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AUGUST 6-10, 2018
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labISA
laboratório de
Instrumentação de Sistemas Aquáticos

INPE's Instrumentation Laboratory for Aquatic Systems

http://www.dpi.inpe.br/labisa/index_en.html

Ongoing studies supporting the monitoring of Brazilian inland Waters

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Session Name: WATER SESSION
Date: 08/08/2018

The Brazilian inland waters

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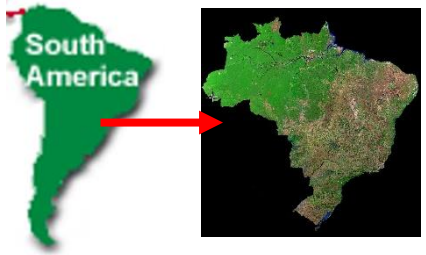
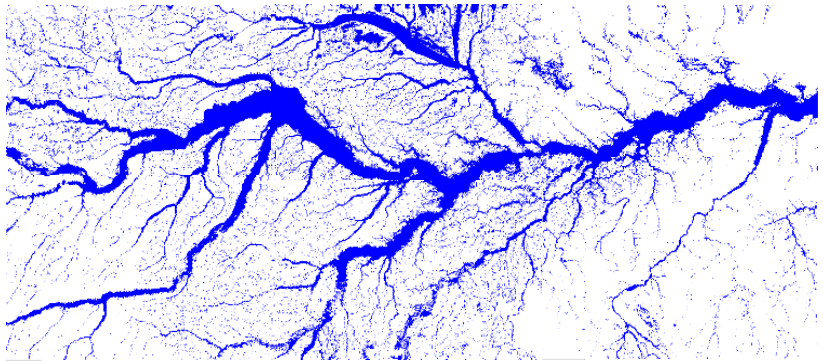
Brazil



- Nearly 17% of Earth`s liquid surface freshwater
- 53 % of surface freshwater available in South America
- Has a large number of natural and artificial aquatic systems

Central Amazon floodable areas



Amazon Basin

- Drains 12% of Earth's surface freshwater
- **10,000 lakes > 1 hectare**
  Less than 1% have been effectively studied
- **Affect and are affected by global & regional processes**
- **The effects climate changes:**
  increase in temperature, frequency and intensity of extreme events

The Brazilian inland waters: Hydroelectric Reservoirs

- Brazilian electrical power matrix (mainly hydroelectricity)
- The area flooded by the 150 largest reservoirs is nearly 40,000 km^2
- net carbon budget are not well known
  need to be determined and monitored
- The continental dimension makes remote sensing the only feasible approach

Remote Sensing applied to Brazilian Inland waters: our experience

- A research group from INPE's OBT has been working for >15 years on remote sensing methods
- Have allowed us to map and characterize patterns of water masses composition
- Spectral composition of the underwater light field were not characterized.
- Aiming to build a bio-optical dataset to support: carbon budget and primary productivity studies, as well as anthropogenic impacts

INPE's OBT acquired a set of hydrological and optical profilers and then created in 2013 the Instrumentation Laboratory for Aquatic Systems (LabISA).

http://www.dpi.inpe.br/labisa/index_en.html

LabISA goals are

- To support and stimulate research on the development of algorithms for the retrieval of water constituent of Brazilian inland water, using remote sensing data, as well as provide the infrastructure for acquiring and processing both in situ and satellite data.

- LabISA also seeks the continued training of human resources, by encouraging the development of thesis and dissertation research projects.

- The lab keeps a constant updated of a multi-temporal bio-optical database of Brazilian inland waters to support the development of scenarios on the impacts of climate and/or land use change related to ecosystem services provided by aquatic systems

- Develop products such as maps of suspended sediments, chlorophyll and trophic state

LabISA equipment infrastructure comprises:

Two AC-S (10 and 25 cm)

