Potential Benefits of Including Motion Sickness Predictions in an Offshore Wind Operational Planning Tool

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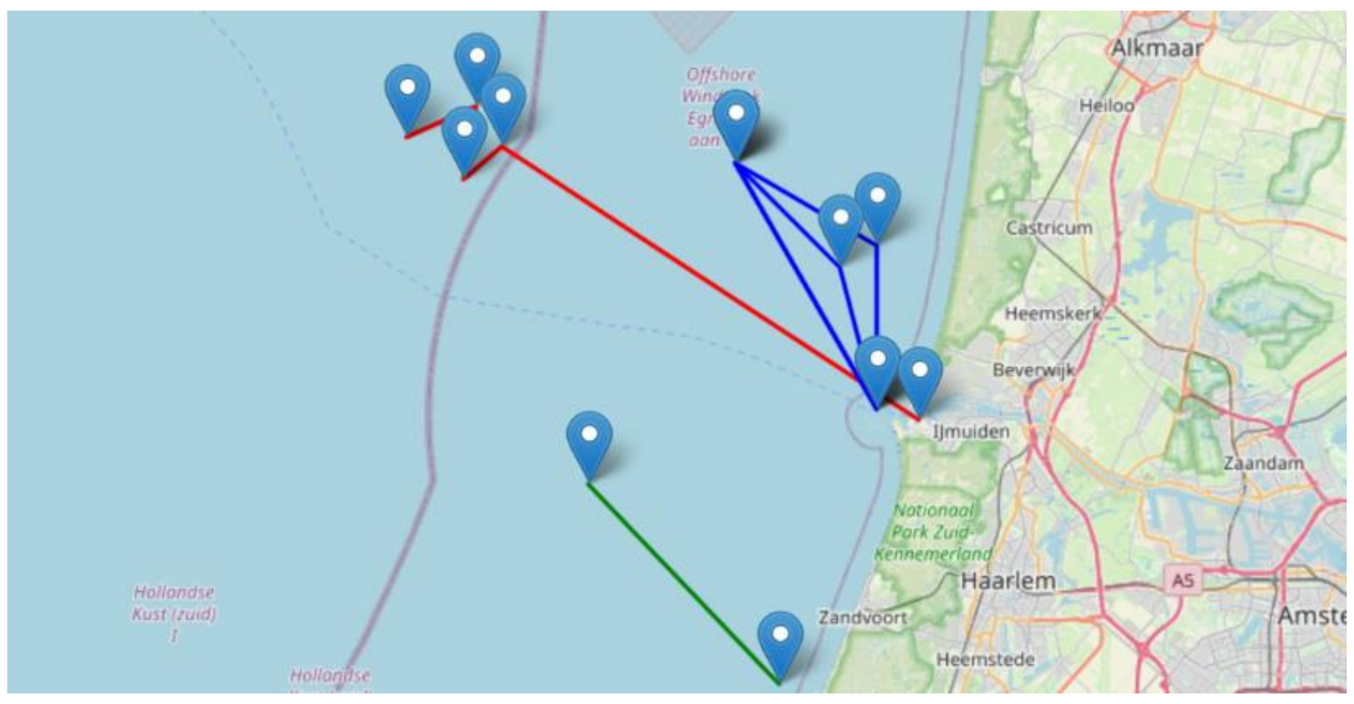
INTRODUCTION

Offshore wind energy plays an important role in the transition to sustainable energy. However, it also poses significant operational challenges. Motion sickness among technicians onboard crew transfer vessels (CTVs) can impair safety, productivity, and operational efficiency. Existing motion-sickness models like the Motion Sickness Incidence (MSI) only quantify the probability of vomiting, neglecting other symptoms like nausea and dizziness. This study applies the Motion Illness Symptoms Classification (MISC) scale, addressing these broader symptoms in conjunction with a vessel motion model to simulate the motions during transit. This integration aims to improve decision-making in offshore wind operational planning.

