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K&C Phase 4 – Status report

Measuring above ground biomass and changes over Brazilian tropical secondary forests and savanna woodlands (Cerrado) using L-band SAR data

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Science Team meeting #22
Tokyo, Japan, February 16-18, 2016

The importance of tropical secondary forests ...

... establishing on abandoned farmland

- act as a carbon sink: accumulation on average ~10 Mg ha^{-1} yr^{-1} and important at recovering biodiversity
- Amazon: ~ 1/3 deforested land supporting secondary forests at some stage in the 1990s and 2000s (Lucas et al., 2000; Carreiras et al., 2006)
- **however**, still high uncertainty in terms of contribution of its dynamics to the global carbon cycle (South America, 50%; Pan et al., 2011)

Project outline and objectives

Assess the sensitivity of L-band SAR data to forest above ground biomass in a range of lower-carbon tropical regions in **Brazil** : **secondary forests** and savanna woodlands (***Cerrado)***

Value of L-band data for measuring forest above ground biomass:

- sensitivity up to ~ 100 t/ha (saturation level at this frequency)
- developing forest monitoring systems (activity data + emission factors) in regions with lower biomass density

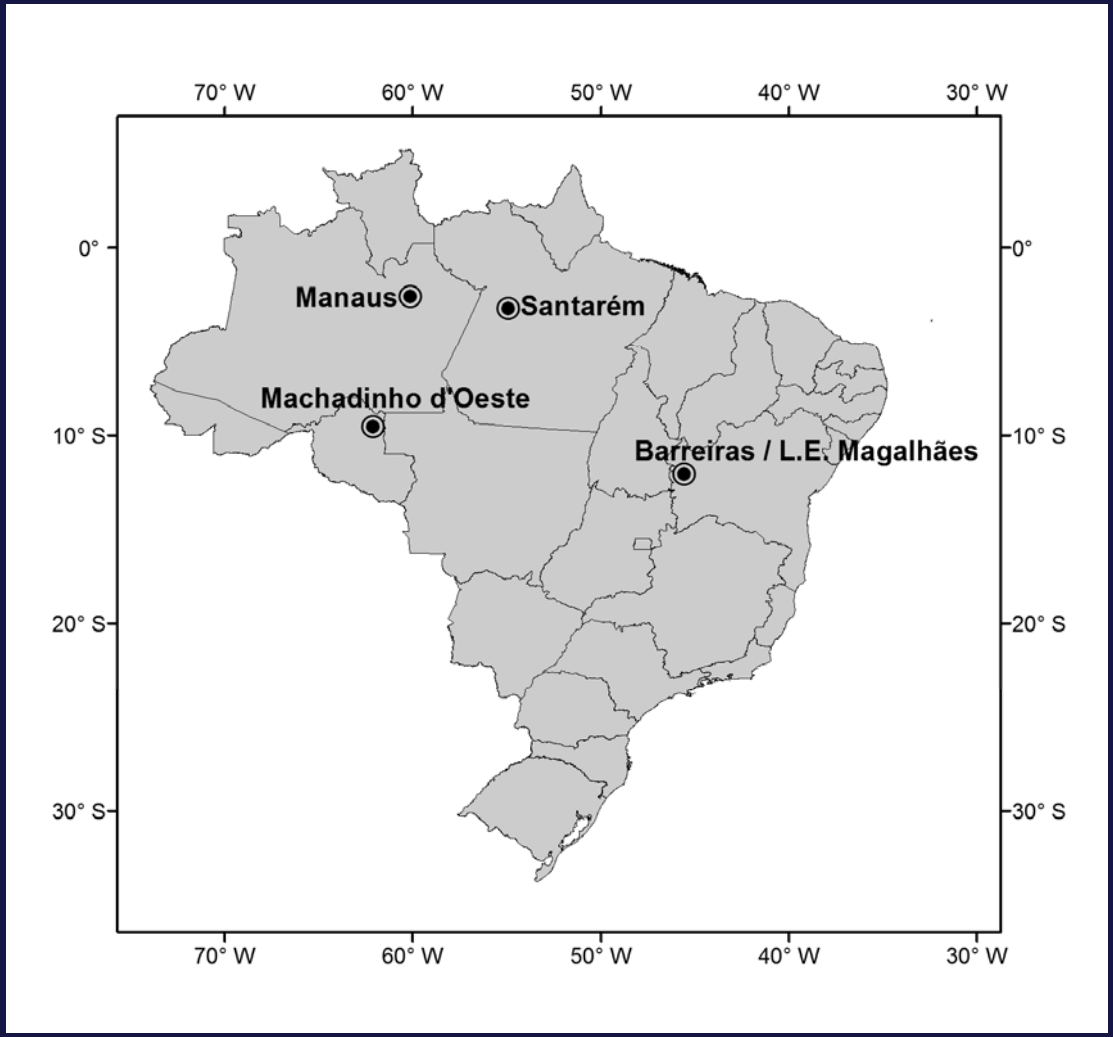
Support of K&C Thematic Drivers

- changes in forest biomass have an impact in terms of **climate**:
  - deforestation: source of carbon to the atmosphere
  - forest growth: carbon removal from the atmosphere

- uncertainties in these biomass-related fluxes in terms of the global carbon budget -> currently estimated as the residual term (exception: Pan et al., 2011, using observational data)

- accurate maps of secondary forests and *Cerrado* biomass and change
  - reduce uncertainty carbon accounting (**UNFCCC**)

Study areas



Secondary forests

- Manaus (Amazonas)
- Santarém (Pará)
- Machadinho d'Oeste (Rondônia)

Savanna woodland (*Cerrado*)

