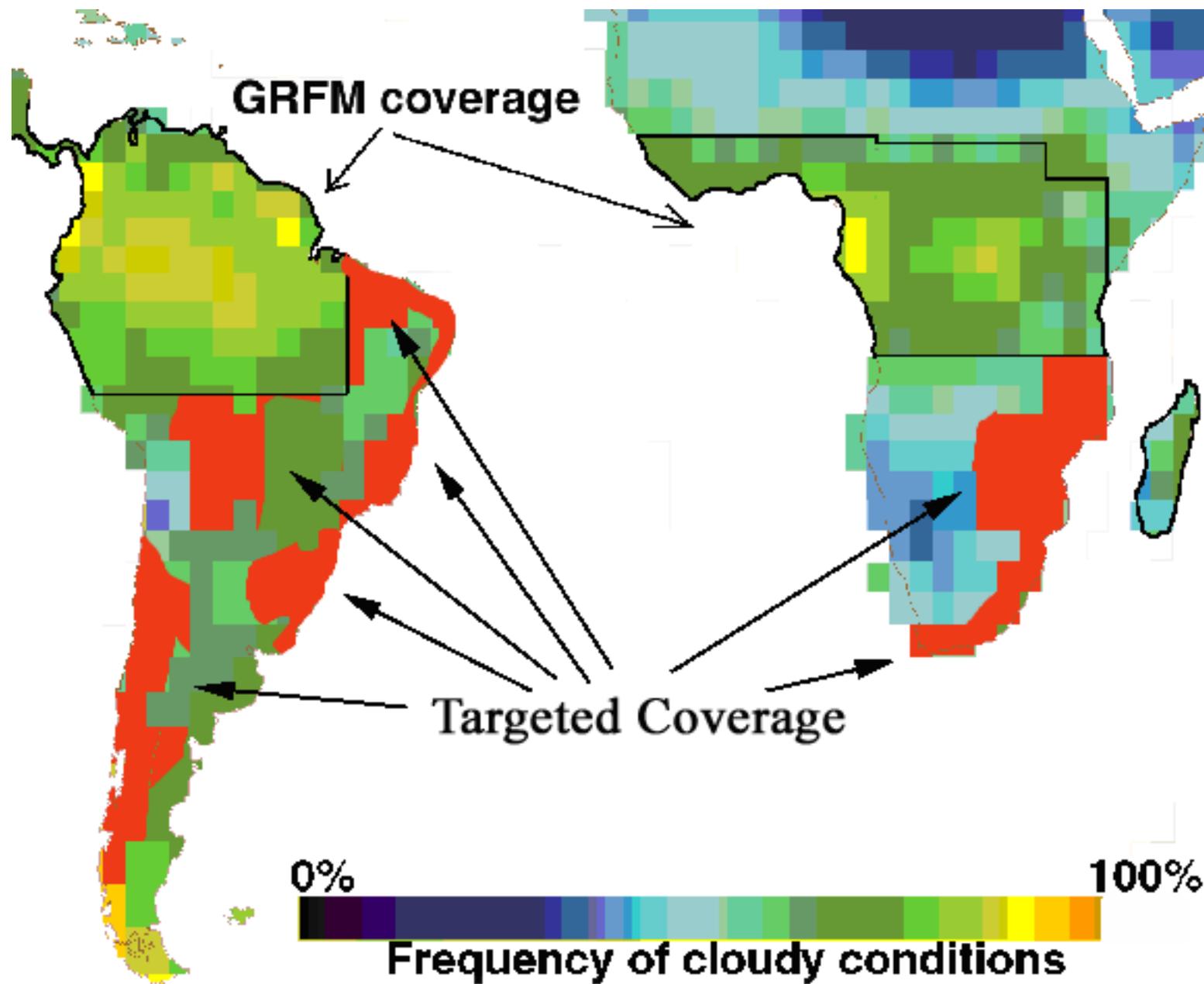


The Development of a Fine Resolution Continental Scale Forest Monitoring System using SAR Imagery

- PI Bruce Chapman, JPL
- Co-I Sasan Saatchi, JPL

Objectives of the Research

- Develop continental scale forest monitoring techniques using high resolution SAR
 - Using JERS-1 SAR data from the 90s
- Demonstrate the use of SAR imagery for filling gaps in optical coverage
- Process imagery over forested areas in Africa and South America (outside GRFM coverage area) for 90s era estimate of forest cover by SAR in these regions



Objectives of the Research

- Motivation :
 - NASDA ALOS satellite will carry a high resolution, polarimetric **L-band** SAR
 - Launch in 2004
 - ALOS Kyoto and Carbon initiative will image continental scale regions **at least twice per year at full resolution**
 - Co-pol and **Cross-pol** data, plus quad pol experimental mode
 - ScanSAR coverage of large regions **every 46 days**

Objectives of the Research

- Relevance to NASA ESE science questions
 - How is the global Earth system changing?
(Variability)
 - How are global ecosystems changing?
 - How does the Earth system respond to natural and human-induced changes? (Response)
 - How do ecosystems respond to and affect global environmental change and the carbon cycle?

Research Approach/Method

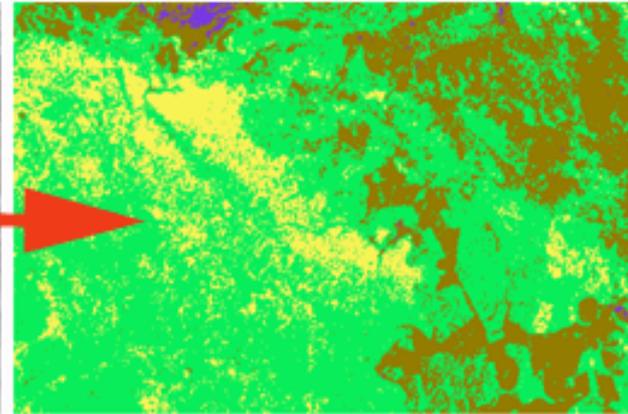
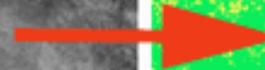
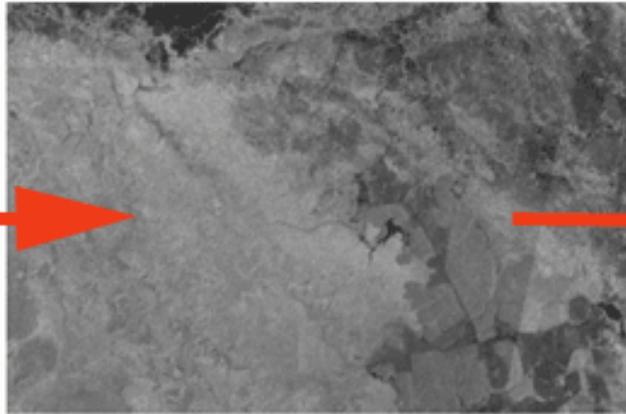
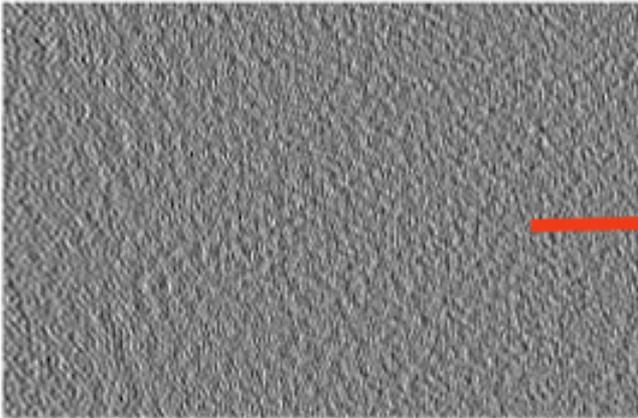
- Data processing issues
 - Evaluation of commercial software
 - Calibration
 - By evaluation of overlap areas
 - Mosaicking
 - Automatic – no hand tie-pointing
 - Classification

