

Remote Sensing of Large Wetlands: capturing the spatial and temporal dynamics of the Amazon Floodplain

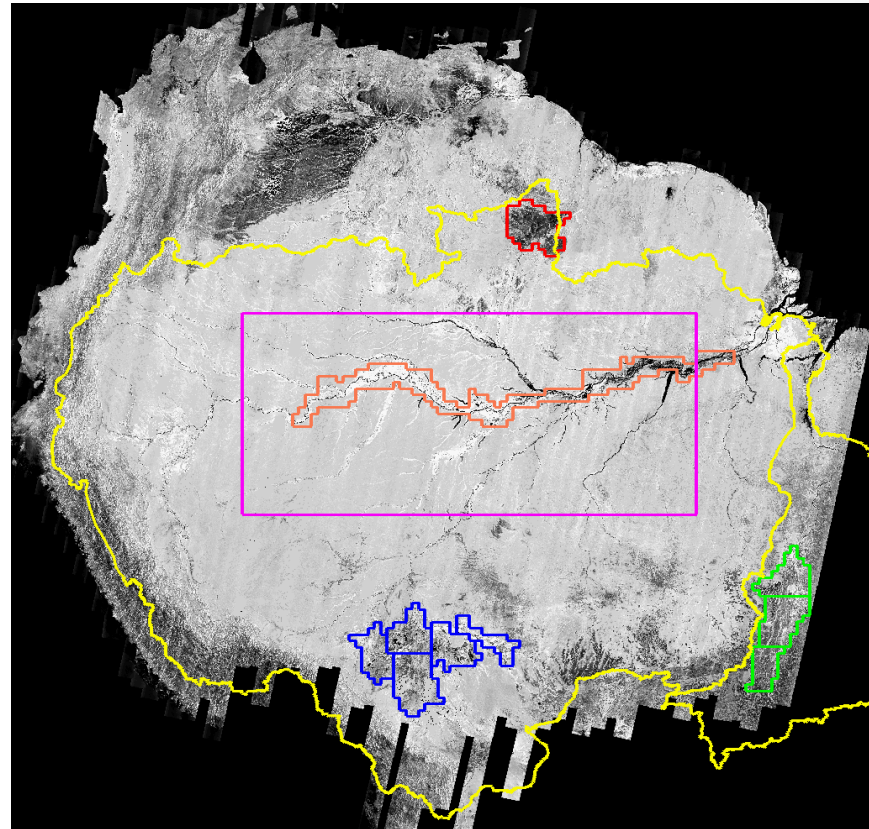
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The Amazon Wetlands

- The extent of wetlands in the Amazon ^(1,2):
 - ~800,000 km² within the lowland Amazon basin (< 500m), including multiple types of wetlands
 - ~ 350,000 km² for the “Central Amazon quadrat”
 - ~ 100,000 km² for the mainstem Solimões/Amazonas floodplain

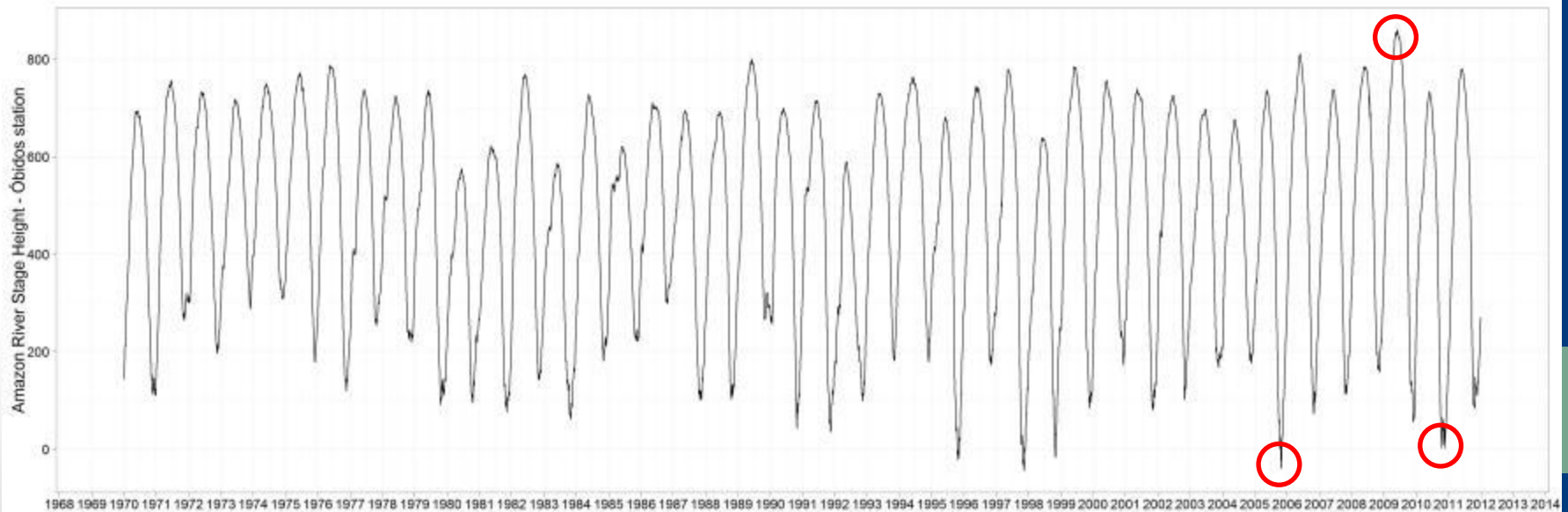


¹ Hess et al. (2003). Dual-season mapping of wetland inundation and vegetation for the central Amazon basin. *Remote Sensing of Environment*, **87**, 404-428.

² Melack and Hess (2010). Remote Sensing of the Distribution and Extent of Wetlands in the Amazon Basin. In: Junk WJ, Piedade MTF, Wittmann F, Schöngart J, Parolin P (eds) *Amazonian Floodplain Forests: Ecophysiology, Biodiversity and Sustainable Management*. Springer Verlag.

