THE HIGHWAVE PROJECT

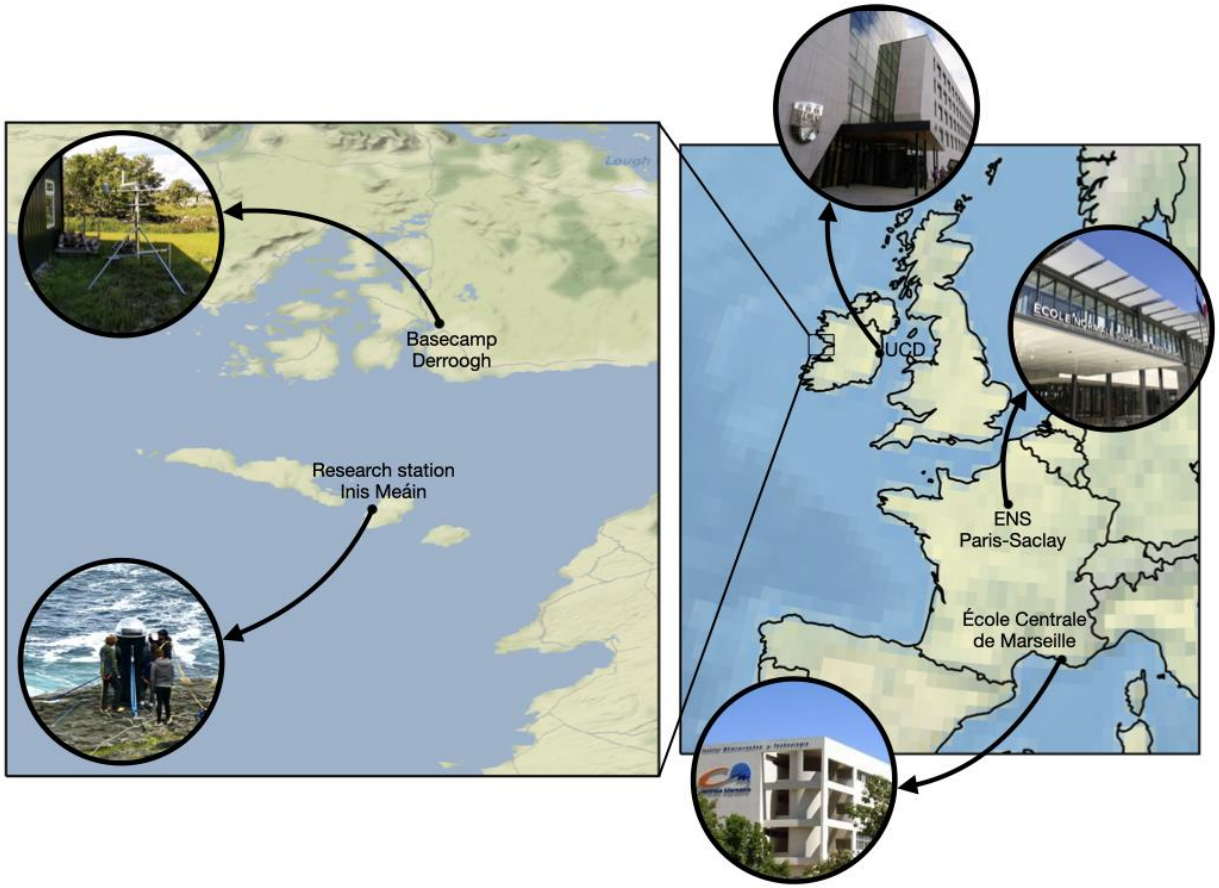
Frédéric DIAS – *ENS Paris-Saclay (FR) & UCD (IE)*

Arnaud DISANT

WAVE GROUP ORGANIZATION

About 15 members

- ❑ The Navier team at ENS Paris-Saclay
- ❑ The Stokes team at University College Dublin
- ❑ Arnaud Disant, technical director of the research station

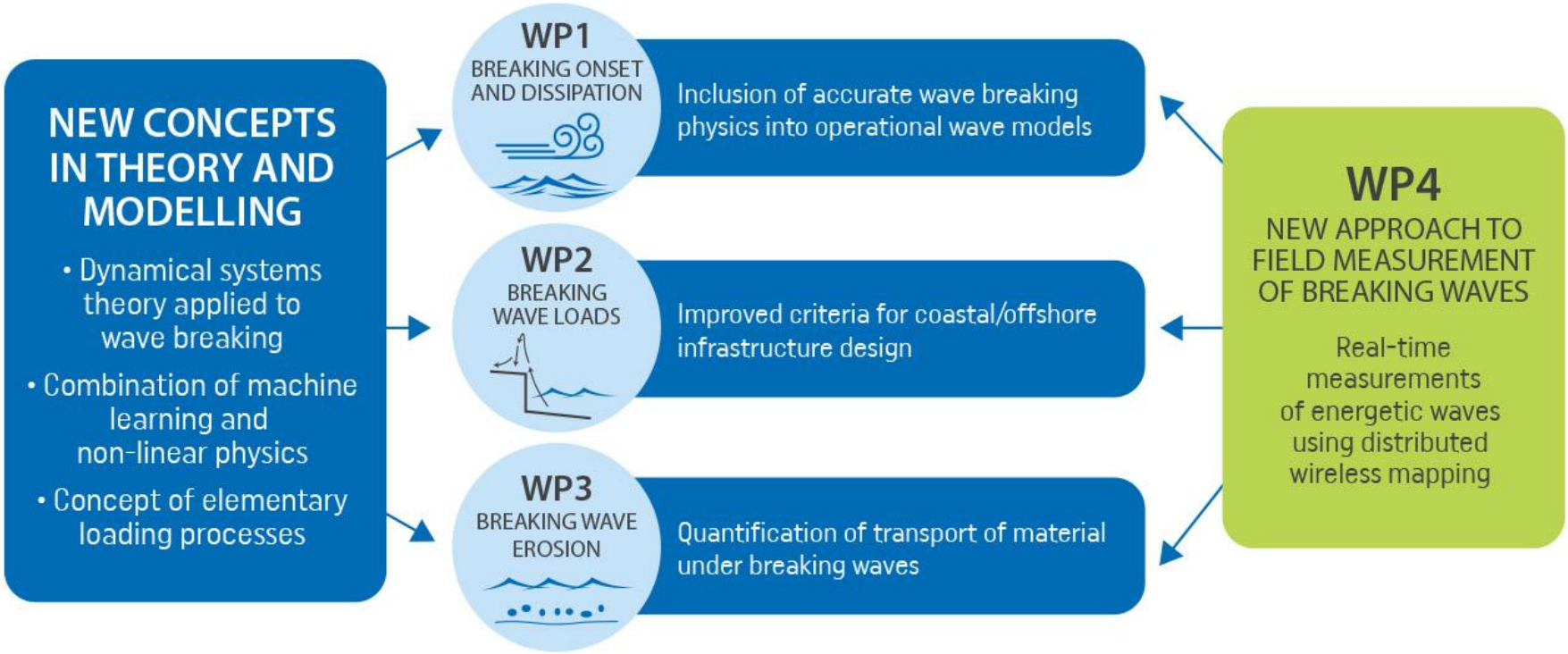


Interdisciplinarity

- ❑ Applied Mathematics, Statistics, Fluid mechanics, Scientific computing
- ❑ Laboratory experiments (Marseille)
- ❑ In situ measurements : new research station on Inishmaan (Aran Islands)

