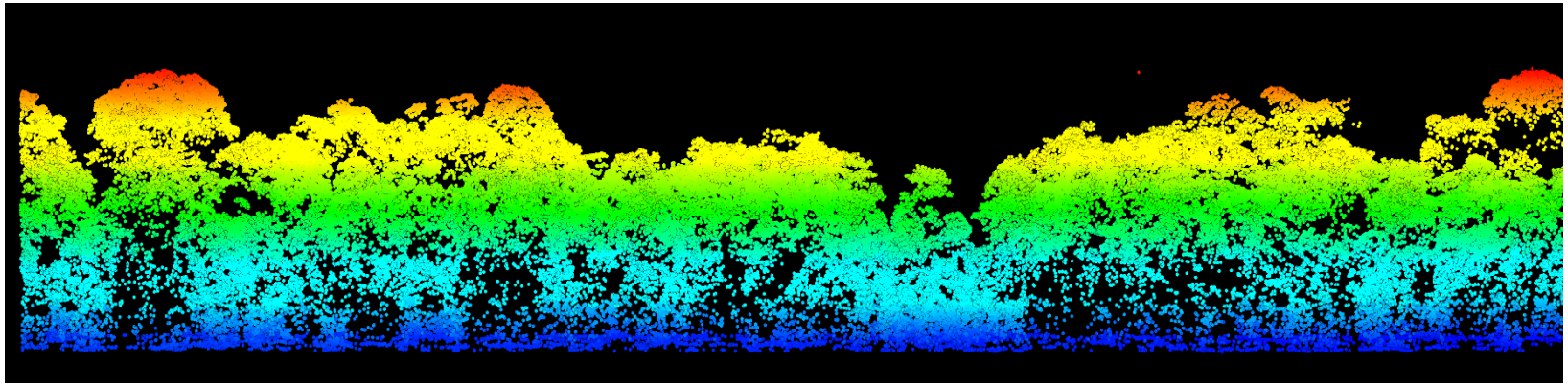
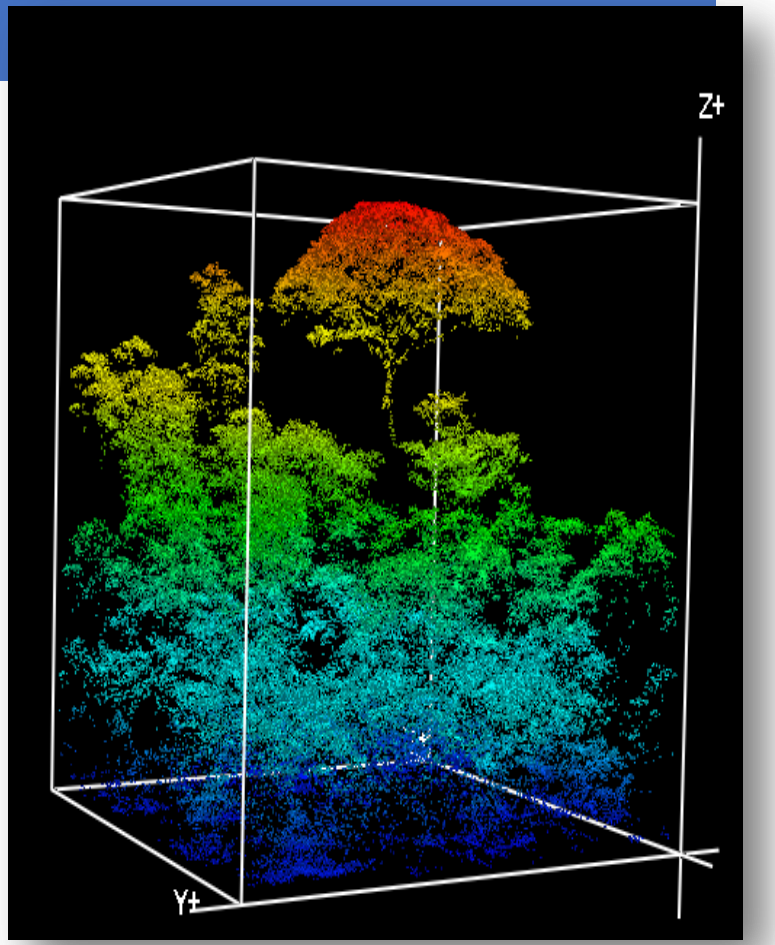
Melhoria dos métodos de estimativa de biomassa e de modelos de estimativa de emissões por mudança de uso da terra





FUNDO AMAZÔNIA

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Ciência para sustentabilidade

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Fundação de Ciência Aplicações e Tecnologia Espaciais

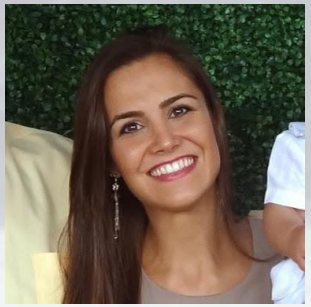
EQUIPE EBA

Jean Ometto

Fabielle Alves

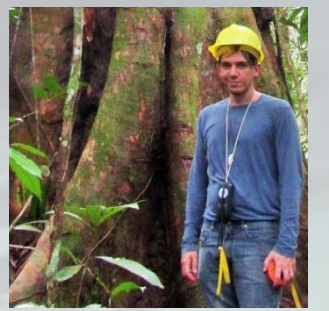
Lucas Silva

Heitor Carneiro

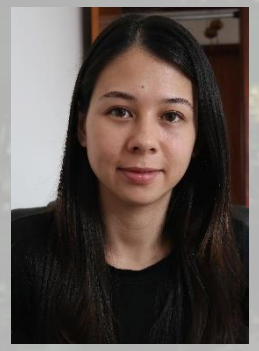


Roberta Cantinho

Eric Gorgens



Pedro Valle



Luciane Sato

Mauro Assis

Francisca Pereira

Aline Jacon

Emily Dias

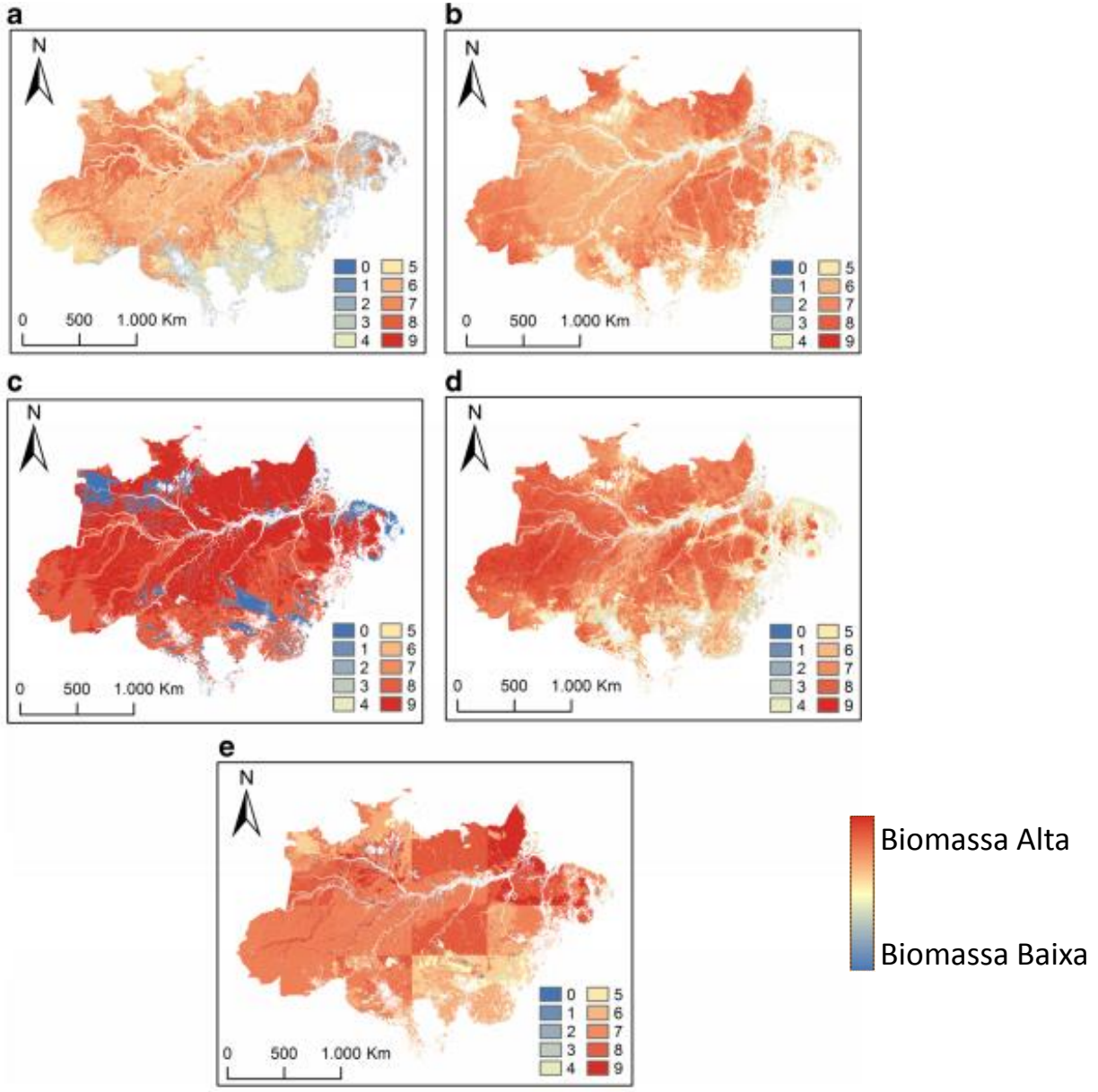
Bruna Leal

Motivação...

