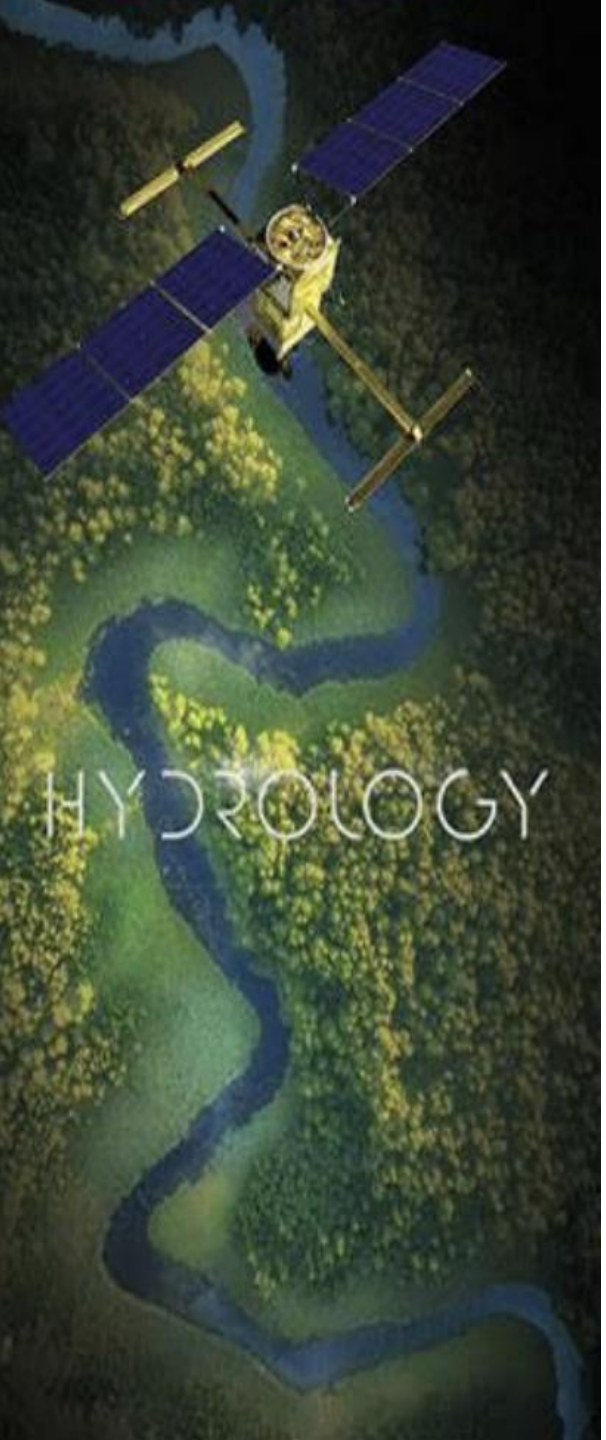


Hydrology from Space – A bilateral cooperation program for the monitoring of the Amazon Basin from satellite to improve water management and cities resilience under climate extremes .

SGB COP 30
Difundindo Geociências para um Futuro Climático Seguro

AND

IRD
Institut de Recherche pour le Développement
FRANCE

Daniel Moreira, Fabrice Papa, Fabien Durand, Alice Fassoni-Andrade, Ayan Fleischmann, Sly Wongchuig, Rodrigo Paiva, Adrien Paris, Frederic Frappart, Paul Coulet, Leandro Guedes, Jefferson Santos Melo, Jean-Francois Crétaux, André Martinelli Santos, Pierre-André Garambois, Benjamin Kitambo and Stéphane Calmant

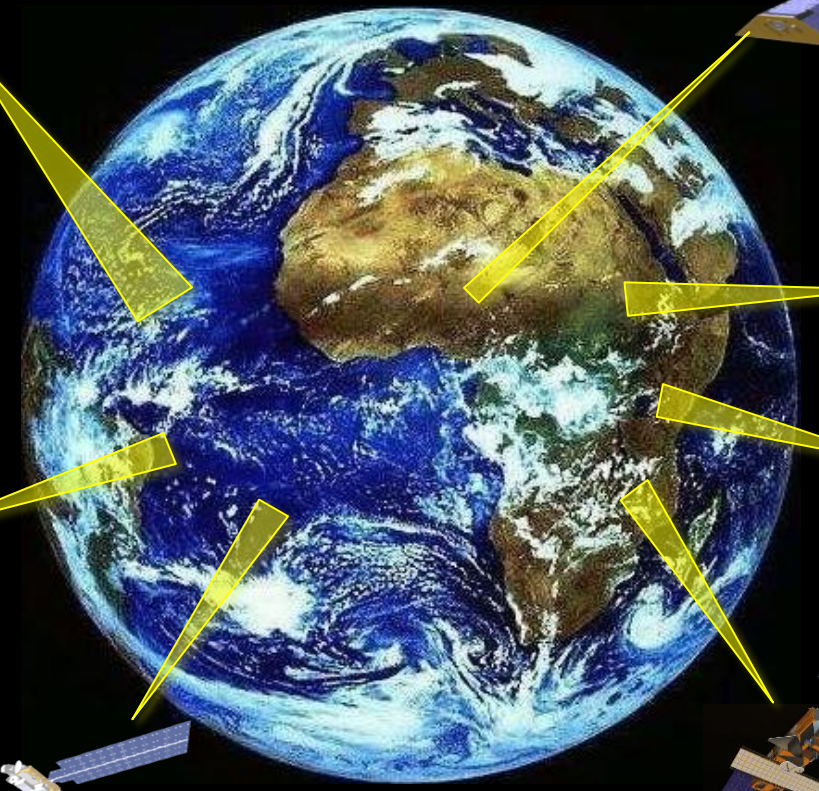
In the context of the research project:
SAMBA, SWOT for the Amazon Basin

IN PATERNSHIP WITH :

cnes
LEGOS
Hydromatters
UnB
Instituto de Desenvolvimento Sustentável Mamirauá

Hydrology from Space

Satellites have changed the way we observe the water cycle and hydrology



Precipitation

Total Water Storage

Evaporation and Temperature

Soil moisture

Surface Water extent

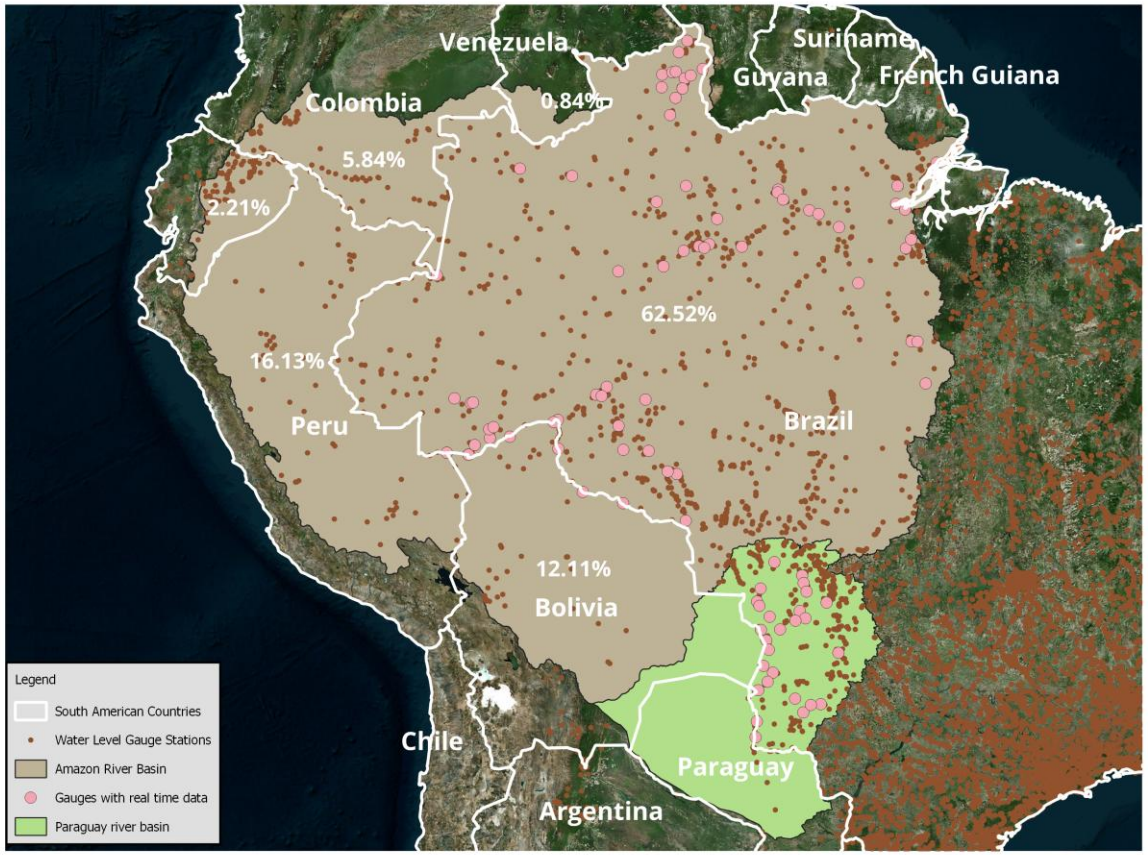
Vegetation Water color

Water level and discharge

Water quality | Water quantity | Variability and Changes

Why SWOT and remote sensing is so important for hydrological monitoring over Amazon river Basin?

Sparse water level gauge network over transboundary basins



Extreme floods and droughts that affects all the population.

The frequency of the extremes events increased a lot in the last two decades .

