Water quality monitoring from space:

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Context: OBS2CO project
a muli-satellite Obsservation of COntinental water COlour

- **Golden age of satellite observations :** global scale, spatial resolution up to 10m, freely available images, temporal and geographic homogeneity, guaranteed continuity up to 2030

- Development of an **automated processing chain for water quality monitoring from satellite** with innovative atmospheric corrections dedicated to surface water**.**

  ➔ **OBS2CO processing chain.**

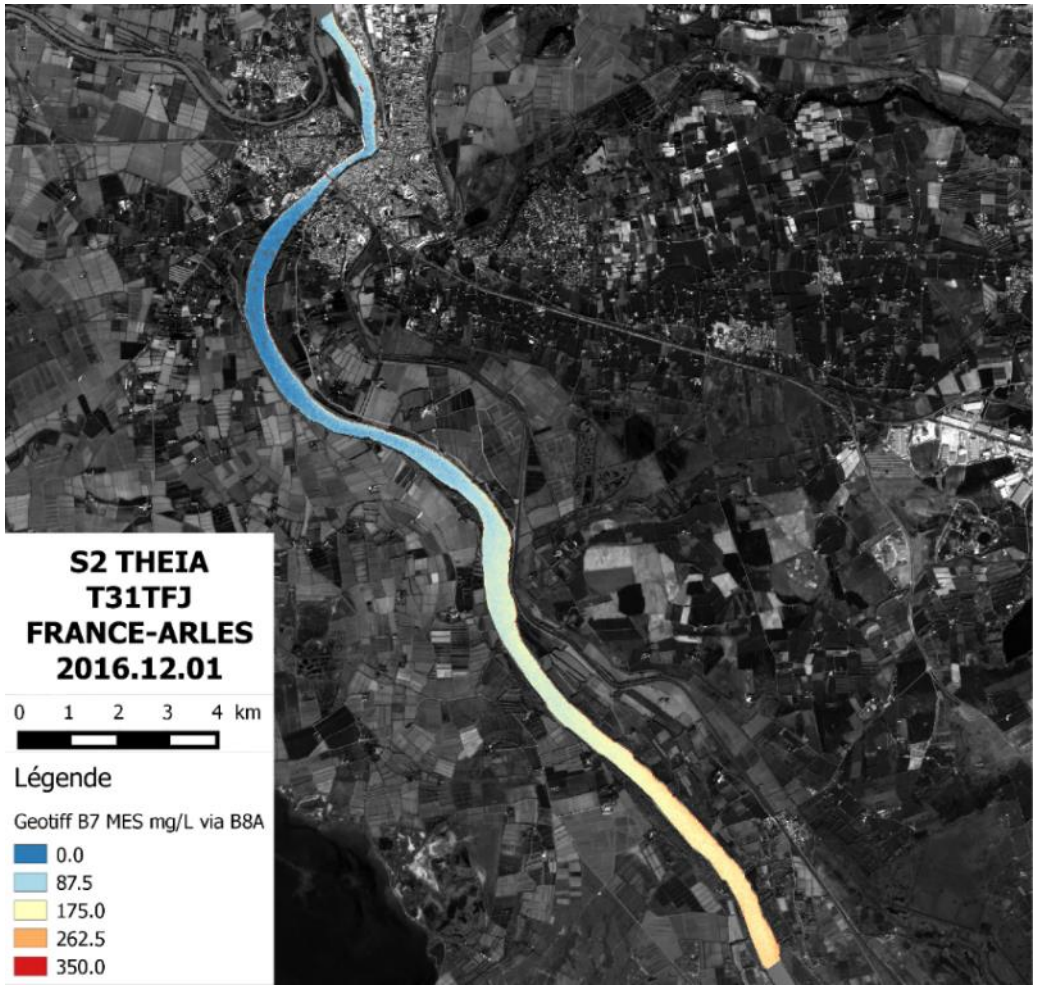
- **Need of in-situ data** to calibrate and validate models.

  ➔ Satellite data as a complement of the in-situ network**.**

  ➔ **Validated water quality products**

- Collaboration between **research teams and water agencies:**

  ➔ Water quality product **in accordance with users' requirements.**



Suspended Particulate Material

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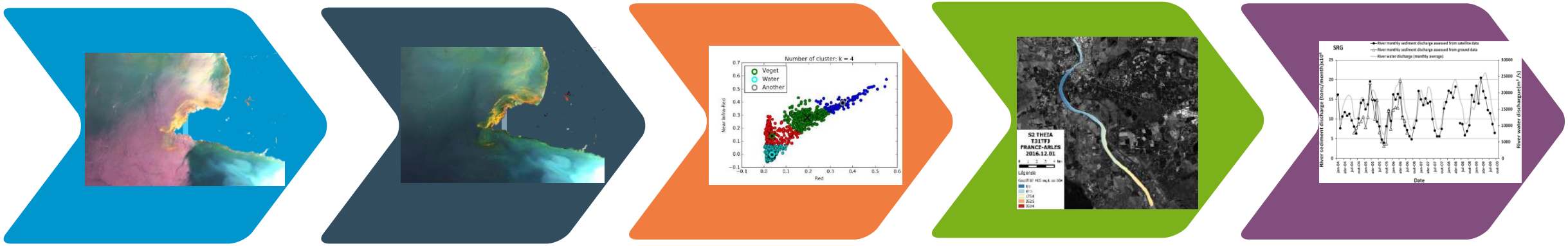
From optical images to water quality monitoring

OBS2CO processing chain

1 2 3 4 5



OPTICAL IMAGES

Sentinel 2 (20m)
Landsat (30m),
MODIS (250m),
Sentinel 3 (300m)

ATMOSPHERIC CORRECTIONS

- Soil reflectance

➔ Importance of sunglint on inland water for Sentinel 2

WATER MASK

- Pixels classification (clustering)
- Only 100% water pixels

SIGNAL INVERSION

- Need of in-situ measurements for the SPM CAL/VAL
- Characterization of diffuse/absorbed radiations

MODELIZATION

- Sedimentary fluxes
- Impact on biodiversity
- Diseases, health hazard alert
- Water Framework Directive and ecological quality in France

