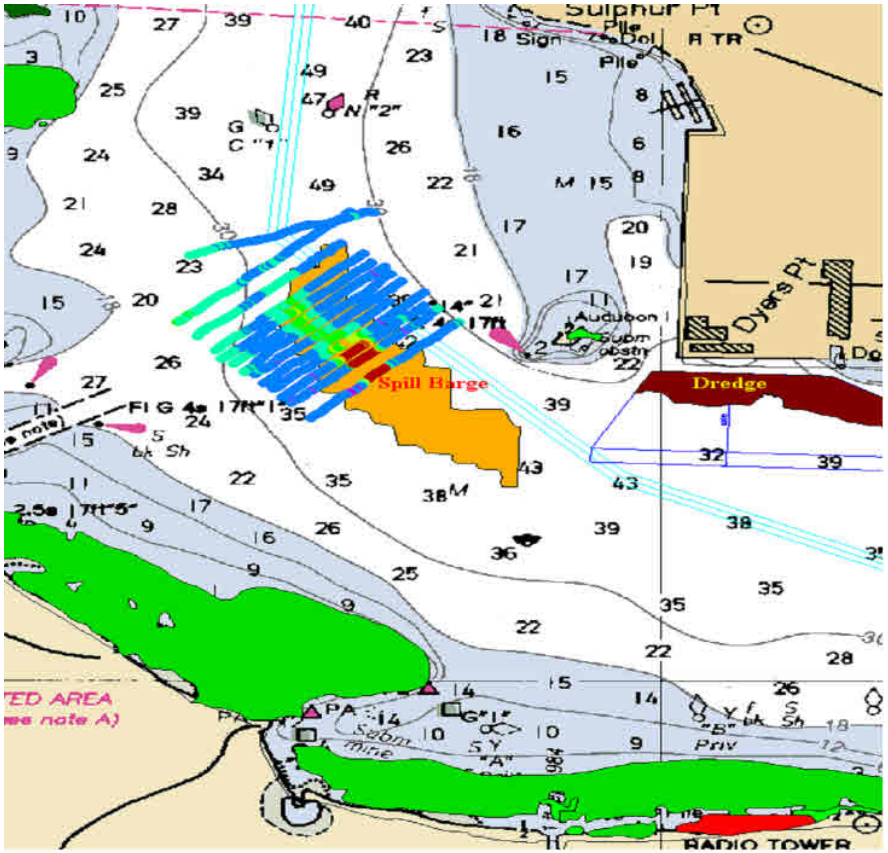
Modeling of Dredging-Induced Sediment Resuspension: Remaining Questions and Progress Toward Answers

Thomas Borrowman
Douglas Clarke
Tahirih Lackey
US Army Corps of Engineers
Research and Development Center,
Vicksburg, MS

