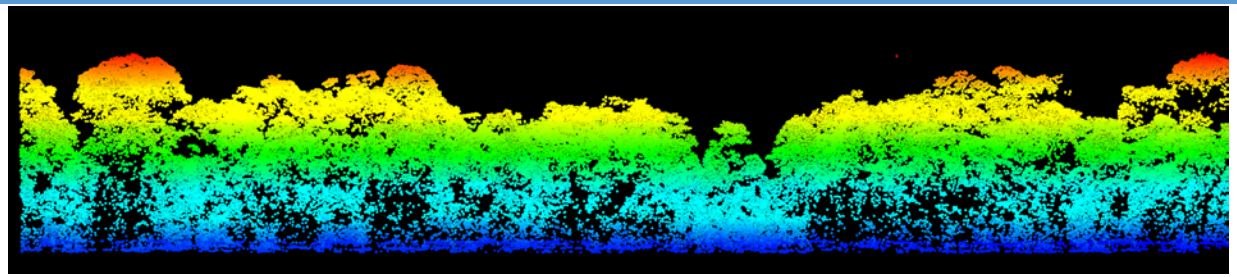
Final GlobBiomass User Consultation Meeting

11-13 September 2017, FAO - Rome, Italy

IMPROVEMENT AND DEVELOPMENT OF MODELING TOOLS OF CHANGES IN LAND USE AND LAND COVER AND ESTIMATED EMISSIONS – MSA/BNDES



Jean P. Ometto

EBA Team

EBA
Estimativa de biomassa na Amazônia

http://www.ccst.inpe.br/projetos/eba-estimativa-de-biomassa-na-amazonia/

Jean Ometto
Coordinator

Administrative Team

Fabielle Alves

Lucas Silva

Technical Team

Luciane Sato

LiDAR processing and map generation

Mauro Assis

LiDAR validation

Heitor Guerra

Processing and database management

Aline Jacon

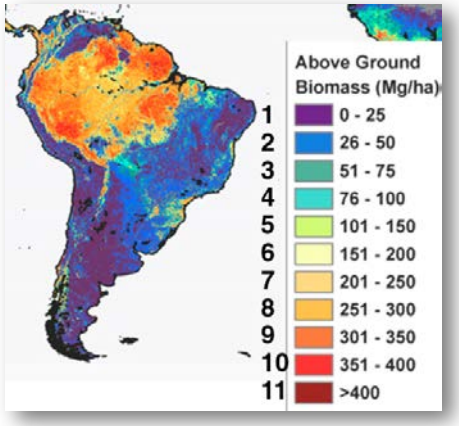
Hyperspectral processing and map generation

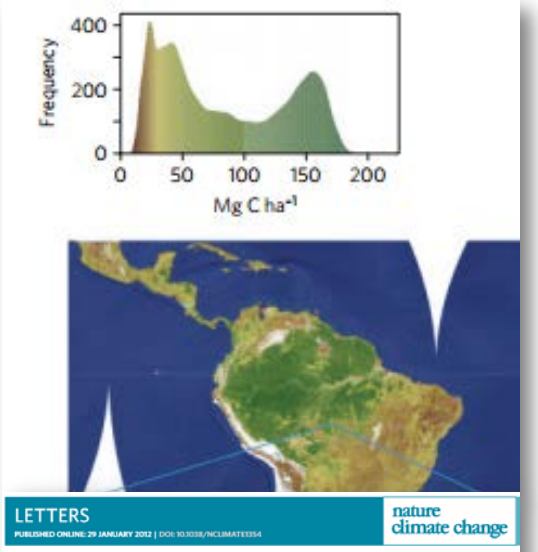
Francisca Pereira

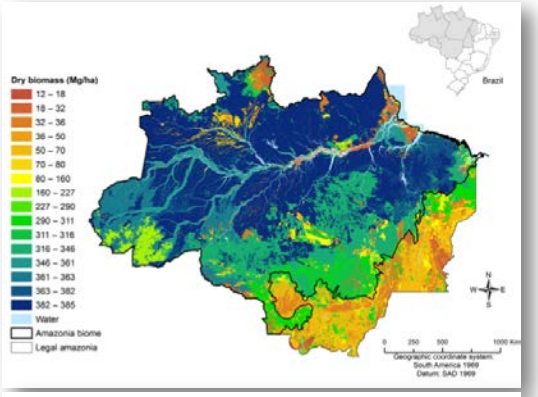
LiDAR processing and map generation

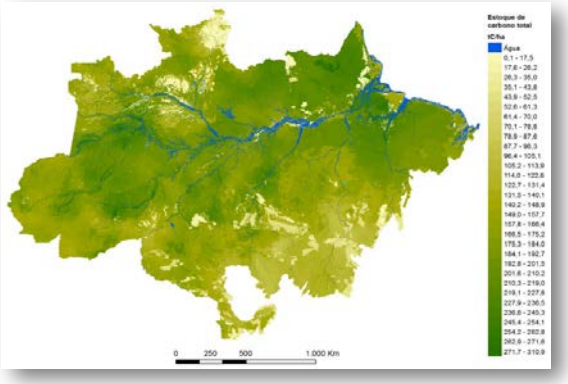
Forest Biomass Maps

Subproject 7

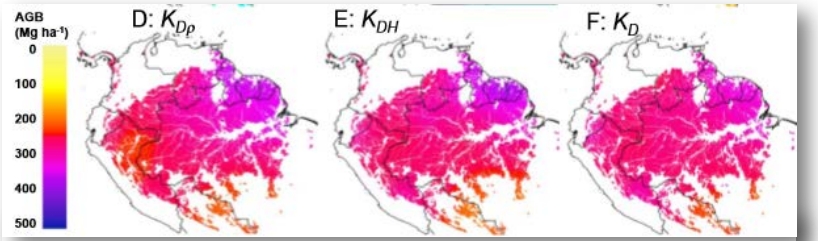








MCTI, TCN, 2016.



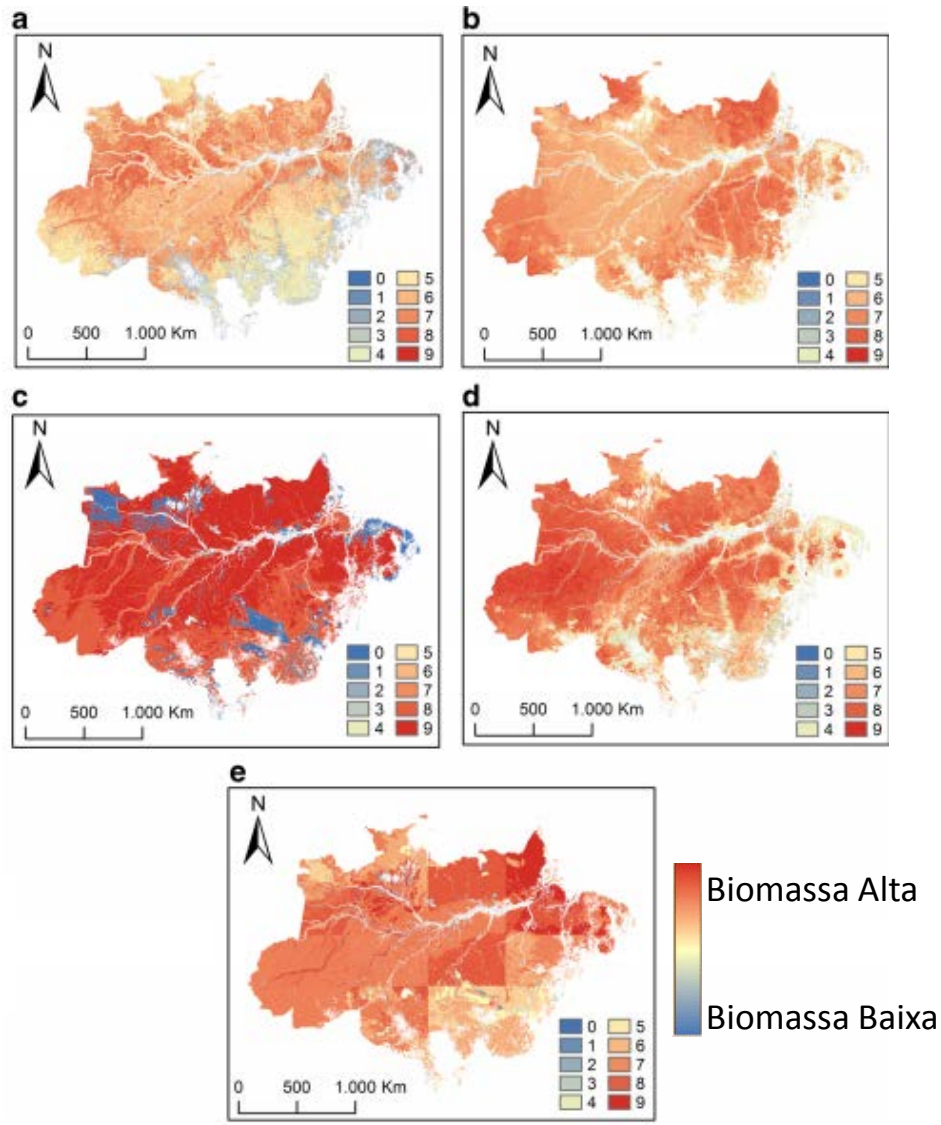
Differences...

