FACULTY OF ENGINEERING AND ARCHITECTURE

Infragravity Wave Hydrodynamics over a Shallow Sandbank: field observations from the Belgian Nearshore Zone

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4TH INTERNATIONAL WORKSHOP ON WAVES, STORM SURGES, AND COASTAL HAZARDS
Incorporating the 18th International Waves Workshop

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Waterbouwkundig Laboratorium
Vlaanderen is wetenschap
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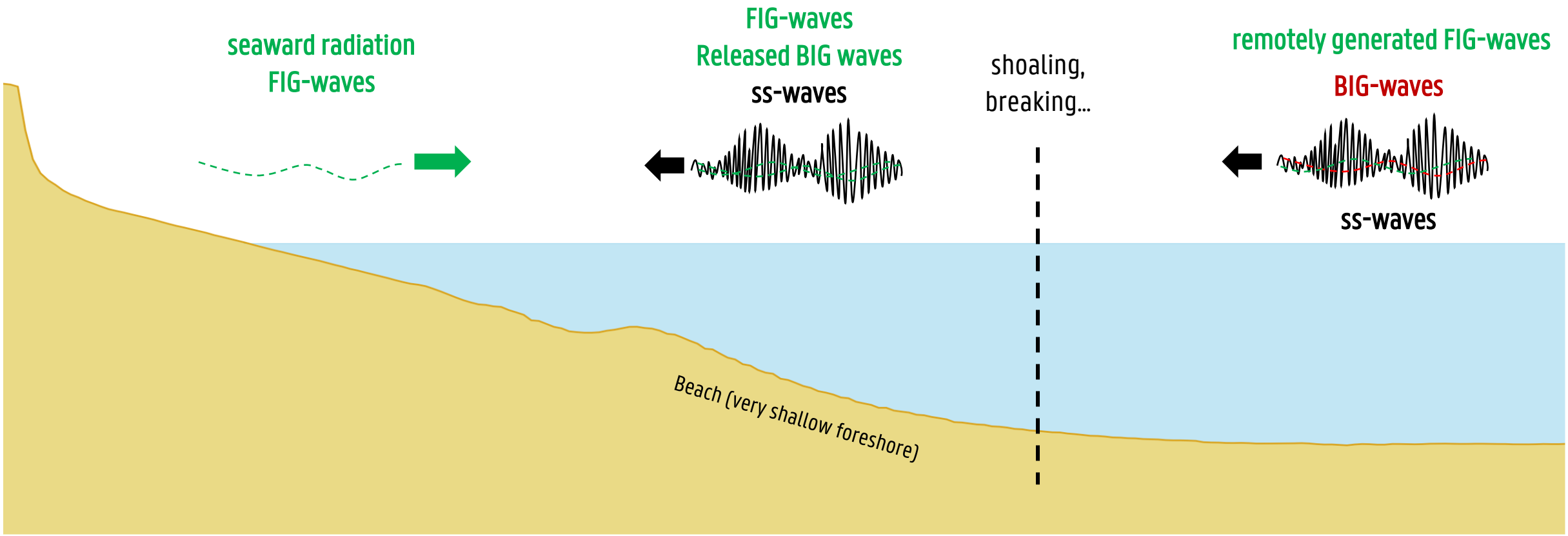
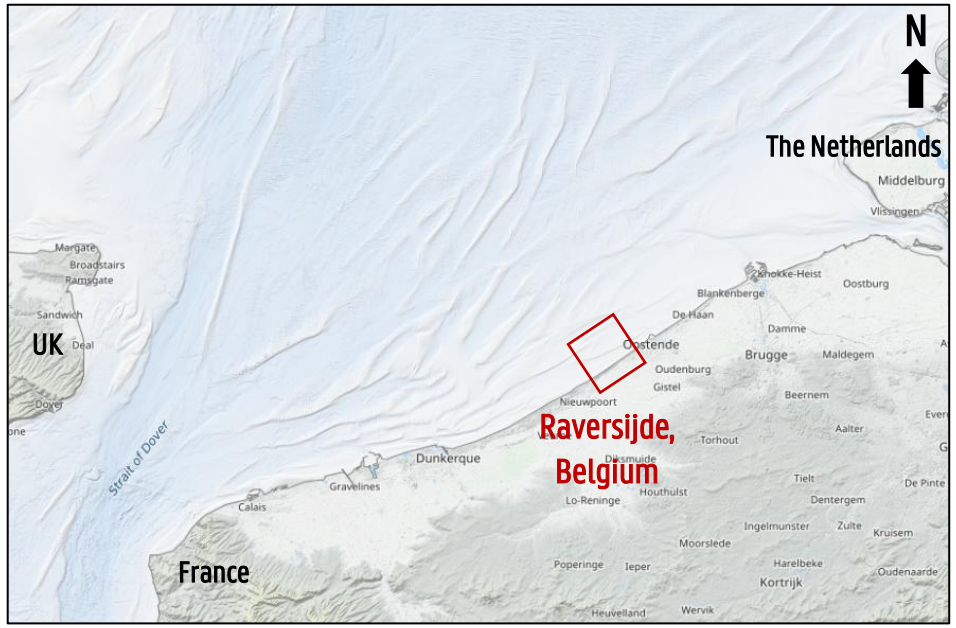
Introduction: IG-waves

