Modelling Changes to Physical Environmental Impacts due to Wave Energy Array Layouts

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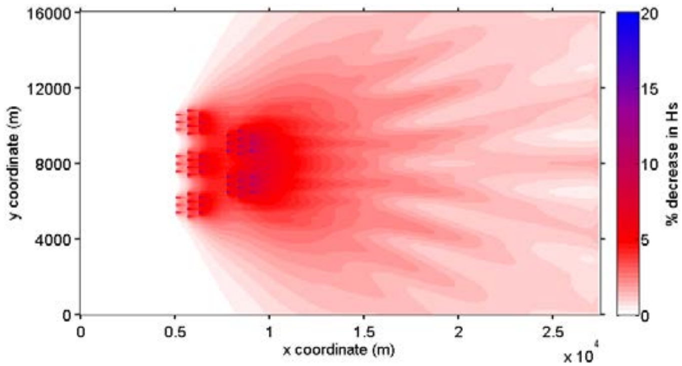
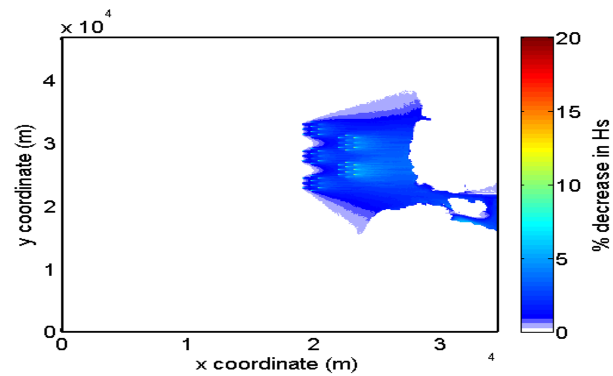
NERC SCIENCE OF THE ENVIRONMENT

EBAO

Overview

1. Context: The EBAO project
2. Theoretical modelling study
3. Case study for EMEC
4. Conclusions and future work





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"Optimising Array Form for Energy Extraction and Environmental Benefit"

