Coupled Wave-Ocean Model for Galway Bay

MÉRA Workshop

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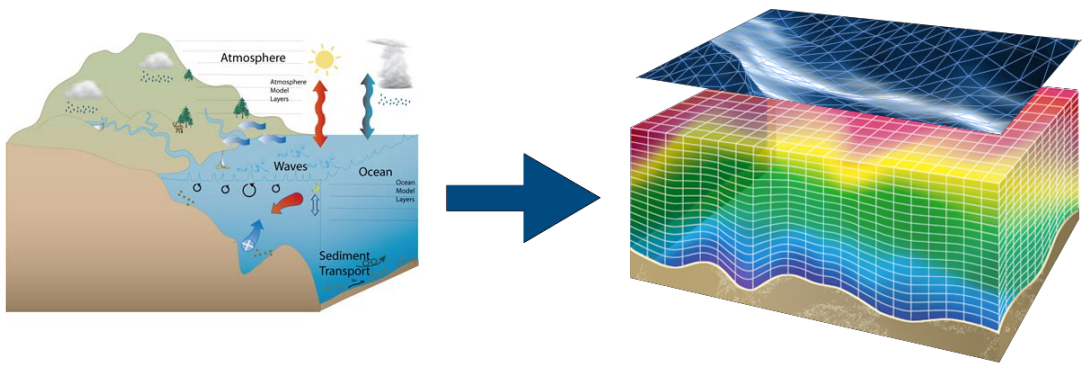
Scope of the thesis

- Set-up a coupled wave-current model for Galway Bay
- Improve the numerical implementation of the wave-current interaction



- How strong is the current interaction in Galway Bay?
- How well are the processes modelled? Can it be improved?

Observations

- Observations have shown that waves and currents can be strongly correlated and interact with each other

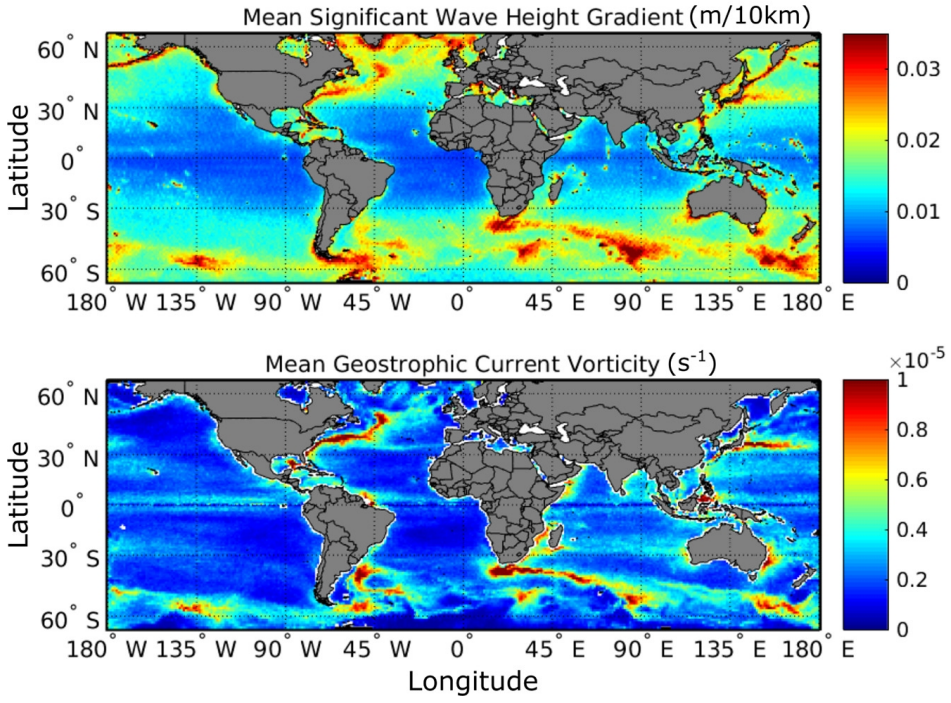


Figure: Mean significant wave height gradient and Mean Geostrophic current vorticity, from [Quilfen et al., 2018]