The Amazon floodplain

- **The flood pulse (Junk et al., 1989)**
 - Annual, recurrent flooding cycle
 - Controls most of the ecological and biogeochemical processes in the floodplain environments
 - Heavily influenced by Pacific and Atlantic Temperature Oscillations



Climate Change and the Amazon Floodplain

- **Temperature increases predicted between 2°C - 9°C**
- **Possible increase in the frequency of hot and dry years**
 - Hypothesized “savanization” of the Amazon
- **Increase in the frequency and intensity of droughts**
- **Large uncertainty over changes in precipitation patterns**
- **Human impacts**
 - Deforestation and habitat loss
 - Fishing
 - Water quality

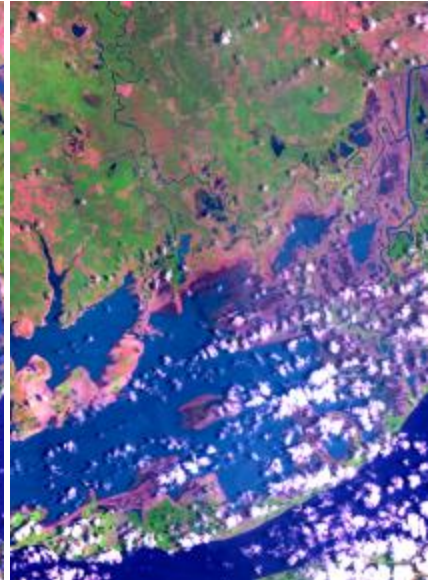
Marengo, J.A., Nobre, C.A., Chou, S.C., Tomasella, J., Sampaio de Oliveira, G., Alves, L.M., Obregón, G.O., Soares, W.R., Betts, R.A. & Kay, G. (2011) *Riscos das Mudanças Climáticas no Brasil: análise conjunta brasil-reino unido sobre os impactos das mudanças climáticas e do desmatamento na Amazônia*.

Davidson, E. a., Araújo, A.C. de, Artaxo, P., Balch, J.K., Brown, I.F., C. Bustamante, M.M., Coe, M.T., DeFries, R.S., Keller, M., Longo, M., Munger, J.W., Schroeder, W., Soares-Filho, B.S., Souza, C.M. & Wofsy, S.C. (2012) The Amazon basin in transition. *Nature*, **481**, 321-328.