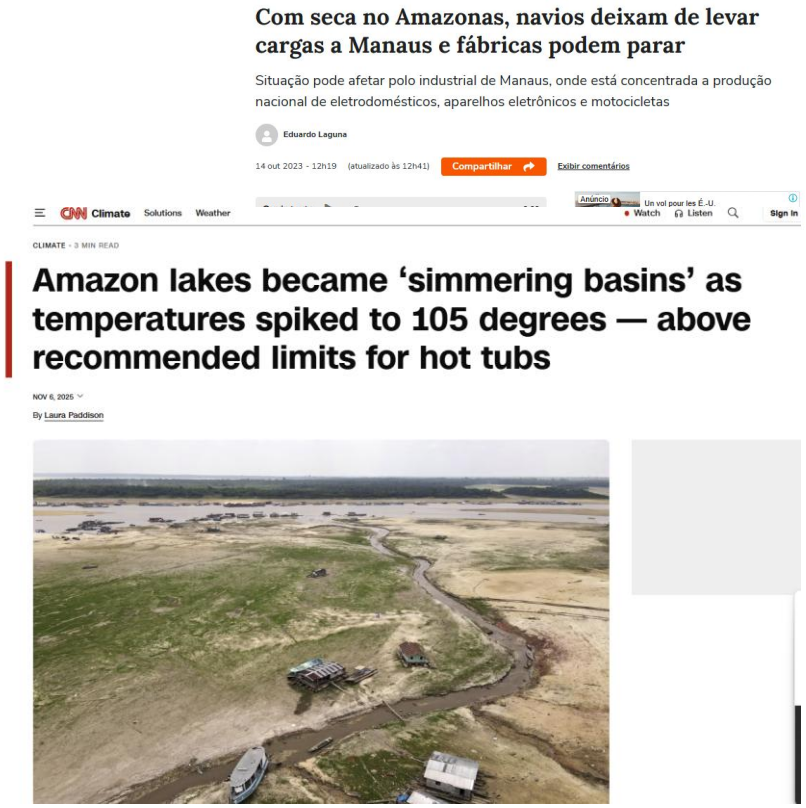

Cheia no Amazonas causa prejuízo de mais de R$ 66 milhões, diz Sepror

Produção de farinha de mandioca foi a mais afetada no setor agrícola. Município de Iranduba concentrou as maiores perdas em 2015.

Sérgio Rodrigues
Do G1 AM

FACEBOOK

Mais de 40 cidades decretaram situação de emergência por conta da cheia em 2015 (Foto: Defesa Civil/Divulgação)


Com seca no Amazonas, navios deixam de levar cargas a Manaus e fábricas podem parar

Situação pode afetar polo industrial de Manaus, onde está concentrada a produção nacional de eletrodomésticos, aparelhos eletrônicos e motocicletas

Eduardo Laguna

14 out 2023 - 12h19 (atualizado às 12h41)

Compartilhar

Exibir comentários

CNN Climate Solutions Weather

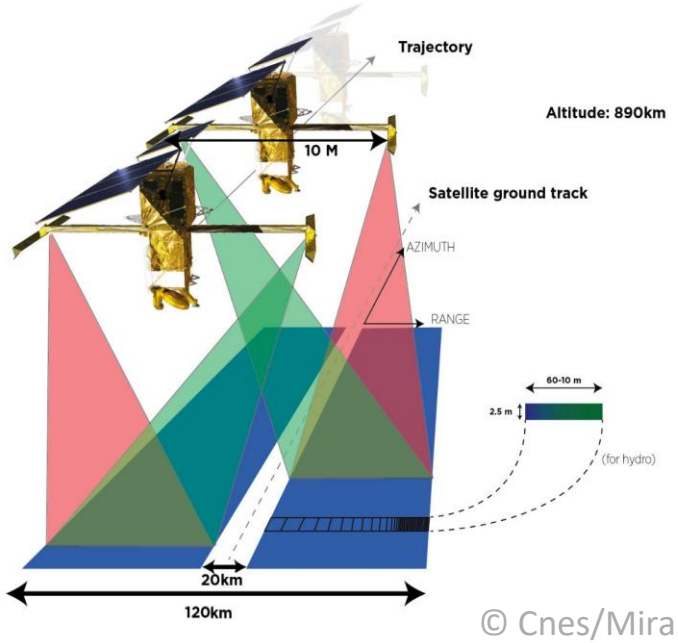
CLIMATE · 3 MIN READ

Amazon lakes became 'simmering basins' as temperatures spiked to 105 degrees — above recommended limits for hot tubs