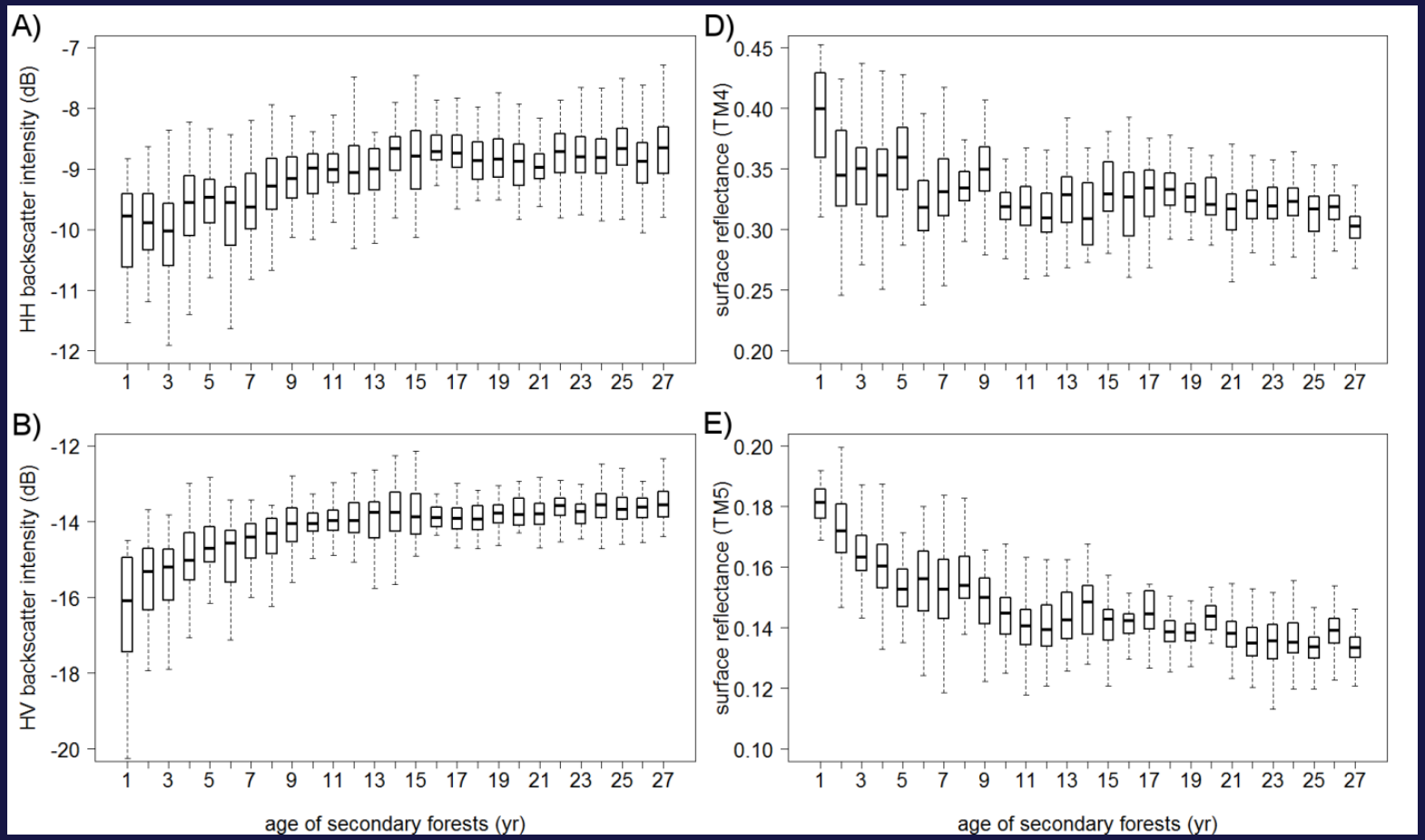
- Barreiras (Bahia)
- Luis Eduardo Magalhães (Bahia)

Preliminary results

What is the capability of optical and L-band SAR data to discriminate the age of tropical secondary forests?

- access to time series maps of non-forest, secondary forest and mature forest spanning three decades (1980s - …) over the three sites
- precise location of areas with secondary forests of known age
- ALOS PALSAR 2007-2010 catalogue
  - dual-pol (HH+HV) level 1.1, JAXA PI programme
- Landsat 5 TM surface reflectance data 2007-2010
  - USGS

Discrimination age of secondary forests



- HH + HV discrimination up to ~ 10 years -> leveling-off
- TM4 + TM5 (and TM7), sensitivity up to ~ 10 years

Mapping secondary forest age classes

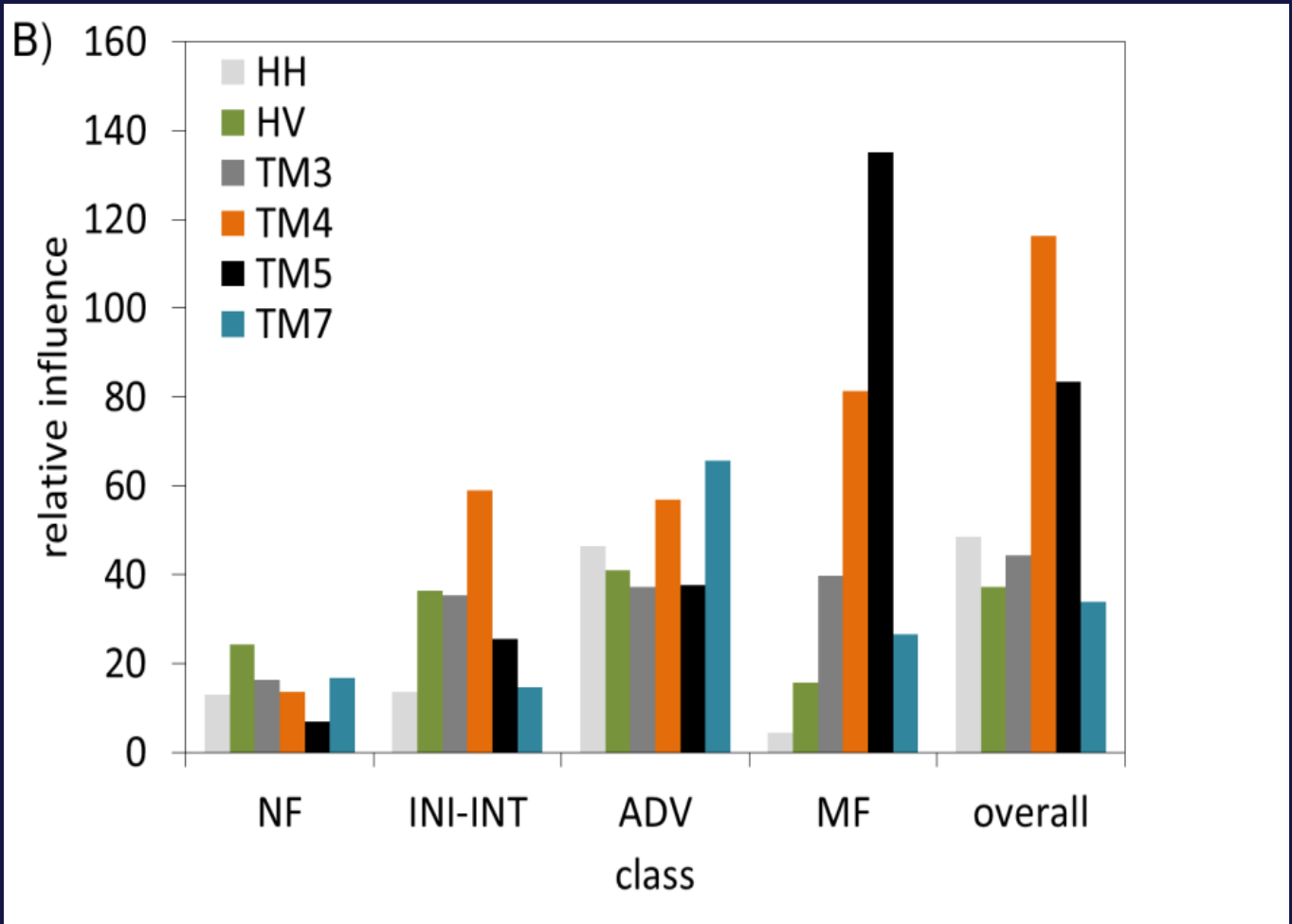
- 2 regrowth age classes
  - initial-intermediate : ≤ 10 yr
  - advanced: ≥ 11 yr
  - also non-forest and mature forest
- 6 predictors
  - HH, HV (ALOS PALSAR)
  - TM3, TM4, TM5, TM7 (Landsat 5 TM)
- algorithm: non-parametric Random Forests (Breiman, 2001)
  - R randomForest package

