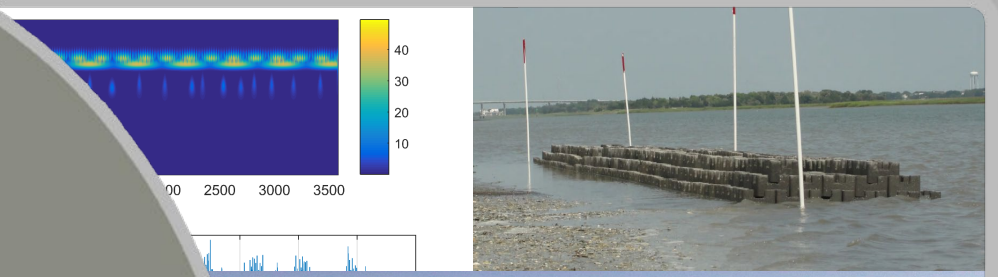


VESSEL WAKE PREDICTION TOOL

INLET ENGINEERING TOOLS

Prichard Styles, Douglas Krafft, Michael Harman

District PDT Members

C. Maglio, F. Fenner (SWG), B. Ward, S. Brown (SAC)

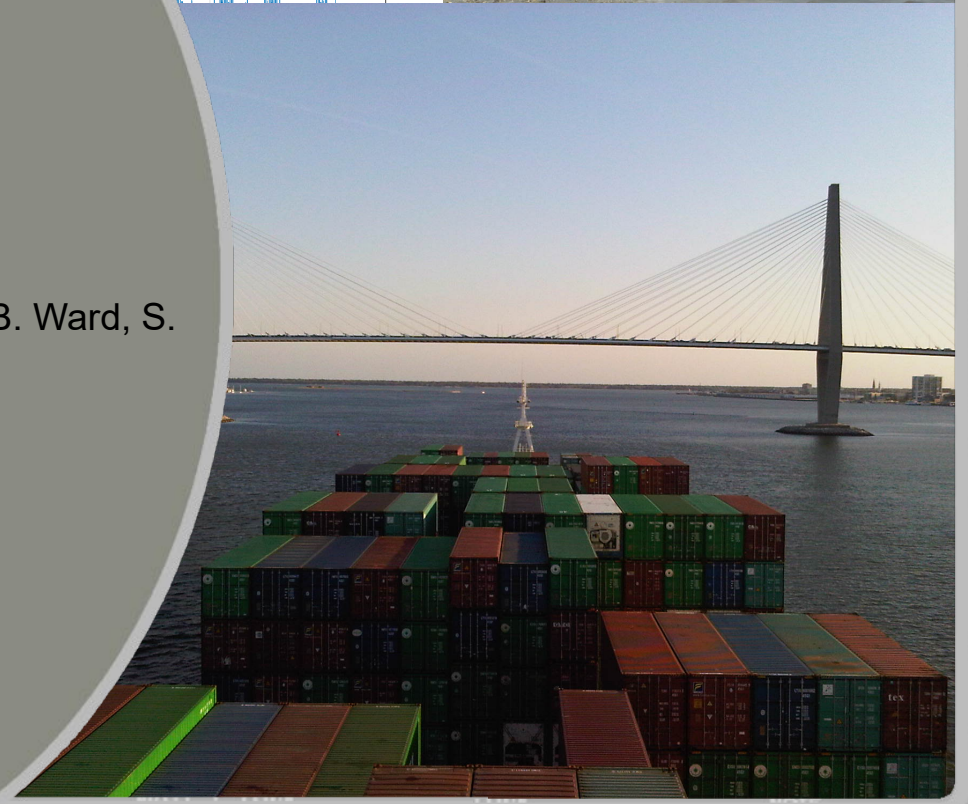
COASTAL INLETS RESEARCH PROGRAM

FY20 IN PROGRESS REVIEW

Mike Ott
HQ Navigation Business Line Manager

Eddie Wiggins
Technical Director

Katherine Brutsché
Associate Technical Director



CIRP: Mission Support, Technology Transfer, Research & Development

US Army Corps of Engineers®

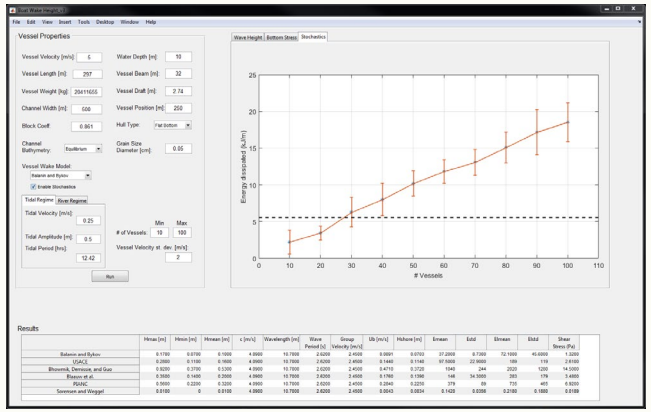
CHL COASTAL & HYDRAULICS LABORATORY

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

DISCOVER | DEVELOP | DELIVER

