Overwater/Offshore Modeling - Development

EPA RSL Workshop

U.S. EPA / OAQPS / Air Quality Modeling Group

Monday, June 21, 2021

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Overwater/Offshore Modeling- Development

- **Purpose/Goal:** Replacement of OCD with AERMOD
- 3 areas of development needed to replace OCD with AERMOD
  1. Treatment of overwater boundary layer – meteorological data processing
  2. Platform downwash
  3. Shoreline (coastal) fumigation
- *Area 1* - EPA to release draft AERMET (AERMET Overhaul) and draft MMIF to include processing of overwater prognostic data (will not address buoy data)
- *Areas 2-3* - Interagency Agreement with Bureau of Ocean Energy Management (BOEM)
  - *Area 2* - Integrating platform downwash algorithm from Offshore and Coastal Dispersion Model (OCD) into AERMOD – **alpha** option
  - *Area 3* - Scoping study to explore options for adding shoreline fumigation to AERMOD
- *Area 2* - BOEM Wind Tunnel Study (with EPA participation)
  - Collecting data for typical offshore platforms for continued development of platform downwash

BOEM

Bureau of Ocean Energy Management

Air Quality Modeling Studies Update

June 21, 2021

EPA Regional/State/Locals Modelers' Workshop

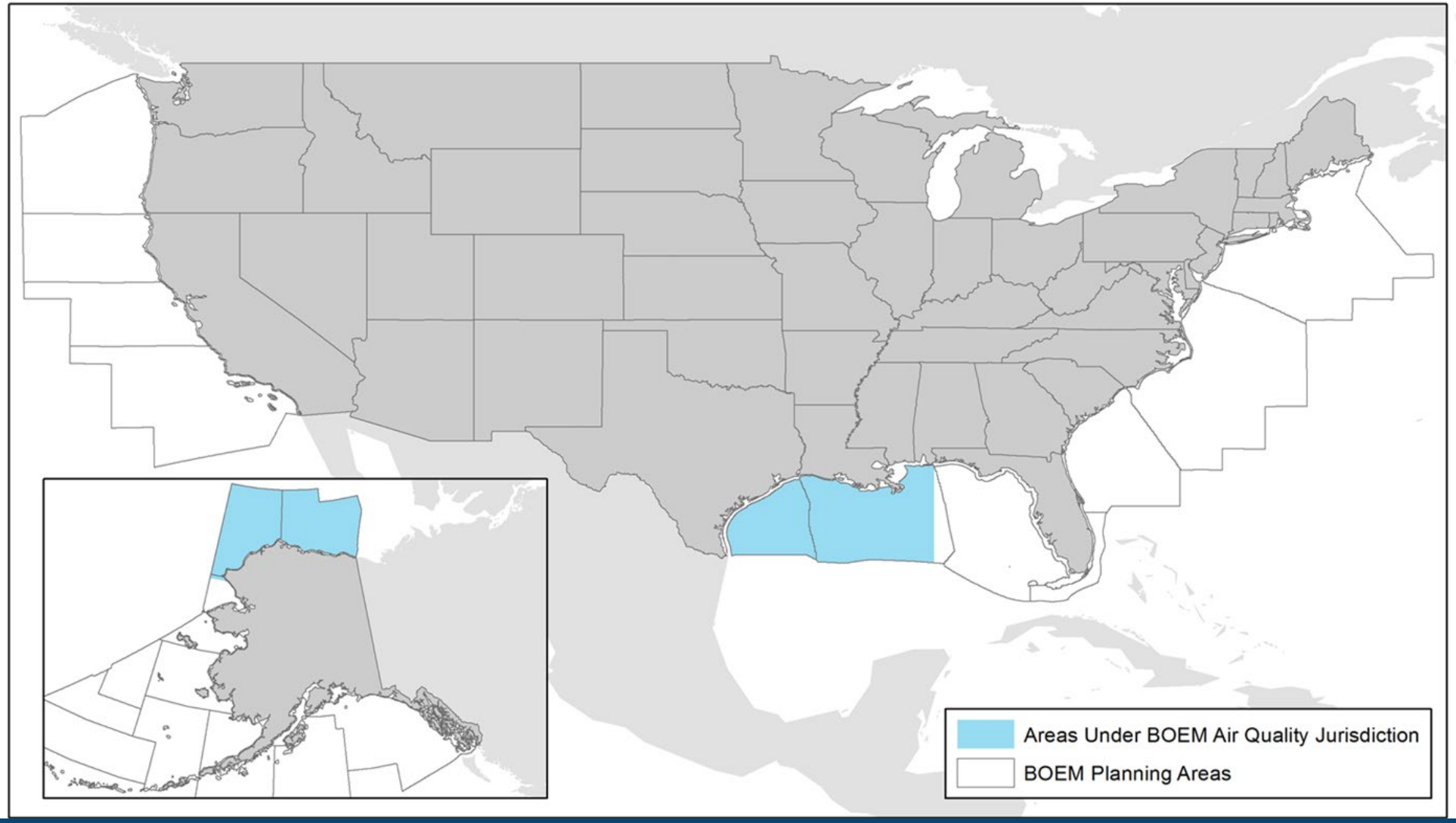
Air Quality: BOEM's Statutory Responsibility

OCSLA Section 5(a)(8) states:

The Secretary of the Interior is authorized to prescribe regulations "for compliance with the national ambient air quality standards pursuant to the Clean Air Act . . . to the extent that activities authorized under [the Outer Continental Shelf Lands Act] significantly affect the air quality of any State."

There are other provisions in OCSLA that authorize regulations for environmental protection such as OCSLA Section 5(a).

BOEM's Air Quality Jurisdiction



BOEM Replacement of OCD with AERMOD

- "EPA White Papers on Planned Updates to AERMOD Modeling System" Memo dated September 19, 2017, planned areas for updates to AERMOD.
- In order to replace OCD with AERMOD as the preferred model for overwater sources, science updates needed: platform downwash, shoreline fumigation, and allow for better characterization of the marine boundary layer.

OCD	AERMOD
Preferred overwater model for short range transport in Appendix W	Preferred overland model for short range transport in Appendix W
Platform downwash algorithms	Building downwash which doesn't include open offshore drilling platforms
Coastal fumigation algorithms	Doesn't include coastal fumigation algorithms
Last substantial change in 1997	Continuous updates
Older Pasquill-Gifford (PG) stability classifications	Modern Monin-Obukhov similarity theory
Can't read modern meteorological files	Can read modern meteorological files
Outputs aren't directly comparable to NAAQS	Outputs are directly comparable to NAAQS
Graphical user interface can't be run on modern computers	Graphical user interface can be run on modern computers

Installing OCD Platform Downwash Algorithms in AERMOD

Purpose of EPA Inter-agency Agreement:

- To improve AERMOD for overwater applications by assessing the compatibility of the OCD platform downwash algorithms with AERMOD, and if found to be compatible, evaluate existing draft AERMOD code that incorporates the platform downwash algorithms from OCD

Status:

- OCD platform downwash algorithms seem to be compatible with AERMOD
- Algorithms in AERMOD but still need to be evaluated
- Period of Performance ends October 2022

EPA United States Environmental Protection Agency

Wind Tunnel Experiments for Offshore Oil Platform and Drilling Rig Downwash

Purpose:

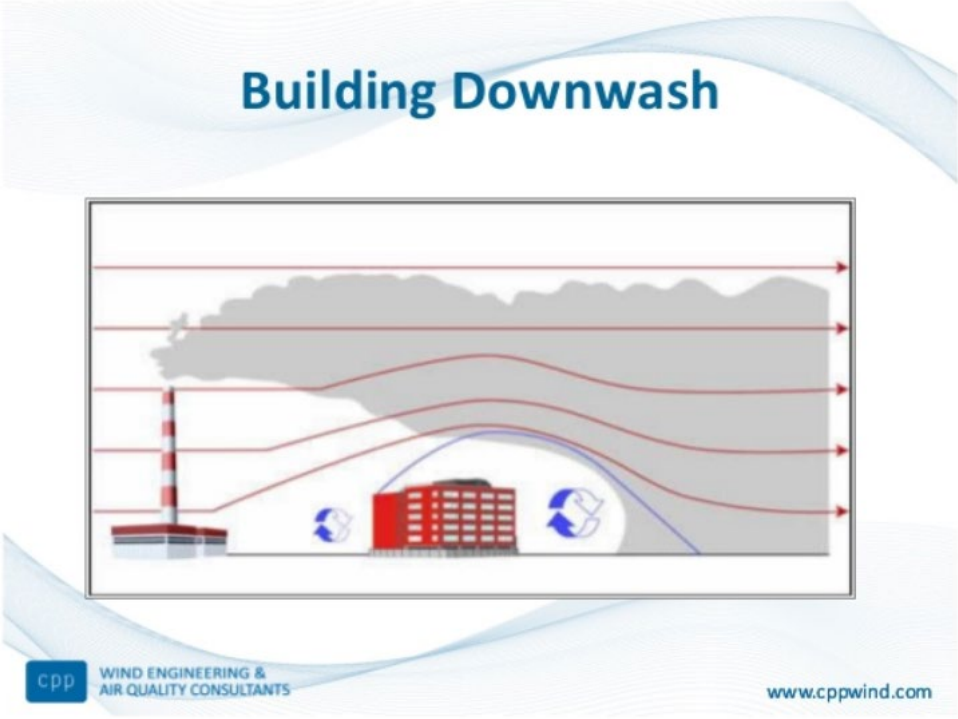
- To conduct wind tunnel experiments to characterize downwash on several types of offshore structures, oil platform and mobile drilling rig during varying conditions

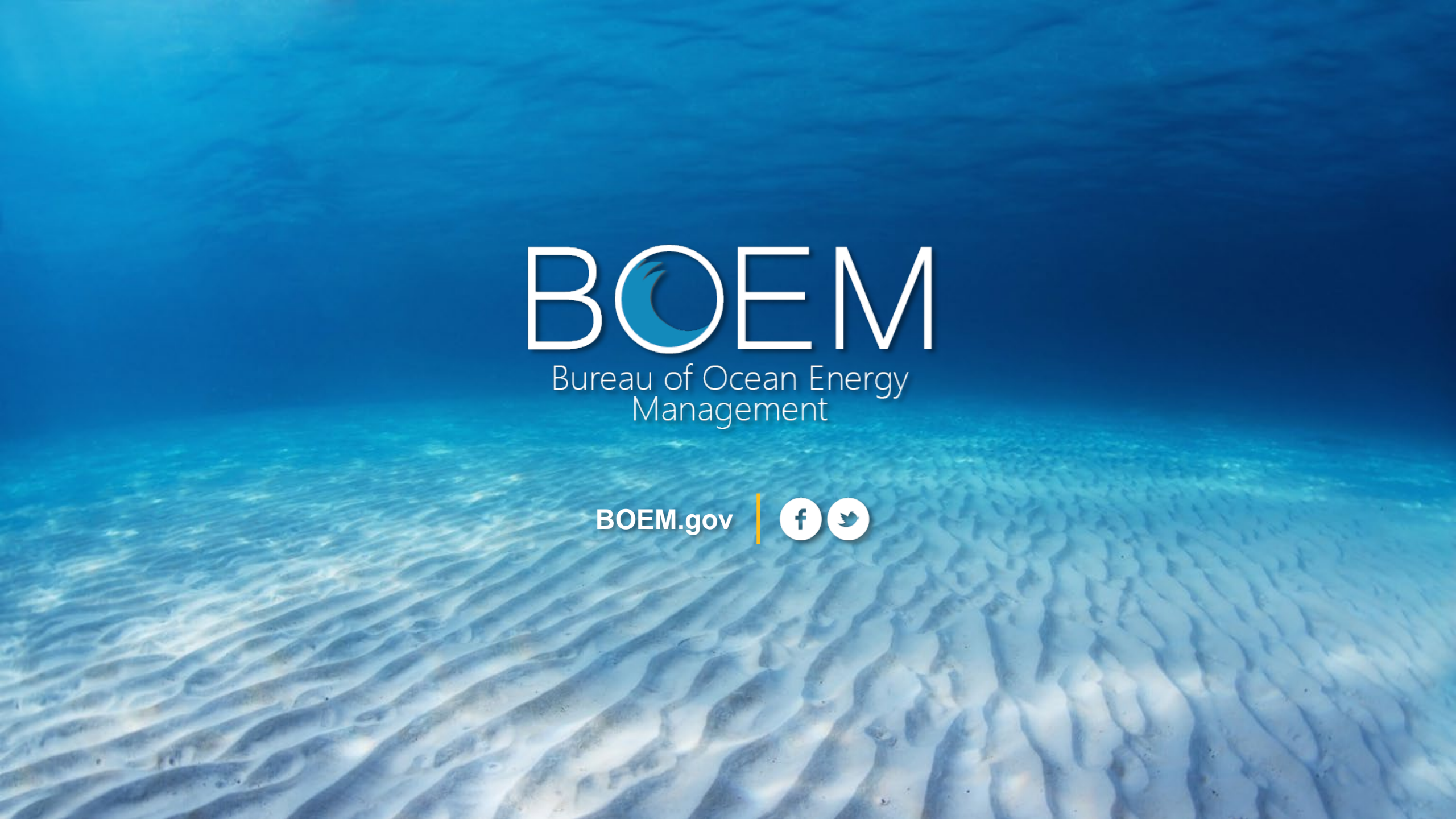
Background:

- EPA suggested platform downwash should be incorporated into AERMOD.

