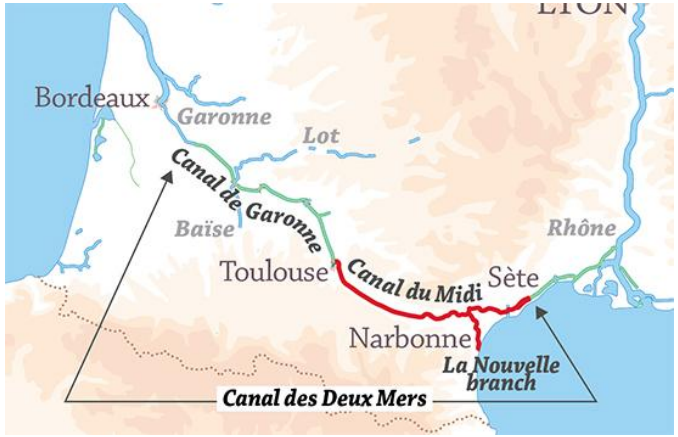
SWOT Discharge Status: Update & Session Overview

Mike Durand on behalf of the DAWG

First Post-Launch Science Team
Thursday, September 21, 2023
Toulouse

Plan for this talk

1. Where we've come from
2. Where we're at
3. Where we're going
4. Overview of session



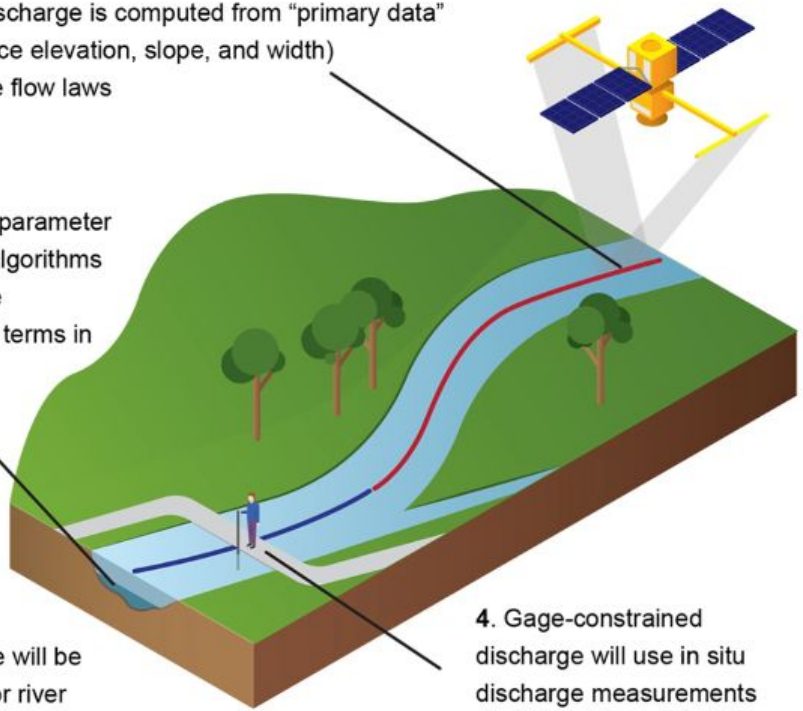
If SWOT Discharge is a boat trip from the Atlantic to the Mediterranean on the Canal de Deux Mers, we're currently in Toulouse!

Canal du Midi, near LEGOS & CNES, 13 September 2023

Where we've come from: SWOT Level 2 discharge framework

1. SWOT discharge is computed from "primary data" (water surface elevation, slope, and width) using simple flow laws

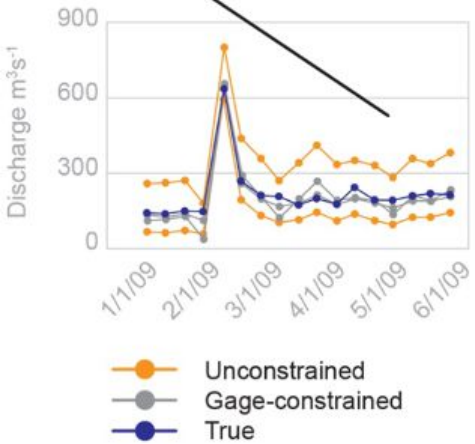
2. Flow law parameter estimation algorithms will estimate unobserved terms in flow laws.



