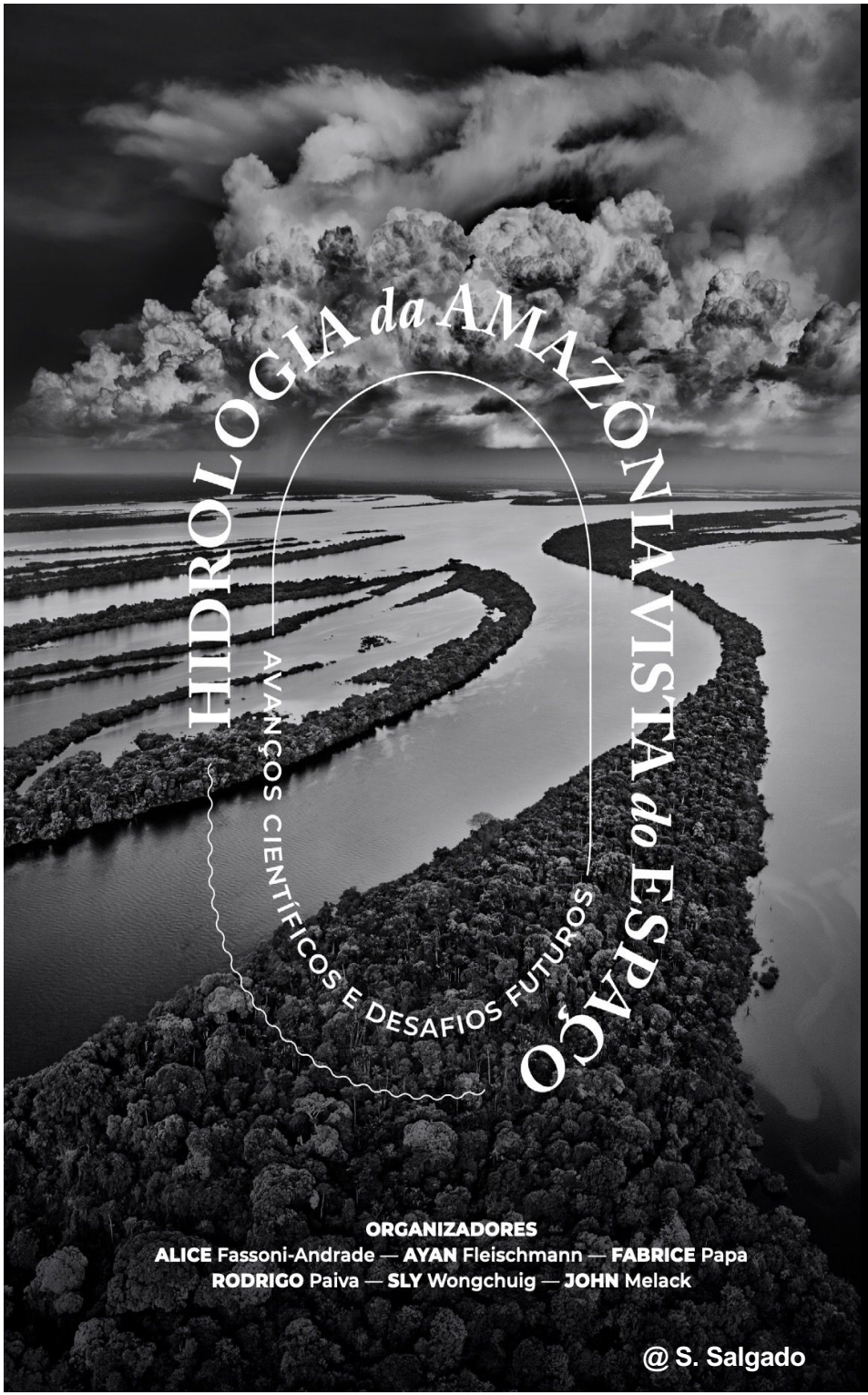

The 2023 Amazon drought

SAMBA, SWOT for the Amazon BAsin

Fabrice Papa (IRD/LEGOS)
Daniel Moreira (SGB, Brazil)
and many contributors

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SERVIÇO GEOLÓGICO DO BRASIL - CPRM

LEGOS

French National Research Institute for Sustainable Development
IRD
Institut de Recherche pour le Développement
FRANCE

RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

SAMBA, a legacy of France-Brazil long lasting collaboration

PI's:

F. Papa (IRD) D. Moreira (SGB)

5 Work Packages (co-PIs from France and South America)

- WP1 SWOT algorithms: S. Pena-Luque, M. Cordeiro
  SWOT hydrology products/algorithm (WL, extent)

- WP2 Amazon River Science: JF Cretaux, A. Fassoni, F. Frappart, F. Papa
  SWOT hydrology products (WL, discharge), processes, Extreme hydroclimatic events characterization

- WP 3: Amazon Wetland : A. Fleischmann, F. Papa, F. Jaramillo, G. Allen
  River and floodplain processes and connectivity, floodplain DEM and water storage variability, Societal applications

- WP 4: Amazon modelling: A. Paris, R. Paiva, S. Wongchuig
  SWOT data assimilation (MGB model)

- WP5 : Cal/Val: D. Moreira, S. Calmant, M. Calzas
  Multi-validation, geoid, in situ, missions with FOAM/FOAMS

Team expertise:
- SWOT data processing
- Hydrology, water cycle
- Hydrological modeling
- Amazon Field trip campaigns

SAMBA

The Amazon basin

- **Key role in global water resource and biodiversity**
- **Impacted by human actions**
  Dam, deforestation, mines
- **Vulnerability to climate change**