Status:

- Awarded in November 2020
- Results will be given to EPA for algorithm drafting and inclusion into AERMOD
- Period of Performance ends August 2022

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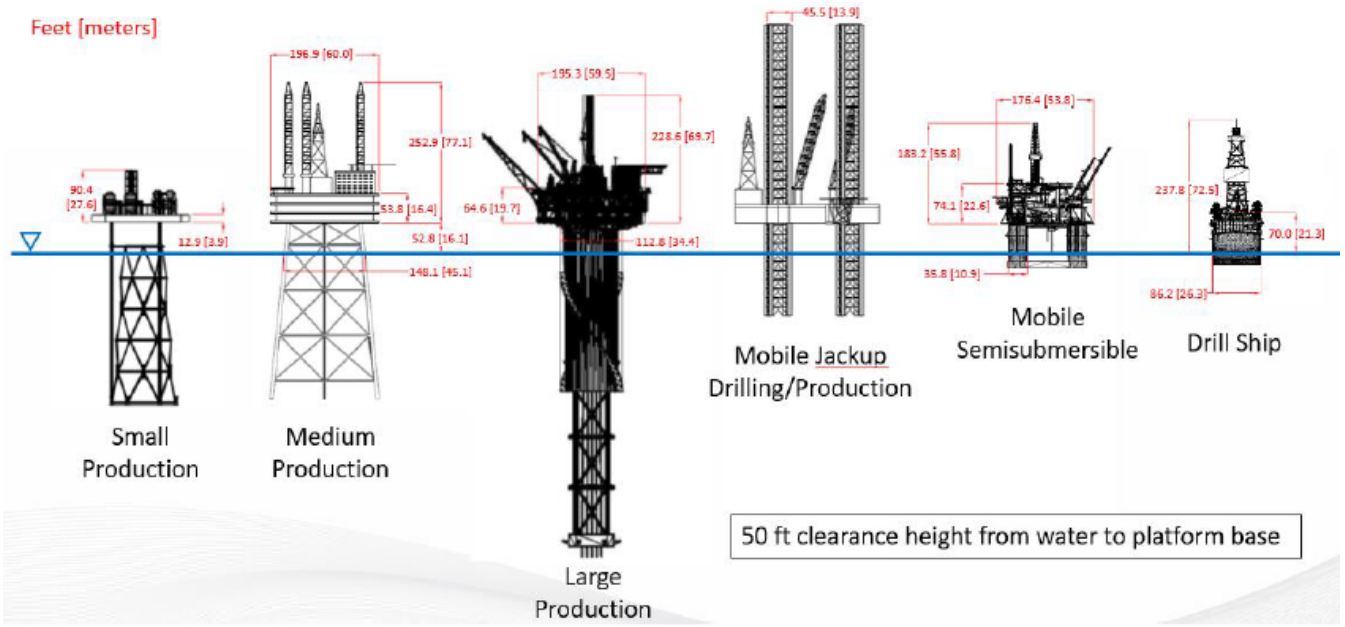
Wind Tunnel Experiments: BOEM-EPA Collaboration

June 21-23, 2021

Jose L. Hernandez – 2021 Virtual EPA Regional/State/Local Dispersion Modelers Workshop

Study Key Remarks

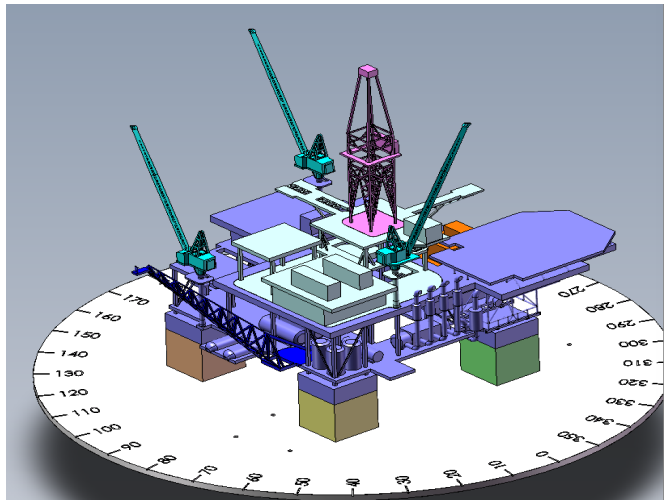
- What? To conduct wind tunnel experiments for offshore oil and gas platforms.
- Why? Because BOEM strives to improve the air quality regulatory models used in pre-lease and post-lease reviews by BOEM's Air Quality unit.
- Who? BOEM contracted CPP and is working with EPA to improve downwash approach in AERMOD[1] through the Interagency Workgroup on Air Quality Models (IWAQM).



[1] AERMOD: American Meteorological Society/Environmental Protection Agency Regulatory Model

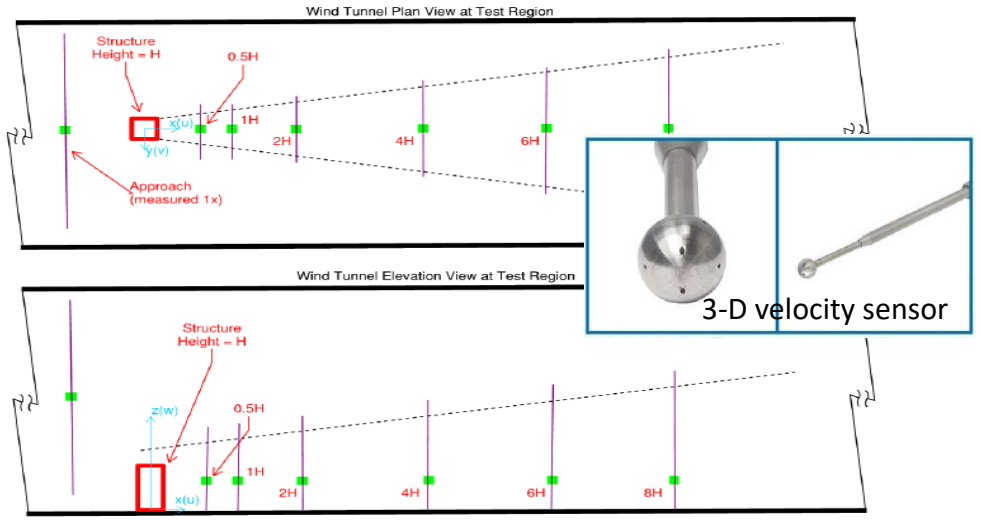
Overview

Oil and gas scale platforms are tested under different wind (speed and direction) conditions.



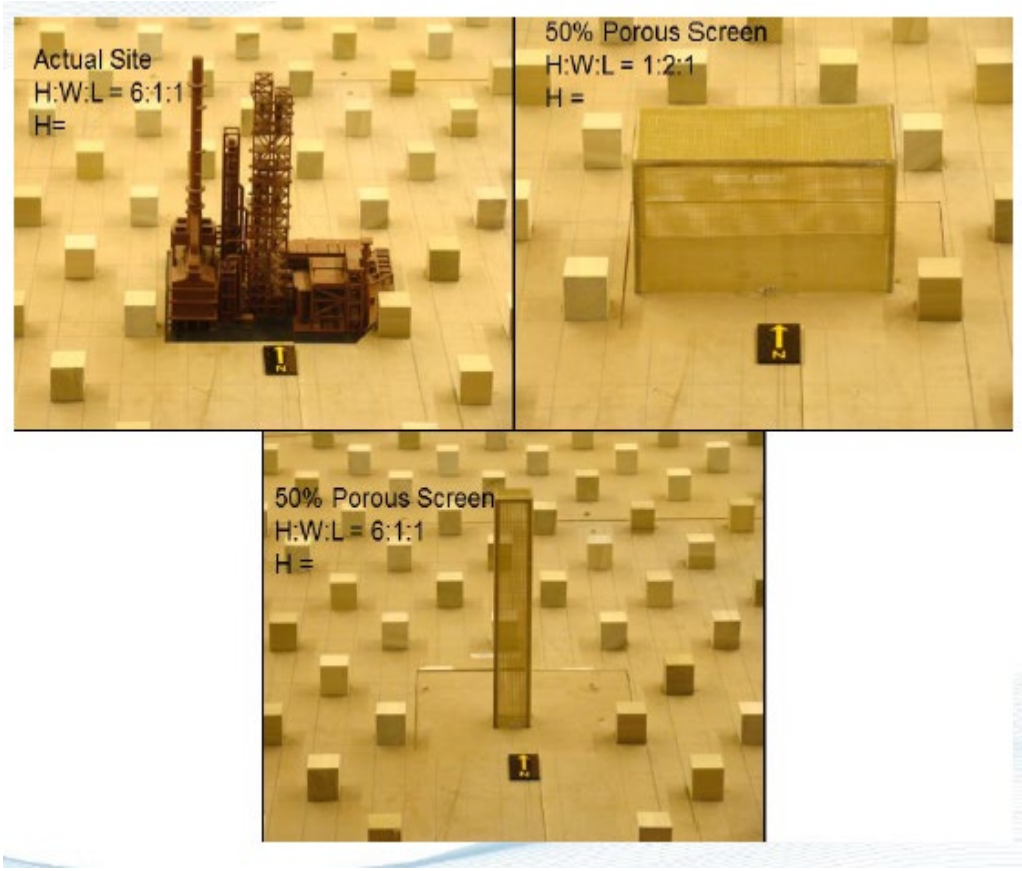
- Previous wind tunnel downwash approach was developed in 1986 for inclusion in the Offshore Coastal Dispersion (OCD) air quality model.
- No detailed velocity and turbulence measurements in the OCD downwash development.

- Current experiments will provide downwash velocity, turbulence, and concentration around an extended number of platforms.
- Typical offshore oil and gas structures operating in the Gulf of Mexico from BSEE-BOEM database information.
- Improve algorithms: AERMOD and PRIME (building downwash).