Scenario A: Constrained channel — Tidal

Scenario B: Sea area between mainland and island — Tidal

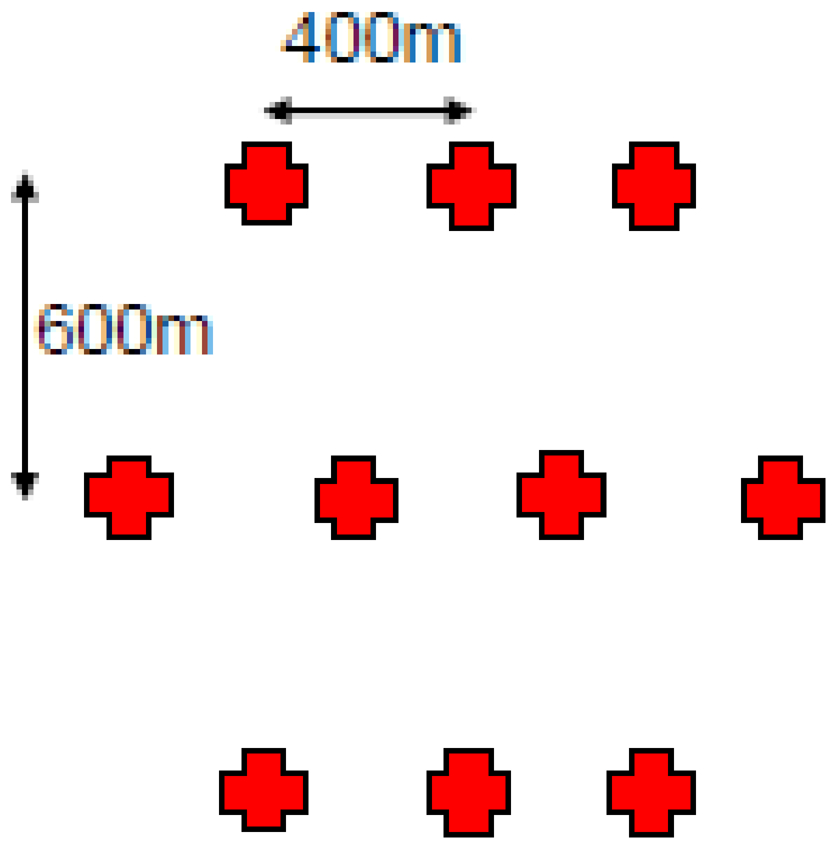
Scenario C: Inshore site — Wave, Tidal

Scenario D: Offshore site — Offshore wind

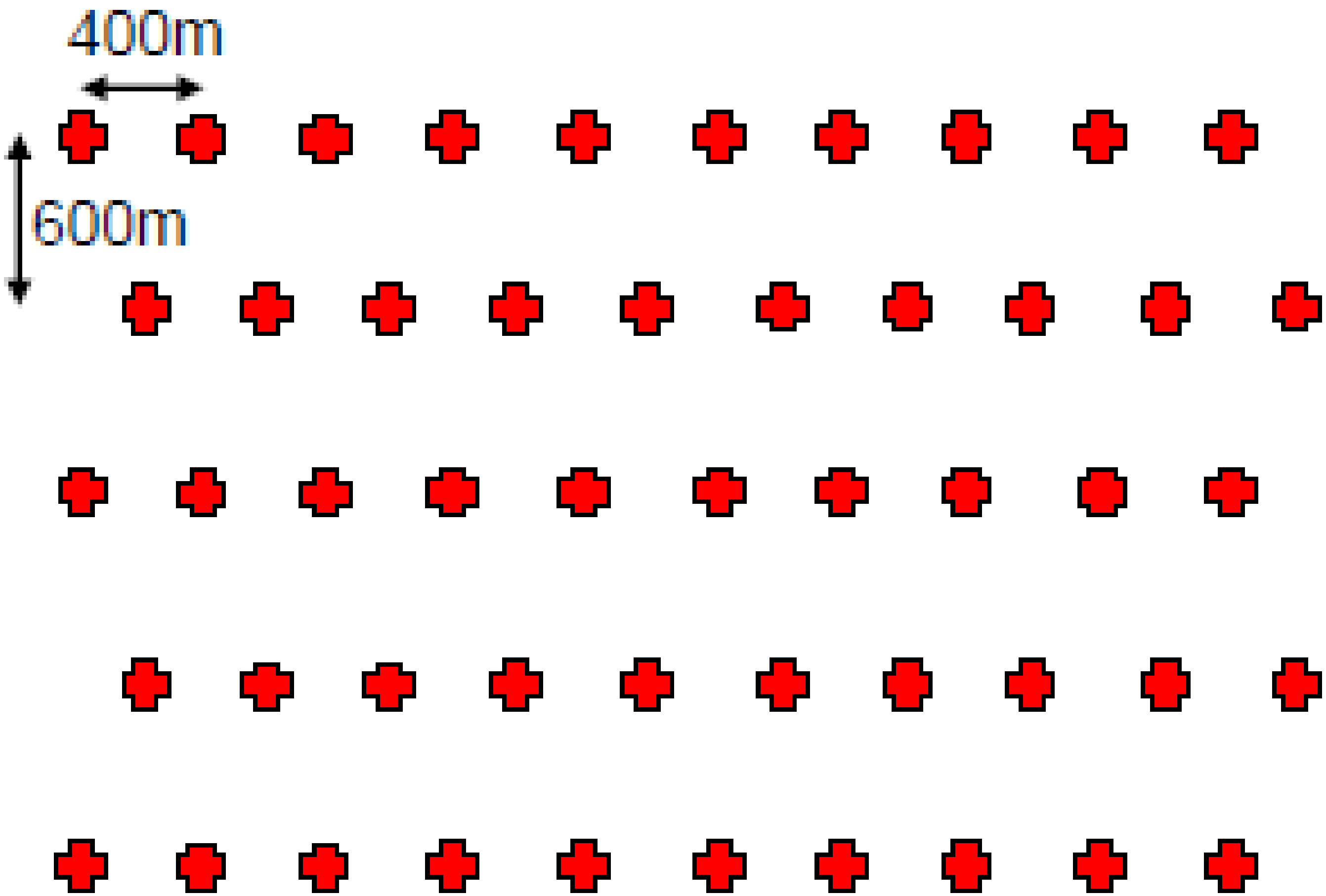
Theoretical model

- 3 array scenarios
- Grid:
  - Parallel depth contours
  - Real bathymetry (Orkney)
- Deepest device located at 60m depth
- 2 sea states – average and large
- 5 wind scenarios
- All modelling using SWAN spectral wave model

