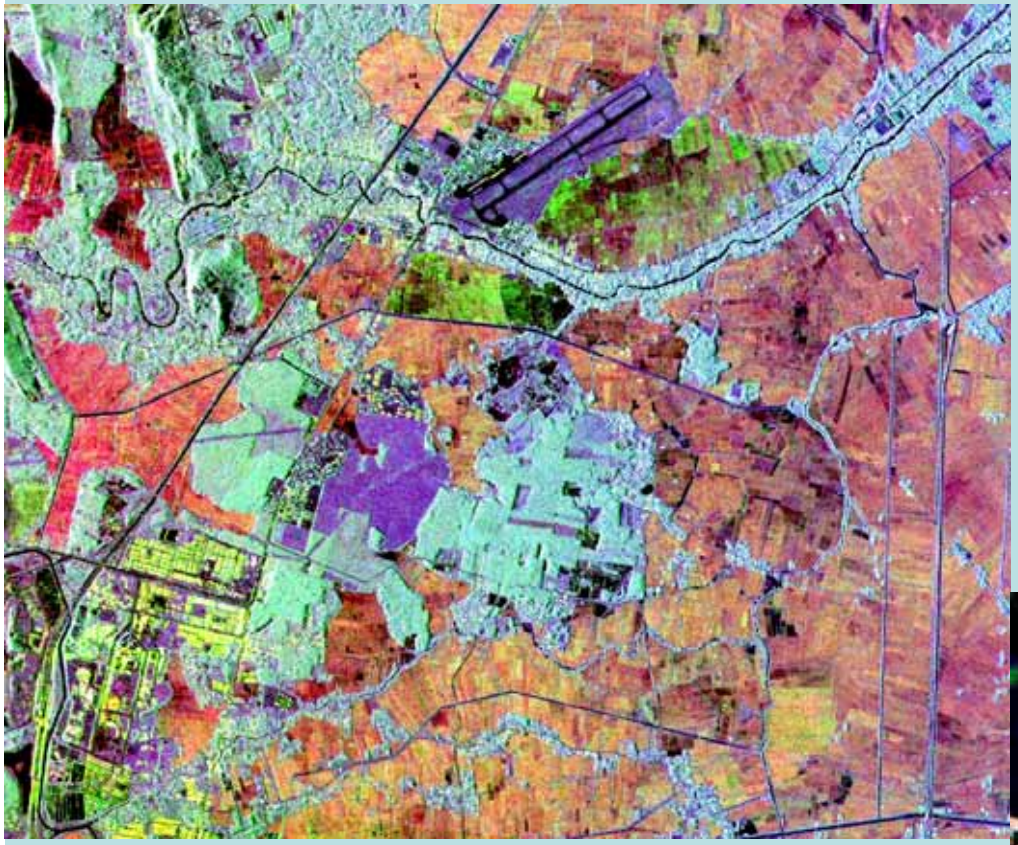
$C_{HH}/L_{HH}/P_{HH}$ (RGB)

Mapping and inventory of mangrove and wetland vegetation communities in tropical regions

Are radar data suitable for defining the biomass and species composition of mangrove populations under threat from environmental impacts?

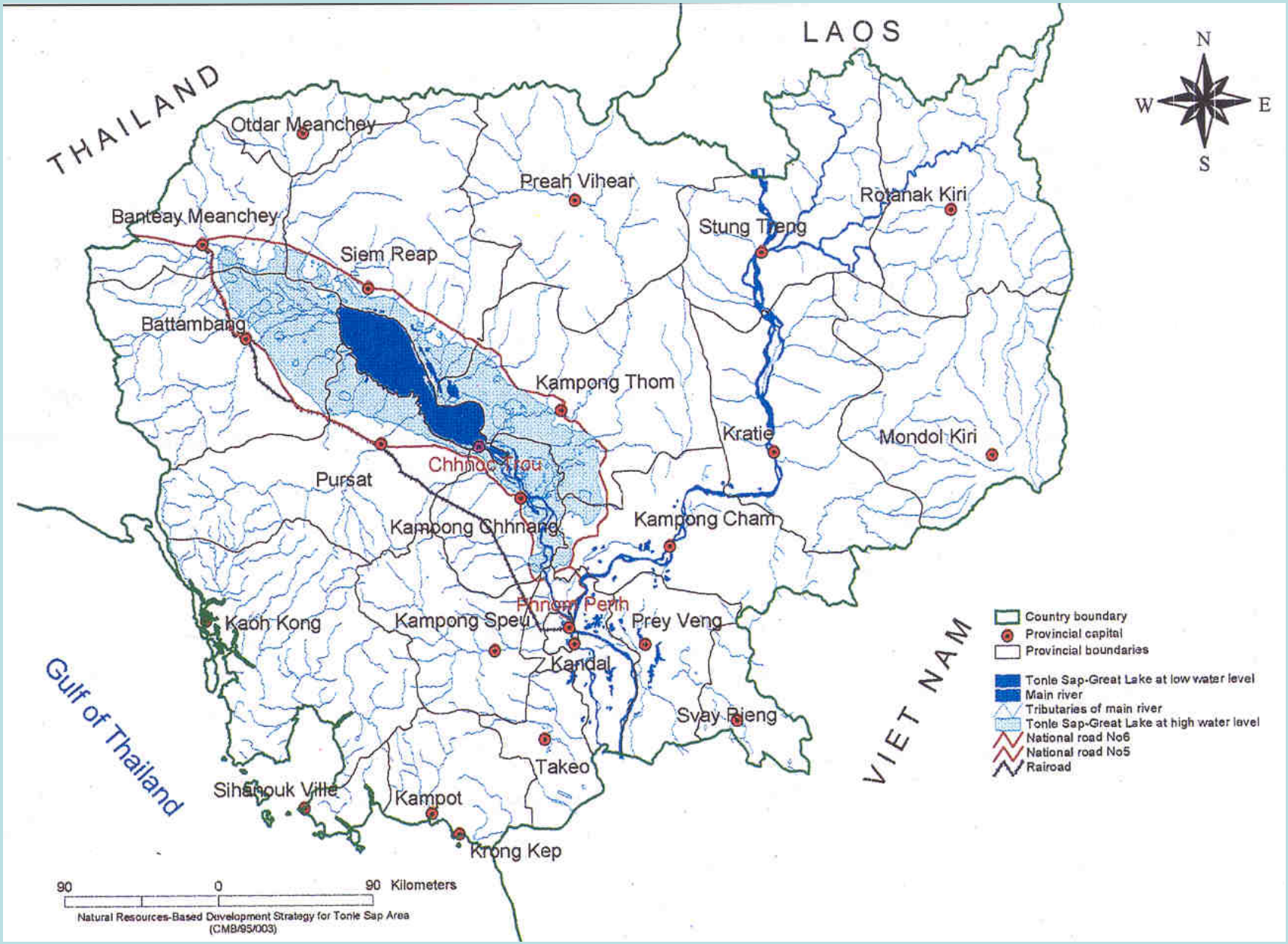
Thailand - AIRSAR bands Cvv/Lhh/Phv (RGB)

Land-cover mapping, crop inventory and agricultural practices



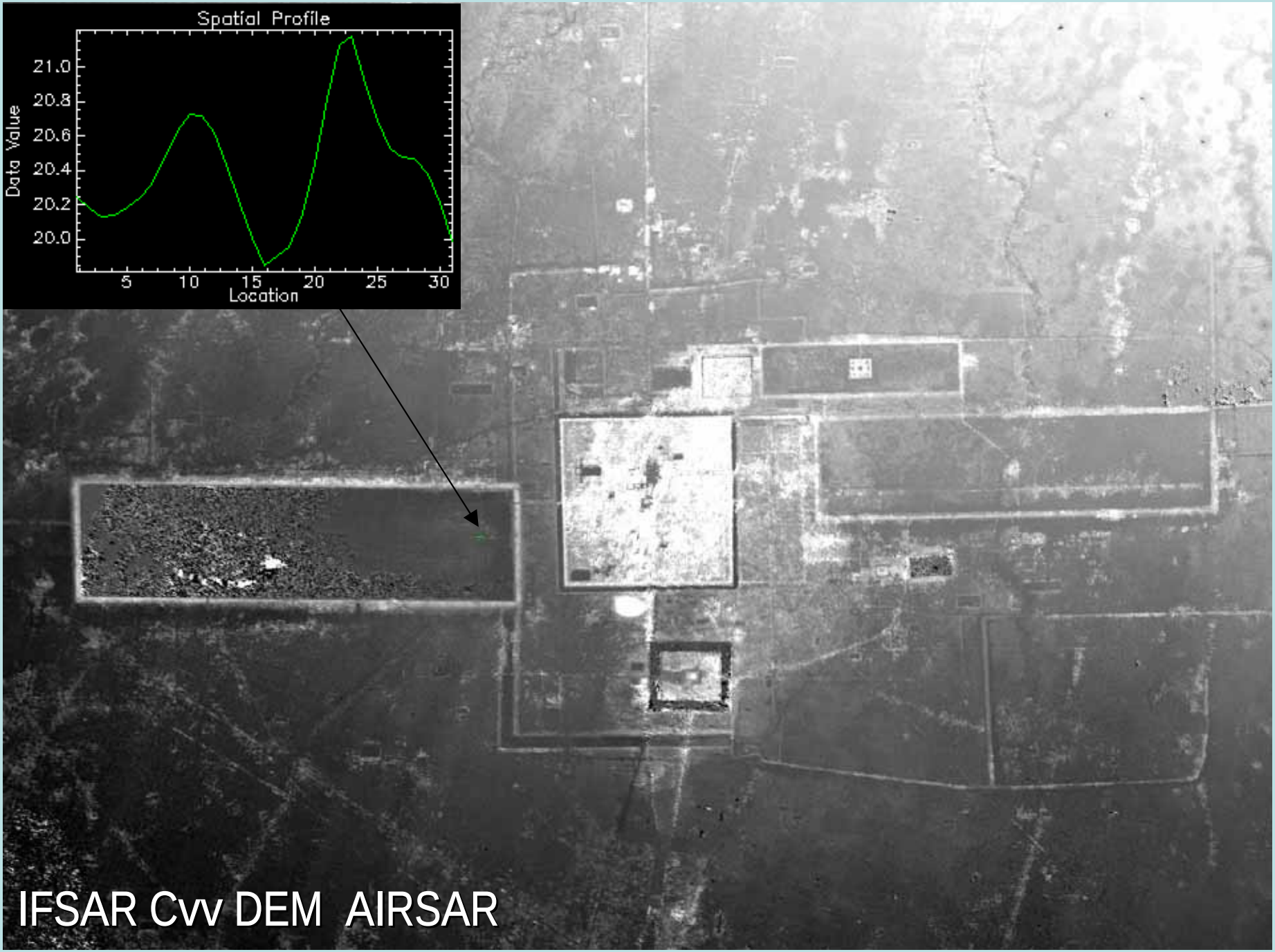
Kedah, Malaysia – radar's sensitivity to vegetation types and density permits the mapping of rice paddy-fields, rubber and palm-oil plantations.

Coastal Pannay, Philippines – detecting the replacement of mangroves with aqua-culture.

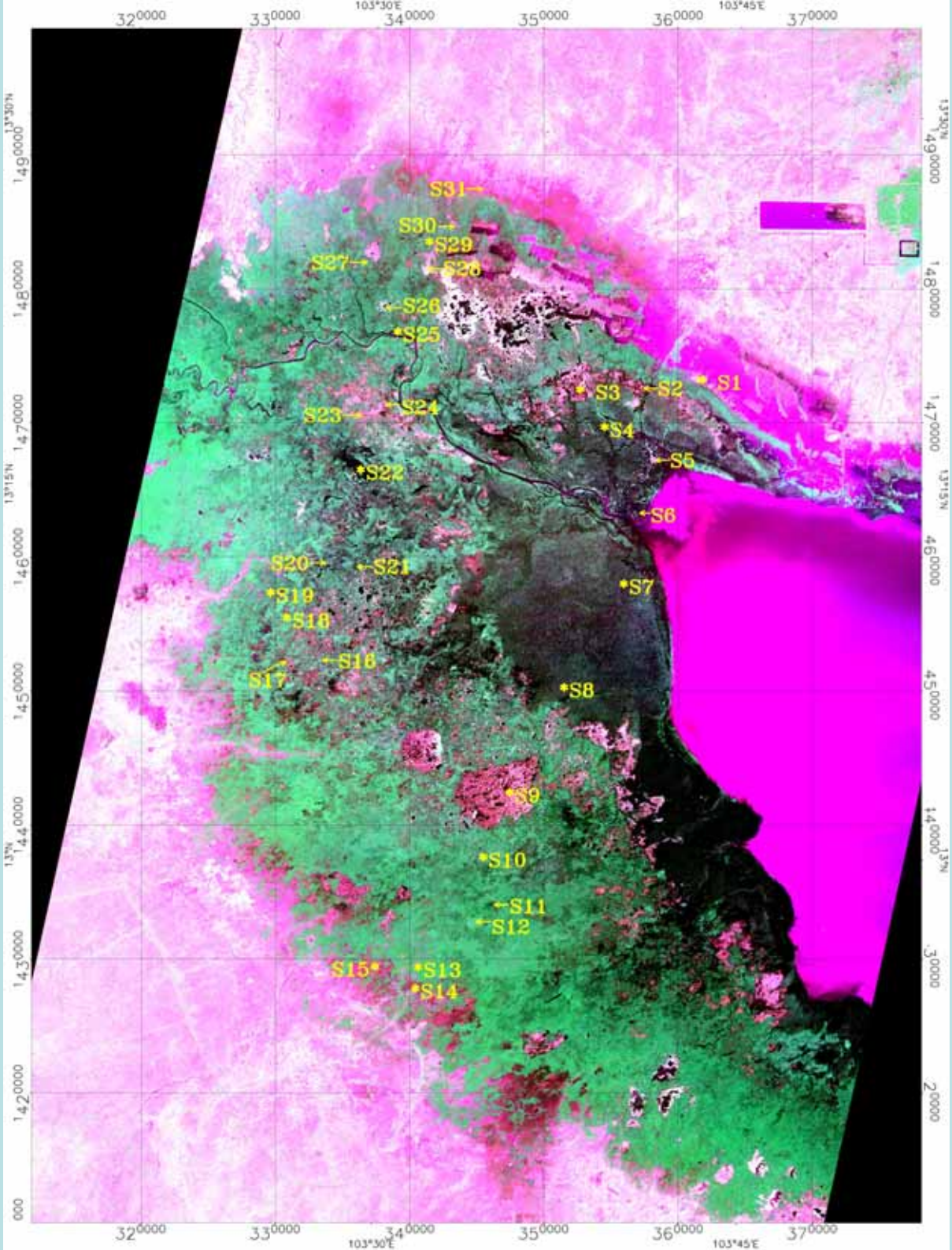


Tonle Sap Great Lake

Reconstruction of the Angkorian habitat, 9-16th century



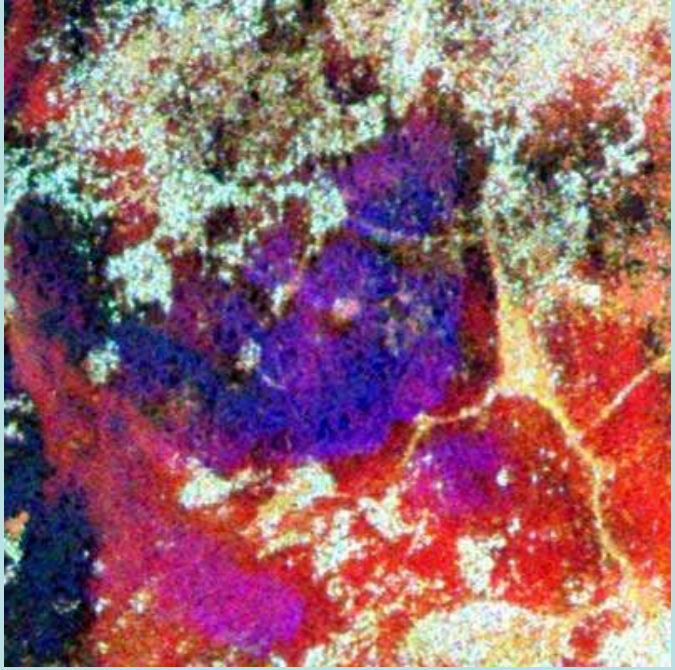
Reconstruction of the Angkorian habitat, 9-16th century



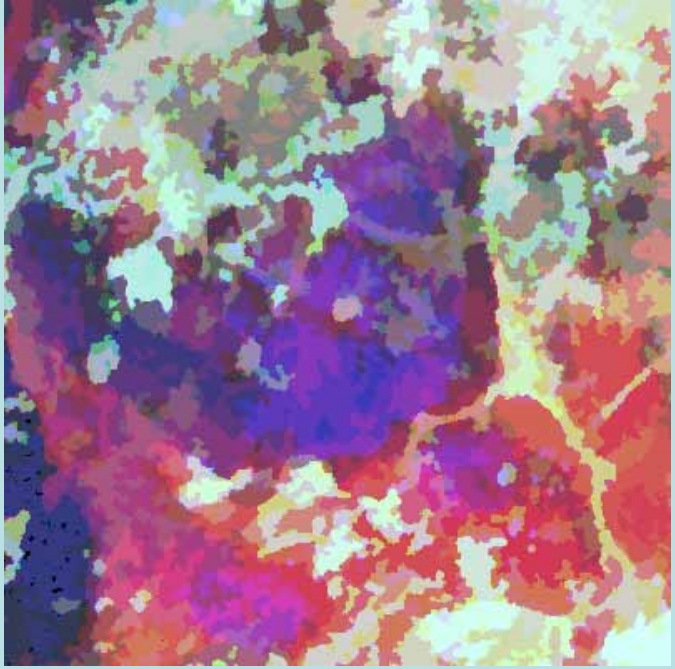
ASTER coverage (Bands 2:3:1 RGB) of wetland site adjacent to Lake Tonle Sap, with the locations of AIRSAR field sites discussed in this study. These ASTER data were collected on 10th January 2002.