Motivation

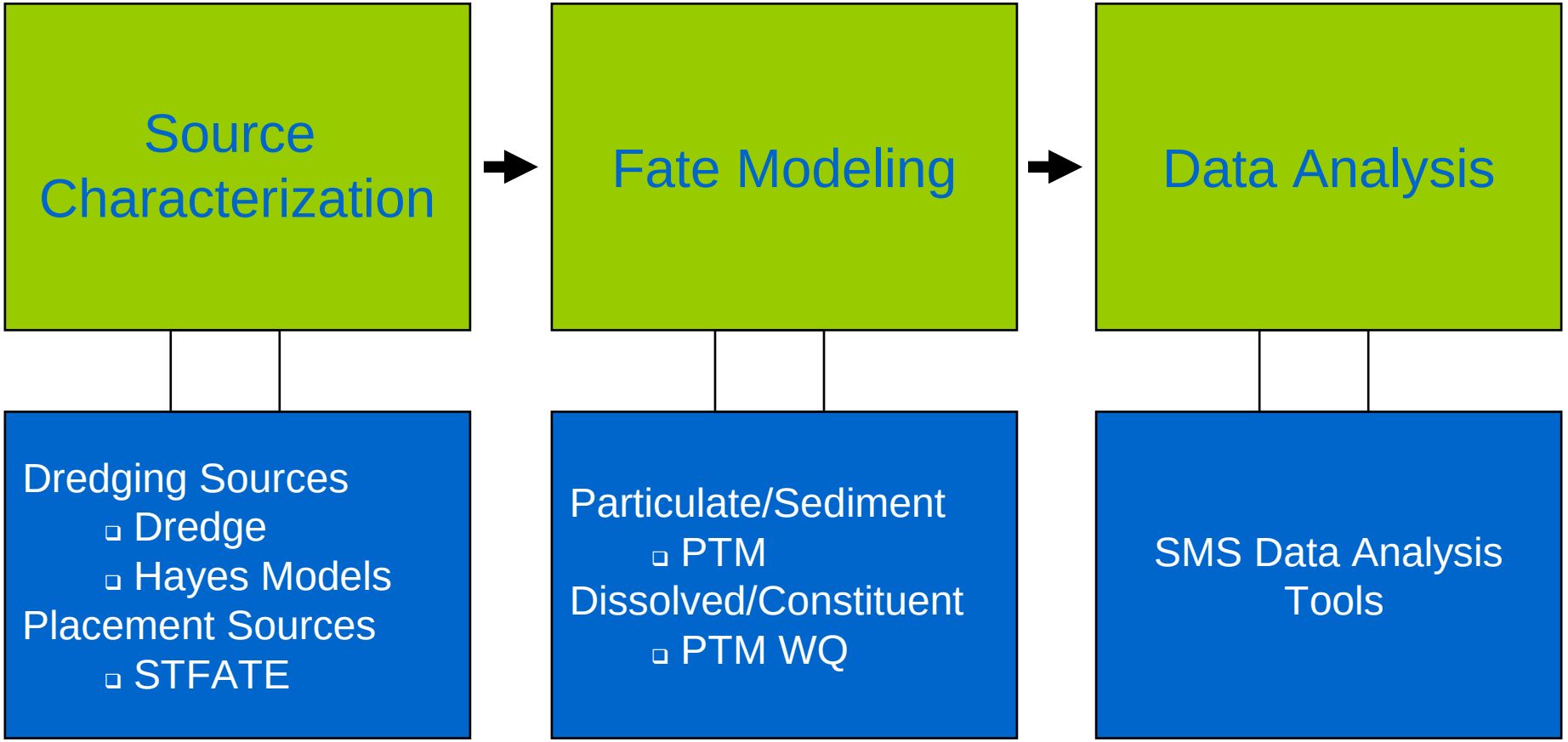
Predictions of the fate of sediment resuspended during dredging operations can be used to assess the impact of dredging and placement on contaminant transport, sensitive habitat, endangered species, rehandling, and beneficial use activity.



Dredging operation near sensitive sea-grass region (Panama City, Florida)

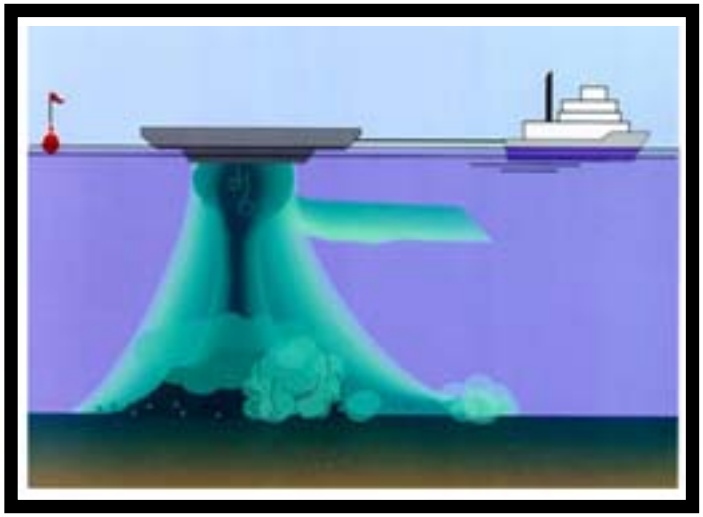
- Areas in green depict seagrass
- Data collection in center of the channel pathway