Processing

Chirp + doppler

SAR compression

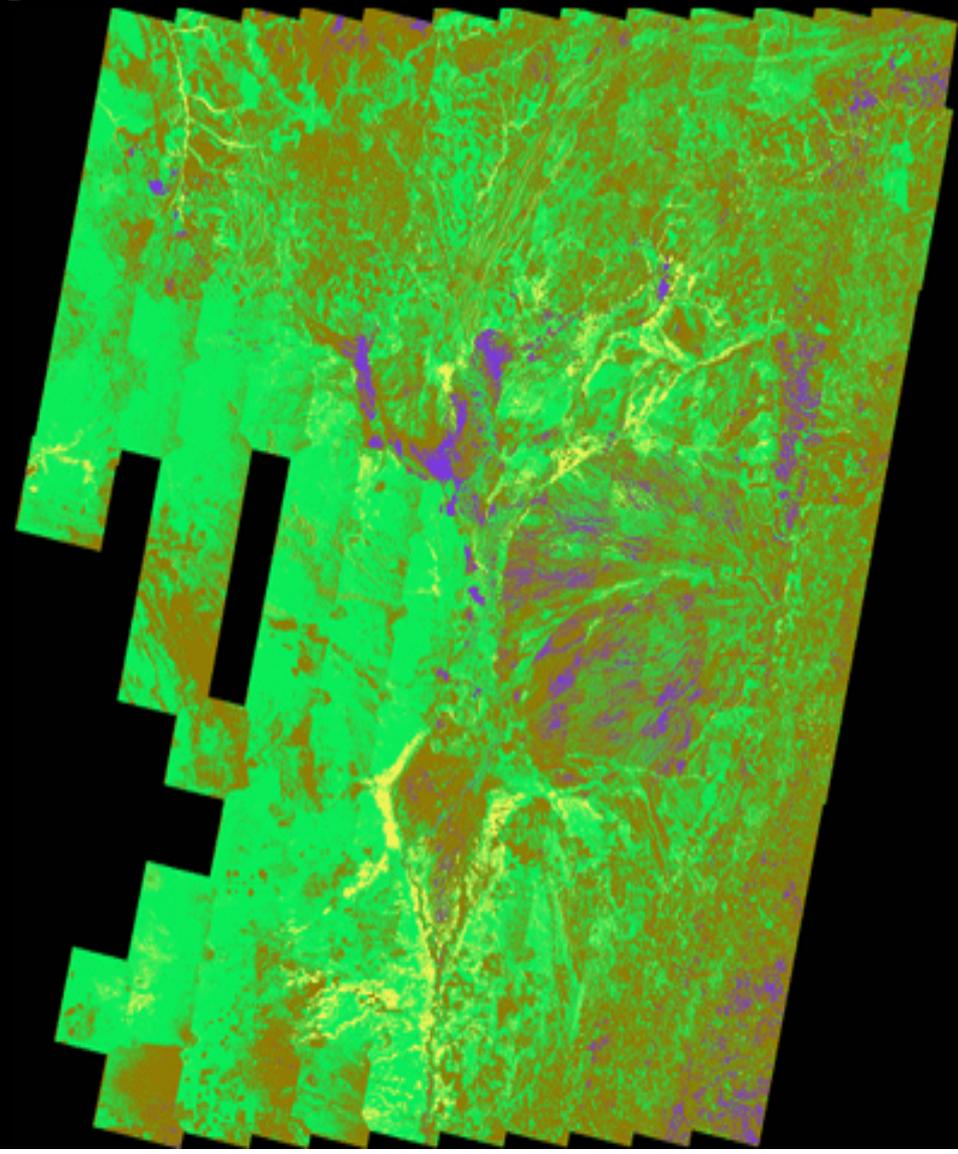
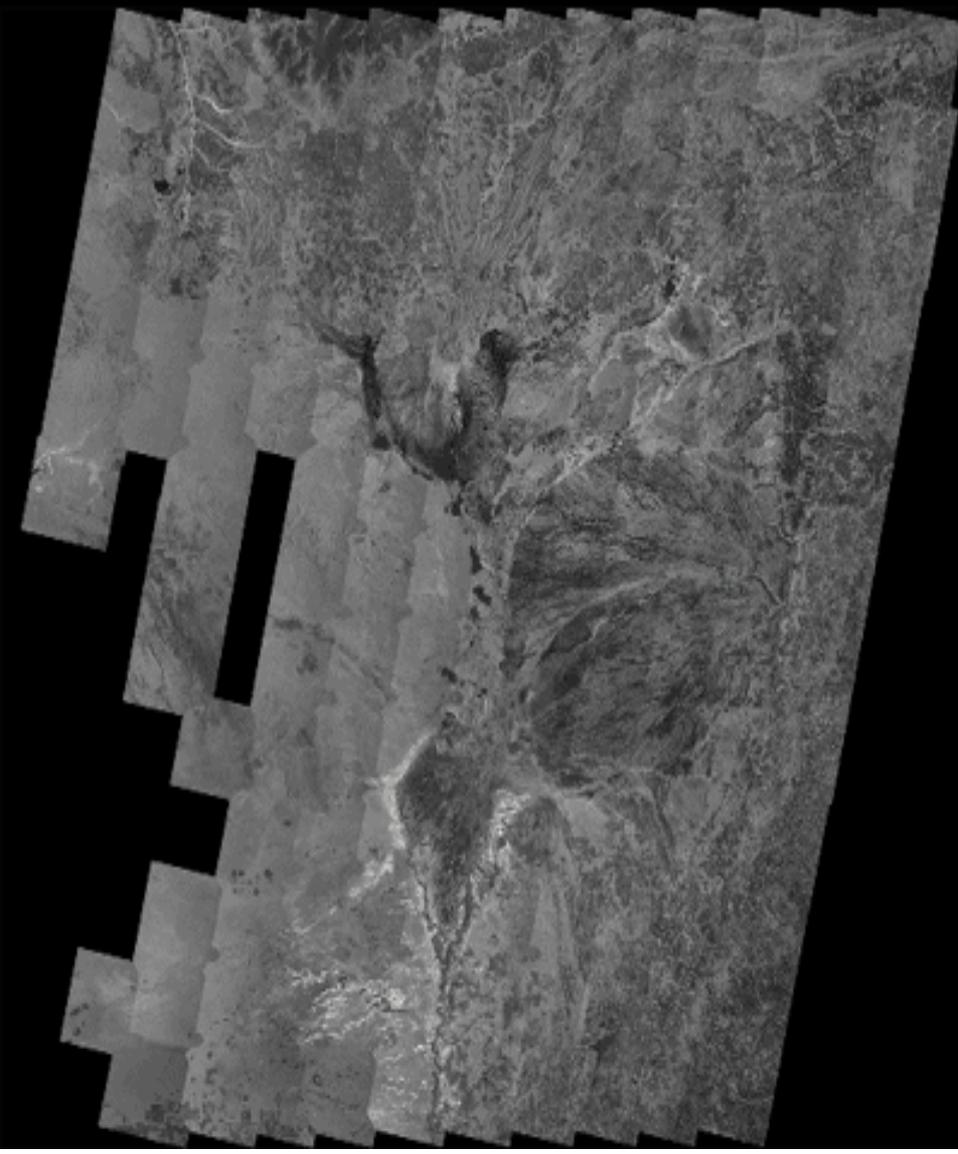
Classification



- Observations independent of cloud cover
- Complementary with optical sensors (gap filling) – especially when using mosaicked imagery
- L-band SAR most sensitive to flooding and forest structure
- Large regional areas may be mapped during a short period (max: 1 orbit cycle)
 - Seasonal changes may be observed