3. Discharge will be computed for river reaches approximately 10 km in length.

4. Gage-constrained discharge will use in situ discharge measurements to constrain flow law parameters

5. An ensemble of discharge estimates is computed for each reach, and for both the constrained and unconstrained branches

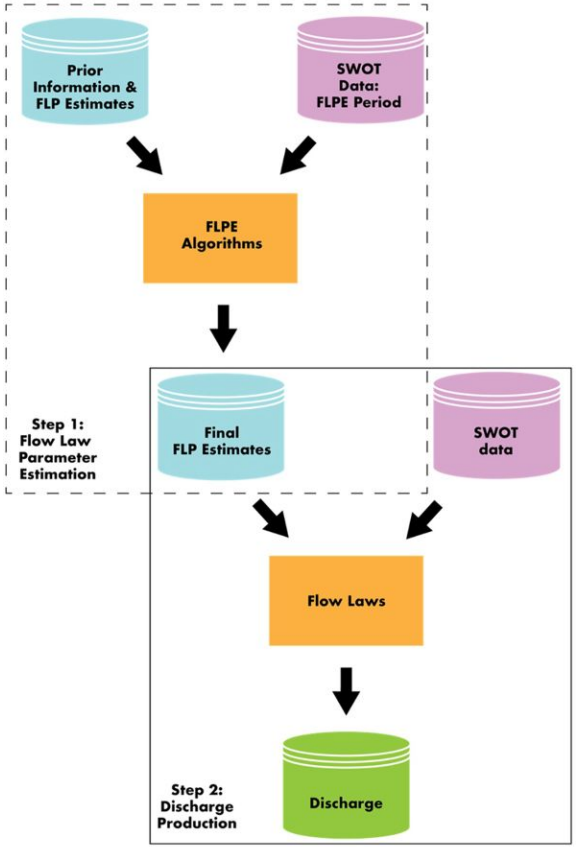


Hind will cover this in detail!

Durand, M., Gleason, C. J., Pavelsky, T. M., Frasson, R. P. de M., Turmon, M., David, C. H., Altenau, E. H., Tebaldi, N., Larnier, K., Monnier, J., Malaterre, P. O., Oubanas, H., Allen, G. H., Astifan, B., Brinkerhoff, C., Bates, P. D., Bjerklie, D., Coss, S., Dudley, R., Fenoglio, L., Garambois, P., Getirana, A., Lin, P., Margulis, S. A., Matte, P., Minear, J. T., Muhebwa, A., Pan, M., Peters, D., Riggs, R., Sikder, M. S., Simmons, T., Stuurman, C., Taneja, J., Tarpanelli, A., Schulze, K., Tourian, M. J., and Wang, J.: A Framework for Estimating Global River Discharge From the Surface Water and Ocean Topography Satellite Mission, Water Resour Res, 59, https://doi.org/10.1029/2021wr031614, 2023.

Where we've come from: SWOT Level 2 discharge framework

The flow law parameters are computed by the Science Team (the DAWG) using a software called Confluence



The SWOT Level 2 discharge product is computed by the Space Agencies / the Project.

