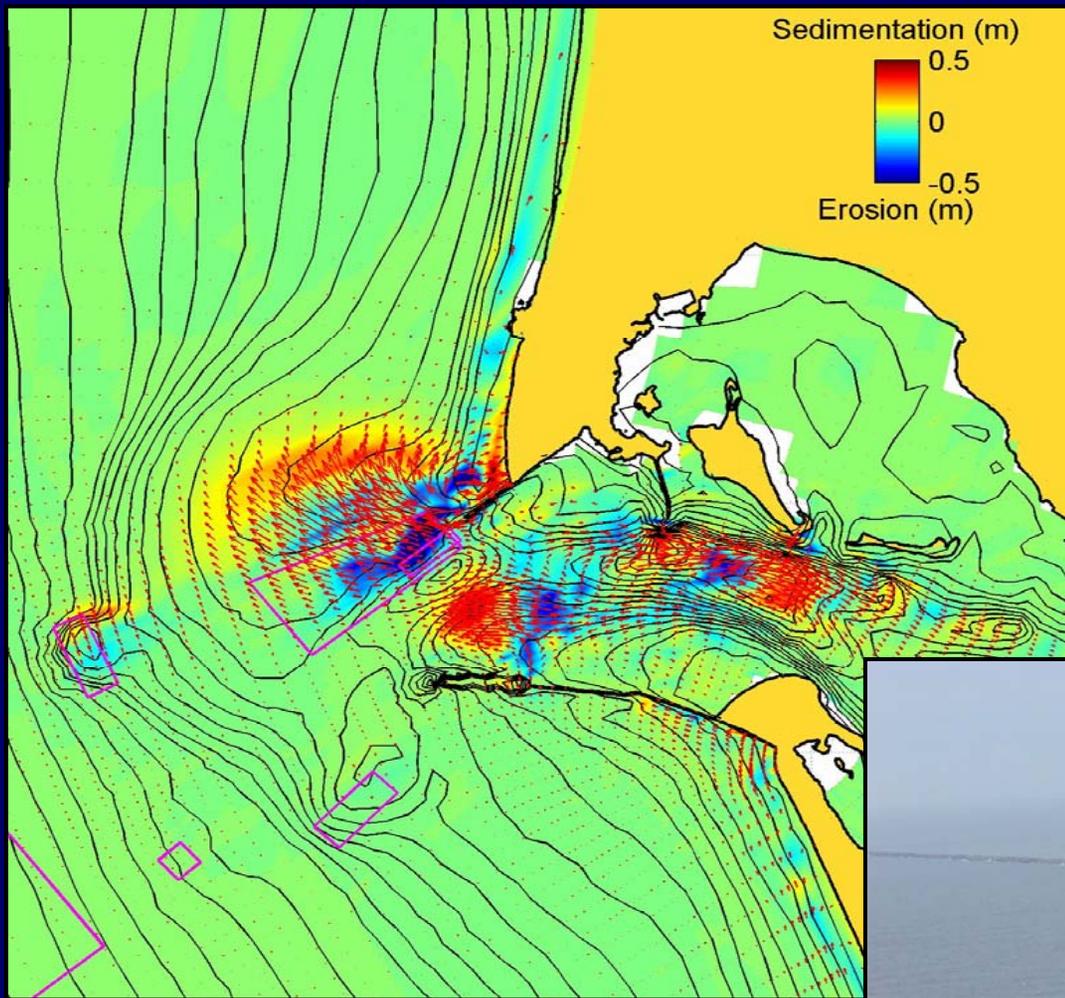


MCR RSM Sediment Transport and Morphological Modeling

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Moritz, and George Kaminsky*

U.S. Geological Survey
Delft Hydraulics
U.S. Army Corps of Engineers
WA Dept of Ecology





Sand transport at MCR
is spatially and
temporarily complex

A complex model is
required to analyze and
evaluate sand management
alternatives

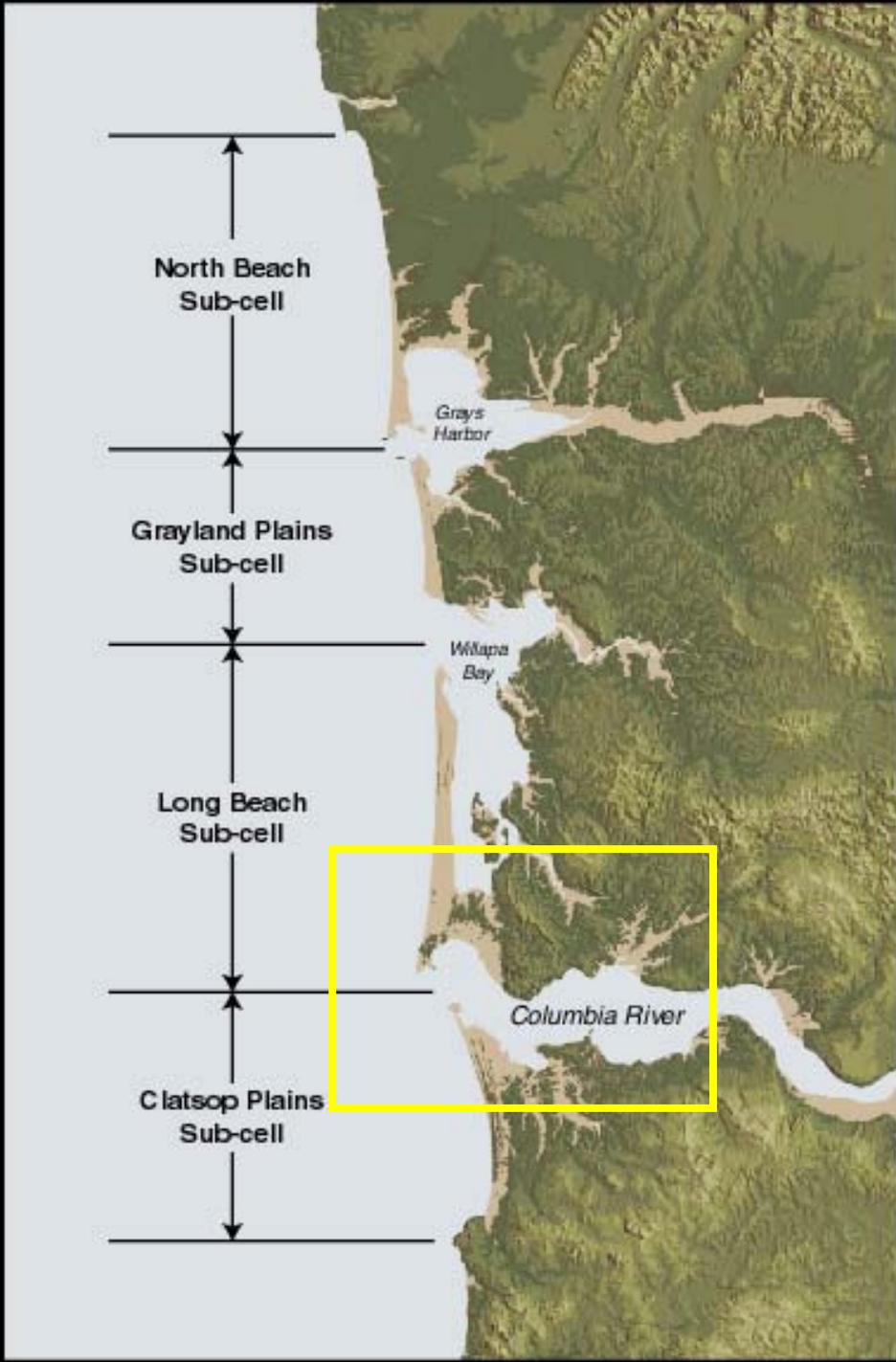


Sediment Transport Modeling: Columbia River Estuary and Adjacent Coast

Goals

Provide a sediment transport analysis tool to:

- Optimize RSM decisions
- Evaluate existing, alternative, and future scenarios
- Understand the natural dynamics of the system



North Beach
Sub-cell

Grayland Plains
Sub-cell

Long Beach
Sub-cell

Clatsop Plains
Sub-cell

Grays
Harbor

Willapa
Bay

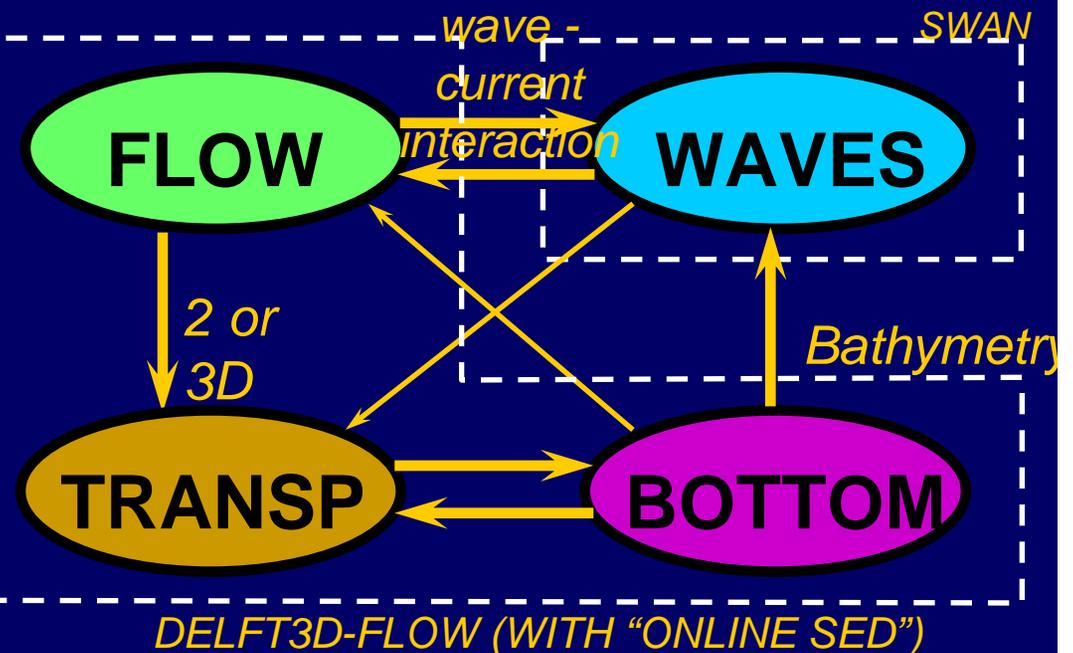
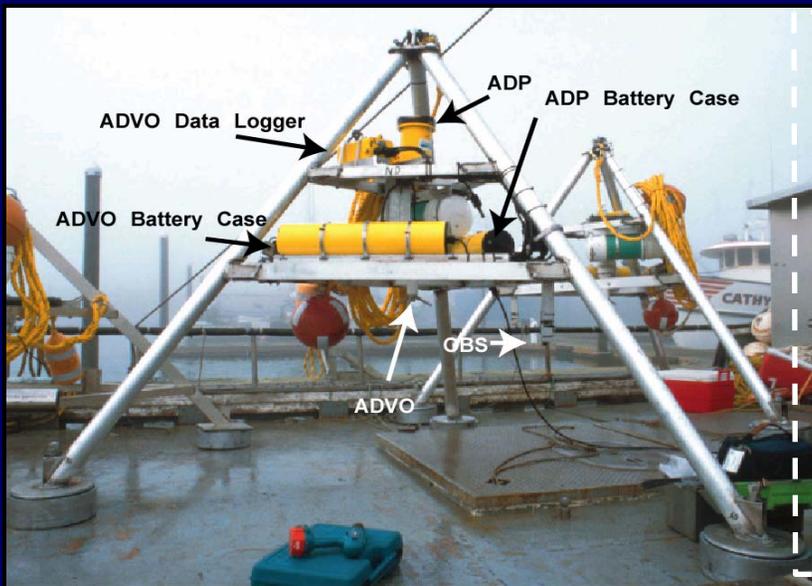
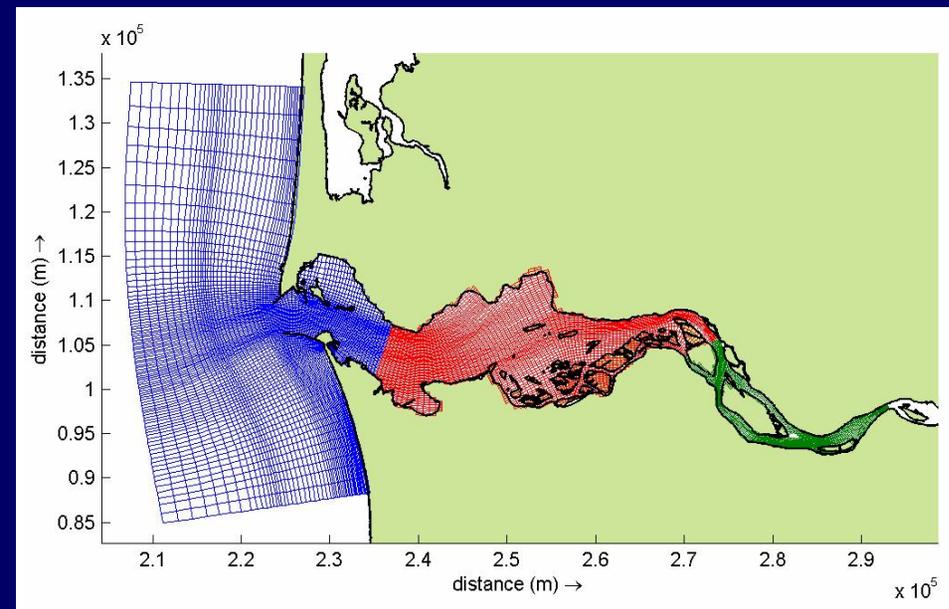
Columbia River