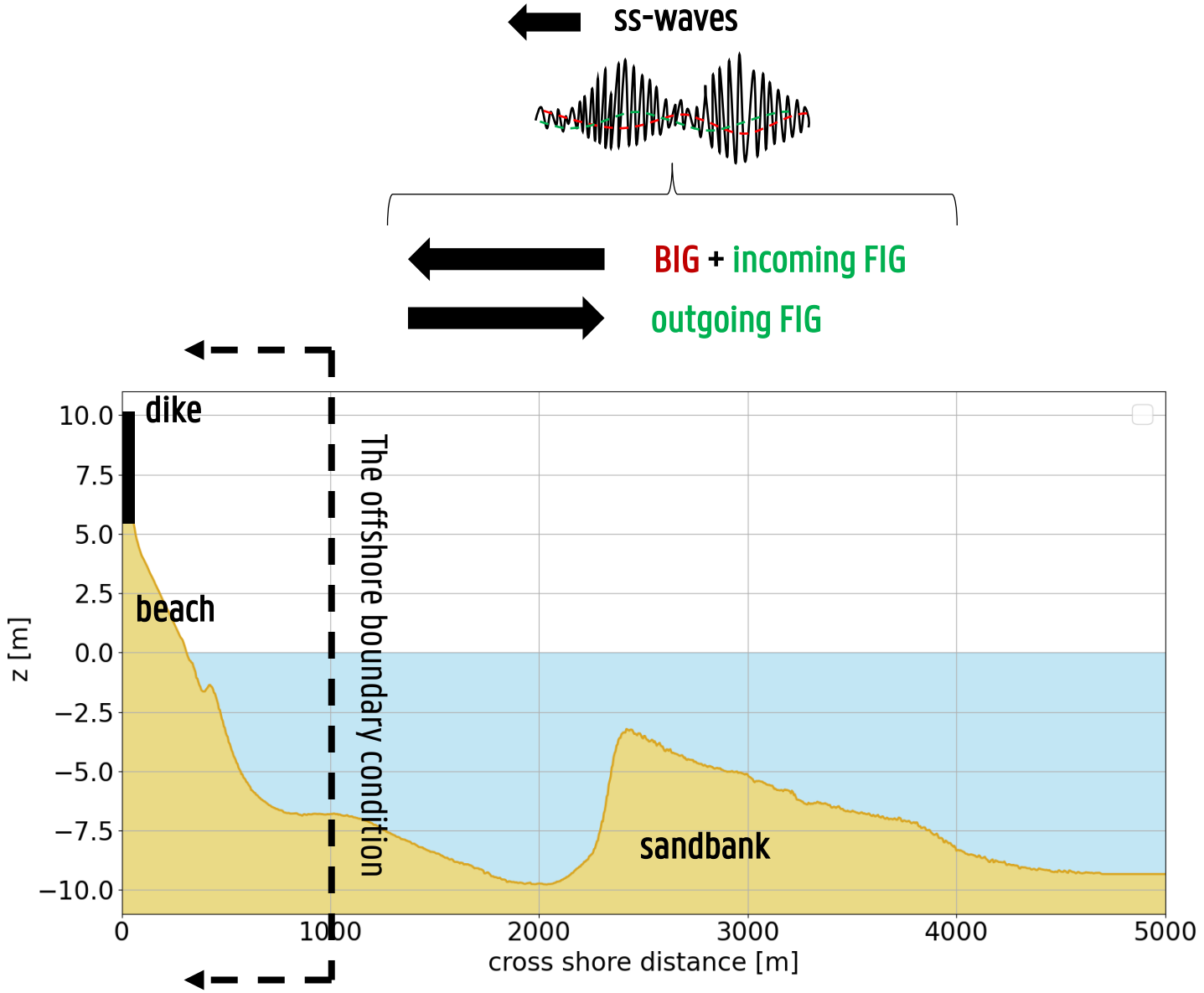
- IG-waves are low-frequency ocean waves, typically with T > 20 s.
- They are small in deep water but become larger close to the coast.
- Observations show that FIG gain importance during storm conditions.



Introduction: Belgian sandbanks



Objective: To define an offshore boundary condition for coastal safety assessments that accounts for the incoming IG waves (FIG and BIG).



