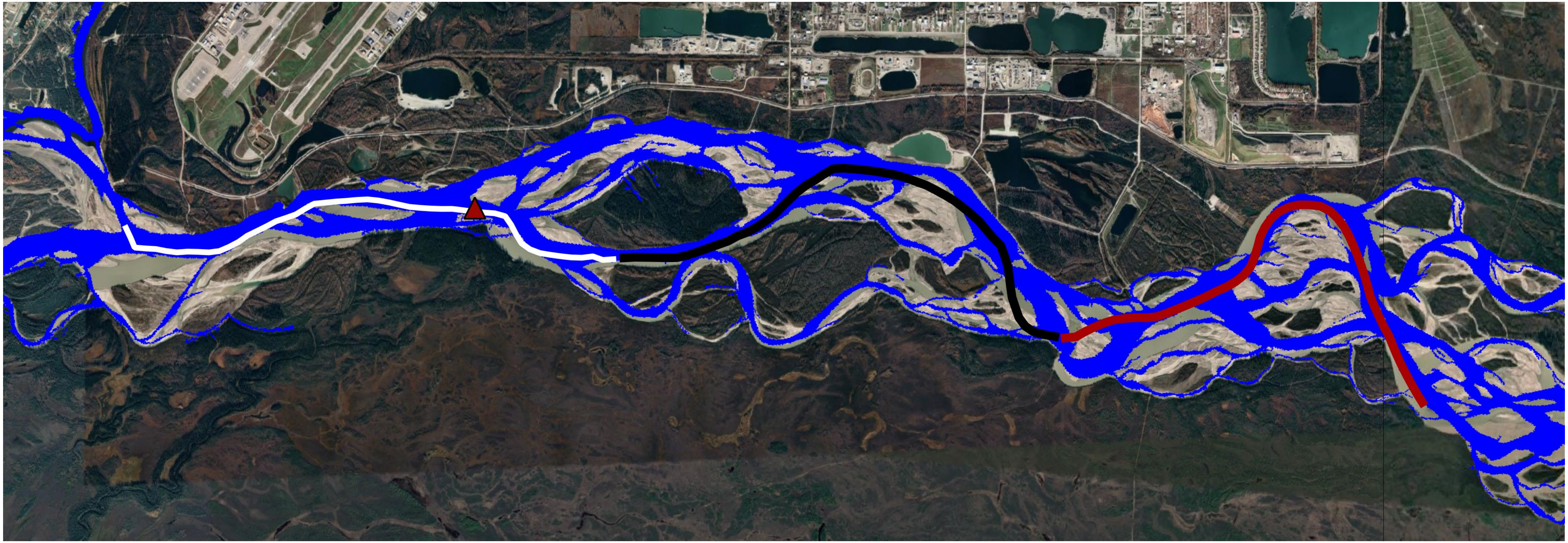
# The Tanana multi-threaded river discharge estimation



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SWOT Science Team Meeting, 2022