Questions the model can address

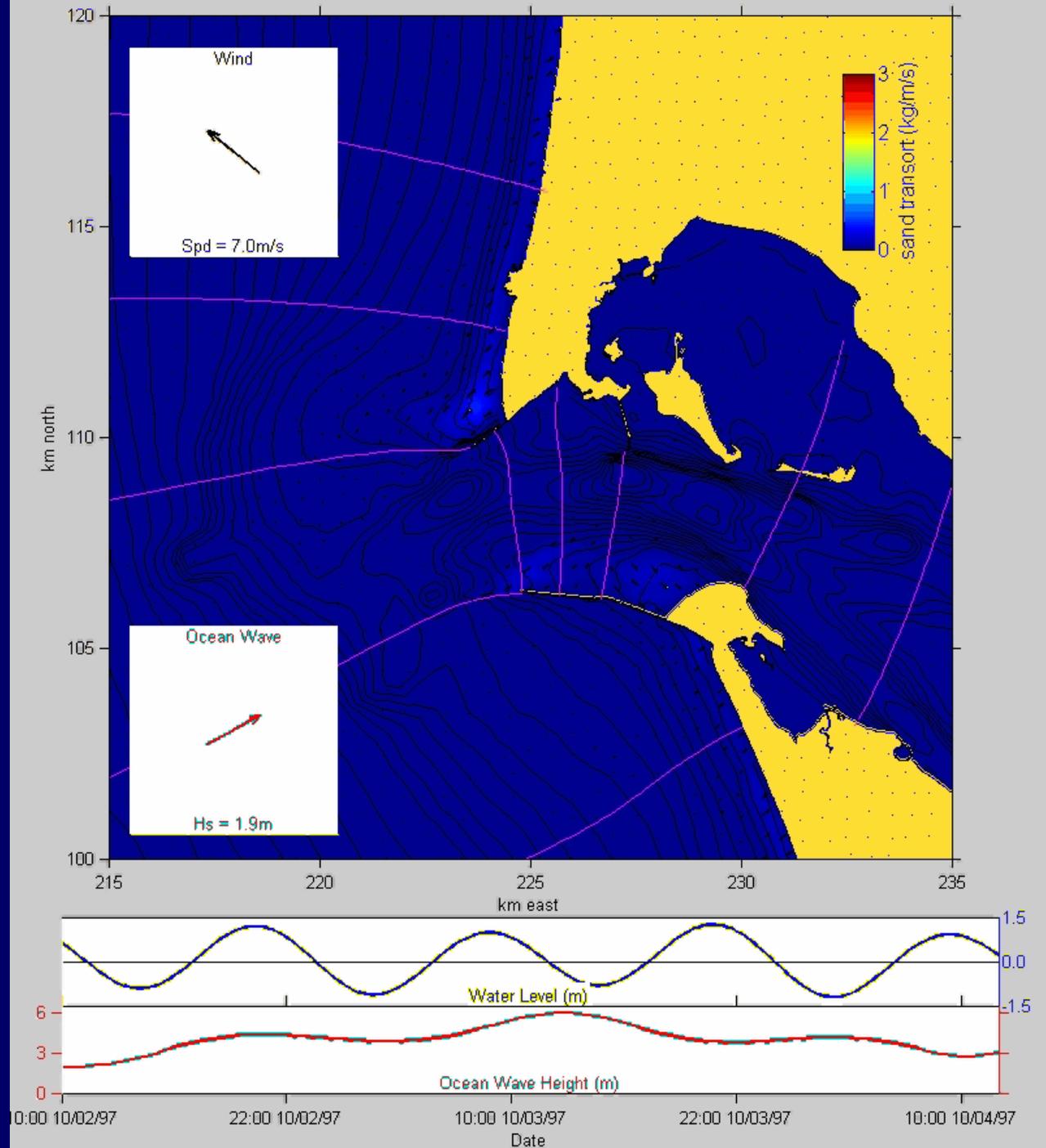
- Fate of material from Site E
- Identification of other nearshore disposal locations
- Stability/undermining of jetty foundations
- Understand and optimize channel dredging strategies
- Predict wave amplification at disposal sites
- Evaluate alternative longshore feeding scenarios
- Effect of flow regulation on MCR sediment dynamics

Approach

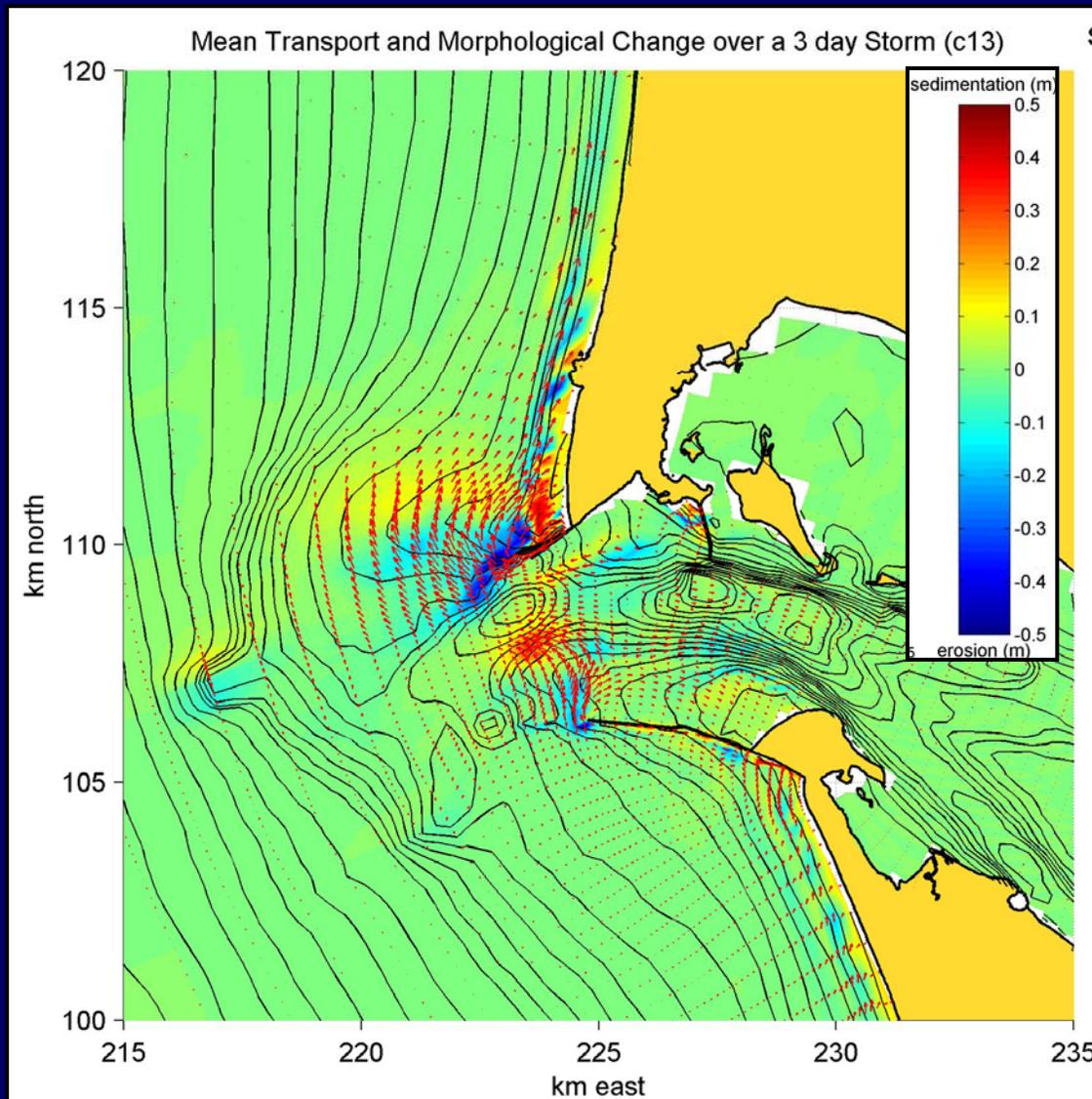
- Data collection
 - Process identification
 - Model calibration
- Process-based morphological modeling