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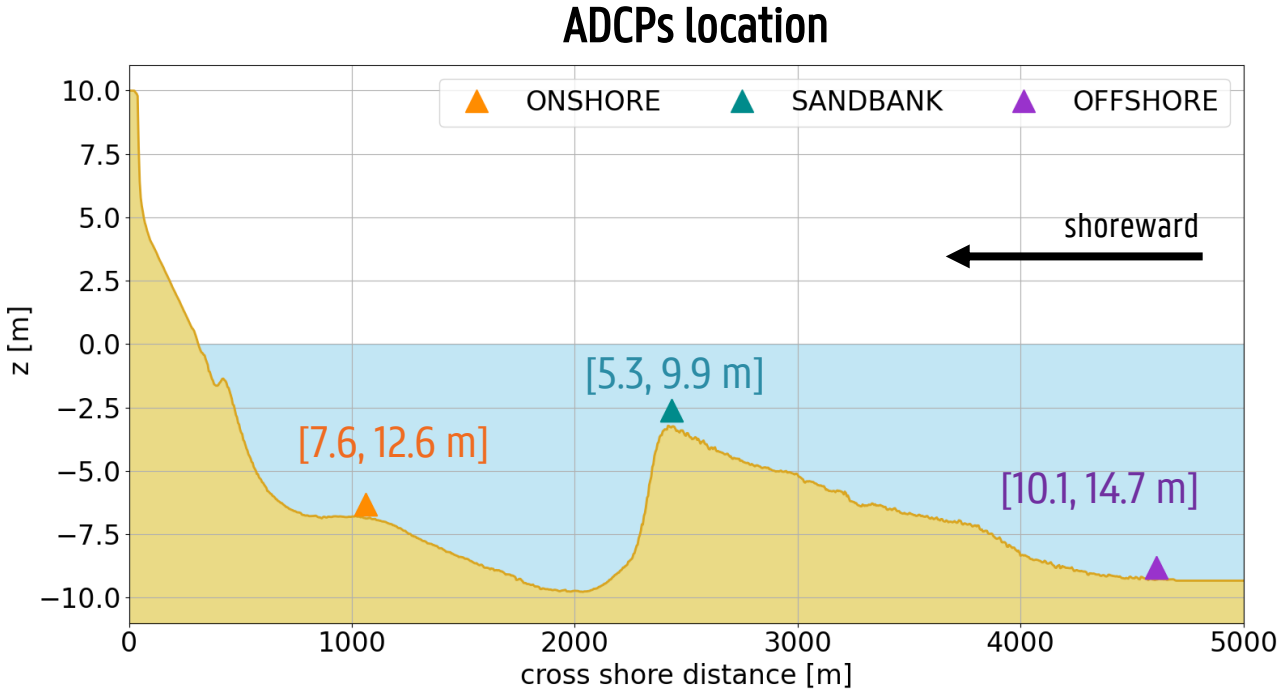
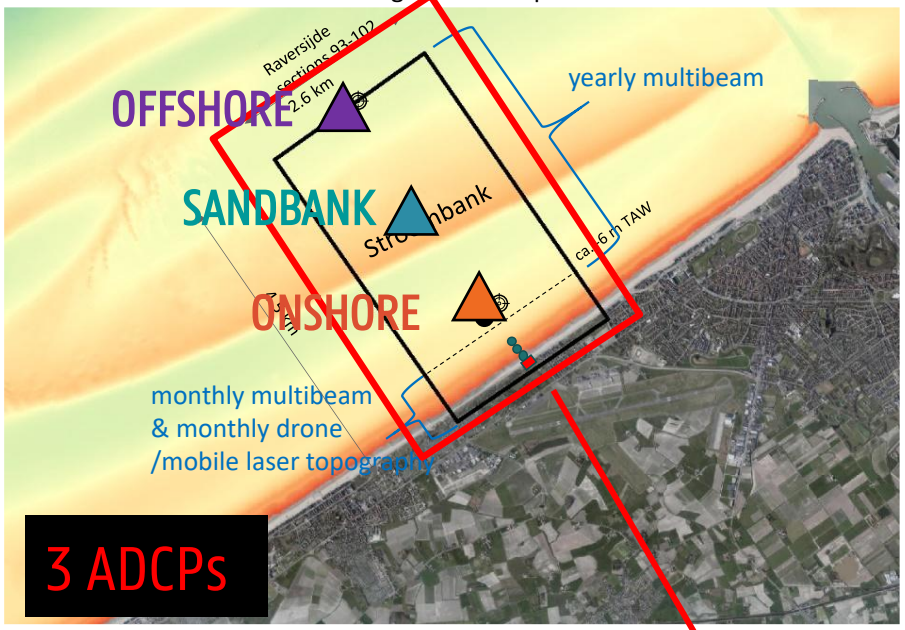
Observations: Living Lab