Subproject 7

Amazon forest biomass density maps: tackling the uncertainty in carbon emission estimates

Jean Pierre Ometto · Ana Paula Aguiar · Talita Assis · Luciana Soler · Pedro Valle · Graciela Tejada · David M. Lapola · Patrick Meir

Climatic Change (2014) 124:545–560
DOI 10.1007/s10584-014-1058-7

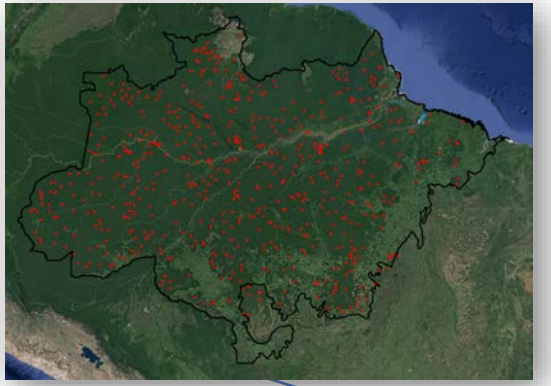


a) Saatchi et al. (2007)
b) Saatchi et al. (2011)
c) Nogueira et al. (2008)
d) Baccini et al. (2012)
e) MCTI (2010)

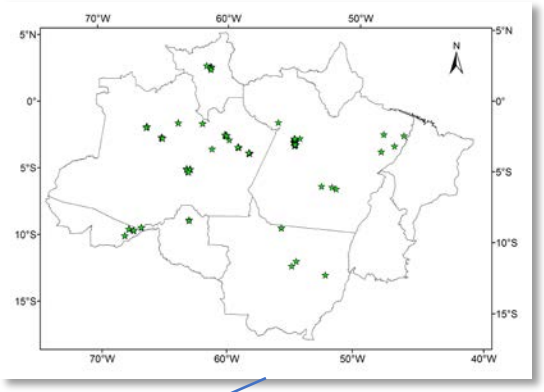
Biomass Map

Subproject 7

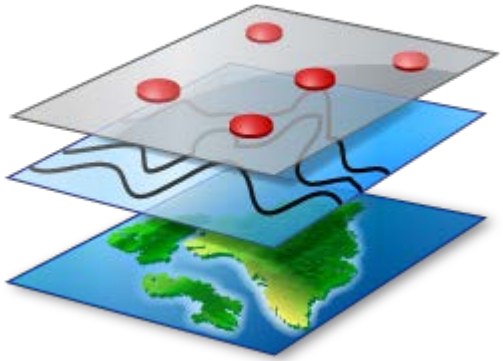
LiDAR data - Transects

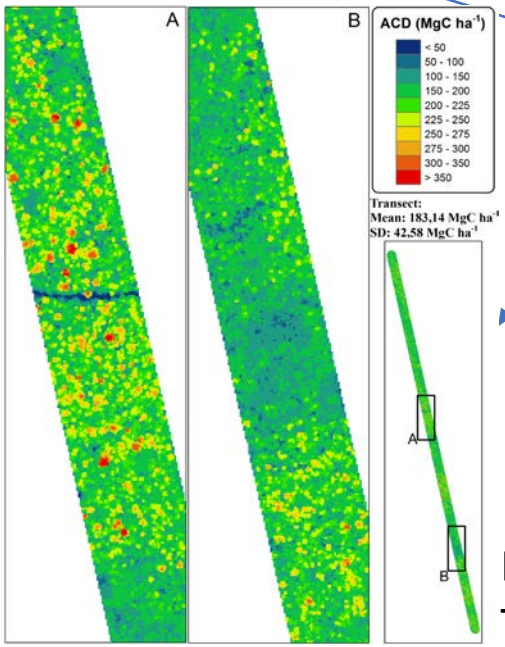


Calibration



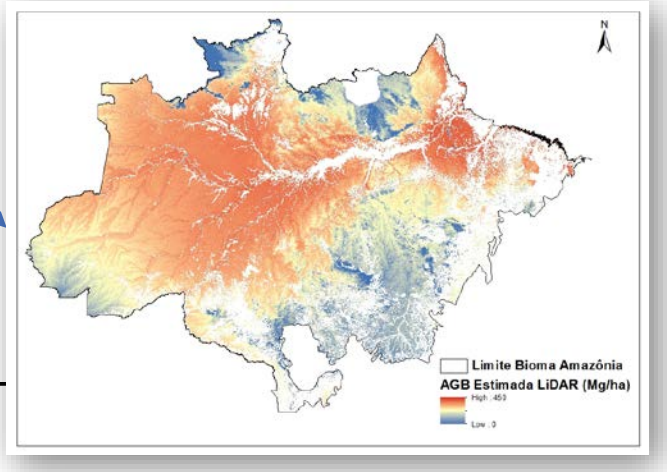
Spatial data





A

B



Biomass Estimation - Transects

Biomass and Uncertainty map

MSA - Project Environmental Monitoring Via Satellite In The Amazon Biome

Subproject 7

Goal: to propose improvements for biomass estimates and models that estimate emissions from land use change.

Climate change - efforts to develop plans to reduce greenhouse gas emissions - contain deforestation and so on.

Fonte: www.pnud.org.br/

National Communications

Fonte: http://redd.mma.gov.br/

National Strategy for REDD +

INPE-EM

CO2 emissions estimates

MSA - Project Environmental Monitoring Via Satellite In The Amazon Biome

Subproject 7

- Agreement of R$ 67 million, financed by the BNDES (Brazilian Development Bank) through the Amazon Fund
- Executed INPE with FUNCATE support (Foundation for Space Science, Technology and Applications)

MSA - Project Environmental Monitoring Via Satellite In The Amazon Biome

Subproject 7

MSA was divided into seven subprojects, and each one has specific goals.

1. Mapping out the use and coverage of land in the Legal Amazon over time;
2. Improvement and development of new features of the free software TerraAmazon;
3. Improvement on reception services, distribution, and use of remote sensing images of INPE;
4. Improvement of the monitoring system of forest fires and burn-offs;
5. Conducting studies on the processes and the trajectories of patterns in deforestation dynamics in the Amazon;
6. Improvement and development of modeling tools of changes in land use and land cover and estimated emissions;

7. Melhoria dos Métodos de Estimativa de Biomassa e de Modelos de Estimativa de Emissões por Mudança de Uso da Terra

Neste projeto está prevista a aquisição de imagens utilizando a aplicação da metodologia LiDAr/Hiperespectral para as estimativas de biomassa. Essa metodologia envolve a utilização de um laser imageador aerotransportado e uma câmara hiperespectral, a qual permite inferir informações sobre as propriedades físico-químicas da vegetação presente na superfície imageada.

Details of LiDAR Sensor

Subproject 7

Sensor LiDAR HARRIER 68i

Scan frequency: 5 Hz to 200 Hz

Full Waveform

Intensity

Field of view: Up to 30º

Inertial Measurement Units (IMU)

Dual frequency GNSS receiver L1 / L2

CESSNA aircraft model 206

Full Scan Angle 45º

Pulse density requested: 4 pulses / m^2

Footprint: 30 cm

Flying height 600 m

Track width on the ground: 494 m

Details of Hiperespectral Sensor

Subproject 7

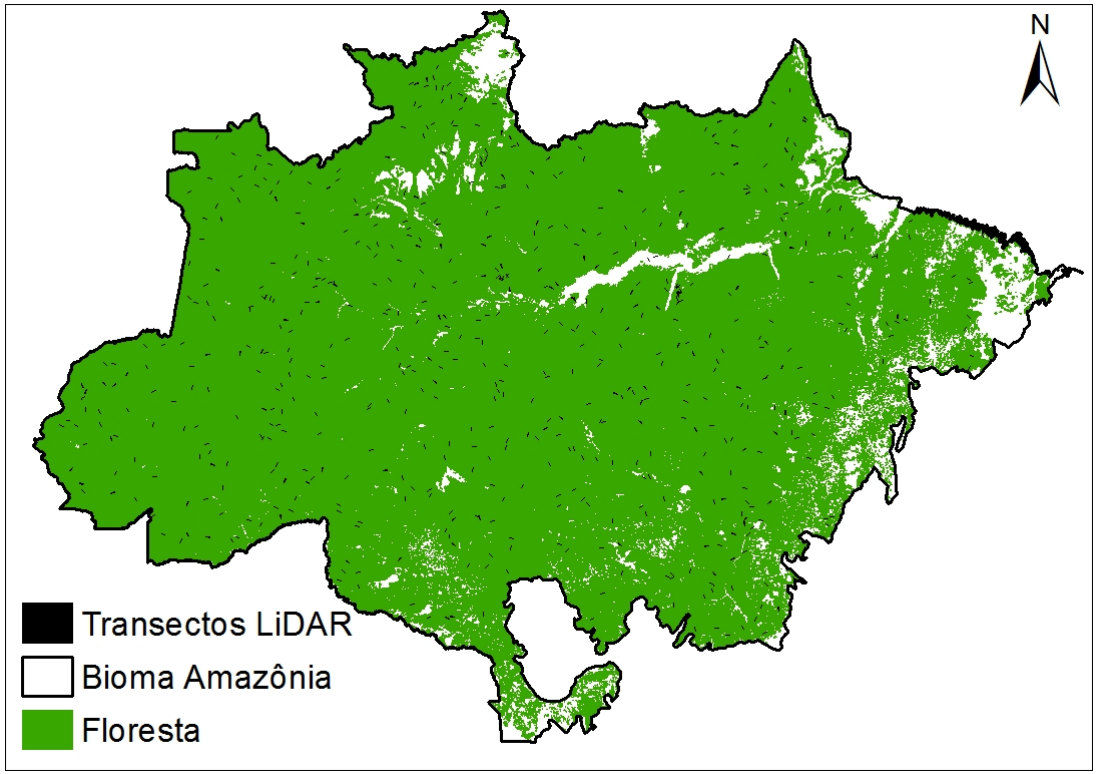
Sensor AISAFENIX

Camera Specifications	VNIR			SWIR
Spectral range	380 - 970nm			970 - 2 500nm
Spectral resolution	3.5nm			12nm
Spatial resolution	384 pixels			
Altitude for 1m pixel size	660 m			
Flying height	800 m			
Detector	CMOS			Stirling cooled MCT
Spectral binning options	2x	4x	8x	-
Number of spectral bands	348	174	87	274
Spectral sampling/band	1.7nm	3.4nm	6.8nm	5.7nm