# Can Mass-conserved Flow Law Inversion (McFLI) work in complex rivers?

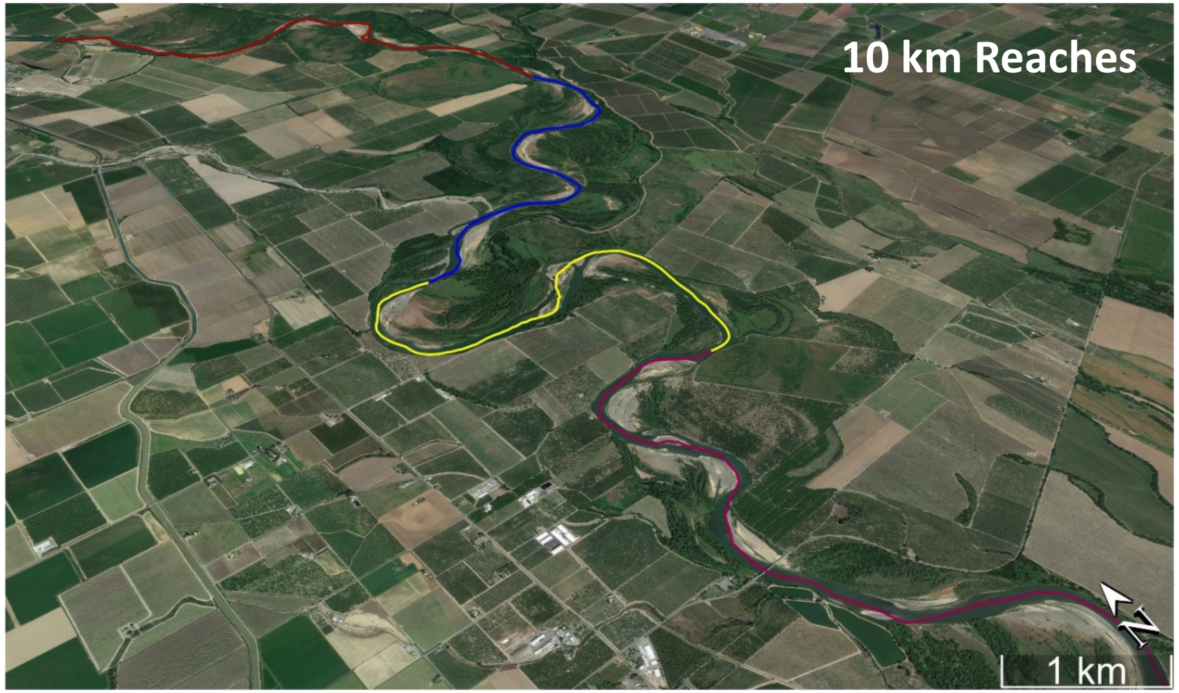
**1- Objectives**

2- ArcticDEM data

3- Equivalent single channel

4- Final remarks

1 - Given a set of contiguous reaches with no tributaries:




2 - Enforce continuity:

$$\frac{\Delta Q}{\Delta x} + \frac{\Delta A}{\Delta t} = f_j$$


At each reach, $f_j$ should be 0

One can write a likelihood function related to the $\sum f_j$

# Tanana River Observations: ArcticDEM – led by Michael Durand, Ian Howat (Byrd Polar, The OSU)

Image sources:
- Quickbird 2
- WorldView 1- 3

→ Water detection → Shoreline delineation → Height measurement at shoreline → River centerline → Height and width profiles