LISST-Portable

UV-VIS-2600 Shimadzu

CTD

attenuation,

absorption,

backscatter

spectroradiometer

profilers

HydroScat-6P

10AU Fluorometer

ECO BB9

Six RAMSES radiometer

ASD HandHeld 2

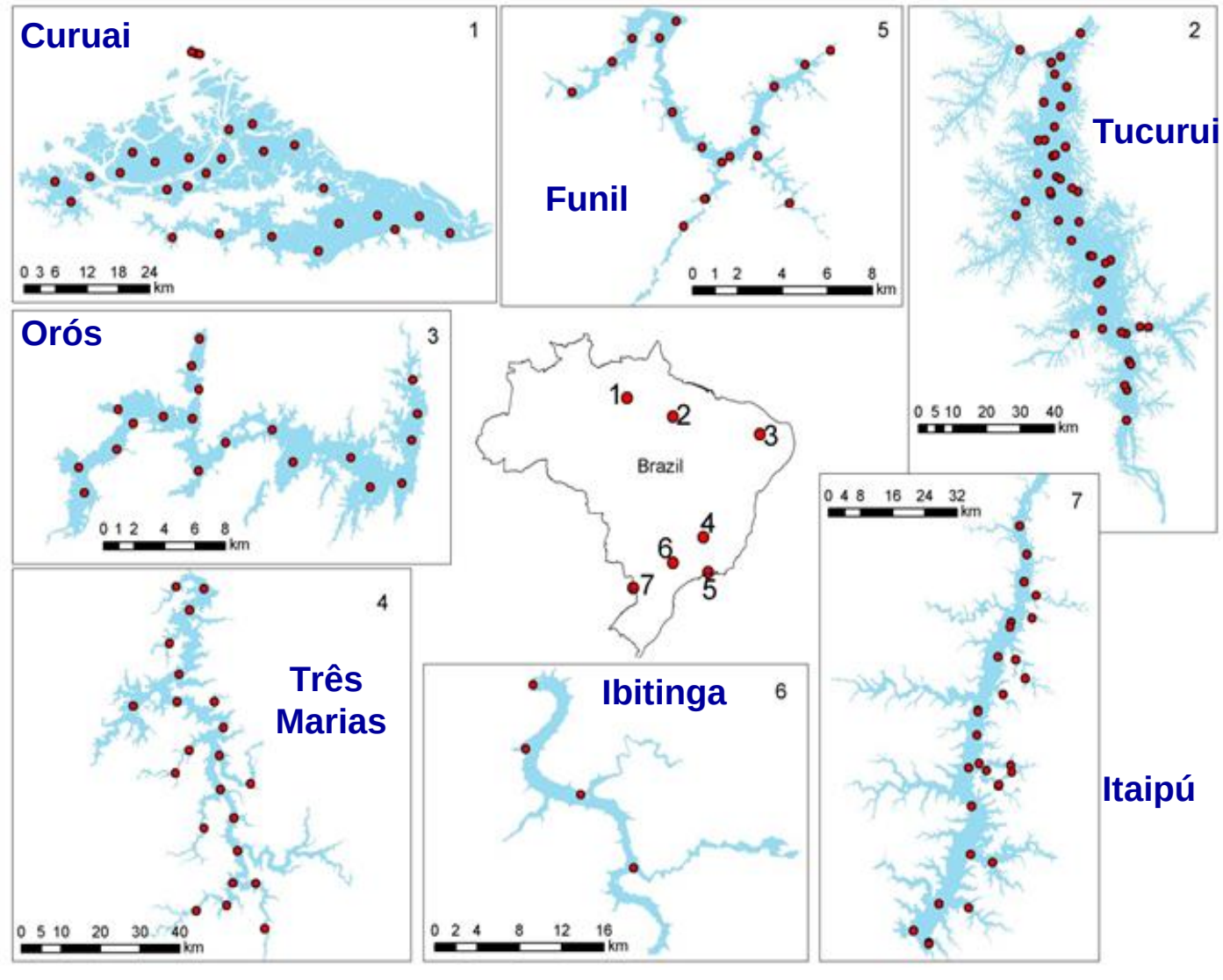
Acoustic Doppler Profiler

Data gathered at reservoir & Amazonian floodplain lake (optical and limnological data)

With this set of equipment, LabISA team started gathering in situ data (AOPs & IOPs)

For the last six years we have gathered optical and limnological in situ data at reservoirs across the country, as well as at Amazonian floodplain lakes.

These data are being integrated in a bio-optical database of Brazilian inland waters



Descriptive statistics of some bio-optical properties of Brazilian inland waters

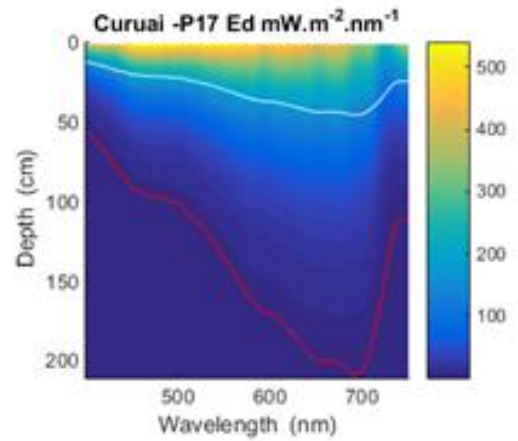
Brazilian inland water bio-optical dataset to support carbon budget studies in reservoirs as well as anthropogenic impacts in Amazon floodplain lakes: Preliminary results.

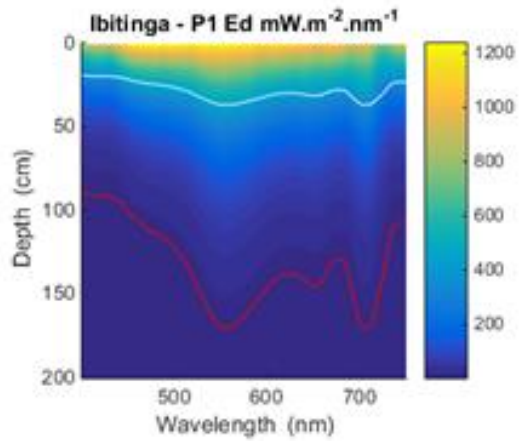
Available at: ISPRS - International Archives of the Photogrammetry, Remote Sensing.