Vlaamse Banken – monitoring for coastal protection 2021-2030



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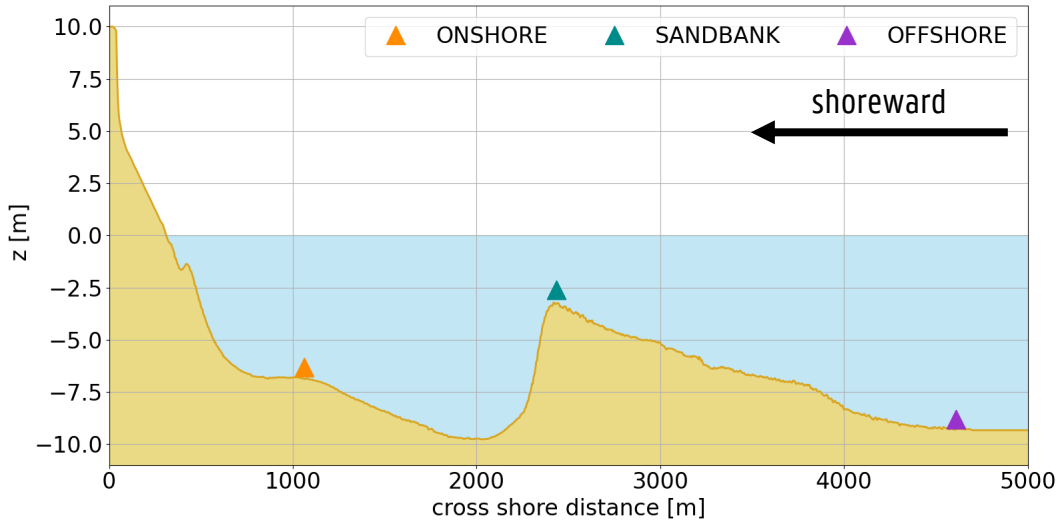
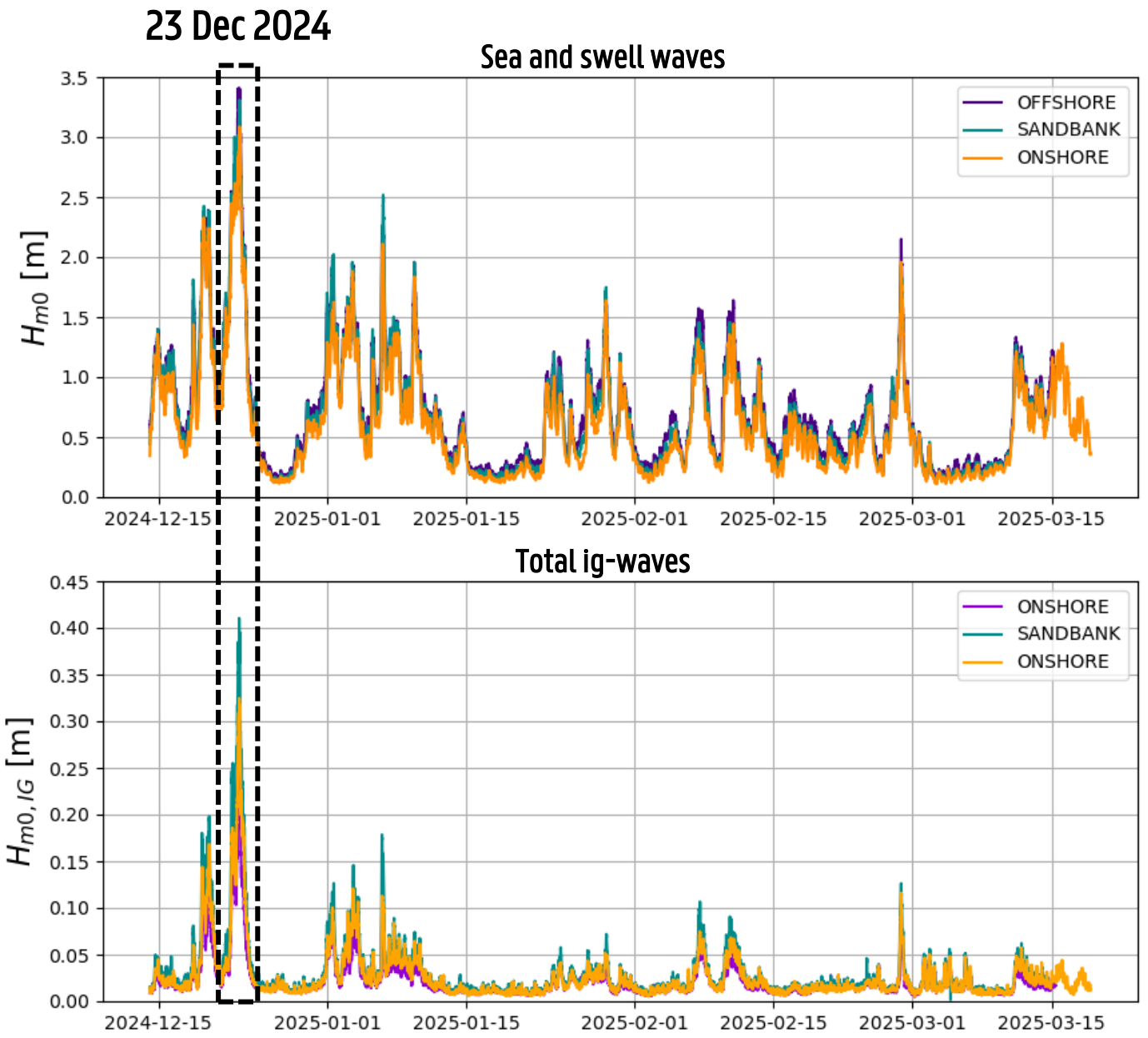
- bottom frame with ADCP and pressure sensor
- wave buoy
- intertidal poles (current meter, pressure sensor, ASM bed level)
- artificial dike

Observations: Living Lab



- Data since winter 2022-2023
- **23 Dec 2024 storm** registered high overtopping volumes at the Research Dike.



