Particle path length estimation: a signal processing approach

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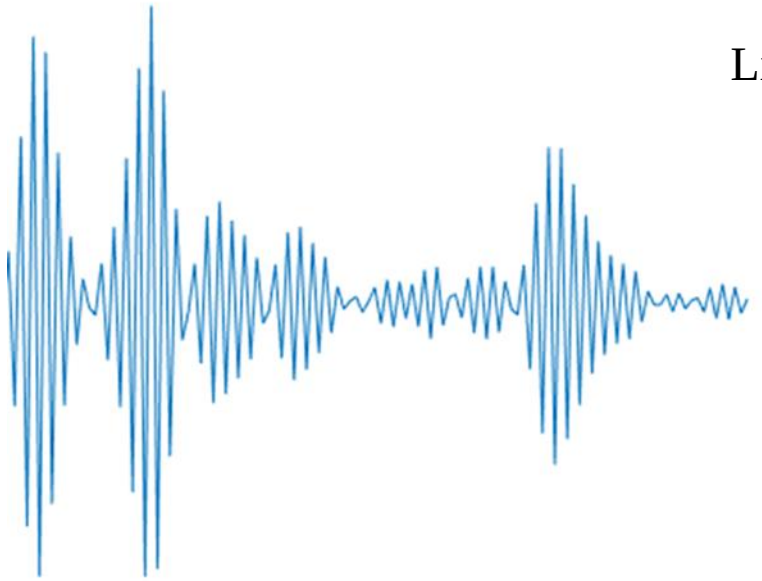
EGU 2022



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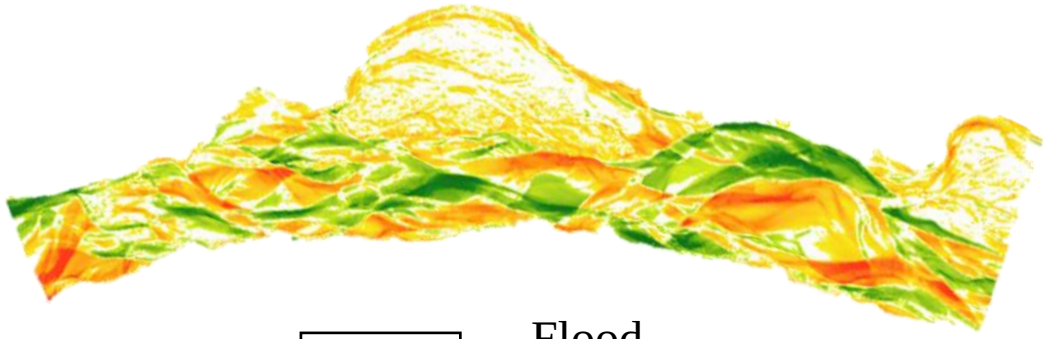
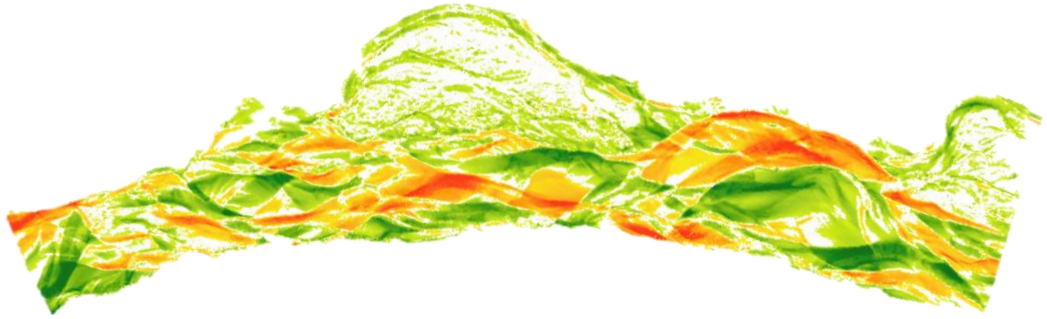
Morphological Method