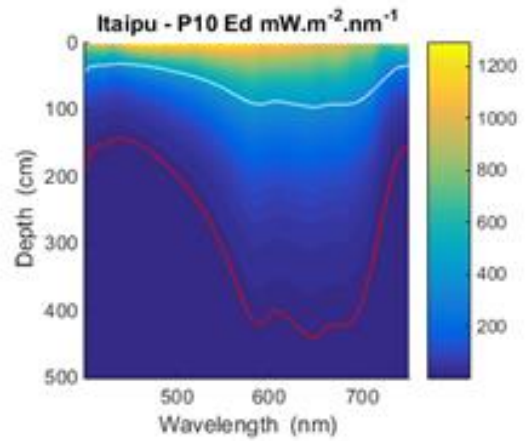
	Statistic	Tucuruí	Itaipú	Três Marias	Curuai	Ibitinga	Funil	Orós
Z_{eu} (1%) [m]	Mean/Median	4.84/6.87	3.17/3.26	6.57/7.54	1.18/1.38	5.61/7.42	2.45/3.11	-
	Min/Max	1.14/9,39	1.89/4.18	2.19/13.14	0.35/2.72	2.66/9.20	1.02/4.51	-
K_d (PAR) [m^{-1}]	Mean/Median	0.95/0.67	1.45/1.41	0.70/0.61	3.90/3.33	0.82/0.62	1.88/1.48	-
	Min/Max	0.49/4.03	1.10/2.44	0.35/2.10	1.69/13.30	0.50/1.73	1.02/4.50	-
	Std. deviation	0.75	0.31	0.37	1.72	0.36	1.00	-
$c_{(450)}$ [m^{-1}]	Mean/Median	4.51/2.89	-	3.66/2.72	20.08/19.44	4.75/4.39	6.44/5.62	-
	Min/Max	1.47/16.04	-	1.40/15.35	12.47/37.95	2.49/8.10	3.26/12.80	-
	Std. deviation	4.11	-	2.99	-	1.84	3.13	-
$a_{CDOM(440)}$ [m^{-1}]	Mean/Median			0.66/0.41	2.16/2.13	0.88/0.90	0.56/0.56	
	Min/Max			0.19/4.3	1.70/2.66	0.78/0.99	0.36/0.67	
	Std. deviation			0.81	0.23	0.09	0.1	
Turbidity (NTU)	Mean/Median	3.12/1.45	7.86/8.50	2.87/0.90	20.88/21.70	10.52/7.20	8.77/6.10	11.23/6.00
	Min/Max	0.10/17.0	3.60/10.70	0.10/24.10	8.10/33.20	1.00/45.40	3.60/33.80	1.12/99.00
	Std. deviation	4.41	2.09	5.28	5.72	10.52	7.63	13.18
Chl-*a* (µg/L)	Mean/Median	7.19/5.01	1.61/1.12	5.47/4.67	18.41/11.74	41.9/20.65	38.00/13.08	22.33/19.44
	Min/Max	2.75/39.53	0.59/04.81	1.17/13.22	0.90/92.06	3.72/180.40	1.39/242.86	0.50/80.67
	Std. deviation	7.10	1.21	3.33	18,82	53.90	64.15	16.23
TSS (mg/L)	Mean/Median	3.43/1.92	1.77/1.61	4.34/3.33	32.37/15.72	7.02/5.20	5.67/5.00	13.26/9.00
	Min/Max	0.26/20.41	0.63/3.77	1.33/11.93	0.53/161.85	0.80/30.80	0.87/18.60	1.00/100.00
	Std. deviation	4.26	0.74	2.54	34.93	7.35	4.50	15.25
DOC (mg/L)	Mean/Median	2.32/1.98	2.17/2.06	1.95/1.90	2.11/7.74	3.63/3.44	3.41/3.32	9.26/8.61
	Min/Max	1.45/7.03	1.73/4.09	0.93/2.71	4.14/7.74	2.72/4.91	2.80/5.22	5.27/14.48
	Std. deviation	1.12	0.62	0.37	1.05	0.63	0.62	1.85

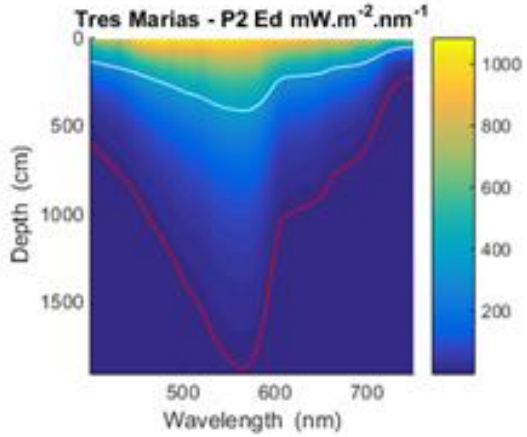
Spectral composition of Underwater light field