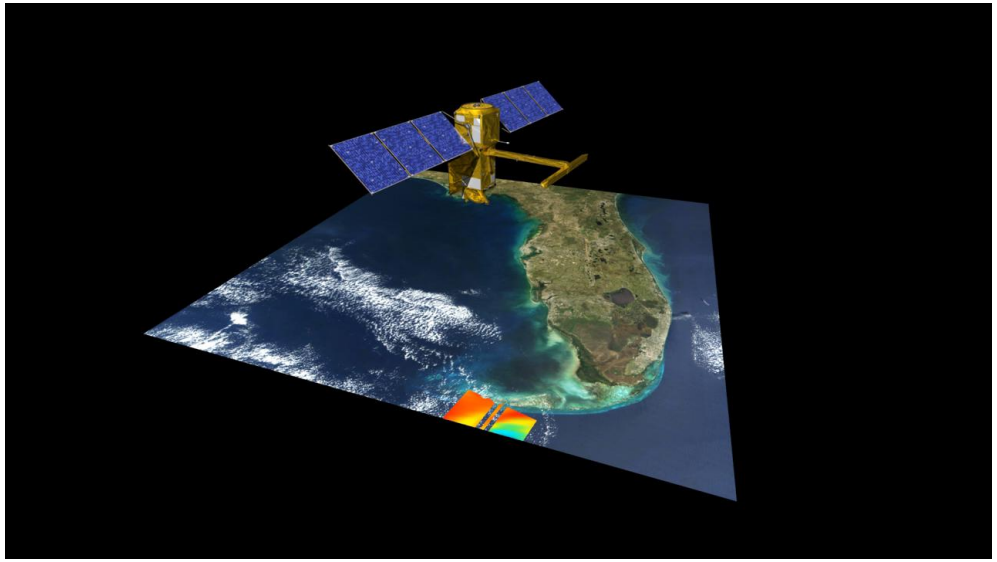
NOV 6, 2025

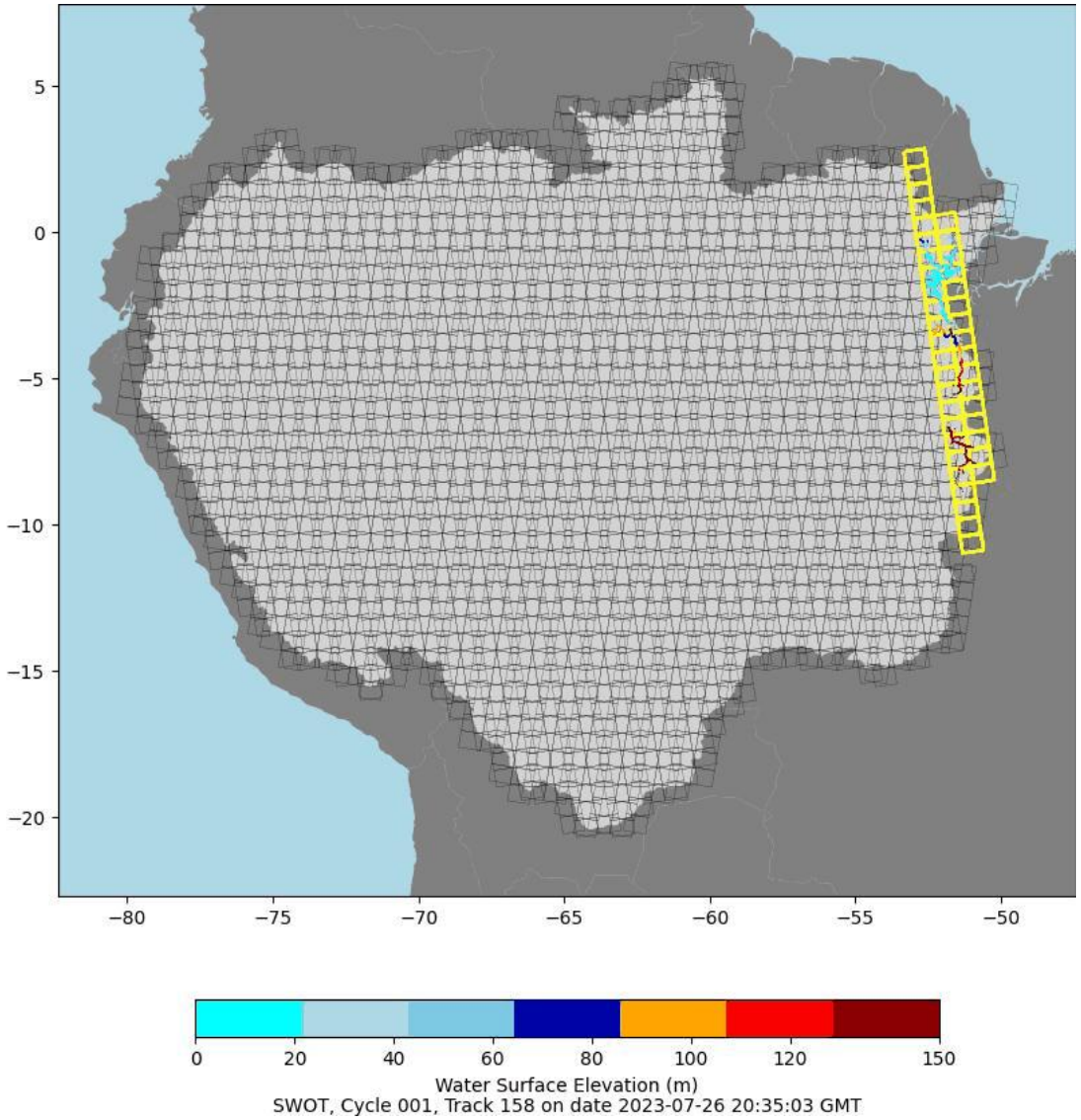
By Laura Paddison

Surface Water and Ocean Topography (SWOT) https://swot.jpl.nasa.gov/



© Cnes/Mira Production





Global lakes & rivers survey from SWOT

SWOT measurements and products

Lakes

Height, extent & volume changes on lakes larger than 250 m x 250 m

⇒ **This will allow calculating water storage changes**

⇒ **This will allow understanding the role of lake in water cycle**

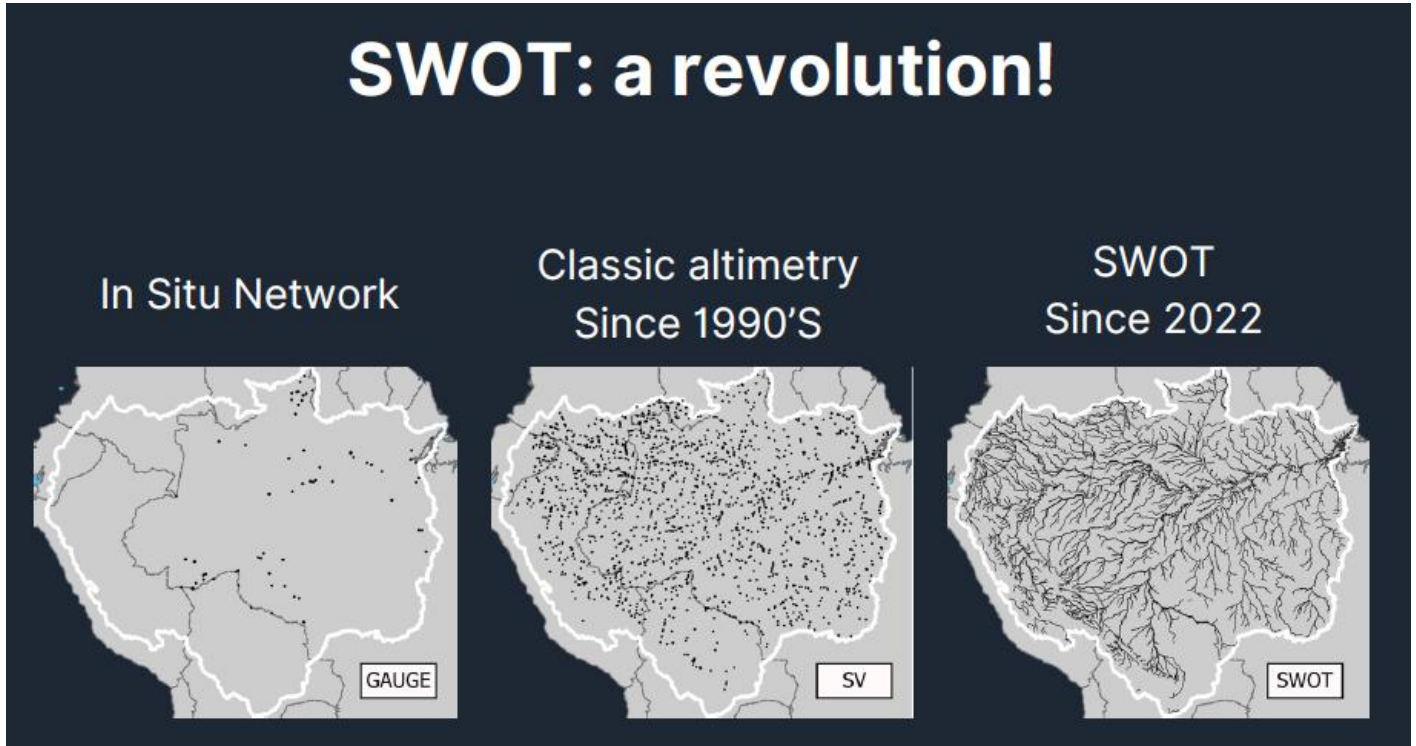
Rivers

Height, slope and width of rivers larger than 100

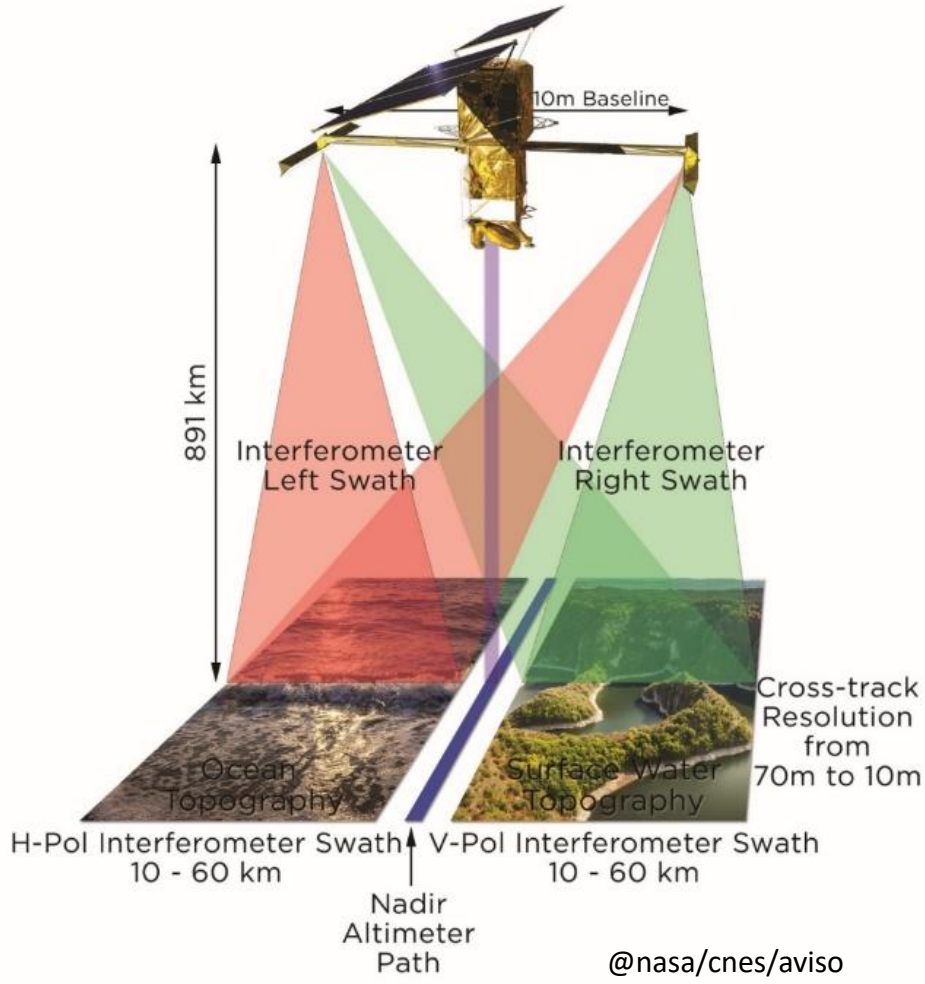
⇒ **This will allow calculating discharges along pre-defined reaches of 10 km**

⇒ **This will allow understanding the role of rivers in water cycle and on sea level changes**

⇒ **This will allow understanding the interaction with floodplain and groundwater dynamics at basin scale**



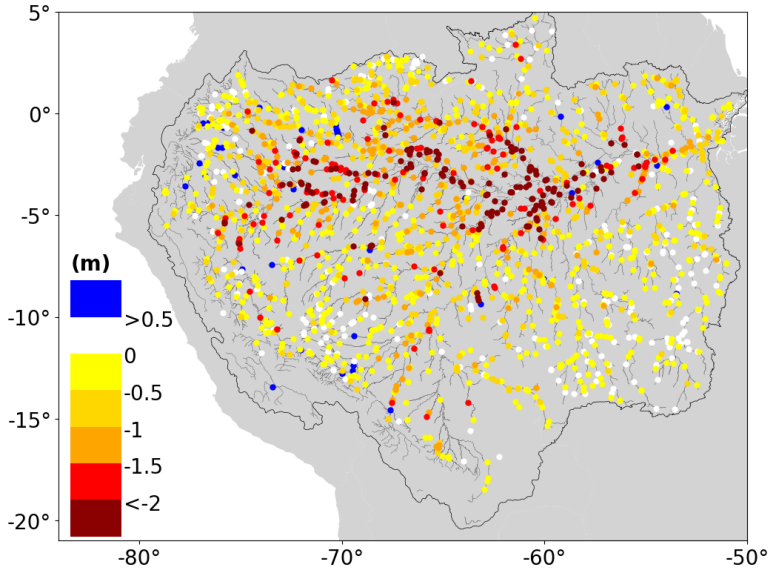
SWOT is an interferometer in Ka Band

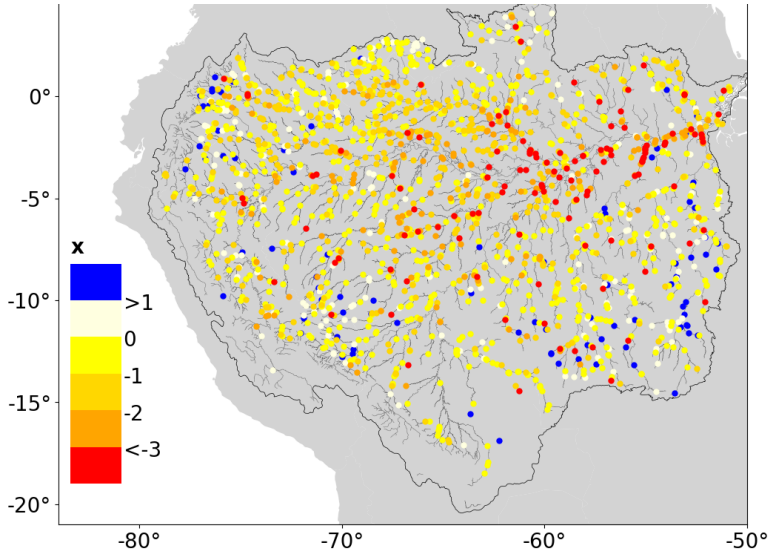


Measurements will be released every 21 days and every passes on shape of vector files, pixel cloud and rasters

AMAZON 2023 DROUGHT FROM THE VIEW OF SATELLITE ALTIMETRY AND SWOT

WATER LEVELS ANOMALY



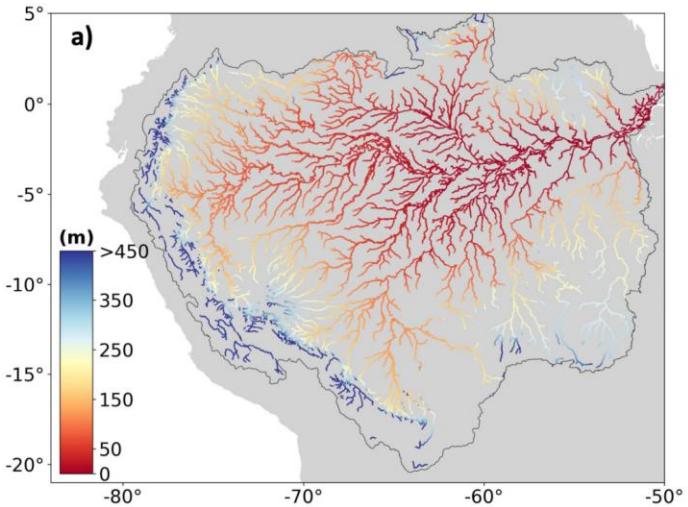


HOW STRONG AS THIS DROUGHT?

