Ph.D. DISSERTATION DEFENSE

Candidate:	Maria Venolia
Degree:	Doctor of Philosophy in Ocean Engineering
School/Department:	Charles V. Schaefer, Jr. School of Engineering and Science /Civil Environmental, & Ocean Engineering
Date:	07/28/2025
Time/Location:	1:00 p.m. EST / Peirce 216
Title:	Wind Wave Climatology Analysis of the Western North Atlantic Ocean Using a Spectral Approach
Chairperson:	Dr. Reza Marsooli, Department of Civil, Environmental & Ocean Engineering, Charles V. Schaefer, Jr. School of Engineering & Science
Committee Members:	Dr. John Miller, Department of Civil, Environmental & Ocean Engineering, Charles V. Schaefer, Jr. School of Engineering & Science Dr. George Korfiatis. Department of Civil, Environmental &Ocean Engineering, Charles V. Schaefer, Jr. School of Engineering & Science Dr. Jesus Portilla-Yandun, Department of Mechanical Engineering, Escuela Politécnica Nacional, Quito, Ecuador

ABSTRACT

This Ph.D. dissertation enhances understanding of wind wave climatology in the Western North Atlantic Ocean through wave energy spectral approach. As coastal regions face increasing challenges from climate variability and extreme weather events, accurate wave climate analysis has become essential for coastal management and marine operations. Traditional methods using integrated bulk wave parameters can misrepresent multimodal sea states, particularly in the Western North Atlantic where energetic currents like the Gulf Stream create complex wave-current interaction patterns.

This research investigates atmospheric and physical process influences on spectral wave characteristics through two objectives: first, analyzing historical in-situ buoy data to construct and partition spectral time series, quantifying spectral population characteristics; second, performing numerical modeling experiments to examine ocean current impacts on spectral wave parameters.

For the first objective, the maximum entropy method is used to construct frequency-direction wave energy density spectra time series from raw spectral data. The watershed algorithm is used to partition spectra into distinct wave systems, while subsequent analysis unveils wave families - aggregate wave system populations with unique characteristics and meteorological origins. This methodology is applied at multiple NDBC stations across the U.S. East and Gulf coasts revealing complex temporal patterns where individual wave families exhibit opposing trends despite consistent bulk parameter trends.

For the second objective, a coupled three-dimensional baroclinic SCHISM-WWM III hydrodynamic-spectral wave model is developed and validated for the Western North Atlantic. The model incorporates full stratification effects essential for Gulf Stream dynamics representation and allows investigation of wave-current interactions and their effects on spectral wave parameters.