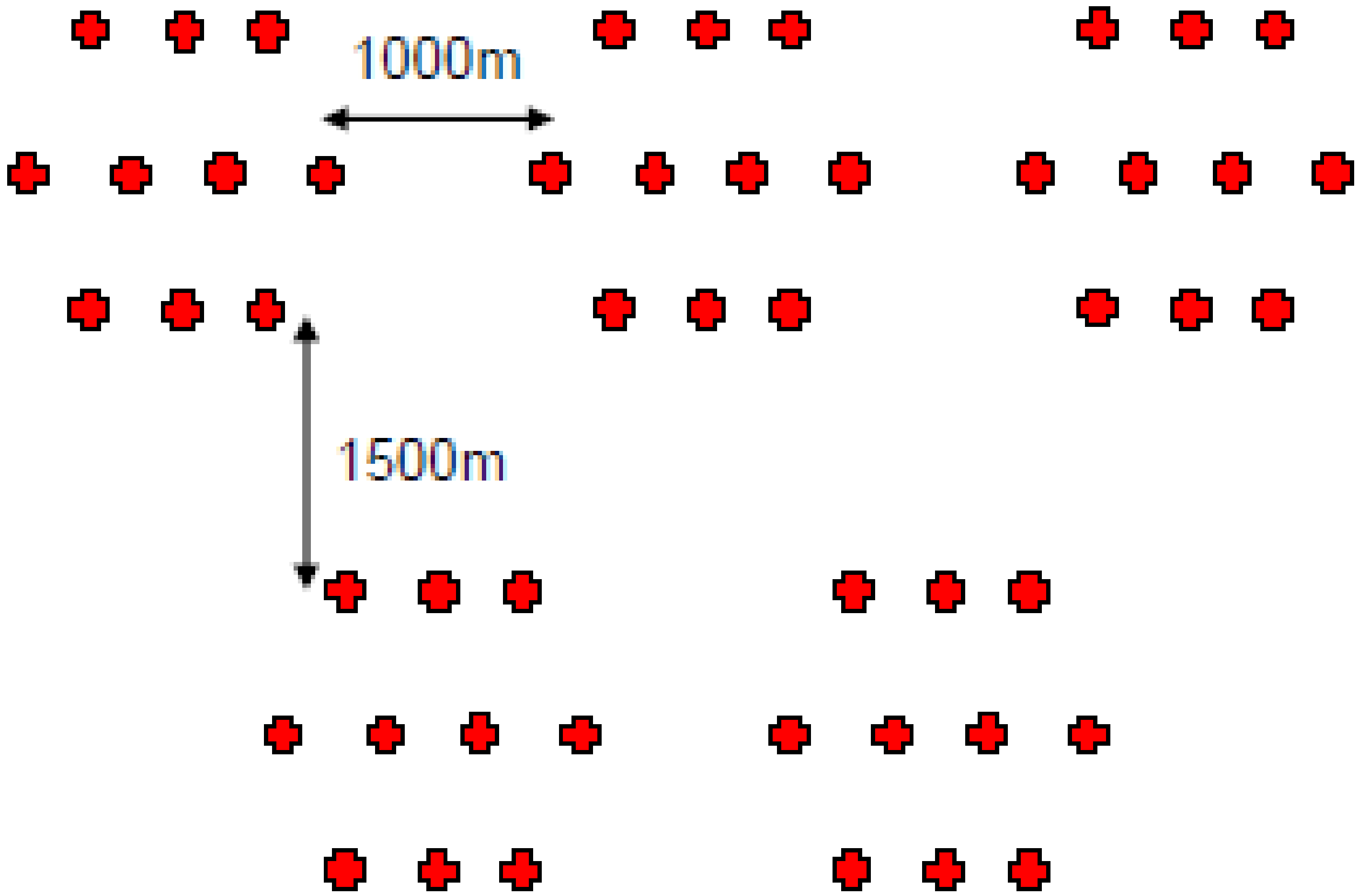
Theoretical model – Scenario1



Theoretical model – Scenario 2



Theoretical model – Scenario 3



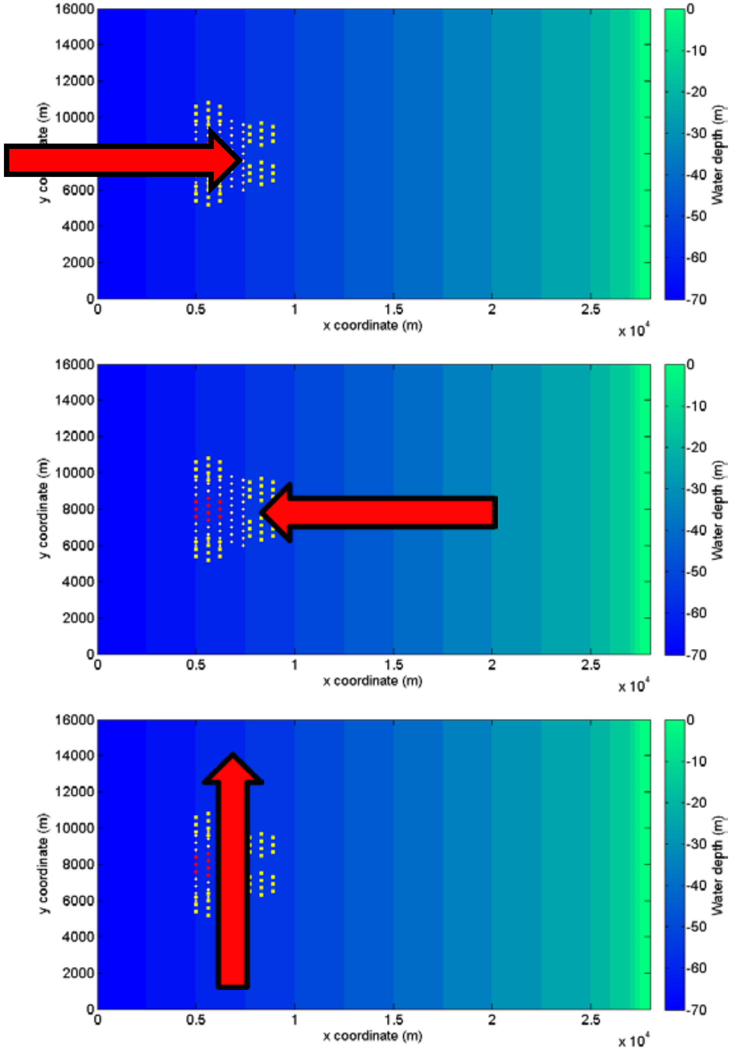