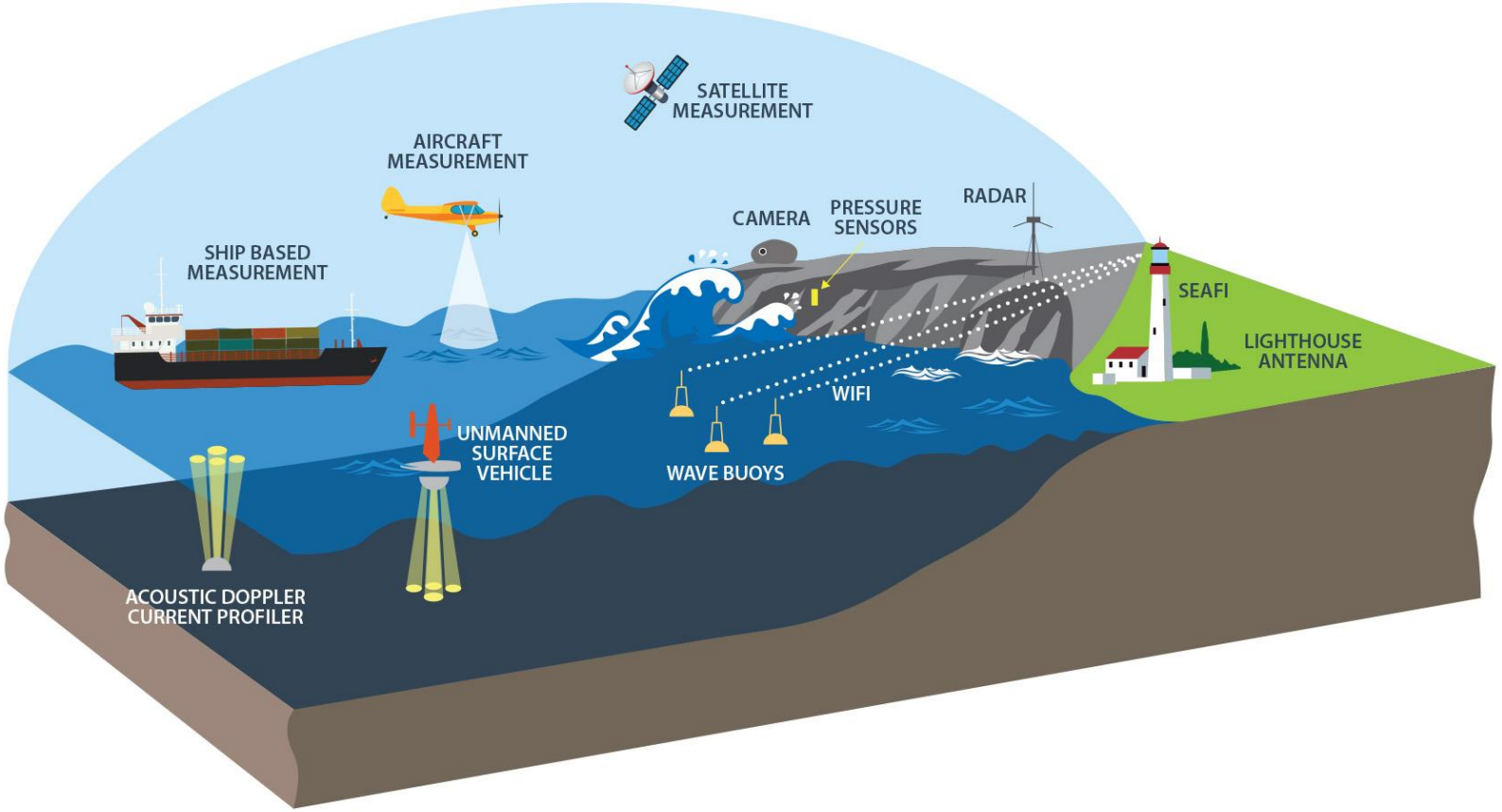
ERC Advanced Grant HIGHWAVE (2019 – 2024)

Breaking of highly energetic waves



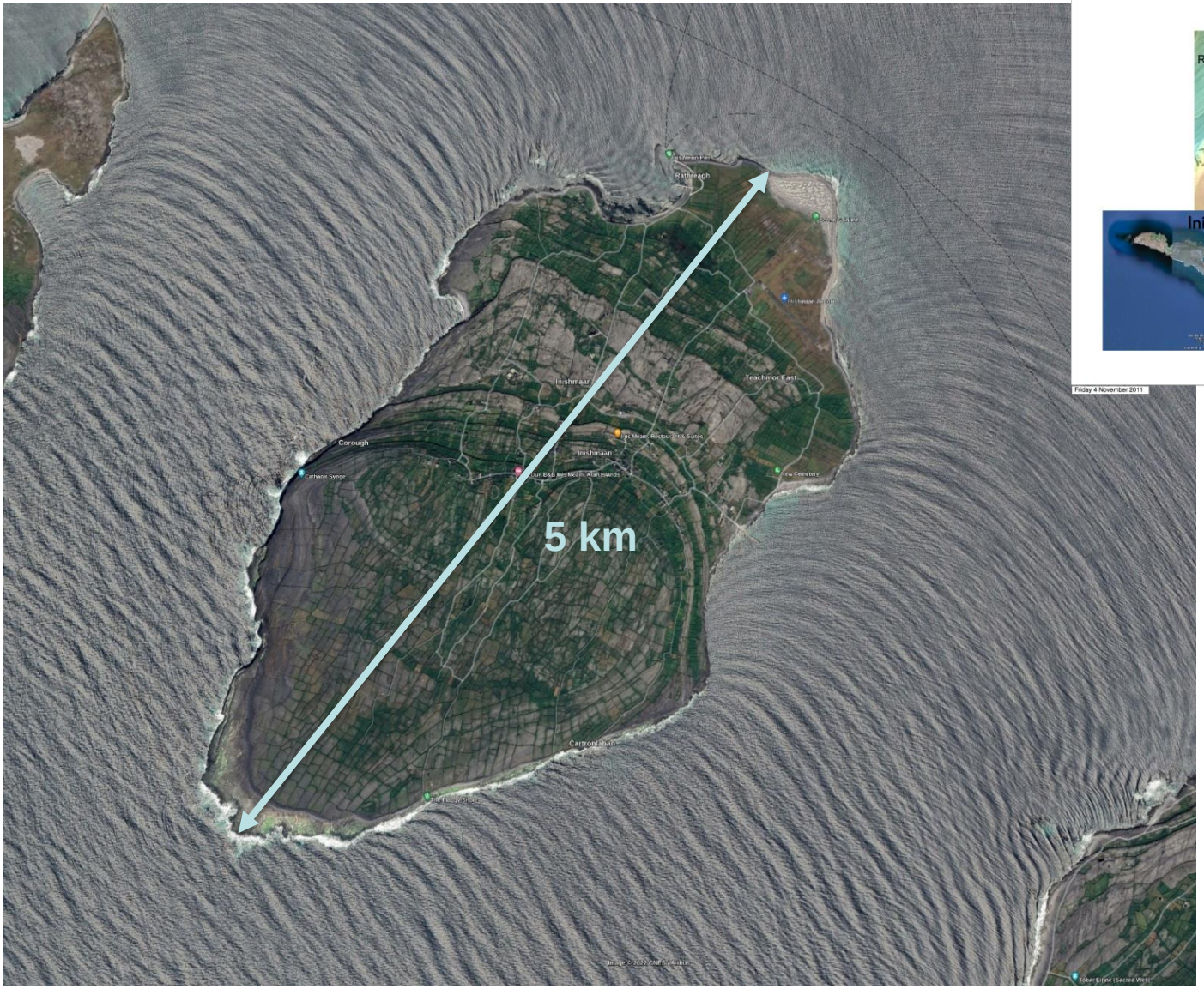
The Stokes team: Arnaud Disant (engineer), James Steer, Tatjana Kokina, Claire Bergin, Constantinos Menelaou, Ryan Smith, Cian Warby (PhD students), Syed Hasan (postdoc)
The Navier team: Lucia Robles Diaz, Susanne Stole Hentschel (postdocs), Daniel Santiago Pelaez Zapata, Ayoub Mansar, Pierre Andraud, Lorena Gil Calo (PhD students)

