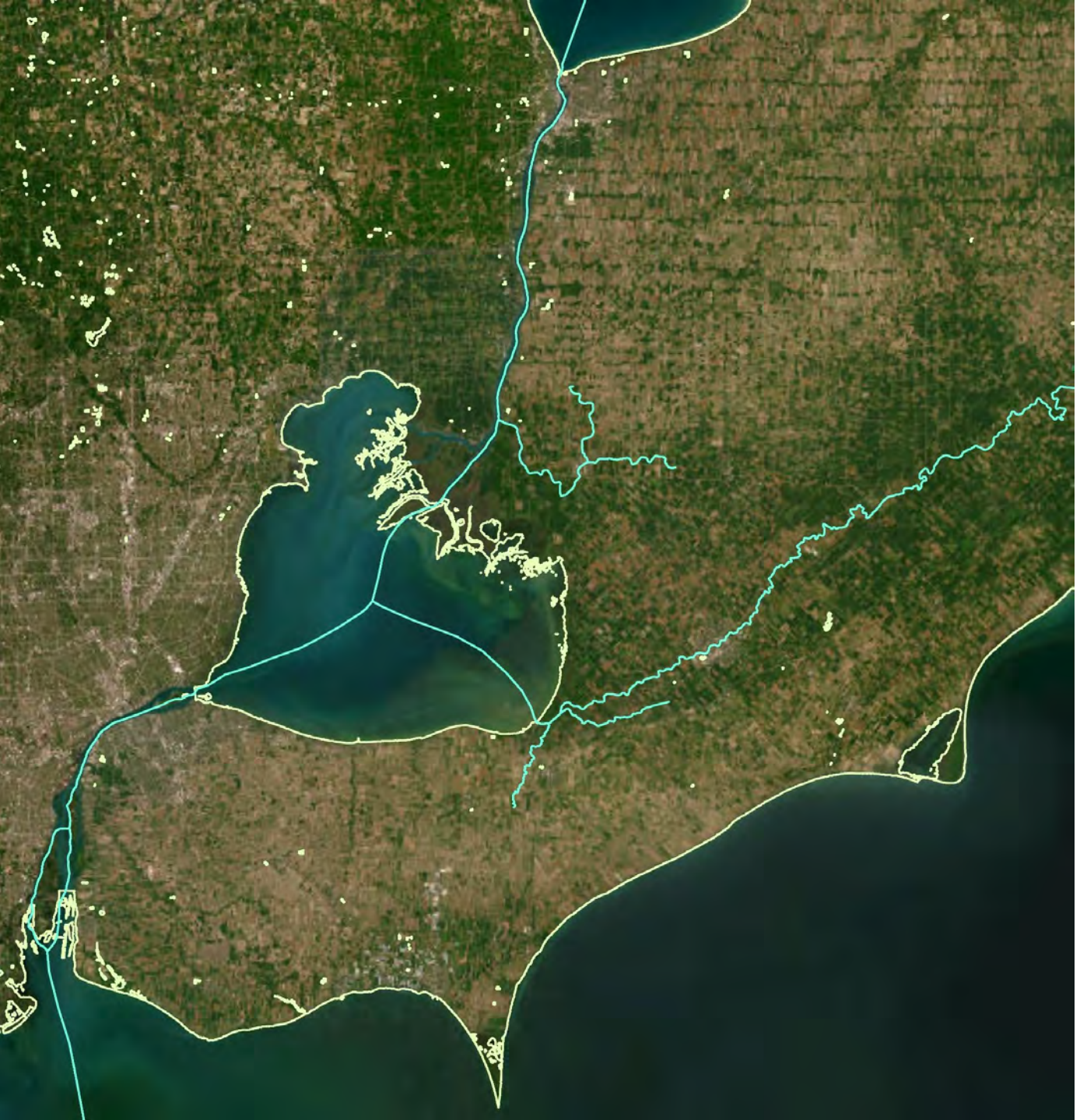


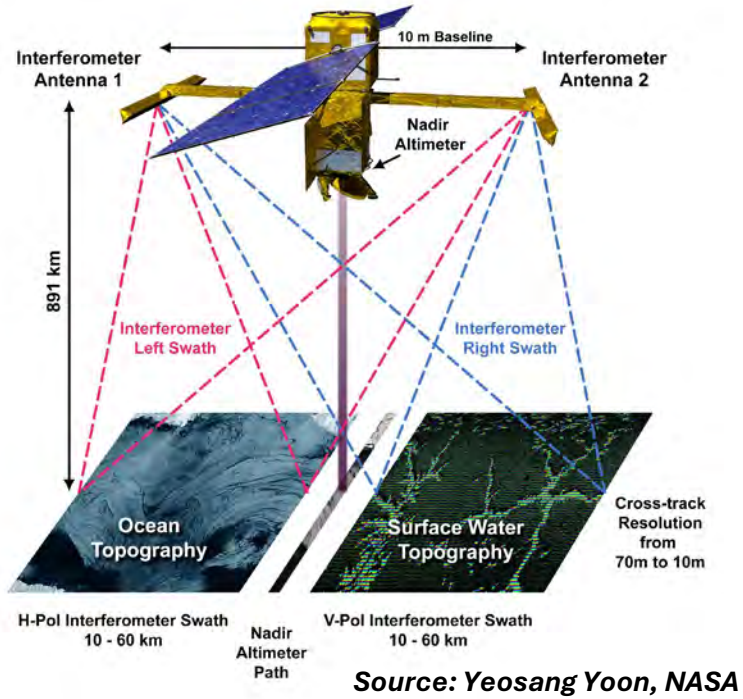
Accounting lakes and reservoirs into discharge estimates