DEM 1

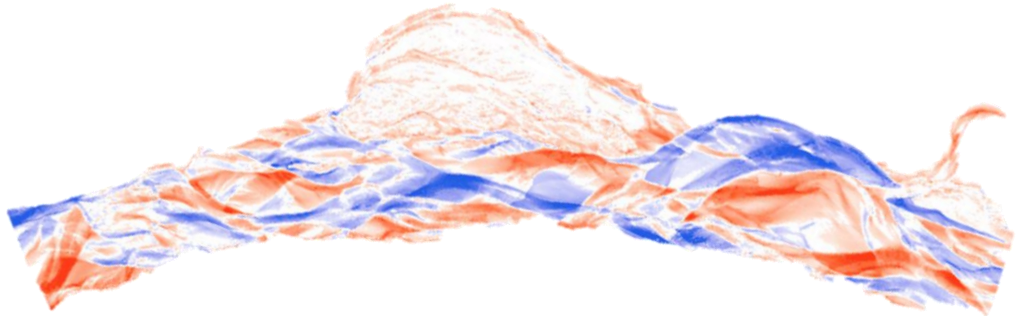


Flood

DEM 2



DoD

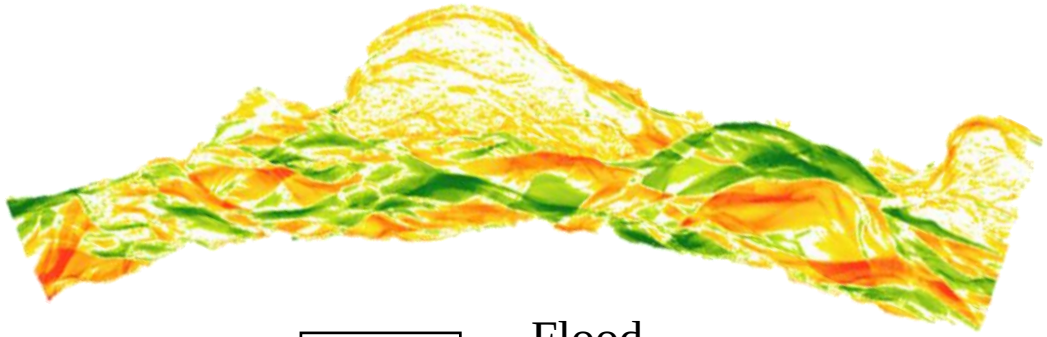


Sediment flux

$$(1-p)\Delta V = (Q_{b_{in}} - Q_{b_{out}})\Delta t$$

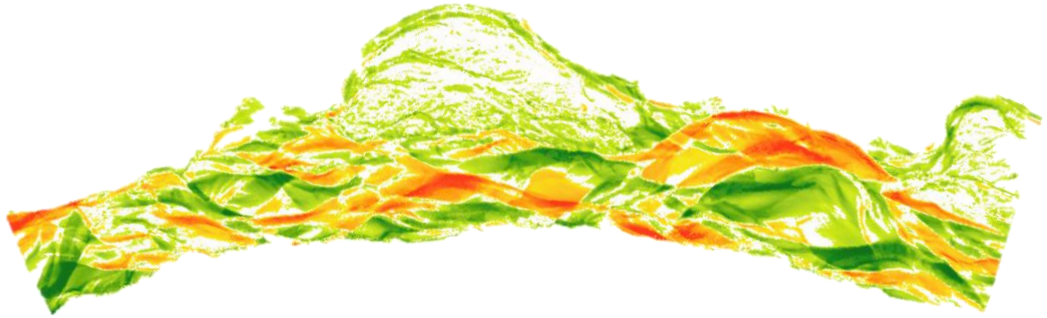
Morphological Method

DEM 1

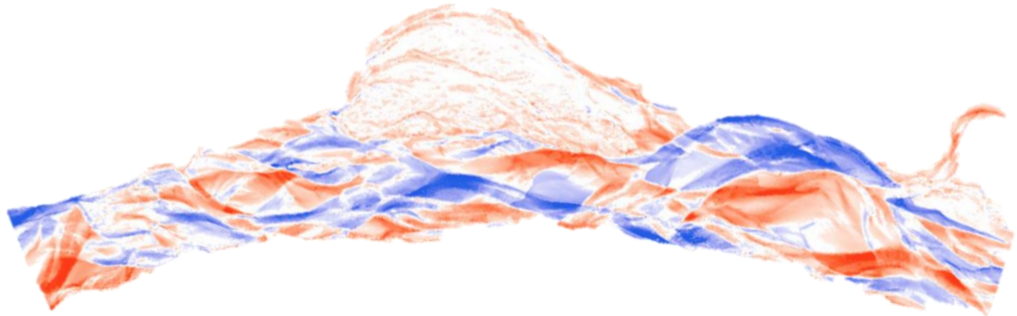


Flood

DEM 2



DoD



$$Q_b = v_b \sum v_e (1-p) \rho_s \Big/ L_c$$

Virtual velocity

$$V_b = \text{Length} \Big/ \text{Time}$$

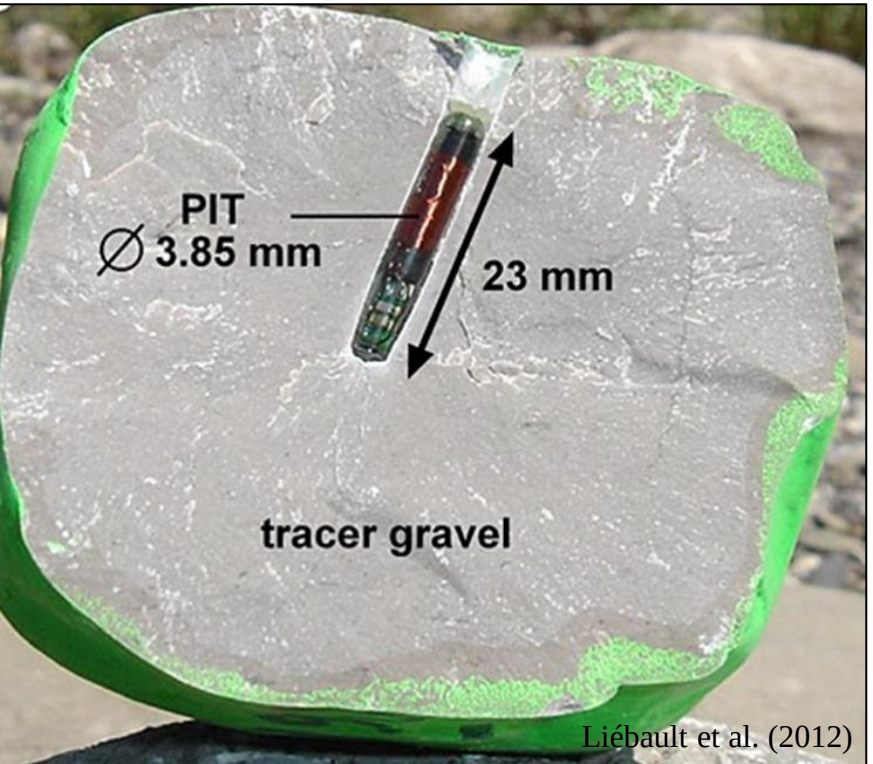
Vericat et al. 2017

Tracer studies

Time intensive

Low recovery rate (hard to find!)

