Generation of Very Low-Frequency Oscillations in the Nearshore

AT A GLANCE

What is it?

Understand and analyze the generation mechanisms for very low-frequency oscillations (VLFs) arising from the mutual dynamic wave-current interaction in surf zones.

How does it work?

Combined theoretical and numerical study of a two-way dynamically coupled wave-current system to analyze the generation of VLFs, their nonlinear evolution and interactions.

What will it accomplish?

Advancing the scientific knowledge to achieve more accurate prediction of waves, currents, and water level fluctuations. This will enhance the Navy's prediction skills in littoral zones, and benefit research on coastal inundation, environmental sustainability, beach hazards/safety.

R&D Sponsor(s)

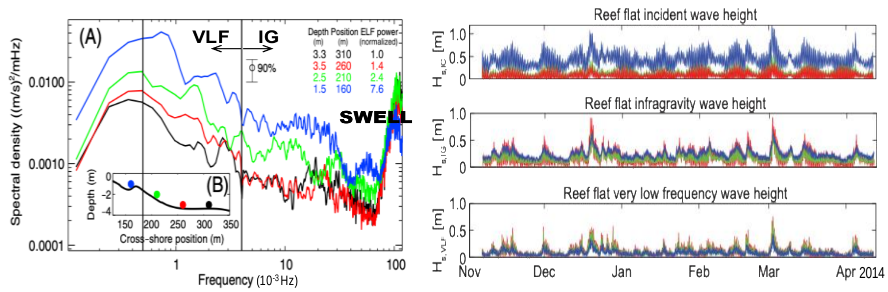
Office of Naval Research

Point(s) of Contact

Jie Yu, PhD
228.688.5710
jie.yu@nrlssc.navy.mil

Jayaram Veeramony, PhD
228.688.4835
jay.veeramony@nrlssc.navy.mil

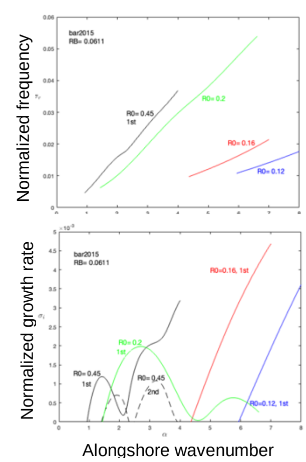
Mark Orzech, PhD
228.688.5974
mark.orzech@nrlssc.navy.mil



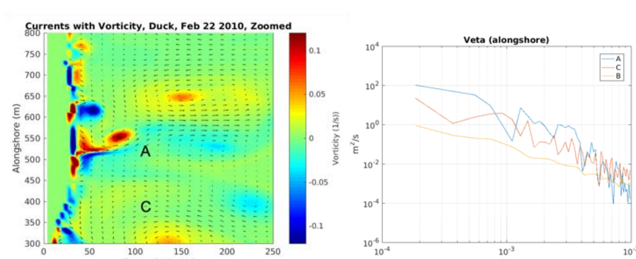
Observations of VLFs exceeding the energy levels of swells, and amplifying shoreward on (left) a sandy beach (Elgar et al. 2019) and (right) a fringing reef (Cheriton et al. 2016)

Low-frequency oscillations in the nearshore can cause water level fluctuations for a prolonged time, resulting in large beach run-ups, flooding and overwash, thus play an important role in littoral and offshore transport of mass and sediments. Theoretical analyses and modeling results both show that VLFs (f ~ 0.001 Hz) can be generated due to the mutual, dynamical coupling of waves and currents (Yu 2006; Yu and Chen 2015; Uchiyama *et al*. 2017). The present approach in the Navy's nearshore modeling lacks the capability to capture such effects of wave-current interactions.

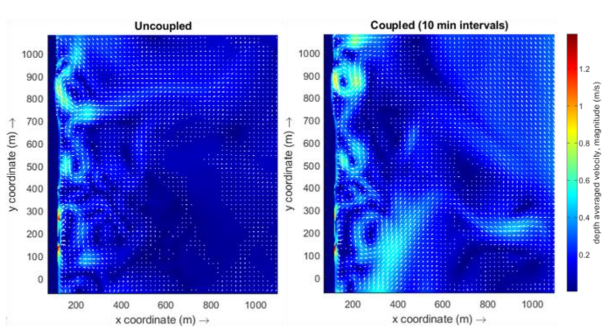
Our research methods combine the instability analysis and high-resolution numerical simulations using both wave-current coupled modeling (SWAN+Delft3D) and phase resolving modeling (SWASH). The research outcomes contribute to identifying and building a pathway to represent such physics in larger scale operational models.



Instability analysis on a beach with a mild bar, showing VLFs modes under various wave conditions R0.



SWASH modeling using the bathymetry profile at Duck, NC. The frequency power spectra based on the alongshore velocity (right) indicate the elevated VLFs energy at the nearshore locations (A,C), compared to that at B (~600 m offshore).



SWAN (wave) + Delft3D (current) using the bathymetry profile at Duck, NC, comparing the effects of wave-current coupling: (left) current is **not** fed back to the wave model; (right) current is fed back to the wave model every 10 minutes. Notice the increased alongshore variability and eddies due to wave-current coupling.