Sediment transport during a 3-day storm

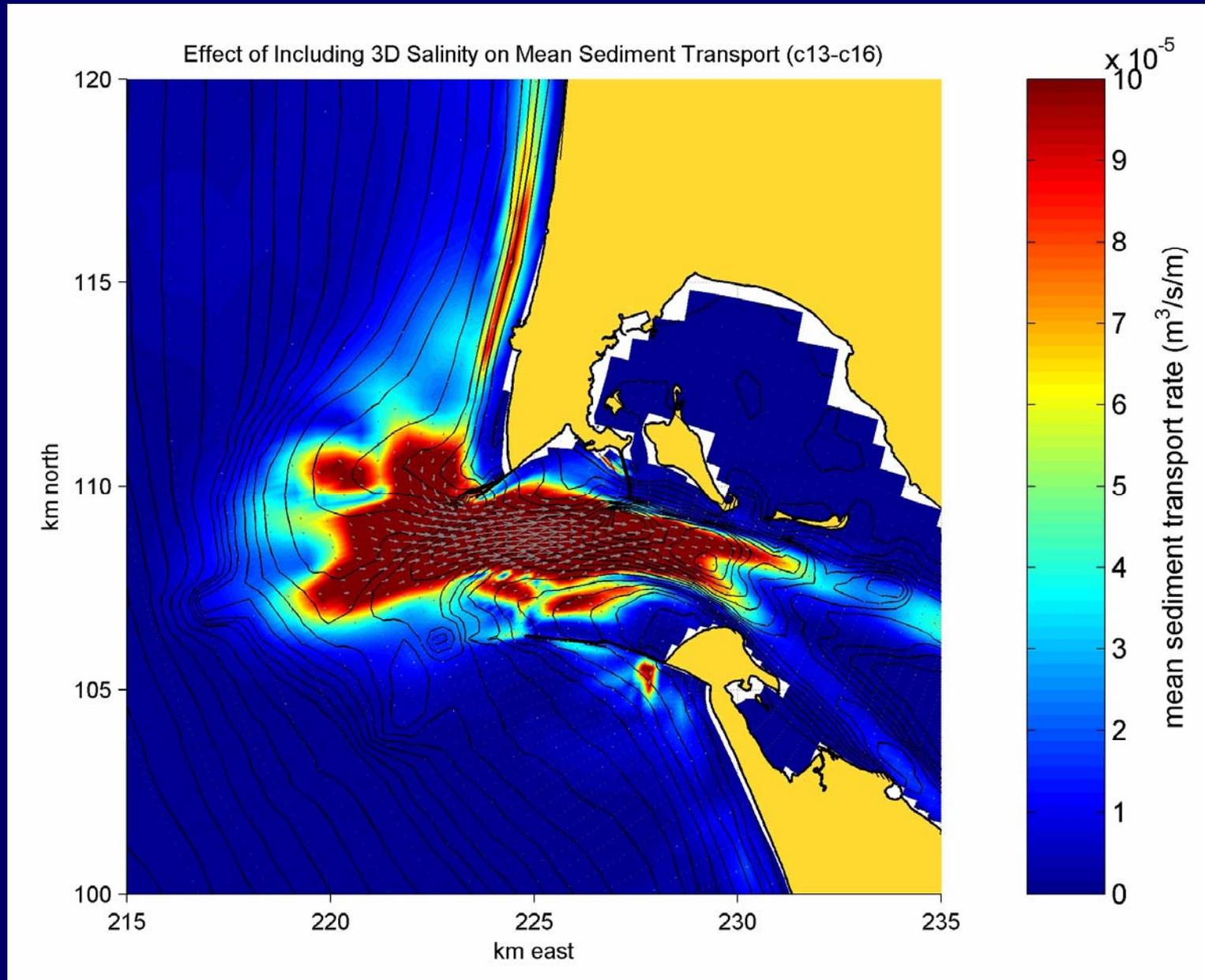


Net Sediment Transport, Erosion, and Deposition

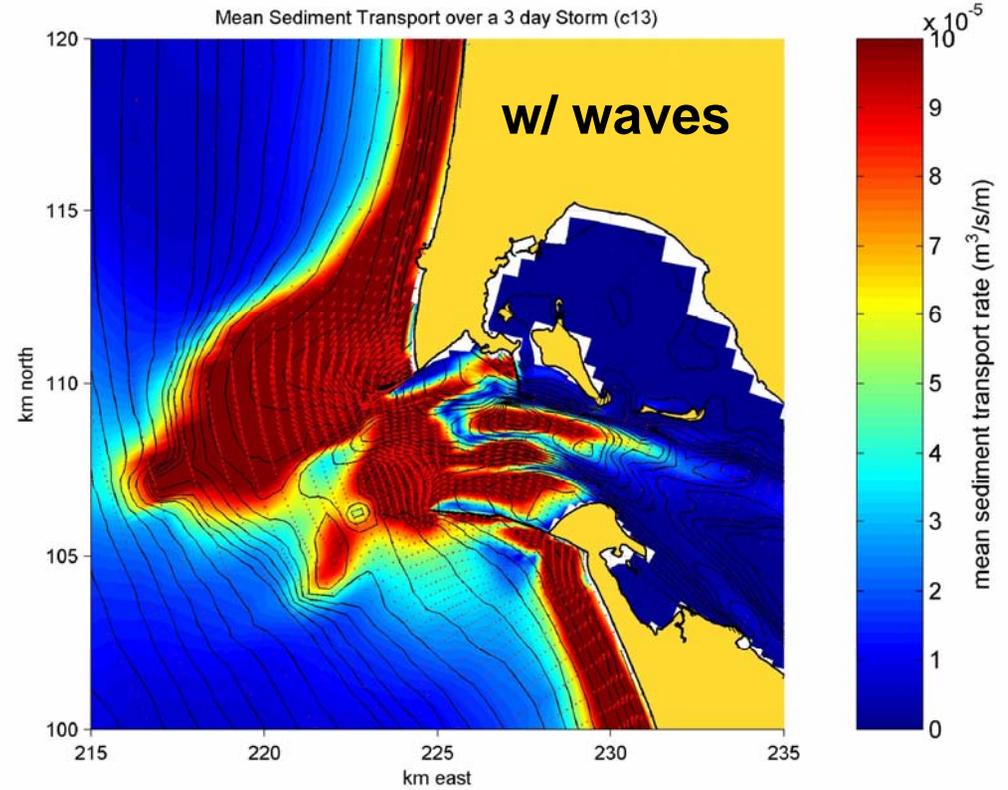
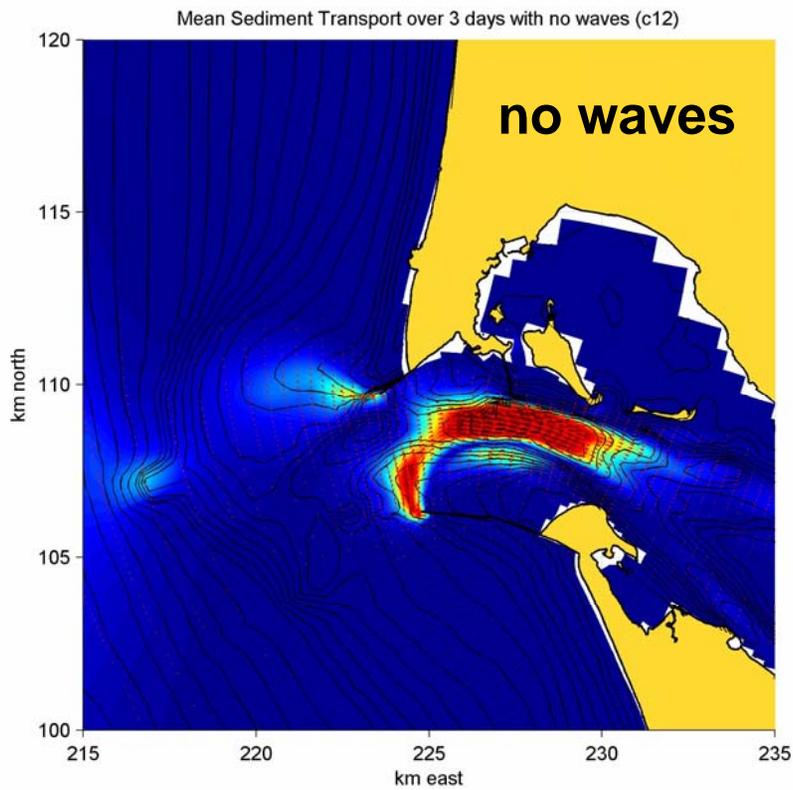


- find dispersive areas
- maximize supply to littoral zone
- minimize re-handling
- minimize undercutting of jetties
- minimize disruption to biota
- Understand Processes

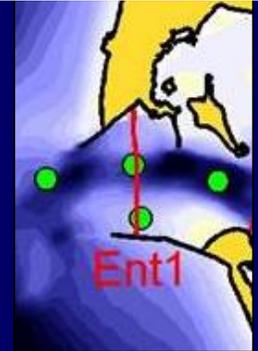
Salinity / estuarine circulation



Effects of waves on net sediment transport

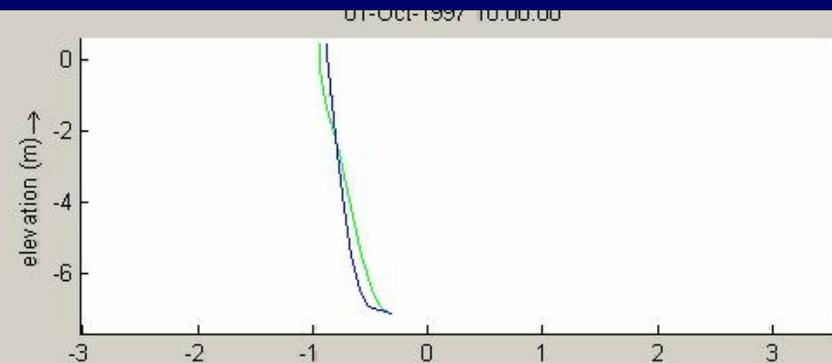
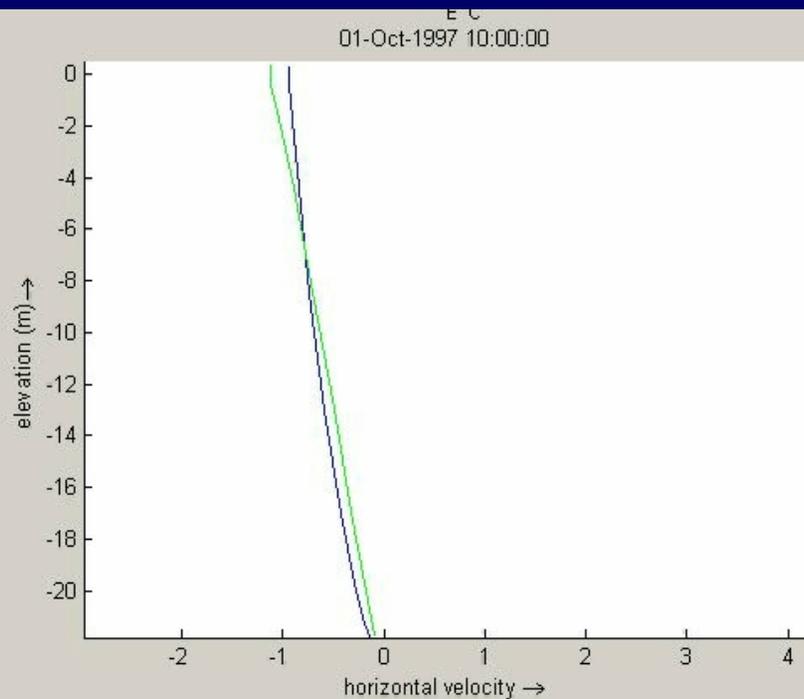


Influence of waves on computed velocity profiles in MCR



In the center of channel

On shoals south of channel



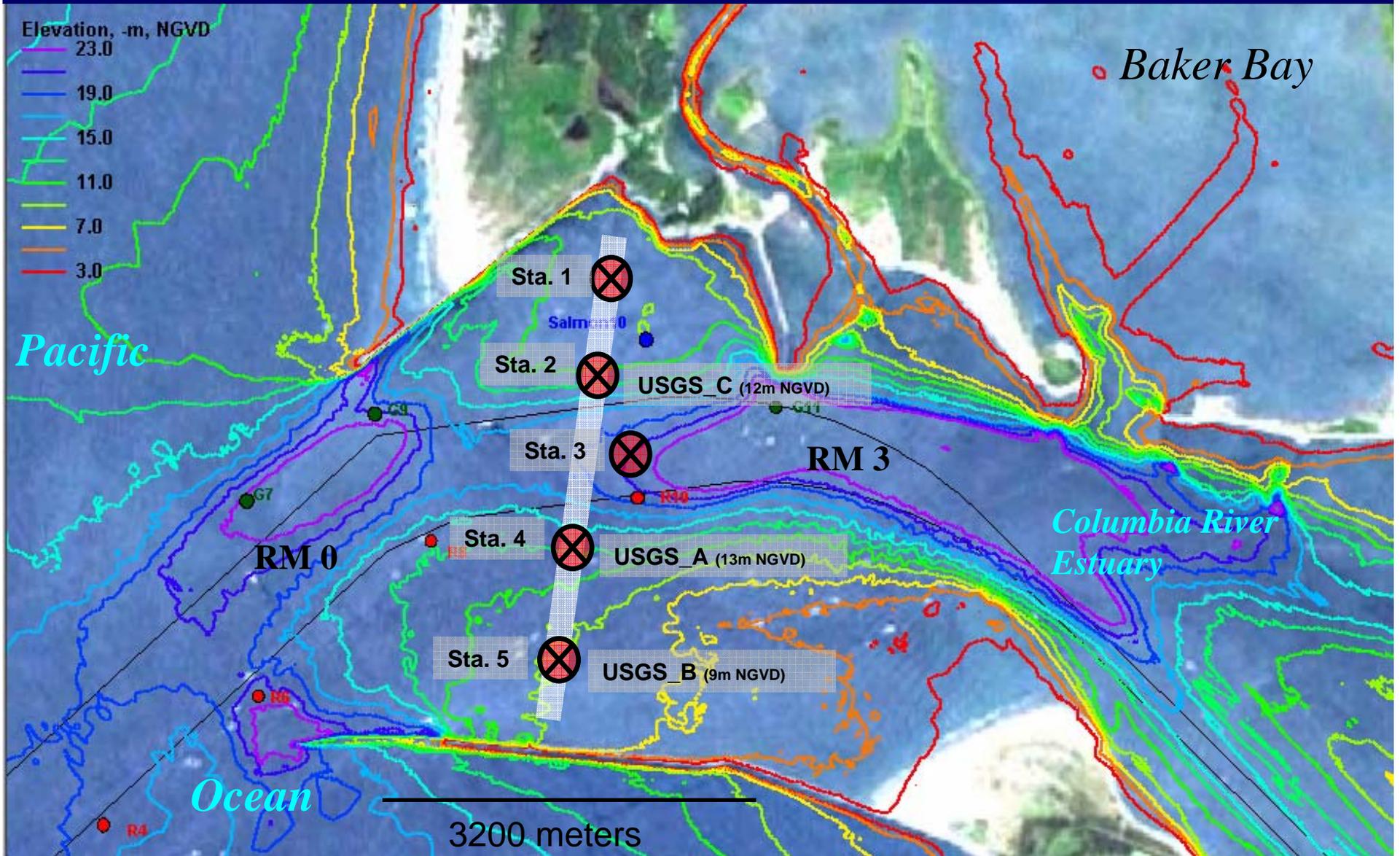
Green line is simulation EXCLUDING waves.
Blue line is simulation INCLUDING waves.

