



SWOT Observations

Advanced River Hydrology & Flood Event Assessment

River Experiment Initiative (RivEx) Webinar Series
<https://www.gewex.org/river-experiment-initiative/>

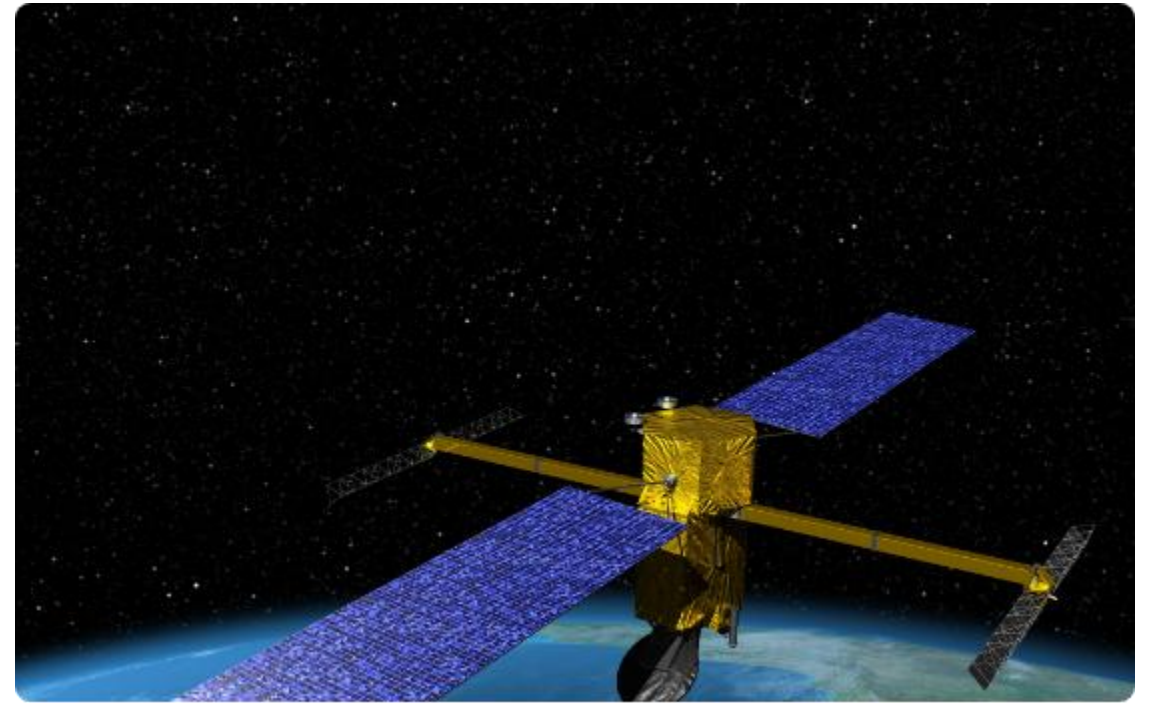
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July 07, 2026

Mission Overview: SWOT

The Surface Water and Ocean Topography (SWOT) mission is a joint NASA/CNES endeavor, providing the first global survey of Earth's fresh water.

