

# Monitoring Tropical Deforestation Globally

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# Scientific Rationale

- Tropical deforestation is a major source of greenhouse gas emissions
- Deforested land now in agricultural use is a significant source of greenhouse gas
- Biodiversity is profoundly affected in fragmented landscapes
- Human health decline
- Deforestation impacts water and energy balance, latent and sensible heat flux, albedo

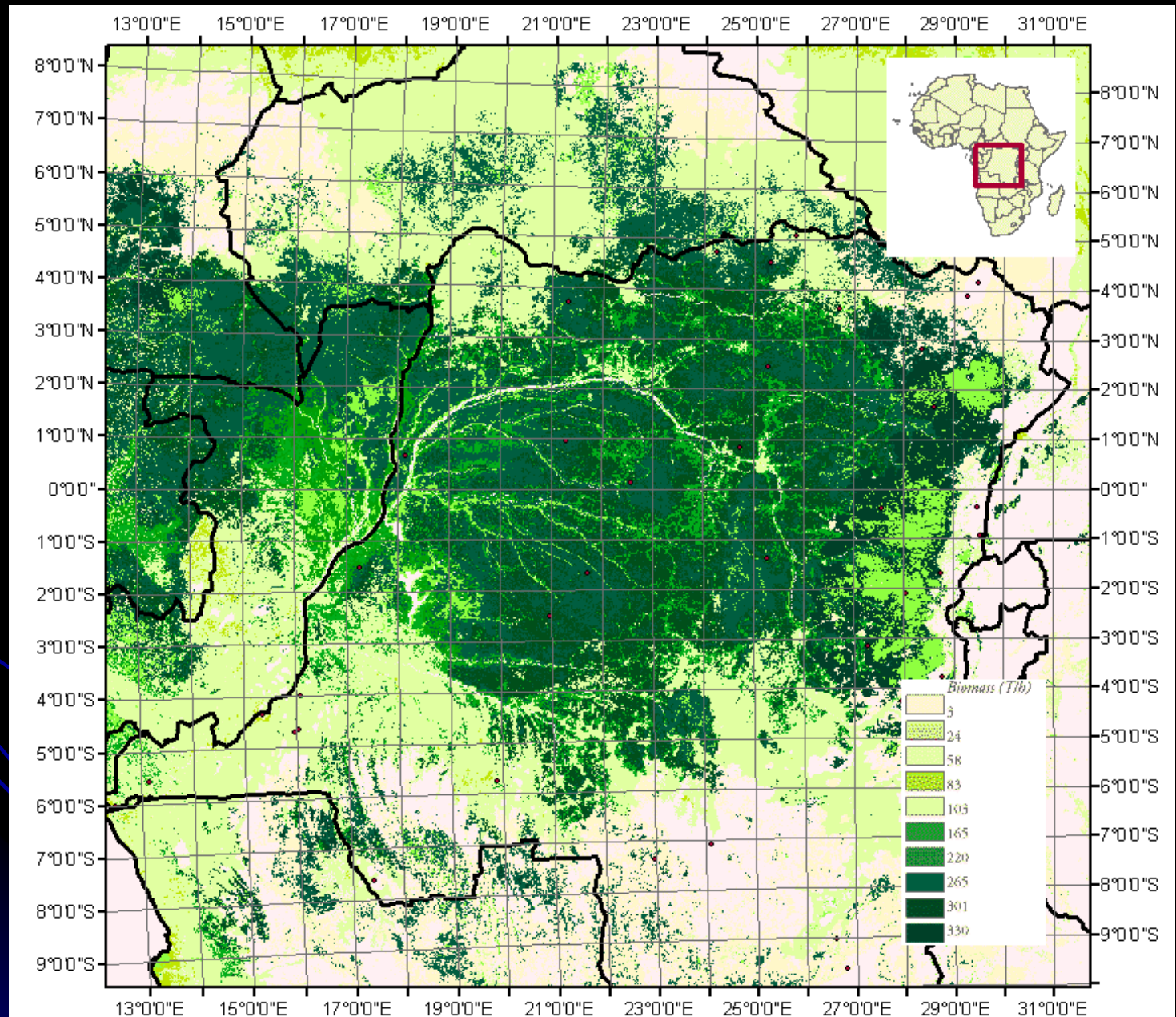
# Scope of the Problem

- The area of closed canopy tropical forests for the globe is not well known
- Knowledge on the history of land cover is sparse and scattered
- An accurate Forest Biomass data set is a necessary input for carbon models
- Changes in closed tropical forest cover over the past three decades are not well known
  - Some studies of key areas (e.g. Amazonia) have been done
  - global surveys done by sampling exist.
- High resolution analysis is optimal to capture fine scale patterns that affect biodiversity and forest ecosystem functions

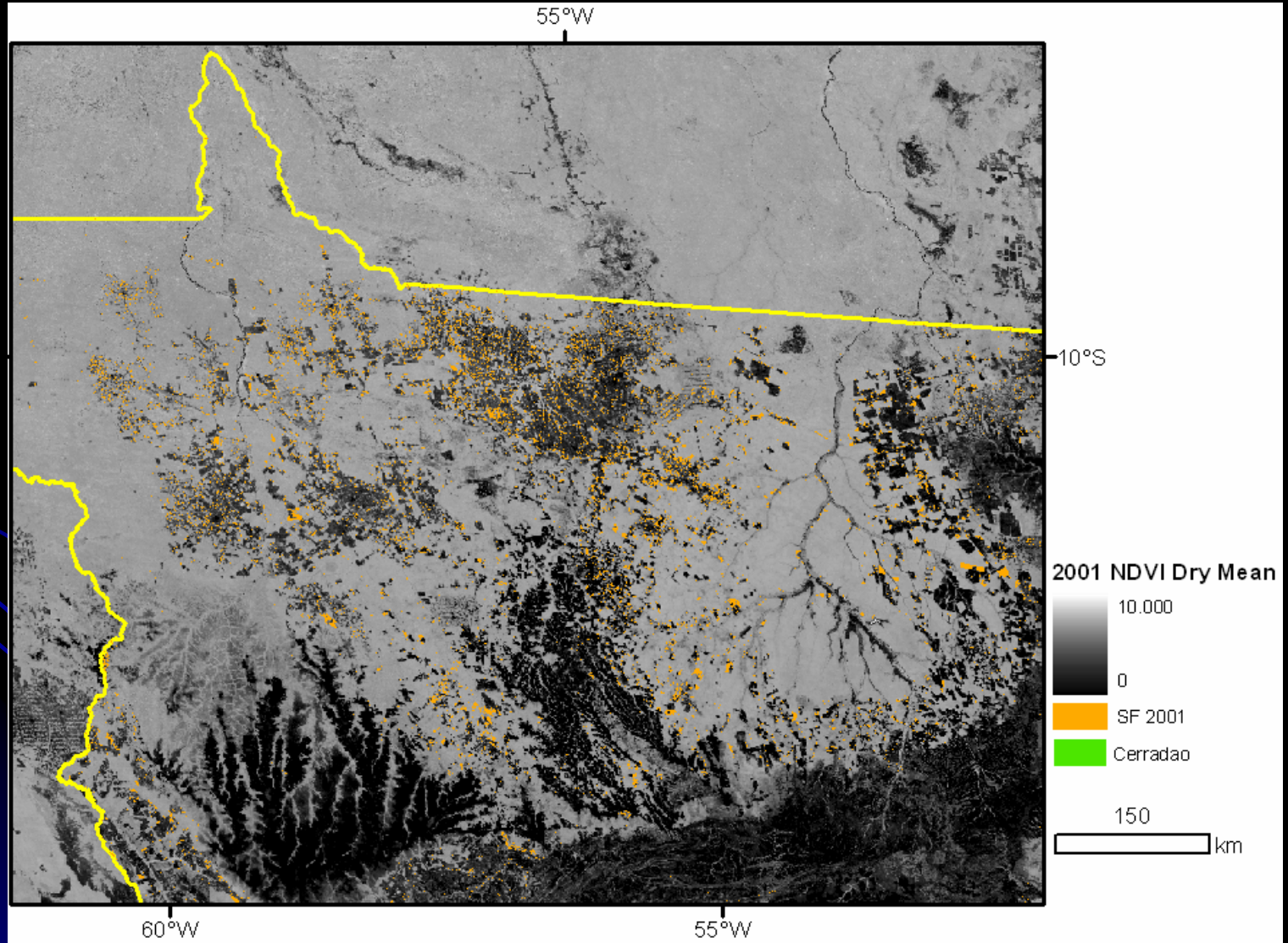
# Scope of this report

- Biomass from MODIS
- Life after deforestation?
- Preliminary report on results of a new method for automated global tropical forest cover assessment
  - Automated 'lights out' processing, multi-date, global extent
  - Multi-sensor (Landsat, MODIS, SRTM)
- The method had been developed and tested
- This report provides an overview of the approach and some early results
- This analysis is retrospective: 1990-2000; future work will be forward looking and annual

# Forest Biomass in central Africa



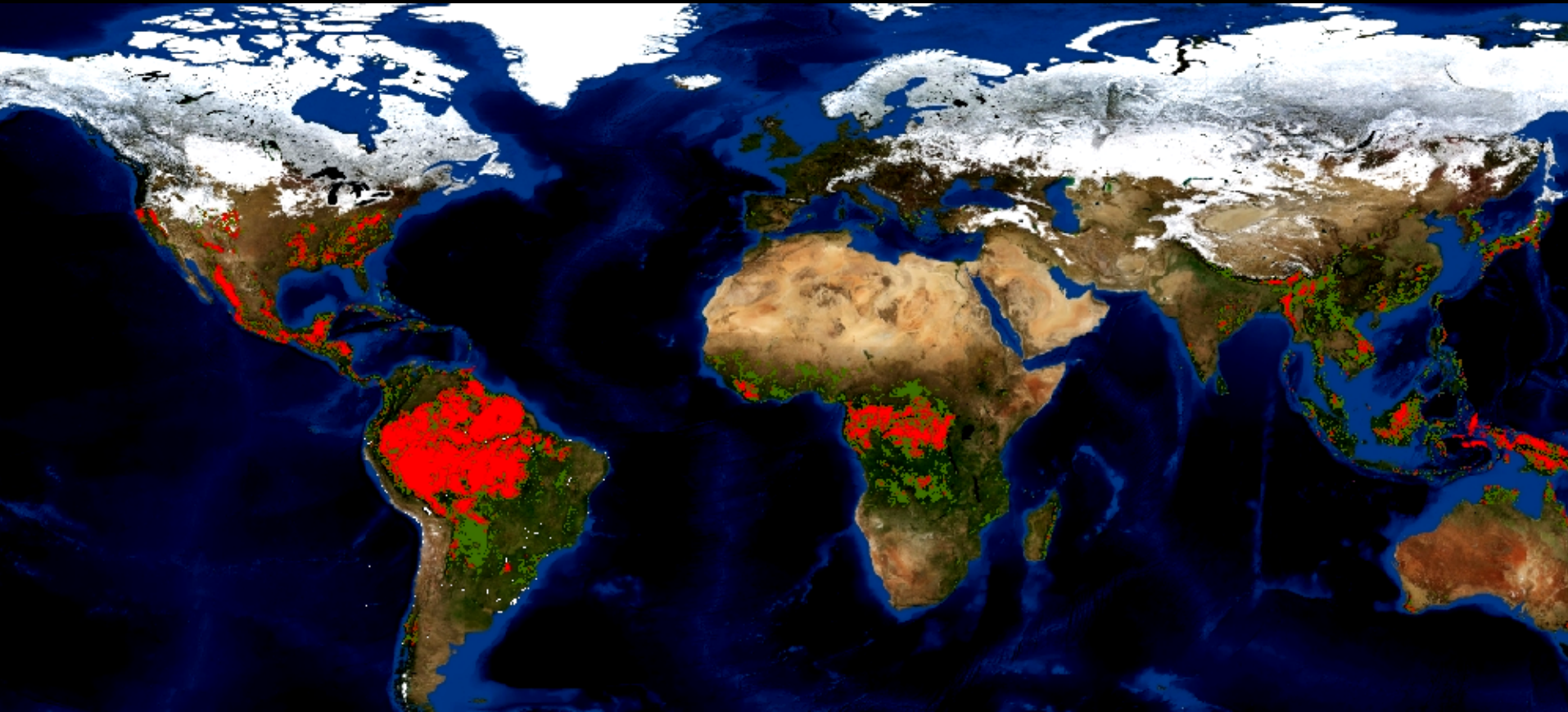
# Secondary forest dynamics in Mato Grosso from dry season MODIS NDVI metrics and extent of previous deforestation