Theoretical model

Wind scenarios

Following: 5ms^{-1}, 10ms^{-1}, 20ms^{-1}

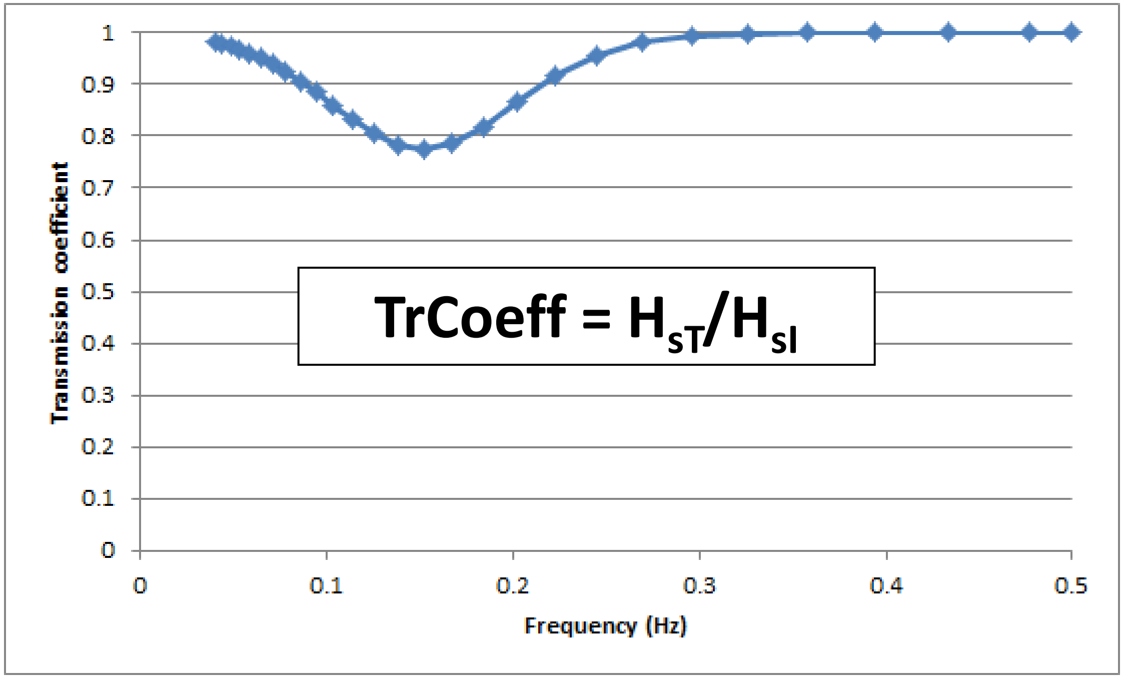
Opposing: 10ms^{-1}

Cross: 10ms^{-1}



Theoretical model