Md Safat Sikder (UIUC), Jida Wang (UIUC), George Allen (VPI), Yongwei Sheng (UCLA), Dai Yamazaki (UTokyo), Jean-François Crétaux (LEGOS), Tamlin M. Pavelsky (UNC)

SWOT ST Meeting 2024
Chapel Hill, NC

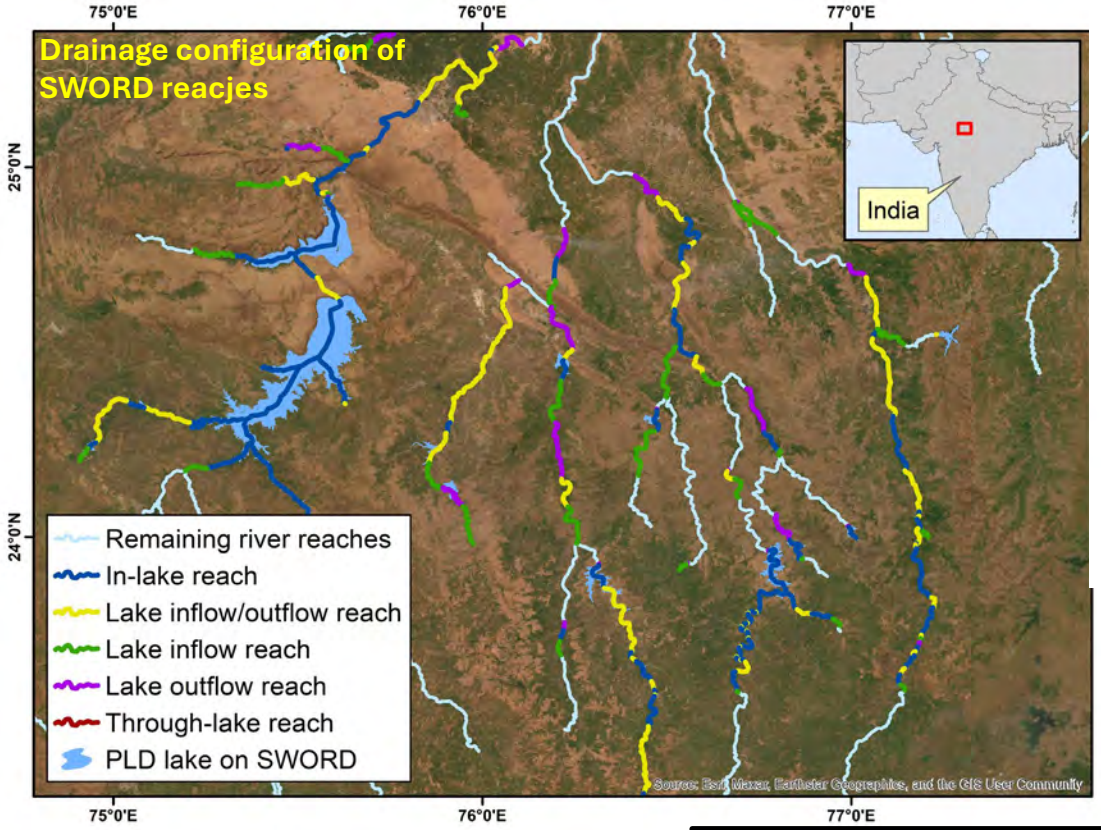
Challenges to integrate lakes/reservoirs in discharge estimation