# Input data sets

- Landsat Geo Cover orthorectified data set (TM and ETM+)
- Global MODIS derived Vegetation Continuous Fields (VCF)
- Global SRTM water bodies data set
- Calibration data from TRFIC global test sites in Amazon, Central America, Africa, Southeast Asia.
- In-situ analysis and IKONOS

# FAO Global Forest Resource Assessment 2000 (closed and fragmented)

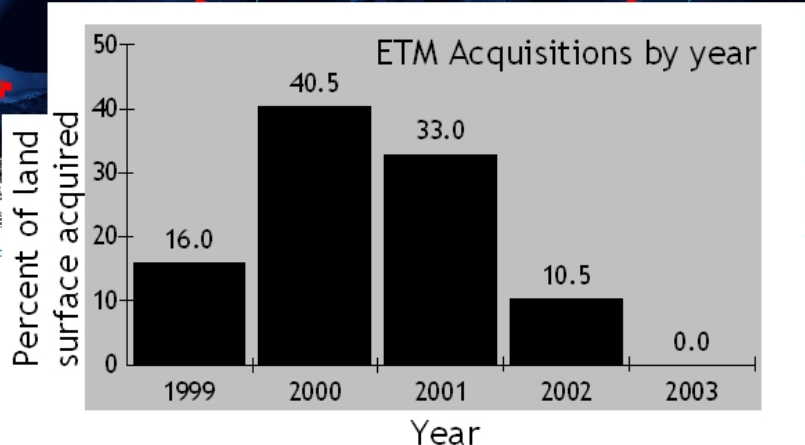
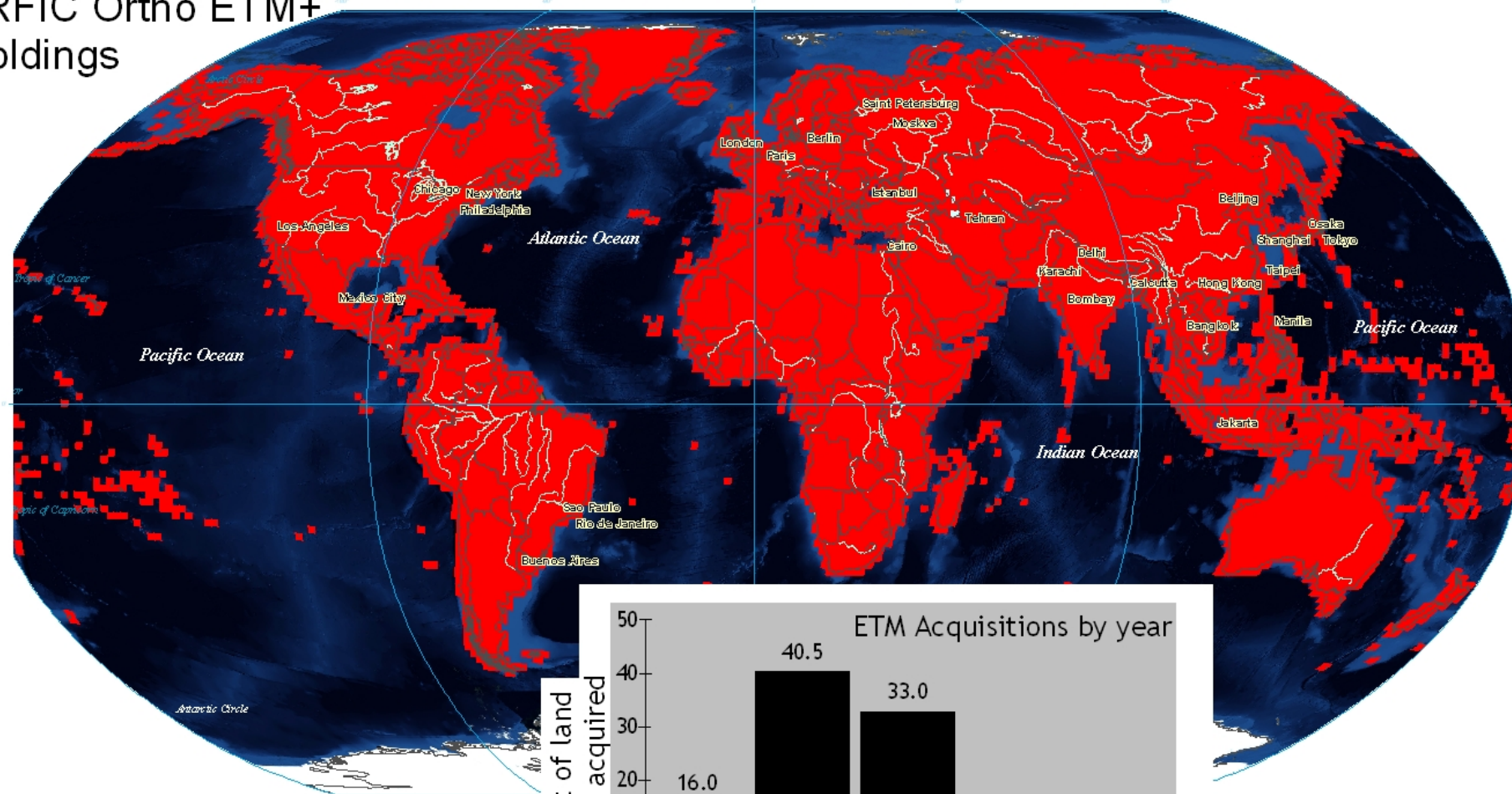


Total area in closed forest = 17,124,059 square km<sup>8</sup>



# Extent and acquisition spread of ETM+ Geo Cover

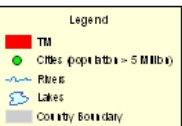
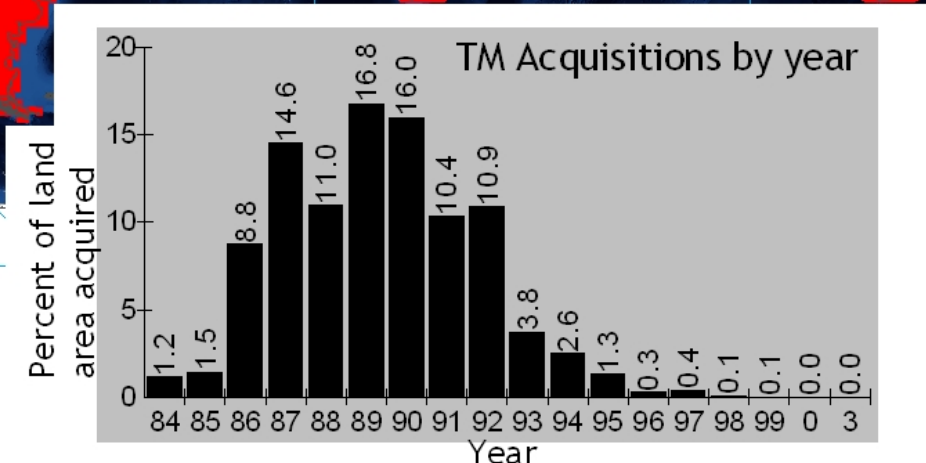
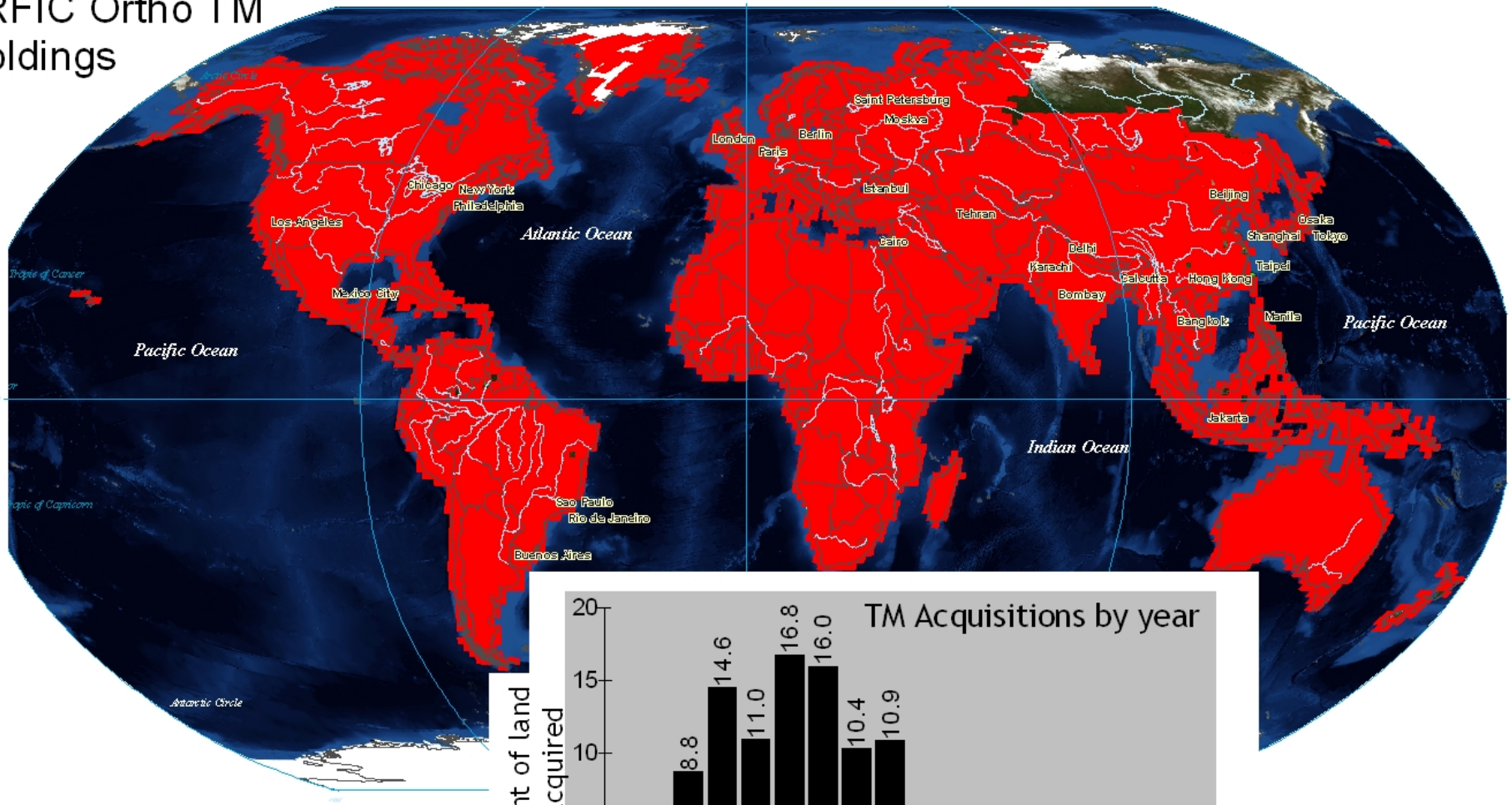
TRFIC Ortho ETM+ Holdings