Pantanal

February 1997



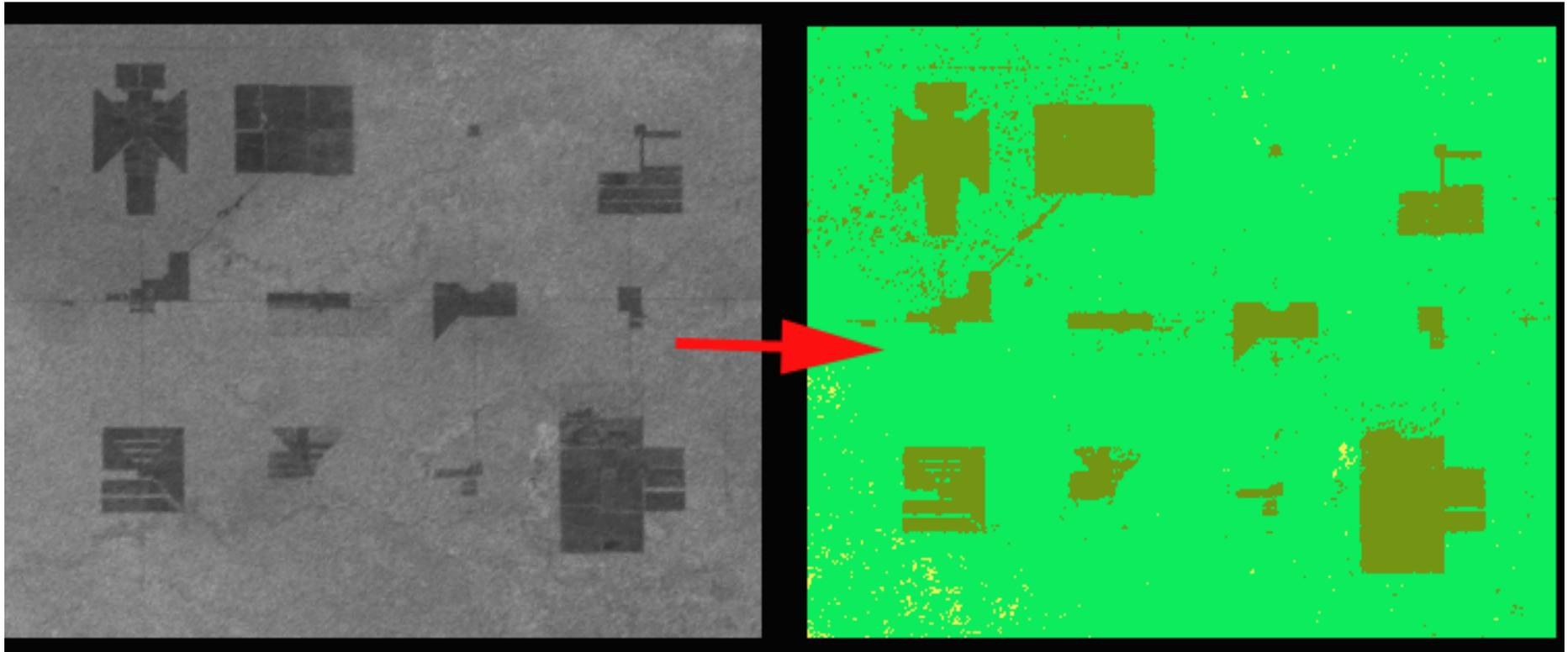
Classification

- Three approaches are being investigated
 - 1) Dominant scattering mechanism of active microwave radiation
 - 2) Change in dominant scattering mechanism
 - Requires at least two acquisitions
 - 3) Sensitivity to moisture and other more subtle effects

Classification

- 1) Dominant scattering mechanism of active microwave radiation
 - Estimation from single channel data based solely on broad backscatter thresholds
 - Technique is well known for polarimetric data
 - Diffuse scattering generally from forest canopies
 - Specular scattering generally from low vegetation, bare soil, and water
 - Double bounce generally from flooded forests
 - Topography, moisture content, biomass, etc are additional separate factors
 - ALOS dual pol data will perform better

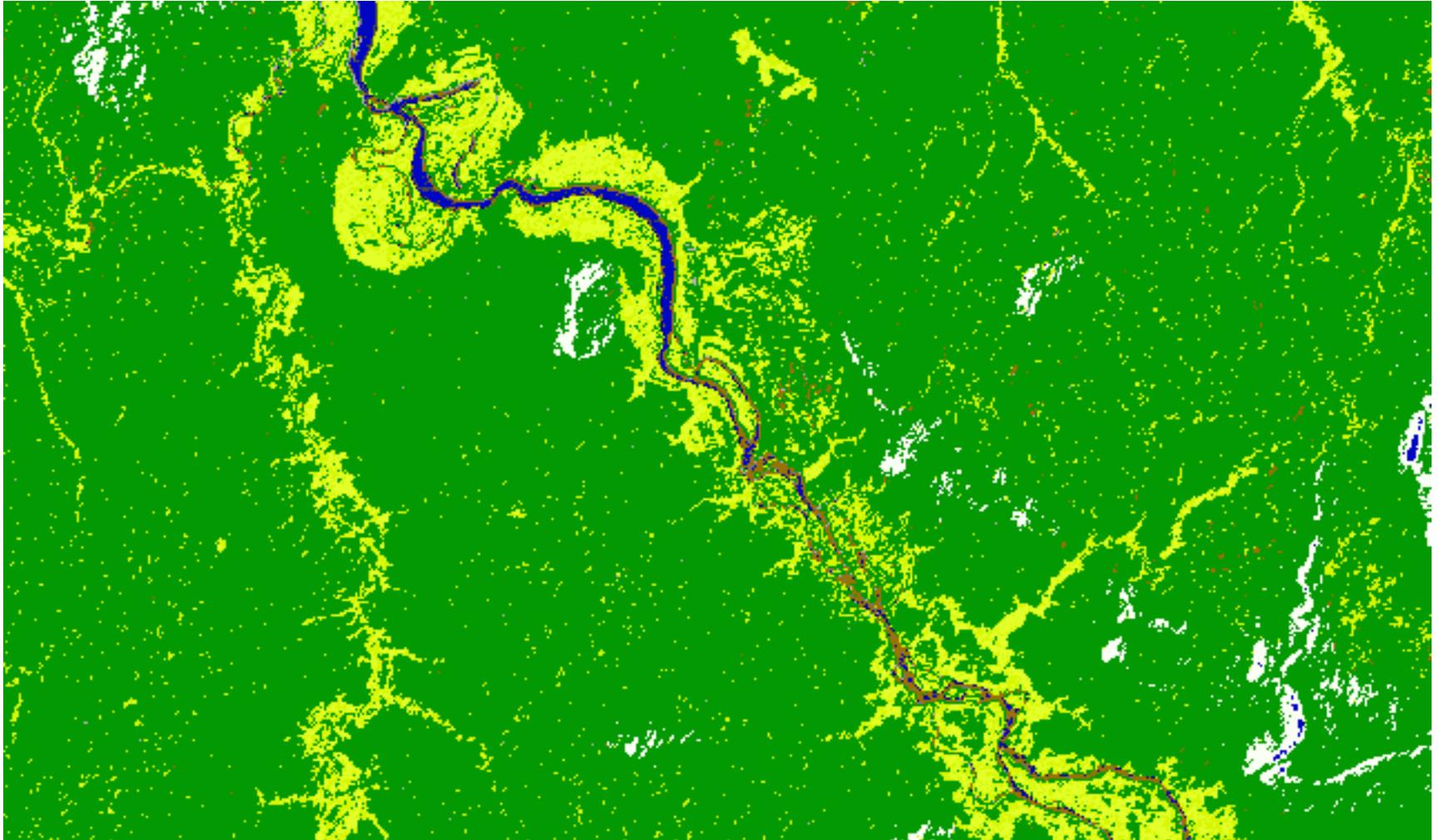
Classification



Classification

- 2) Change in dominant scattering mechanism
 - Diffuse to specular indicates change to forest canopy
 - Specular to diffuse indicates regrowth
 - Diffuse to double bounce indicates flooding
 - These changes in scattering mechanism result in large changes in radar backscatter
 - Calibration does not have to be perfect