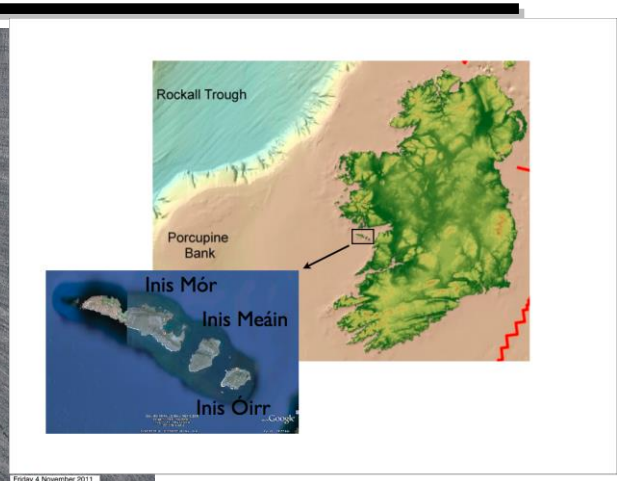
ERC Advanced Grant HIGHWAVE (2019 – 2024)



Collaborators: Lili Kimmoun († 2023), Andrew Kennedy (USA), Tom Bridges & Matt Turner (UK), Patricio Catalan (Chile), Michael Stresser (Germany), Nadav Lensky & Haggai Eyal (Israel), Dan Toal (Ireland), Gabriele Facciolo (ENS Paris-Saclay), Wouter Mostert (UK)
PhD co-supervisors: Vikram Pakrashi & Brendan Murphy (UCD), Anne-Claire Bennis (France)

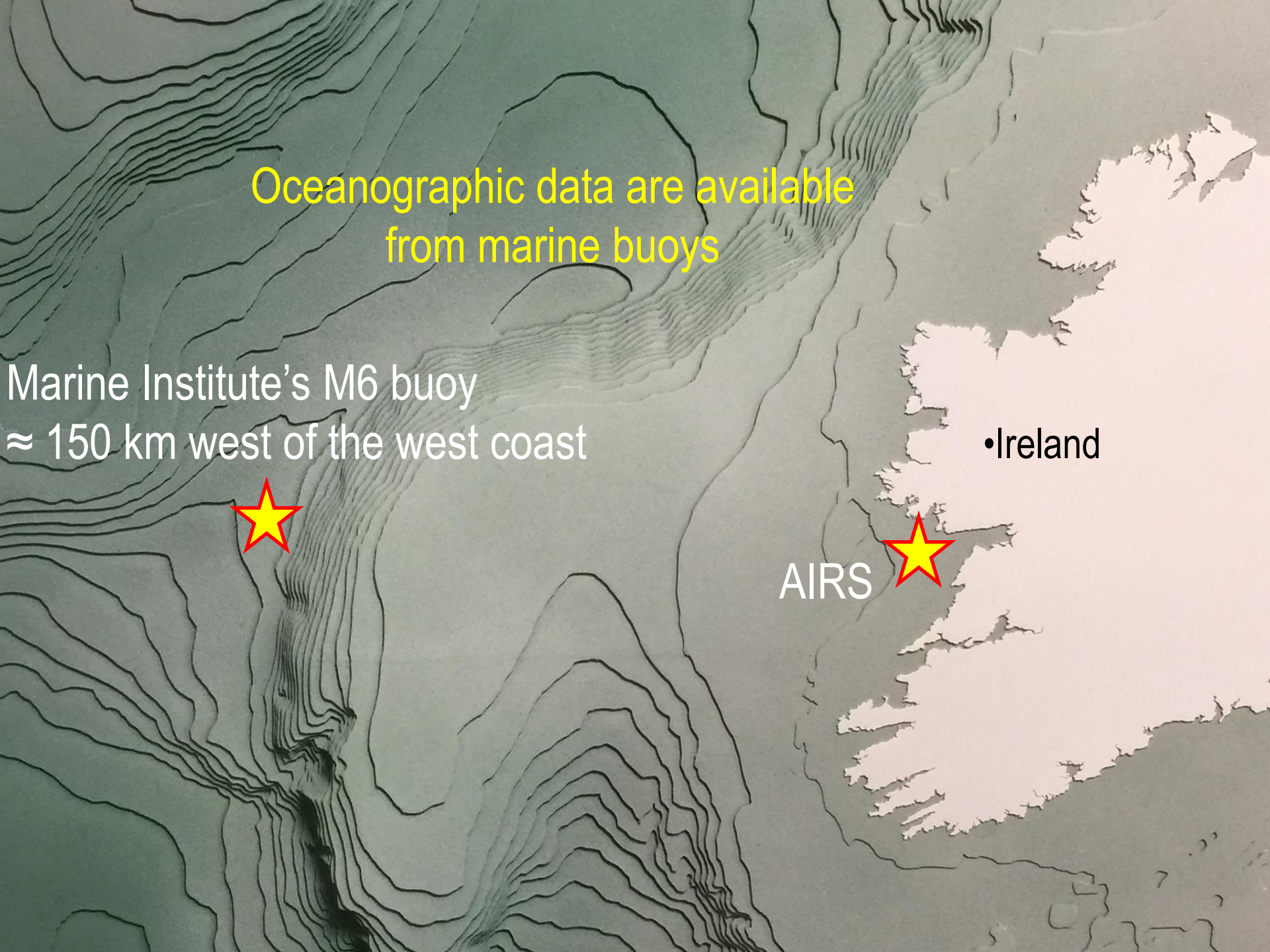
WAVES AROUND INISHMAAN





Synthetic-aperture radar (SAR) image over Inishmaan with long swell on 01 February 2021

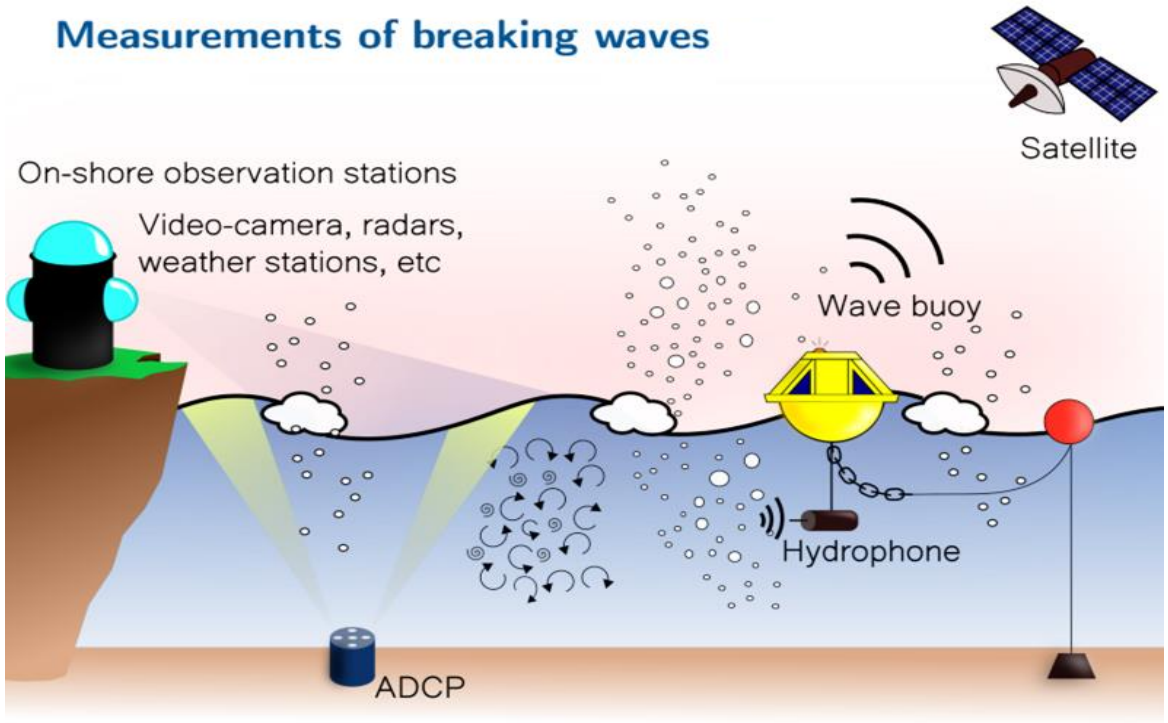
Credit: Fabrice Collard (OceanDataLab)