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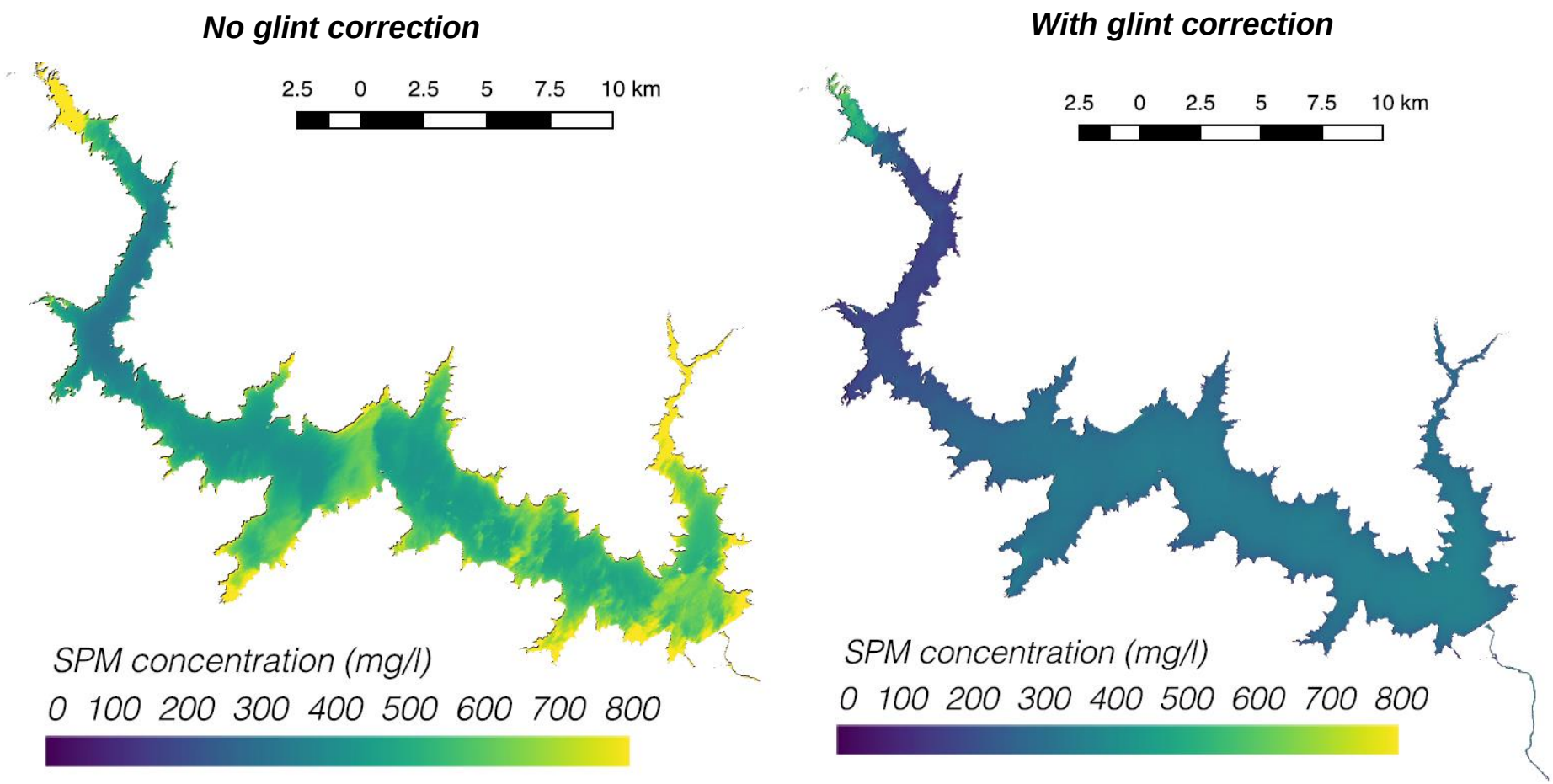
OBS2CO distinctiveness: atmospheric correction

!! Specific atmospheric corrections on inland water surfaces is mandatory

GLINT correction

- Lead to an overestimation of SPM concentrations
- crucial for Sentinel 2 images

➔ GRS Algorithm
(Glint-Removal for Sentinel 2-like images). *T. Harmel et al, 2018*



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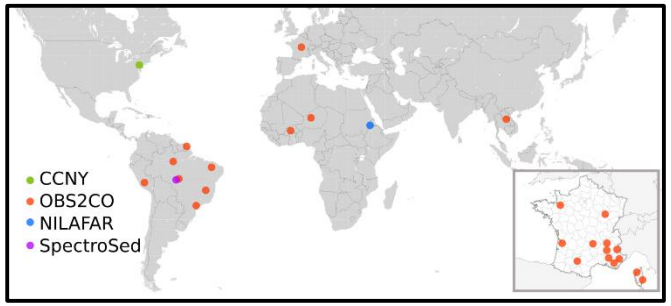
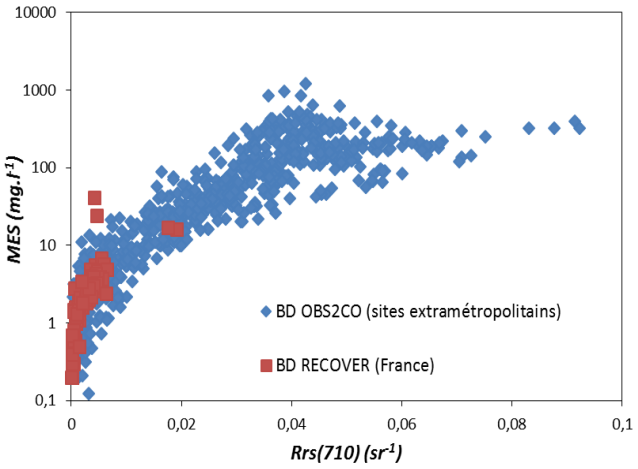
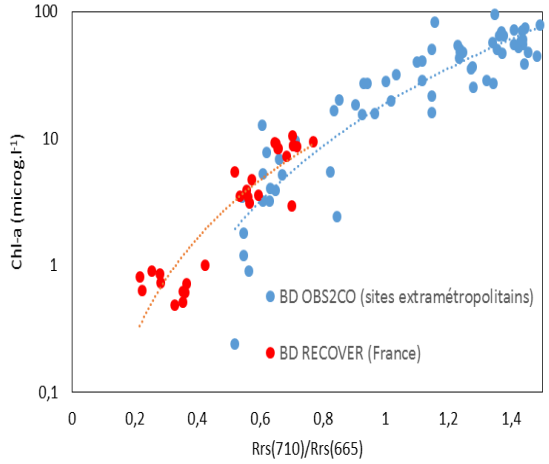
OBS2CO distinctiveness: qualified products

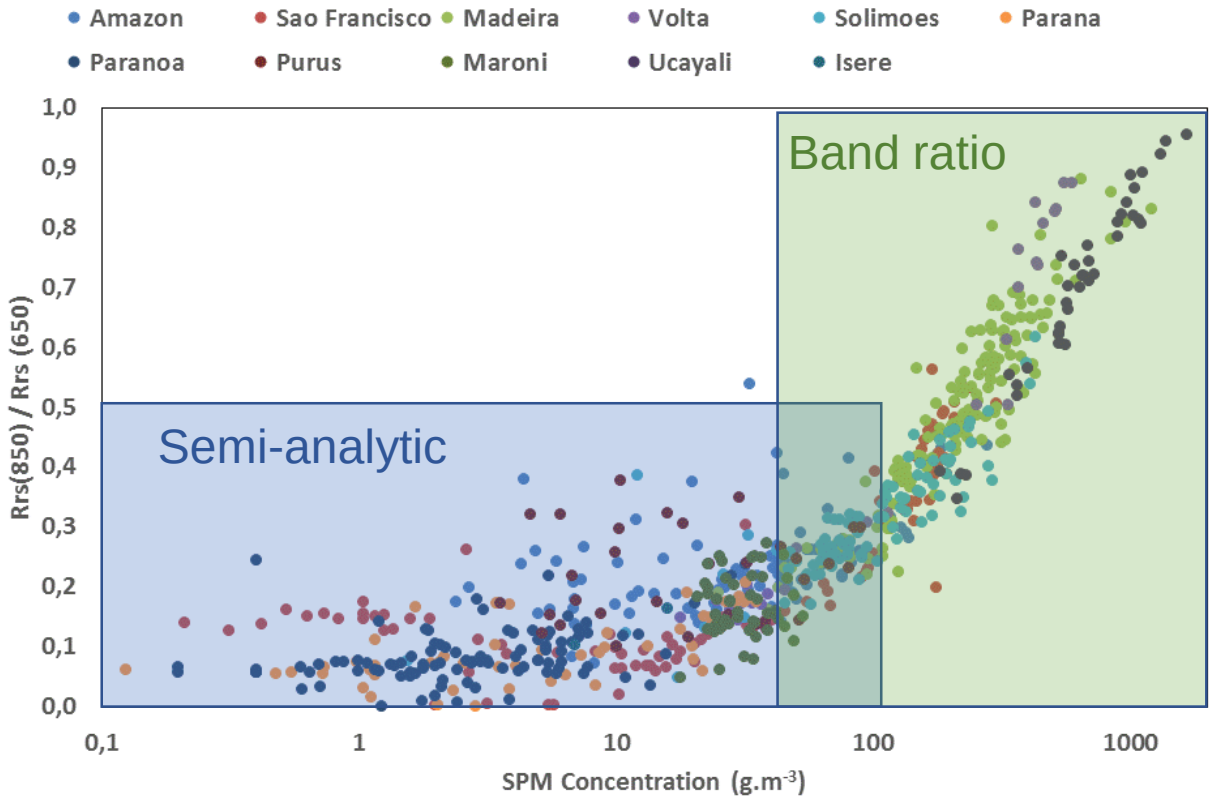
Large in-situ dataset for calibration and validation **over all turbidity range** (from oligotrophic and transparent water to extremely turbid water)