Theoretical framework

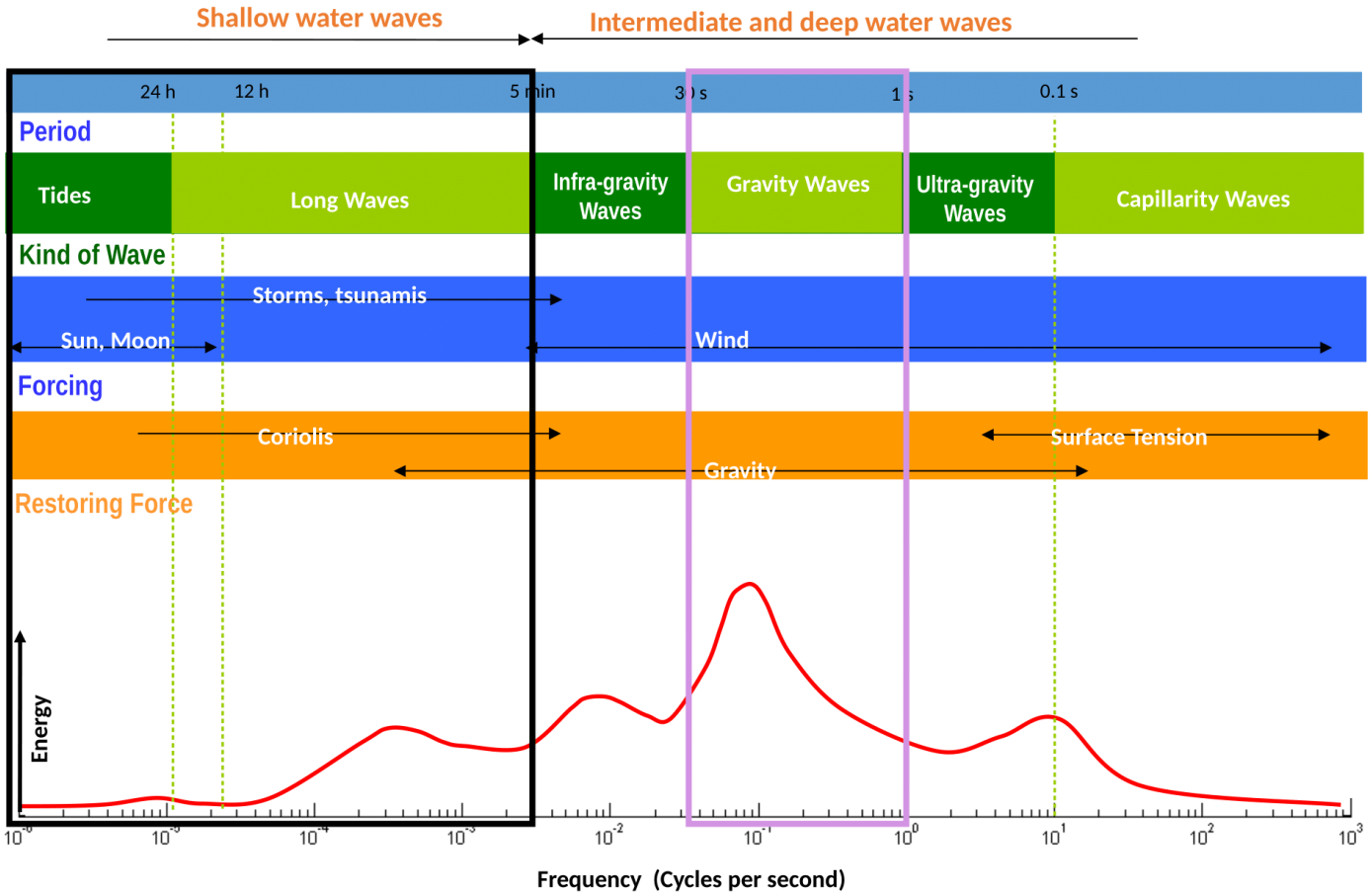
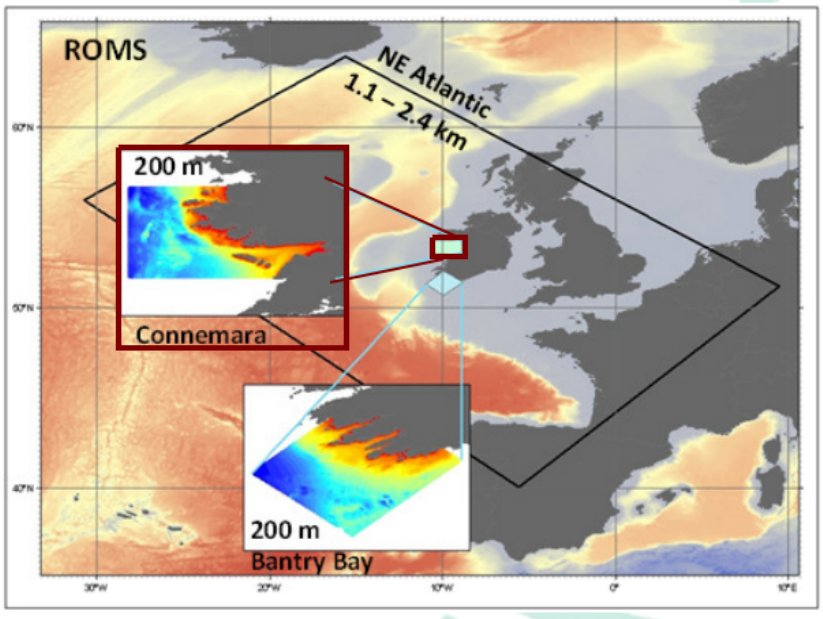


