Small boulders transport dynamics in a highly energetic coastal environment

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European Research Council

HIGHWAVE

école normale supérieure paris—saclay

université PARIS-SACLAY

CENTRE BORELLI

Introduction

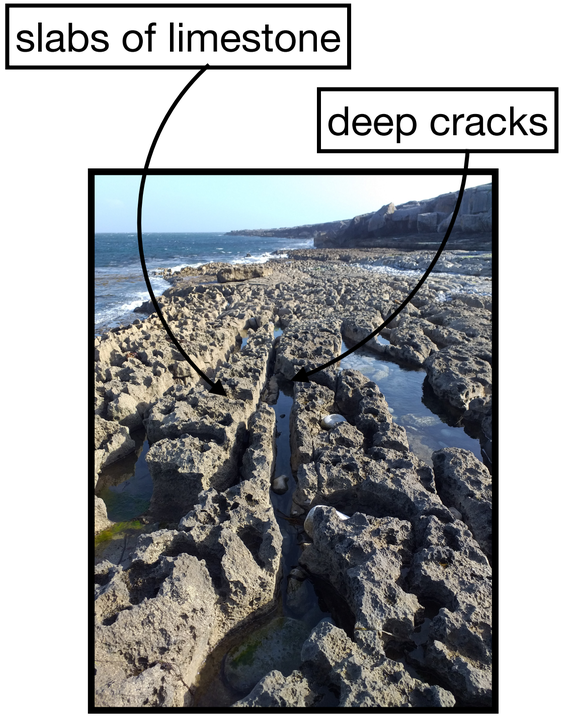
The HIGHWAVE Project

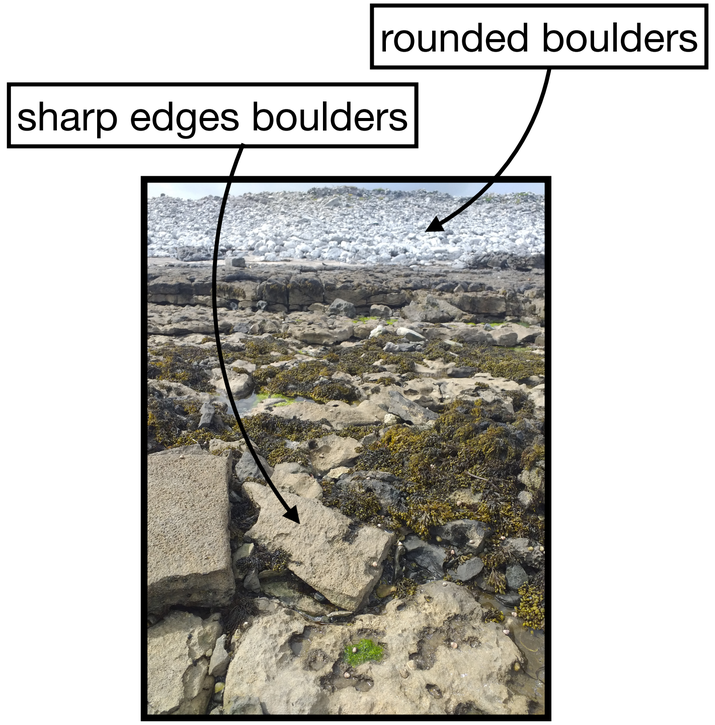
Objective: quantify the effect of highly energetic breaking waves on coastal areas.

Experiment site landscape

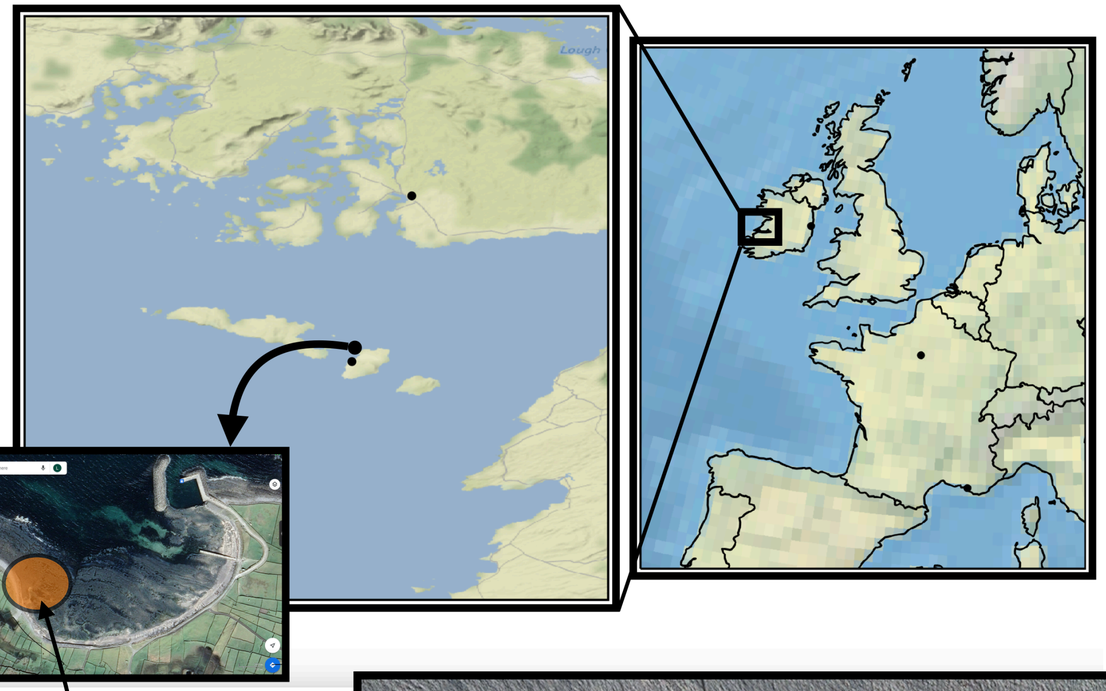
Karst limestone that was formed 350 million years ago.