➔ **Robust inversion algorithm**









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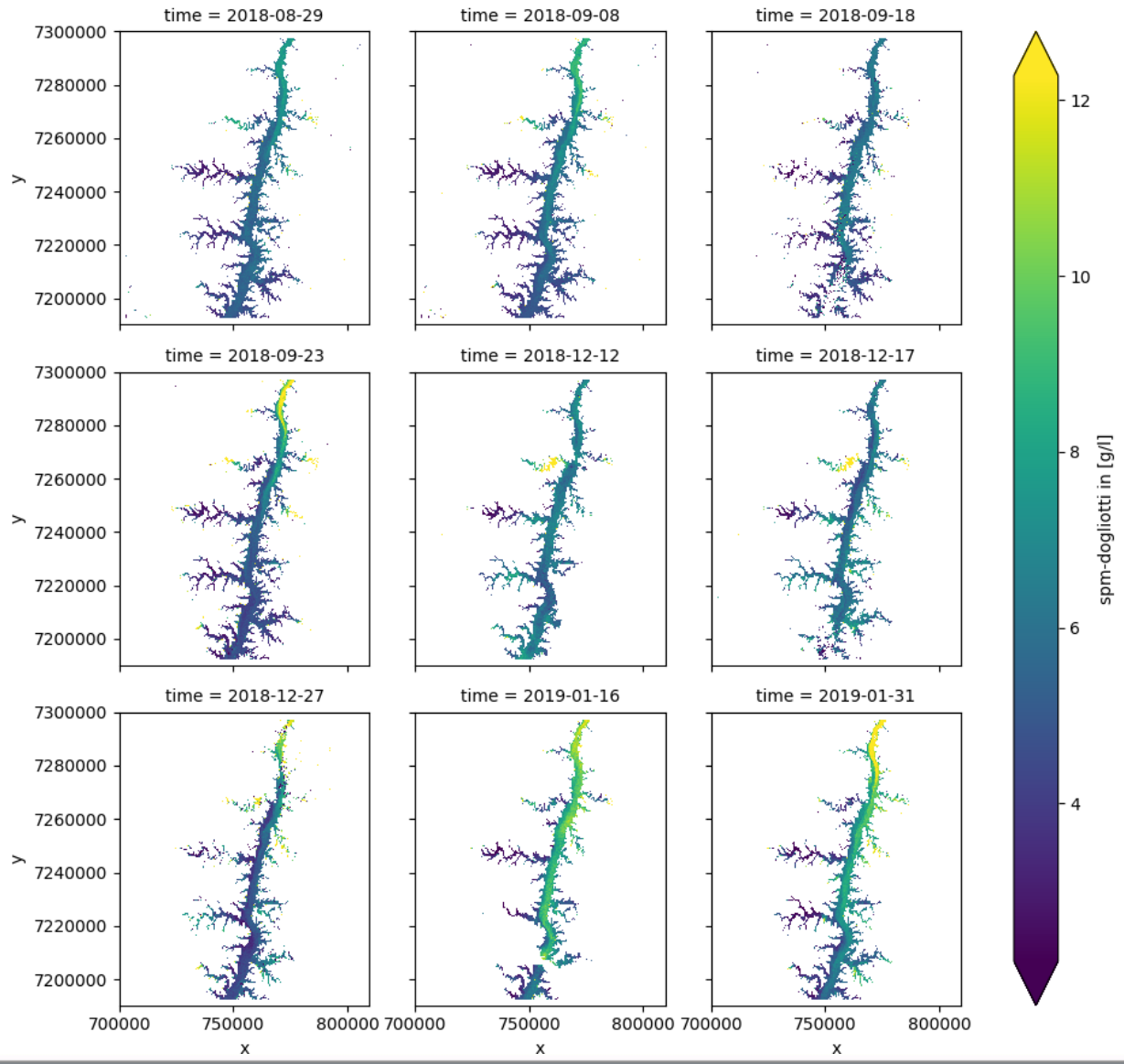
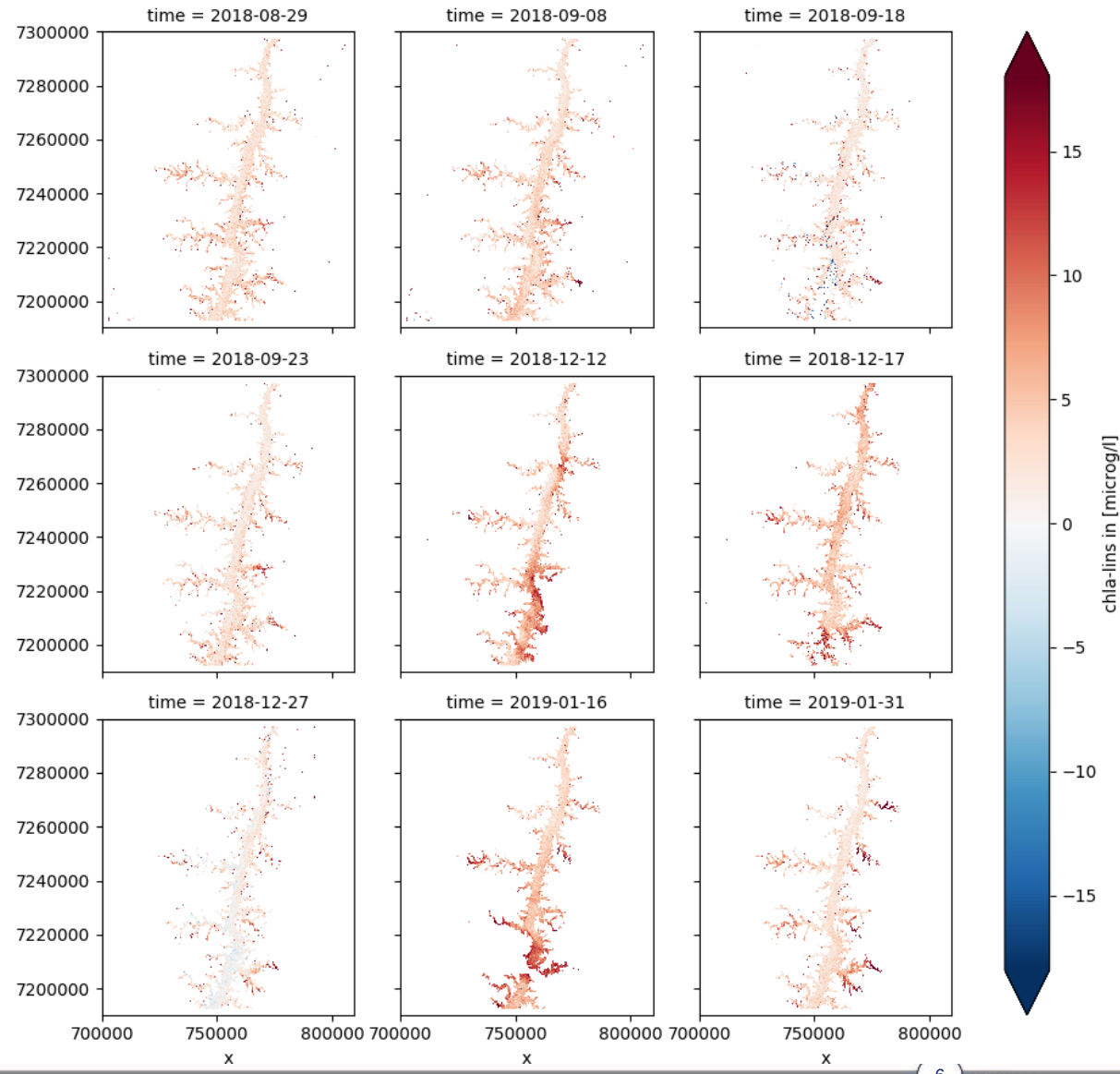
OBS2CO water quality product: Itaipu dam – Rio Paraná