- 361 bands
- 1 m spatial resolution

LiDAR

Subproject 7



	Área (km)	
Amazon Biome	4.196.943	
Vegetation	3.416.391	
LiDAR	3.750	0,11%

LiDAR + Hiperespectral

Subproject 7

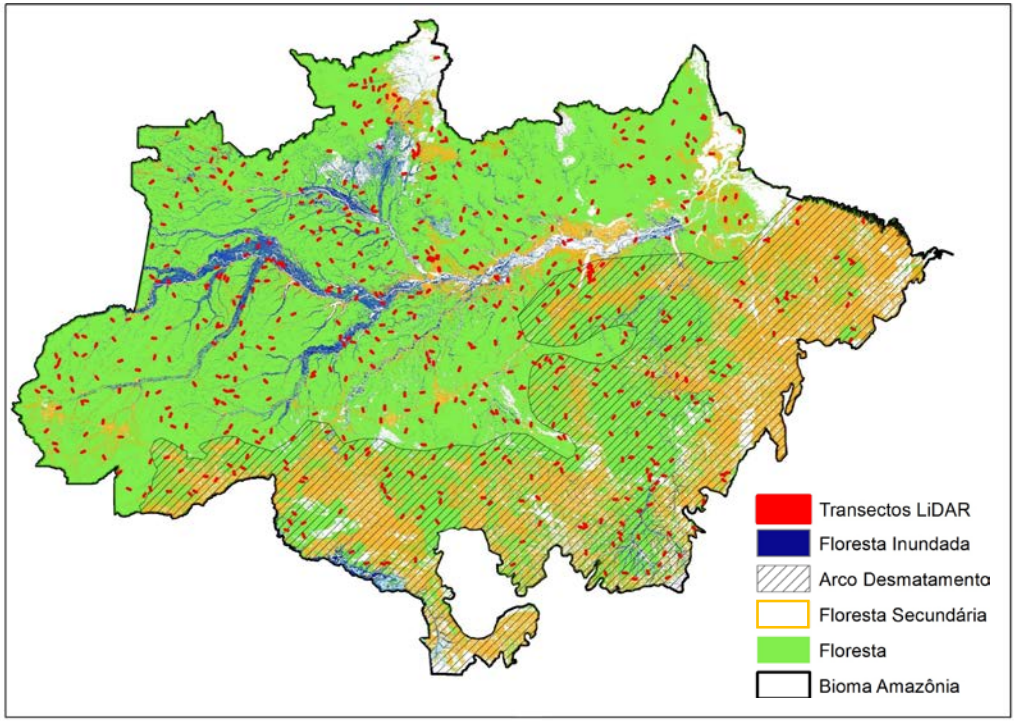
1000 LiDAR transects
Width: **300m**
Length: **12,5Km**
Area: **375**ha

192 flown twice (Arc/Degradation)
91 directed to field plots
405 field plots

Randomly distributed:

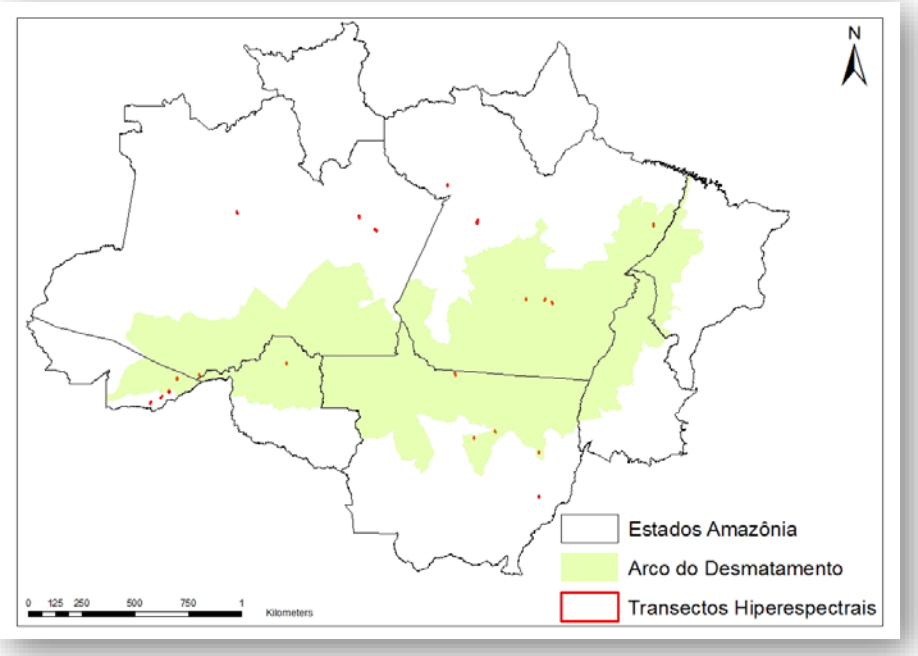
- PRODES forest (INPE)
- TERRACLASS Secondary vegetation (INPE) and
- Wetlands – (*Hess et al. 2015*)

50 Hyperspectral transects



Hiperespectral Transects

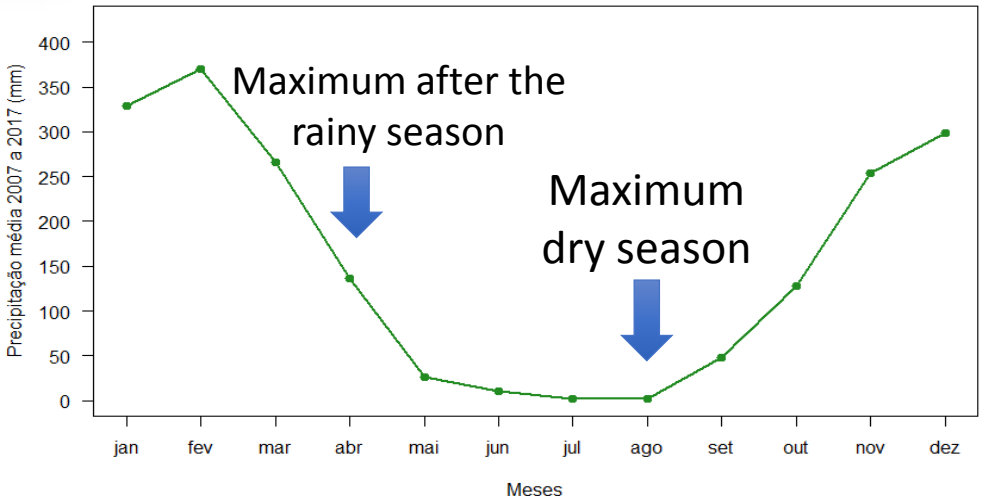
Subproject 7



- 50 images collected in two seasons

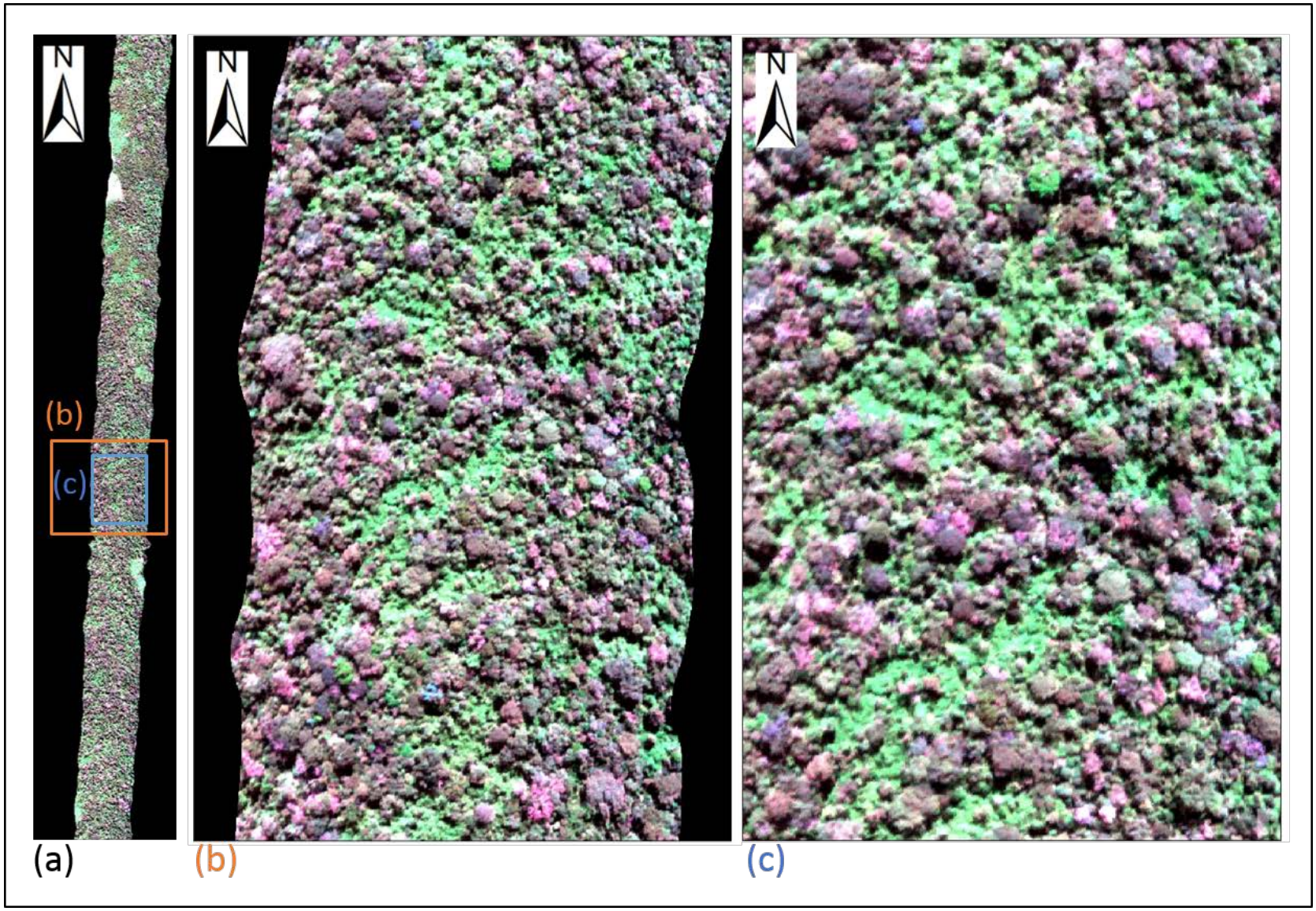
Criteria flight:

- LiDAR data
- Field data
- DGPS
- Representative vegetation



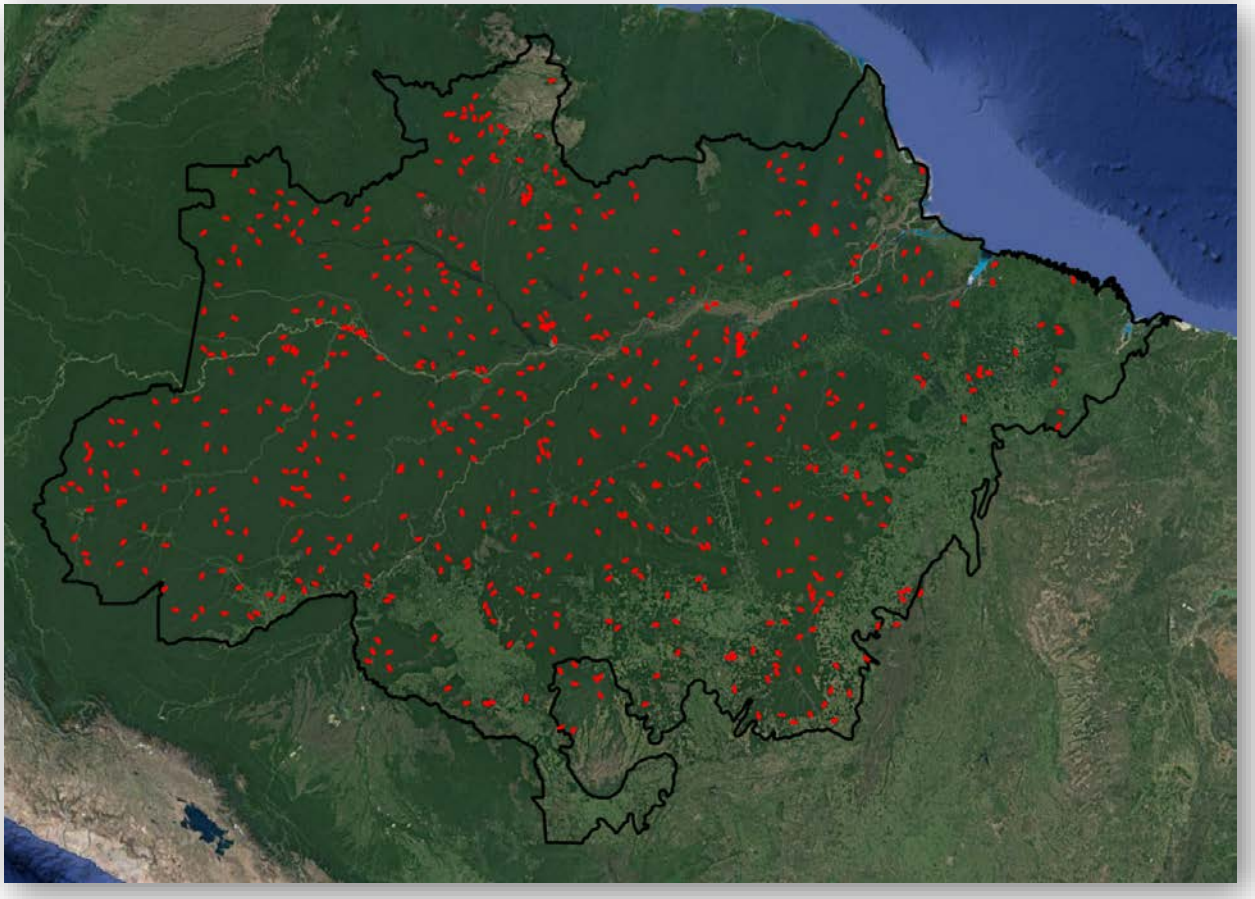
Hiperespectral Image

Subproject 7



Collected Transects

Subproject 7



625 Transects

and Validated

Field Partners – Calibration plots

Subproject 7

Georeferenced with differential GPS and minimum 20 meters width

- EMBRAPA Acre (Marcus Vinicio): 12 permanent plots
- SUSTAINABLE LANDSCAPES (Michael Keller): 110 plots; some intact and others with disturbance, 50x50 m;
- TREES (Luiz Aragão -INPE): 22 with 250x10m (2011 and 2014); 4 with 100x100m (2010 to 2016) e 16 with 25x100m (2015); some burned plots;
- Mamirauá Institute: wetlands; 12 plots with 50x200m measured in 2016;
- University of Leicester (Polyanna Bispo): 21 plots; 50x50m.
- University of Lancaster (Fernando Espírito-Santo): 10 plots; 50x50m.

Field Partners – Validation plots

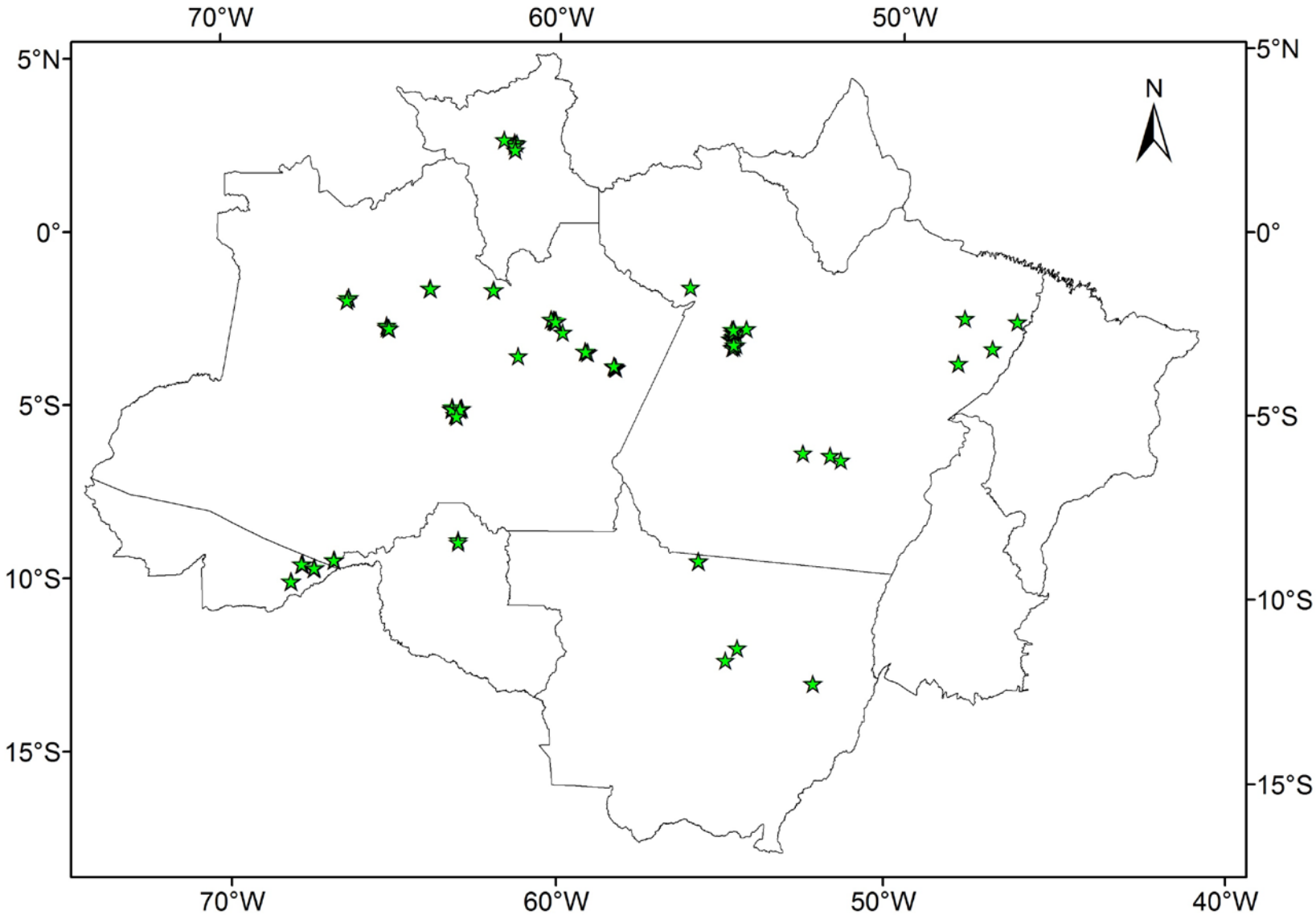
Subproject 7

Used just to compare with EBA Team biomass estimates

- TREES: 20 plots (10x250); some of them secondary (burned); measured in 2015;
- INPA (Niro Higuchi): 73 temporary plots with 20x125 and 35 plots with 20x125;
- SUSTAINABLE LANDSCAPES : 11 with GPS navigation;
- Yosio Shimabukuro (INPE):