← Offshore (m/s) Onshore →

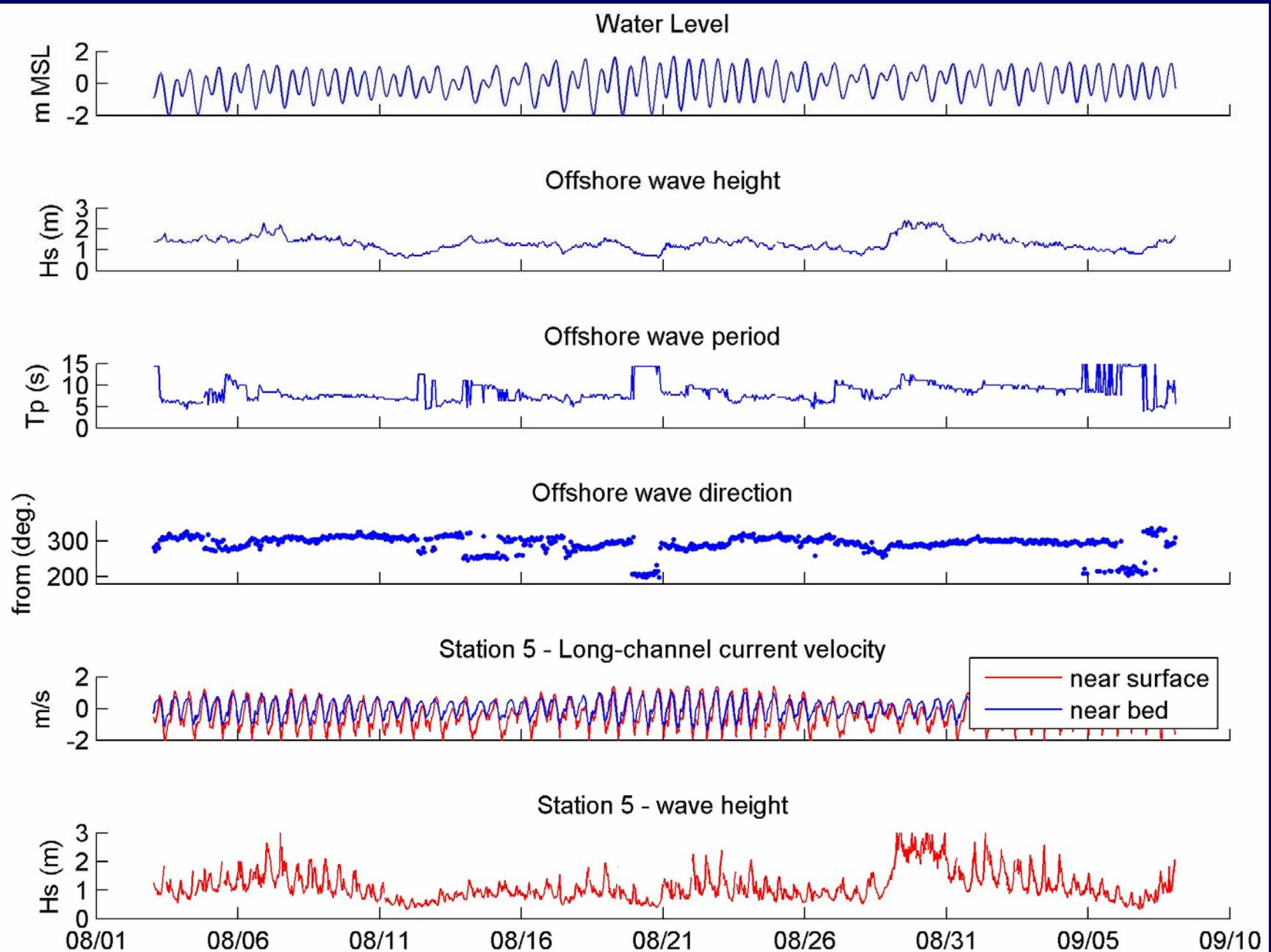
Waves tend to push water (and sediment) IN over the shoals and OUT through the deep channel.

MCR "Mega Transect" field experiment

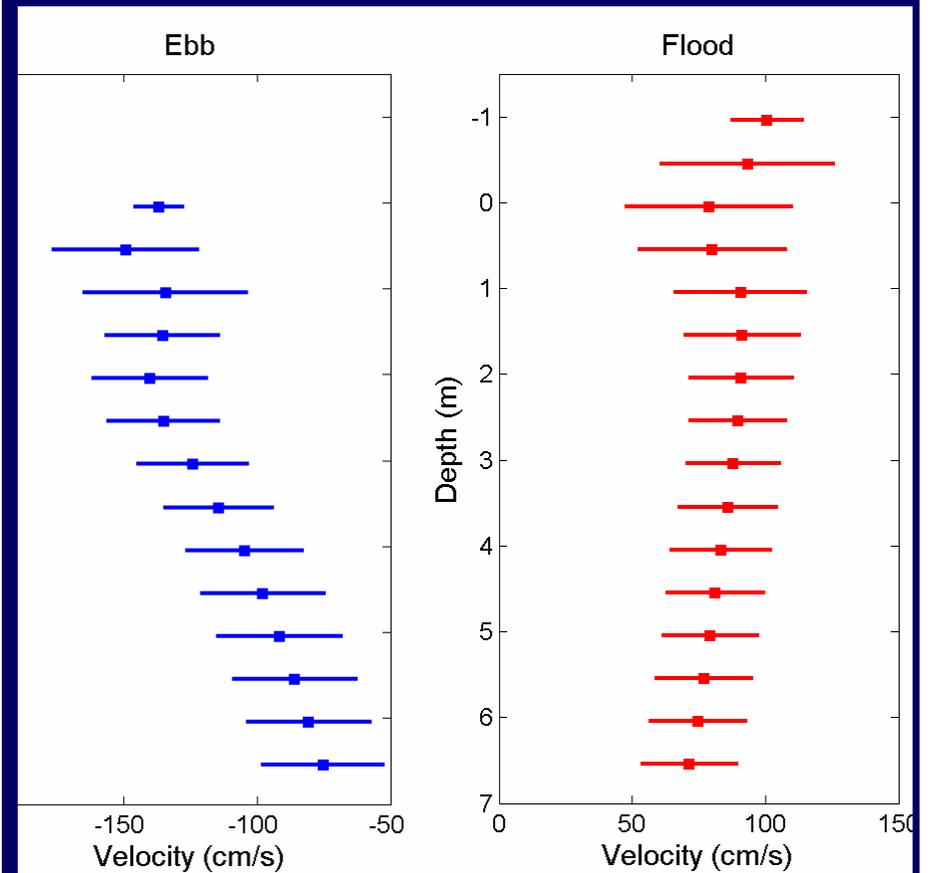
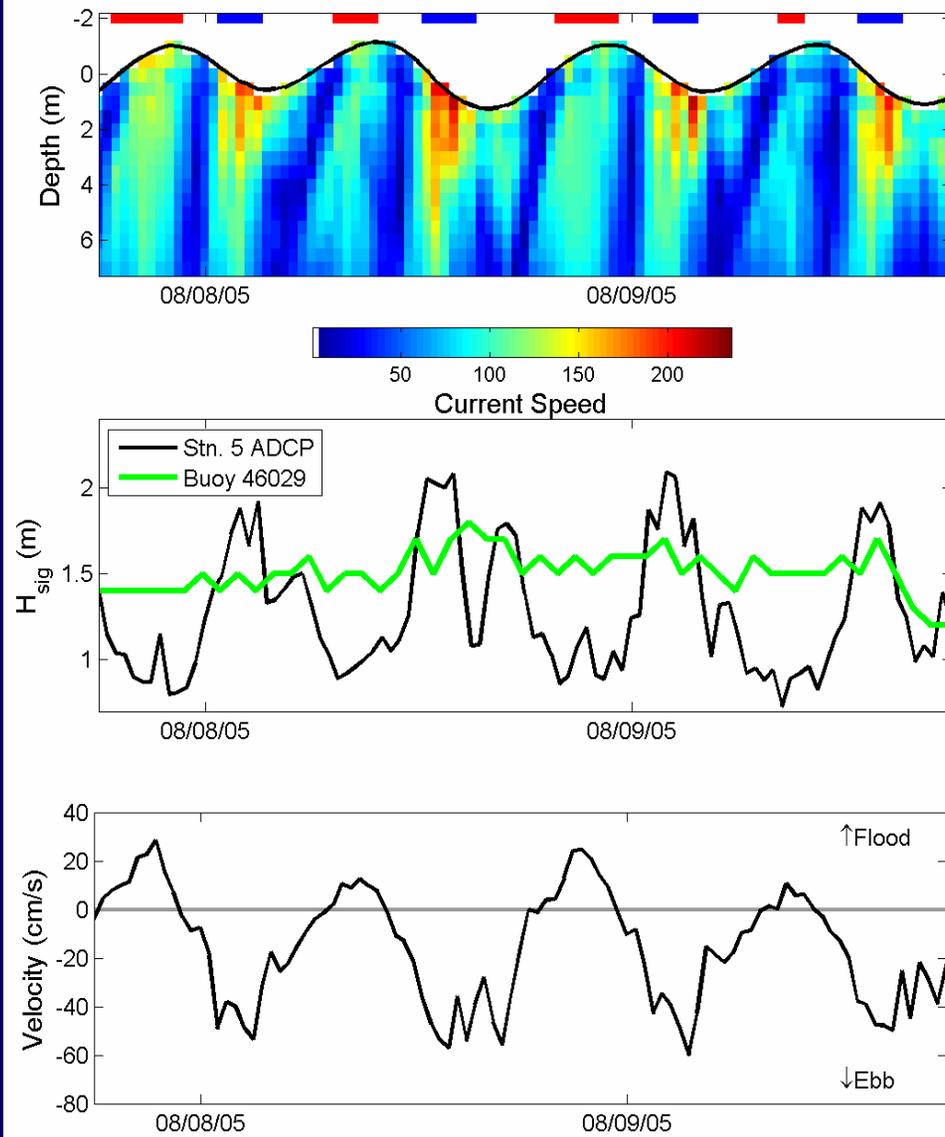
August – September 2005



Conditions during the field experiment.

