Applications of IKONOS images in support of researches of NASA LBA-Ecology Program

Xiangming Xiao

George Hurtt, Michael Keller, Michael Palace, Berrien Moore III

Complex Systems Research Center

Institute for the Study of Earth, Oceans and Space

University of New Hampshire, Durham, NH 03824, USA

NASA/USGS/NIMA High Spatial Resolution Commercial Imagery Workshop

March 19-21, 2001, Greenbelt, MA

Outline of the presentation

- **Scientific issues addressed by the LBA-Ecology program**

- **The status of acquisition and distribution of IKONOS images in 2000 for the LBA-Ecology program**

- **Preliminary evaluation of IKONOS images for Land Cover and Land Use Change research in the Amazon basin**

What, who, when, where and why of LBA-Ecology *(http://lba-ecology.gsfc.nasa.gov/lbaeco/)*

What

LBA-Ecology is one of several international research components under the Brazilian-led Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA), and concentrates on the processes and effects of land use change.

Who

NASA Terrestrial Ecology program and NASA Land Cover and Land Use Change program

When

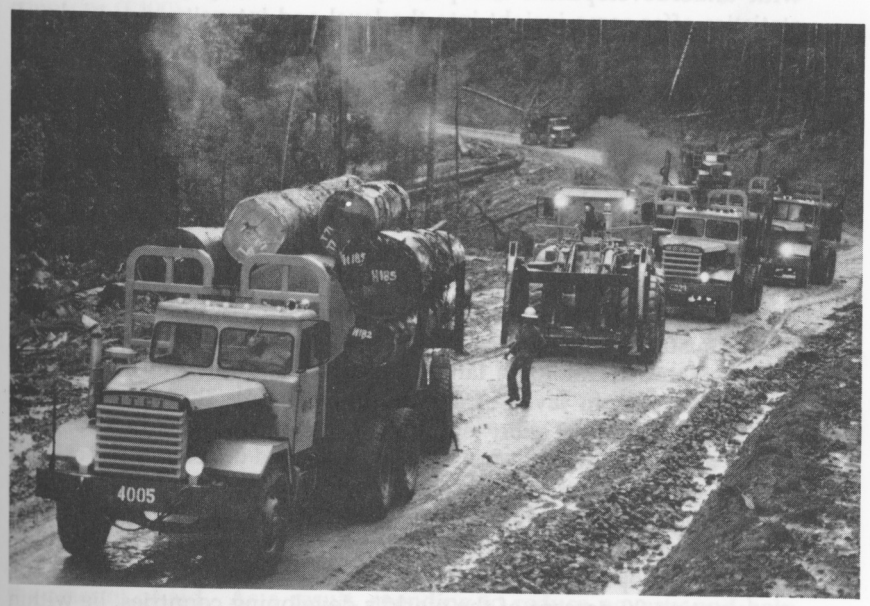
NASA's support of this multi-year project is expected to extend through the year 2003.

What, who, when, where and why of LBA-Ecology (http://lba-ecology.gsfc.nasa.gov/lbaeco/)

Why

The overall science question for LBA-Ecology is:

How do tropical forest conversion and re-growth, and selective logging influence carbon storage, nutrient dynamics, trace gas fluxes, and surface water chemistry and the prospects for sustainable land use in Amazonia?



Lumber workers transport dipterocarp logs, which command high prices on the international market, out of the tropical rain forest on the island of Borneo, Indonesia. If these tall trees are not harvested carefully, significant damage can be done to the surrounding forest. Credit: James P. Blair © 1983 National Geographic Society.

What, who, when, where and why of LBA-Ecology *(http://lba-ecology.gsfc.nasa.gov/lbaeco/)*

Where

LBA-Ecology has study sites located in Brazilian and Ecuadorian Amazon Basin

The LBA Scaling Strategy

Although the LBA scaling strategy builds partly on the methodology developed in previous land surface experiments, unlike these, LBA is concerned with the fate of the entire ecosystem. This is reflected in the time-scale of LBA field activities, which includes multi-year monitoring of environmental characteristics.

Status of acquisition of IKONOS images in 2000

NASA Scientific Databuy Program

Image acquisition criterion: <10% clouds cover

The first IKONOS image acquisition proposal: early 2000

15 eddy flux tower sites in Amazon basin

The second IKONOS image acquisition proposal: mid-2000

14 extensive land use sites in Amazon basin

IKONOS images acquired: 13 out of 15 tower sites, 4 out of 14 land use sites.

Distribution of IKONOS images to LBA-Ecology users

Data distribution : http://www.eos-webster.sr.unh.edu

Statistics as of 3/16/2001

Number of people who have looked at the IKONOS subsystem on EOS-WEBSTER (excludes repeat logins): 139

Number of registered IKONOS users: 17

Number of IKONOS data products (images) that have been ordered (downloaded via ftp) : 67

Data volume of IKONOS orders: 7.92 gigabytes

Specific scientific questions to be addressed:

1. Landscape-scale spatial variations of eddy-flux tower sites

visual interpretation, explorative data analysis

2. Sub-pixel heterogeneity and large-scale mapping

end-member selection, validation,

3. Selective logging of forests

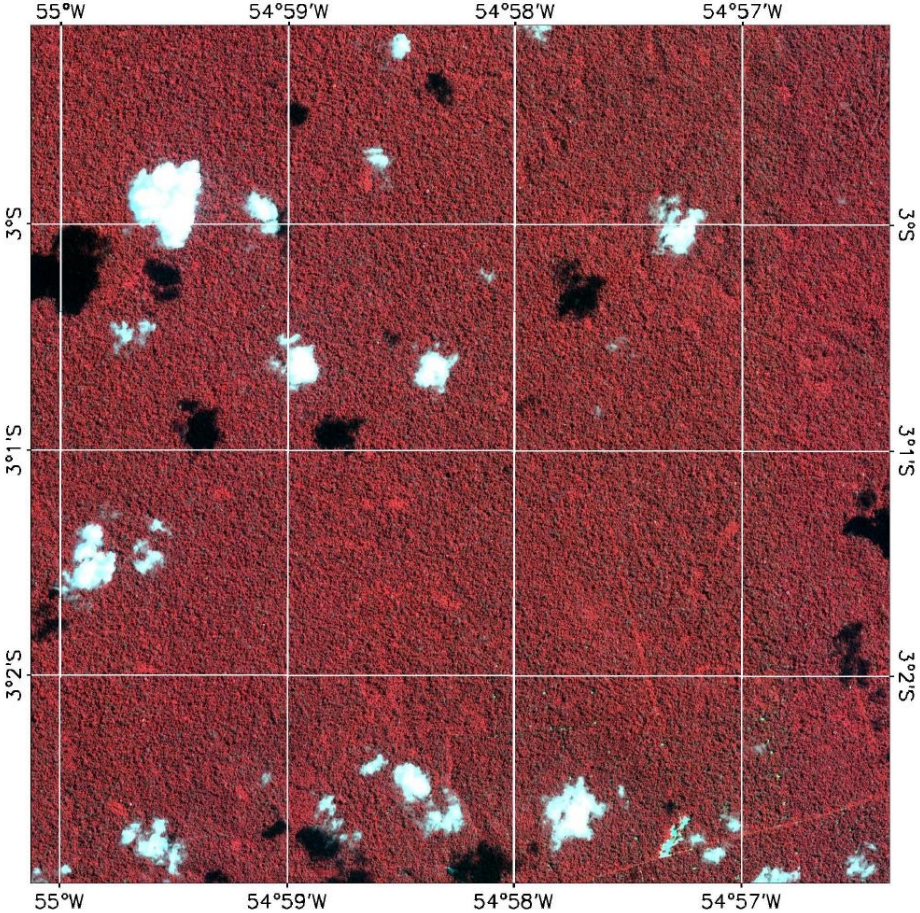
4. Secondary forests

successional stage, age, pathway

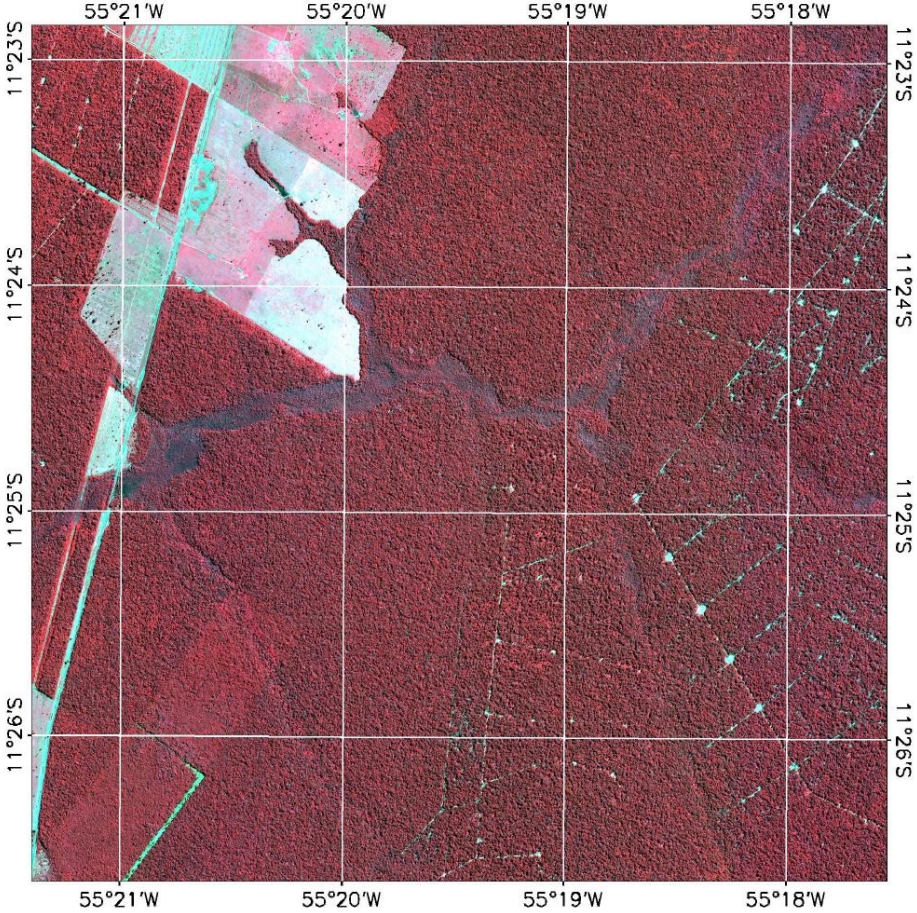
5. Forest canopy gap

natural disturbance

Visual interpretation

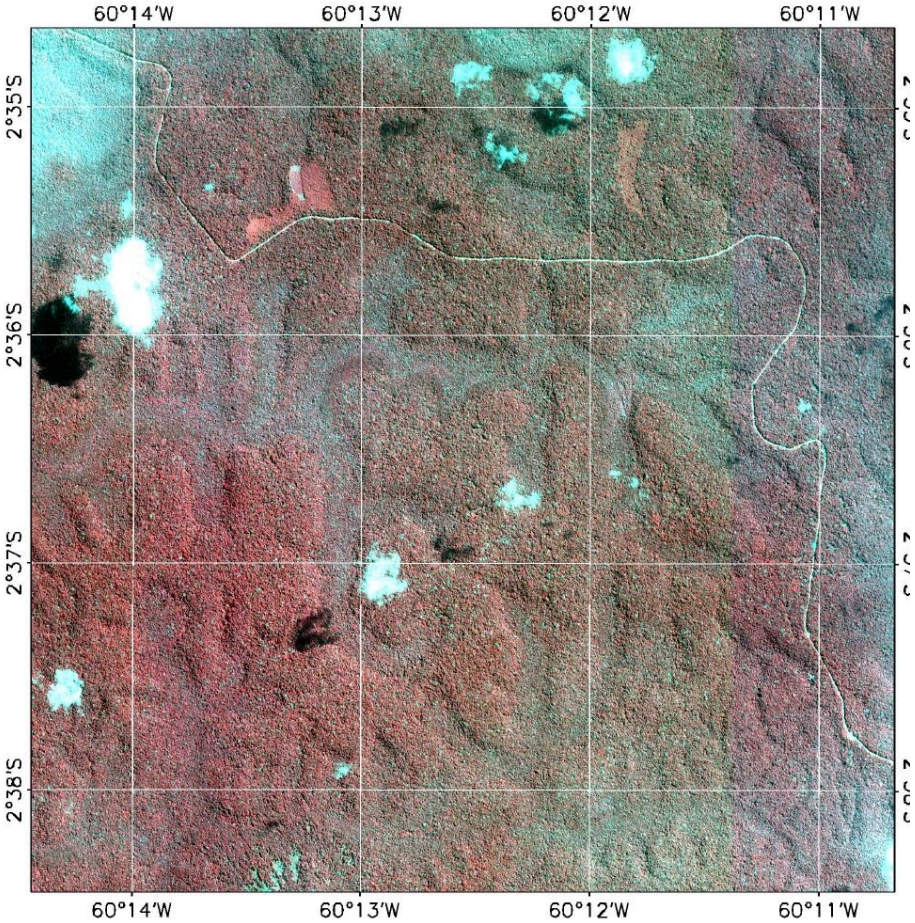


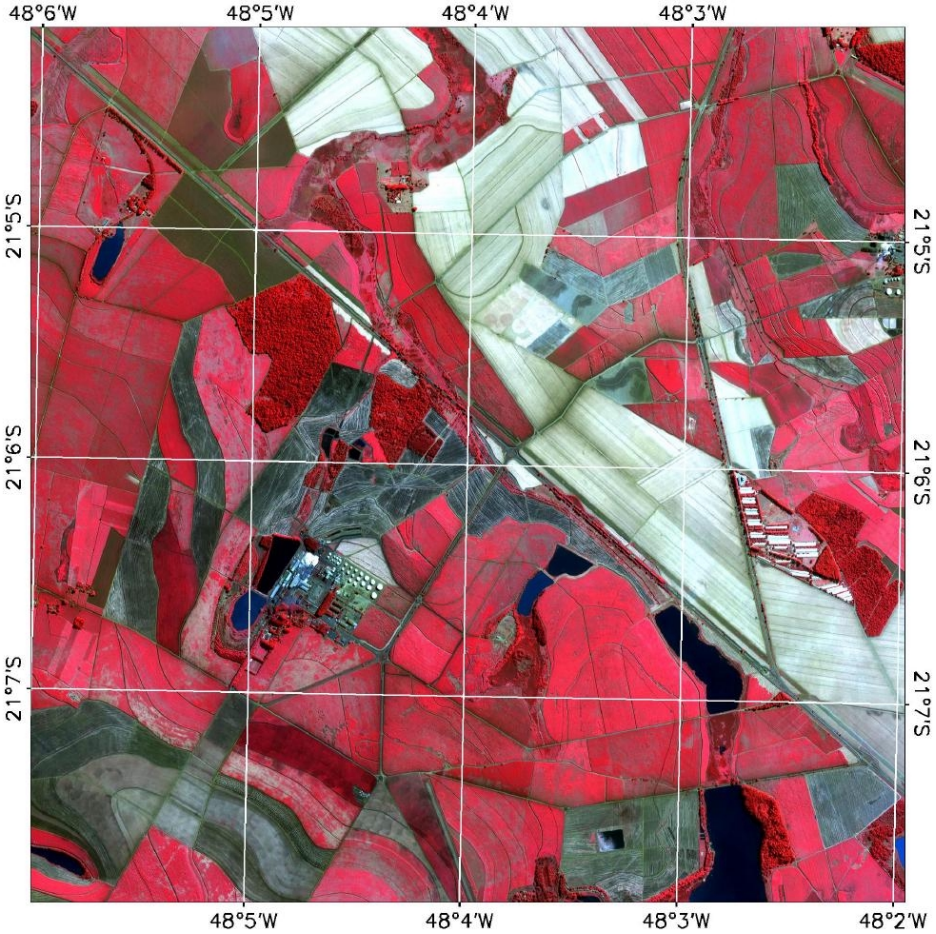
Forest eddy flux tower site at Santarem (#2), 8/29/2000



Forest eddy flux tower site at Mato Grosso, 4/30/2000