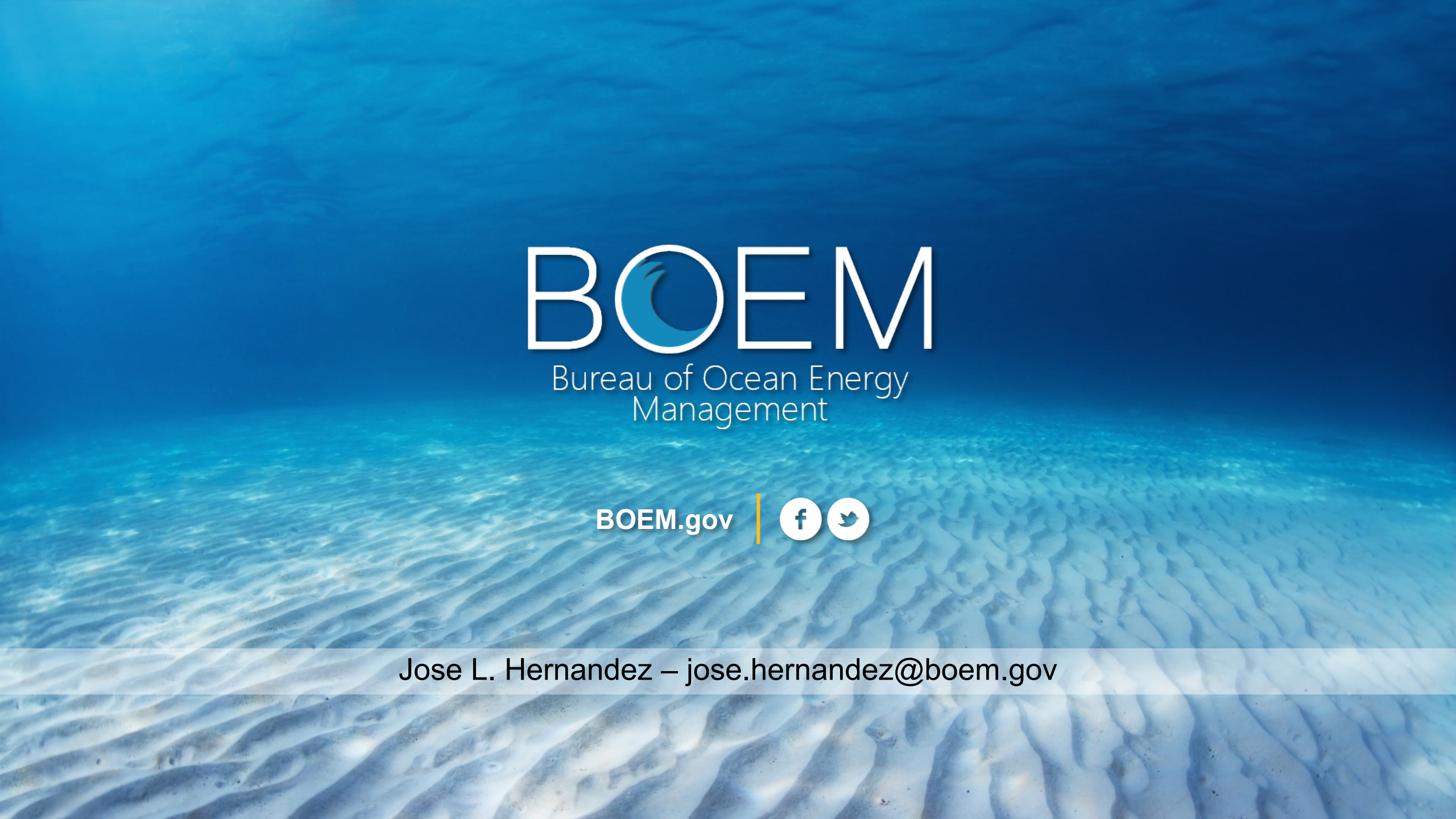


Wind Tunnel Experiments and AERMOD Updates

- A separate effort, OCD downwash to AERMOD, is in the final stage and will propose updates in Fall 2022.
- USEPA anticipates that the next opportunity to upgrade AERMOD will happen 5 years later in 2027.
- Currently, BOEM, EPA, and CPP are coordinating upgrades in the Wind Tunnel Experiment Study based on the first tests (small and medium platforms) and data analysis.
- In progress: Proposed changes in the initial set of platforms and the evaluation of current AERMOD versus wind tunnel observations.



Porosity and roughness length



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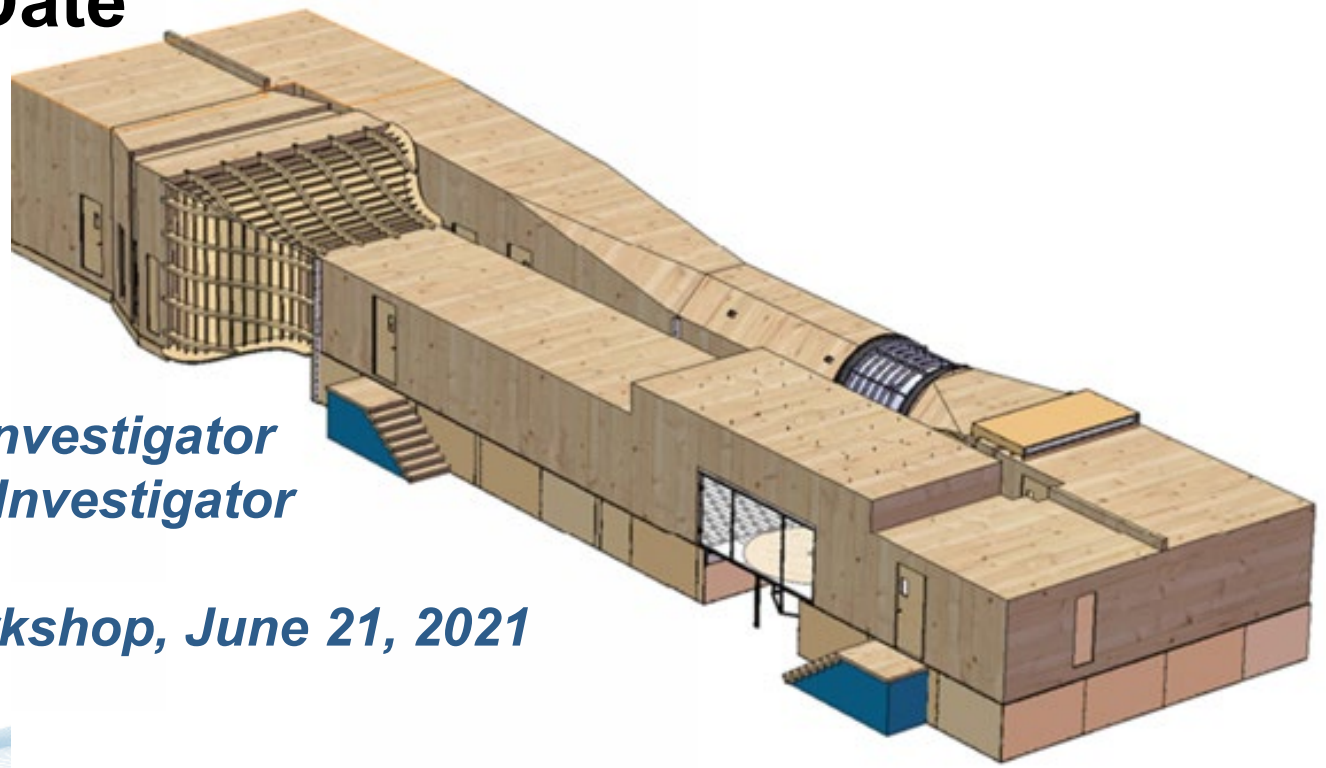
cpp

WIND ENGINEERING &
AIR QUALITY CONSULTANTS

Wind Tunnel Experiments for BOEM: Summary of Testing/Results to Date

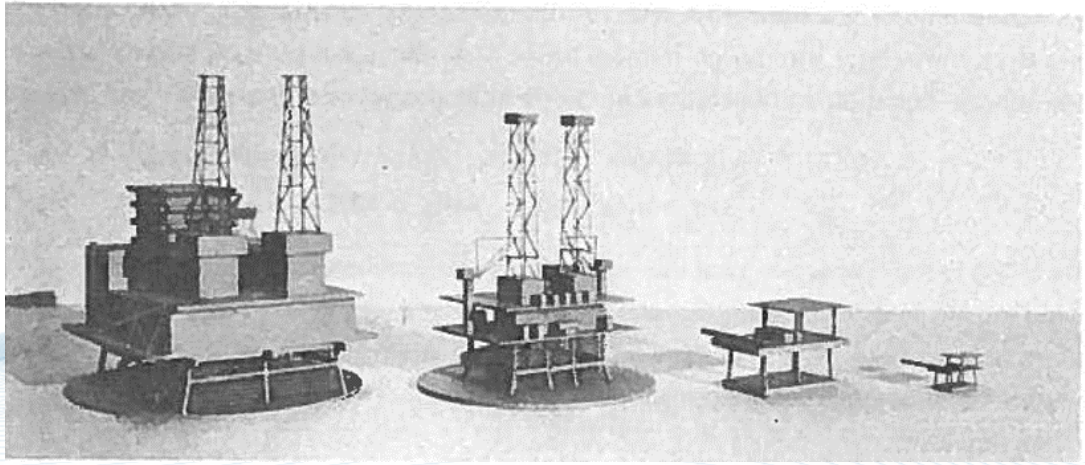


Ron Petersen, Petersen Research, Principal Investigator
John Carter, CPP, Project Manager/ Principal Investigator

2021 Regional, State and Local Modelers Workshop, June 21, 2021

Project Objectives

- Conduct wind tunnel experiments to characterize downwash for several types of offshore structures, oil platforms and mobile offshore drilling rigs.
- Provide results that can be used to improve air quality modeling for these type structures.
- Provide results that can be used to validate future model improvements.