Field Partners Plots

Subproject 7



Georeferenced with differential GPS

Subproject 7

DGPS – differential GPS

DGPS – differential GPS

Forest Inventory

Subproject 7

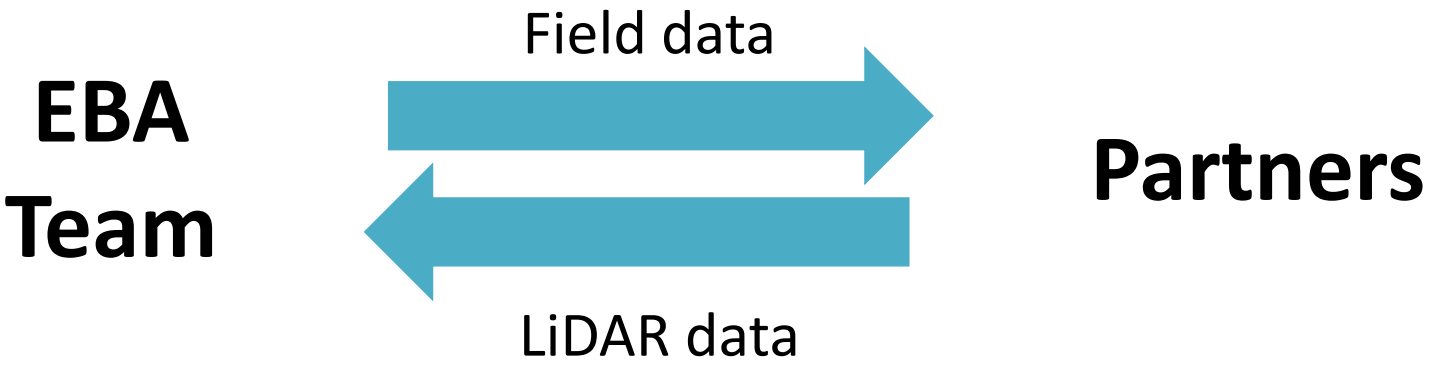
Field Partners

Subproject 7

EBA project fly over partners inventory plots;

Exchange of information: partners make available inventory plots data to EBA Team and EBA Team make available LiDAR transects data for processing.

Teams work together



Field Partners - Scientific Production

Subproject 7

» Doctoral proposal

TREES - INPE:

Catherine Torres de Almeida: “Study of biodiversity, phenology and carbon stock in the Amazon using LiDAR and Hyperspectral data”

TREES - INPE:

Ricardo Dal' Agnol da Silva : "Assessment of biomass and carbon dynamics associated with tree mortality in amazonia using remote sensing“

Dr. Jean Ometto – INPE (Advisor)

Graciela Tejada Pinell: "Brazilian amazon forest biomass assessment for the deforestation-driven carbon emissions modeling"

» Master proposal:

TREES - INPE:

Celso Henrique Leite Silva Junior: “The impacts of forest fire on forest fragmentation and loss biomass in the Amazon”

Dr. Yosio Shimabukuro – INPE (Advisor)

Erone Ghizoni dos Santos: “Forest biomass estimation using Landsat and Lidar data of the Mato Grosso State”

Challenges

Subproject 7

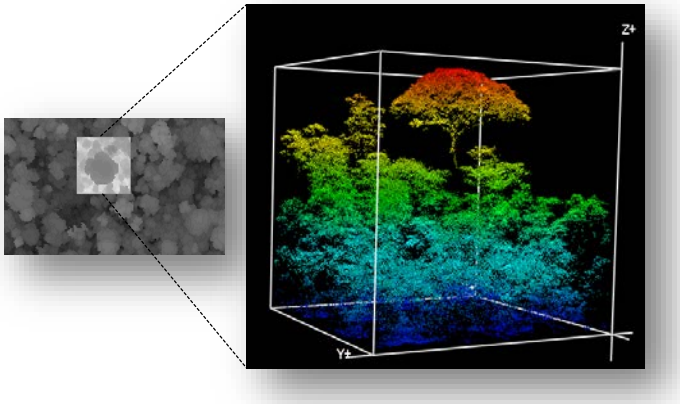
Field data from partners:

- Different plot size
- Forest inventory data: DBH, height, species, density wood and etc
- Different years between field data

LiDAR data:

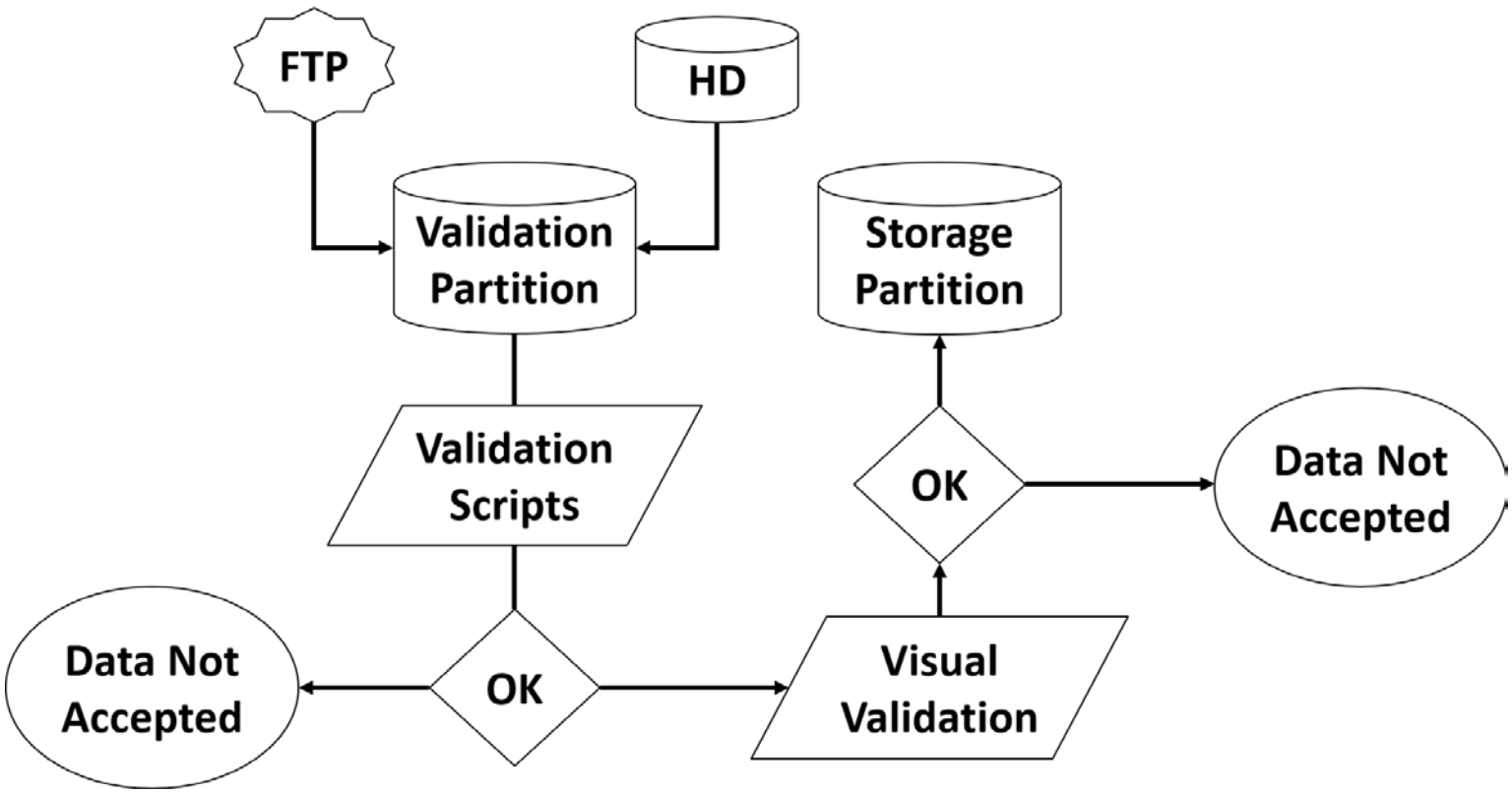
Big data:

- 15 GB received/transect, +15 TB total
- 2,4 x 10^6 data records/transect +2,4 x 10^9 total data records (FWF)
- Parallel processing



Automatic Validation Routines

Subproject 7

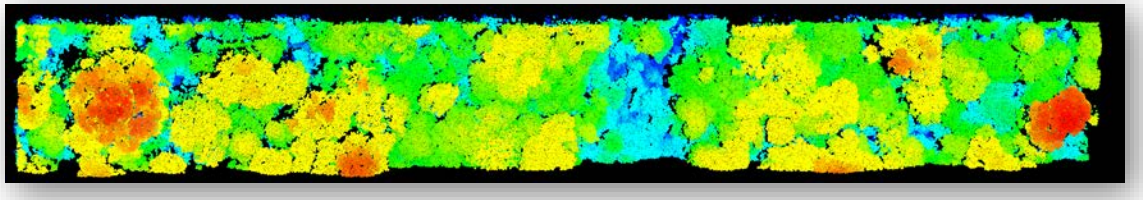


Number of pulses: 4 pulses / m^2

Validation Routines

Subproject 7

- File signature
- LAS file format version
- **Total returns**
- Number of returns per return number
- **Min and max values**
- Global points density
- Percent of area below points density
- Xt, Yt, Zt values
- Overlap quality
- Cloud localization
- Visual aspect