Visual interpretation

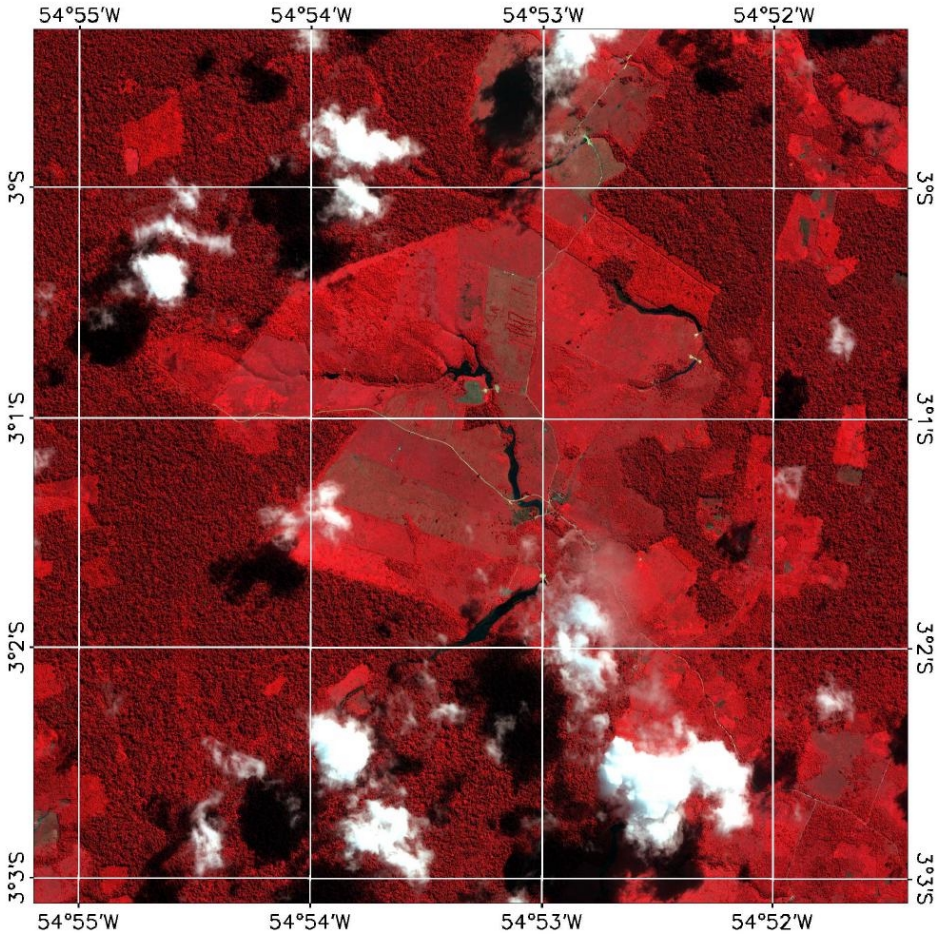


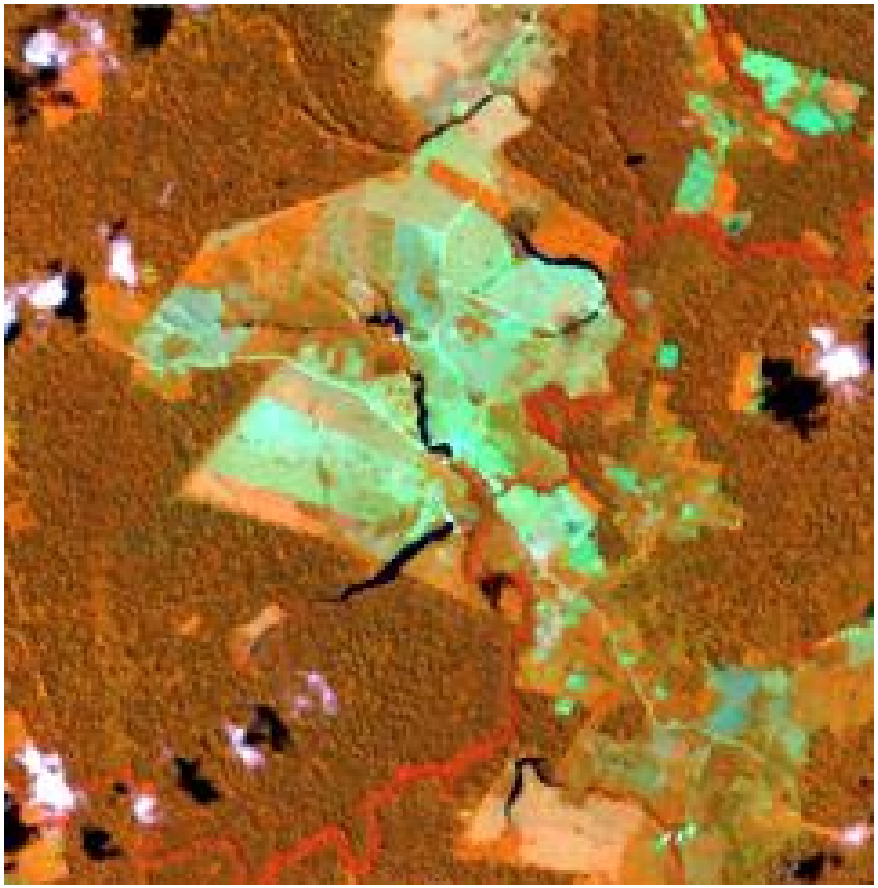


Forest eddy flux tower site at Manaus (#2), 8/24/2000

Sugarcane site, on 6/12/2000

Visual interpretation: Pasture eddy flux tower site at Santarem (#1)





IKONOS on 6/13/2000

Landsat 7 ETM+ on 6/21/1999

Forest canopy structure and understory structure at the Tapajós National Forest,

Source:http://www-as.harvard.edu/chemistry/brazil

Scientific question:

Landscape-scale spatial variations for the eddy flux tower sites

Eddy flux tower site at the Tapajós National Forest, (Steve Wofsy at Harvard University).

