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NASA Summer School

Topic: Human Influences on the Water Cycle

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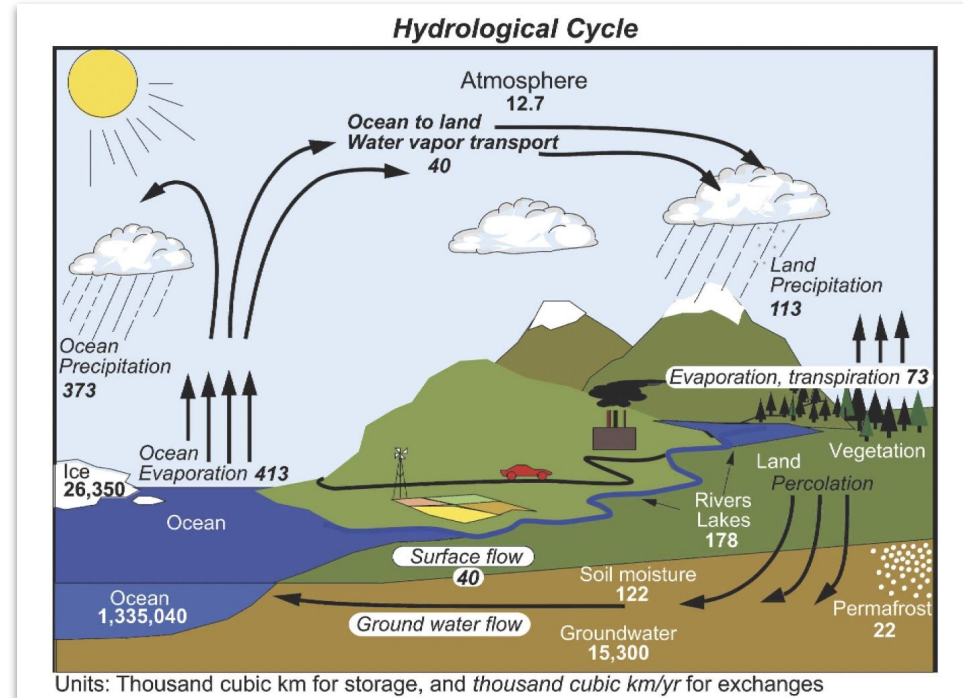
*5 August 2024
NASA Summer School*

