In-situ bedload measurements using MBES and ADCPs

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Outline

- Acoustic Mapping Velocimetry (AMV) Background
- AMV applied to Multi-Beam Echo Sounder (MBES) Survey
  - Particle Image Velocimetry applied to Acoustic Maps
  - Estimation of the Bedload Rates
- Planning for Year two of the project

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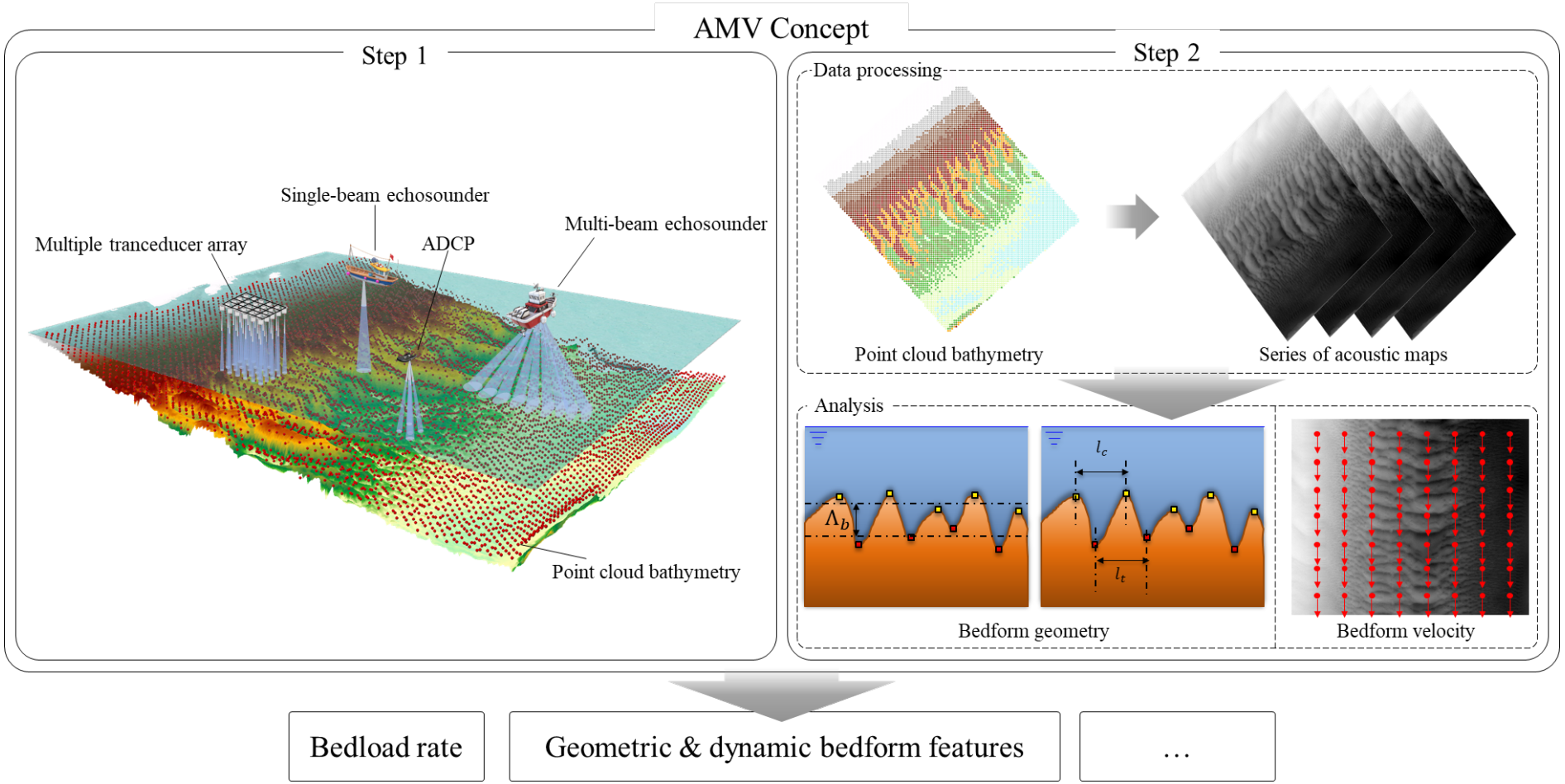
Acoustic Mapping Velocimetry