METHODS

Models used:

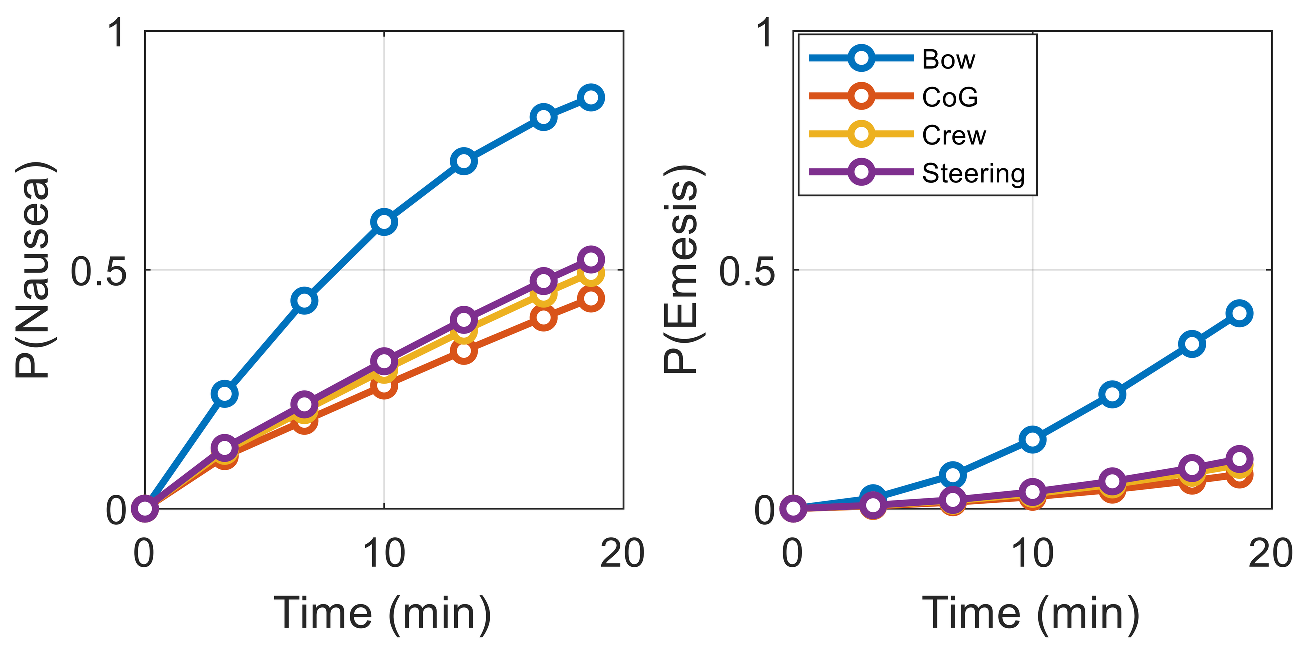
- *Vessel Motion Model:* Predicts accelerations (surge, sway, heave) using hydrodynamic response amplitude operators (RAOs) based on sea state simulations.
- *MISC-Based Motion Sickness Model:* Incorporates three degrees of freedom accelerations, frequency weighting, and symptom classifications (0-10 scale).



