

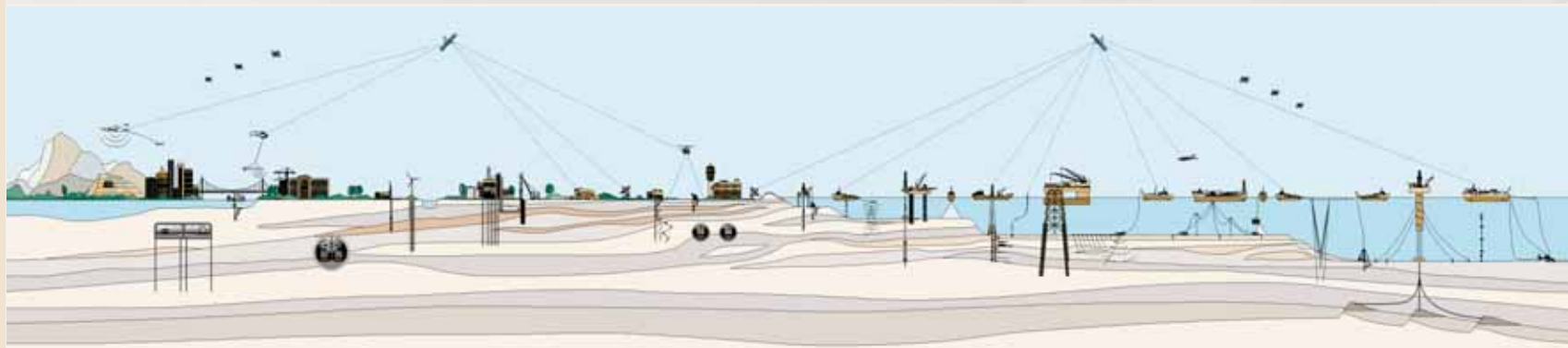


# **Introduction to the New GeoSAR Interferometric Radar Sensor**

**Bill Sharp  
GeoSAR Regional Director - Americas**

**Becky Morton  
Regional Manager**

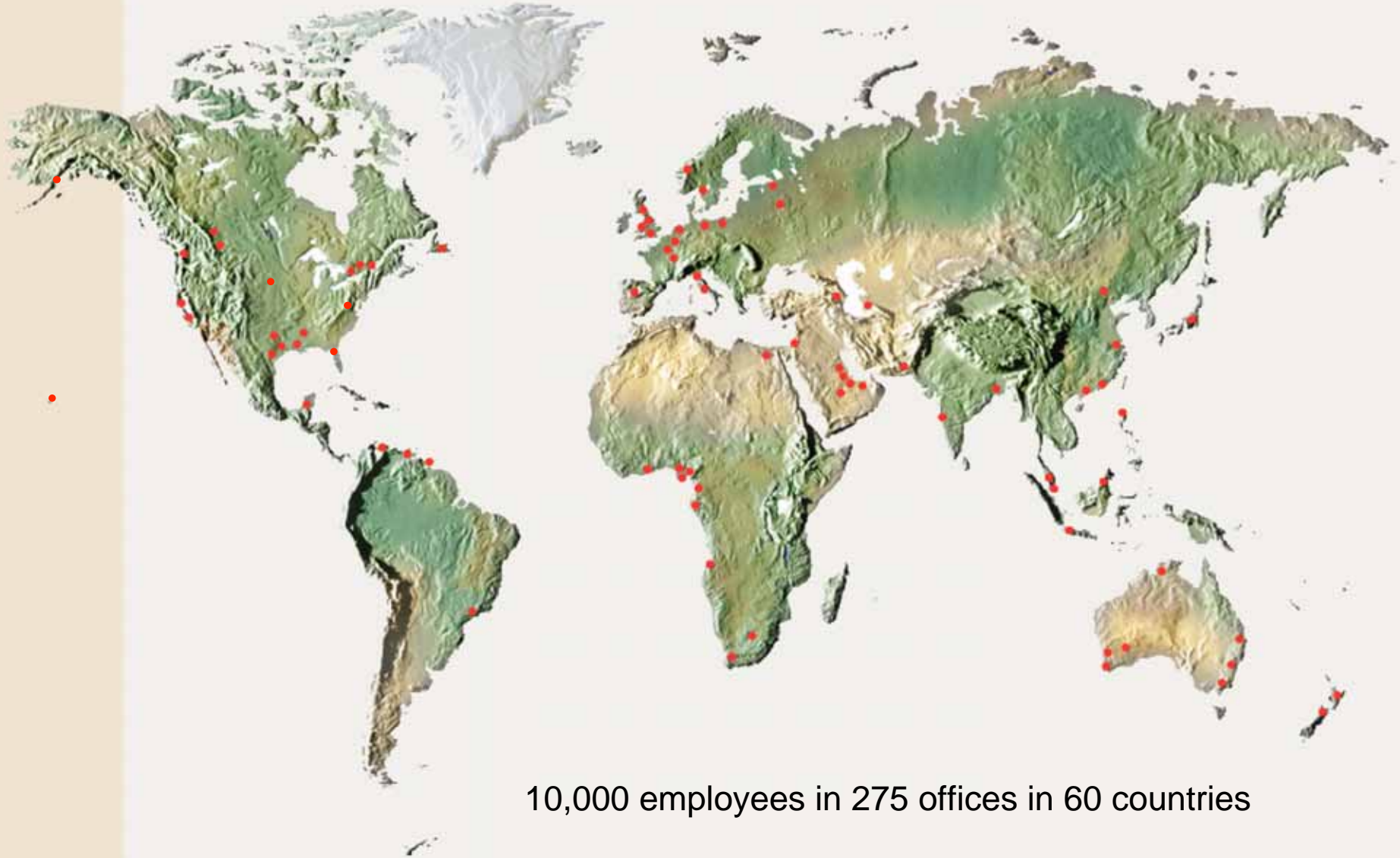
**Configuration, Capabilities, Limitations, and Examples**





# About FUGRO EARTHDATA

## FUGRO Corporate Global Network



10,000 employees in 275 offices in 60 countries

## Objectives:

Present the GeoSAR IFSAR sensor

## Presentation:

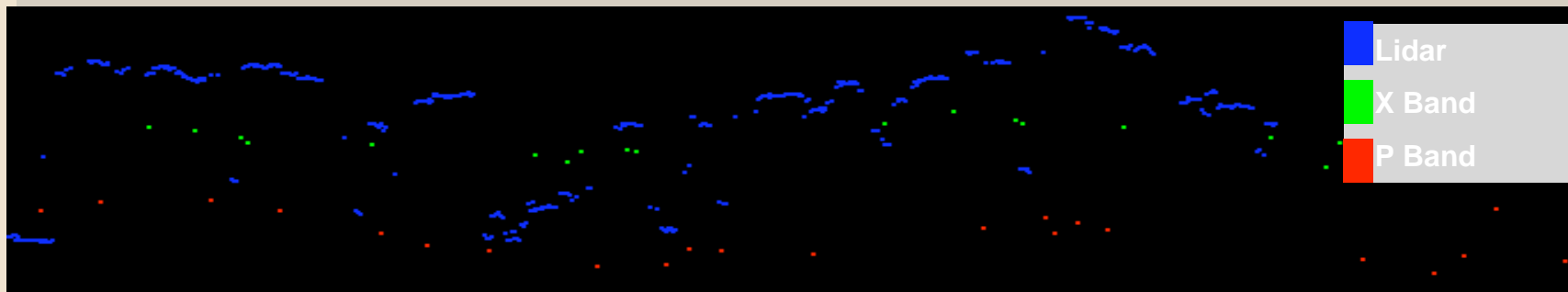
- Introduction to GeoSAR
  - What is GeoSAR?
  - Technology and Components
- Data and Applications
  - Elevation Data
  - Magnitude Images (MAG)
  - Band Combinations and Visualizations

## What is GeoSAR?

- ❑ **Single-pass, dual frequency, interferometric radar mapping system**
  - X-band shows first surface
  - P-band reveals detail beneath canopy
- ❑ **Rapid, large area mapping through cloud cover, day and night**
- ❑ **Products include**
  - Ortho-rectified X and P radar reflectance images, co-registered with each other and...
  - Digital elevation models (DEMs)
  - Lidar profiler derived ground control points

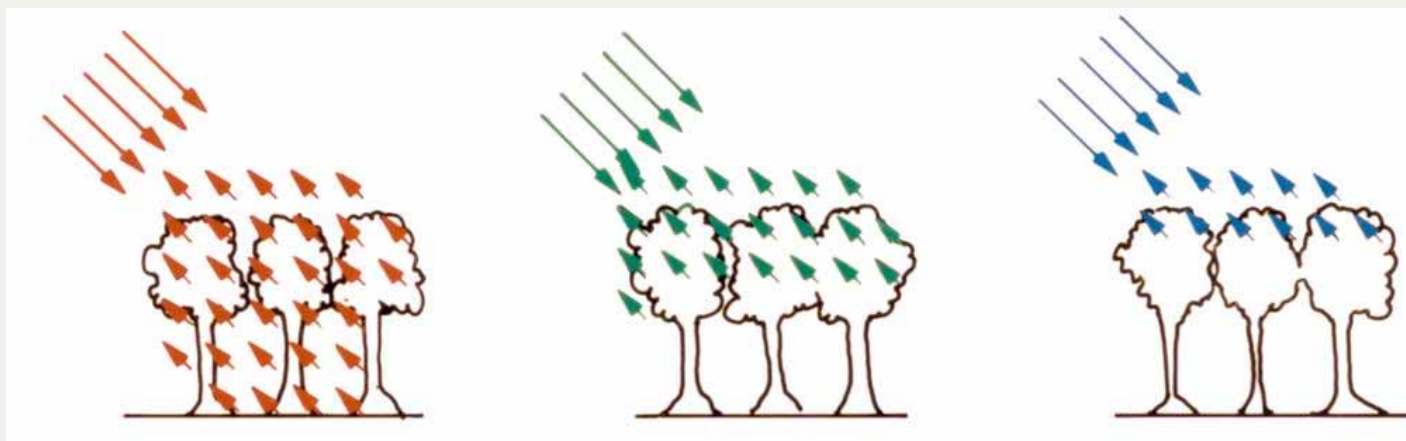


# X and P Compared to L Bands



## Diferences between Lidar and Radar Bands

GeoSAR	Other sensors	GeoSAR
Phh (85 cm)	L (24 cm)	Xvv (3 cm)



Forest: leaves reflect X-band signals but not P-band which penetrates the canopy to probe the vertical trunk region of the foliage at a wavelength comparable to trunk dimensions.

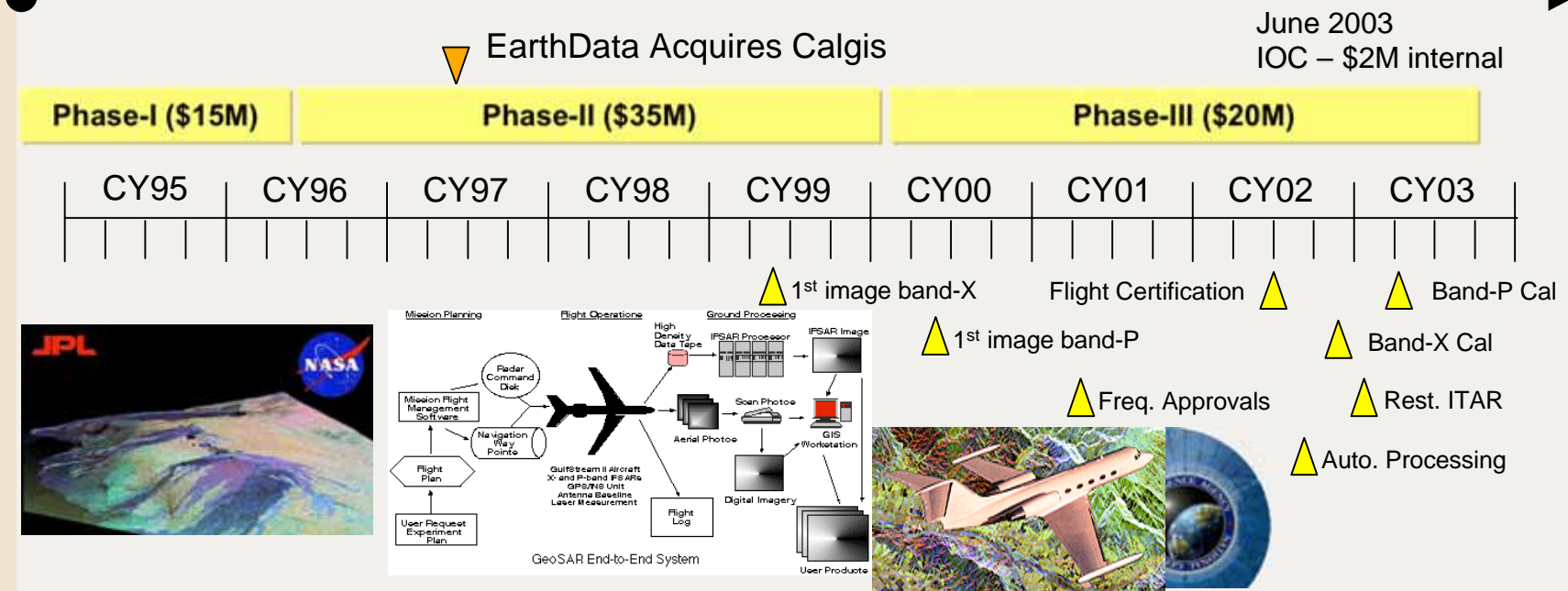


# GeoSAR Investment History

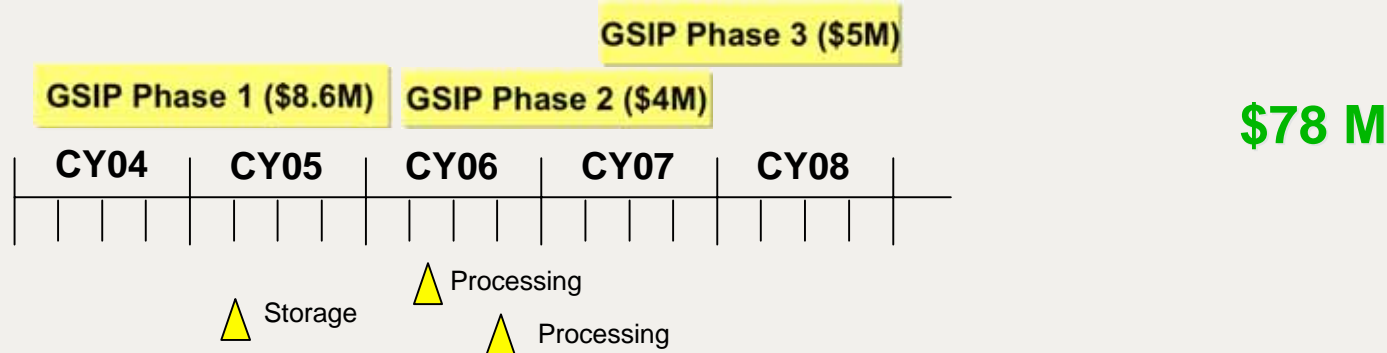
**DARPA Leadership**

**TEC PM**

**NGA Leadership**



## System Improvement Program (Internal & External)





# GeoSAR Components



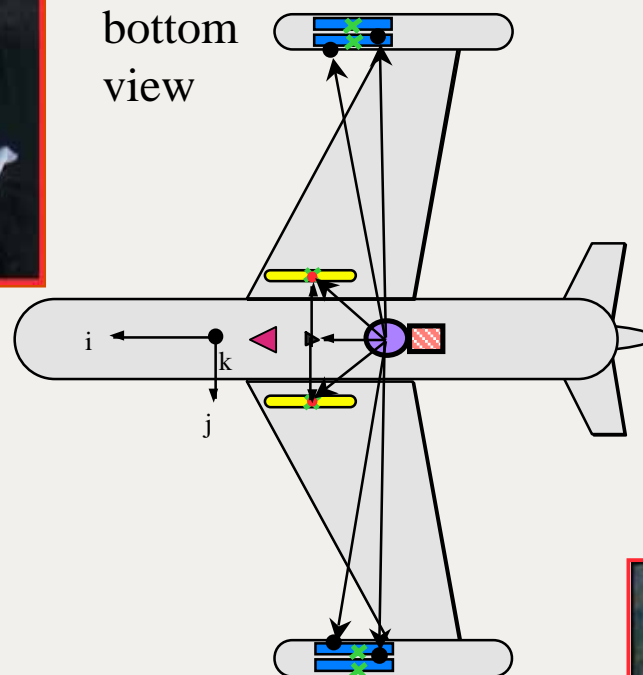
Antenna  
Positioning  
Measurement Unit