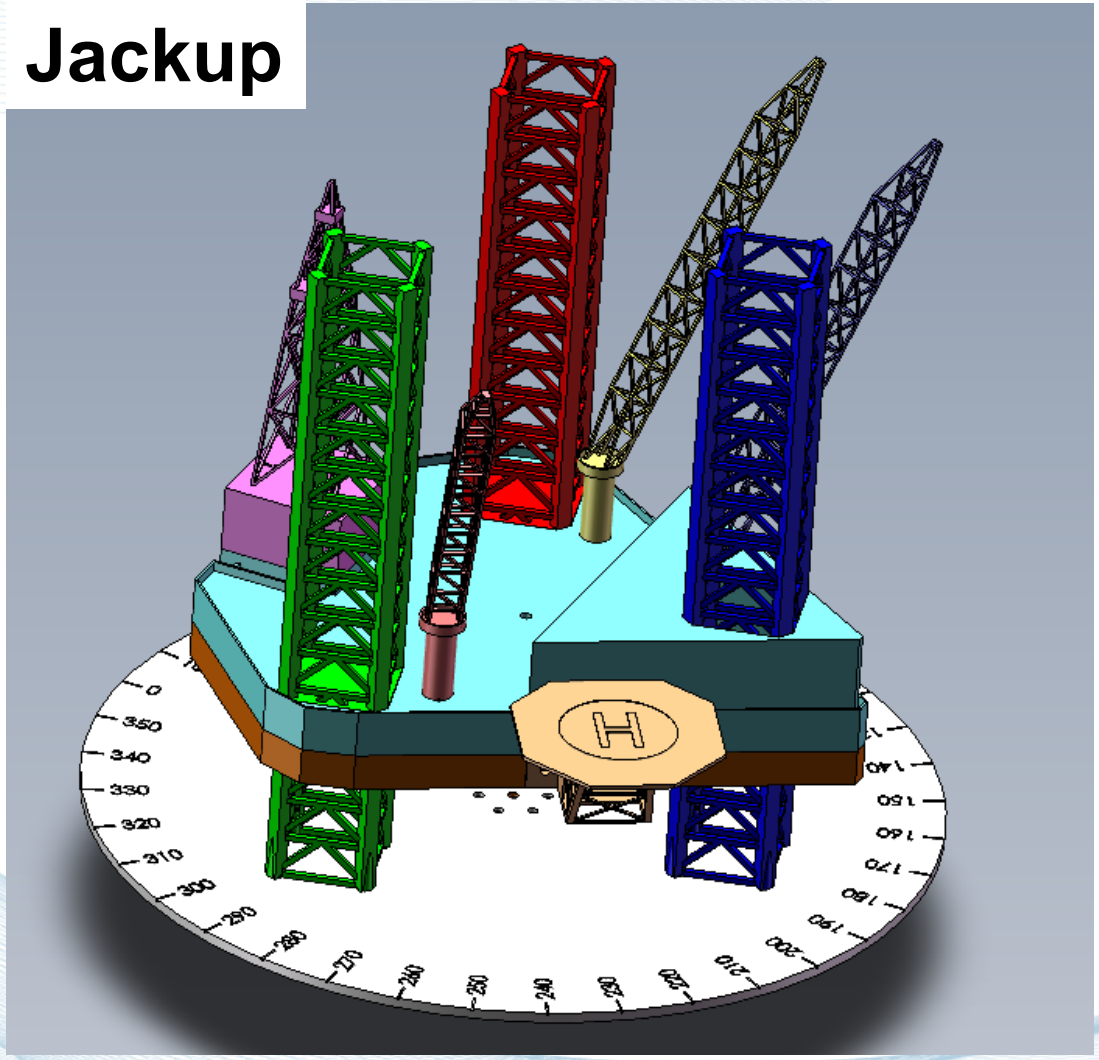


Testing Scope

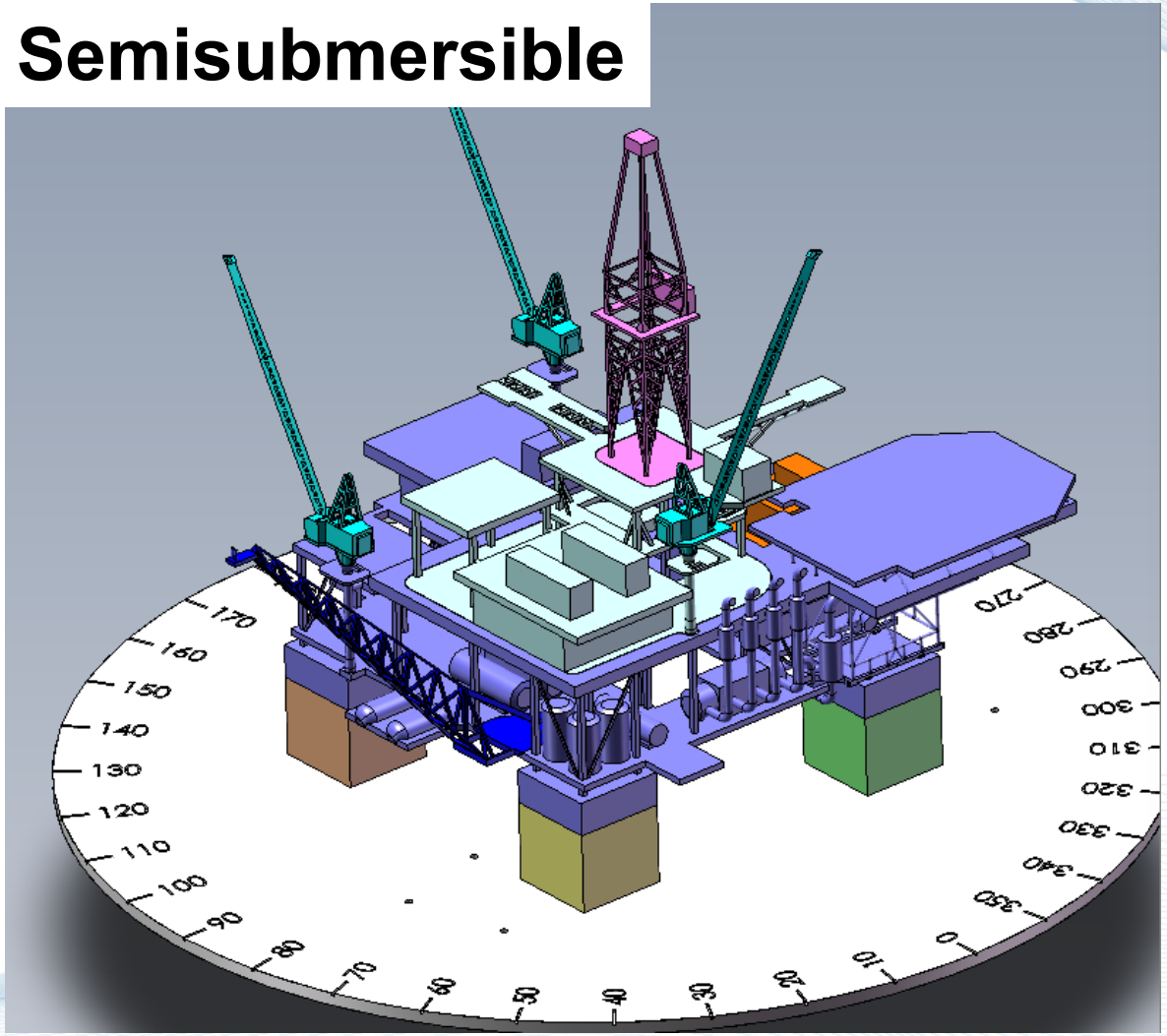
1. Mobile Jackup Drilling/Production Platform (3 wind directions).
2. Mobile Semisubmersible Platform (3 wind directions).
3. Medium Production Platform (2 wind directions).
4. Small Production Platform (2 wind directions).
5. Generic Platform (3 leg heights, 2 porosities and 2 surface roughness's).

