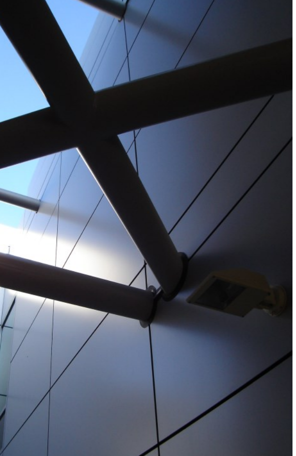

MECHANICAL ENGINEERING
DISSERTATION DEFENSE

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Rosalinda Lopez

Friday, September 3, 2021,
9AM Pacific time

Sea ice drift in spring- and summer-time Arctic marginal ice zones derived from optical satellite imagery

Doctor of Philosophy, Mechanical Engineering
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Dr. Monica Martinez Wilhelmus, Chairperson

Warming temperatures and extreme weather conditions have transformed the Arctic climate system. Most salient are the reduction of ice cover and the growth of marginal ice zones (MIZ). MIZ are regions along the ice edge where meso/submeso-scale variability strongly influences the sea ice field and vice versa. Understanding how sea ice and ocean circulation evolve in MIZ is crucial to fully characterize the mechanisms that control surface dispersion and consequently transform the Arctic.

Existing sea ice products cannot retrieve comprehensive dynamical observations in MIZ. As a result, critical dynamical processes are often overlooked in scientific studies and are not properly constrained in numerical models. The main goal of this study was to develop a sea ice detection algorithm designed to acquire measurements in MIZ extending throughout the 21st century.

Optical remote sensing imagery, namely Moderate-resolution Imaging Spectroradiometer (MODIS), was employed to develop an algorithm capable of retrieving the complex MIZ sea ice motion. The algorithm filters the atmospheric conditions abating MODIS images while maximizing ice identification via image processing and feature matching techniques. The robustness of the method was tested along the eastern coast of Greenland. Upon validation, a unique dataset of sea ice characteristics and kinematics was extracted from Fram Strait and the Beaufort Sea from 2003 to 2020. The dataset included geometric shape parameters, along with Lagrangian trajectories, angular velocities, and Eulerian velocity fields.

The data was employed to assess the influence of meso/submeso-scale ocean turbulence on sea ice dynamics. First, an in-depth analysis of the role of atmospheric and oceanic forcing on ice floe motion demonstrated the importance of meso/submeso-scale processes driving sea ice drift. Next, the seasonal and decadal variability of the ice flow field in the summer and spring-time MIZ was quantified. In these regions, sea ice dynamics differed from the central Arctic basin, highlighting the importance of a correct parametrization of sea ice in MIZ. Finally, for the first time, satellite-tracked sea ice was employed as surface tracers to analyze the topology of the underlying flow field. The results were validated with high-resolution buoys, providing an additional resource to characterize the turbulent eddy field.