Two X-band antennas

Two P-band antennas



Aircraft,  
bottom  
view



-  Lidar
-  EGI
-  APMU
-  X-band antenna
-  P-band antenna
-  APMU target
-  phase center



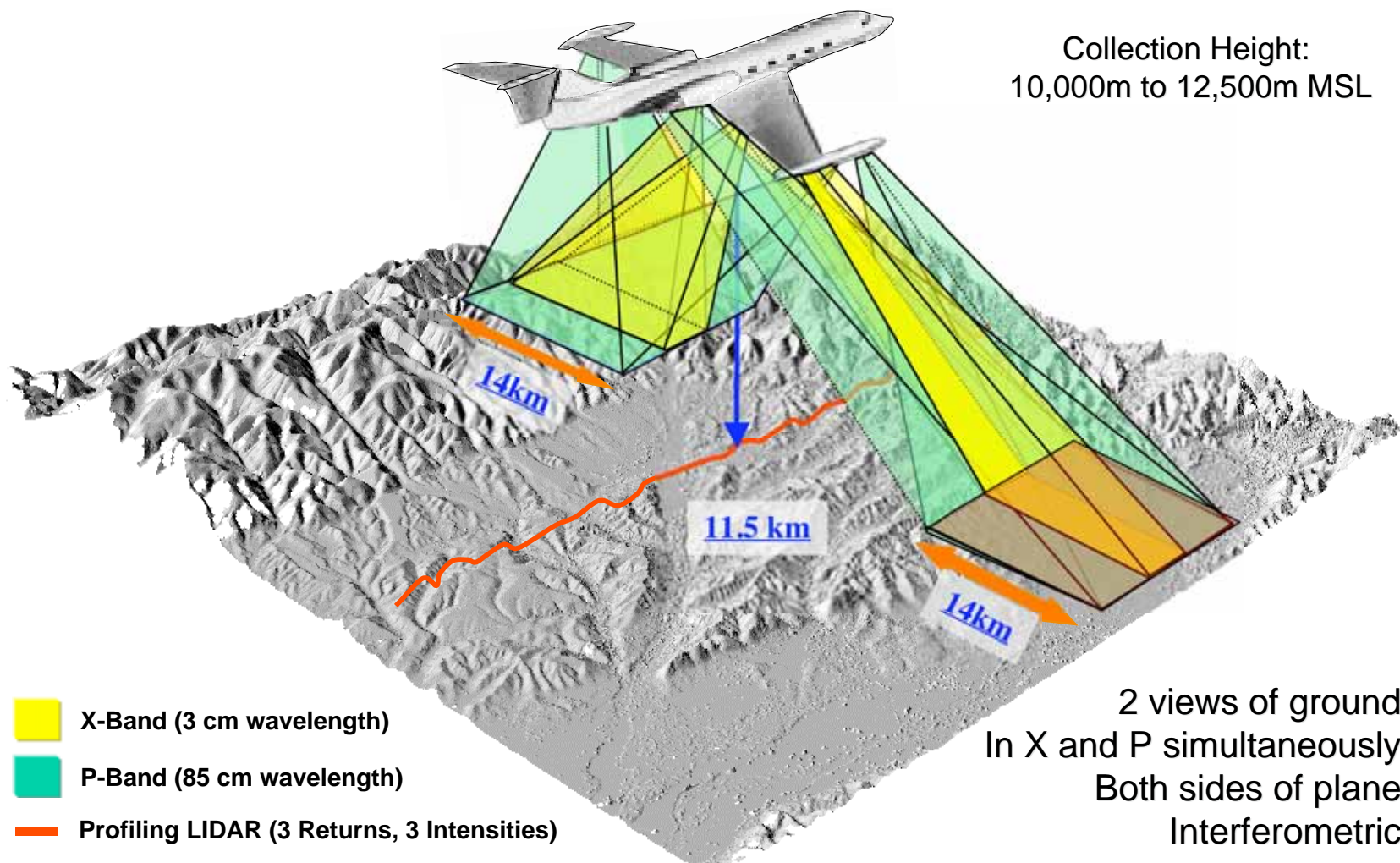
APMU target array viewed  
in flight

- **A dozen (12) GPS/IMU for motion measurement**
- **Motion measured and compensated – 1 millimeter**





# Flight Characteristics

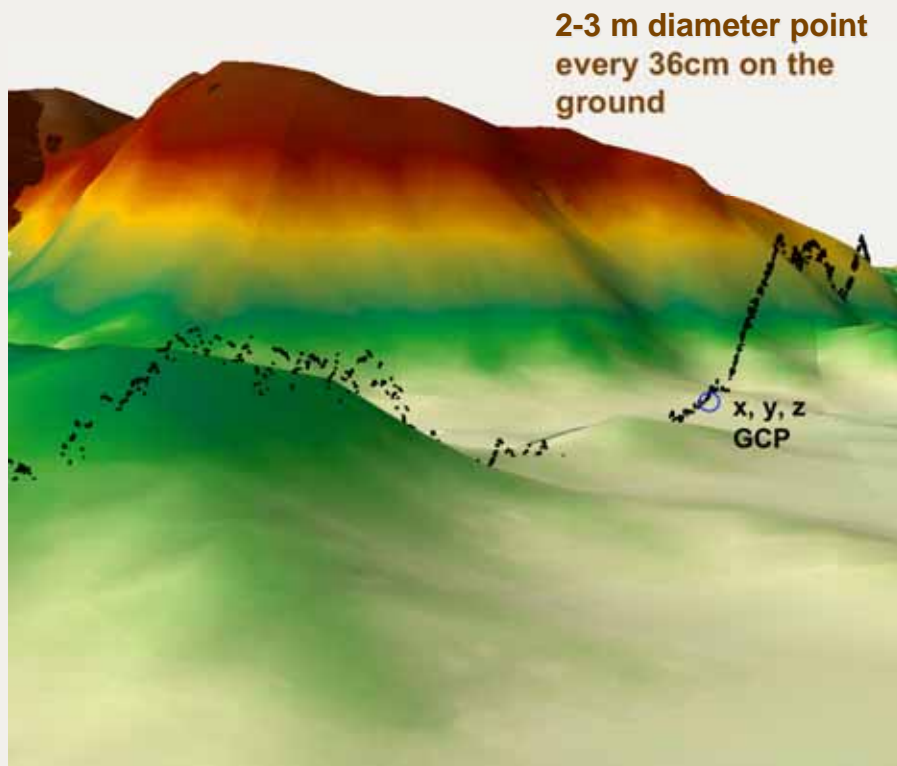




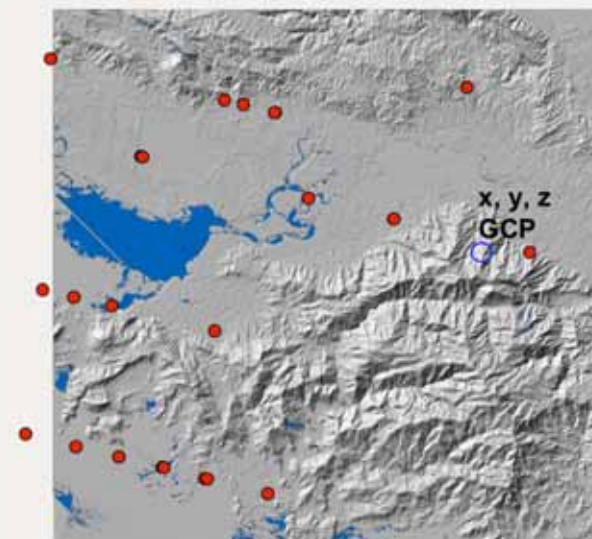
# Additional Control from the Profiling LASER



**3 ground distance and intensity measurements per pulse reduces/eliminates the necessity for additional control in remote areas, increasing the precision of DEM's and mosaic products.**

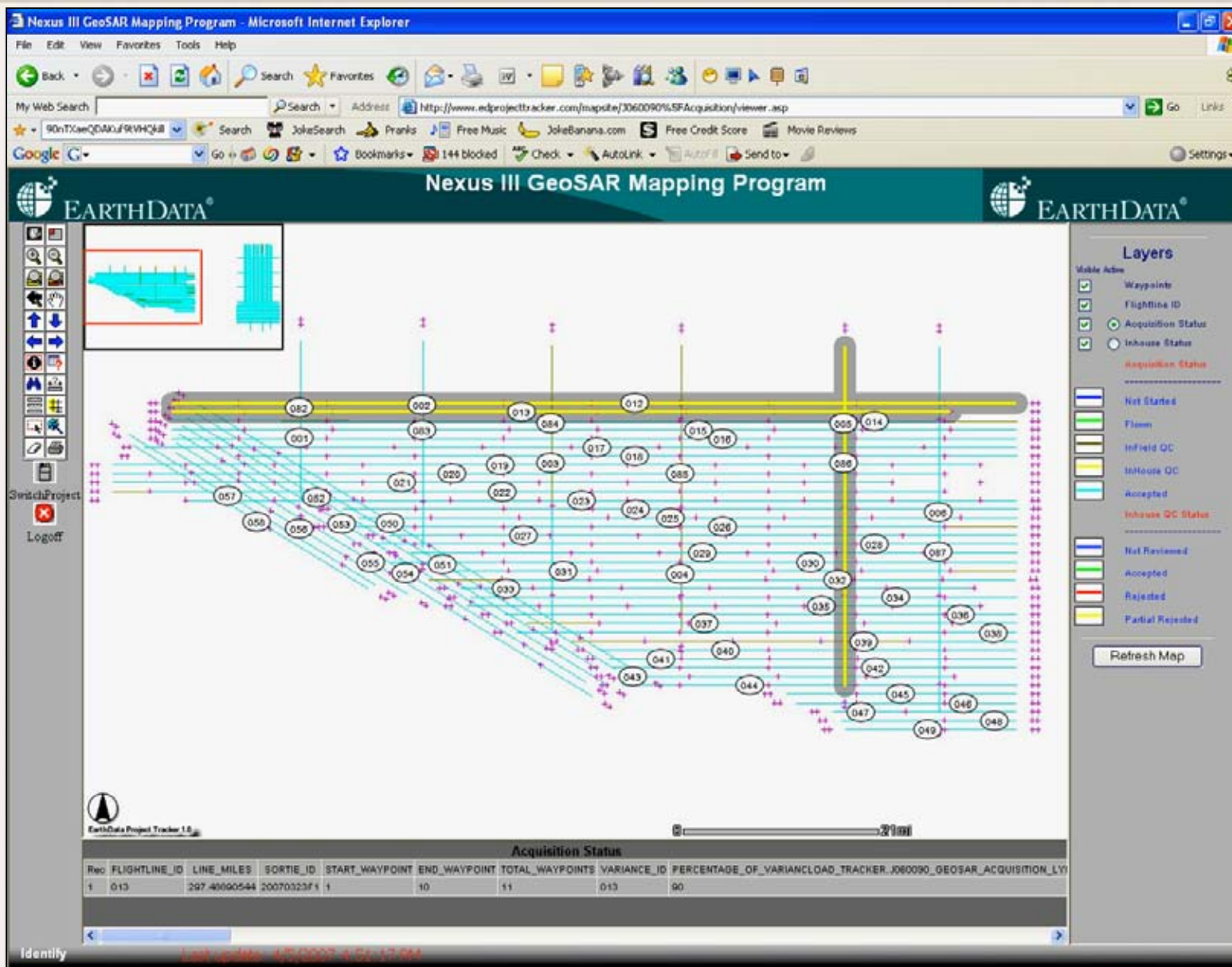


**Lidar Leica ALS40 modified for profiling at altitude (12 km or more)**





# On-line Project Management – Acquisition & Production





# GeoSAR Product Characteristics

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

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



# Fugro EarthData, Inc. Processing Facility

## SGI Processing

- 512GB RAM
- 128 processors



- 86 TB On-line
- 88 TB Near-line

## Processor monitoring



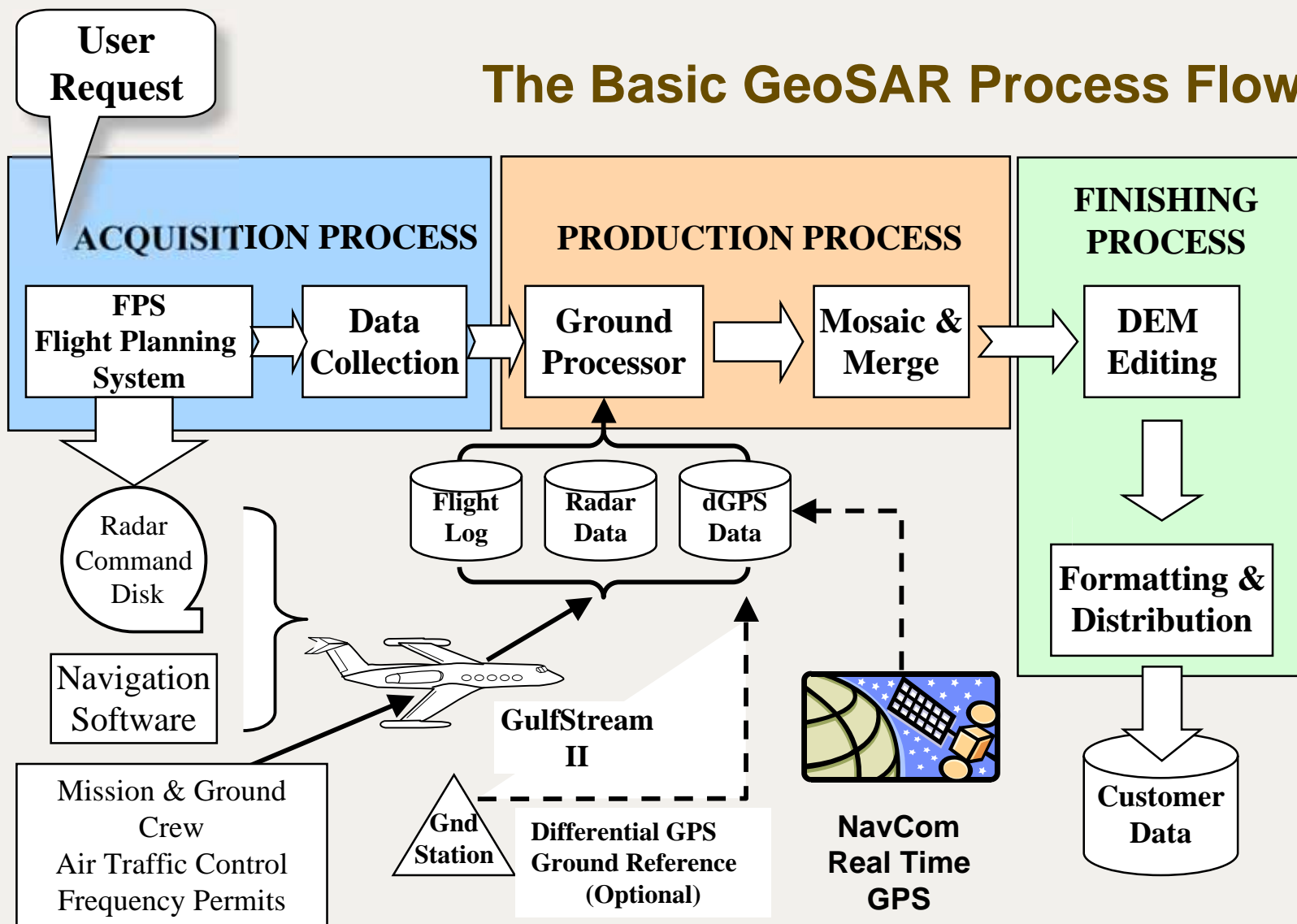
- 128 processors in action
- Any system problem triggers 24hr page notification to IT staff