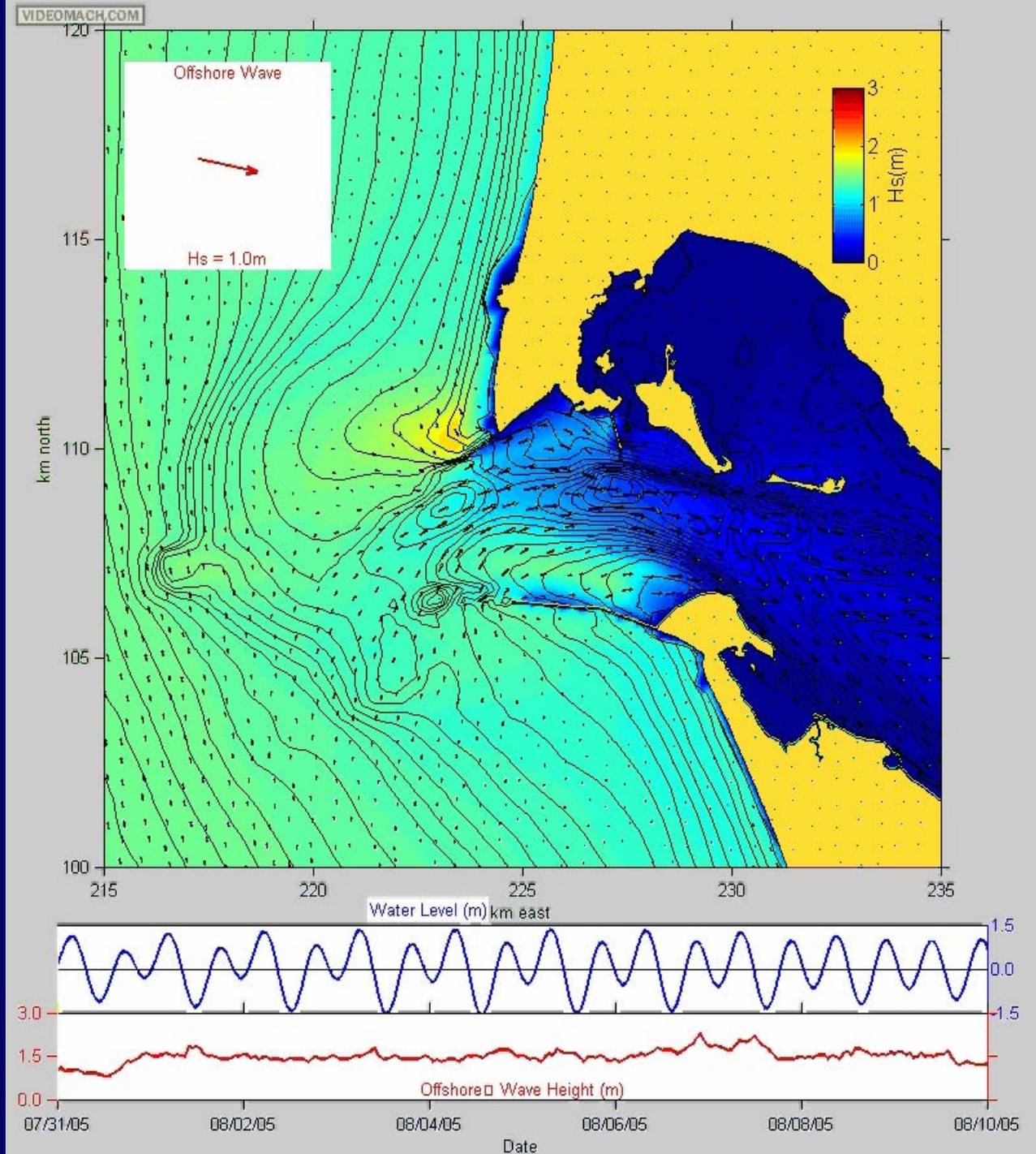


Field observations waves modified by currents

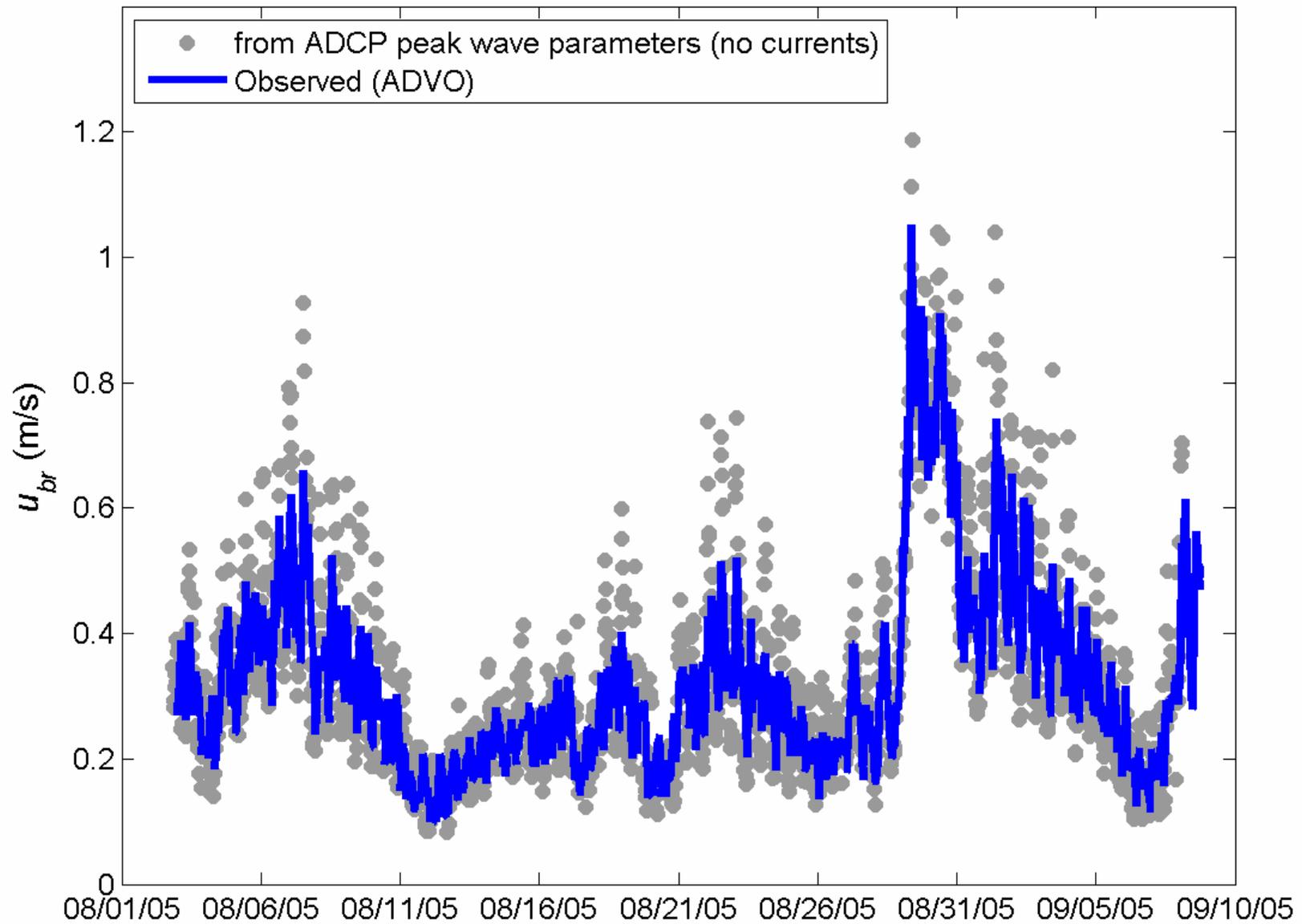


Wave simulation

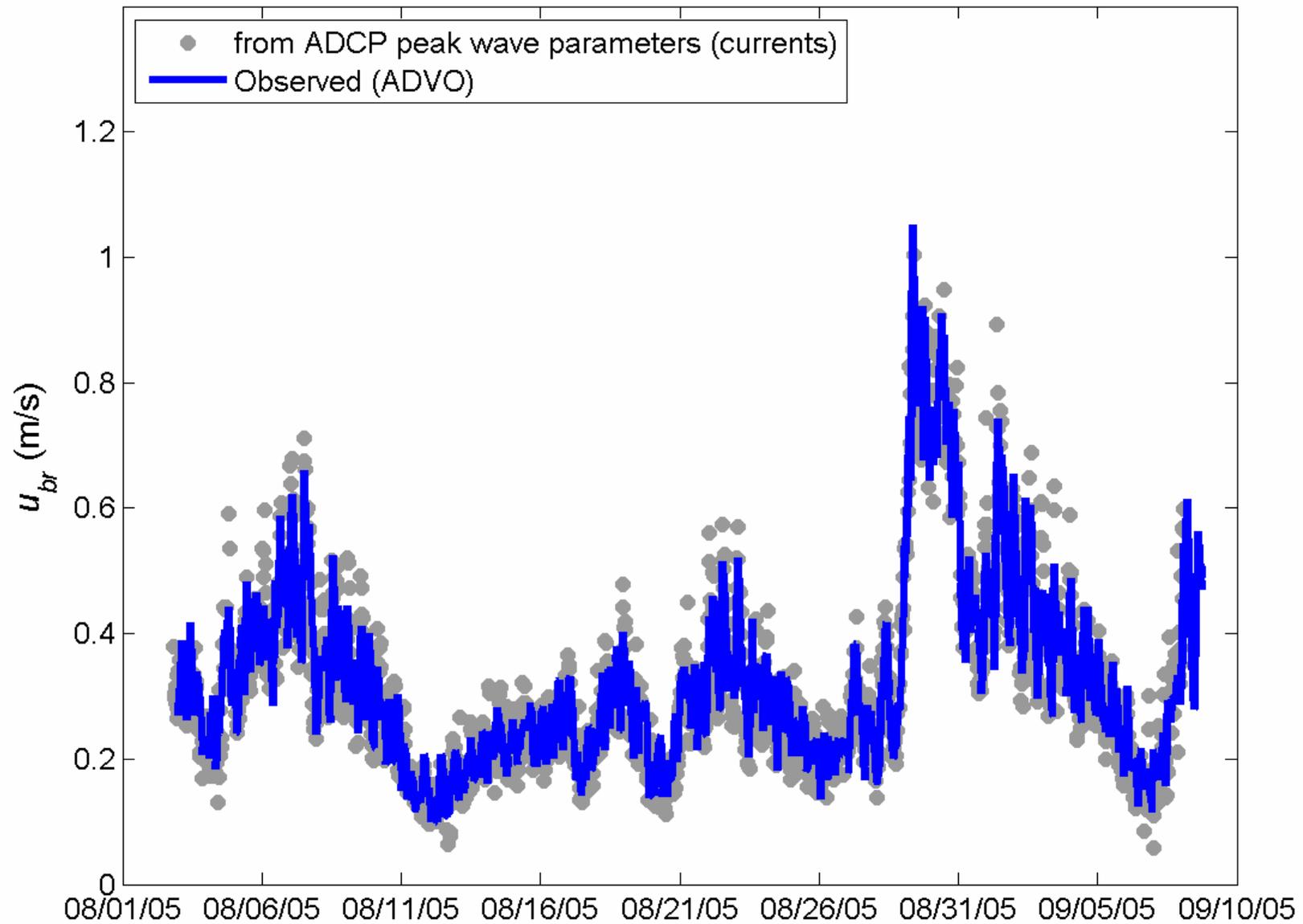
Including depth-weighted
ambient current