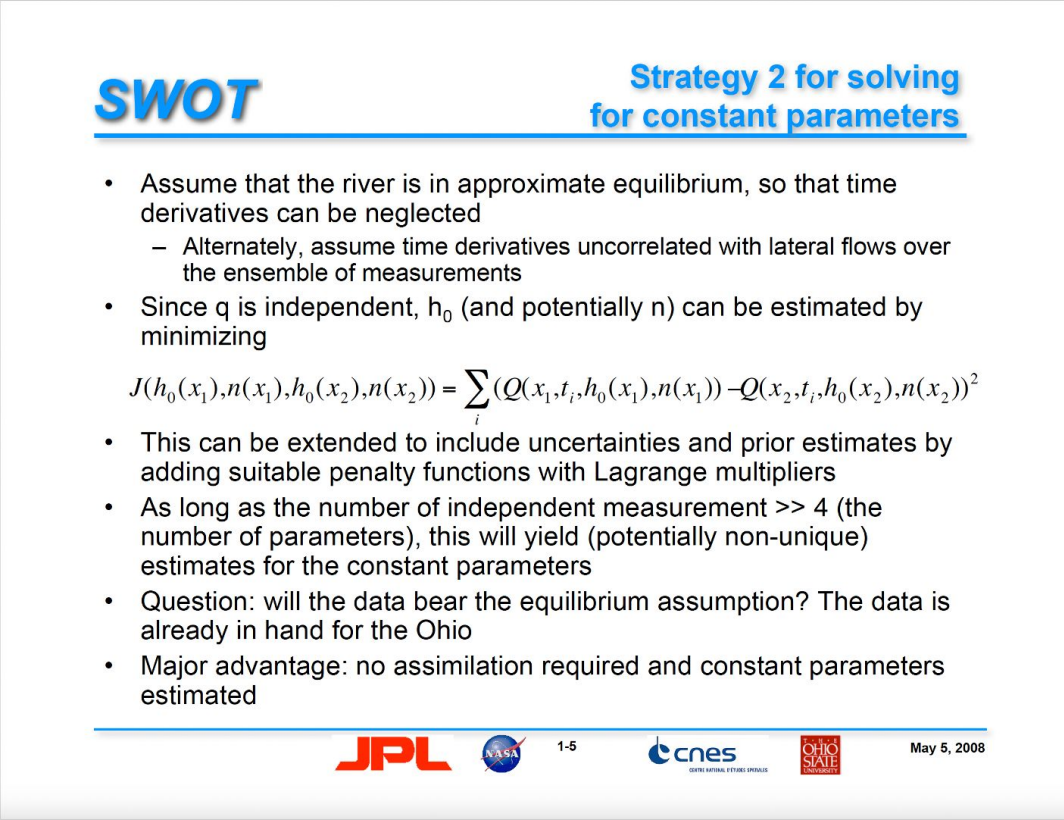
Hind will cover this in detail!

Where we've come from: SWOT discharge origins

How did we get here? The answer is (as usual) Ernesto Rodriguez!

This slide from fifteen (15!!) years ago from a eight-person US & French workshop in Seattle laid the groundwork for the DAWG, and SWOT discharge in general.

We would not have SWOT or SWOT discharge without Ernesto!



Where we're at: First public presentation of a Confluence run today!

SWOT data we used for today's runs…

Validated SWOT data (CRID*=??)

- What we'll have by the validation meeting
- Meets science requirements

Beta Pre-Validated

(CRID=PIB0, V1.1)

- Just released
- Reprocessed
- Not as good as what we'll have eventually
- All major algorithms running to create river height+width data

Forward Processed (CRID=PIA1)

- Early data
- No cross-over calibrations
- Many missing cycles
- Not shown at this meeting except for this Confluence run

* CRID is the composite release identifier. It's included in all granule ids/filenames

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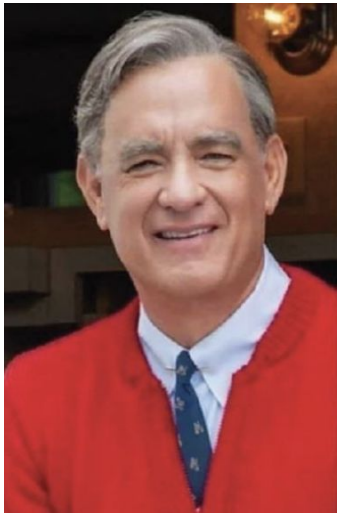
(CRID=??)



Mr. Rogers

Beta Pre-Validated
(CRID=PIB0, V1.1)

Forrest Gump

Forward Processed
(CRID=PIA1)

Cast Away

Where we're at: First public presentation of a Confluence run today!

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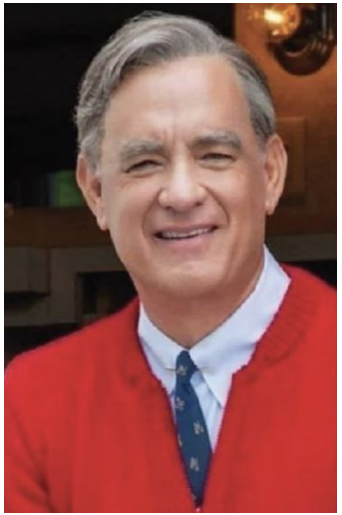


Tom Hanks as Mr Rogers in "A beautiful day in the neighborhood"