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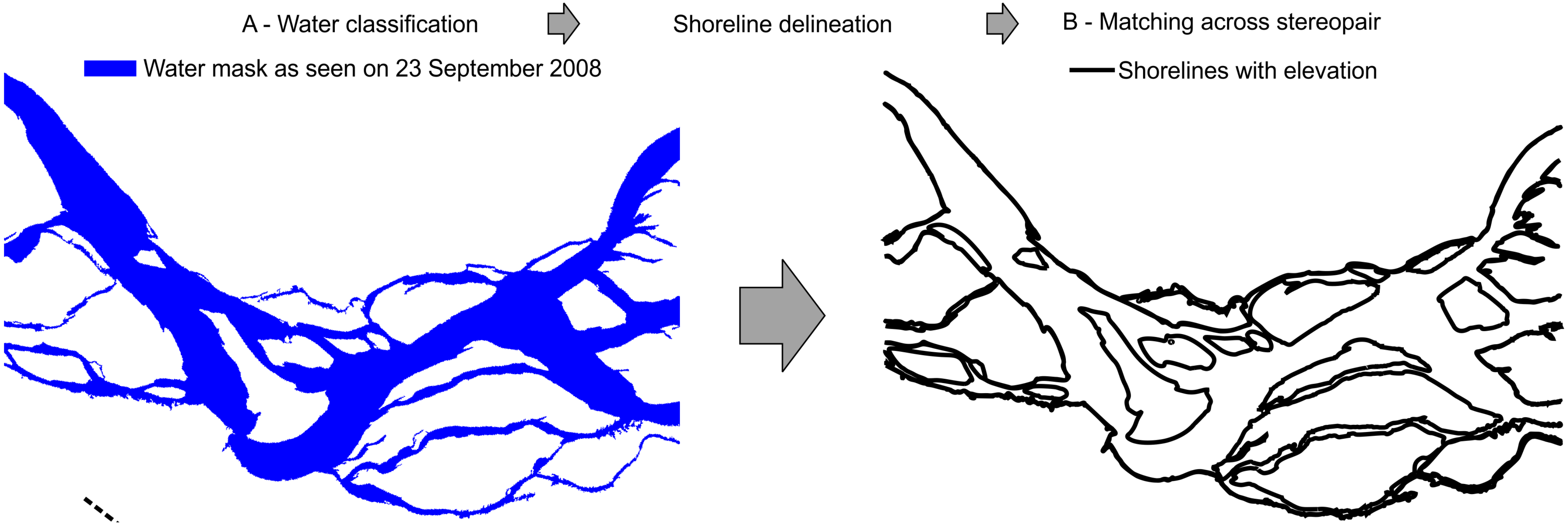
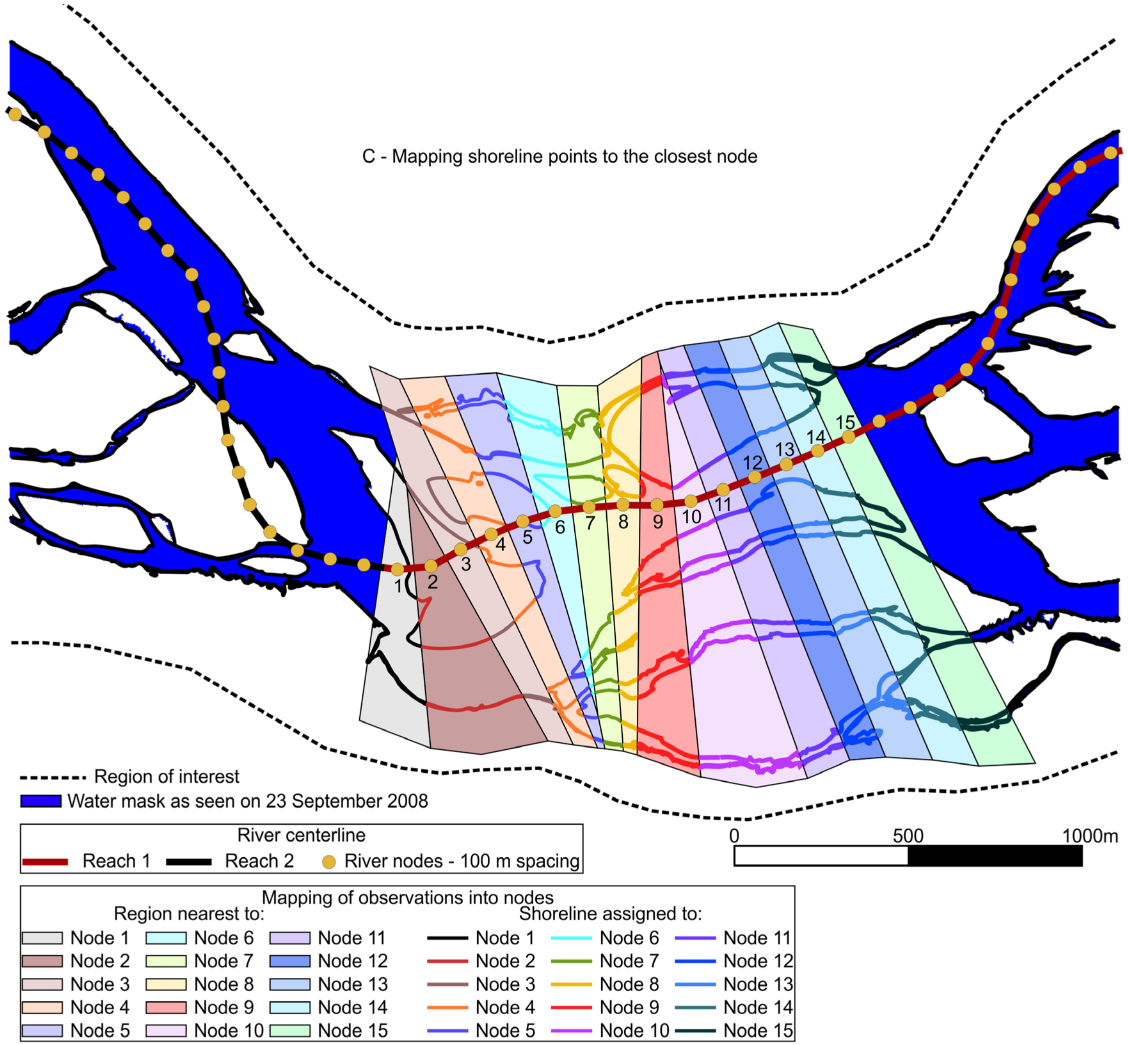