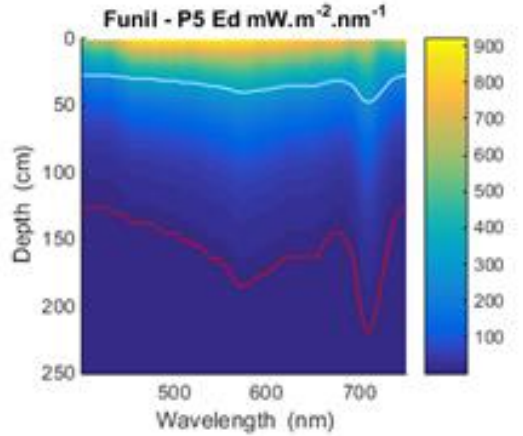
The first and most comprehensive bio-optical information available for the Brazilian inland waters











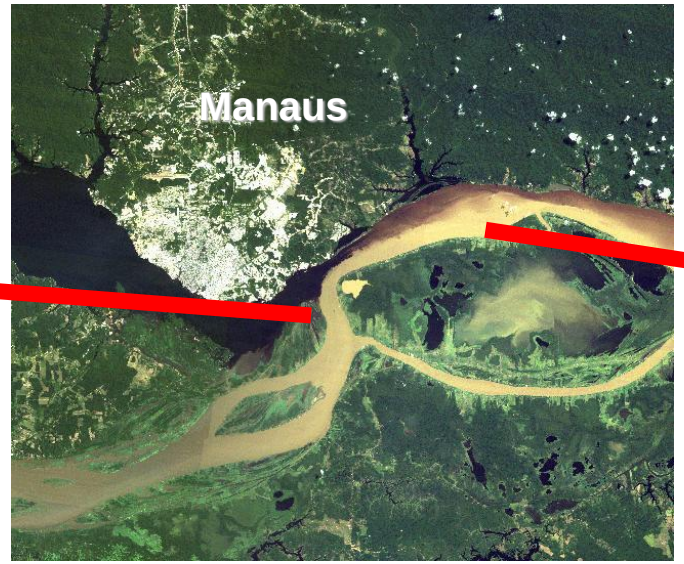
Red curves are the depth of euphotic zone,

White curves are the attenuation depth

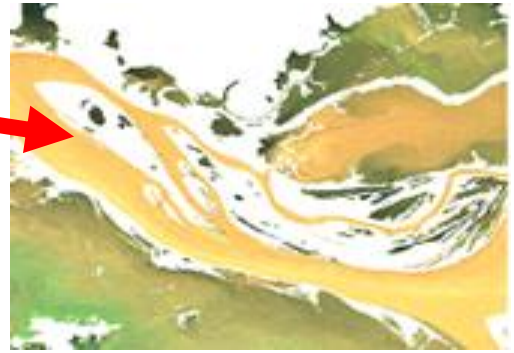
The diversity of Brazilian inland waters

Black water (Negro River)

Organic dissolved matter



White water (Amazon River)



High inorganic matter

Chlorophyll concentration 500-800μg/liter

Clear Water (Tapajós River)

The measured variables:
Apparent & Inherent Optical Properties (AOP/IOP)

key **in situ variables** for satellite ocean color sensor validation, algorithm development and validation (Mueller, 2003-NASA)