## Robotic Tape Library

- 3000 Tape capacity
- 500 GB / tape
- 1.5 PB storage



# The Basic GeoSAR Process Flow



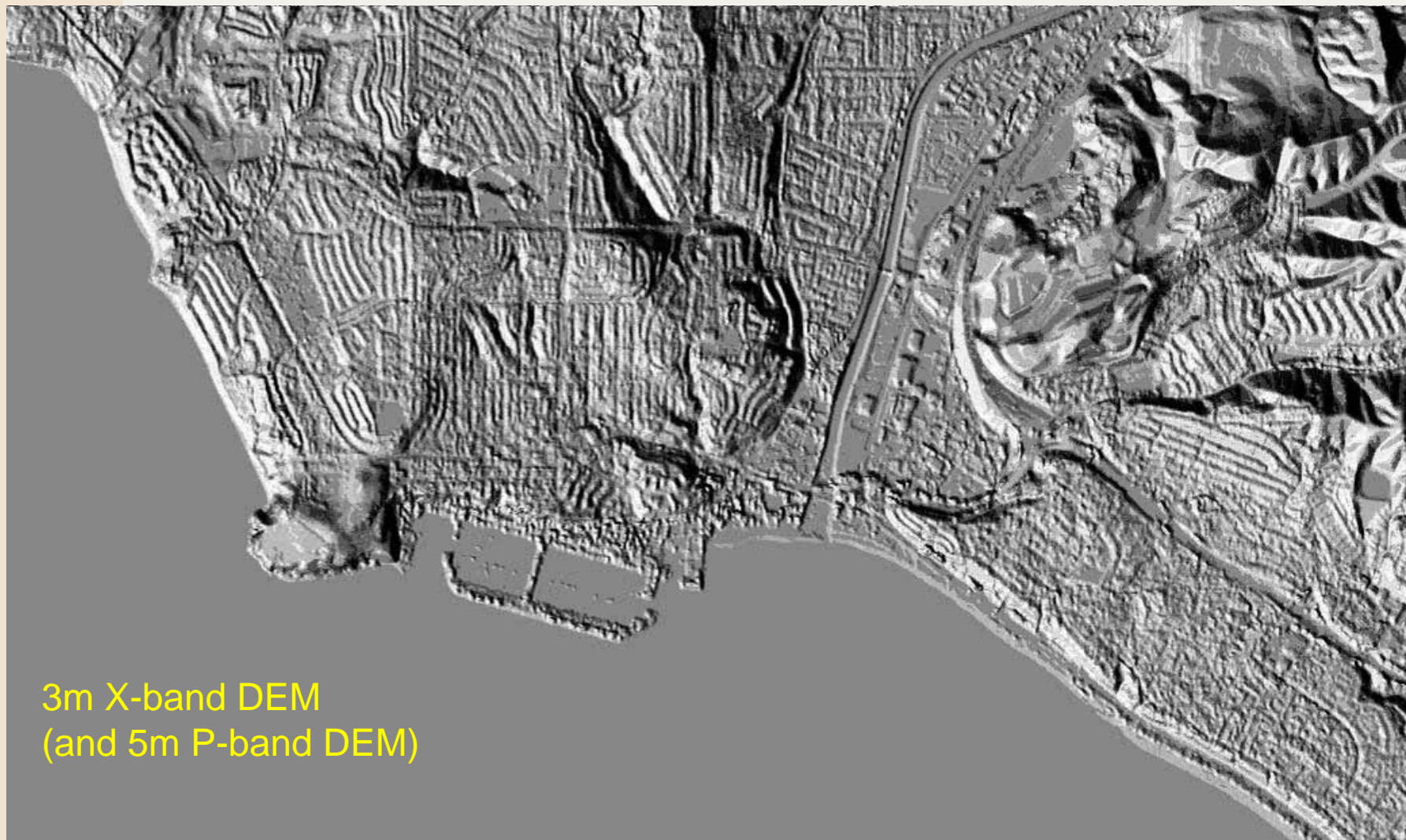


### Overcoming limitations

- See individual trees, water, paths, fences, wires and other features beneath vegetation canopy that blocks Lidar and optical data
- Detect moisture levels in vegetation or soils
- Map vegetation covered or buried structures
- Delineate land/water boundaries
- Gap fill in areas which continually challenge other sensors
- Integrate with other sensors (fusion with airborne or satellite)



## Standard Products of GeoSAR



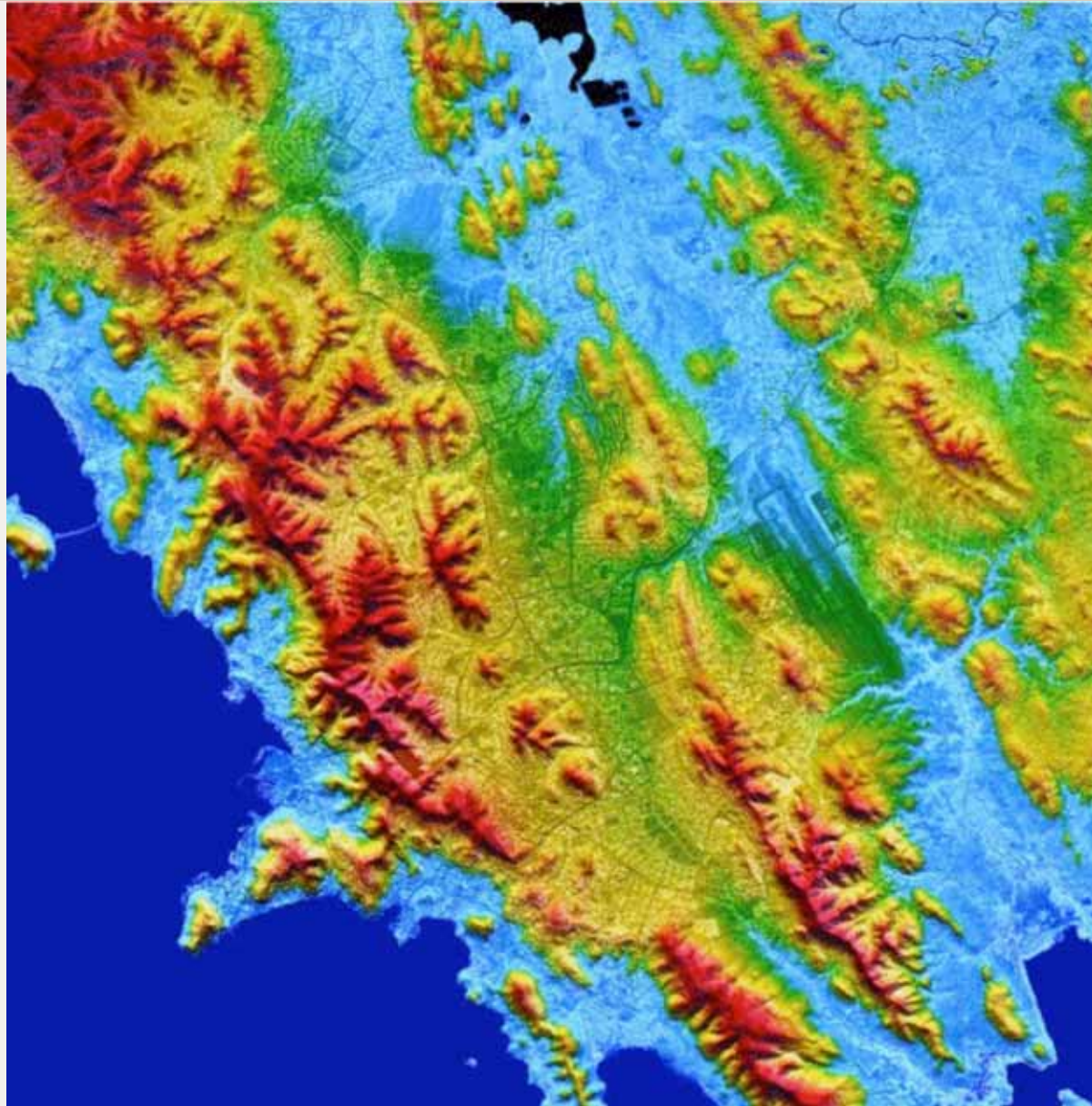
3m X-band DEM  
(and 5m P-band DEM)