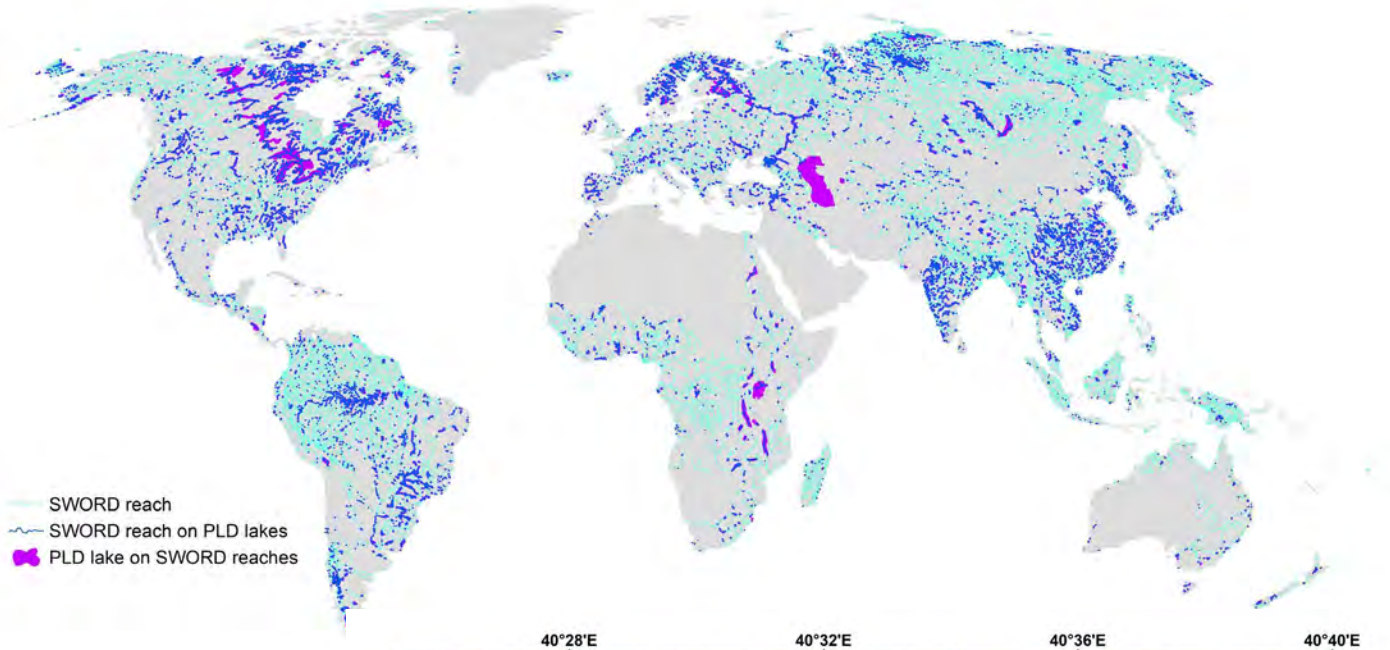
- Discharge in rivers and water storage variation in lakes/reservoirs are two major products of the SWOT.
- Integration of these two components will allow us to track surface water dynamics at an unprecedented spatiotemporal scale.
- Integration is challenging due to:
  - I. SWORD and PLD have been developed separately as independent products.
  - II. Drainage relationship between SWORD reaches and PLD lakes are not directly available.
  - III. Lakes/reservoirs that connected with narrow SWOT non-observable streams are completely disconnected from the SWORD network.
- The harmonized SWOT prior lake and river database will:
  - I. Assist in the synergistic use of SWOT river discharge and lake storage changes to understand global surface water dynamics.
  - II. Help SWOT's discharge estimation through leveraging the water mass conservation between lakes and the connecting rivers.
  - III. Advance the development of coupled river-lake hydrological models to more exhaustively and realistically incorporate lake and reservoir impacts.