Platforms Tested to Date

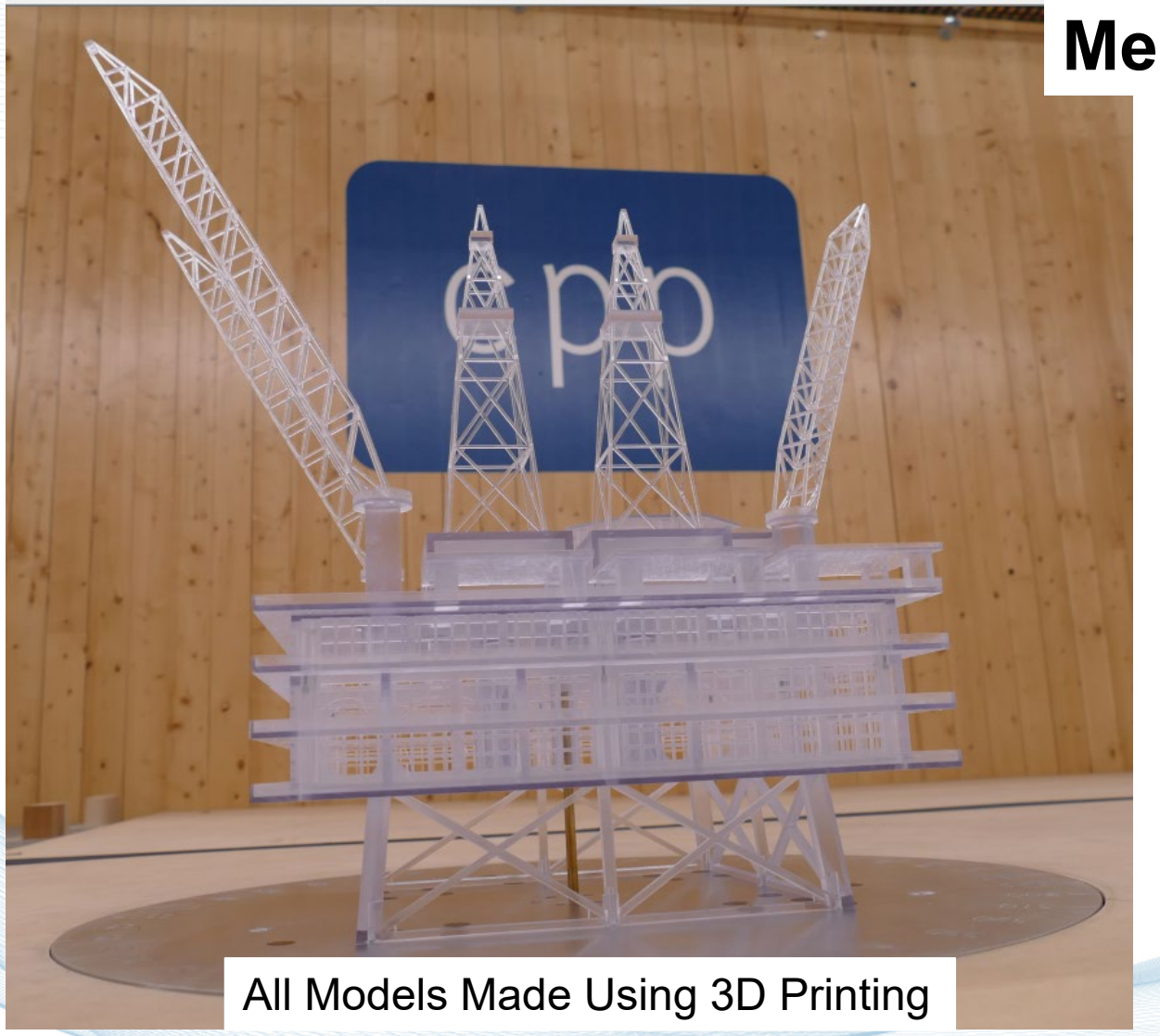
Jackup



Semisubmersible

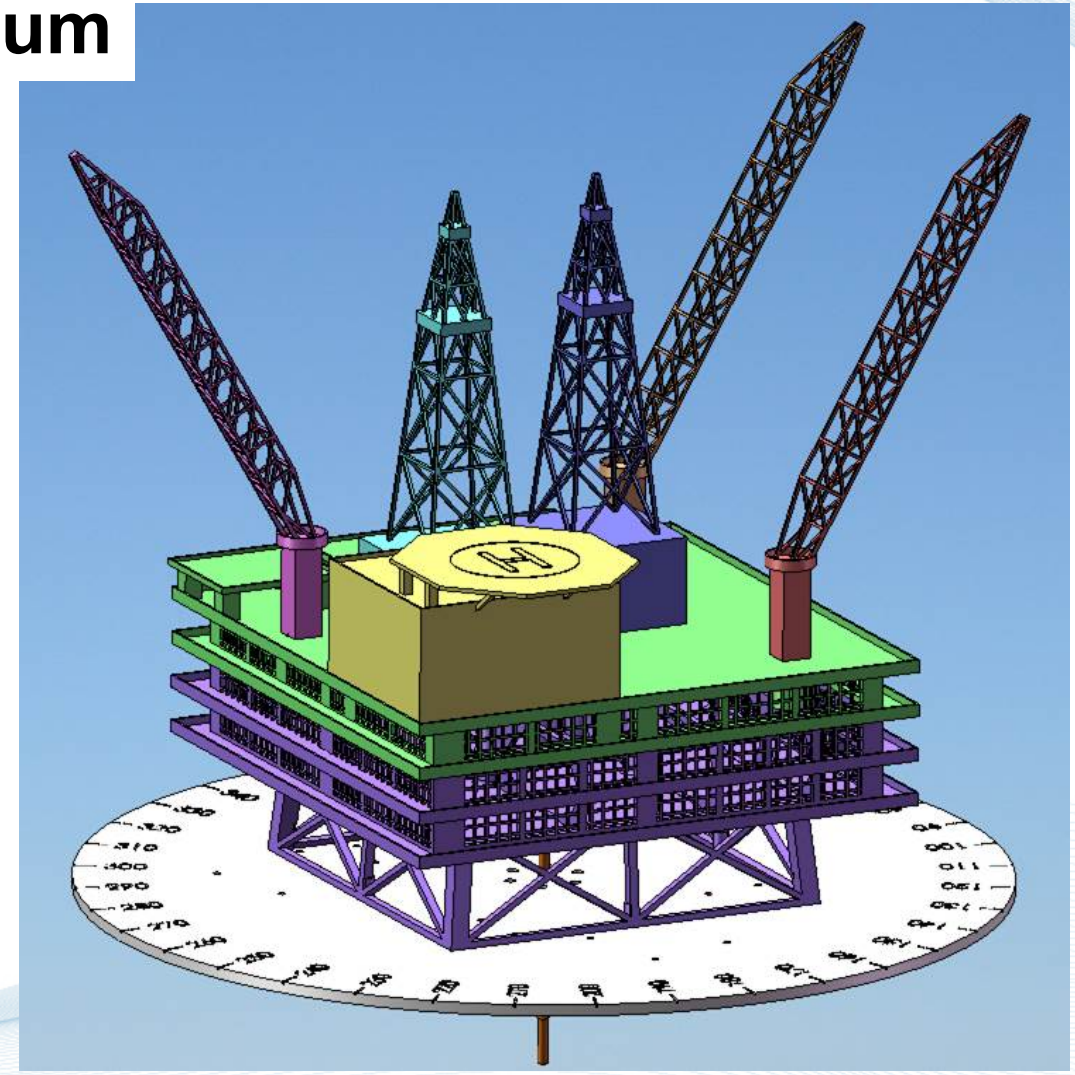


Testing in Process



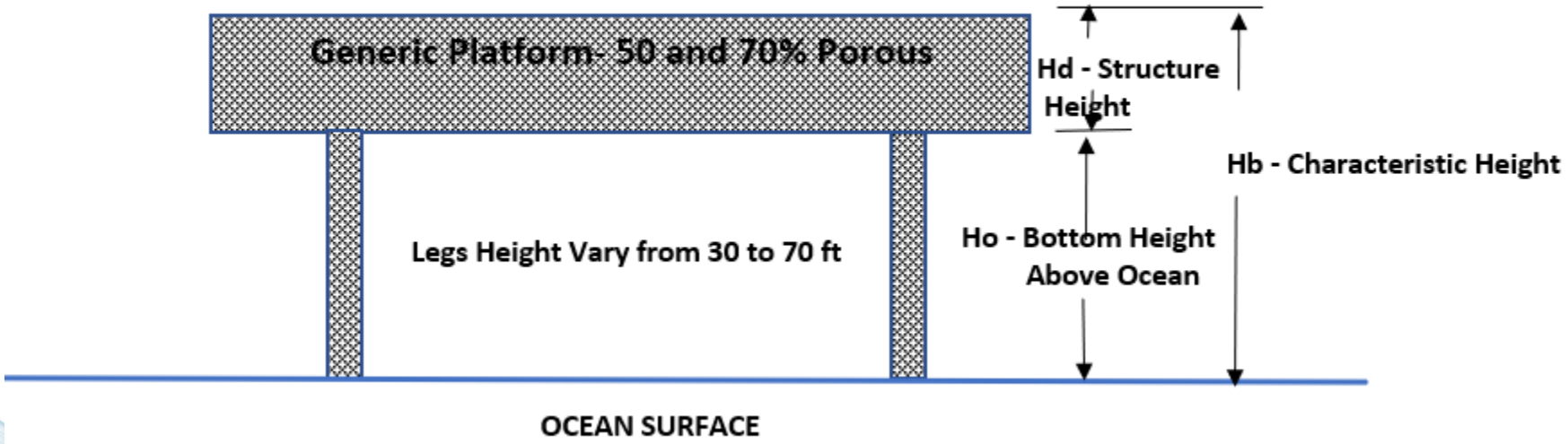
All Models Made Using 3D Printing

Medium



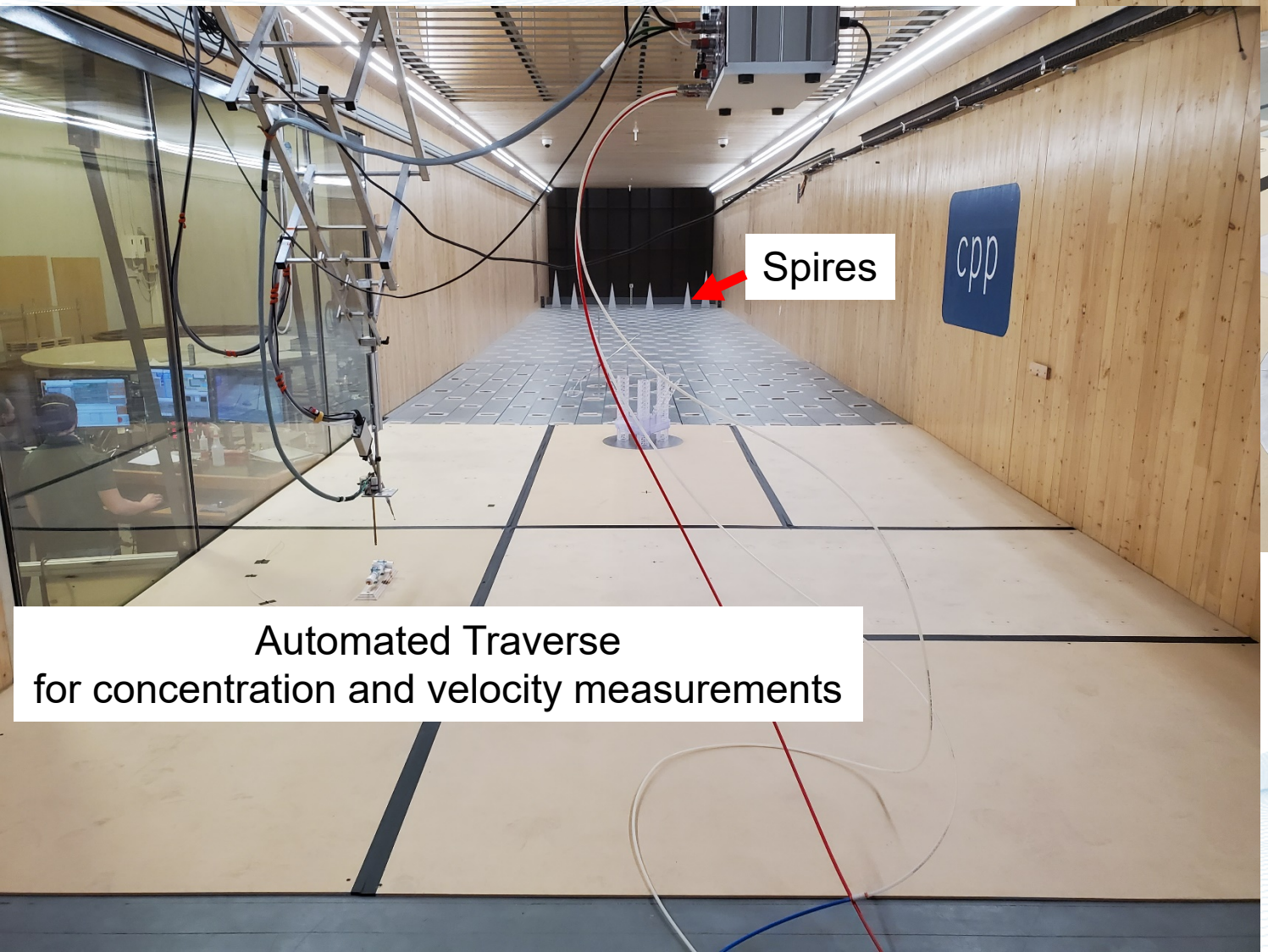
Next Models to Test

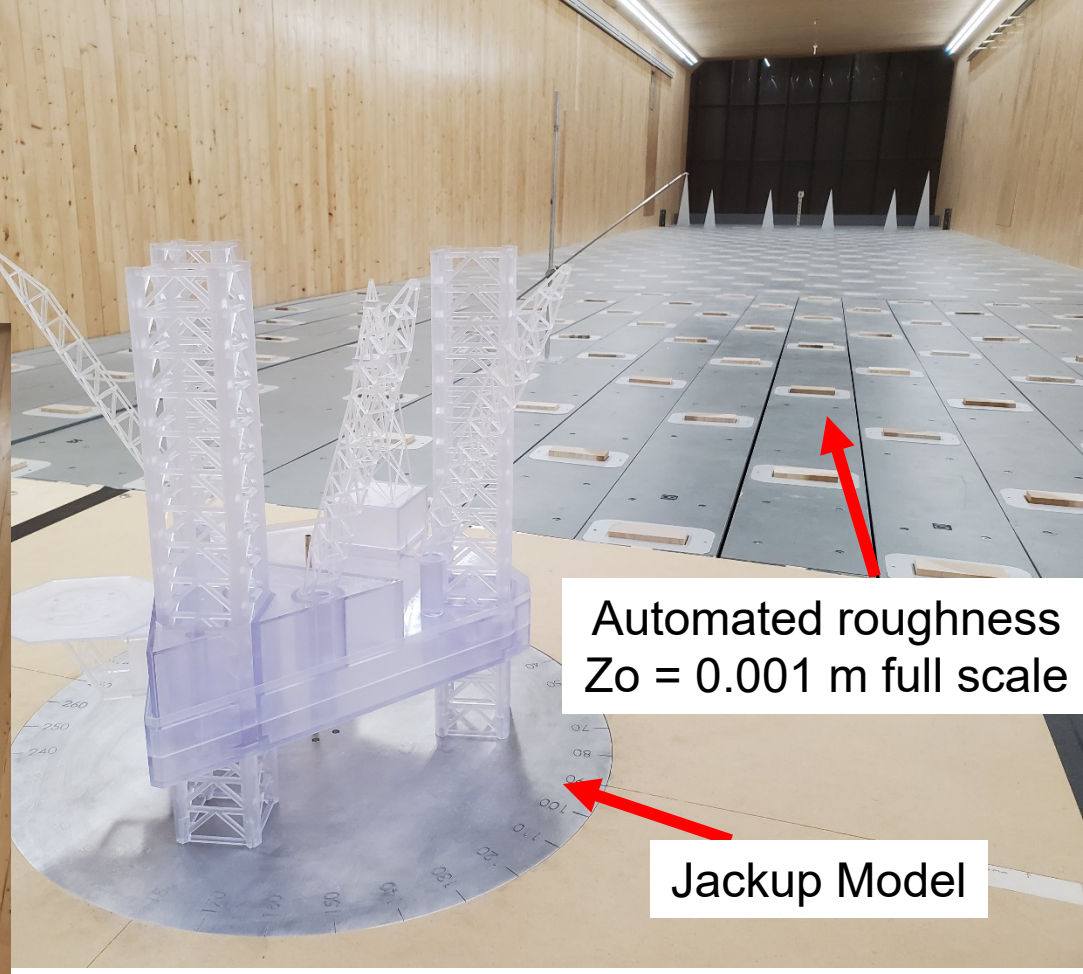
Generic



Small Platform

Photos of Wind Tunnel Setup for Jackup

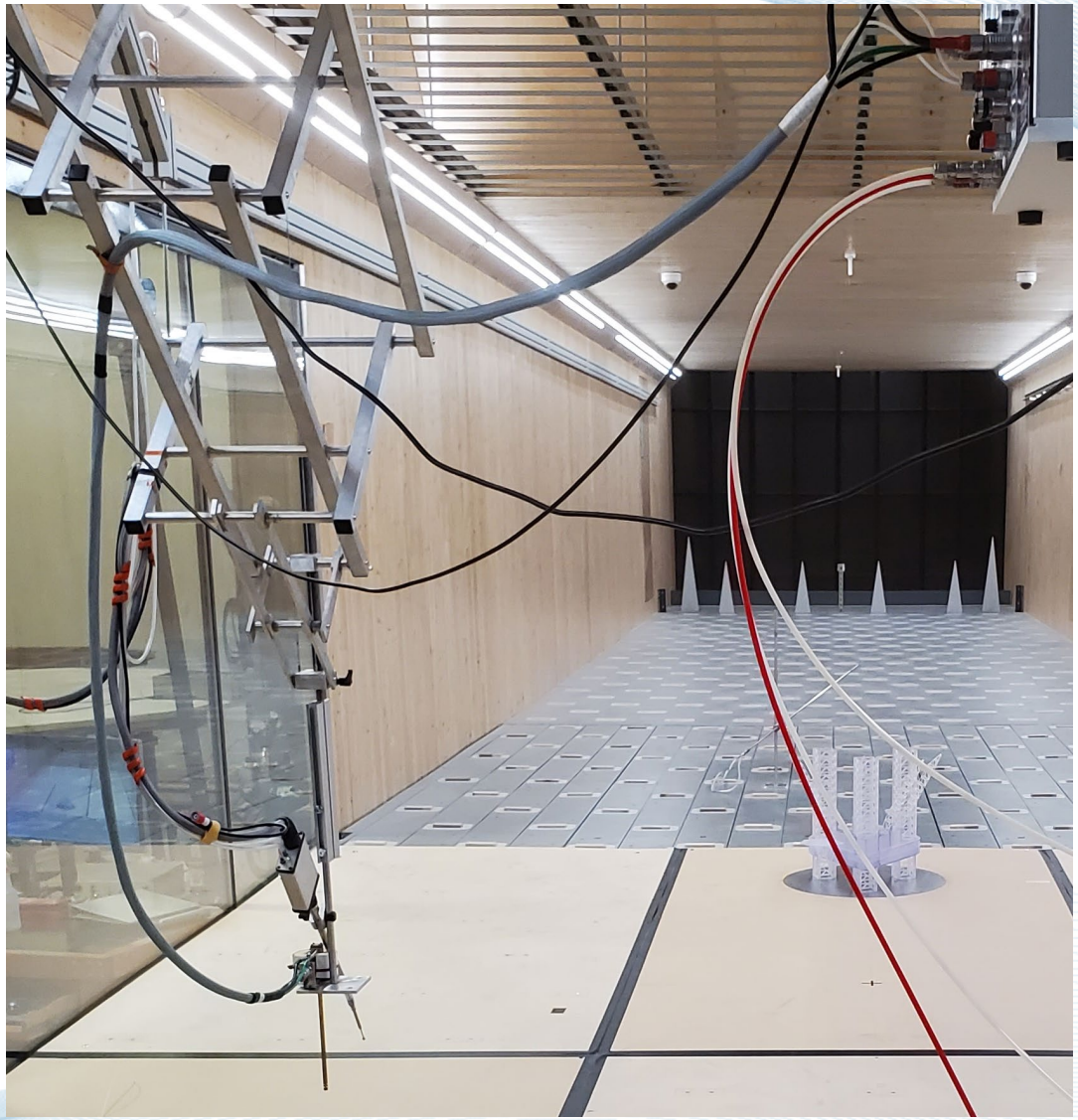




Velocity Measurements