Closed canopy forest trees (Top) and open canopy forest trees with patches of shrubland and open water (Bottom)

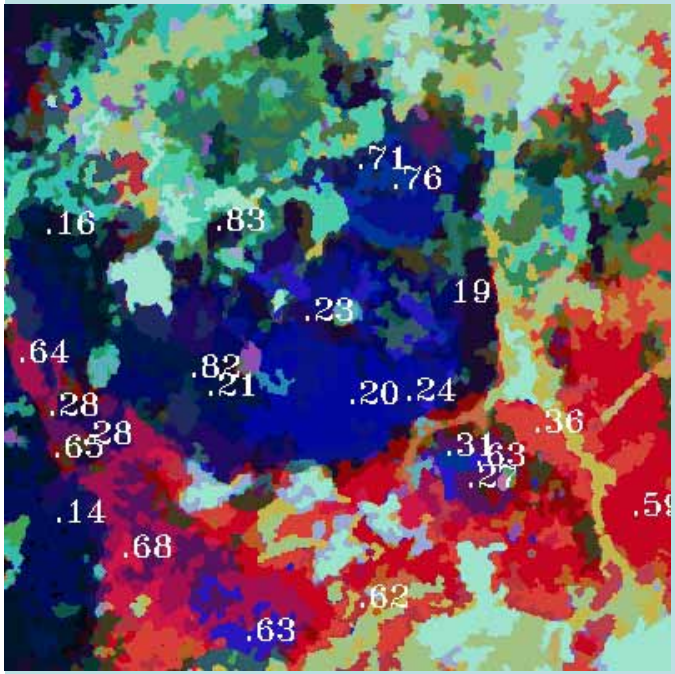
Flooded grasslands



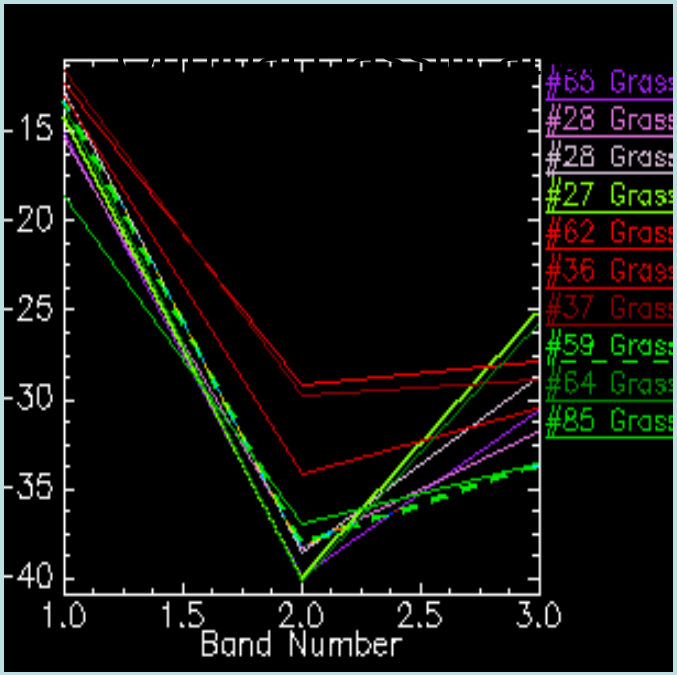
Original data Cvv/Lhv/Pvv



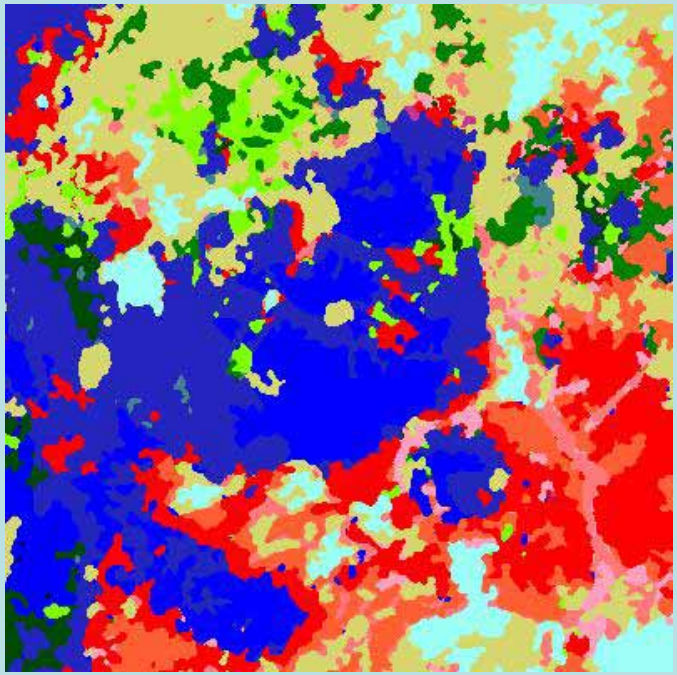
Segmentation: Mean values Cvv, Lhv, Pvv



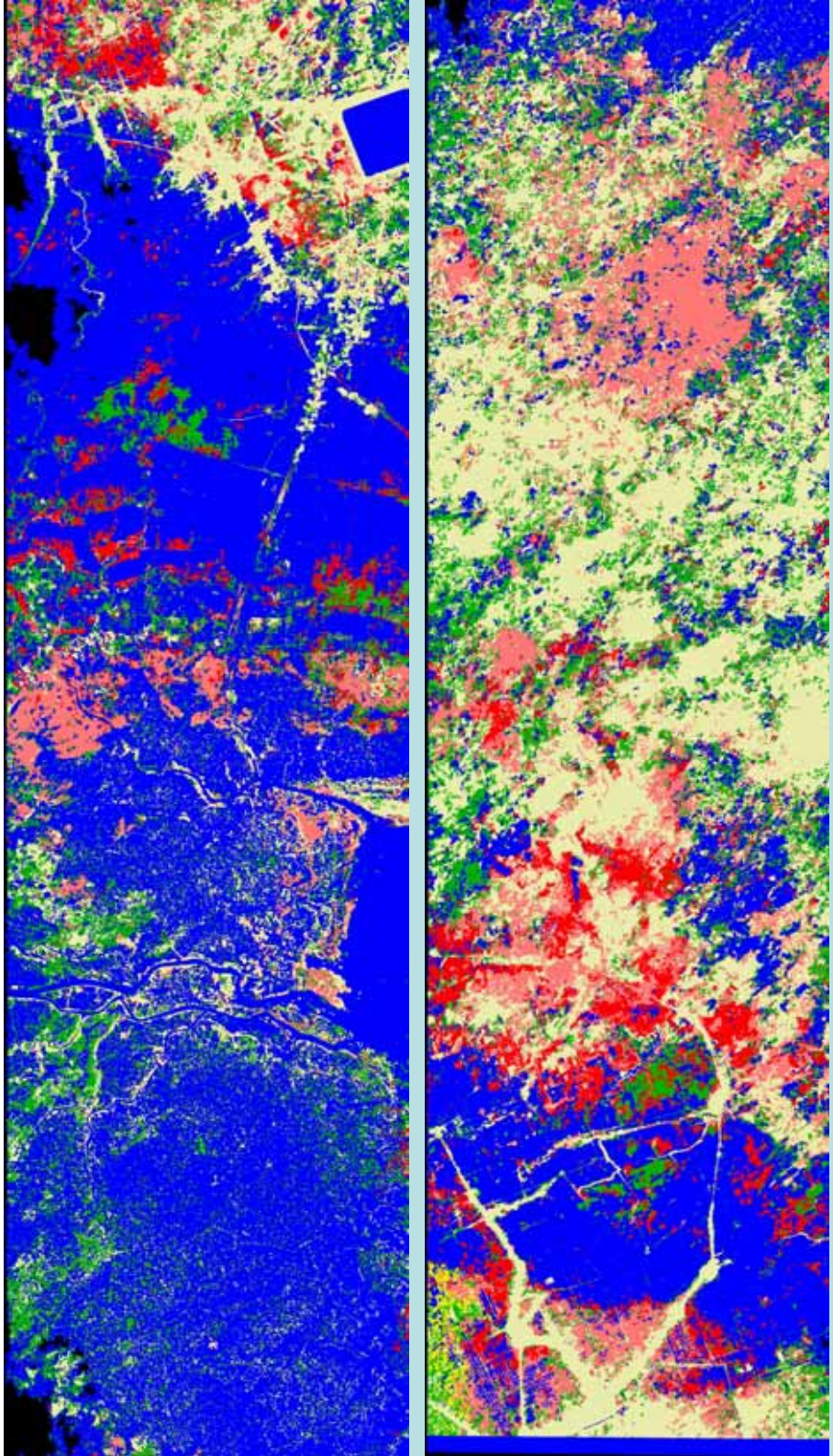
Original classification



Radar signatures: Cvv, Lhv and Pvv



Final classification



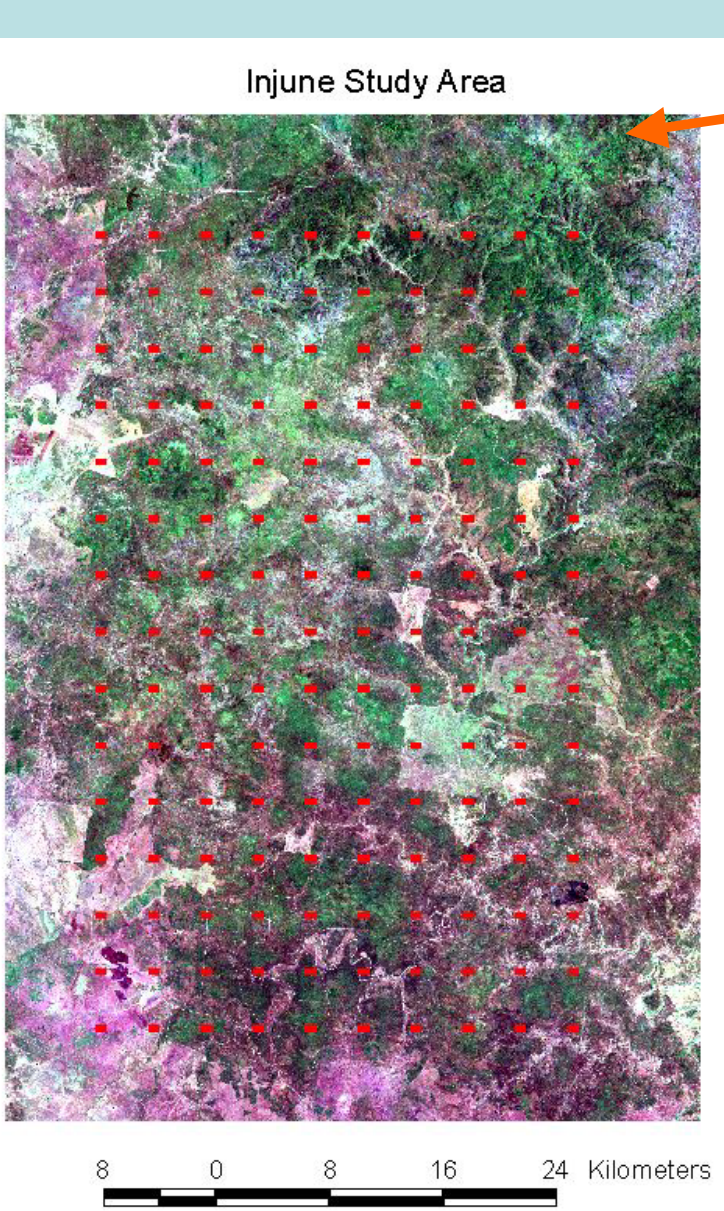
Wetland classification – super classes

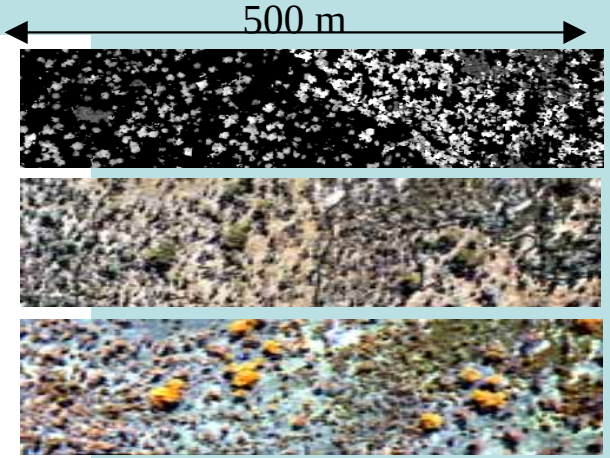
Class 1: Water
Class 2: Flooded fields / grasslands
Class 3: Macrophytes
Class 4: Shrubland
Class 5: Forest trees
Class 6: Irrigated ricefields
Class 7: Non-stuff

Class distribution:

Class 1: 44.0%
Class 2: 5.8%
Class 3: 12.3%
Class 4: 13.2%
Class 5: 24.3%
Class 6: 0.4%

Remote Sensing Data Acquisition: Injune



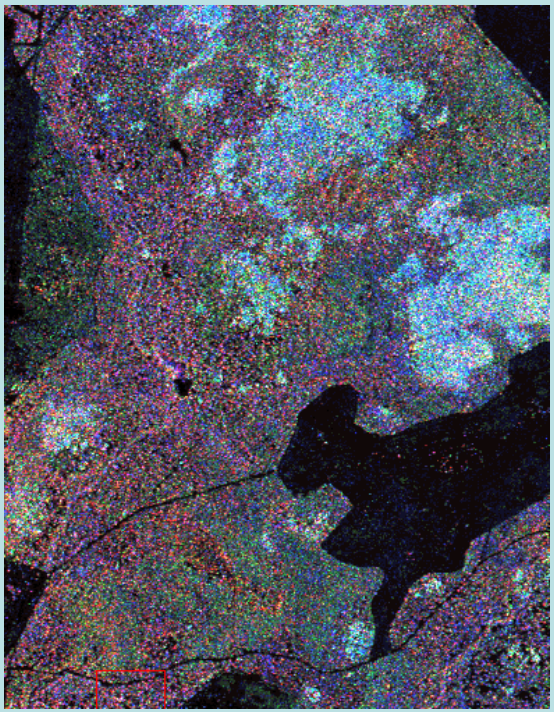


LASER

Aerial Photography

CASI

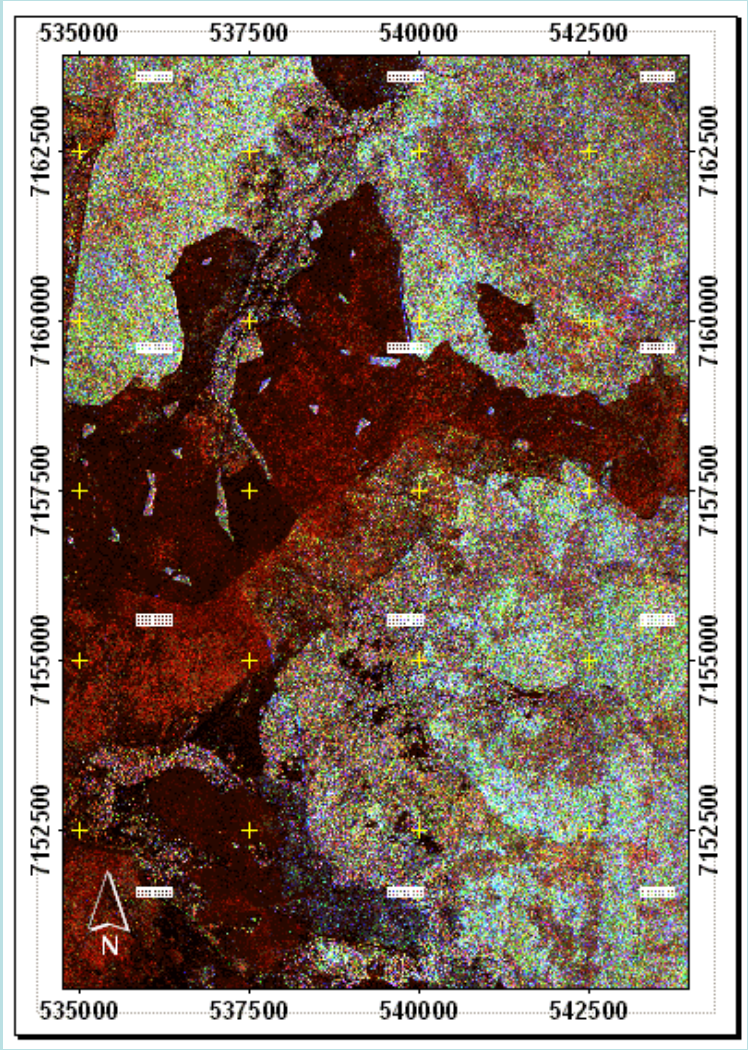
Landsat ETM+



AIRSAR

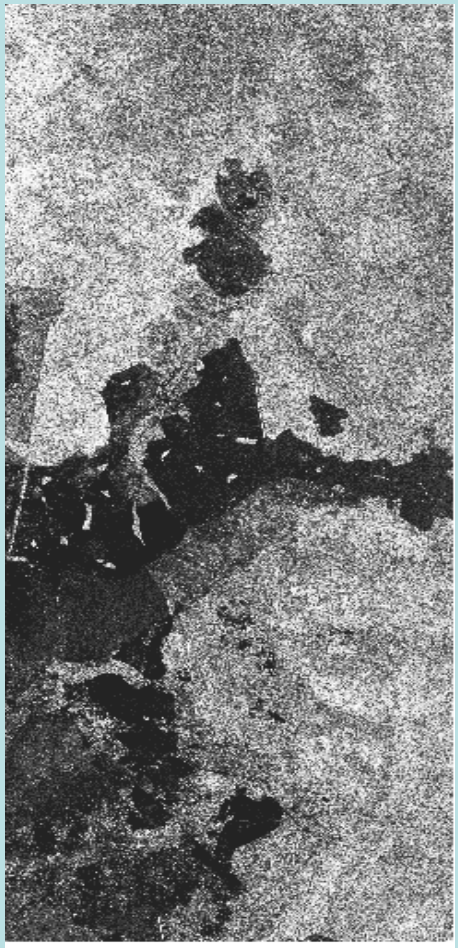
AIRSAR (POLSAR) data

- 4 strips of NASA JPL AIRSAR data acquired (12.5 x 80 km)
- Full range of forest types.
- Incidence angle variation from ~ 30^{o} to 60^{o}.
- Fully polarimetric
  - HH, VV and HV.