Develop Software Tools to Investigate the Relative Effects of Vessel Wake

Motivation: Concern over the impact of navigation to the environment (marsh edge erosion, sacrificial berms, shoreline change) has led to increased need to provide simple tools to evaluate vessel wake effects.



SoNs:

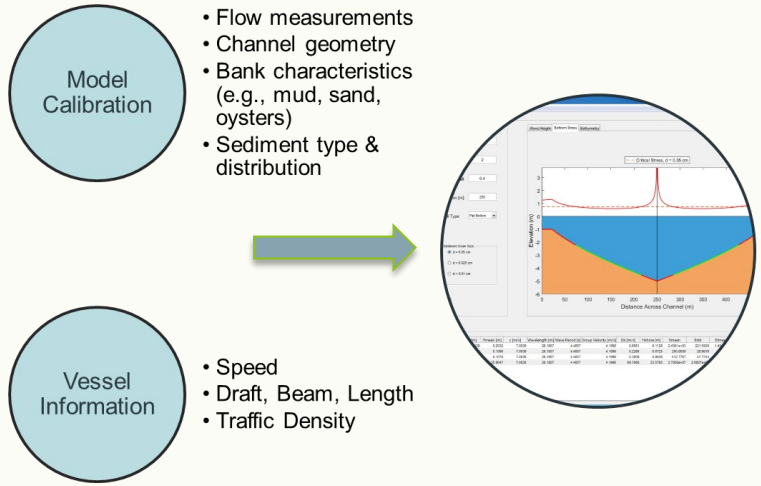
2017-N-01; 2019-N-1370 Testing and evaluating USACE coastal numerical models

2017-N-09 shoreline sediment resuspension and energy dissipation due to vessel wake

2019-A-1297 Vessel Wake Analysis Tool

Capability and Strategic Impact Statement

Develop simple desktop application that can assess the potential contribution of vessels in comparison to other erosion sources (tides, river flow)