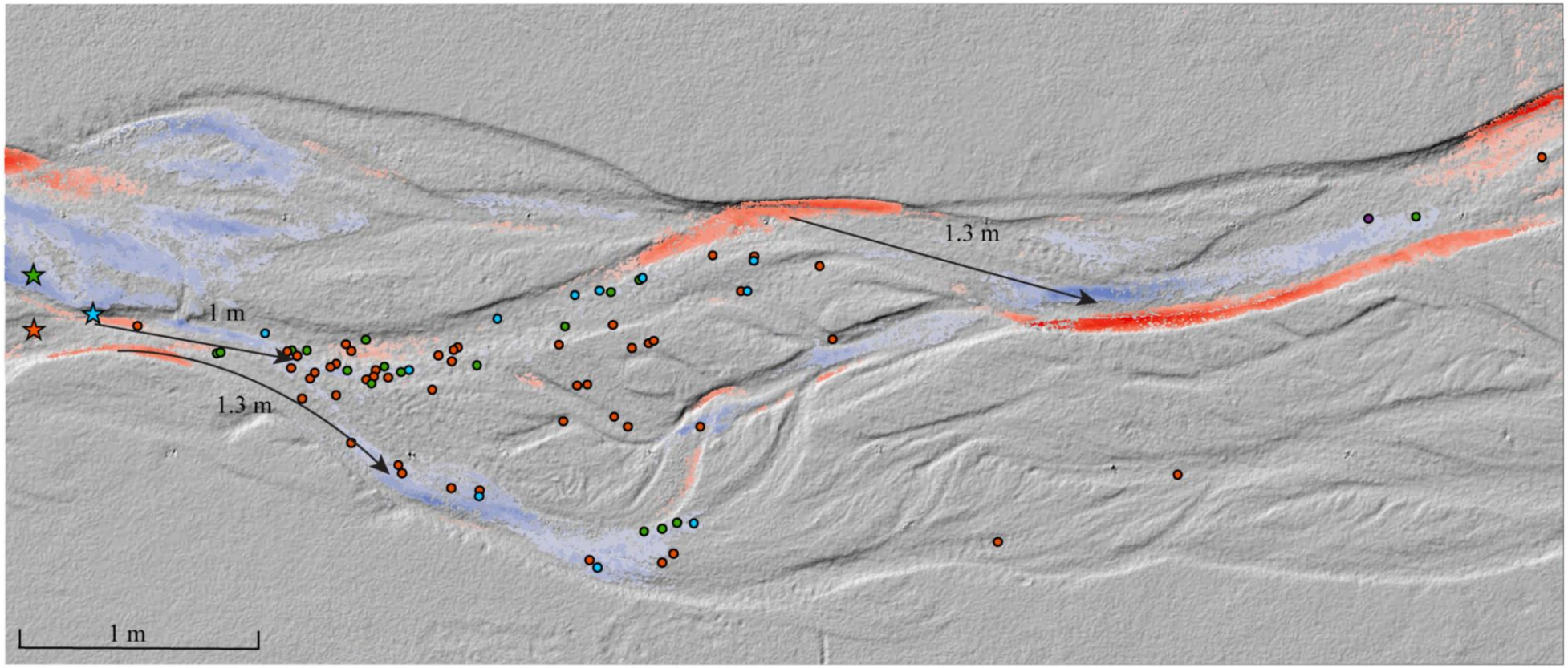
Morphologically specific



Liébault et al. (2012)

Objectives

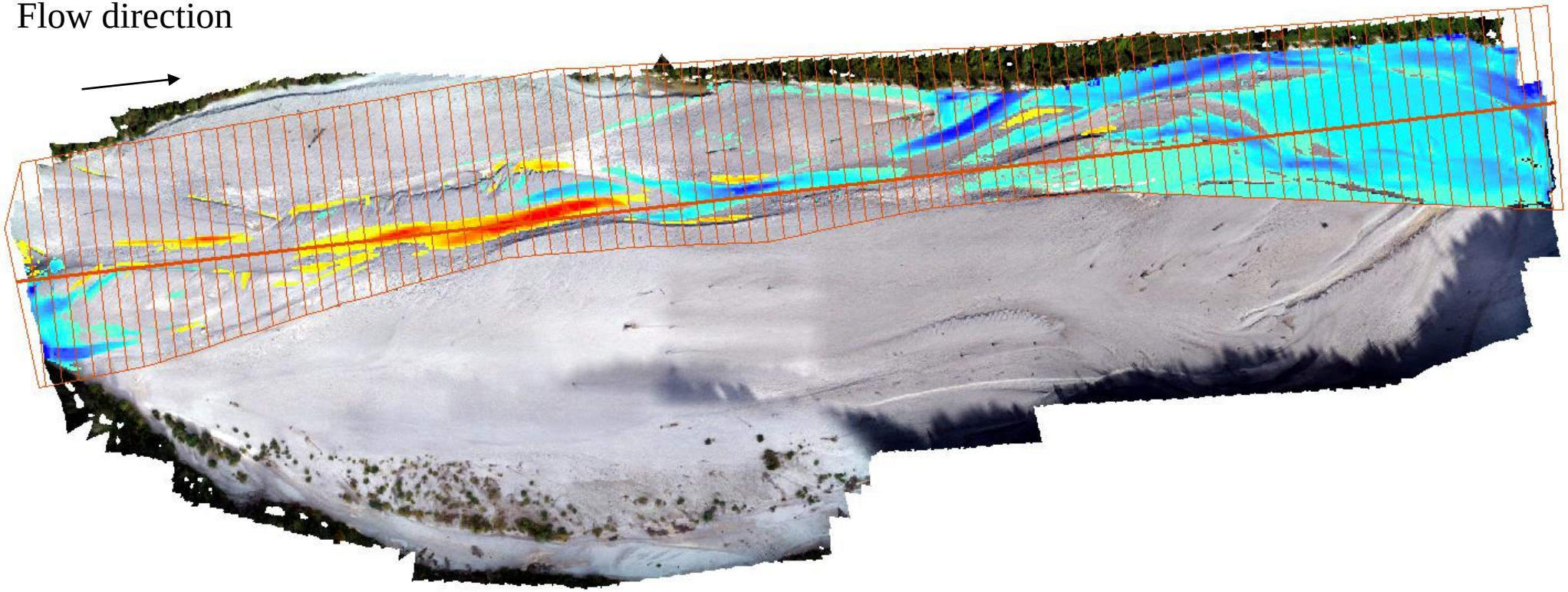
- **Estimate particle path length from DoD for use in morphological method**
- Validate the estimates with published data