Subproject 7

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

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



Ometto et all

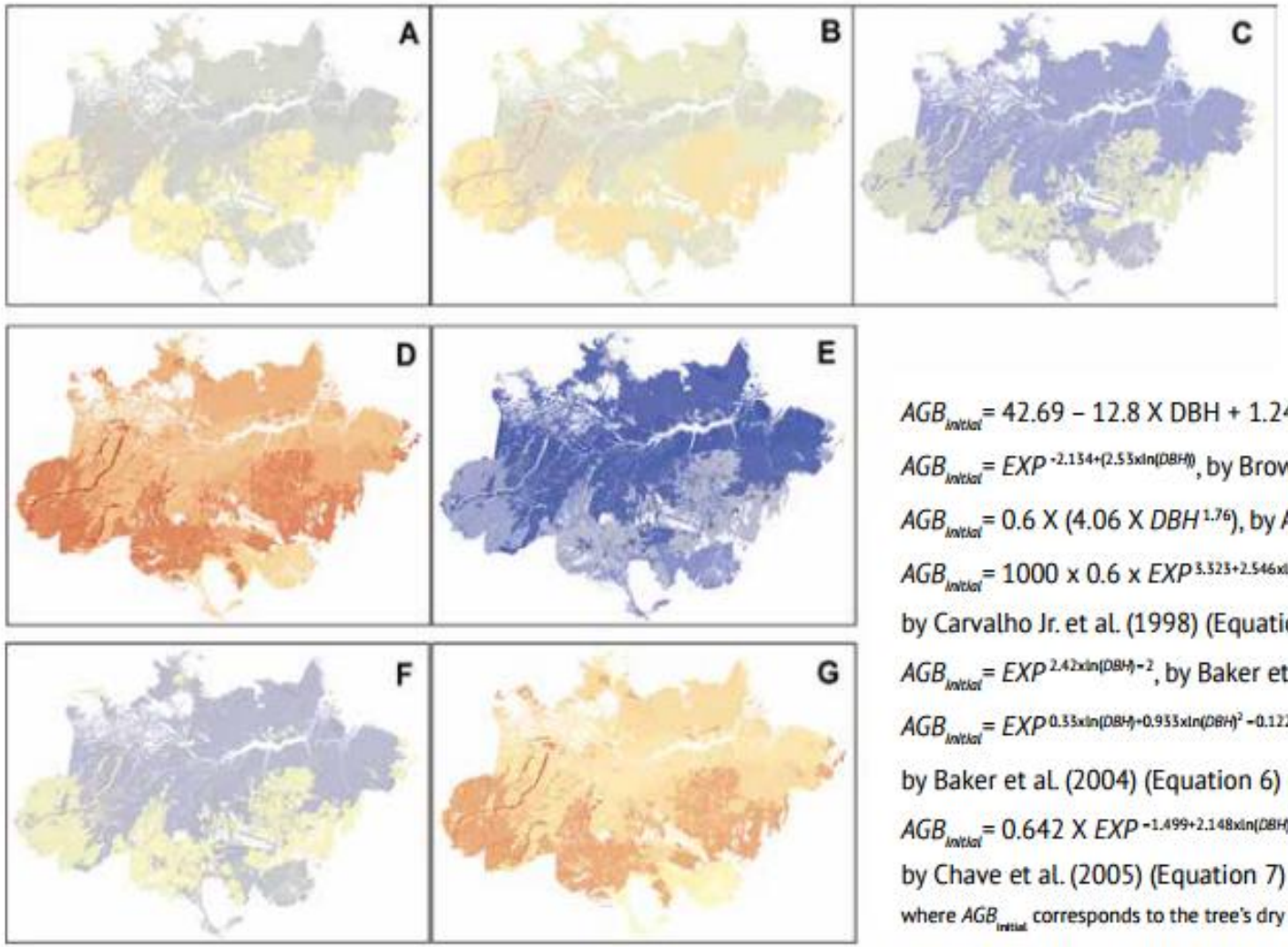
Climatic Change (2014) 124:545–560
DOI 10.1007/s10584-014-1058-7

Motivação...

Equações Alométricas

3ª Comunicação Nacional à UNFCCC (2016)

Difference between aboveground biomass estimated by Mithchard et al. (2014) and results of equations 1 (A), 2 (B), 3 (C), 4 (D), 5 (E), 6 (F) and 7 (G)



$AGB_{initial} = 42.69 - 12.8 \times DBH + 1.242 \times DBH^2$, by Brown (1997) (Equation 1)

$AGB_{initial} = EXP^{-2.134+(2.53 \times \ln(DBH))}$, by Brown (1997) (Equation 2)

$AGB_{initial} = 0.6 \times (4.06 \times DBH^{1.76})$, by Araújo et al. (1999) (Equation 3)

$AGB_{initial} = 1000 \times 0.6 \times EXP^{-3.323+2.546 \times \ln(\frac{DBH}{100})}$

by Carvalho Jr. et al. (1998) (Equation 4)

$AGB_{initial} = EXP^{2.42 \times \ln(DBH)-2}$, by Baker et al. (2004) (Equation 5)

$AGB_{initial} = EXP^{0.33 \times \ln(DBH)+0.933 \times \ln(DBH)^2-0.122 \times \ln(DBH)^3-0.37}$,

by Baker et al. (2004) (Equation 6)

$AGB_{initial} = 0.642 \times EXP^{-1.499+2.148 \times \ln(DBH)+0.207 \times \ln(DBH)^2-0.0281 \times \ln(DBH)^3}$,

by Chave et al. (2005) (Equation 7)

where $AGB_{initial}$ corresponds to the tree's dry matter in kg and the tree's DBH is given in cm.

Melhoria dos métodos de estimativa de biomassa e de modelos de estimativa de emissões por mudança de uso da terra

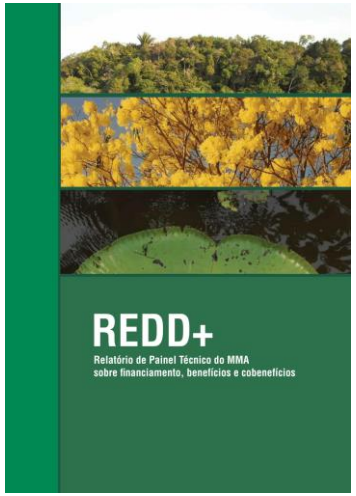
Objetivo: Melhorar as estivamativas de biomassa e avancar nos modelos que estimam emissões a partir da mudança no uso do solo.

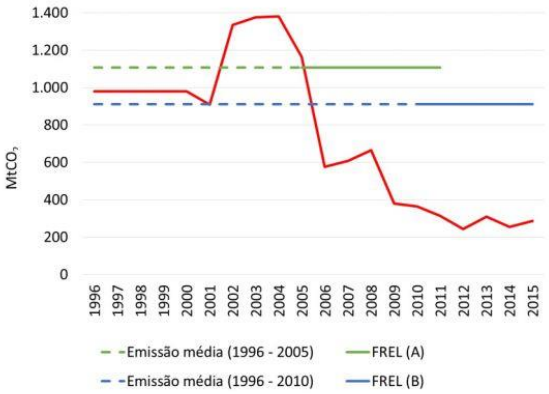
Mudanças Climáticas; Iniciativas para reduzir as emissões de GEE (e.g., NDC); Biodiversidade; Ocupação do território, …