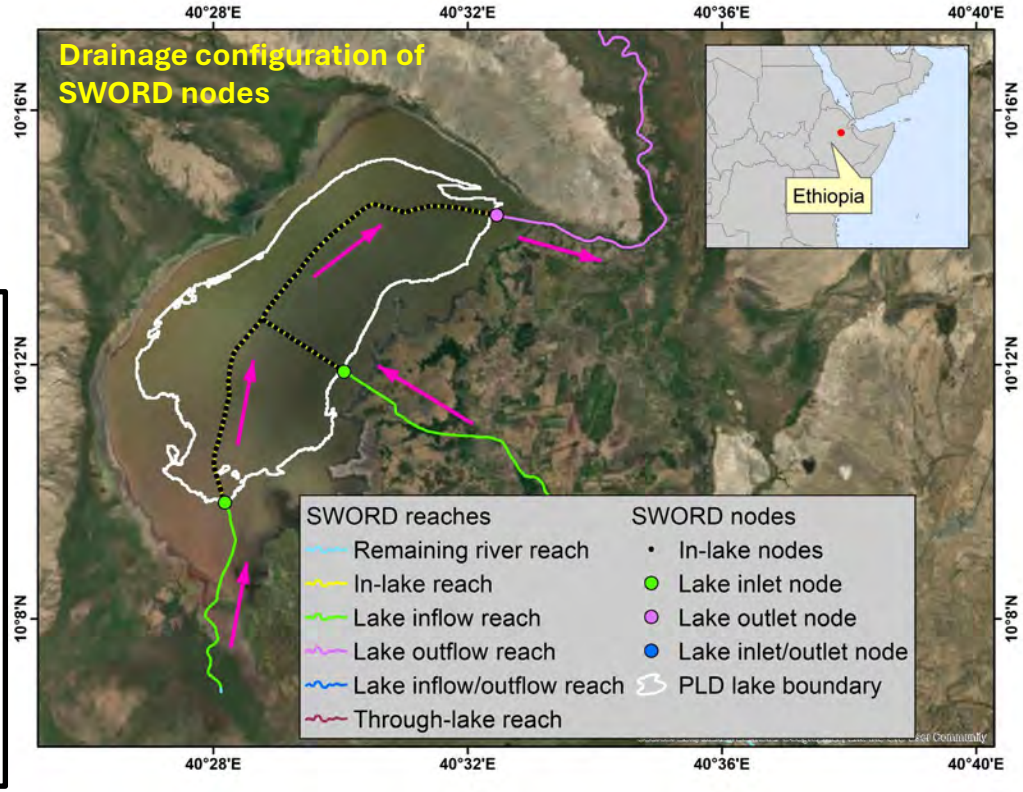


Source: Yeosang Yoon, NASA

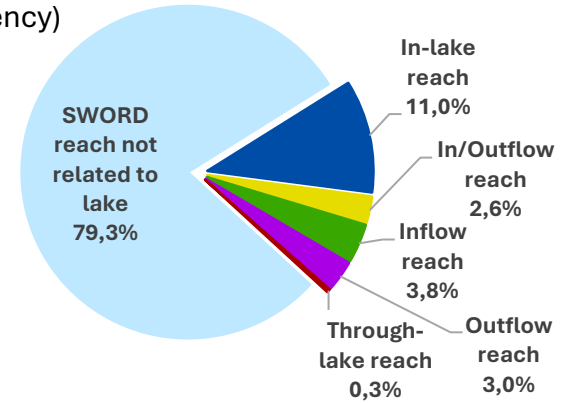
Drainage relationship of intersected SWORD reaches/nodes and PLD lakes







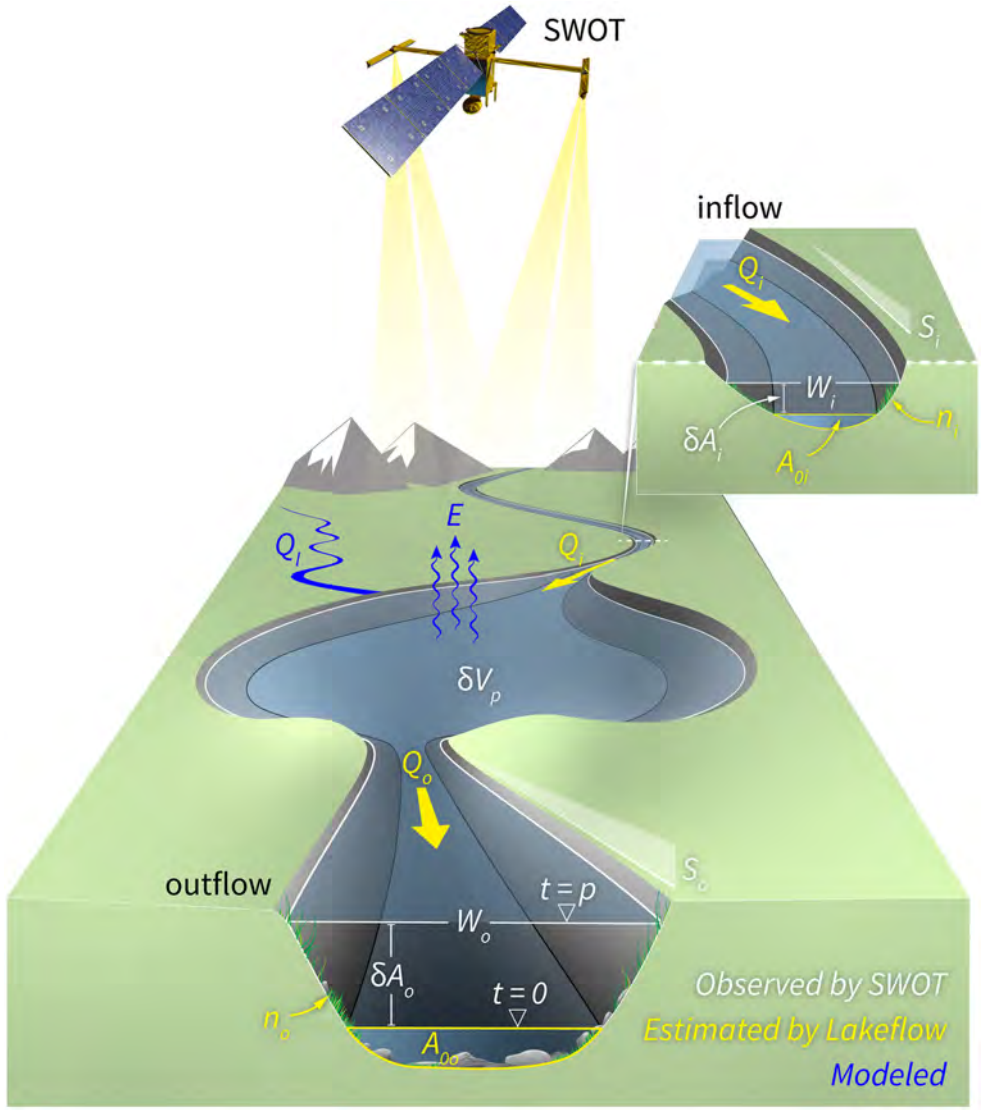
Drainage configuration of SWORD reaches (in % frequency)