Mapping secondary forest age classes

		observed (# plots)					
		non-forest	**initial-intermediate**	**advanced**	mature forest	Total	Commission Error
Predicted (# plots)	non-forest	5,620	22	1	0	5,643	0.4
	initial-intermediate	22	564	82	4	672	16.1
	advanced	1	98	940	96	1,135	17.2
	mature forest	1	32	137	2,004	2,174	7.8
	Total	5,644	716	1,160	2,104	9,624	
	Omission Error	0.4	21.2	19.0	4.8		

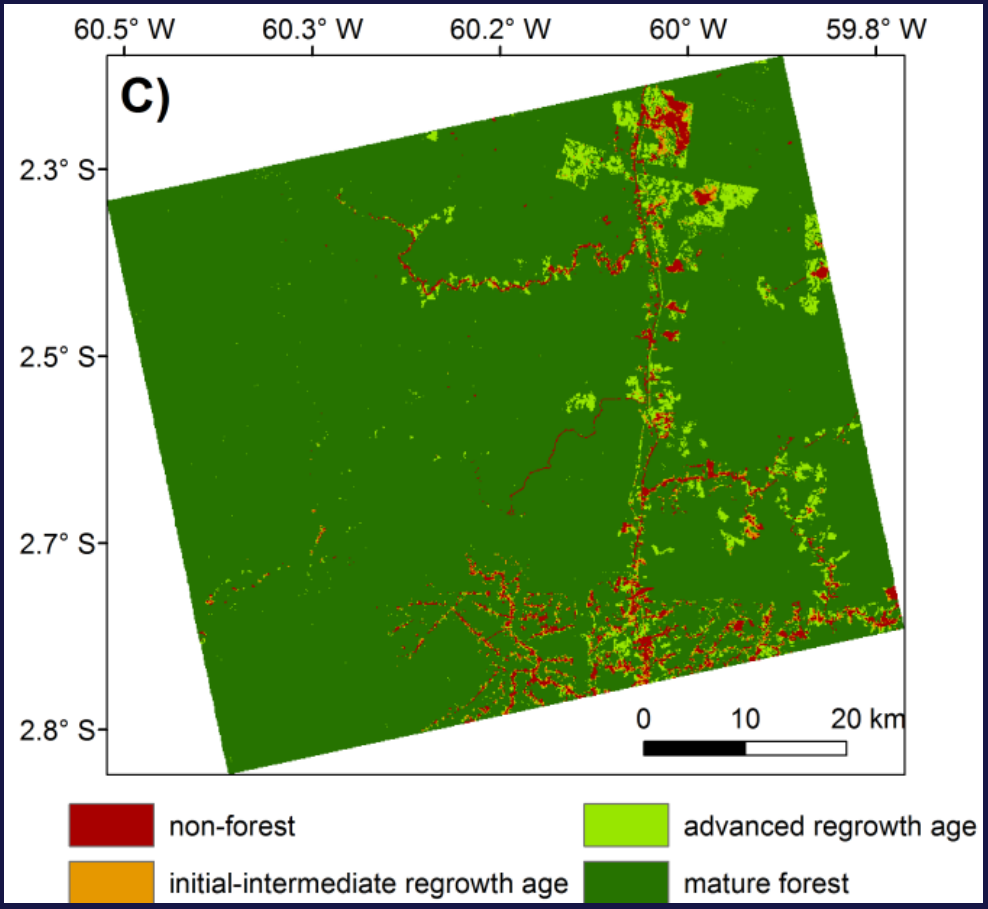
- overall accuracy: 95%
- ini-int regrowth: misclassification (16-21%) mainly as advanced regrowth
- advanced regrowth: misclassification (17-19%) mainly as ini-int and mature forest