# Tanana River Observations: ArcticDEM



- Shoreline heights mapped to the nearest “river node”
- Process similar to RiverObs
- Nodes mapped into reaches for reach-average height and slope.



# Tanana River Observations: ArcticDEM

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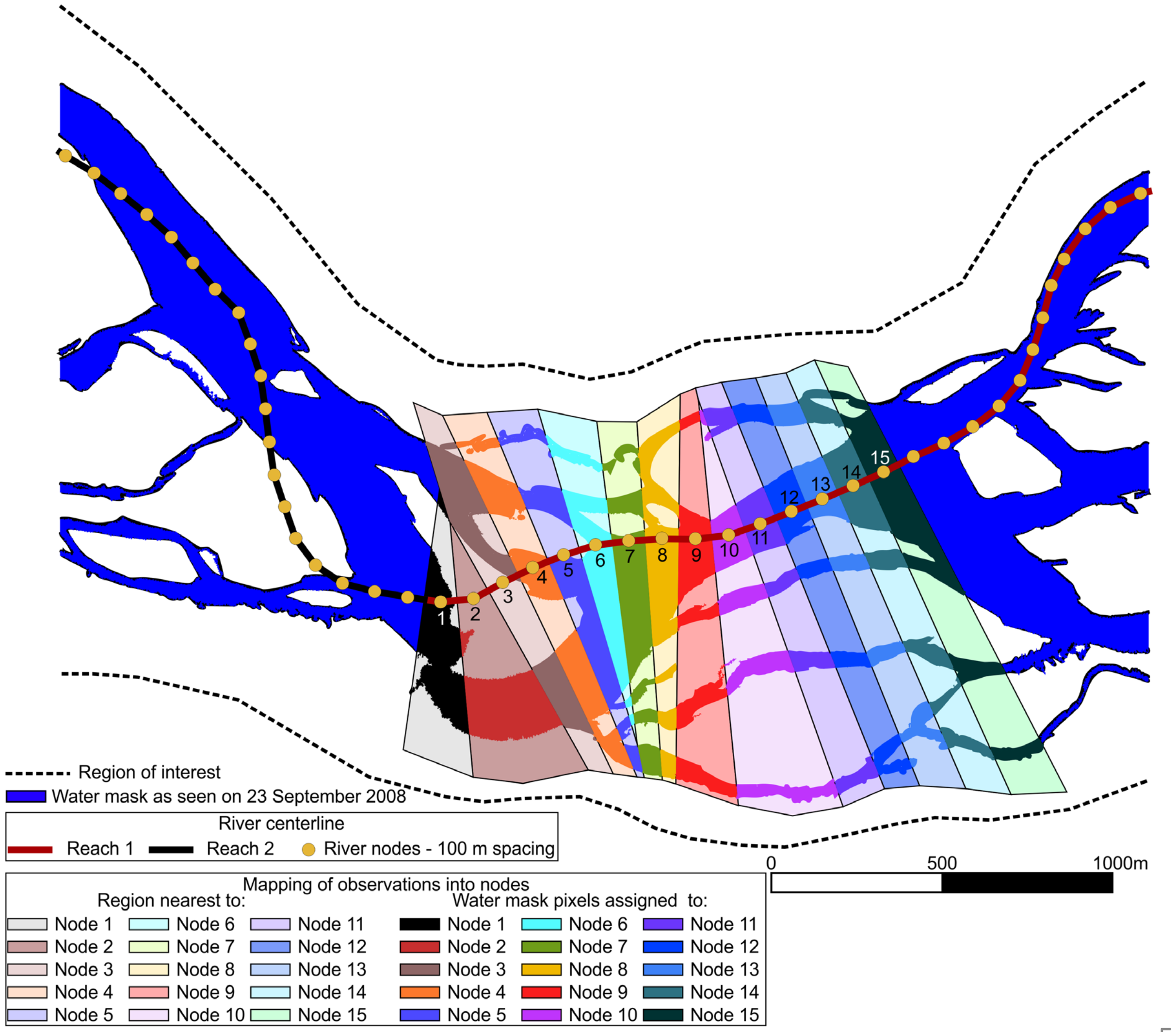
- Water pixels are mapped to the nearest node
- Node surface area = Σ area of all pixels
- Reach area = Σ area or all nodes
- Reach width = Area/reach length