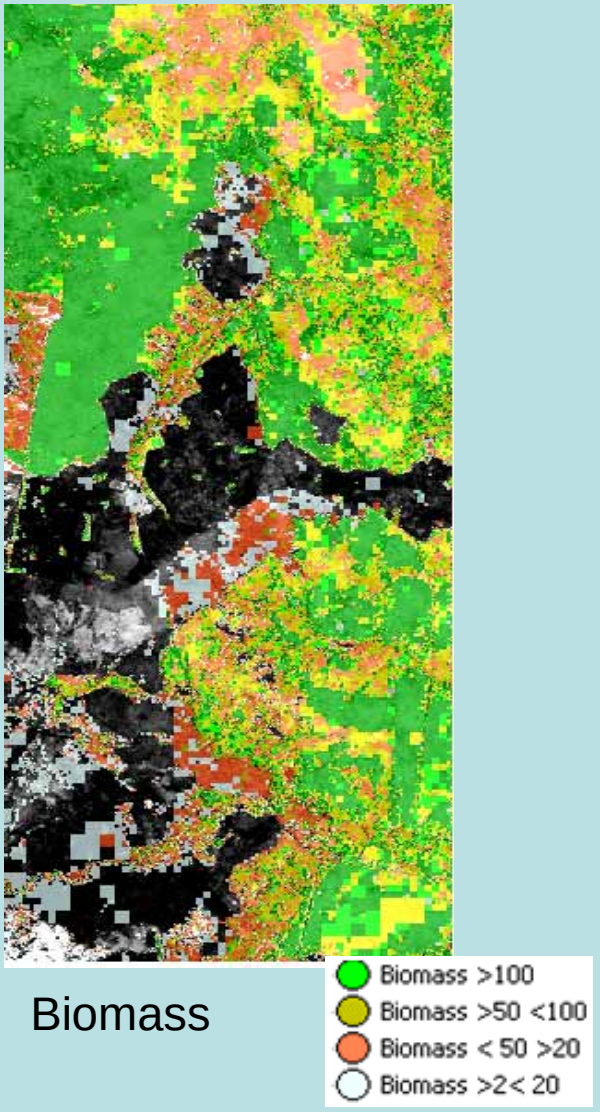


Biomass Mapping Using Empirical Relationships, Injune, Queensland

FPC layer

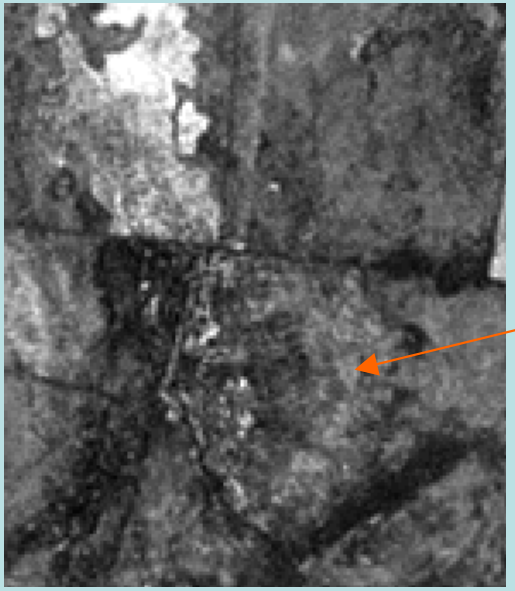


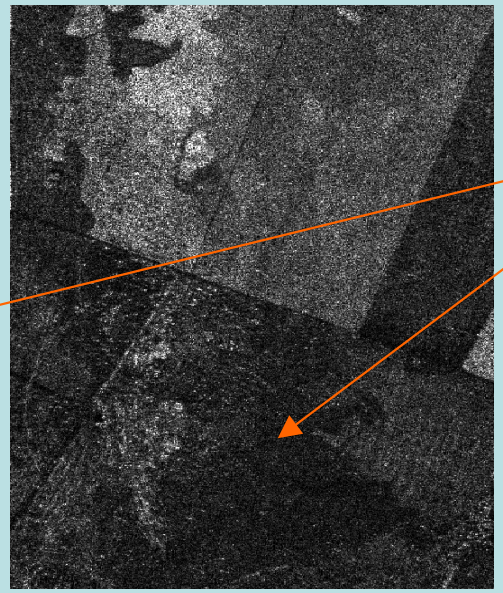
P-band HH

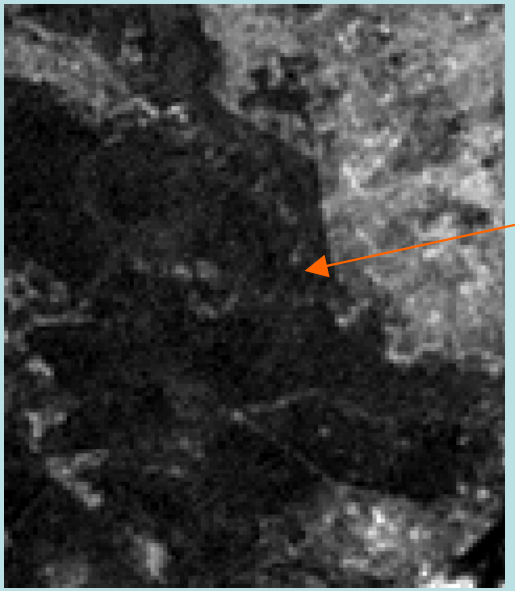


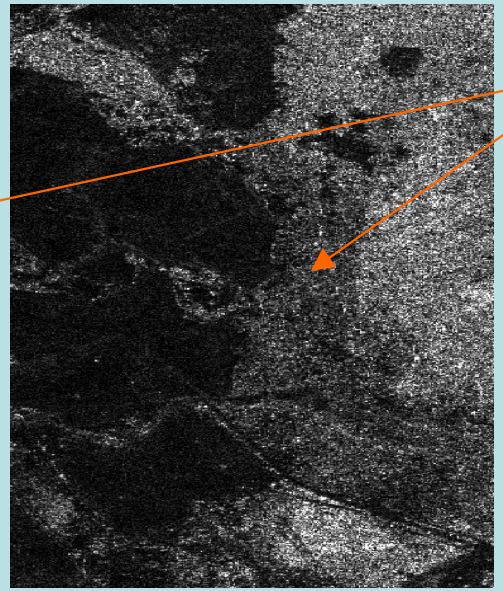
Biomass

Identifying woody regrowth and tree mortality







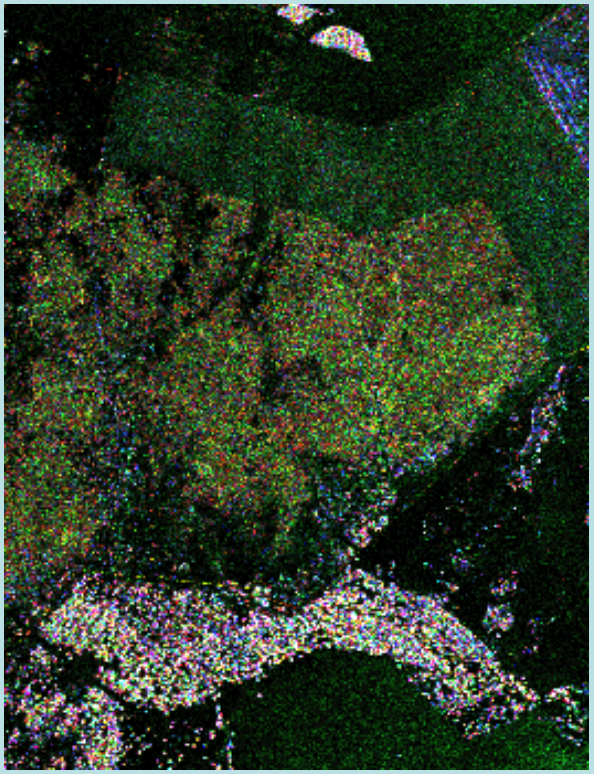


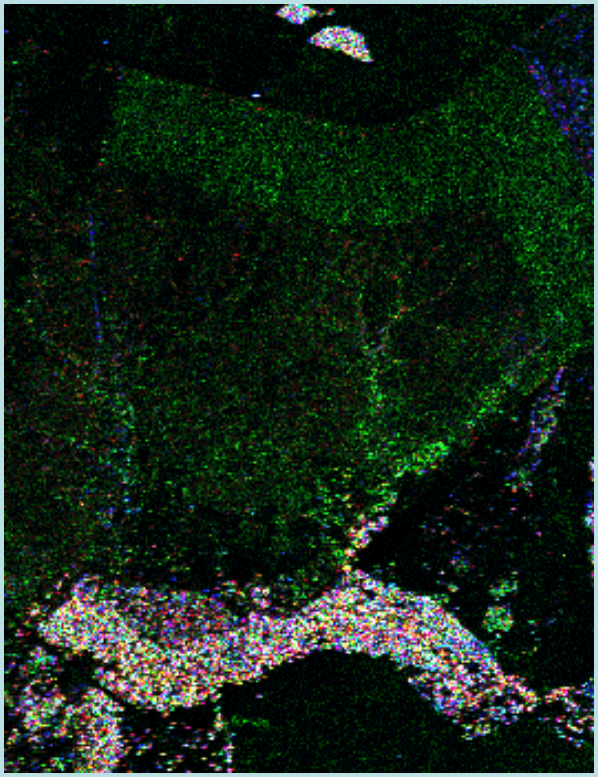
Foliage Projected Cover

ALOS PALSAR L-band HH

SAR Observations of Brigalow-dominated regrowth

a) 

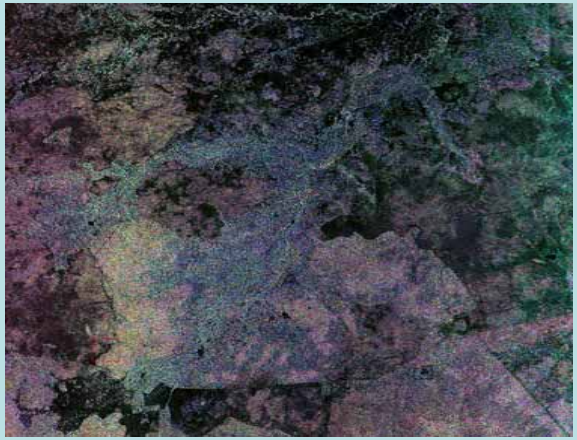
b) 

c) 

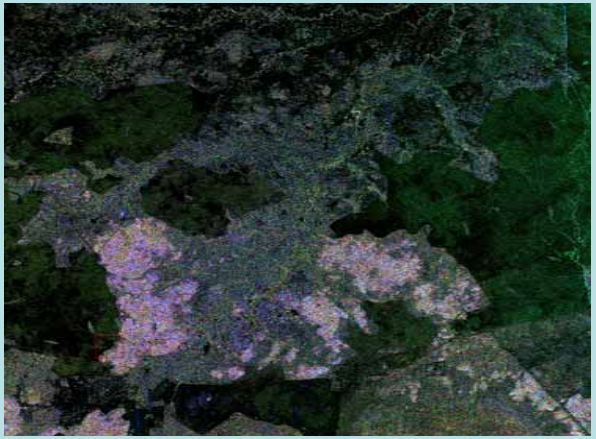
a) C-band, b) L-band and c) P-band backscatter (HV, VV and HH in RGB) data illustrating reduced return from Brigalow-dominated regrowth with decreasing frequency.

SAR Observations of Brigalow-dominated regrowth

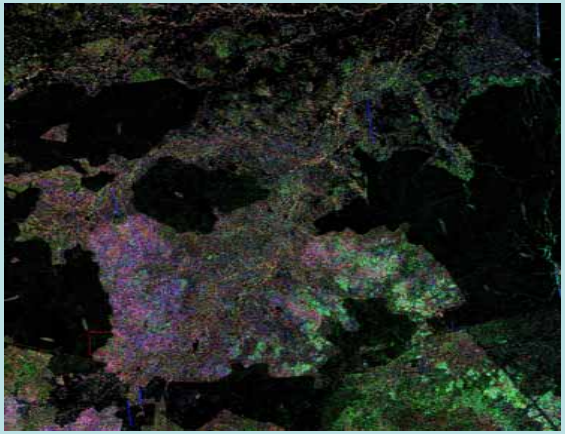
C-band



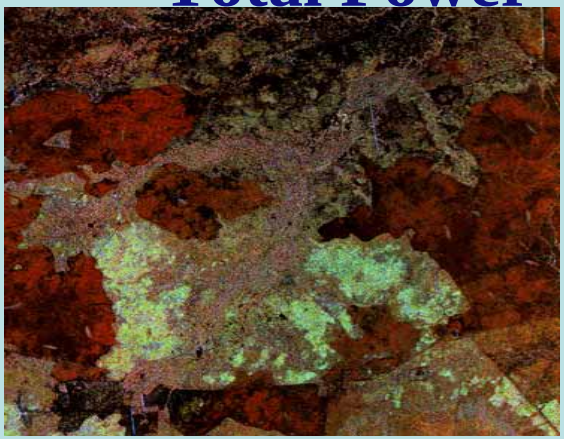
L-band



P-band



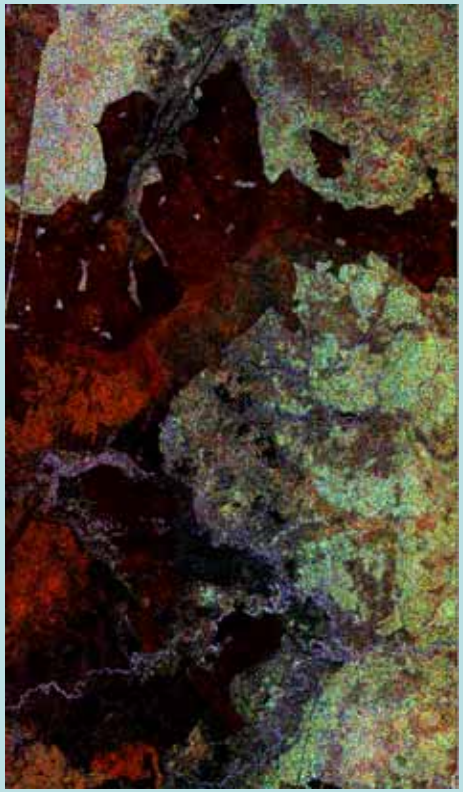
Total Power



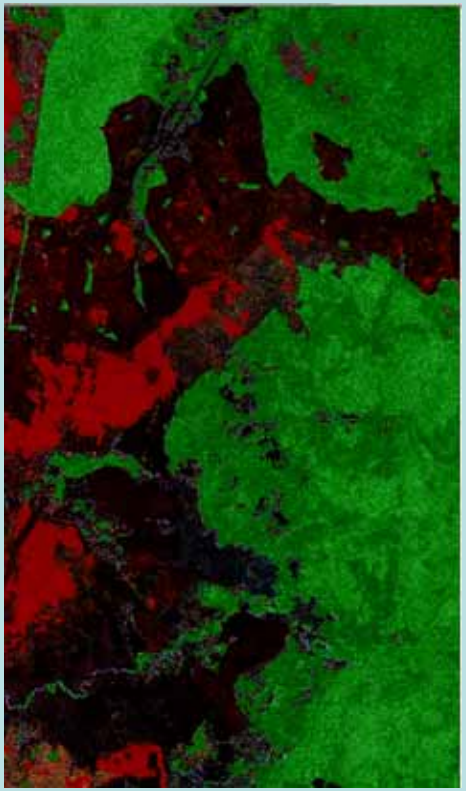
Reduced return from Brigalow-dominated regrowth with decreasing frequency