Beta Pre-Validated (CRID=PIB0, V1.1)

Tom Hanks as Forrest Gump in "Forrest Gump"

Forward Processed (CRID=PIA1)

Tom Hanks as Chuck Noland in "Cast Away"

Where we're at: A note on current SWOT Single-pass data versions

- River Single Pass datafiles are created via space agencies using River Tile Processor, Single Pass Processor, originally based on RiverObs, in the Science Data System (SDS)
- Forward processed: CRID=PIA1.
  - Run using software and input data available at the time of processing, pushed automatically to PO.DAAC
  - Software and input data has evolved throughout the year, so data are inconsistent
  - Not all algorithms were used: e.g. the cross-over calibration processor was not used, leading to degraded products
  - Many cycles are missing, when processors simply had crashed
  - Status & Domain: Available for whole one-day orbit
- Reprocessed: CRID=PIB0
  - Run using a single software and input dataset
  - Processing: includes some manual work, but the cross-over calibration processor was used. However, not all cross-over calibrations were succesful
  - Status & Domain: Six passes were requested. Agencies worked hard to deliver these by end of August, but were only delivered Friday, and only two passes.
- What this means is that existing Confluence discharge results are based on very noisy data, and should not be expected to be at expected SWOT precision for the reprocessed data

Caprese salad is ALL about good tomatoes.

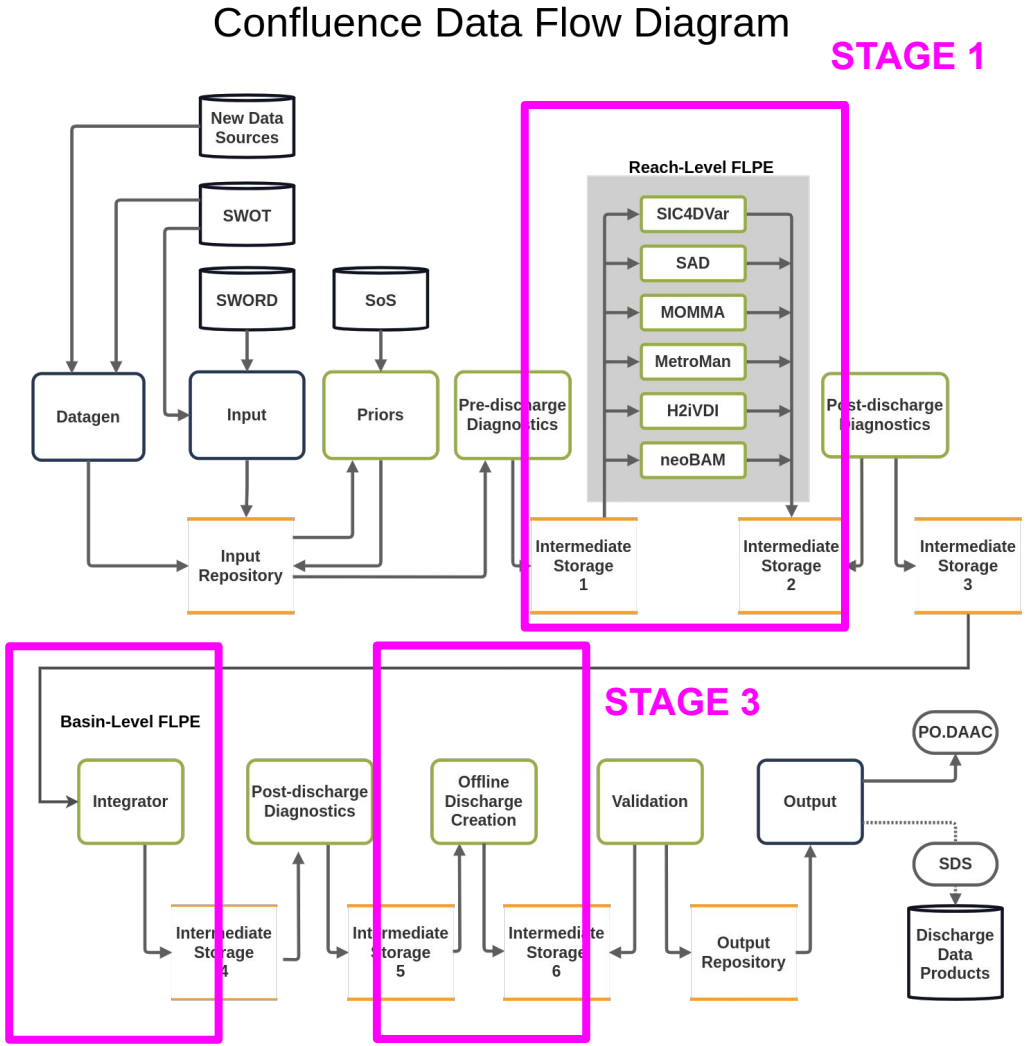
Right now, we are making caprese salad with tomatoes from a can. It is food, but it is not very tasty.