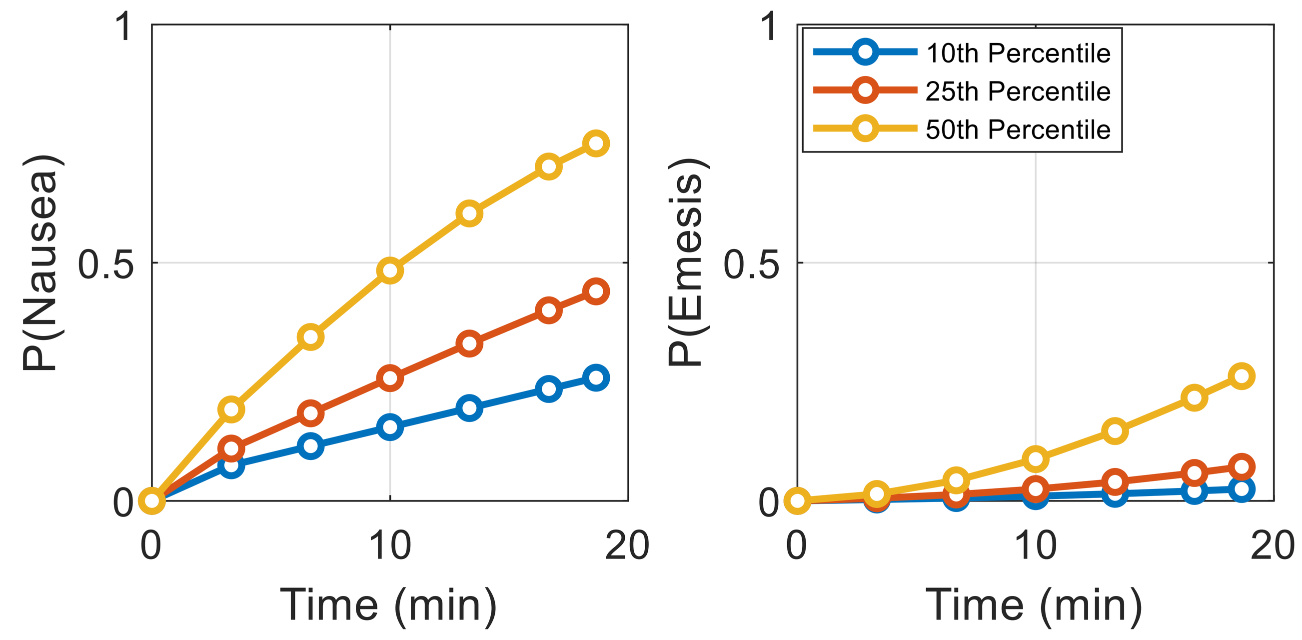
Case studies:

- **Scenario 1 (blue lines):** Analyzes the transit from the Port of IJmuiden to a wind turbine in Offshore Windpark Egmond aan Zee, focusing on power spectrums, vessel positions, population motion sickness susceptibility, comparison with ISO2631-1, and calmer sea conditions.
- **Scenario 2 (green line):** Evaluates the effects of varying vessel speeds. A separate transit route than scenario 1 is used to mitigate rounding issues, as the RAO data is less not as complete for lower speeds.
- **Scenario 3 (red lines):** Examines the impact of sequential visits to multiple wind turbines and a brief pause at the first turbine on crew motion sickness in Princess Amalia Wind Park.