Amazon Floodplain

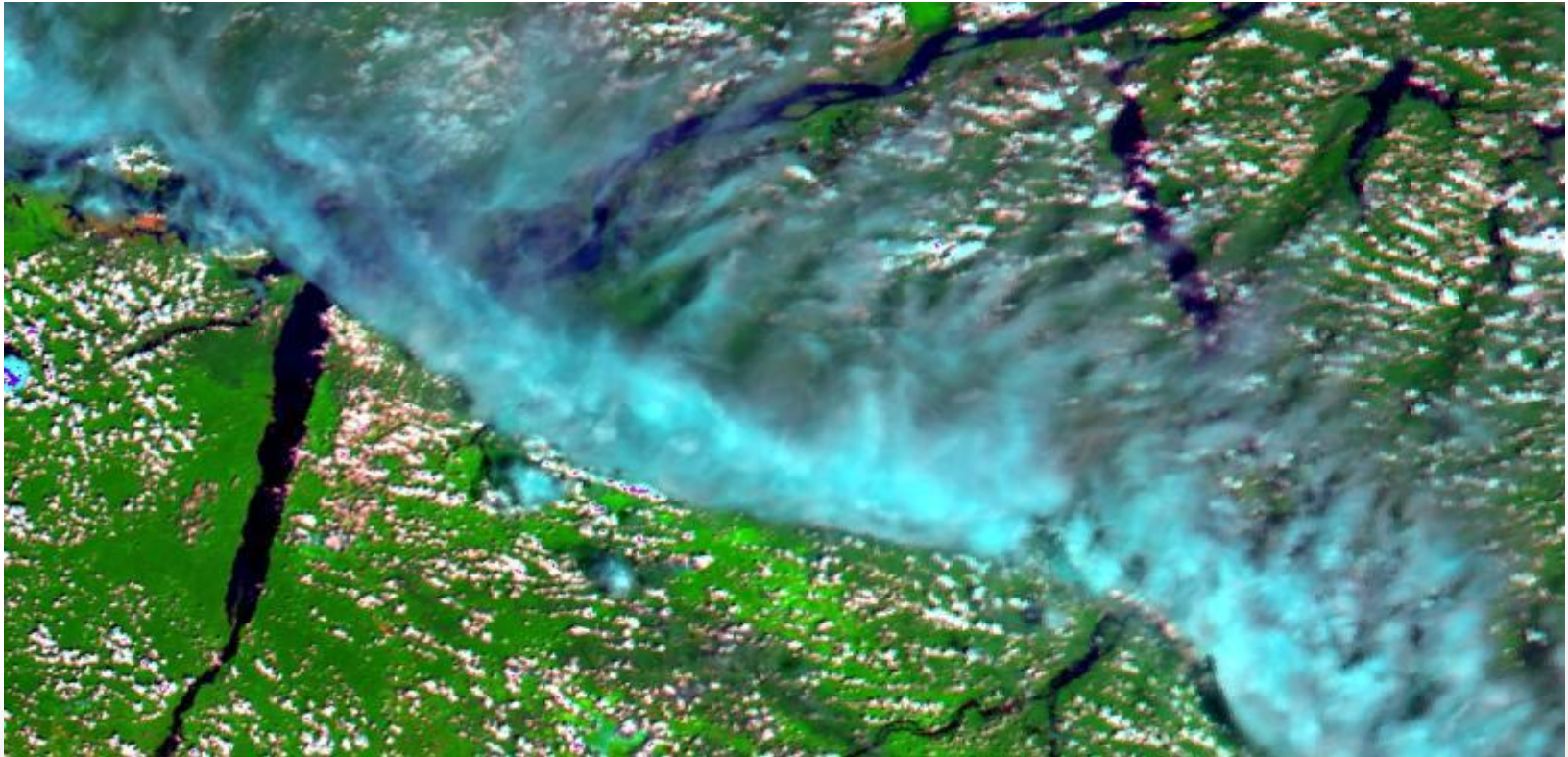


CHANGE



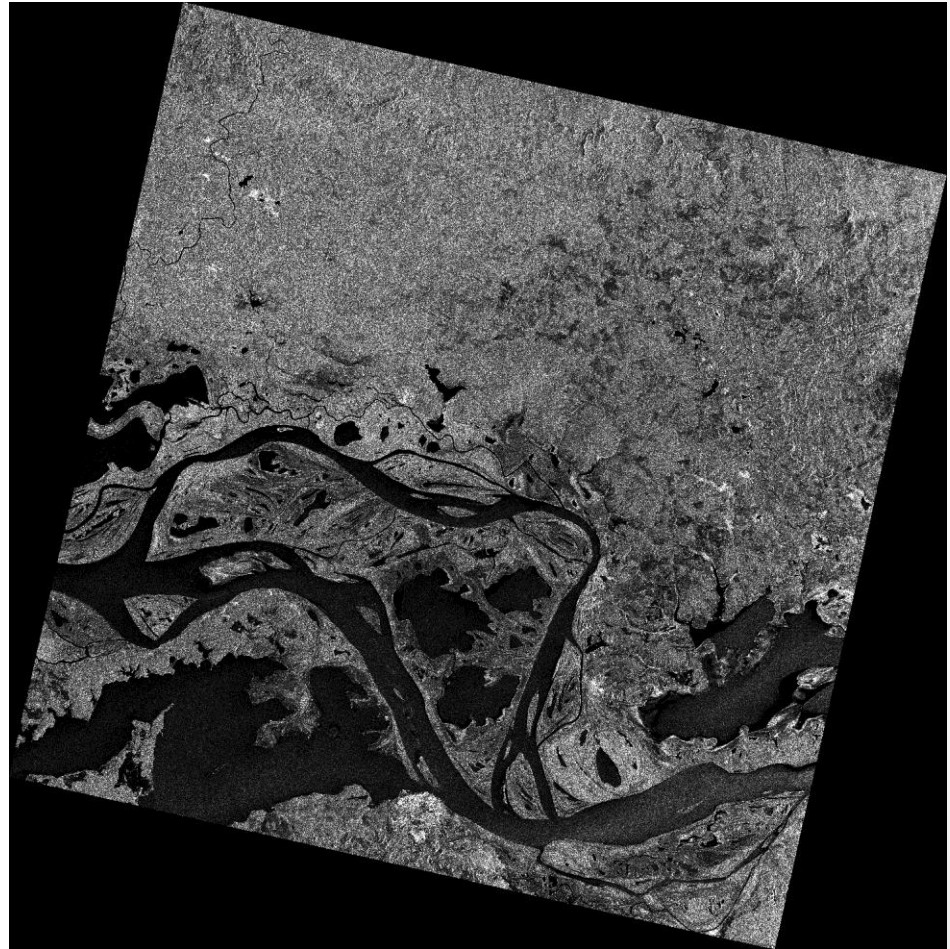
Remote sensing, change and ecosystem functioning

- **How to use remote sensing to further understand this variability?**
 - Problem 1: CLOUDS



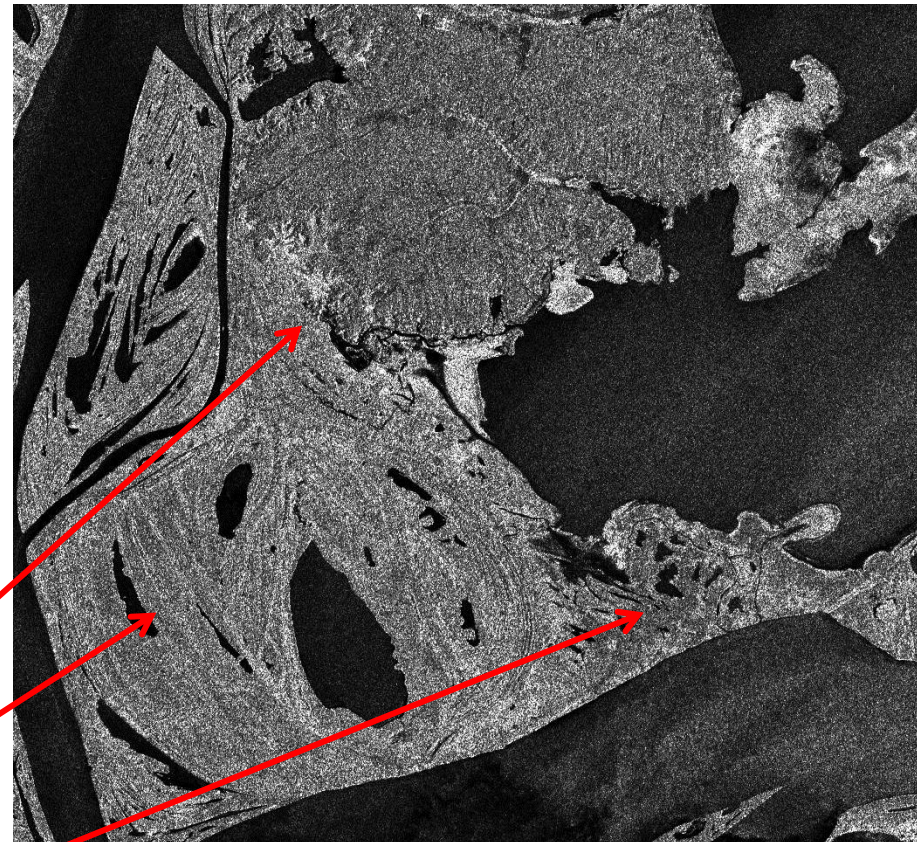
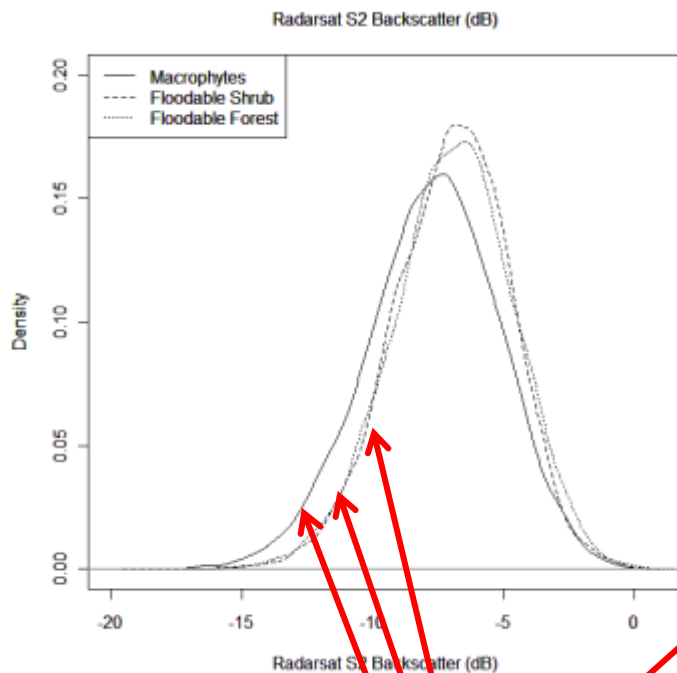
Remote sensing, change and ecosystem functioning

- **How to use remote sensing to further understand this variability?**
- Problem 1: CLOUDS
- **Synthetic Aperture Radar**
 - Can penetrate cloud-cover (repeatability)
 - Sensitive to changes in canopy/biomass structure
 - Sensitive to inundation under canopy



Remote sensing, change and ecosystem functioning

- **How to use remote sensing to further understand this variability?**
 - Problem 2: Separation