SPM concentration



Chl-a concentration



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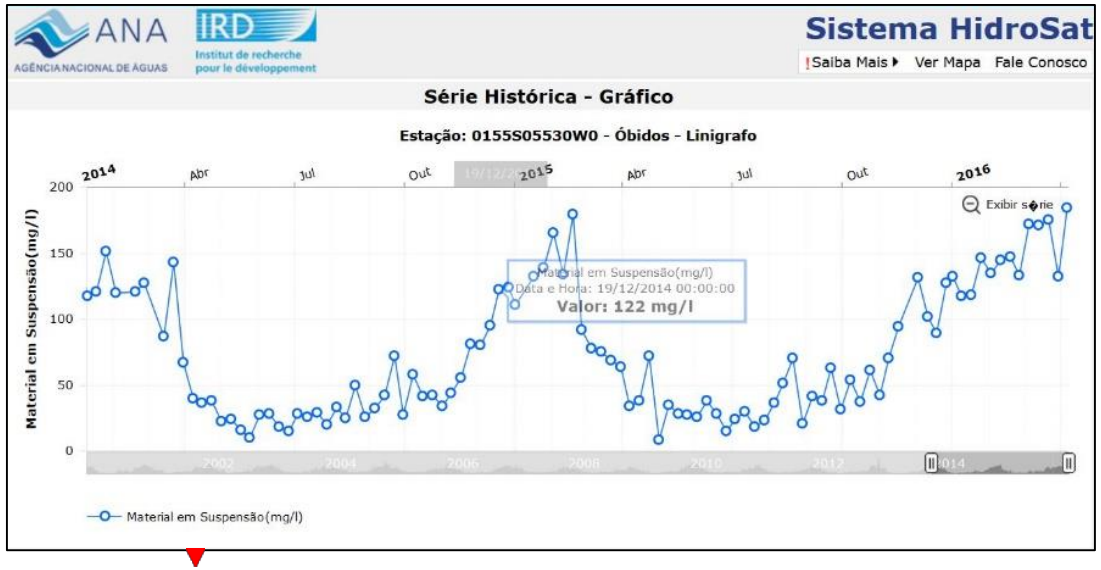
Application: Agencia Nacional de Aguas in Brazil for ANA

Pre-operational service, in collaboration with Brazil water agency

➔ Automatic processing of **MODIS images** to monitor rivers' water quality in Brazil : turbidity, chlorophyll a , suspended mater + water elevation from altimetry data

http://hidrosat.ana.gov.br



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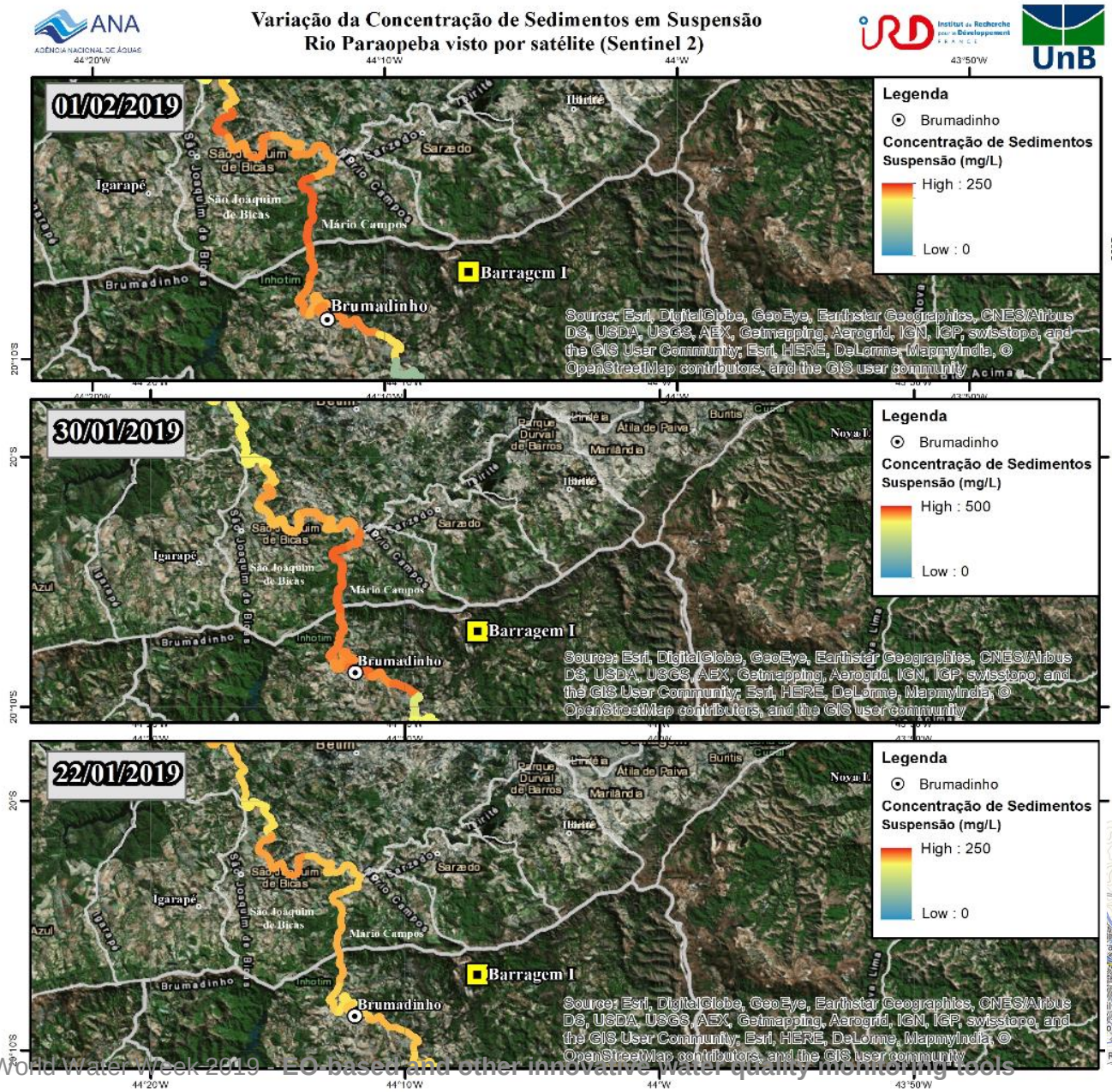
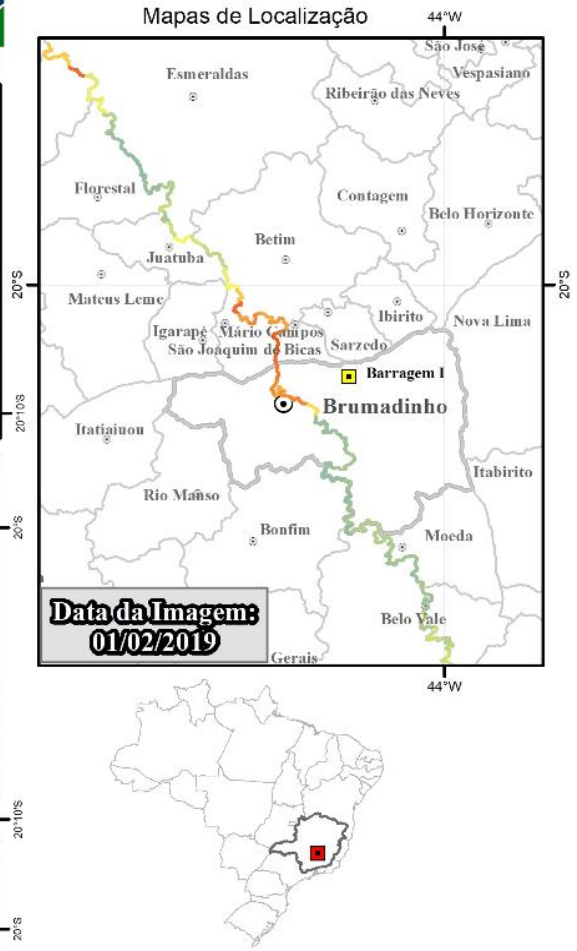
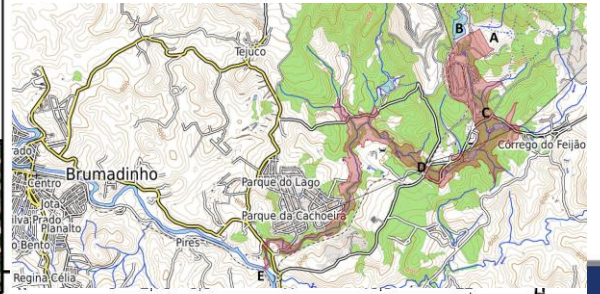
Application: Brumadinho dam failure 25/01/2019