But Confluence team is getting our olive oil picked out, making sure knives are sharp, and deciding on brand of mozzarella.

Confluence results shown today may not be tasty, but they show that we are ready to cook once the tomatoes in the garden are ripe!

Where we're at: Three stages of discharge production

- Stage 1: Assimilation and McFLI compute discharge & flow law parameters
- Stage 2: Force hydrologic continuity at the sub-basin scale, recomputing discharge & flow law parameters
- Stage 3: Estimate discharge using simple flow laws and stage 2 flow law parameters, copying exactly how discharge will be computed in the level 2 products



Steve will cover this in detail!

Where we're at: Overview

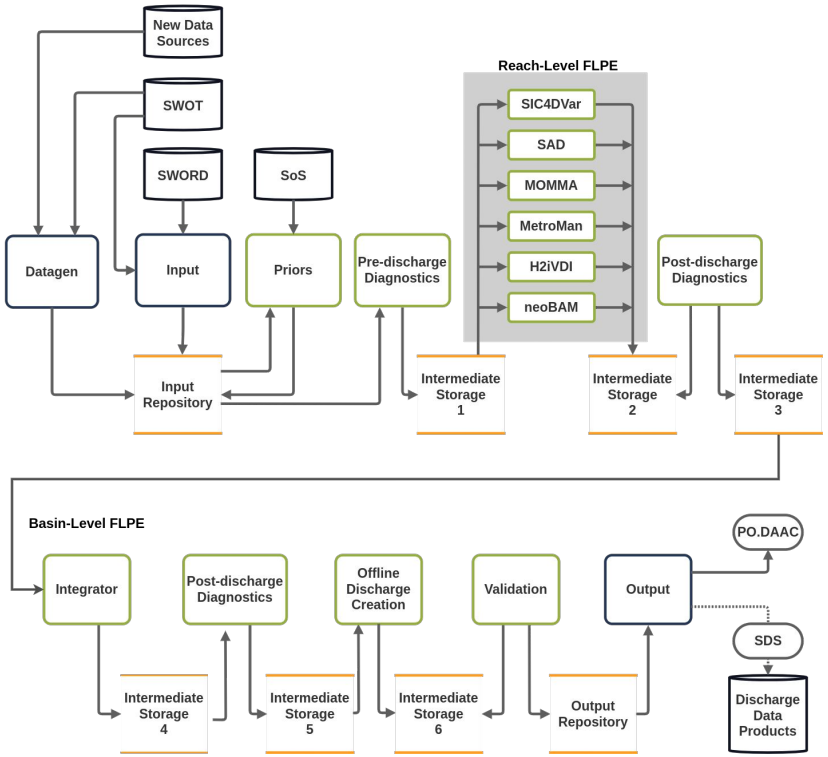
Confluence is successfully running (order 1,000 reaches), and is ready to run globally.

We so far have run only lower precision "forward-processed" SWOT data

We are squashing bugs in Confluence input and output. Mature reach level FLPEs are being adapted to noisy forward-processed SWOT data.

We are ahead of where we expected to be.