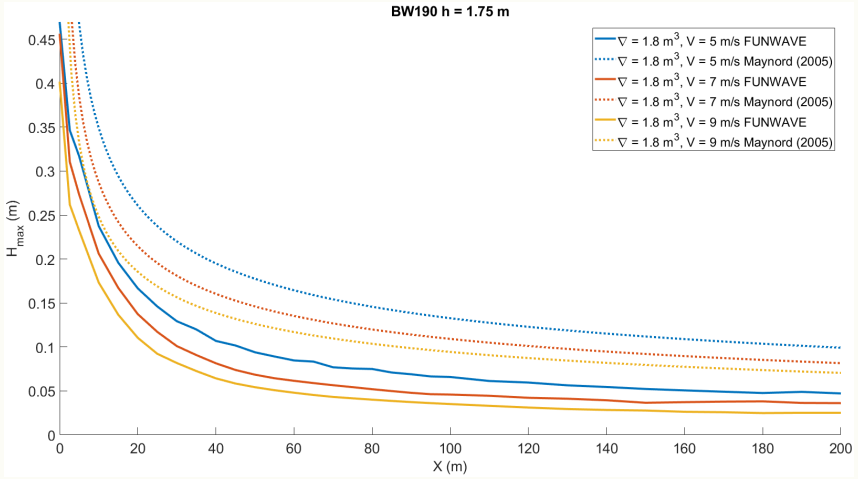


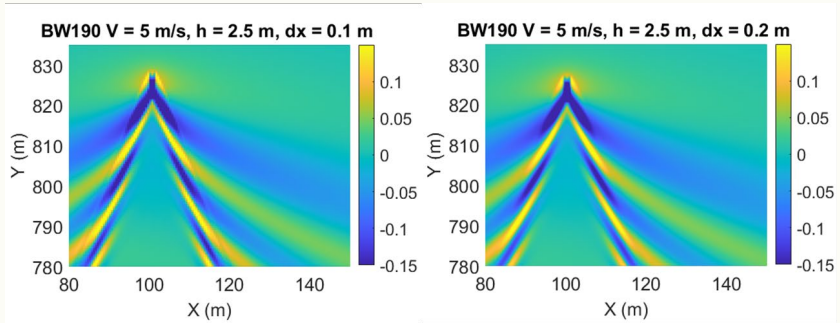
The tool can be used as a low-level scoping aid that provides information on vessel characteristics (metrics) for pre-project evaluation.

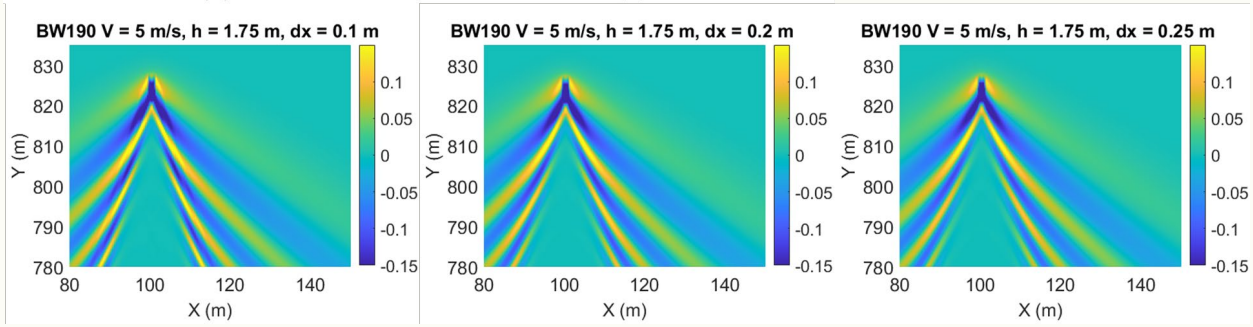
Vessel Wake Prediction Tool

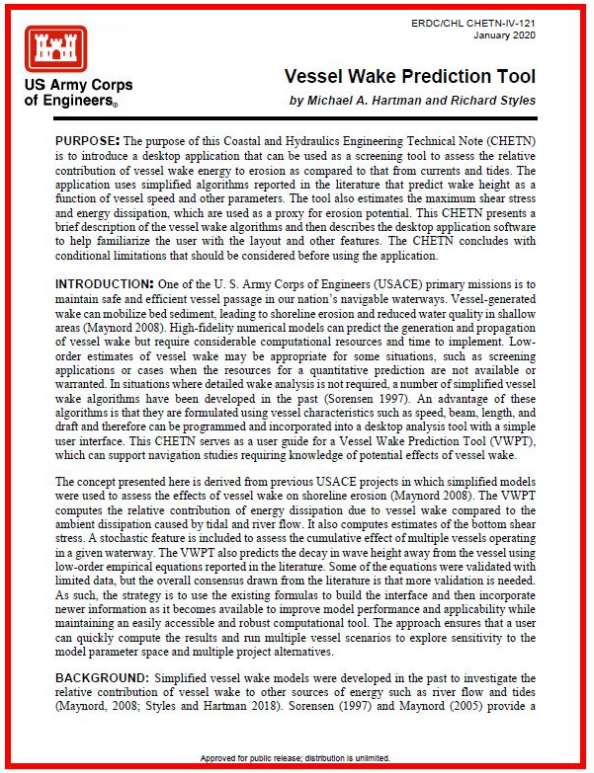
Technical Achievements:

1. Develop executable and uploaded to CIRP webpage
2. Publish TN (guide to executable tool)
3. Conduct numerical model runs (FUNWAVE)
4. Compare to Maynord Model for recreational craft









ERDC/CHL CHETN-IV-121
January 2020

US Army Corps of Engineers

Vessel Wake Prediction Tool

by Michael A. Hartman and Richard Styles

PURPOSE: The purpose of this Coastal and Hydraulics Engineering Technical Note (CHETN) is to introduce a desktop application that can be used as a screening tool to assess the relative contribution of vessel wake energy to erosion as compared to that from currents and tides. The application uses simplified algorithms reported in the literature that predict wake height as a function of vessel speed and other parameters. The tool also estimates the maximum shear stress and energy dissipation, which are used as a proxy for erosion potential. This CHETN presents a brief description of the vessel wake algorithms and then describes the desktop application software to help familiarize the user with the layout and other features. The CHETN concludes with conditional limitations that should be considered before using the application.

INTRODUCTION: One of the U. S. Army Corps of Engineers (USACE) primary missions is to maintain safe and efficient vessel passage in our nation's navigable waterways. Vessel-generated wake can mobilize bed sediment, leading to shoreline erosion and reduced water quality in shallow areas (Maynord 2008). High-fidelity numerical models can predict the generation and propagation of vessel wake but require considerable computational resources and time to implement. Low-order estimates of vessel wake may be appropriate for some situations, such as screening applications or cases when the resources for a quantitative prediction are not available or warranted. In situations where detailed wake analysis is not required, a number of simplified vessel wake algorithms have been developed in the past (Sorensen 1997). An advantage of these algorithms is that they are formulated using vessel characteristics such as speed, beam, length, and draft and therefore can be programmed and incorporated into a desktop analysis tool with a simple user interface. This CHETN serves as a user guide for a Vessel Wake Prediction Tool (VWPT), which can support navigation studies requiring knowledge of potential effects of vessel wake.

The concept presented here is derived from previous USACE projects in which simplified models were used to assess the effects of vessel wake on shoreline erosion (Maynord 2008). The VWPT computes the relative contribution of energy dissipation due to vessel wake compared to the ambient dissipation caused by tidal and river flow. It also computes estimates of the bottom shear stress. A stochastic feature is included to assess the cumulative effect of multiple vessels operating in a given waterway. The VWPT also predicts the decay in wave height away from the vessel using low-order empirical equations reported in the literature. Some of the equations were validated with limited data, but the overall consensus drawn from the literature is that more validation is needed. As such, the strategy is to use the existing formulas to build the interface and then incorporate newer information as it becomes available to improve model performance and applicability while maintaining an easily accessible and robust computational tool. The approach ensures that a user can quickly compute the results and run multiple vessel scenarios to explore sensitivity to the model parameter space and multiple project alternatives.

BACKGROUND: Simplified vessel wake models were developed in the past to investigate the relative contribution of vessel wake to other sources of energy such as river flow and tides (Maynord, 2008; Styles and Hartman 2018). Sorensen (1997) and Maynord (2005) provide a

Approved for public release; distribution is unlimited.