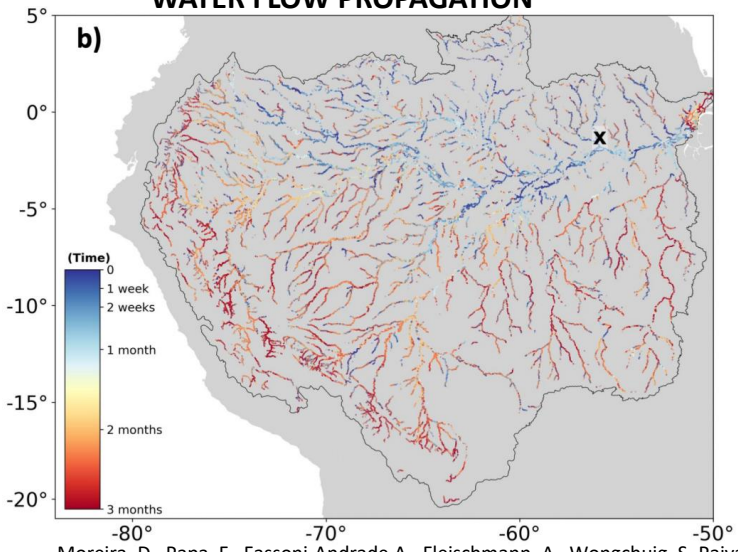
X - Represents X times of Drought Magnitude from Normal Standard Deviation of all droughts observed by Satellite Altimetry

SWOT

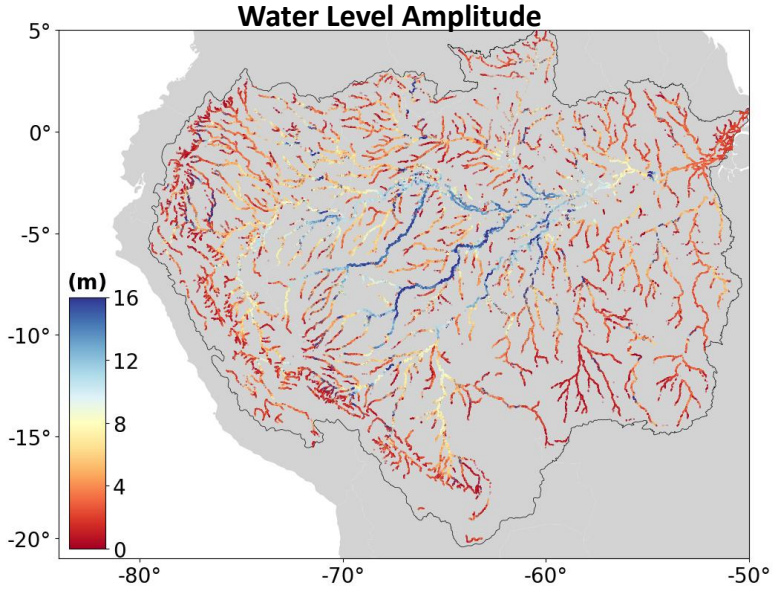
Minimum River Water Levels



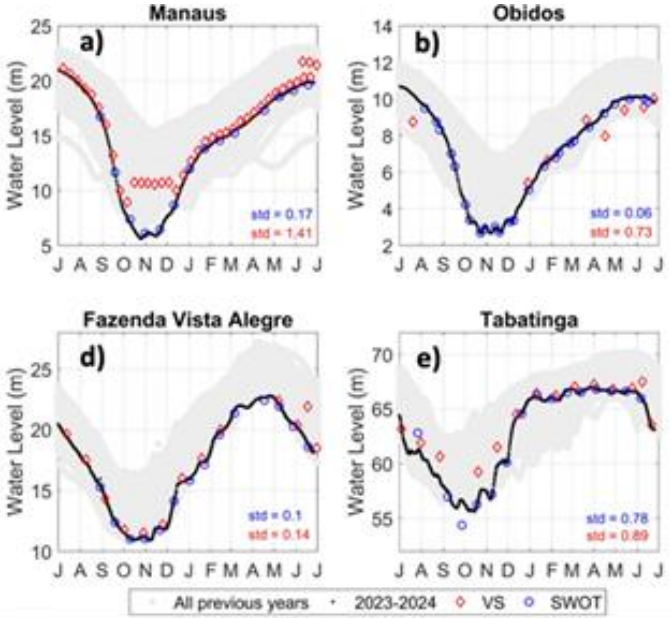
WATER FLOW PROPAGATION



Water Level Amplitude

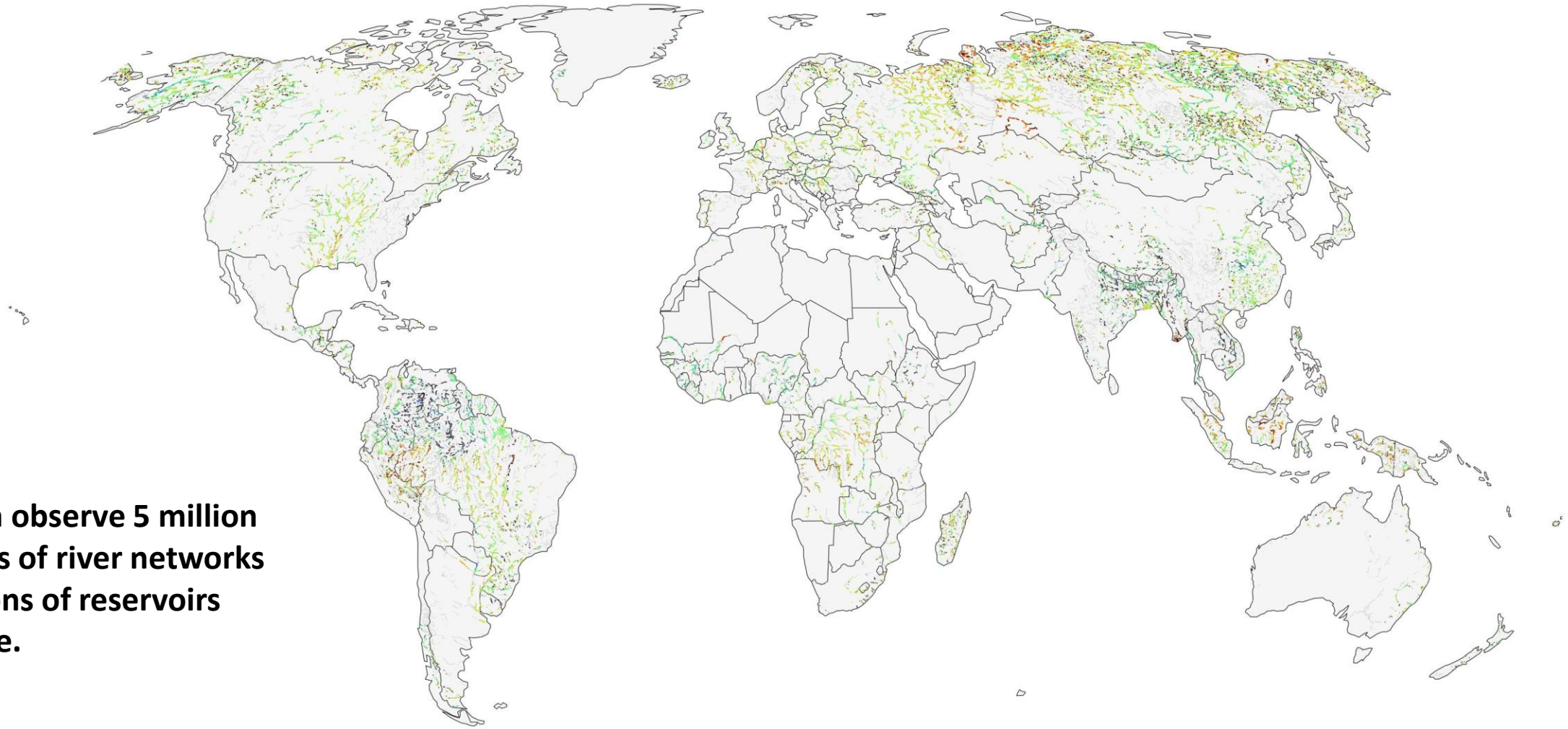


How gauges, SWOT and satellite altimetry observe the water level from 2023 drought?