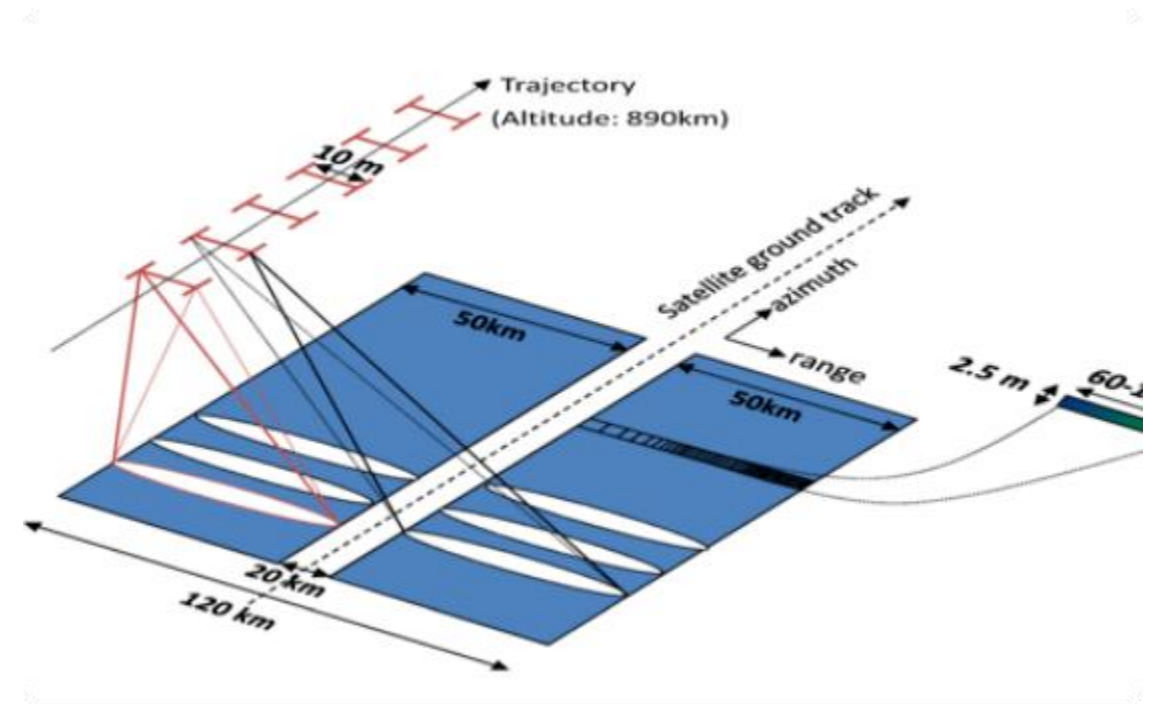
- **Freshwater Mapping:** Unprecedented view of water storage changes.
- **Climate Resilience:** Monitoring impacts of climate change on hydrology.
- **Global Coverage:** Observes nearly all rivers >100m wide and lakes >15 acres.
- **RivEx Synergy:** Providing critical observation data for local river modeling.



Ka-band Radar Interferometry (KaRIn)

The KaRIn instrument enables wide-swath altimetry, a leap in hydrological technology.

- **Wide Swath:** Two 50km wide swaths provide 120km of cross-track coverage.
- **High Resolution:** Captures elevation and water surface width simultaneously.
- **Frequency:** Re-visits sites every 21 days for detailed time-series monitoring.
- **Spatial Accuracy:** Decimeter-level height precision.