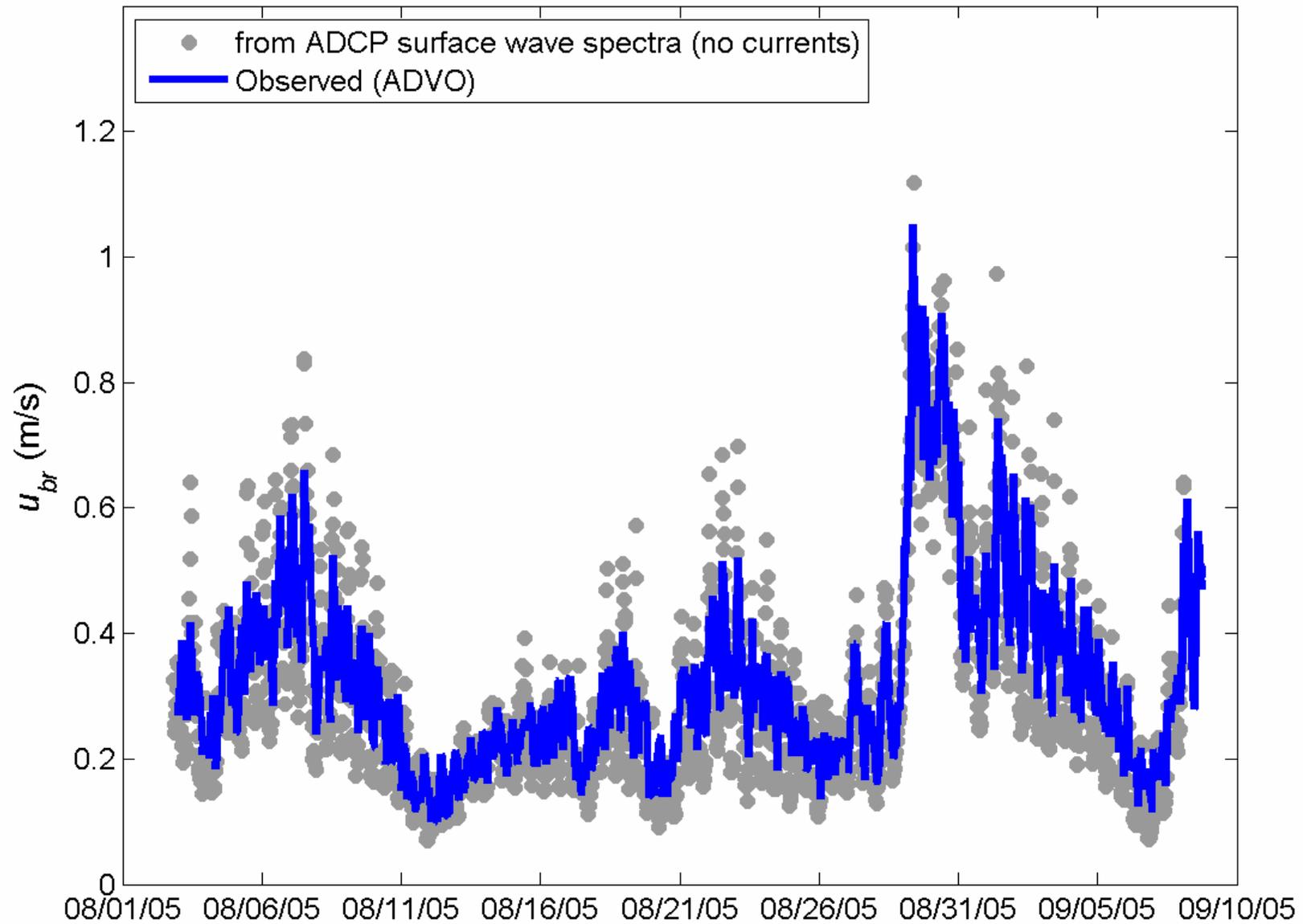
Computed vs. measured orbital velocity



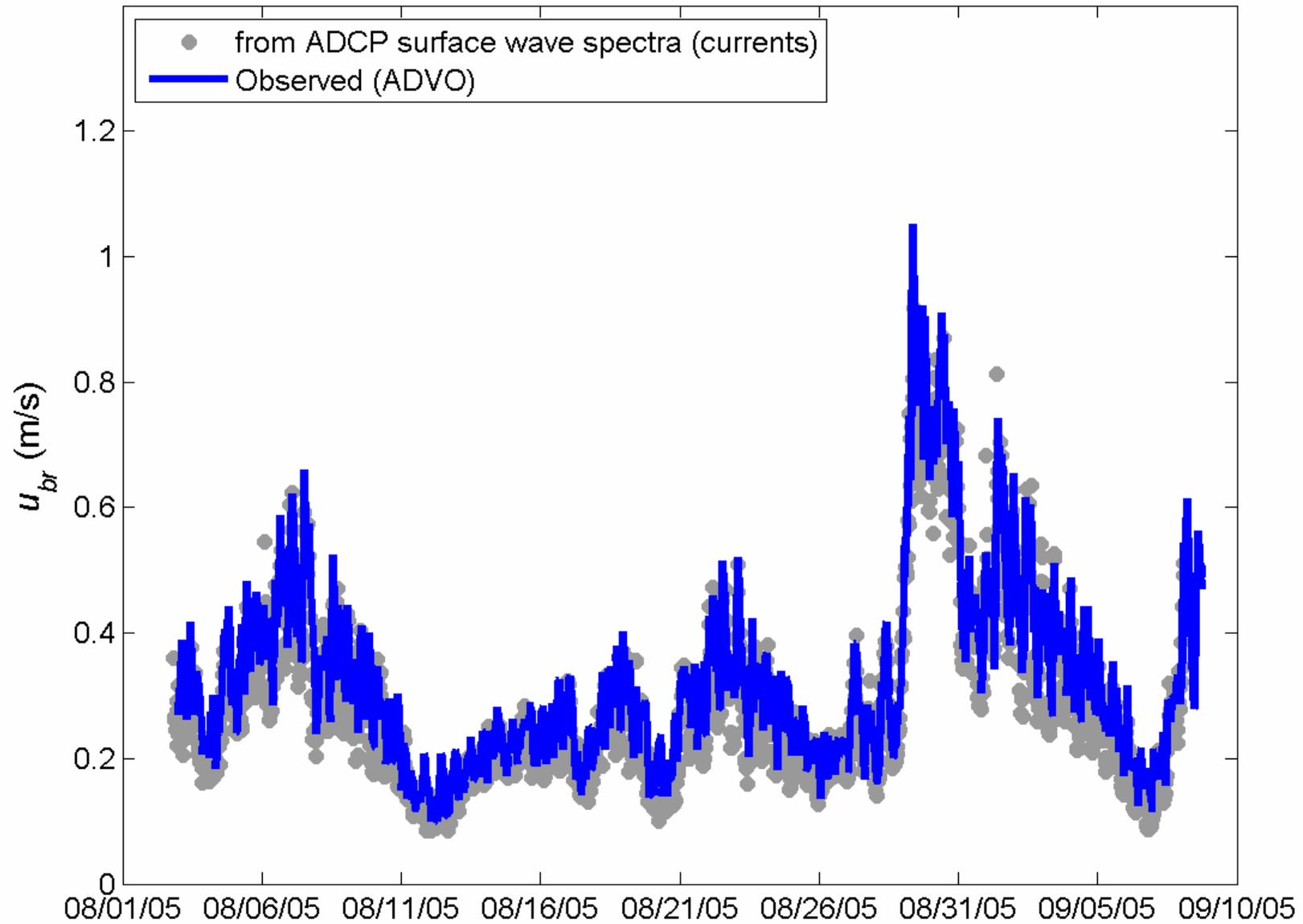
Computed vs. measured orbital velocity



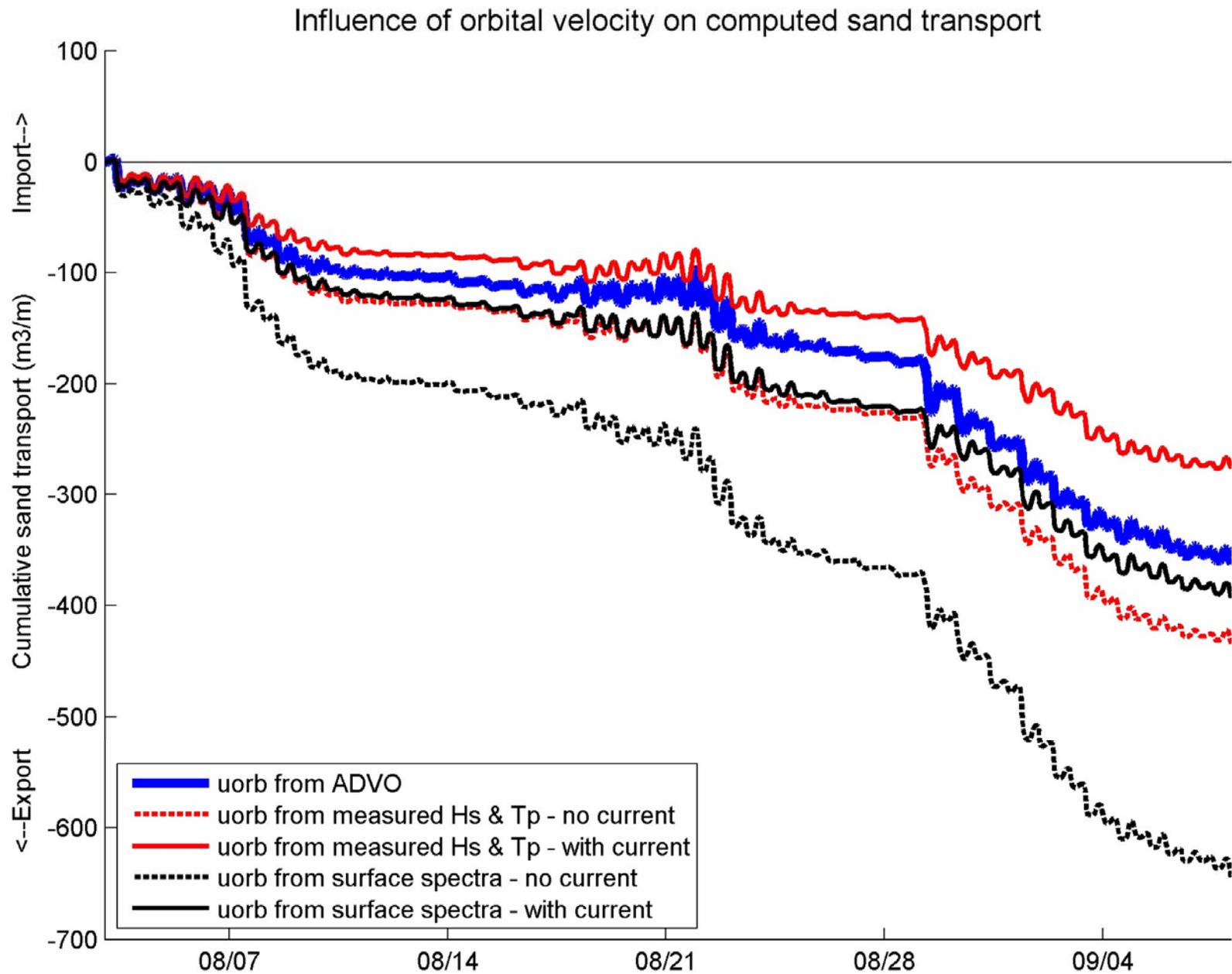
Computed vs. measured orbital velocity



Computed vs. measured orbital velocity



Implications for sediment transport



Model Sensitivity

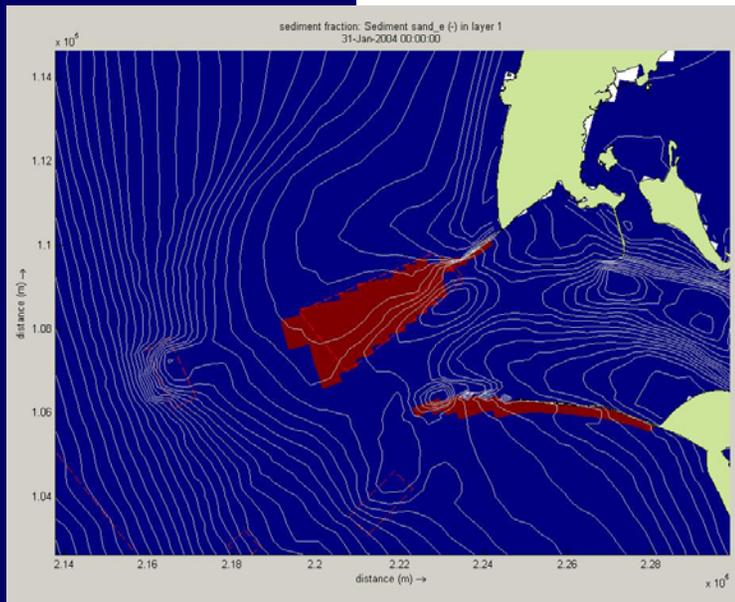
Boundary Conditions

- Starting Bathymetry
- Wave Climate
- Tidal Schematization
- River Flow
- Local Wind Effects

Model Parameters

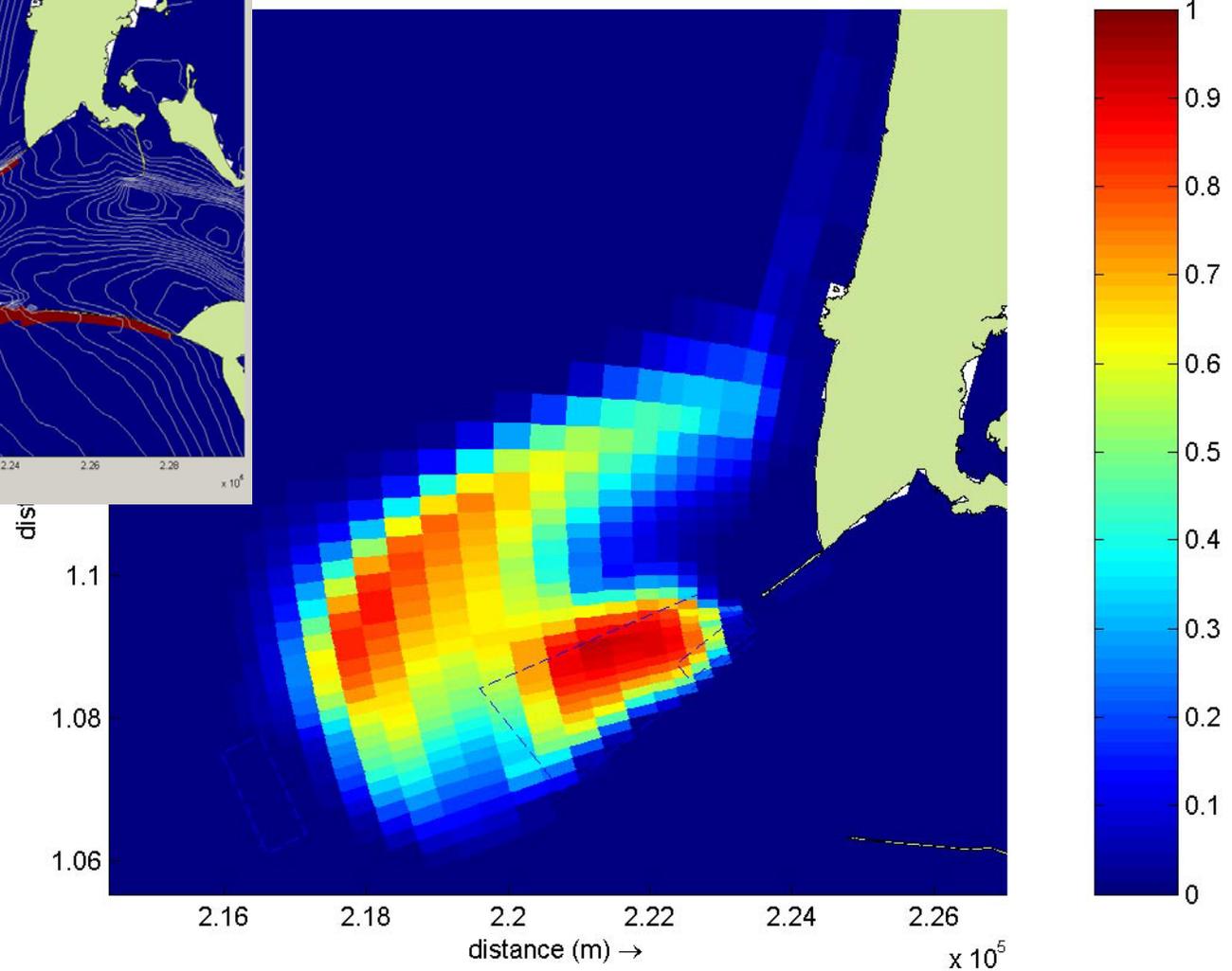
- Bottom Roughness
- Slope effects on sed transport
- Sediment transport formula
- Wave-current interactions
- Horizontal diffusivity