Approach: Modeling Framework for Resuspension Due to Dredging Operations



SOURCE CHARACTERIZATION – Quantification of Dredging-Induced Resuspension

- Dredging
  - Hopper
  - Clamshell
  - Cutterhead
- Placement
  - Barge
  - Pipeline



Improved Source Algorithm Development

- Currently gross empiricism
- Need process and mechanism driven algorithms
  - Temporal and spatial variation of releases
  - Linked to dredging operational parameters
- Built around thorough sediment characterization
  - Grain size distribution, organic content, and density profiles
  - Atterberg limits, liquidity index
  - Other sediment stability parameterization, e.g. plop test, SEDflume, etc…
- Can be incorporated directly into predictive models

New Resuspension Factor Approach

Clamshell Resuspension Sources:

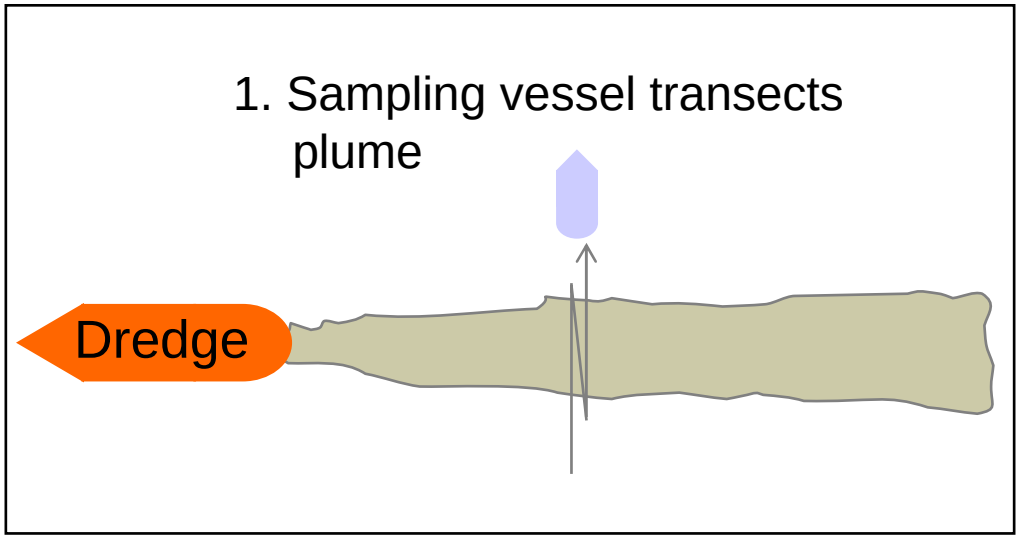
- Impact
- Slewing
- Ascent/Descent

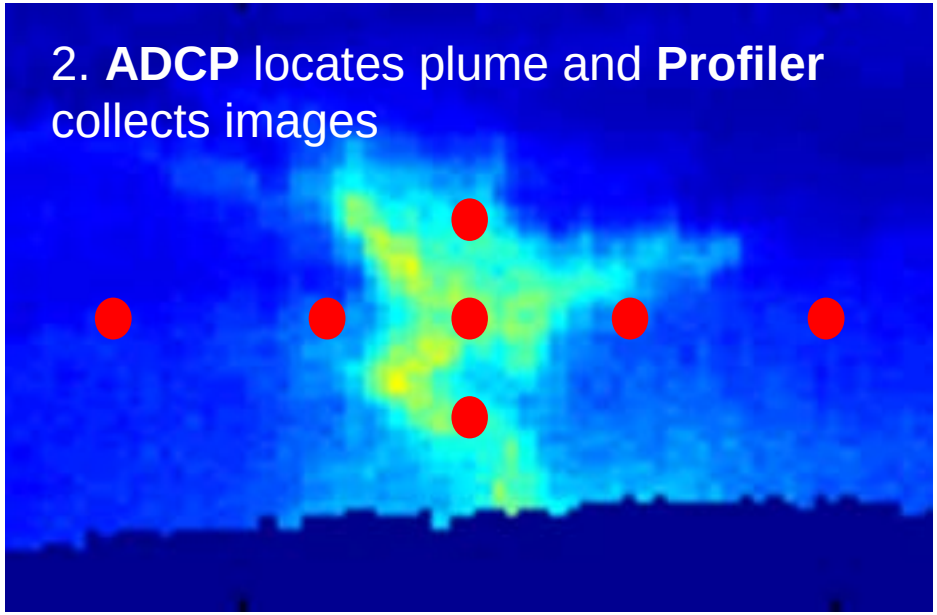
- Empirically or user-defined "characteristic resuspension rates" for a "characteristic dredging operation"
  - Operation parameters and resuspension rates defined by site specific and general data
- Resuspension rate adjusted using data based mechanistic corrections that are functions of:
  - Operational characteristics (swing speed, hoist speed, etc)
  - Sediment properties (atterberg limits, cohesiveness)
  - Cut dimensions and ambient conditions

Supporting Research for Parameterization and Calibration of Source Algorithms

- Resuspension experiments using an array of sediment types and densities
  - Isolate the physical processes that contribute to resuspension
- Bench scale to near-full scale experiments
  - Near-Full scale experiments
    - Apply lessons learned from lab to controlled large apparatus
    - TAMU dredging flume, ¾ CY bucket, 10” cutterhead diameter
- Field monitoring
  - Operational variation
  - Thorough sediment characterization
  - Plume monitoring near dredge

