# An Open Source, Cross-Platform Tool for Implementing River Discharge Algorithms for the Surface Water and Ocean Topography (SWOT) Satellite Mission


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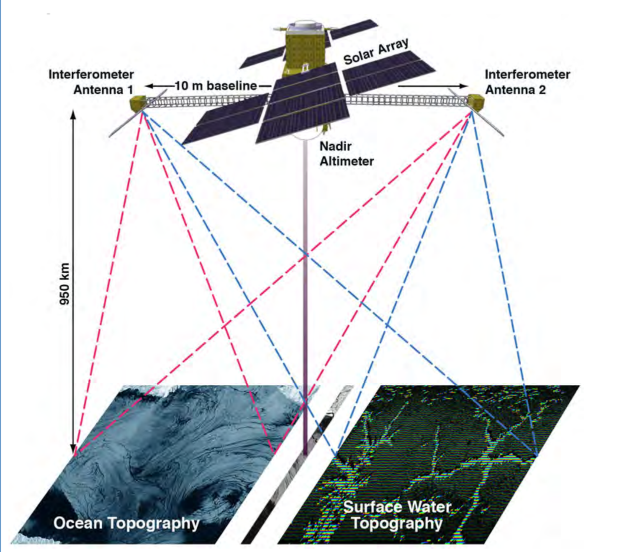
## INTRODUCTION

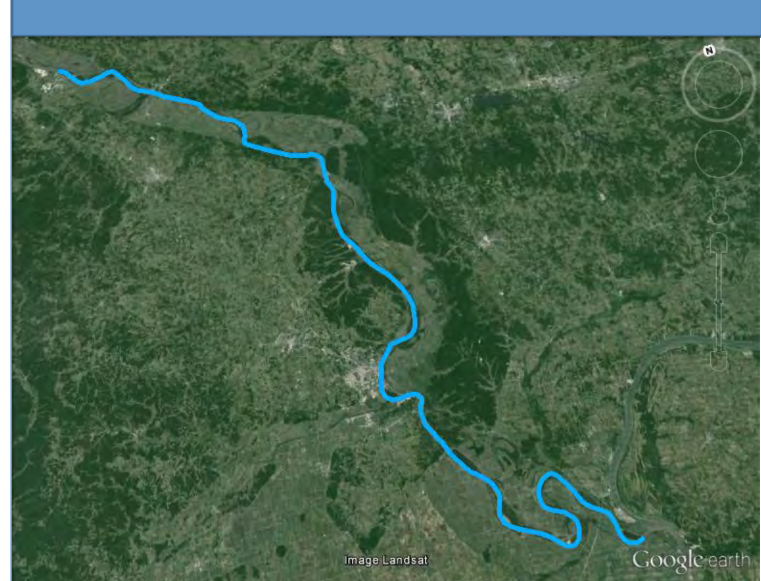
Thorough knowledge of river discharge is critical for flood forecasting, water resource engineering, and sea level rise estimates under different climate change scenarios. However, this knowledge is sparse for much of the world (Pavelsky el al. 2014). To that end, the NASA/CNES Surface Water Ocean Topography (SWOT) satellite mission (planned launch date: 2020) aims to map river discharge from space at sub-monthly repeat intervals. In preparation for SWOT, several algorithms for estimating river discharge from SWOT-like data have been published (Bjerklie et al., 2005, Durand et al., 2014; Gleason and Smith, 2014; Garambois and Monnier, 2015). However, each of these algorithms require different input data, are written in different programming languages, and have a suite of parameterizations that are cumbersome to implement. In order to efficiently interpret geospatial data to address river discharge. Here, we present a novel tool to process hydrologic data and implement algorithms via a single graphical user interface (GUI) written in Python. We hope to use this tool to support the SWOT mission, to help close the current knowledge gap pertaining to the global distribution of flow in rivers, to enhance hydrologic science development, climate modeling, and aid governments in natural disaster forecasting.