Data from Kasprak et al. 2015

Segment the DoD

Flow direction



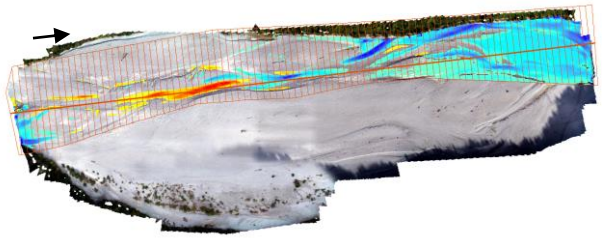
4.7 m

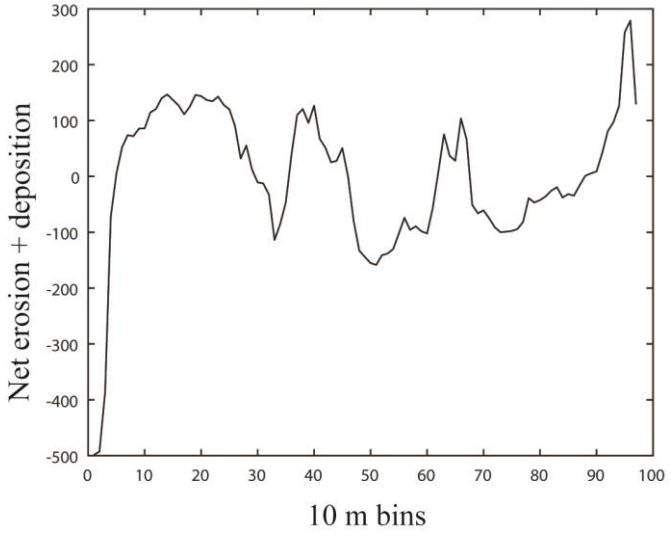
-2.4 m

Fluvial Corridor Toolbox

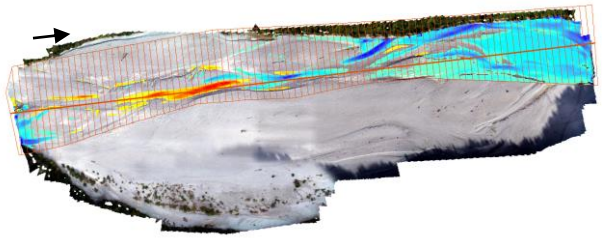
Roux et al. 2015

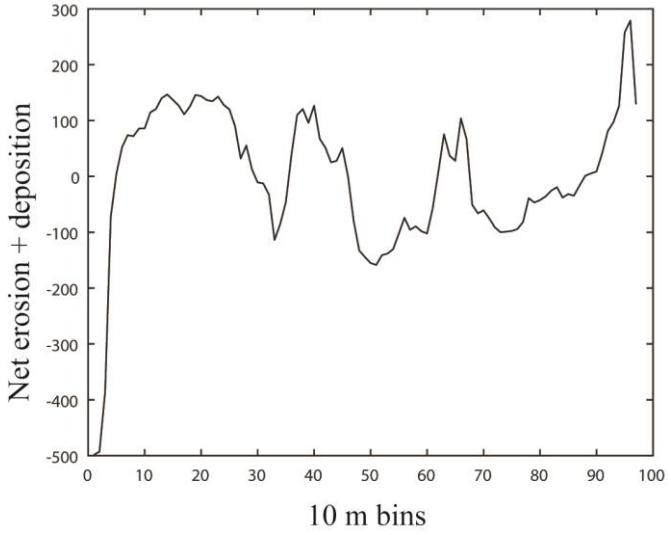
Sum each bin

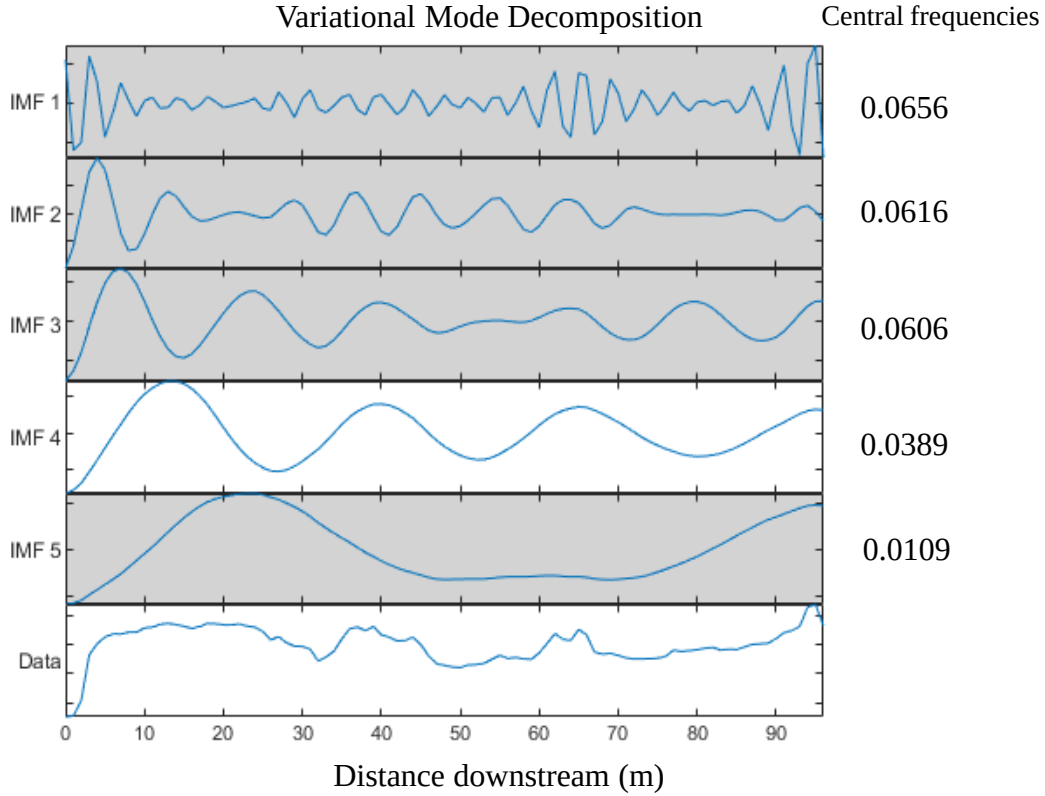