Areas of Brigalow particularly prominent (red) in Total Power image (C-band in red)

Woody regrowth mapping using AIRSAR and JERS-1 SAR

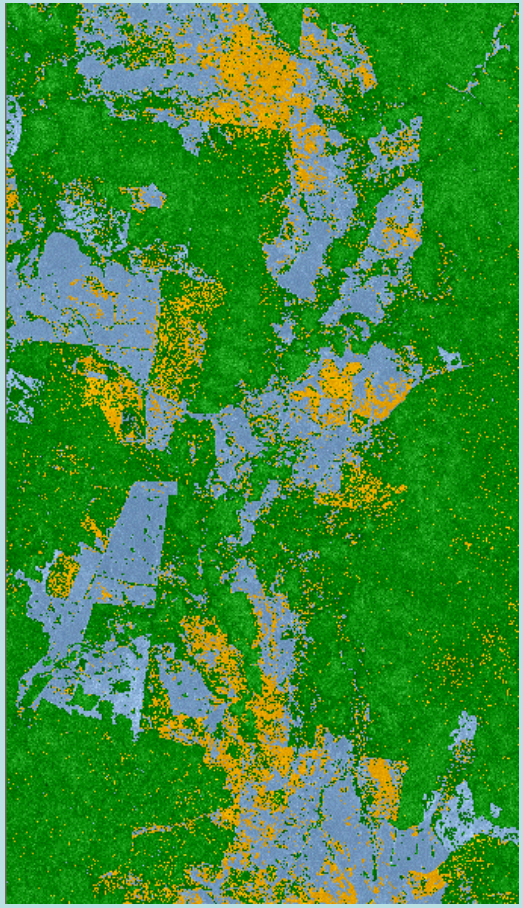


2000 AIRSAR
(C-, L- and P- band
Total Power in RGB)



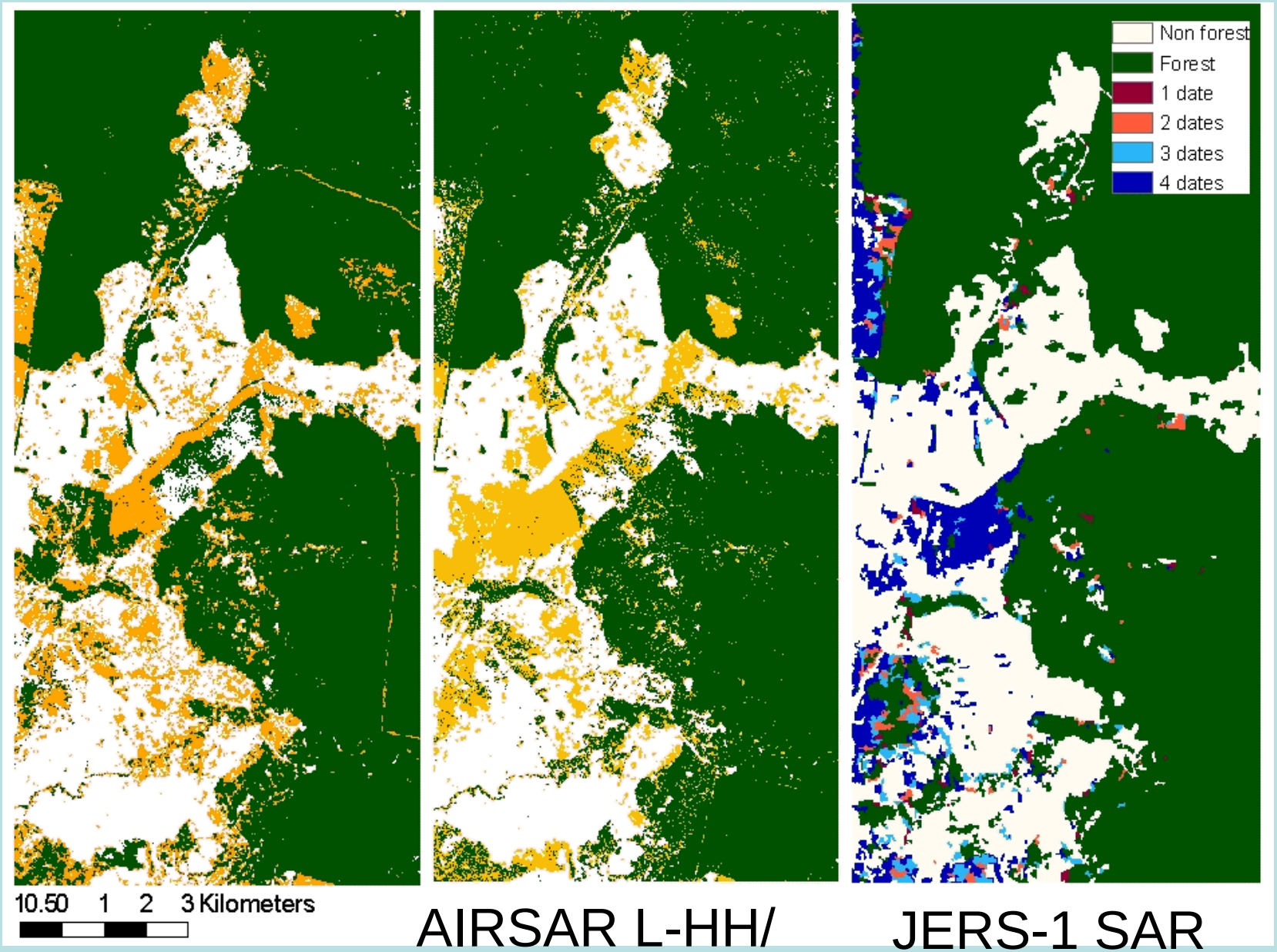
Classification of
Woody regrowth
Using L-band HH and
2000 FPC

1995 JERS-1 SAR
with 1995 Landsat FPC
(in R)



Map of woody
Regrowth (mainly
Brigalow; orange),
Non-forest (blue)
And forest (green)

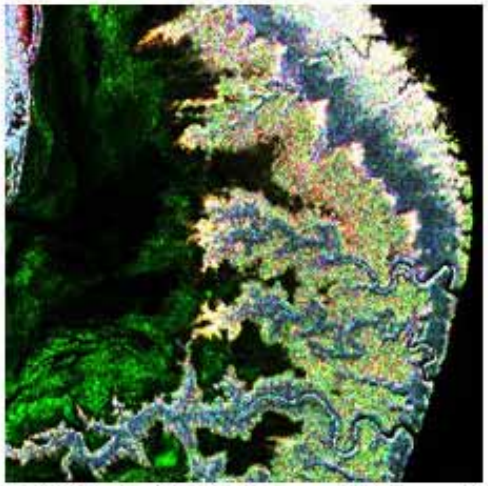
Comparisons with Queensland Statewide Land Cover and Trees (SLATS) datasets



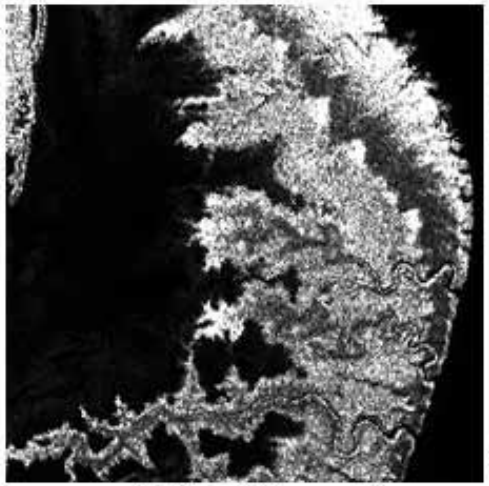
SLATS Time-series

AIRSAR L-HH/ FPC

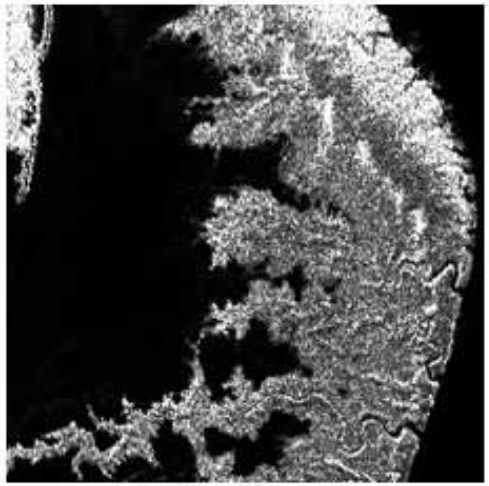
JERS-1 SAR (4 dates)/FPC



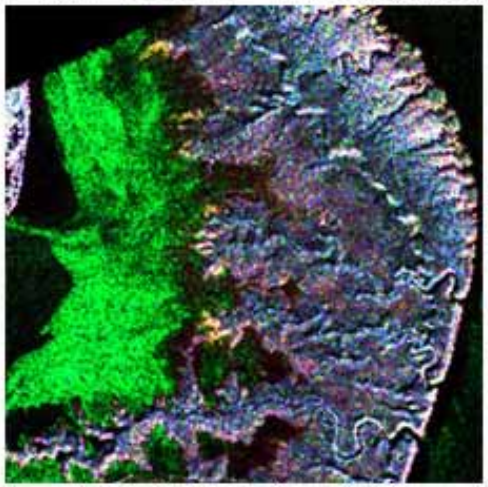
AIRSAR 1996 L-band (Sigma0)



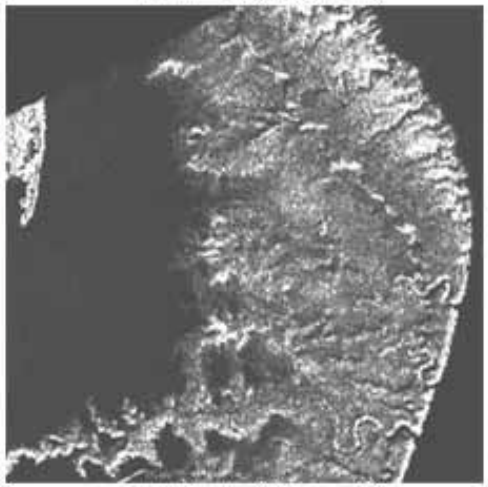
L-HH (Sigma0)



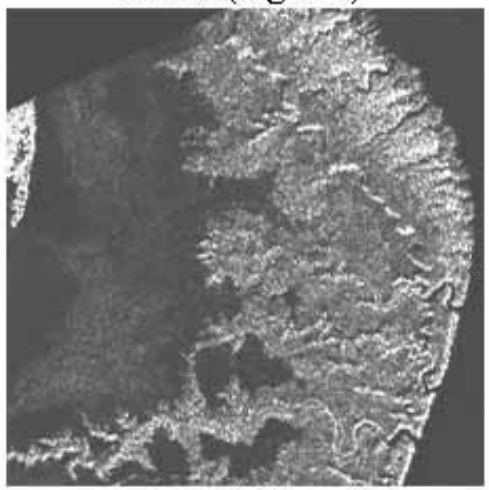
L-HV (Sigma0)



AIRSAR 2000 L-band (Sigma0)

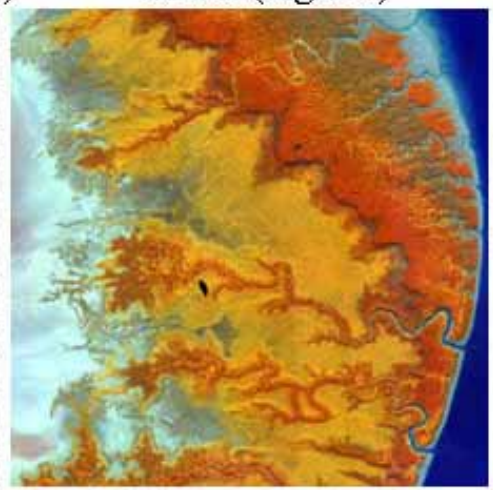


L-HH (Sigma0)

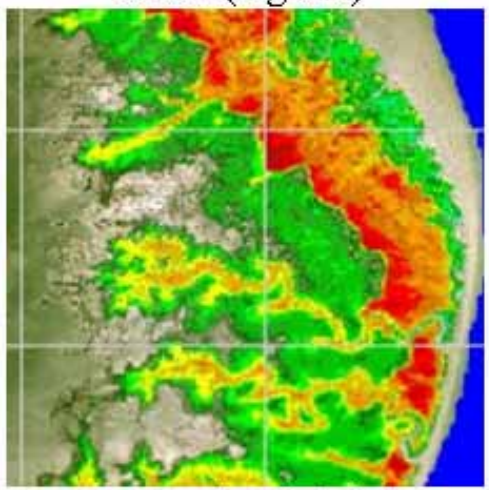


L-HV (Sigma0)

JERS-1 SAR L-HH (Sigma0)



CASI (bands 14,9,1)



DEM (tree height)

West Alligator Mangroves

Species/ Community Differentiation

IERS-1 SAR allows
ome differentiation of
nangrove zones.

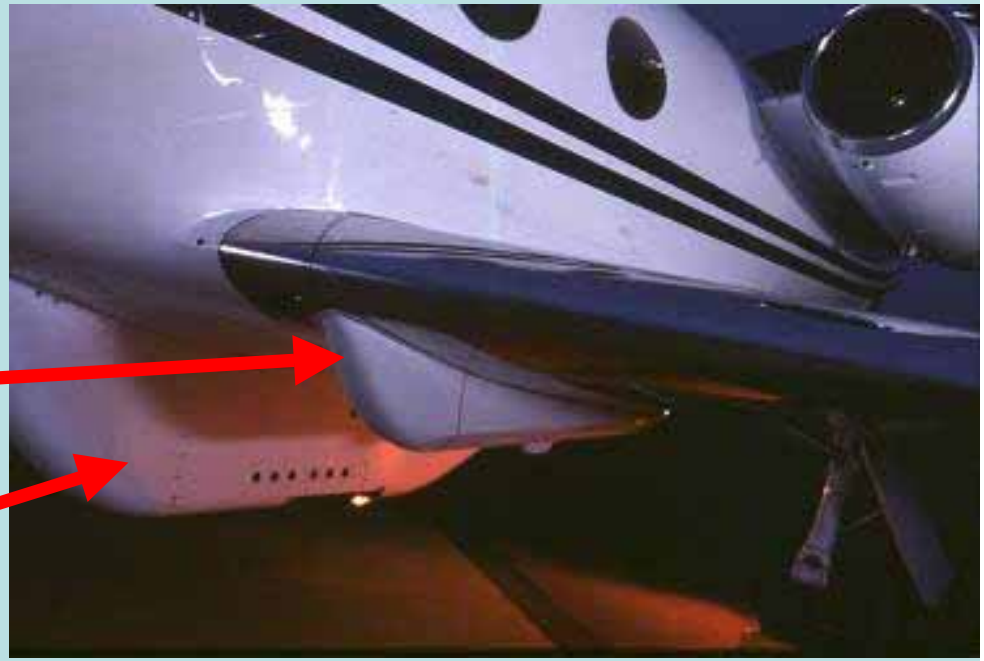
Difference in main
Communities can occur