Fonte: www.pnud.org.br/

National Communication on GHG emiss. to the UNFCCC

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





National Strategy for REDD +

http://inpe-em.ccst.inpe.br

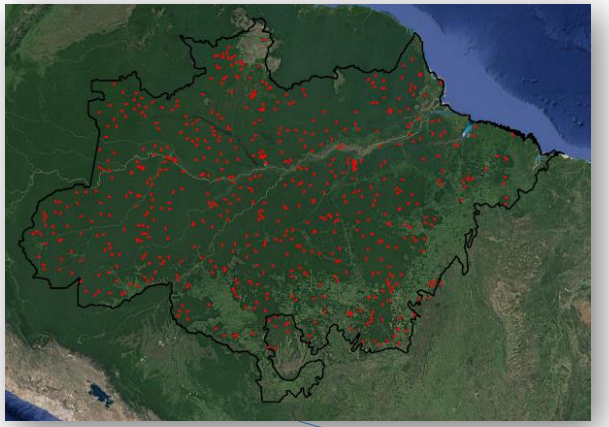
INPE-EM

CO2 emissions estimates

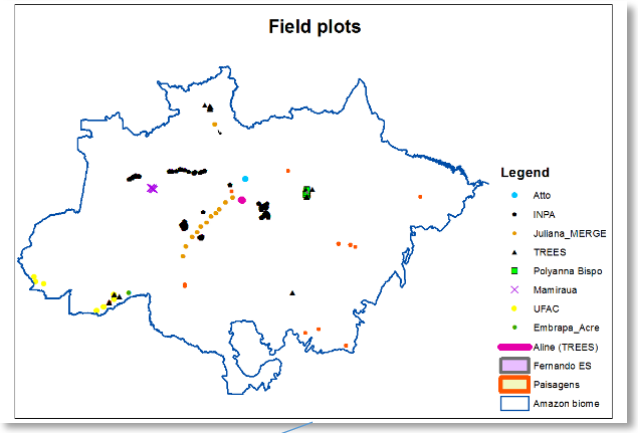
Mapa de Biomassa

Subproject 7

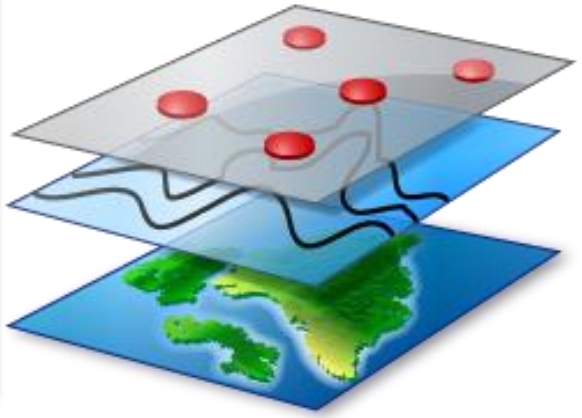
LiDAR data - Transects

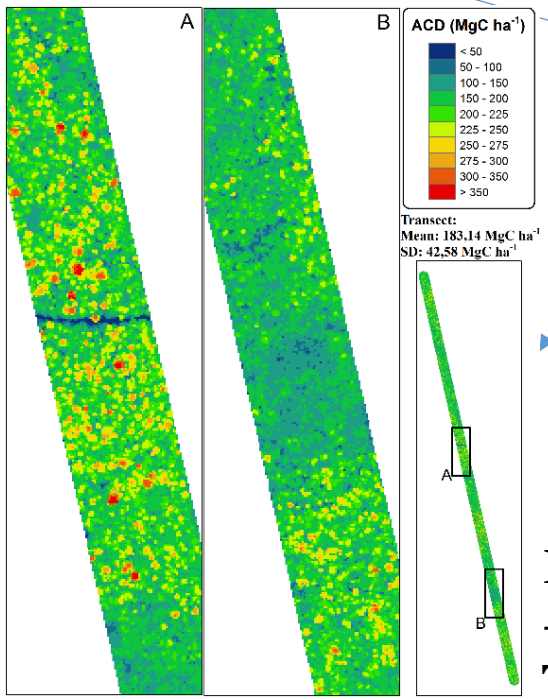


Calibration



Spatial data



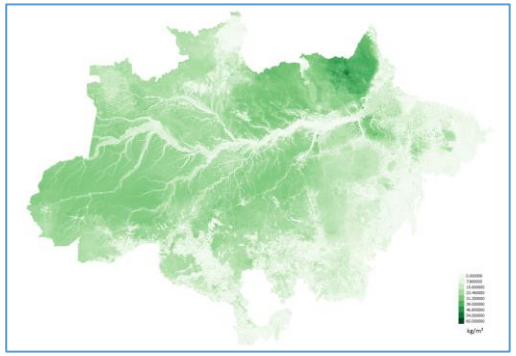


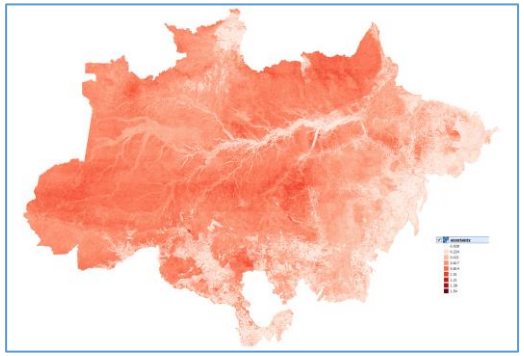
A

B

Biomass Estimation – Transects

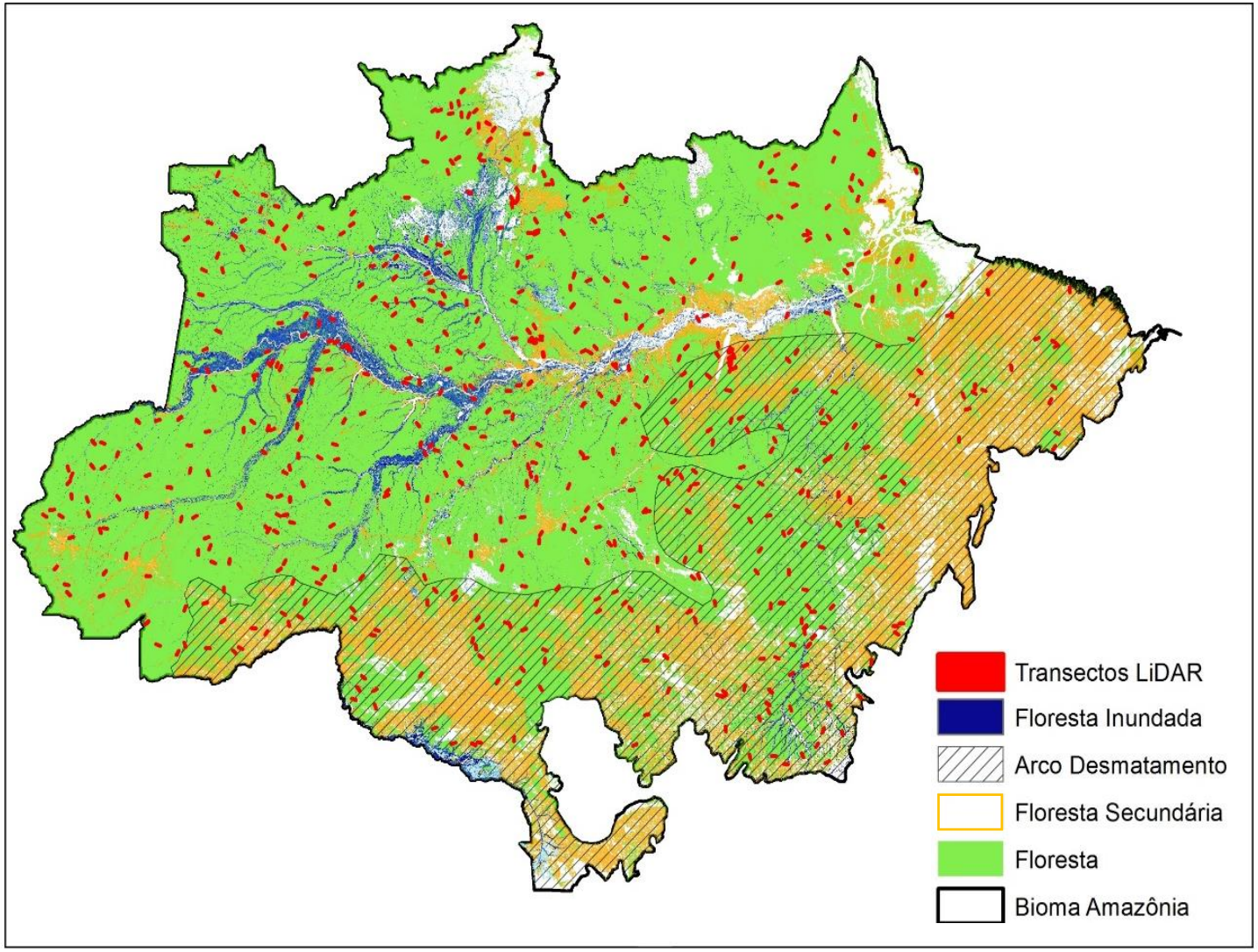
Biomass and Uncertainty map





LiDAR + Hiperespectral

Subproject 7



1000 LiDAR transects
Width: **300m**
Length: **12,5Km**
Area covered: 3,750km2 (~0,11%)

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

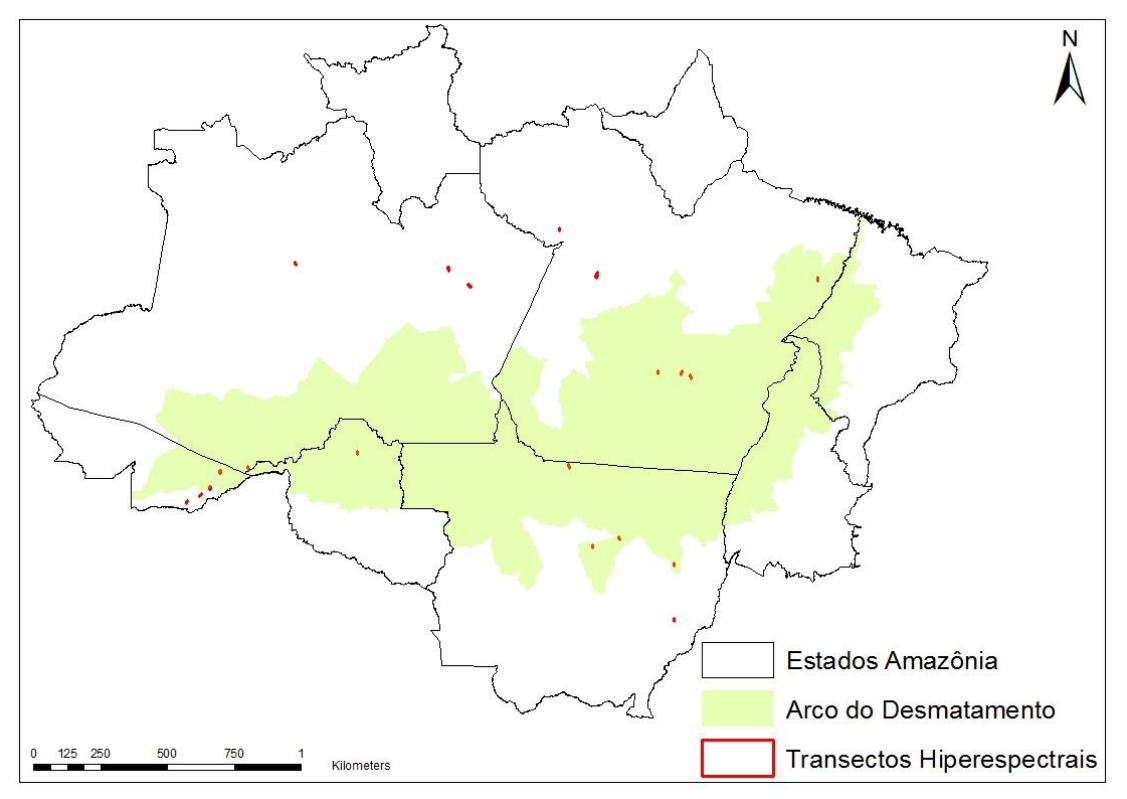
Randomly distributed:

- PRODES forest
- TERRACLASS Secondary vegetation and
- wetlands

50 Hyperspectral transects

Data Paper Submitted to **PANGEA**
Data Publisher for Earth & Environmental Science

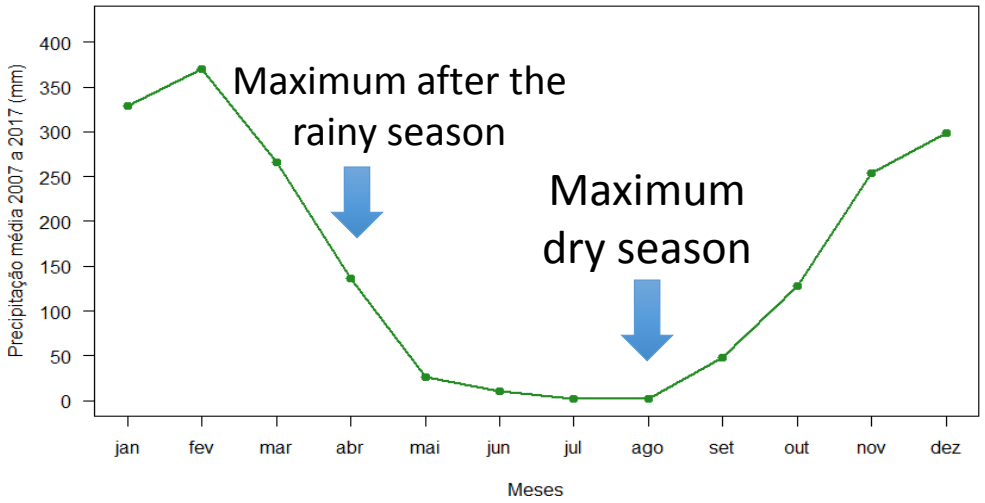
Hiperespectral Transects



- 50 images collected in two seasons

Criteria flight:

- LiDAR data
- Field data
- DGPS
- Representative vegetation



Hiperespectral

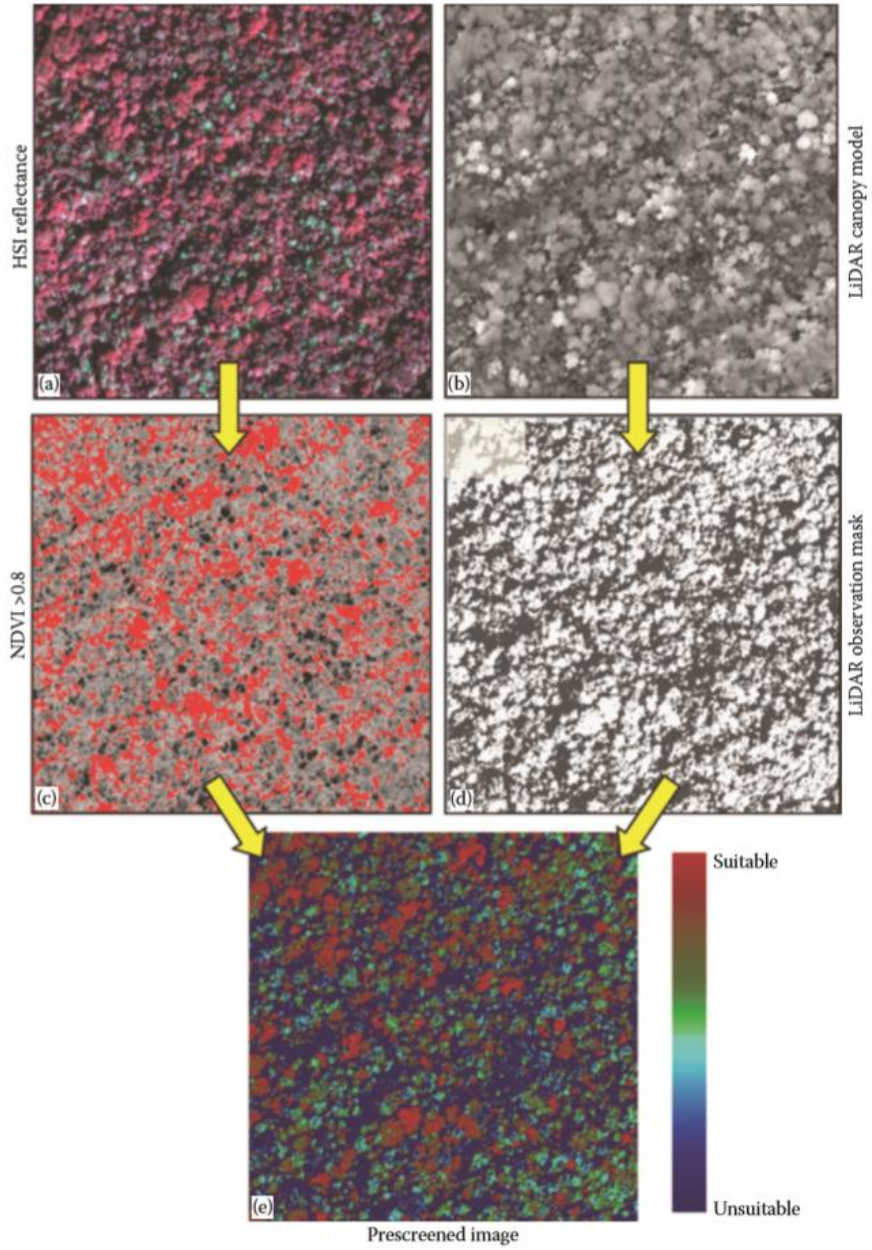
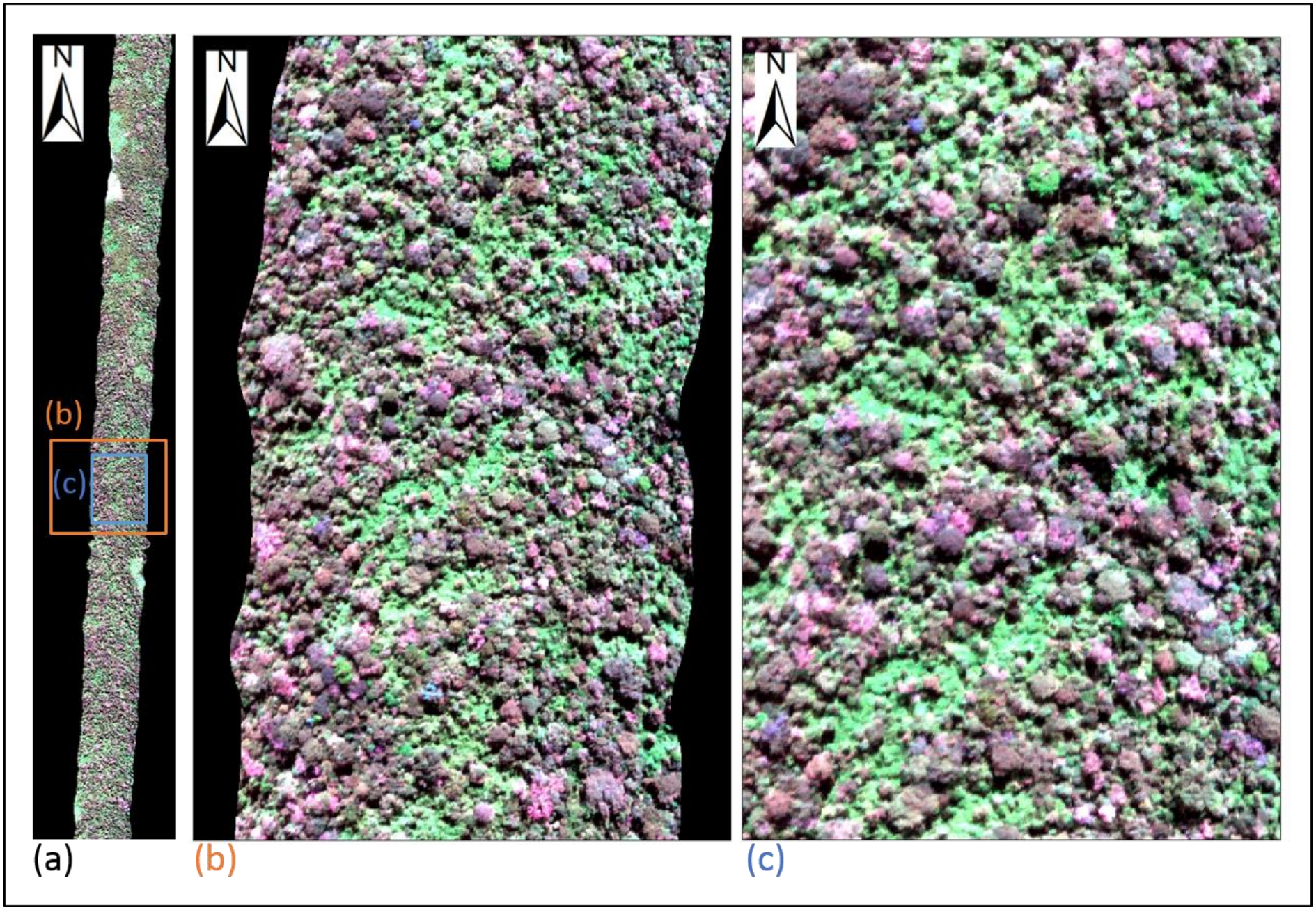


FIGURE 16.7 Prescreening of (a) HSI data using fused (b) LiDAR data. This can be accomplished in various ways, and an example is shown here. (c) A minimum NDVI threshold of 0.8 ensures sufficient foliar cover in the analysis. (d) Combining LiDAR and solar-viewing geometry, a filtering mask is generated to remove pixels in shade or of ground and water surfaces. (e) The resulting suitability image provides an indication of pixels that can be used for biophysical, biochemical, and/or physiological analysis.

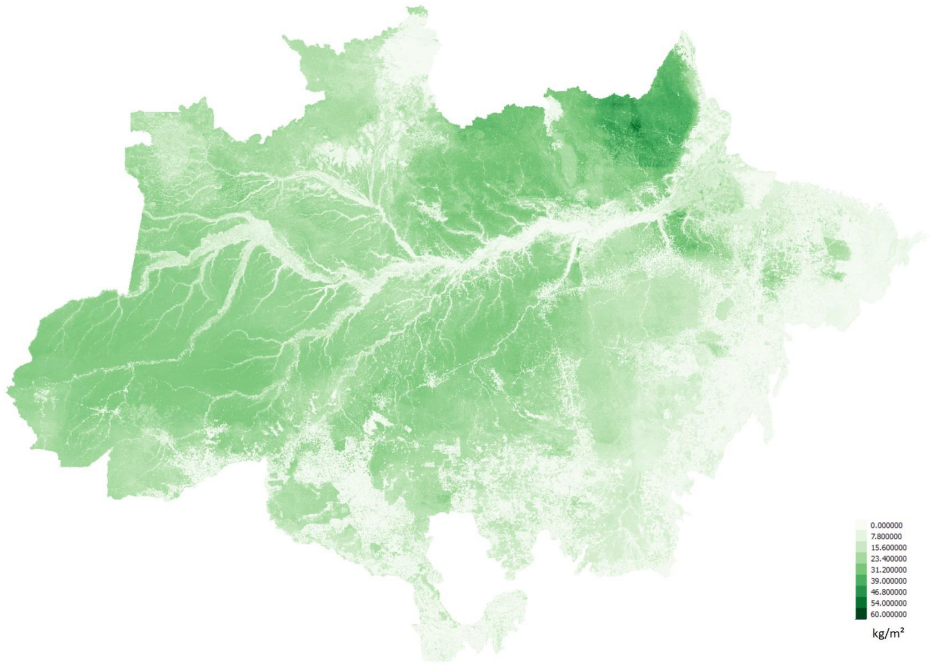
Table 2 List of references on the fusion of hyperspectral/LiDAR for biomass estimation and forest species classification.

References	Parameters	Methods	Goals
Hill et al.[100]	PCs 1 and 2 of HyMap and Digital Canopy Height Model (DCHM)	Segmentation and ISODATA	Mapping of woodland species composition and structure
Geerling et al.[51]	Pixel-level fusion of 10 CASI bands and 6 LiDAR texture bands (min, max, mean, median, SD, and range)	MLC	Classification of floodplain vegetation
Sugumaran et al.[127]	4 band Quickbird image with and without LiDAR; 24-band AISA hyperspectral image with and without LiDAR; 63-band AISA Eagle hyperspectral image with and without LiDAR.	Object-oriented classification	Tree species identification in an urban environment
Dalponte et al.[103]	25 hyperspectral bands, elevation and intensity of the first LiDAR return; 40 hyperspectral bands, elevation and intensity of the first LiDAR return; 126 hyperspectral bands, elevation and intensity of the first LiDAR return.	SVM classifier; GML-LOOC; K-NN	Classification of complex forest
Jones et al.[104]	AISA data (40 bands); 40 AISA bands and CHM; 40 AISA bands and 4 CVPs; 40 AISA bands, and 2 CVPs	A multiclass SVM classifier	Mapping species distribution
Onojeghuo et al.[130]	Spectral data only; spectrally compressed data: PCA transformed data and MNF transformed data; SSPCA transformed data; texture combined data: MNF 1-15-GLCM45; (Optical MNF + texture) and LiDAR derived measures; Optical SSPCA image and LiDAR derived measures.	Maximum likelihood classifier (MLC)	Optimize the use of LiDAR and hyperspectral data for reedbed habitats mapping
Naidoo et al.[106]	Height only dataset; Hyperspectral indices only dataset (CRI, NDVI, PRI, red edge NDVI); Height and indices dataset (Height, CRI, NDVI, PRI, red edge NDVI); Raw bands datasets (all 72 CAO raw bands); SAM selected bands dataset (Band Add-On); Nutrient and Leaf Mass Bands Dataset	Random forest module	Classification of savanna tree species
Anderson et al.[131]	24 AVIRIS MNF bands and 4 LVIS metrics (RH25, RH75, RH50 and RH 100)	Stepwise mixed linear regression techniques	LiDAR-hyperspectral fusion for inventory of a northern temperate forest