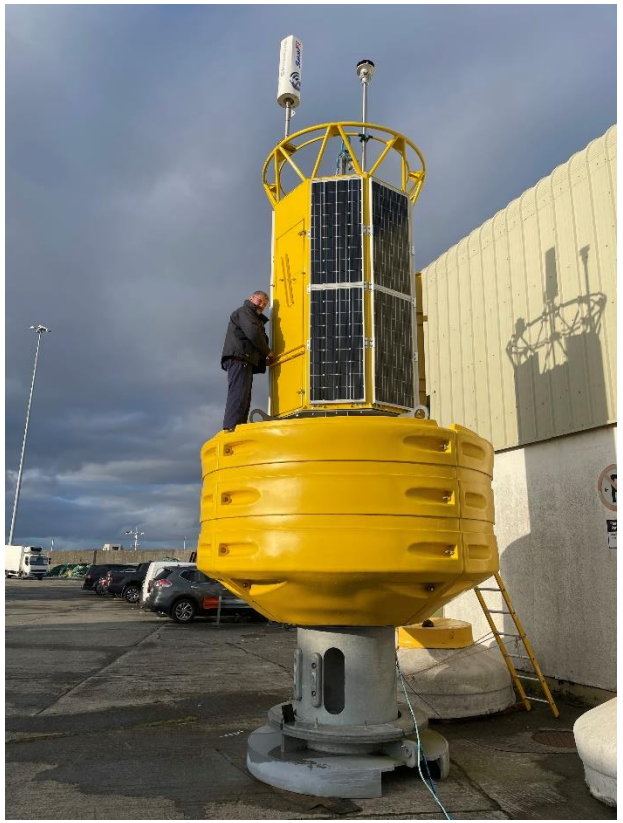

Oceanographic data are available
from marine buoys
Marine Institute's M6 buoy
≈ 150 km west of the west coast
•Ireland
AIRS

HIGHWAVE ON INIS MEÁIN: HIGH RISK

The major technical risks in the project relate to the difficult nature of measurements in the field and to the difficult nature of simulations of detailed breaking processes using a Navier–Stokes solver over a large computational domain.

HIGHWAVE ON INIS MEÁIN





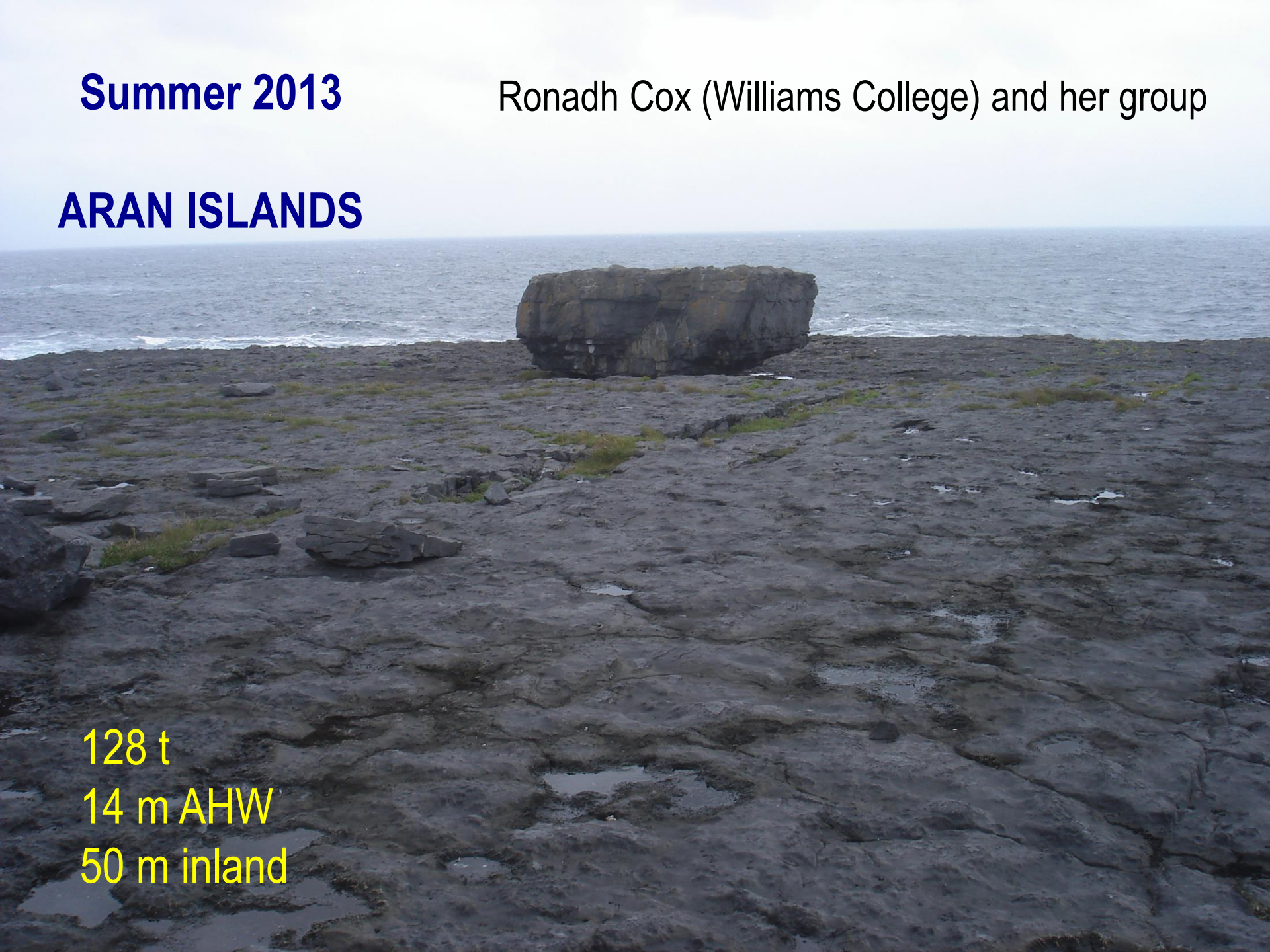
- Wide range of remote sensing equipment for experiments on Inis Meáin
- 2019 – 2023: Building and setup of infrastructure - antennas, mobile research station, portable observation devices (PODs), wind turbines, solar panels, data buoys, ADCP, radar, seismometer, pressure sensor