SAMBA

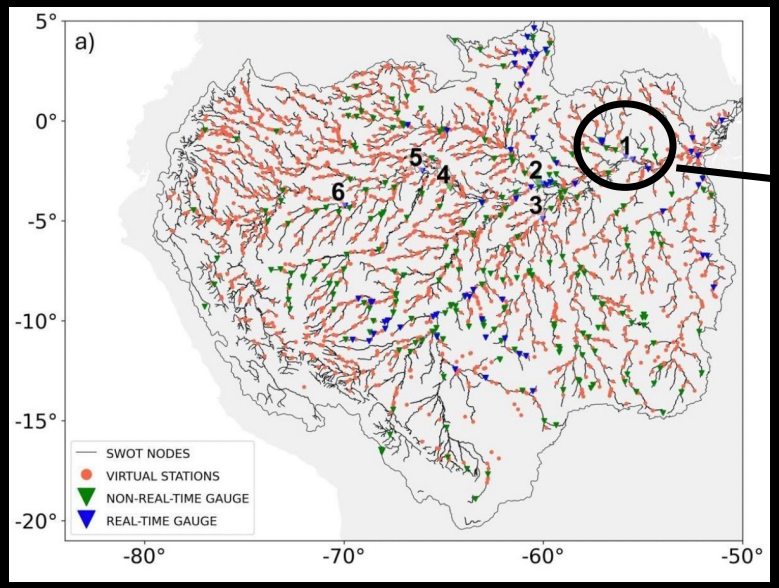
The Amazon basin

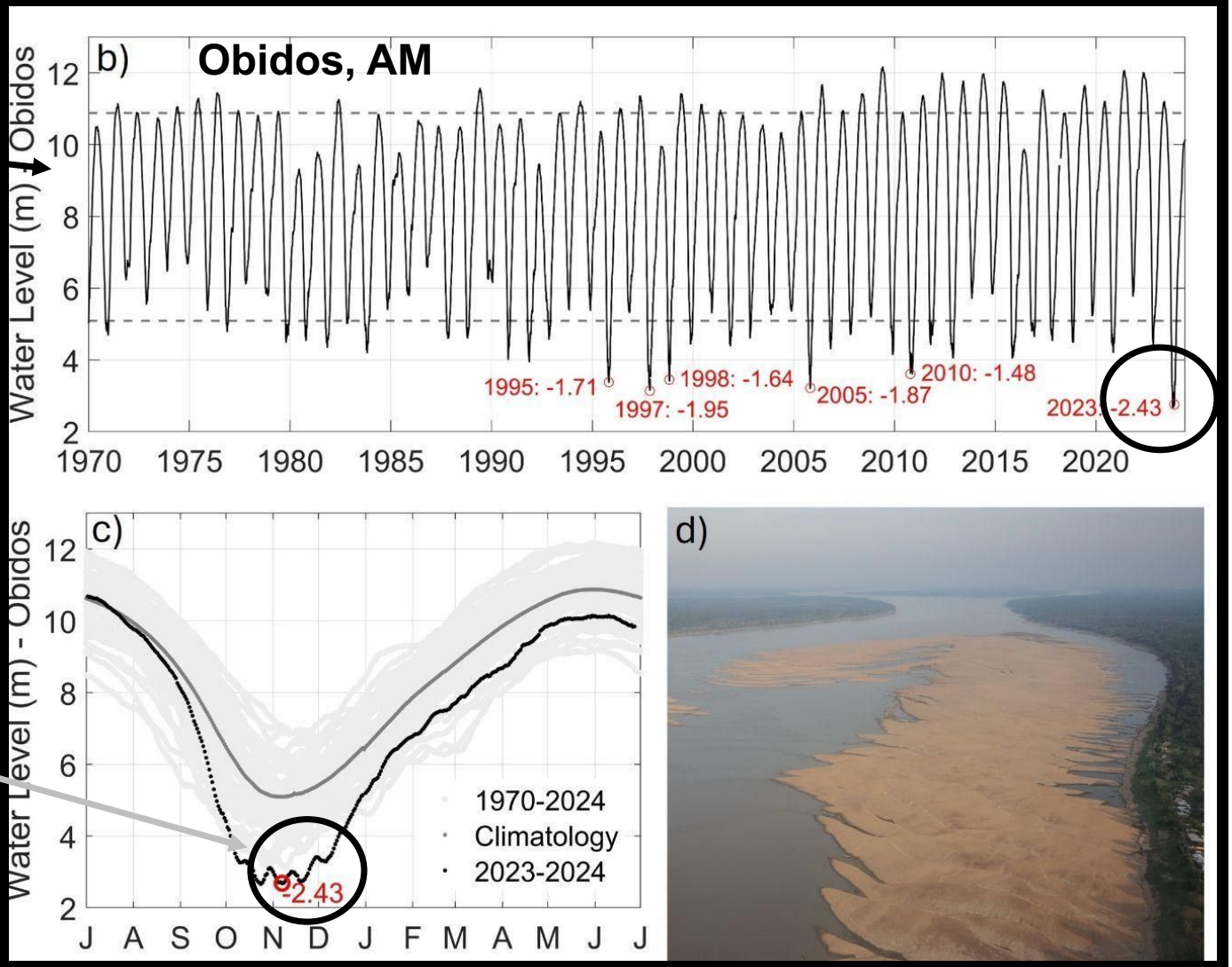
- **Key role in global water resource and biodiversity**
- **Impacted by human actions**
  Dam, deforestation, mines
- **Vulnerability to climate change**
- **Extreme events**

  « Wet gets wetter
  Dry gets drier »

The 2023 Amazon drought

In Sept-Nov 2023, the Amazon basin experienced a severe drought, with the lowest river water levels (RWL) ever recorded *in situ*