Forest

Shrubs

Macrophytes

Macrophytes, variability and carbon cycling

- Radarsat 1 time series: ~ 16 dates per year, guaranteed

Red: Low water 2005
Green: Average 2005
Blue: St. dev. 2005



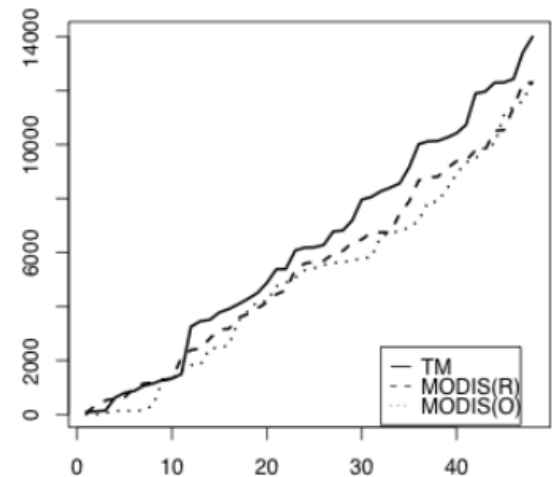
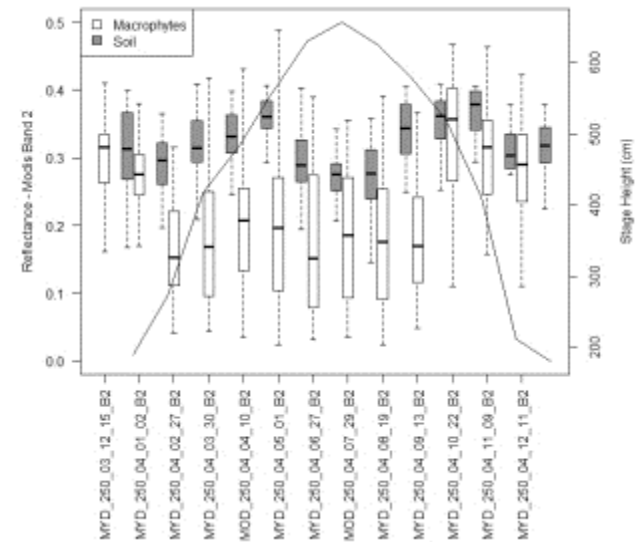
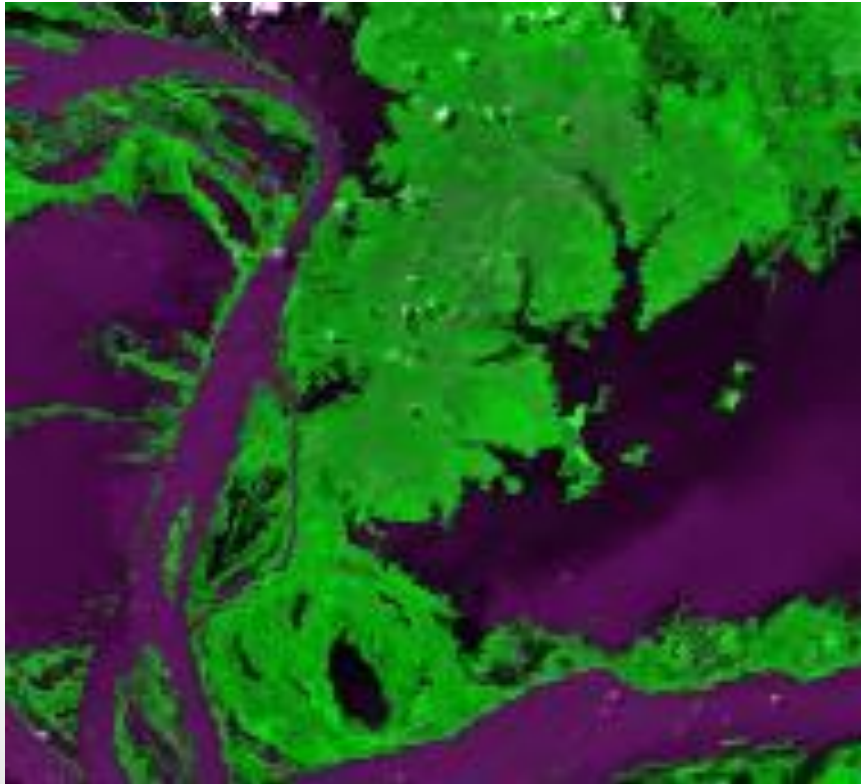
Forest

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Macrophytes, variability and carbon cycling

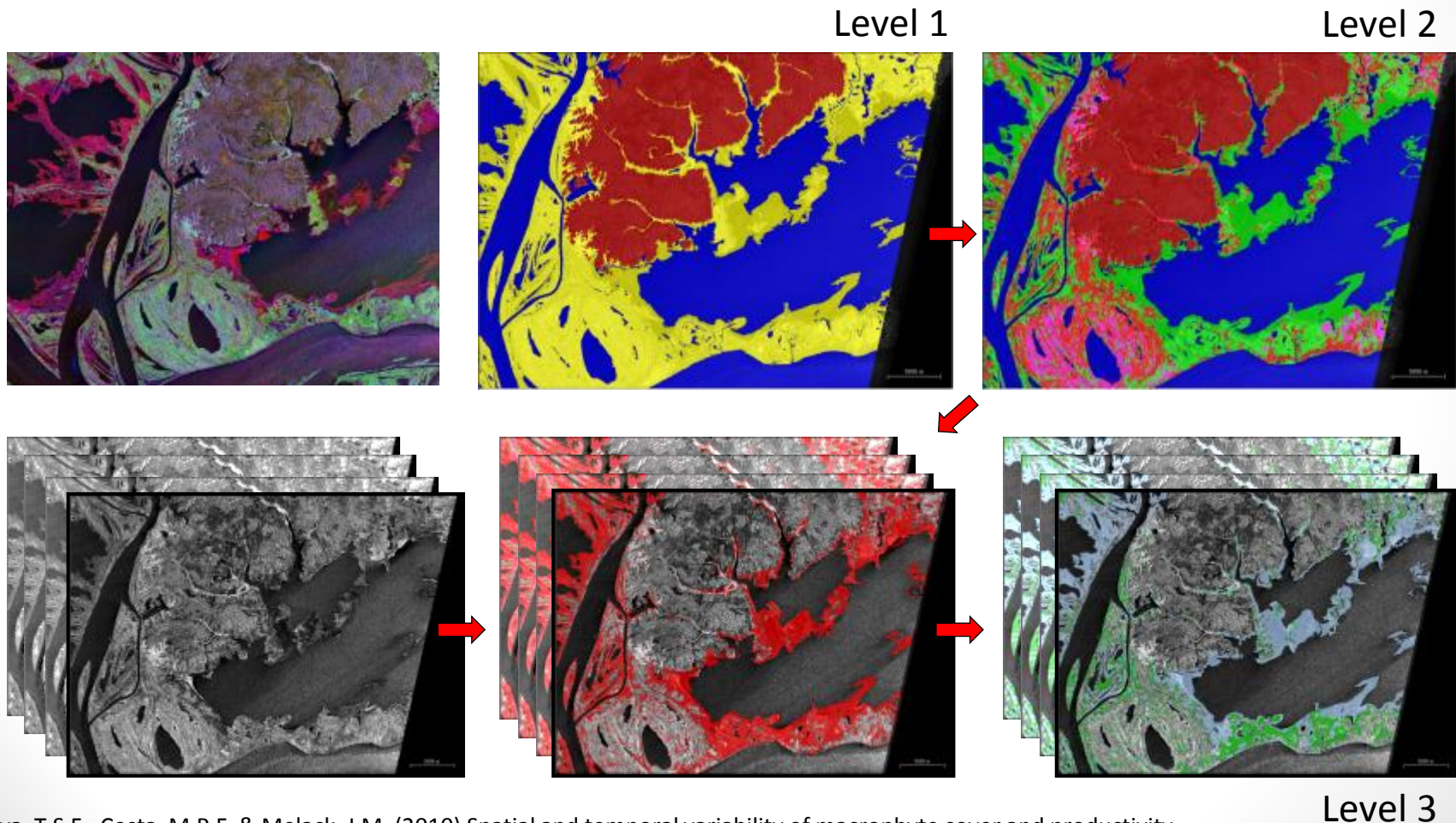
- MODIS imagery
 - Sacrifice spatial resolution for temporal resolution
 - At least 1 cloud free image per month