With its northern boundary located 50 km south of Santarém, Pará, Brazil, the Tapajós National Forest covers approximately 600,000 ha between the Rio Tapajós and the Santarém-Cuiabá Highway (BR-163).

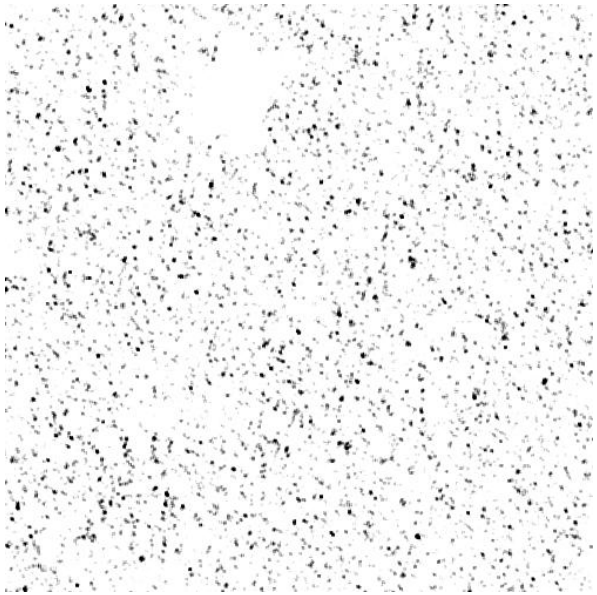
It was constructed in 2000. Arrows indicates the location of eddy-covariance instruments at 60m (above all trees) and 45m (maximum height of emergent trees)

Source:http://www-as.harvard.edu/chemistry/brazil/

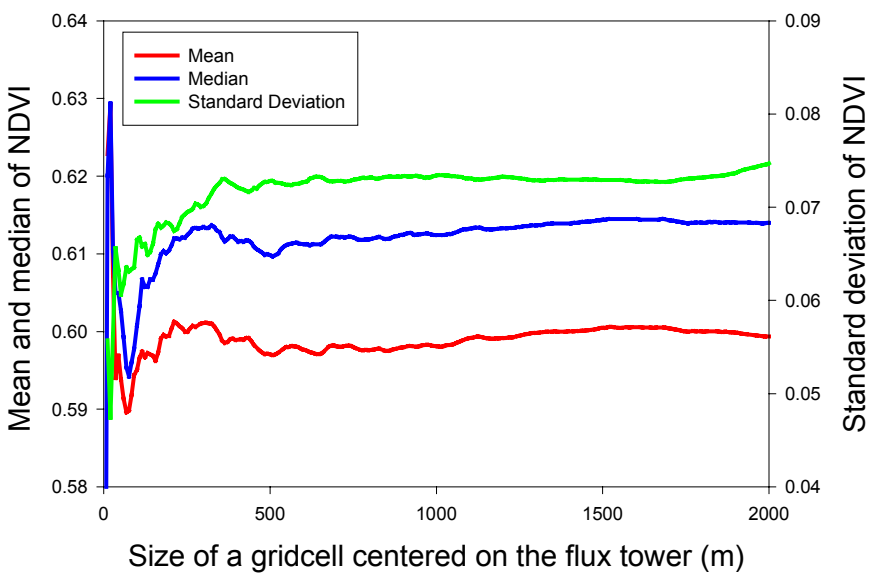
IKONOS image for the Santarem #2 eddy flux tower site in Para,

NIR – RED – GREEN bands (RGB)

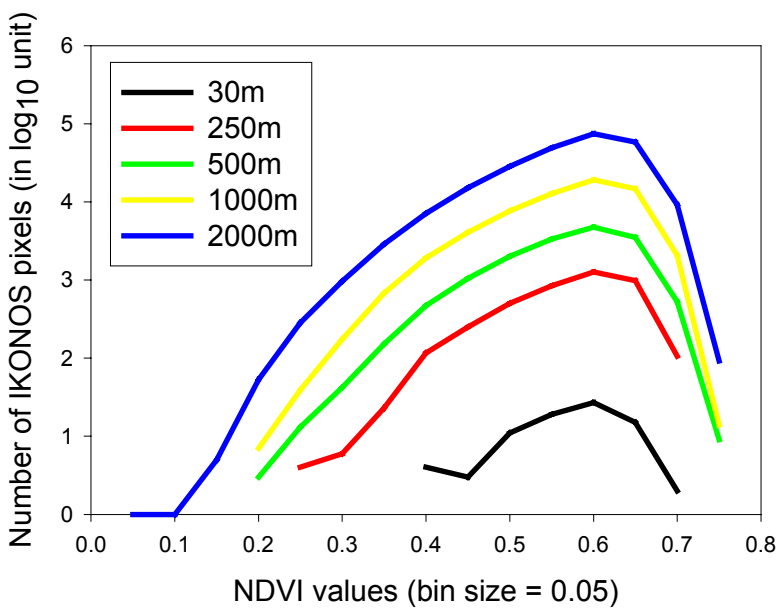
Homogeneity image of NDVI



NDVI value within a gridcell of variable sizes (Santarem 2)

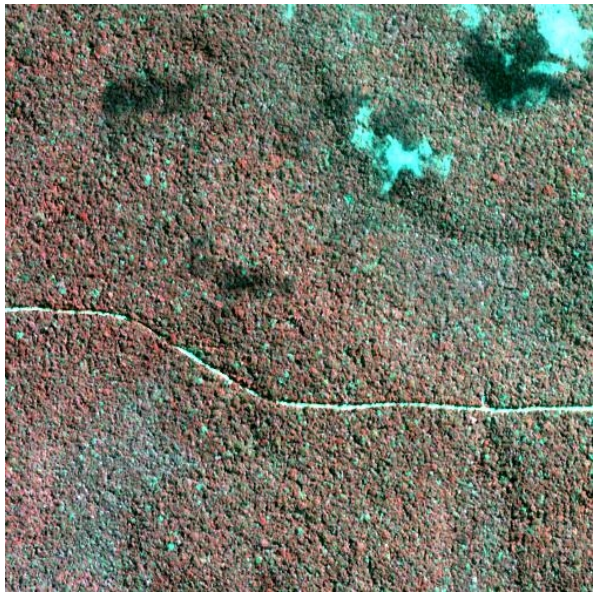


Histogram of NDVI within a gridcell (Santarem 2)