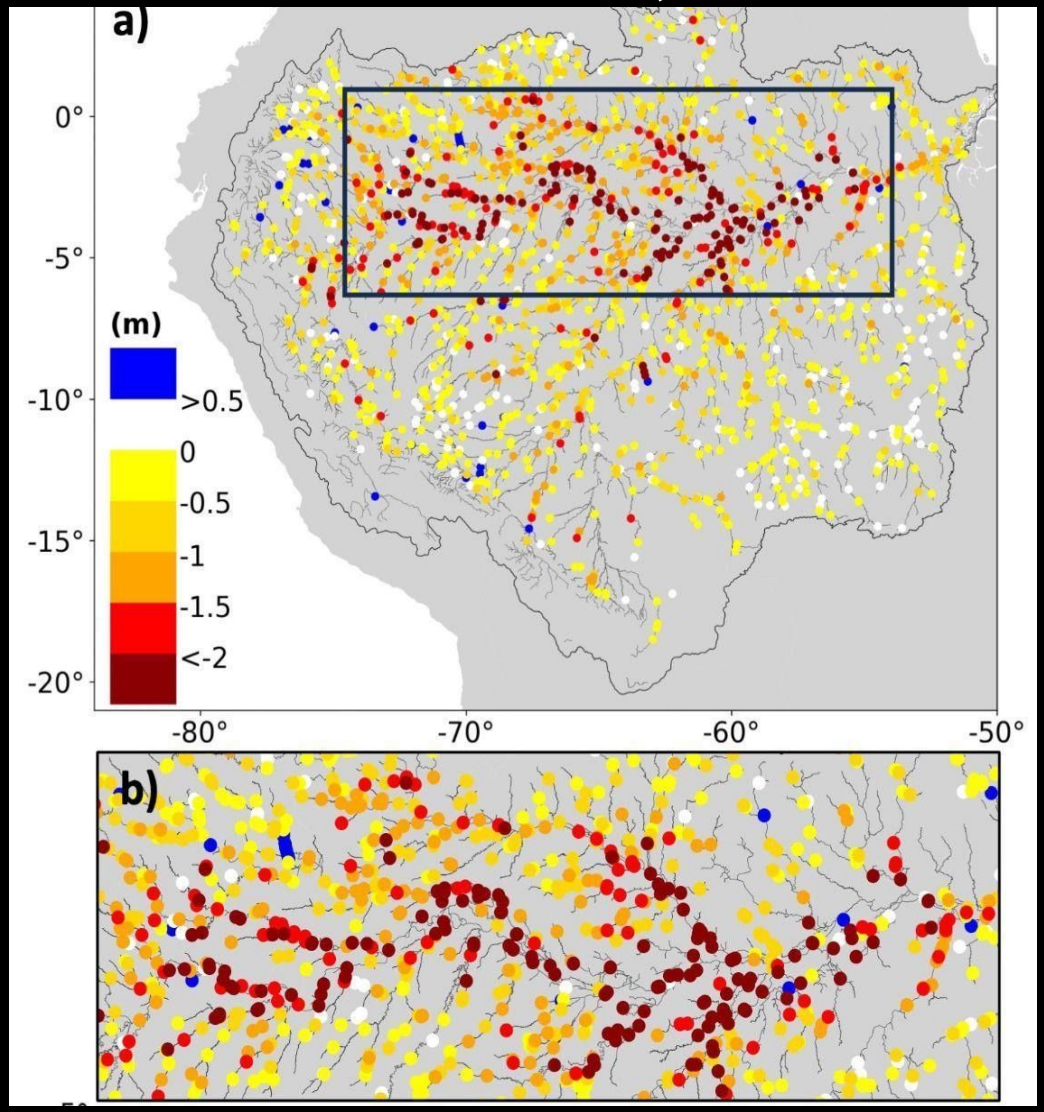
See Espinoza et al.,2024 for the drought drivers and mechanisms (ENSO, Atlantic SST)

Moreira et al., 2025 GRL

The 2023 Amazon drought

In Sept-Nov 2023, the Amazon basin experienced a severe drought, with the lowest river water levels (RWL) ever recorded *in situ*

~ 2000 VS from S3-A/B, Jason-2/3



It is well depicted by nadir altimetry

- Widespread low RWL across the basin in Sept-Oct 2023
- The 2023 minimum RWL in the Central Amazon were 3 m or more below their annual average (2016-2023)

