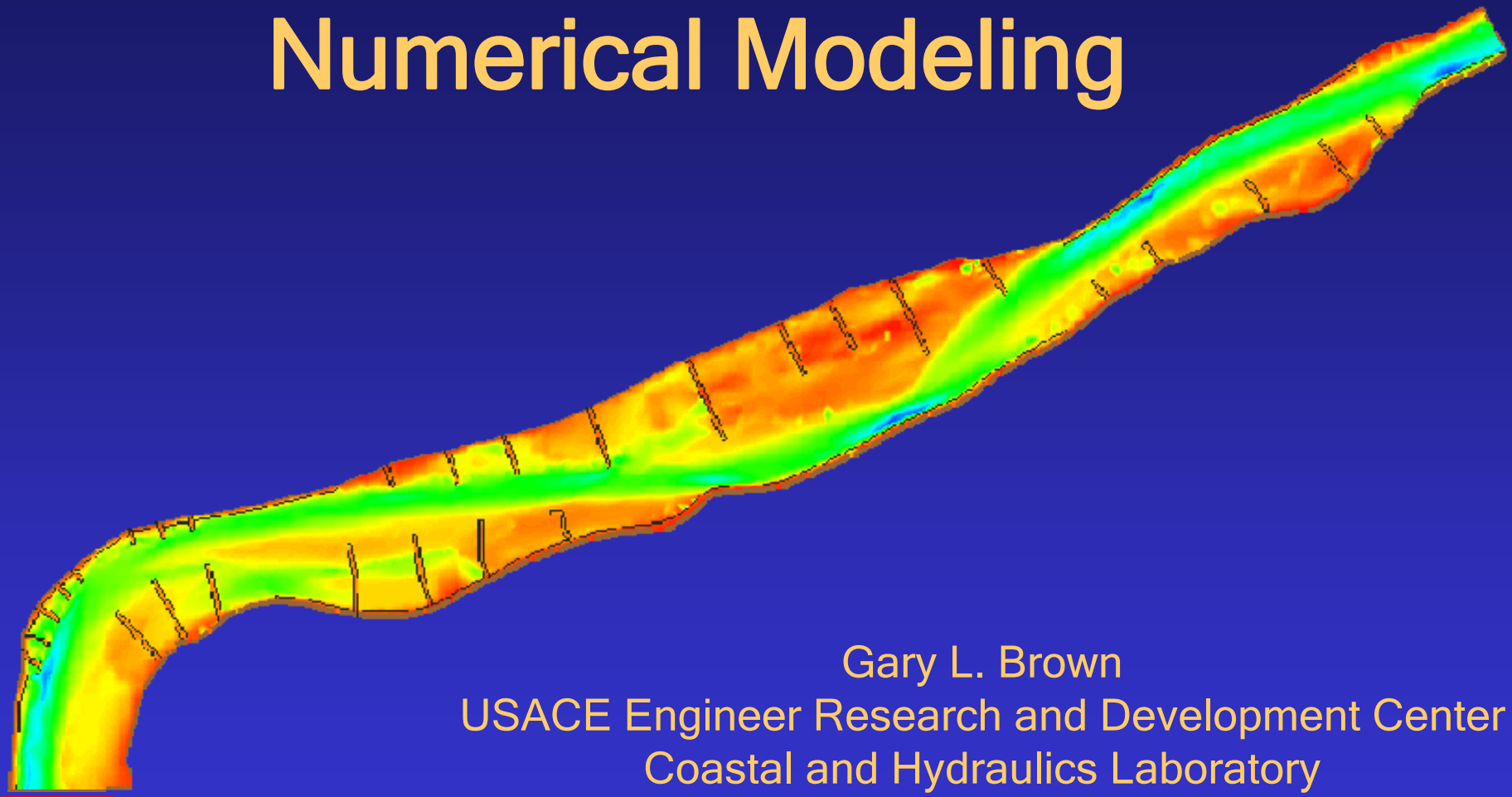
Multidimensional Riverine Numerical Modeling