Disaster monitoring

Brumadinho dam

- Jan. 2019, 25th : >300 human casualties
- Sentinel 2 and Landsat 8 images

Turbidity variations of the Paraopeba river affected by mining tailings

OBS2CO products used for Brazilian federal investigations.

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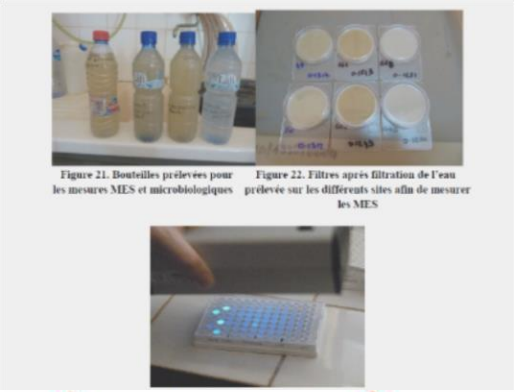
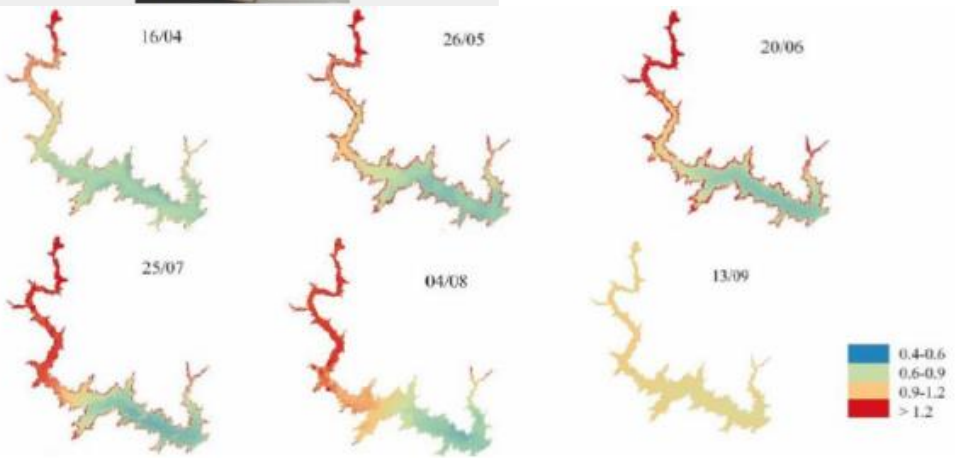
Perspectives : Health hazard Alert

Water quality ⟺ Diarrhoea disease

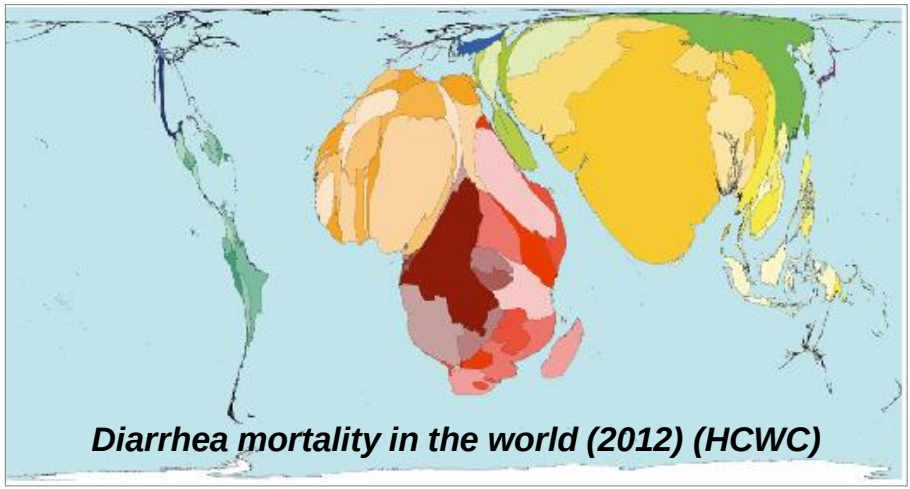
Research project ongoing over African lakes

- *To combine risk and vulnerability to define a warning system*

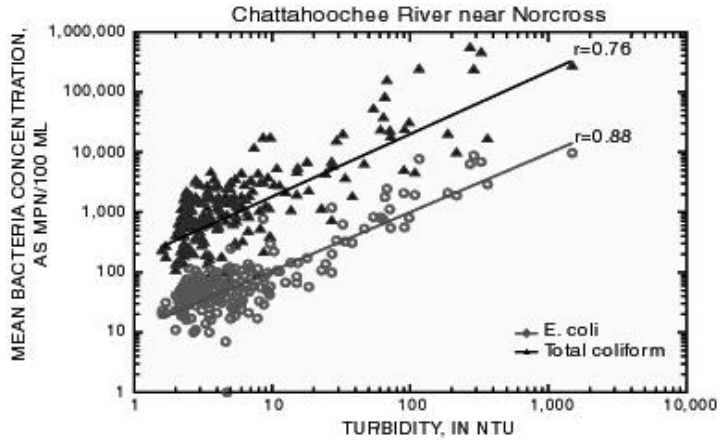




SPM evolution and dilution in rainy season –Bagré Reservoir
(Robert et al. 2016, ESA Living Planet)



Diarrhea mortality in the world (2012) (HCWC)



Link between bacteria E coli, water turbidity and SPM

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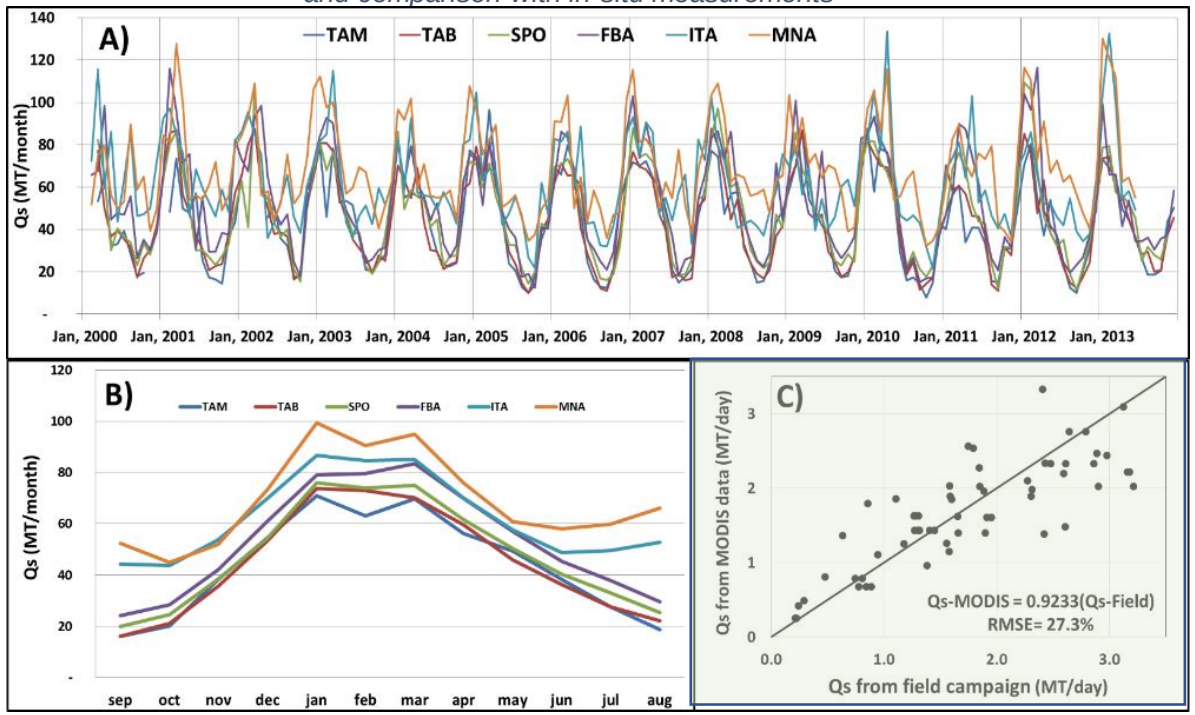
Perspectives: assessment of river sediment discharge