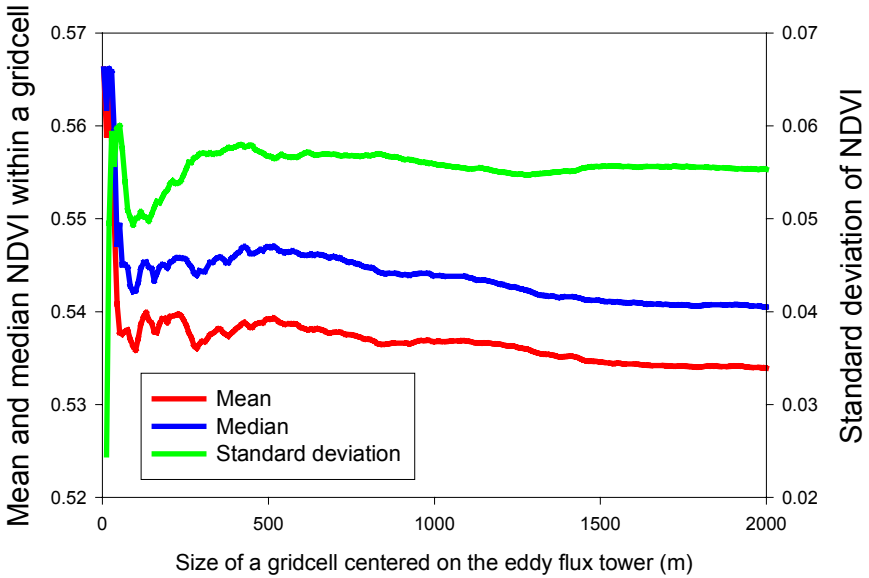
IKONOS image for the Manaus #2 eddy flux tower site in Amazonas,

NIR – RED – GREEN bands (RGB)

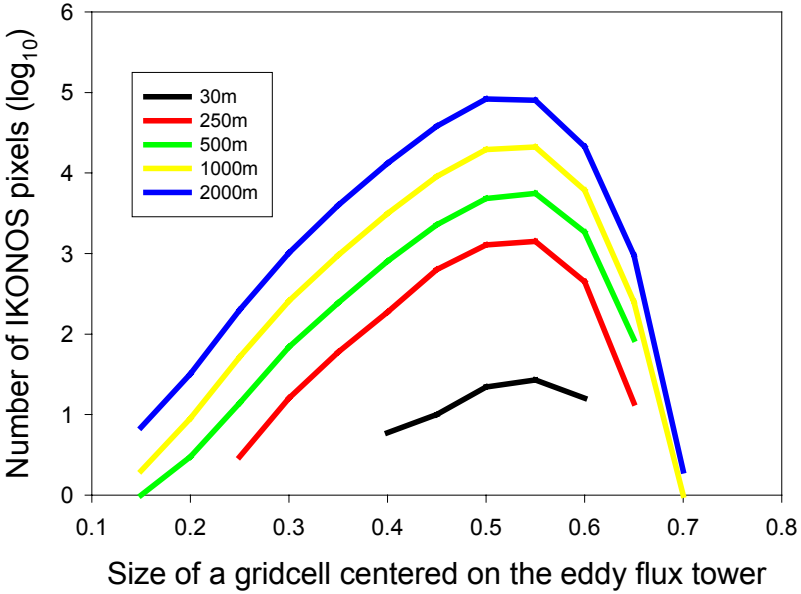


Homogeneity image of NDVI

NDVI within a gridcell of variable sizes

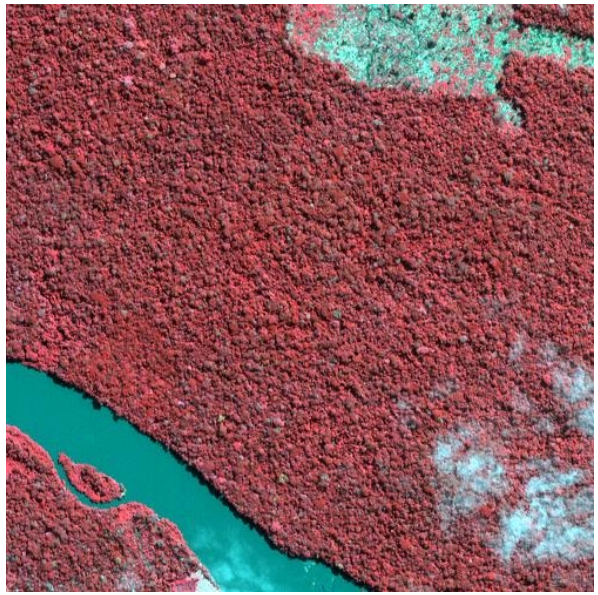


Histogram of NDVI within a gridcell (Manaus 2)

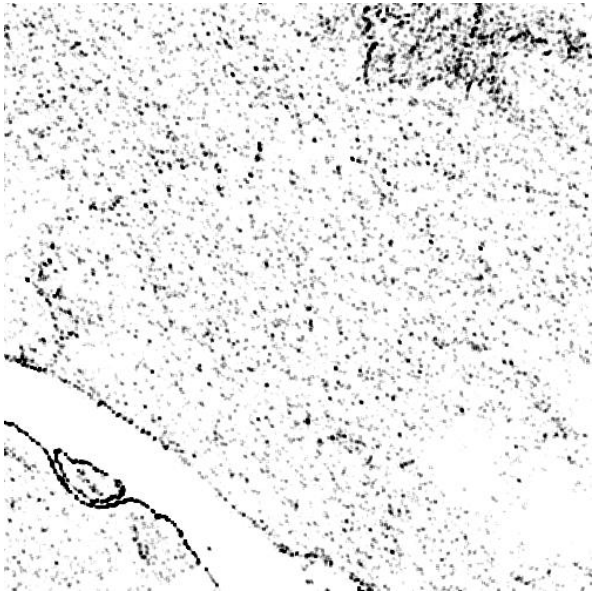


IKONOS image for the Jaru eddy flux tower site in Rondonia,

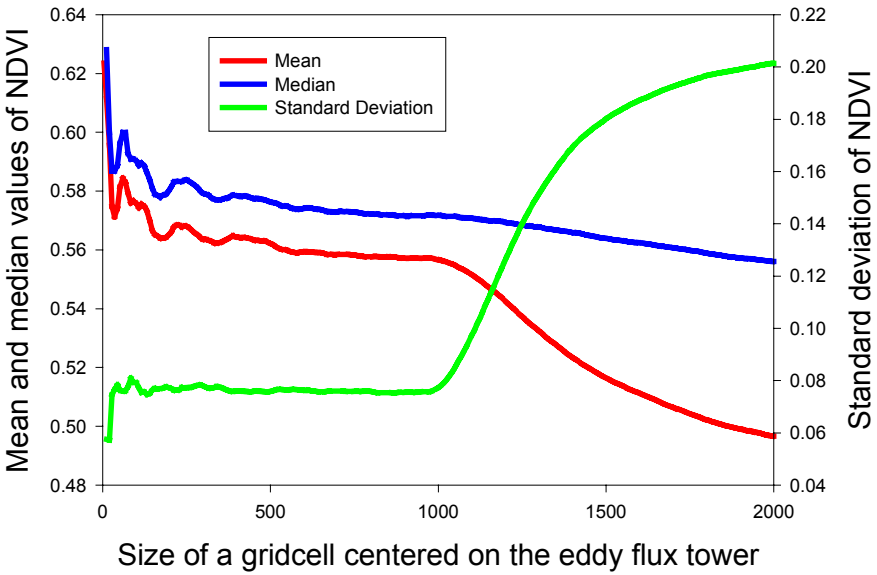
NIR – RED – GREEN bands (RGB)