Field Data Collection and Analysis

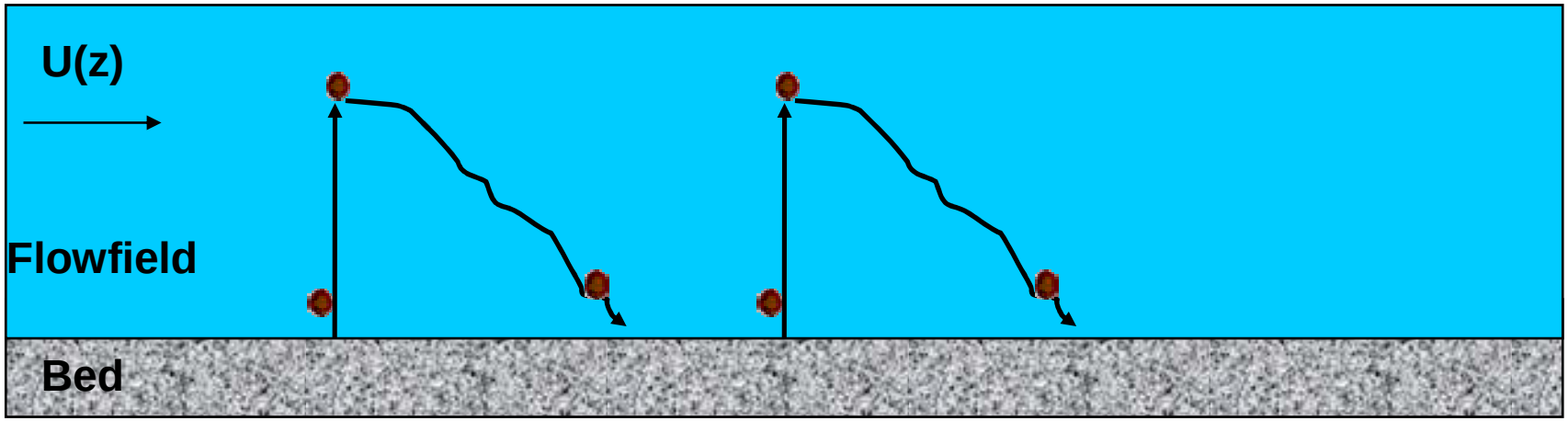




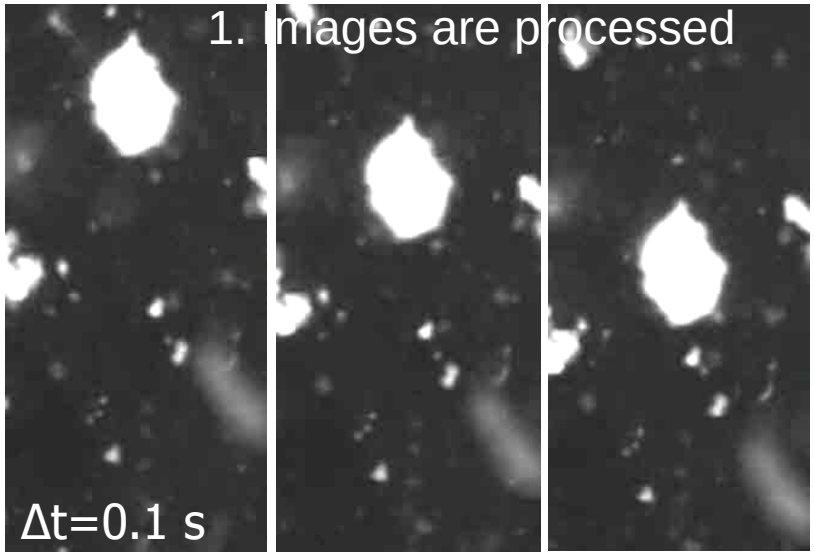
FATE MODELING – The Particle Tracking Model