nconsistencies in
lassification

GeoSAR

GeoSAR Components

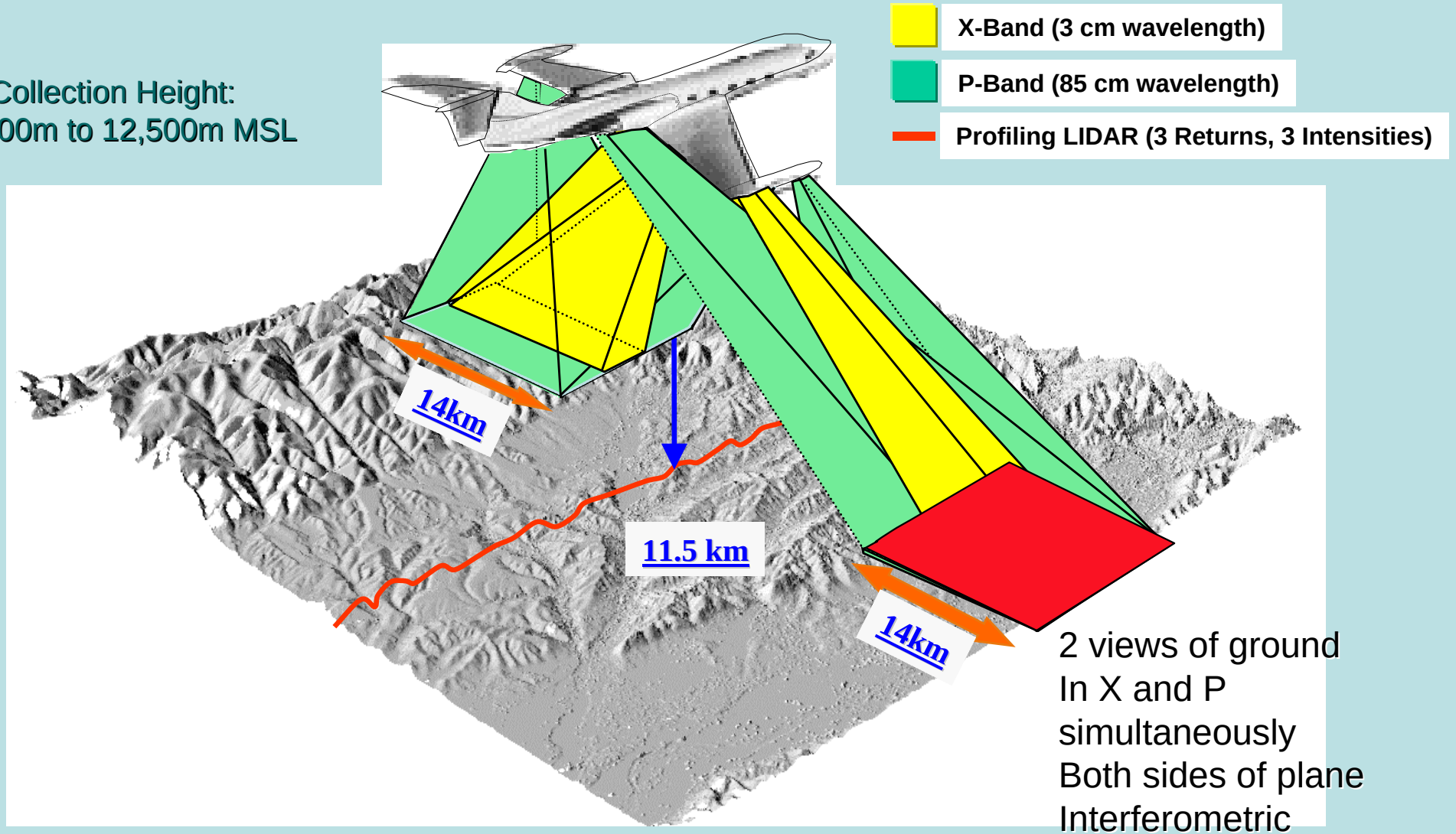
- Two P-band antennas
- 20m / 40m dual baseline



- Two X-band antennas
- Antenna Positioning Measurement Unit

Flight Characteristics

Collection Height:
10,000m to 12,500m MSL



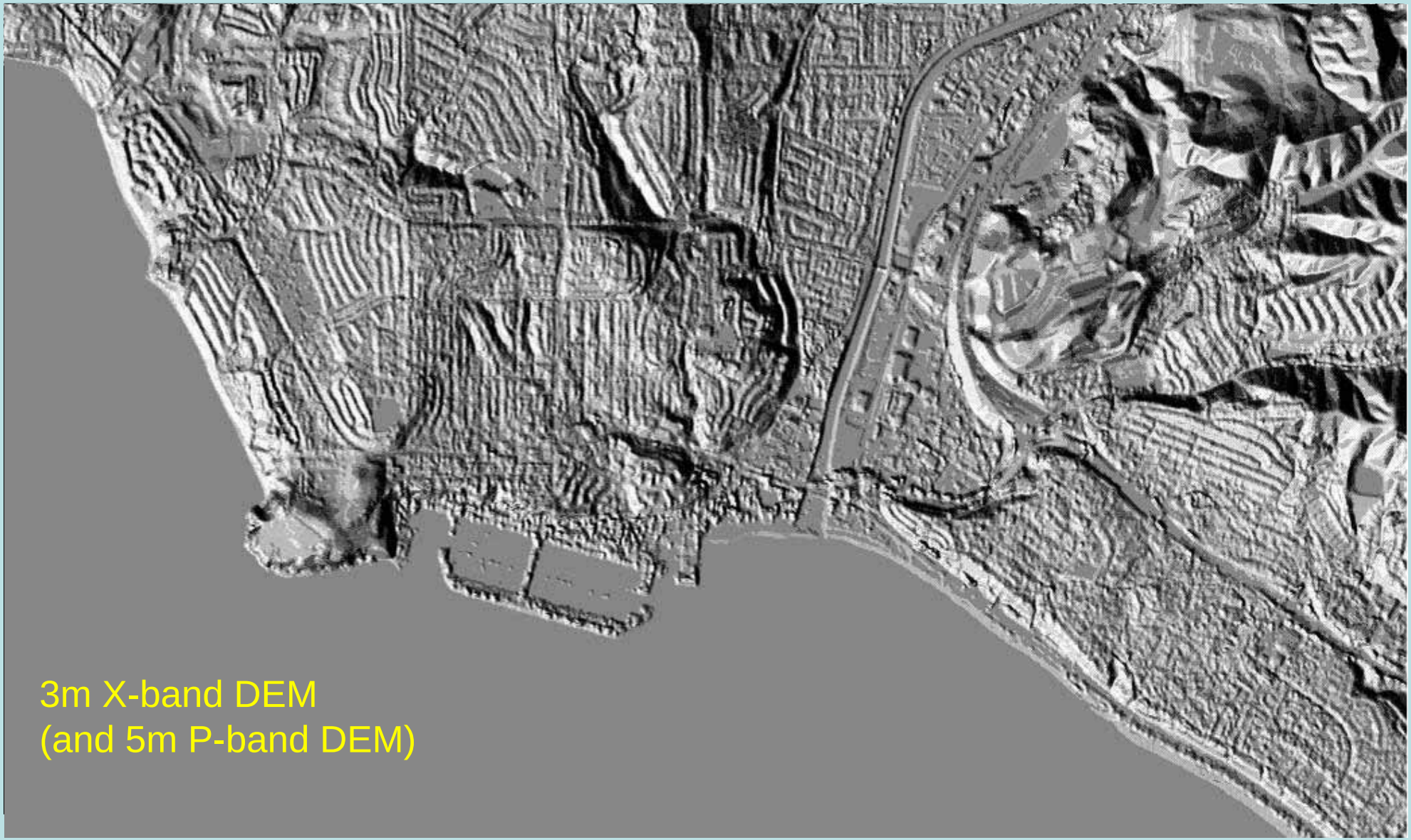
2 views of ground
In X and P
simultaneously
Both sides of plane
Interferometric

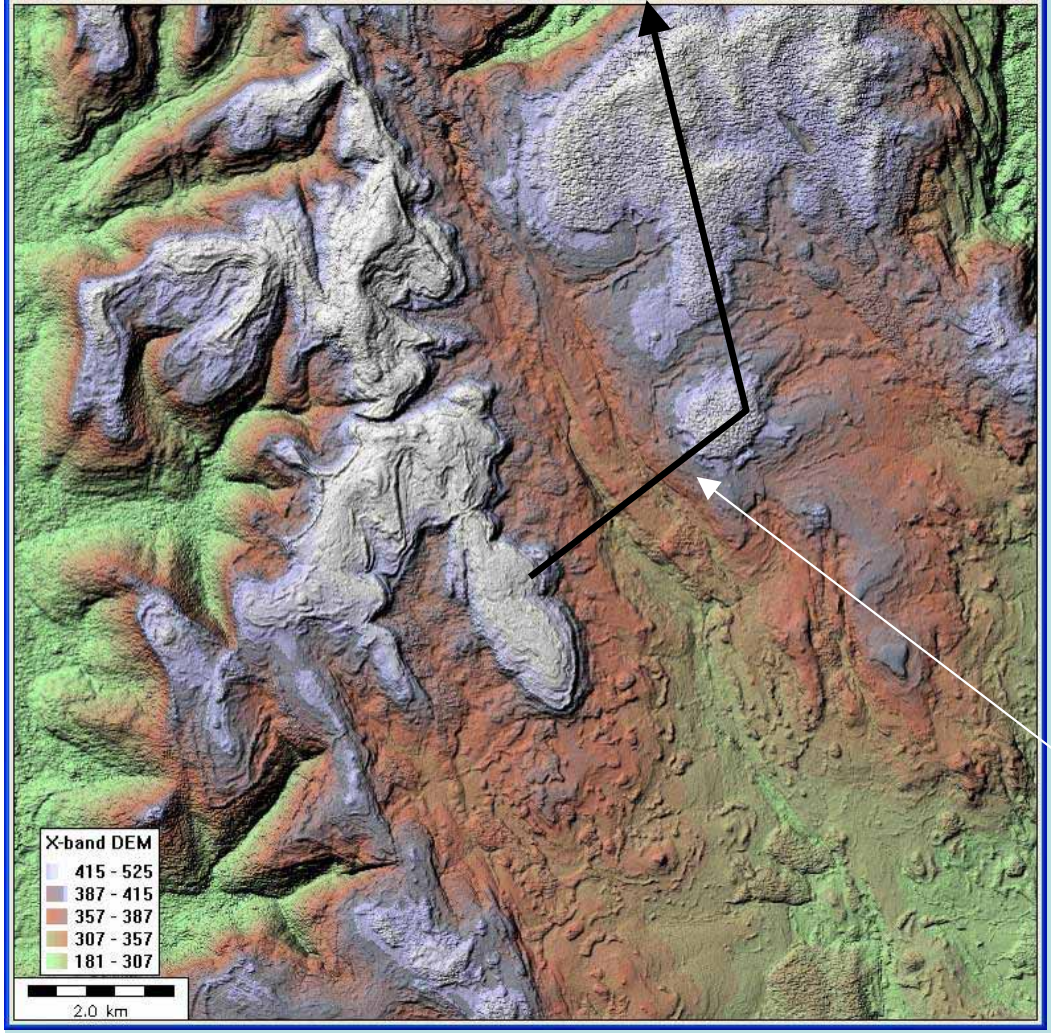
GeoSAR Product Characteristics

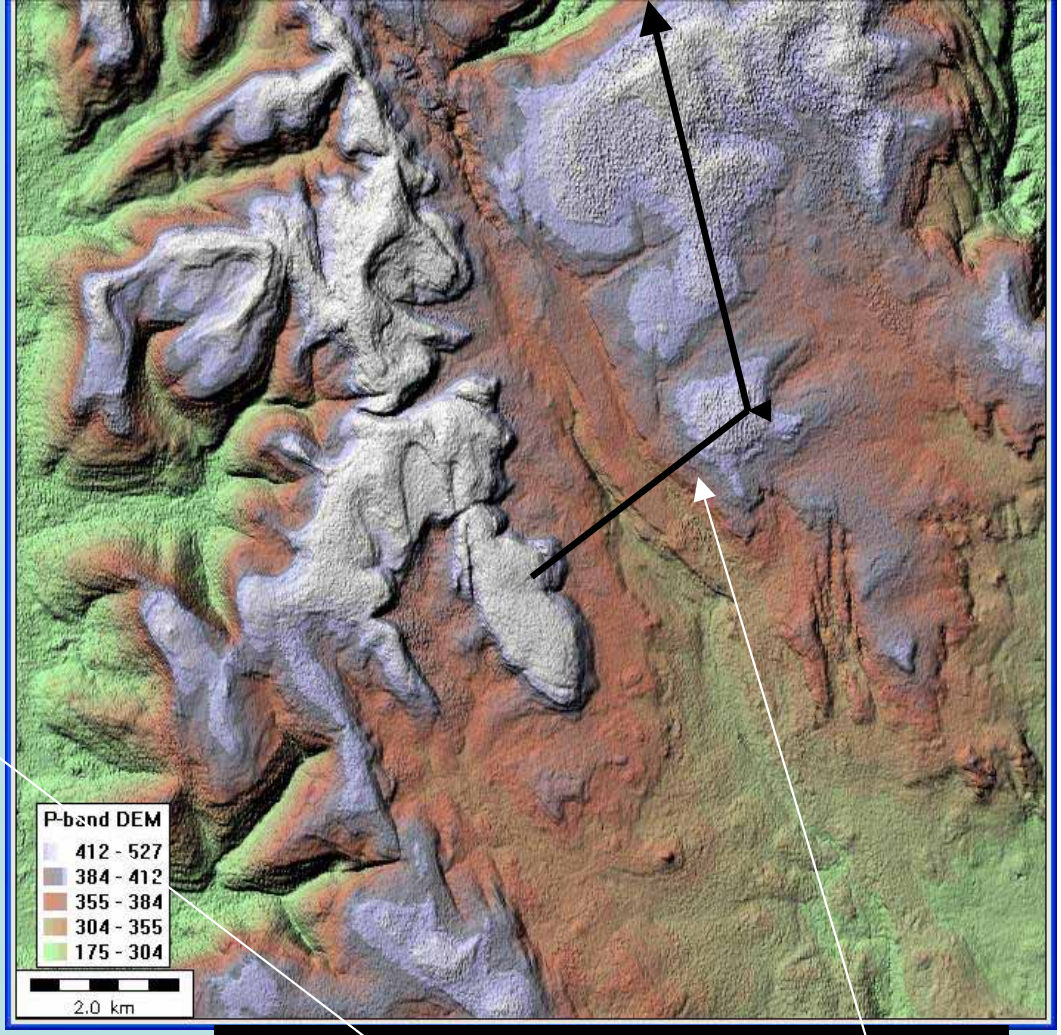
	X-band	P-band
DEM height accuracy		
Single swath	0.5-1.2 m (Relative)	1-3 m (Relative)
Mosaic	~1.0 m (Absolute)	1-4 m (Absolute)
DEM resolution	2.5 - 5 metres	2.5 - 5 metres
Planimetric Accuracy	1 m (Relative) < 2.5 m (Absolute)	2 m @ 5 km Altitude (Absolute) 4 m @ 10 km Altitude (Absolute)
Ground swath	12 -14 km on each side	12 -14 km on each side
Polarization	VV	HH and HV or VV and VH
Pixel Size	1.25 – 3m	1.25 – 5m

Multi-swath mosaicking and application of Lidar ground measurements results in considerable improvement over single-swath accuracy.