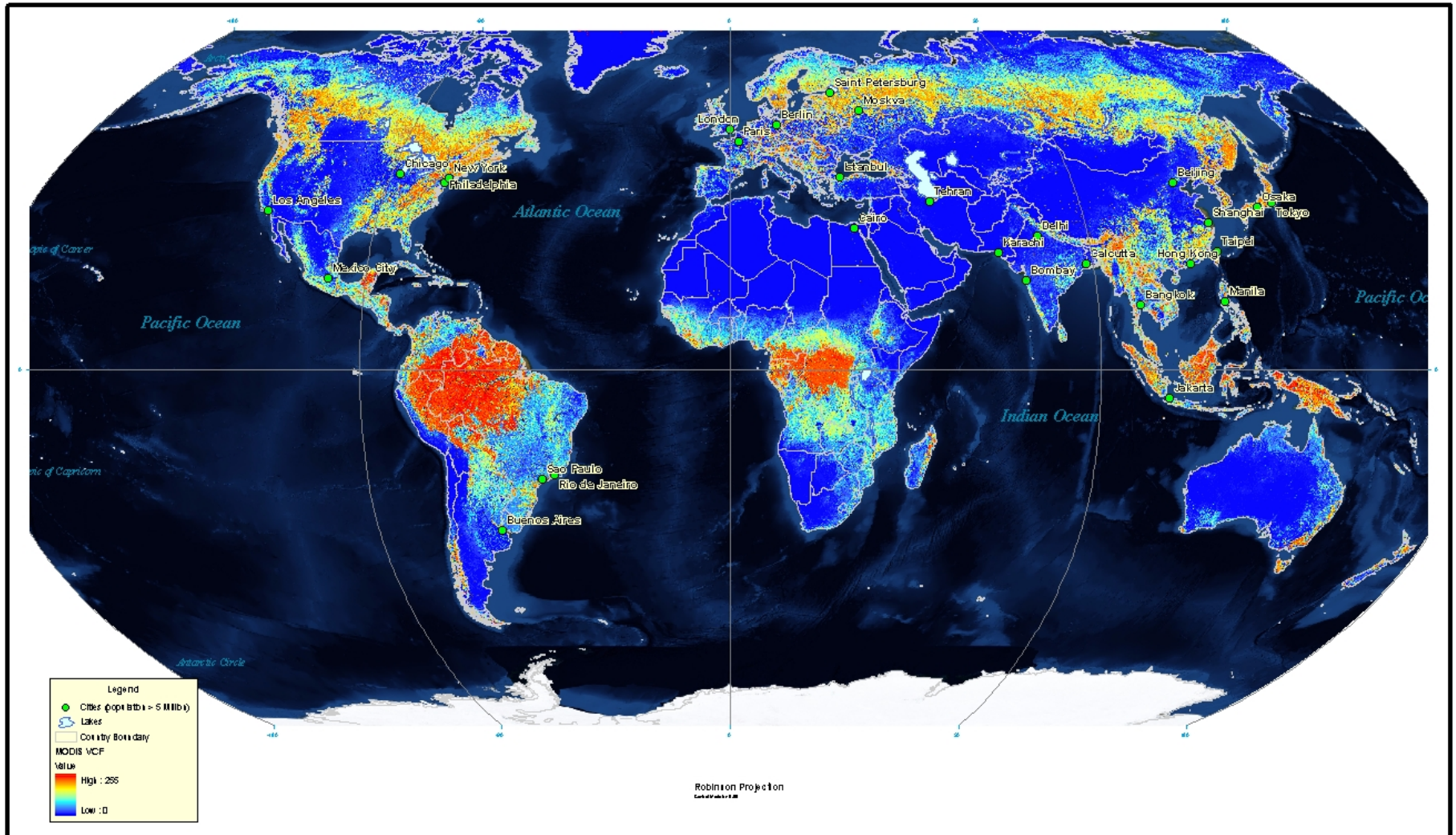
Legend  
 ● Cities population > 5 million  
 ~ River  
 ☪ Lakes  
 --- Country Boundary  
 ■ ETM+

# Extent and acquisition spread of TM Geo Cover

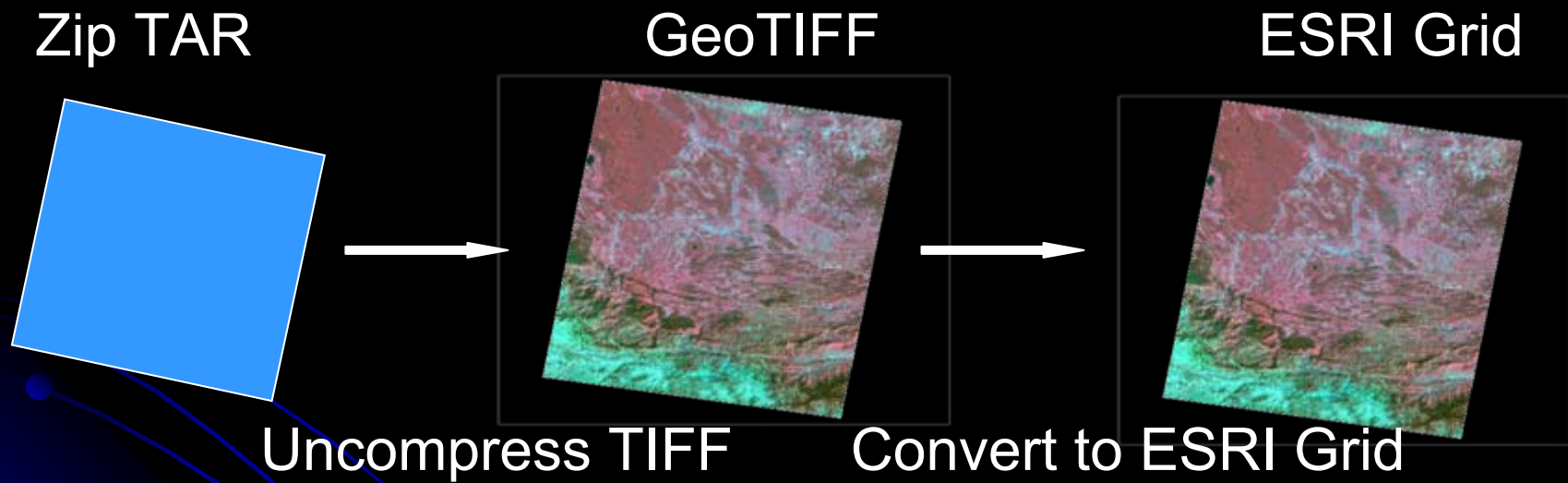
TRFIC Ortho TM Holdings



# MODIS VCF collection 3

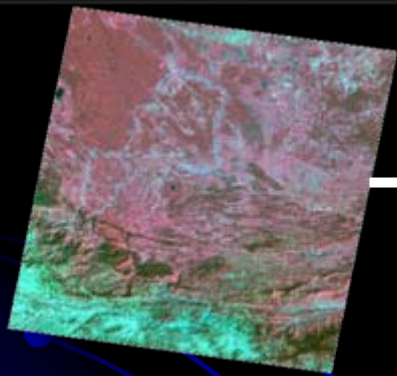


# Component 1: Data staging for TM and ETM+



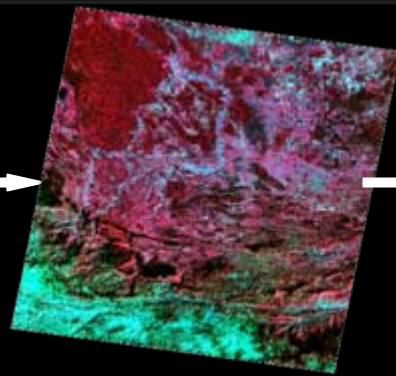
# Component 2: Radiometric correction and Level 1 product generation for TM and ETM+

ESRI Grid DN



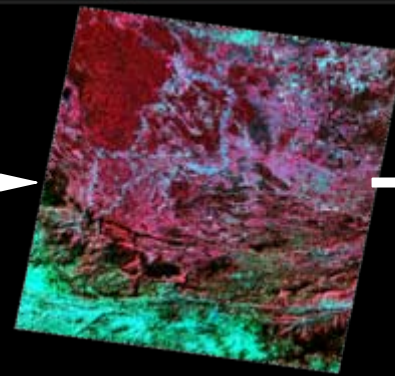
6 bands

Grid Rad



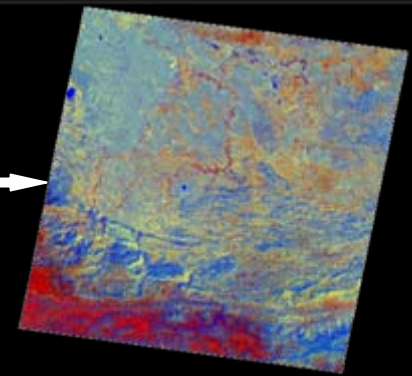
6 bands

Grid Ref



6 bands

Grid tasseled cap

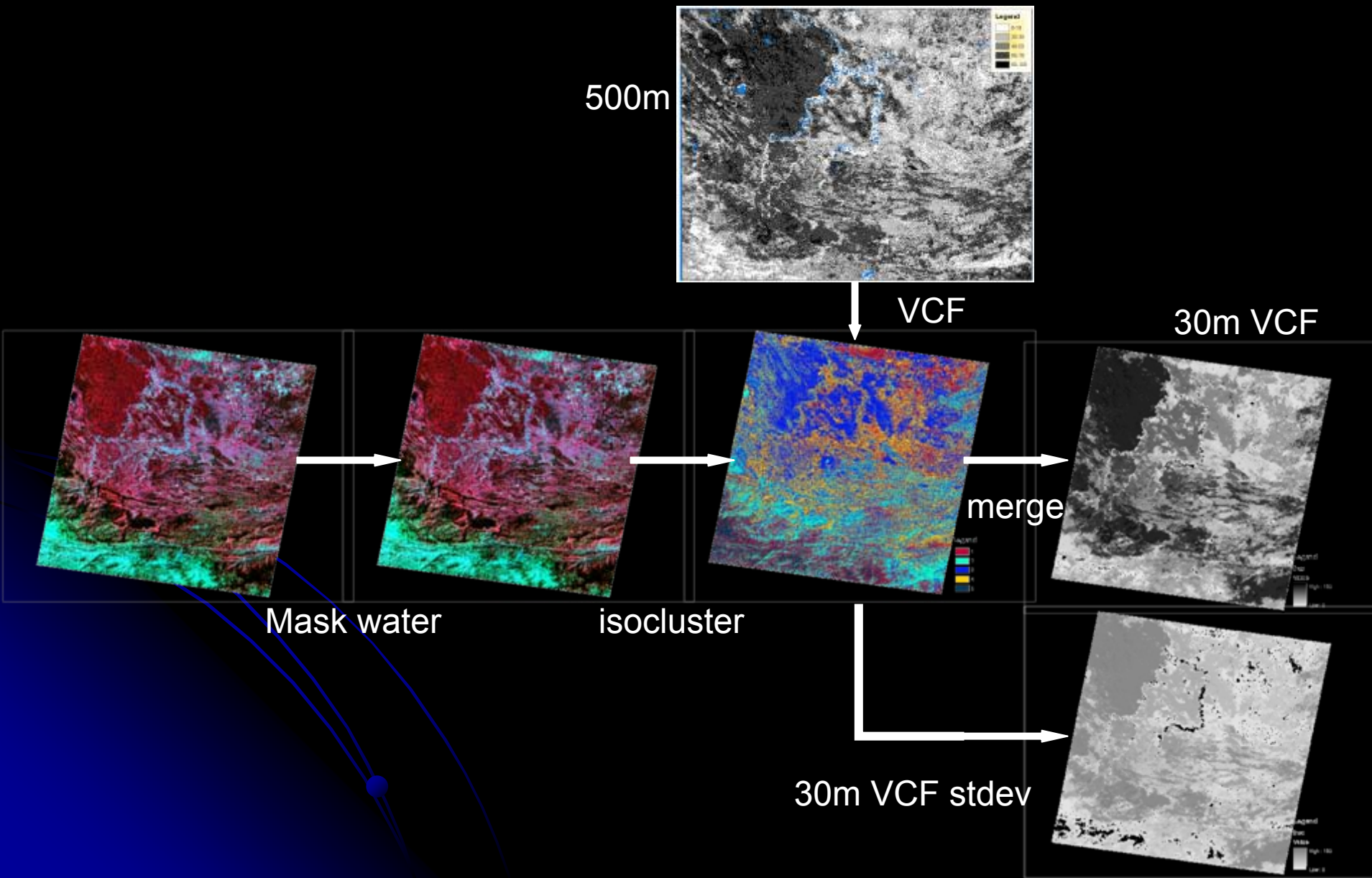


Brightness  
Greenness  
Wetness

• Issue: radiometric correction is performed on the ortho data rather than source data