# Quality control

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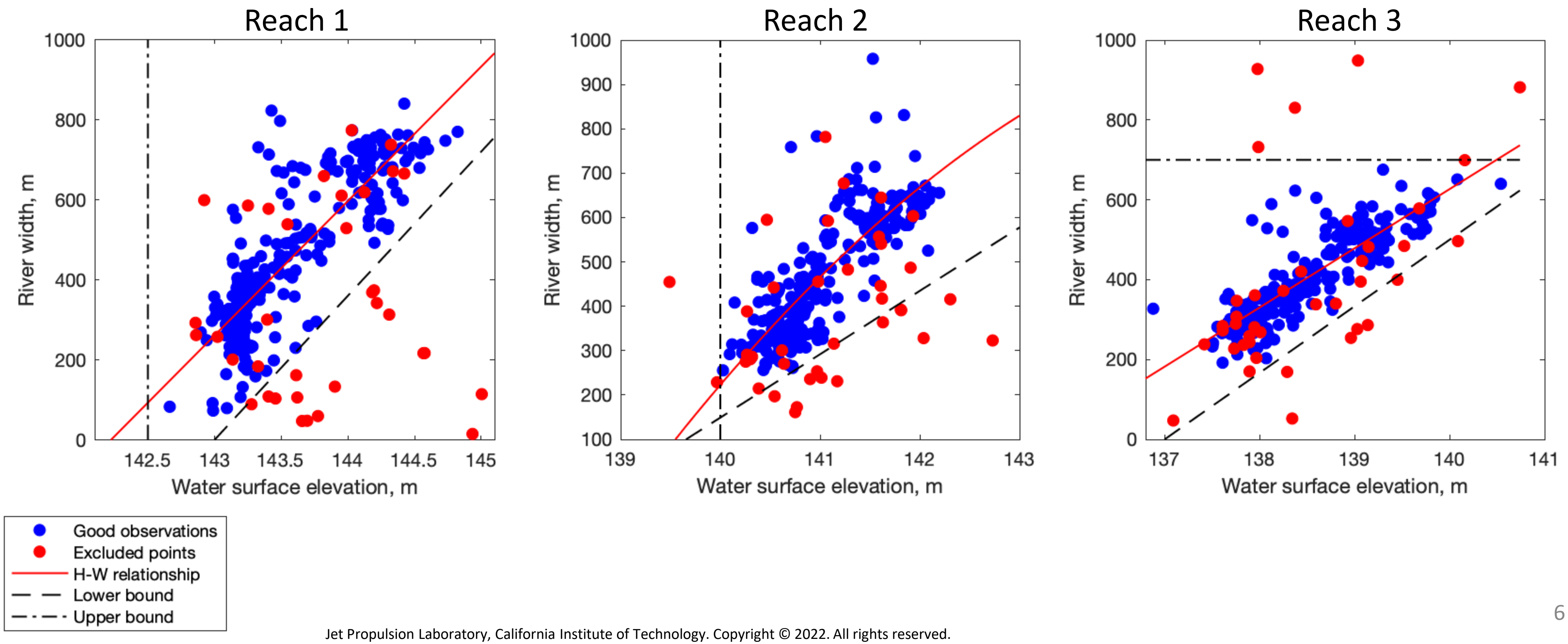
- Visual inspection of width/elevation pairs ⇨ lower/upper bounds
- Points must pass QC for all three reaches simultaneously