Figure: Water waves energy spectrum, slide from Dr. Olabarrieta's COAWST Workshop presentation.

Galway Bay

- The Marine Institute is already running an ocean model for Galway Bay
- A coupled model was tried but only went past the first validation steps



Model name	North East Atlantic
Model code	ROMS 3.7
Model Grid	Curvilinear (1.1km – 2.4km)
Bathymetry	GEBCO & INFOMAR
Forcing	• 3-Hourly ECMWF 0.125° • Copernicus global ocean 1/12° • TPXO8 tides 1/30° • River climatologies
Forecast Period	+3 days (daily)
Hindcast Period	-7 days (weekly)
Output	• 3D velocities, T, S, water level • @ 3 hrs spatially • 2265 stations @ 10 mins • Surface velocities @ 1 hour
Nested Domains	• Connemara (~200m) • Bantry Bay (~200m)
Other Domains	Clew Bay, Berthraghboy Bay, Kenmare Bay, Kilmakilloge Harbour, SW Ireland

Figure: Operational ROMS models run by the Marine Institute.

The Coupling system: COAWST

- From the wave model: wave parameters, dissipation terms
- From the ocean model: current field, surface elevation

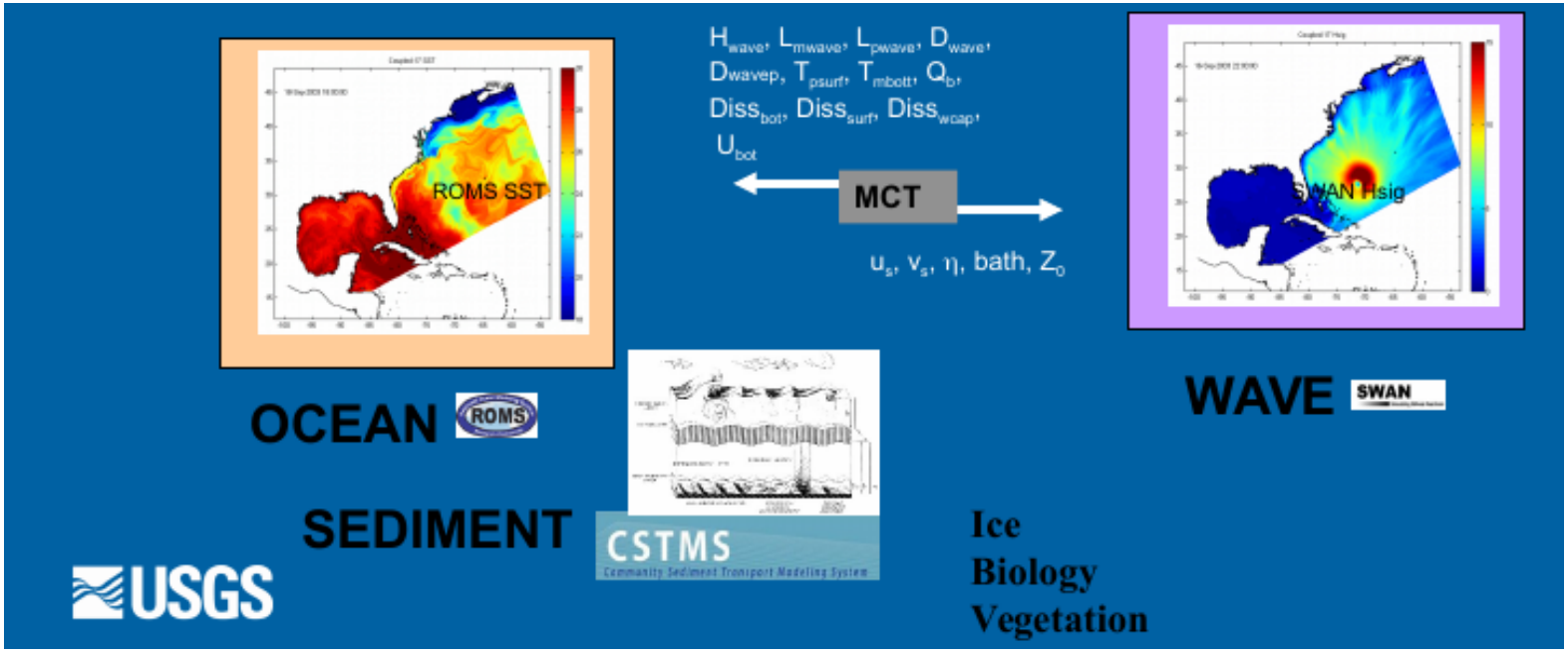


Figure: The coupling between currents (ROMS) and waves (SWAN) inside COAWST

Model description

Grid	Geographic curvilinear grid (200mx200m)
Bathymetry	Infomar and Gebco - 20 levels
Forcing	NE Atlantic MI model - 10min freq River climatologies - 1day freq MÉRA atmospheric forcing - 1hr freq
Hindcast Period	01/10/2016 to 29/01/2017 - 15s time-step

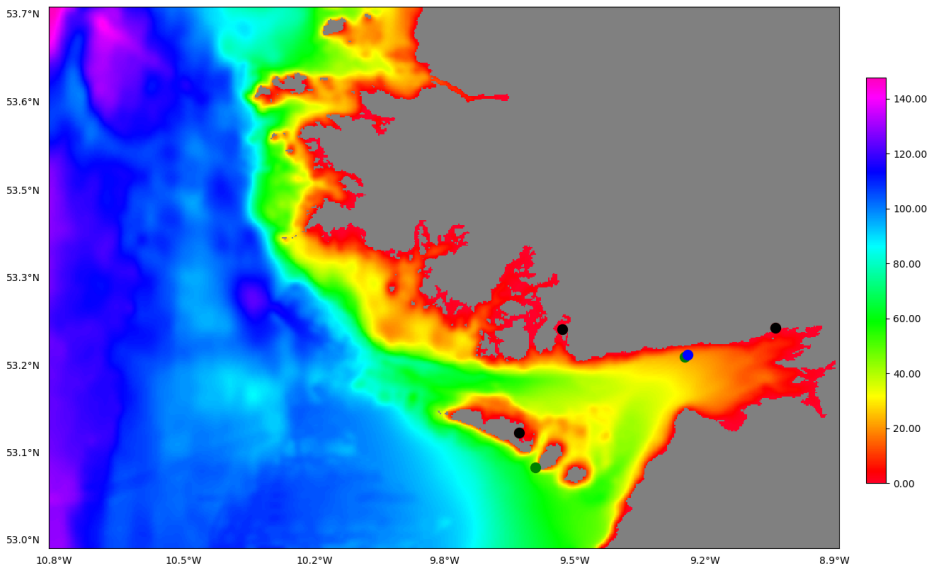
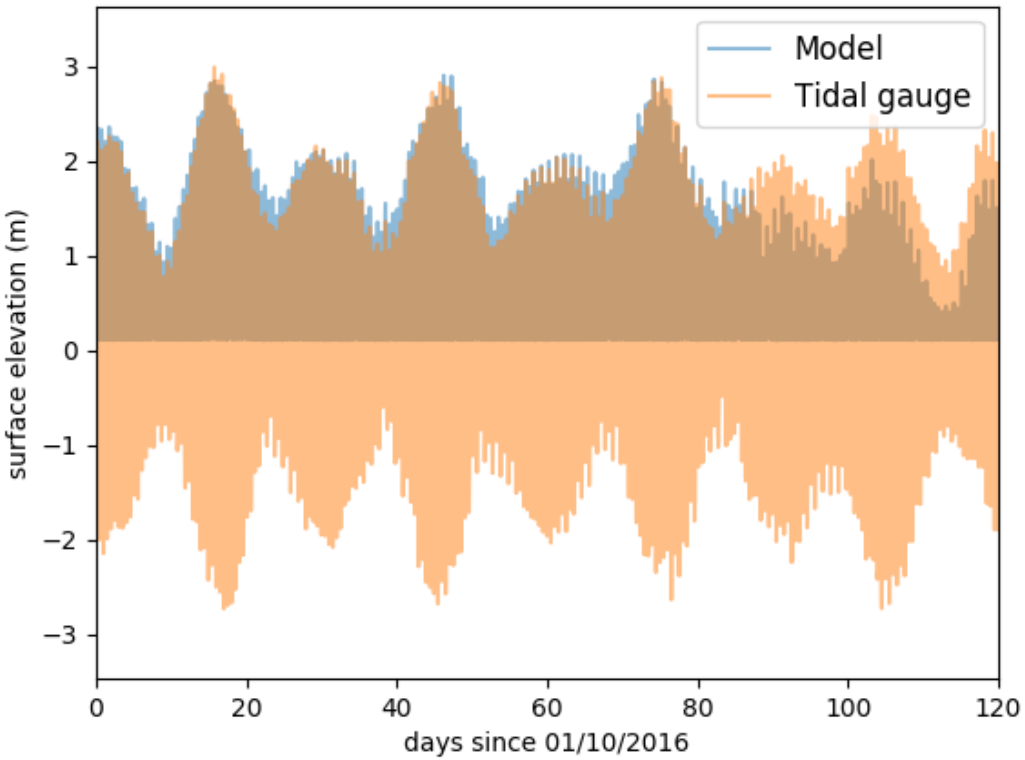
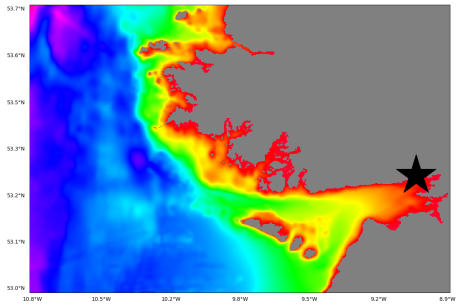