- **IOP & AOP Profiles**

  attenuation, absorption, backscattering
  Downward/Upward irradiances

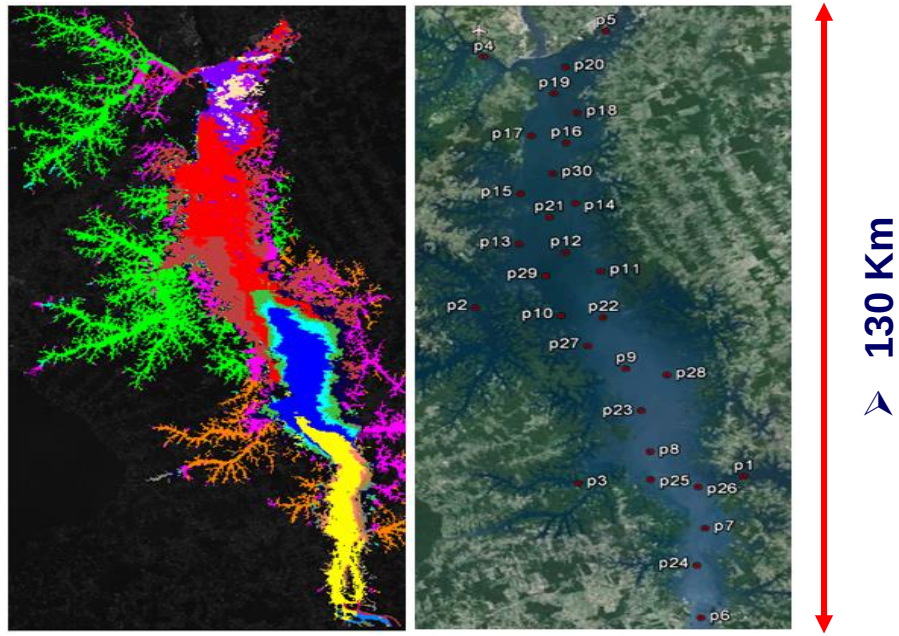
- **Above water AOPs**

  Lw, Ls, Es,

- **Laboratory**

  Constituent concentration

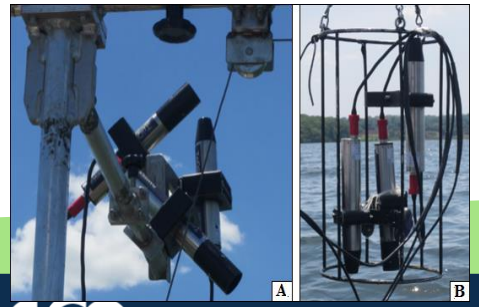
  Specific IOPs (aph*, aNAP*, aTP*)



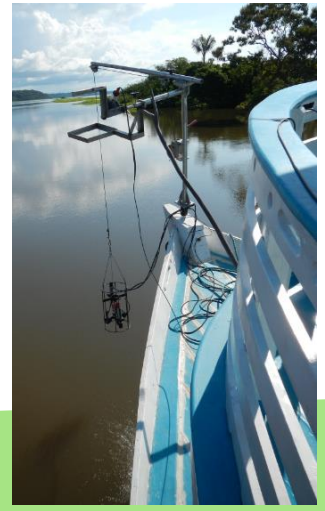
Sampling stations at each site were defined based on different water masses spectral response

Field infrastructure

on the left you see the infrastructure at reservoirs



On the right you see the infrastructure at Amazonian lakes



Ongoing study: Variability of dissolved organic matter

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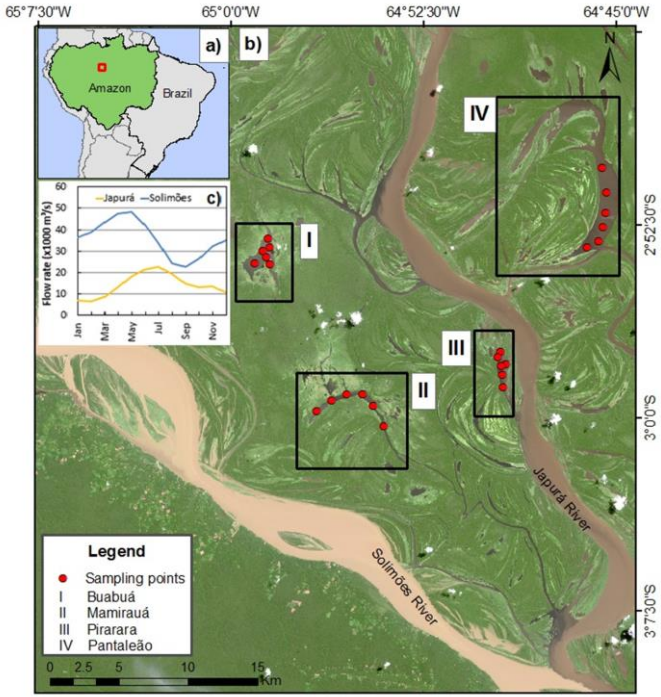
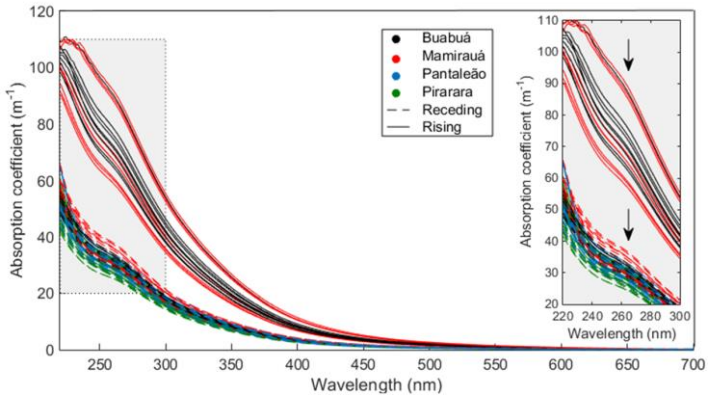
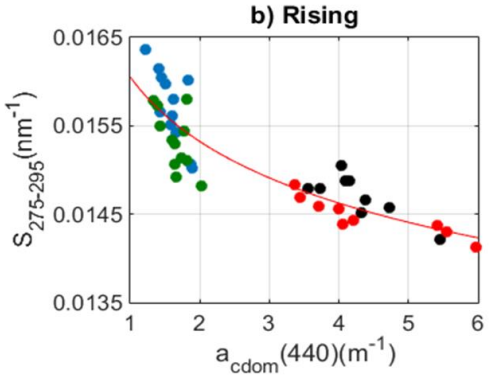
Spectral slope of CDOM absorption was used study DOM