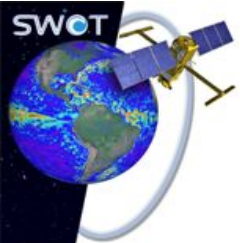


Credit: NASA Blue Marble

Observing the Water Cycle is not Easy

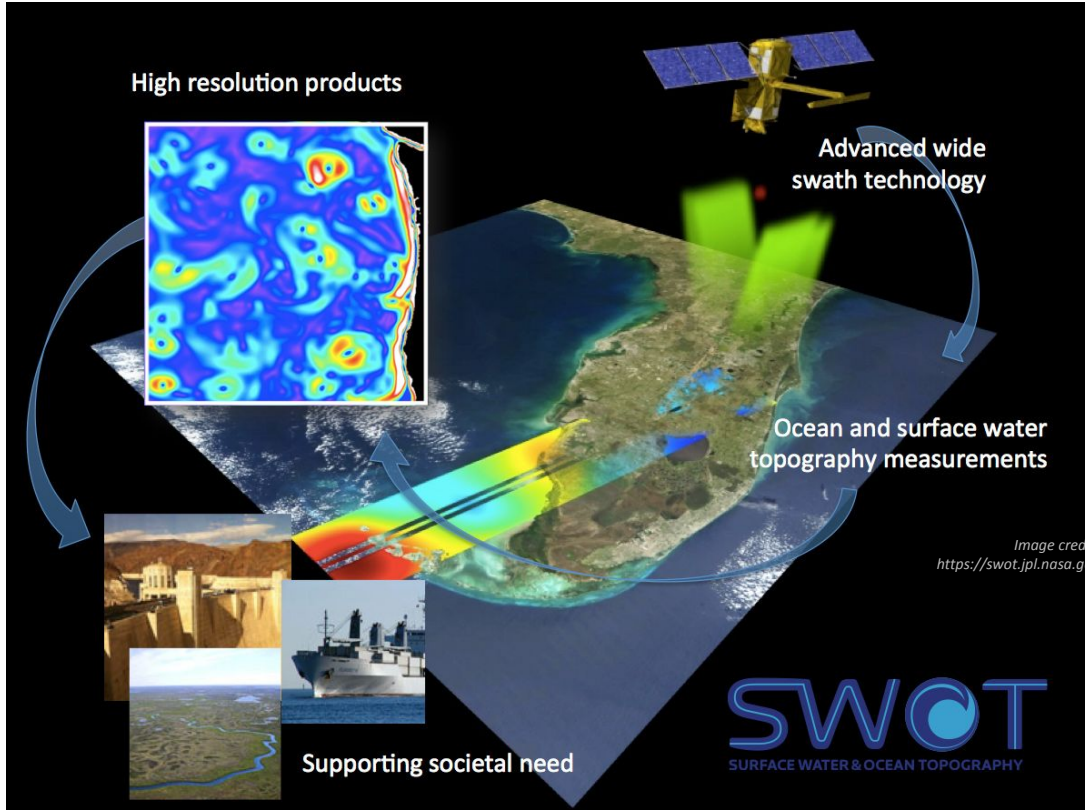
- So many systems and variables, too few observations
- Observations are highly variable in space and time
- Our understanding of the global water cycle portrays a stable and unchanging system
 - **Humans change things!**
- Remote sensing can add puzzle pieces to the equation





Surface Water and Ocean Topography (SWOT) Mission

SWOT measures global **ocean** surface topography and **land surface water** extents & elevation with great accuracy using interferometry.



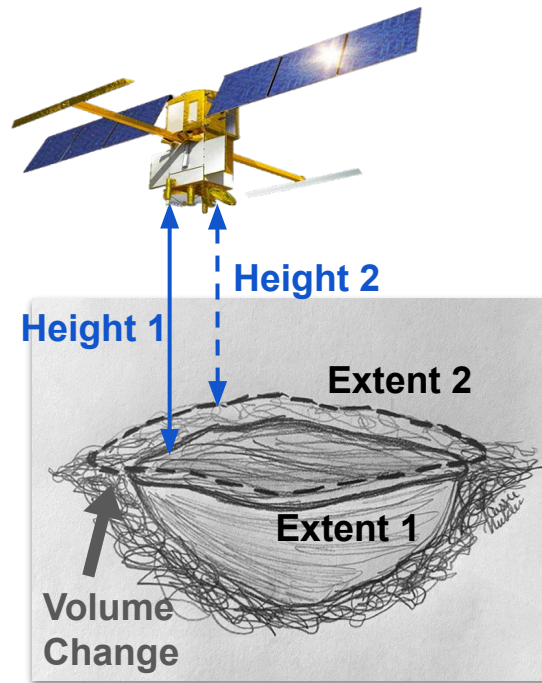
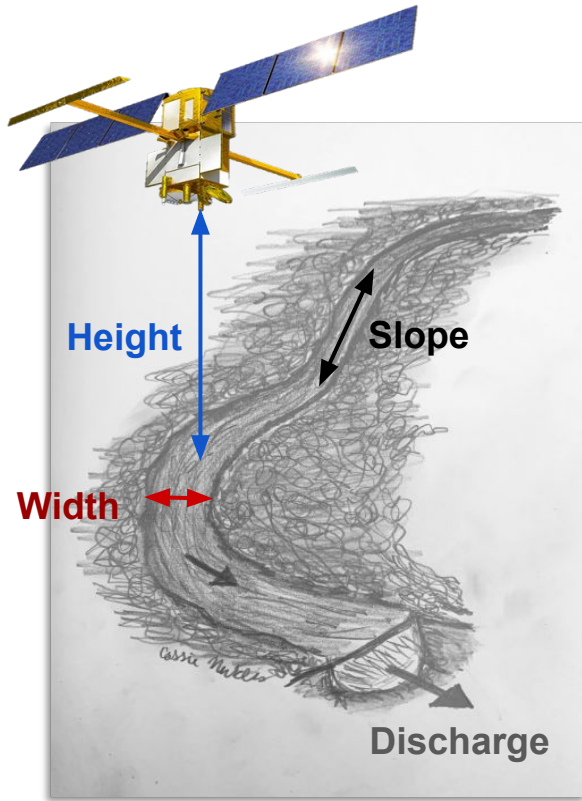
SWOT
Launched
Dec 2022!