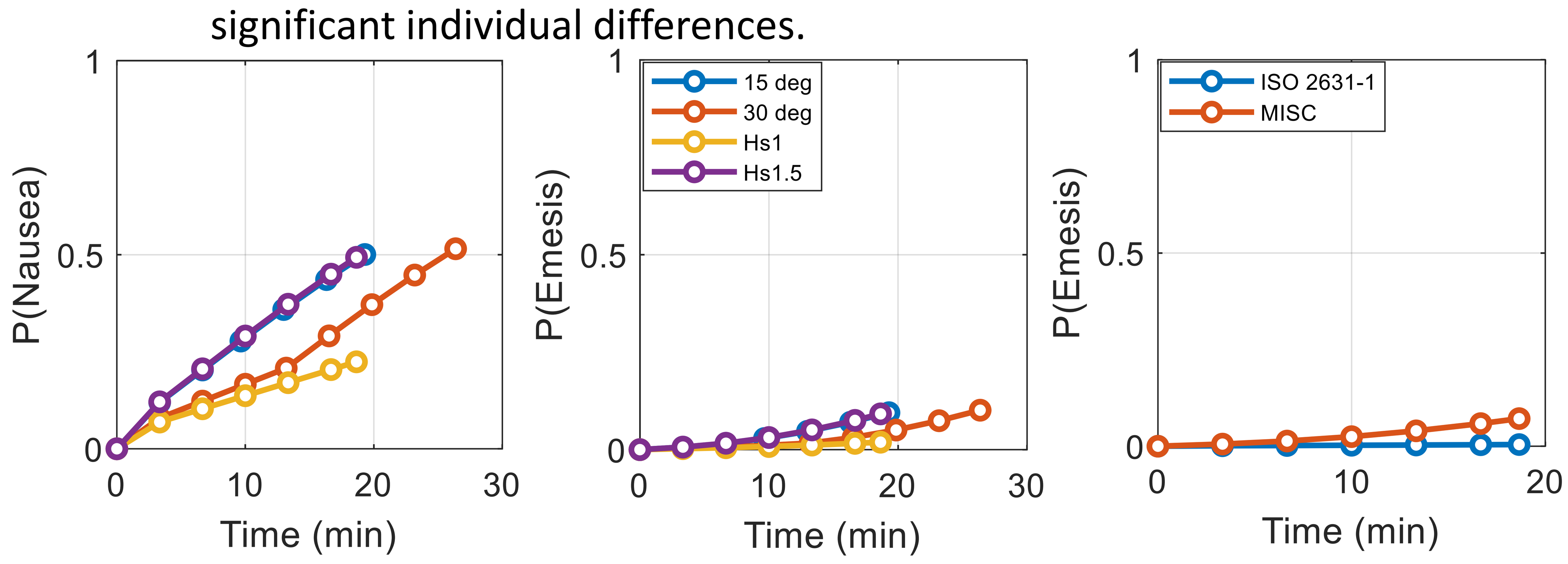
RESULTS AND DISCUSSION

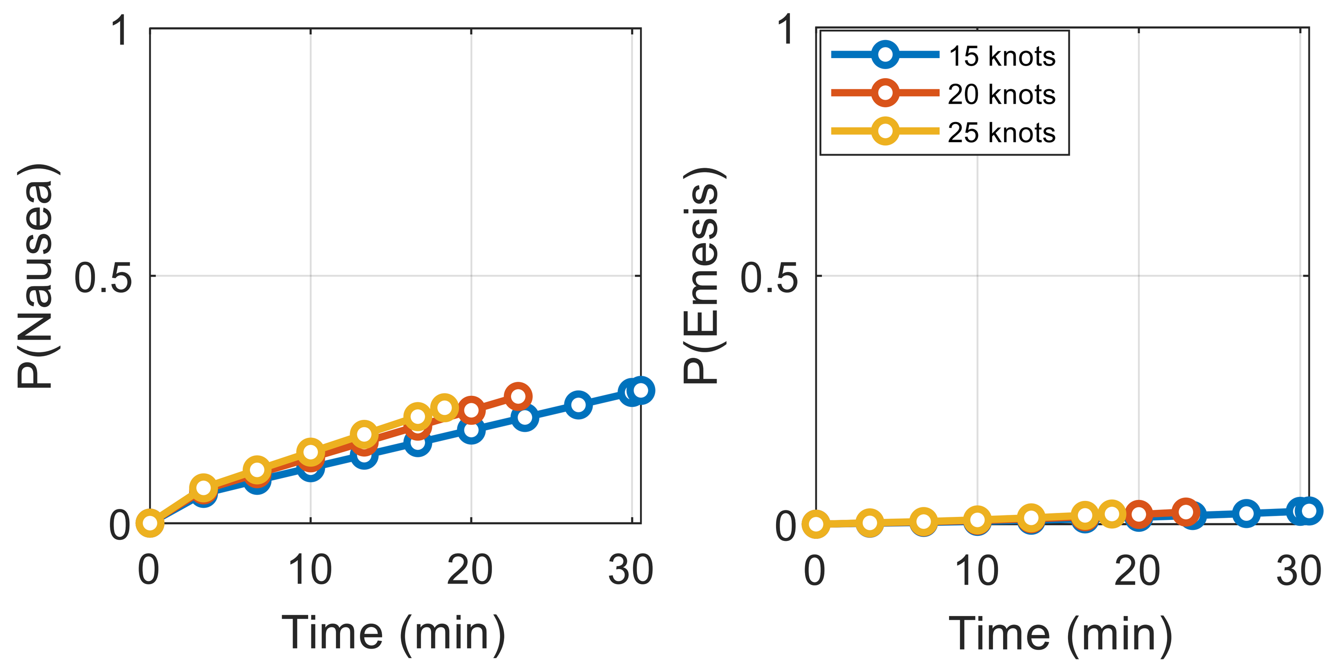


The motion sickness results (figure above) show that the bow of the vessel causes the highest motion sickness due to more intense accelerations, while the lowest motion sickness is near the center of mass, where accelerations are less.