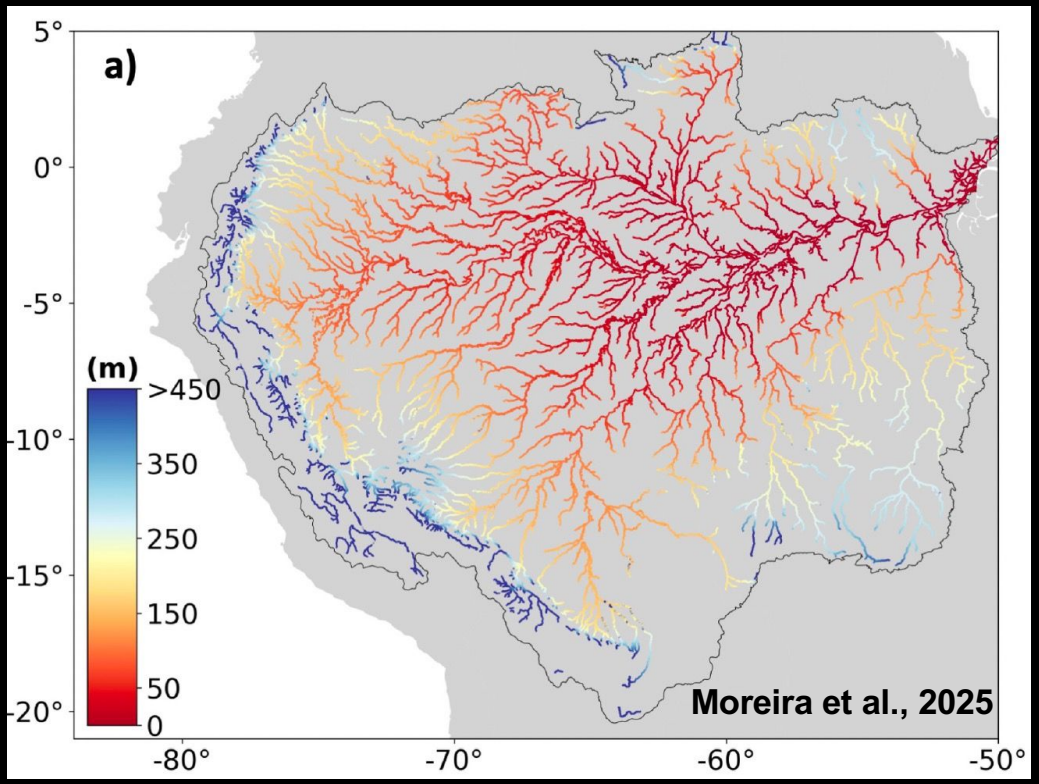
Moreira et al., 2025

SWOT captures the 2023 Amazon drought

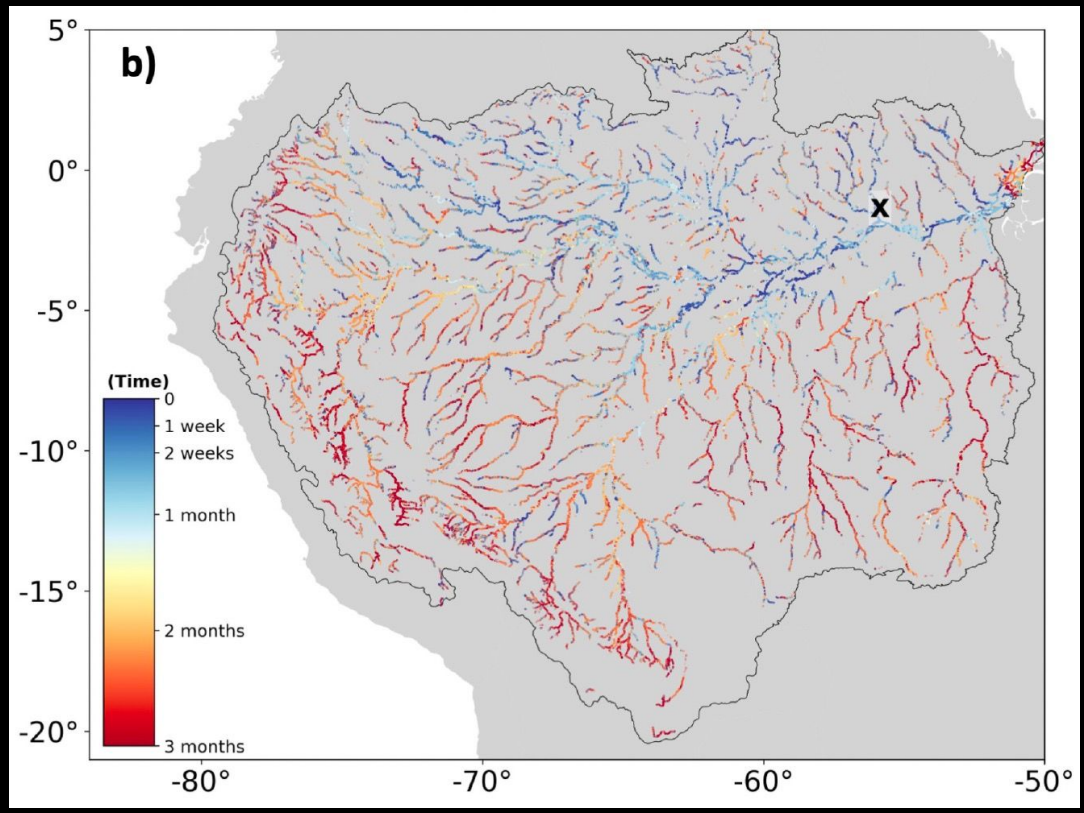
SWOT reveals extreme low water levels across the basin at 200m resolution

a) SWOT captures very low river water level (flag 0 and 1 + filtering)

SWOT Level-2 HR River Single Pass - Node

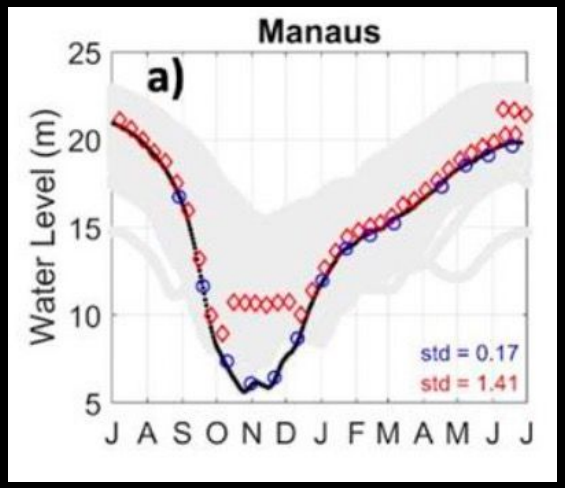


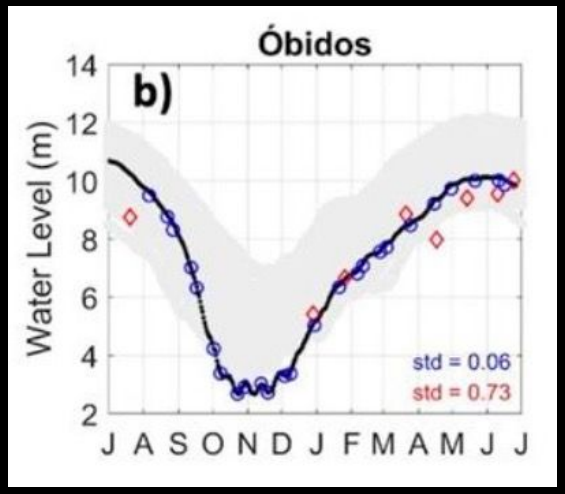
b) the drought wave propagation (time difference between RWL minimum at each node and at Obidos)