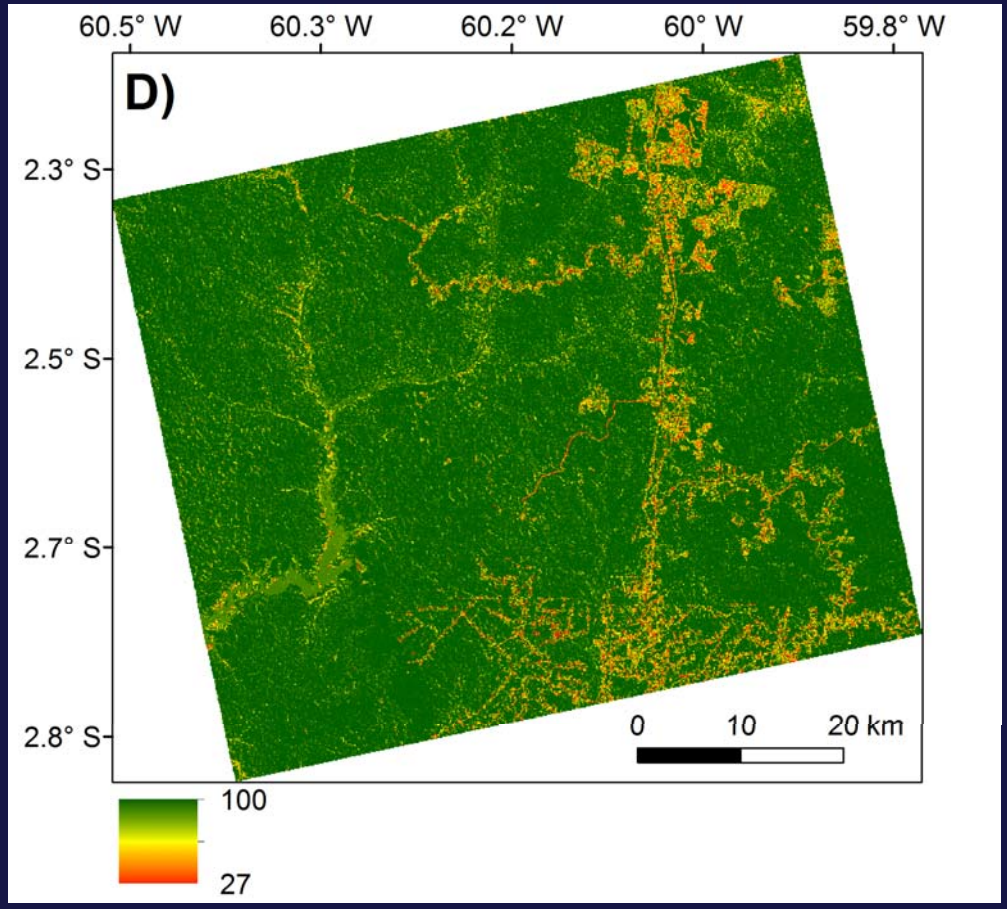
Mapping secondary forest age classes



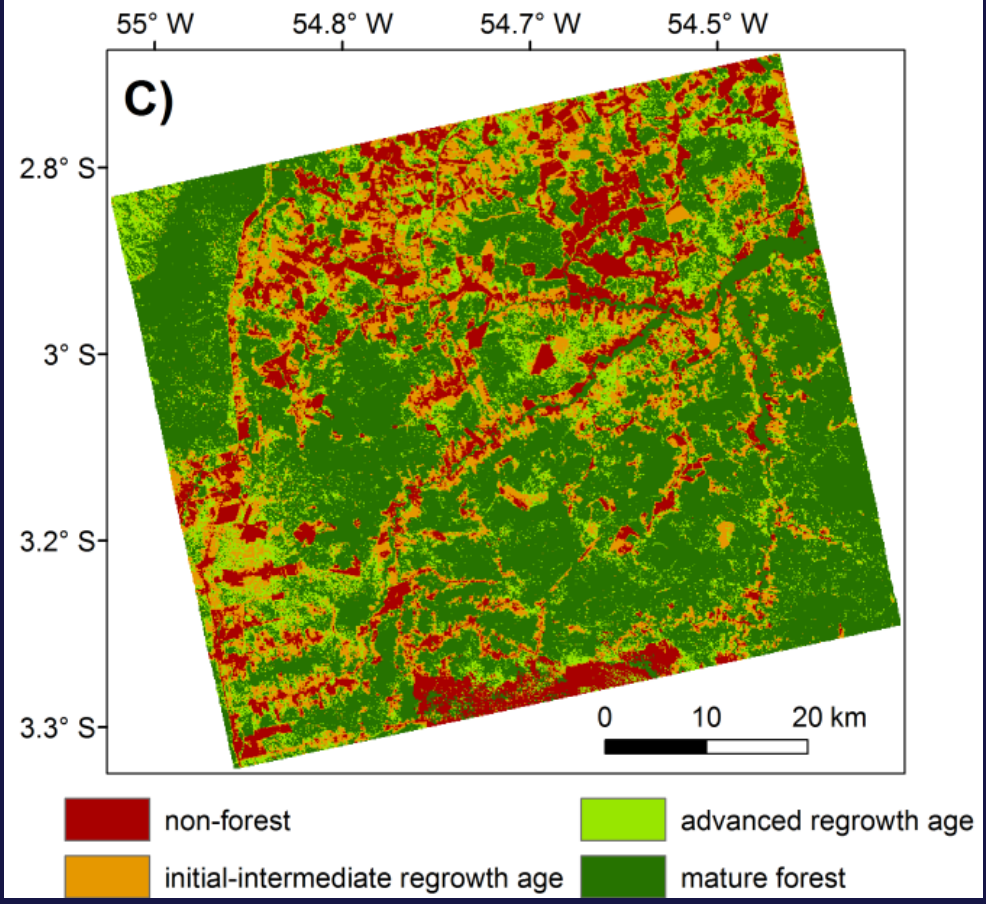
Surface reflectance in the near infrared and shortwave infrared more important at discriminating the age of regrowth classes than L-band dual-pol backscatter