Implementation of Particle Image Velocimetry (PIV) protocols to river bathymetry acoustic maps to obtain bedload dynamics and rates



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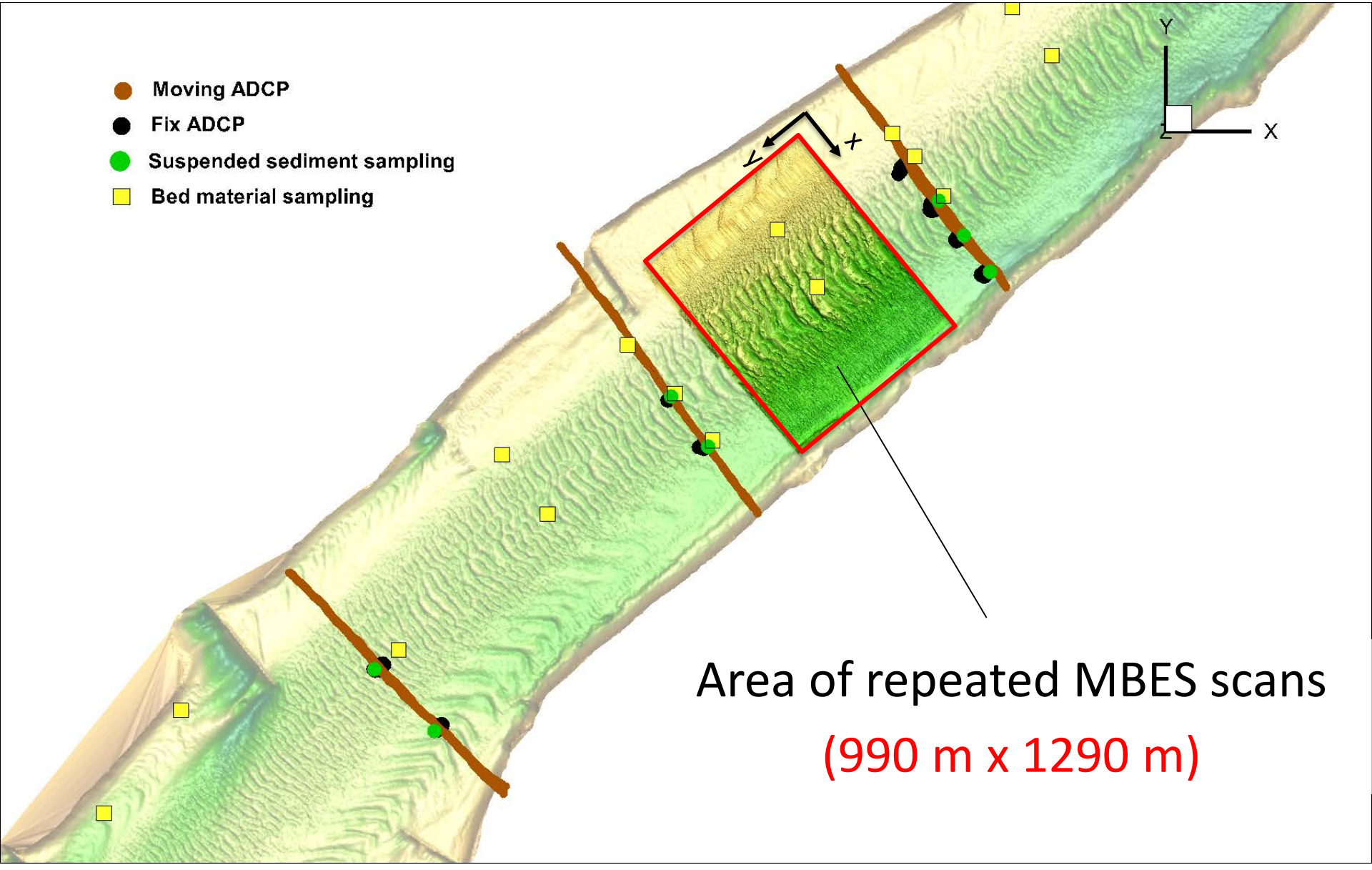
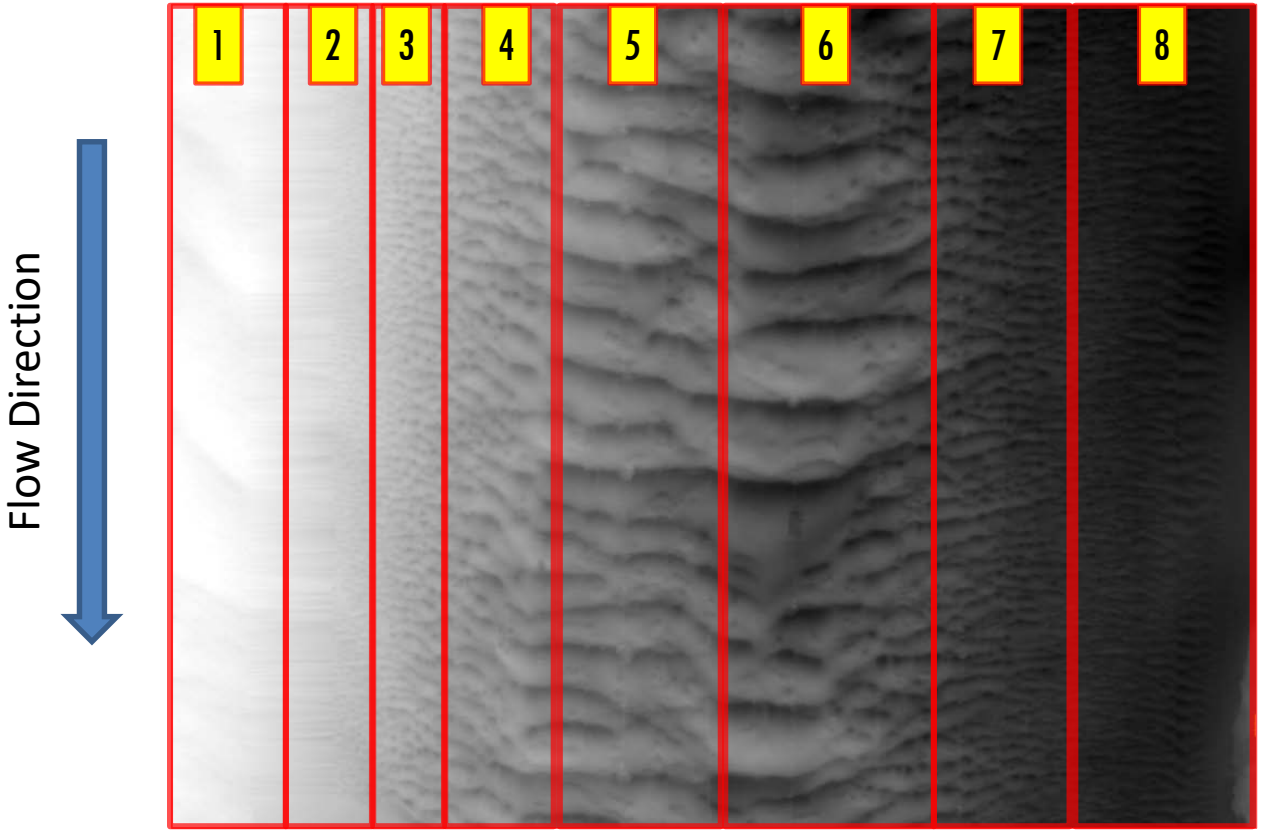
USACE acoustic measurements in Mississippi