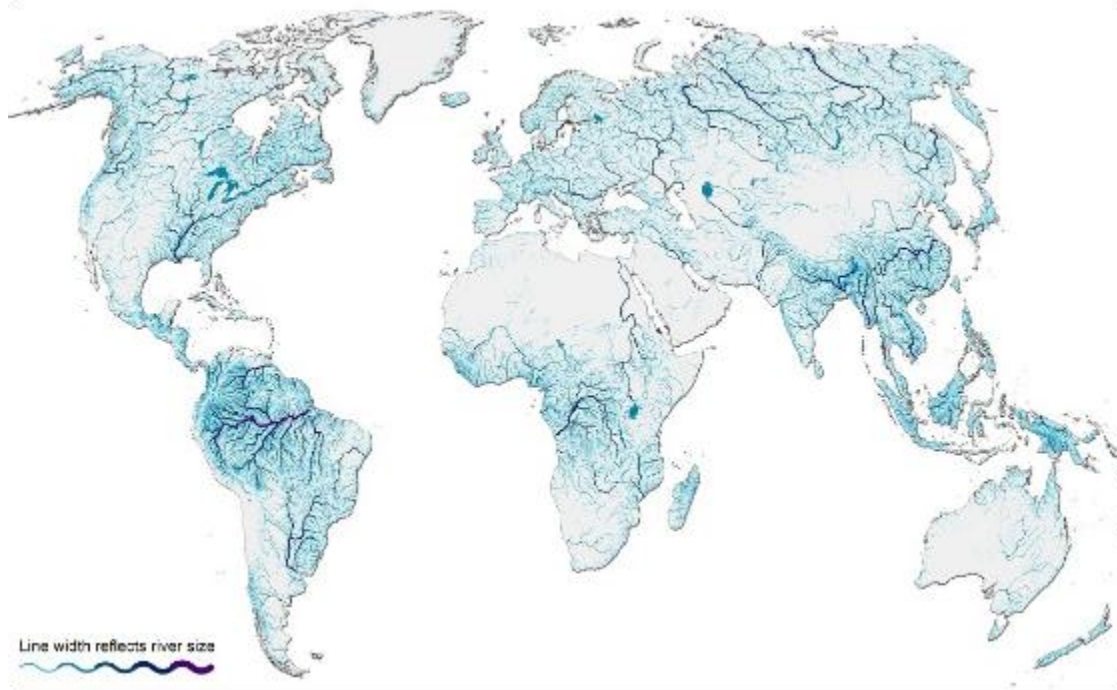
Hydrological Measurement

$$Q = \frac{1}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

SWOT measures Water Surface Elevation (WSE) and width (W). Using these, we calculate discharge (Q) via Manning's equation:

- **n:** Roughness coefficient (estimated from channel morphology).
- **A:** Cross-sectional area (inferred from SWOT width/elevation data).
- **R:** Hydraulic radius.
- **S:** Water surface slope, derived from SWOT long-track elevation changes.

RivEx & Data Integration



Integrating SWOT observations into global hydrodynamic models is a core RivEx goal:

- **Assimilation:** Using SWOT reaches to update model state/output. Soman, M. K., Indu, J., & Karmakar, S. (2026). Assimilation of SWOT reach water surface elevation product toward enhanced basin-scale discharge modeling. *Earth and Space Science*, 13, e2025EA004527. <https://doi.org/10.1029/2025EA004527>
- **Calibration:** Calibrating channel roughness & bathymetry parameters Larnier, K., Garambois, P.-A., Emery, C., Pujol, L., Monnier, J., Gal, L., et al. (2025). Estimating channel parameters and discharge at river network scale using hydrological-hydraulic models, SWOT and multi-satellite data. *Water Resources Research*, 61, e2024WR038455. <https://doi.org/10.1029/2024WR038455>.
Youtong Rong, Paul Bates, Jeff Neal, Yanchen Zheng, Jiangchao Qiu, 2026. Advancing river bathymetry mapping through physics-informed neural networks and SWOT satellite observations, *Remote Sensing of Environment*, Volume 342, 115481, <https://doi.org/10.1016/j.rse.2026.115481>.
- **Validation:** Using local gauging station & other data to cross-check satellite signals. L. Yu, H. Zhang, W. Gong and X. Ma, "Validation of Mainland Water Level Elevation Products From SWOT Satellite," in *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 17, pp. 13494-13505, 2024, doi: 10.1109/JSTARS.2024.3435363.
- **Community Tooling:** Providing standard API access to River-Reach data products.

Flood Event Dynamics

SWOT provides high-frequency monitoring for dynamic flood events:

- **Inundation Mapping:** Detecting spatial extent of extreme flood pulses.
Atul Kumar Rai *et al* 2026 SWOT satellite assessment for monitoring the extreme 2025 floods in Australia's inland Channel Country. *Environ. Res. Lett.* 21 064013DOI 10.1088/1748-9326/ae530f
- **Wave Propagation:** Capturing the velocity of flood waves downstream.
Thurman, H. R., Allen, G. H., Williams, B. A., Cerbelaud, A., & David, C. H. (2025). SWOT captures hydrologic waves traveling down rivers. *Geophysical Research Letters*, 52, e2024GL113875. <https://doi.org/10.1029/2024GL113875>
- **Preparedness & Response:** Informing early warning & flood forecasting/assessment systems to minimize disaster impacts.
Mzoughi, A., Trudel, M., Biron, P. M., Choné, G., and Siles, G. L.: Assessment of SWOT water surface elevations for flood monitoring of a narrow river (< 50 m width), *Hydrol. Earth Syst. Sci.*, 30, 4141–4155, <https://doi.org/10.5194/hess-30-4141-2026>, 2026.
- **Synergy:** Fusing optical/SAR imagery with SWOT height measurements for a 3D flood view.
Zhan, P., Wang, J., Chen, T., Luo, S., Liu, K., Ke, L., et al. (2026). Integrating SWOT with multi-source satellite observations for near-daily reservoir water level monitoring. *Water Resources Research*, 62, e2024WR039711. <https://doi.org/10.1029/2024WR039711>