21-day orbit
cycle (average
2 observations
per cycle)

78 N/S
coverage

<https://swot.jpl.nasa.gov/>

SWOT Hydrology Measurements



Requirements:
Rivers > 100 m wide
Lakes > 250 m²

Future Derived Products:

- River flow (i.e. discharge)
- Lake/reservoir volume change

Check your Assumptions!

- The last paper of my PhD
- Drainage area assumption without including human influence
- Results were not what I expected → I had to pivot

Leveraging River Network Topology and Regionalization to Expand SWOT-Derived River Discharge Time Series in the Mississippi River Basin

by Cassandra Nickles ^{1,*}   and Edward Beighley ^{1,2} 

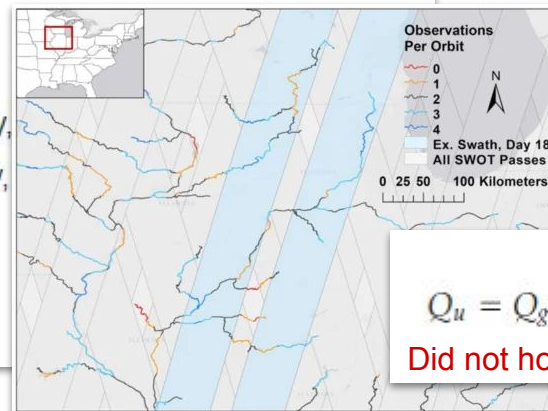
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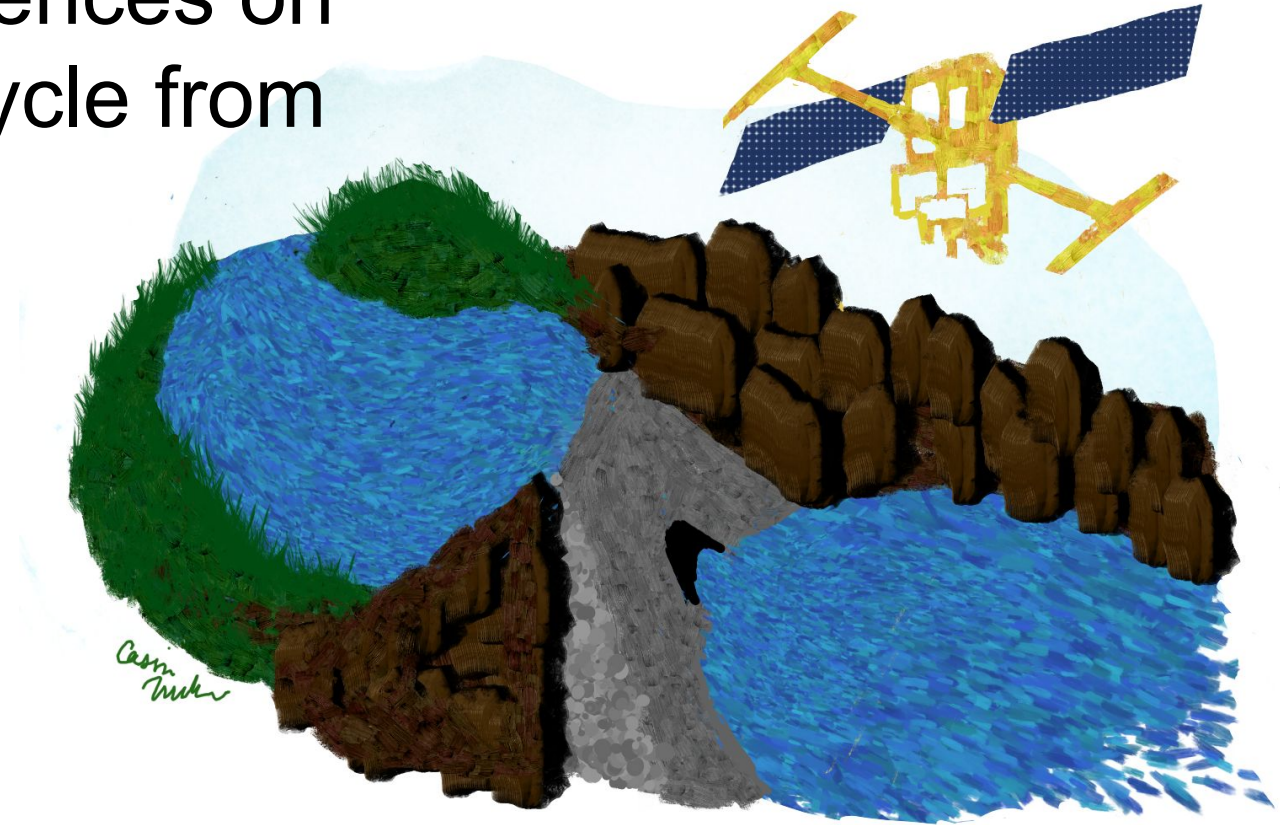
* Author to whom correspondence should be addressed.