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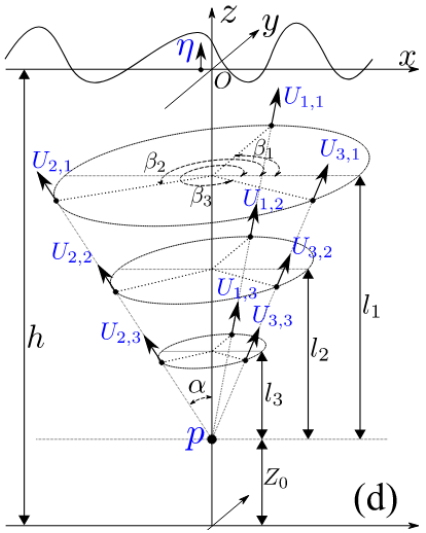
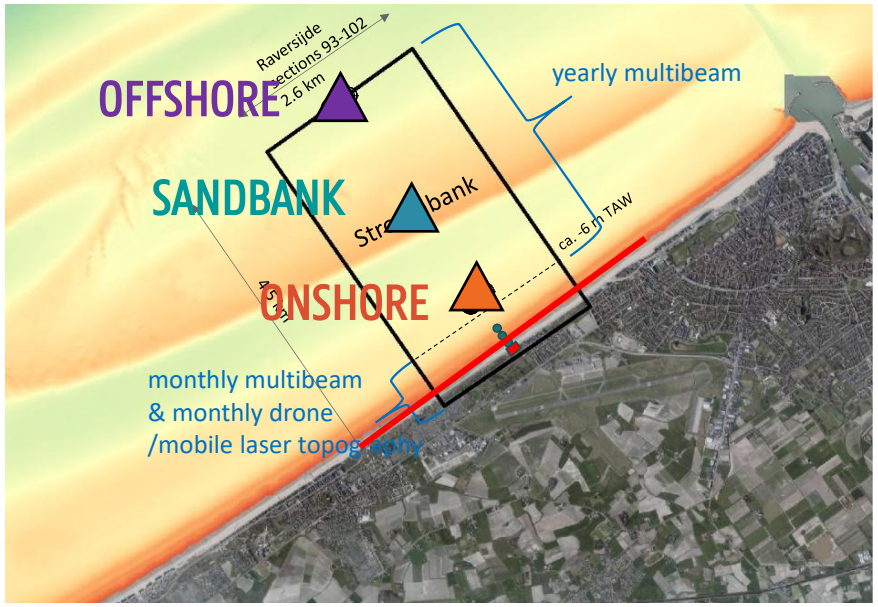
Methodology

- Reconstruction of FIG and BIG based on (Matsuba et al., 2022)
- It considers differences between FIG and BIG based on the weakly nonlinear wave theory.



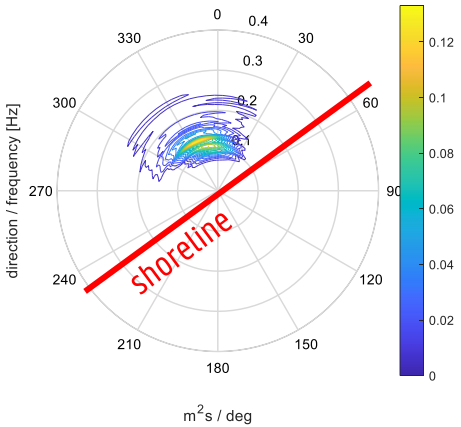
Observations by Doppler directional wave profiler (Matsuba et al., 2022)

Vlaamse Banken – monitoring for coastal protection 2021-2030

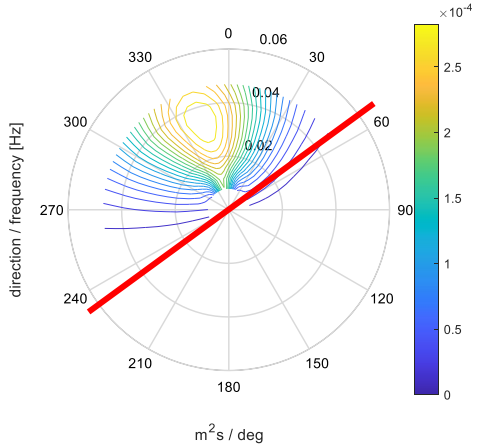


ONSHORE: Example of sea state in the peak of the storm 23 Dec 2024 (high tide)

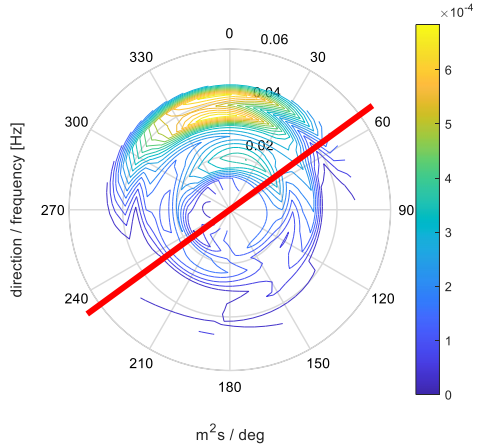
Sea-swell



Bound IG



Free IG



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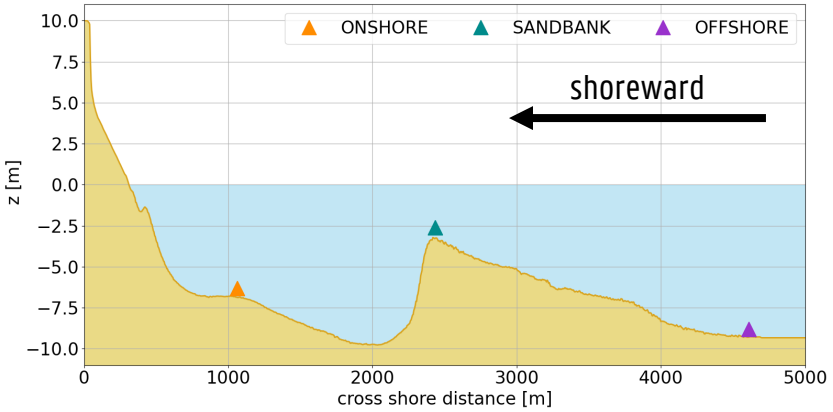
Results: evolution of incoming Free IG