Silva et al. 2007. Assessment of image restoration techniques to enhance the applicability of MODIS images on Amazon floodplain landscape studies. XIII Simpósio Brasileiro de Sensoriamento Remoto, 6969-6976. Florianópolis.

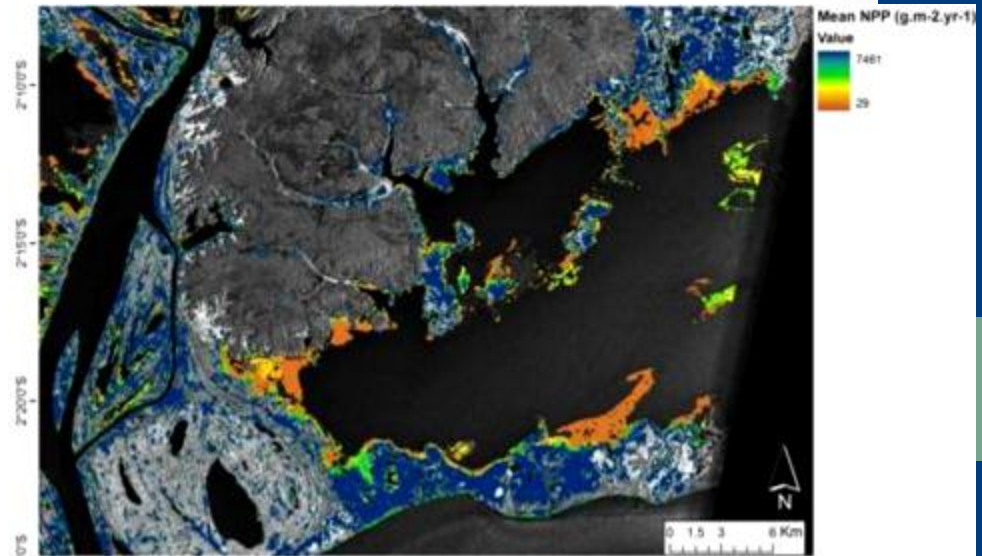
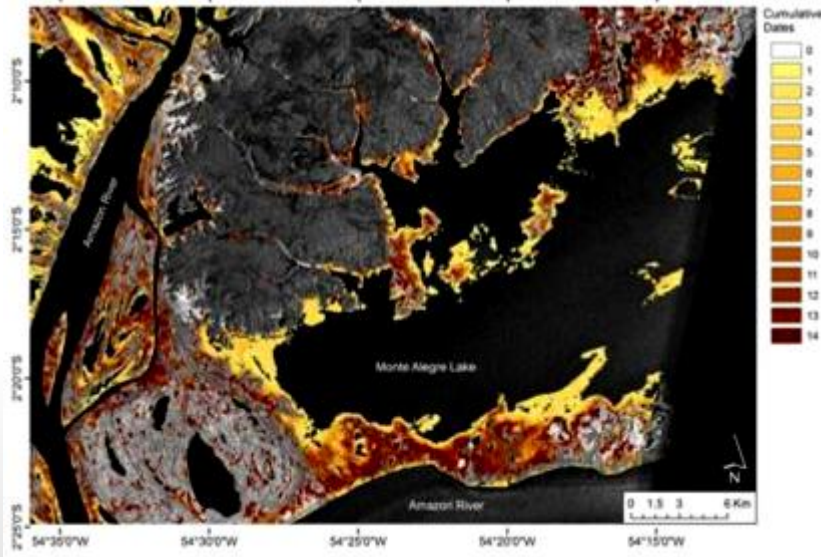
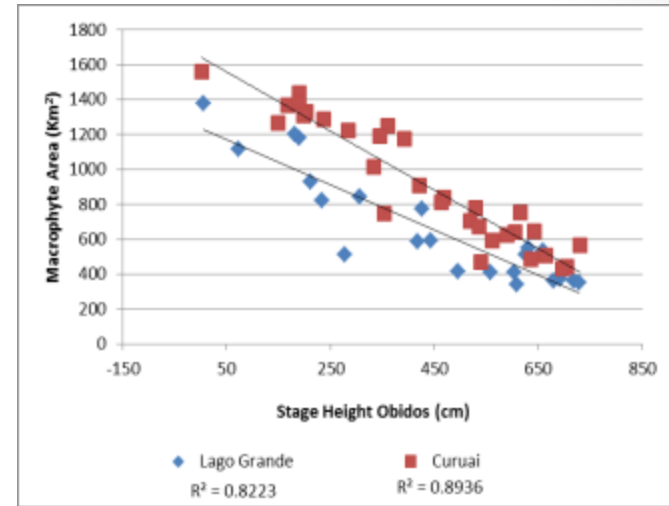
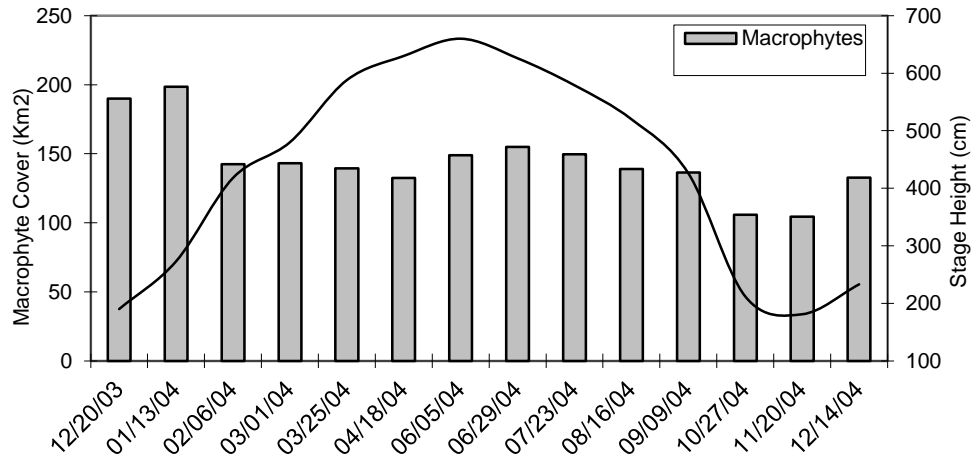
Macrophytes, variability and carbon cycling