## Coastal Mapping

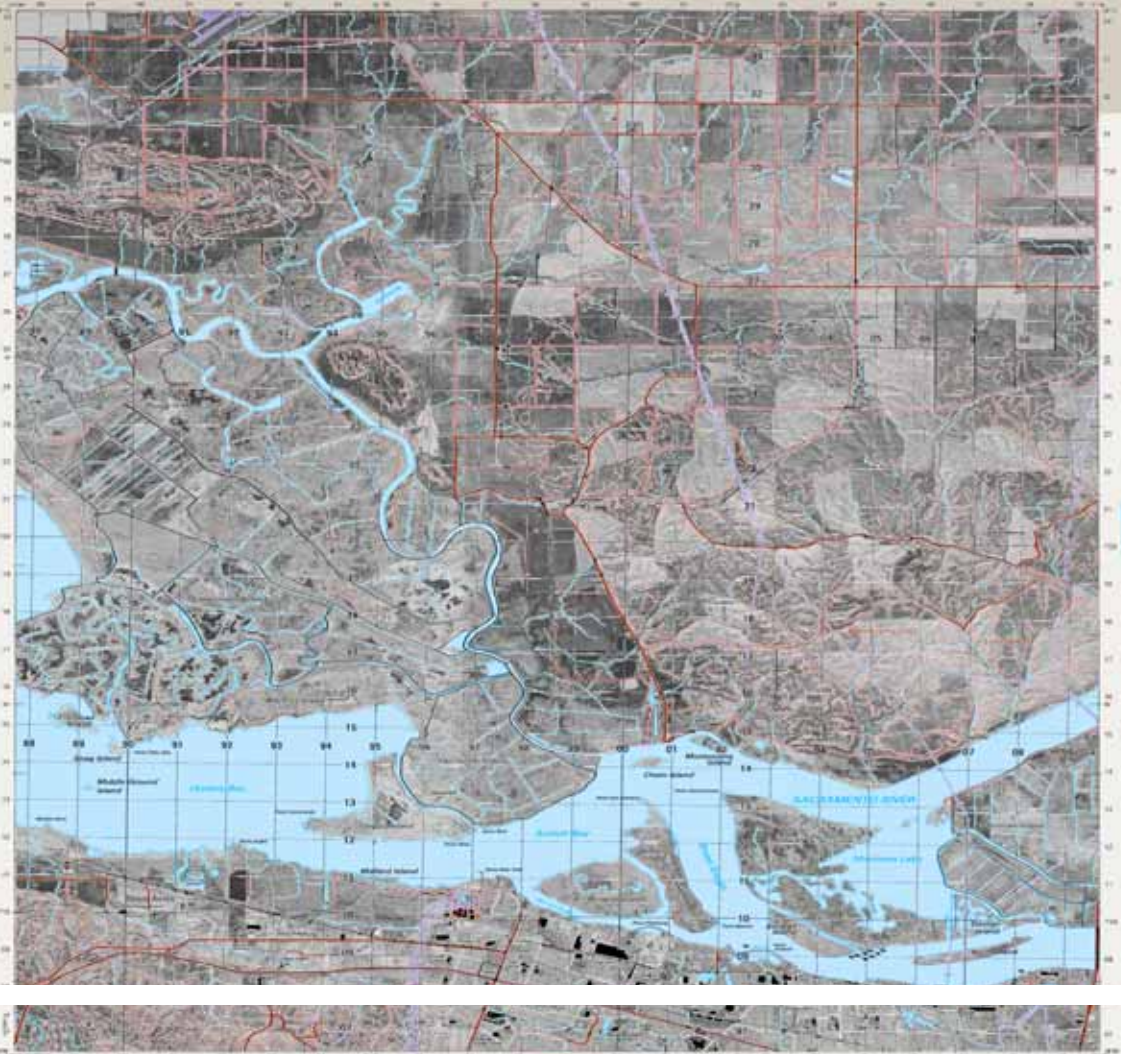
## Port Moresby X-DEM





## Malibu, Ortho-Image over DEM





Scale: 1:50,000

LEGEND

NOTES

CONVERSION TABLE

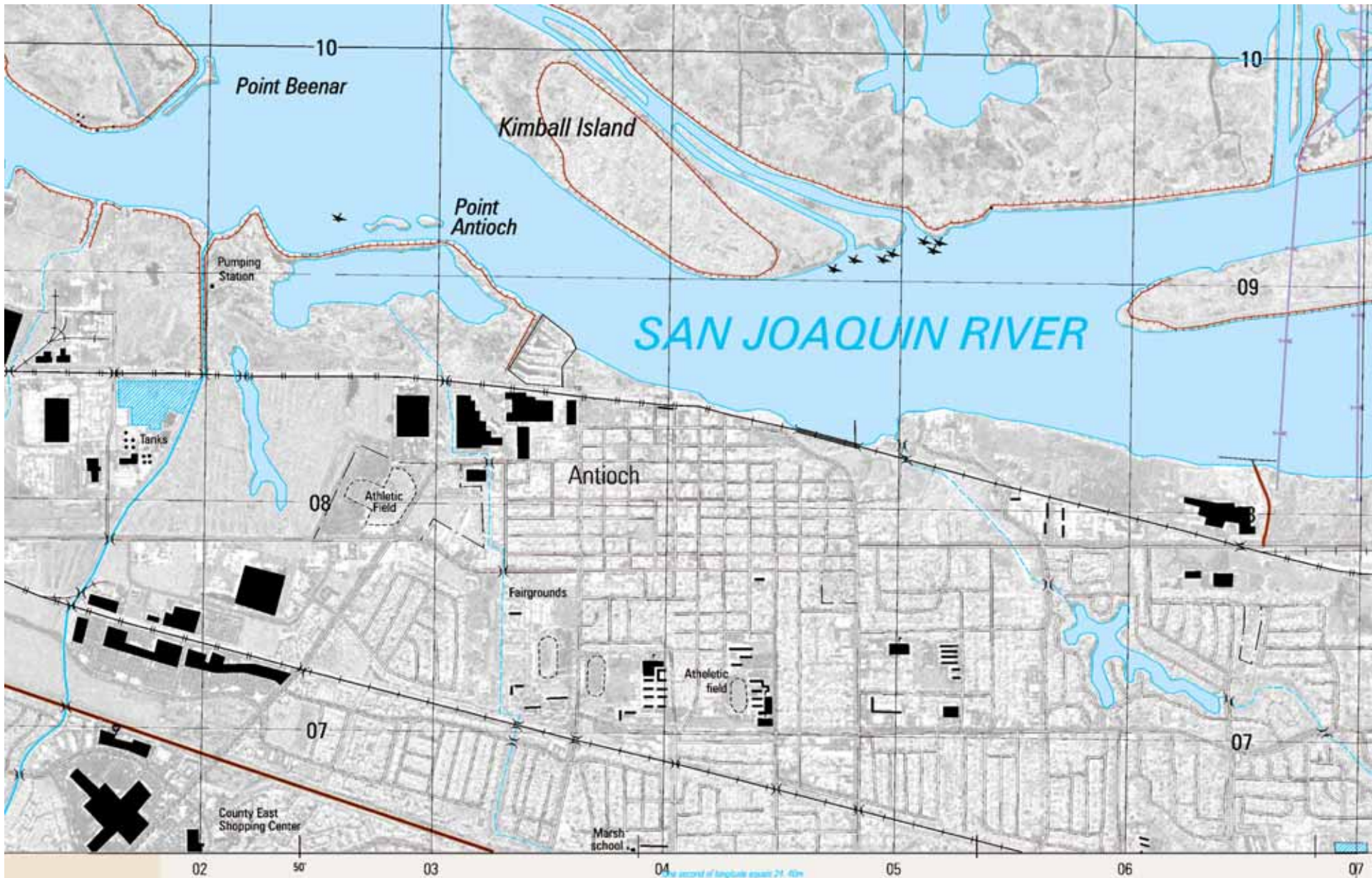
SCALE BAR

INDEX MAP

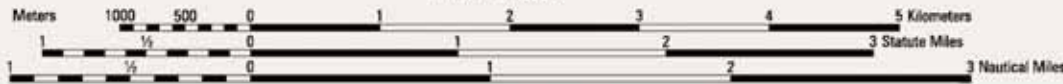
RELATIONSHIP MAPS

RELATIONSHIP MAPS

RELATIONSHIP MAPS



Scale 1:20,000



**NOTES**

IN DEVELOPED AREAS ONLY THROUGH ROUTES  
 www.earthdata.com  
 A LANE ON THIS MAP IS CONSIDERED TO BE A1

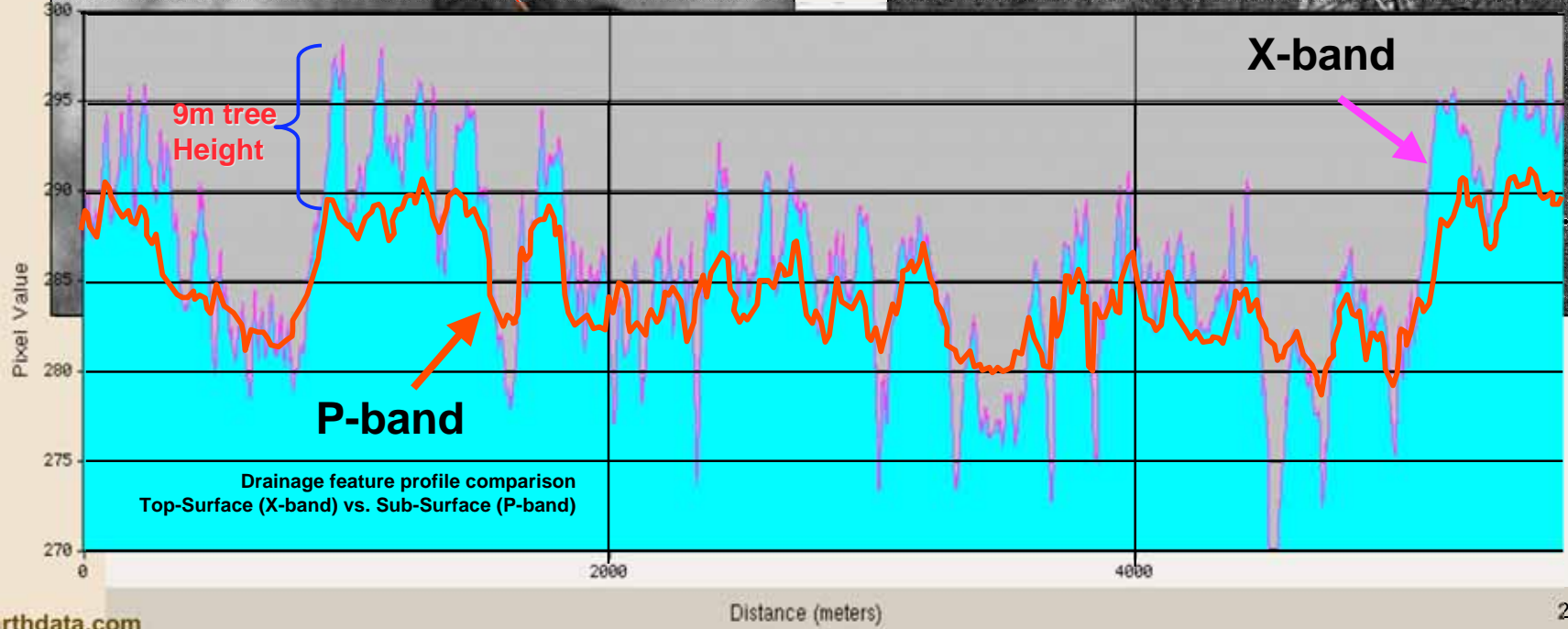
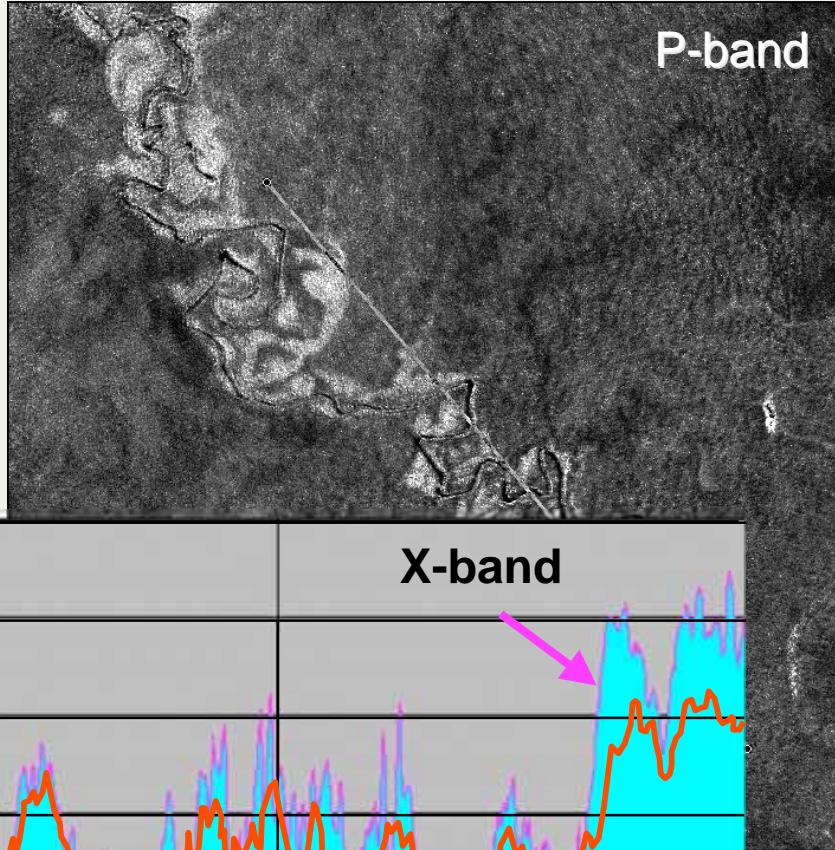
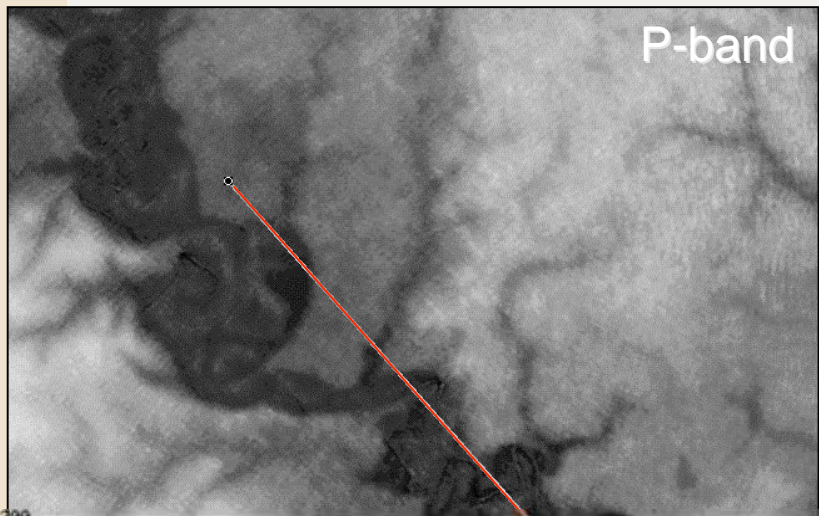
ELEVATIONS IN METERS



# Colombia, Forested Area

## Digital Elevation Model

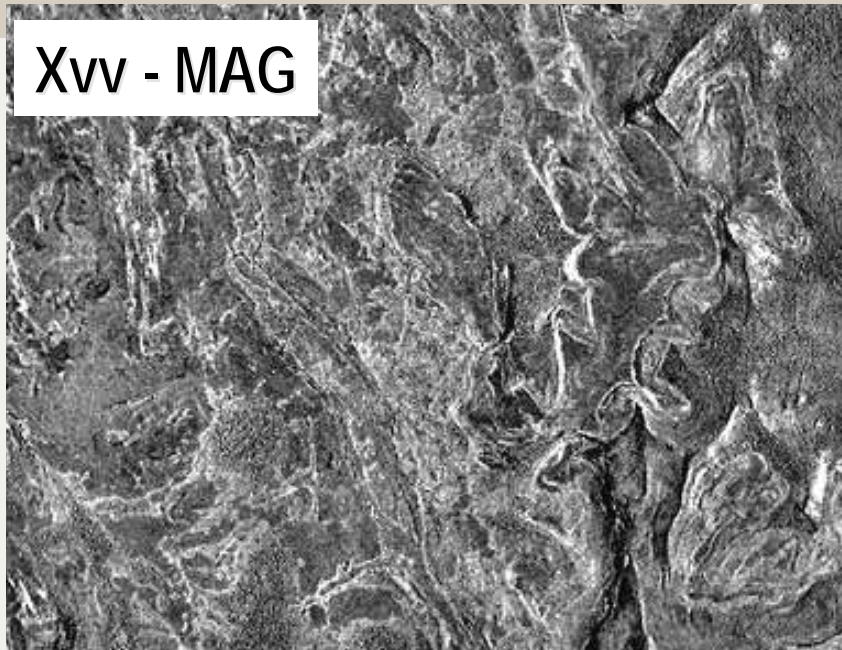
## Magnitude Images



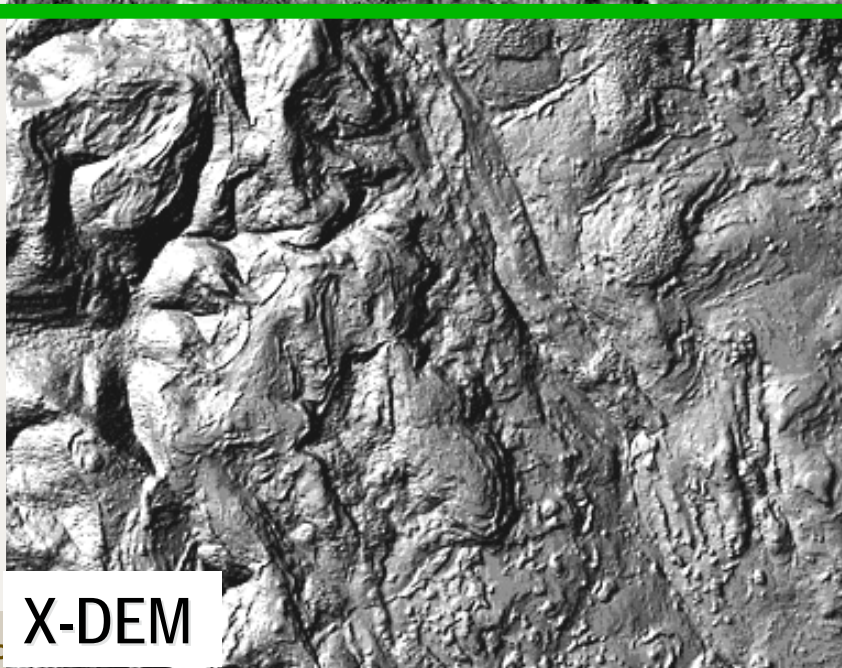
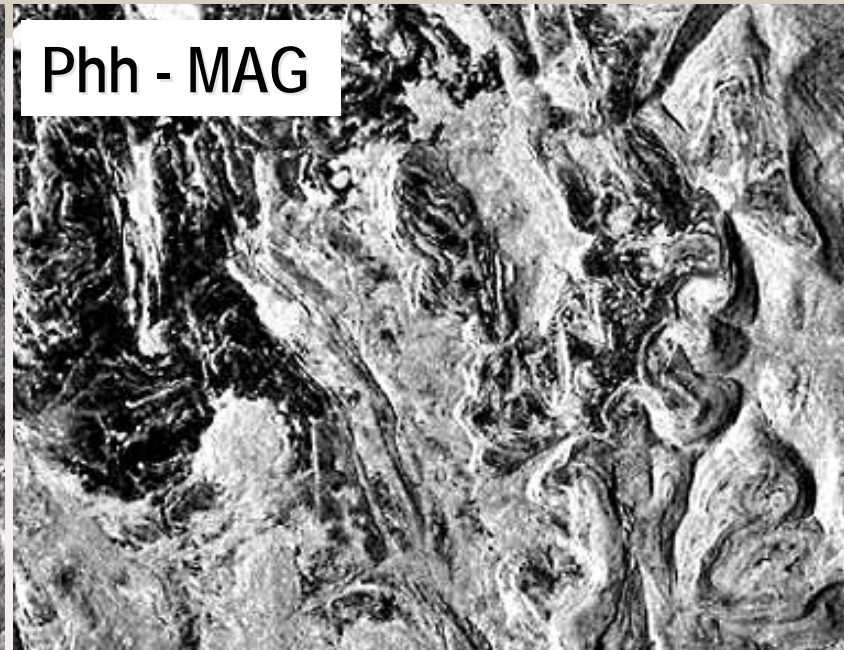