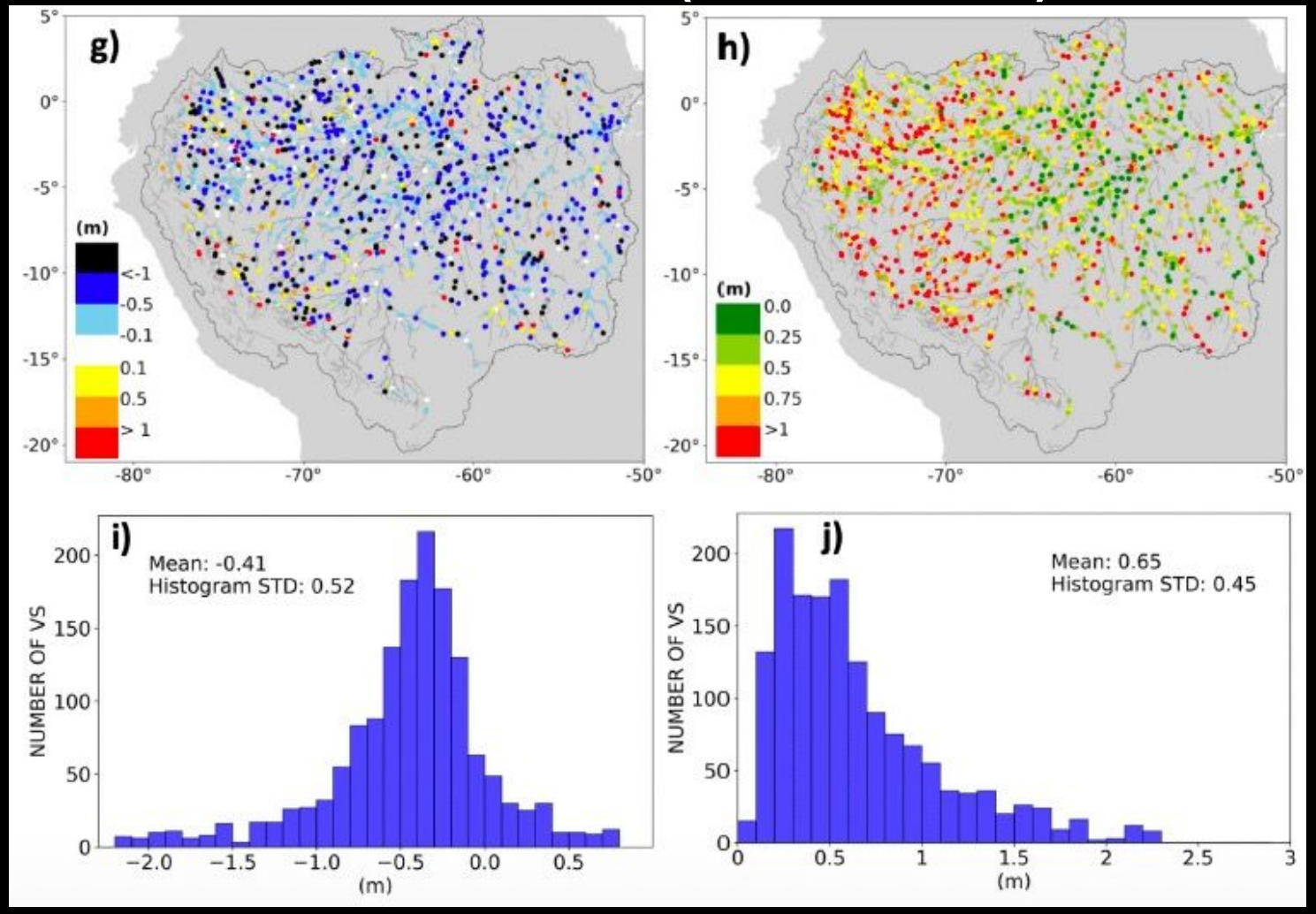


Evaluation at Amazon scale

SWOT vs in situ and nadir altimeters RWL (>20,000 obs)







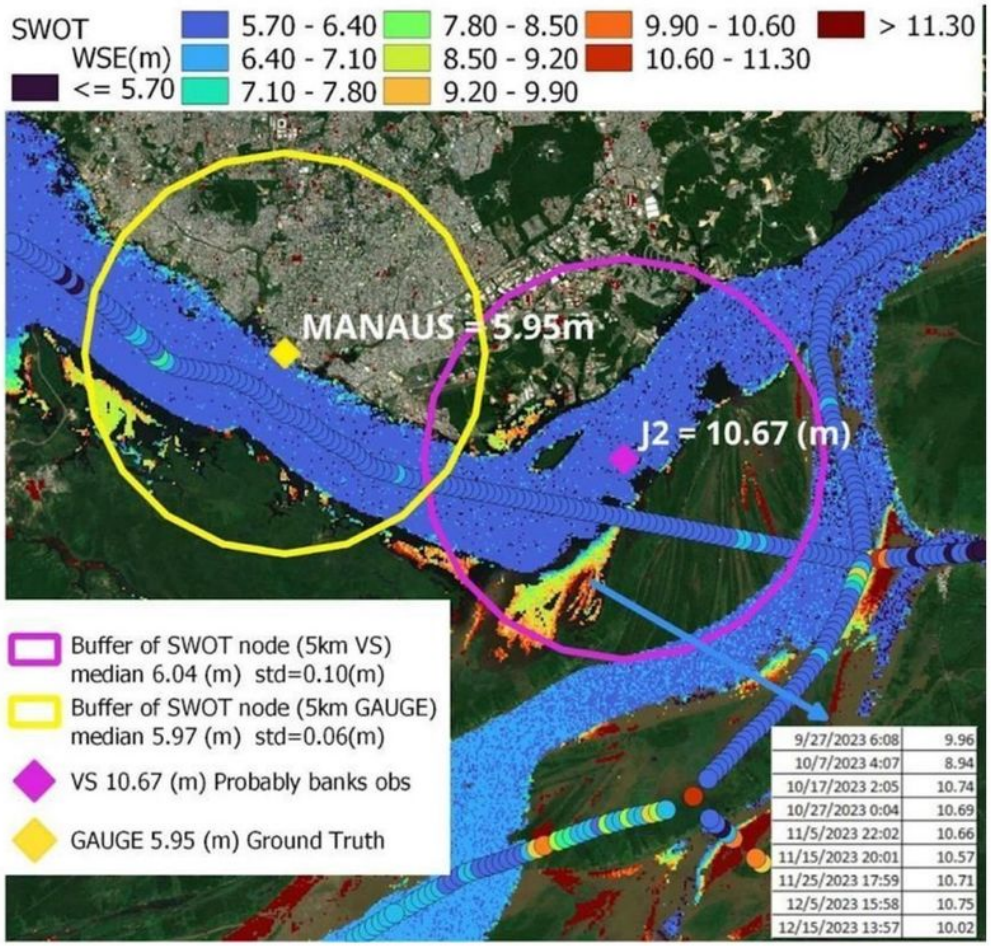
SWOT vs all nadir altimetry for > a year: mean absolute difference of ~41 cm and STD ~65 cm