Aran Islands
Photo by Peter Cox

Summer 2013

Ronadh Cox (Williams College) and her group

ARAN ISLANDS



128 t
14 m AHW
50 m inland


Summer 2014
moved 7.4 m
128 t
14 m AHW
50 m inland

ODYSSEUS AND POLYPHEMUS

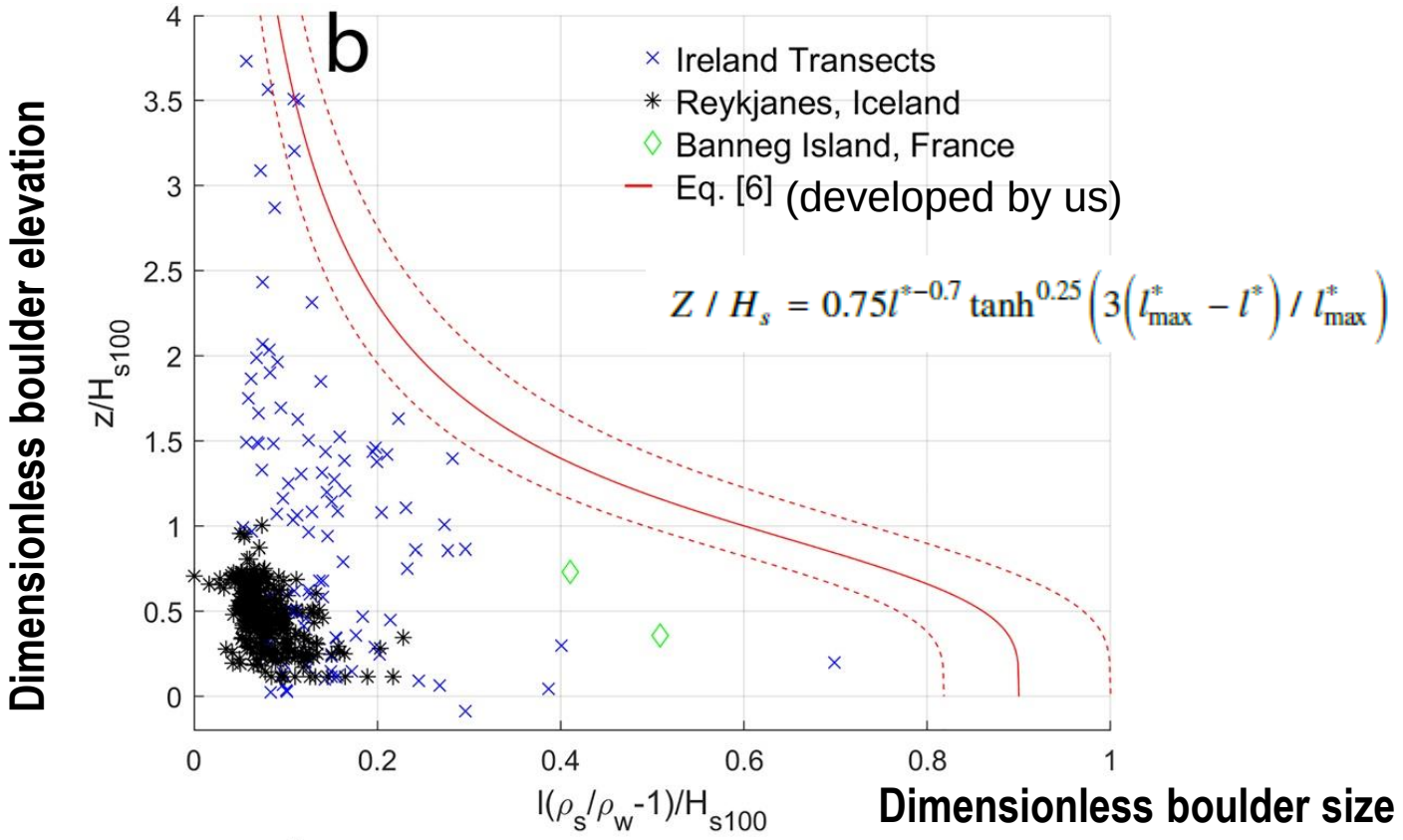
Arnold Böcklin (1896)

Episode from the Odyssey

A blind giant Cyclops, Polyphemus, is preparing to hurl a boulder at the escaping boat of Odysseus and his crew. Odysseus in return is taunting him from the stern of the vessel.

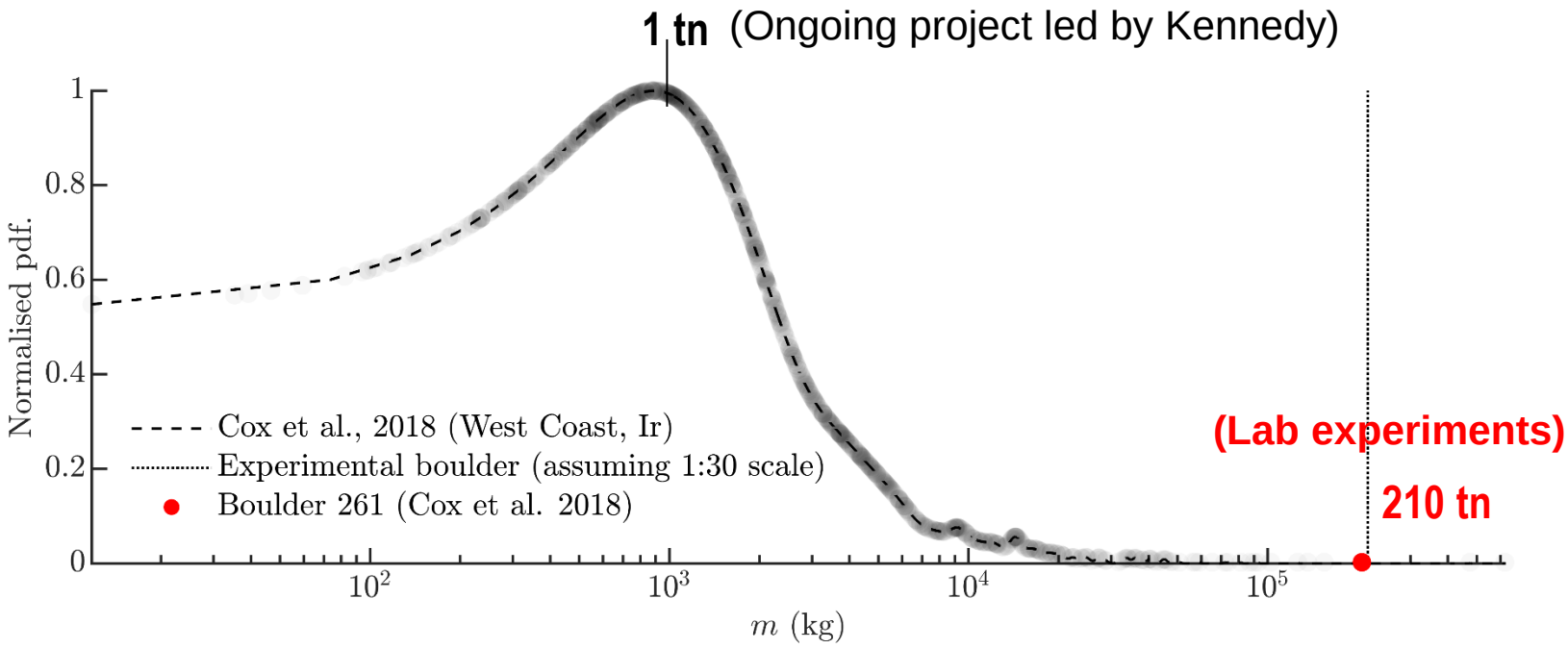
Boston Museum of Fine Arts

DISPLACEMENT OF CLIFFTOP BOULDERS BY WAVES



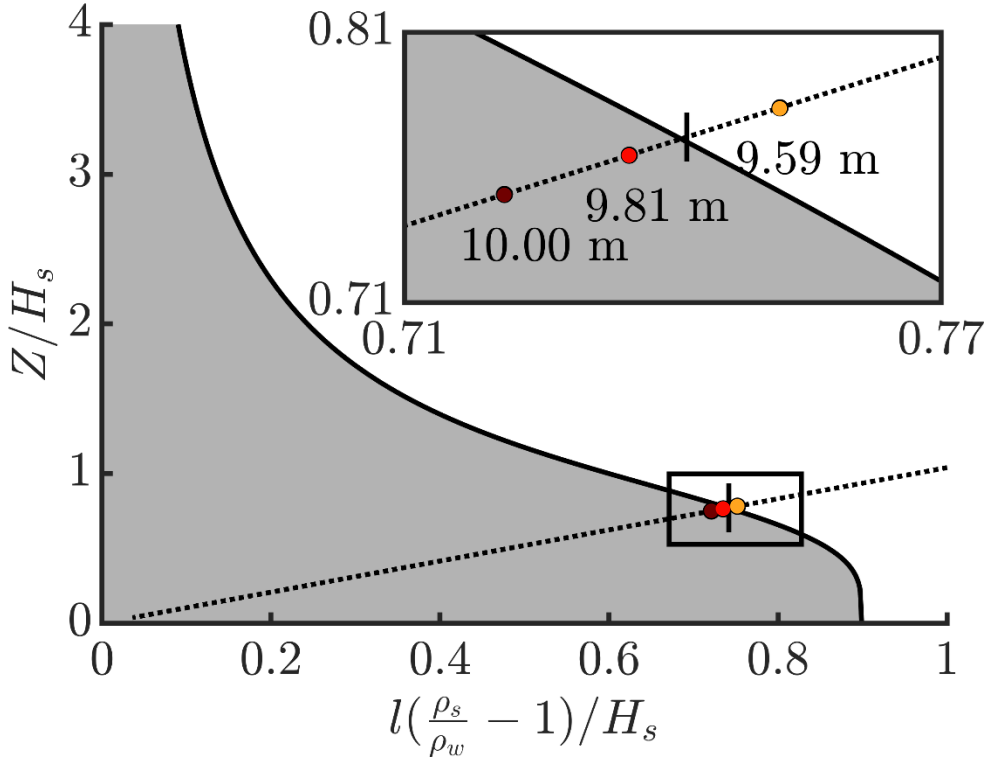
Boulder initiation of motion boundary as presented as part of a boulder displacement meta-study published in Kennedy, Cox & Dias (2021)