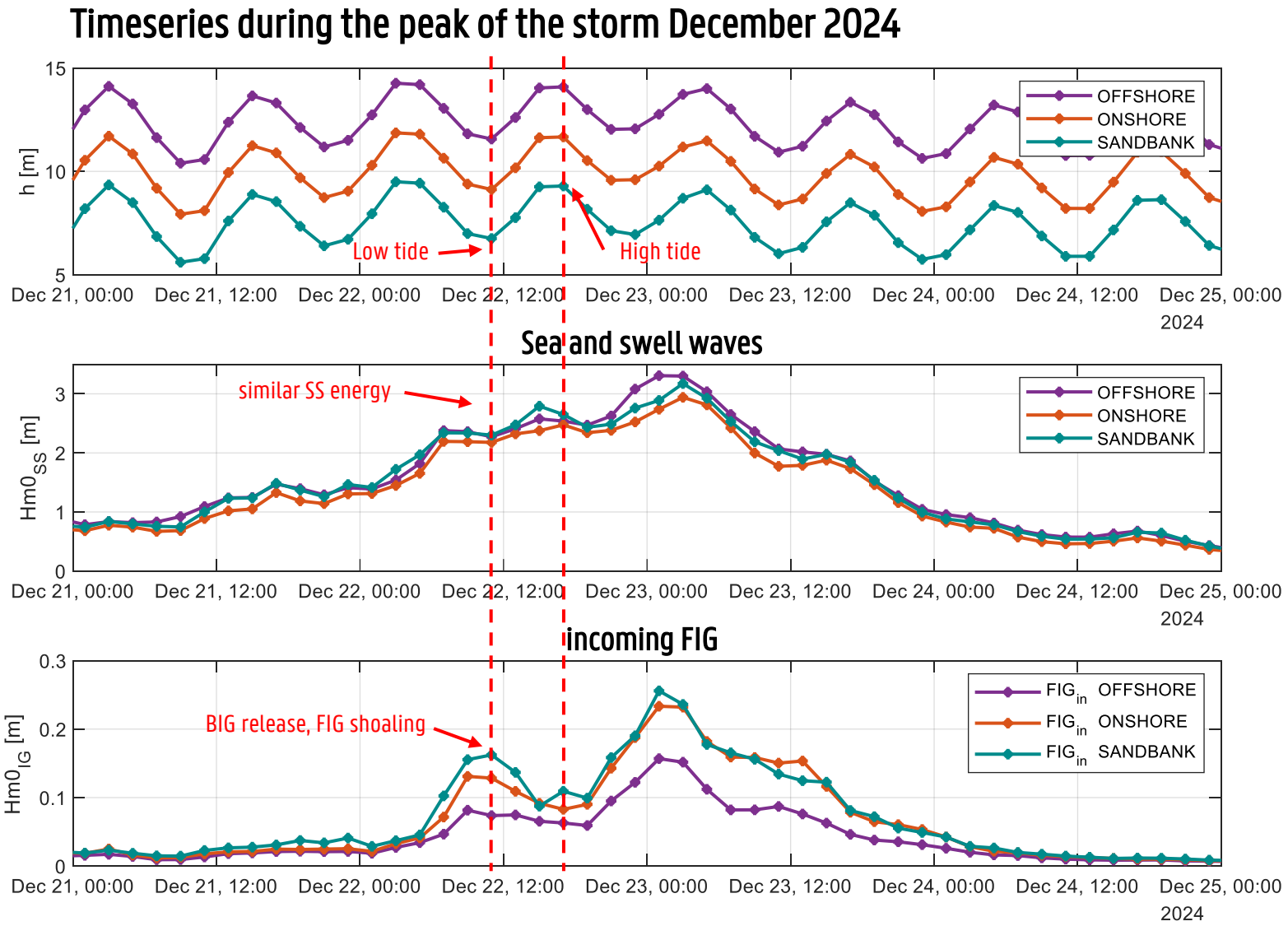
From **OFFSHORE** to **SANDBANK**

- Shoaling and SS breaking → ↑FIG

SANDBANK → **ONSHORE**

- deshoaling → ↓FIG
- SS breaking and FIG released → ↑FIG





Results: incoming Free IG

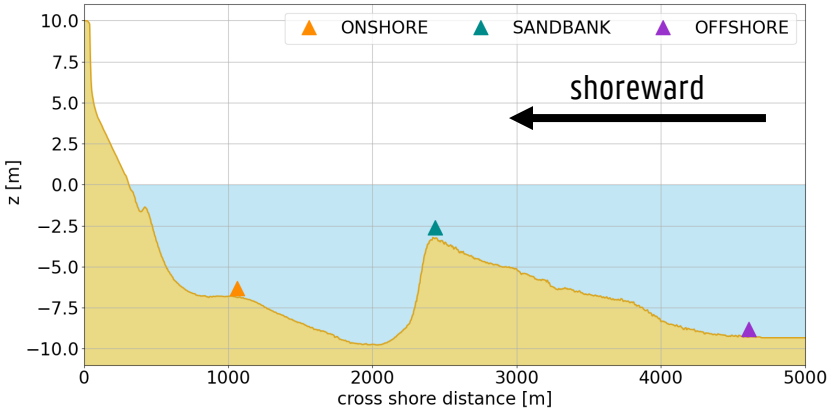
- Each point corresponds to a measured sea state with $Hm0_{SS}$ > 1.50 m.
- Incident FIG increases with offshore SS energy.
- From **OFFSHORE** to **SANDBANK**