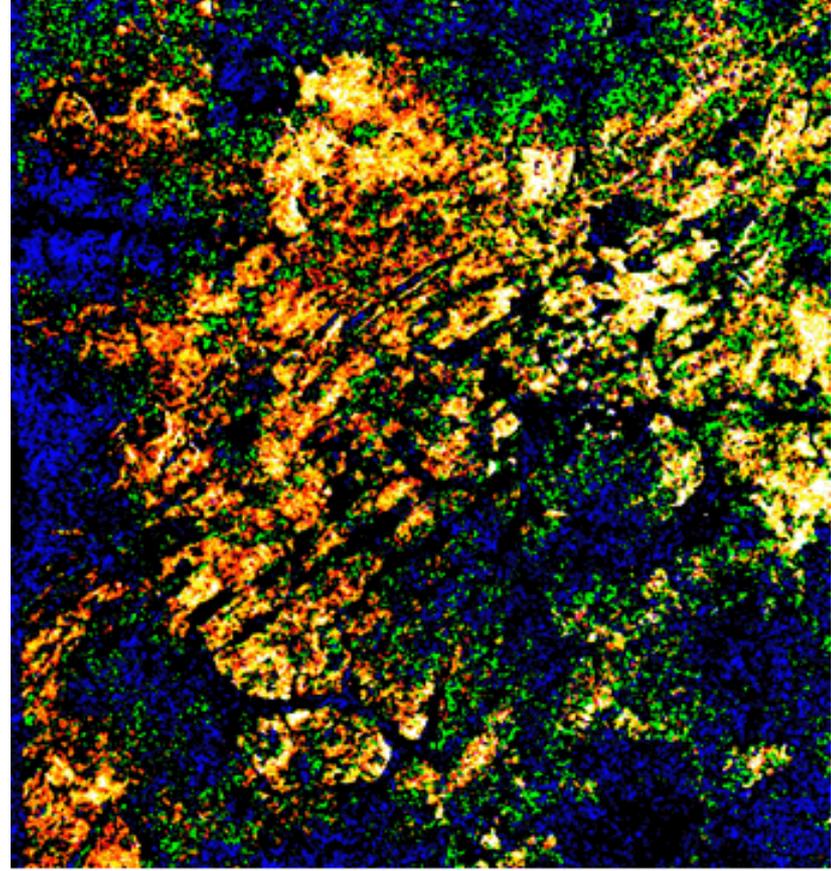
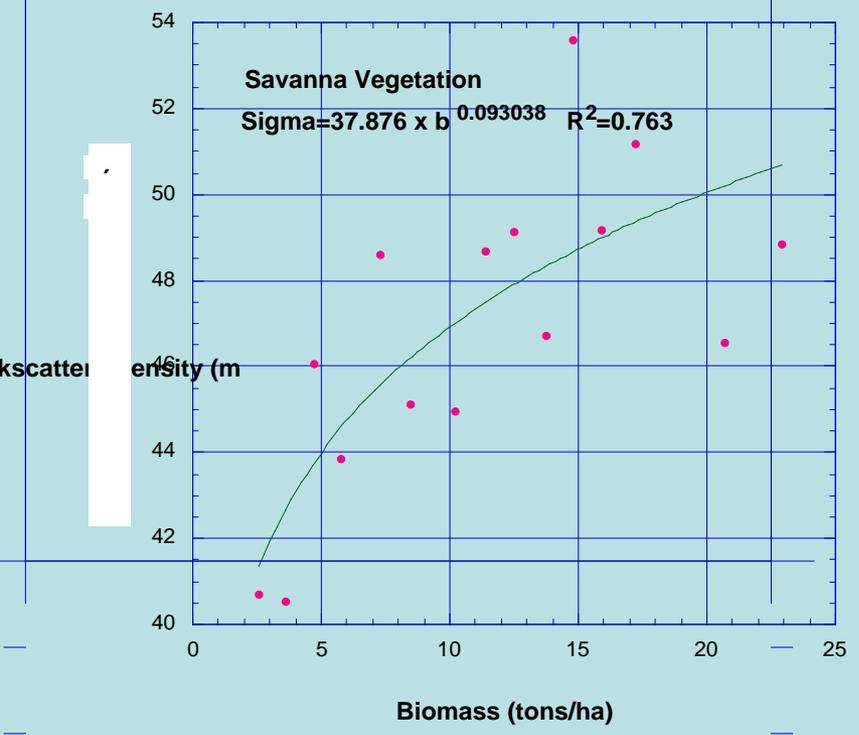
Flooding at Iwokrama



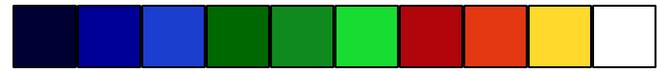
Classification

- 3) Moisture and other subtle effects
 - May require site specific knowledge for interpretation
 - May require more sophisticated algorithms
 - Change detection with multi-temporal series of data
 - ALOS dual pol data will perform better

Saatchi et al. 2000



JERS-1 Biomass Relation Developed Over Savanna Woodlands in South America



0.0 **1.0**

Above Ground Biomass Distribution Normalized to Scene Maximum Derived Biomass

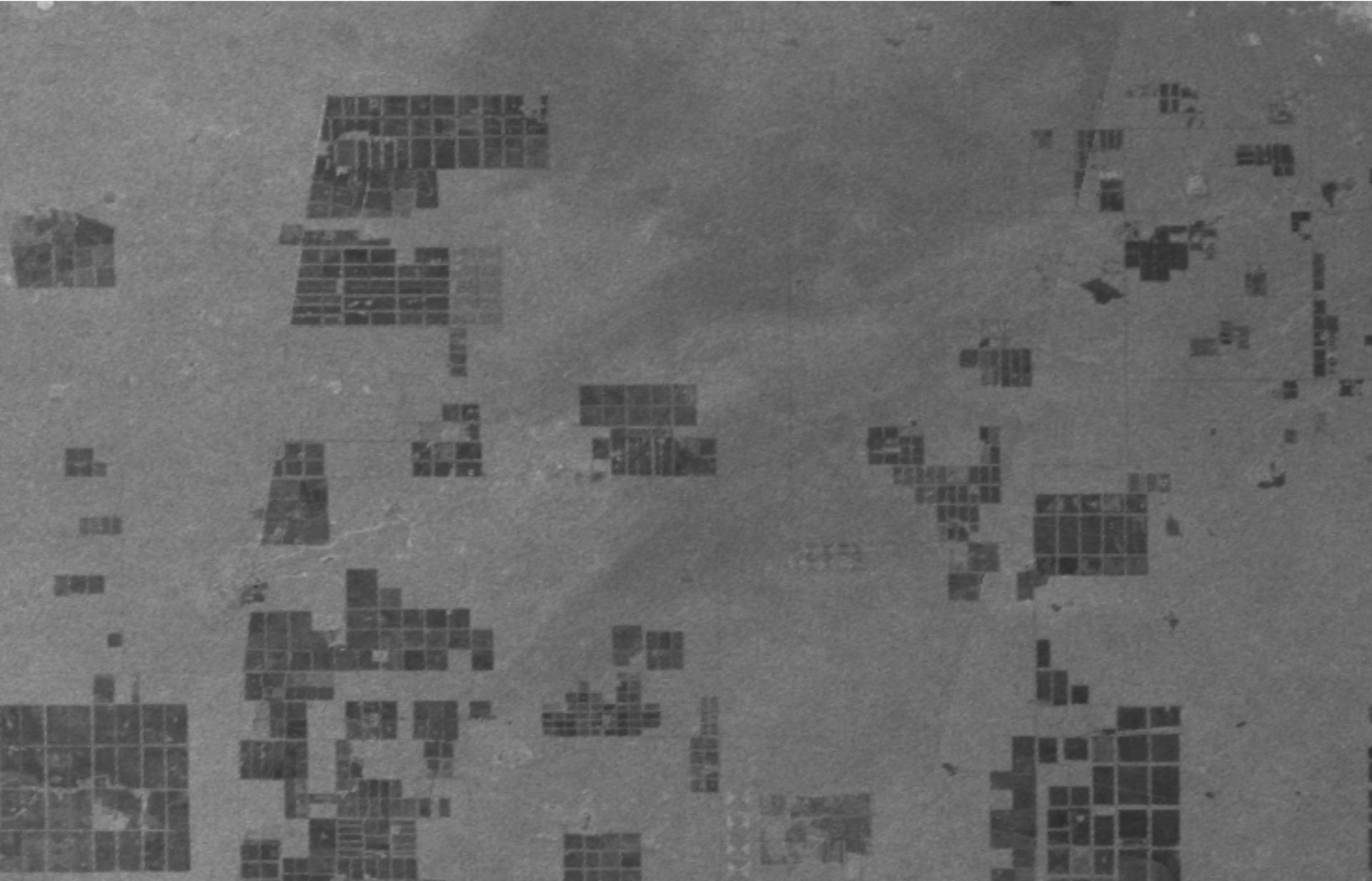
Research Approach/Method

- Close collaboration with NASDA
- Field work and validation by collaborators
- Collaboration with software vendor
- Distribution of products will be by cdrom and web (NASDA restricts usage to scientific or educational) by multiple sites (i.e. JPL, NASDA, INPE, ...)