DISPLACEMENT OF CLIFFTOP BOULDERS BY WAVES



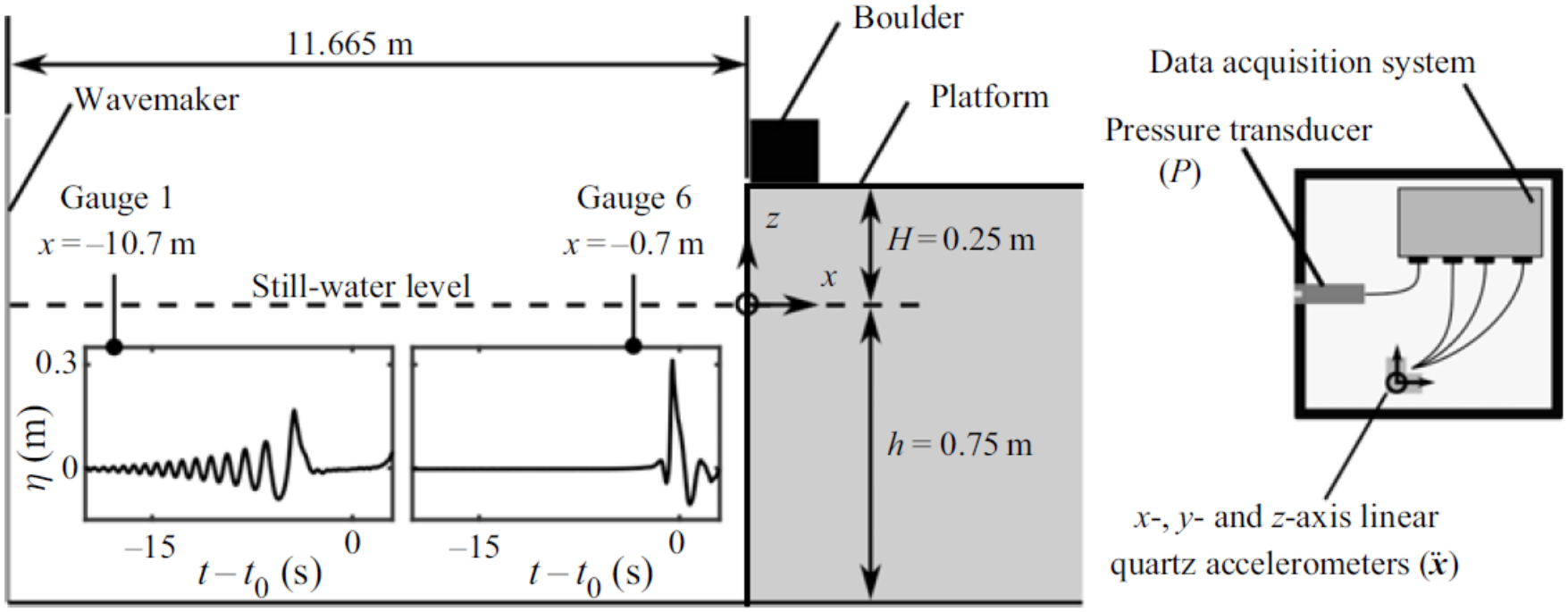
Boulder mass probability distribution (normalised) on the Irish west coast as measured by Cox et al. (2018). The mass of the model boulder, at prototype scale (1:30), is given by the dotted line and boulder 261 is denoted by the red dot.

DISPLACEMENT OF CLIFFTOP BOULDERS BY WAVES – Laboratory experiments (Steer, Kimmoun & Dias 2021)



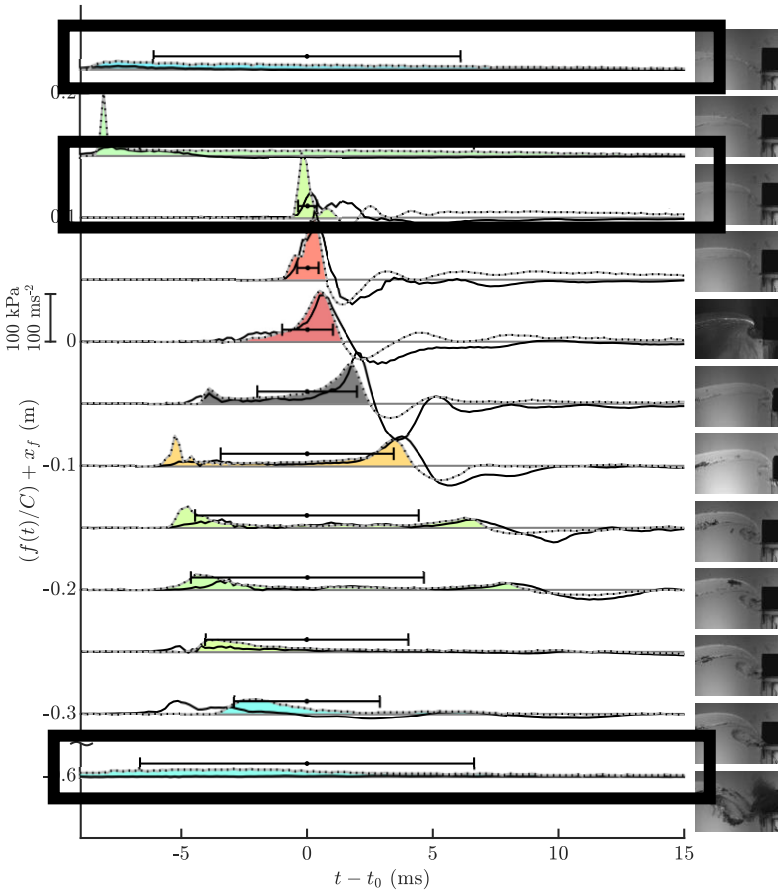
Position of the experimental waves in the initiation of motion space derived by Kennedy, Cox & Dias (2021)