Net erosion + deposition
300
200
100
0
-100
-200
-300
-400
-500
0
10
20
30
40
50
60
70
80
90
100
10 m bins

Decompose the “signal”







Trento Flume Experiment

- 9 runs at 1 L/sec
- Alternate bar morphology
- Repeat DEMs
- Measured sediment flux

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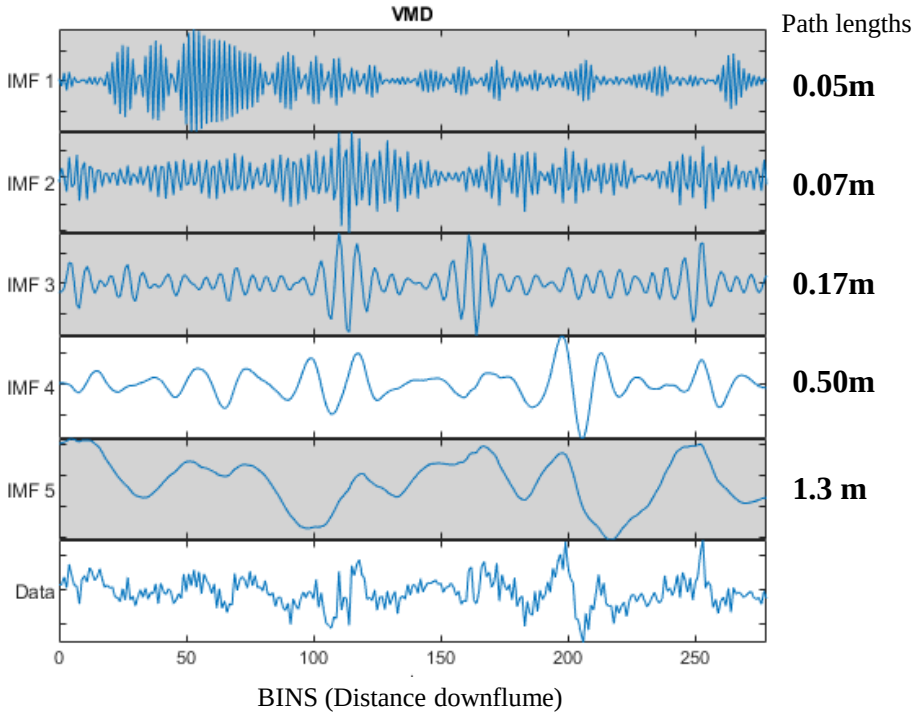
DoD 4-3