Vessel Wake Prediction Tool

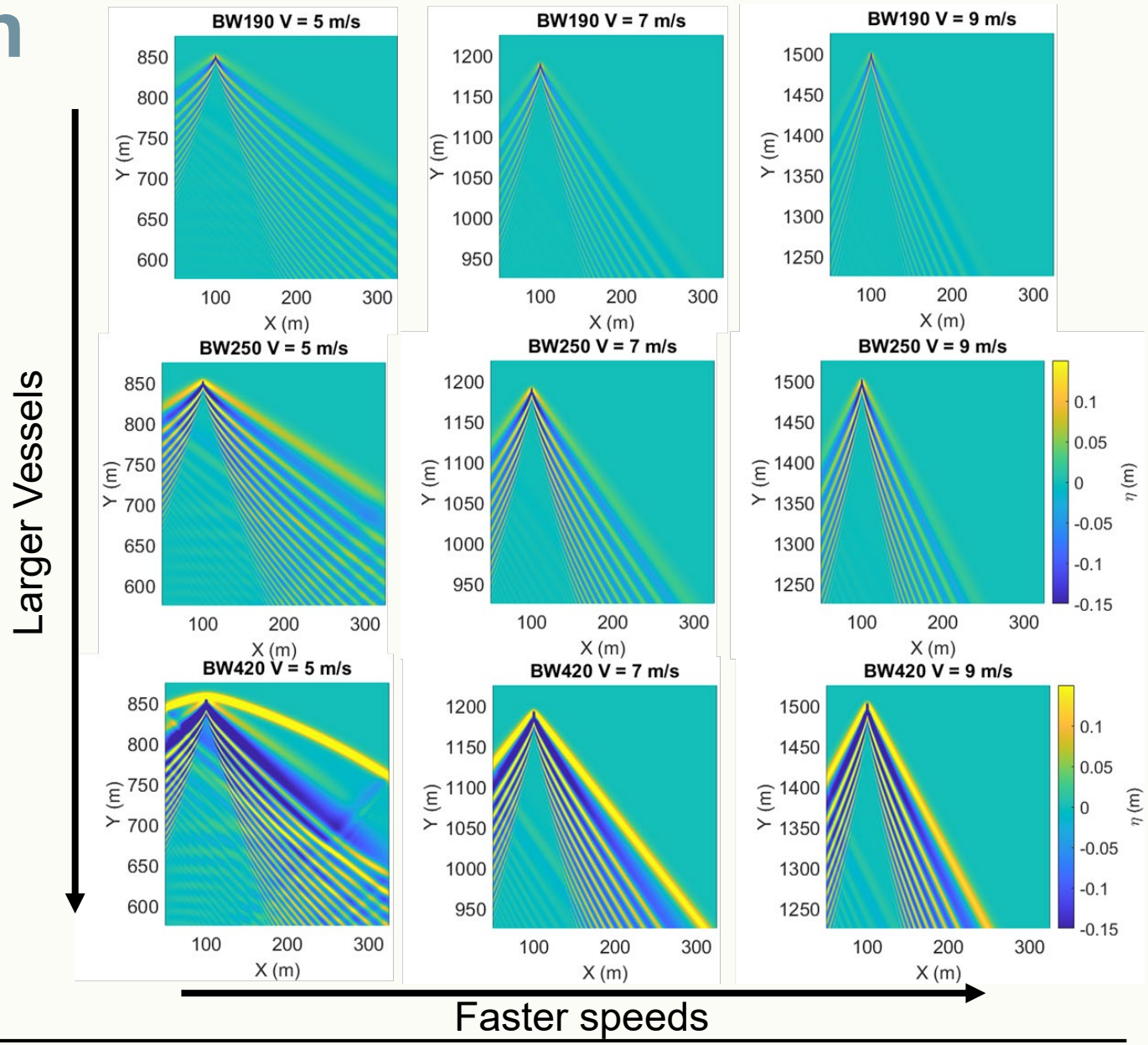
Technical Achievements
Numerical Model Test Matrix