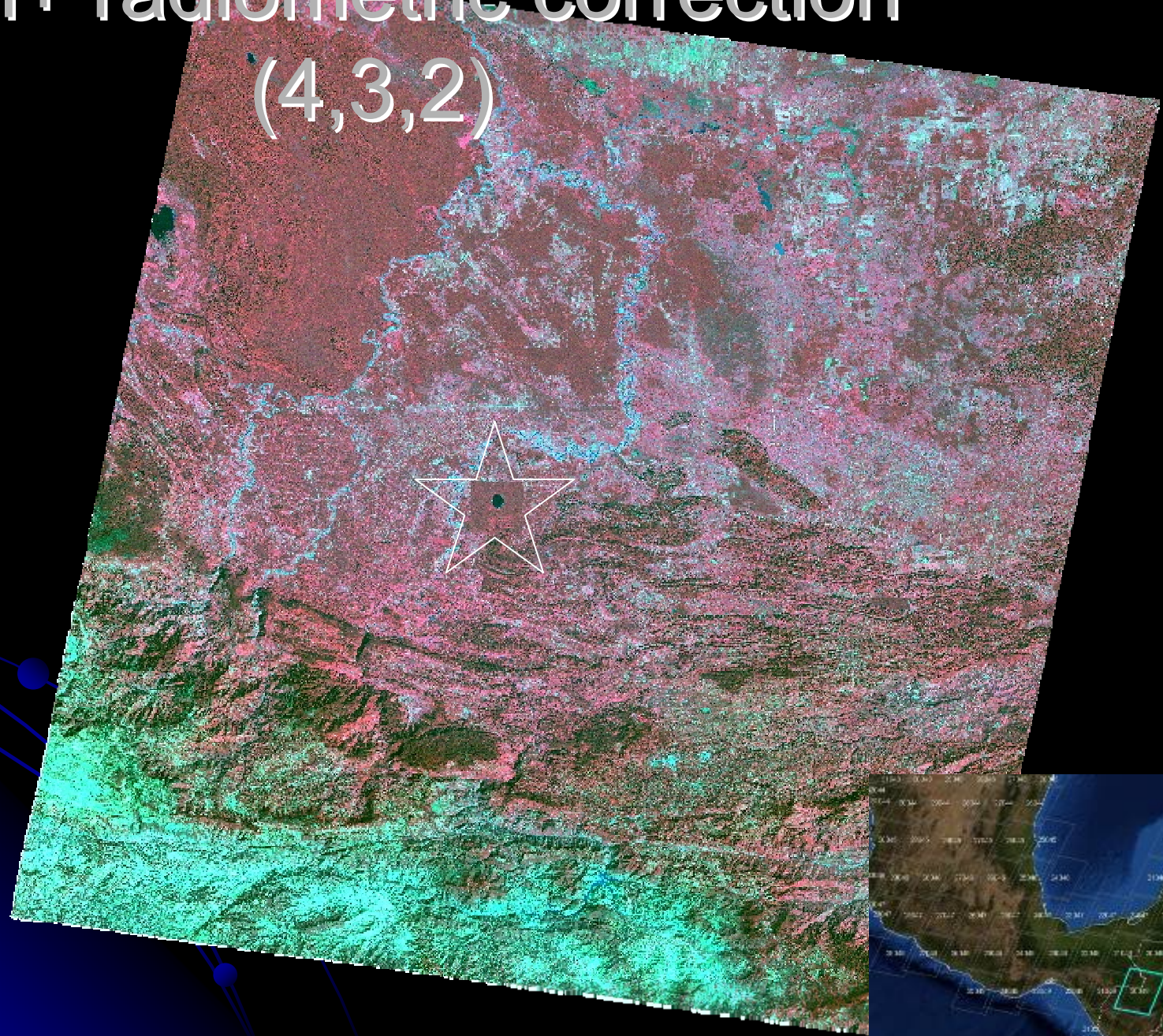
- No pre-ortho TM exists
- ETM pre-ortho just now being archived at TRFIC
- SRTM only 90m available

# Component 3: 30m VCF

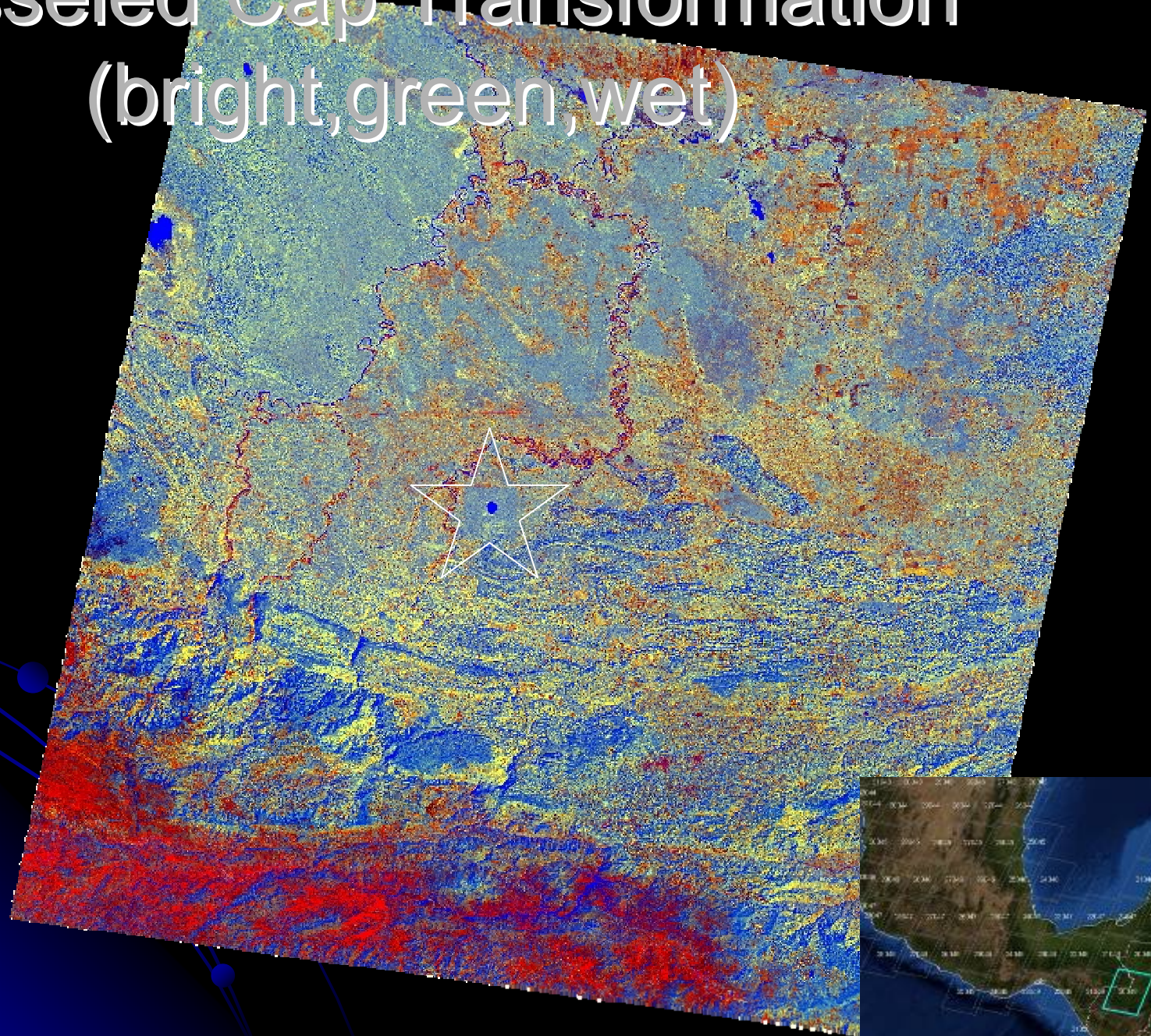


# ETM+ radiometric correction

(4,3,2)



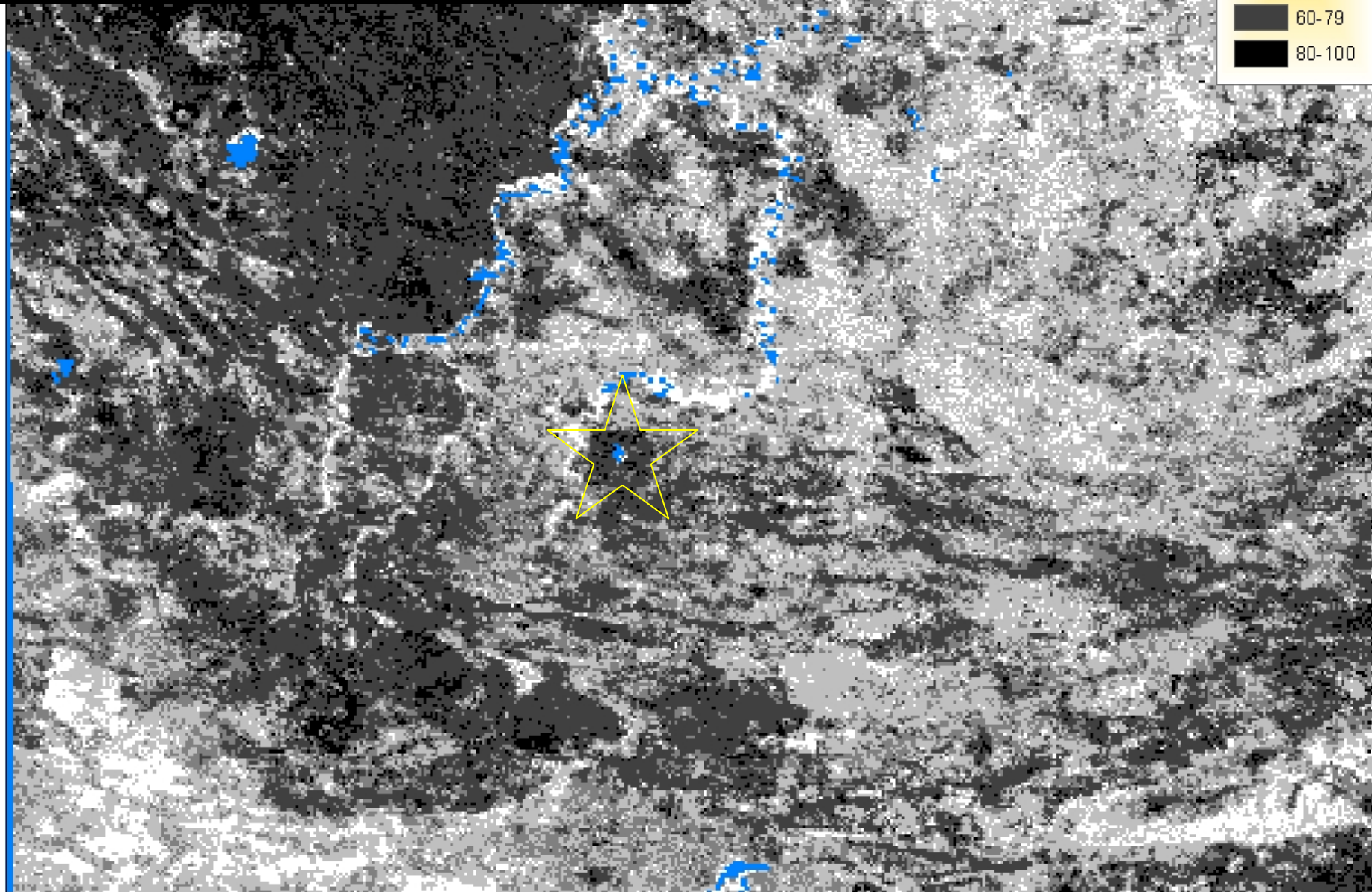
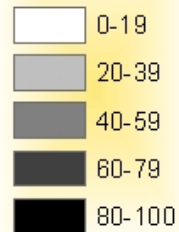
# Tasseled Cap Transformation (bright, green, wet)