The Aran Islands (Ireland) are one of the finest examples of a Glacio-Karst landscape in the world.

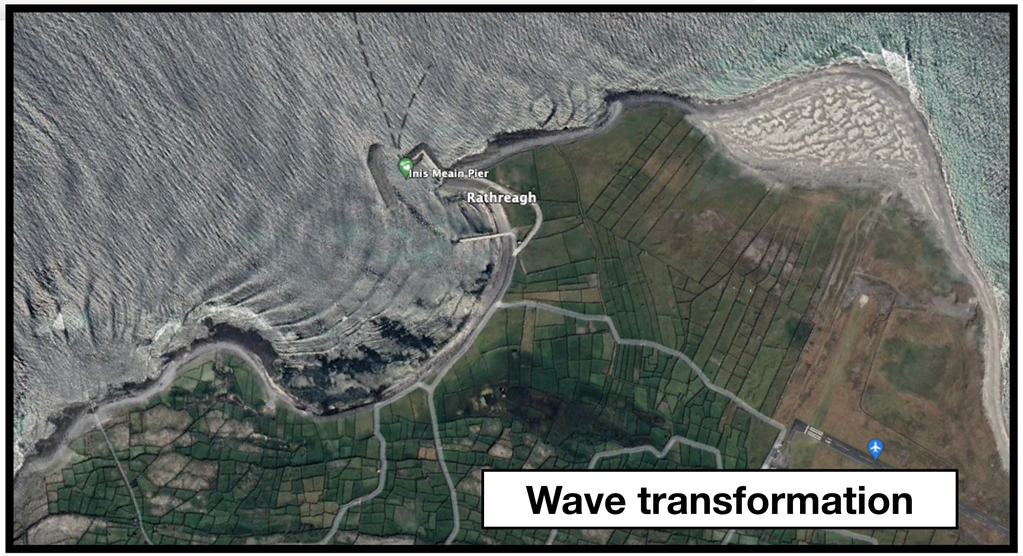




Study area and objective



Boulder deposit



Wave transformation

High tide conditions

Low tide conditions

Field experiments

Spotter buoy

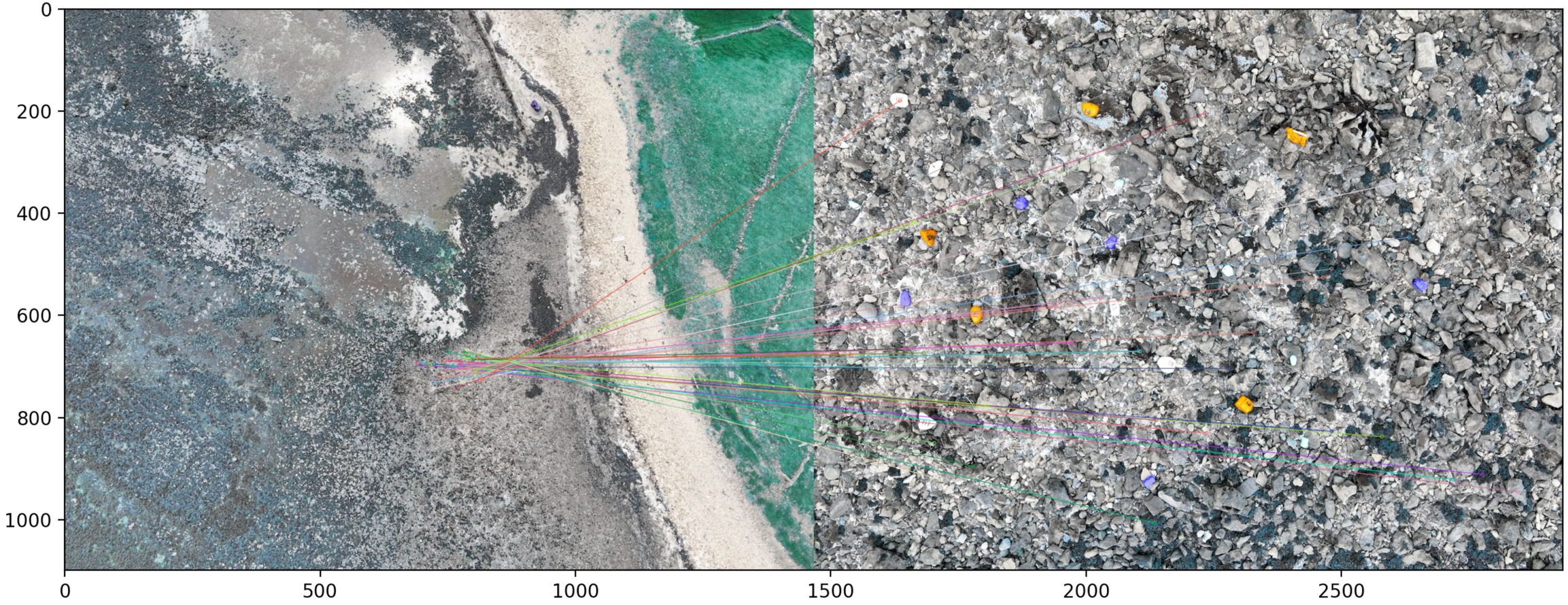
Marked boulders

Drone

Pressure sensor

Data analysis

Drone imagery post-processing: Image registration



Reference image **Sensed image**

Data analysis

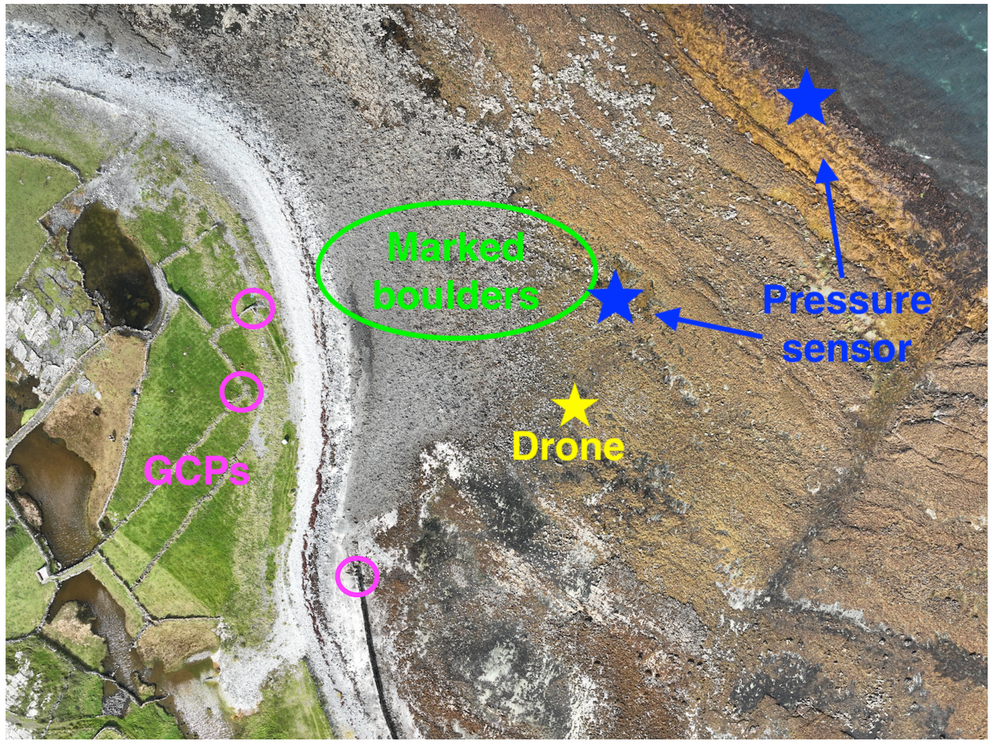
Drone imagery post-processing: Image warping