Four Standard Products of GeoSAR

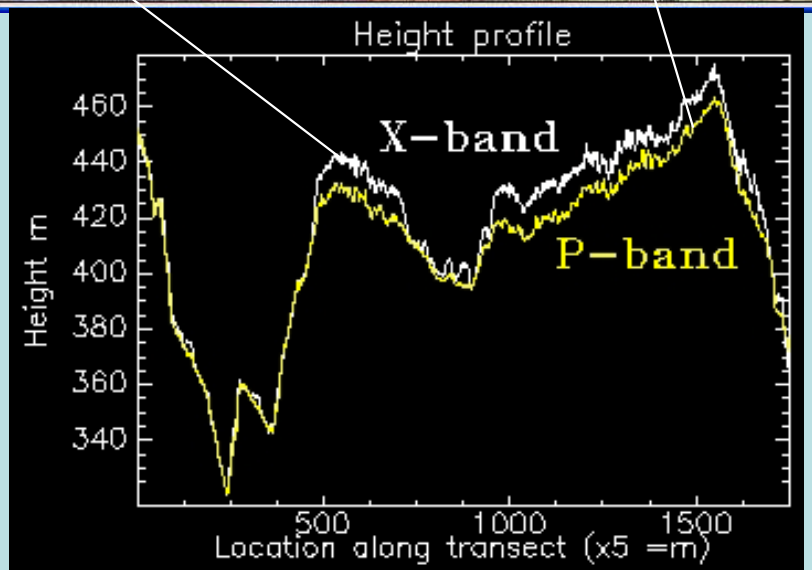






X-band

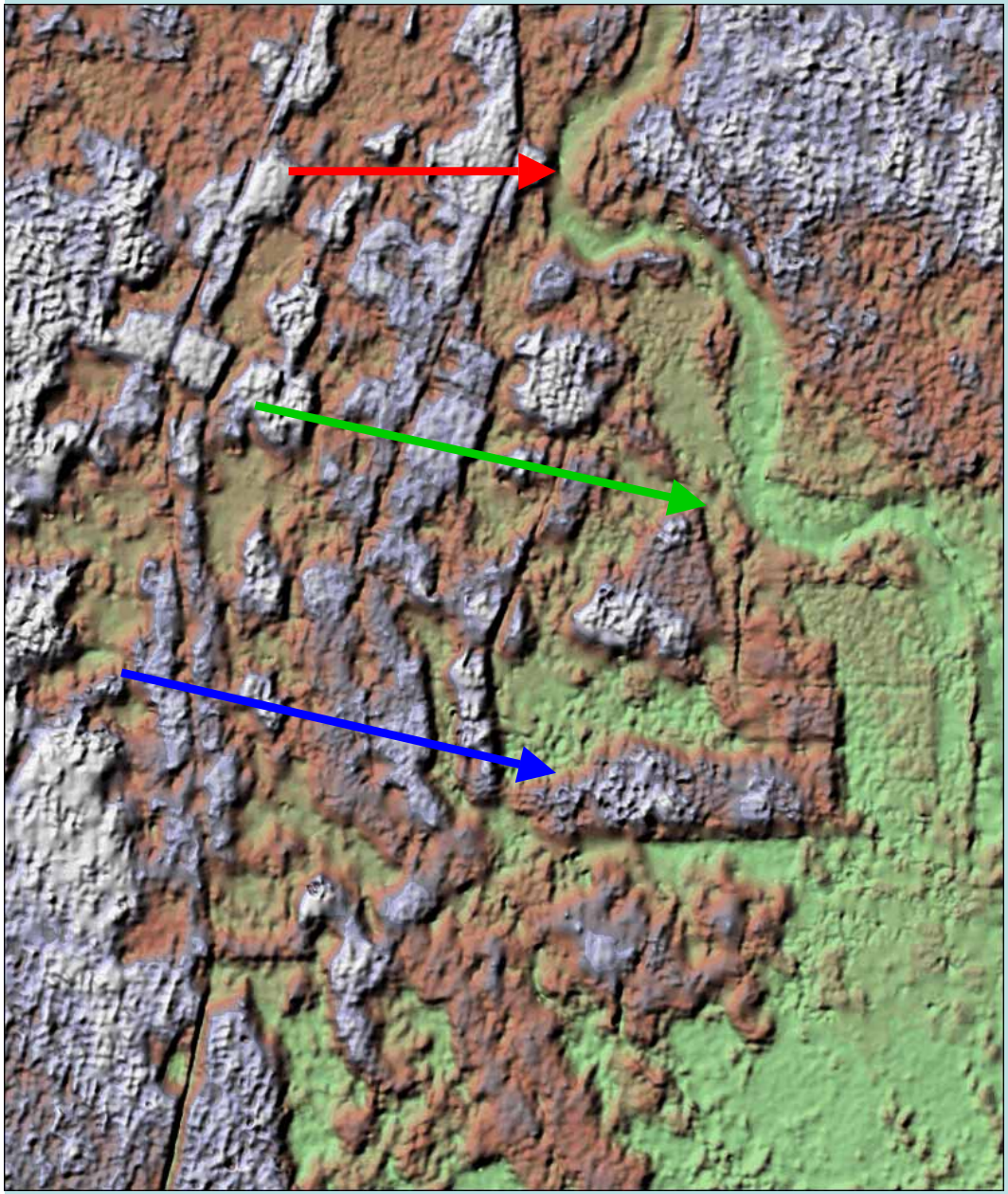
P-band



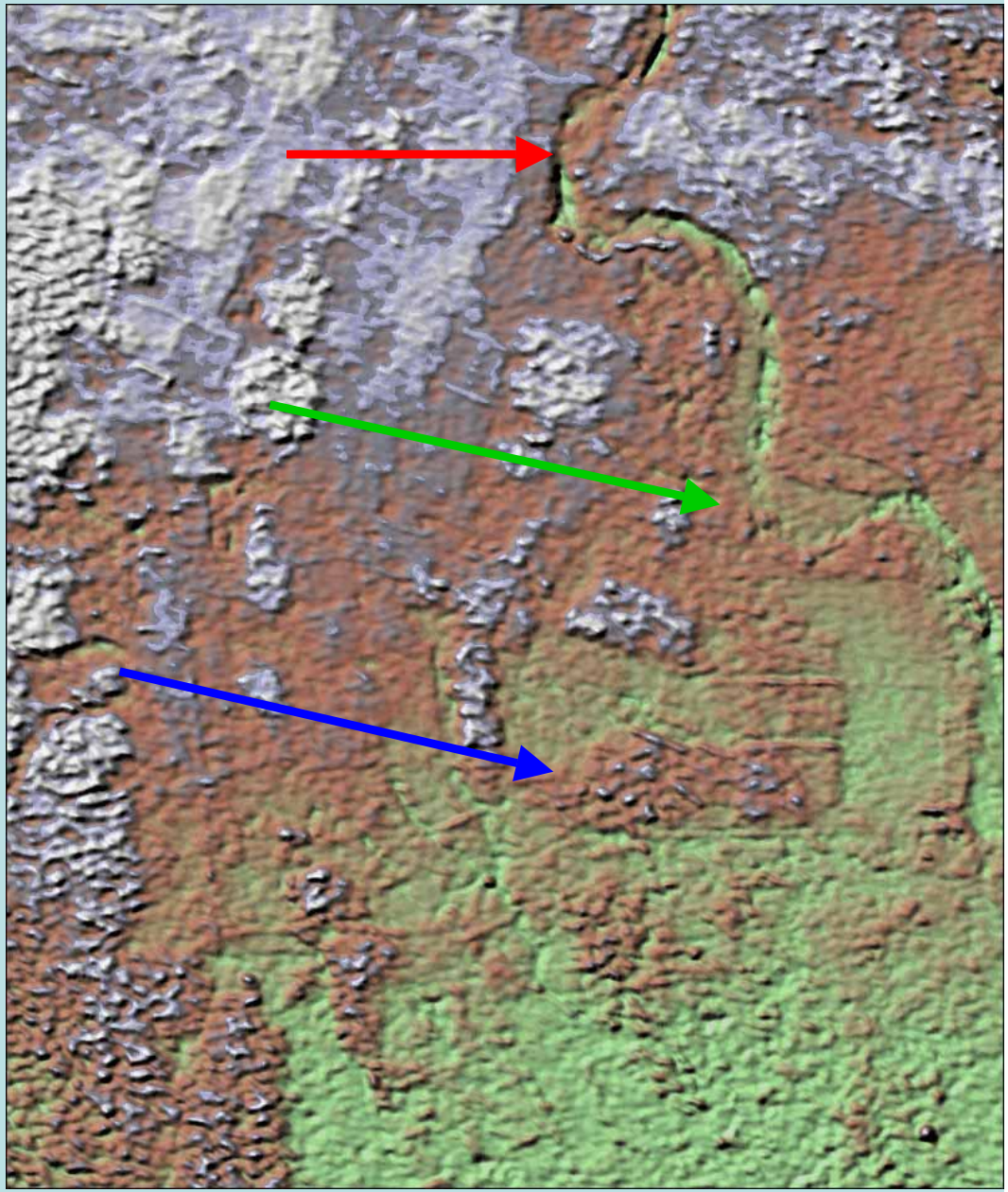
Shaded relief models of X and P-band DEMs – Andean foothills, Colombia