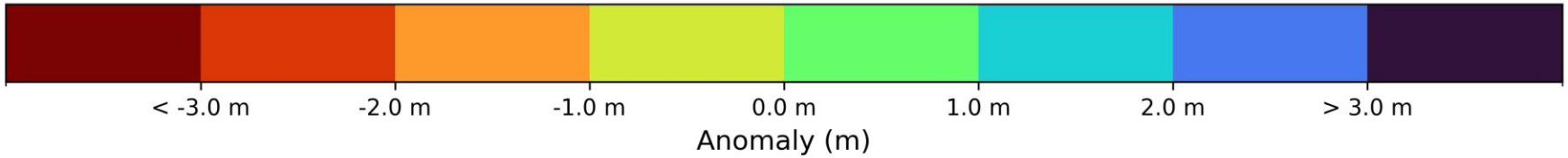


Moreira, D., Papa, F., Fassoni-Andrade,A., Fleischmann, A., Wongchuig, S.,Paiva, R., et al. (2025).
Widespread and exceptional reduction in river water levels across the Amazon Basin during the 2023 extreme drought revealed by satellite altimetry and SWOT.
GeophysicalResearch Letters, 52, e2025GL116180.
https://doi.org/10.1029/2025GL116180

River Water Level Anomaly - July 2023



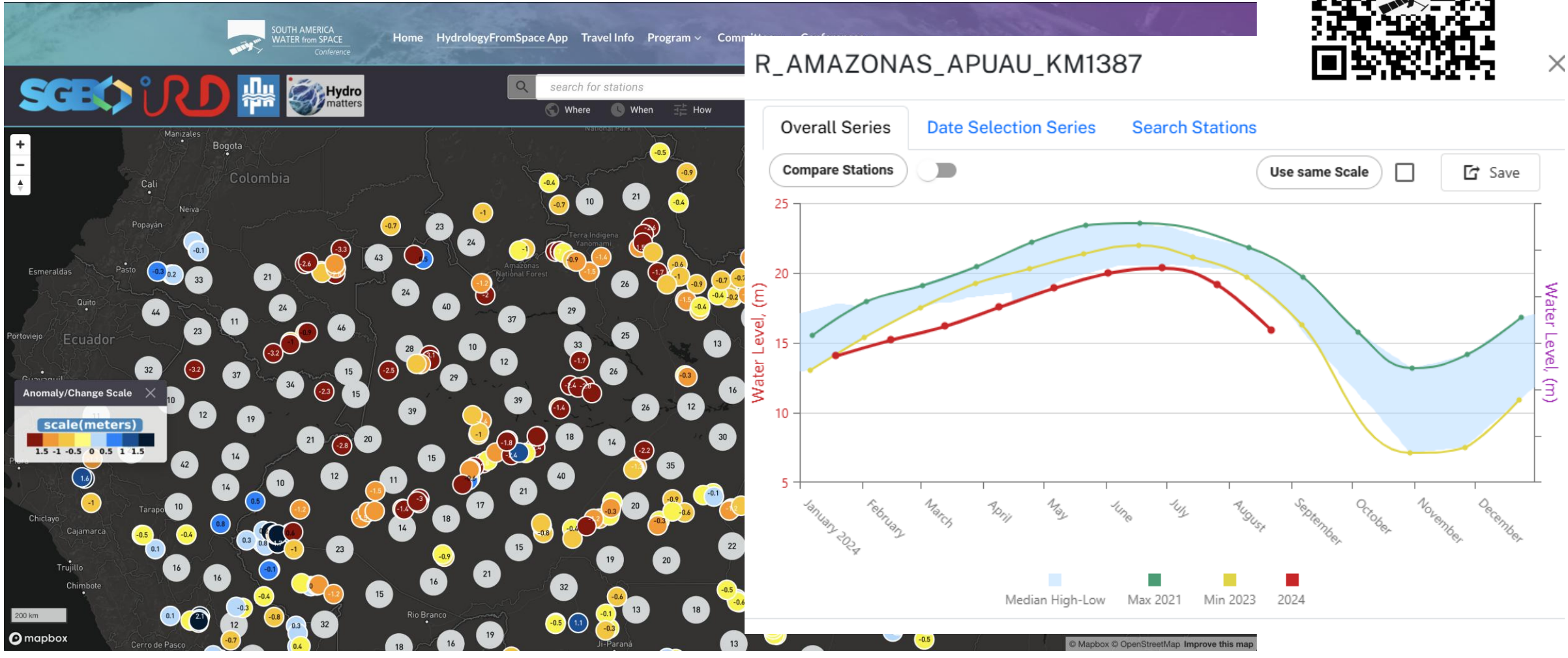
SWOT can observe 5 million kilometers of river networks and millions of reservoirs worldwide.



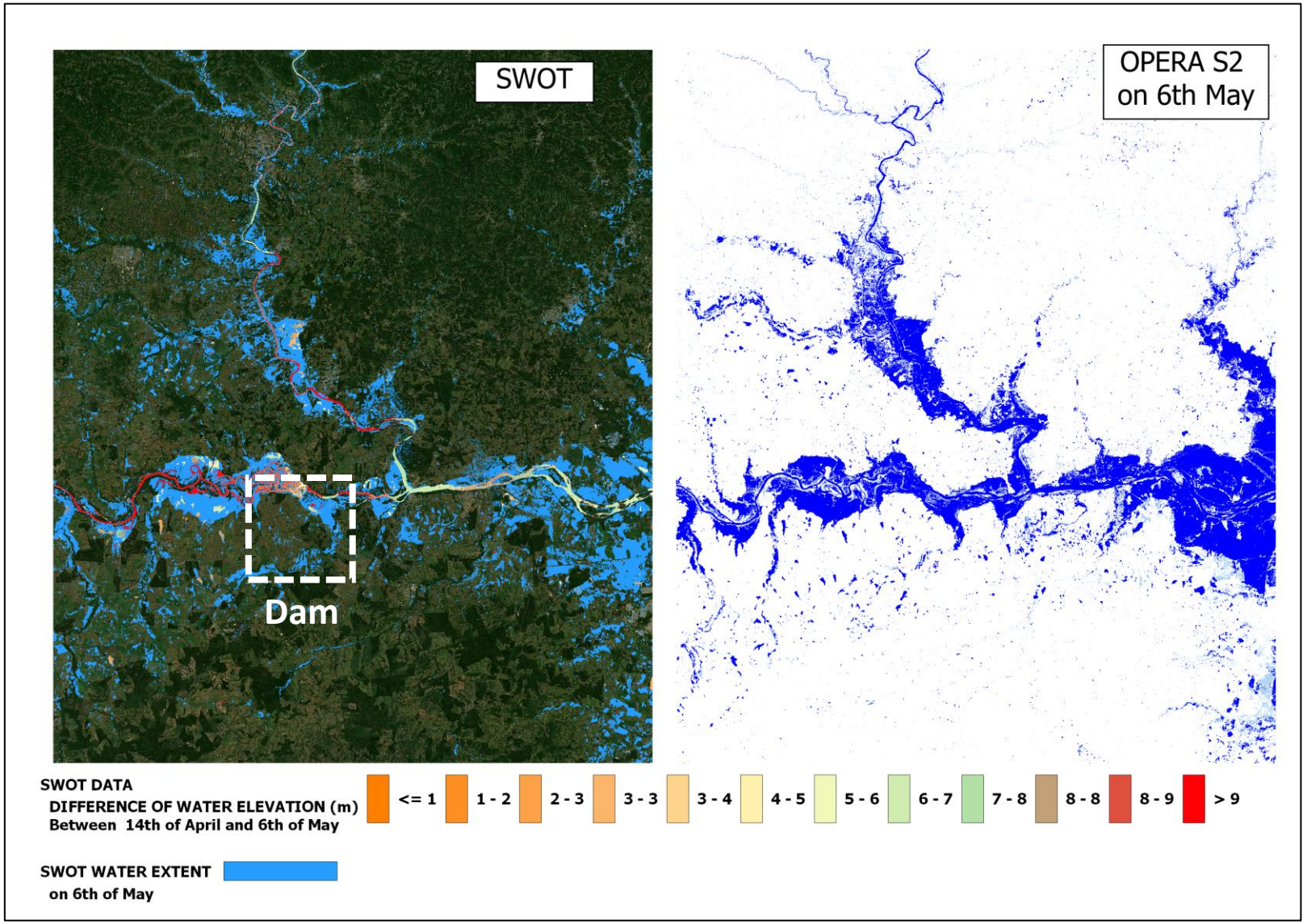
Moreira et Papa , in prep..

Through all these fruitful partnerships leads by IRD and SGB, we are able to provide important information to society, which we are already using in our warning systems to monitor the Amazon drought.

hydrologyfromspace.org : an augmented regional Hydroweb.next App for altimetry in the Amazon

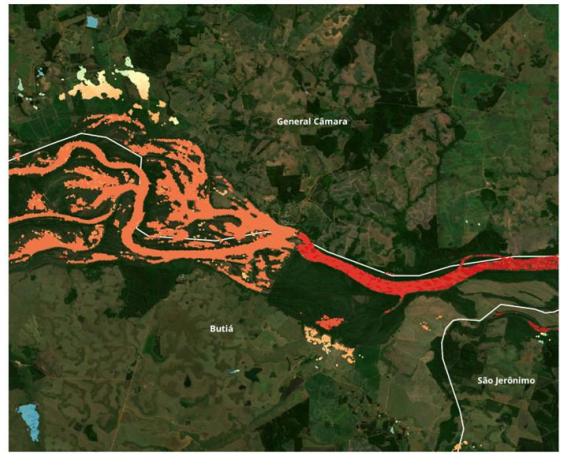


SWOT WAS ABLE TO SHOW THE AREAS IMPACTED BY THE FLOOD IN SOUTH OF BRAZIL



SWOT OBSERVED DAM OVERFLOW DURING THE FLOOD

14th of April 2024 (CYCLE 13)