SWOT Mission scheduled for launch in 2020

- **To bridge the gap between river hydraulic data and different discharge algorithms.**
- **To increase the efficiency of hydrologic data interpretation.**

## CASE STUDY: MISSISSIPPI

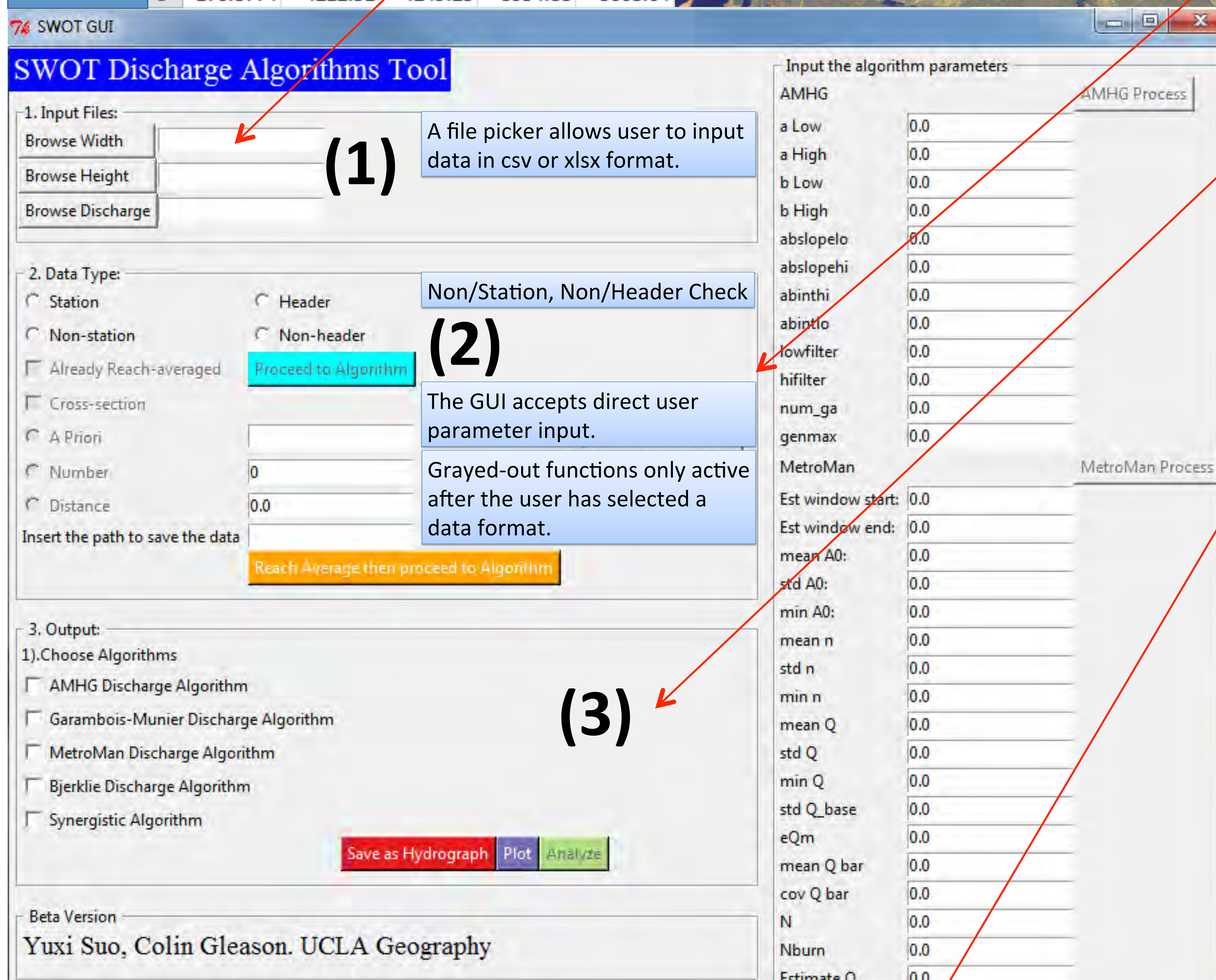


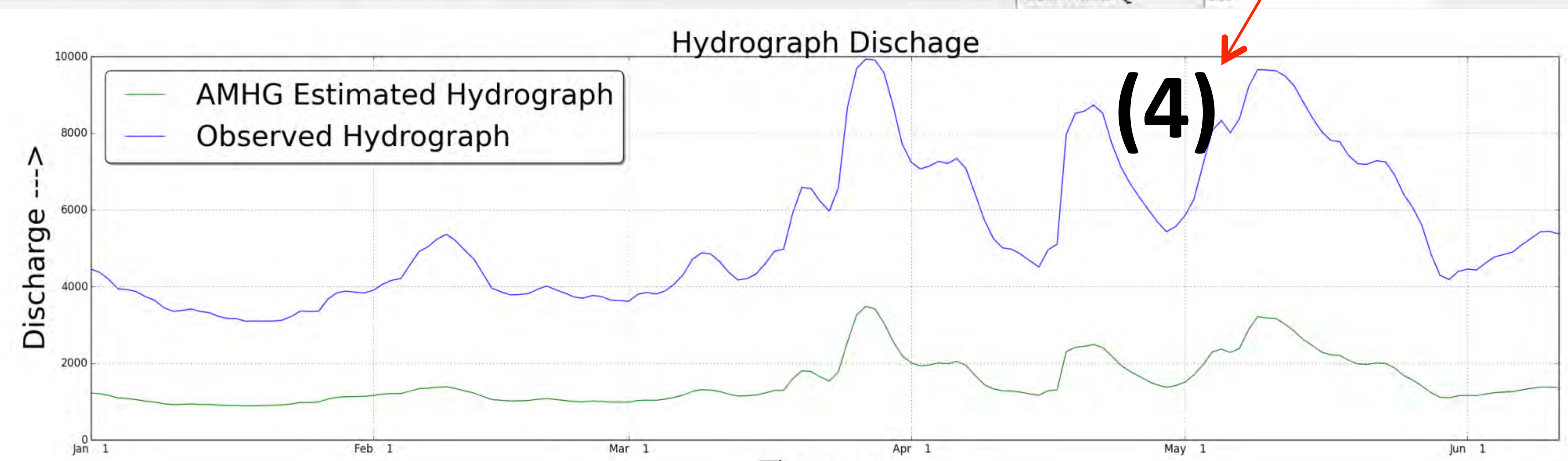
**Study Site:**
177km of the Mississippi River upstream of the confluence with the Ohio River. Stream width and height data are generated by the HEC RAS hydrodynamic model developed by the US Army Corps of Engineers. The model was forced with gauge data from USGS gauge 0702200 at Thebes, IL and solved for width and discharge at each cross section in the model.

**Experiment design:**
We present only AMHG results using 262 days of simulated hydraulic data for the Mississippi. The GUI is intended to run the Metro Man, GaMo, AMHG, and Bjerklie algorithms.

**1) Data Input:**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Station | Date1 | Date2 | Date3 | Date4 |
| 2 | 177.6336 | 4212.13 | 4248.94 | 3954.45 | 3668.16 |
| 3 | 177.6334 | 4212.13 | 4248.94 | 3954.45 | 3668.16 |
| 4 | 177.632 | 4212.13 | 4248.95 | 3954.45 | 3668.17 |
| 5 | 176.8774 | 4212.51 | 4249.23 | 3954.88 | 3668.64 |




After clicking on the 'Save as Hydrograph' button, the GUI will save the algorithm estimated hydrograph and the observed hydrograph (if available) to a .txt file. Plot button will plot the two time series. The green line in our case study is the AMHG estimated Mississippi River hydrograph, while the blue line represents the observed (true) hydrograph. The plot can be saved for further comparison.