HGC

GeoSAR DEMs - suppression of vegetation

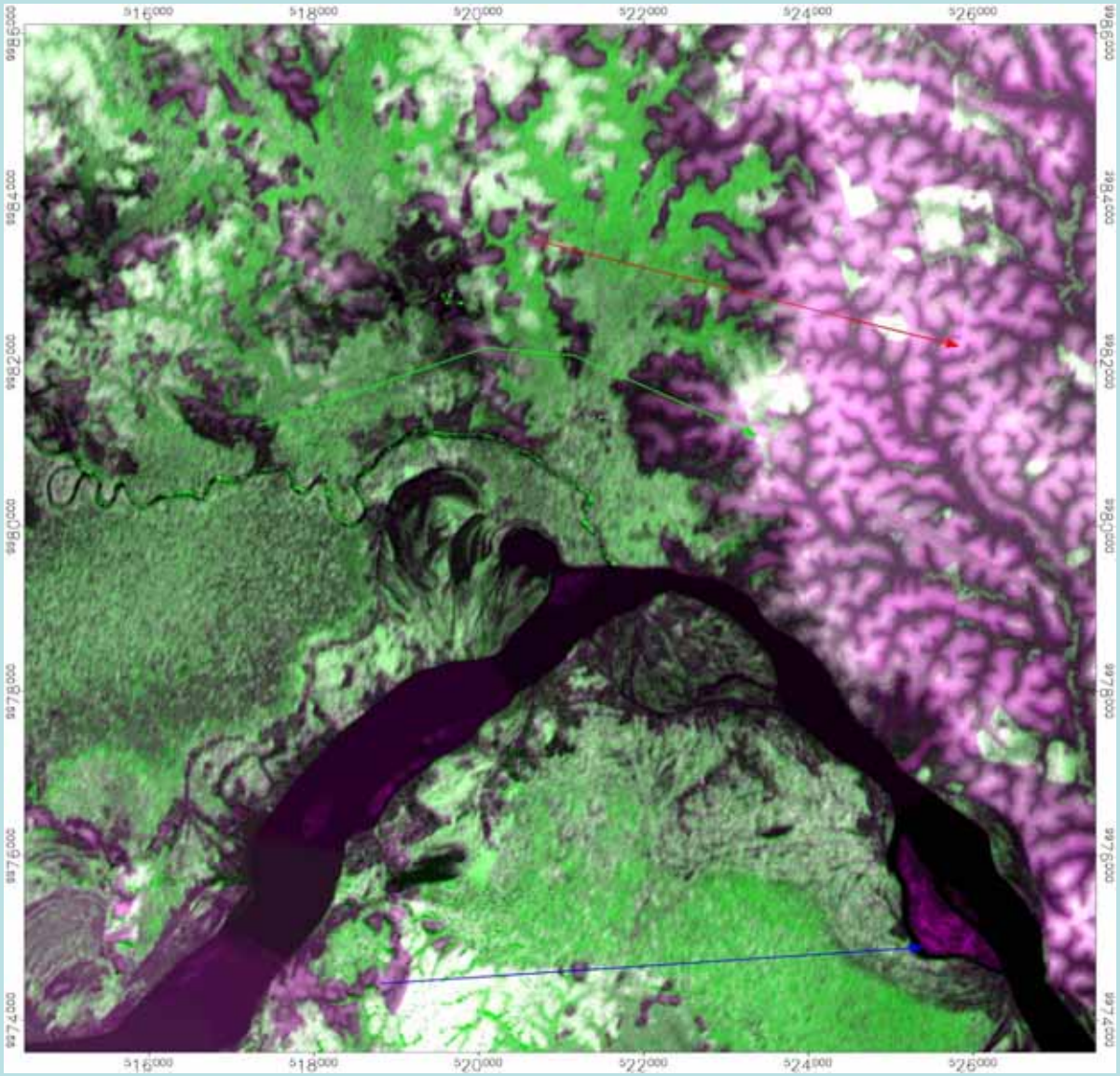


X-DEM

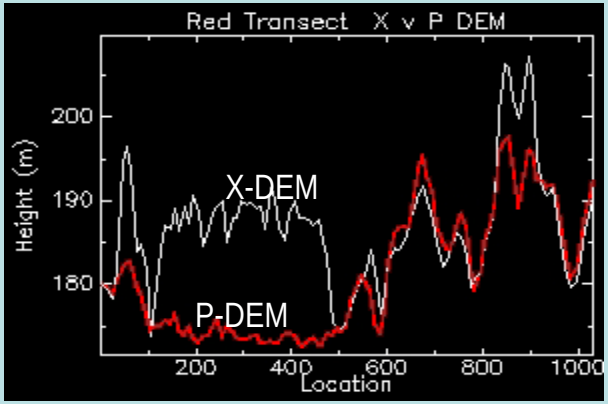


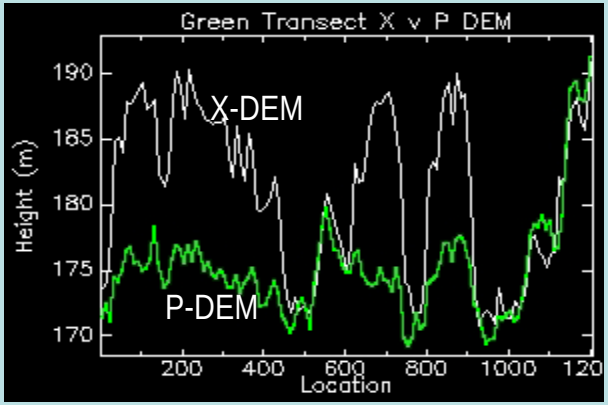
P-DEM

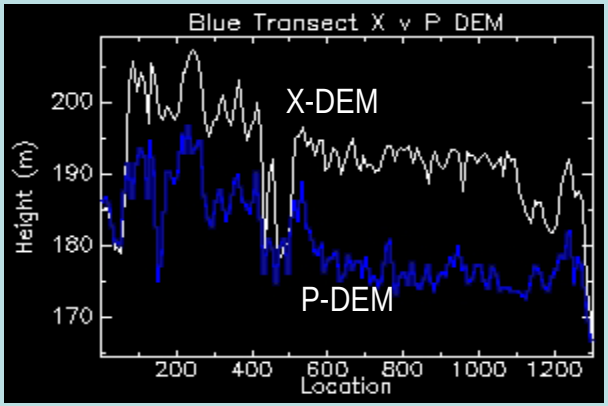
Airborne GeoSAR Xand P band



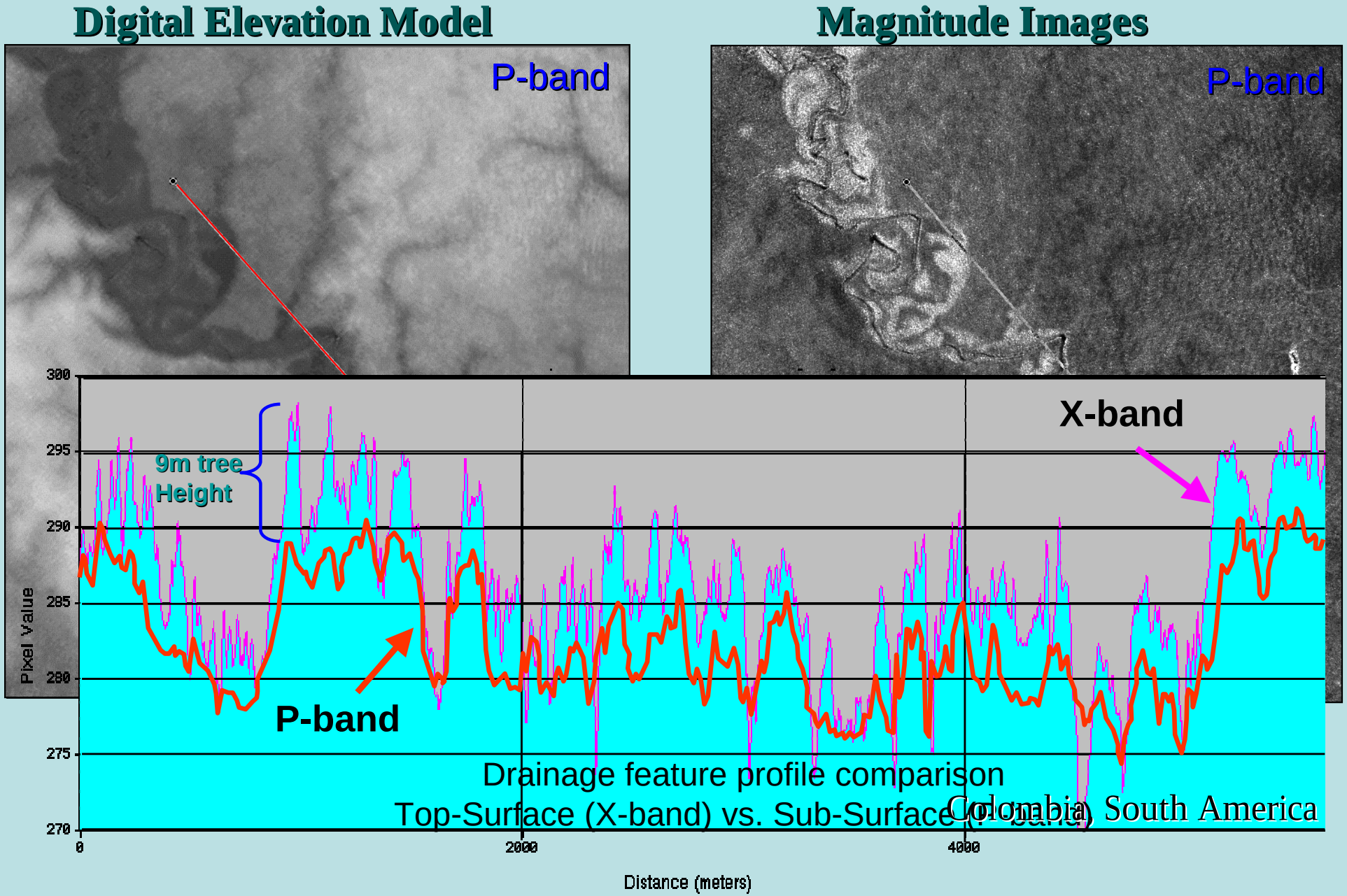
RGB composite P:X:P IFSAR data







Airborne GeoSAR Xand P band

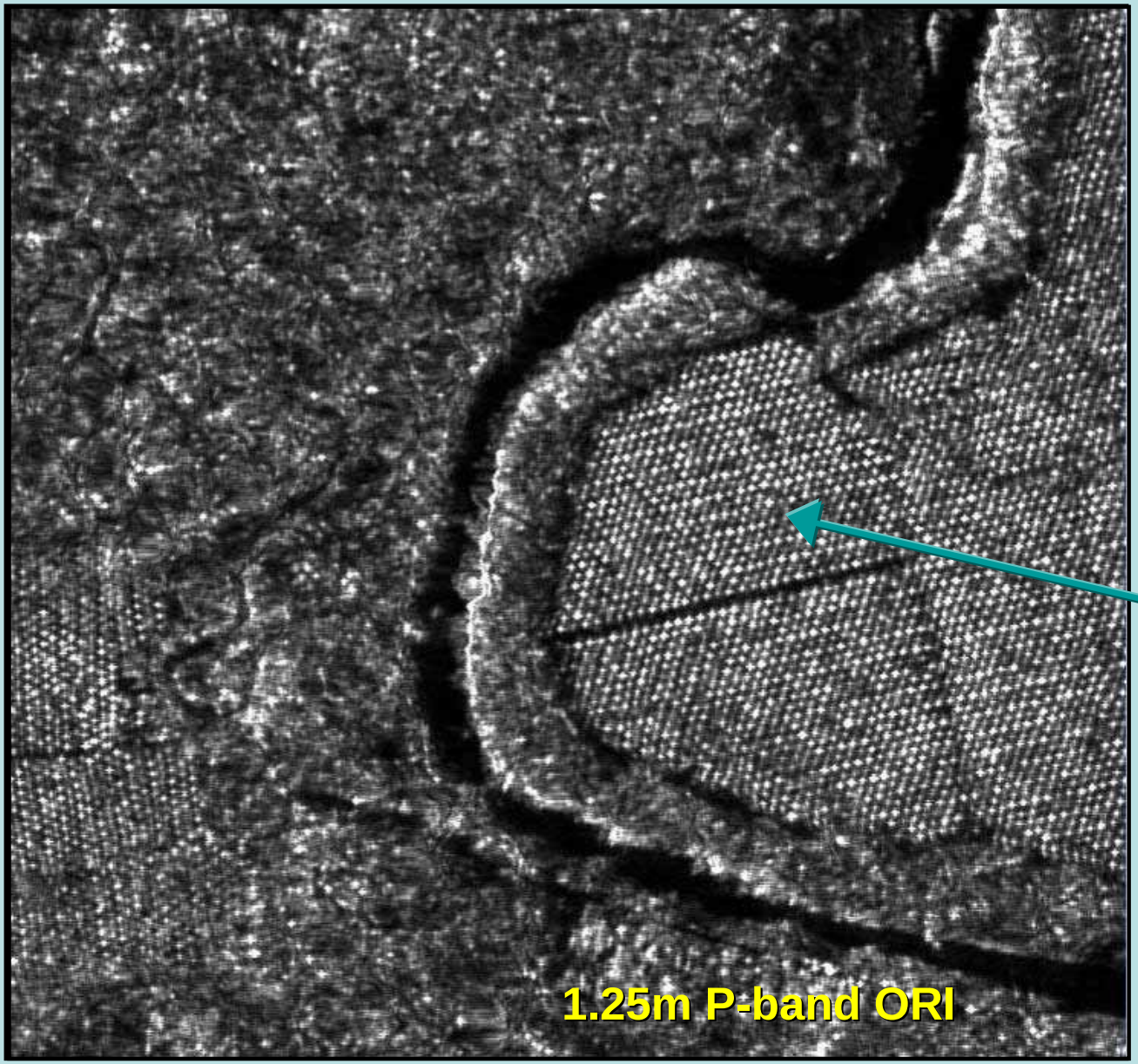


Drainage feature profile comparison
Top-Surface (X-band) vs. Sub-Surface (P-band)

Colombia, South America

Airborne GeoSAR Xand P band

Airborne GeoSAR Xand P band



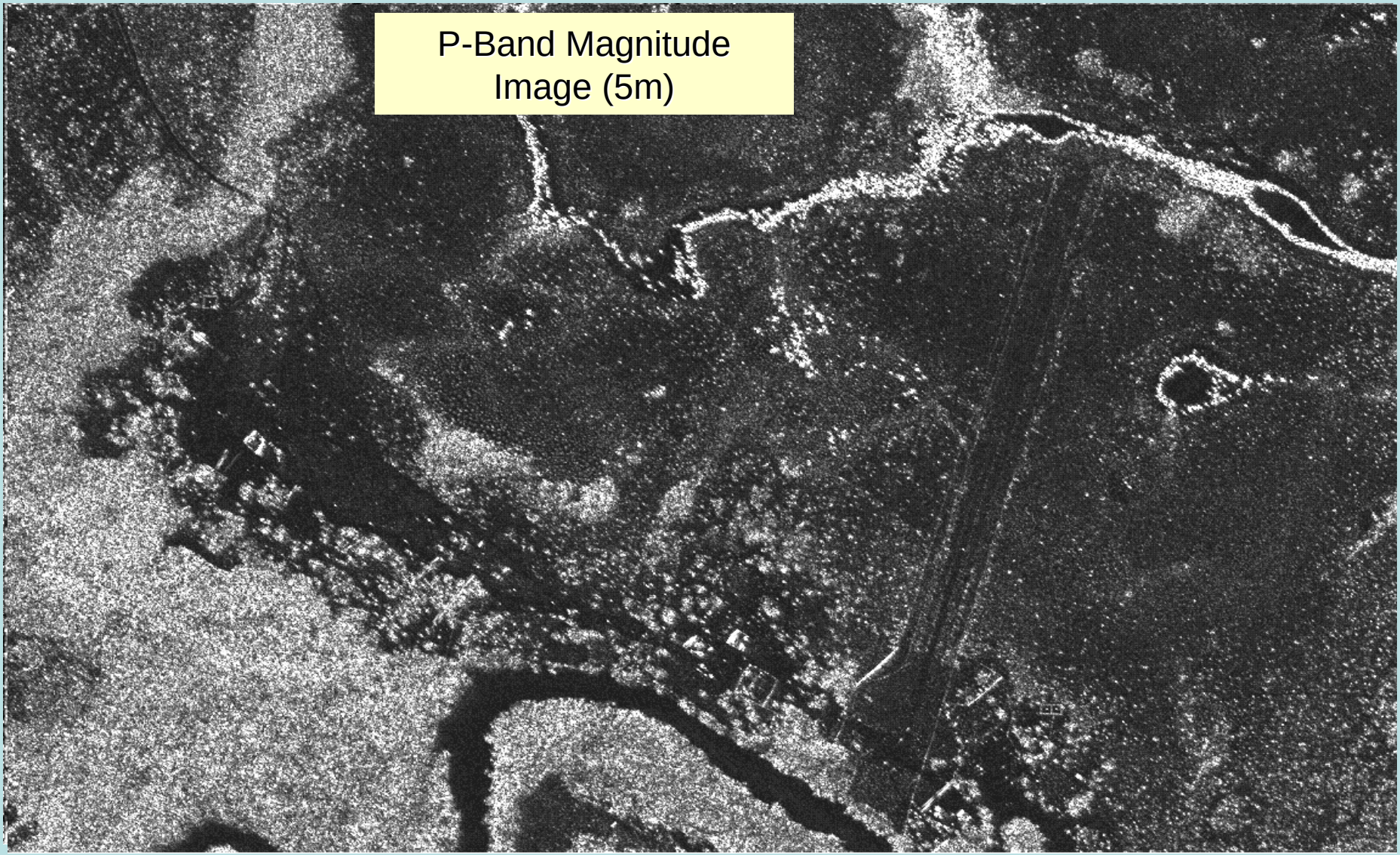
1.25m X- and P-band Radar Images

Orchards and trails, irrigation patters, drainages exposed in P-band

Capable of counting trees in orchards

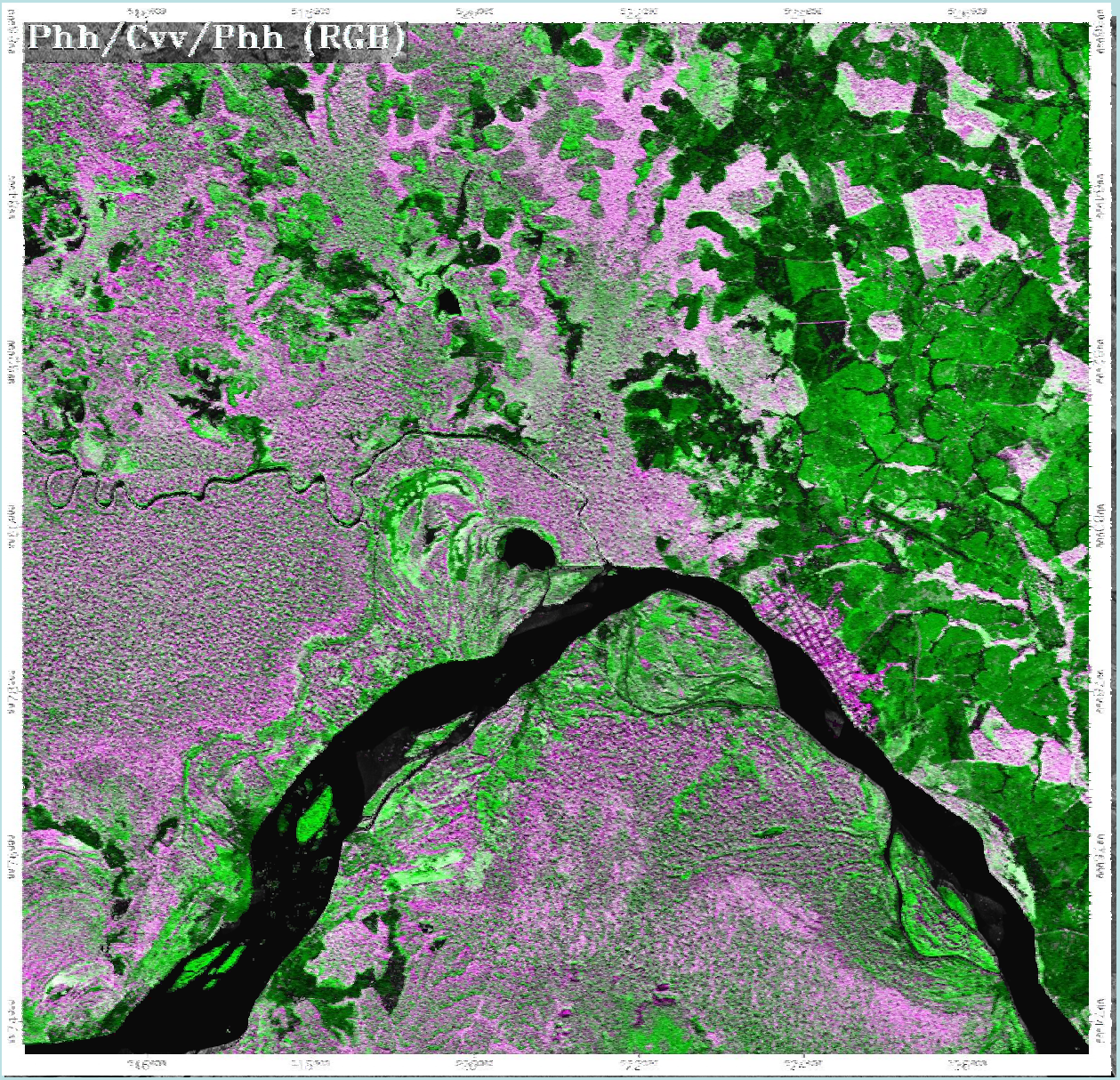
Papua New Guinea

Airborne GeoSAR Xand P band



Air strip and associated man-made features, Colombia, South America

Airborne GeoSAR Xand P band

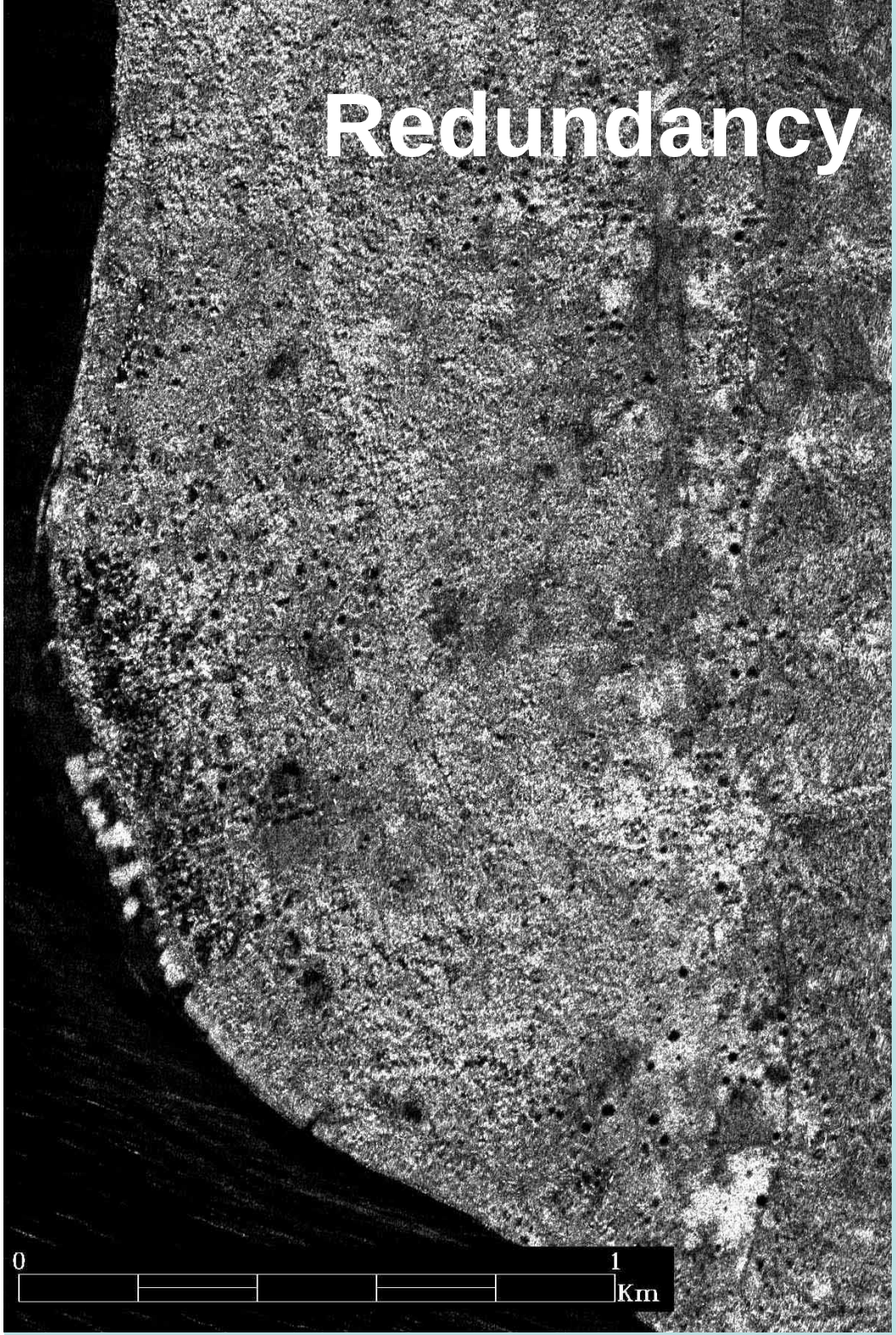


Colombia, 2006

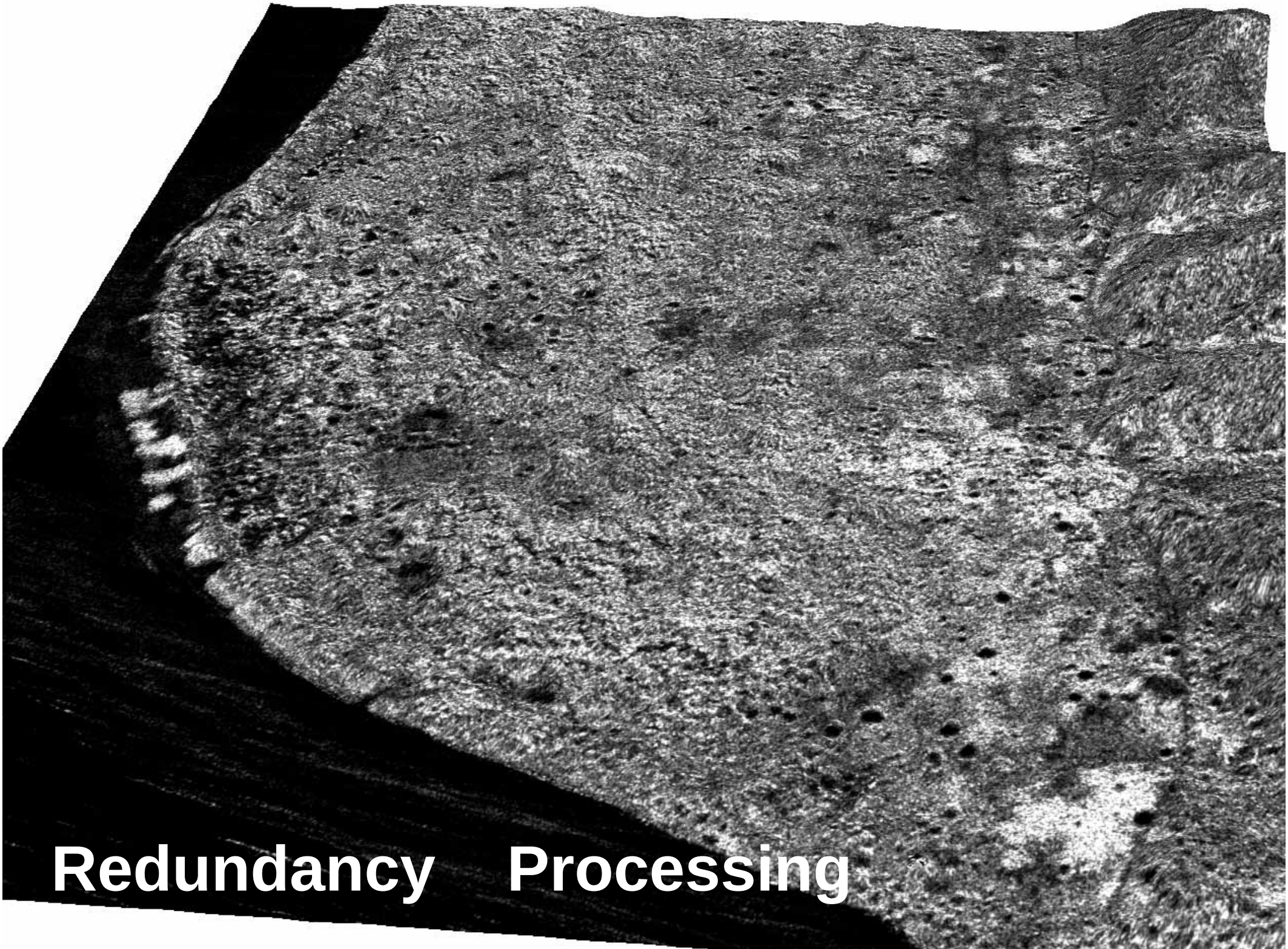
Radar colorized though image processing of band combinations