# Time series of “SWOT-like” observations

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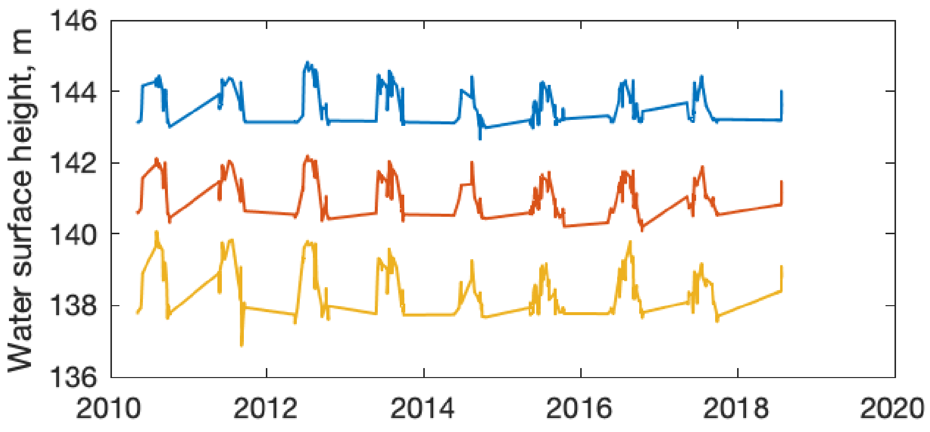
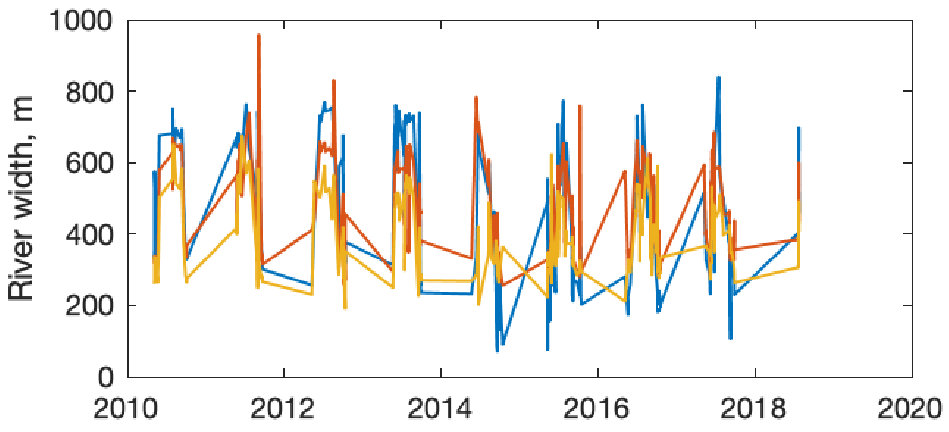
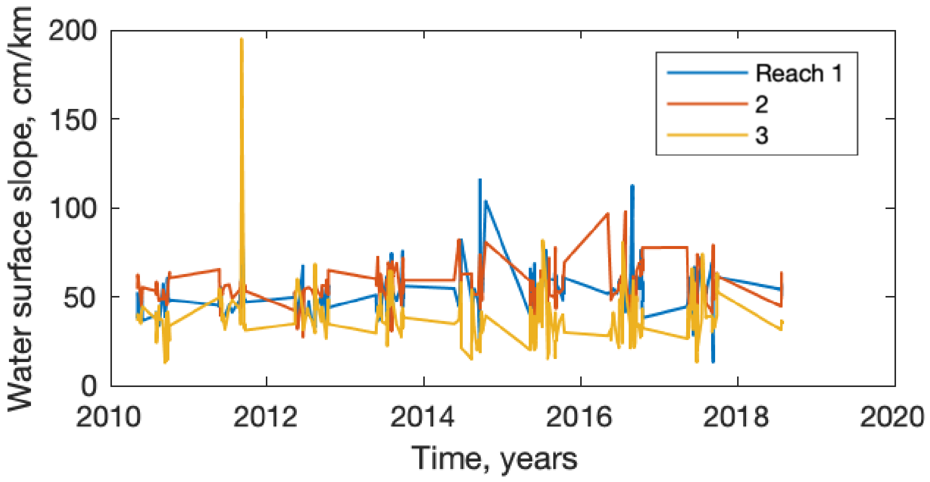
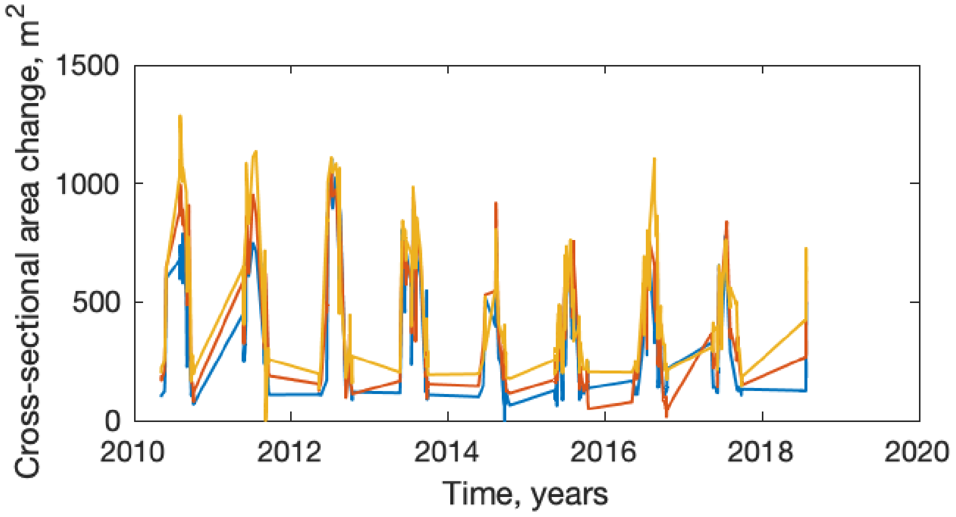