Path lengths

0.05m

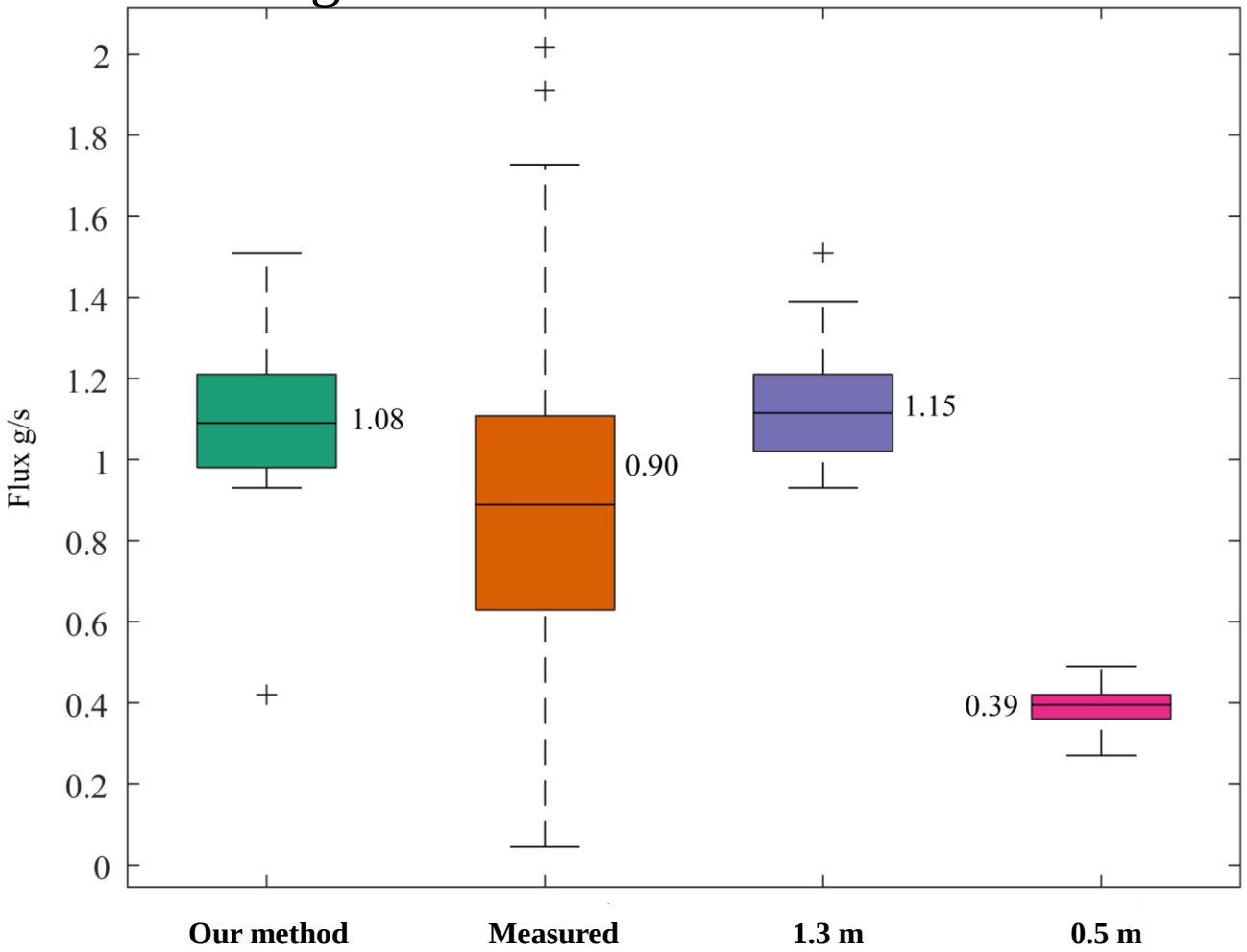
0.07m

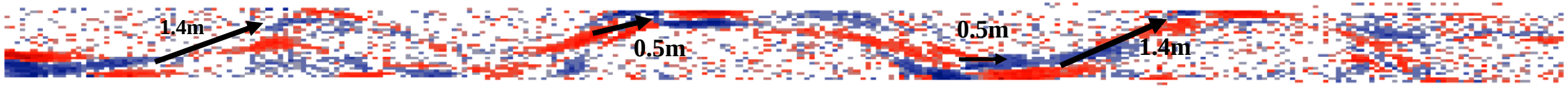
0.17m

0.50m

1.3 m

Average all runs





McQueen et al. 2020

2018-2019
5 events
RFID tracer data
DoDs

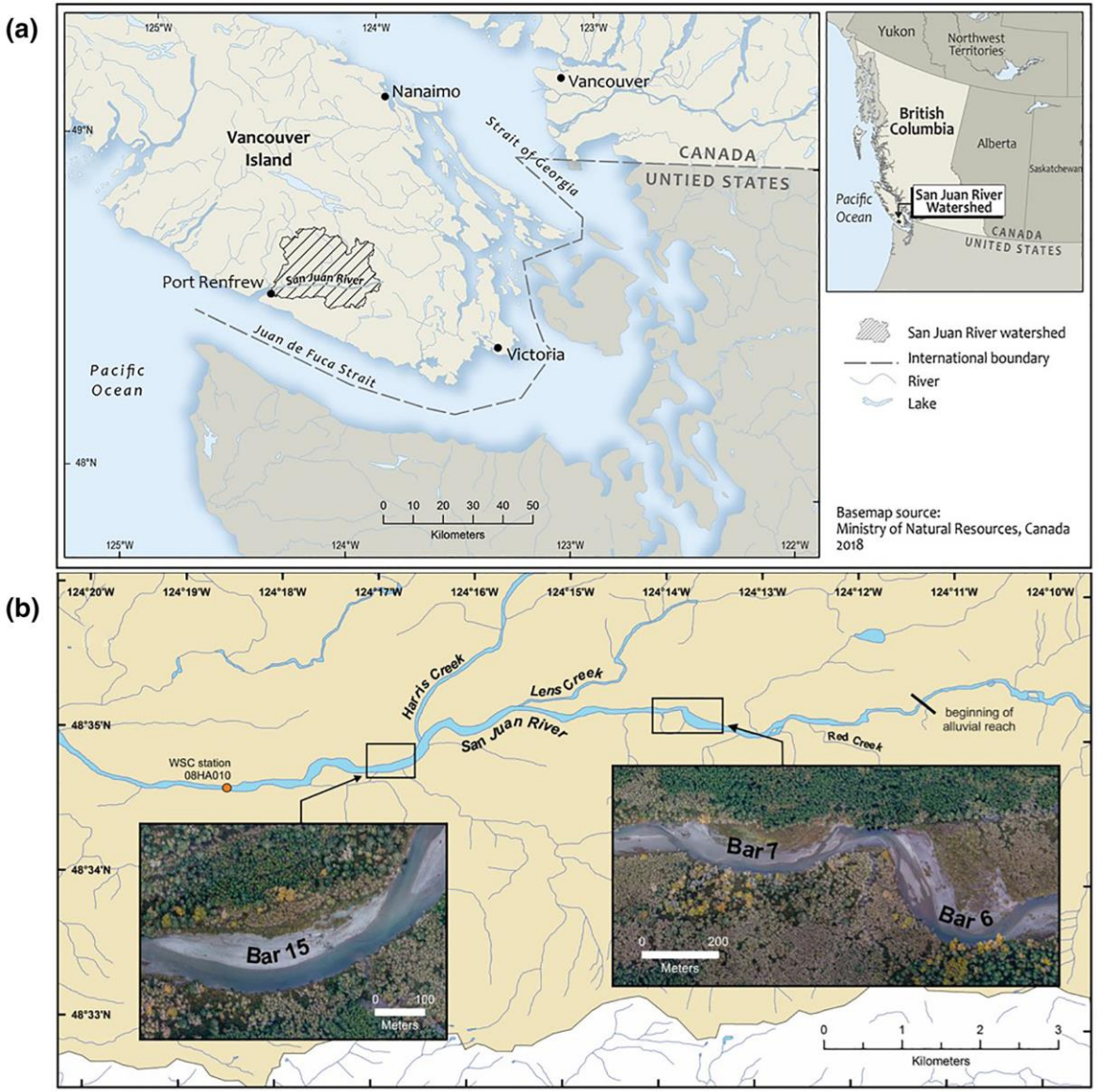


Figure 1 McQueen et al. 2020

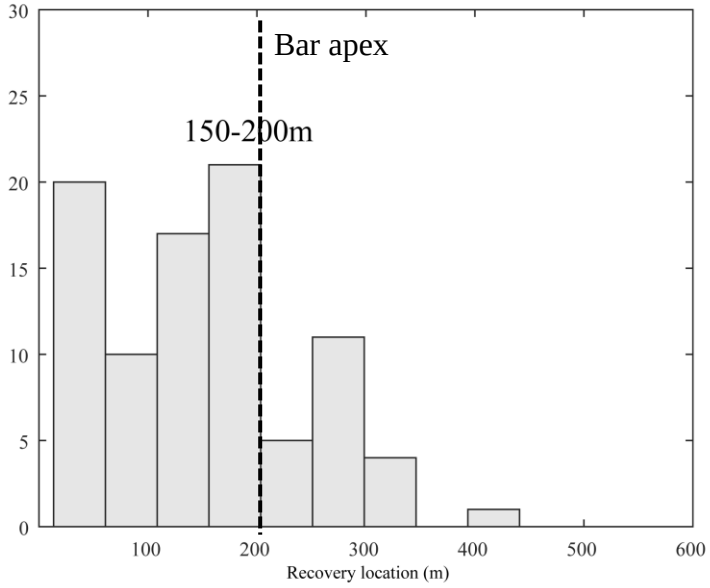
Bar 6