Geodatabase

Subproject 7

- **Construction of a Geodatabase: PostgreSQL**

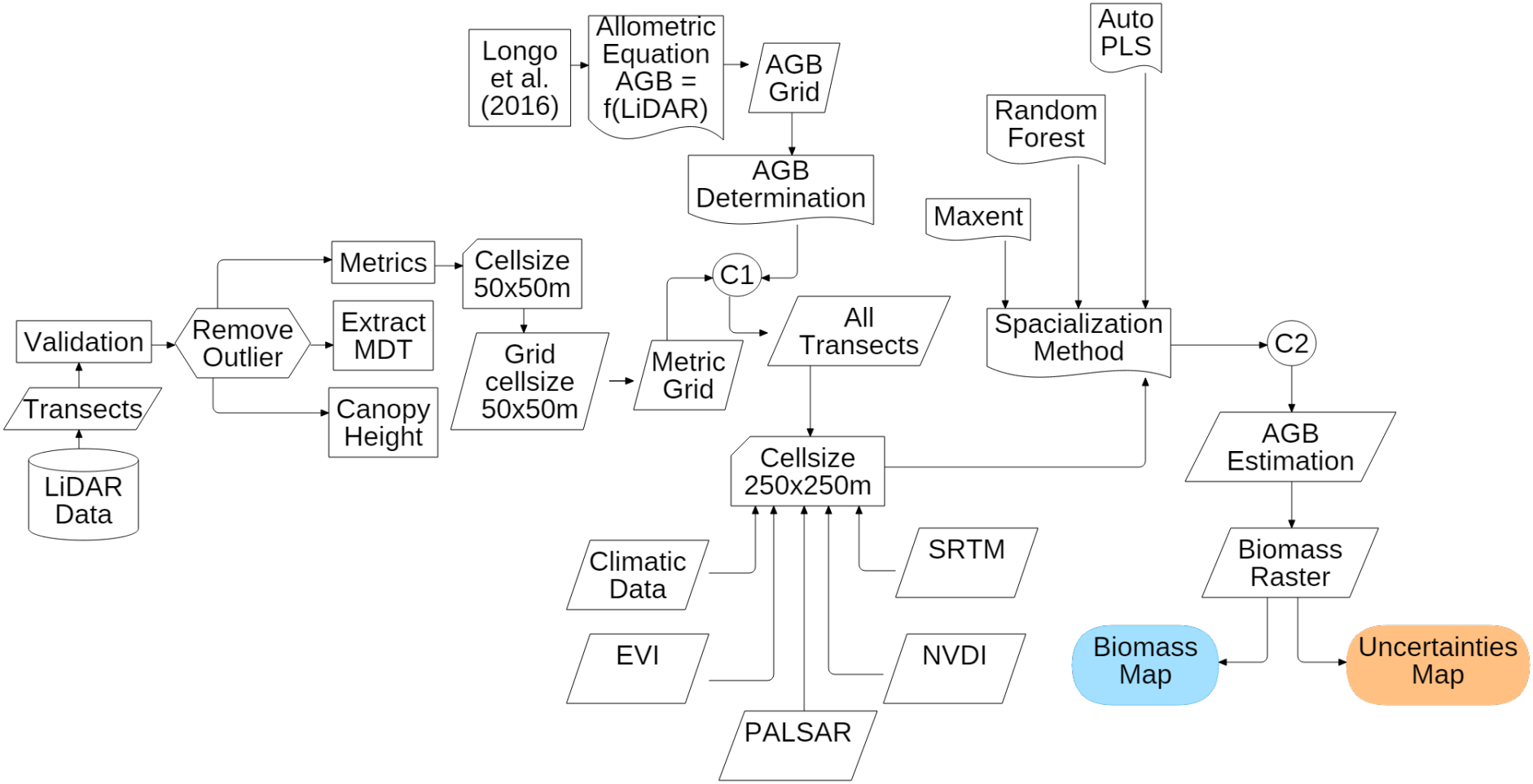
Goal: Automate the biomass calculation and the generation of the biomass map

LiDAR data process:

- LiDAR metrics are automatically generated for each new transect delivered by the ALS flight company - Script

Steps of the Methodology – Biomass Map

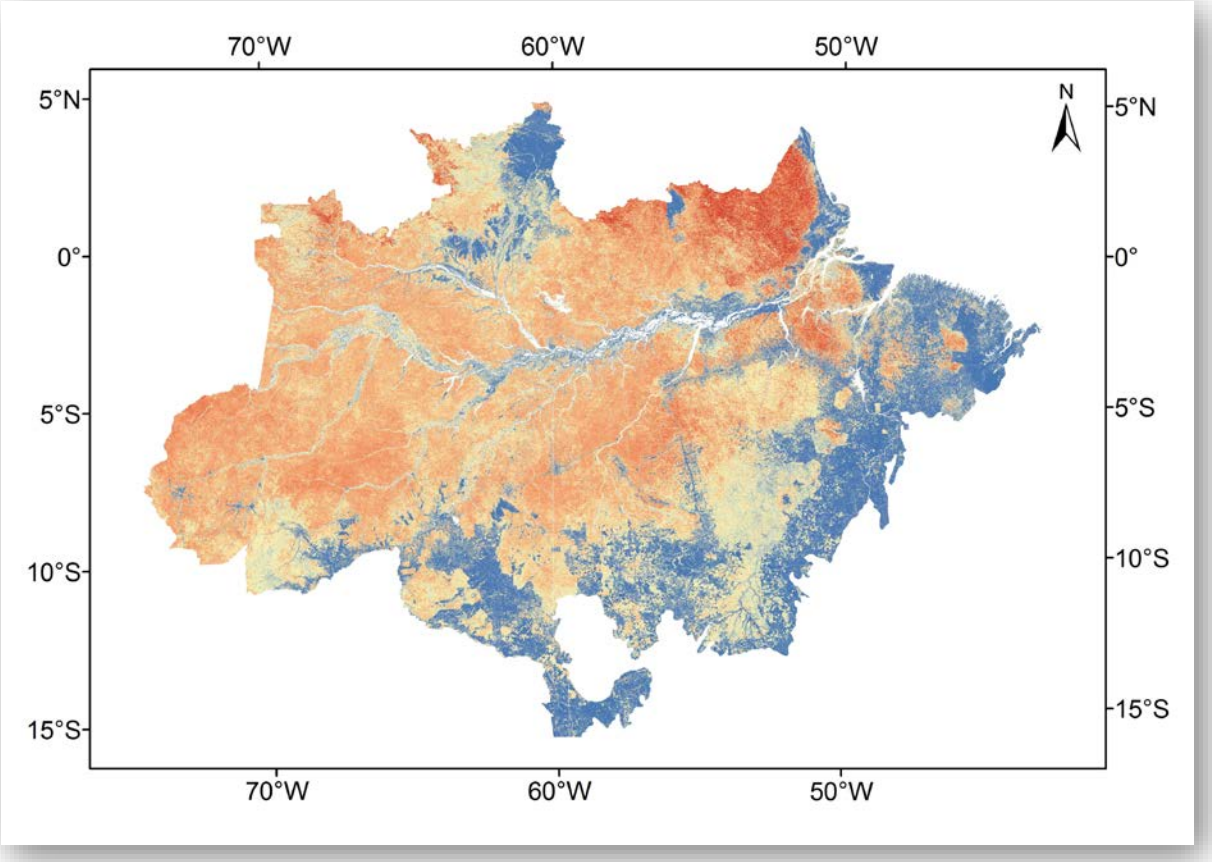
Subproject 7



Longo, M., M. Keller, M. N. dos-Santos, V. Leitold, E. R. Pinagé, A. Baccini, S. Saatchi, E. M. Nogueira, M. Batistella, and D. C. Morton (2016), Aboveground biomass variability across intact and degraded forests in the Brazilian Amazon, Global Biogeochem. Cycles, 30, 1639–1660, doi:10.1002/2016GB005465.