DISPLACEMENT OF CLIFFTOP BOULDERS BY WAVES

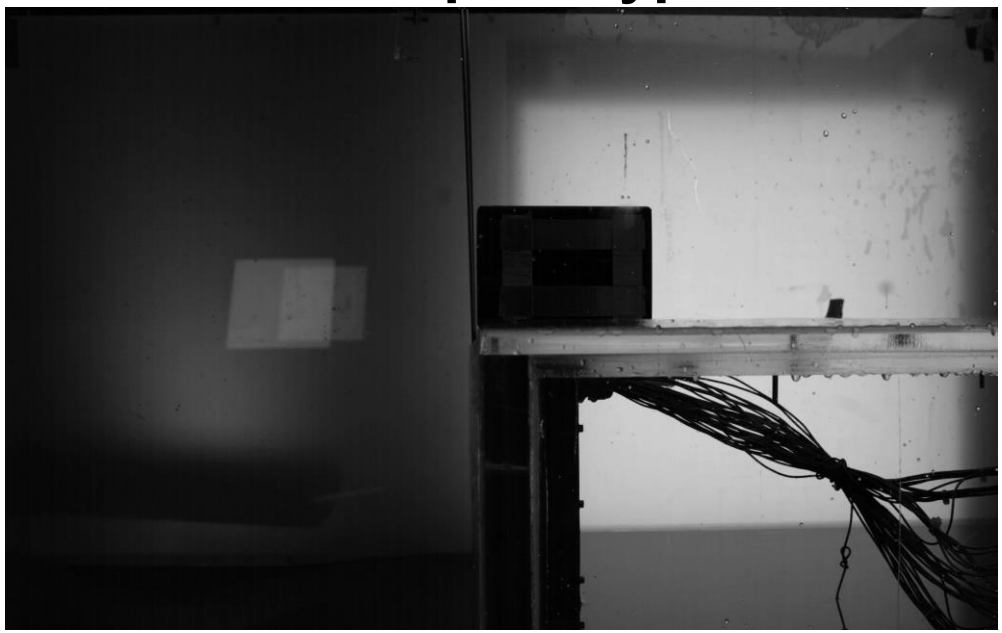


Experimental setup showing the wave flume on the left and the “smart” boulder internal instrumentation on the right *(Ecole Centrale de Marseille)*

LABORATORY EXPERIMENTS



Wave Impact Types



Pressure measured at the boulder front face for increasing wave breaking positions (and, subsequently, different wave breaking types).

WP2 : MAIN CONCLUSIONS

- ❑ Influence of wave-impact mode (aerated, breaking or sloshing) on the displacement of clifftop boulders
- ❑ Largest boulder displacement measured in the breaking range : two strong pressure peaks
- ❑ Smallest boulder displacements recorded in the broken and unbroken ranges
- ❑ Frictional similarity between prototype and laboratory scales?

J. Fluid Mech. (2021), *vol.* 929, R1, doi:10.1017/jfm.2021.841

JFM RAPIDS

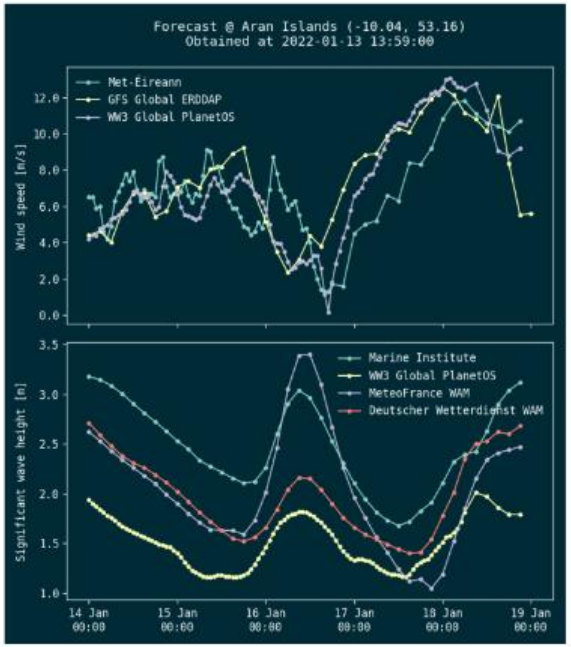
Breaking-wave induced pressure and acceleration on a clifftop boulder

James N. Steer[1],†, O. Kimmoun[2] and F. Dias[1,3]

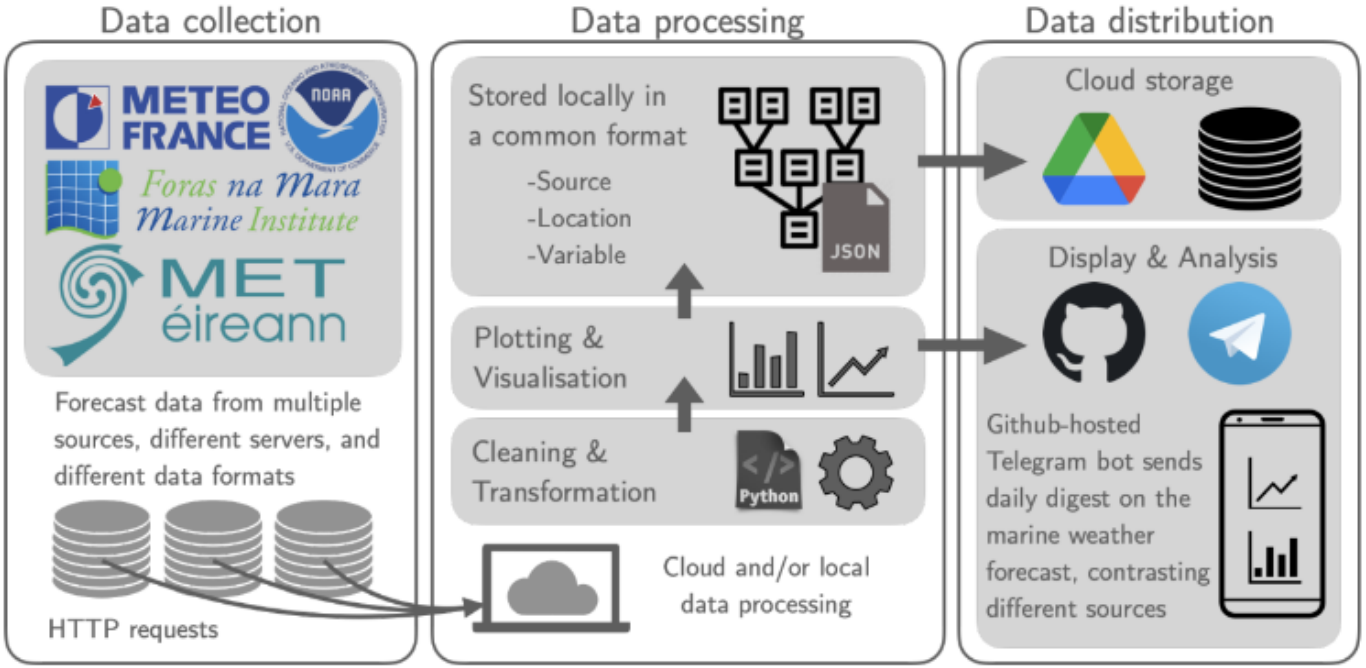
IMPROVING THE SEA STATE FORECASTS BY USING LOCAL WAVE OBSERVATIONS AND THE ENSEMBLE_BMA SOFTWARE

Kokina, Pelaez-Zapata, Murphy & Dias (2023)

ENVIRONMENTAL DATA SCIENCE

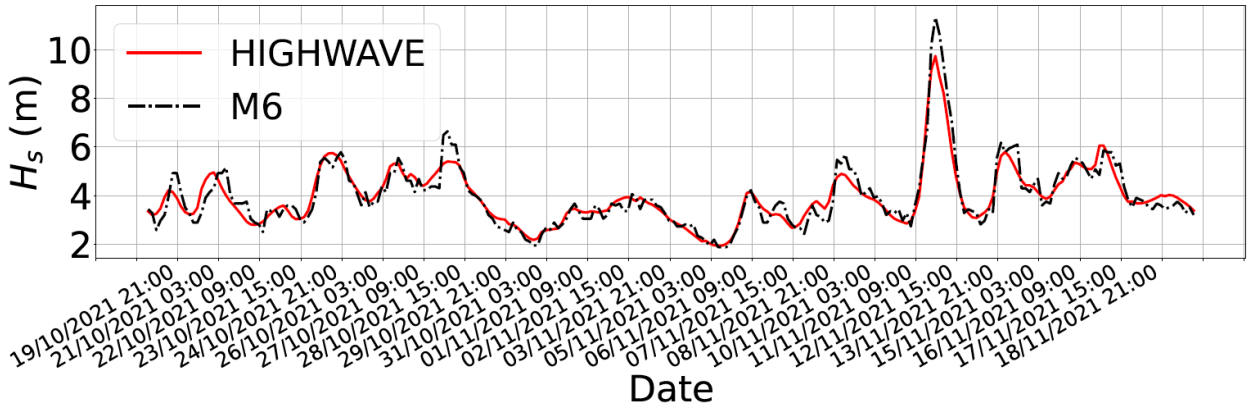


- **Main goal :** to investigate if the combination of publicly available **sea state forecasts can be improved**, on a local scale, using **Bayesian Model Averaging techniques**.
- Percentage change in **the mean absolute error is 6%** at least, and **in some cases 48%**
- Proposed process is **simple and can be carried by anyone** who needs an **accurate sea state forecast**