Reference image - warped sensed image

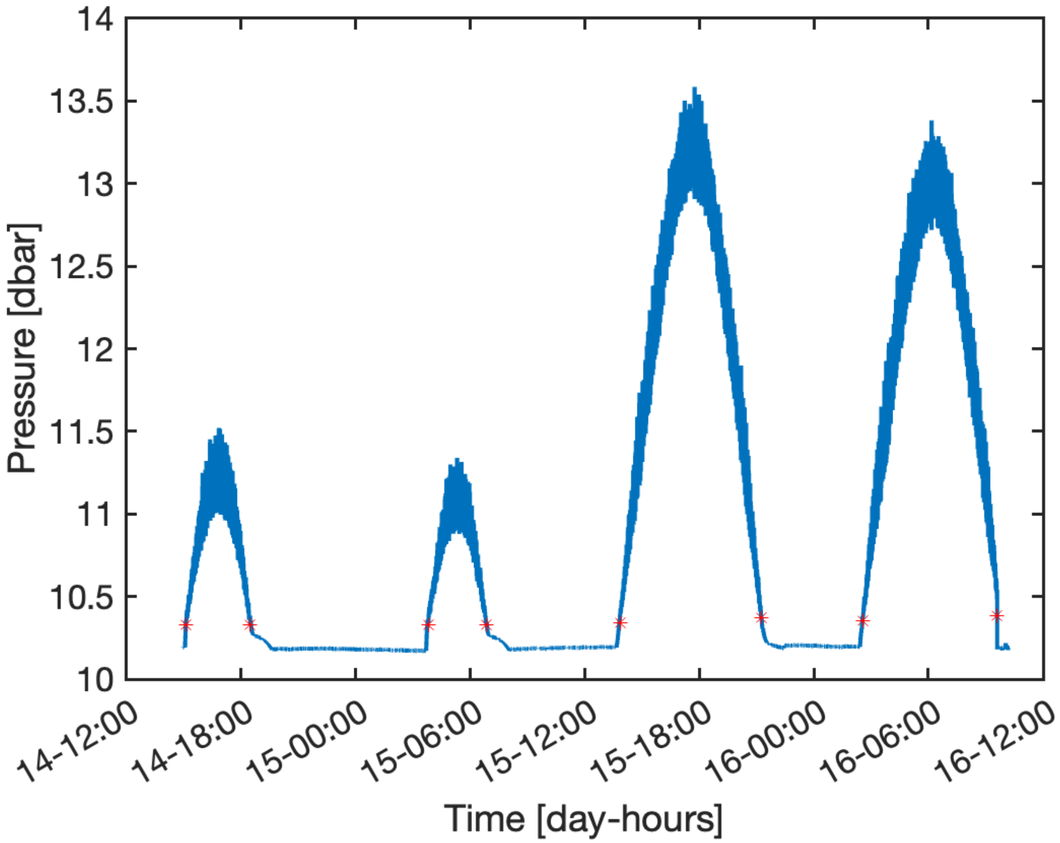
Target points (boulders) coordinates

Data analysis

Pressure sensor and wave energy spectra



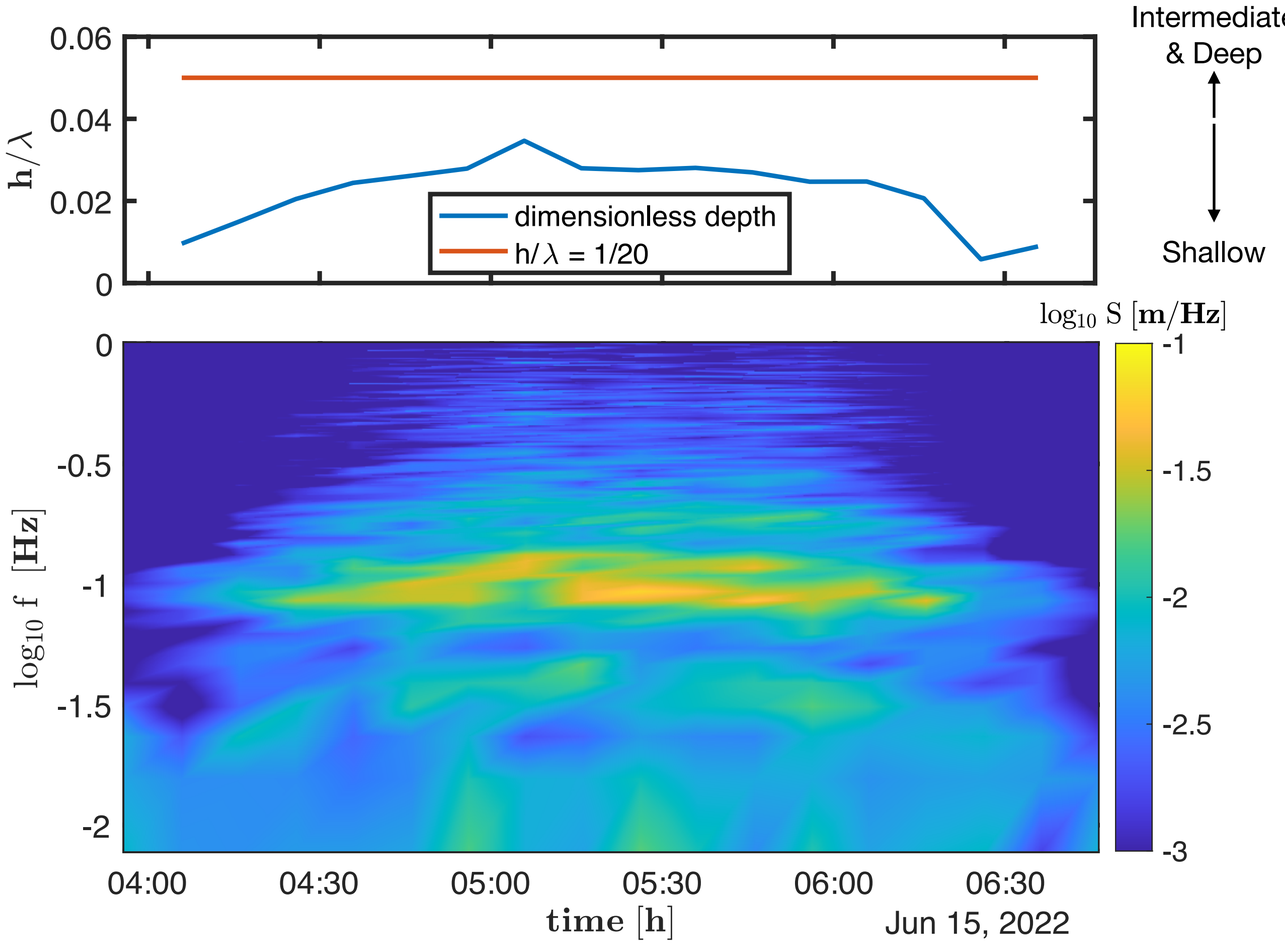
Deployment locations