Forest Biomass Map

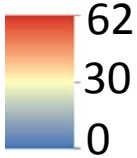
Subproject 7



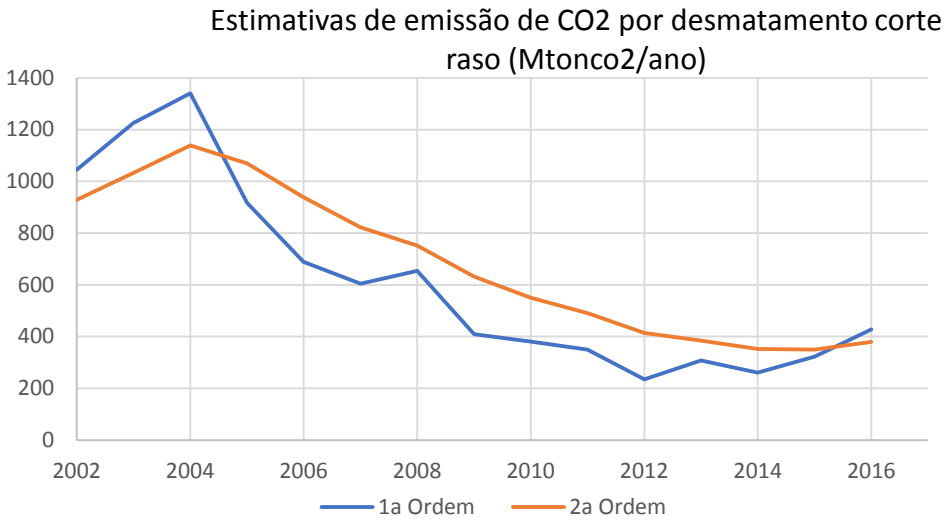
Random Forest

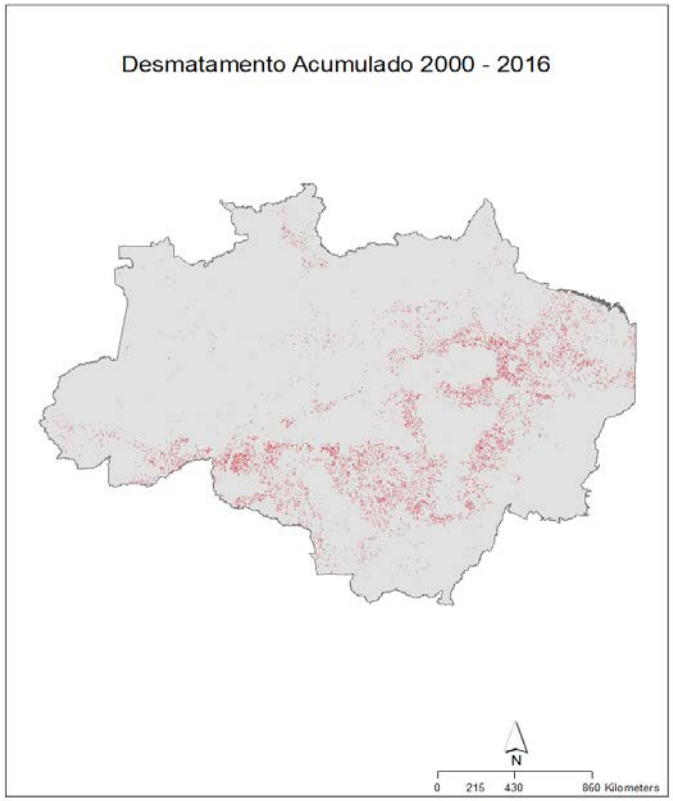
- PALSAR
- NDVI, EVI – MODIS
- SRTM
- $R^2 = 0.5$
- RMSE = 7.17 kg/m²
- Spatial resolution: 250 x 250m

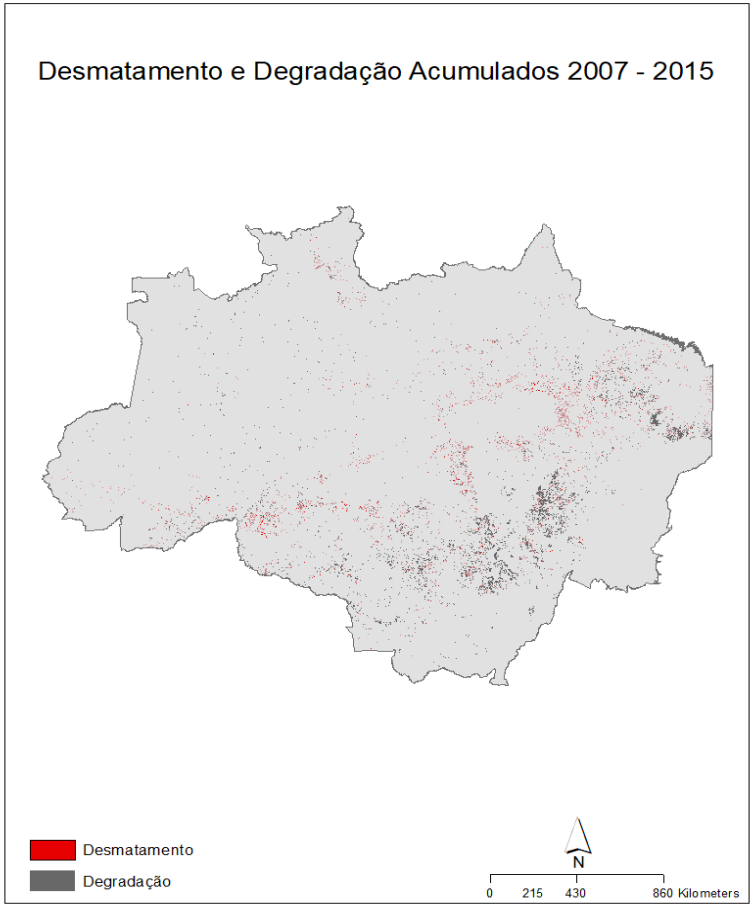
AGB – kg/m²



Testing other methodologies: Maxent, Kriging, IDW


Estimativas de emissão de CO2 por desmatamento corte raso (Mtonco2/ano)
1400
1200
1000
800
600
400
200
0
2002
2004
2006
2008
2010
2012
2014
2016
1a Ordem
2a Ordem

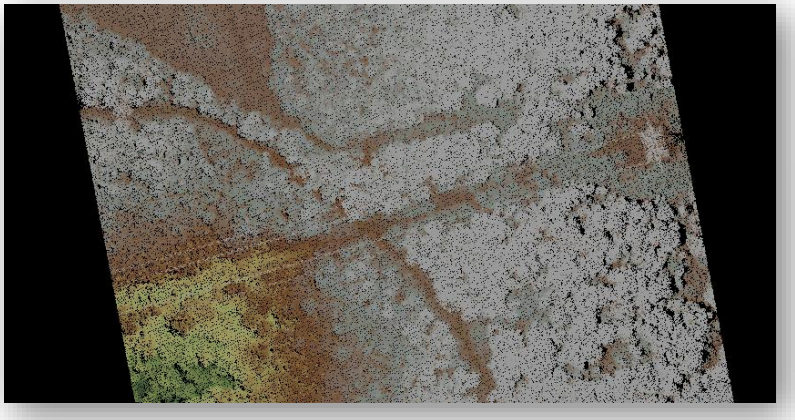

Desmatamento Acumulado 2000 - 2016
N
0 215 430 860 Kilometers

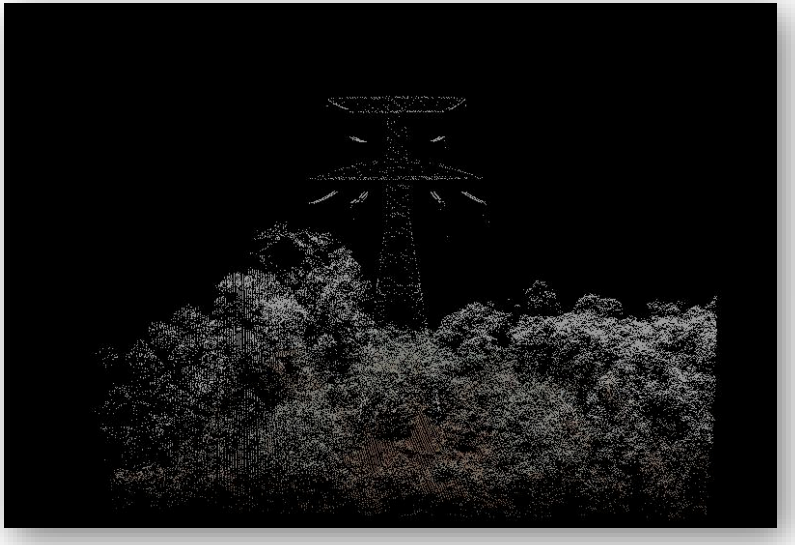

Desmatamento e Degradação Acumulados 2007 - 2015
Desmatamento
Degradação
N
0 215 430 860 Kilometers