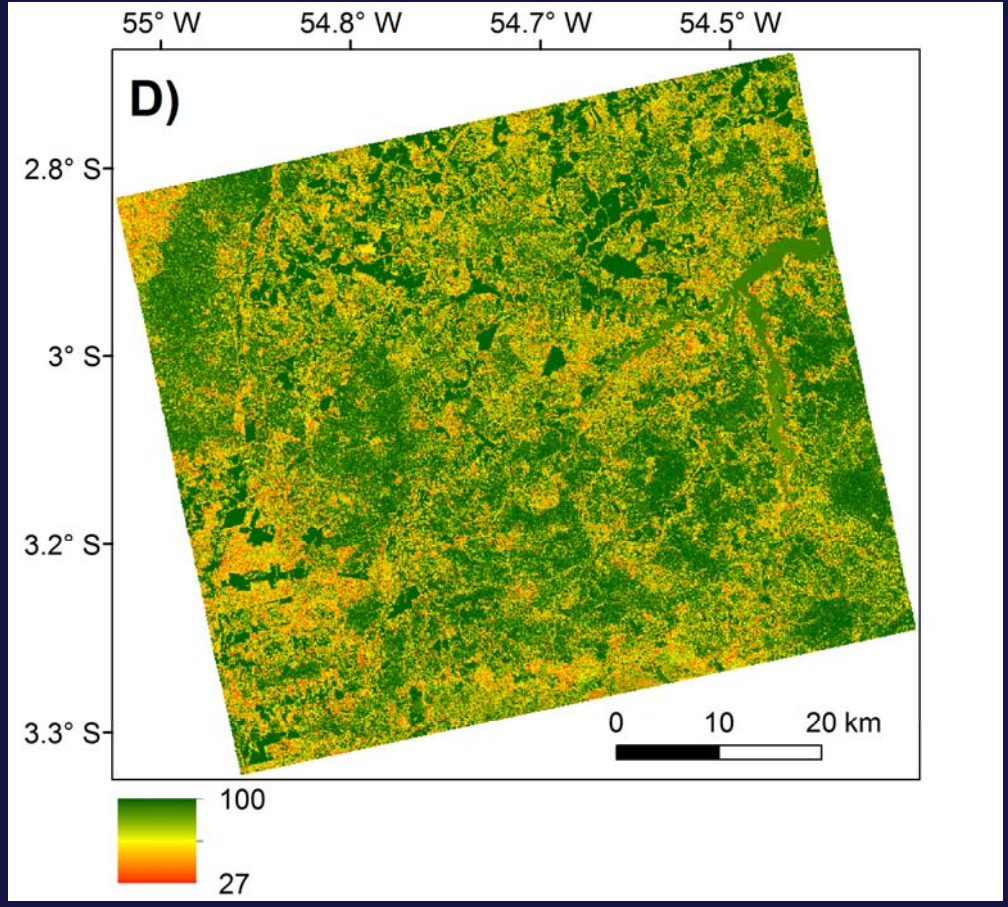
Mapping secondary forest age classes: Manaus, 2010



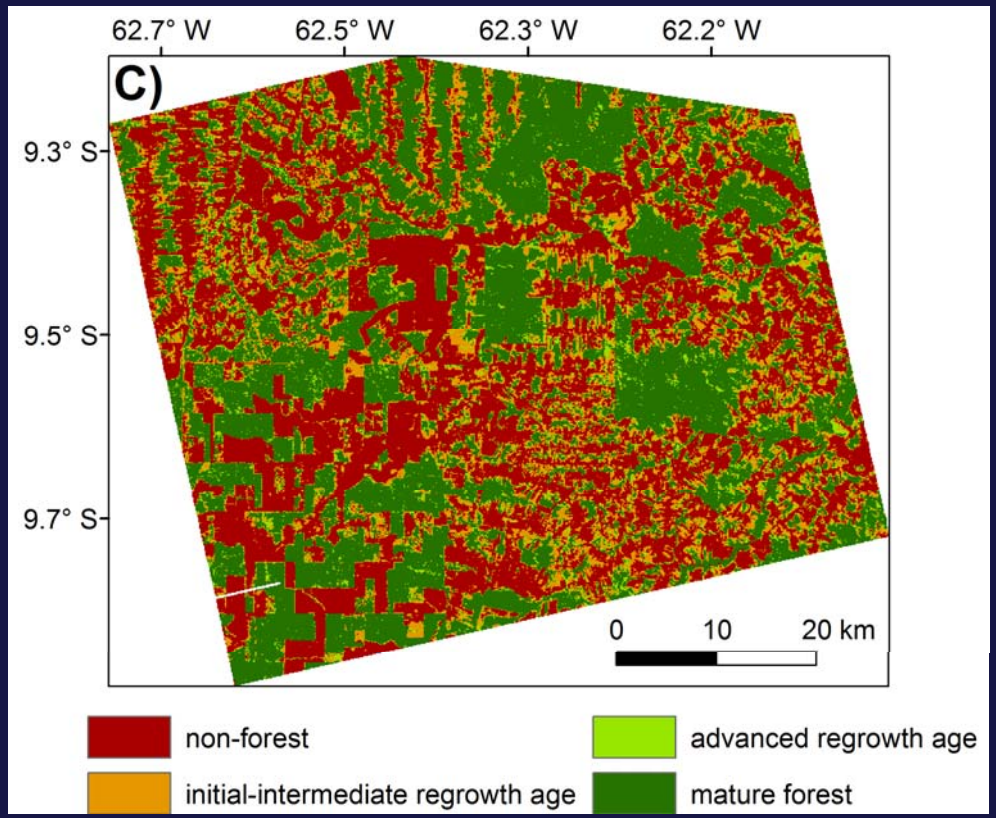


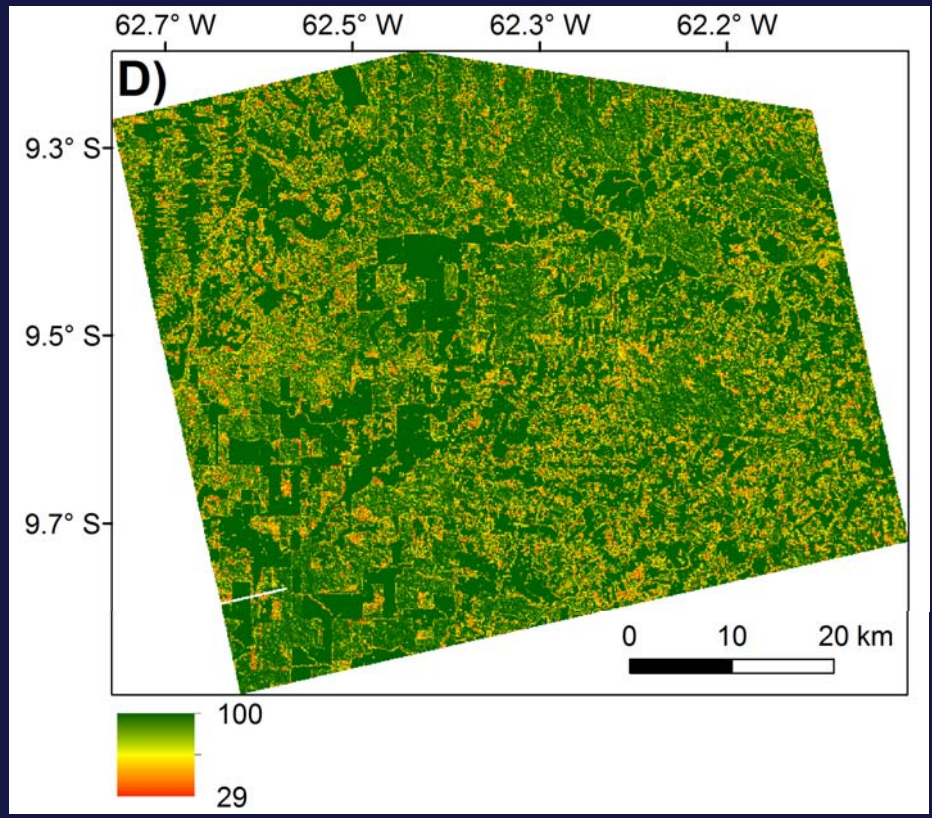
Mapping secondary forest age classes: Santarém, 2010