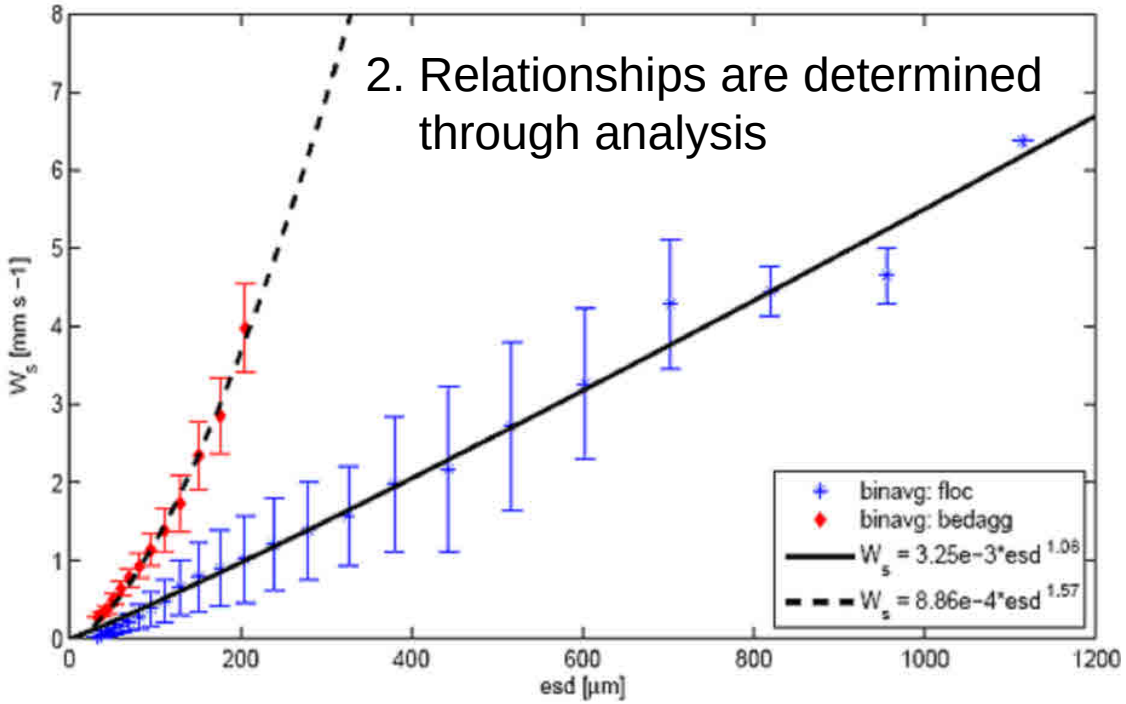
- The Particle Tracking Model (PTM) is designed specifically to predict the far-field fate of sediment suspended during dredging and placement.