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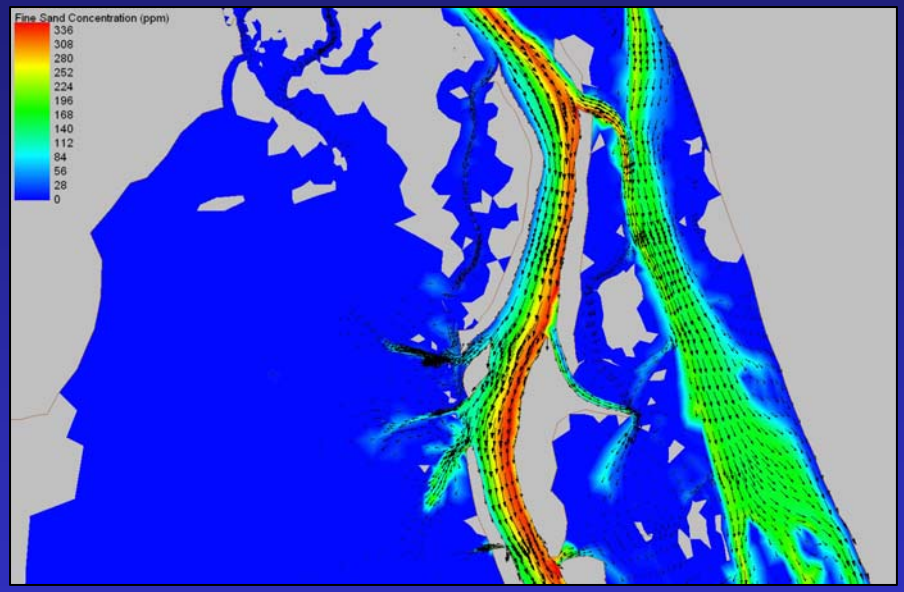
Why Multi-Dimensional Modeling?

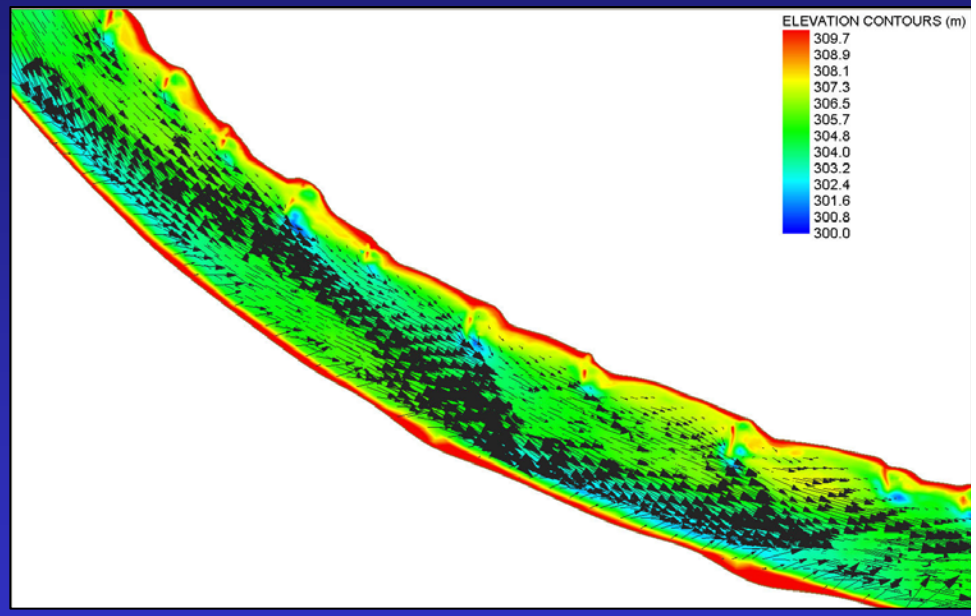
- Sediment transport is in general a multi-dimensional problem
  - Spatial variation of suspended sediment concentration, both horizontally and vertically
  - Spatial variation of water flux, and hence sediment mass transport, both horizontally and vertically



Velocity vectors and color contours of suspended concentration of fine sand in Pool 5 of the Mississippi River

Why Multi-Dimensional Modeling?