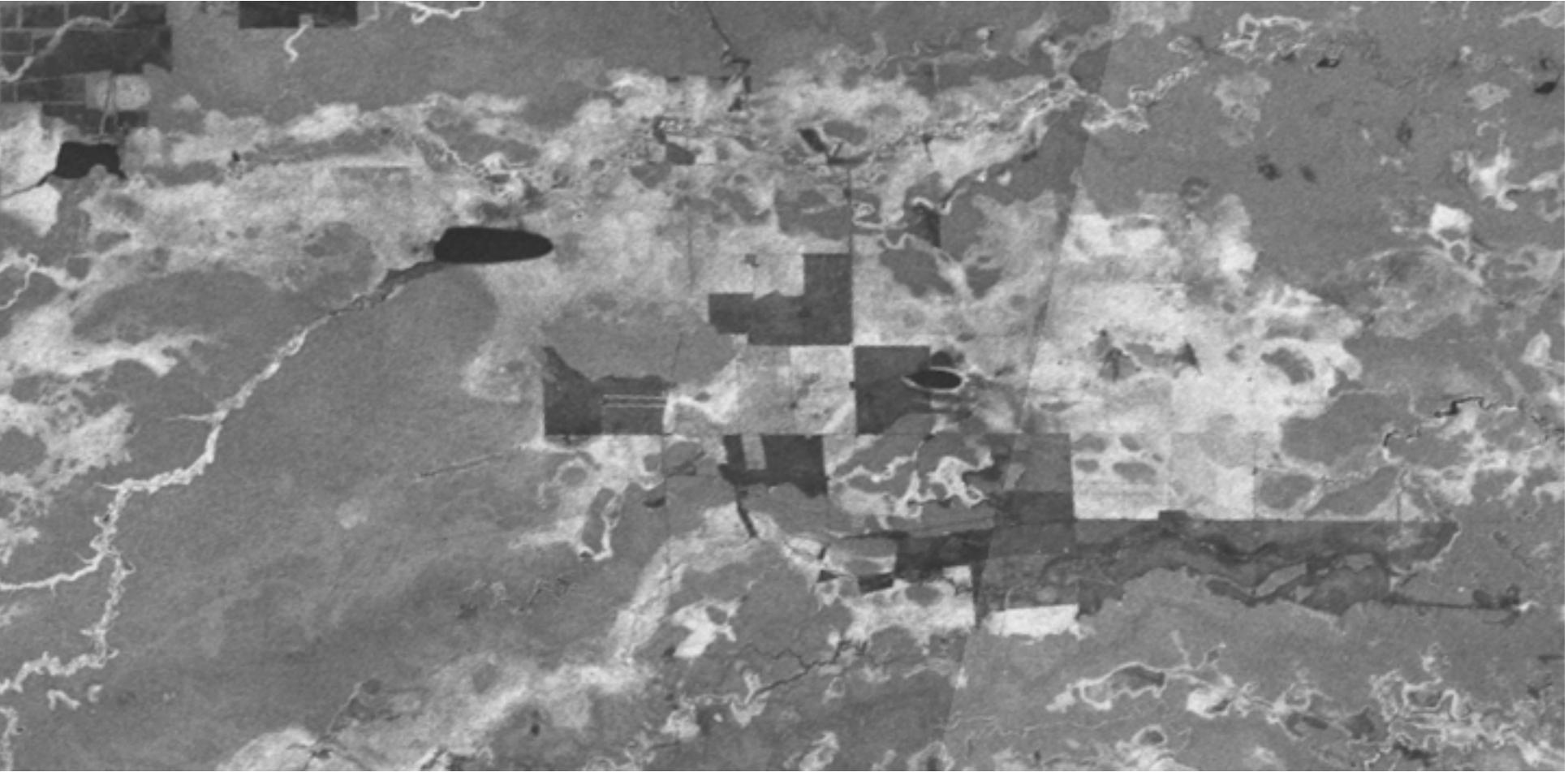
Scientific Results

- Pantanal – single season
 - Maycira Costa (INPE)
- Iwokrama – high flood/low flood
 - Vijay Datadin (Iwokrama)
 - Eileen Helmer (USFS- IITF)
- Miombo – multi-temporal
 - Sasan Saatchi
 - Stephen Prince