## GUI FUNCTIONS

**(2) Reach averaging input data**
Integrates cross-sectional hydraulic data by averaging width, height, and/or discharge data according to user-specified dimensions or automatically generated spatial partitions. The GUI will produce reach-averaged data according to user's selection of reach-averaged methods.

**(3) Selection and implementation of algorithms**
The user can estimate discharge by selecting from five algorithms:1) AMHG (Gleason and Smith, 2014), 2) GaMo (Garambois and Monnier, 2015), 3) MetroMan (Durand et al., 2014b), 4) Bjerklie (Bjerklie et al., 2005) ,and 5) a synergistic algorithm. We require the user to input different parameters for each algorithm currently, but we are planning to optimize the user experience by implementing input parameter file function.

**(4) Analysis of results**
The GUI generates a hydrograph ,summary plots, and statistical comparisons across different algorithms based on user's selections.

## CONCLUSIONS

- The GUI provides flexible user-friendly interaction thanks to straightforward inputs and output.
- The GUI encourages comprehensive data output: both quantitative statistic and graphical plotting.
- The GUI makes algorithms slower
- The GUI tool is easily saved and transferred to other computers as a python script file. Multiple functions and algorithms are called inside one script file.
- The GUI is supported by Windows, Mac and Linux/ Unix.
- The GUI helps bridge the gap between hydraulic data and different discharge algorithms. It also increases the efficiency of hydrologic data interpretation.

**Future Work:**
- Input parameter file.
- Implementing GaMo, Bjerklie, Synergistic Algorithms.

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