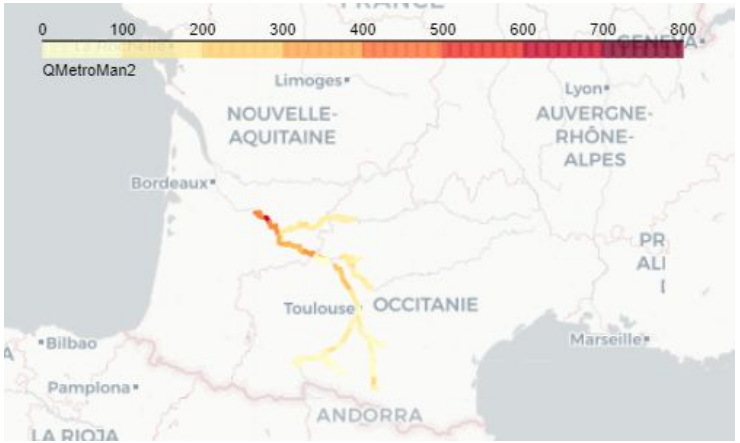
Confluence Data Flow Diagram

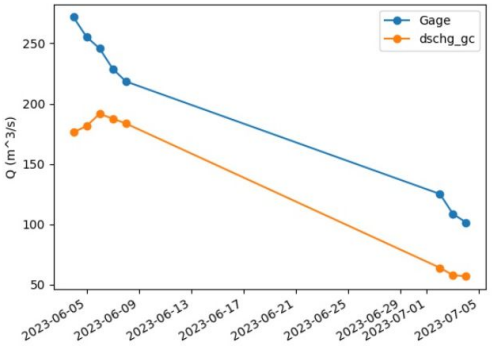


Where we're at: Example

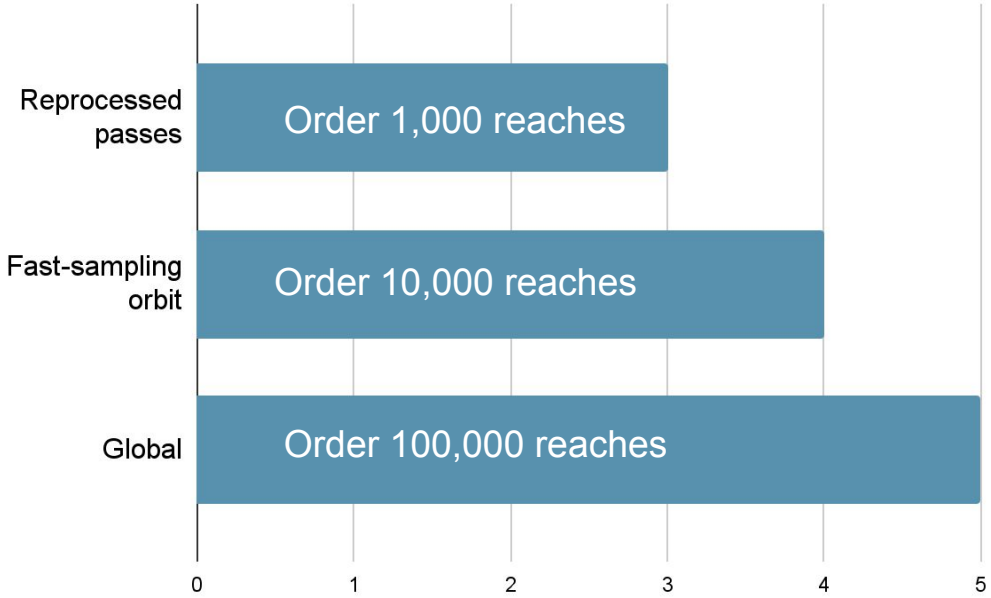
Steve will cover this in detail!

This is remarkable: we are converting SWOT measurements to discharge in the cloud, in a fully scalable way, automatically pulling in near real-time gage measurements from many countries, using methods that are fully applicable to ungaged basins, with algorithms designed by many members of the Science Team, on both sides of the Atlantic, expandable to include more.