Mamirauá Sustainable Development Reserve





$$a_{cdom}(440) = 4.39 \cdot e^{(B2/B3)} + 0.59 \cdot e^{(B6/B5)} - 6.67$$

Sentinel/MSI

➔*Use of absorption optical indices to evaluate seasonal variability of dissolved organic matter in Amazon floodplain lakes (on major review)*

Ongoing study: Monitoring water siltation caused by small scale gold mining in Amazon rivers using multi-satellite Images

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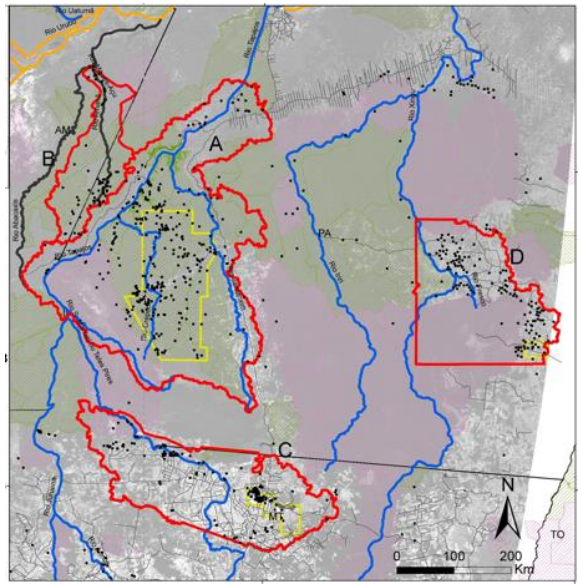
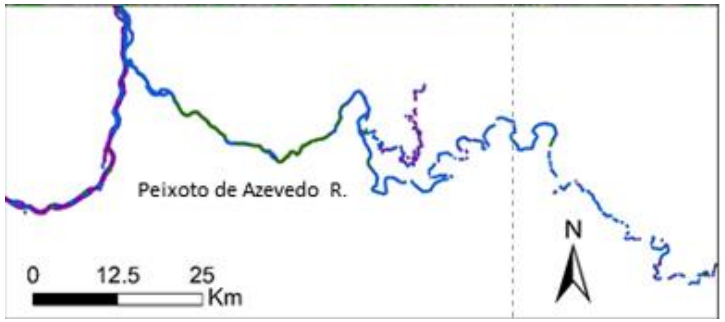
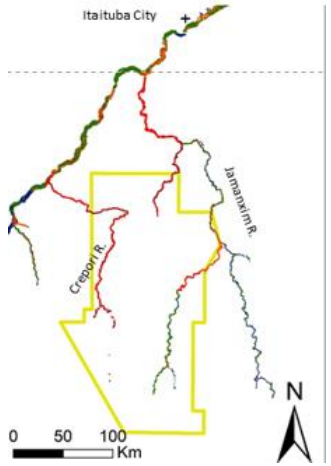
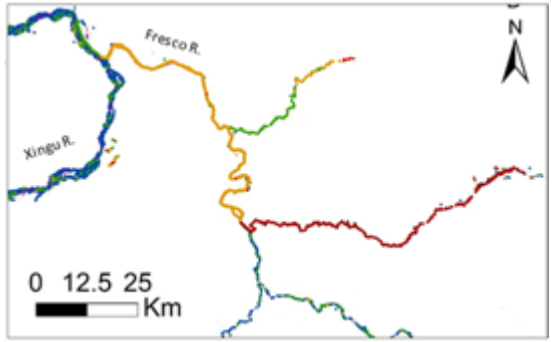
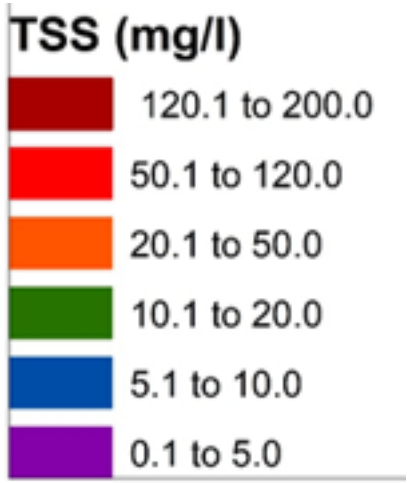