Sediment dispersal

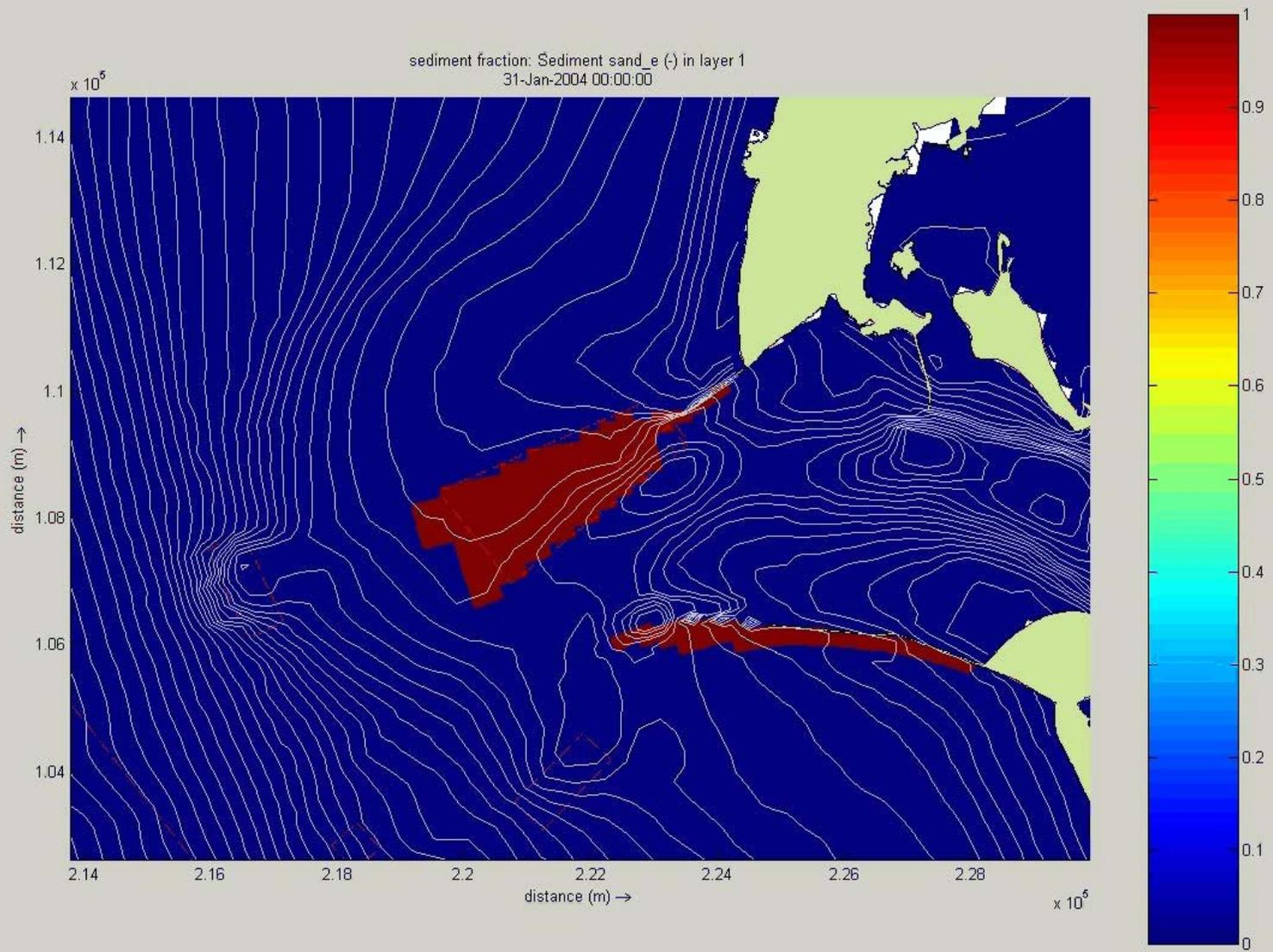


Initial
distribution
of "Site E"
sand

sediment fraction: Sediment sand_e (-) in layer 1
29-Feb-2004 12:00:00

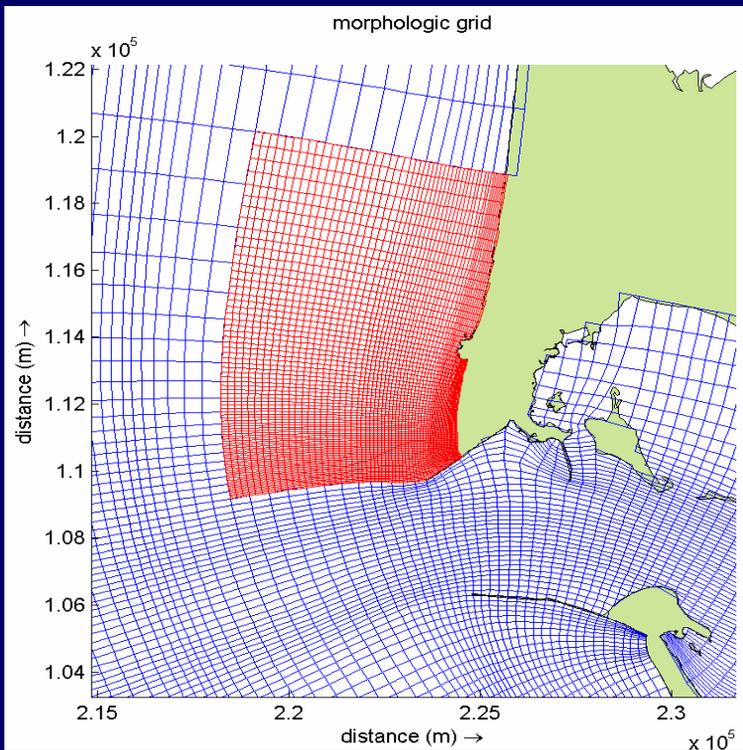


"Final" distribution of site E disposal sand in the top 5cm of bed
at the end of February 2004

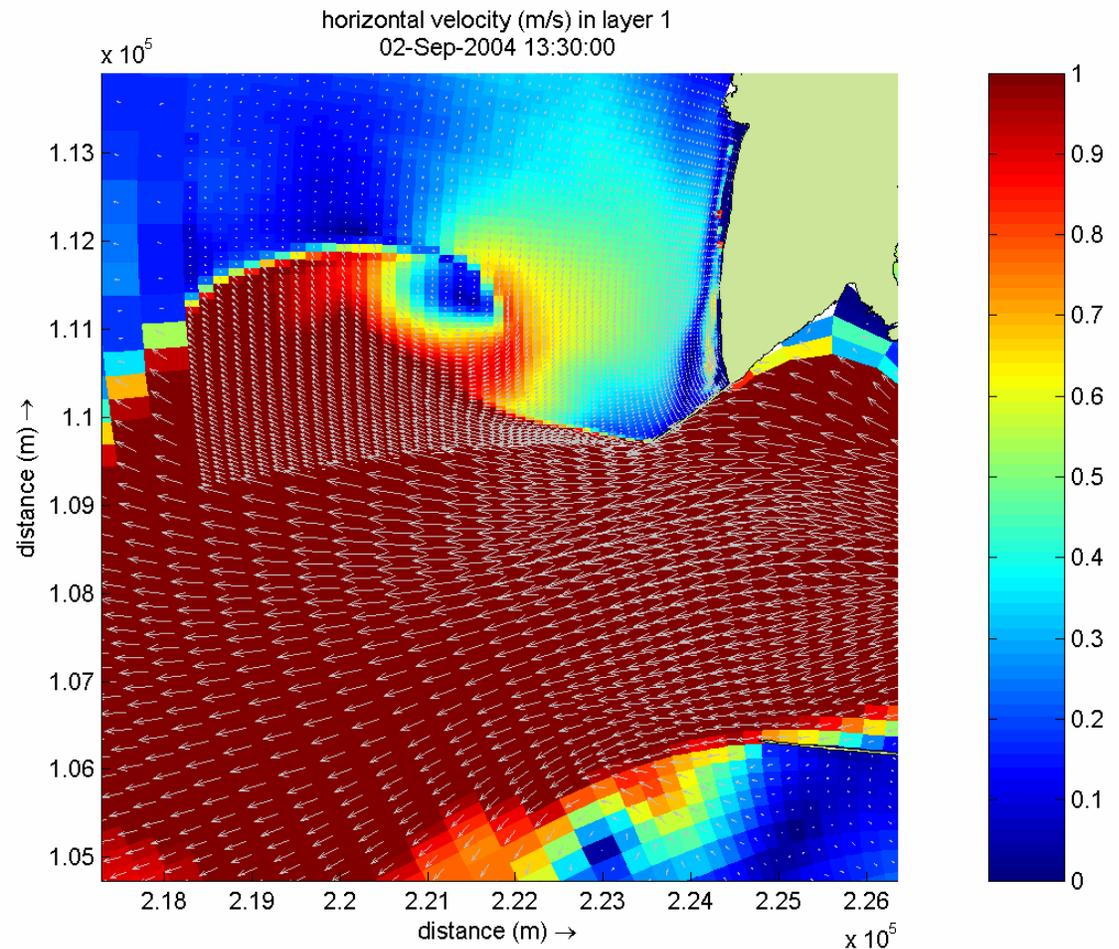


Focusing on particular sites

Computed surface current velocities



Domain Decomposition grid for Benson Beach

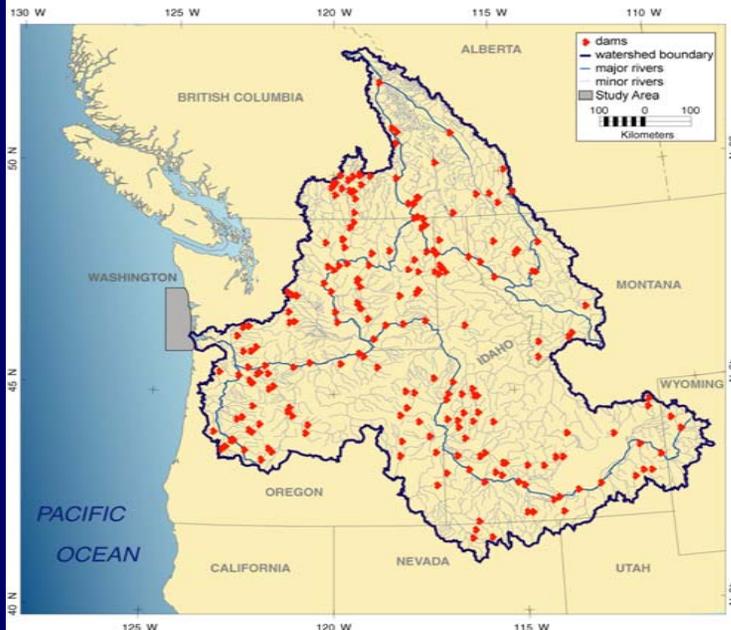


Next steps

- Calibrate / validate model against existing data
- Clarify / prioritize key questions
- Perform modeling studies
- Identify areas of uncertainty/sensitivity and field data required to reduce
- Collect further data if necessary
- Repeat as necessary



Columbia River Basin Dams



Sediment Retention Structure, North Fork Toutle River



May 1989, by Steven R. Brantley, USGS/CVO

Grand Coulee Dam

Built 1942

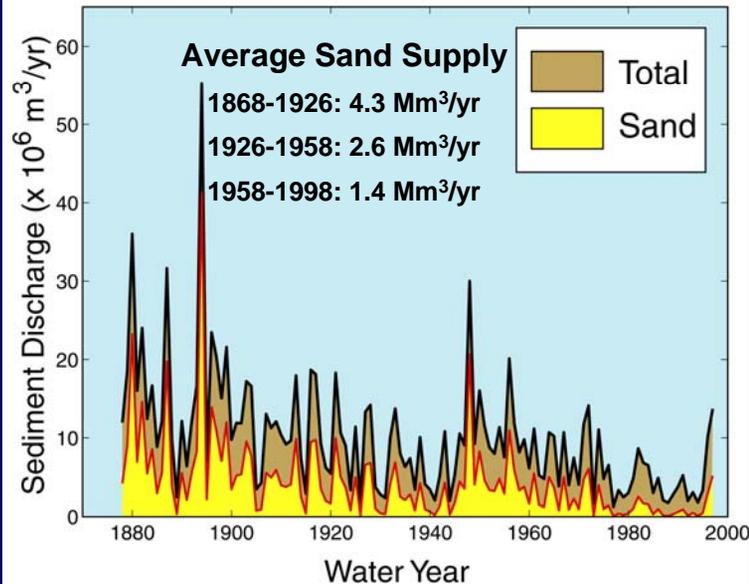
Hydroelectric, Irrigation, Flood Control, Recreation



modify flow

photo from Bonneville Power Administration

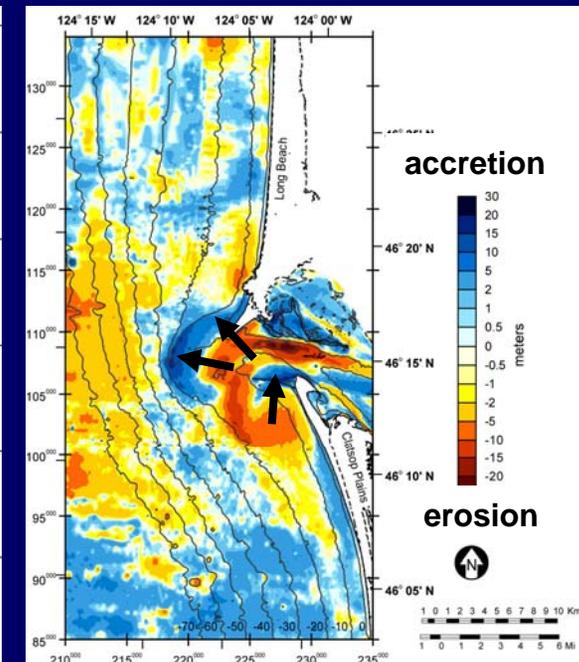
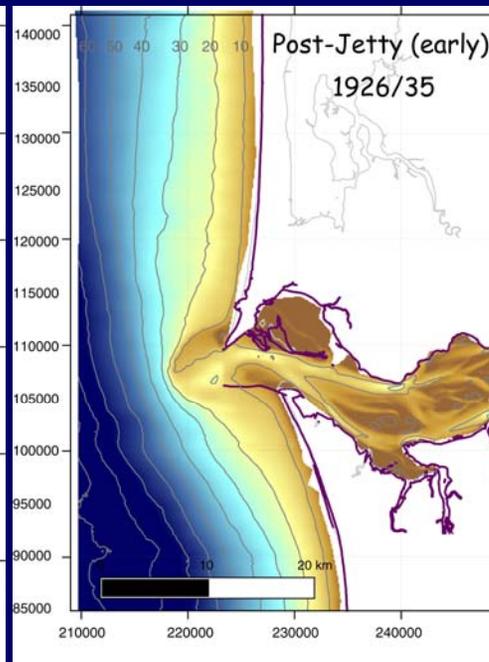
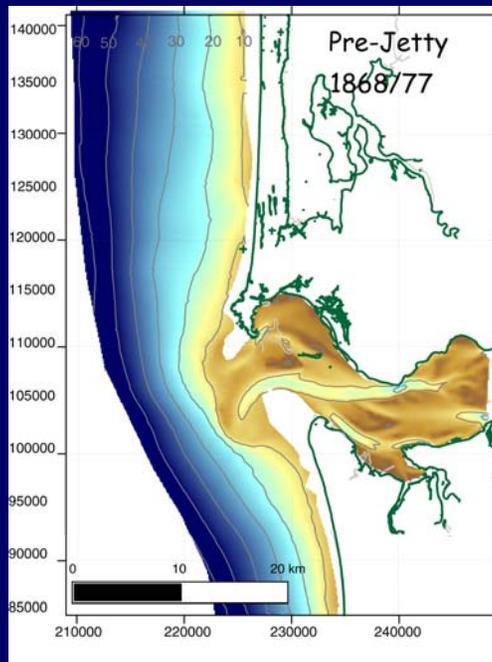
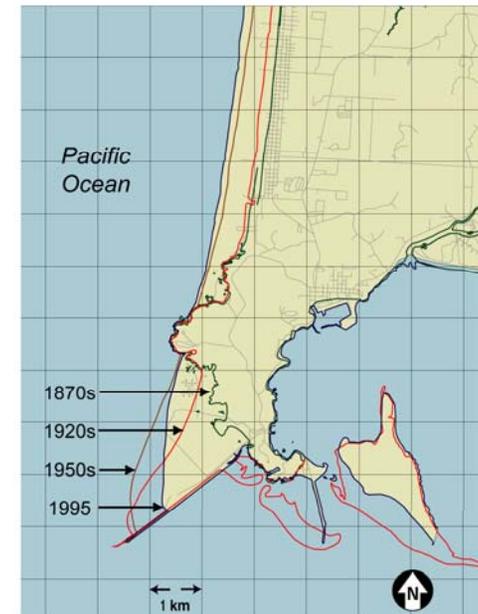
Columbia River Sediment Discharge Hindcast from Daily Riverflow at The Dalles