River discharge + SPM concentration ➔ sediment fluxes from subwatersheds to ocean

➔ Algorithm principles validated with MODIS images

➔ **Perspectives with the future SWOT** (Surface Water and Ocean Topography) a CNES/NASA mission->2021

River sediment discharge from MODIS satellite over the Amazon river and comparison with in-situ measurements



Espinoza et al. 2018 – CRAS

SWOT

➔ *2D images of water elevation with **high vertical accuracy** (10cm over rivers) and **river discharge** estimation for river (width >100m)*

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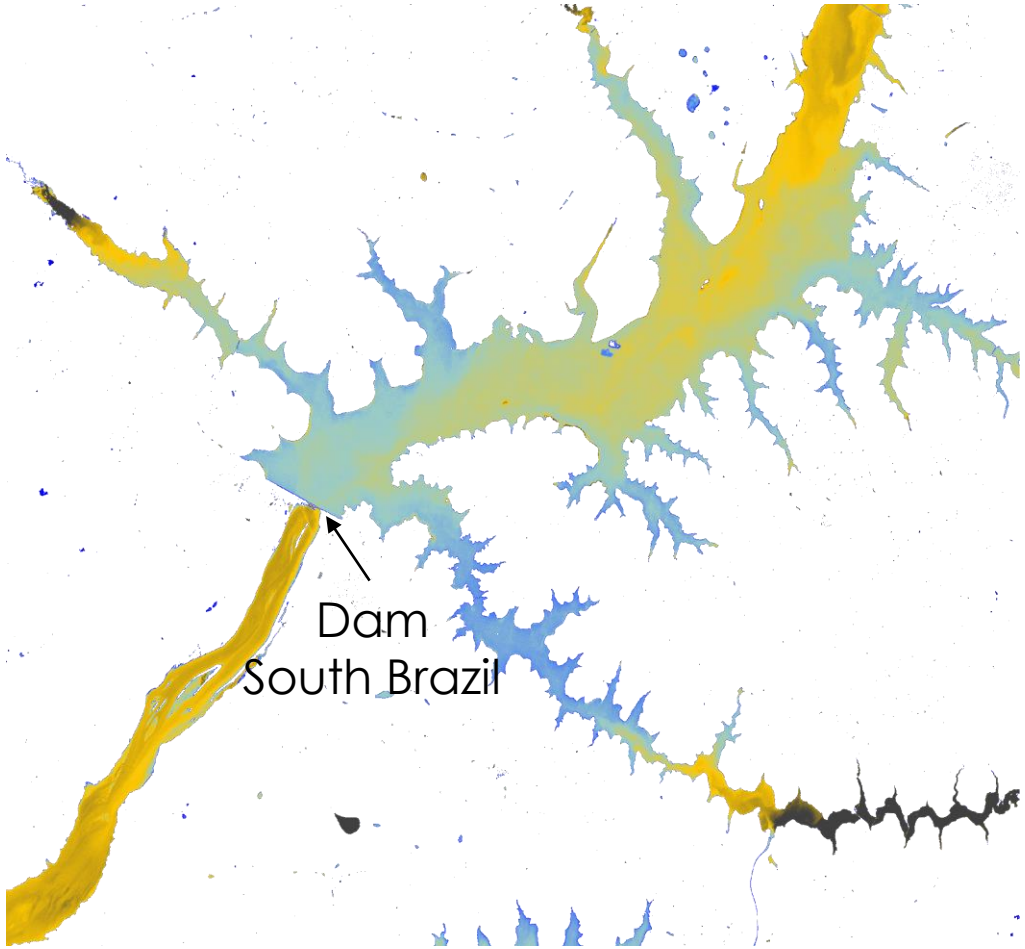
To sum up

- **OBS2CO :** an automated processing chain for monitoring water quality from space**.**
  - High resolution (20m), validated products
  - First products available on the THEIA land data centre: https://www.theia-land.fr/en

- **Forthcoming improvements:**
  - **Improve algorithms**: atmospheric correction with coupled estimation of aerosol and surface roughness.
  - **Increase the number of sites** : **150 worldwide water quality sites** over the 30 largest basins and 20 main lakes + up to **480 lakes in France** (depending on quality products flag)
  - **Increase the temporal resolution** by merging all sensors : toward multi-missions water quality products (MODIS, Sentinel 2, Sentinel 3, Landsat)

- **Perspectives** :
  - analysis of **lakes ecological status**
  - coupling water quality products with the future SWOT water elevation to estimate river **sediment discharge.**



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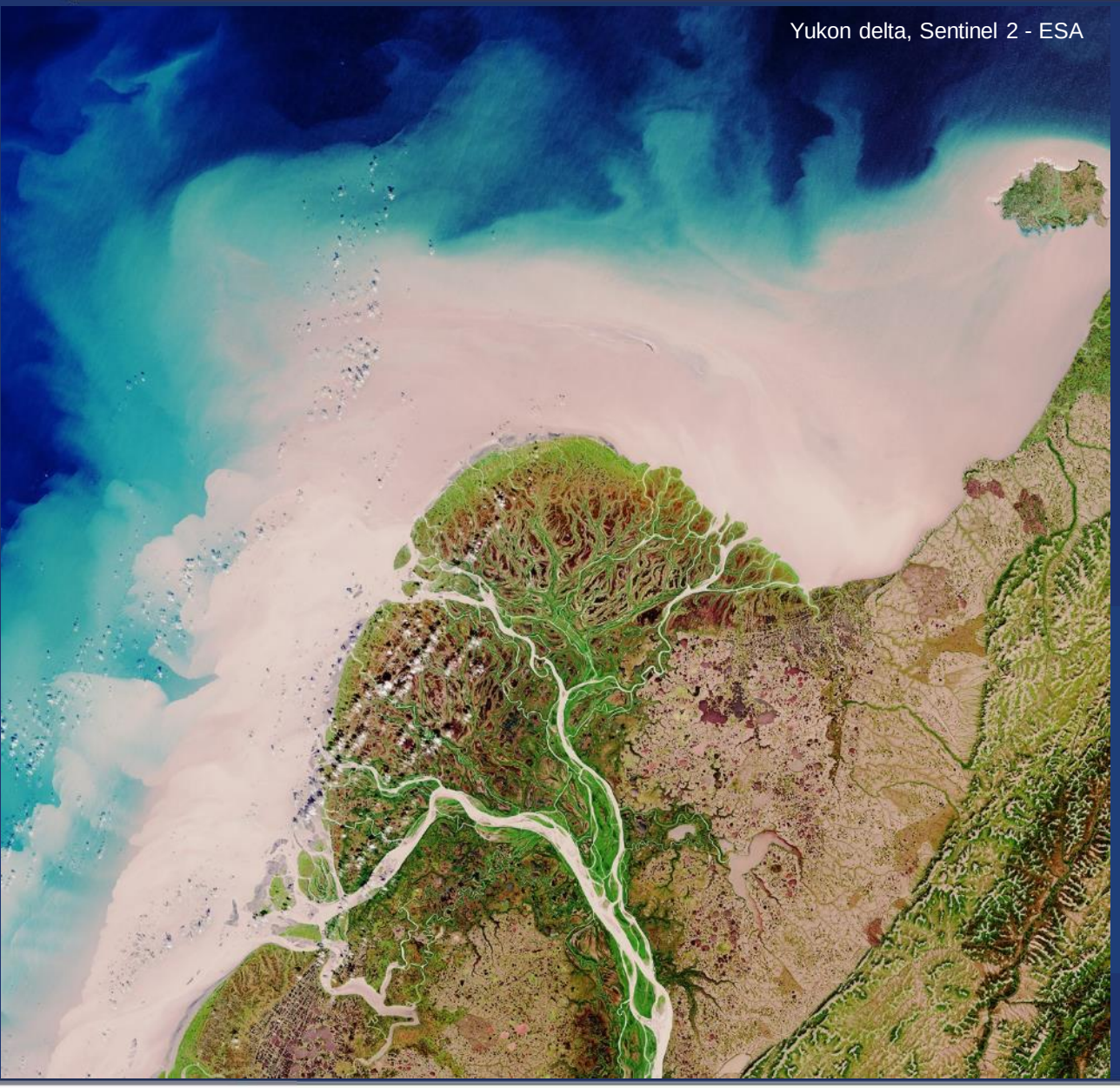
Yukon delta, Sentinel 2 - ESA