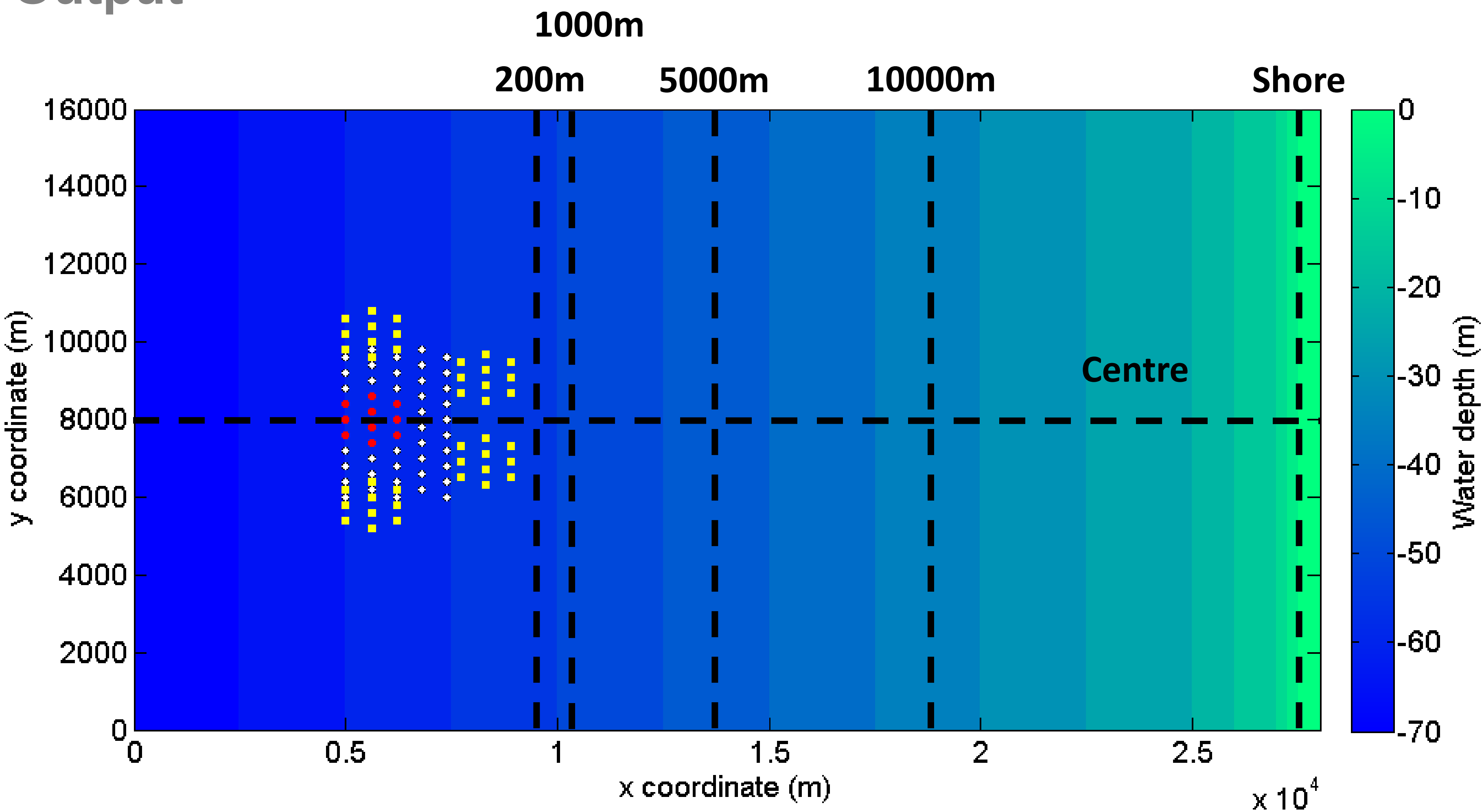
- SWAN spectral wave model
- Devices represented as 50m partially transmitting barriers
- Frequency-dependent energy absorption



