Besoins en mesures et modélisation des états de mer extrêmes pour le dimensionnement des éoliennes en mer
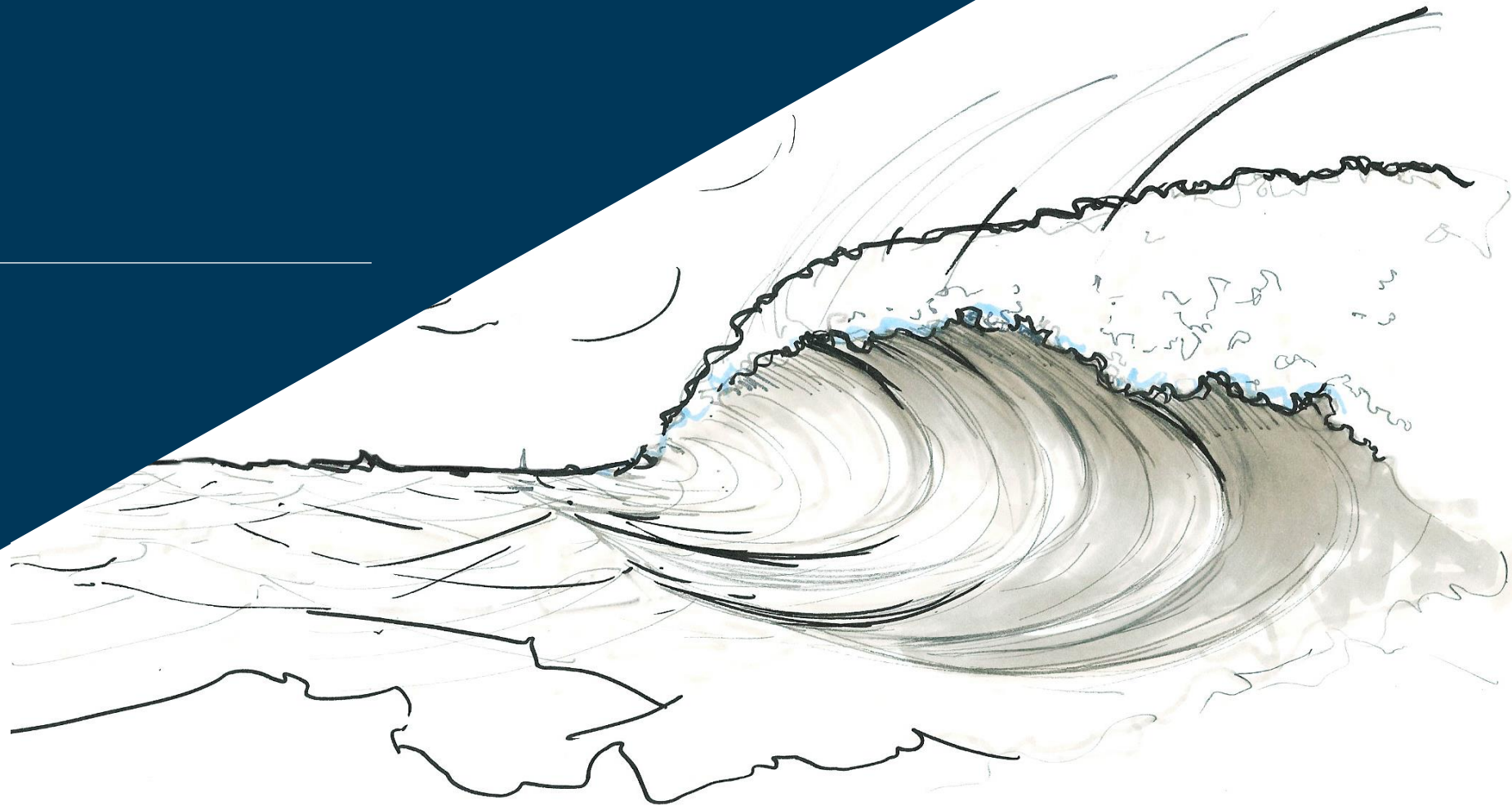
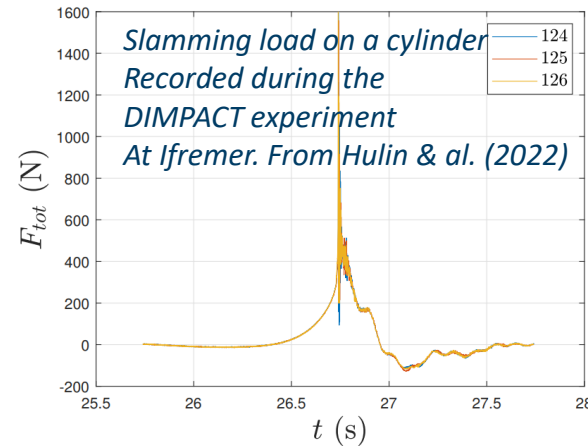Jean-François Filipot (FEM)
Jean.francois.filipot@ite-fem.org