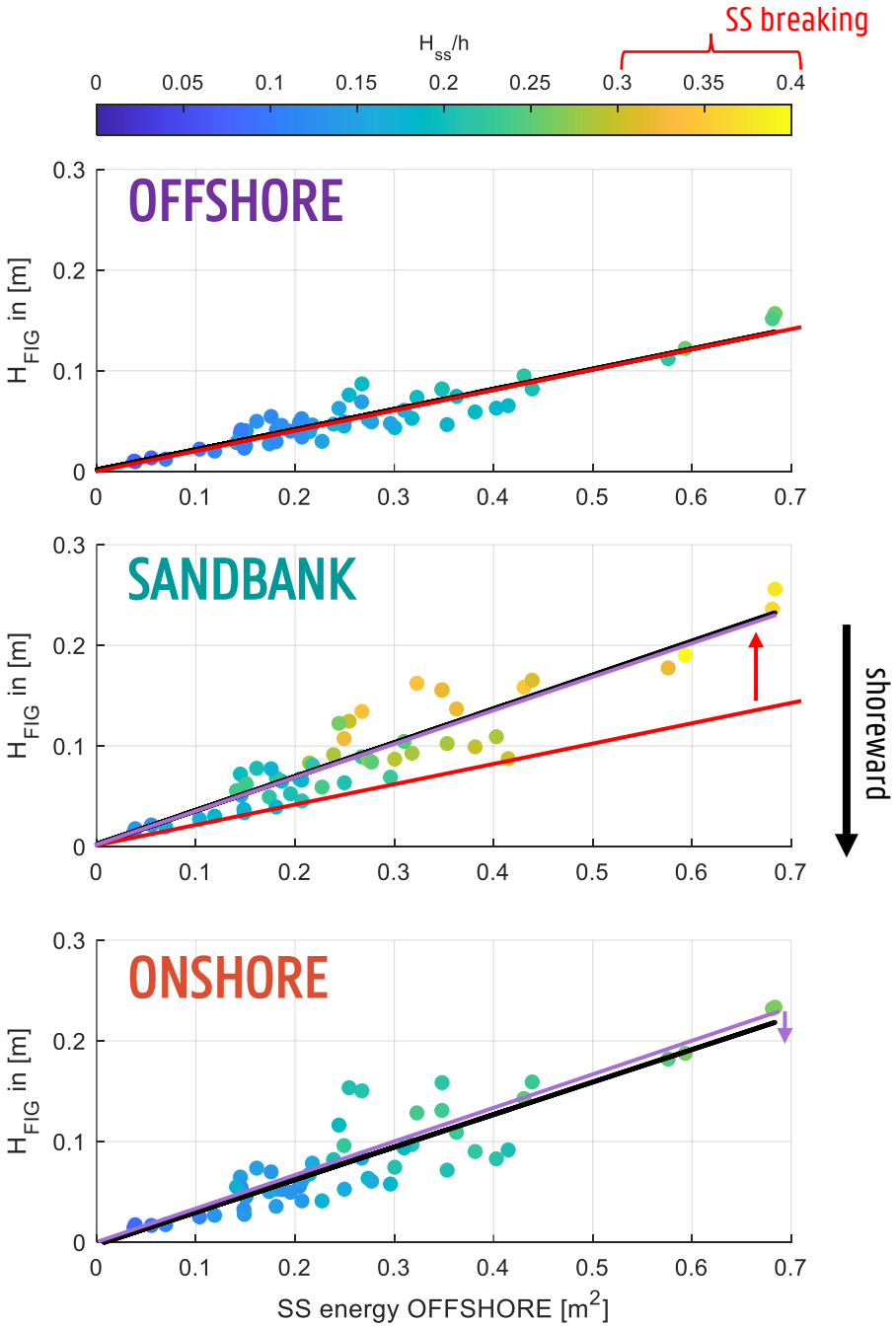
→ shoaling and SS breaking

- From **SANDBANK** to **ONSHORE**

→ deshoaling

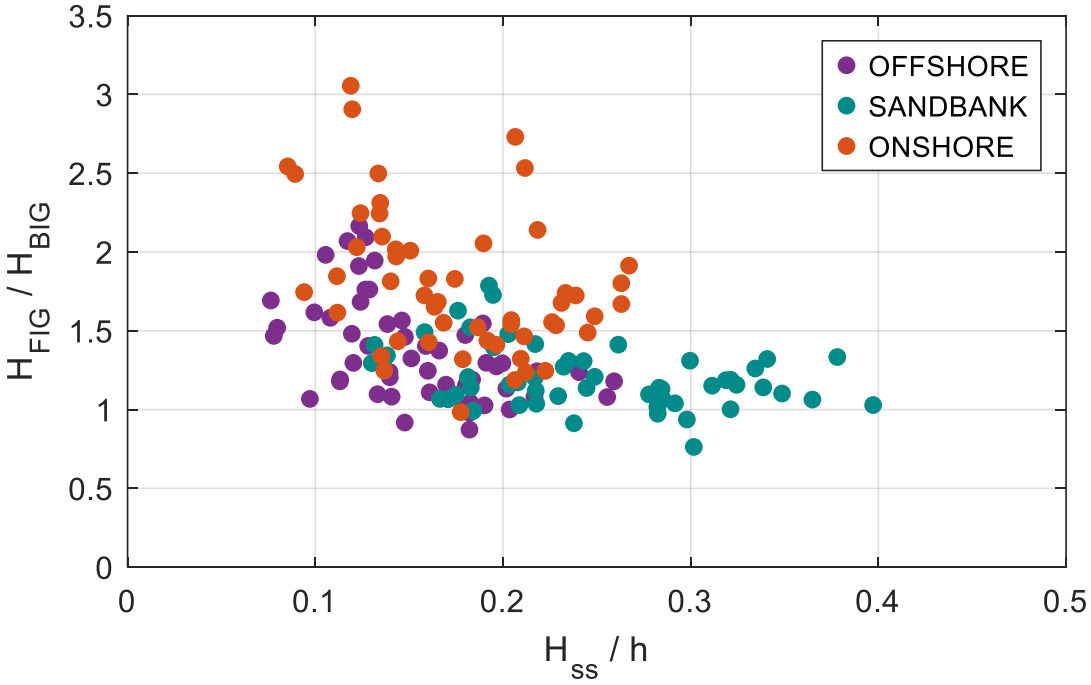
→ less SS breaking (yellow dots)