- **Nadir altimetry has problems in headwaters and during the 2023 drought peak**

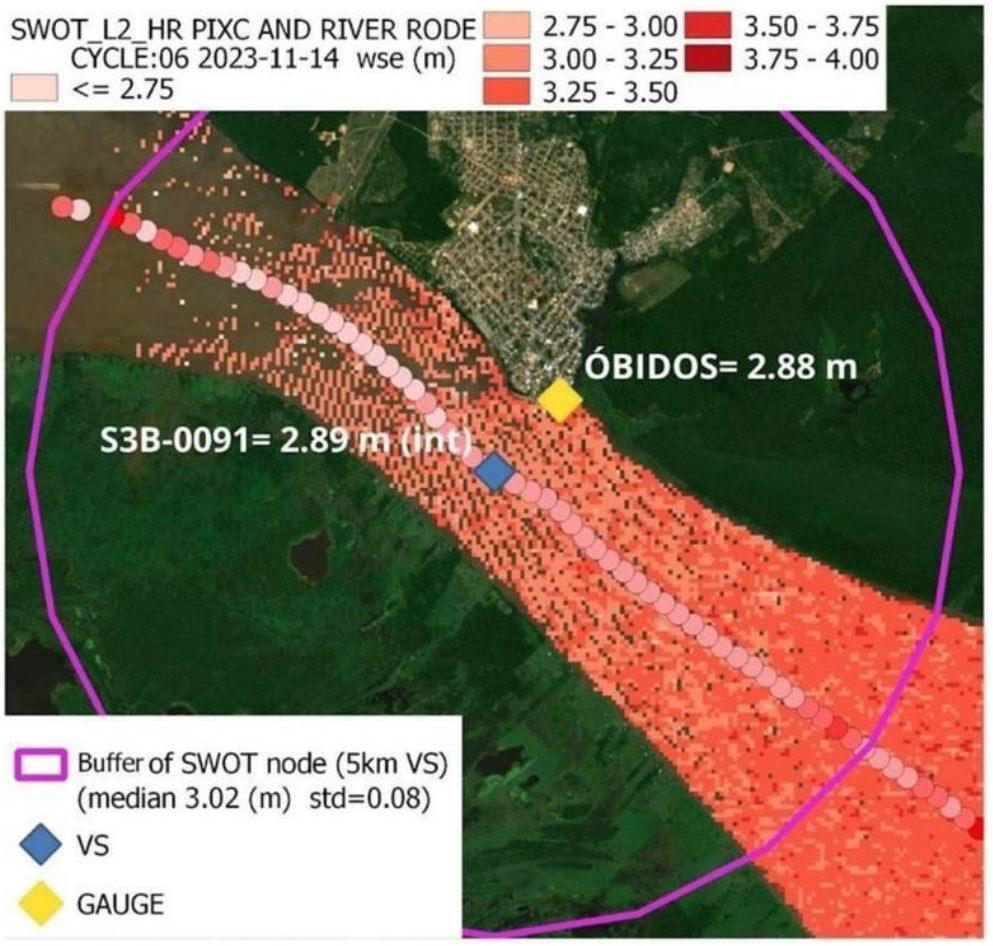
- **Nevertheless, SWOT vs leveled gauges: 1cm MD and less than 15 cm STD**