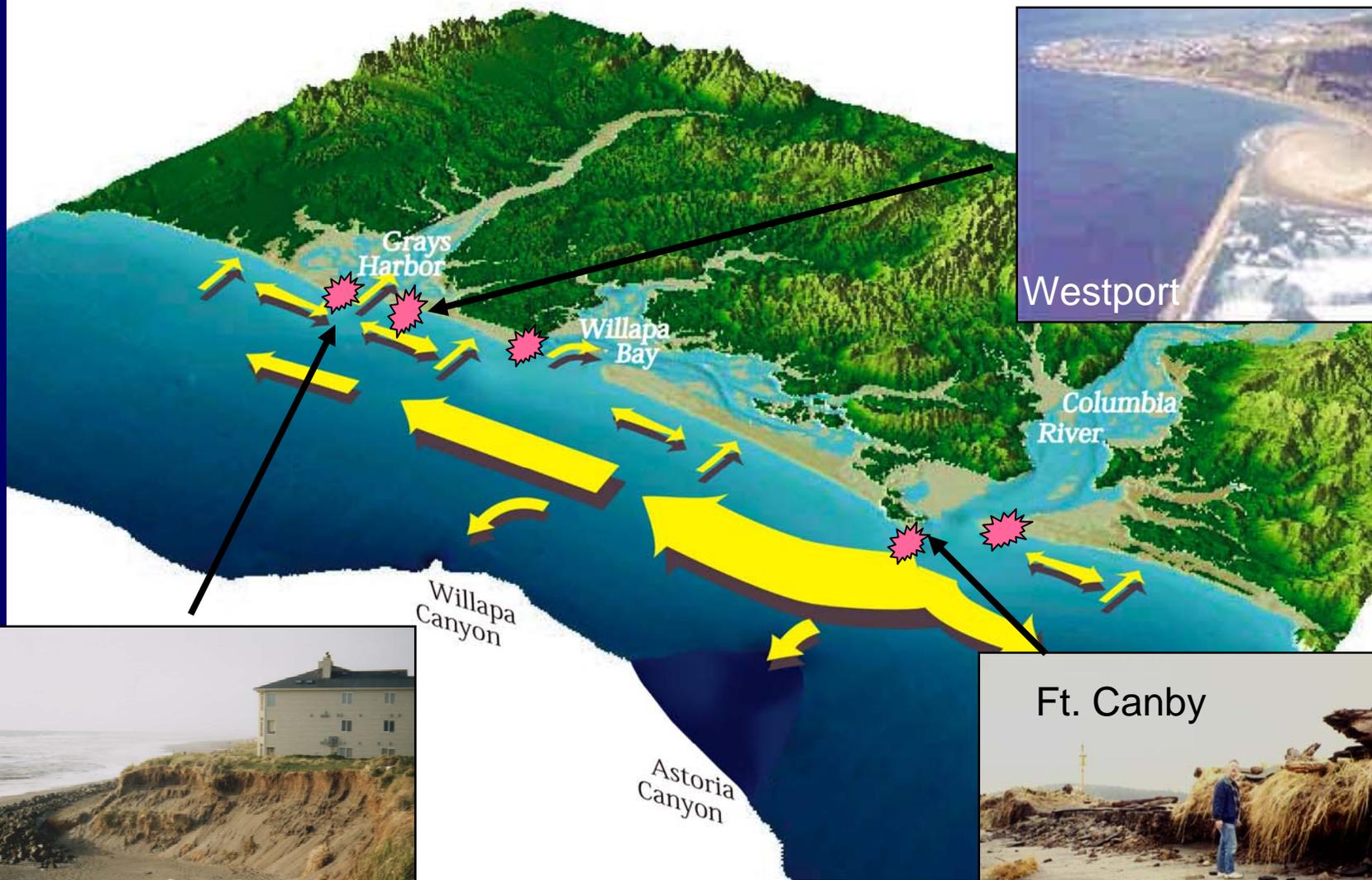
Influence of jetties on sediment dispersal



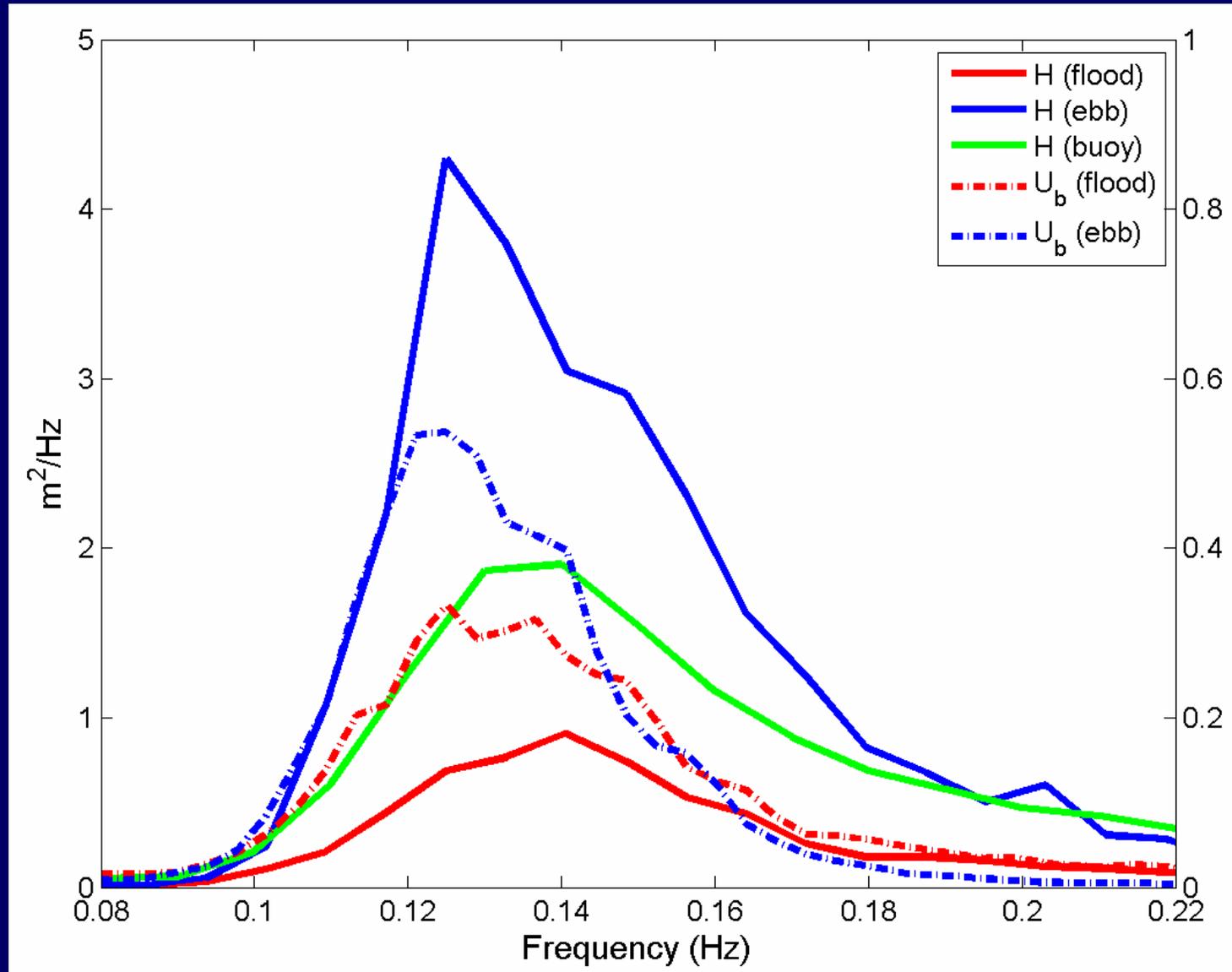
Shoreline Change - Fort Canby 1870 - 1995

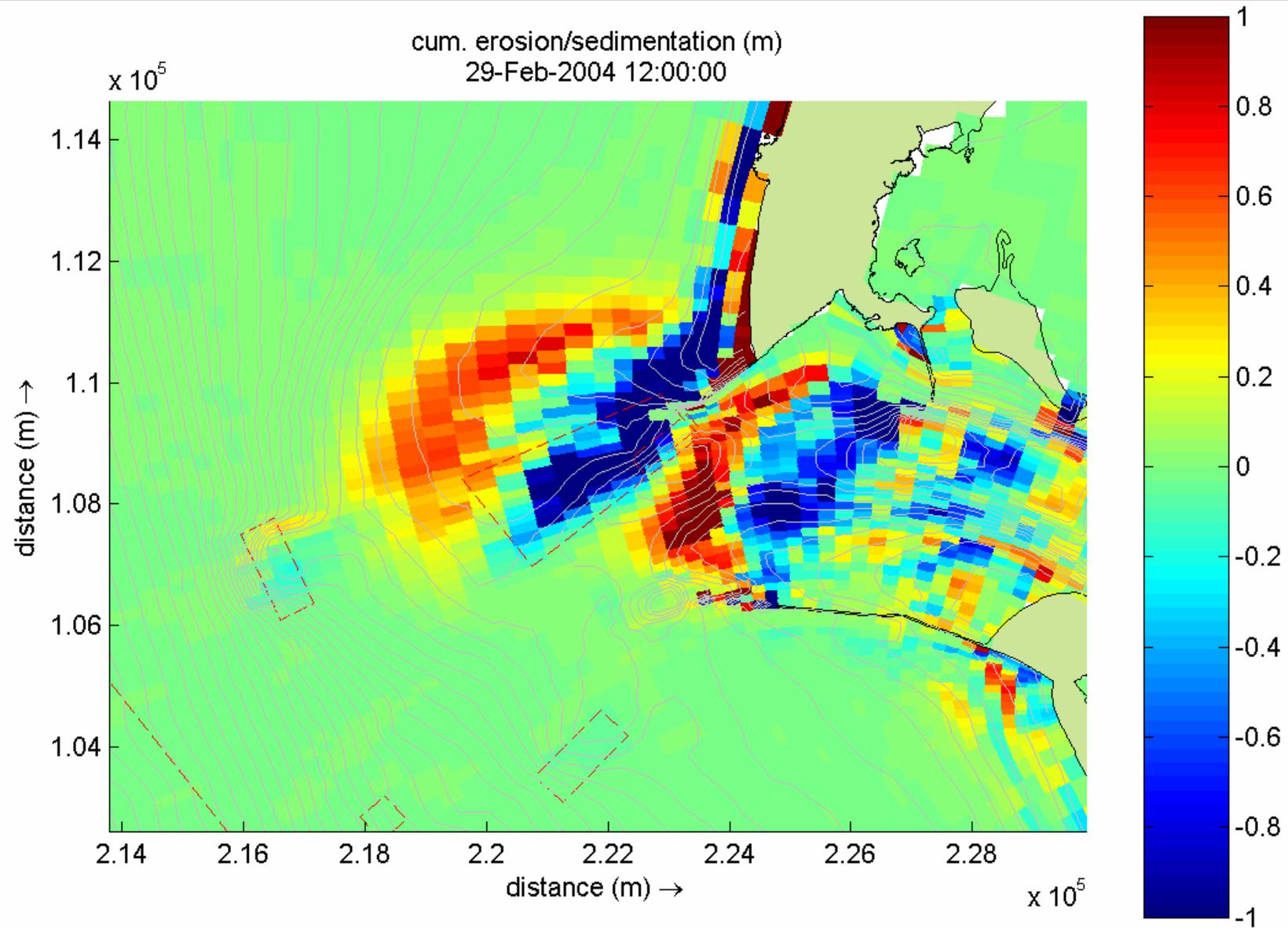


Columbia River Sediment Dispersal



Observed orbital velocity spectra





Resulting sedimentation and erosion (from both "Site E"
sand and normal sand)