Hiperespectral Image



Forest Biomass Map



Tested other methodologies: Maxent, Kriging, IDW

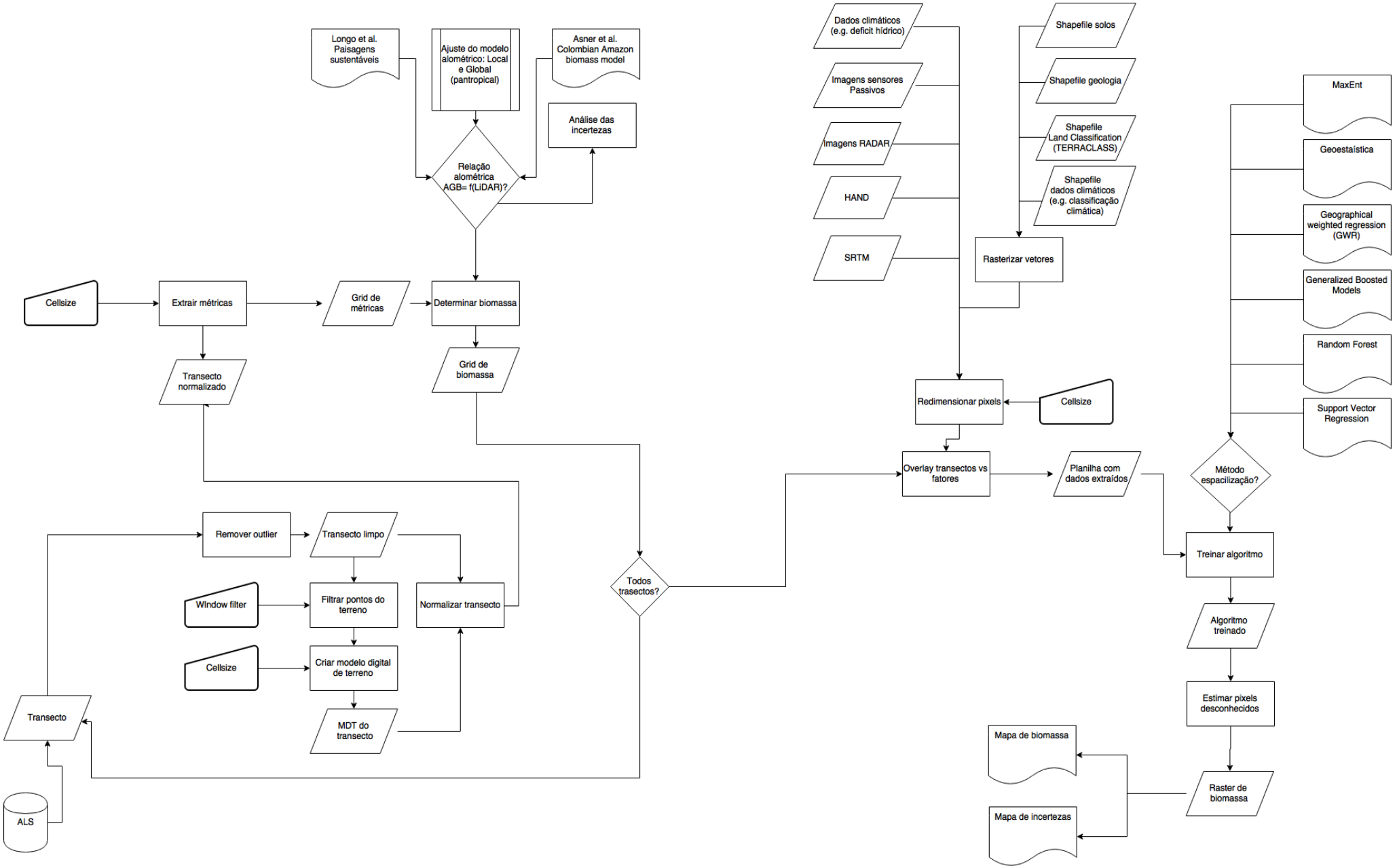
1st Level: field plot → the data are used to validate the biomass estimated by LiDAR (2nd). Eq. used by Chave et al 2014 and Longo et al 2016 (407 field plots were used for this validation)

3rd - Map produced by extrapolating the biomass biome using MODIS vegetation index, SRTM data, ppt from TRMM, PALSAR and soil and vegetation maps.

Random Forest (nonparametric regression method) → correlates the above ground biomass within the LIDAR transects to a list of variables, and then used for the extrapolation of the biomass to the region.

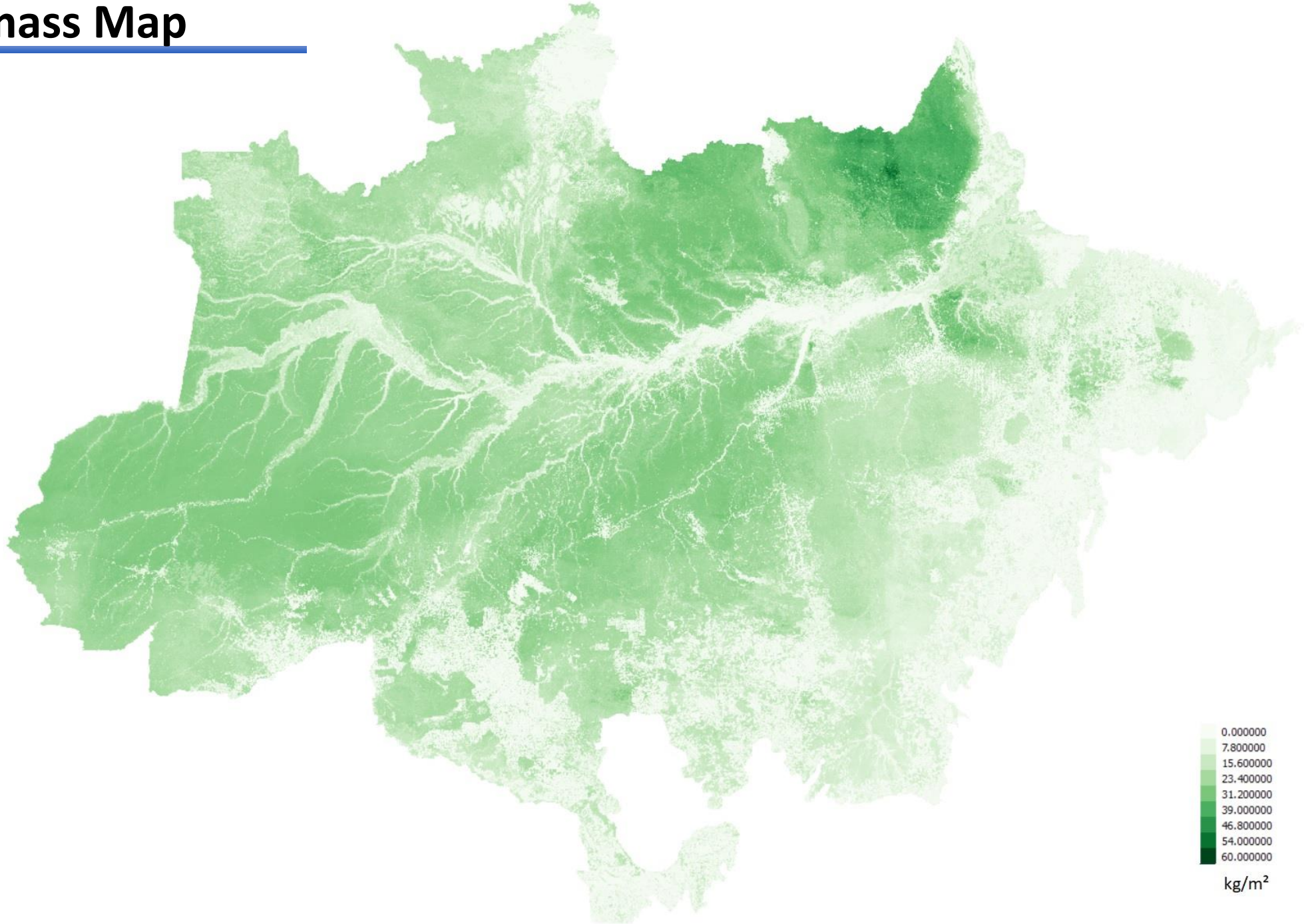
The coefficient of determination and the root mean squared error between the third level extrapolated biomass data and the LiDAR data were R^2=0.8059 and 20.58 $MgC.ha^{-1}$

Steps of the Methodology – Biomass Map



Forest Biomass Map

Subproject 7



Forest Biomass Uncertainty Map

Ainda em processamento ...!!!