Vessel

- BW190: 2 Ton
- BW250: 6 Ton
- BW420: 23 Ton

Speed

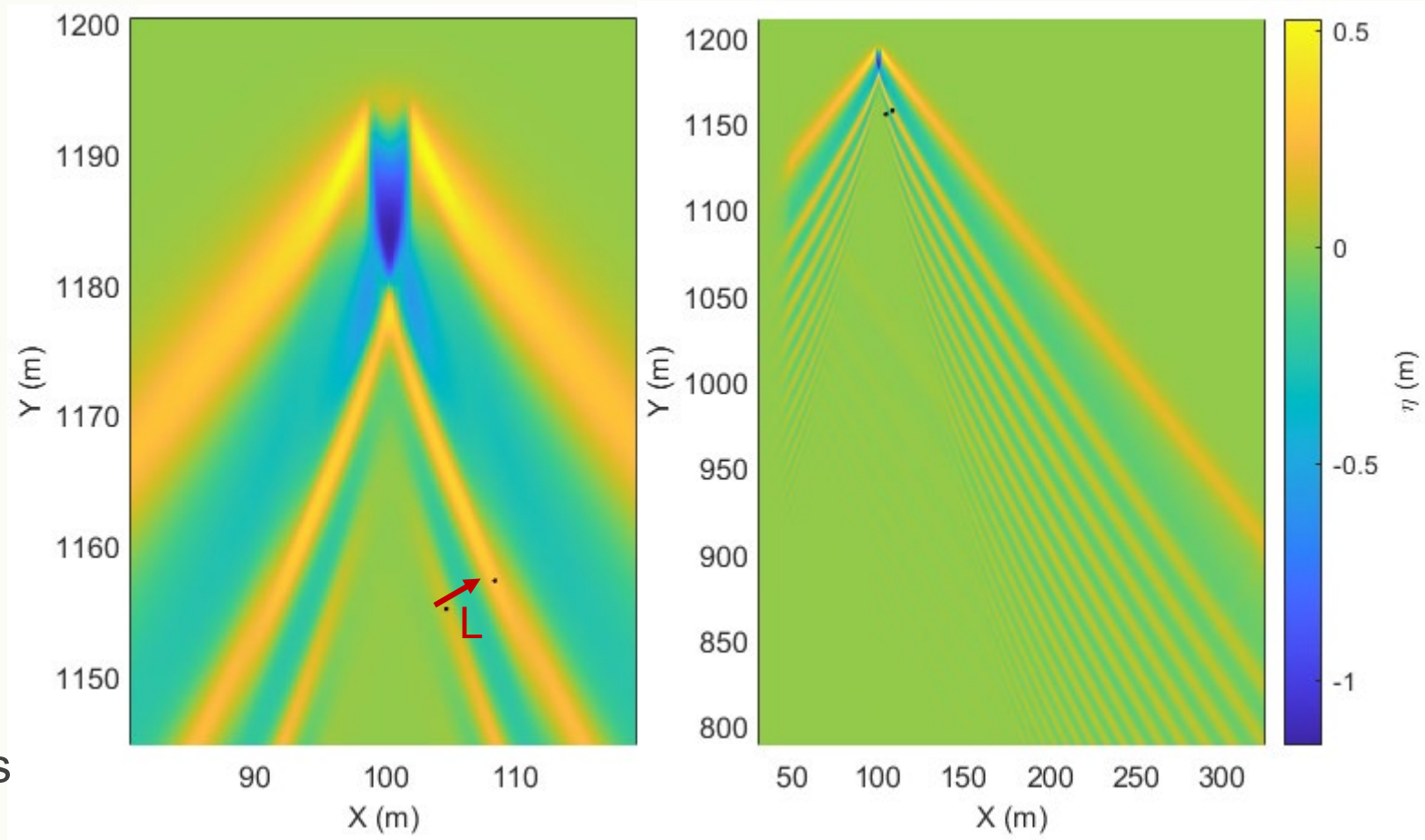
- Completed: 5 m/s (10 knots), 7 m/s (14 knots), 9 m/s (18 knots)
- Investigated numerical constraints (reflection, damping, adequate resolution)



Vessel Wake Prediction Tool

Technical Achievements

- **Intended Model Regime**
  - Intermediate and shallow water waves
- $k \cdot h < \pi$ **or L > 2h**
- **Simulated Wake Length (L)**
  - Wake length estimated as the distance between peaks near the vessel
  - Manual point selection (accuracy with 0.2 m cells)
  - Issues encountered in simulations with $L < 2h$



Summary

FY20 Major Advances in Capability

- Tool deployed on CIRP webpage
- Setup numerical model runs
- Developed partial suite of numerical model wake height solutions for lookup table
- Initiated comparison to Maynord model results.

FY20 Major Products & Collaborations

- “Vessel Wake Prediction Tool”, TN (Feb 20)
- CIRP TD (Aug 20)
- Tool Highlighted in ERDC SITREP (Feb 20)
- Leveraged with DOER and NavSys
- Coastal and Estuarine Research Federation bi-annual meeting, “Vessel Wake and Ship Usage in Charleston Harbor” (Nov 19)
- Reimbursable: Software tools used in SAC study, DOTS request, SAS (planned), LRD

FY21 Products/Advances

- Regroup on numerical modeling strategy
- Analyze/assess vessel wake data
- Explore other numerical modeling strategies