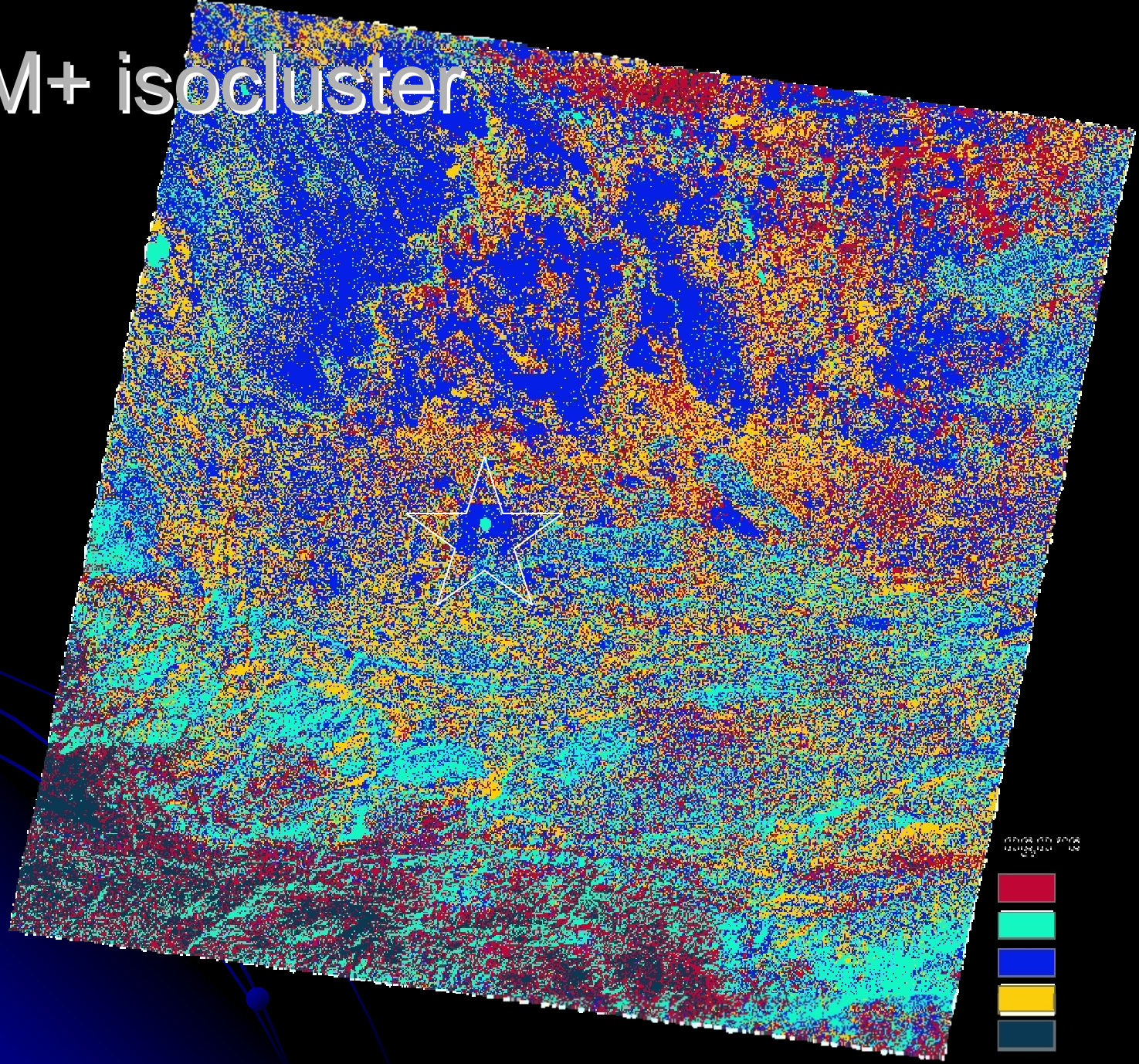


# VCF 500m

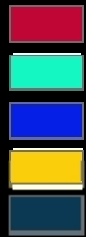
## Legend



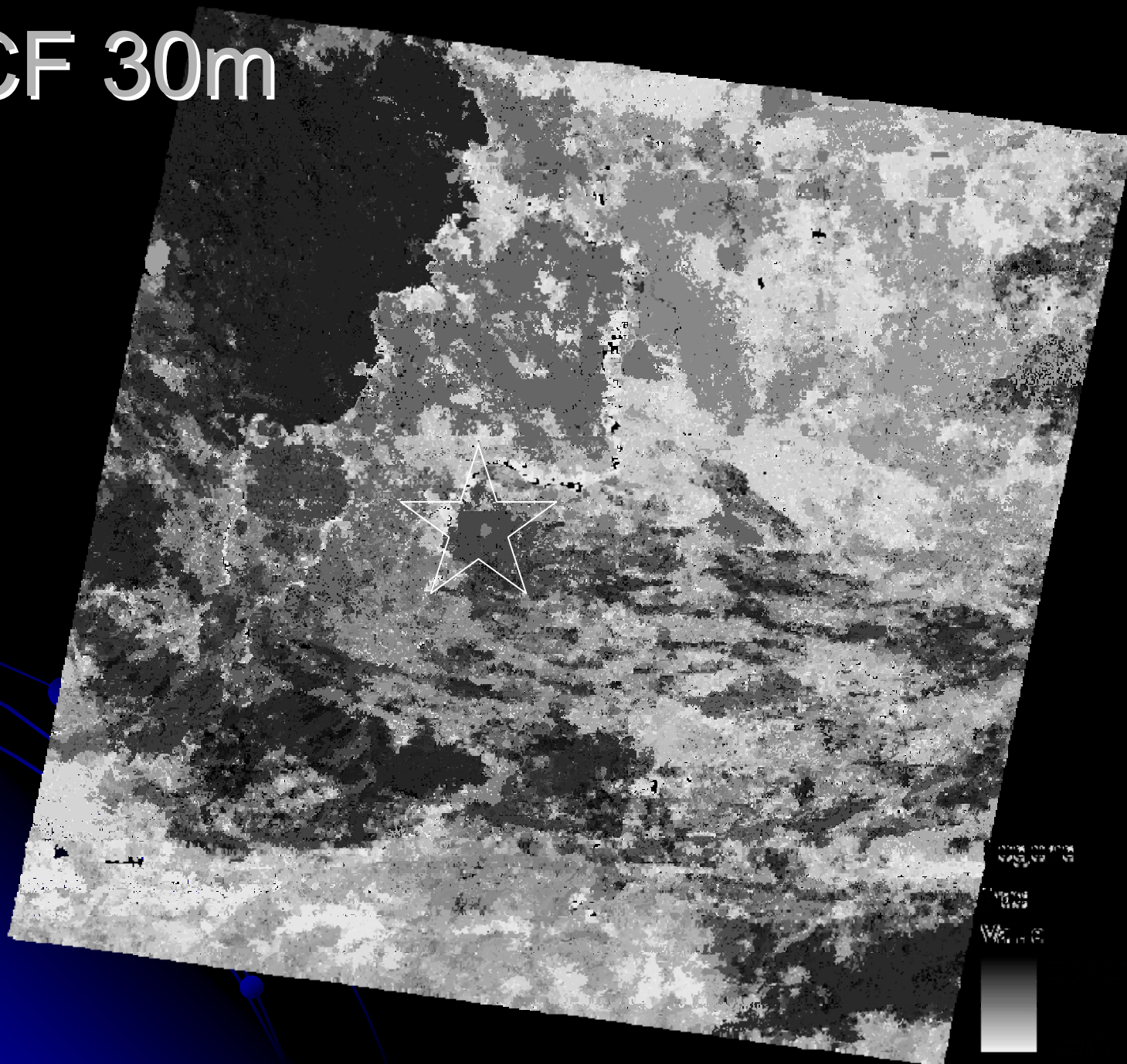
# ETM+ isocluster



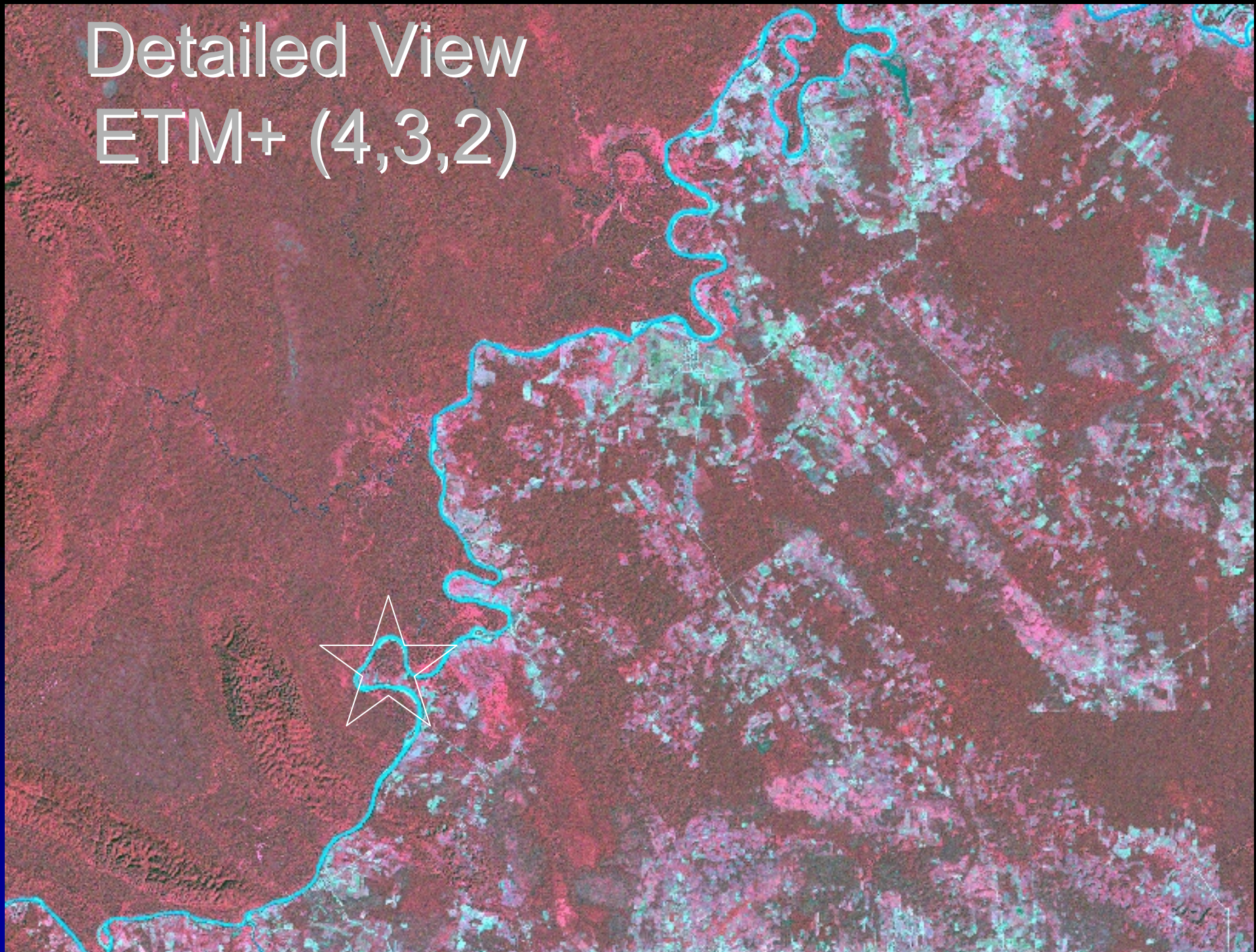
ETM+ isocluster



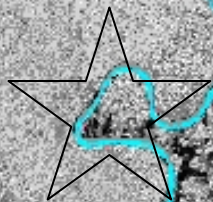
# VCF 30m



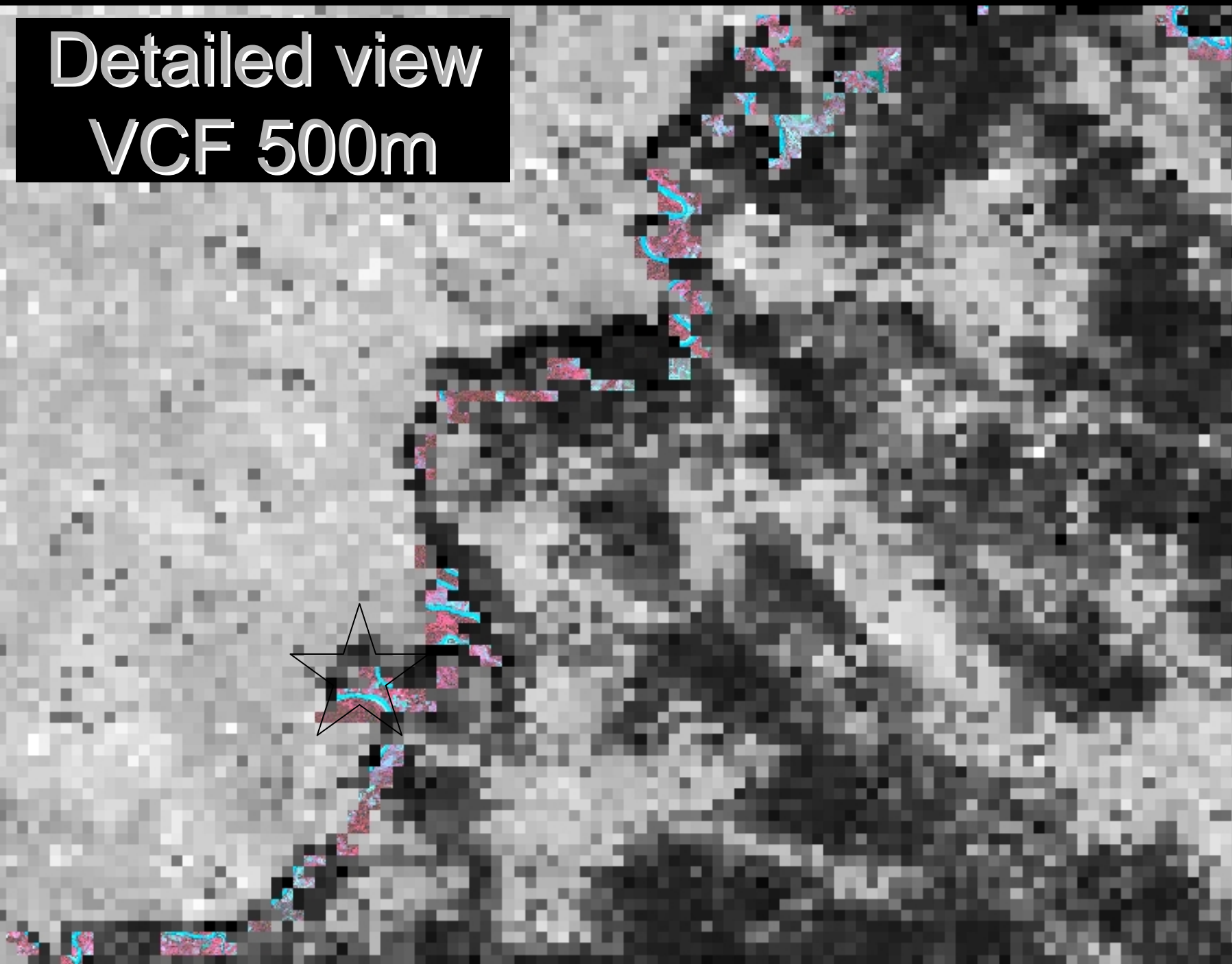
Detailed View  
ETM+ (4,3,2)



Detailed view  
VCF 30m



Detailed view  
VCF 500m



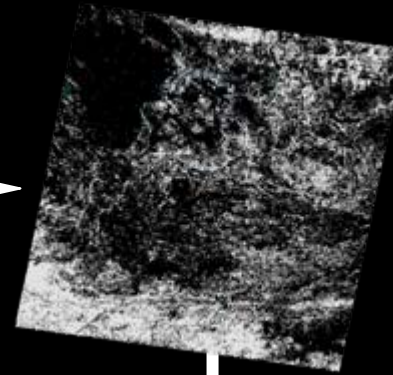
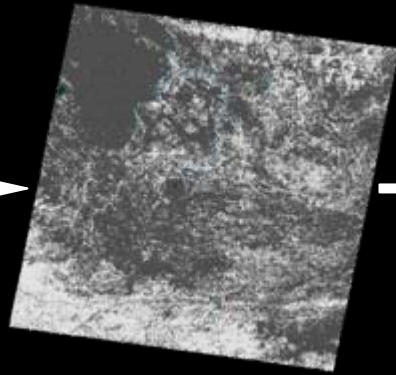