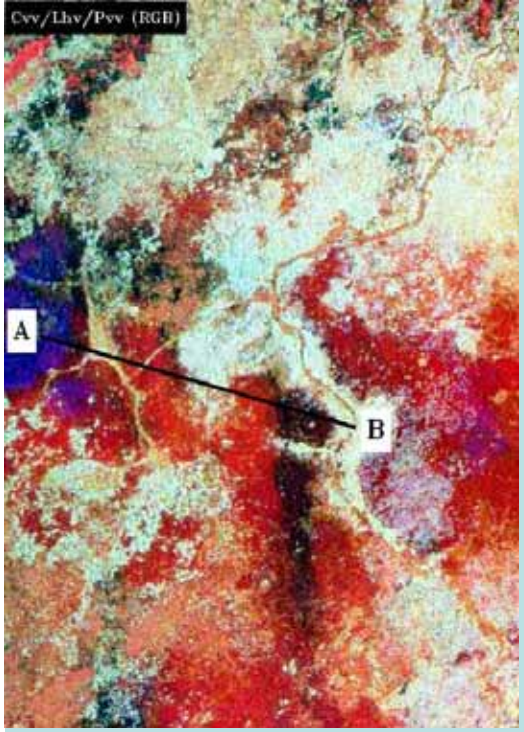
Makeshift airfield revealed in P-band

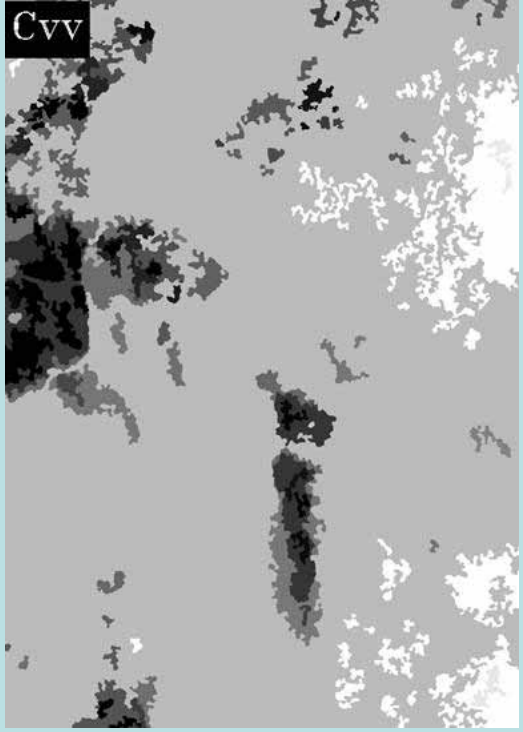
Airfield – Kupiano, PNG

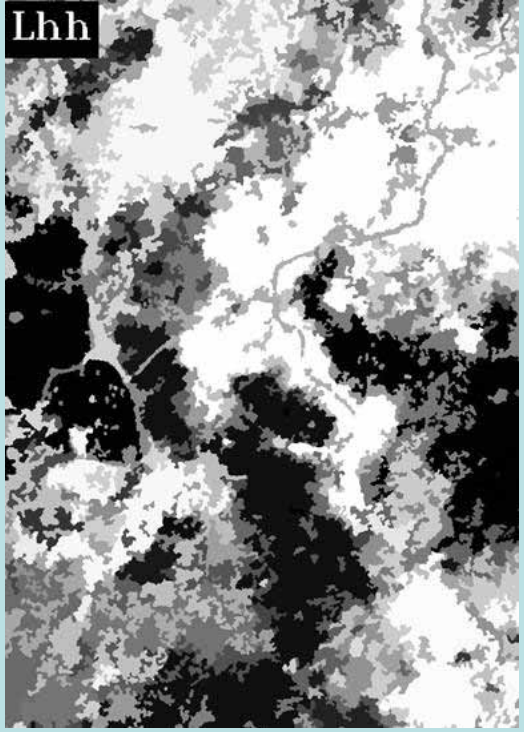

Redundancy
0
1
Km


Processing
X-MAG
Block2
0
0.2
Km


Redundancy Processing



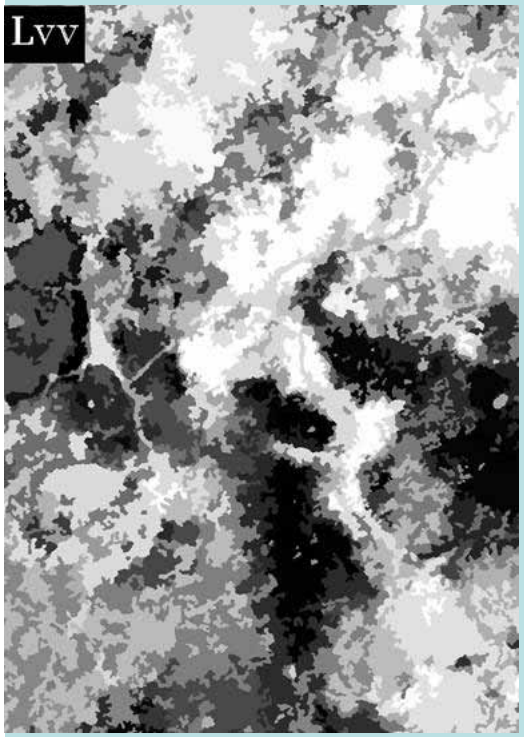


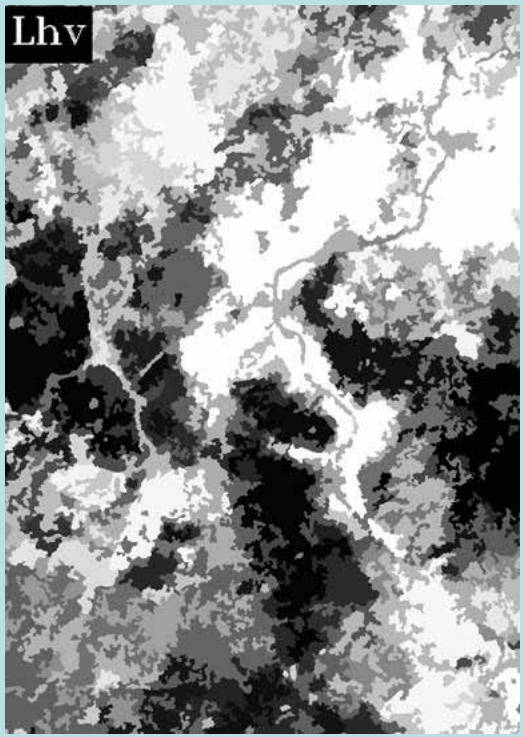


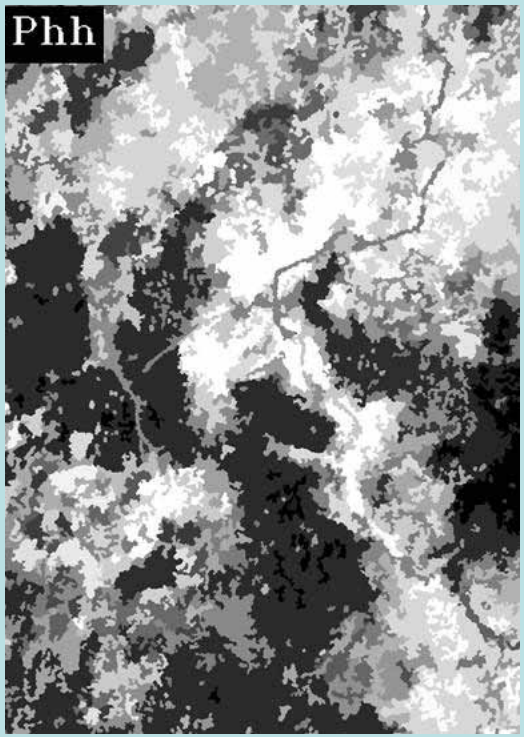
HGC

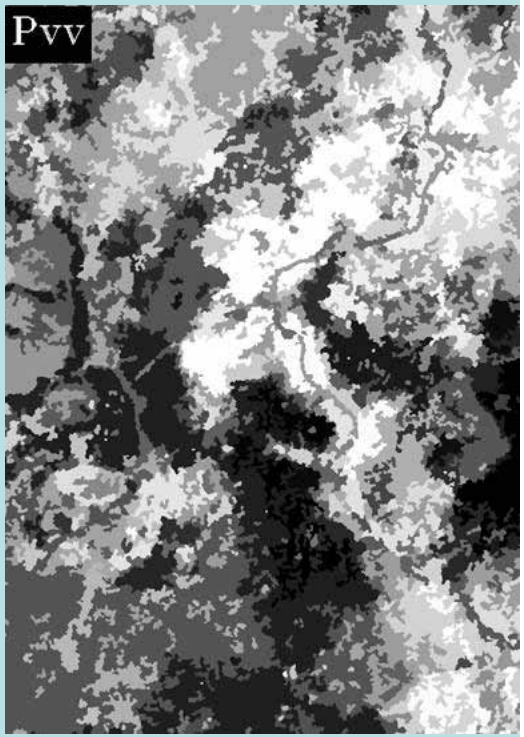
HORIZON GEOSCIENCE CONSULTING

AIRSAR MULTI-BAND DATA







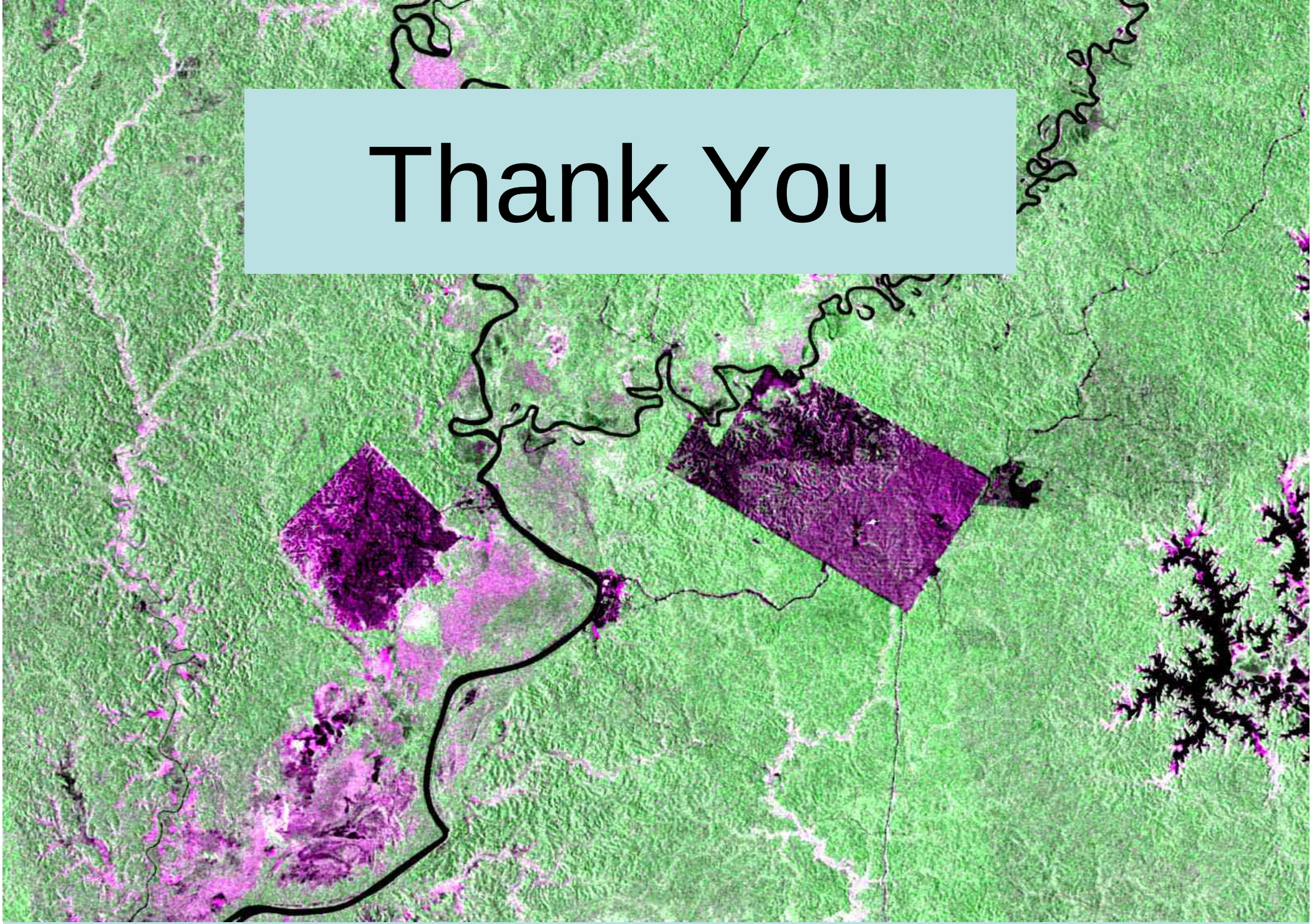


All-bands subset analysis

Cvv	Lhh	Lvv	Lhv	Phh	Pvv	100%
Cvv	Lvv	Lhv	Phh	Pvv		95.1
Cvv	Lhh	Lvv	Lhv	Pvv		93.6
Cvv	Lhh	Lvv	Lhv	Phh		92.4
Cvv	Lhh	Lvv	Phh	Pvv		88.8
Cvv	Lvv	Lhv	Pvv			87.9
Cvv	Lvv	Lhv	Phh			87.5
Cvv	Lhh	Lvv	Pvv			81.3
Cvv	Lhv	Phh	Pvv			80.7
Cvv	Lhh	Lhv	Pvv			80.6
Cvv	Lhh	Lvv	Phh			80.4
Cvv	Lhv	Pvv				73.2
Cvv	Lvv	Lhv	(ENVISAT / RADARSAT and ALOS)			72.2
Cvv	Lvv	Phh				71.1
Cvv	Lhv	Phh				70.4
Cvv	Lhh	Pvv				68.2
Cvv	Lvv	Pvv				67.1
Cvv	Phh					54.1
Cvv	Lhv					53.9
Cvv	Lhh					52.0
Cvv	Pvv					51.6
Cvv	Lvv					50.7
Lhv	Pvv					50.1
Lhv	(ALOS-PALSAR)					31.2
Lhh	(ALOS-PALSAR)					29.3
Phh						28.8
Lvv	(ALOS-PALSAR)					28.0
Cvv	(ENVISAT-ASAR, RADARSAT)					27.0
Pvv						25.7

73.2%

3D model of AIRSAR bands Phh/Lped/Cvv (RGB) overlaid on TOPSAR DEM


Thank You
HH:HV:HH (RGB)