# Can Manning's equation be applied to complex reaches?



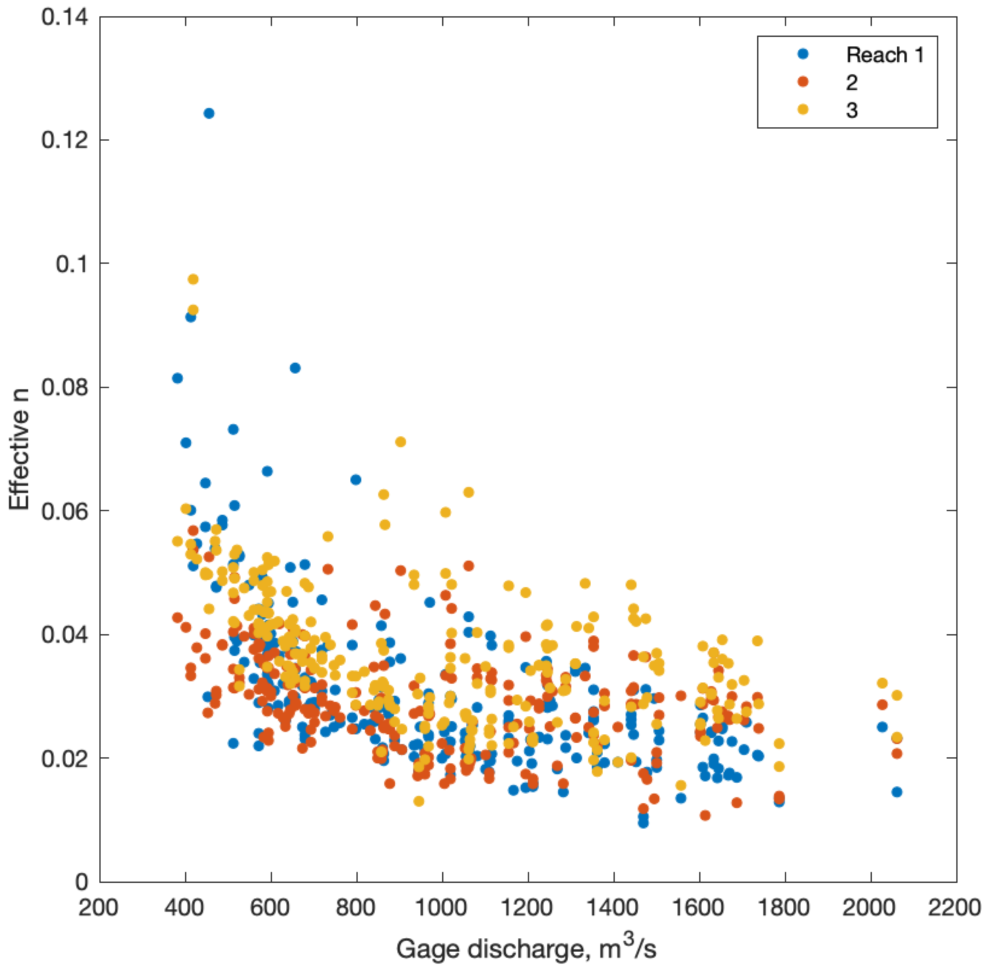
- Used discharge at the Fairbanks USGS gage to identify the optimal unobservable fraction of the cross-sectional area ($A_0$).
- Computed the equivalent n at each point in time:

$$n = \frac{1}{Q}(A_0 + \delta A)^{5/3} W^{-2/3} \sqrt{S}$$

- Evaluated the dependency of n discharge values

# Can Manning’s equation be applied to complex reaches?






- Treating the effective n as a closure term.
- Effective n was within a reasonable range.
- The expected decreases in n with Q with asymptotes between 0.02 and 0.03.
- Height, Width, Area, Slope were much noisier than the expected SWOT errors. May explain the noise in the effective n.

# Modeling n dependency on discharge

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- One of the n parameterizations is in terms of "hydraulic depth" defined as A/W

$$n = n_a \left( \frac{A_0 + \delta A}{W} \right)^b$$

- $n_a, A_0, b$ found through optimization using USGS-measured Q
- Unfortunately, hydraulic depth did not vary considerably, leading to unsatisfactory results.
- Next steps: testing alternative parameterization