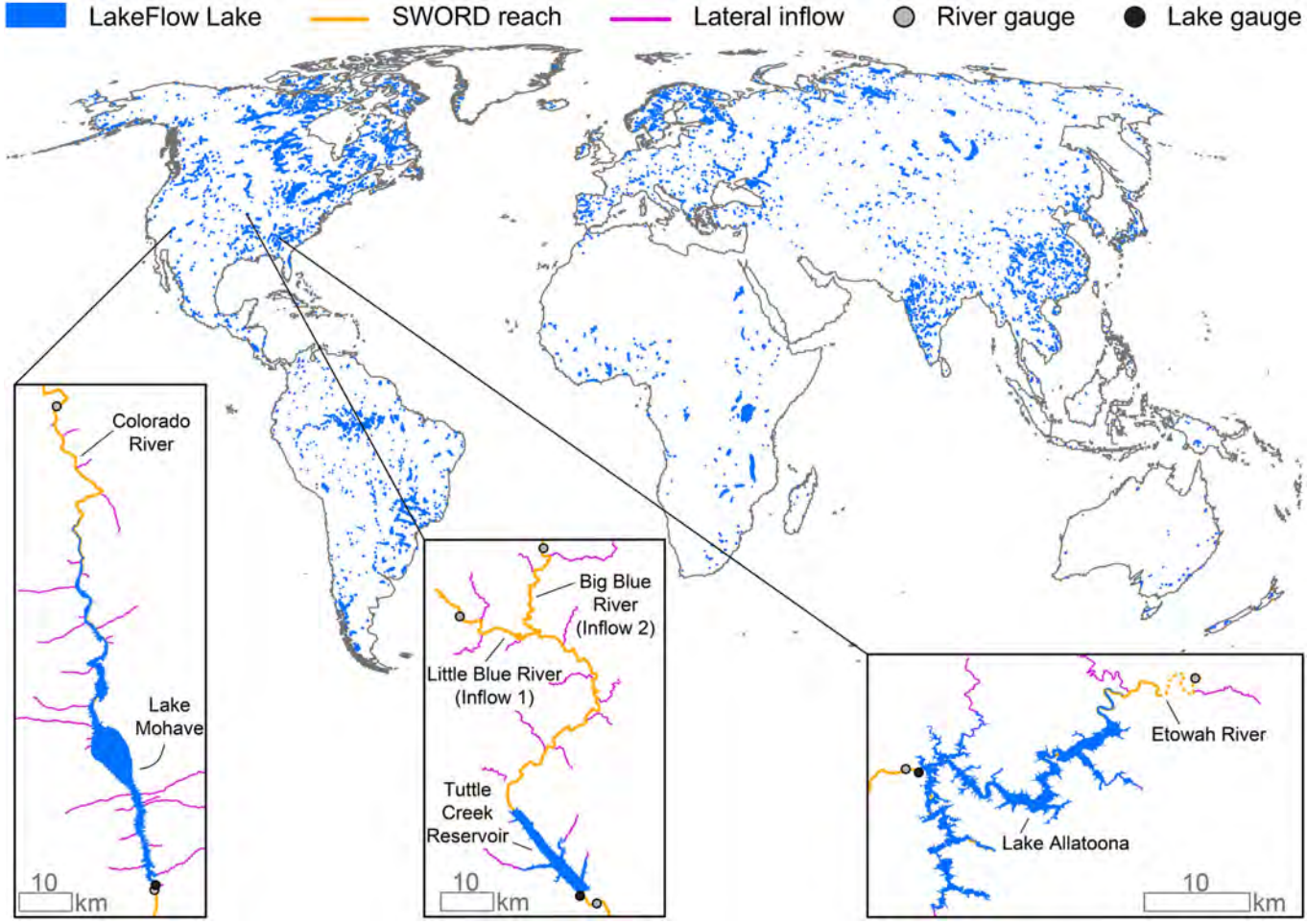


Configuring drainage topology between PLD lakes and SWORD river network

- **PLD lakes:** Total 17,821 lakes out of ~6 million PLD lakes (~0.3% of all PLD lakes) are located on the SWORD network.
- **SWORD reach level:** The drainage relation of 50,096 SWORD reaches (20.7% of the total) with PLD lakes have been configured.
- **SWORD node level:** Total 19,574 and 17,756 SWORD nodes have been identified as lake inlet and outlet, respectively.

An application of drainage relationship of SWORD and PLD: LakeFlow (*Riggs et al., 2023*)





The LakeFlow algorithm:

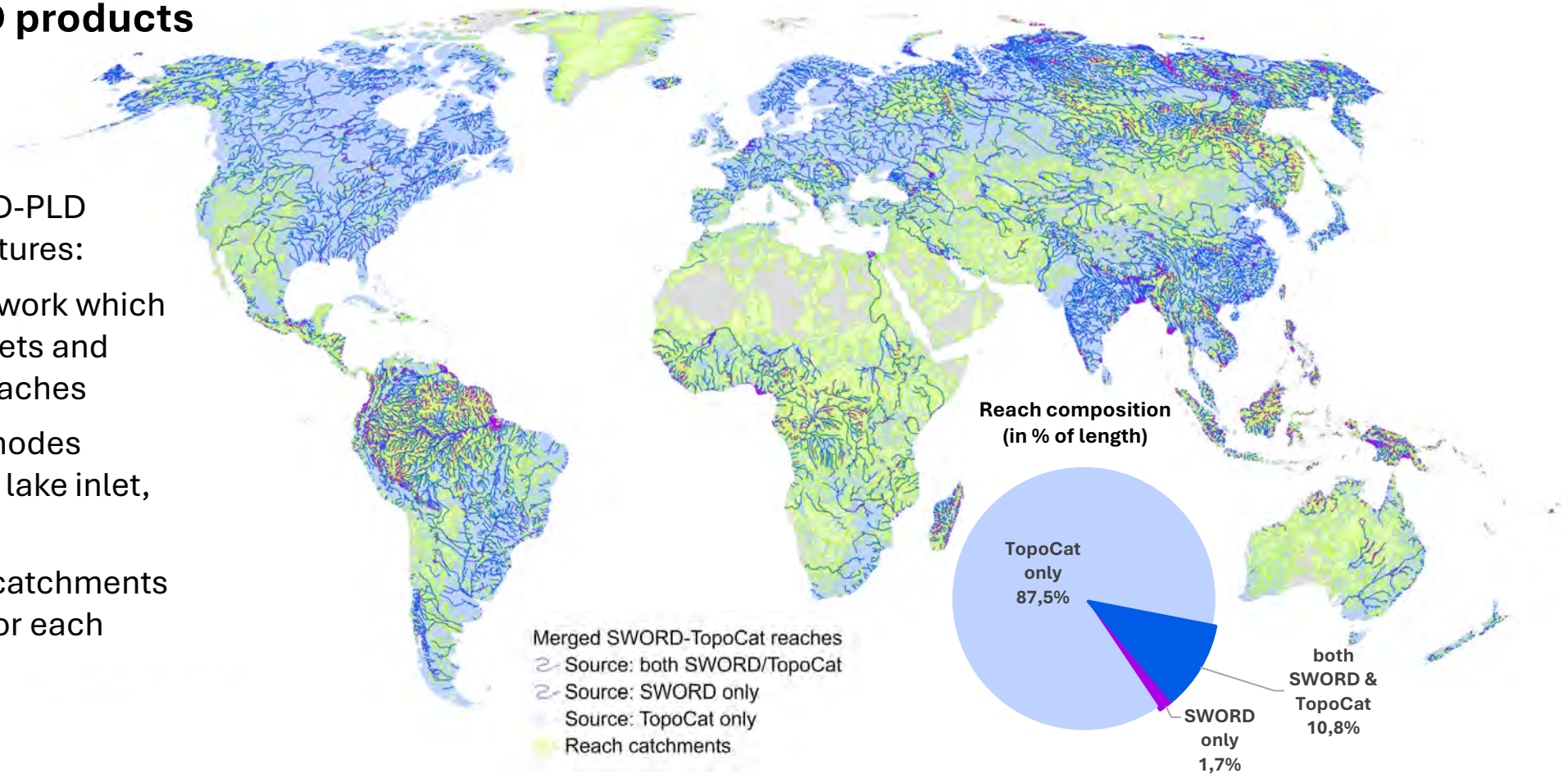
- Based on river-lake mass conservation and Manning's equation.
- Developed for estimating the SWOT-invisible FLP and applicable for the 17821 lakes and 50096 reaches identified from the PLD-PRD topology configuration.

$$\delta V_p = \int_{t=0}^{p} \left(n_i^{-1} (A_{0\,i} + \delta A_i)^{5/3} W_i^{-2/3} S_i^{1/2} - n_{out}^{-1} (A_{0\,o} + \delta A_o)^{5/3} W_o^{-2/3} S_o^{1/2} + Q_l - \mathrm{E} \right)_t dt$$

Harmonized SWORD-PLD products

The fully harmonized SWORD-PLD dataset consists of three features:

1. the harmonized river network which connects all PLD lake inlets and outlets to the SWORD reaches
2. the harmonized feature nodes (reach downstream end, lake inlet, and lake outlet), and
3. the harmonized feature catchments (unit/local catchments for each feature)