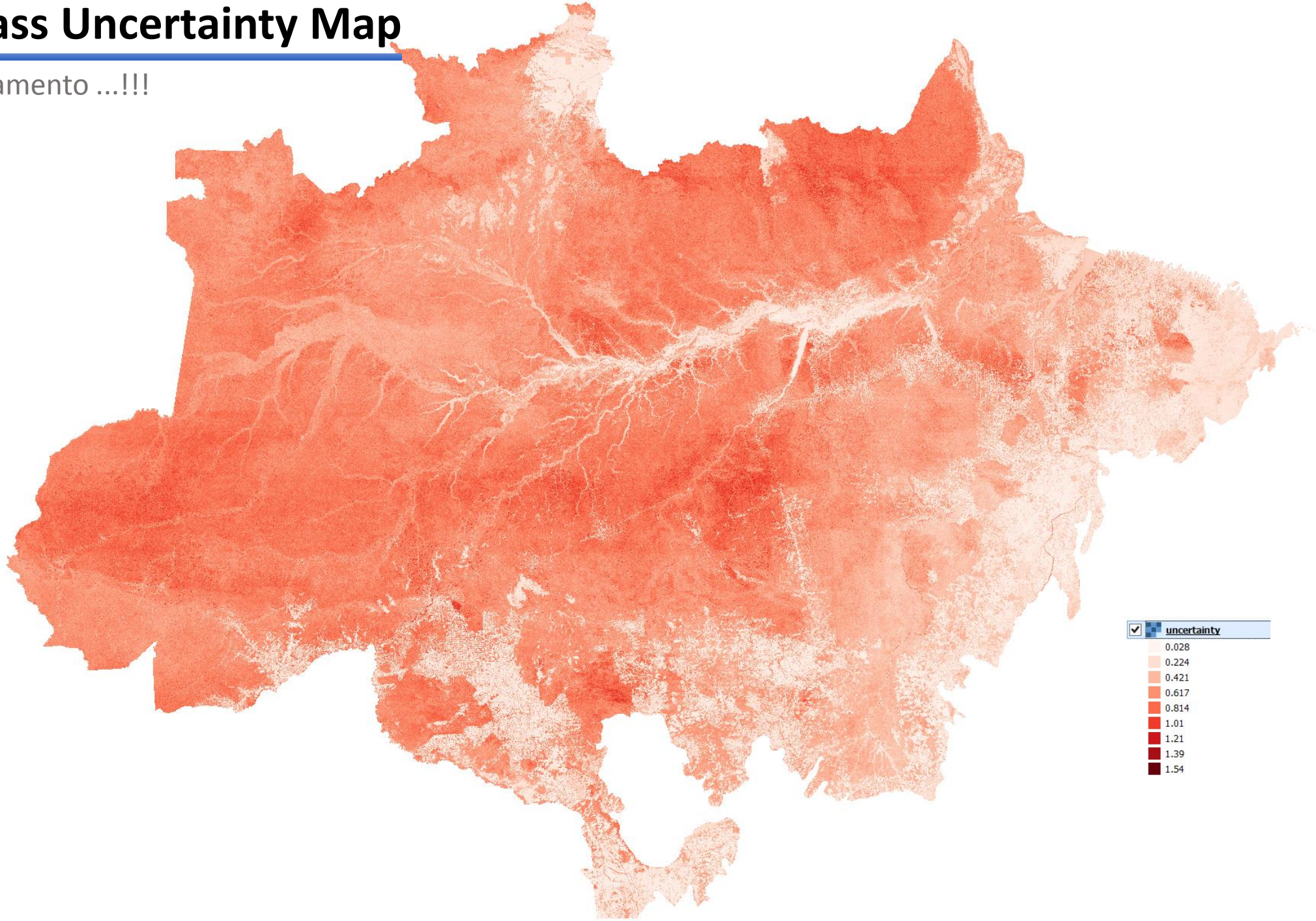
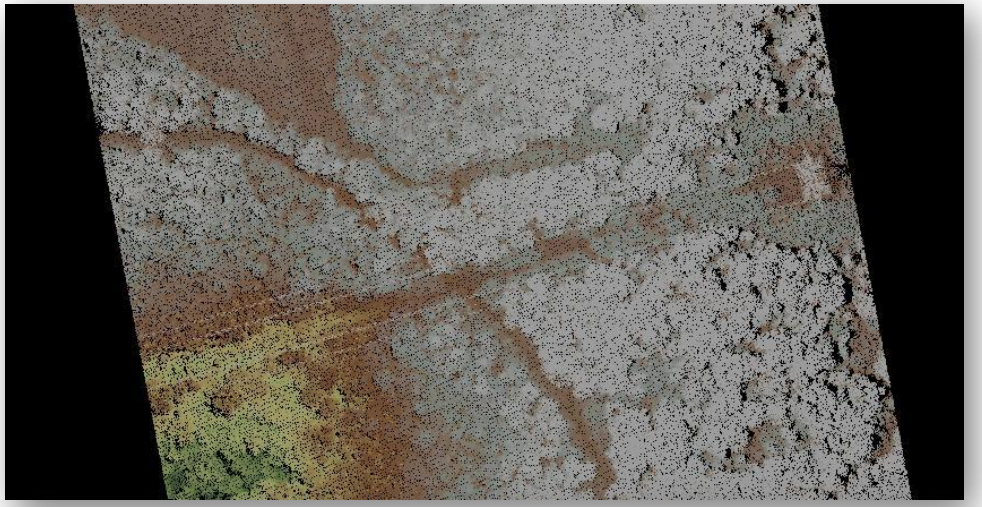
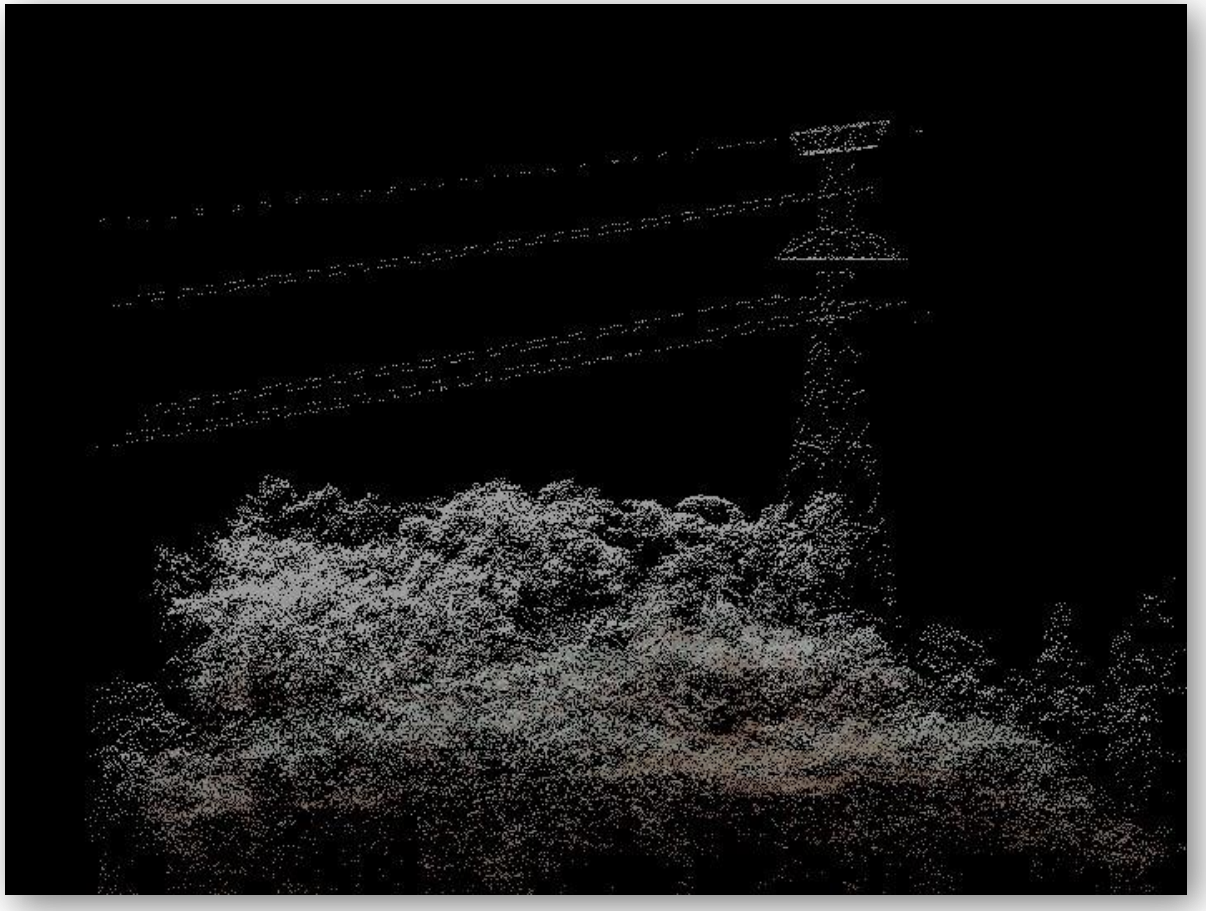