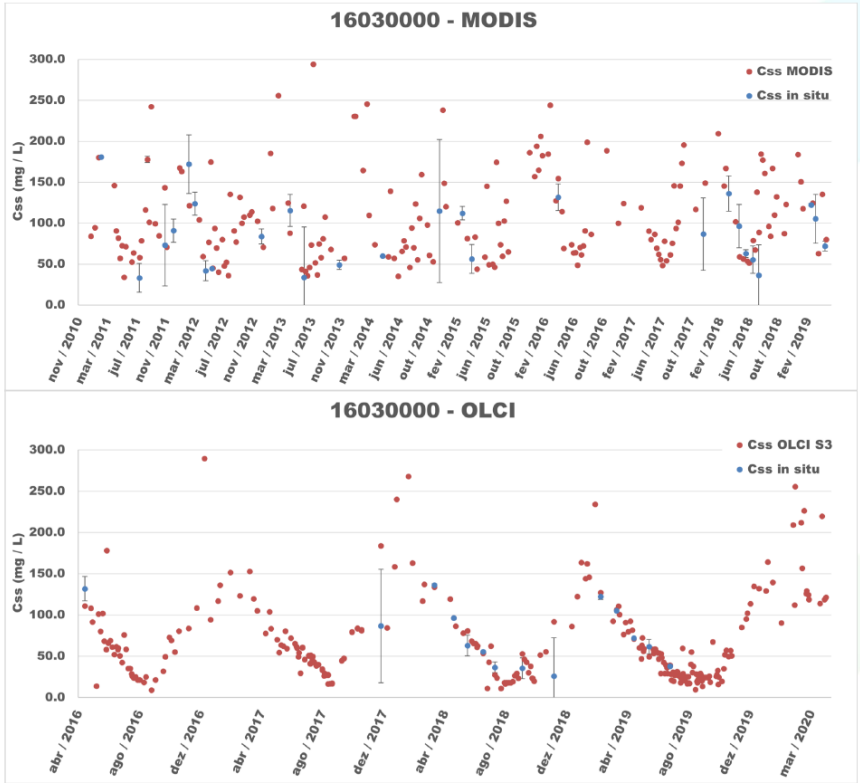


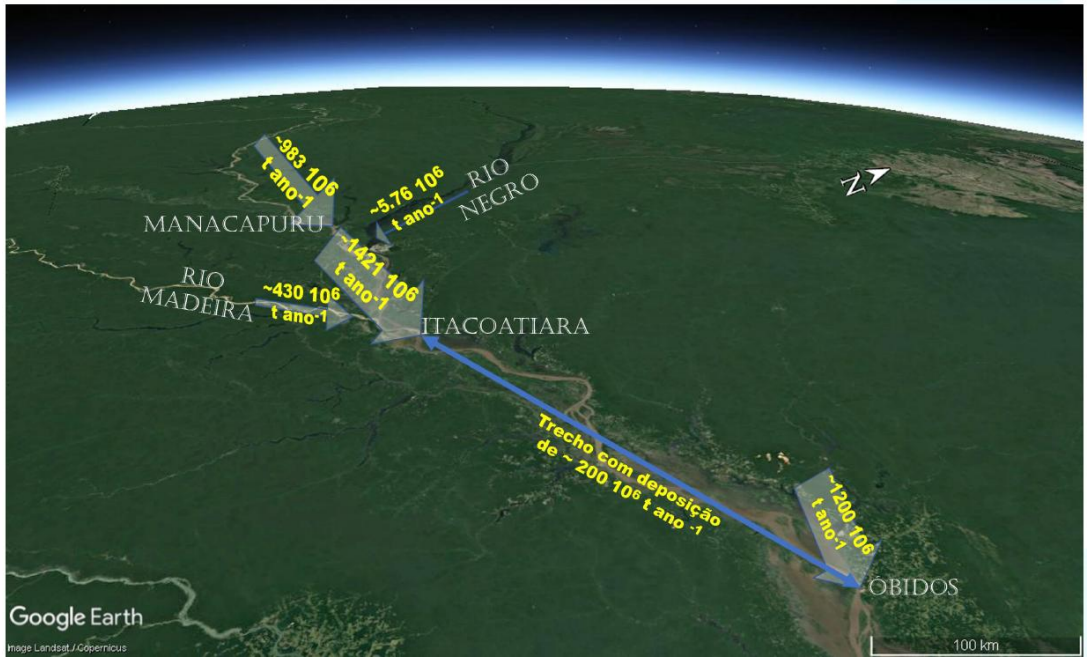
6th of May 2024 (CYCLE 14)

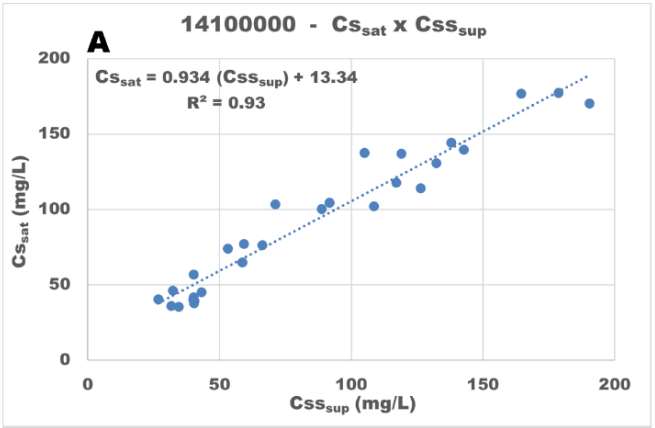
SWOT WSE (meters)

1 - 2 | 2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 10 - 11

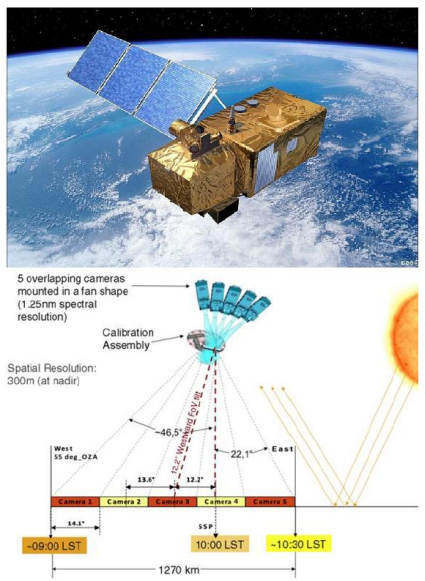
Sediment concentration time series







Possible adjustments and the importance of data validation with *in situ* information



X

Other remote sensing applications (Fleischmann et al., 2025). https://doi.org/10.1126/science.adr4029

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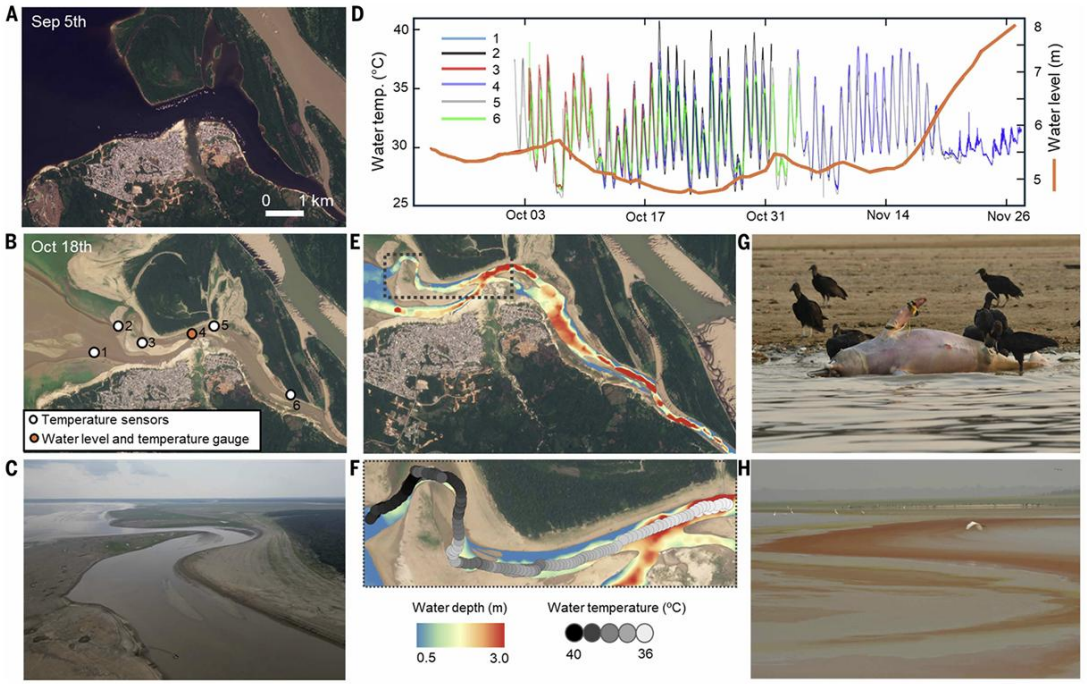
HOME > SCIENCE > VOL. 390, NO. 6773 > EXTREME WARMING OF AMAZON WATERS IN A CHANGING CLIMATE