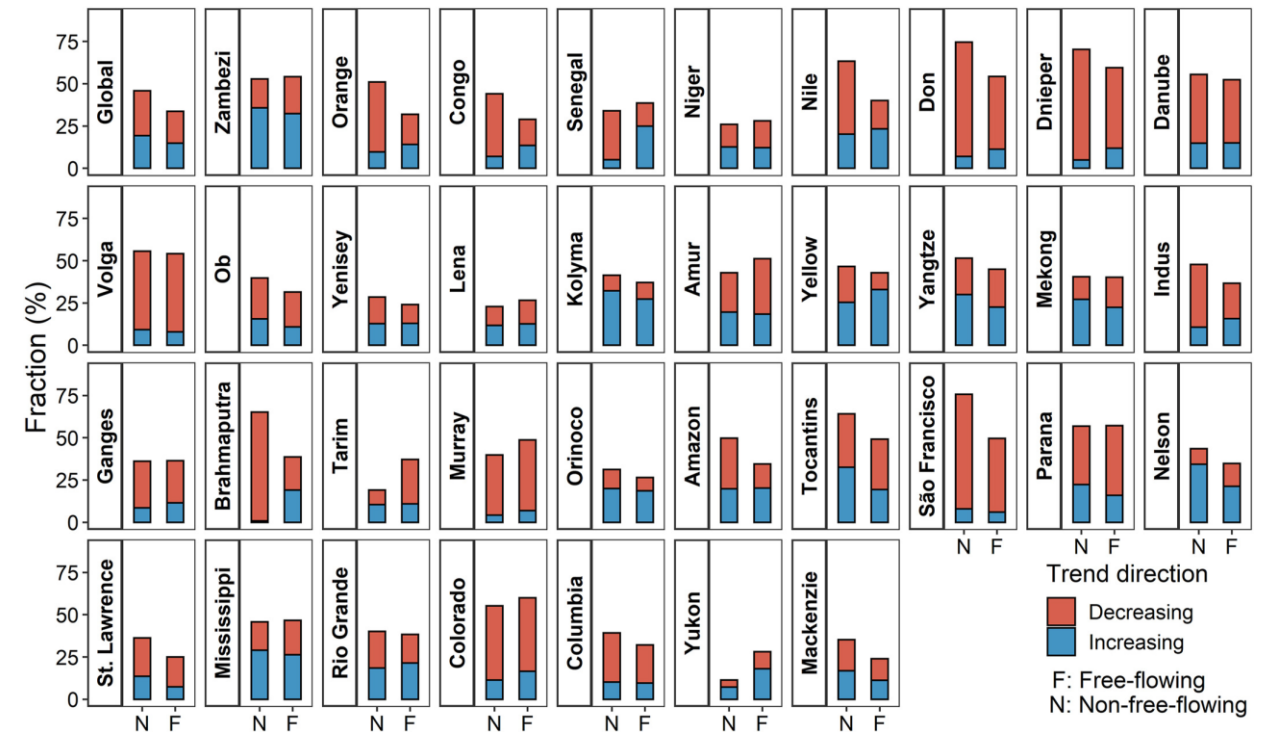
Key Monitoring Statistics

Water Feature	Target Count	Resolution
Global Rivers (>100m)	~93,000 miles	Very High
Lakes & Reservoirs (>15ac)	~460,000 features	High
Data Revisit Cycle	21 Days	Consistent

SWOT dramatically expands our global inland water observatory network.