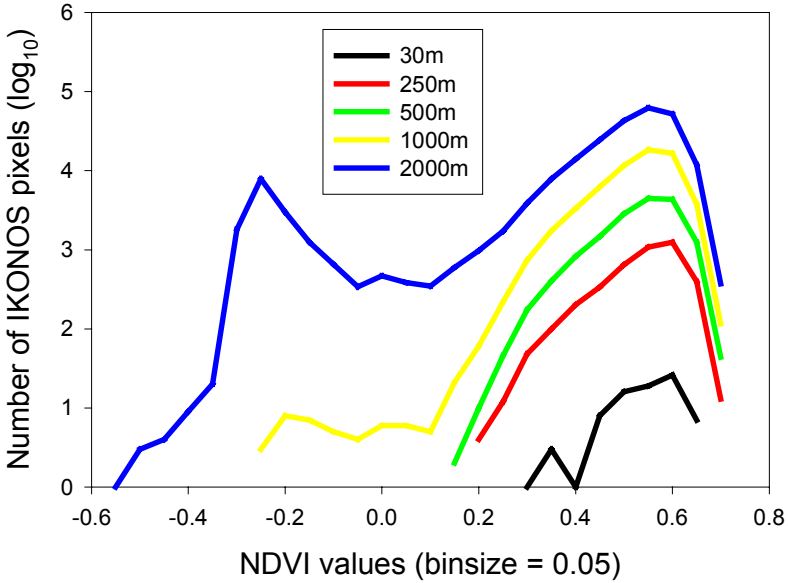
Homogeneity image of NDVI



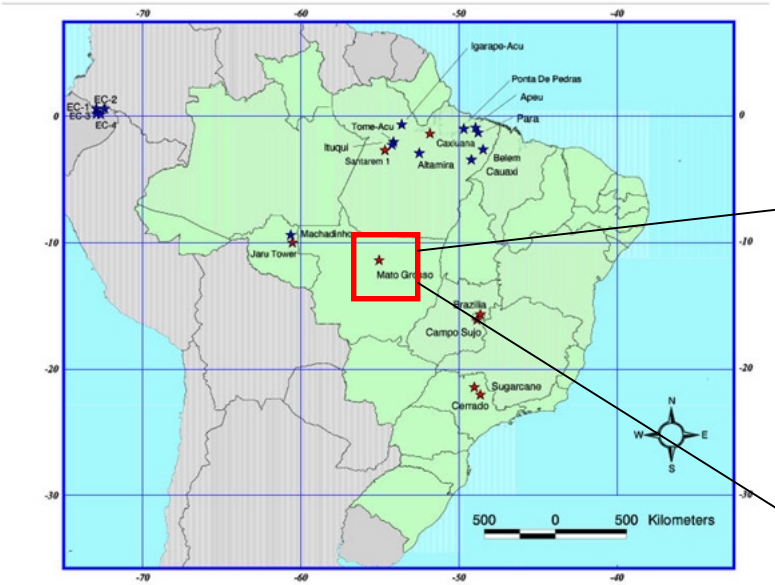
NDVI within a gridcell of variable sizes (Jaru tower)

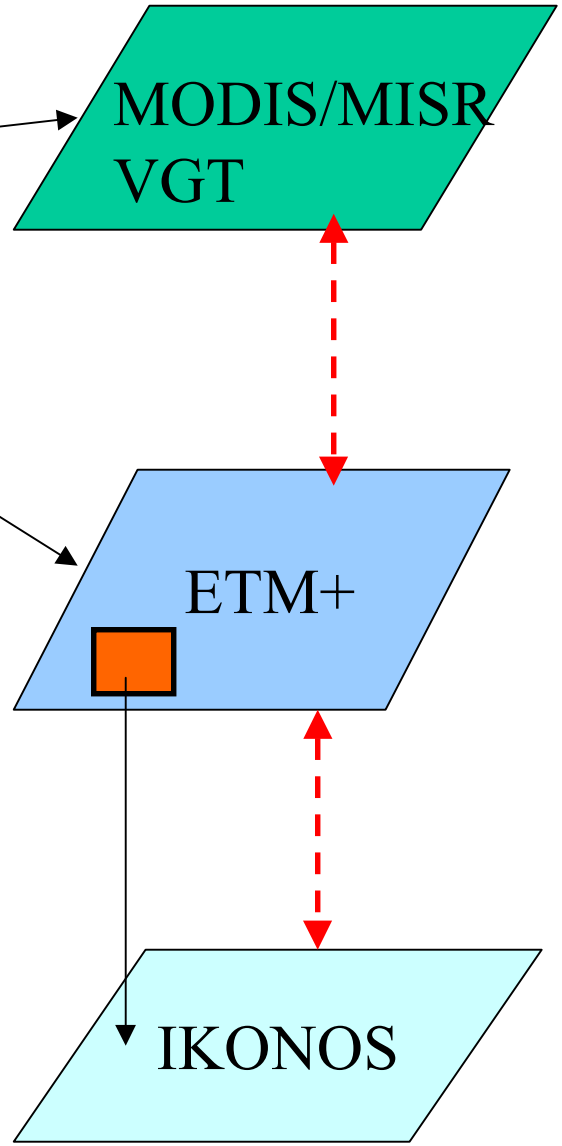


Histogram of NDVI within a gridcell of variable size (Jaru)