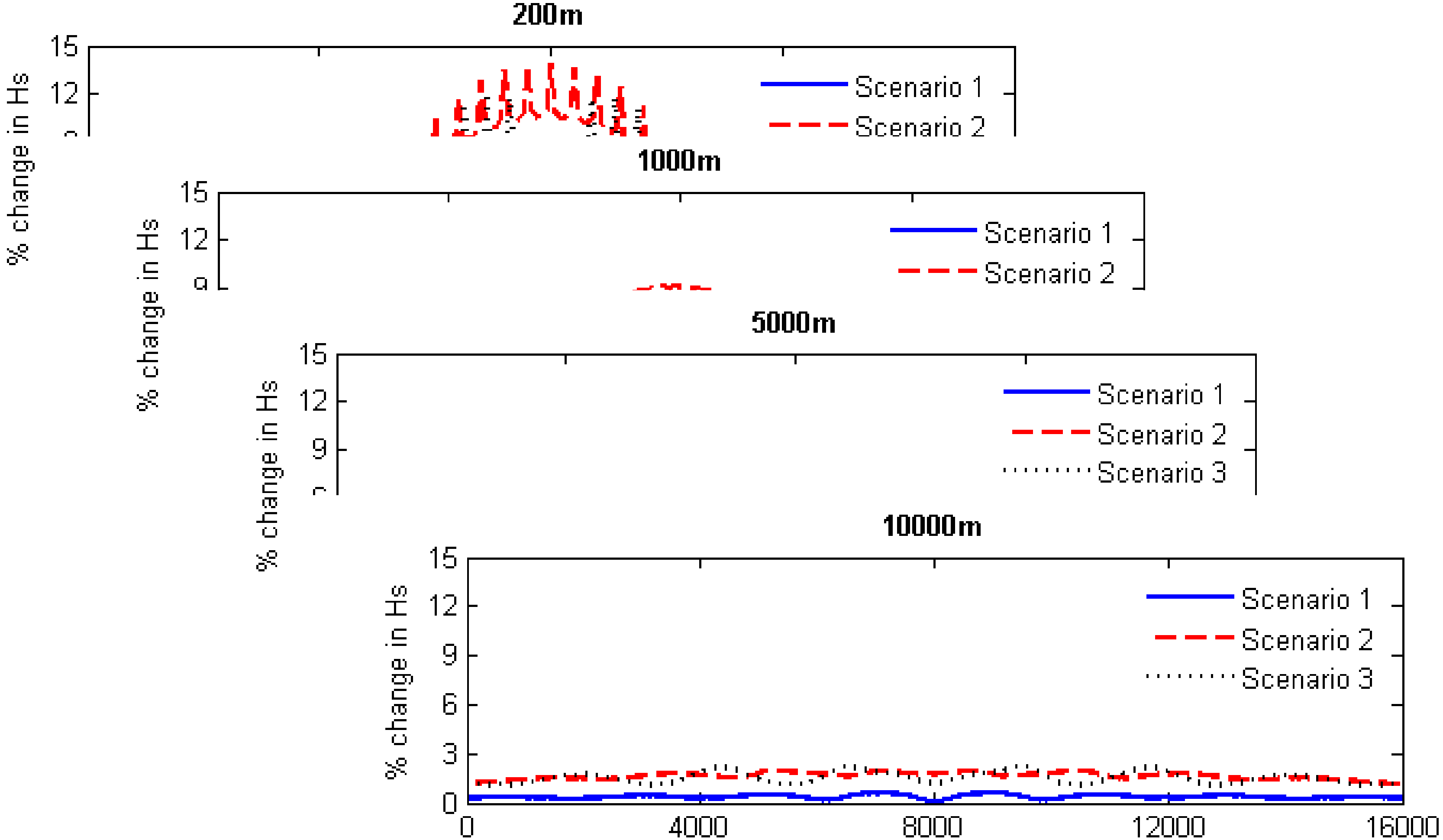
- Limitations of SWAN?