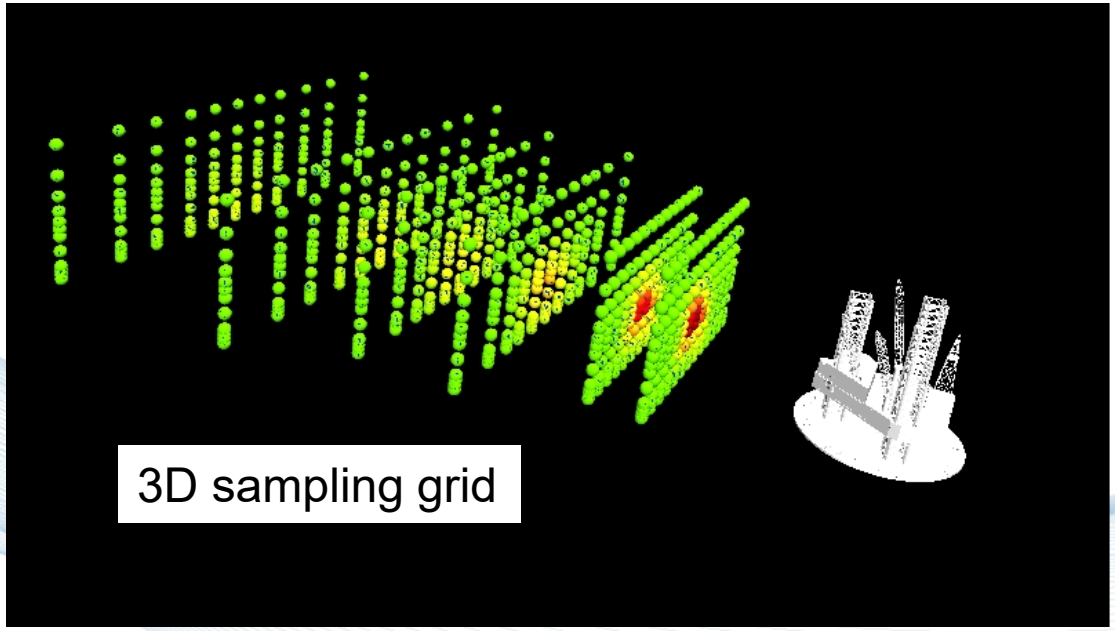
- 3D measurement grid.
- Automated data collection.
- Measurements normalized to match PRIME theory.
- 3 components of velocity measured, u, v, w.

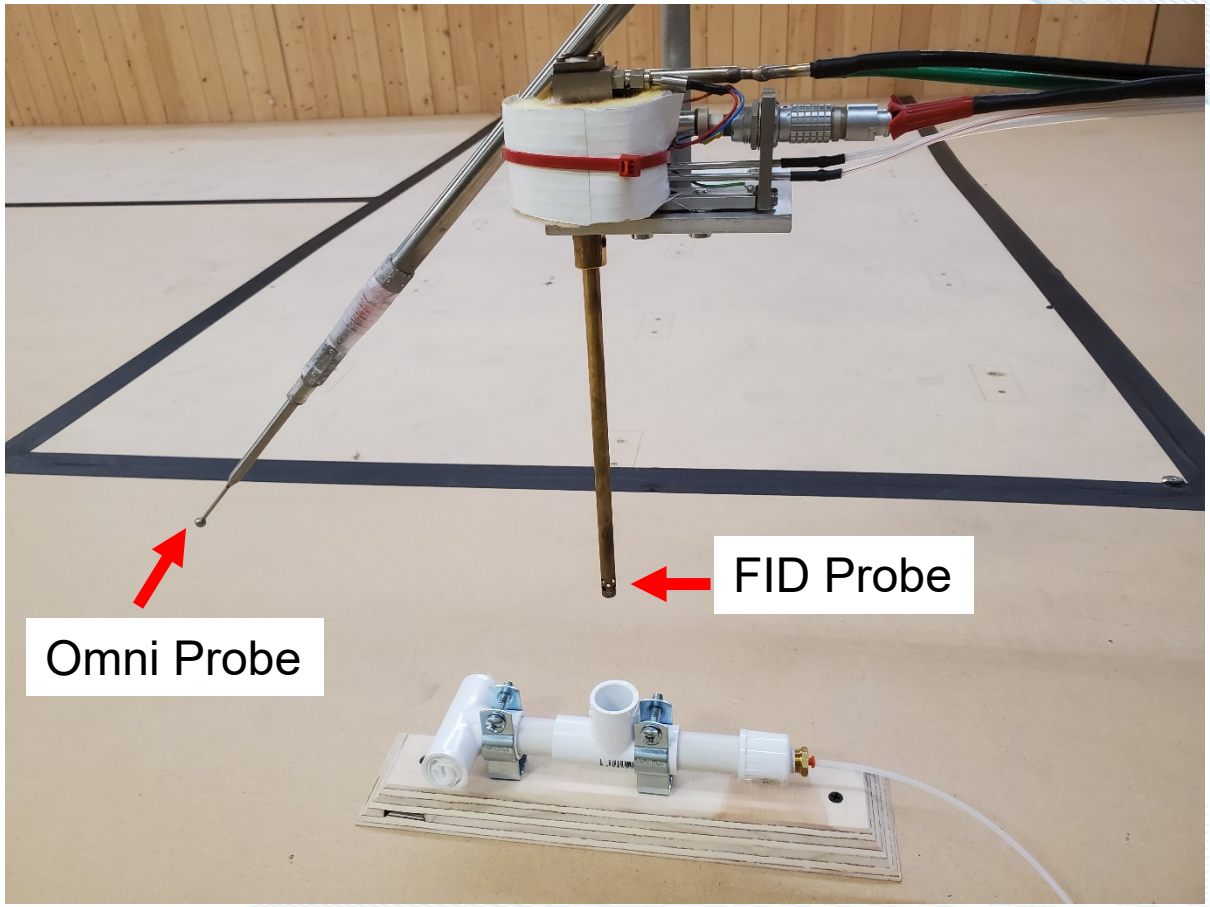
Omniprobe used which can measure three components of velocity



Concentration Measurements

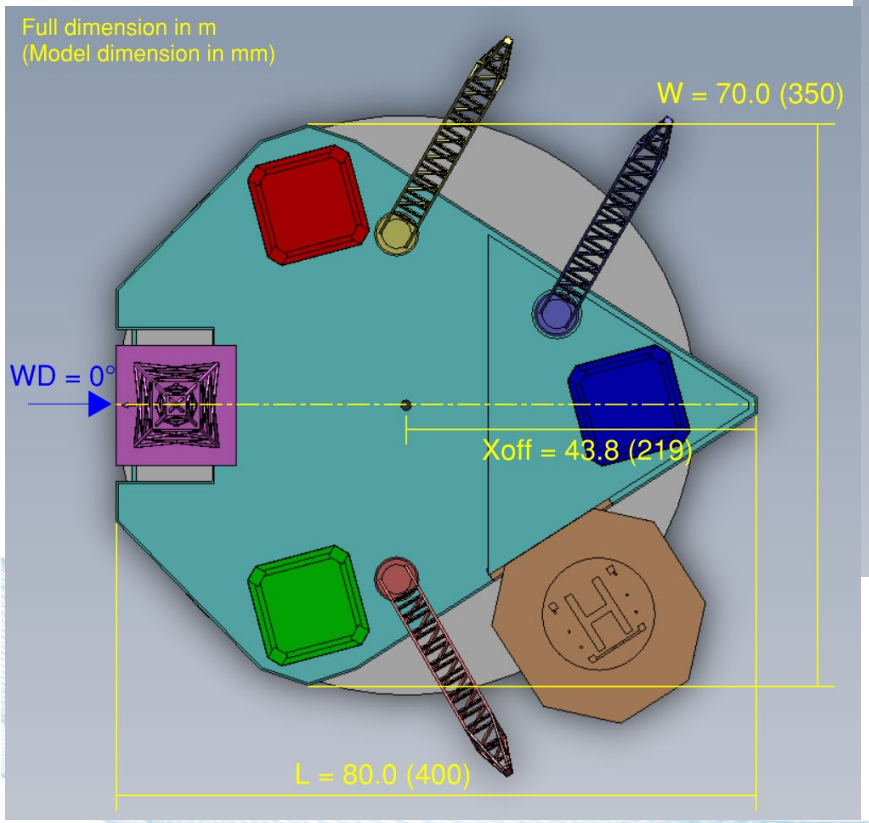
- 3D concentration measurement grid.
- Automated.
- Simultaneous with velocity measurements.
- High Frequency FID used for all measurements.