Mapping secondary forest age classes: Machadinho d'Oeste, 2010





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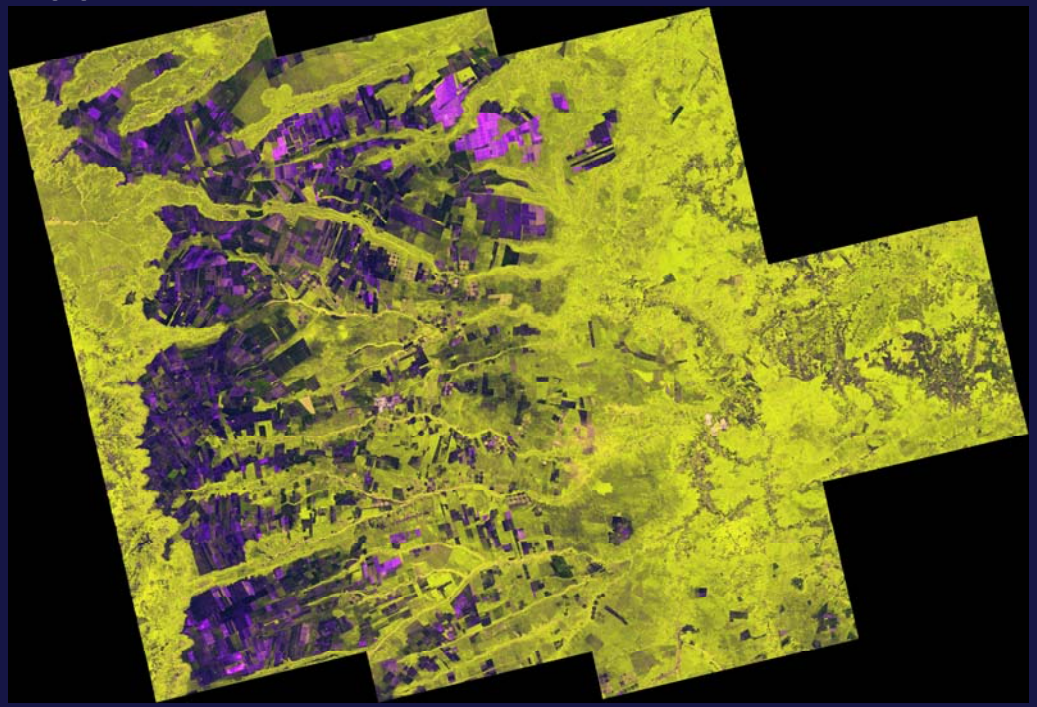
Cerrado, Brazil

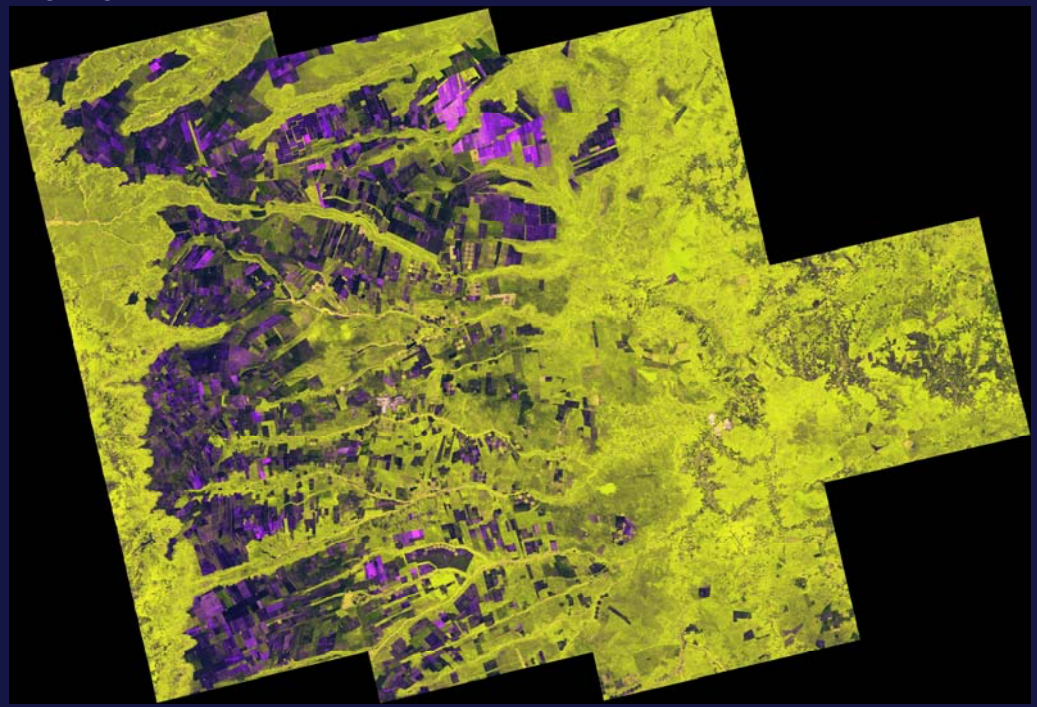
Barreiras + Luis Eduardo Magalhães (Bahia)