Theoretical model

Output



Theoretical model - results

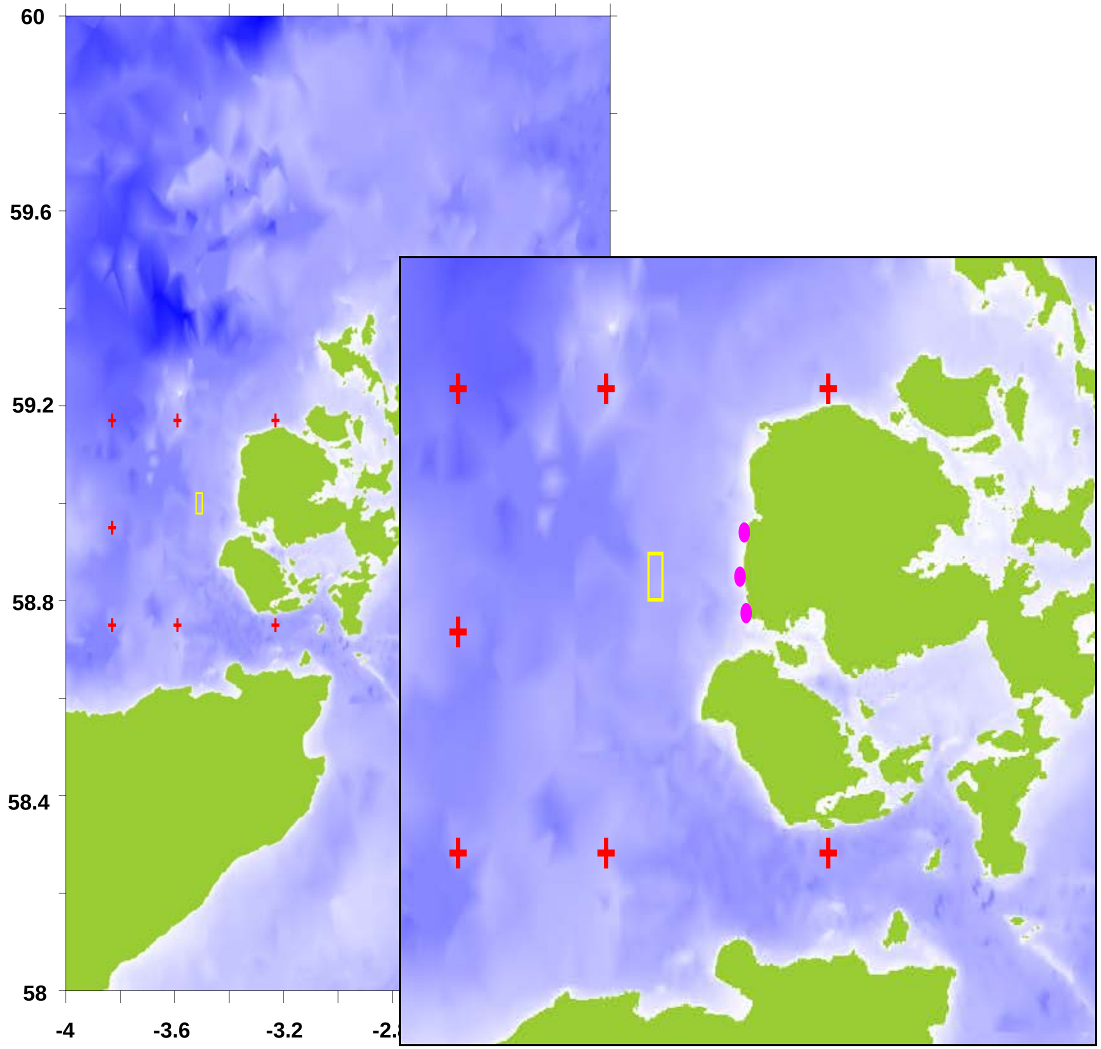


Sea state 1, no wind

Theoretical model - summary

- Increasing the number of devices increases the impact
- Clusters of devices with corridors lessen impact closer to devices, but this becomes negligible by the shoreline
- Impact decreases with increasing following or cross wind
- Impact increases with opposing wind
- Impact increases at shoreline for steeper seabed
- Impact slightly higher for larger sea state