Our method

217 m

Measured average

153 m



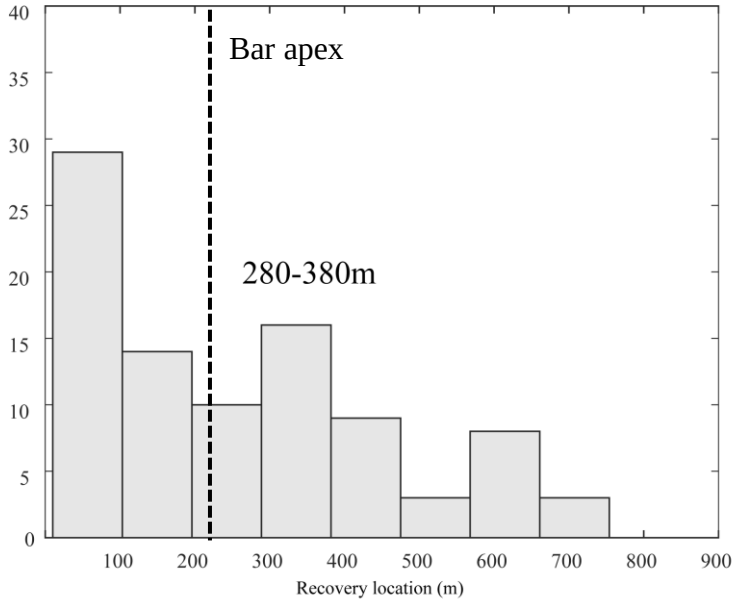
Bar 7

Our method

324 m

Measured average

255 m



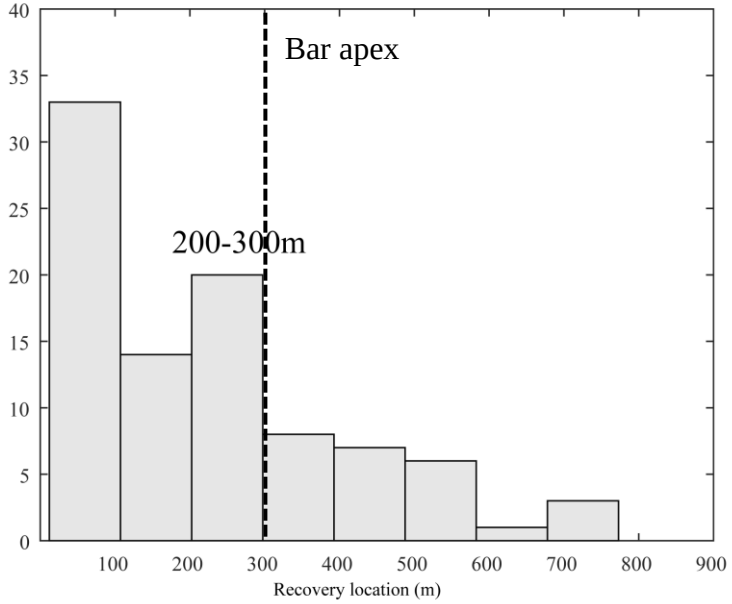
Bar 15

Our method

323 m

Measured average

221 m

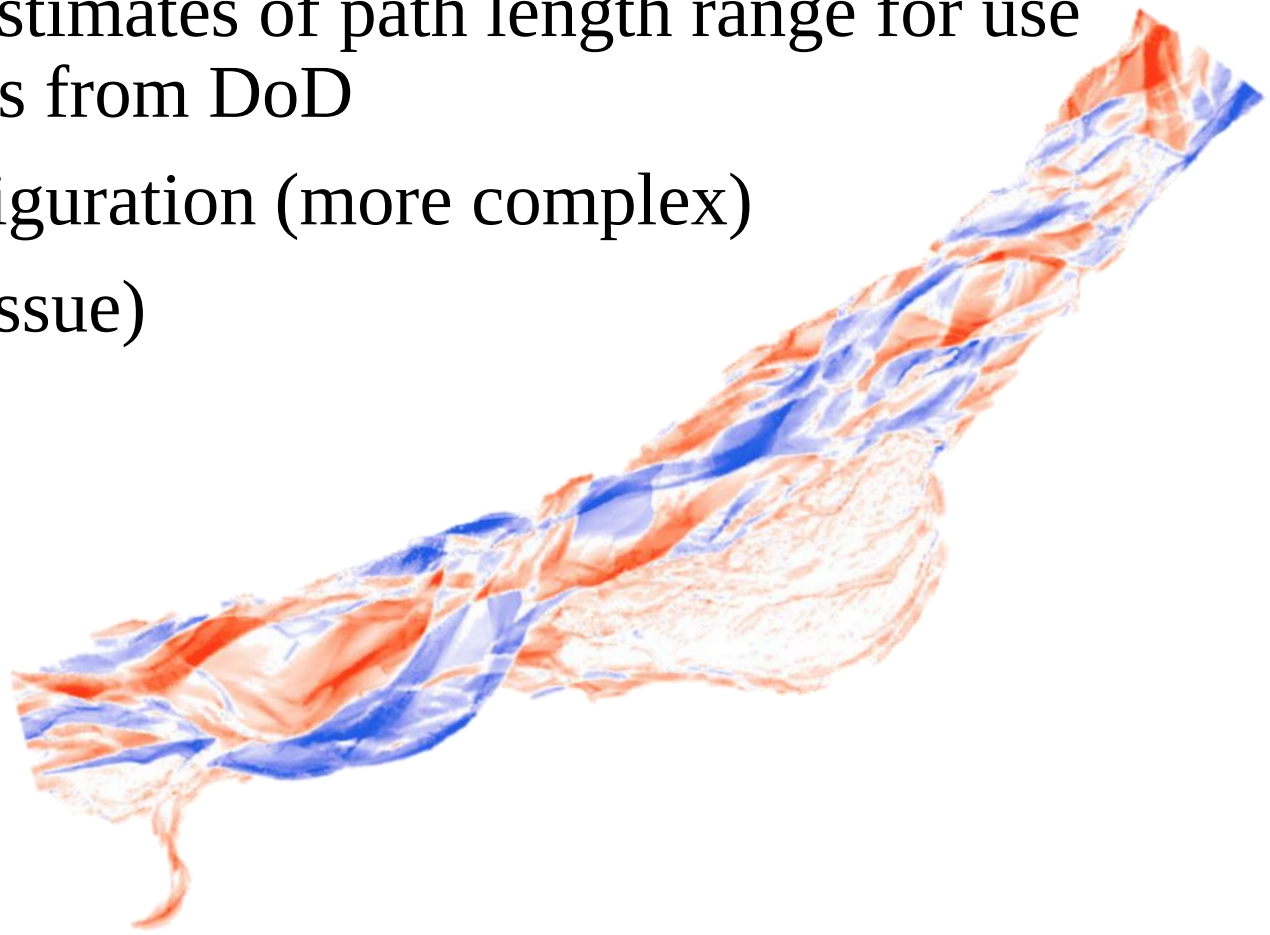


Conclusions

- Our method provides plausible estimates of path length range for use in sediment transport calculations from DoD
- Next application to braided configuration (more complex)
- Time is critical! (compensation issue)

$$\frac{Q_b = v_b \sum v_e (1-p) \rho_s}{L_c}$$

$$V_b = \frac{\text{Length}}{\text{Time}}$$



Questions?

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