## Colombia, Revealing Terrain Under Forest Canopy

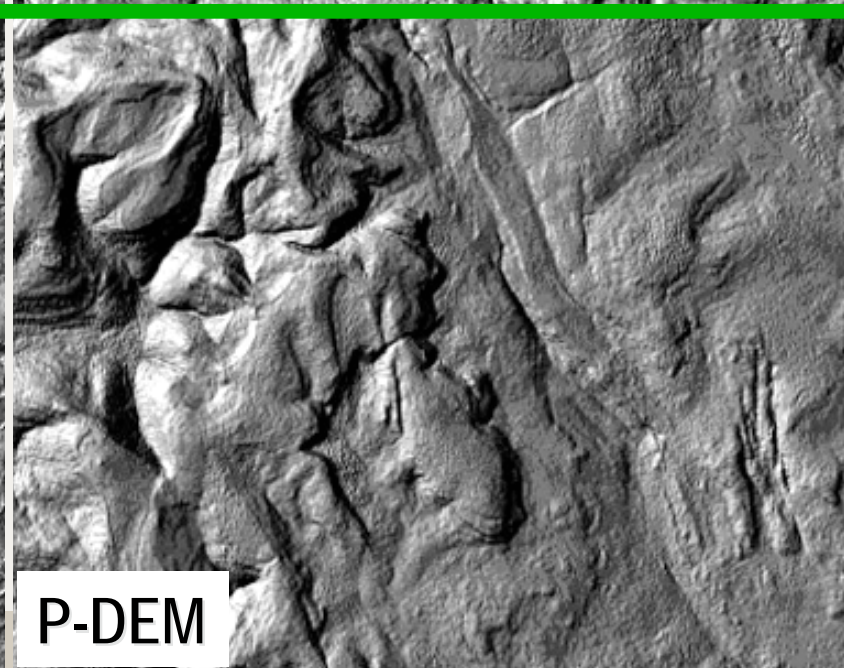
Xvv - MAG



Phh - MAG



X-DEM

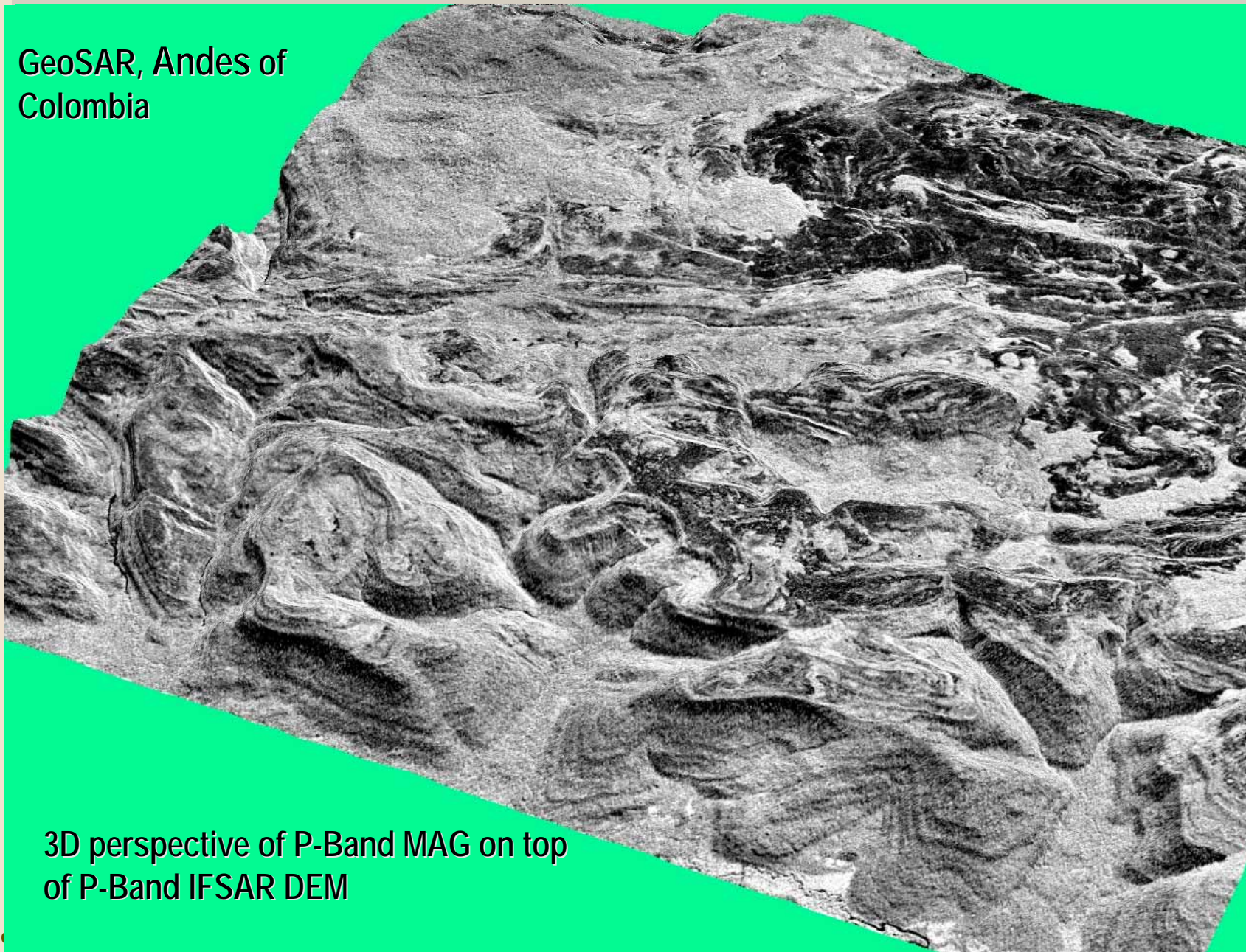


P-DEM



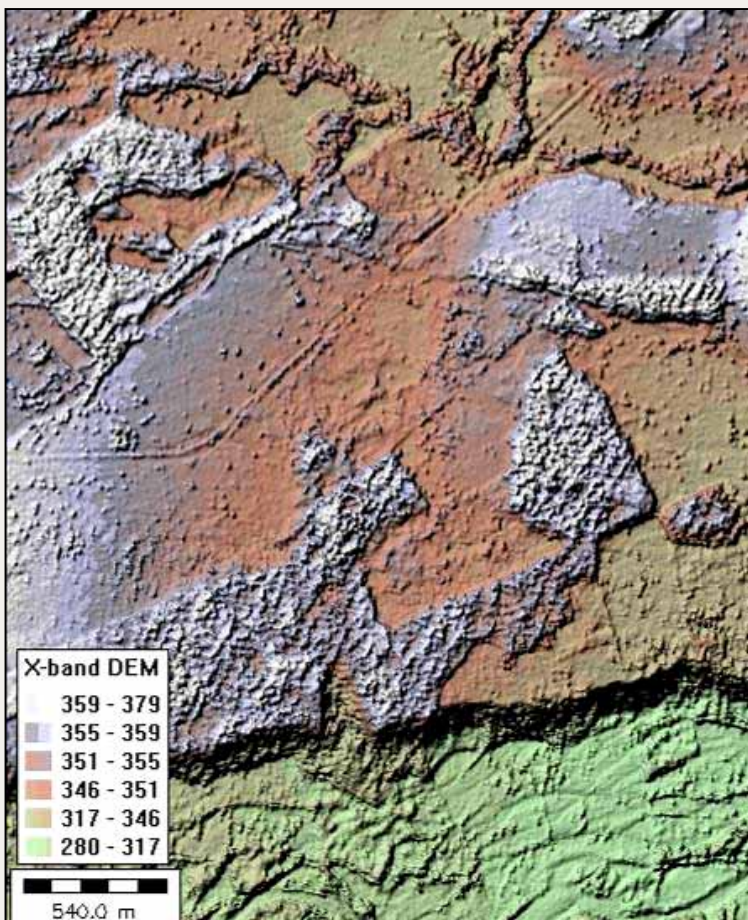
## Reveling Geologic Structure

GeoSAR, Andes of  
Colombia

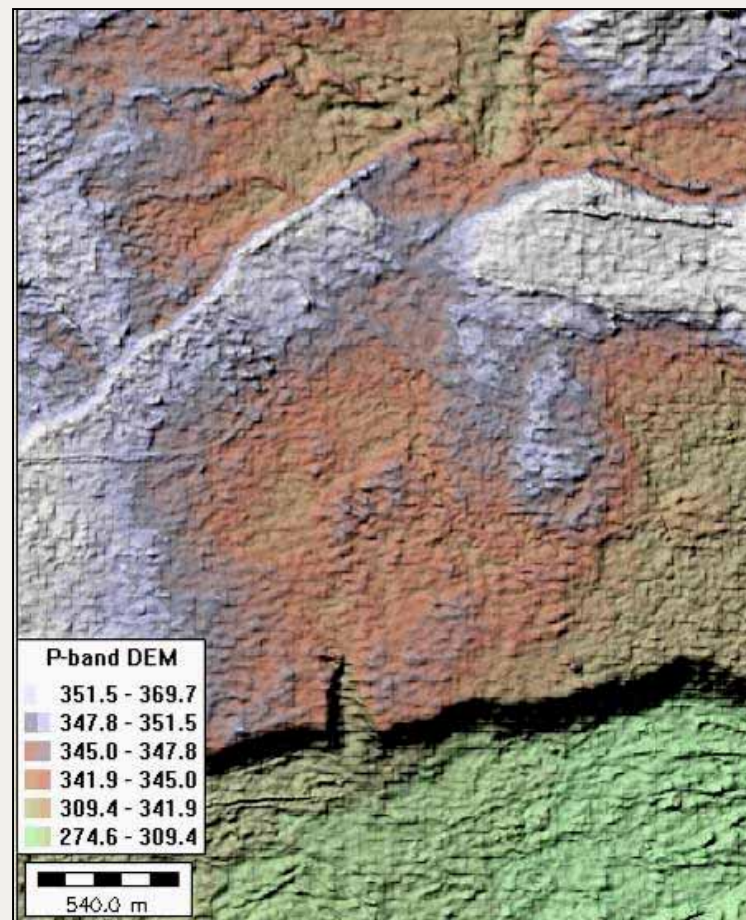


3D perspective of P-Band MAG on top  
of P-Band IFSAR DEM

# Colombia, Separating Forest from Terrain



**Comparison of X  
and P band DEM**

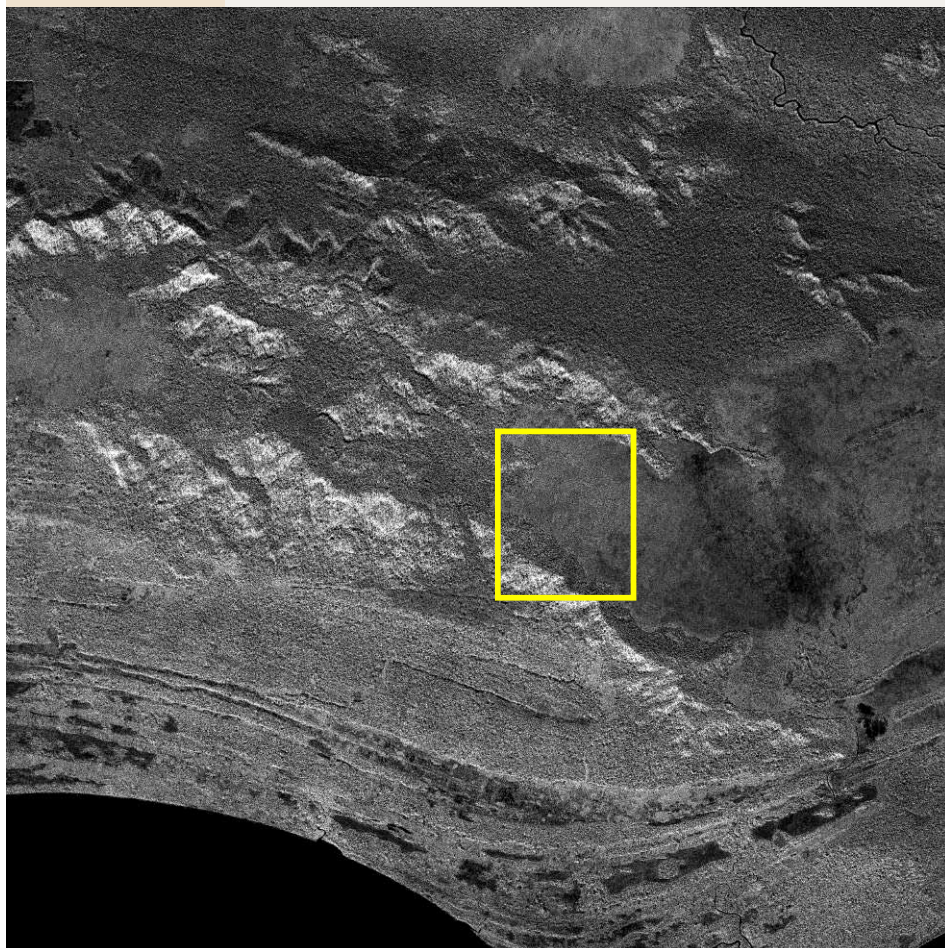


**Foliage surfaces disappear  
in P-band DEM**

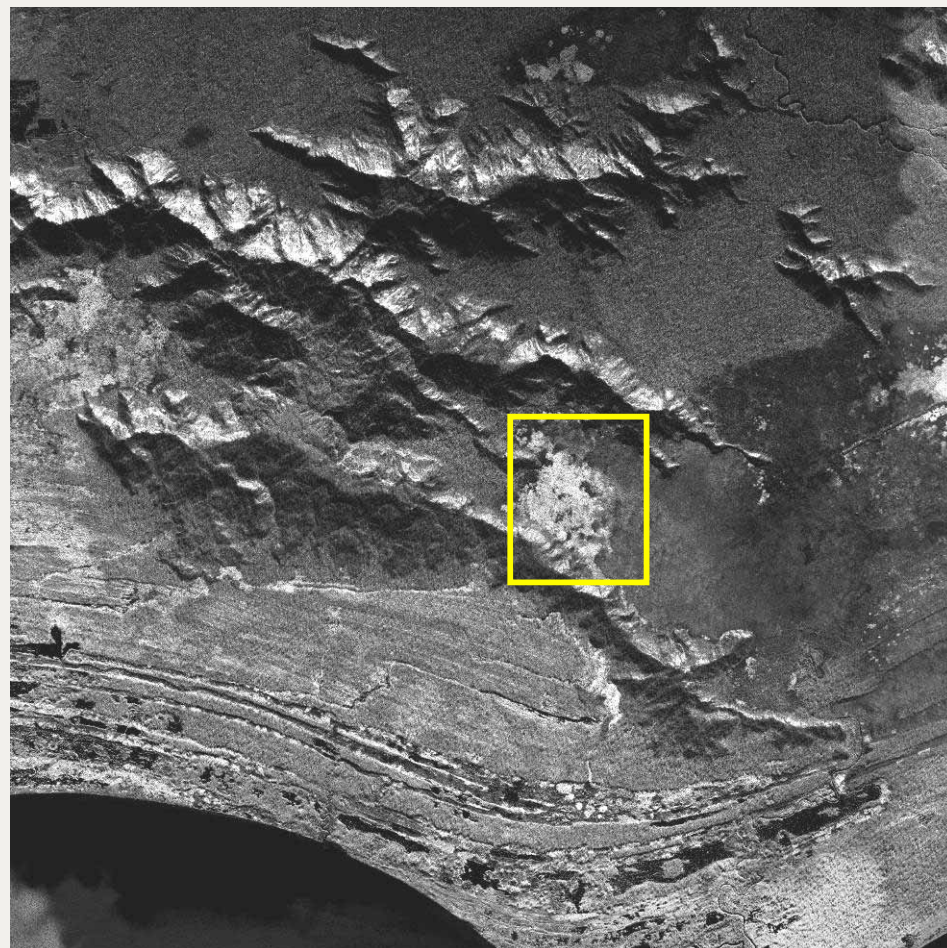




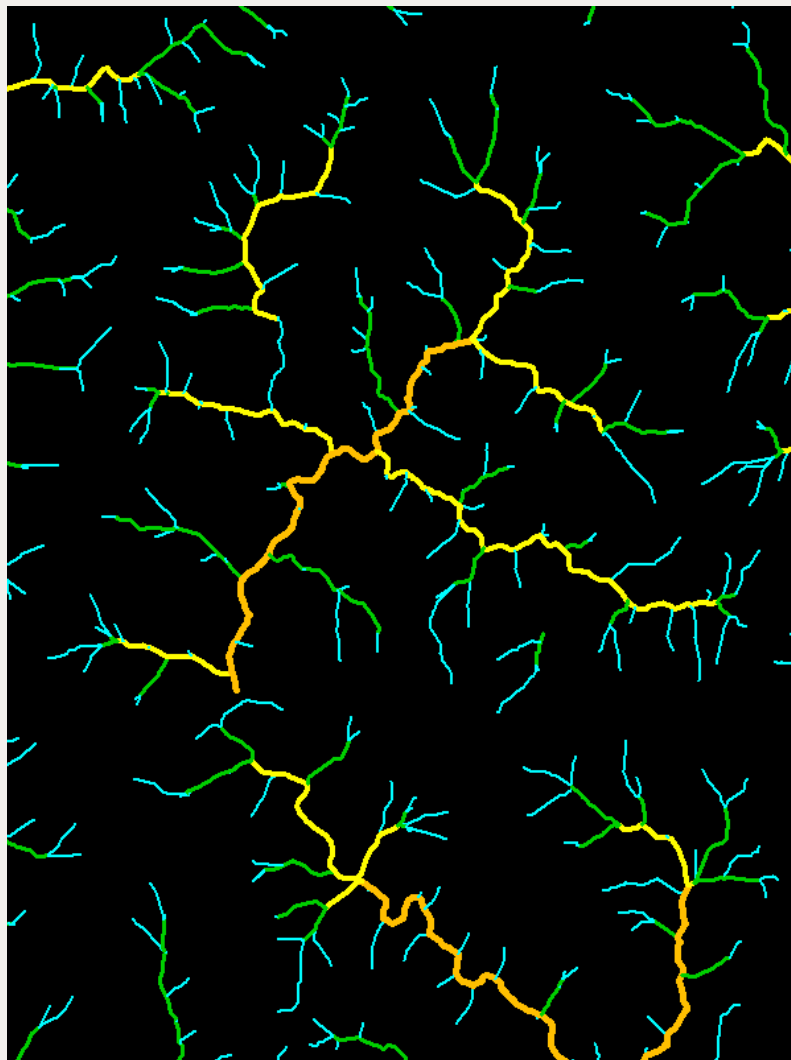