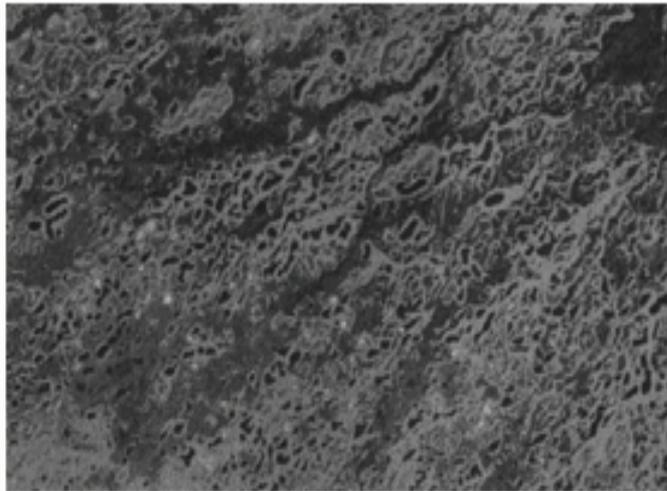
Disturbance



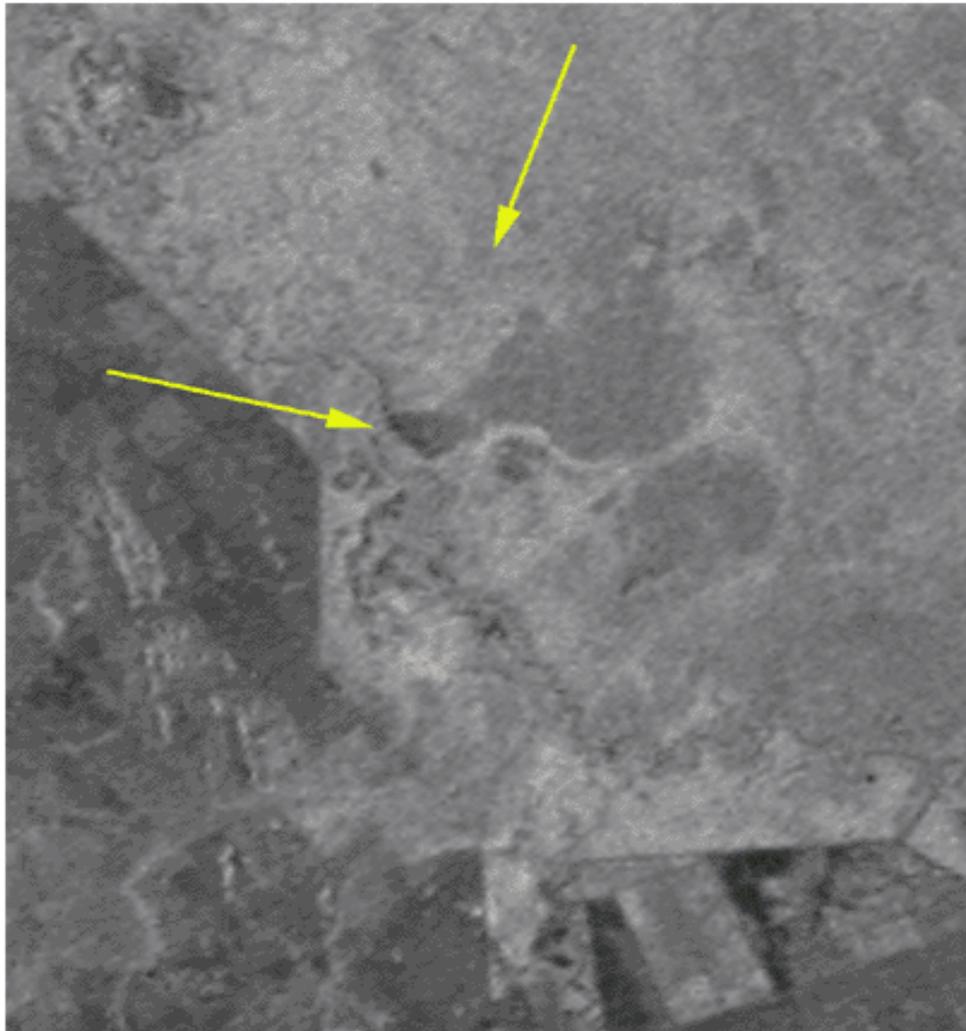
Disturbance of inundated forests



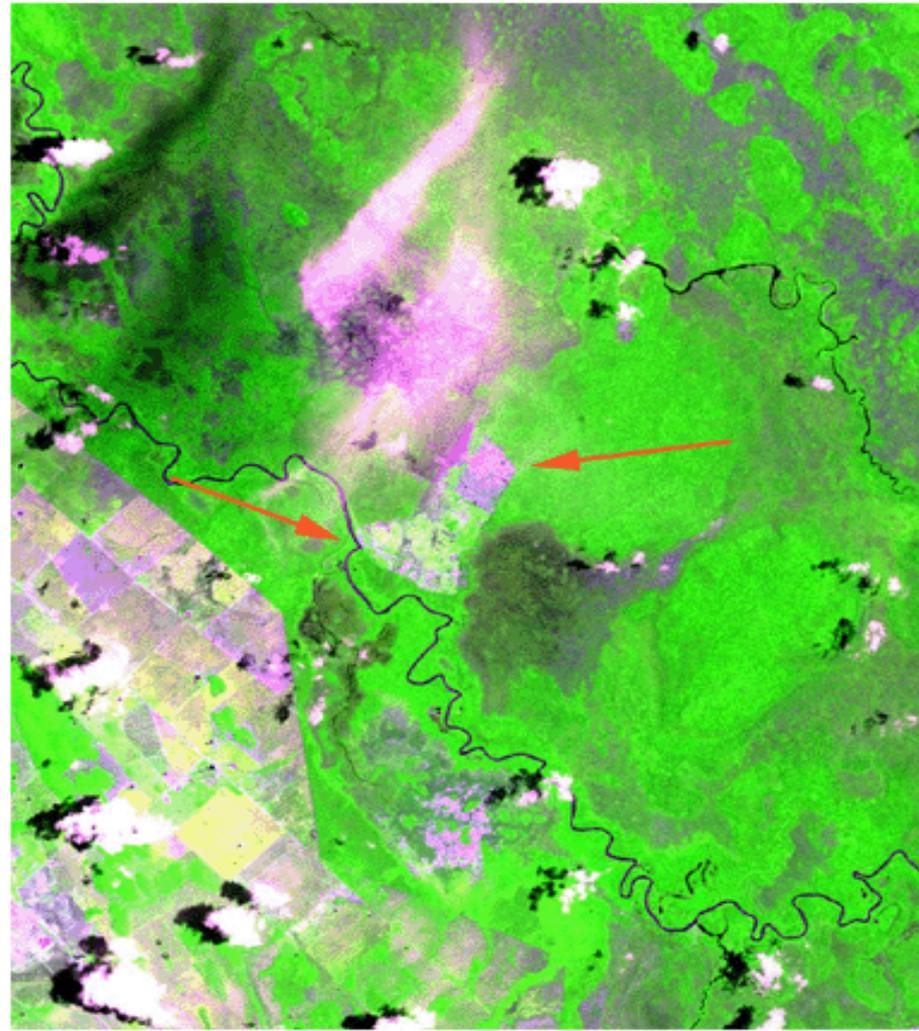
Pantanal – lagoons and capoes



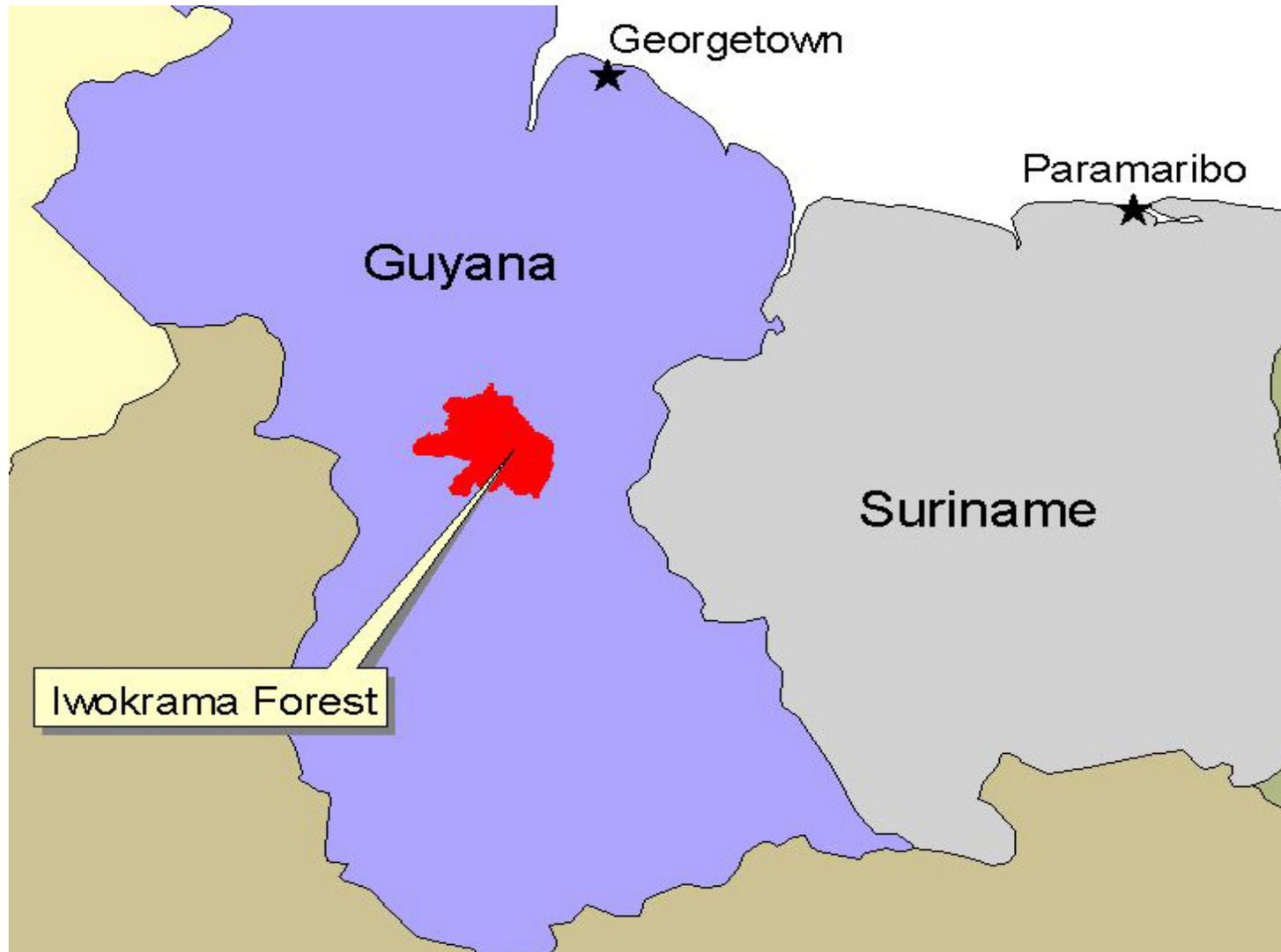
JERS -1 SAR 1997



Aster 2001



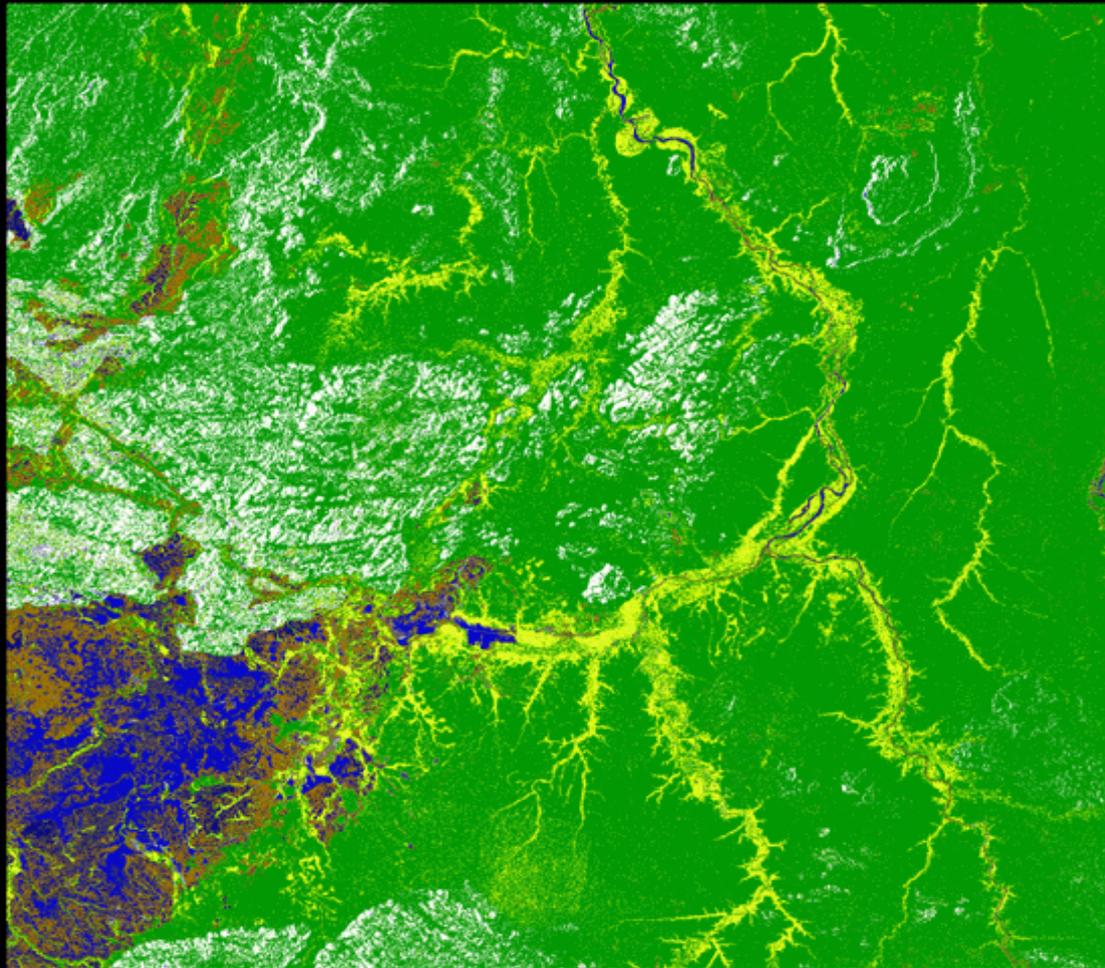
Iwokrama



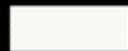
Iwokrama

classification from JERS-1 SAR

1995-1996