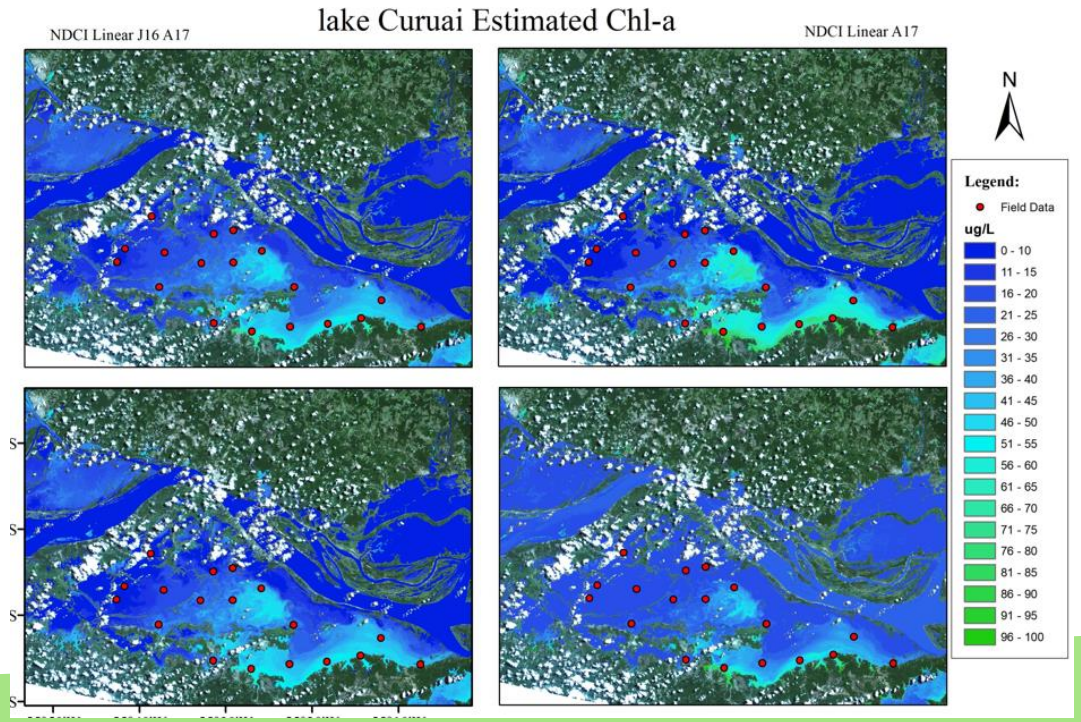


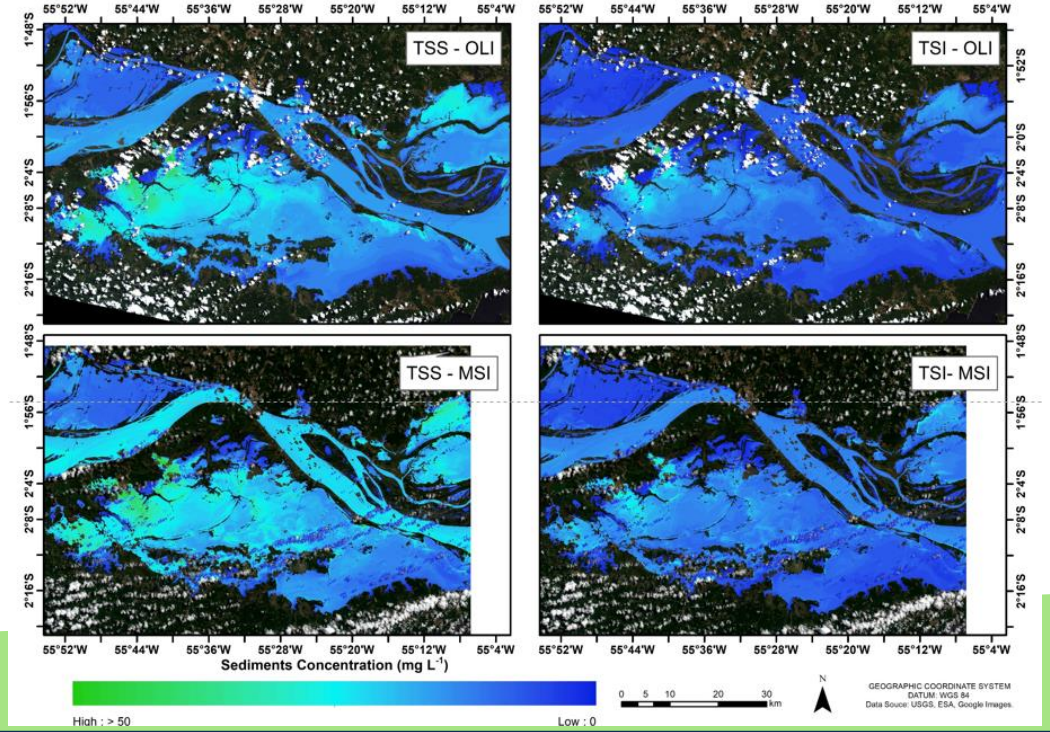
- *Mapping Mining Areas in the Brazilian Amazon Using MSI/Sentinel-2 Imagery (2017)*
  (Lobo et al, 2018- Remote sensing)

Ongoing study: *Parametrization & assessment of bio-optical algorithms for estimating chlorophyll-a and suspended sediments concentration*

- *Empirical and semi-analytical algorithms*
- *Investigating hybrid algorithm due to broad concentration range*
- *Dataset: OLI, MSI and OLCI bands simulated from in situ data*