- **Object-oriented hierarchical classification:**
 - Combination of Radarsat-1, MODIS, and SRTM using multilevel classification



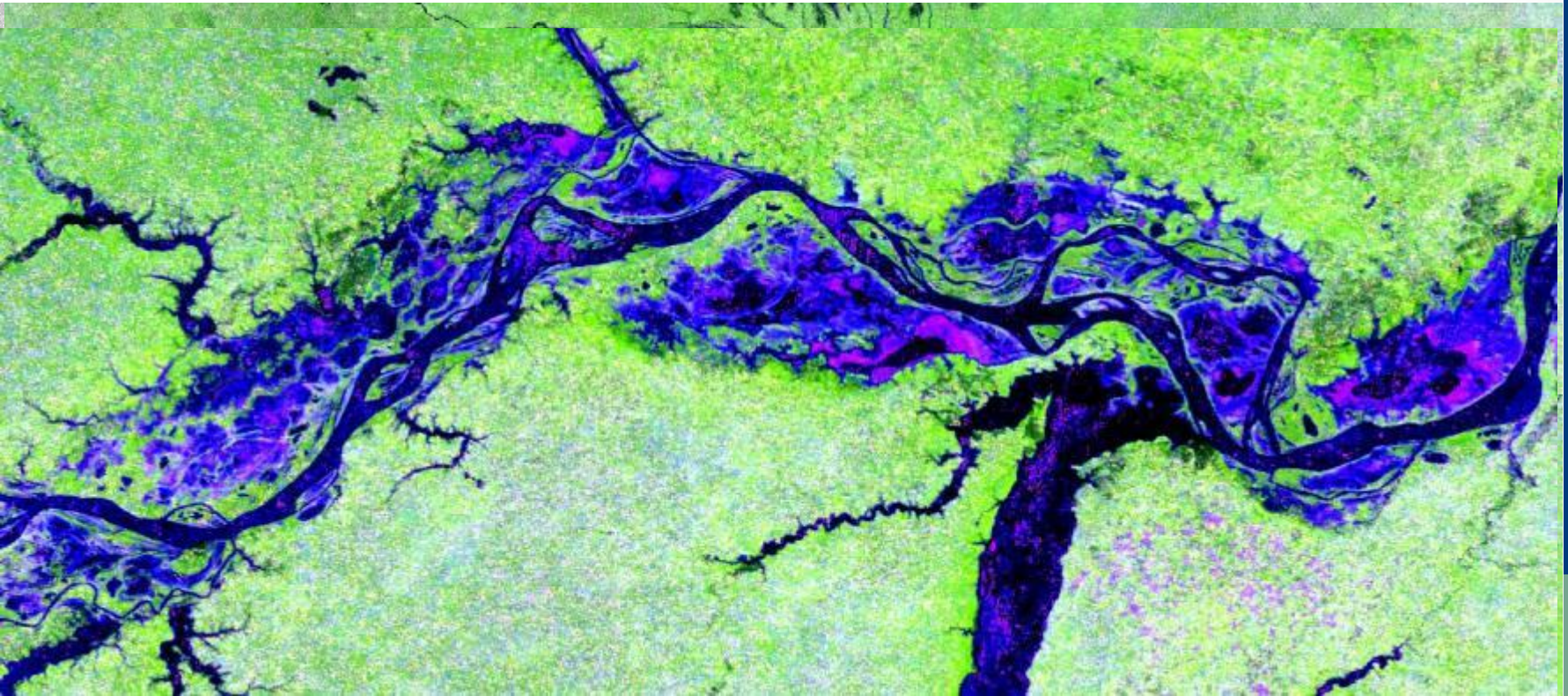
Macrophytes, variability and carbon cycling

- Temporal evolution of macrophyte cover, NPP simulations



Variability across the floodplain

- **MODIS Vegetation Index products (MOD-13)**
 - Produced for every 16-day interval since 2003, but noisy (clouds)
 - Could we apply the same idea here?



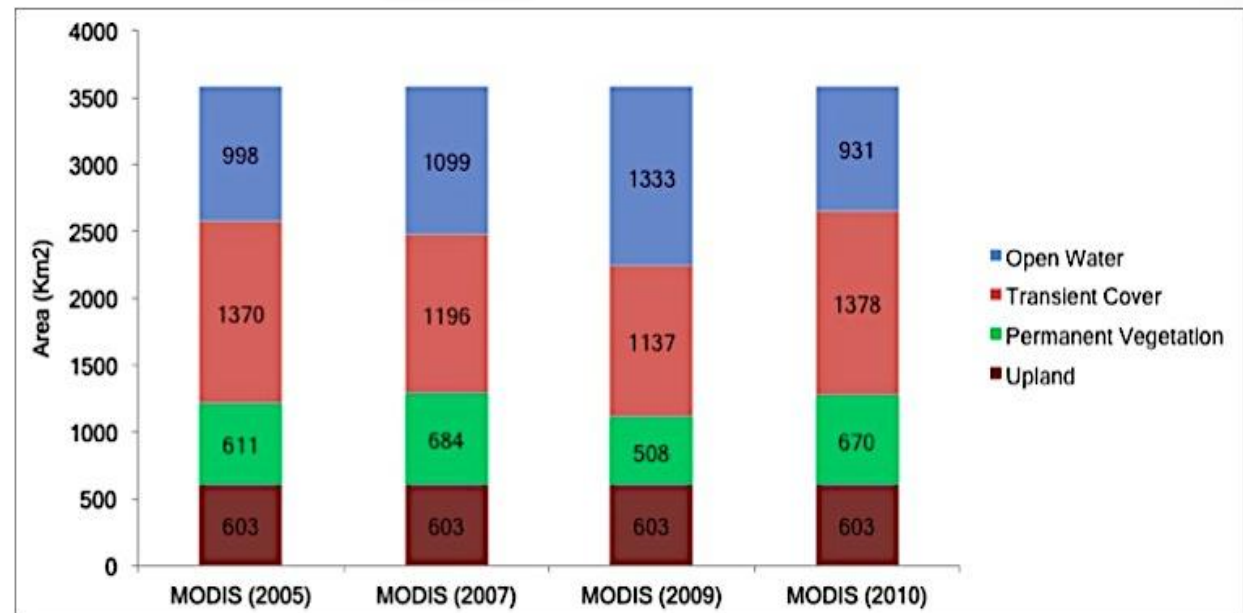
Green: Annual Mean
Red: Annual Maximum
Blue: Annual St. Deviation

