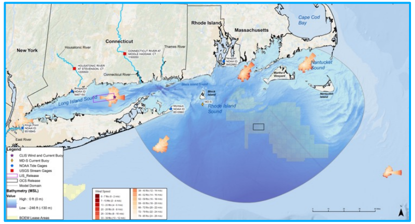
Coastal Sediment Transport Modeling of Offshore Wind Farm Construction Activities

Yan Zhang, Ph.D., P.E & Katy Teske, EIT

Introduction

The USACE Particle Tracking Model (PTM) is a sediment transport model using the Langrangian approach for coastal and dredging projects. A key input is hydrodynamic forcing, which is read in either 2-D or 3-D datasets, each triggering different particles advection schemes. The 3D approach is used where interaction with native bed and vertical movement are significant. We examined two commonly used construction methods for offshore windfarm and cable installation by modeling sediment movement from seafloor disturbance. The time series of hydrodynamic currents were simulated using Delft3D-FM and ADCIRC (2D) with a domain encompassed the entire Long Island Sound and the OCS off the New England coast. We examined impact of dimensionality on coastal sediment transport. Results of the sediment modeling were used to support Construction Operation Plan filing with BOEM and state water quality permitting for the Beacon Wind Offshore Wind Project.



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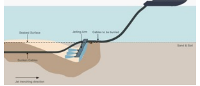
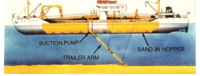
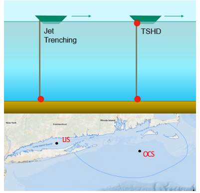


Trailing Suction Hopper Dredge (TSHD)

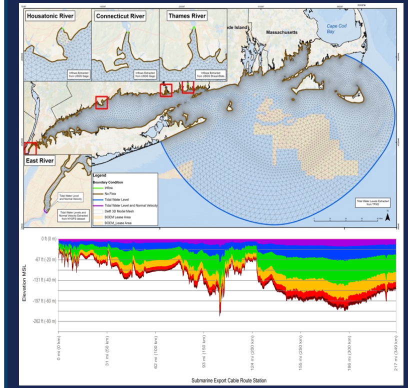


Methods & Assumptions

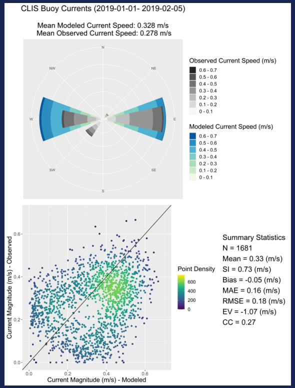
- 2D Hydrodynamics: ADCIRC
- 3D Hydrodynamics: Delft3D-FM
- Model Validation against sea surface
- heights (SSH) and currents
- Hypothetical dredging Areas:
  - Atlantic OCS ("low energy")
  - Long Island Sound (LIS)
  - ("high energy")
- Moving release source



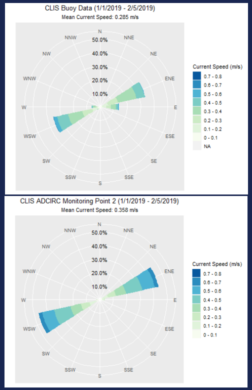
Hydrodynamic Models



Delft3D - Validation



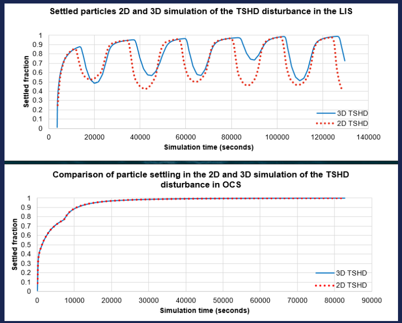
ADCIRC (2D) Validation



PTM: 3D vs 2D (U.S. Army Corps of Engineers)

	2D PTM	3D PTM
Horizontal movement	Local horizontal velocity of the centroid elevation applied to entire particle distribution	Local horizontal velocity at the elevation of the particle
Vertical movement	No vertical advection. Particles move in the vertical due to changes in the particle centroid elevation	Vertical velocity component
Particle-bed interaction	Not included	Included
Deposition	If local mobility < critical mobility	When particle passes below the 1/4 of the skin roughness height
Resuspension	If local mobility > critical mobility	Based on frequency of entrainment (function of shear stress, burial depth, active transport layer thickness, etc.)

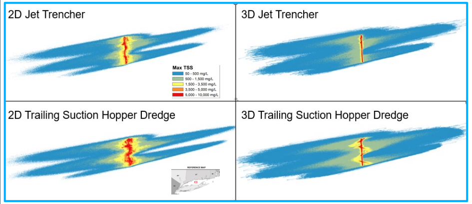
PTM Results – Total Sediment Deposition (Fraction) vs Time



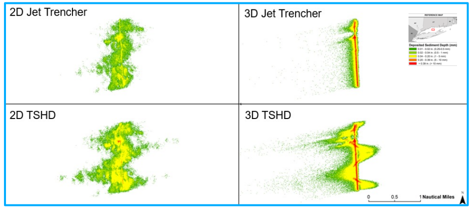
OFFSHORE WINDPOWER

Sediment Transport Modeling Results

Maximum Suspended Sediment Concentration (mg/L)



Sediment Deposition Thickness (mm)



Summary of Observations

- Both 2D and 3D PTM modes are capable of adequately predicting the trajectories of suspended sediment movement.
- Compared to the 3D mode, the 2D PTM mode appears to predict greater suspension or less deposition, due to (a) Use of depth averaged current velocities, and (b) Lack of simulating sediment-bed interaction.
- The 3D PTM mode provides the most detailed representation of sediment transport incorporating processes of sediment vertical movement and interaction with bed; hence more defendable to support permitting.
- At OCS, PTM predictions between 2D and 3D modes are seemingly identical possibly due to low energy or lack of sediment-bed interaction.

Acknowledgements

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Contact Info

yan.zhang2@aecom.com
(781) 999-0621

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