Challenges & Processing

- Sensor Noise:** Processing KaRIn data requires sophisticated noise reduction algorithms.
Tréboutte, A.; Carli, E.; Ballarotta, M.; Carpentier, B.; Faugère, Y.; Dibarboure, G. KaRIn Noise Reduction Using a Convolutional Neural Network for the SWOT Ocean Products. *Remote Sens.* **2023**, *15*, 2183. <https://doi.org/10.3390/rs15082183>
- Latency Requirements:** Implementing the <90-day latency targets for rapid product release.
<https://www.aviso.altimetry.fr/en/missions/current-missions/swot/swot-level-3-version-30-reprocessing-shorter-latency.html>
- Anthropogenic Influences:** Differentiating natural flow variability from human-made diversions (dam/irrigation management).
Feng, D., Gleason, C. J., Yang, X., Allen, G. H., & Pavelsky, T. M. (2022). How have global river widths changed over time? *Water Resources Research*, 58, e2021WR031712. <https://doi.org/10.1029/2021WR031712>
 - Used Landsat for width changes over time. Could this be done with only a few years of SWOT observations? See amazing video for global flow variations at the end of this presentation!
- Data Volume:** Managing the petabyte-scale influx of satellite data products.



RivEx & SWOT Synergy

RivEx provides a framework for multi-institutional data usage:

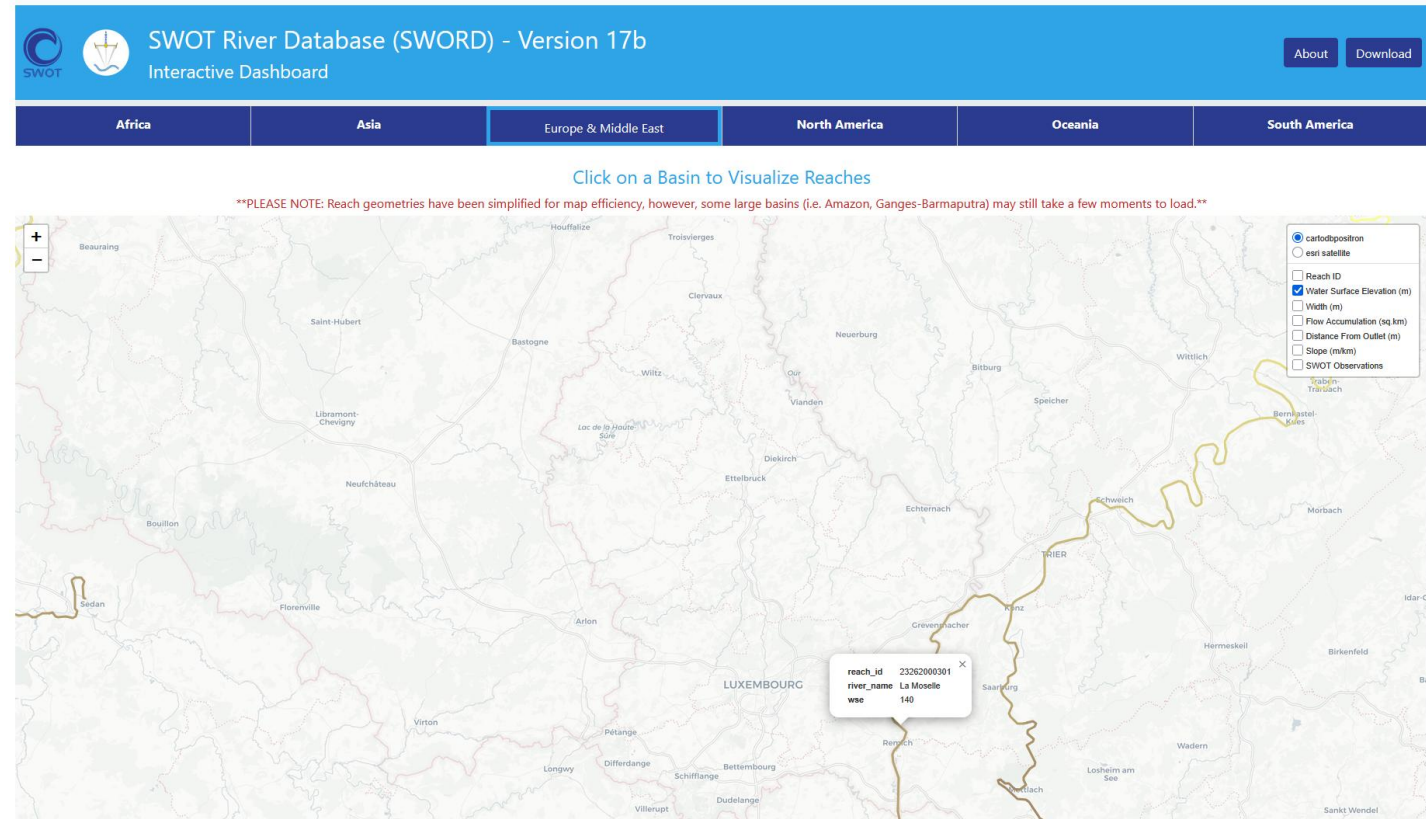
1. **Benchmark Datasets:** Curating "golden-reach" reaches for model validation.
2. **Knowledge Transfer:** Training the community on satellite-derived hydrology tools.
3. **Human-Influence:** Collaborative projects to isolate human management from natural hydrological signals.
4. **Open Science:** Advocating for transparent, shareable data formats across borders.