Evaluation at Amazon scale

Complex case



(less) complex case



- Sand bar
- SWORD

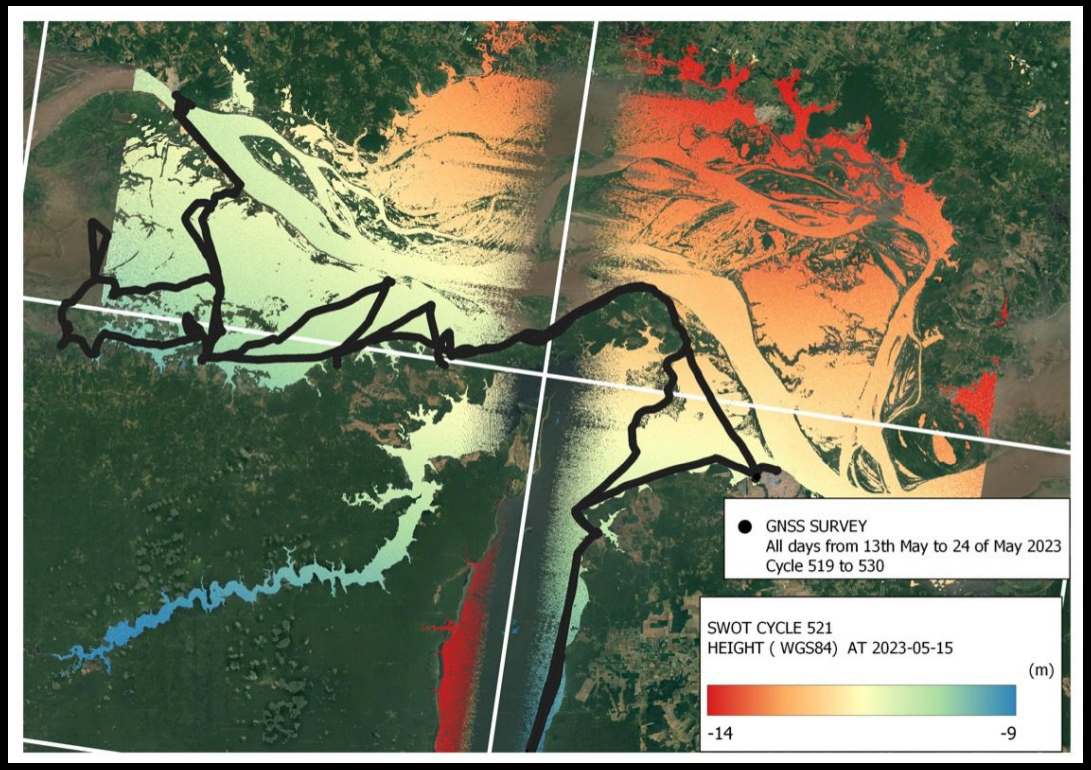
Geophysical Research Letters

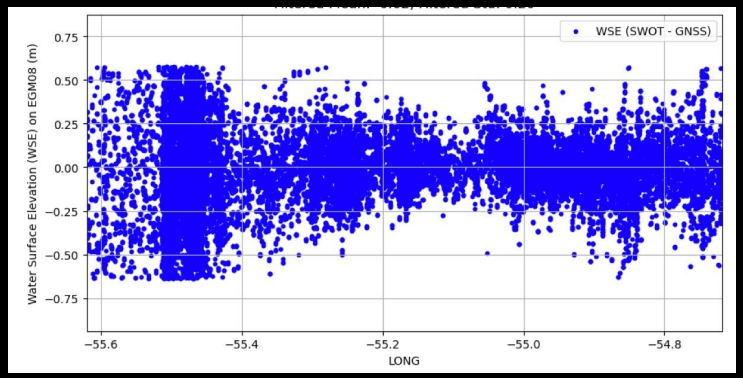
Widespread and Exceptional Reduction in River Water Levels Across the Amazon Basin During the 2023 Extreme Drought Revealed by Satellite Altimetry and SWOT

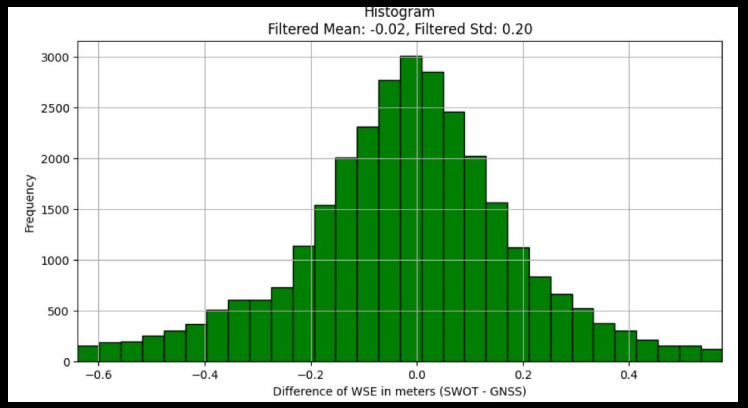
Daniel Moreira[1,2], Fabrice Papa[3,4], Alice Fassoni-Andrade[4], Ayan Fleischmann[5], Sly Wongchuig[3], Rodrigo Paiva[6], Adrien Paris[3,7], Frederic Frappart[8], Jefferson Melo[1], Jean-Francois Crétaux[3], André Martinelli Santos[9], Pierre-André Garambois[10], Benjamin Kitambo[3,11], and Stéphane Calmant[7]

Fine scale validation

SWOT observations vs 1-day orbit (see Moreira et al. poster)