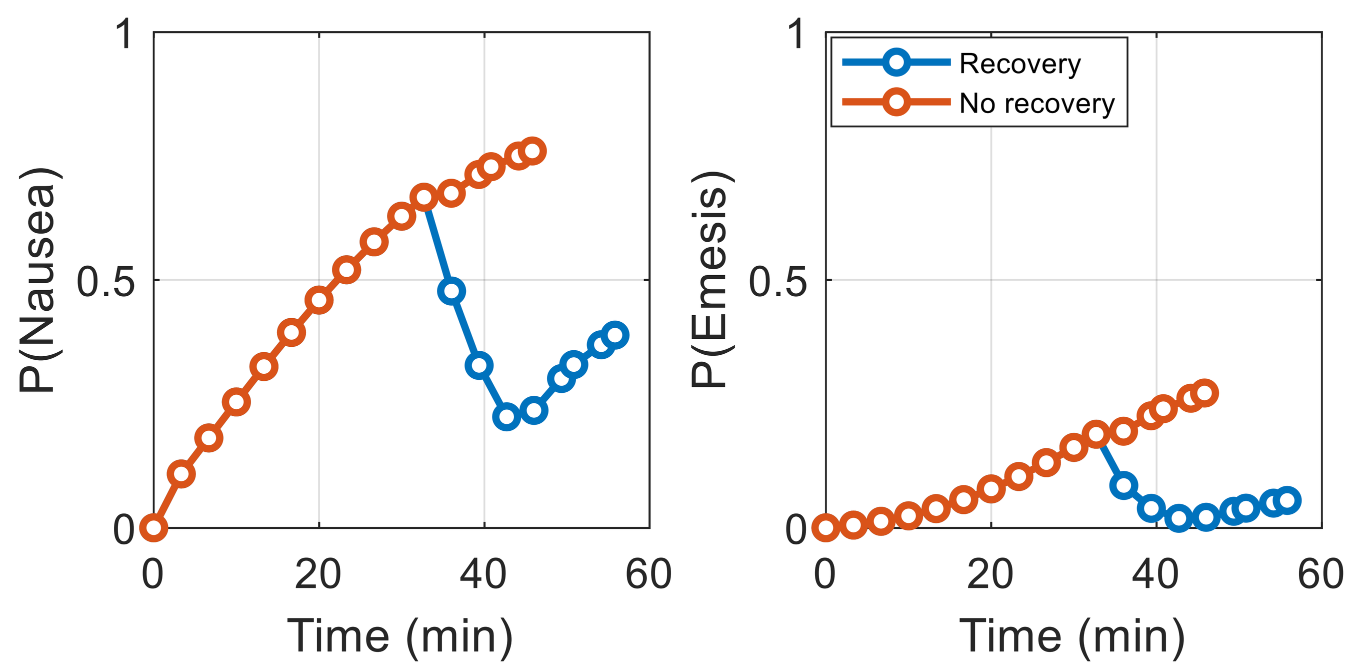


The figure above shows variations in motion sickness sensitivity, with percentiles indicating the most resistant individuals, such as the 10th percentile representing the top 10% in resistance, highlighting significant individual differences.





Testing an alternative to straight-line sailing, where the journey is split into two equal-length segments with deviation angles of 15° and 30°, showed that while deviations can reduce motion intensity, the increased travel time offsets these benefits in the evaluated scenarios. A reduced significant wave height shows the largest effect on the perceived motion sickness. Changes in the vessel's speed from 25 knots to 20 or 15 knots keeps motion sickness about equal by the trip's end due to longer motion exposure, despite a slower accumulation rate, which is a similar trade-off as with the deviated sections.



A 10-minute rest at the first wind turbine significantly reduces motion sickness over time, despite an increase when transit resumes, resulting in lower overall sickness levels by the end of the journey.

CONCLUSIONS

This study introduces a MISC-based motion sickness model for potential integration into offshore wind O&M scheduling tools. The model uses vessel motion data to predict a range of motion sickness symptoms, offering insights into various scenarios such as different vessel locations, weather conditions, and transit routes. While not yet validated for marine applications, the model demonstrates its potential value in planning strategies. Future research should focus on validating the model for marine environments, optimizing its integration into daily O&M tools, and exploring the impact of motion sickness on technician performance and vessel design.

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