Variability across the floodplain

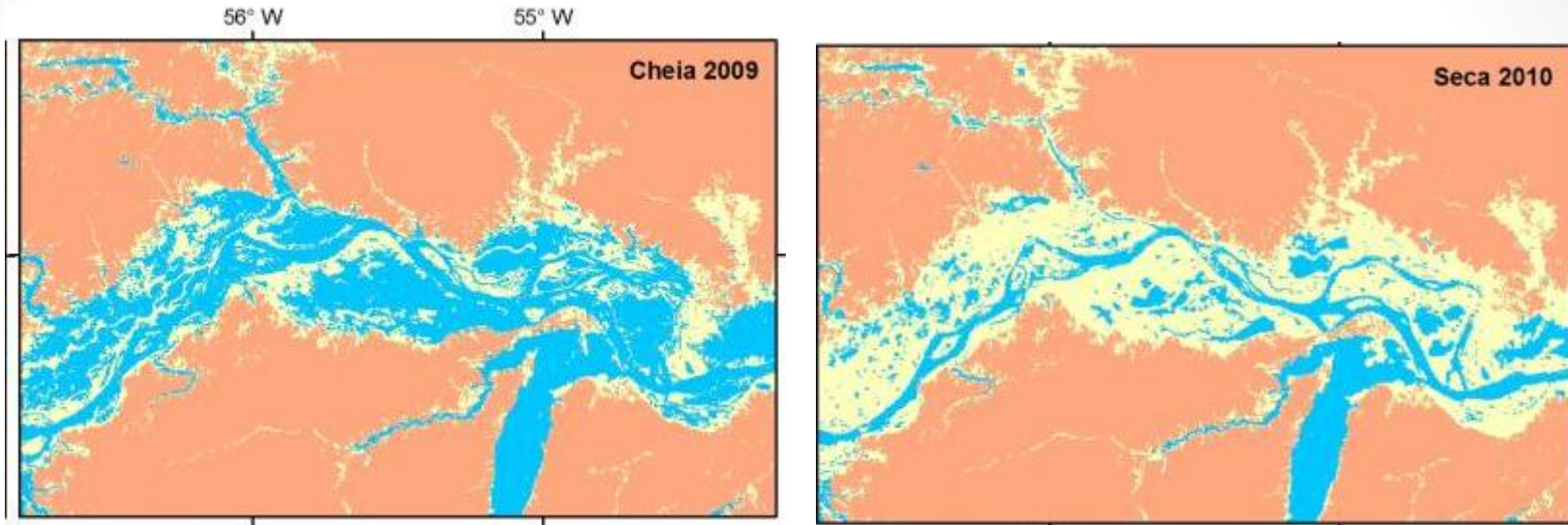
- Preliminary results show good agreement with other classification attempts

	MODIS 2005	Radarsat-1 2005	MOD-R1	MOD/R1
Permanent Vegetation	611	571	40	1,07
Transient Cover	1370	1400	-30	0,98
Open Water	998	822	176	1,21
Upland	603	789	-186	0,76
Total	3582	3581	1	1,00

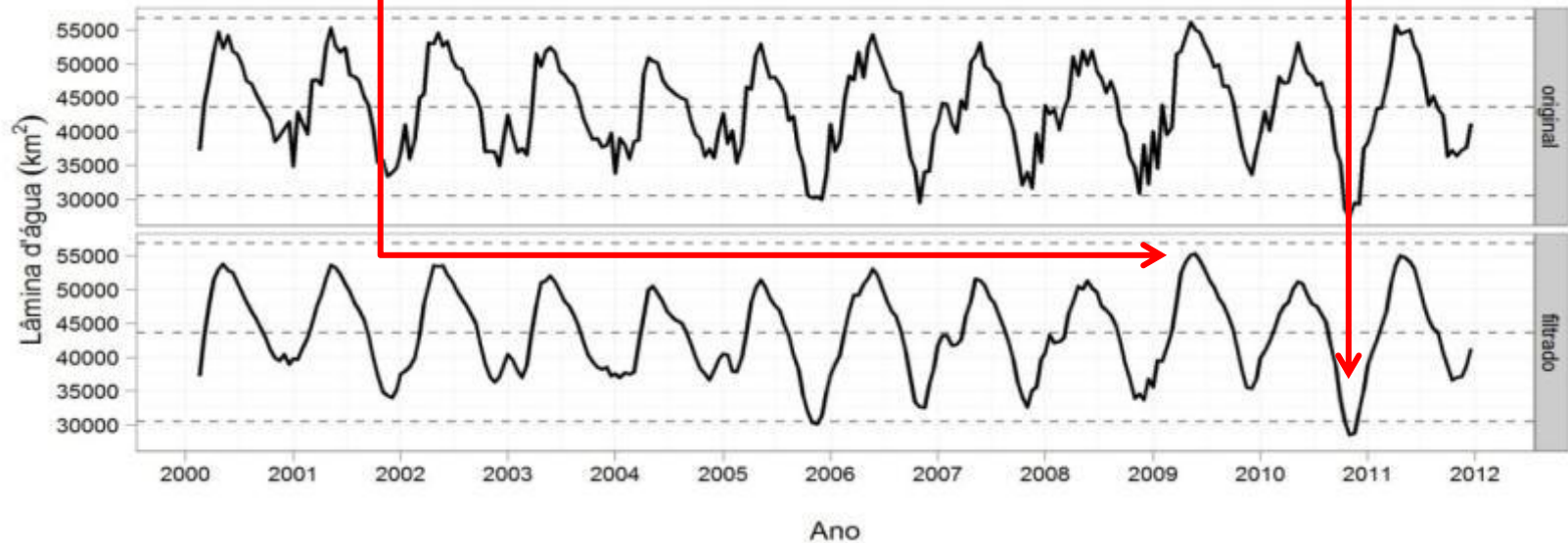
	MODIS 2007	ALOS 2007	MOD-ALOS	MOD/ALOS
Permanent Vegetation	684	690	-6	0,99
Transient Cover	1196	1148	48	1,04
Open Water	1099	1066	33	1,03
Upland	603	678	-75	0,89
Total	3582	3582	0	1,00