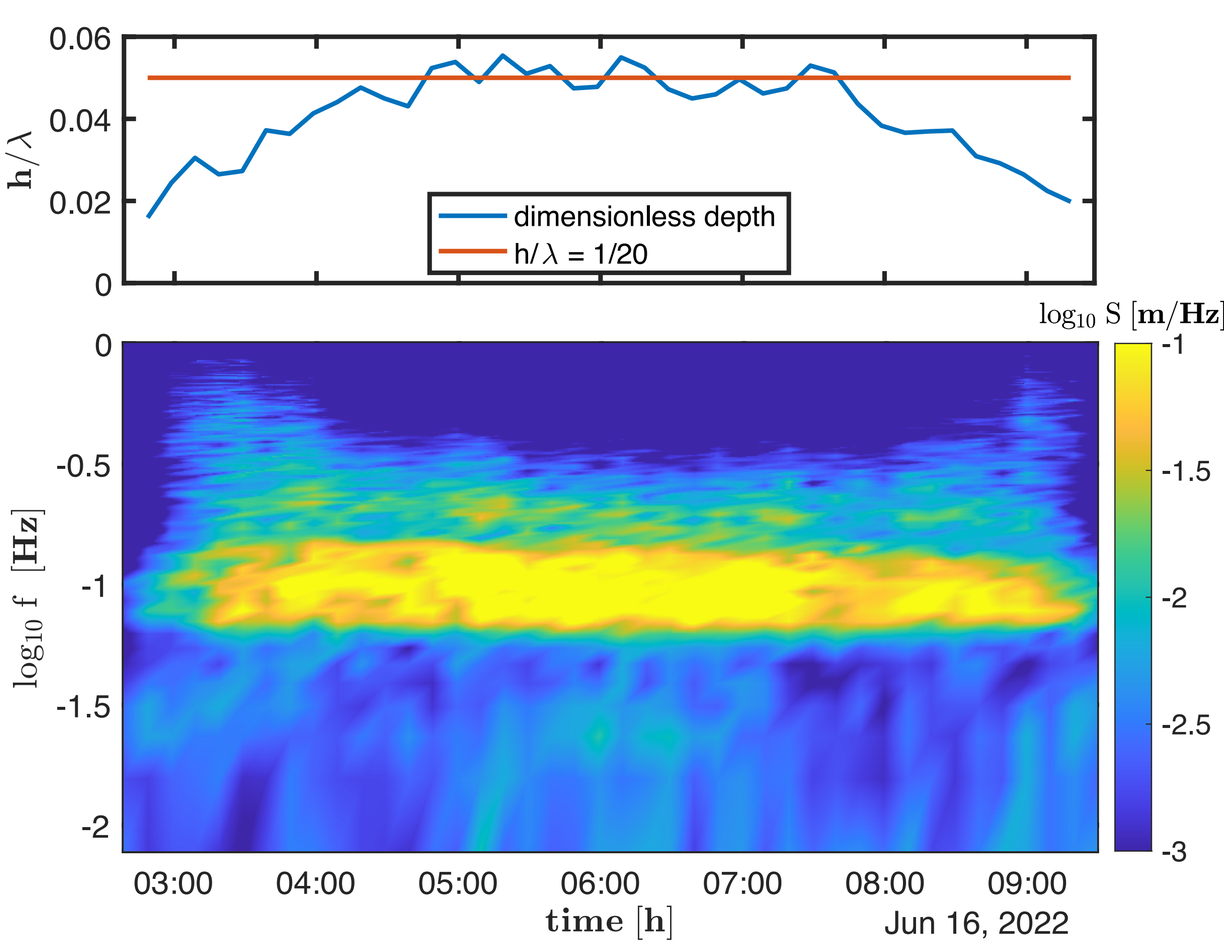


Pressure sensor time series

Data analysis

Pressure sensor and wave energy spectrogram



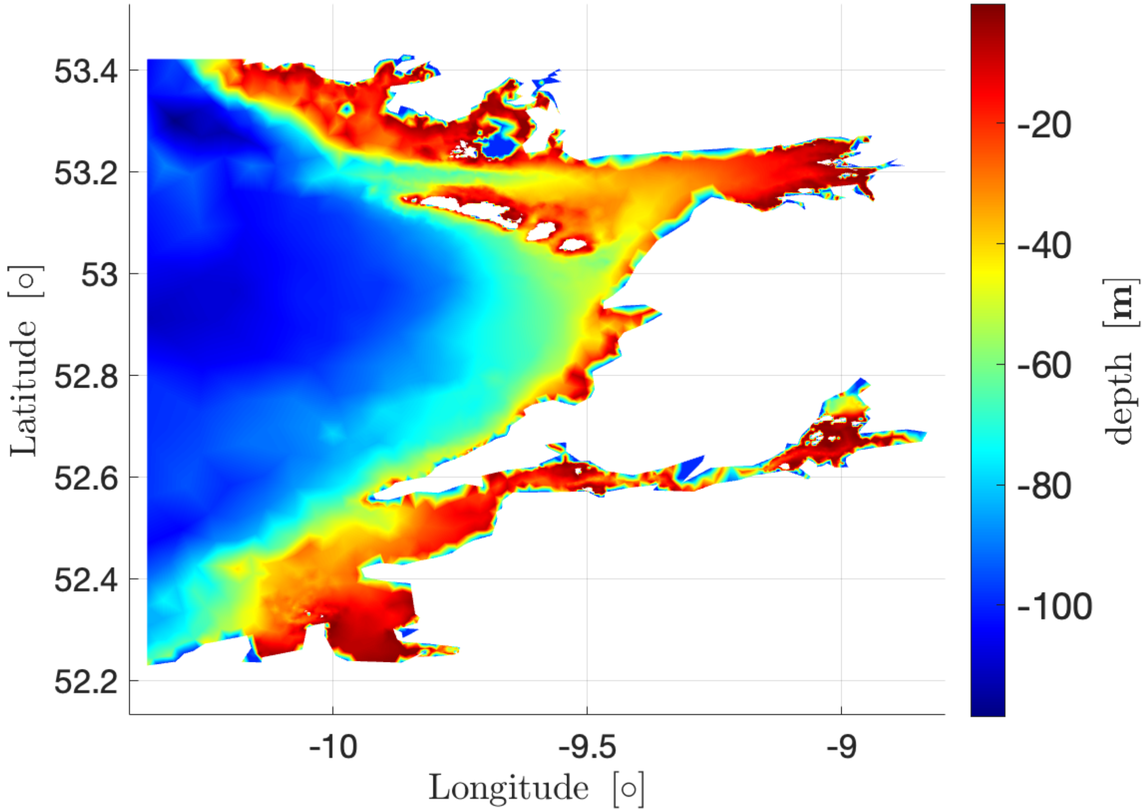


1-m depth location

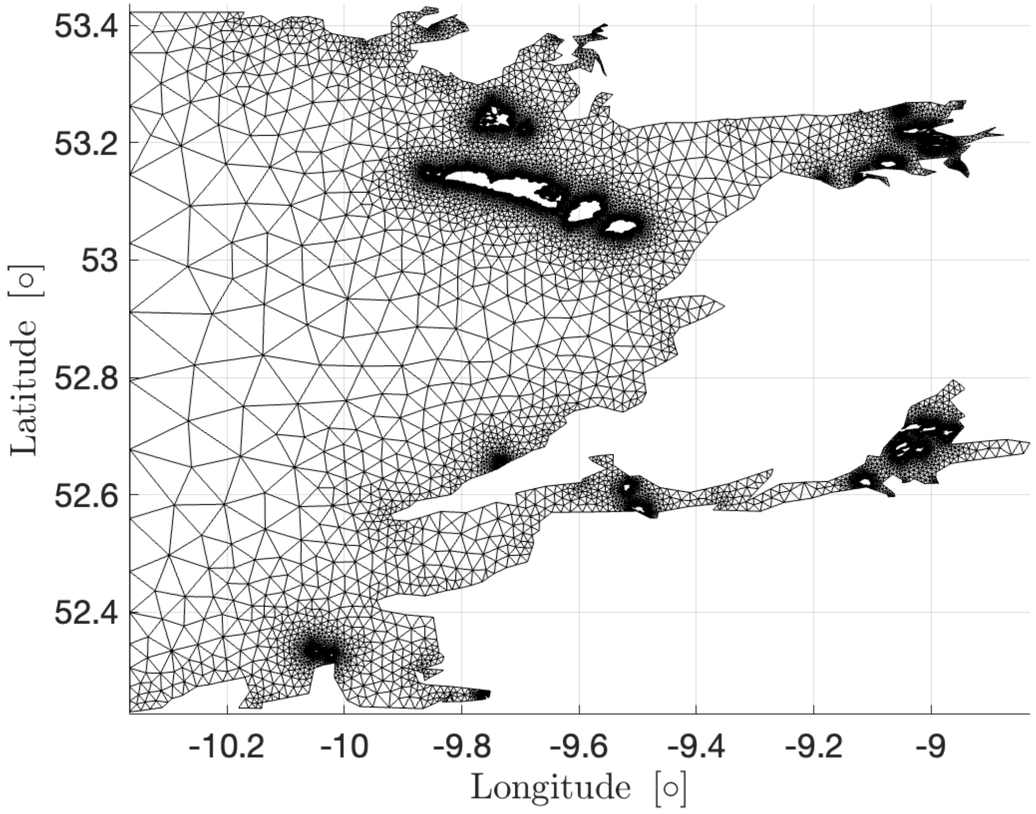
3-m depth location

Numerical simulations