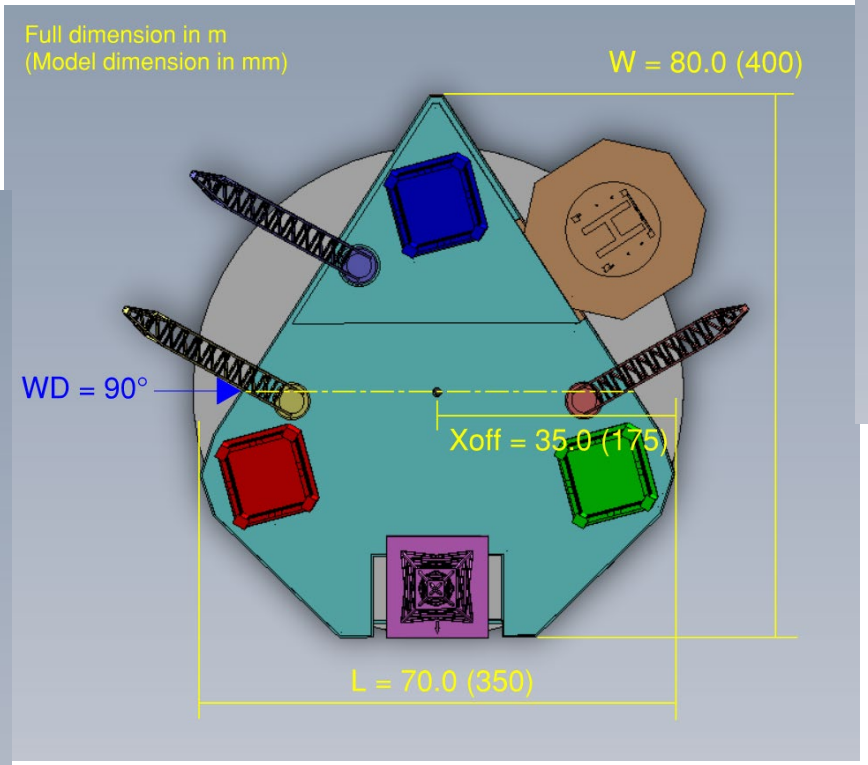


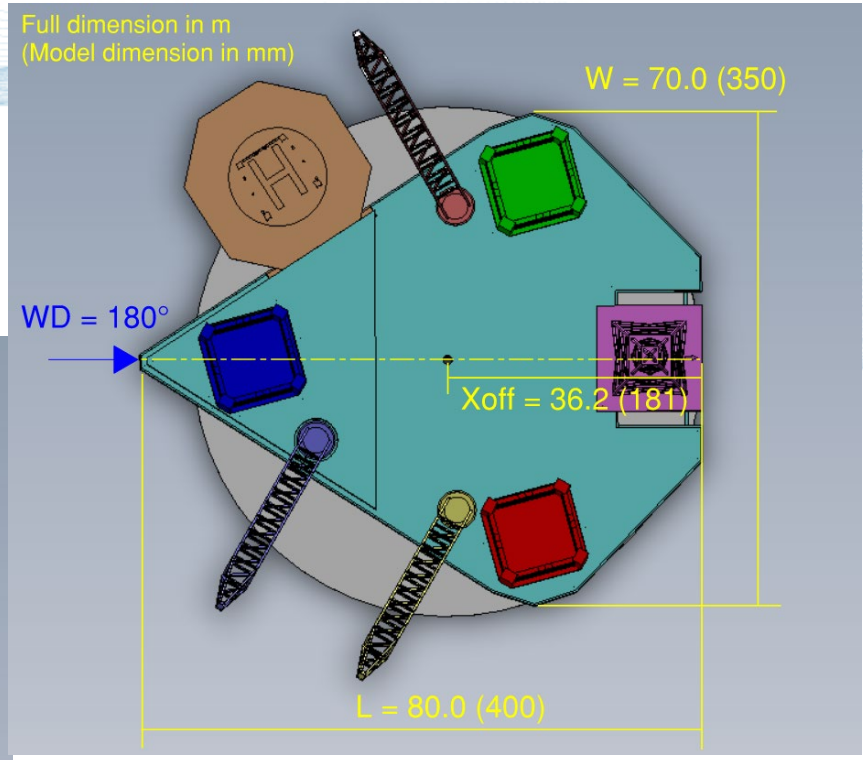


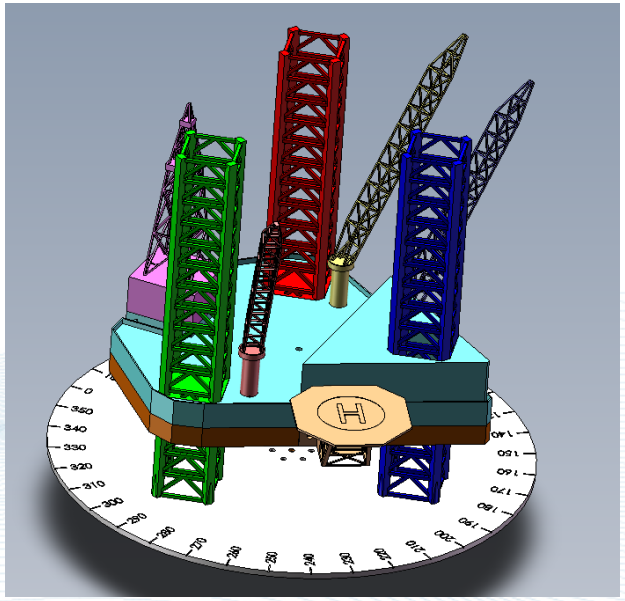
Selected Results to Date

Jackup Wind Directions Tested

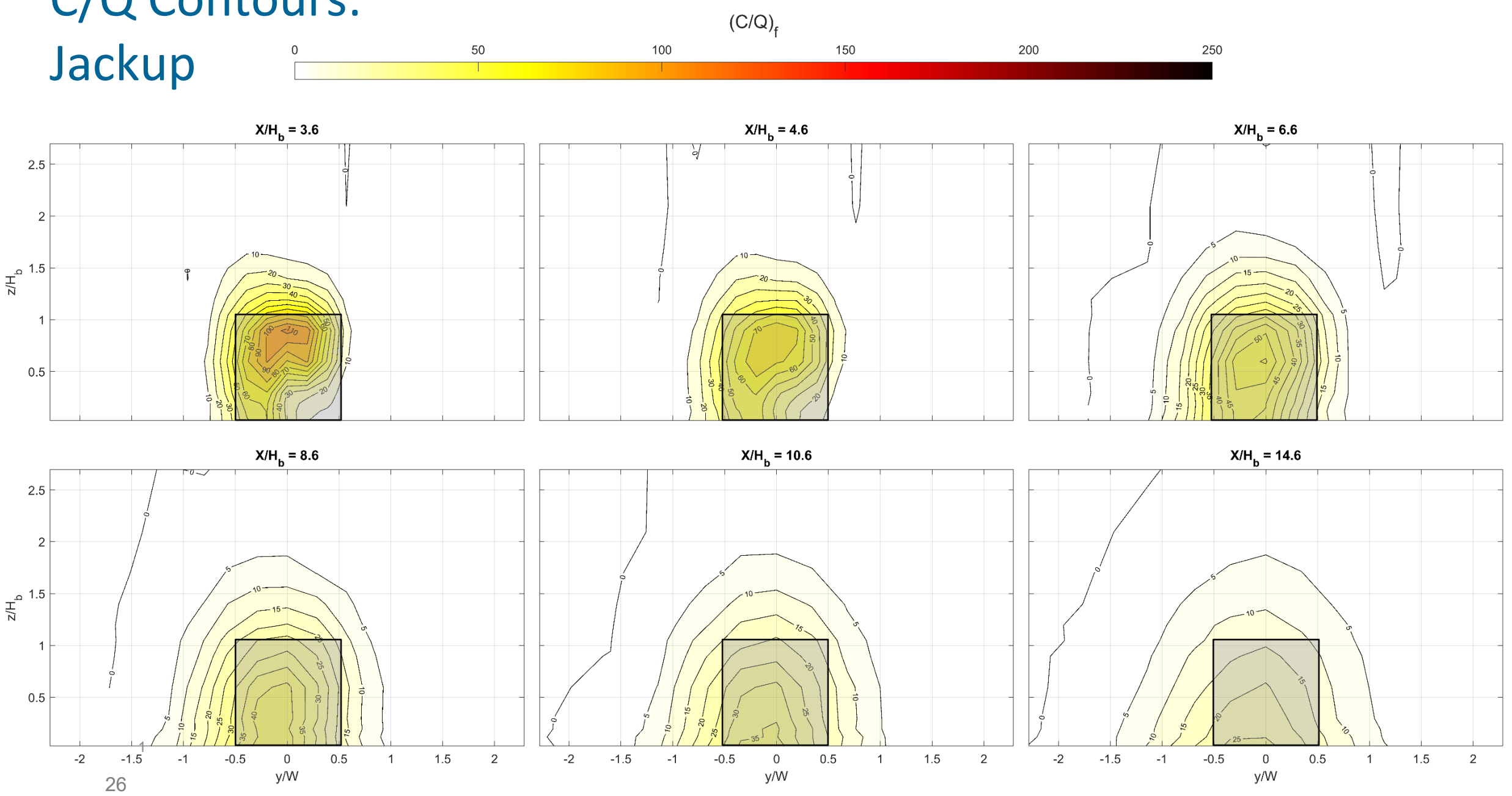






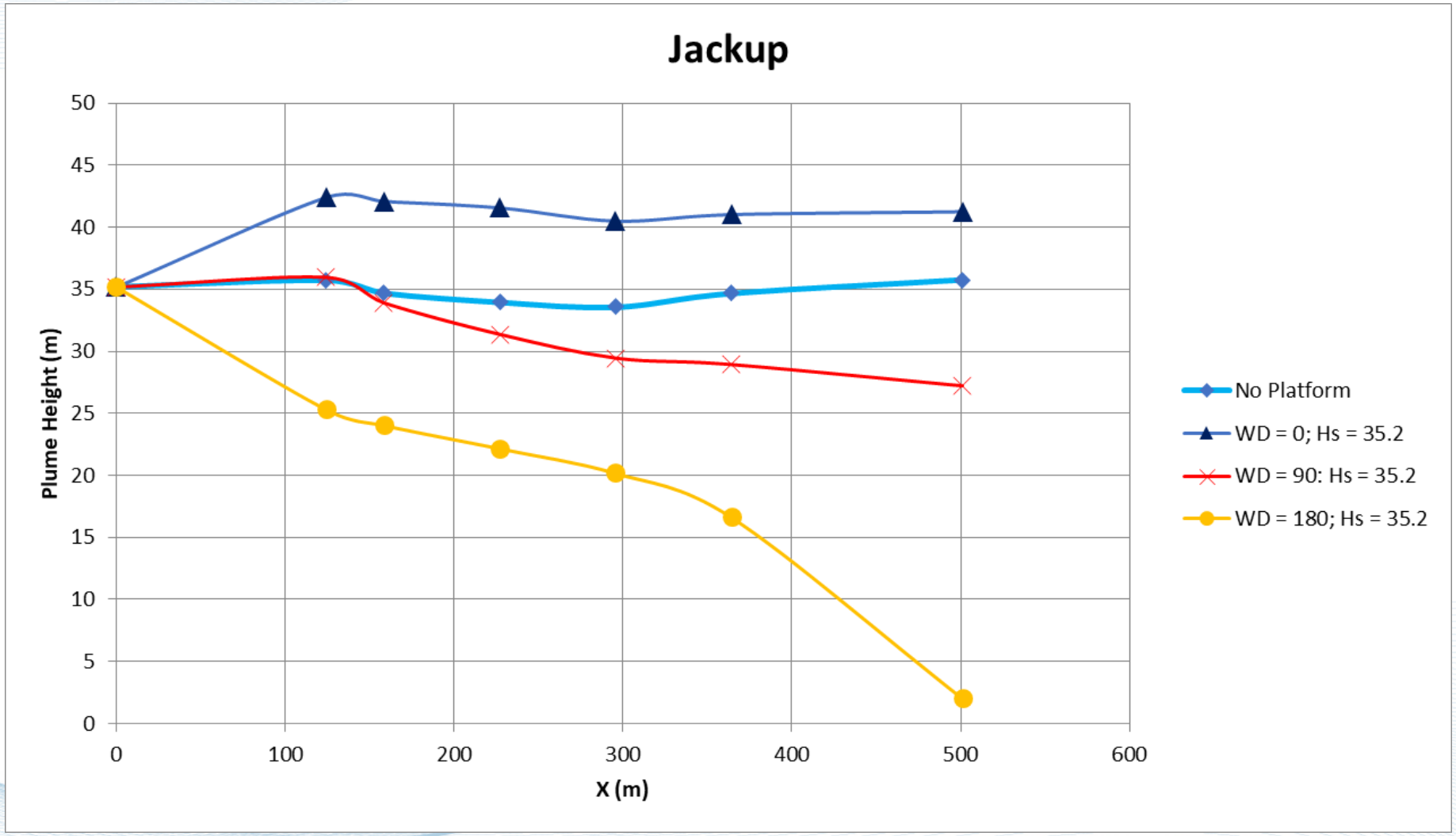


C/Q Contours: Jackup



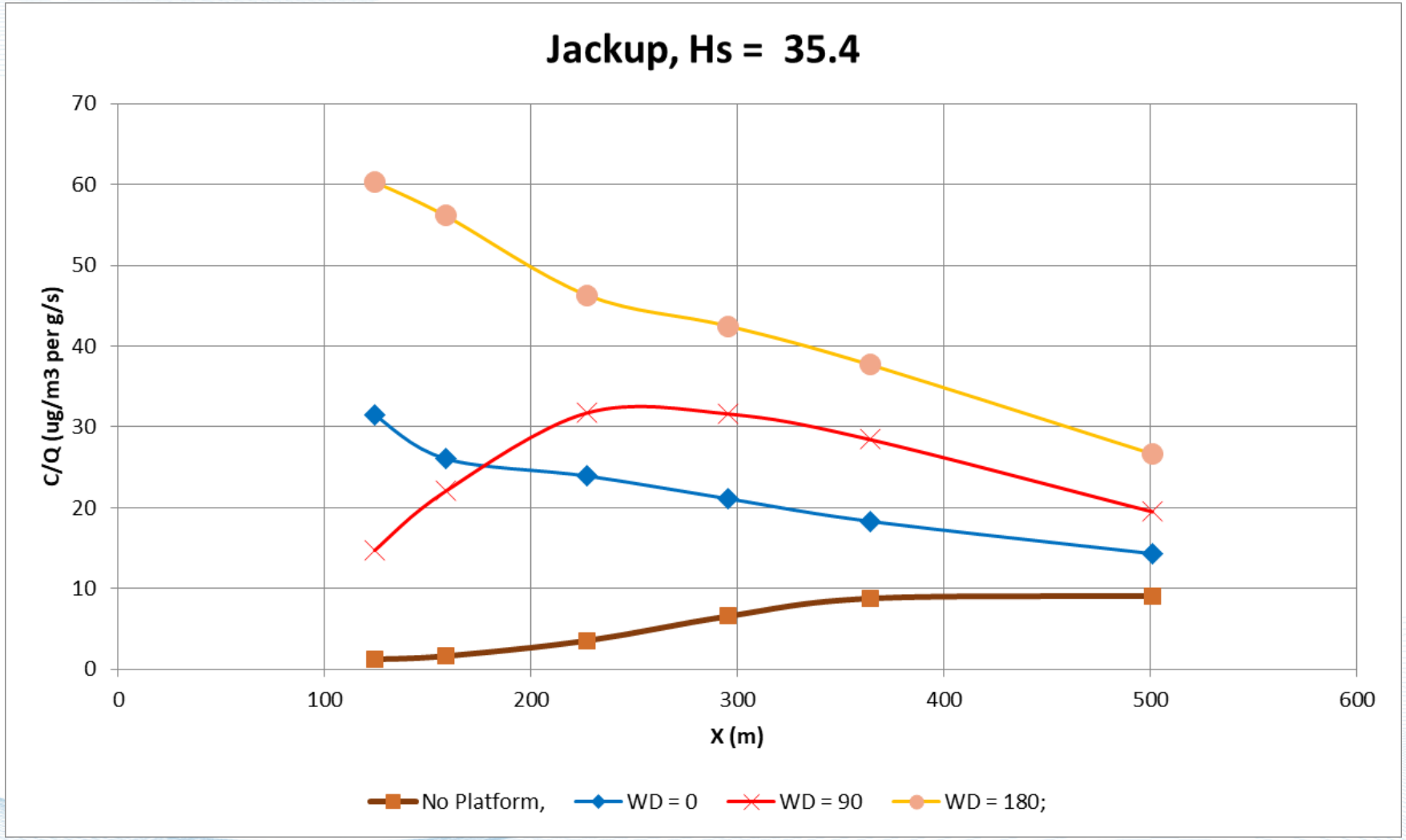
Observed Plume Rise: Jackup

Varies significantly with wind direction.