- Process driven computations (field data and theory)
  - Advection/Diffusion
  - Resuspension
  - Settling
  - Particle Bed Interactions

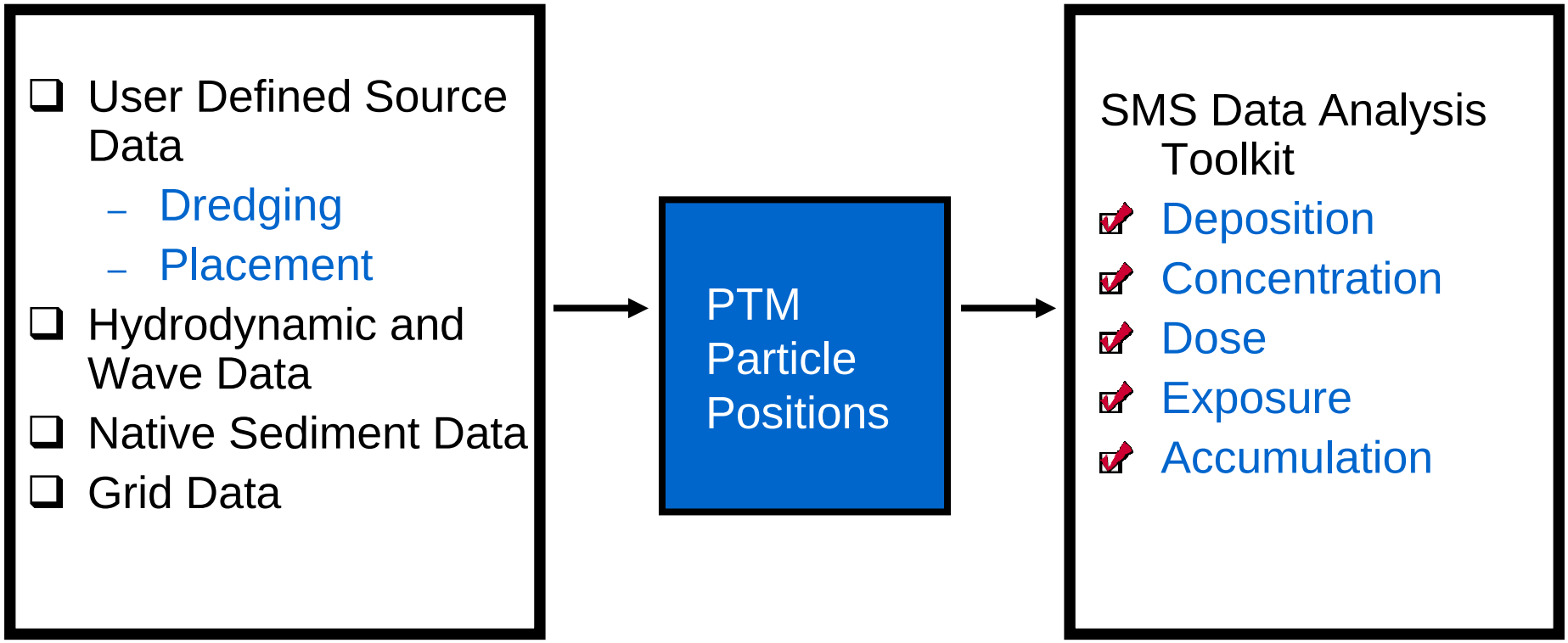


Supporting Research – Settling Analysis

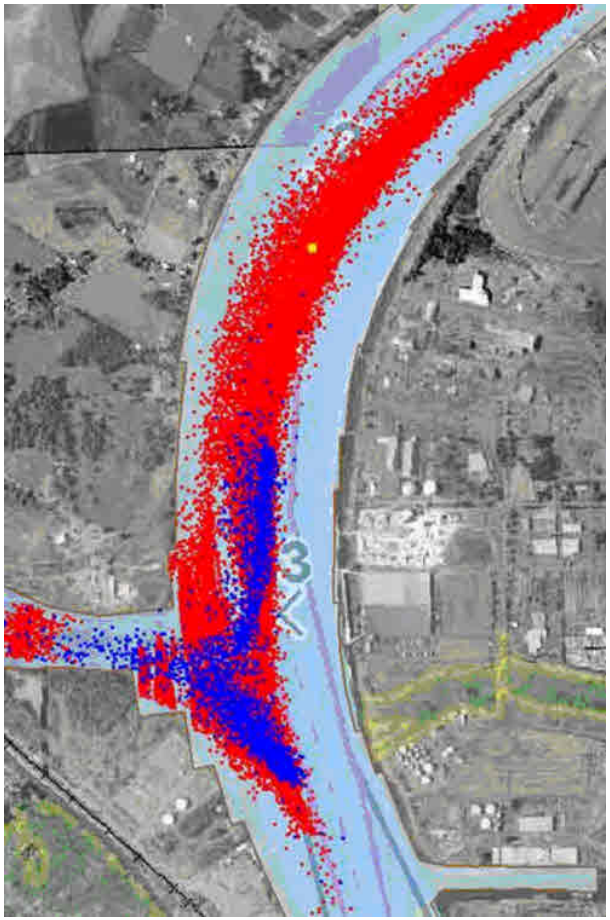


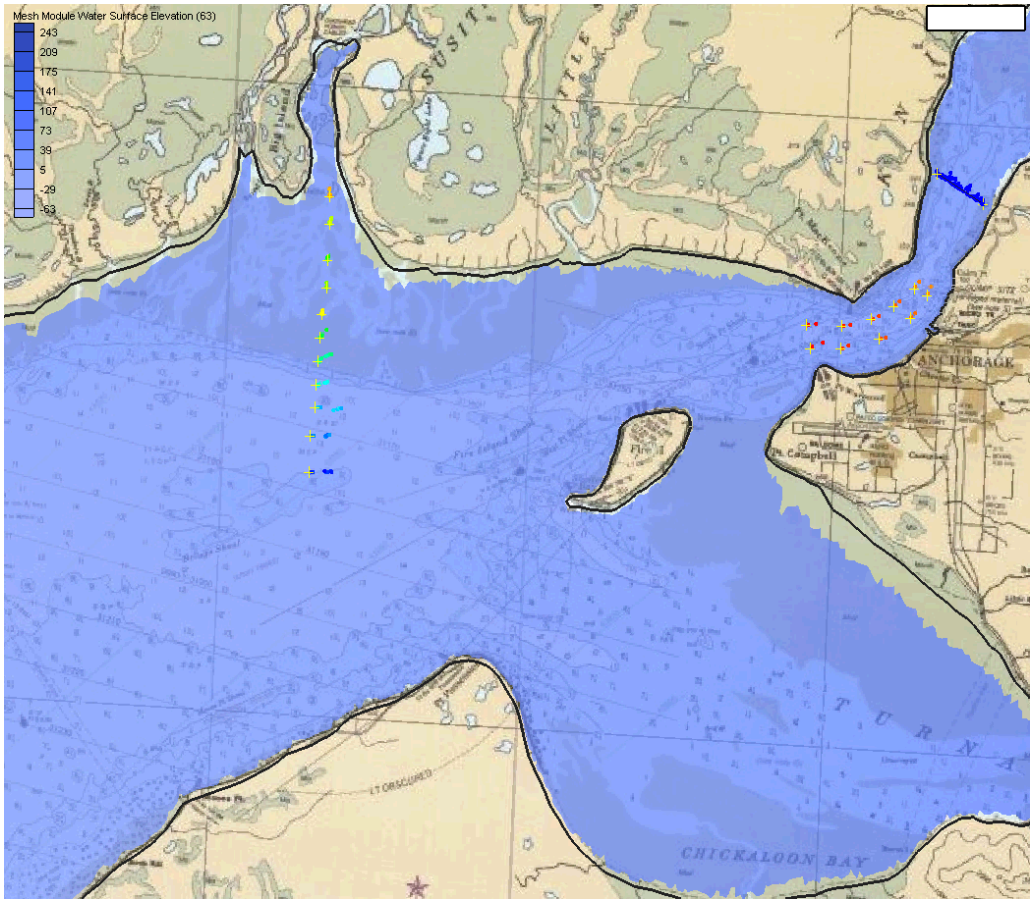