Remote Sens. **2021**, *13*(8), 1590; <https://doi.org/10.3390/rs13081590>

<https://www.mdpi.com/2072-4292/13/8/1590>

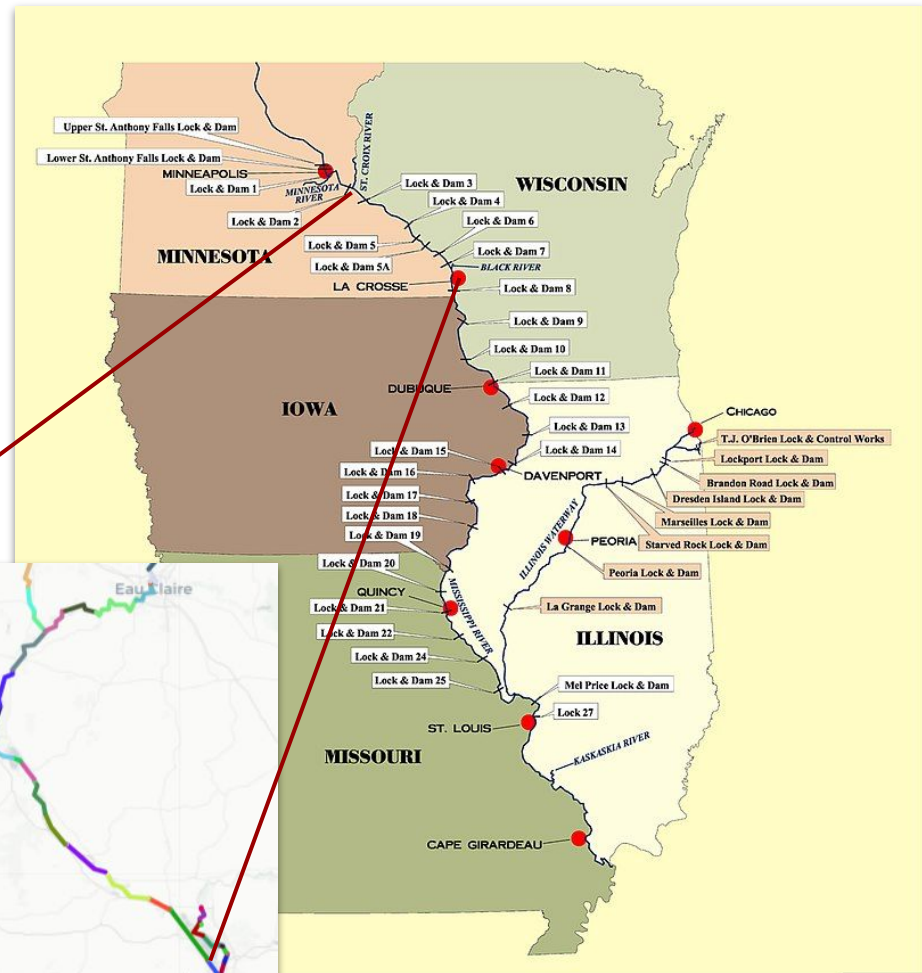
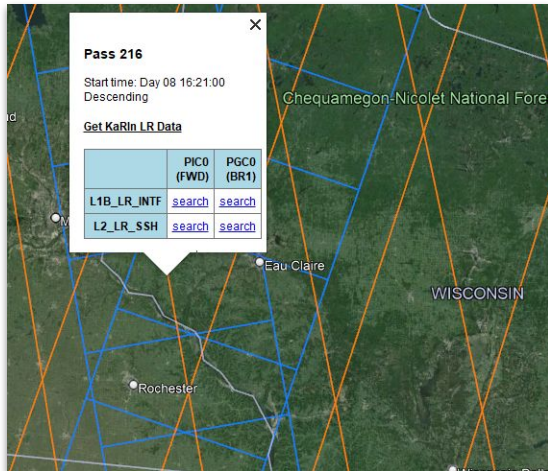