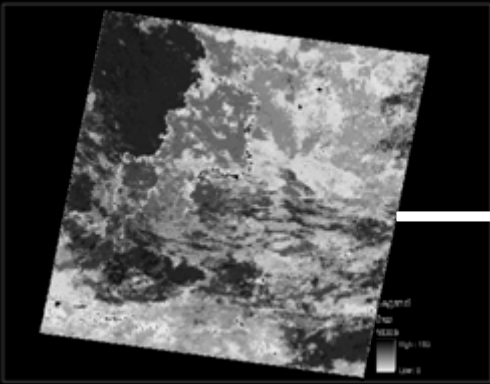
# Component 4: Change Detection

30m VCF

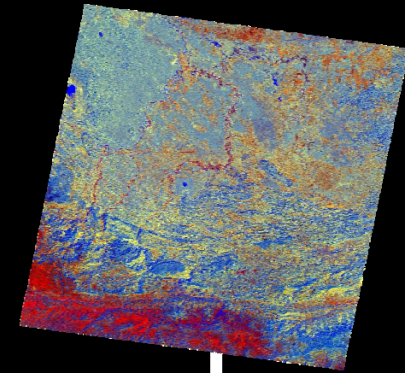
F/NF map  
>30% = Forest

NF mask

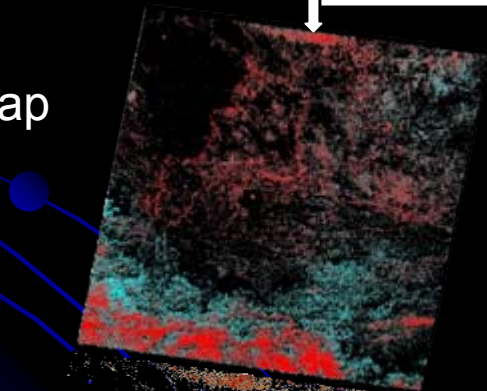
Tasseled Cap



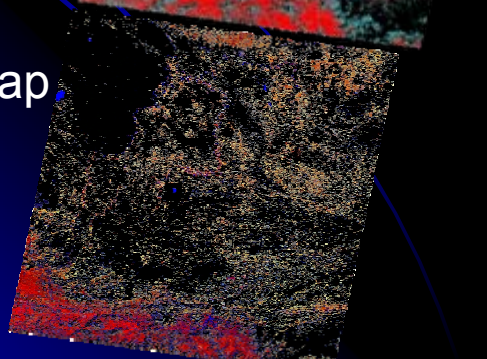
+



Tasseled cap  
ETM+  
(forested  
masked)

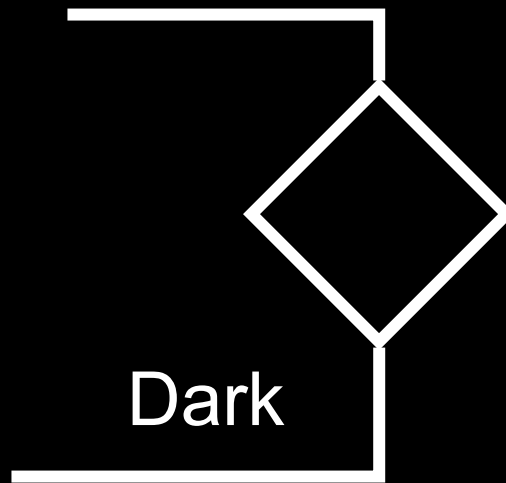


Tasseled cap  
TM  
(forested  
masked)



Bright

Dark



$$\Delta \geq X$$

TM-ETM  
Change  
(deforestation)