SWAN - Wave spectral model implementation



Bathymetry

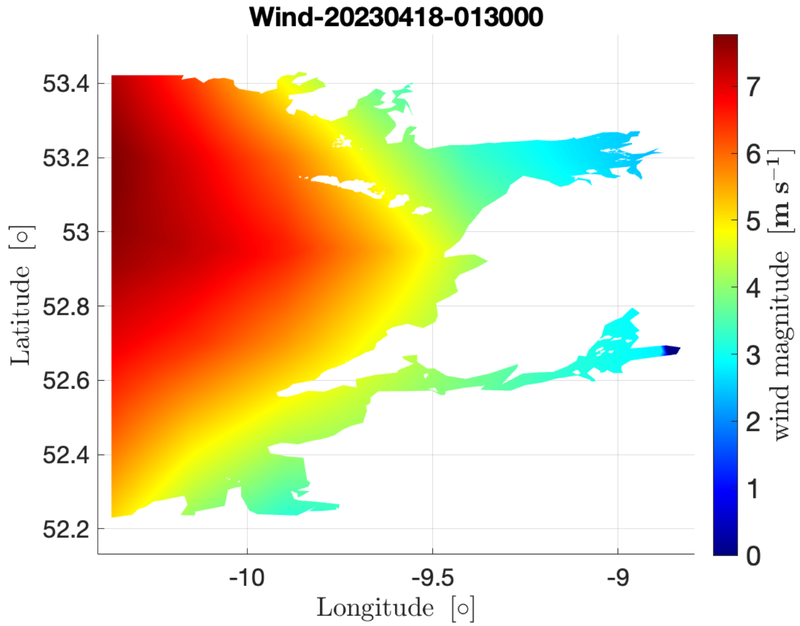


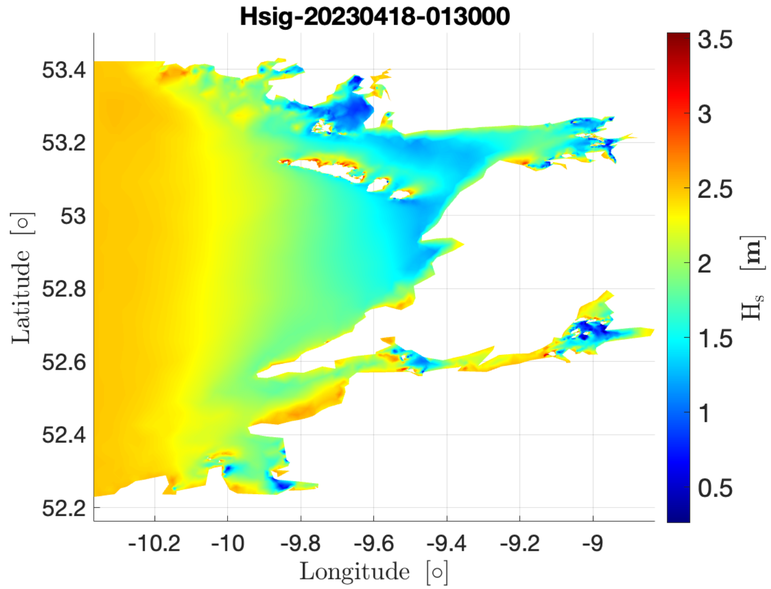
Computational mesh

Numerical simulations

SWAN - Wave spectral model implementation