ALOS PALSAR mosaics generated between 2007-2010

2007

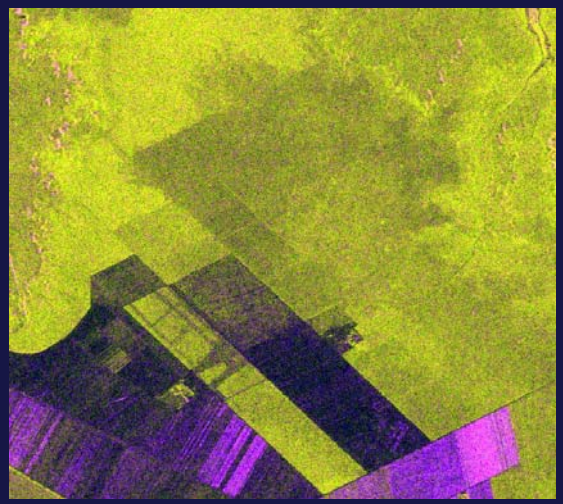


2010

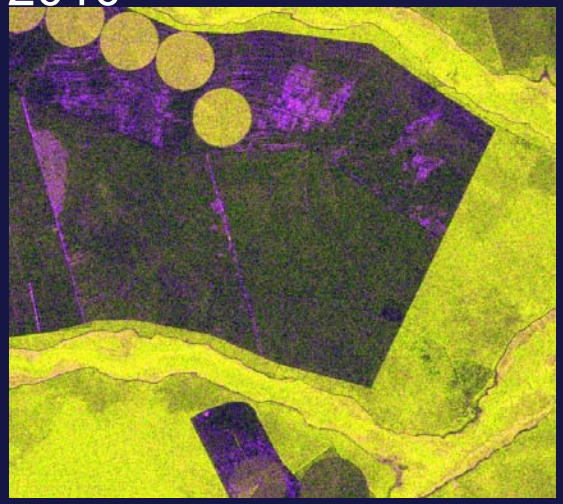


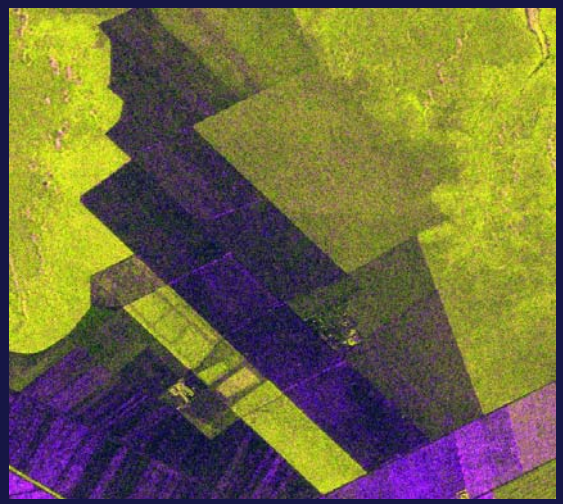
Some examples of frontier deforestation over Cerrado