# Change Detection Example

VCF 30m

ETM+

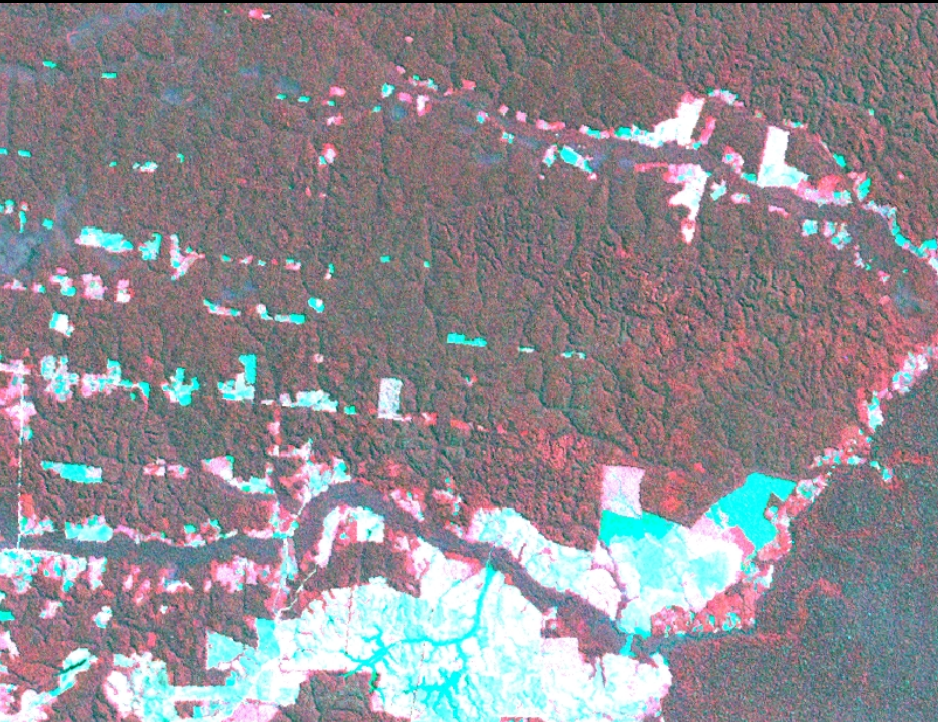
TM

Change Detection inputs: VCF 30m, Geo Cover ETM+, Geo Cover TM



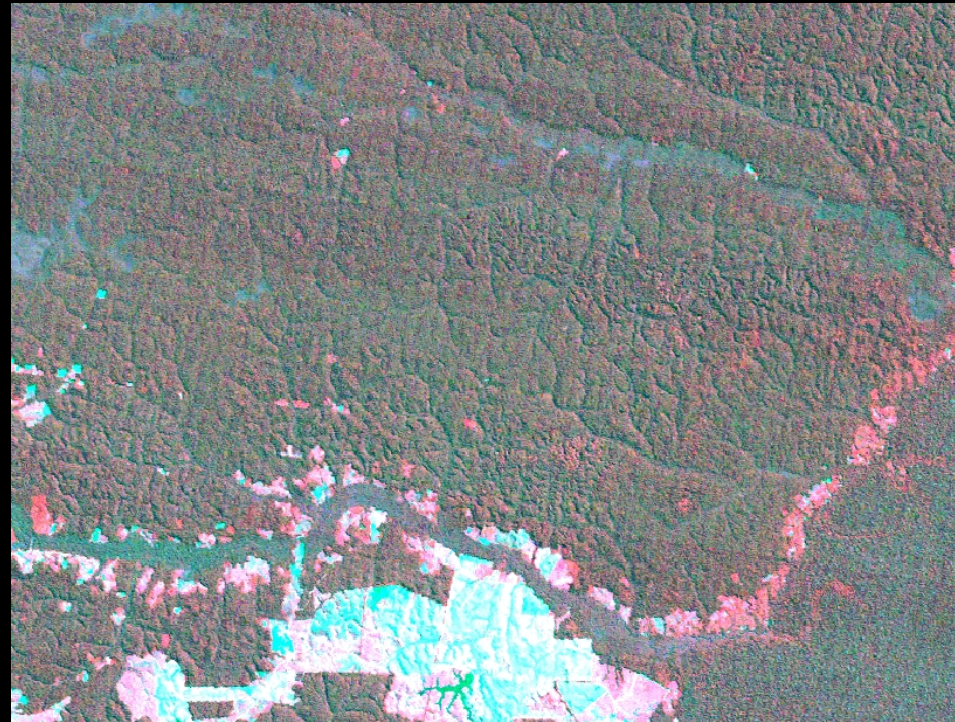
# Detailed View

ETM+



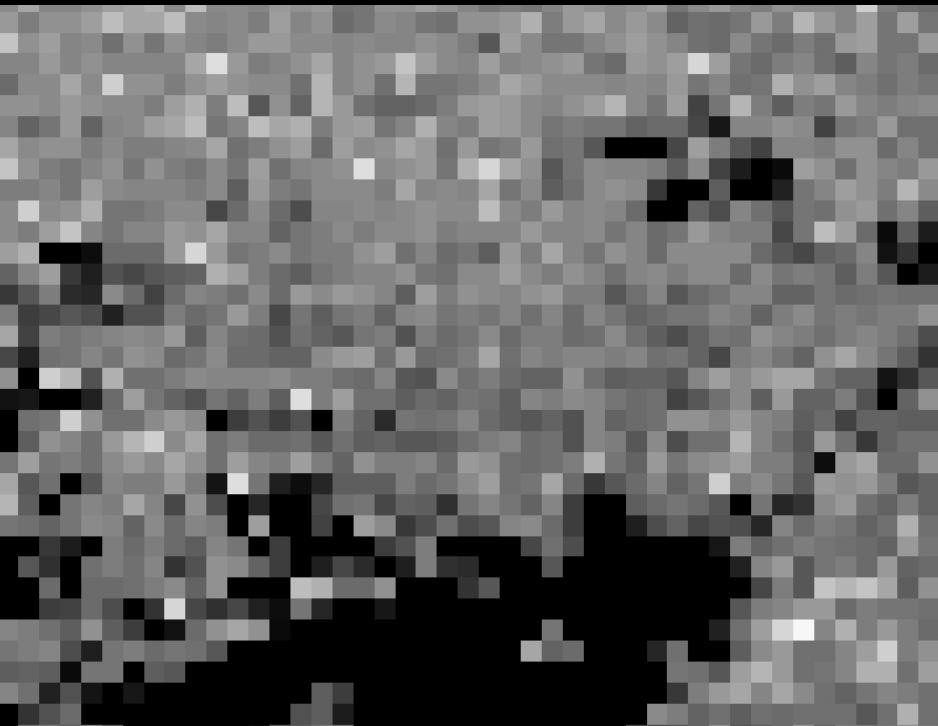
Acquired August 12, 2001

TM

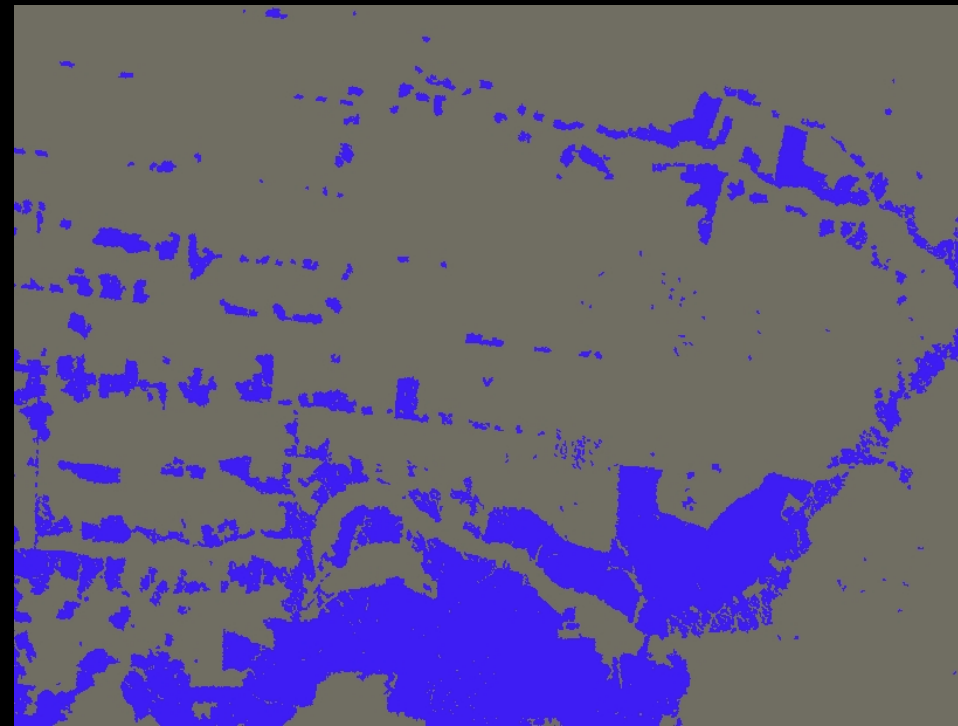


Acquired July 7, 1992

# Forest/Non-forest mask derived from VCF 500m

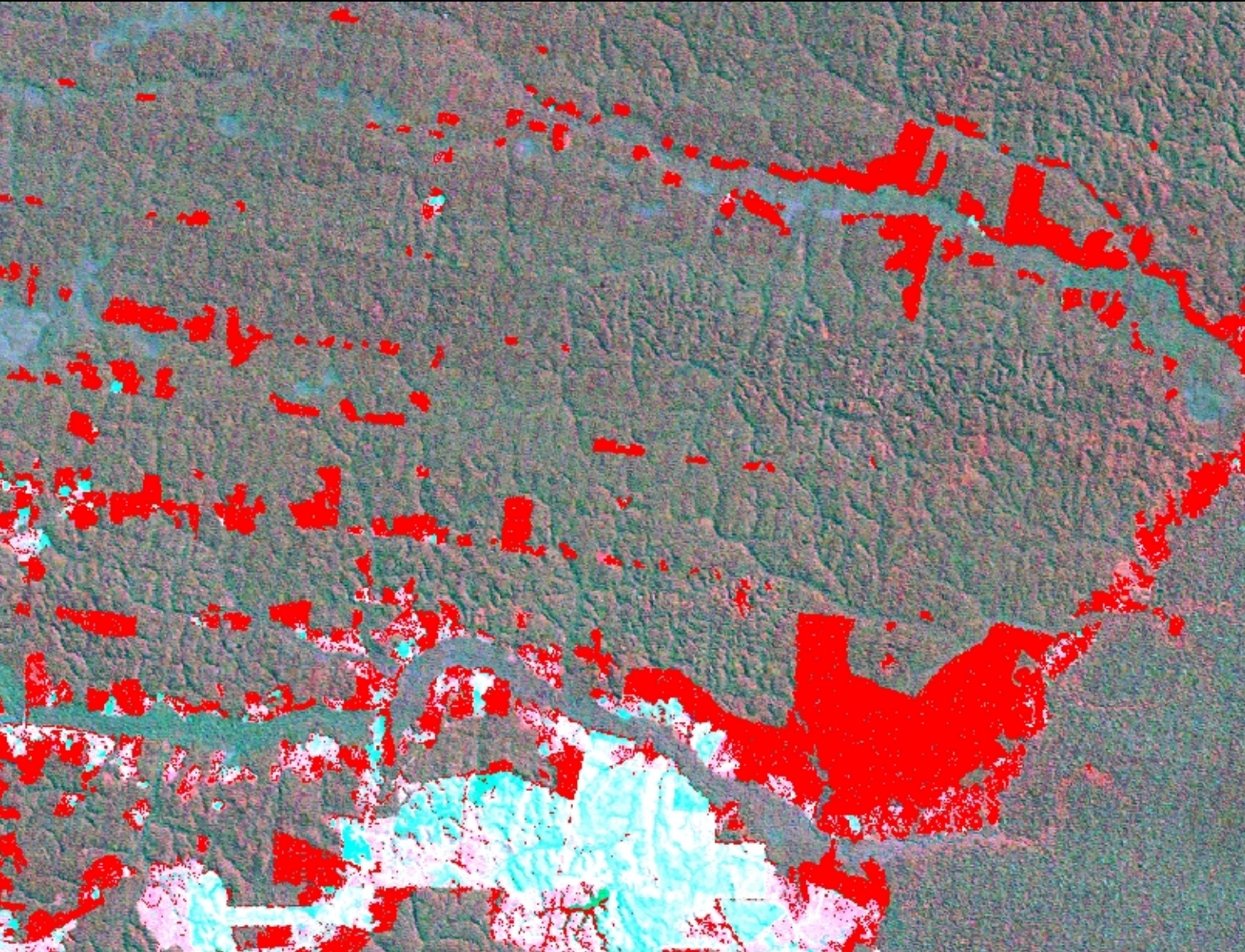


VCF 500m



Forest/Non-forest mask

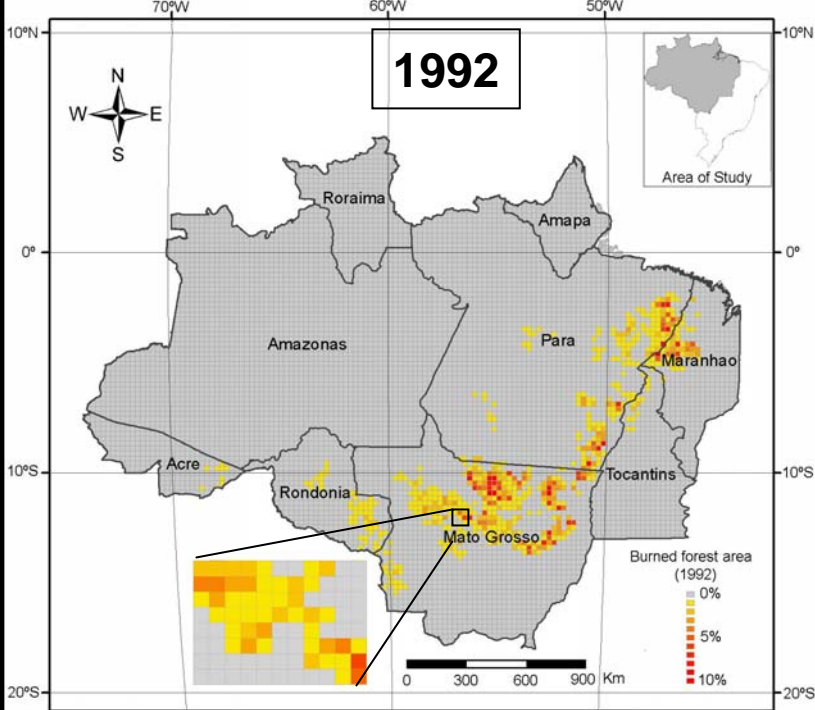
# Change deforestation shown in red



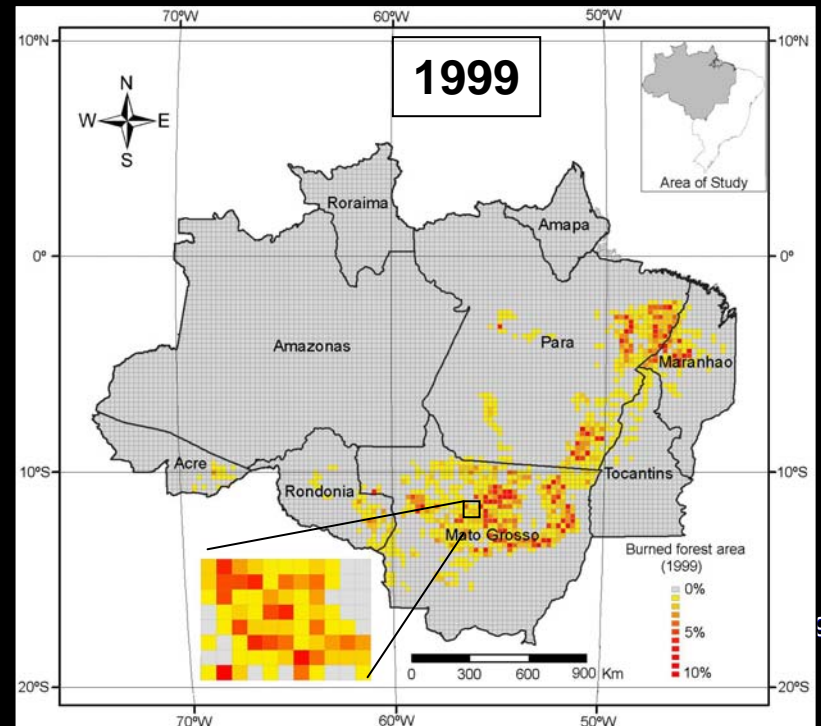
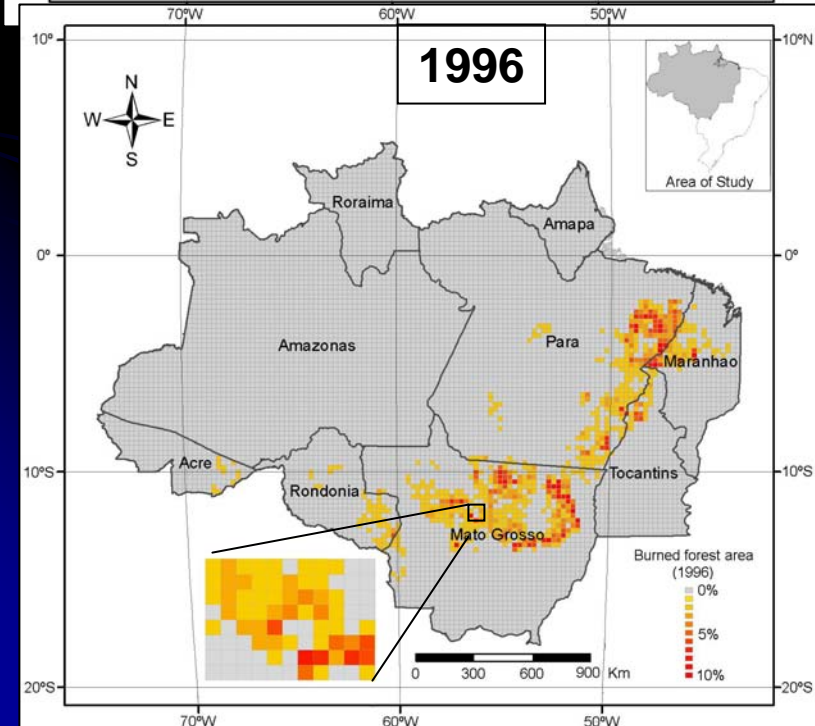
# Preliminary Results

- System in processing while I am here
- Some early numbers coming out of the pipeline (units=square km) 1990-2000

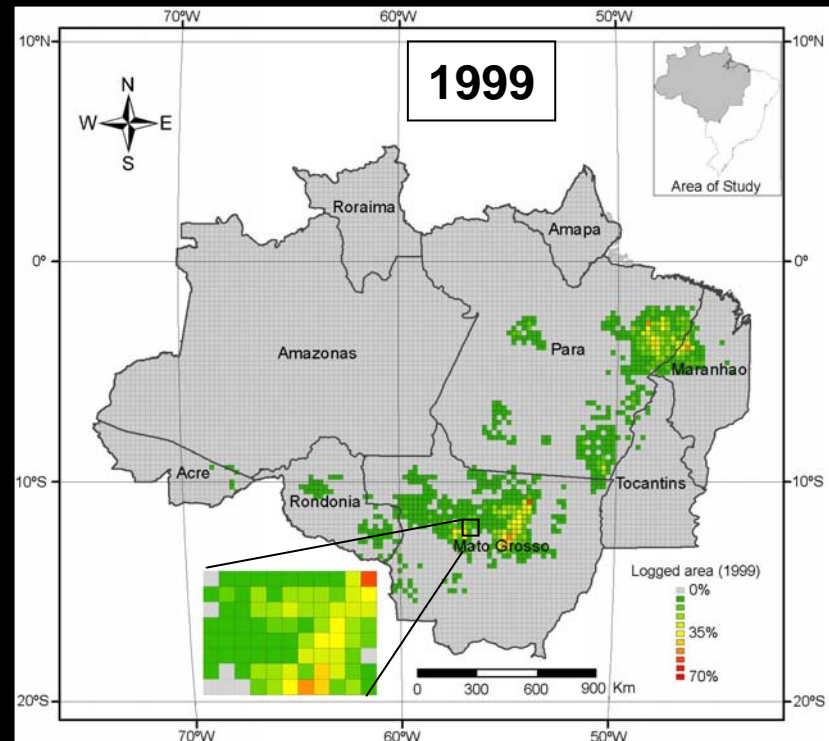
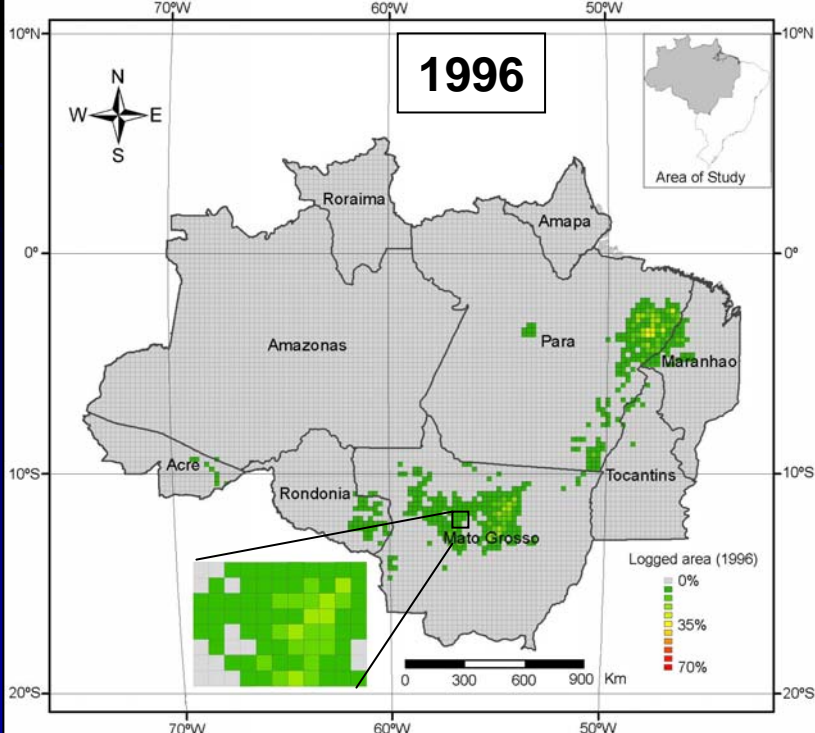
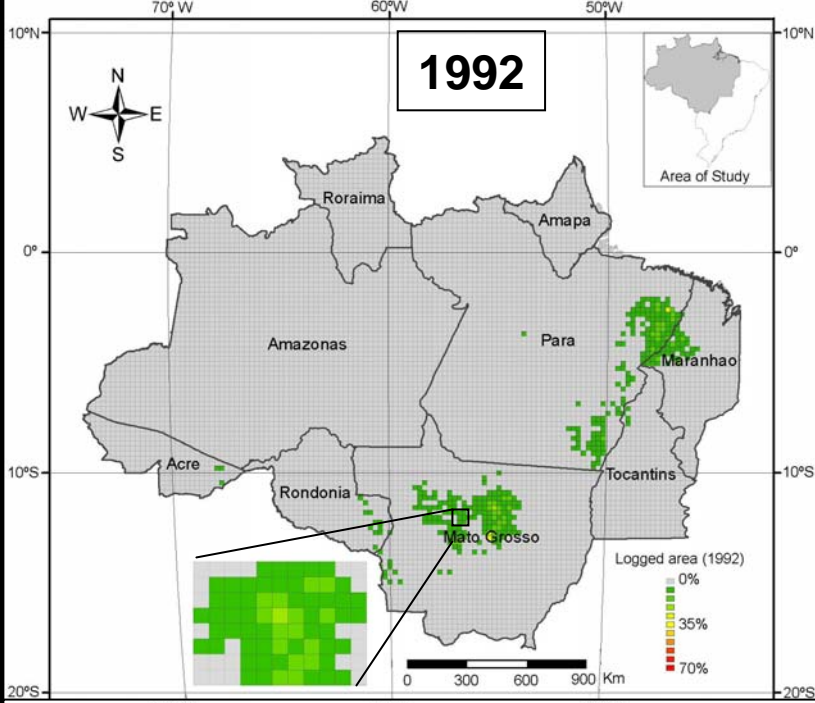
● Brazil	194,050,939
● Thailand	5,267
● Vietnam	9,327
● Laos	6,727
● Cambodia	2,456



# Burned Forest in Amazonia



# Logging in Amazonia



# Logged and Burned Forest in Amzonia

Year	Burned only (km <sup>2</sup> )	Burned & Logged (km <sup>2</sup> )	Logged only (km <sup>2</sup> )	Total degraded (km <sup>2</sup> )
1992	5,889.4	391.6	5,588.2	11,869.3
1996	6,177.7	1,403.3 <sup>(a)</sup>	8,951.0	16,532.0
1999	9,038.4	2,470.7 <sup>(b)</sup>	24,188.1	35,697.3

<sup>a</sup> Total includes 290.2 km<sup>2</sup> of burned forest detected in 1996, which was previous logging detected in 1992 and not detected in 1996;

<sup>b</sup> Total includes 573.4 km<sup>2</sup> of burned forest detected in 1999, which was previous logging detected by 1996 and not detected in 1999.

# The End





Land use following deforestation in Mato Grosso, Brazil, derived from MODIS-based phenology, helps to identify economic drivers of forest loss and the duration of land cover conversions.