Loads due breaking waves

The « slamming » loads

Slamming loads :

- due to breaking waves

- Severe and impulsive

- Difficult to measure and model

→*Slamming loads are similar to what you experience when:*

1) *you enter water at a beach exposed to breaking waves,*

2) *or during a "belly flop" at the swimming pool*

Slamming load on a cylinder Recorded during the DIMPACT experiment At Ifremer. From Hulin & al. (2022)

Figure: Top panels : A massive wave slamming La Jument lighthouse. Credit : Air, Vide et Eau. Bottom panel : 2 kids experiencing a slamming load

Why do we need to assess them for the design of OWT?

Effects on Offshore Wind Turbines :

- Local structural damage

- Mode excitation of the tower up to the nacelle

- Run-up : water climbing up along the

- foundation (bottom-fixed or spar type floating OWT)

- Green water : submersion of the substructure

Specifity of Floating Offshore Wind Turbines :

- Floater motion (surge)

- Floater-turbine tilt

→ May affect slamming loads

→ Need fully aero-hydro-elastic-servo models

(See Derisk project for slamming loads on bottom-fixed OWT)
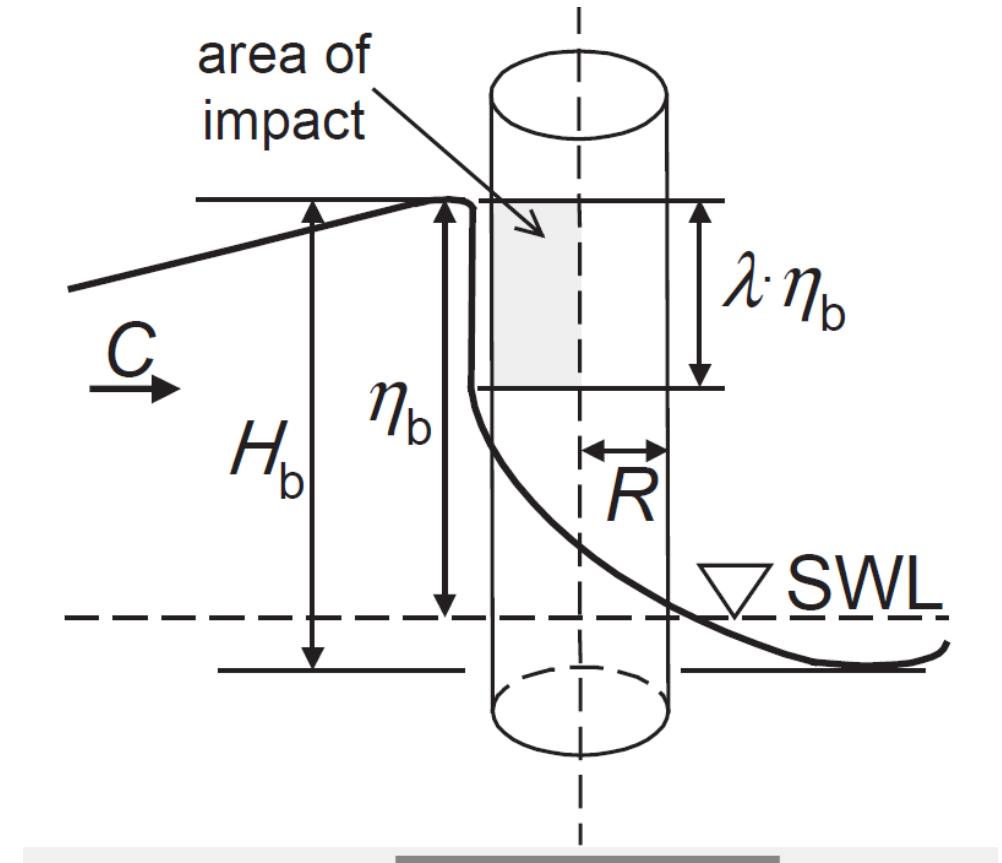