- Sediment transport is also a multi-process problem
  - Different modes of transport: bedload and suspended load
  - Sediment sorting within the bed: armoring
  - Variations in sediment supply
  - Cohesive sediment transport: completely different and more complex processes



Vectors of bedload flux in the Missouri River, demonstrating the influence of bed slope on the bedload flux direction

Why Multi-Dimensional Modeling?

- Sediment diversions are in general a 3D problem
  - Vertical variation of suspended sediment concentration influences suspended sediment capture efficiency
  - Horizontal variations of suspended sediment concentration and current distribution influence suspended sediment capture efficiency
  - Flow energy and bed slope influence bedload sediment capture efficiency
  - Sediment sorting in the water column and the bed influence selective sediment type capture efficiency

West Bay Diversion

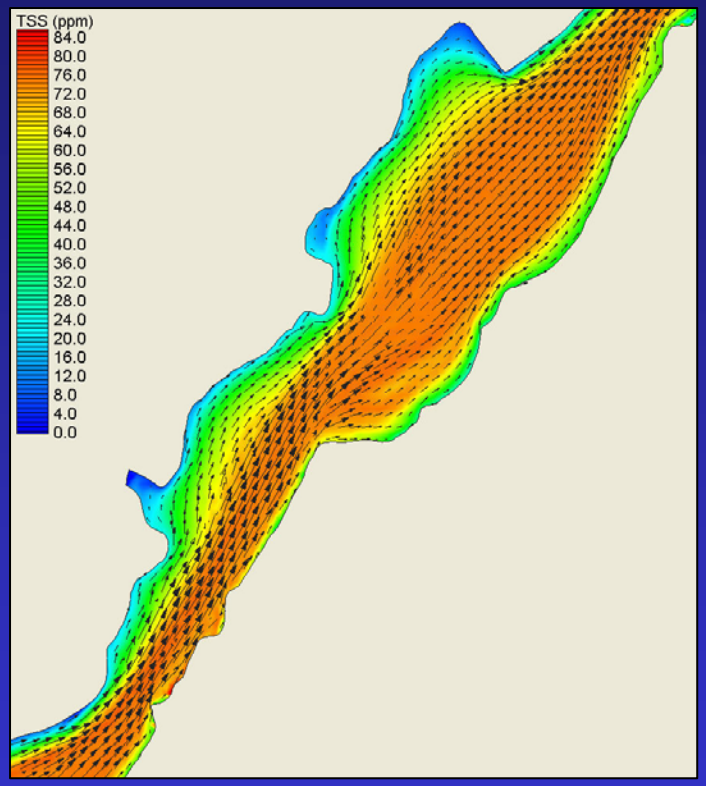
AdH: Sediment Transport Modeling

Fully unstructured modeling framework permits high resolution in areas of interest, and ability to make large domain runs such that boundary effects do not influence the results