Thank you

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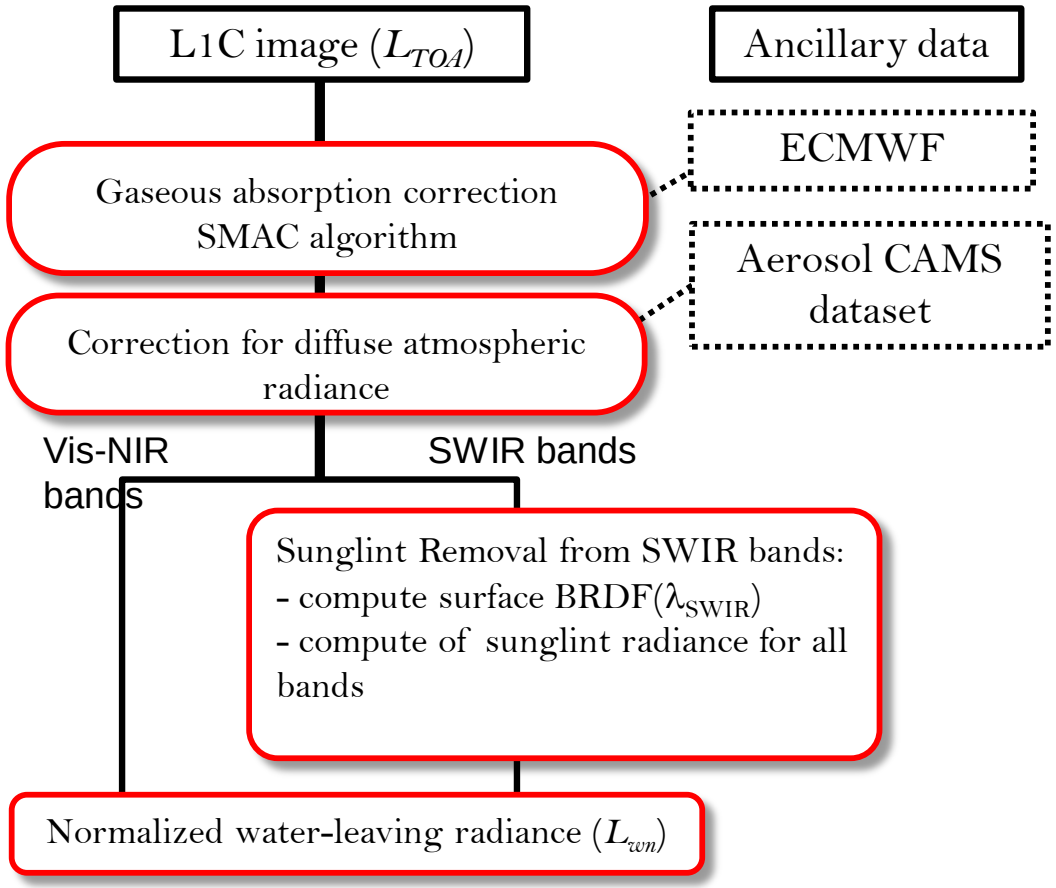
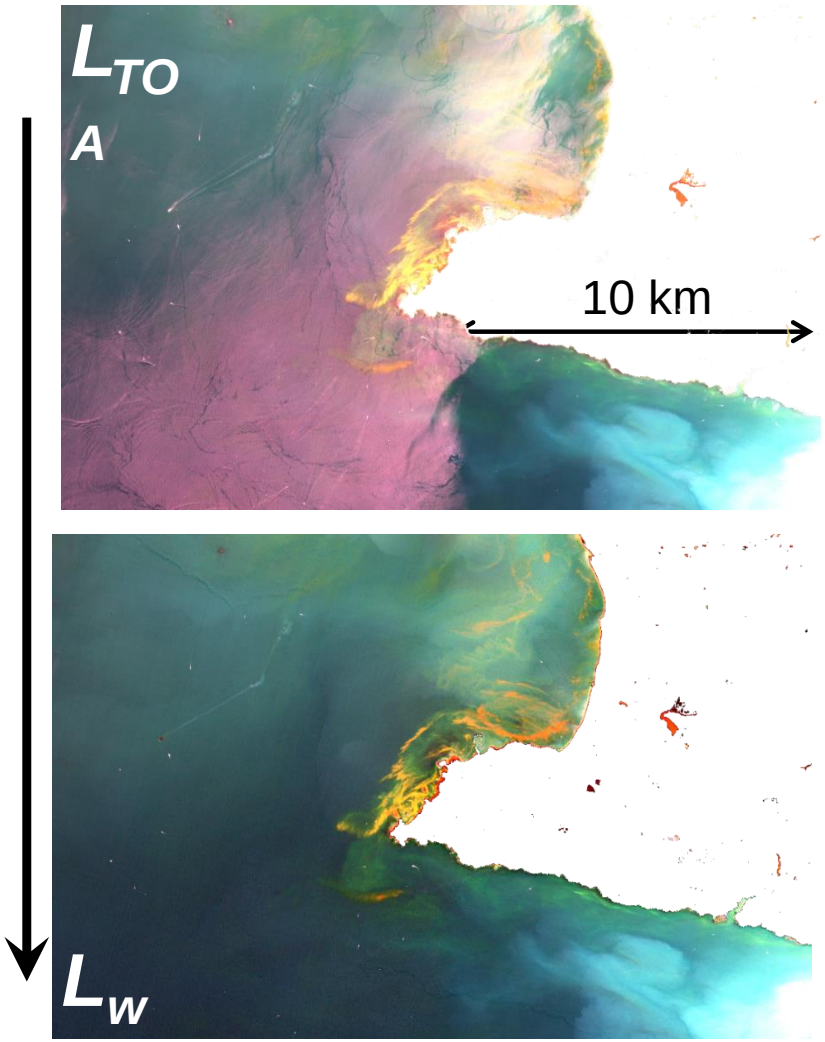
Glint Removal for Sentinel2 like data – GRS algorithm