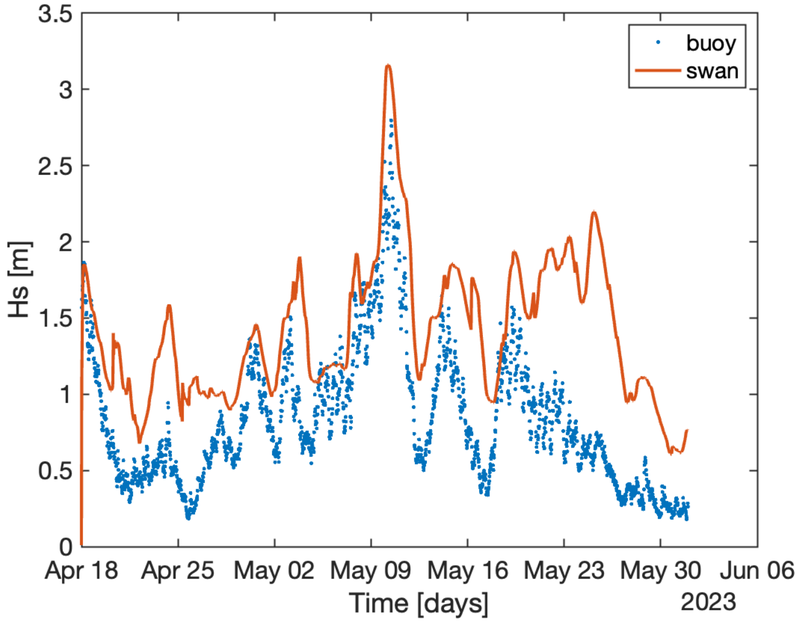
- Wind input ERA5
- Wave boundary conditions ERA5
- Computational time step: 10 min
- Used formulation ST6
- Simulation of 1 and 1/2 months takes 1 day and 20 h.
- Validation: comparison with spotter buoy data
- Need to include tides