Figure: A breaking wave impacting an OWT on the Horns Reef 1 wind farm, Denmark. From Lykke Andersen et al. [2011].

Need for the design of offshore wind turbines

Need robust statistics on :
- Crest elevation
- Fluid velocity in the crest
- Breaking severity (breaking type)
- Occurrence rate

- In all water depths…
- In the field…

Need for the design of offshore wind turbines

Limitations of buoy measurements

- no valid (enough) breaking criterion from wave buoys

- information in space is needed : shape cannot be derived from

  time series for highly nonlinear waves

- buoys go around large crests?

Kinematics and Statistics of Breaking Waves
Observed Using SWIFT Buoys

Adam Brown, Jim Thomson, Ashley Ellenson, Fadia Ticona Rollano, H. Tuba Özkan-Haller, and Merrick C. Haller

Need for the design of offshore wind turbines

Stereo-Video system :

☺ No-ambiguous breaking occurrence detection

☺ Direct estimation of crest shape

☺ Direct estimation of crest speed

☺ May survive extreme waves

☹ Does not work at night, with rain, sunglit

☹ Heavy data processing

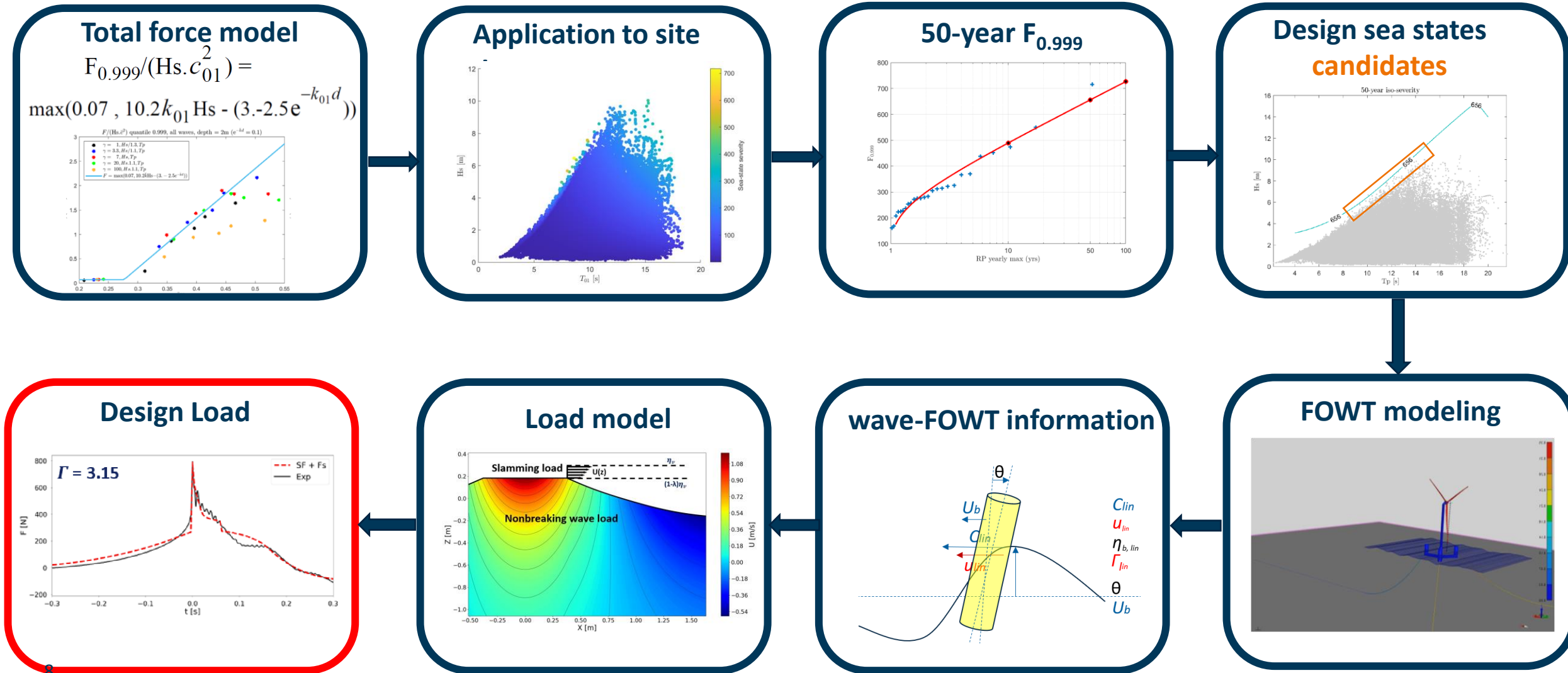→ Good for research dealing with slamming loads (provides the right input)
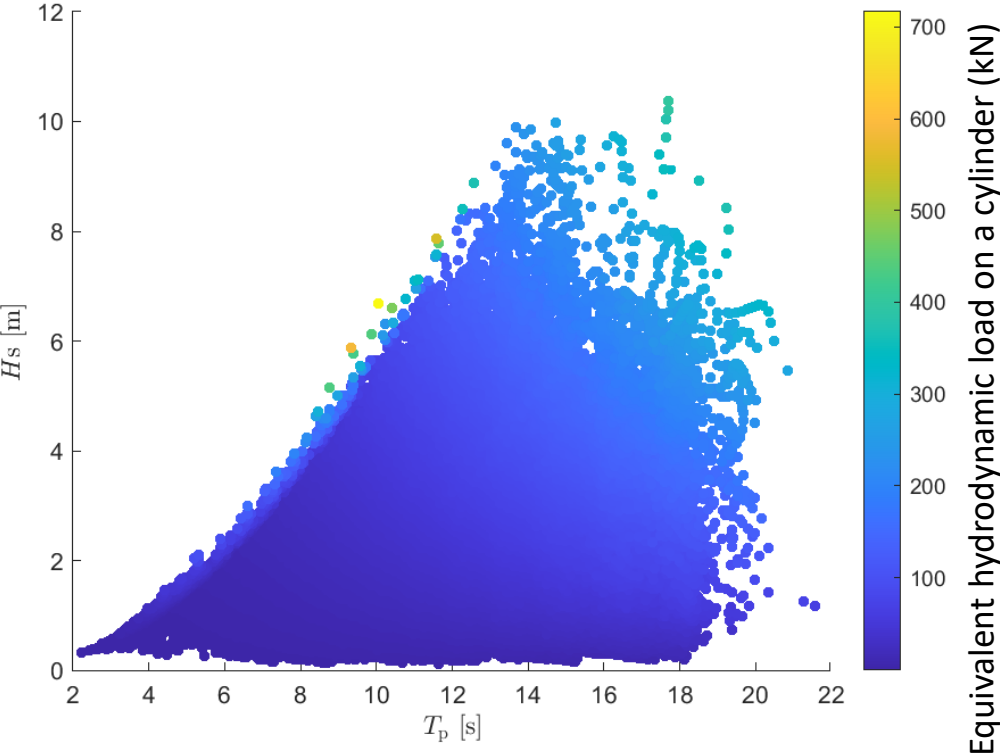→ Bad for generation of robust statistics
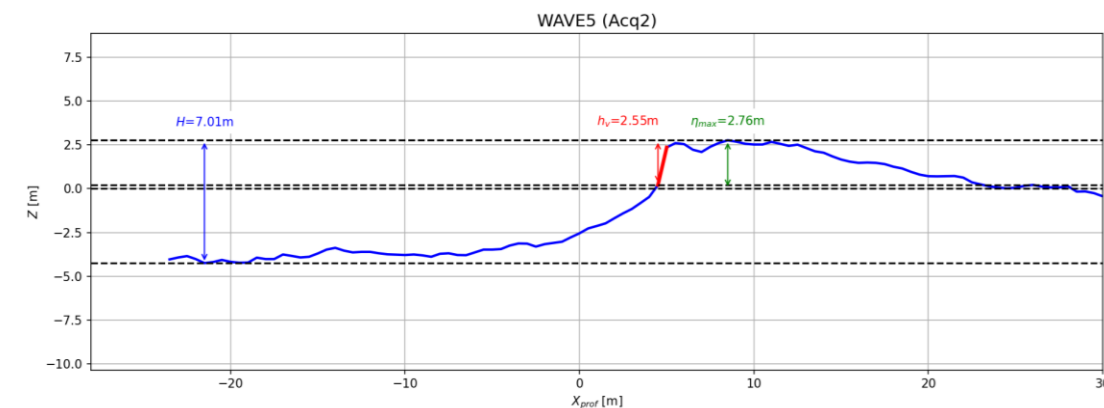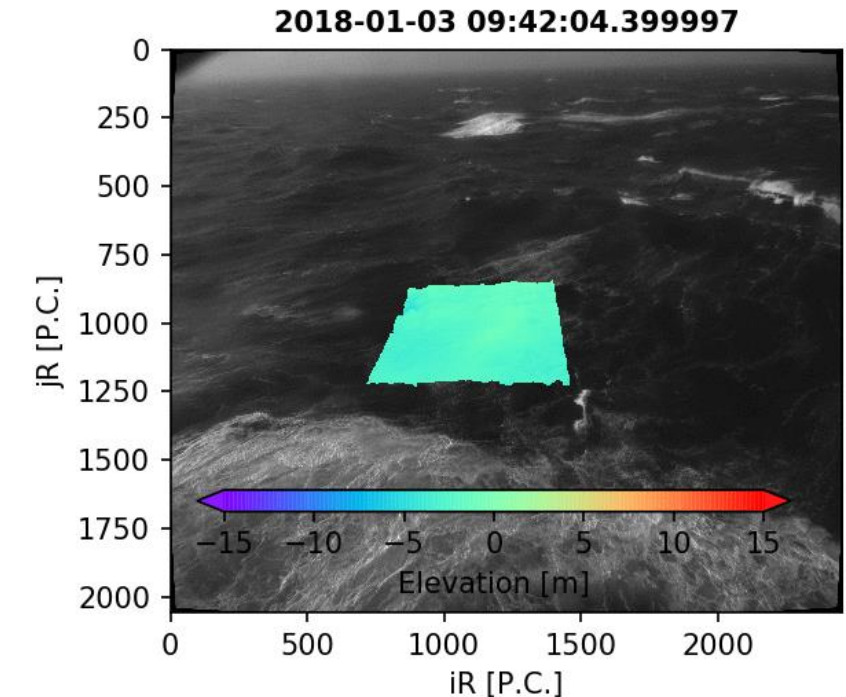
Wave profile, from F. Leckler (FEM)
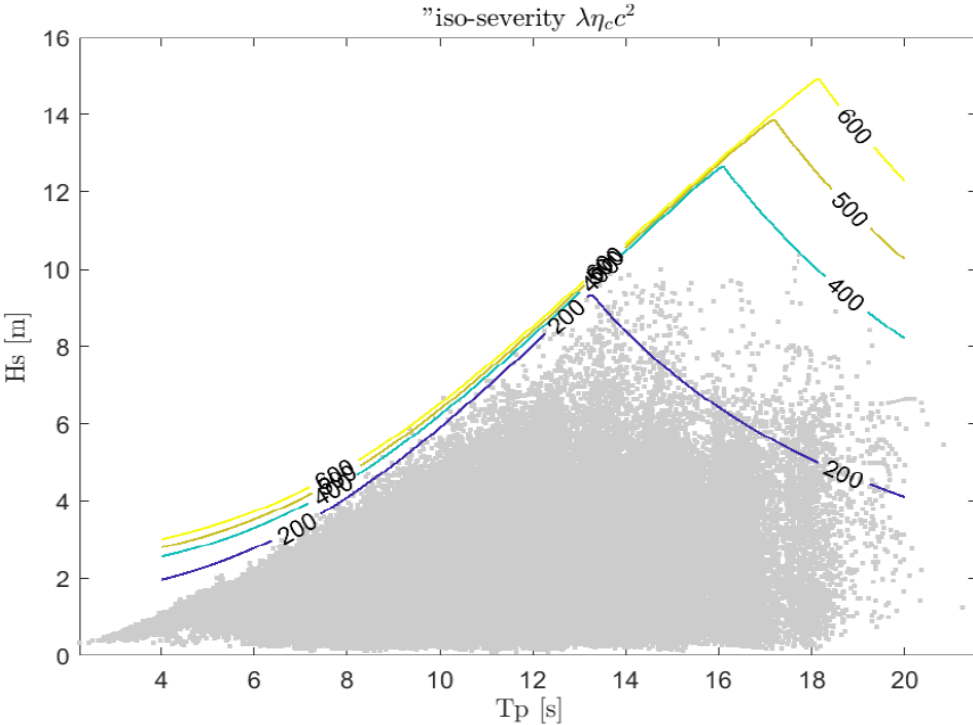
The saturation zone problem