Topic: Observing Human Influences on the Water Cycle from SWOT Data



Man-made Infrastructure in Rivers: Locks, Dams, and Reservoirs

- Locks and Dams in the North of the Mississippi River
- 6 Dams in ~115 miles
- SWOT passes 216 & 565



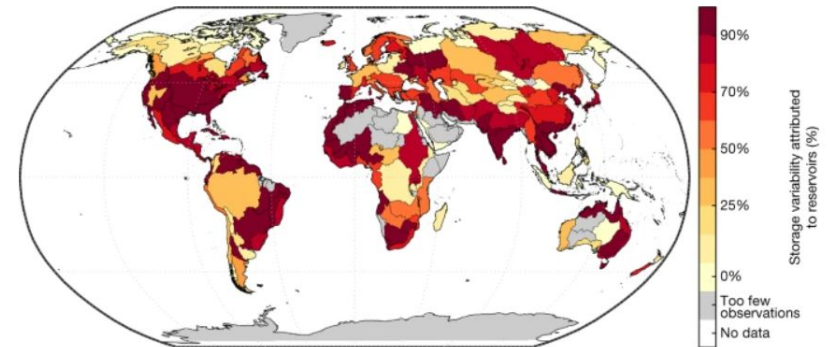
Human alteration of global surface water storage variability

[Sarah W. Cooley](#) , [Jonathan C. Ryan](#) & [Laurence C. Smith](#)

Nature **591**, 78–81 (2021) | [Cite this article](#)

- Used ICESat-2 to look at reservoir and lake elevation variability
- 57 percent of the seasonal variability in Earth's surface water storage now occurs in dammed reservoirs and other water bodies managed by people

Fig. 3: Proportion of seasonal surface water storage variability associated with reservoirs by hydrologic basin from October 2018 to July 2020.