Figure: Bathymetry and position of measurements stations

First results





- Depth issue (wet/drying)
- Bad agreement after 90 days

Figure: Model and tidal gauge surface elevation in Galway Port - ROMS only

Work plan

- Obtain an optimal parametrization for ROMS
- Run and obtain an optimal parametrization for SWAN/WW3
- Run the couple model and investigate the coupling

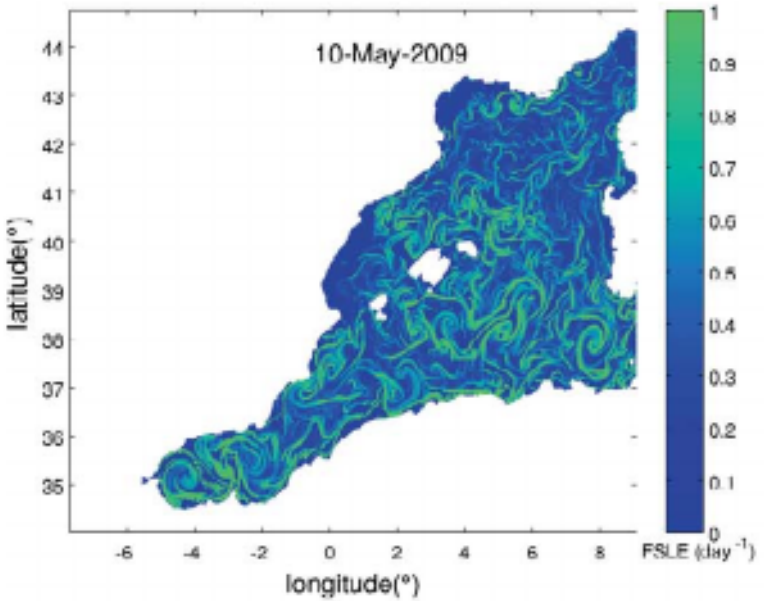


Figure: Finite Size Lyapunov Exponents, Mediterranean Sea - [Sayol et al., 2013]

- Study the Lagrangian trajectories/residence time
- Select and improve the modelling of some specific processes

Acknowledgement

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Journal of Geophysical Research: Oceans, 118(12):6371–6384.