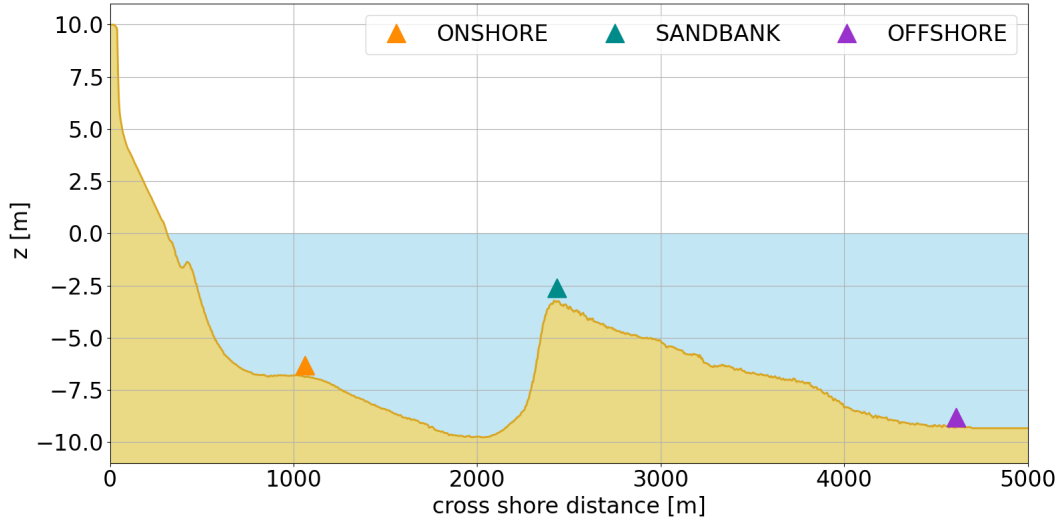




BIG vs. incoming FIG

- Each point corresponds to a measured sea state with Hm0 SS > 1.50 m.
- In ONSHORE incident FIG is on average 180% greater than BIG.
- While 120% in SANDBANK → ss waves breaking
- In OFFSHORE 137%





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Conclusions

- Directional spectra of SS, BIG and FIG have been reconstructed based on ADCP field measurements in intermediate water.
- Field observations have demonstrated that FIG_{in} is 180% greater than BIG during storm conditions in the **ONSHORE** location (the offshore boundary condition).
- Therefore, FIG waves should be investigated as boundary conditions to determine the effect of their inclusion on overtopping predictions.

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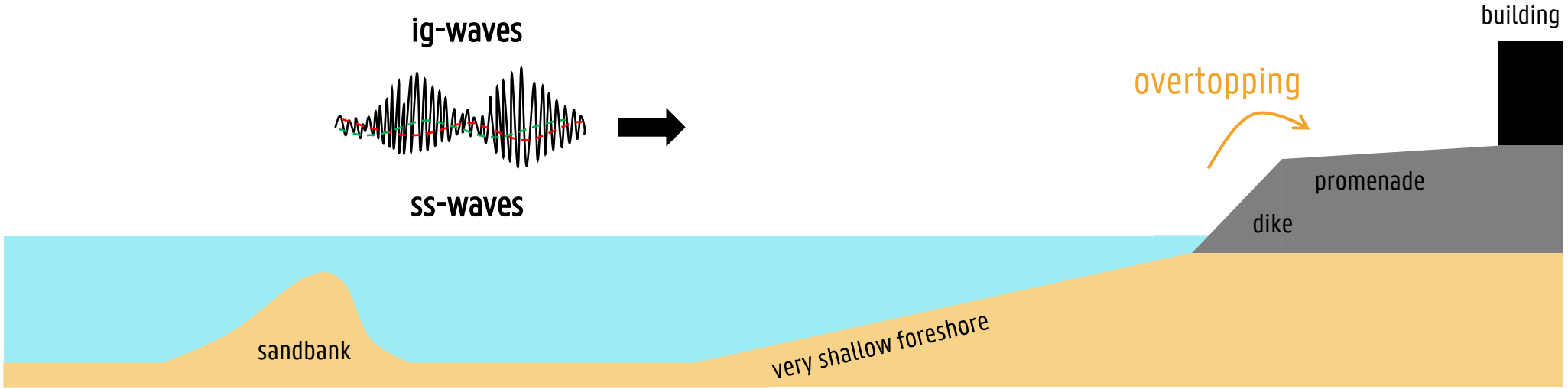
Future work

- Once the boundary conditions are defined, the next step is to validate SWASH numerical model using overtopping data measured at the Research Dike.

Research Dike



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