Tristant Harmel et al., 2018





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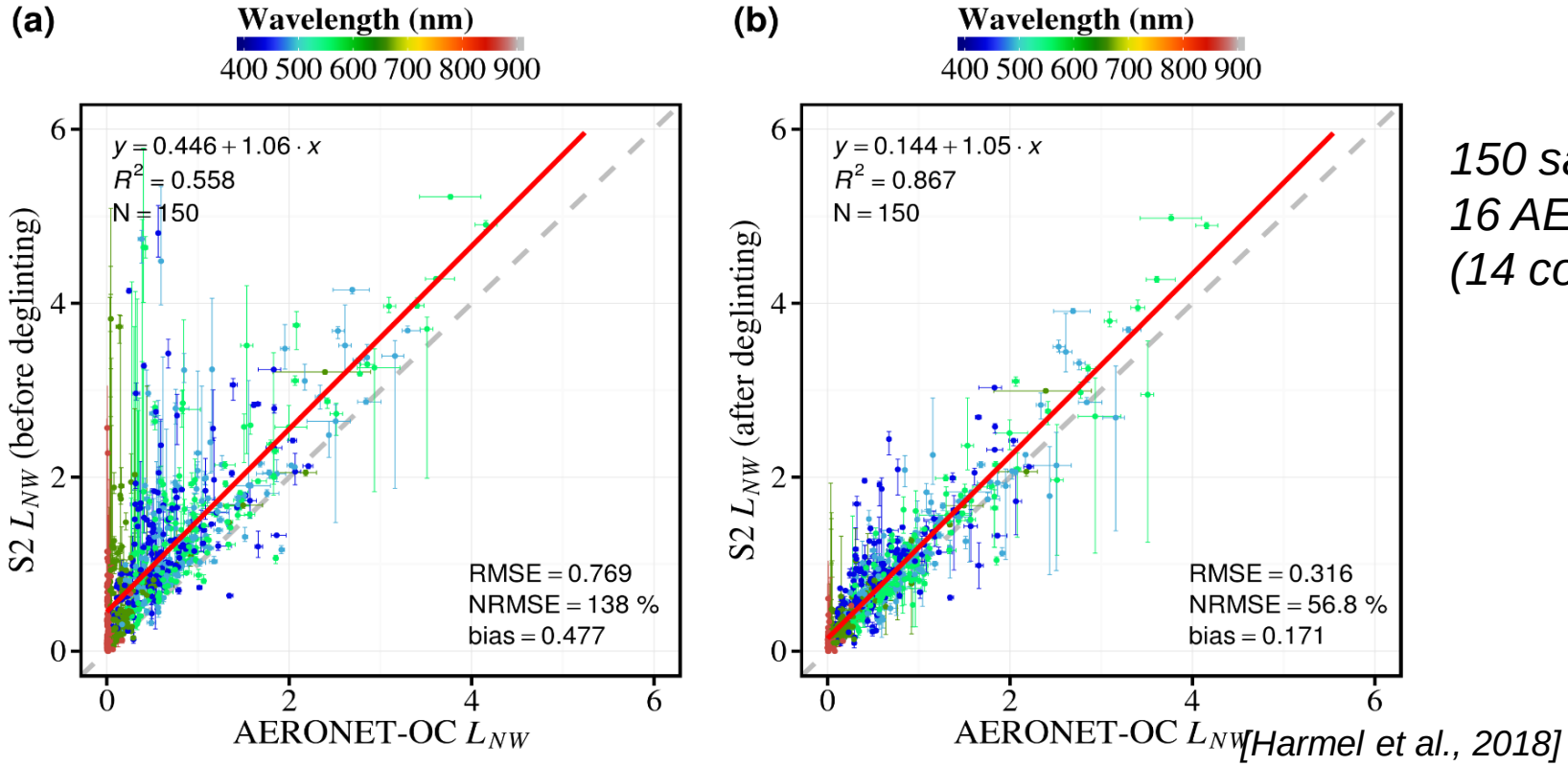
VALIDATION WITH AERONET-OC DATA

AC only

AC + glint removal



150 satellite images (S2)
16 AERONET-OC
(14 coastal, 2 lake sites)

[Harmel et al., 2018]

→ Now, part of the ACIX-II exercise (ESA/NASA) for algorithm intercomparison, (matchup points > 1500 for S2A, S2B, L8)

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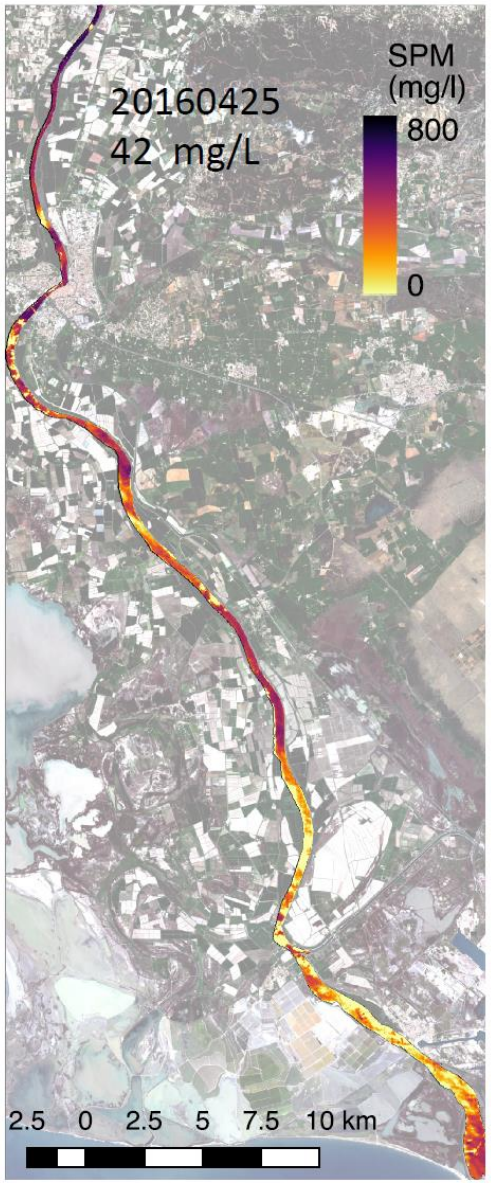
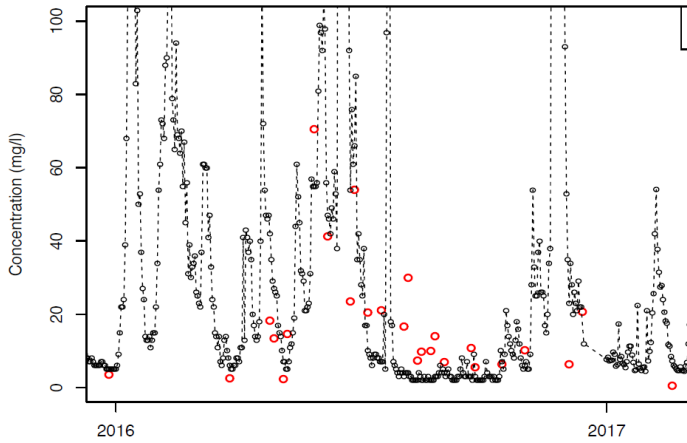
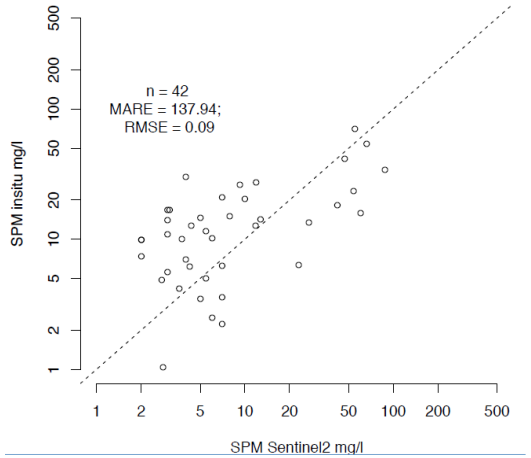
Examples of OBS2CO water quality product







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