Imagem EBA

Curiosidades

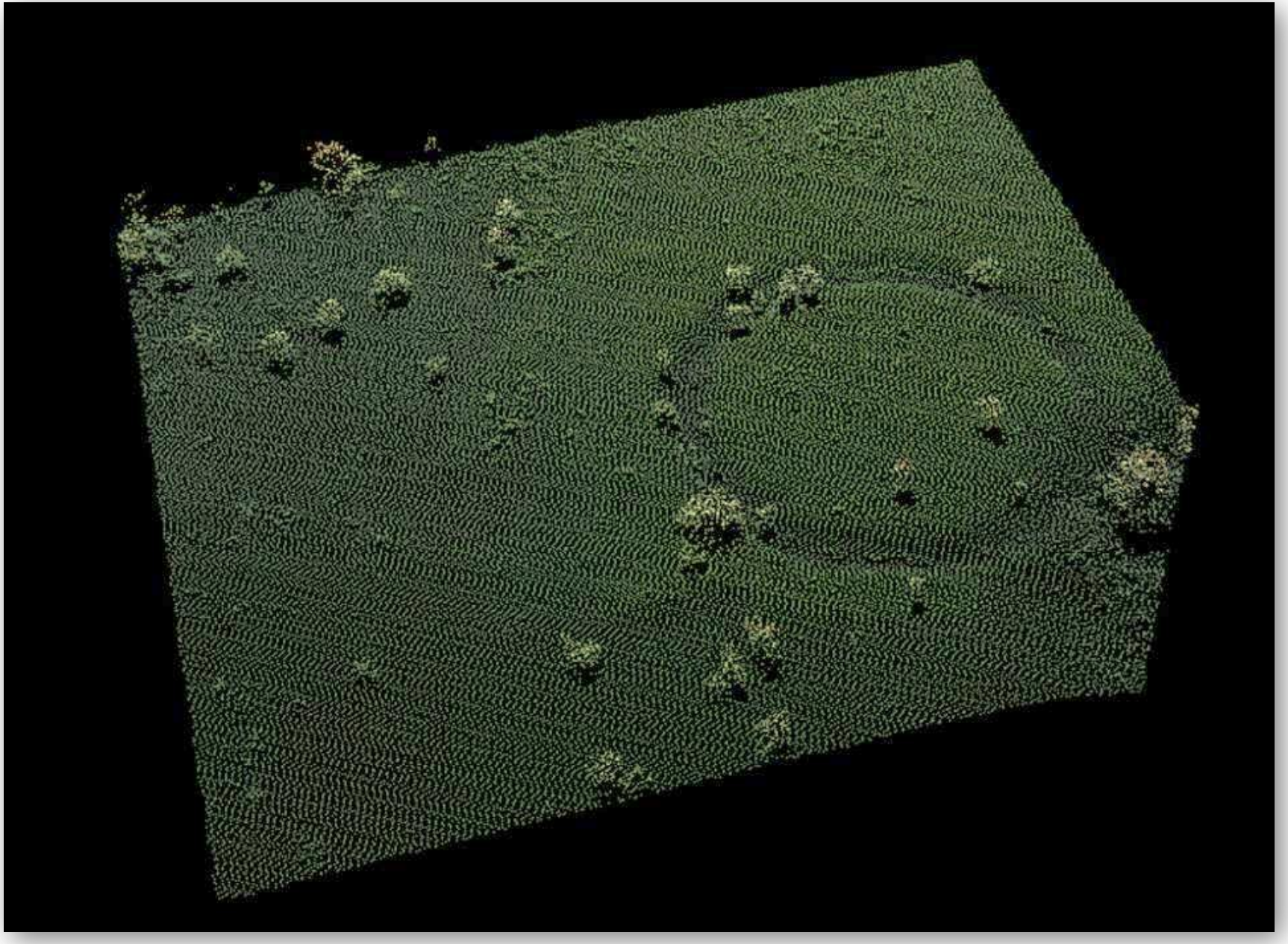
Torres de transmissão





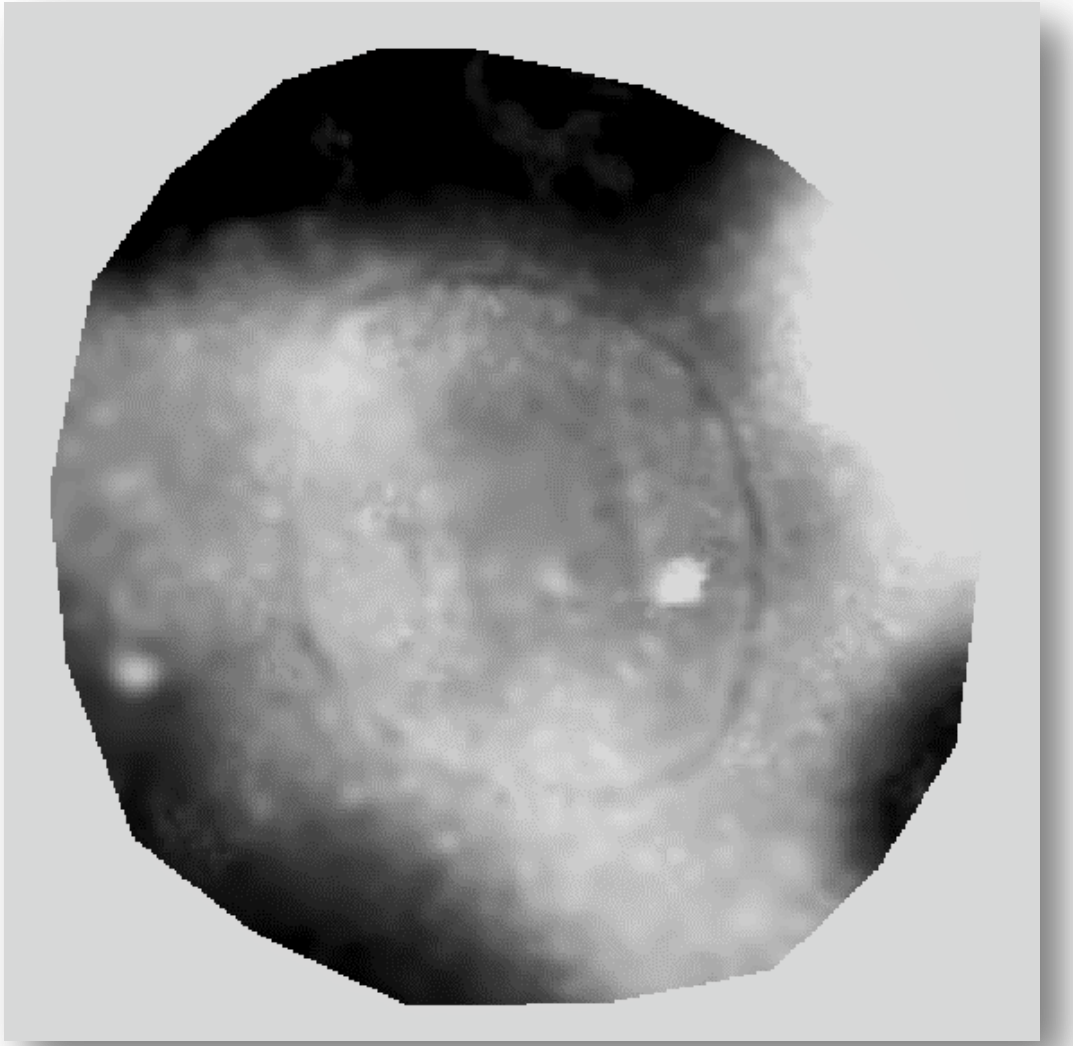
Curiosidades

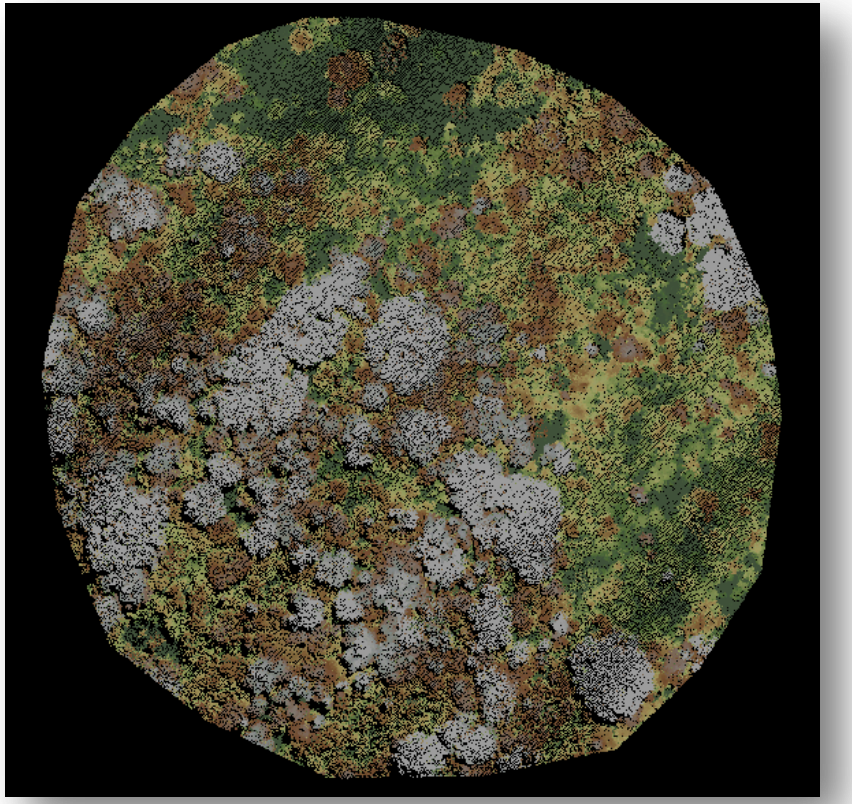
Geoglyph - ACRE

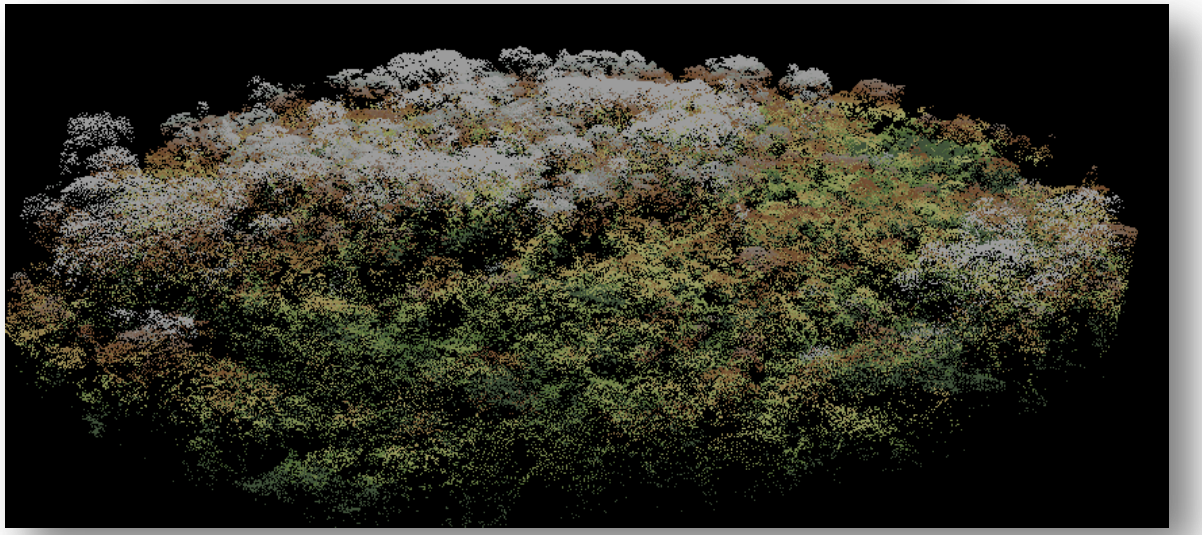


Curiosidades

Geoglyph - Amapá

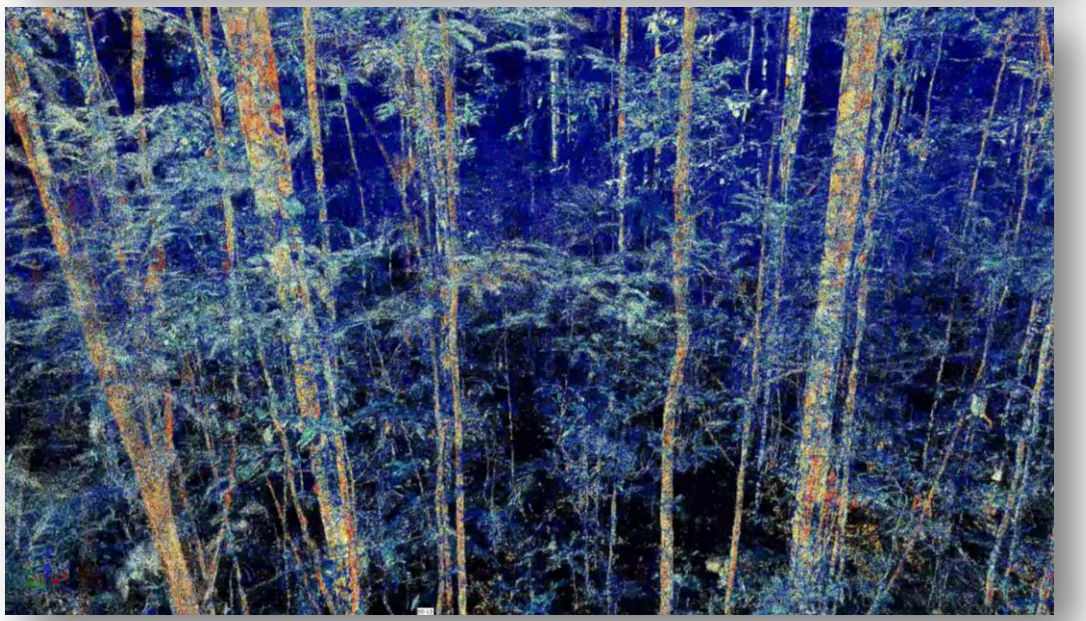


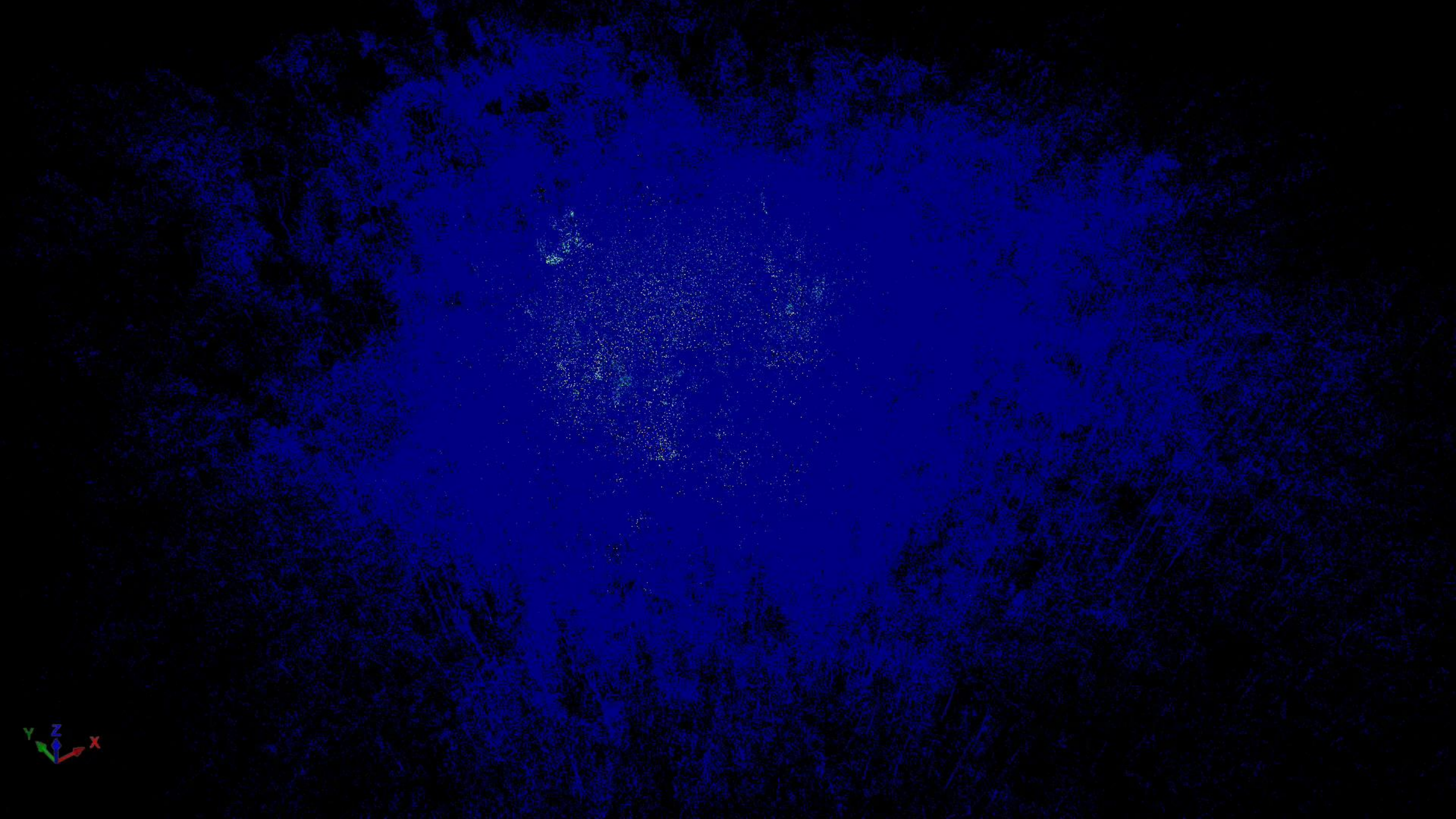




Terrestrial LiDAR

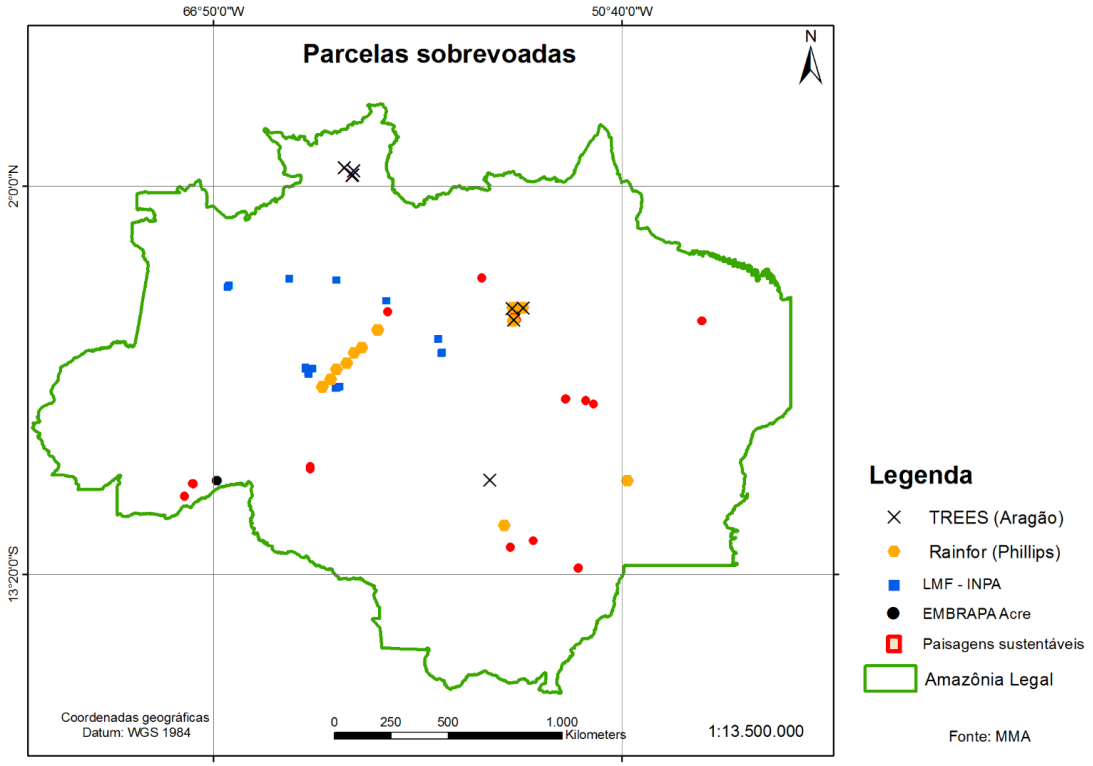
AmazonFace project

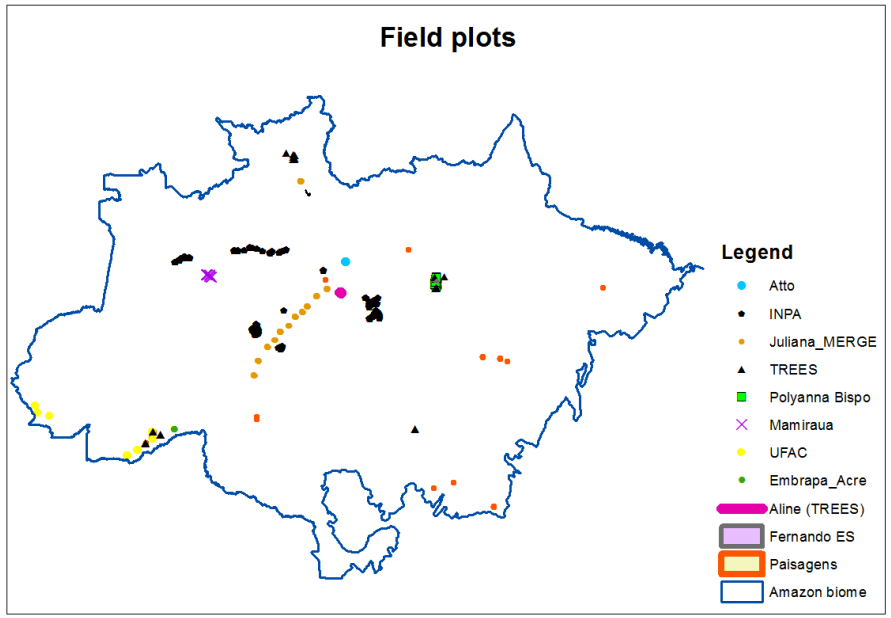



Y
Z
X

Parcerias e trabalhos de campo

- **Paisagens Sustentáveis – EMBRAPA – Michael Keller**
- **LMF, INPA – Niro Higuchi**
- **EMBRAPA Acre – Marcus Vinicio Oliveira**
- **TREES (DSR, INPE) – Luis Aragão**
- **RAINFOR – O. Phillips**
- **Universidade de Lancaster – Fernando Espírito-Santo**
- **PPBIO – Juliana Schietti e Carolina Castilho**
- **Inst. de Des. Sustentável Mamirauá - Mariana Ferreira**
- **Universidade de Leicester - Pollyana Bispo**
- **DSR/OBT INPE_Lenio Soares Galvão**
- **GRUPO GEDI (Global Ecosystem Dynamics Investigation Lidar – NASA)_Jim Kelner e Laura Duncanson**
- **Processamento – JET PROPULSION LABORATORY (JPL)_Sassan Saatchi, Marcos Longo**
- **UFVJM - Universidade Federal Dos Vales Do Jequitinhonha E Mucuri _ Eric Gorgens**
- **ESALQ/USP – Luiz Carlos Estraviz**
- **Universidade de Oxford_Students Exchange Programme**
- **....**





Eventos e reuniões

- **I e II WIBEMA (*Workshop Improving Biomass Estimation Methods for the Amazon*)**
- **EIBEMA (Expedição Improving Biomass Estimation Methods for the Amazon**
- **2 Curso de Campo: Amazonia and Climate Chamge_INPA / AmzFACE**
- **Amazonia em Foco: Floresta de hoje e do amanhã. Museu do Amanhã**
- **IUFRO 2018_Posadas_Special Session on Amazon biomass**
- **GloBiomass: Global Carbon Project; International Nitrogen Conference, ...**

A seguir....

http://luccme.ccst.inpe.br/

inpe-em.ccst.inpe.br/

www.ccst.inpe.br/projetos/inland/

Ciência para sustentabilidade