# ME Seminar

## Bridging the scales: A Modeling Framework for the Marine Atmospheric Boundary Layer with Applications to Offshore Wind Energy

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### ABSTRACT

Wind-wave interactions are central to quantifying momentum transport at the air-sea interface and are critical to developing offshore renewable energy. Significant knowledge gaps exist regarding the coupling between waves, the atmospheric boundary layer, and their effects on offshore wind turbines. To this end, I will discuss a modeling framework for the marine atmospheric boundary layer that quantifies small-scale effects through physics-based models and couples them to high-fidelity simulations of large-scale flows. I will present a new “wall” modeling approach that overcomes these limitations and accurately predicts the wind-wave momentum transfer by modeling the pressure-based surface drag on the wind due to simple wavefields. Further, the model can be extended to realistic oceanic conditions using a dynamic procedure that calculates the momentum transfer due to waves unresolved in flow simulations based on a self-consistency condition of the total drag. Finally, I will discuss the application of the dynamic wave model to offshore wind farm simulations.

### ABOUT THE SPEAKER

Dr. Aditya Aiyer is an Assistant Professor in the Department of Mechanical Engineering and Mechanics at Lehigh University. He received his BSE in Mechanical Engineering and MS in Physics from the Birla Institute of Technology and Science funded by an INSPIRE fellowship. He received his MS in 2019 and Ph.D. in 2020 from the Department of Mechanical Engineering at Johns Hopkins University, where he studied the effects of microscale droplet mechanisms and ocean turbulence on the fate of oil from a Deepwater spill. Prior to his current appointment, he was a postdoctoral scholar at Princeton University in the Mechanical and Aerospace Engineering department. At Lehigh University he leads the Multiscale Fluid Dynamics and Turbulence lab where his group uses theory, modeling, and numerical simulations to study environmental turbulent flows, with specific projects focused on air-sea interaction, offshore renewable energy, and particle transport.

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