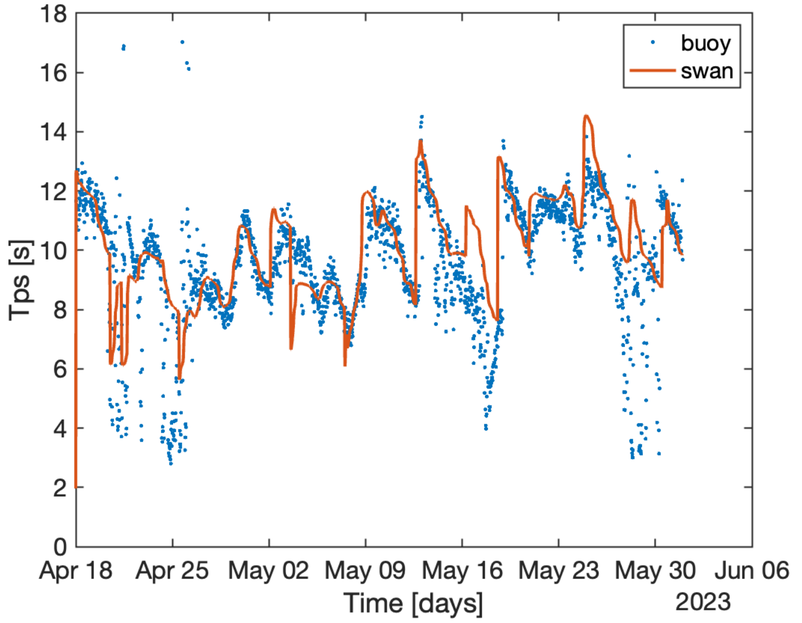


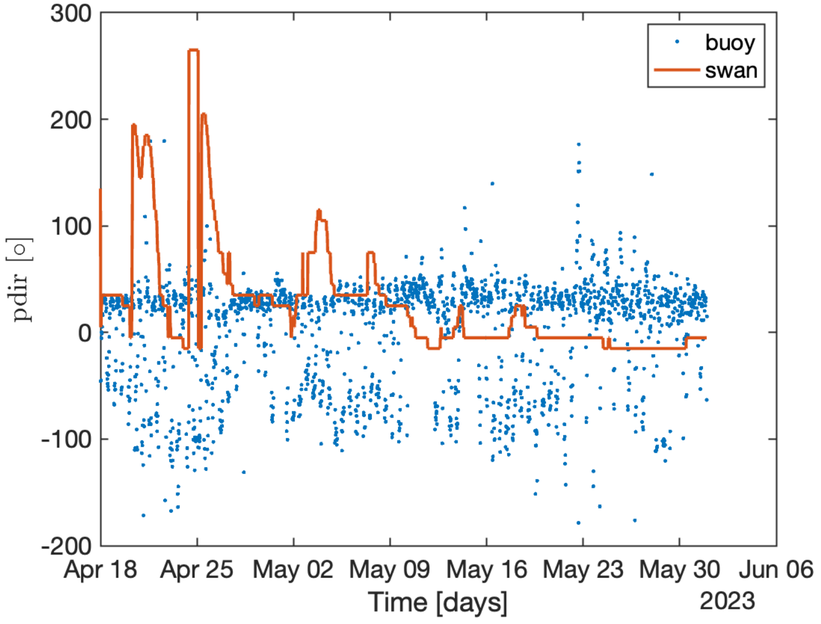


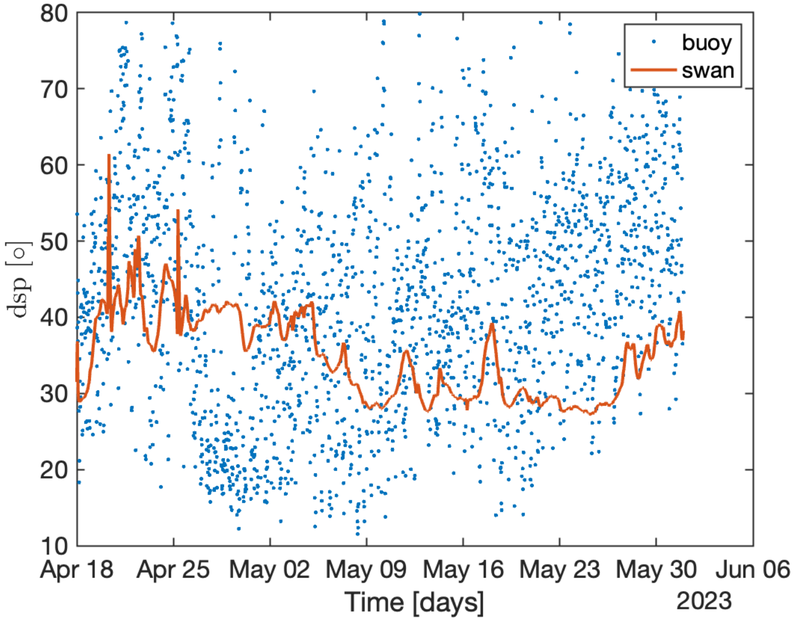
- Spatial resolution 0.25 degrees
- Temporal resolution 1h

Validation of SWAN simulations



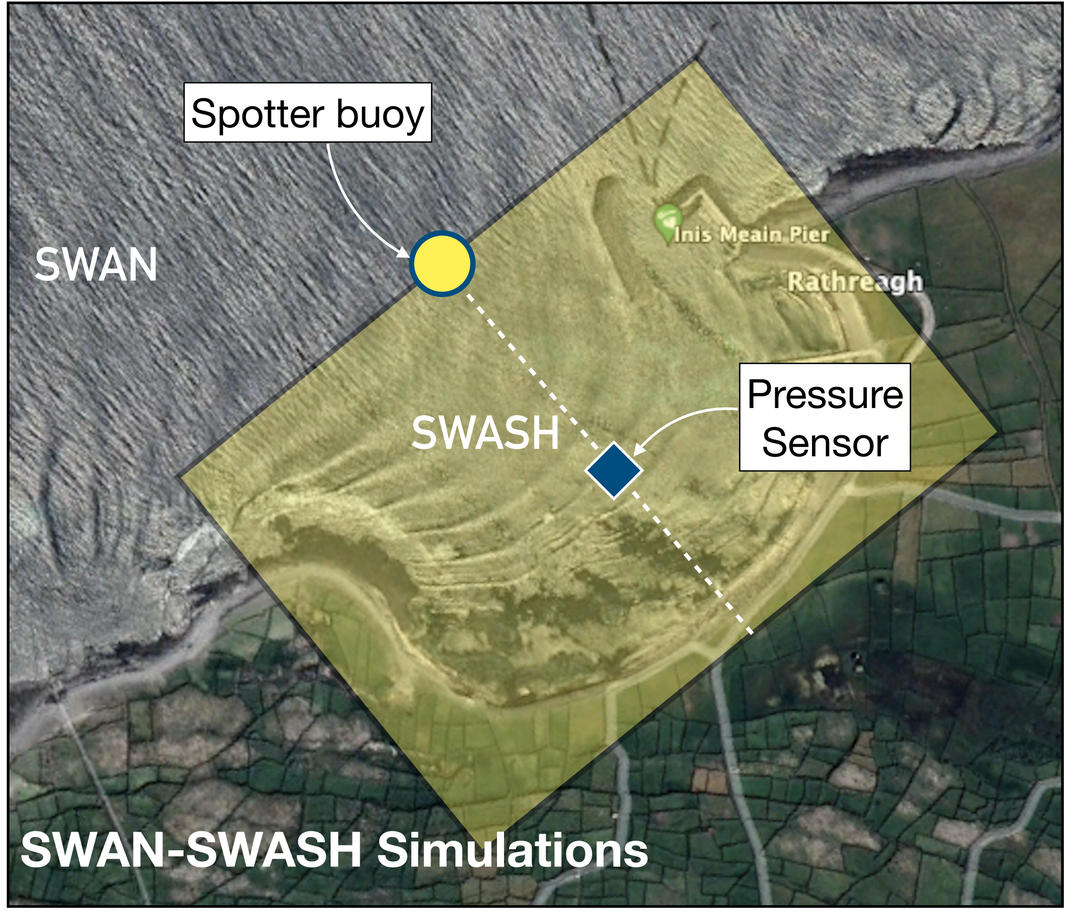






Future work

- Several field campaigns to capture boulder transport under storm wave conditions.
- SWASH simulations (1D - 2D mode)
- Bathymetry: Drone-mounted Lidar data processing (resolution of up to several cm).
- Deployment of smart boulders equipped with IMUs (Eyal et al., 2021).



Summary

- This first approach will give us an idea of where marked boulders tend to move, under which wave energy conditions they move, and the probability of recovering them.
- We will be able to associate the observed transport dynamics with the hydrodynamics conditions simulated by the SWASH model.
- With a regular deployment of marked boulders, we can estimate the more likely areas of deposition under wave storm conditions.
- By using smart boulders, we can know more about the threshold of the motion initiation and associate it with the hydrodynamics conditions of the area.

Thank you very much for your attention!

Acknowledgements

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