## Flooded wetlands below canopy



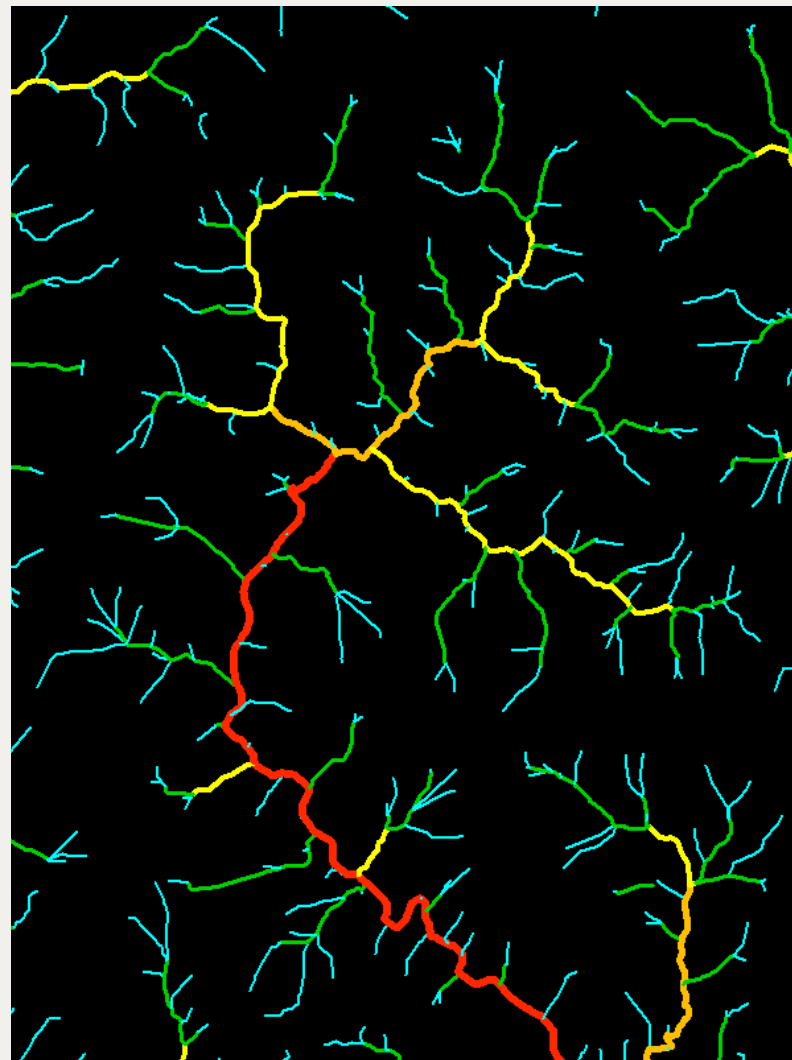
X-band MAG



P-band MAG



X-DEM drainage, Strahler Orders 3-6



P-DEM drainage, Strahler Orders 3-7



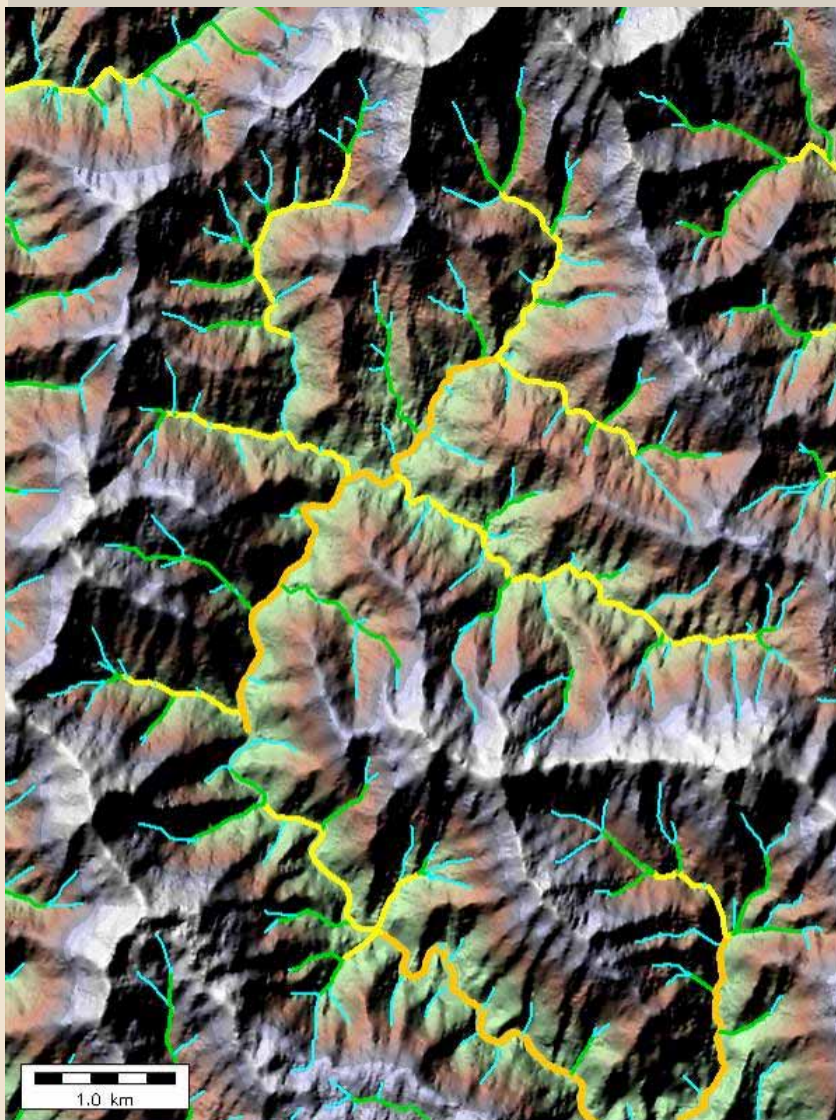
X-band Strahler Drainage Orders 4-6



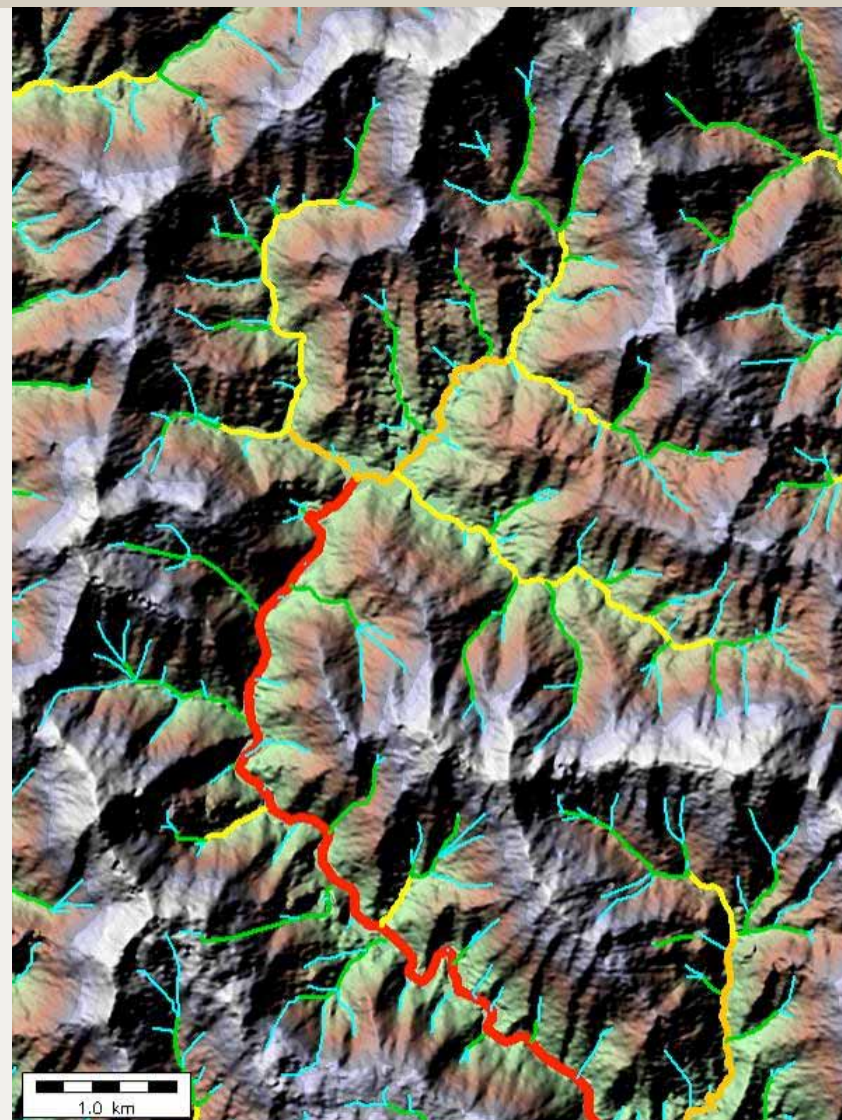
P- band Strahler Basin Orders 1-4



# Superimposing drainage over terrain models



X – Strahler Orders 3-6

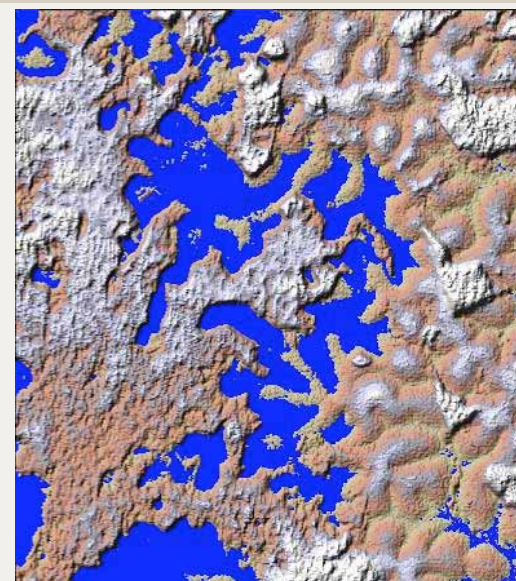
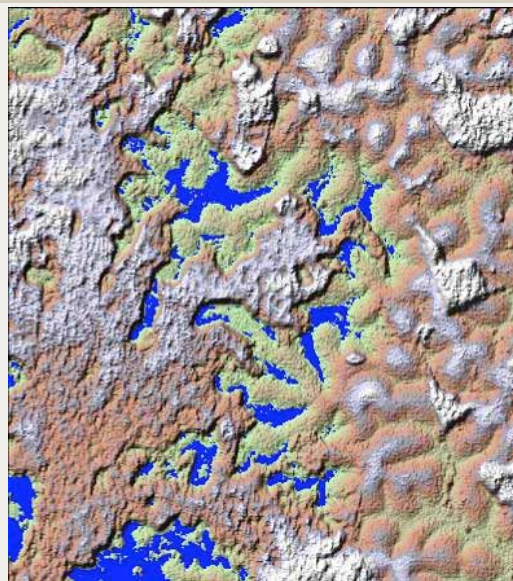
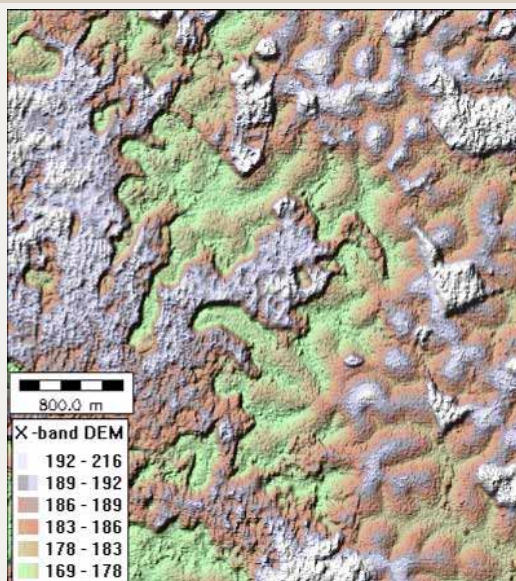


P- Strahler Orders 3-7

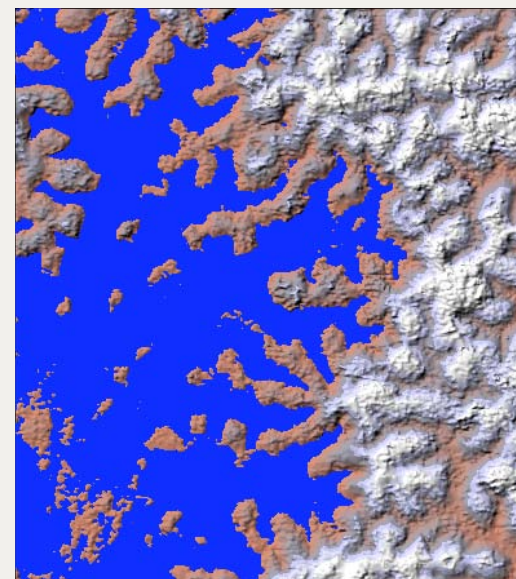
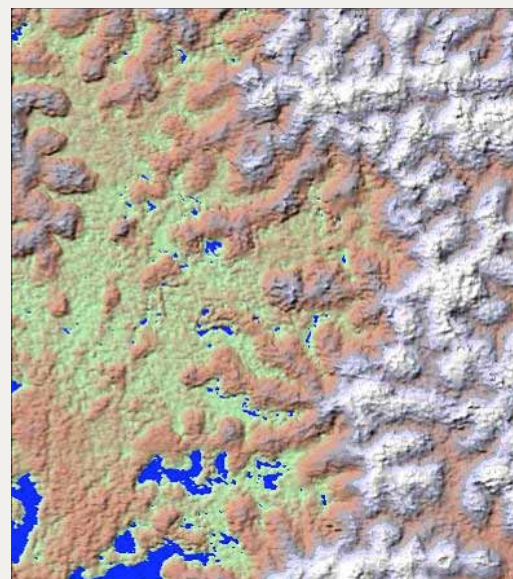
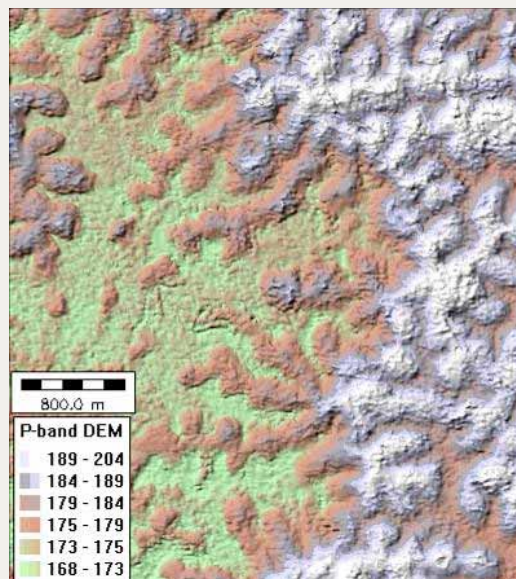