The DIMPACT method for the design of offshore wind turbines
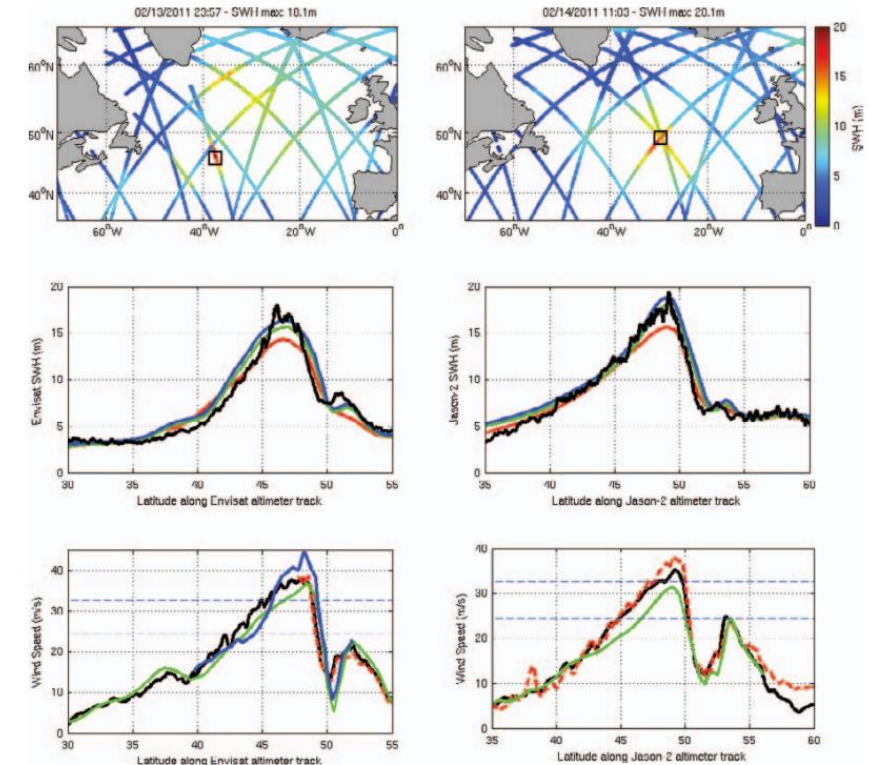
The saturation zone problem

Hs, Tp scatter plot from HOMERE database and equivalent hydro. Load (quantile 0.999) per sea sea state (M. Prevosto)

Iso-contour of the N-Year equivalent loads on a cylinder

The saturation zone problem

- How good are spectral wave models for this wave regime?

- In deep/intermediate and shallow water?

- How accurate are the wave buoys measurements in these conditions?

- Can we rely on other source on information (altimeters, SAR)
To provide Hs and Tp?

From Hanafin et al. (2012)