Wave Obs pipeline

Daily forecast delivered through a Telegram bot



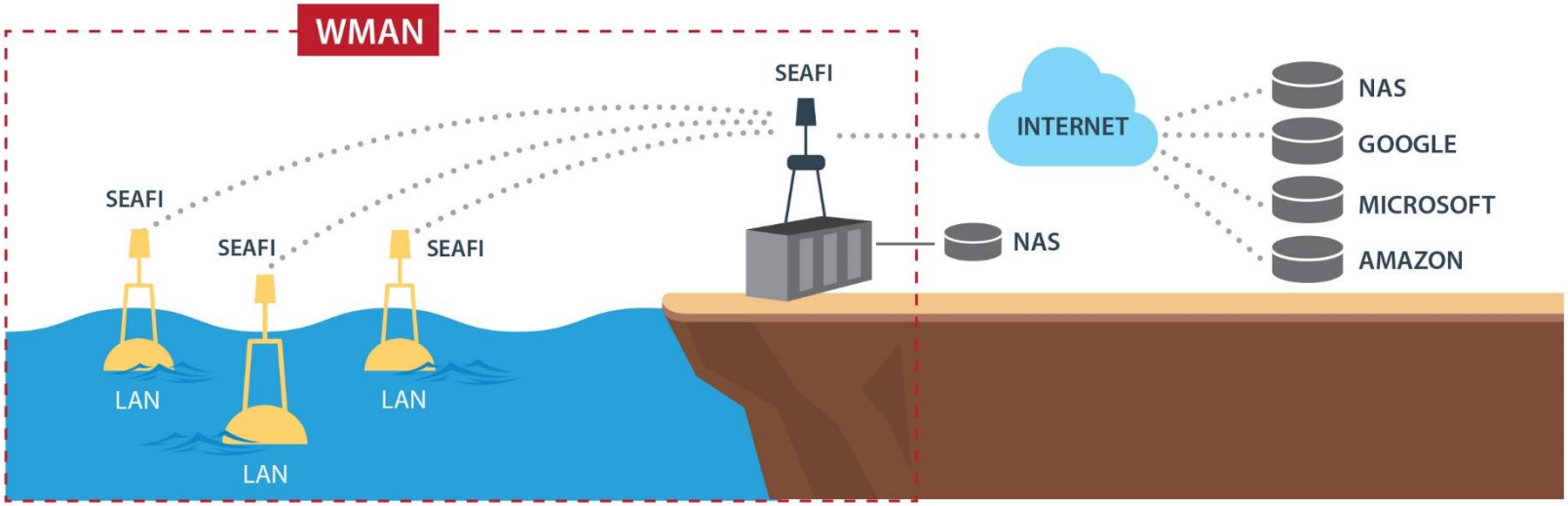
Ensemble forecasts (HIGHWAVE) produced by our procedure **compared to the actual record** from the M6 buoy for the winter period.

ERC PoC REALTIMESEA

- 1st May 2023 – 31st October 2024

- Innovative real-time network

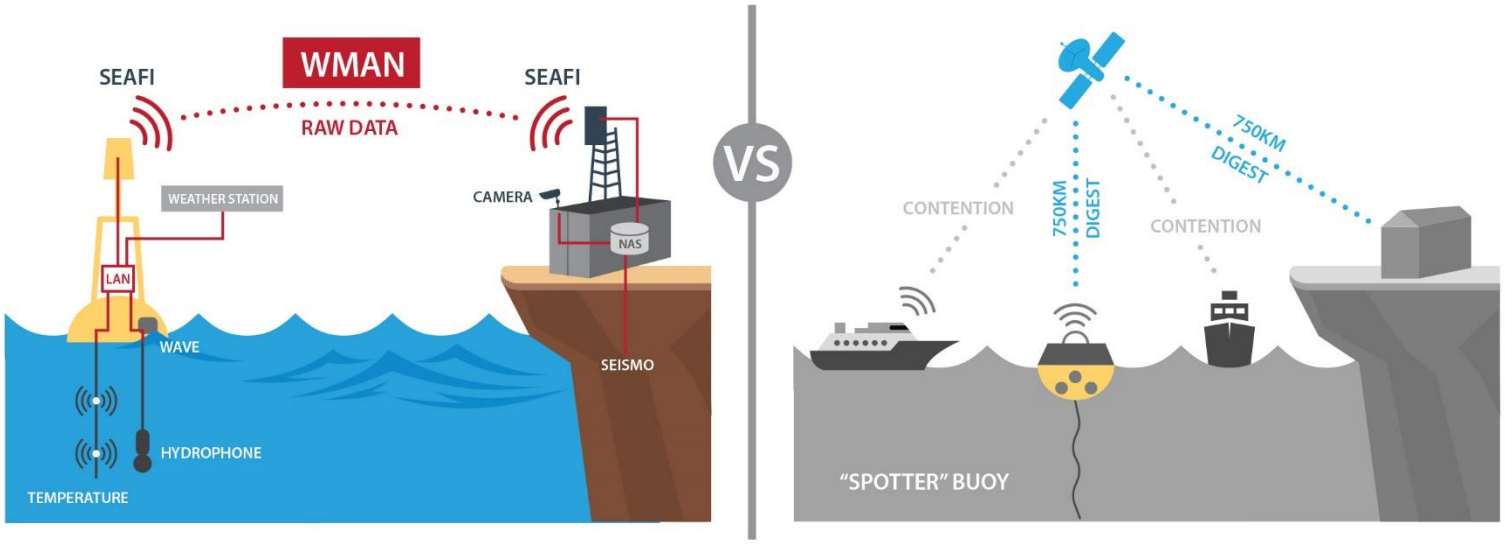
- Data acquired by one or several data buoys and transmitted from the local area network (LAN) to a shore-based Wi-Fi station using the SeaFi communication system (WMAN).



ERC PoC REALTIMESEA

• The Proof of Concept design envisages a wave sensor, a temperature sensor and a weather station deployed on a data buoy at a distance of 10 km from the shore.

• A low-cost “Spotter” buoy will be added to the 12-month experiment. The connected buoy and the “Spotter” buoy will be tested at the HIGHWAVE site in Inishmaan, Ireland.



Aran Islands Research Station

SeaFi Challenge 2023

The furthest maritime broadband transmission without satellite or cellular connection was established in 2018 between Rochespoint lighthouse and the Offshore Supply Vessel Ocean Spey, with 19.4 nautical miles.

Inishmaan: 27 May 2023

Challengers: Prof. Frederic Dias (ENS-PS), Sr Research Engineer Arnaud Disant (UCD), Dr Syed Ahmad Hasan (UCD), Project Engineer Micheal O'Conghaile (Eire Composites), Sr Technician Willy Larsonnier (Addenda-IT), Software Engineer Daniel Pelaez Zappata (ENS-PS), Evidence Management: Tatjana Kokina (UCD) Claire Bergin (UCD), Marie Claye (UCD), Coastal station operators Cedric Larsonnier, Pat Faherty, Public Relation: Salomon Gleeson, Ellie Mai Moloney, Inishmaan community.

Disant A. & Dias F. 2020 Microwave propagation in maritime environments. *Marine Technology Society Journal* 54, 17-24

THANK YOU

Credit : Paul Marshall Doran

Co. Mayo **IRELAND**

www.highwave-project.eu