# Flood modelling from IFSAR DEMs

X



P



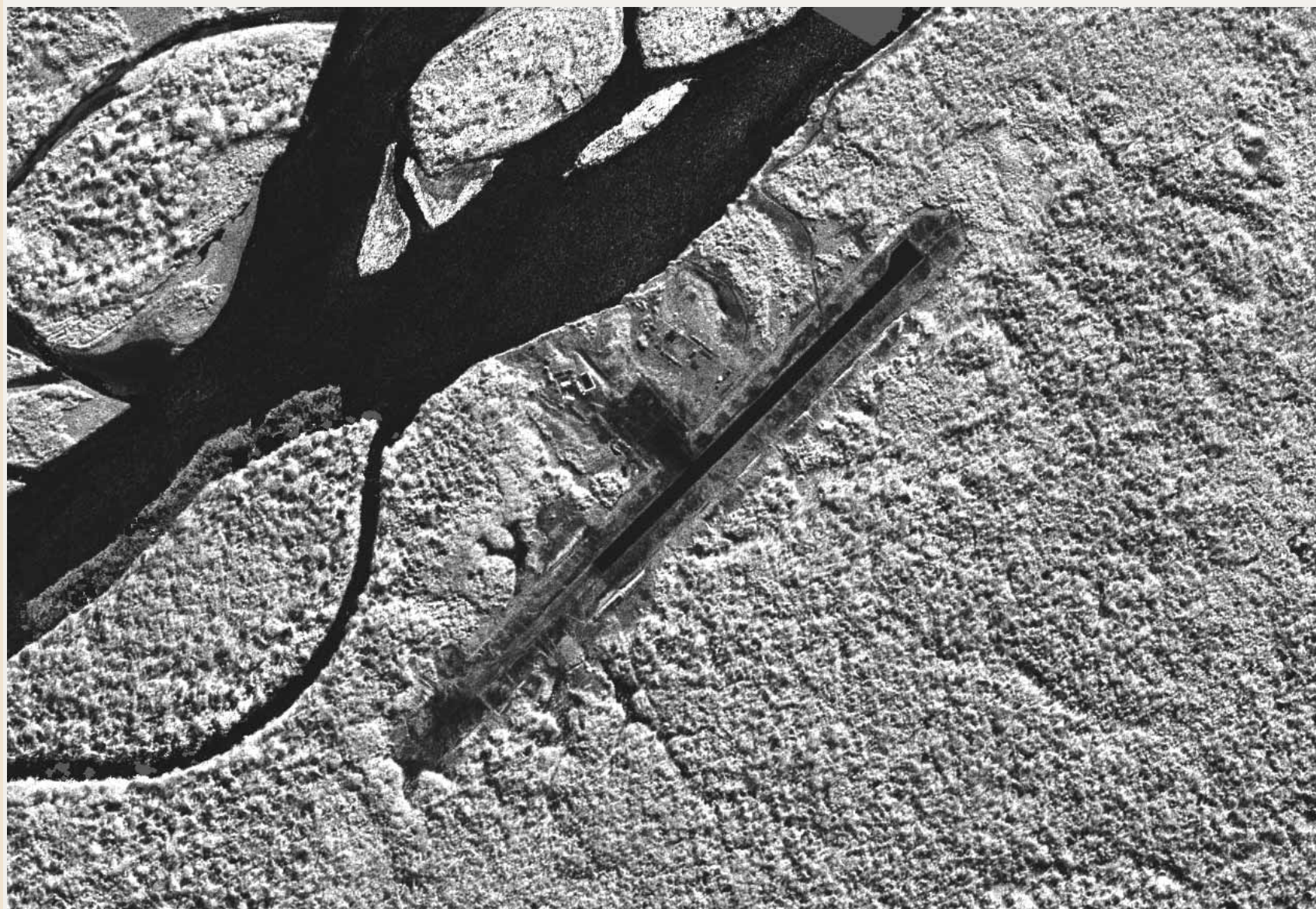
Shaded relief

5m flood

10m flood



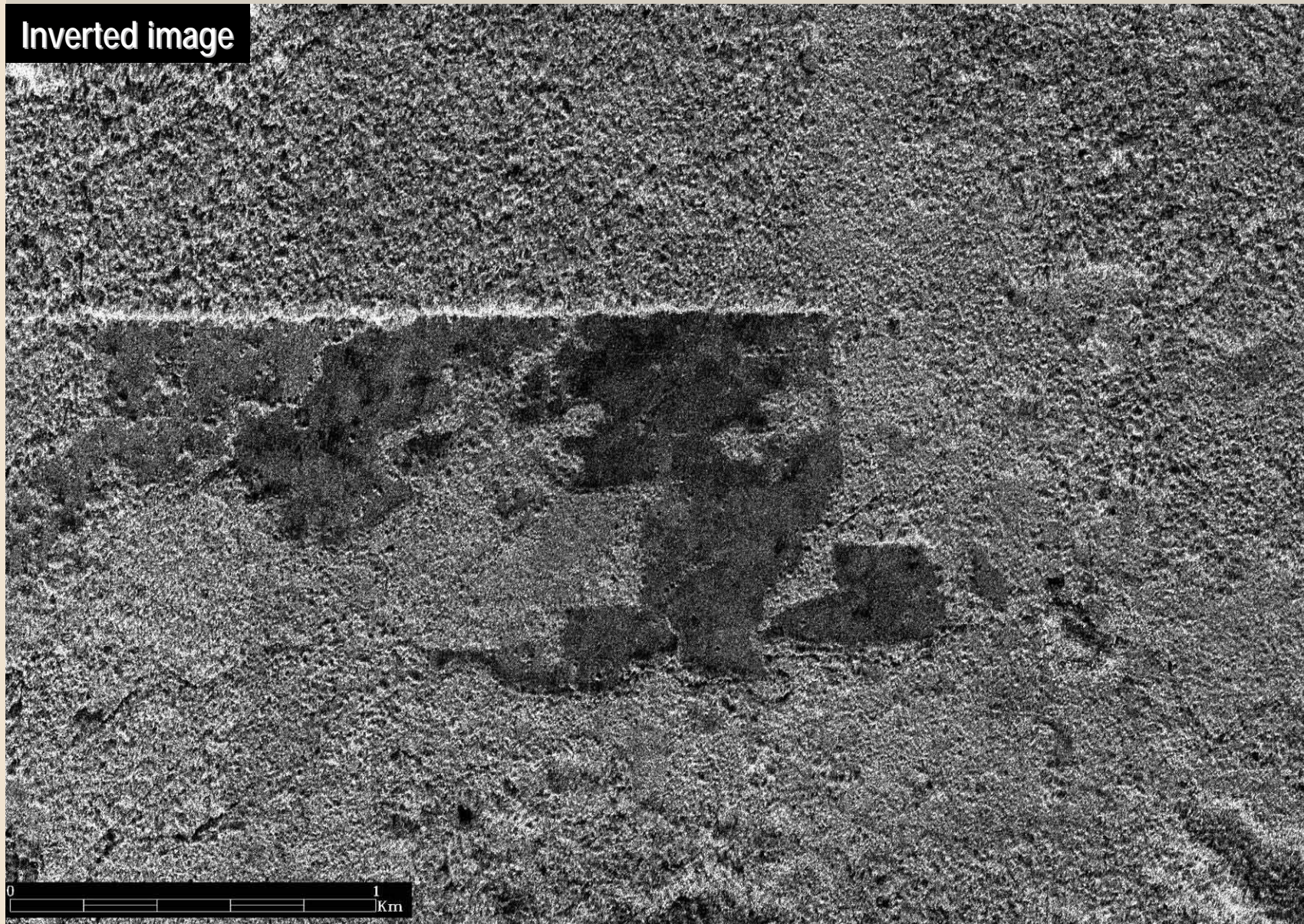
## Standard X-band (3m), Colombia, 2006





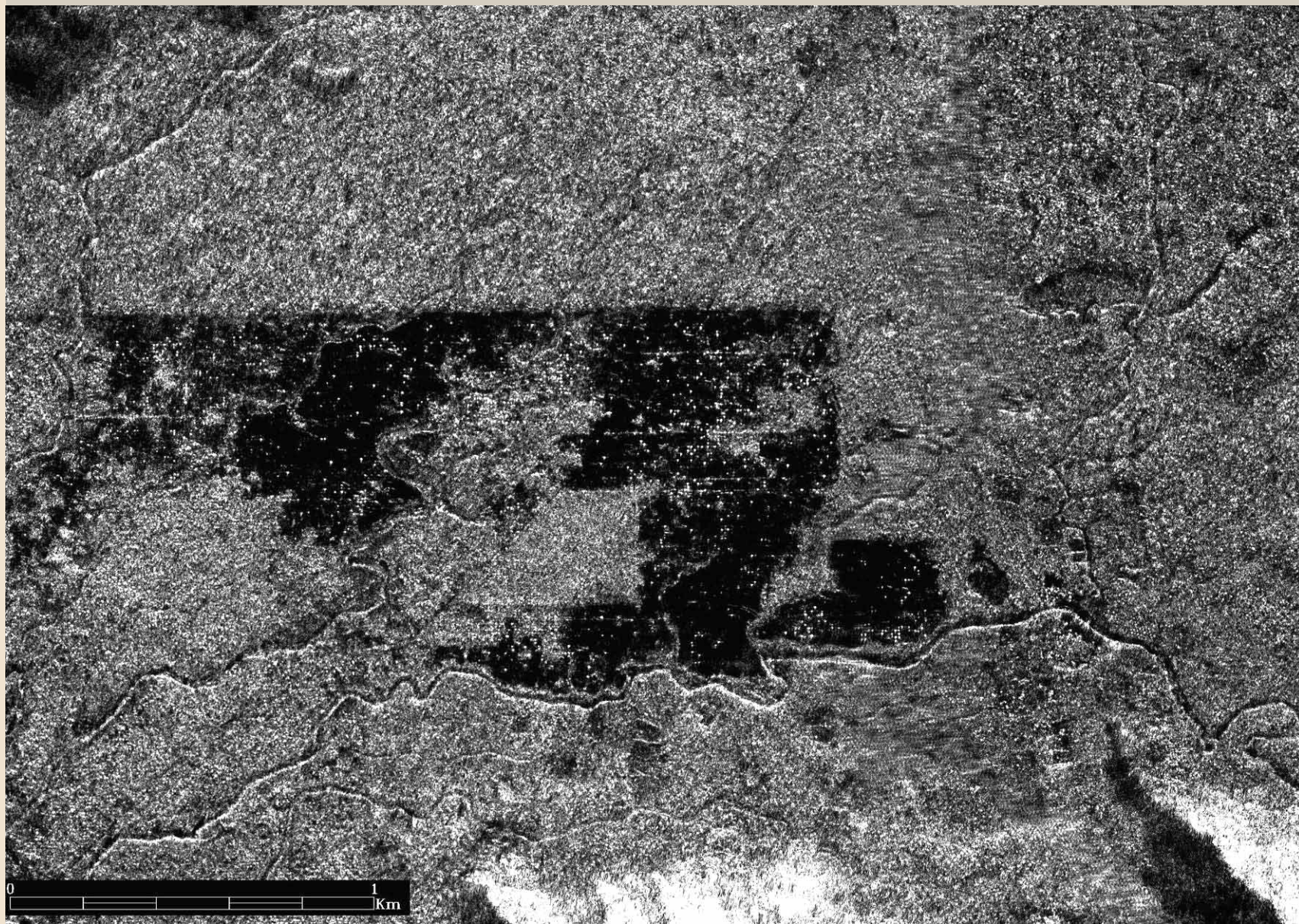
## Identification of subtle drainage channels "hidden" by tall forest