High water conditions (April 29, 2013, Q = 27800 m^3/s)



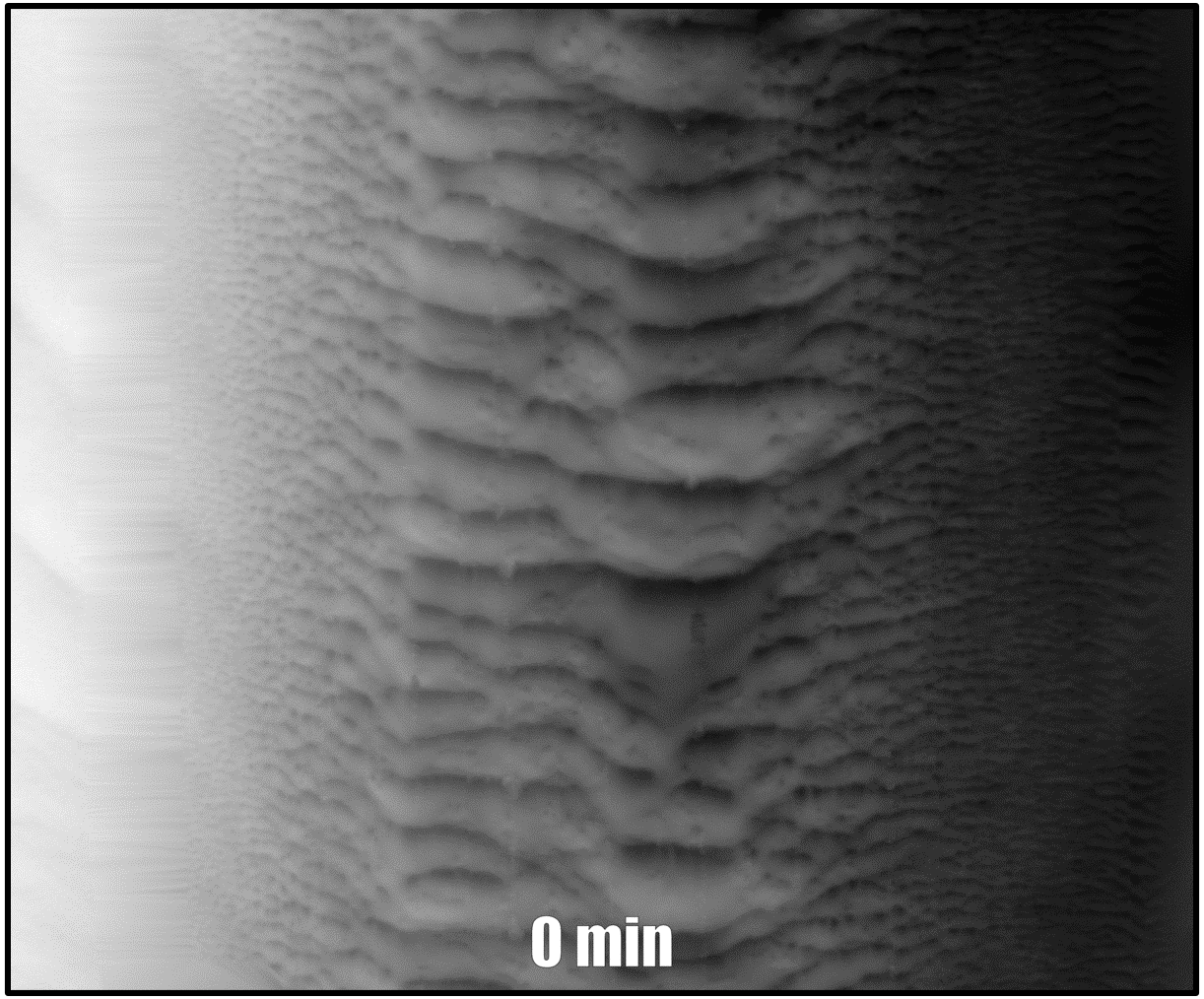
USACE MBES measurements in Mississippi

8 zones across the section featuring different bedform characteristics



USACE MBES measurements in Mississippi