Multi-sensor/resolution image database for eddy-flux tower sites





Spatial resolution

250-m, 500-m, 275-m

30-m, 15-m

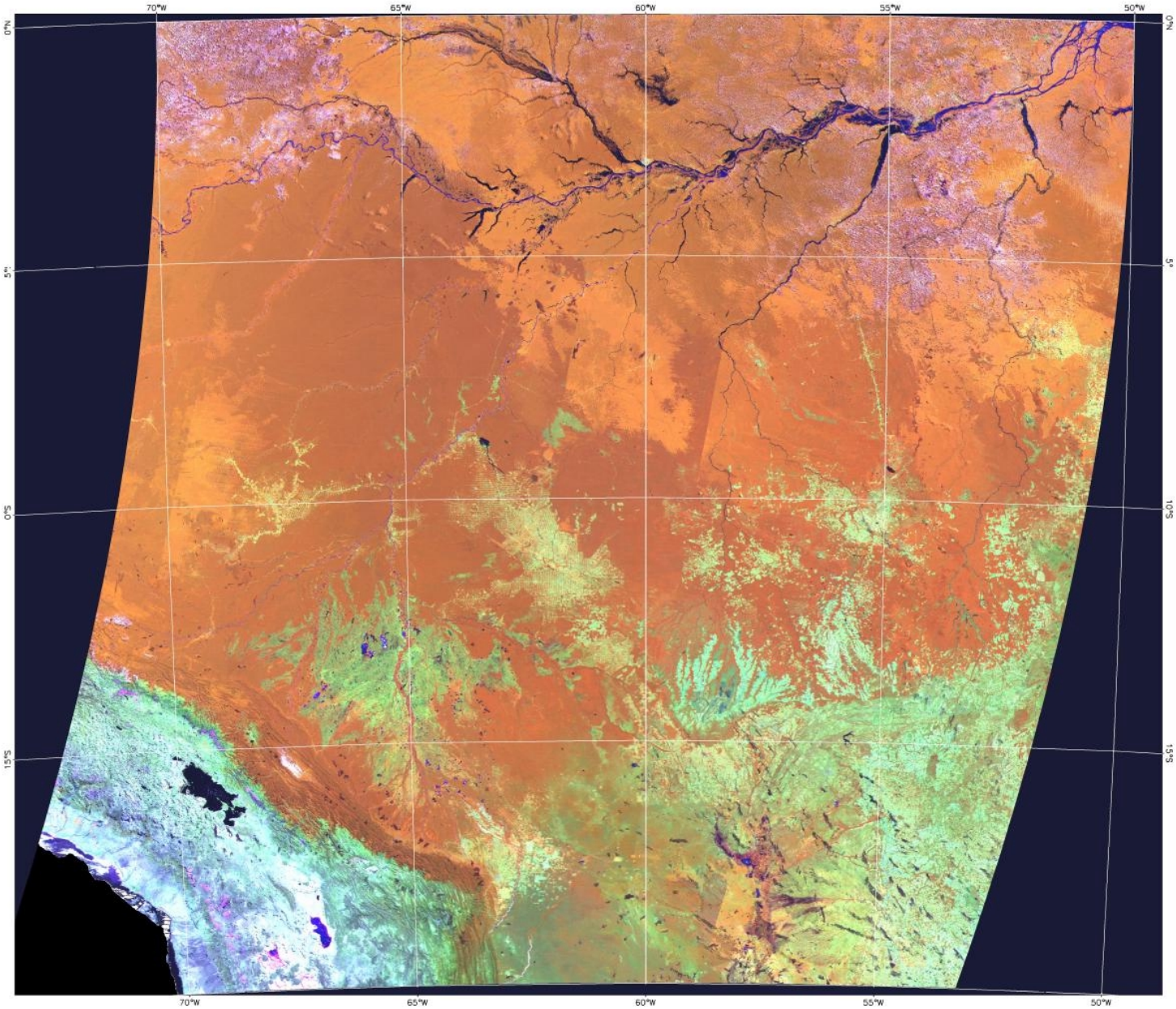
4-m, 1-m

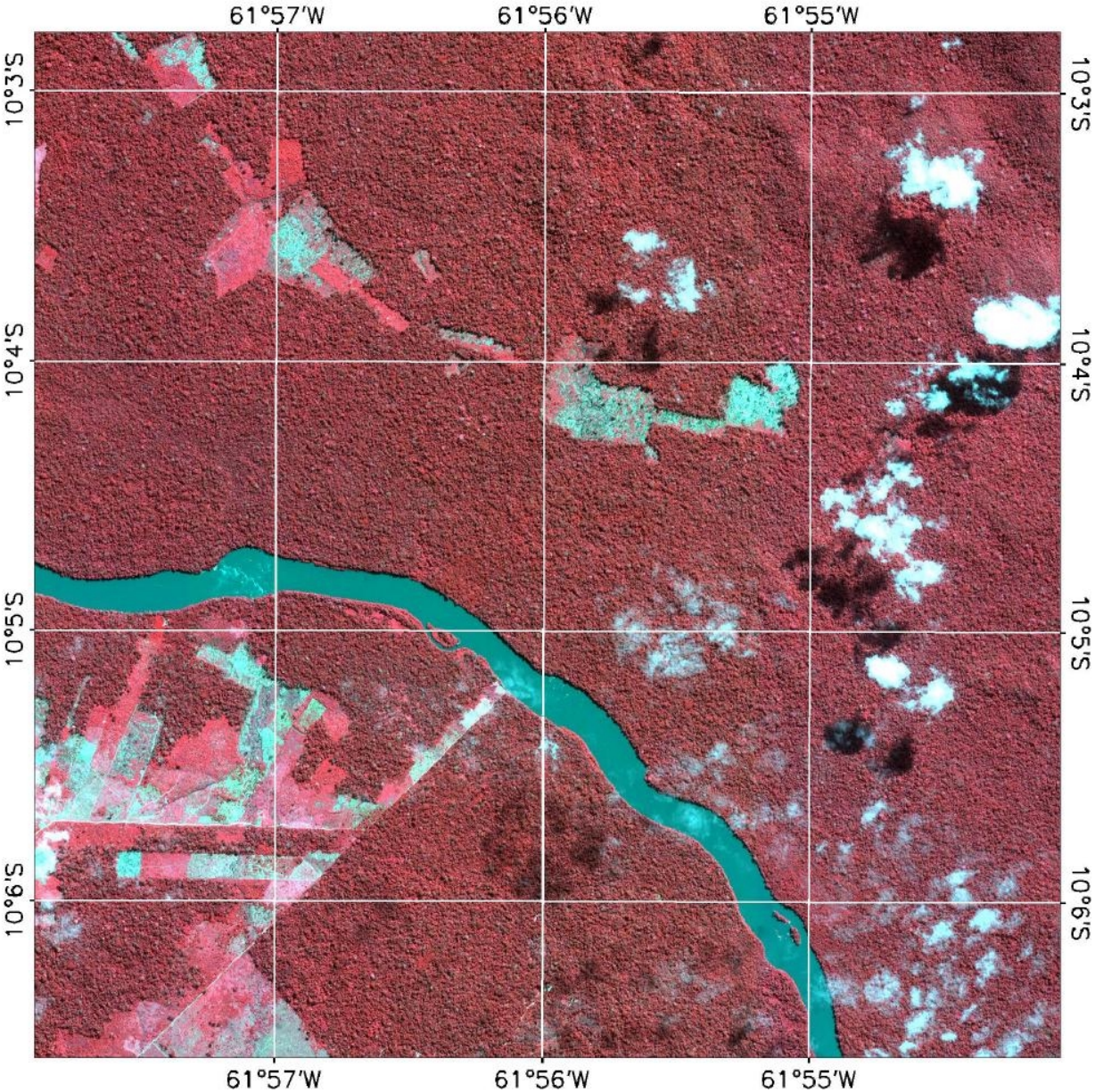
Scientific question:

Sub-pixel heterogeneity and large-scale mapping

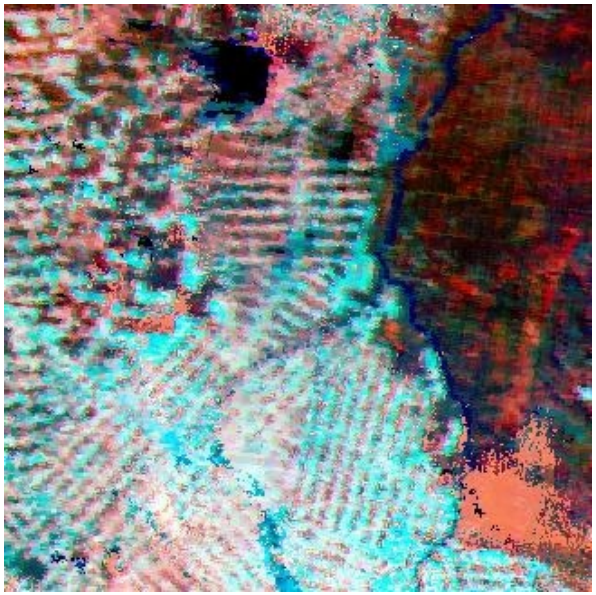
Image database needs to be linked with field databases

MODIS 8-day surface reflectance composite (band 2-6-1) in 7/20 - 7/26, 2000 at 500m spatial resolution