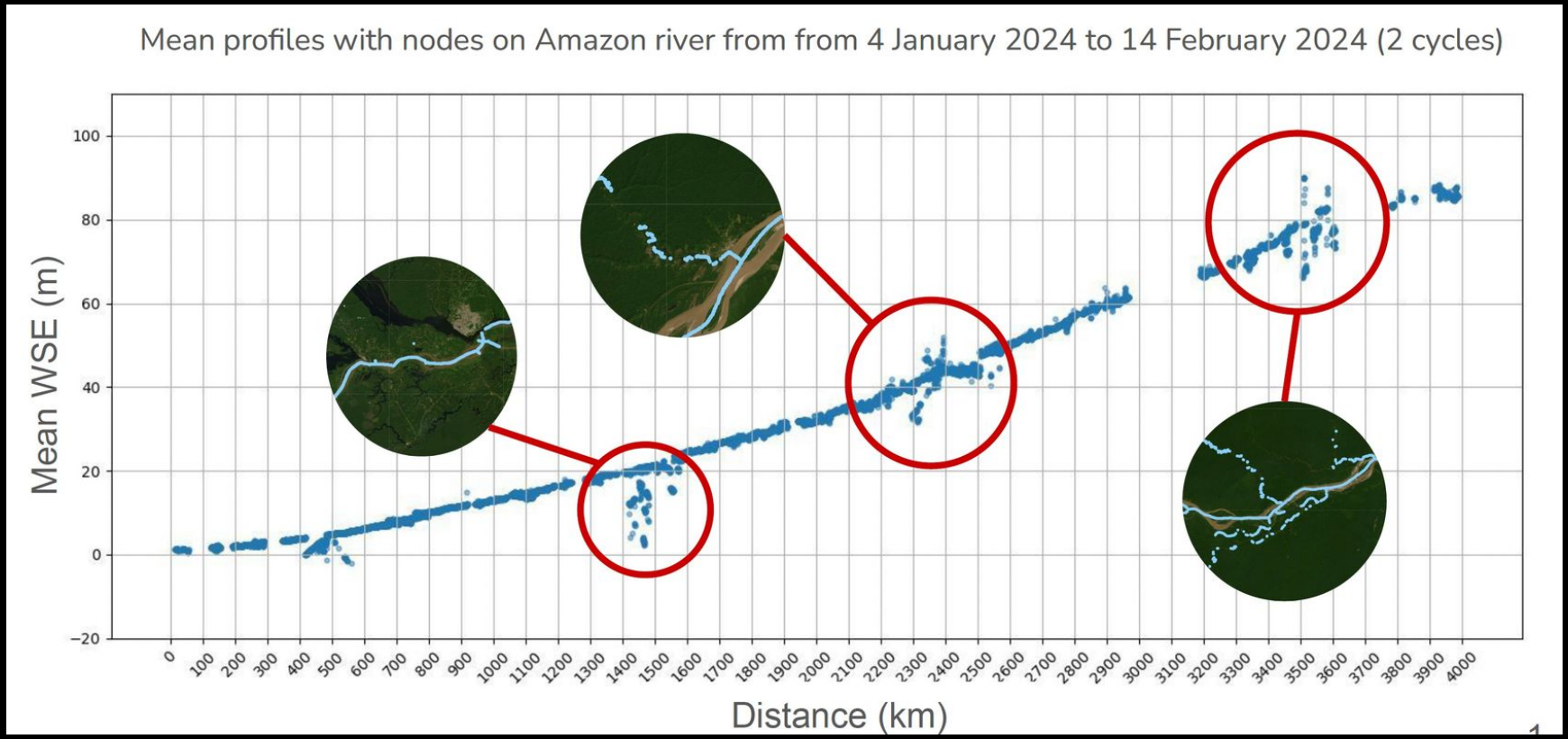




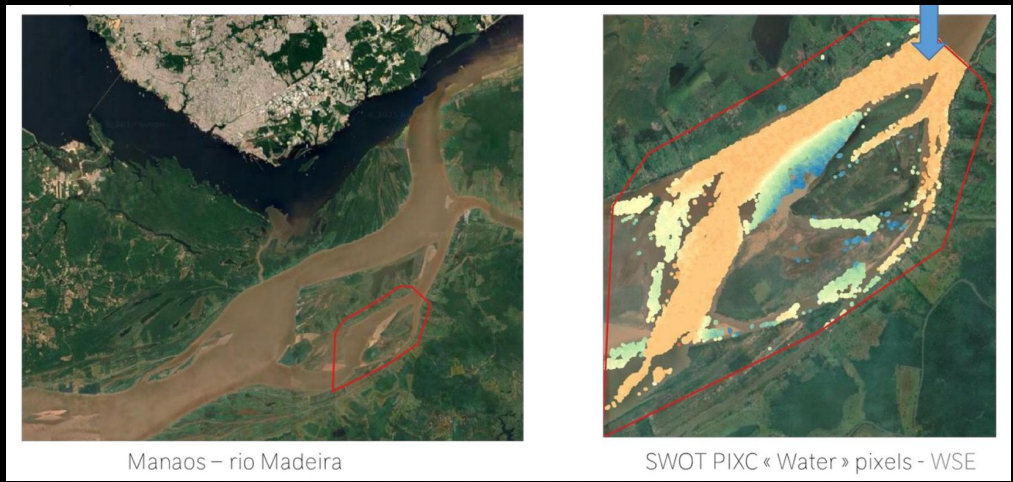
Lago Grande Curuai,
using geodetic carpet during fast sampling orbit (Water Level SWOT-GNSS)
STD of ~ 10cm

(from SGB-IRD-CNES 2023 and 2024 field campaign)

Next important steps



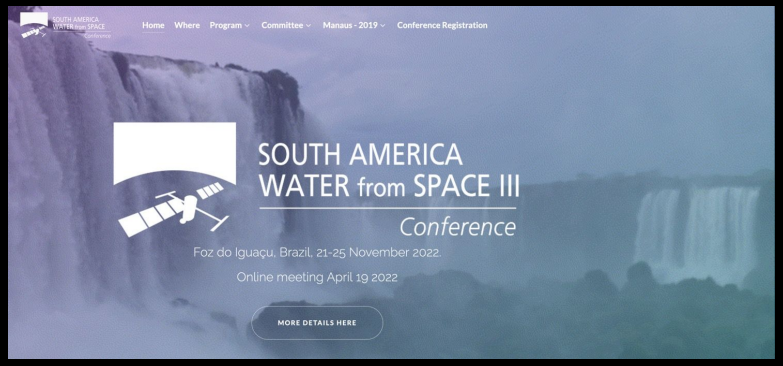
Water detection improvements (S Pena Luque; M Codeiro)

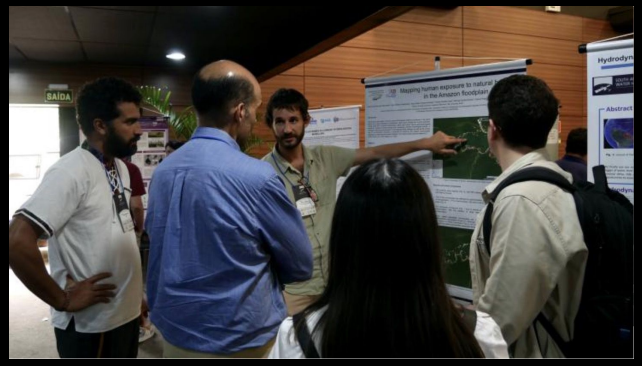


Sword correction +WSE over the entire Amazon (C. Blondel)

South America Water from Space conference

Rio 2015, 2017, Santiago Chile 2018, Manaus 2019, Foz d'Iguacu 2022





Belem 2024

We will soon announce the 2026 edition in

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