Forest



Terrain Slope



Water



Low Vegetation

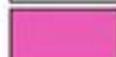


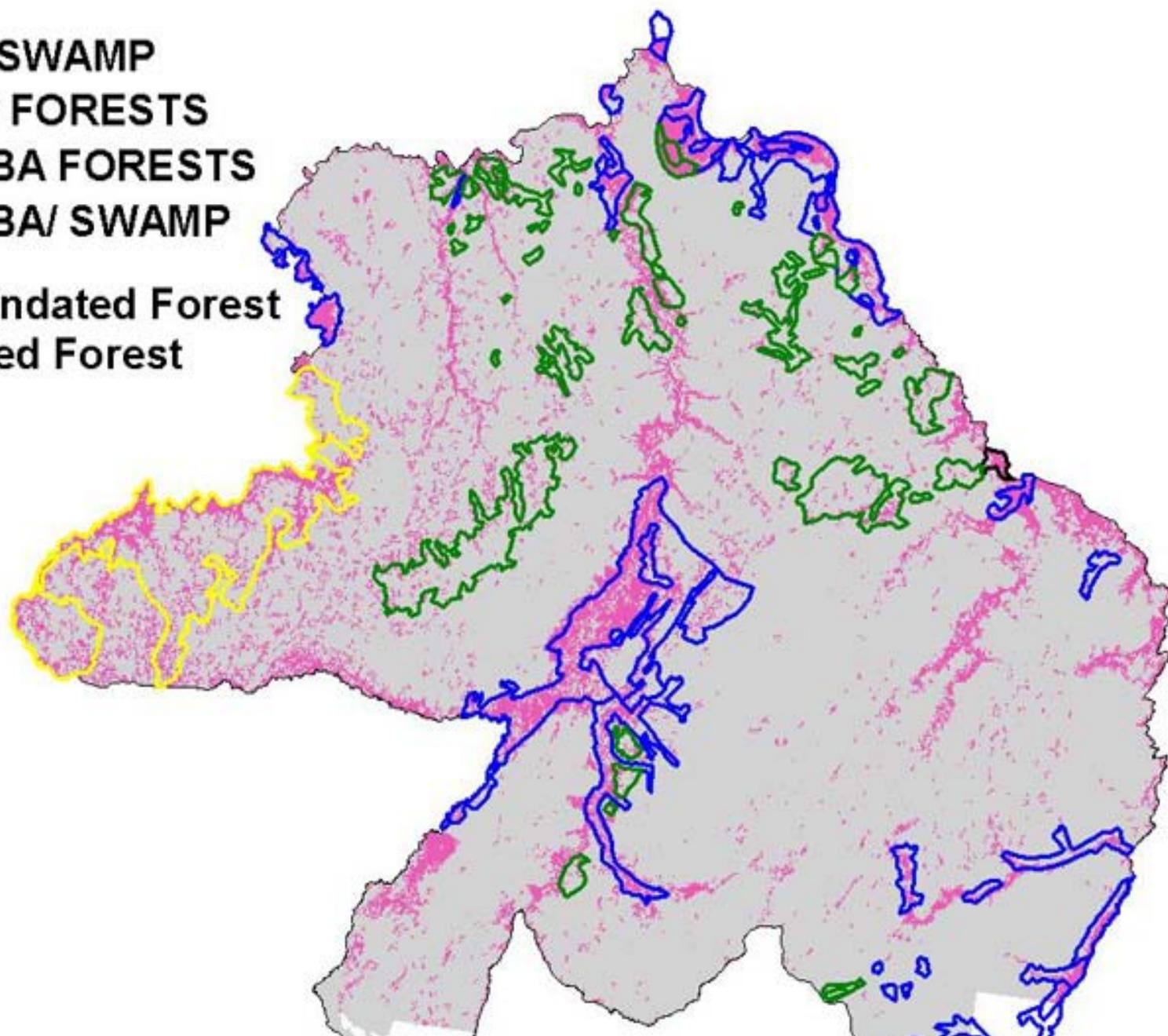
Flooded Forest



Unclassified

Legend

-  MIXED/ SWAMP
-  SWAMP FORESTS
-  WALLABA FORESTS
-  WALLABA/ SWAMP
-  Non-Inundated Forest
-  Inundated Forest

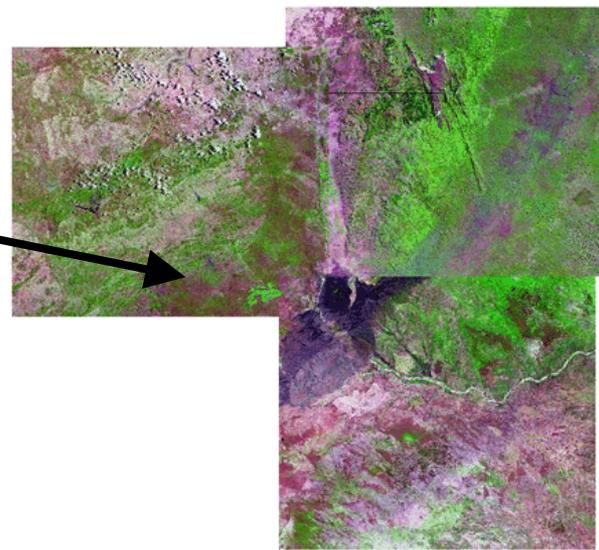


Application of JERS-1 Radar Imagery Over Subtropical Dry Forest - Multi-temporal Africa data