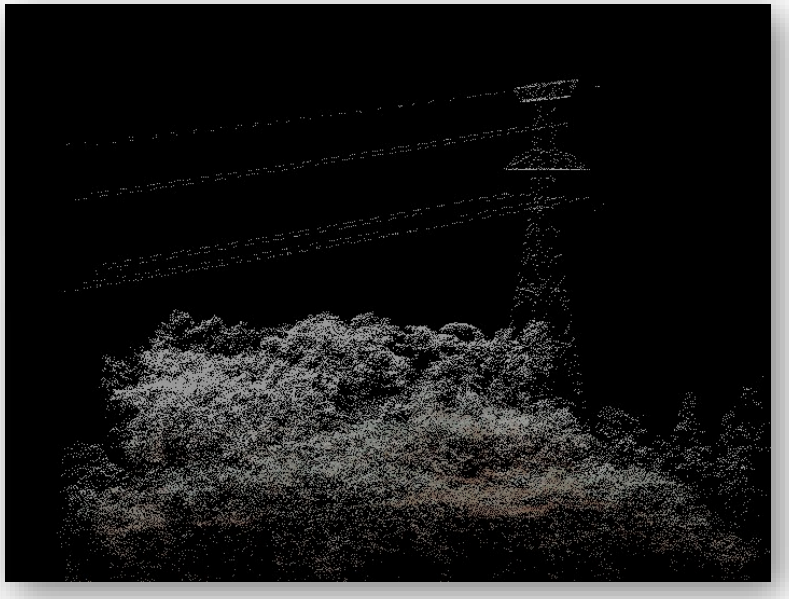
Curiosities

Subproject 7

Electric power transmission



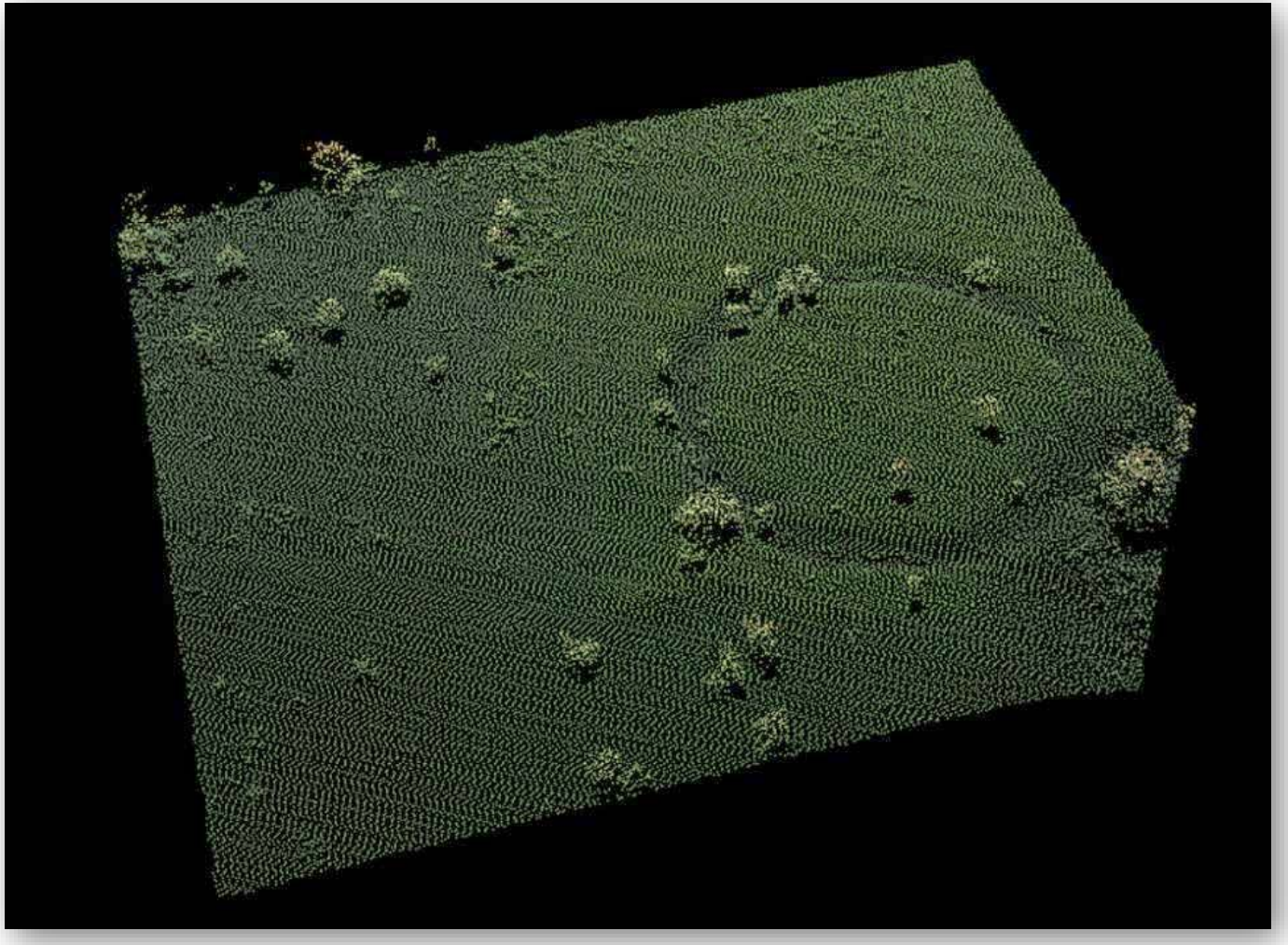




Curiosities

Subproject 7

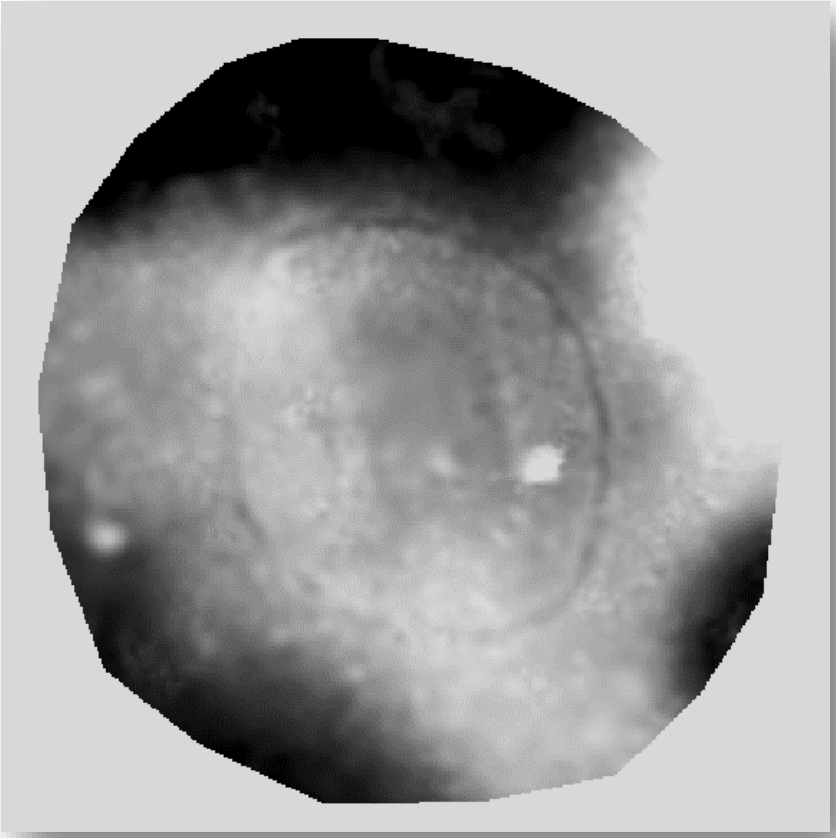
Geoglyph - ACRE

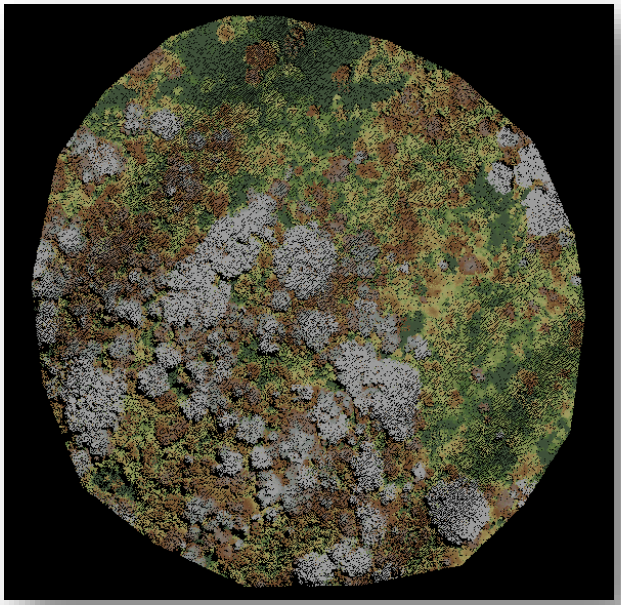


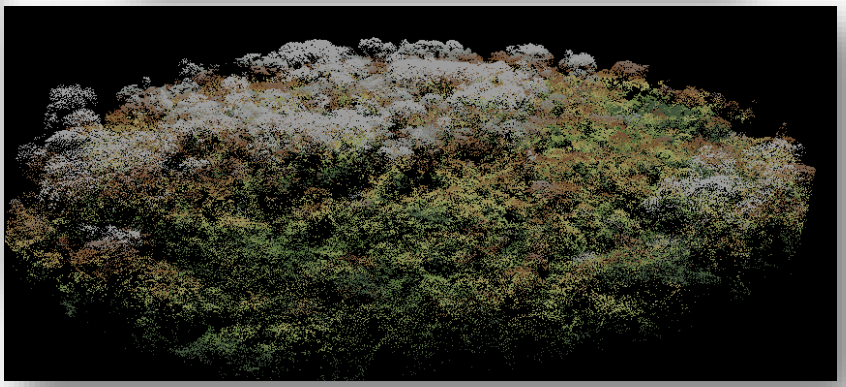
Curiosities

Subproject 7

Geoglyph - Amapá

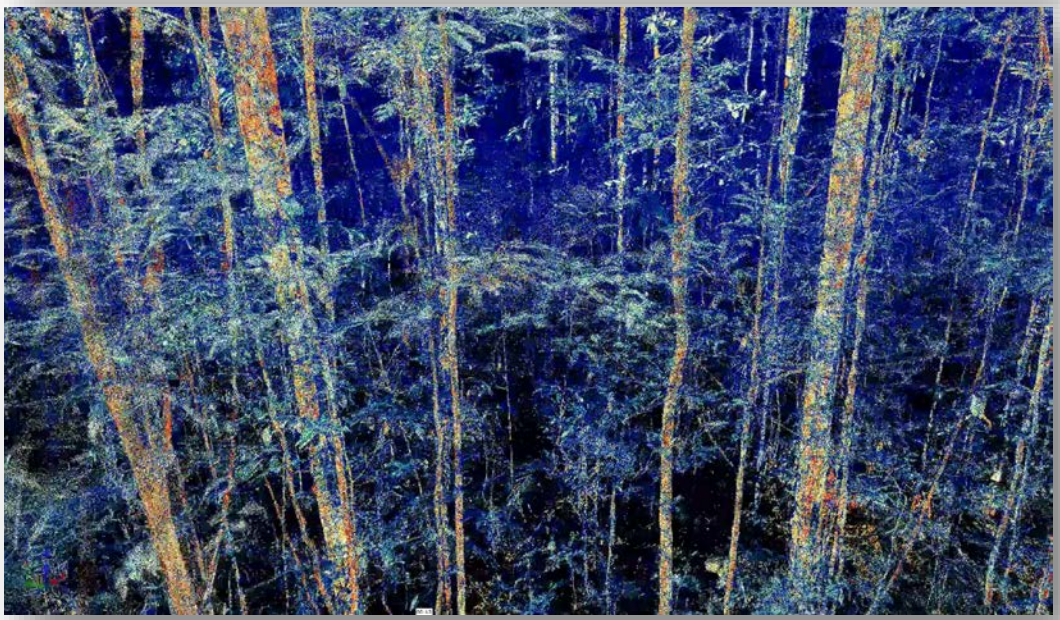






Terrestrial LiDAR

AmazonFace project



- For more information or if you have any suggestion to help our group...
- Or if you are interested in establishing a partnership...

Thank you!

FUNDO AMAZONIA

BNDES

FUNCATE
Fundação de Ciência Aplicações e Tecnologia Espaciais

INPE

CCST
Ciência para sustentabilidade