2007



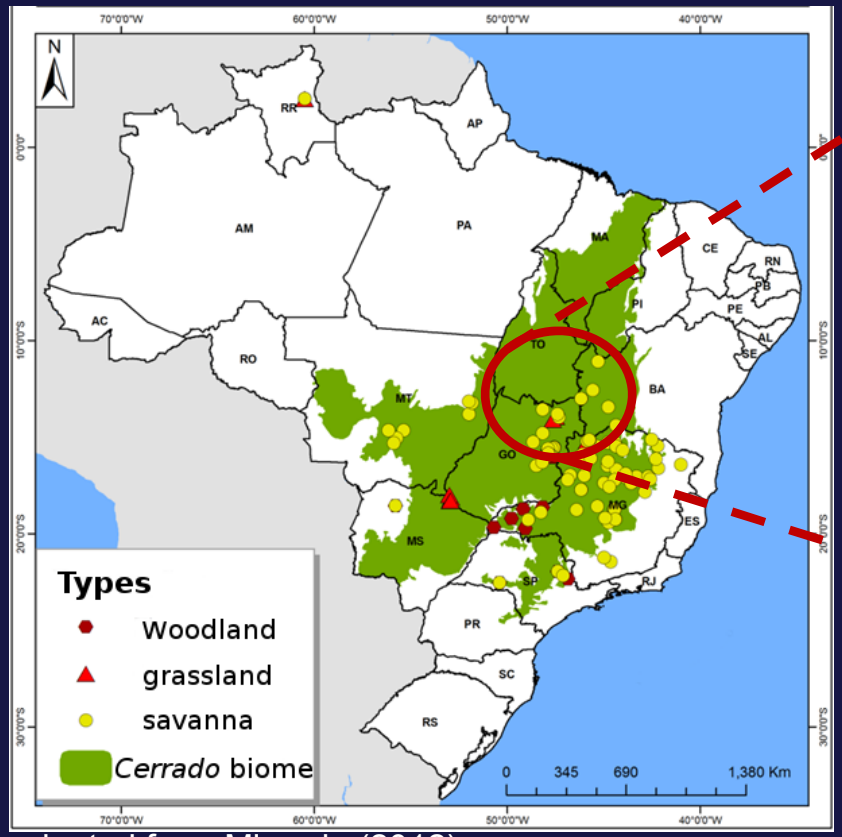
2010



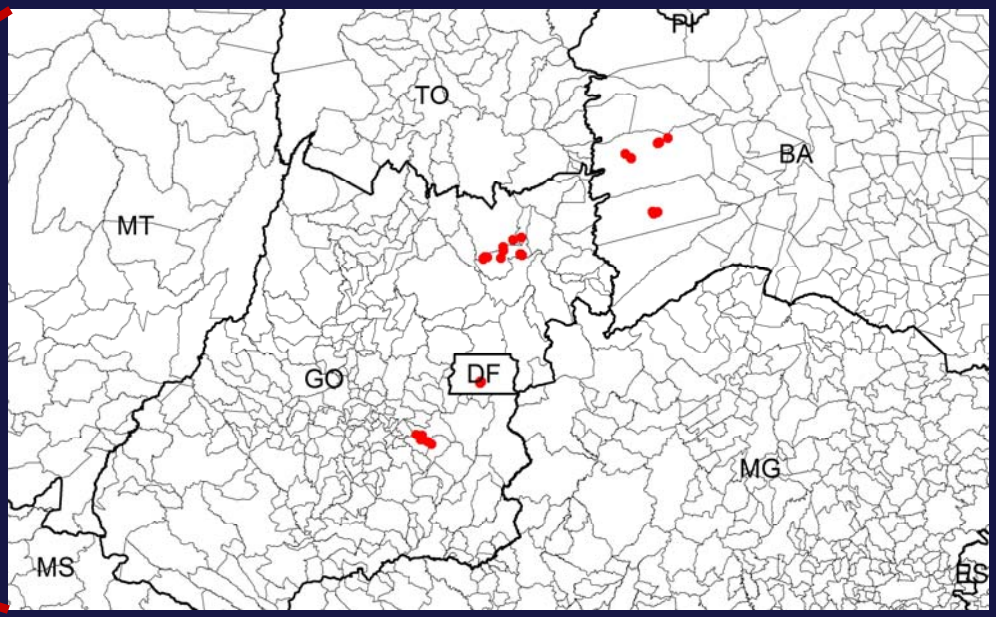


- important to monitor and know the contribution of these disturbances in terms of the regional carbon budget
- requires information about the distribution of pre-disturbance biomass

Compilation of biomass plot data over *Cerrado* savanna



adapted from Miranda (2012)



23 studies and ~160 sites

Site name	Municipality/ State	# plots	Average biomass (Mg ha^{-1})	Standard deviation (Mg ha^{-1})	Source
ALTO	Alto Paraíso/GO	10	109	58	Miranda (2012)
PNCV	Alto Paraíso/GO	10	92	48	Miranda (2012)
SIL	Silvânia/GO	9	151	64	Miranda (2012)
SD	São Desidério/BA	9	144	129	Miranda (2012)
COR	Correntina/BA	10	128	68	Miranda (2012)
INTER	Distrito Federal	10	122	44	Miranda (2012)
VALE	Distrito Federal	10	106	35	Miranda (2012)
JBBCV	Distrito Federal	10	196	69	Miranda (2012)

Project milestones

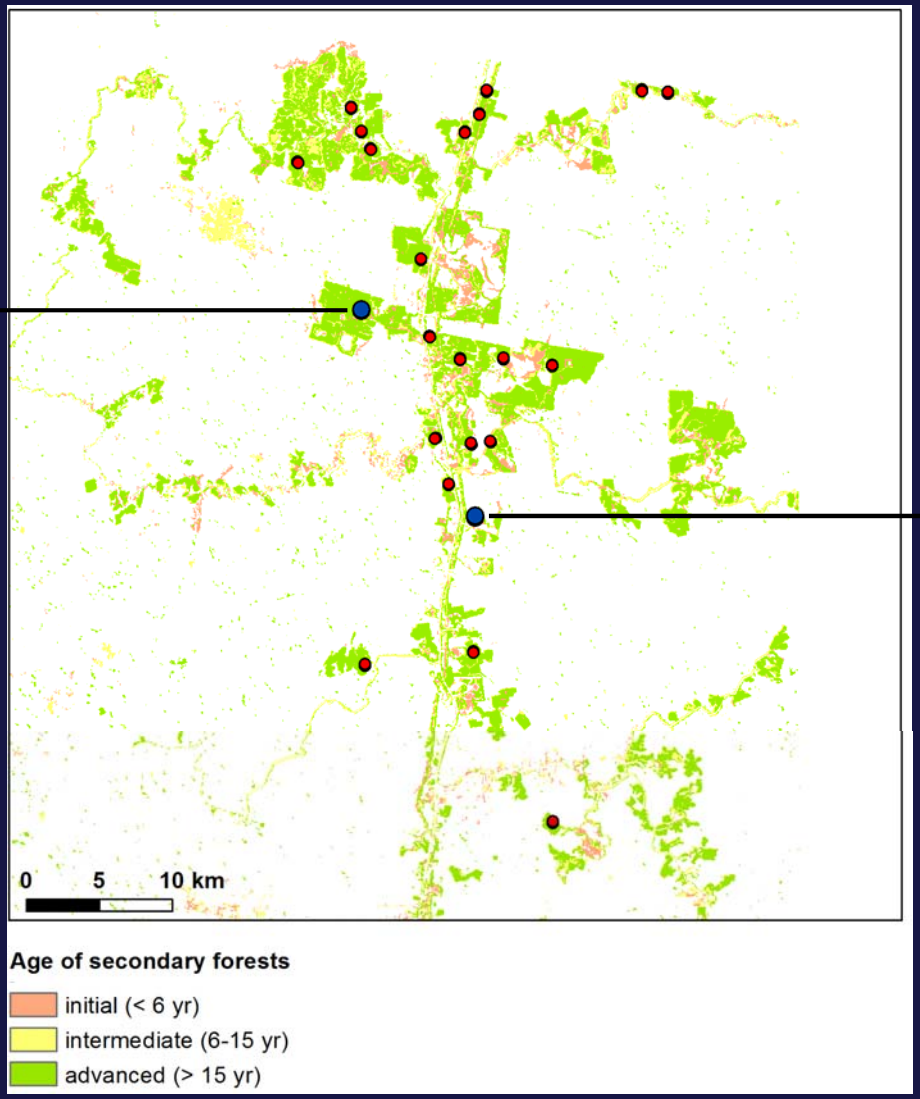
- Initial maps of AGB of secondary forests and savanna woodlands (*cerrado*) and their changes (mid-2016)

- Validation of above-ground biomass maps of secondary forests and savanna woodlands (*cerrado*), associated error analysis and final map products, including error maps (late 2017)

Data sharing

Manaus | August 2014

Adv22_18
ASF = 19 yr
PALU = 7 yr
FC = 2x



Adv12_2
ASF = 23 yr
PALU = 1 yr
FC = 2x

Deliverables

- Above-ground biomass map of secondary forests over areas of approximately 200x200 km around each regrowth hotspot site (Manaus, Santarém and Machadinho d'Oeste)

- Above-ground biomass map of Cerrado in the eastern part of the municipalities of Barreiras and Luis Eduardo Magalhães, Bahia State

- Change maps for these regions and assessment of their implications for carbon and biodiversity

Acknowledgements

- JAXA K&C 4: PIKC1621
- JAXA ALOS 4th RA: PI1208
- Foundation for Science and Technology, Portugal, REGROWTH-BR (PTDC/AGR-CFL/114908/2009)
- UK NERC National Centre for Earth Observation (NCEO) (R8/H12/82)
- United States Geological Survey (USGS)

Thank you!!! Questions?