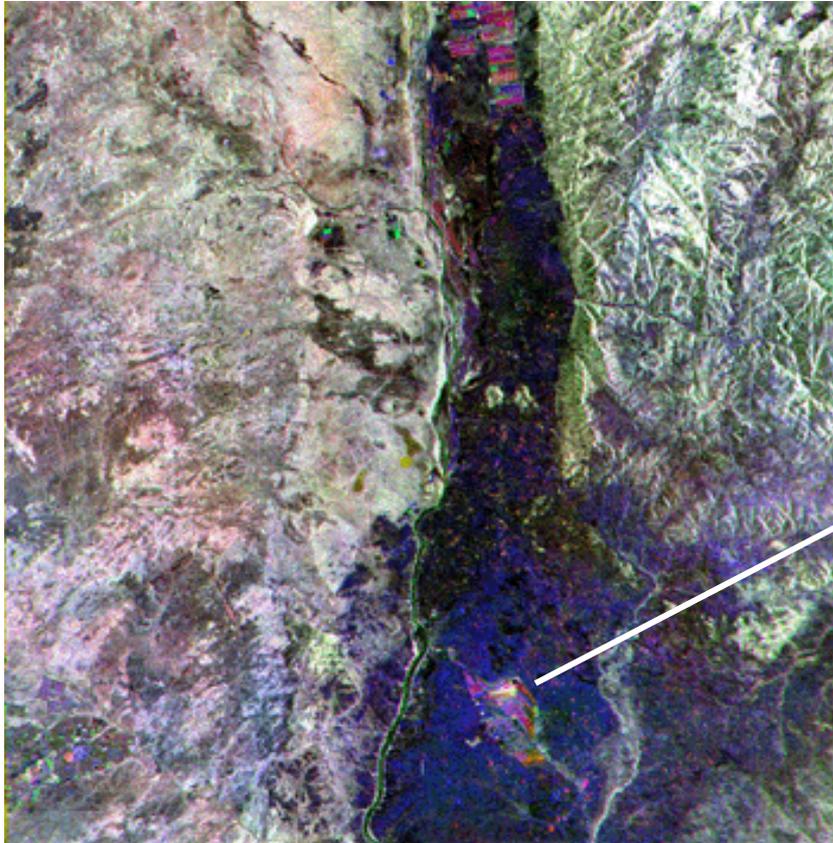
- Frequent radar images can help to map and monitor changes of vegetation cover due to human and natural disturbances.
- Radar sensitivity to surface moisture is useful in monitoring draught conditions due to climate variability (such as ENSO scenarios)
- L-band (25 cm wavelength) radar data is suitable for estimating low above ground vegetation biomass (<100 tons/ha) typical in subtropical open forests and woodlands



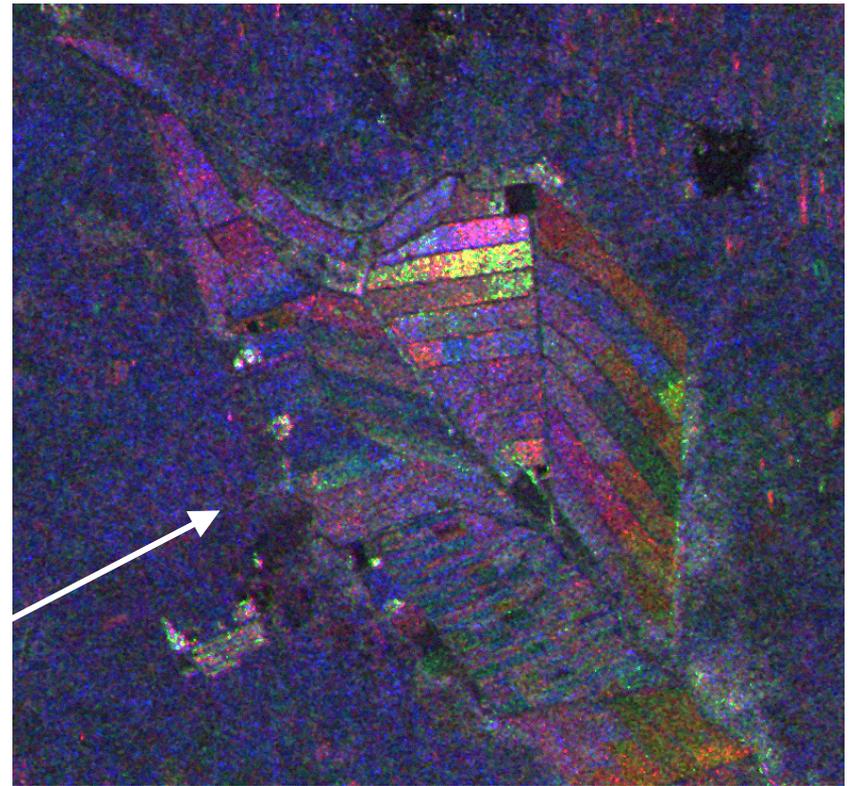
Chirinda Forest Site, Zimbabwe
Scene Center: 20.62 S, 32.21 E



Landsat TM Mosaic



R: 01-24-1996
G: 05-22-1997
B: 07-05-1997



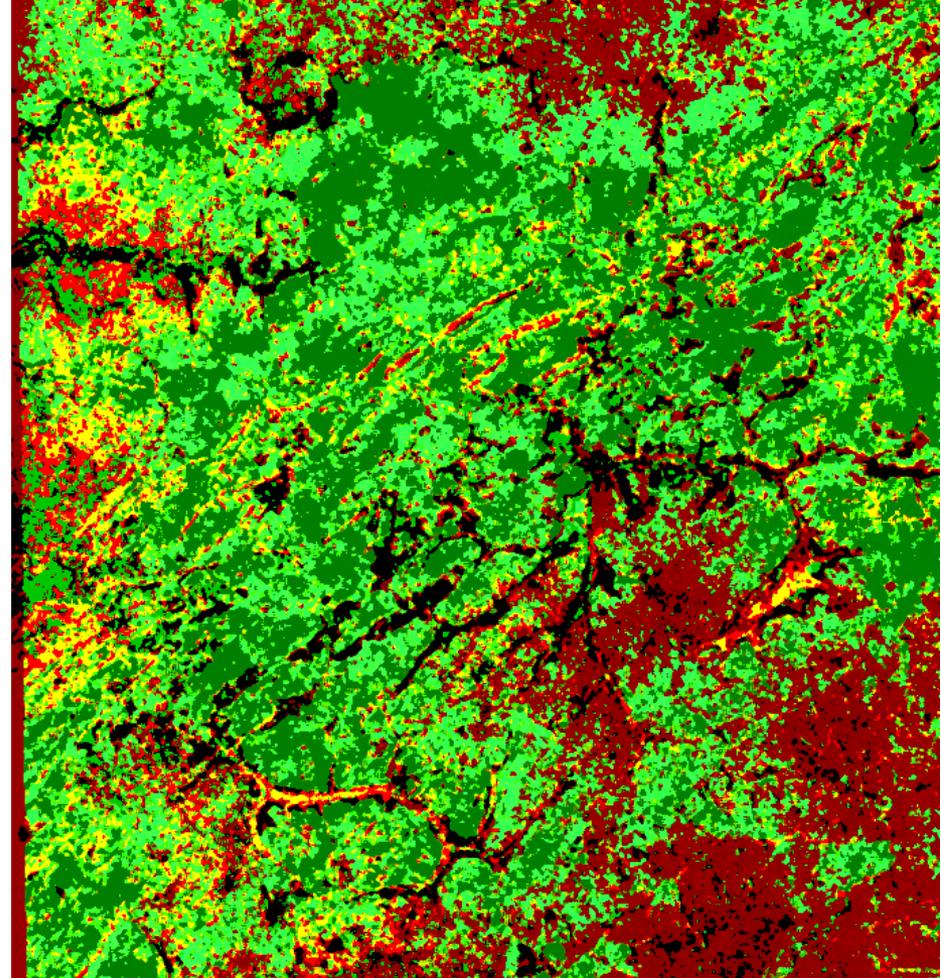
Land Use Change Captured by
Multitemporal High Resolution
(25 m) Radar Images



R: 01-24-1996

G: 05-22-1997

B: 07-05-1997



Dense Woodland



Grassland



Open Woodland



Vegetation Changes



Shrubland



Water/Nonvegetated

Future Steps

- Continue acquisition and processing of data
- Mosaicking
- Classification
- Distribution
- ALOS observing strategy

Problems, Issues, Potential Solutions

- Data distribution from NASDA
 - Transcription occurring in order data acquired by satellite
 - ASF proposal has been accepted for data available at that facility

Programmatic Summary

- Pantanal region has been processed, mosaicked, and classified
- So far, over 1 million sq km of JERS SAR imagery has been processed
- 0% social science
- New products
 - SAR image mosaics and classifications