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SWOT Data Discovery & Access

Access processed SWOT observables via these primary portals:

- **NASA PO.DAAC:** The official archive for SWOT L2 and L3 hydrologic data products, offering comprehensive metadata.
- **CNES AVISO+:** Centralized access for mission-critical altimetry data and collaborative hydro-products for European users.
- **NASA Earthdata Search:** A unified discovery portal for finding, subsetting, and downloading specific Earth observation data collections.
- **Community Tools:** Various API-integrated platforms and "RivEx"? community repositories for streamlined reach-level data extraction:
 - <https://dahiti.dgfi.tum.de/en/>
 - <https://www.swordexplorer.com/>



Future Research Prospects

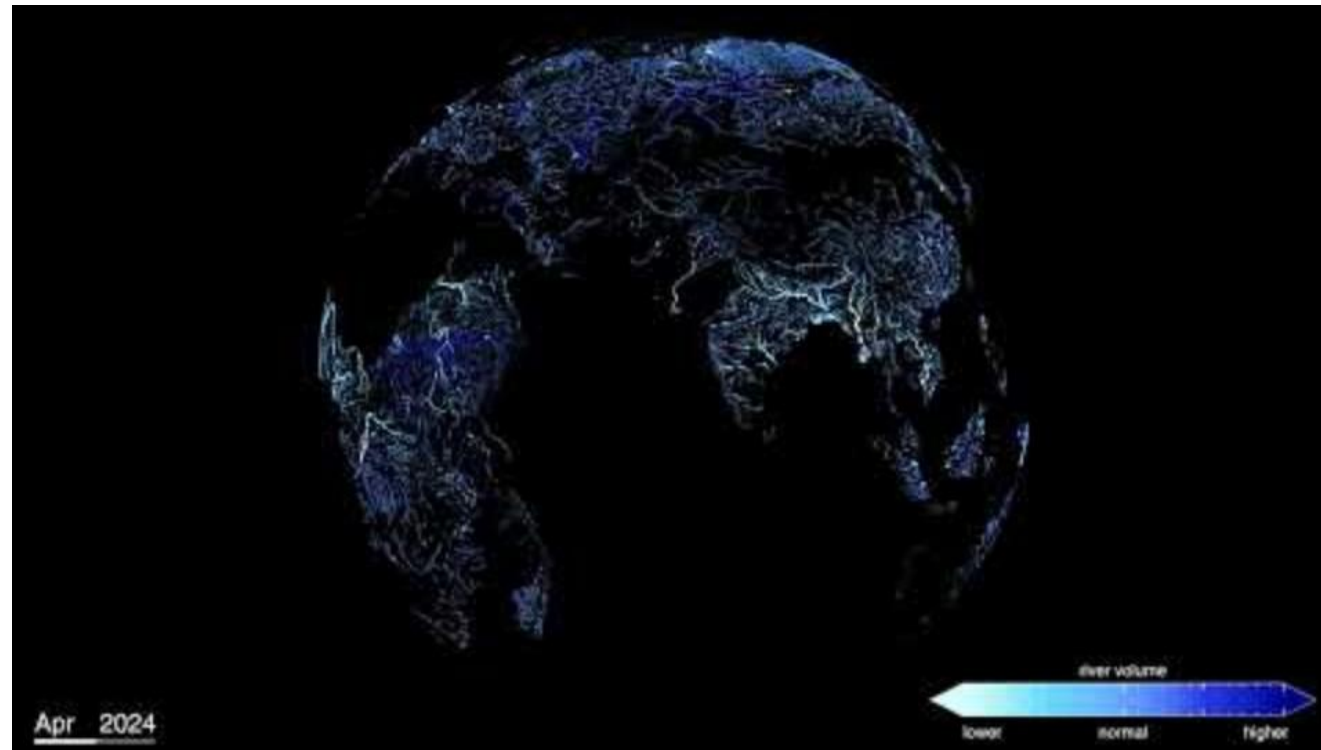
- **Hydrodynamic Models:** Using SWOT data for global-scale calibration of Manning's coefficients.
- **Flood Warning:** Automating flood rapid-response routines.
- **Water Security:** Providing data to transboundary river commissions for better water management.
- **Next-Gen SAR Integration:** Combining SWOT with future NISAR data for even greater temporal density.
- **SMASH:** "Small Satellites for Hydrology" concept is a proposed constellation of nanosatellites, designed to provide daily measurements of water levels on Earth's rivers and lakes.
https://cnes.fr/sites/default/files/2024-08/03_TOSCA_BILAN_GT_SURFACES_CONTINENTALES.pdf
<https://bwi.earth/constellation-of-altimetric-nanosatellites/>