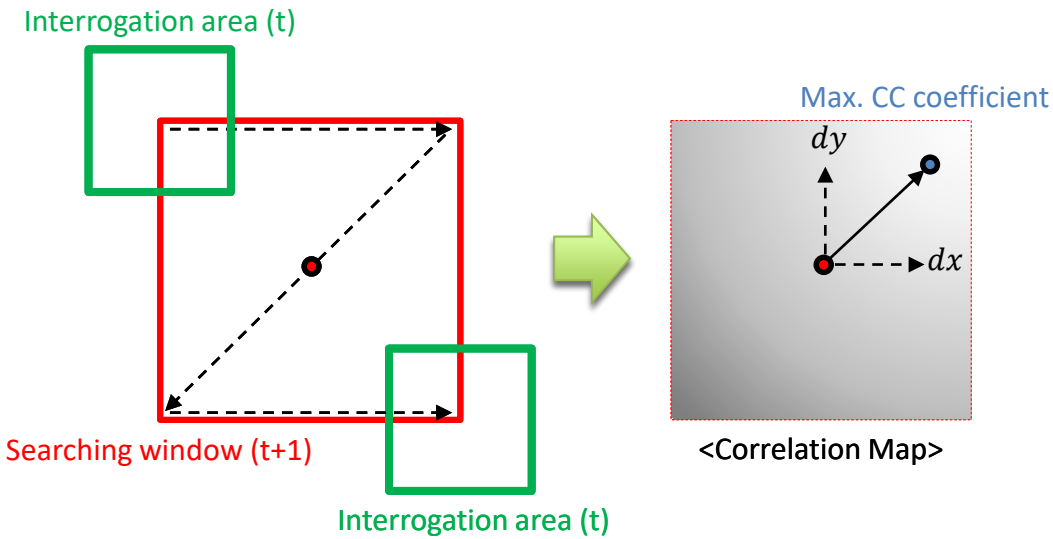
Four acoustic maps (survey time ~ 5 hours)



Developed & Tested PIV Algorithms

Cross-Correlation (CC) Algorithm

Spatial 2D cross-correlation

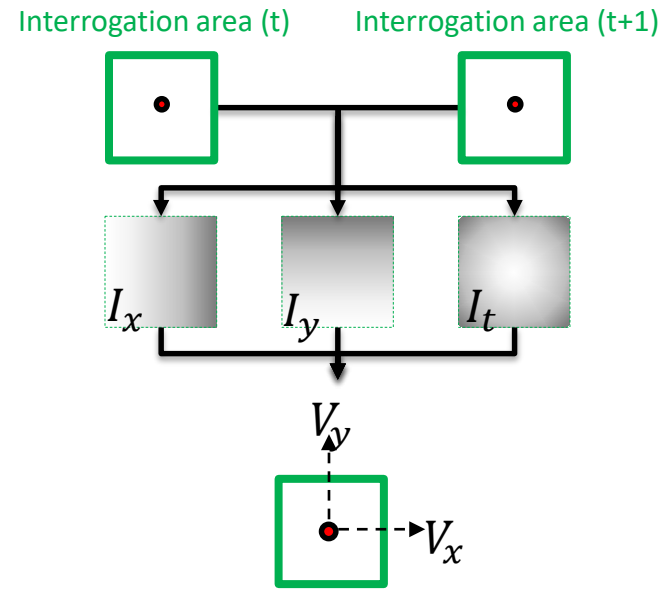


2 implementation approaches:

- **Whole image one set of PIV parameters (Conventional CC)**
- **Segmented image & individual PIV parameters (Optimized CC)**

Optical Flow (OF) Algorithm

Convolution of spatial gradients (x, y, t)



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Bedload rate calculation

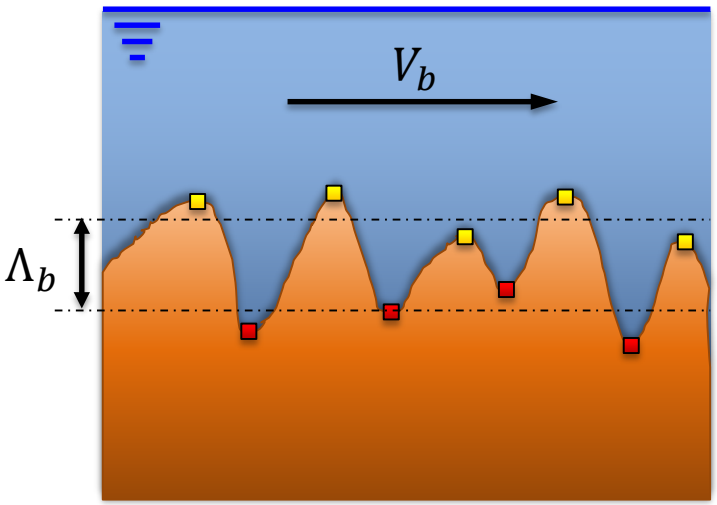
Exner Equation

Particle Image Velocimetry (PIV)

$$q_b = \frac{1}{2}(1-p)V_b\Lambda_b\beta$$

Bedform Tracking Tool (BTT)

- q_b: Bedform transport rate per unit width [m³/s/m]
- p: Bedform porosity (for sand = 0.4)
- V_b: Average bedform velocity (streamwise) [m/s]
- Λ_b: Average bedform height [m]
- β: Shape factor (for triangular shape = 0.5)



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FISP Project Planning

First year

- validating AMV with in-situ with data available at USACE-ERDC from previous MBES surveys

Second year

- establishing protocols for AMV implementation using virtual ADCP surveys (development of the “Virtual ADCP” software package)
- Acquiring in-situ ADCP data (USGS station 07250550, Arkansas River) with the pre-established protocols to test the AMV performance in conjunction with ADCP data

FISP Project Planning

Task	Description	Charge	FISP$
T.1	Development of specifications for acquiring acoustic maps suitable for AMV using MBES (includes setting of tradeoffs between data collection time and map resolution)	Muste	
		Postdoc	x
T.2	Development of data acquisition protocols with consideration of non-homogeneity of bedform dynamics in natural streams	Muste	
		Postdoc	x
T.3	Optimization of the analytical algorithms for bedload rate estimation (includes conversion of acoustic maps to grey-level scale, automated algorithms for determination of bedform geometry, and testing of various bedload rates algorithms)	Muste	
		Postdoc	x
T.4	Production of the end-to-end software package for AMV field implementation	Postdoc	x
T.5	Testing the AMV with datasets of time-sequenced bathymetric sets acquired with MBES (includes validation with ISSDOTv2 as reference)	Abraham	
		Postdoc	x
T.6	Development of specifications for acquiring acoustic maps suitable for AMV using ADCPs (includes establishment of tradeoffs between data collection time and required map resolution)	Wagner	
		Postdoc	x
T.7	Acquisition of time-sequenced bathymetric datasets with ADCPs	Wagner	x
T.8	Testing the AMV with datasets of time-sequenced bathymetric sets acquired with ADCPs	Postdoc	x
T.9	Validation of AMV with MBES and ADCP collected at the same site	Wagner	
		Postdoc	x
T.10	Report writing and preparation of knowledge-transfer materials	Muste	
		Postdoc	x