PTM Model Input and Output



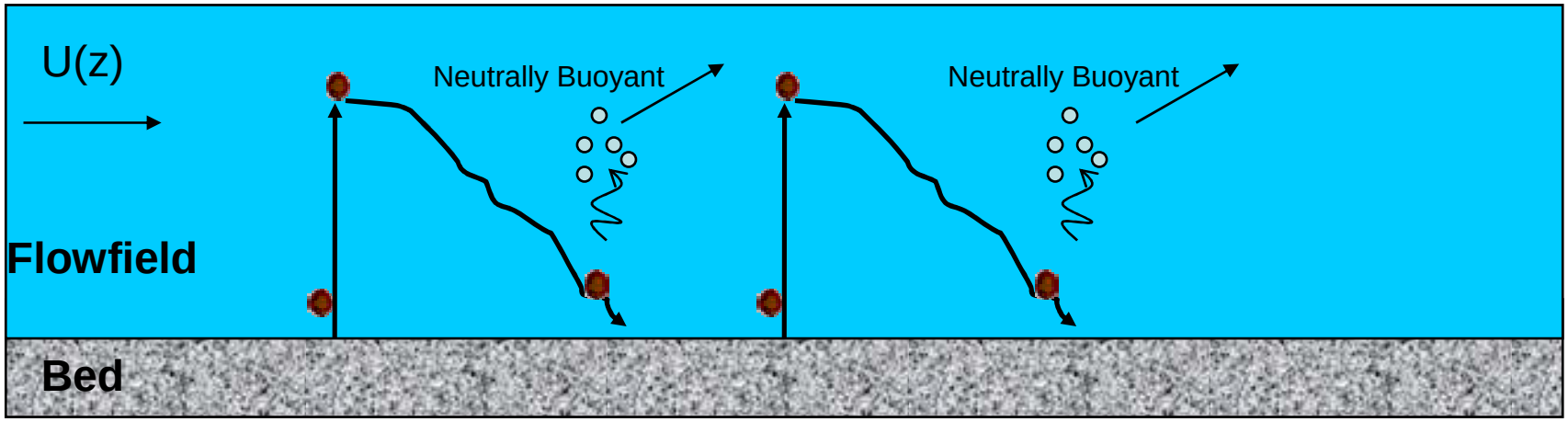
Example Predictions by PTM





Current Developments: PTM Water Quality Modeling

- Resuspended sediment disassociates
  - Particulate
  - Dissolved
- Rate of disassociation
  - Time dependent partitioning
- Kinetics of dissolved particles
  - Chemical reactions
- Mass conservation



Contact Information

- Dredging Source Terms
  - Thomas.D.Borrowman@usace.army.mil
- PTM (v2.0)
  - Tahirih.C.Lackey@usace.army.mil
- SMS (v10.0)
  - USACE contact: Barbara.P.Donnell@usace.army.mil
  - Technical Support: azundel@aquaveo.com