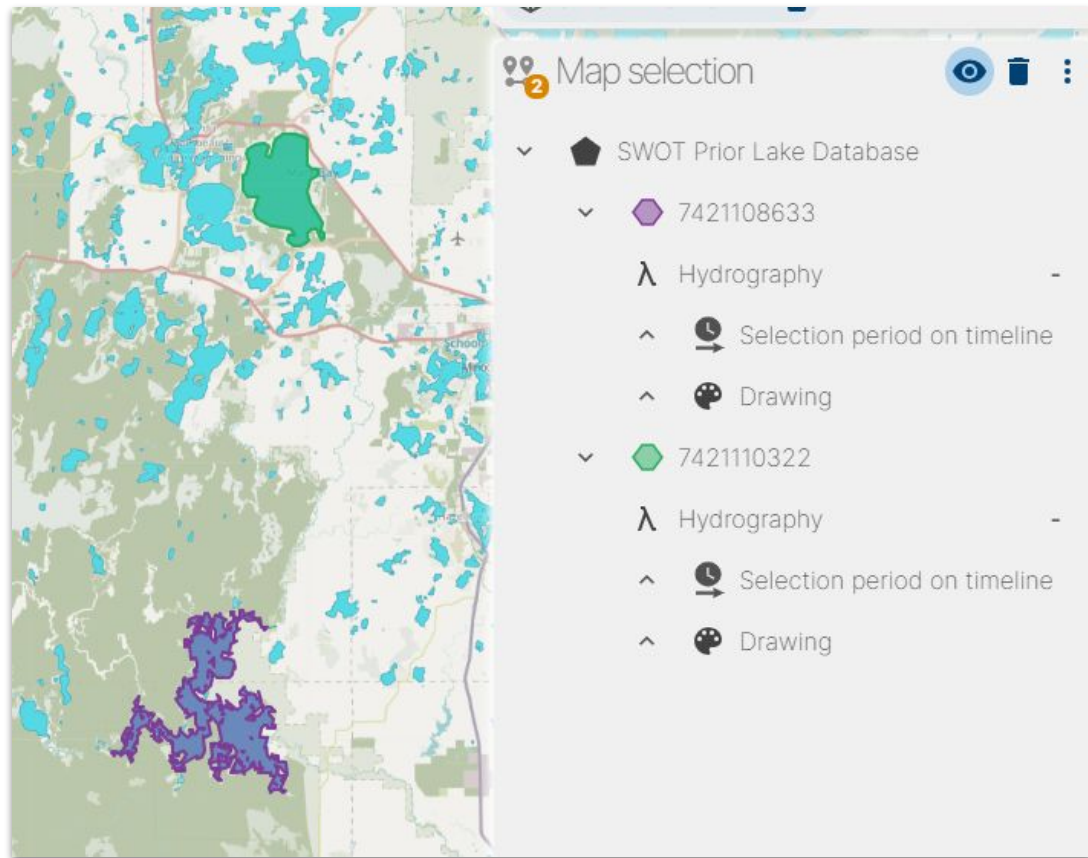


Darker colours represent greater influence of human-managed reservoirs on surface water storage and lighter colours represent less influence. Grey tones indicate basins that received fewer than 10 ICESat-2 water level variability observations. Note the high dominance of reservoirs in the continental USA, Middle East, western and southern Africa, eastern South America and the Indian subcontinent.

<https://sustainability.stanford.edu/news/how-much-do-humans-influence-earths-water-levels>
<https://www.nature.com/articles/s41586-021-03262-3>

Water Surface Elevation Variability using SWOT

- Wisconsin case study
 - Fence Lake
~ 3483 acres (green)
 - Willow Reservoir
~ 4217 acres (purple)
- SWOT passes 188, 259 over this region
- How do they compare?



Topic: Human Influences on the Water Cycle

Topic: Observing Human Influences on the Water Cycle from SWOT Data

Datasets: SWOT rivers and lakes (SWOT_L2_HR_LakeSP_2.0, SWOT_L2_HR_RiverSP_2.0)

Geographic foci: Mississippi River Basin

Questions:

1. Often in heavily managed rivers, locks and dams are prevalent, influencing river flow and water surface elevation (WSE). Plot a river profile of WSE over a specified portion of the Mississippi River. Can you pinpoint the location of the dams and locks based on the water surface elevation profiles? How would we expect the longitudinal profile to look without these dams or locks?
2. The Mississippi River Basin has many man made reservoirs and natural lakes. Here, we'll compare water surface elevation variability from a reservoir and a lake in Wisconsin. SWOT observes reservoirs and lakes > 250 m x 250 m over the released observable record (July 2023 - present day). How do the water levels change over time and compare to each other? Do your findings concur with this study that used ICESat-2 data? <https://www.nature.com/articles/s41586-021-03262-3>
3. Even if there are no reservoirs, dams or locks along a stretch of river, what other avenues can you see humans influencing the flow of surface water? How about the water cycle in general? What other NASA datasets could be useful for analyzing human influence on the water cycle?

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