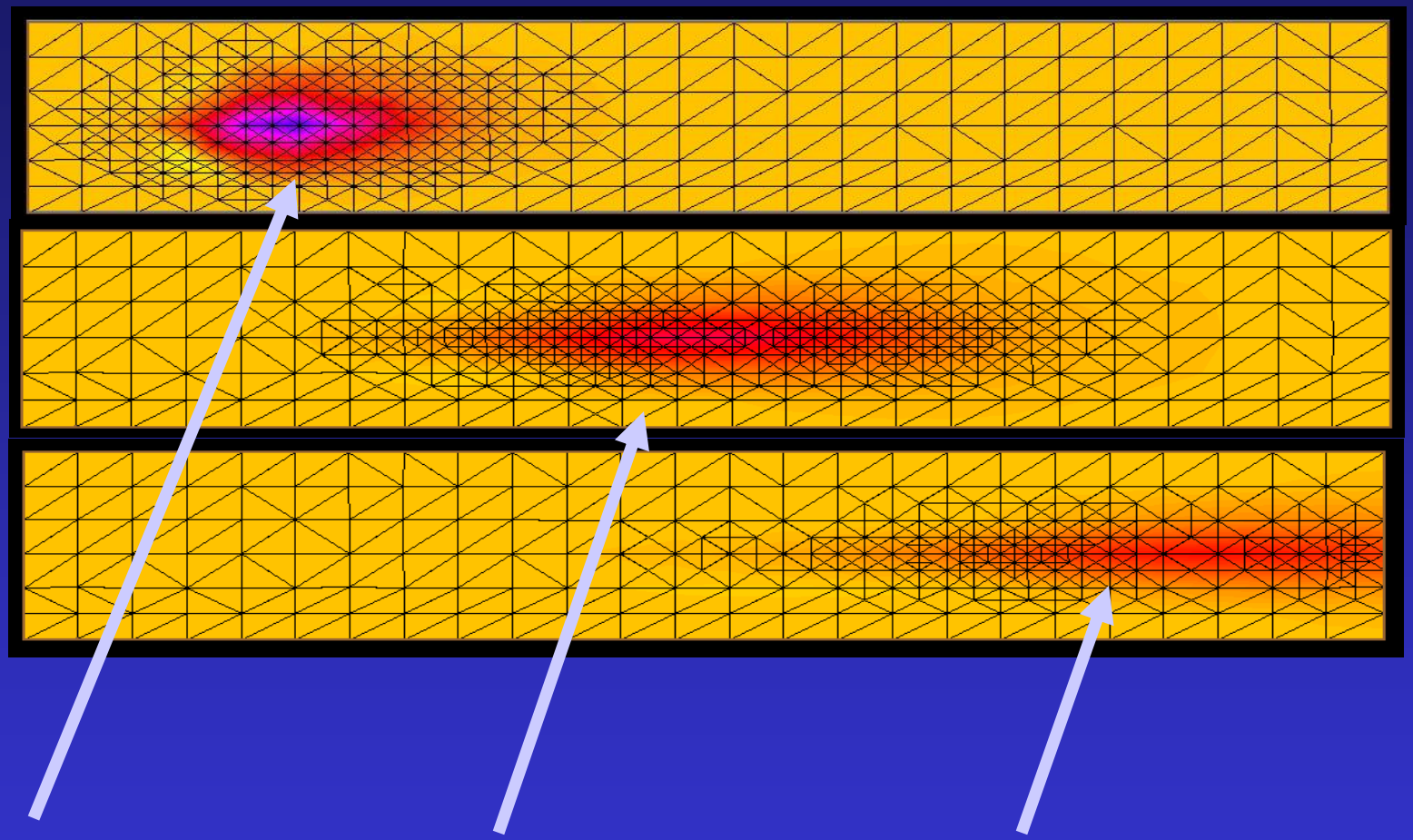
Multiple grain-sized cohesionless (sand) and soon cohesive (silt and clay) transport

Fundamental algorithms modeled closely after those used in CH3D, with some modifications (such as bedload slope correction)

Development of 2D capability to simulate quasi-3D behavior, by applying bendway vorticity corrections and nonuniform vertical sediment profile corrections.



Adaption - Concentration Cloud



Mesh refines and unrefines to resolve the concentration cloud as it progresses along the flume

Diversion Modeling Philosophy

- We propose to use the lowest dimensional modeling system that can give scientifically defensible results
  - The lower the dimension, the more model runs and longer runs can be attempted
  - 1D models -decadal time scale runs
  - 2D models - annual time scale runs
  - 3D models - monthly time scale runs

Diversion Modeling Philosophy

- A priori, we do not know what is the lowest dimensional model that can be used
  - Diversions are in general 3D phenomena
  - For a given diversions, it may be possible to use a 2D model with some quasi-3D behavior, or use 2D and 3D models together
  - These higher dimensional models can in turn be used to develop rating curves for lower dimensional models

Diversion Modeling Philosophy

- We will use both ADH (in 2D) and Ch3D (in 3D) to take advantage of the features of both
  - ADH can provide improved boundary condition information to Ch3D, and can be used to investigate the significance of the horizontal resolution
  - Ch3D can be used to determine the significance of vertical variations at the diversion site
  - Both models can be used to investigate sediment processes
  - Redundancy and cross-checking can be used to determine whether or not all **significant** processes have been accounted for