- The SMASH mission concept has evolved into a new commercial-public partnership. The French space agency (CNES) selected Blue Water Intelligence (BWI) to develop this daily hydrology constellation, now named **REVALTO**. BWI and partners are building the initial satellites.
<https://bwi.earth/h2r-revalto-satellite-hydrology/>

Presentation Summary

The SWOT mission represents the new gold standard for global hydrology.

By leveraging the RivEx community's expertise in modeling and data assimilation, we can transform these high-resolution satellite measurements into actionable insights for climate adaptation and flood mitigation.

The next decade of surface water research starts here.



[SWOT River Volume Variations \(rivers only\)](#)

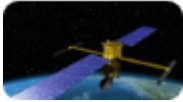
Questions & Discussion

Thank you for your attention and engagement.

RivEx Webinar Series

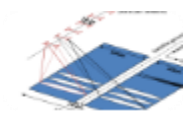
<https://www.gewex.org/river-experiment-initiative/>

Image Sources



https://swot.jpl.nasa.gov/rails/active_storage/blobs/redirect/eyJfcmlFpbHMiOmsibWVzc2FnZSI6IkJBaHBaUT09liwiZXhwIjpudWxsLCJwdXliOiJibG9iX2lkIn19--521146b72491b10fe4b7e4d3bca6bceb8a41cc51/gal_26.jpg

Source: swot.jpl.nasa.gov



https://www.aviso.altimetry.fr/fileadmin/_processed_/e/6/csm_swot-swath-px_cc3272203e.png

Source: www.aviso.altimetry.fr



https://cdn.prod.website-files.com/5f45ccc2b5b5183eda63de16/60871ef6aa1496df2692519c_HydroRIVERS_Figure_sm2.jpg

Source: www.confluvio.com



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Source: www.floodmapp.com