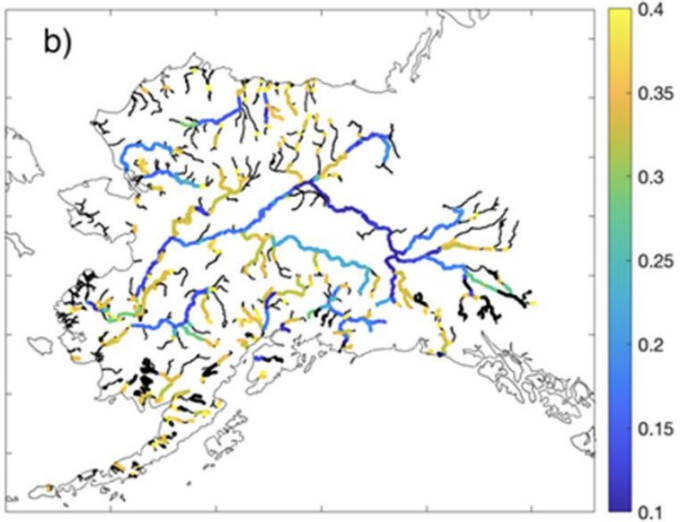


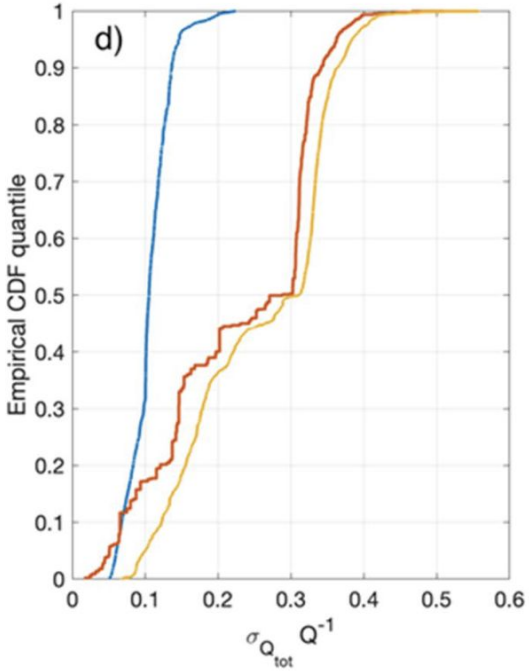
Where we're going: Global



The Confluene architecture is ready to run globally! Travis will cover this in detail.

Where we're going: Accuracy goals





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Target errors of <20% RMS for basins with gages, and <35% for basins without gages for the consensus algorithm (constrained data product), for 67% or more basins.

Where we're going: SoS to be made public

The SWORD of Science (SoS) stores discharge data from each reach-scale run, including discharges computed essentially as an L4 product. It also includes additional uncertainty metrics, and node-level information e.g. bathymetry estimates.

The SoS is in the process of being approved for access at PO.DAAC, making these Level 4-type products! Nikki Tebaldi (JPL) is leading this effort.

These data will likely be highly useful but will not replace the L2 discharge product which will have lower latency.

Suresh will cover this in detail!

Where we’re going: Big Picture

We are on track to produce first global SWOT discharge on schedule, realizing the beginning of the promise of SWOT discharge to enable new discoveries of how the global water cycle works.

We are working with the Agencies to formulate plans for how Confluence can continue to be run and improved, in the next Science Team cycle.

We developed much of the theory underpinning SWOT discharge in a very data poor environment. In order for SWOT discharge to fully realize its potential, we must make new developments to algorithms, informed by the SWOT data

Where we’re going: Confluence improvements

Realizing the true promise of SWOT in terms of global discharge accuracy in ungaged basins will require another cycle of development: Several directions:

- Improvement of flow laws and inversion
- Incorporation of lateral inflows and dynamic prior flows
- Incorporating information from lake storage change
- Incorporation of more in situ gages

Overall, this will improve the accuracy and coverage of SWOT discharge: From science to applications.

Overview of today’s session: Decision to make

Exercise in outlining papers: Kostas will lead an early paper with the goal of being ready to present early SWOT discharge results around the time the data go public, in October.

Right now, Confluence is running fine on these six passes (~1000 type-1 river reaches) of un-reprocessed data during fast-sample phase (~6 weeks of daily data). When the reprocessed data come, do we just use that as the basis for this paper? And thus that first paper will “just” be on the 1000 reaches? Or do we wait for the rest of the fast-sample orbit?

Overview of today’s session

9:15-9:35 Hind Oubanas: A scientific overview of SWOT discharge

9:35-9:55 Travis Simmons: Confluence Technical Update

9:55-10:15 Steve Coss: Exploring latest Confluence runs

10:15-10:25 Suresh Vannan: Confluence dataset: SWORD of Science

10:25-10:30: Discussion Prompt

10:30-11:00 Coffee Break

11:00-11:15 The first SWOT discharge paper: Kostas Andreadis

11:15-11:45 Discussion