OLI, MSI and OLCI data





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Bio-optical characterization of an Amazon floodplain lake over a hydrological year

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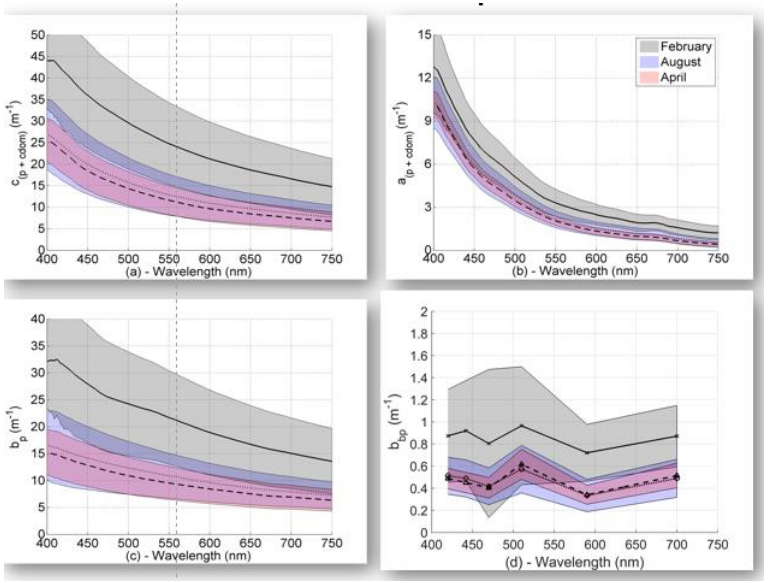

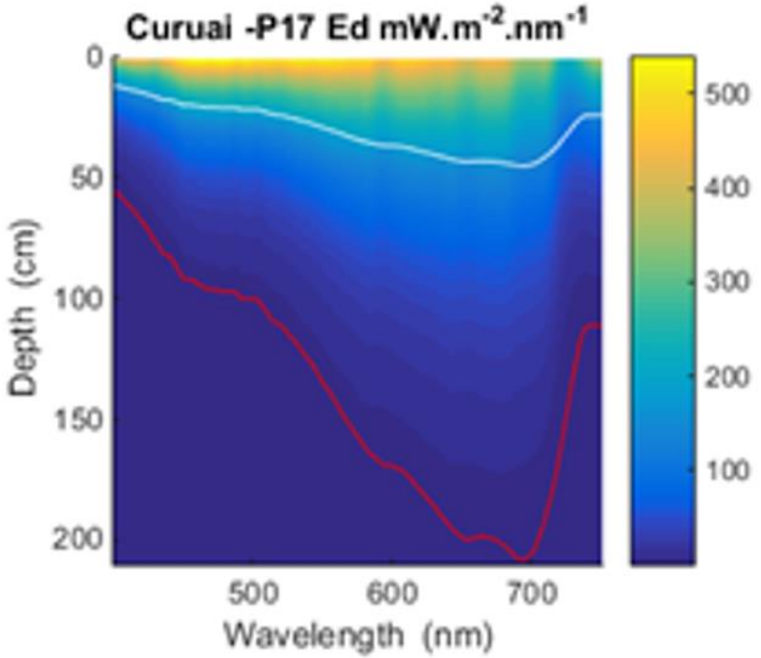

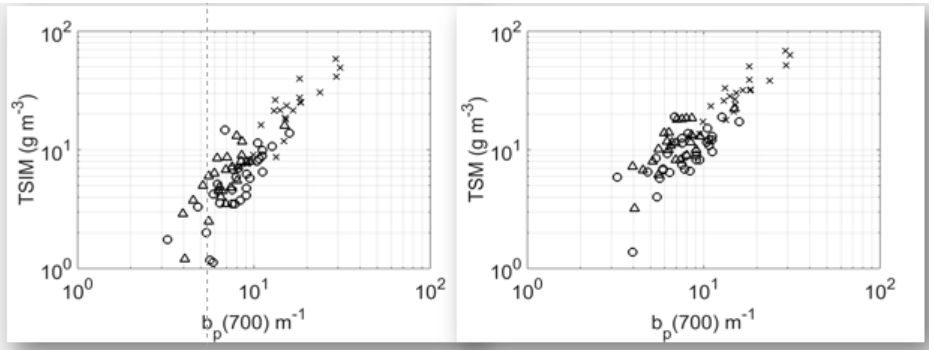

Coefficient	Field Campaign	$b_p^*(700)$ (m^2g^{-1})	UPD (%)	MRPD (%)	RMSE (gm^{-3})
TSM	*February*	0.43	0.08	14.17	5.76
	August	0.69	1.18	28.88	3.13
	April	0.50	1.89	25.48	3.42
TSIM	*February*	-	-4.95	22.79	5.03
	August	-	-26.09	47.39	2.59
	April	-	-2.19	30.96	2.13

Thanks!

http://www.dpi.inpe.br/labisa/index_en.html