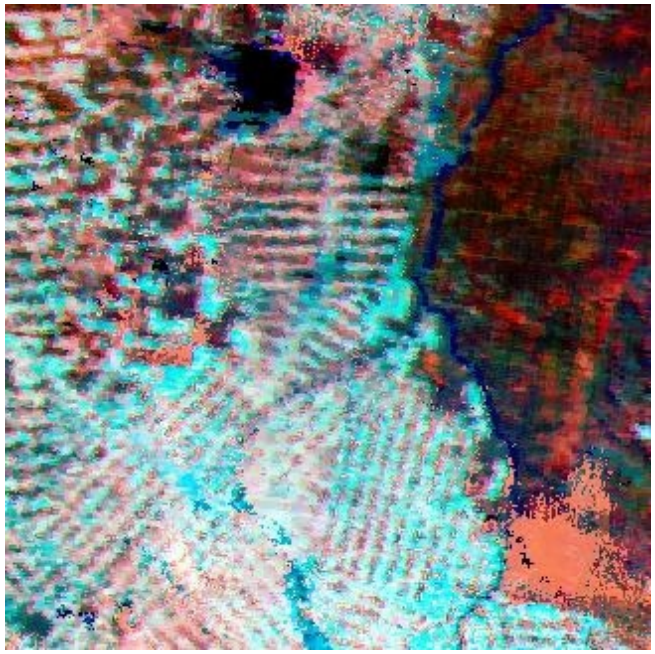


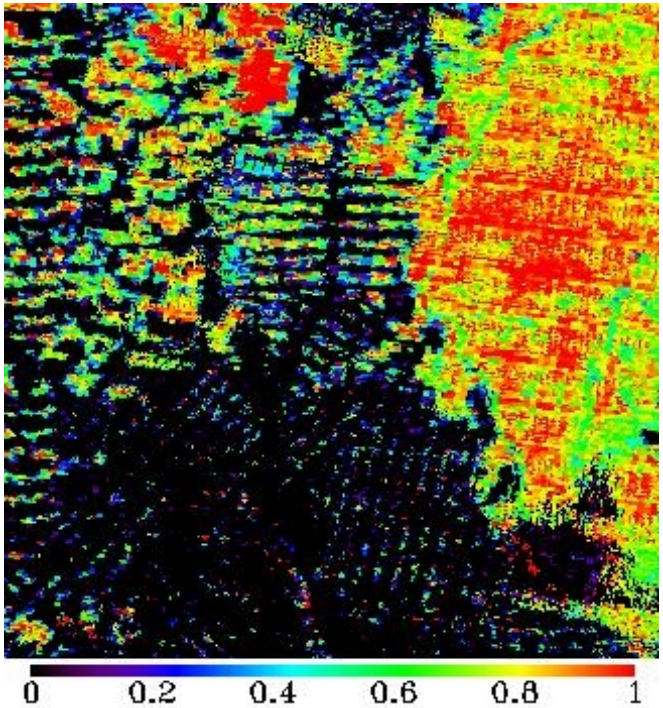
IKONOS image for the Jaru forest eddy flux tower site in Rondonia on 4/6/00 (NIR-RED-GREEN bands)

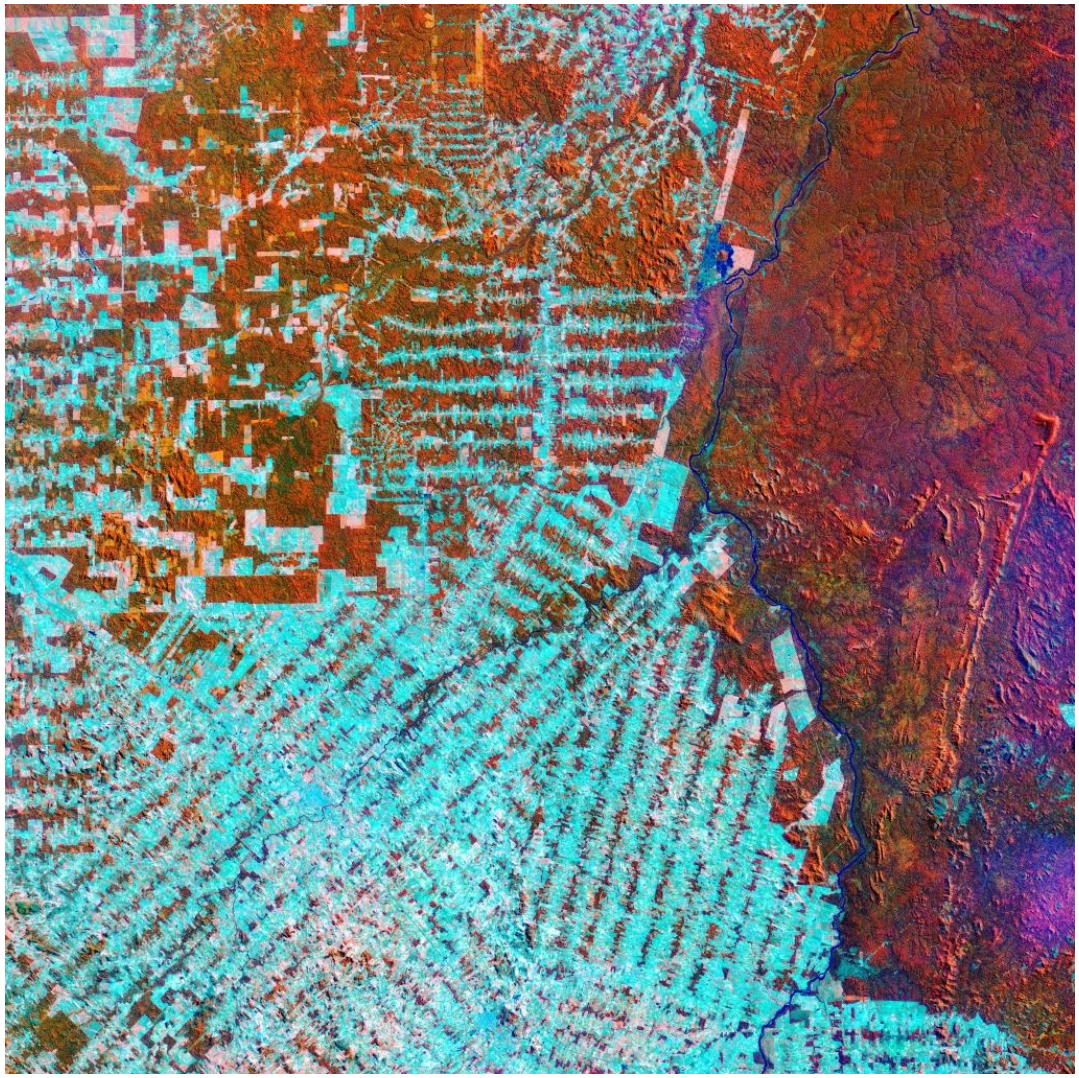


MODIS 8-day composite July 20-26, 2000

Spectral mixture analysis







Upper-left – MODIS surface reflectance

Lower-left --fractional of forest from MODIS

Right – Landsat 7 ETM+ on 8/6/1999

Forest succession: Aerial view of mature forest, *Vismia* and *Cecropia* forests

Summary

- **We are still at the early stage of IKONOS evaluation.**
- **For visual interpretation (qualitative analysis), IKONOS images are very useful for many LCLUC activities in the tropical landscapes.**
- **For quantitative analysis, the potential of IKONOS images needs to be fully assessed.**

  more case studies, new methods,
- **IKONOS images contribute substantially to the scaling issue in remote sensing and modeling.**