Variability across the floodplain

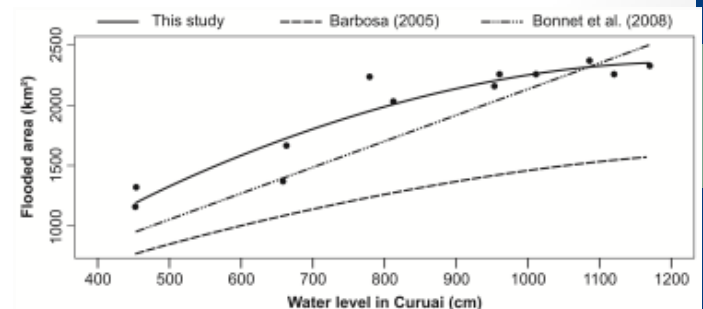
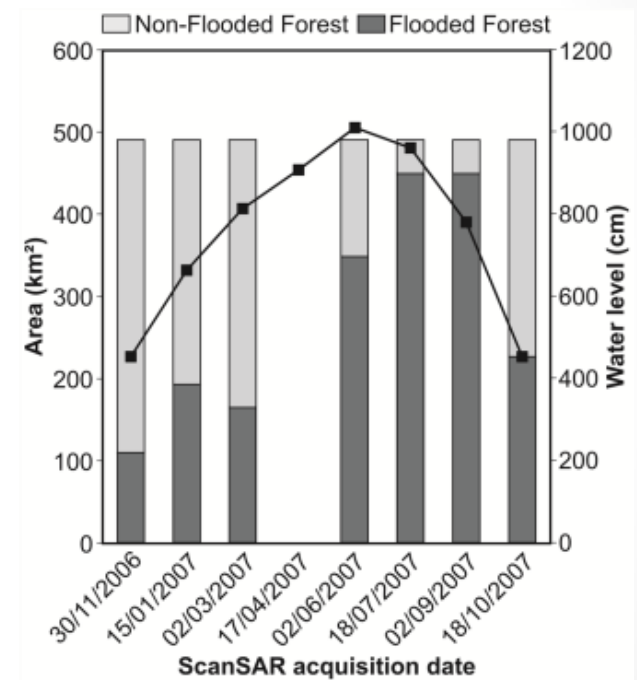
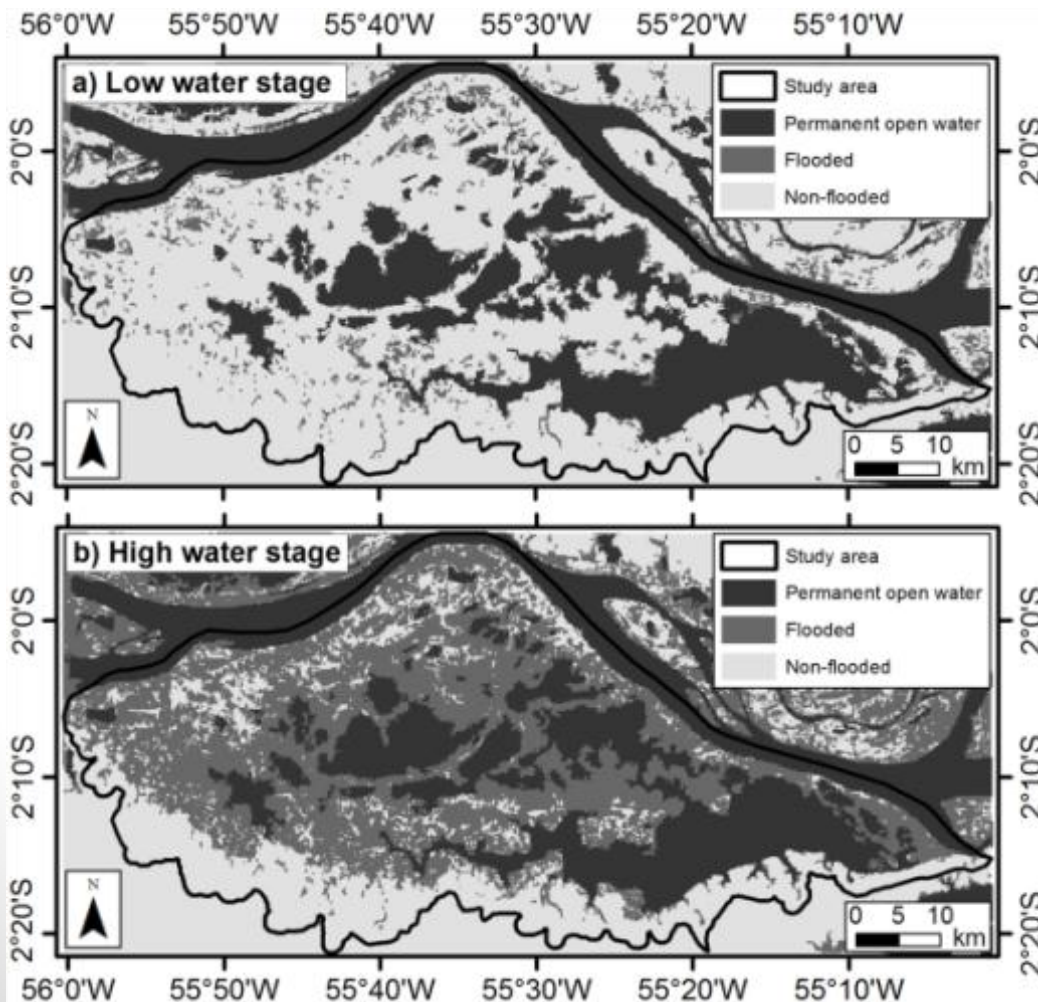


Open water only



Flood mapping in the Amazon

- **Undrestanding changes in inundated area**
 - Allan Saddi Arnesen (MSc. Student), ALOS PALSAR ScanSAR image series



Conclusion

Remote Sensing of the Amazon (and other wetlands):

Embrace Change

Explore data synergy

Think of estimates, instead of maps



Thank you!

Obrigado!

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