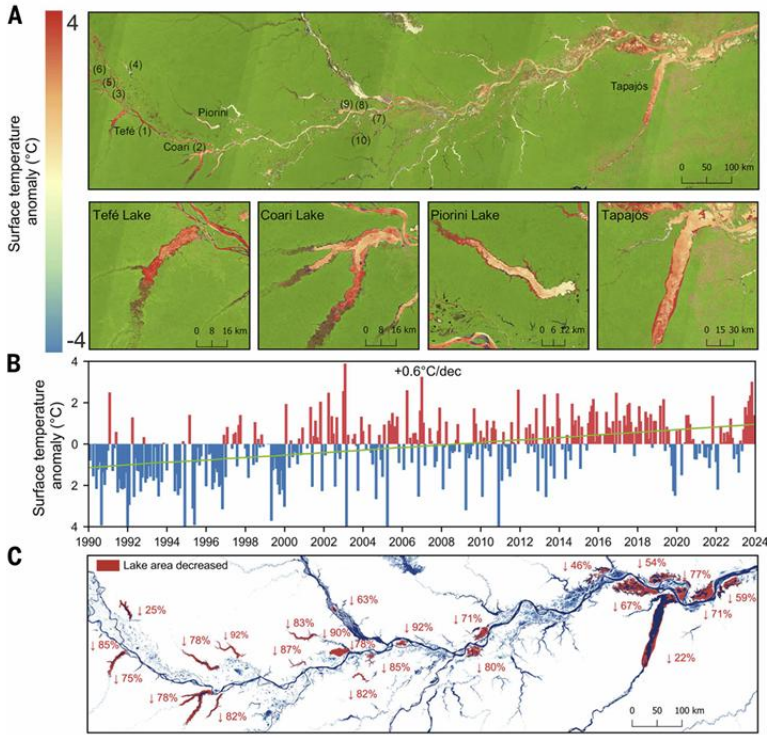
RESEARCH ARTICLE | CLIMATE IMPACTS

Extreme warming of Amazon waters in a changing climate

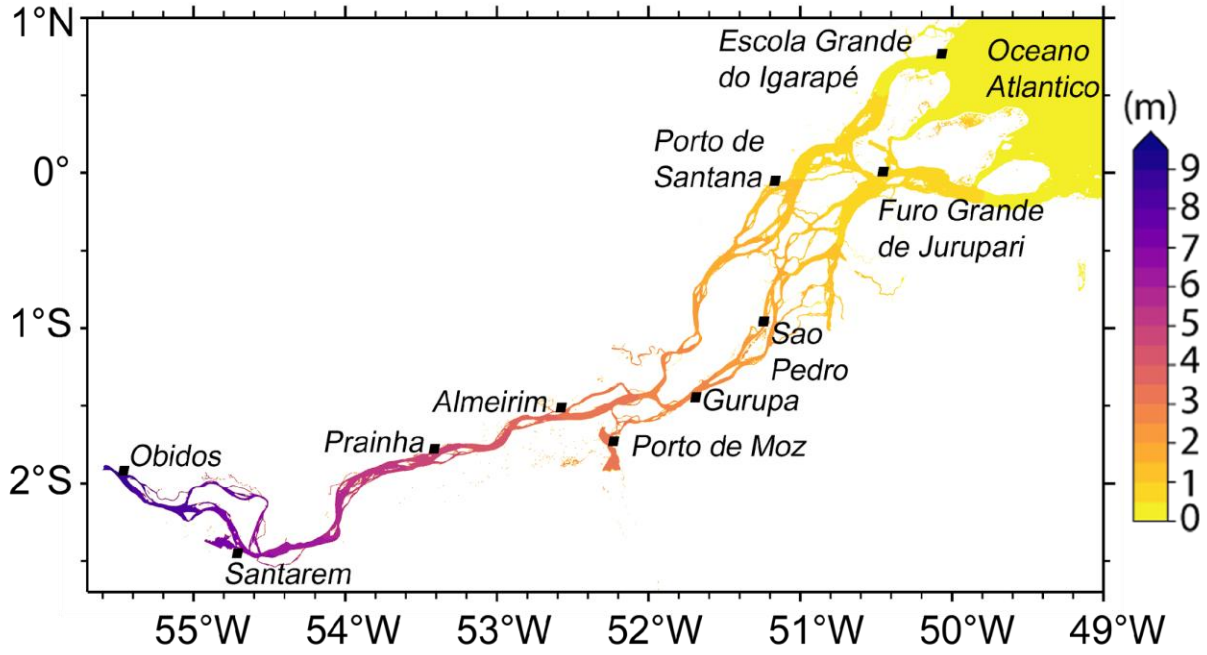
AYAN SANTOS FLEISCHMANN, FABRICE PAPA, STEPHEN K. HAMILTON, JOHN MELACK, BRUCE FORSBERG, ADALBERTO VAL, WALTER COLLISCHONN, LEONARDO LAIPELT, JÚLIA BRUSSO ROSSI, BRUNO COMINI DE ANDRADE, BRUNA MENDEL, PRISCILA ALVES, MAIBY BANDEIRA, LADY CUSTÓDIO, MARIA CECÍLIA GOMES, DÉBORA HYMANS, ISABELA KEPPE, RAIZE MENDES, RENAN NASCIMENTO, PAULA DOS SANTOS SILVA, CAMILA VIEIRA, RODRIGO XAVIER, ANDRÉ ZUMAK, ANDERSON RUHOFF, WENCAI ZHOU, SALLY MACINTYRE, EDUARDO G. MARTINS, NAZIANO FILIZOLA, ROGÉRIO MARINHO, EDNALDO BRAS SEVERO, MARIANA FRIAS, RENATA D. ALQUEZAR, LUCAS LAURETTO, WALESKA GRAVENA, ANDRÉ COELHO, HILDA CHÁVEZ-PÉREZ, SUSANA BRAZ-MOTA, MICHEL CHAMY, DANIEL MEDEIROS MOREIRA, LEANDRO GUEDES SANTOS, JOSÉ R. PACHECO PELEJA, AND MIRIAM MARMONTEL fewer Authors Info & Affiliations

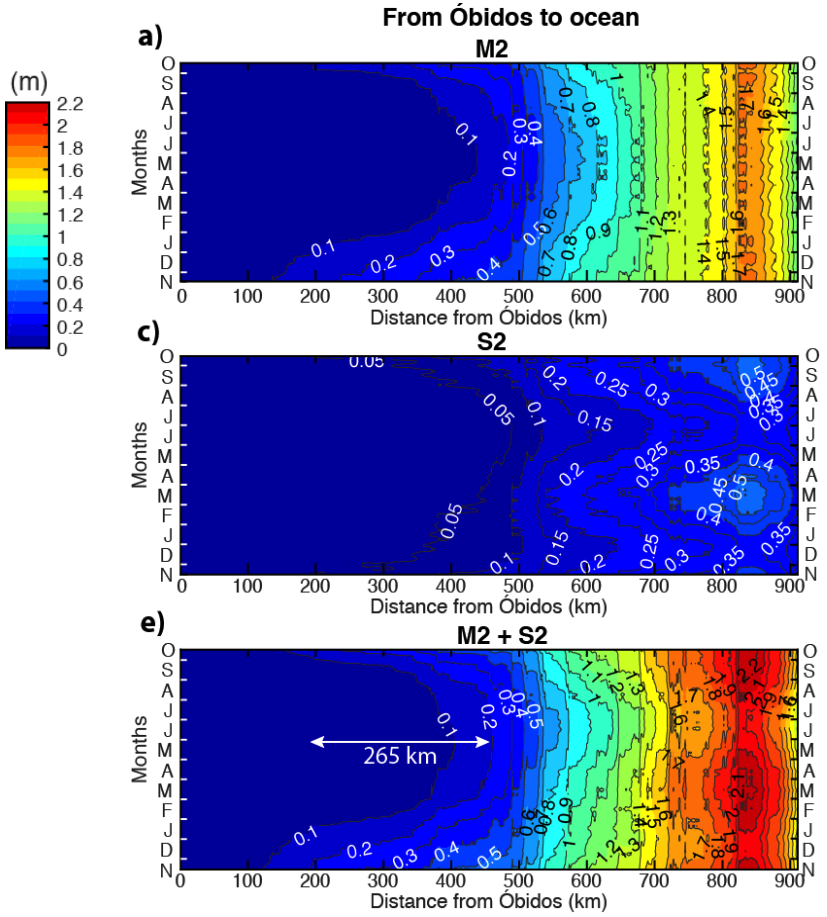
SCIENCE · 6 Nov 2025 · Vol 390, Issue 6773 · pp. 606-611 · DOI: 10.1126/science.adr4029





La modélisation haute résolution de l'estuaire du plus grand fleuve au monde révèle le rôle du climat dans la multiplication de crues extrêmes.





FASSONI-ANDRADE, ALICE CÉSAR ; DURAND, FABIEN ; AZEVEDO, ALBERTO ; BERTIN, XAVIER ; SANTOS, LEANDRO GUEDES ; KHAN, JAMAL UDDIN ; TESTUT, LAURENT ; MOREIRA, DANIEL MEDEIROS . Seasonal to interannual variability of the tide in the Amazon estuary. CONTINENTAL SHELF RESEARCH, , 2023

COULET, PAUL ; DURAND, FABIEN ; FASSONI-ANDRADE, ALICE ; KHAN, MD JAMAL UDDIN ; TESTUT, LAURENT ; TOUBLANC, FLORENCE ; SANTOS, LEANDRO GUEDES ; MOREIRA, DANIEL MEDEIROS ; AZEVEDO, ALBERTO . Dynamics of Yearly Maximum Water Levels in the Amazon Estuary. Estuaries and Coasts, 2025

COULET, PAUL ; DURAND, FABIEN ; FASSONI-ANDRADE, ALICE ; KHAN, JAMAL ; TESTUT, LAURENT ; TOUBLANC, FLORENCE ; SANTOS, LEANDRO GUEDES ; MOREIRA, DANIEL MEDEIROS . Assessment of the hydrodynamical signature of the record-breaking 2021 flood along the Amazon estuary. OCEAN MODELLING, 2025

NEGRO CAL/VAL SITE SURVEY FROM 06th to 18th of June - 2023

Team : Daniel Moreira, Fabrice Papa, Pauline Brossat, Jefferson Melo, Ricardo Oliveira, Robson Azevedo, Daniel Garcia, Malika, Arthur Abreu, Taina Conchy, Jacques Verron, Marquinho, Fábio Viveros, Ramos.