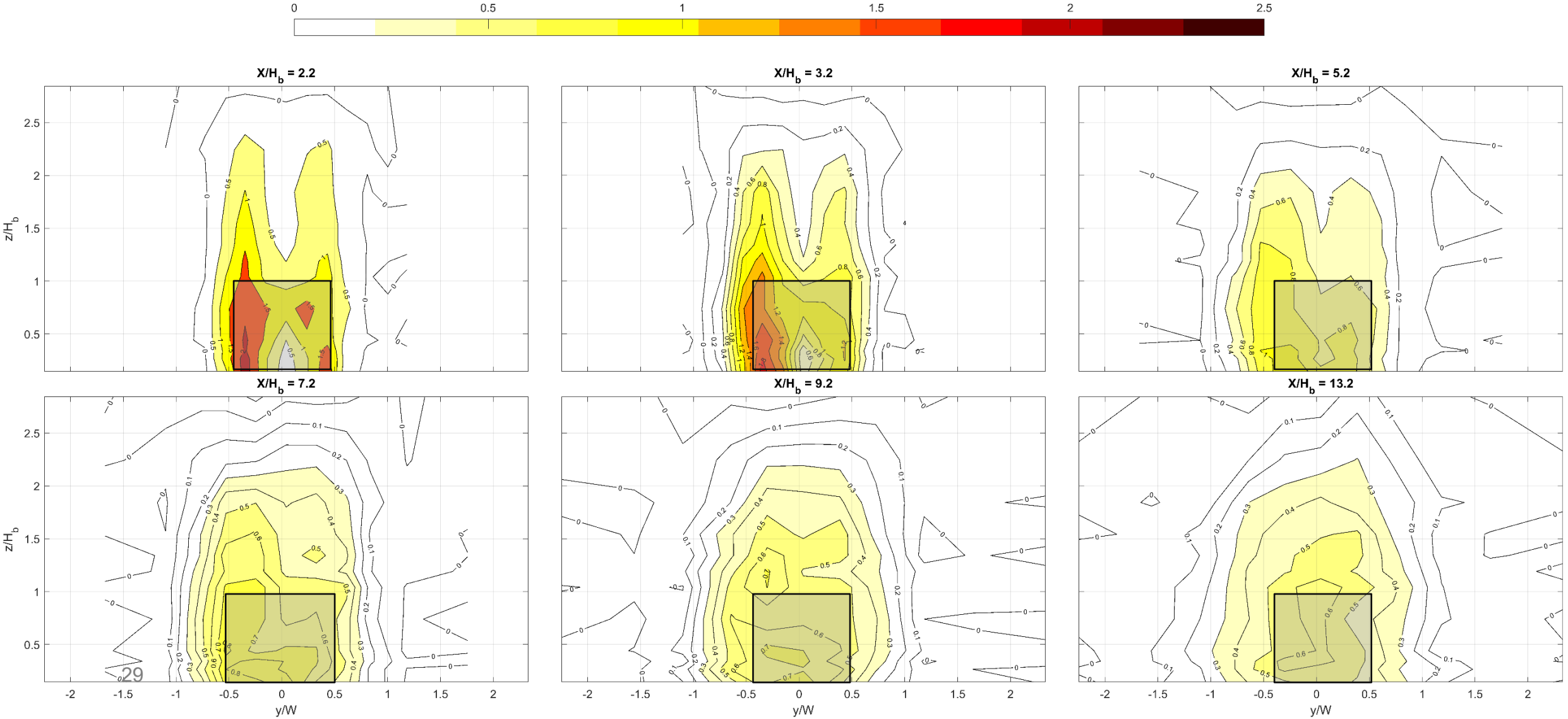
Observed Maximum Ground Level C/Q versus X: Jackup

Notice the variation with wind direction and the much higher concentrations with the platform.



Jackup Vertical Turbulence Increase Contours: WD = 0

Note: 1 is a factor of two increase. 0 is no increase.

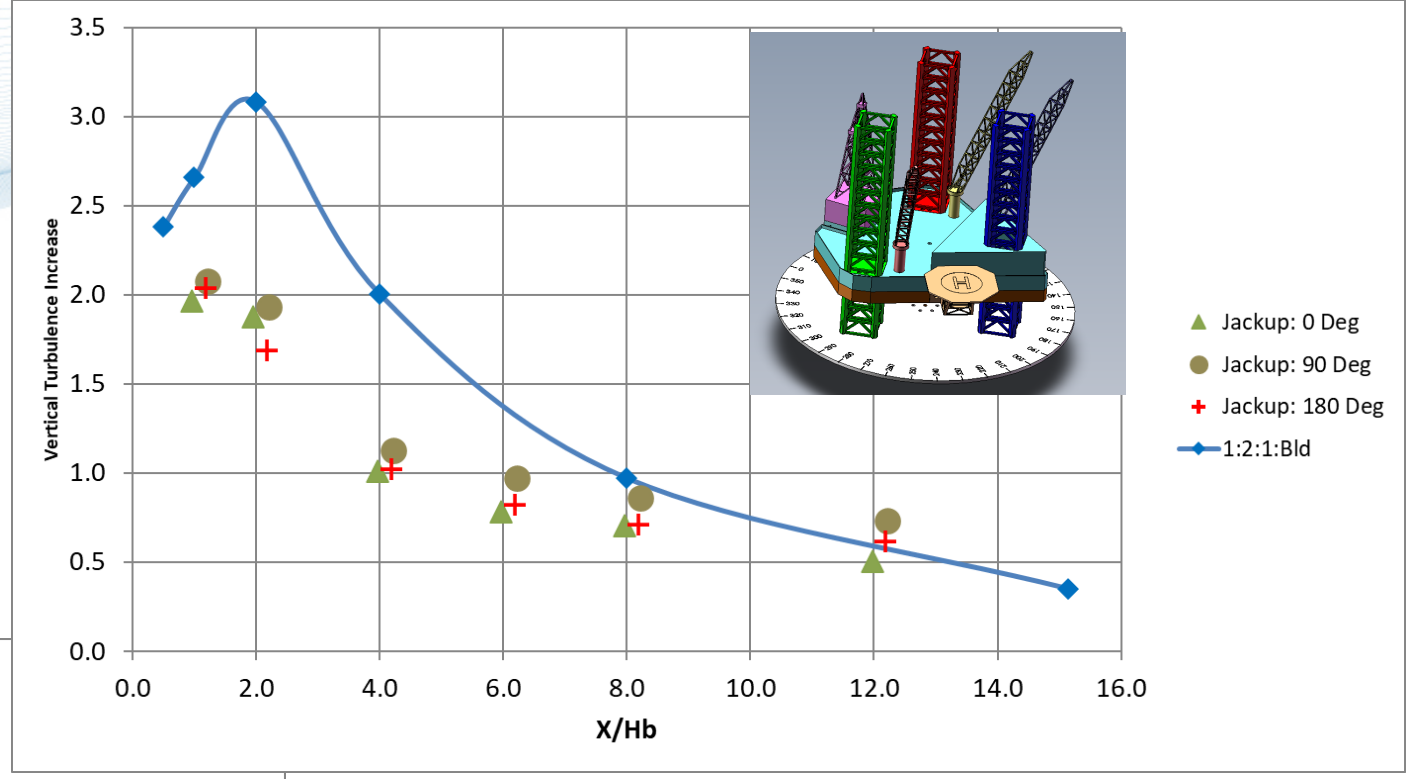


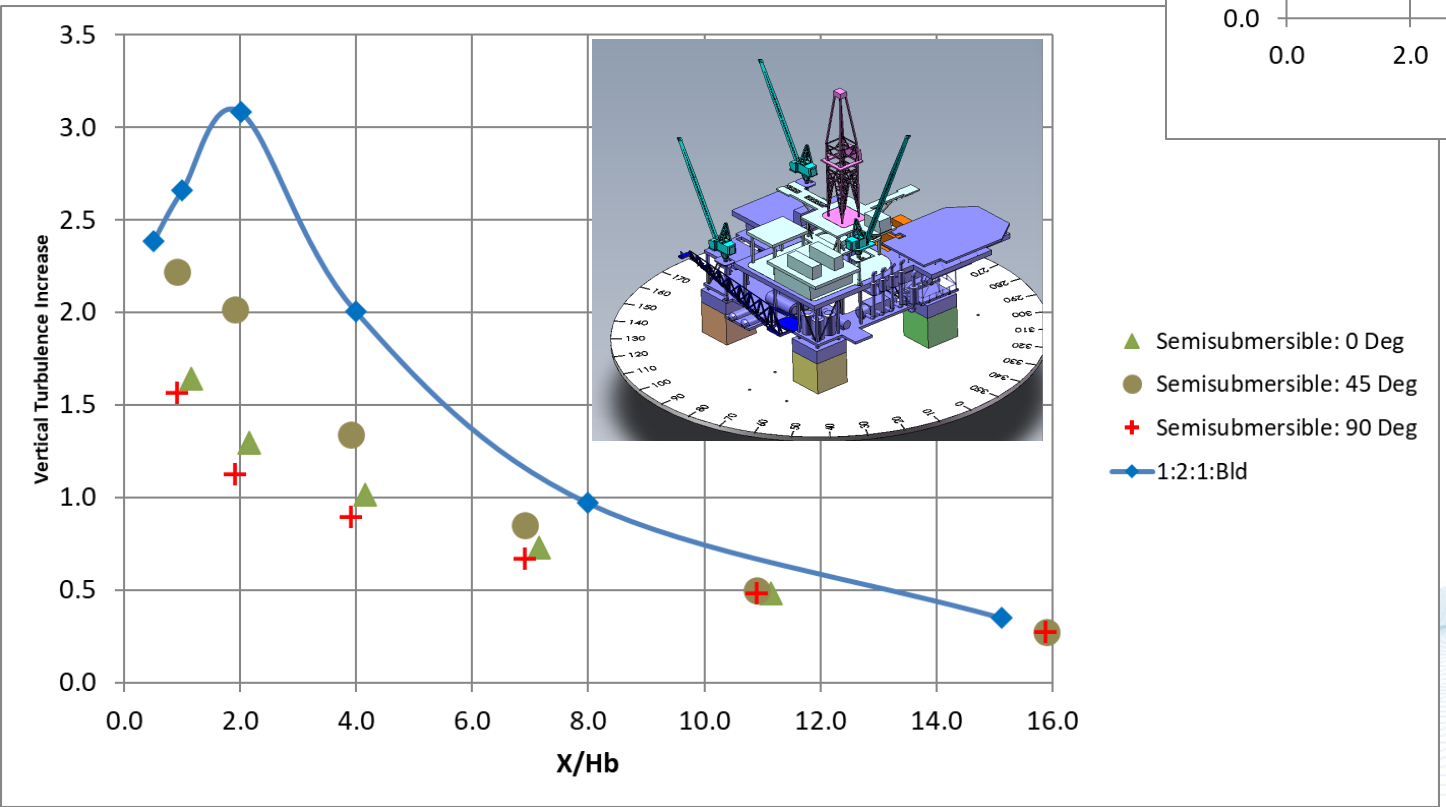
Observed Maximum Vertical RMS Turbulence Increase vs. X

Notes:

- 1 is a factor of two increase. 0 is no increase.

- the blue line is for a solid rectangular building.





Next Steps

- Provide interim results to EPA for use in evaluating initial overwater AERMOD enhancements (OCD).
- Complete the wind tunnel testing.
- Analyze results and develop PRIME2 type equations for ultimate use in PRIME.
- Submit final report and peer reviewed Journal Article.
- Use the results to update and evaluate changes to AERMOD.

Questions?

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