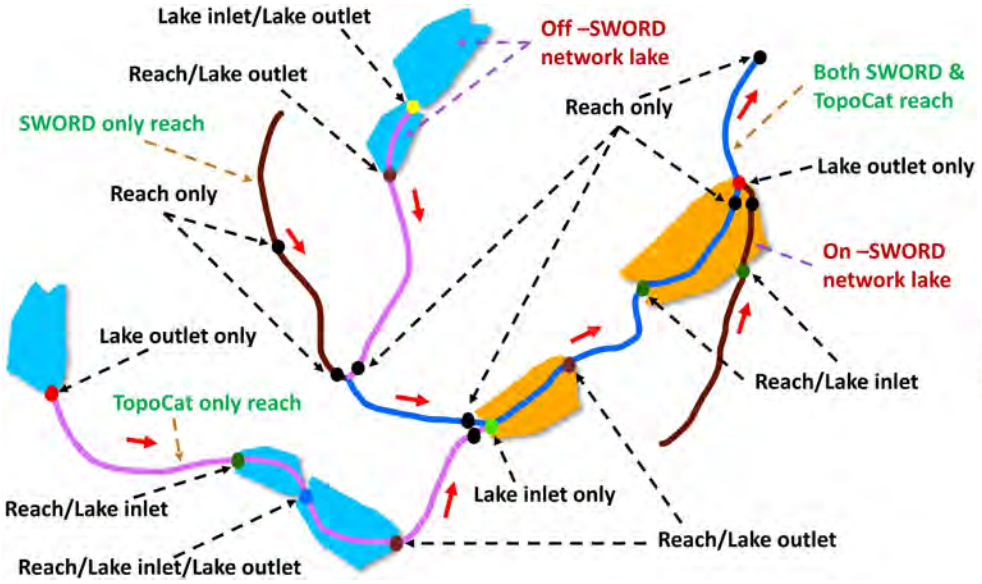
The Harmonized network:

- The harmonized river network is the merged SWORD reaches and inter-lake reaches of the PLD lakes (from PLD-TopoCat; *Sikder et al., 2023*)
- Total length of the harmonized network is about 9 times larger than the SWORD network.
- A total of 12,544,835 reaches connects the inlets and/or outlets of 5,892,853 PLD lakes into the SWORD network

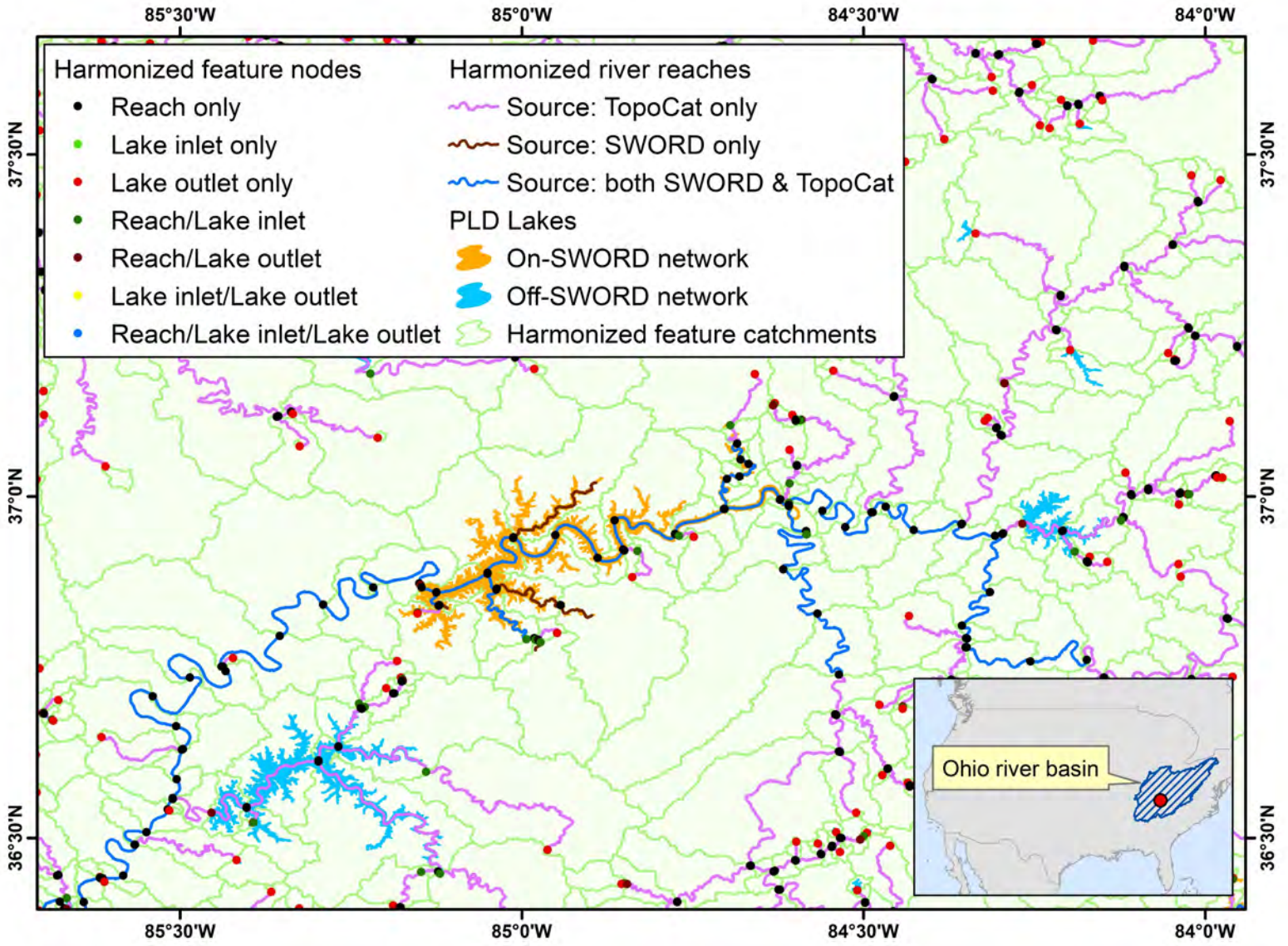
Harmonized SWORD-PLD products

The Harmonized feature nodes and catchments:

- Total 15,945,655 nodes (i.e., lake inlets, outlets, and reach downstream ends) and their drainage topology
- Subbasins for each nodes; covering nearly 90% of the land area excluding Antarctica



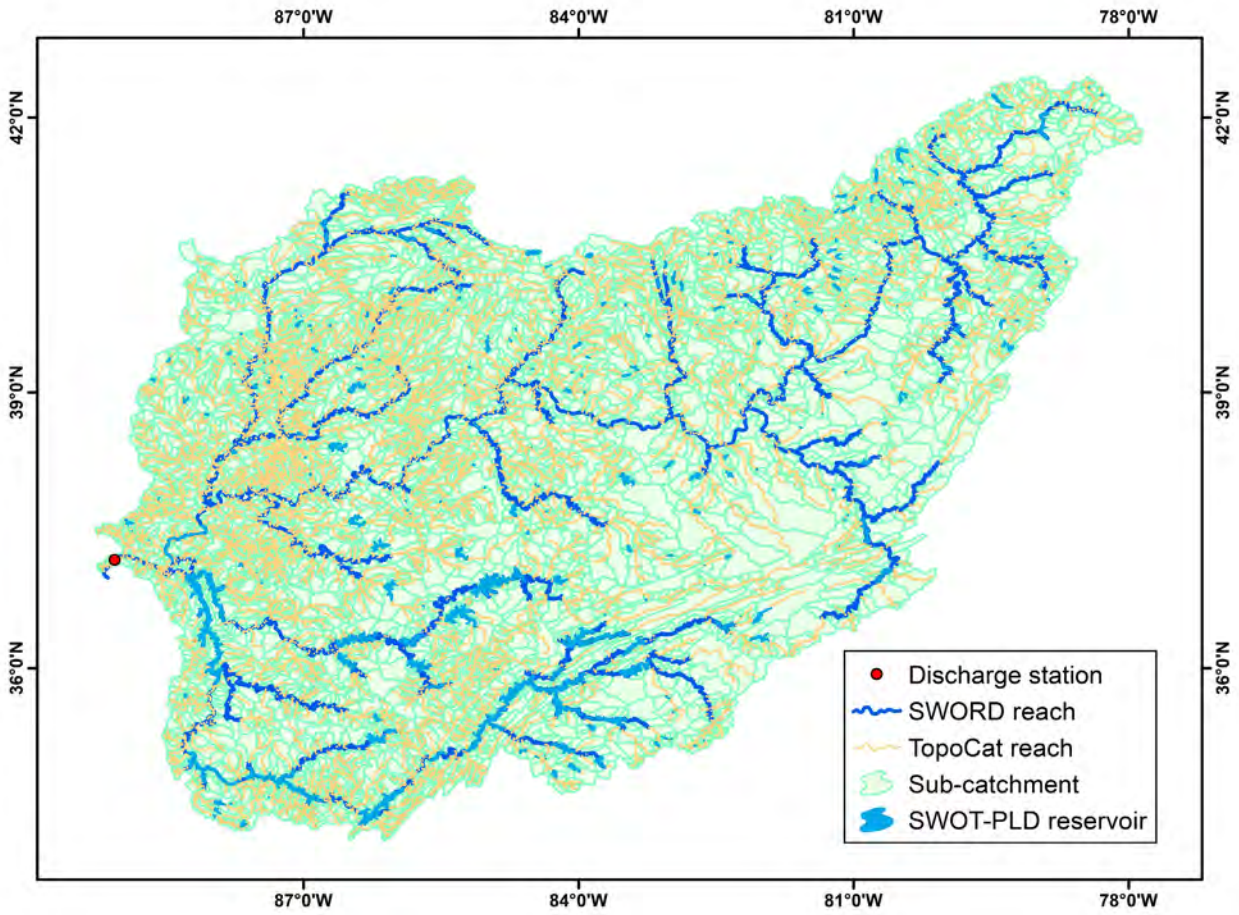
Types of harmonized feature nodes and their drainage configuration in the harmonized river network



An application of the harmonized SWORD-PLD database: River routing model with reservoirs

RAPID (David et al., 2011) model simulation:

- Total 23,108 river reaches, with 4.65 km average reach length and average catchment area is ~22.83 km^2
- Total 278 reservoirs, where reservoir capacity were available from GeoDARv1.1 (*Wang et al., 2022*)
- NLDASv2 VIC LSM Hourly 0.125˚ x 0.125˚
- Simulation period: Jan 2010 – Oct 2023



	W/O dam	With dam
NSE	0.836	0.845
KGE	0.845	0.874

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Scan to access the Harmonized SWORD-PLD v1.0 beta database

Please see the poster presented at the early career poster session

CONTACTS:
Md. Safat Sikder(mssikder@illinois.edu)
Jida Wang (jidaw@illinois.edu)