Inverted image



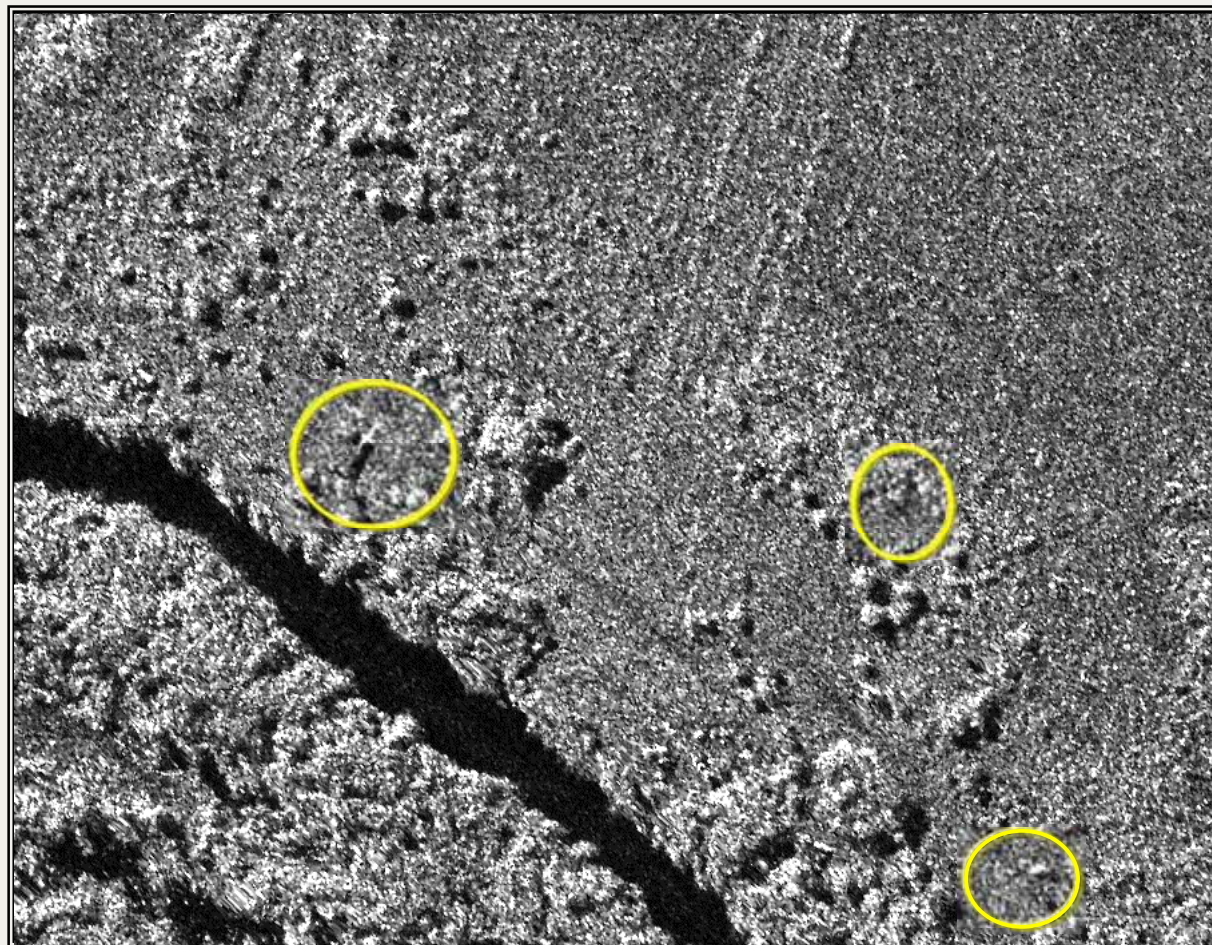


## Identification of subtle drainage channels "hidden" by tall forest





## Comparing X and P Bands

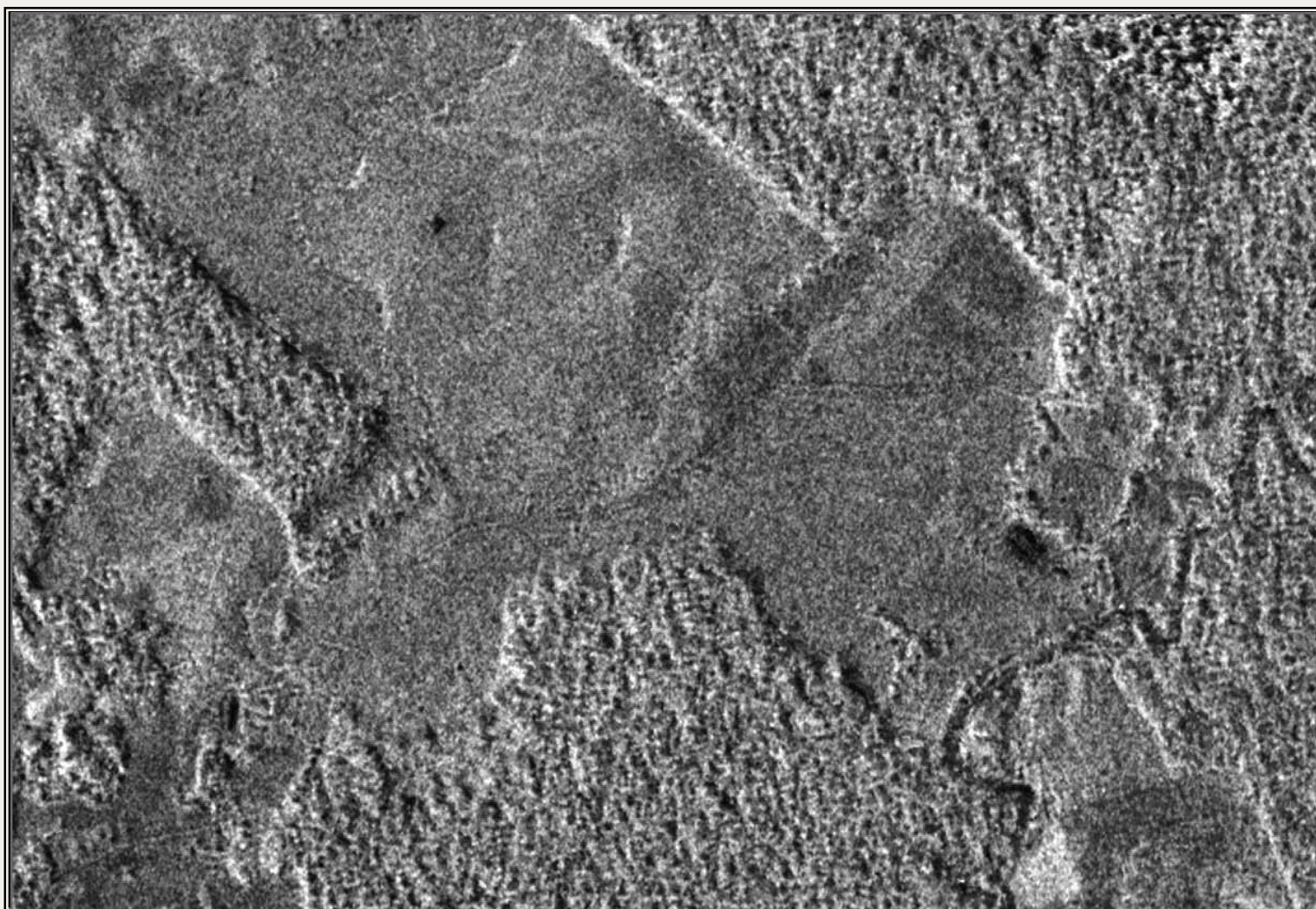


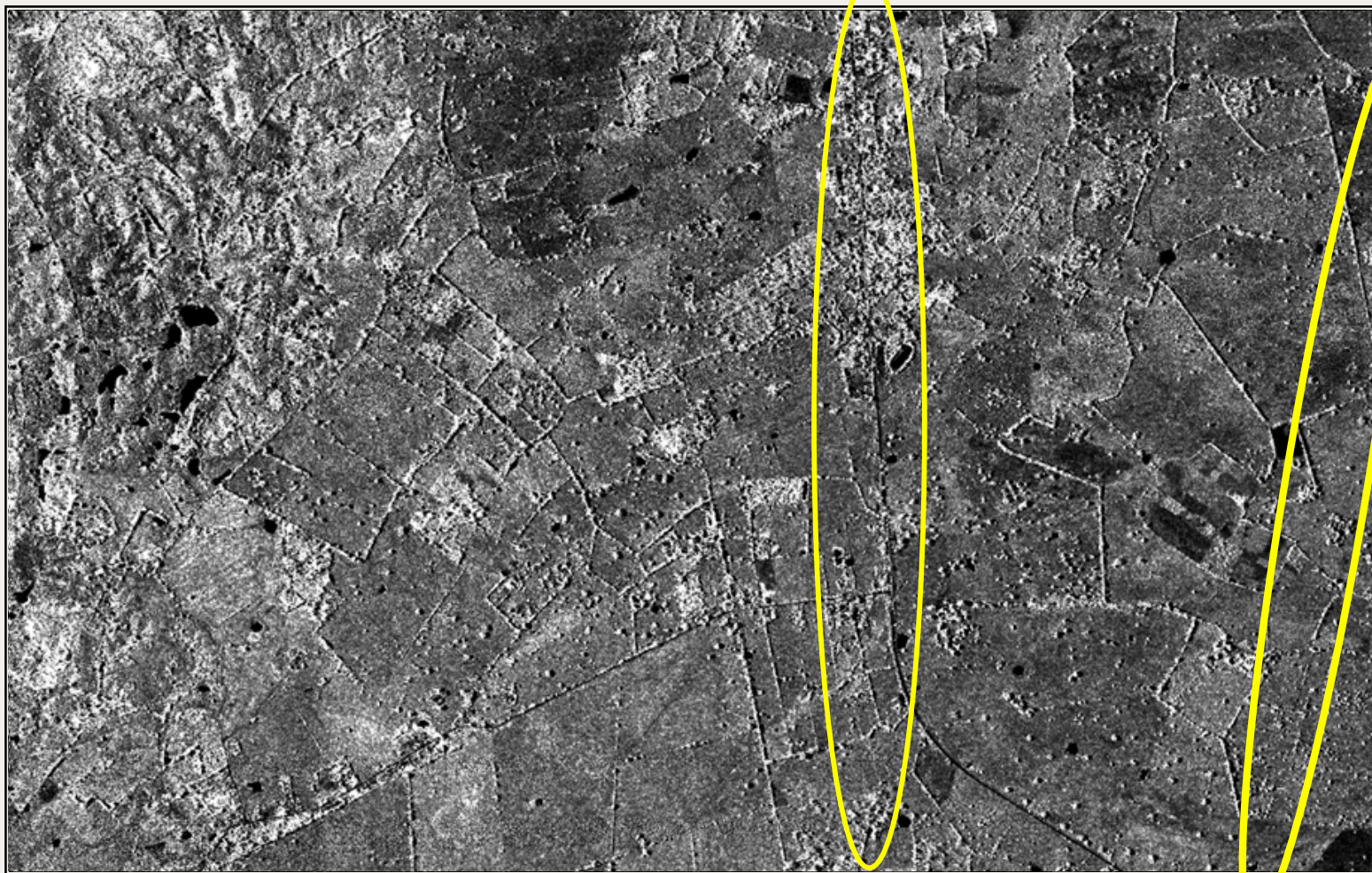
X-band image



## Detecting structures below dense vegetation

### Comparing X and P Bands

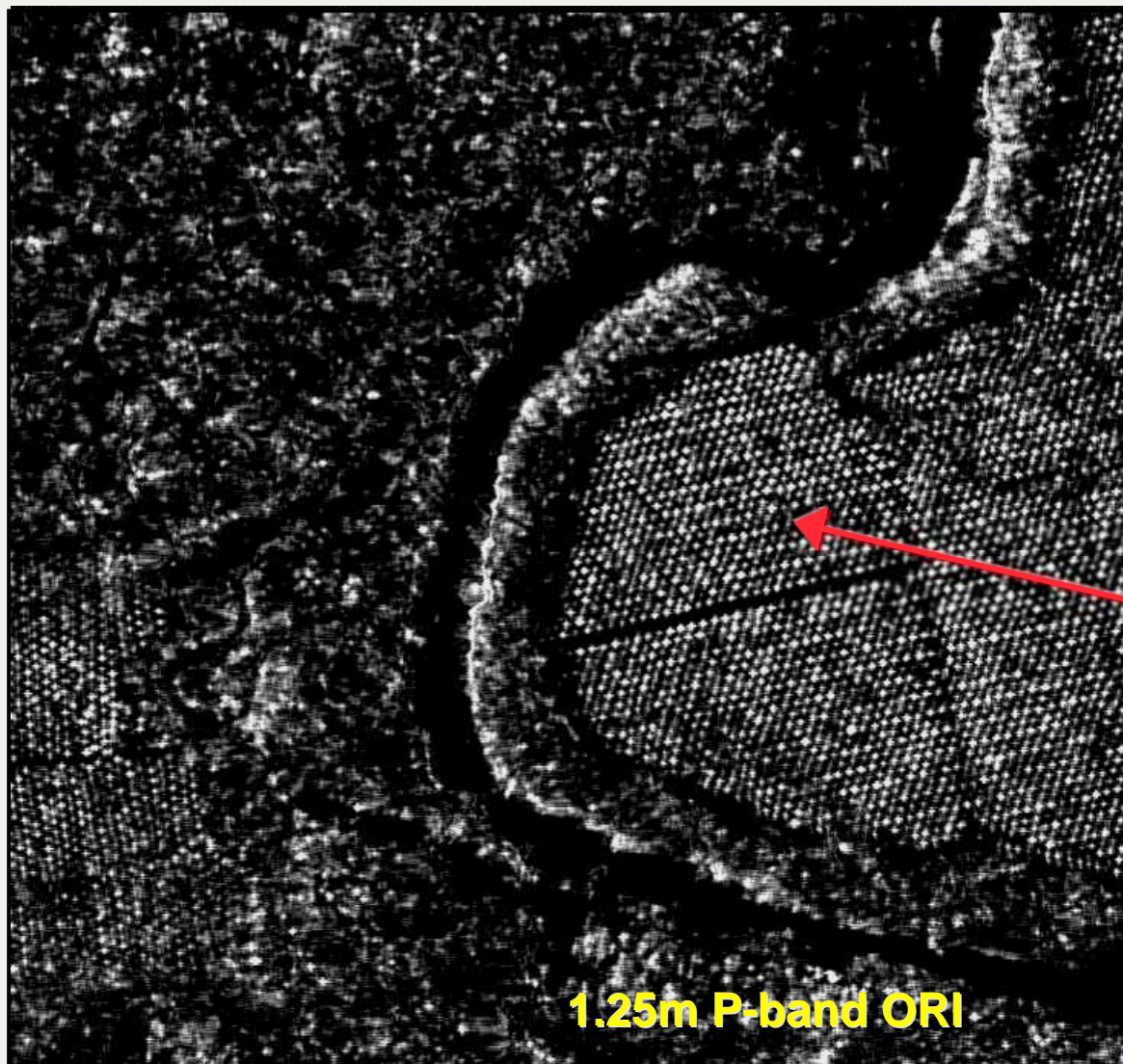




**Fence lines, trails, Power lines, and disturbed soils show up in the P-band**



## X- and P-band Radar Images, Papua New Guinea

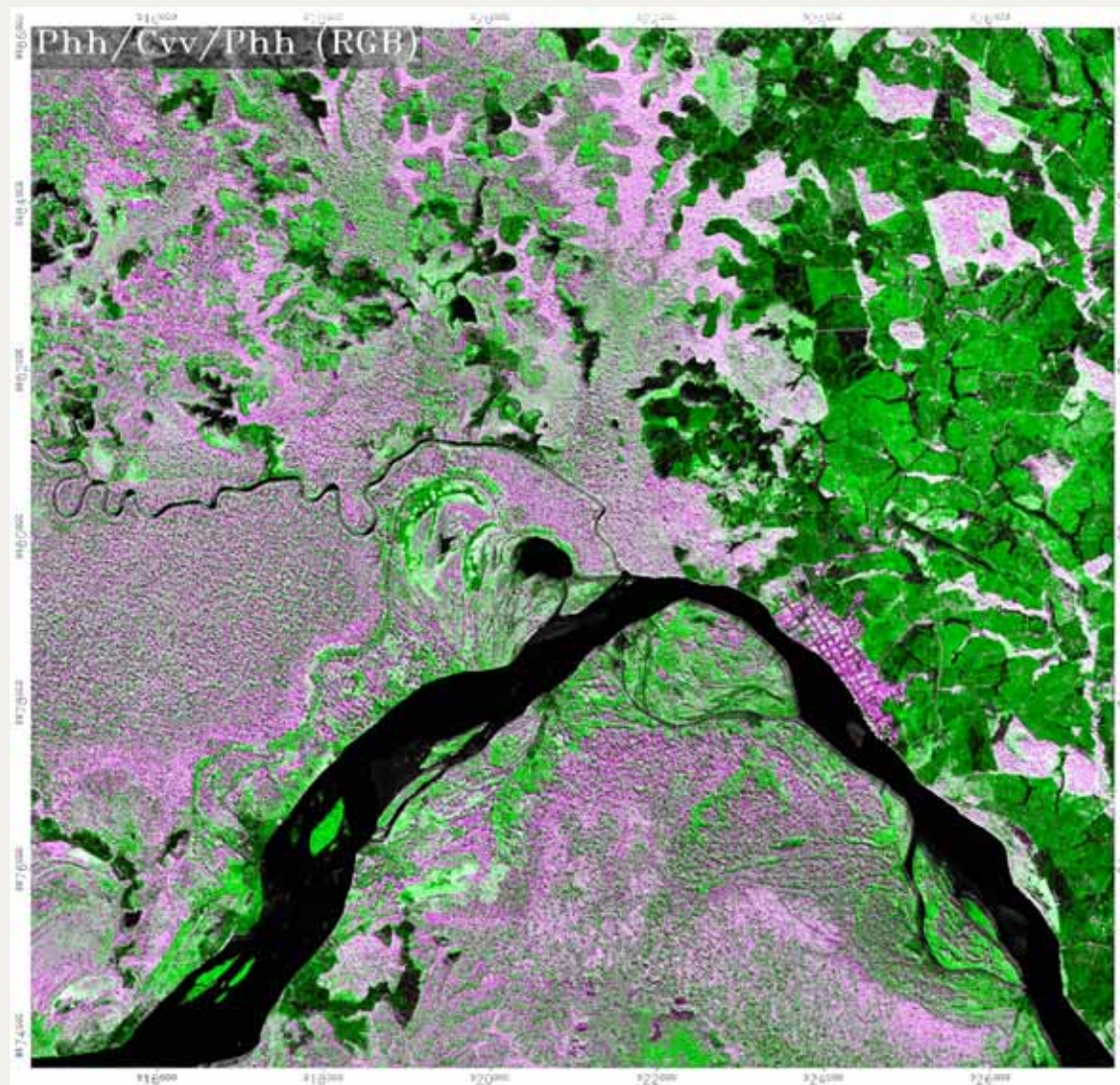


Palm orchards and trails, irrigation patters, drainages exposed in P-band. Capable of counting trees in orchards

1.25m P-band ORI



## Colombia, 2006 – Adding Color



Radar colored  
though image  
processing of band  
combinations

P, X, P

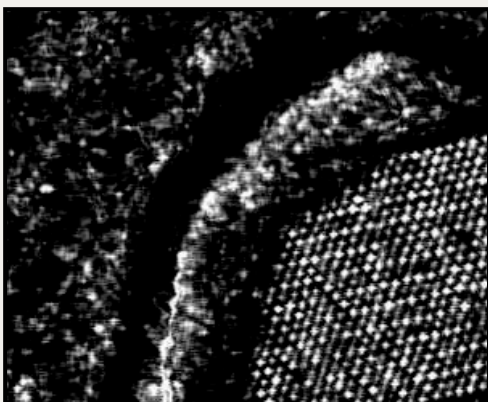
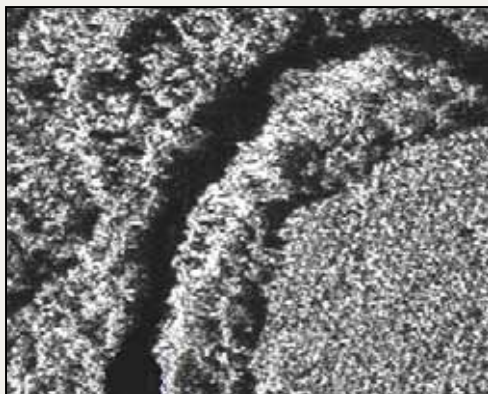


# Colombia, 2006 - Radar bands **R** = P, **G** = X, **B** = P-X





# Turning Spatial Data Into Knowledge



**Thank you!**

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**Cell: (240) 215 - 7996**