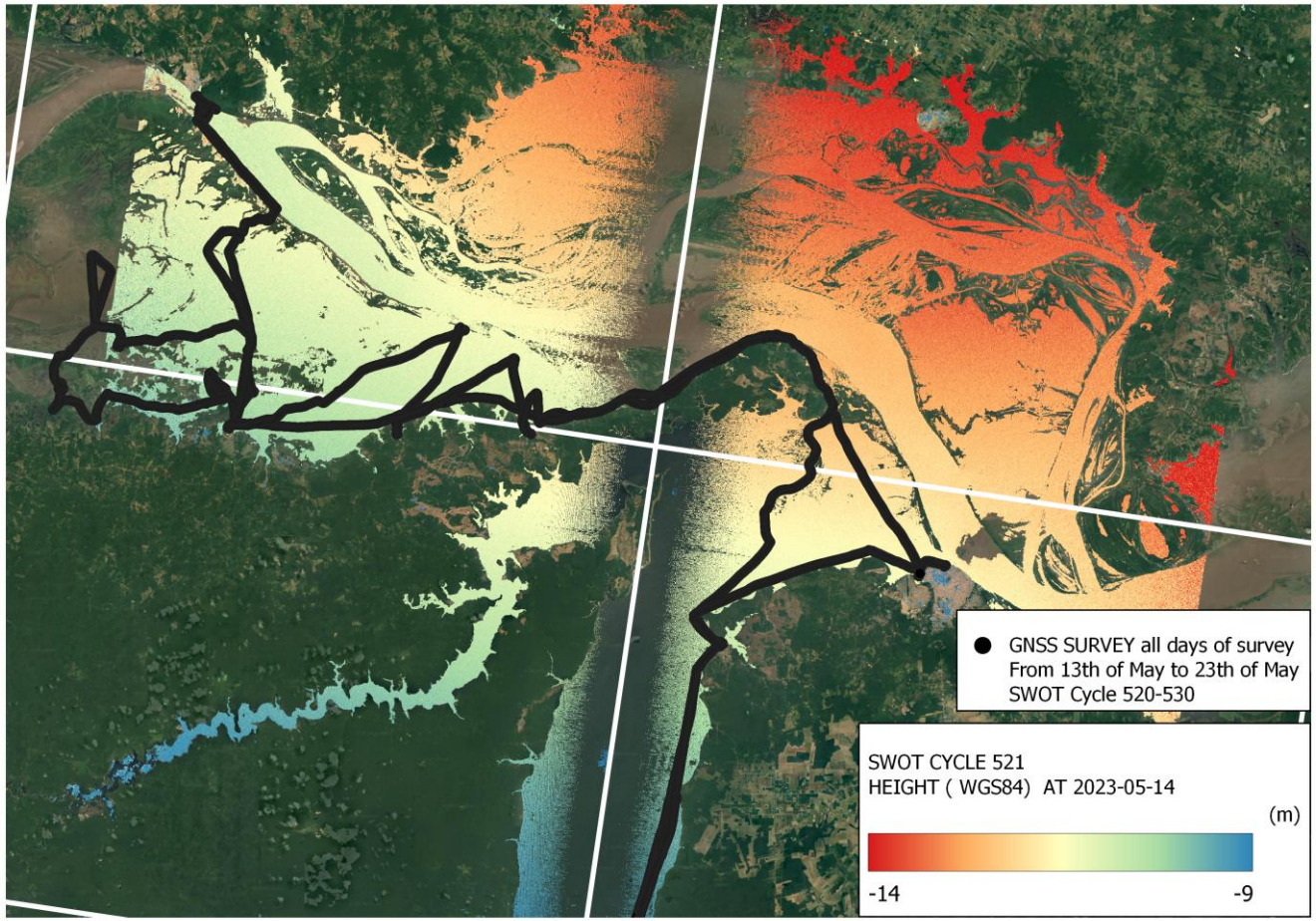
WATER SURFACE ELEVATION (EGM08) in meters

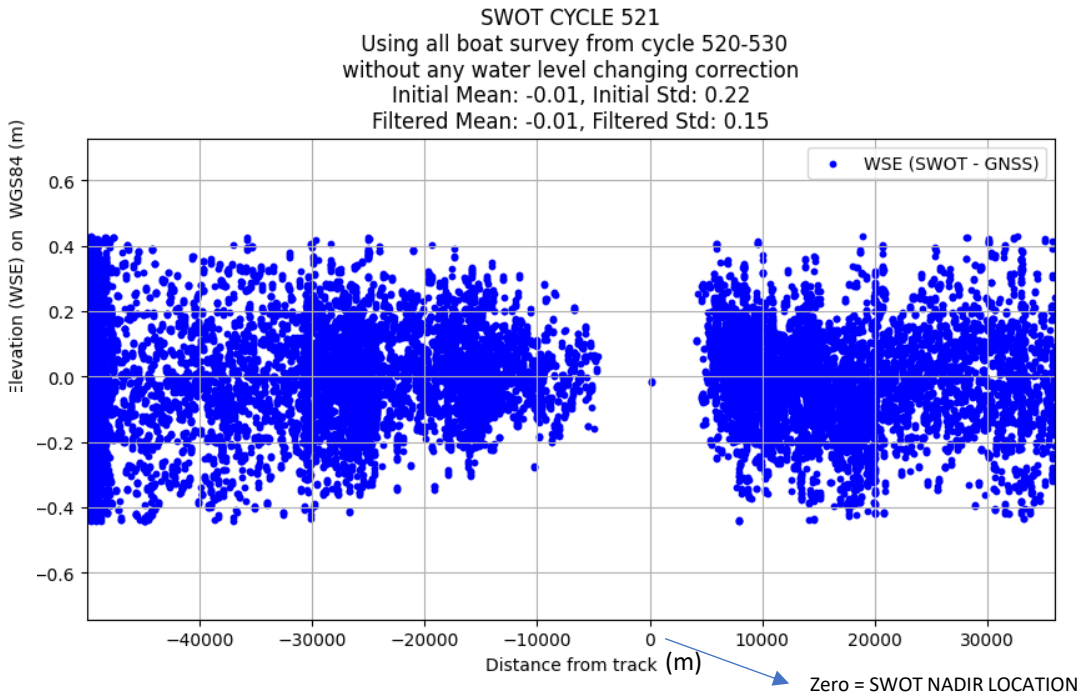
56.1 - 58.3 | 58.3 - 60.4 | 60.4 - 62.6 | 62.6 - 64.7 | 64.7 - 66.9 | 66.9 - 69 | 69 - 71.2 | 71.2 - 73.3 | 73.3 - 75.4 | 75.4 - 77.6

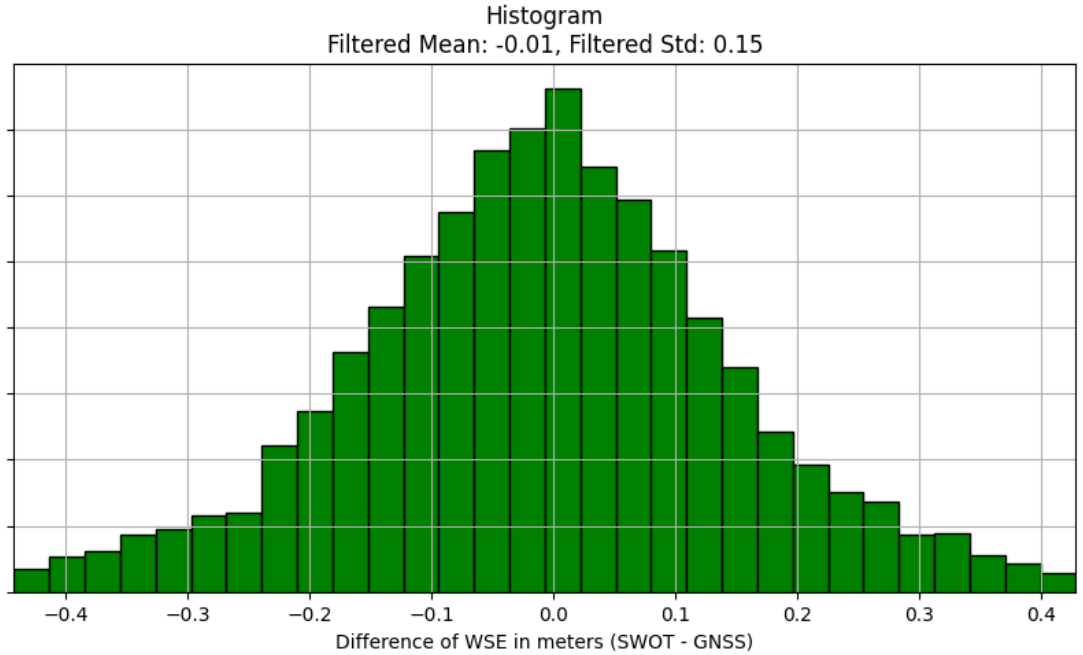
WITH SMALL WATER LEVEL CHANGES (~4cm)
during CAL/VAL SURVEY

We obtain very promising results for the entire survey coverage using SWOT CYCLE 521

(even if we don't correct this 4 cm of raise of water level)

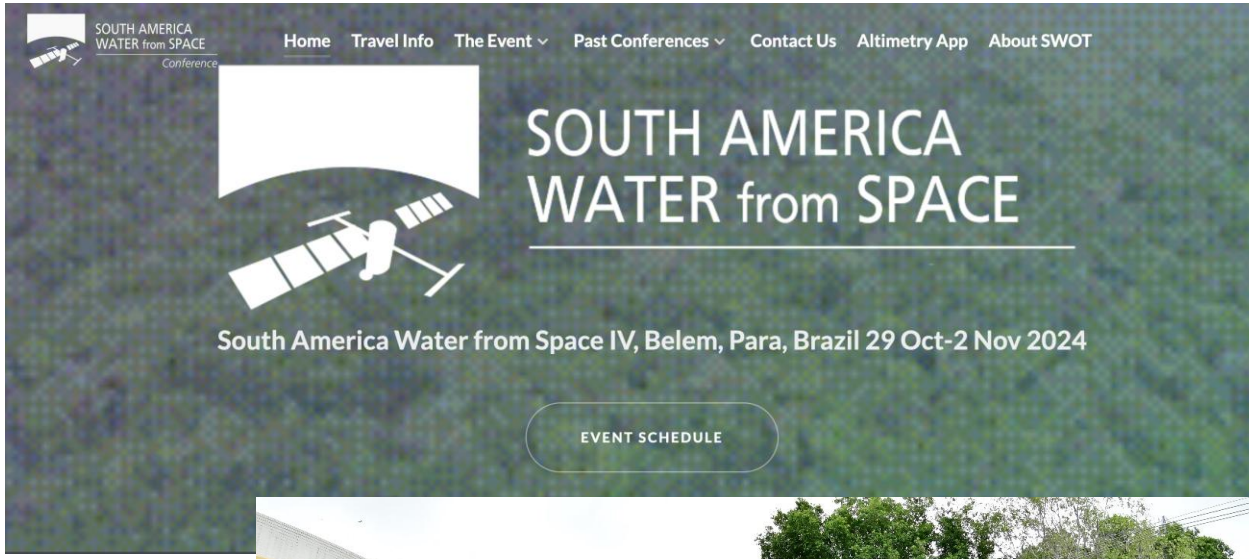






From the last two decades IRD and SGB deeply worked for validation , research , development and application of remote sensing technologies for hydrology monitoring.

www.hydrologyfromspace.org



Creating a network of many institutions focused on validation, development and capacity building for use hydrology from space technologies.

SERVIÇO GEOLÓGICO DO BRASIL | COP 30

Difundindo Geociências para um Futuro Climático Seguro

OBRIGADO

daniel.moreira@sgb.gov.br

SERVIÇO GEOLÓGICO DO BRASIL

MINISTÉRIO DE MINAS E ENERGIA

GOVERNO DO BRASIL
DO LADO DO POVO BRASILEIRO