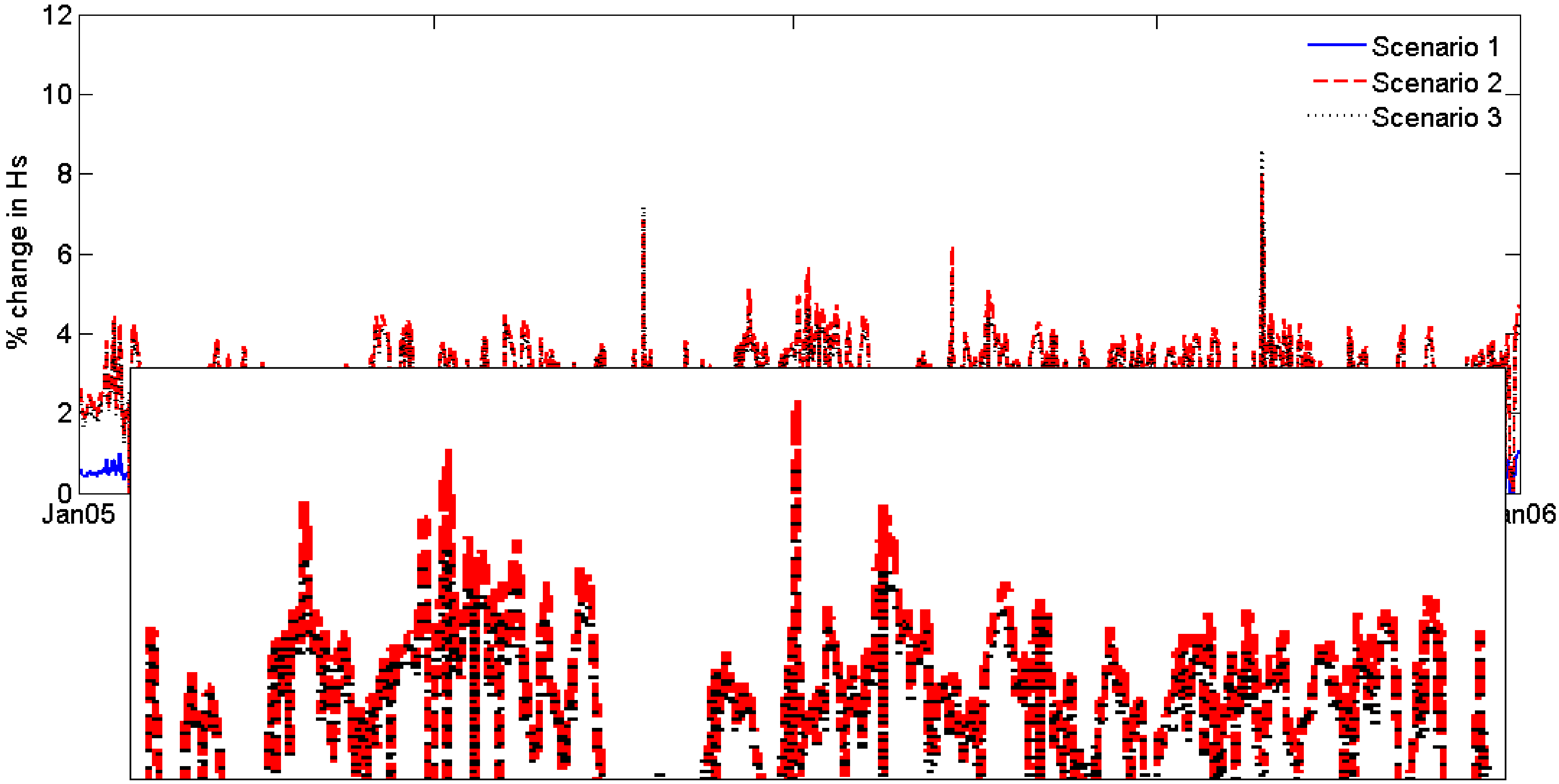
EMEC case study



- Run over full year (2005)
- Input data from EMEC hindcast
- Same 3 scenarios modelled
- Output at three ~10m depth locations

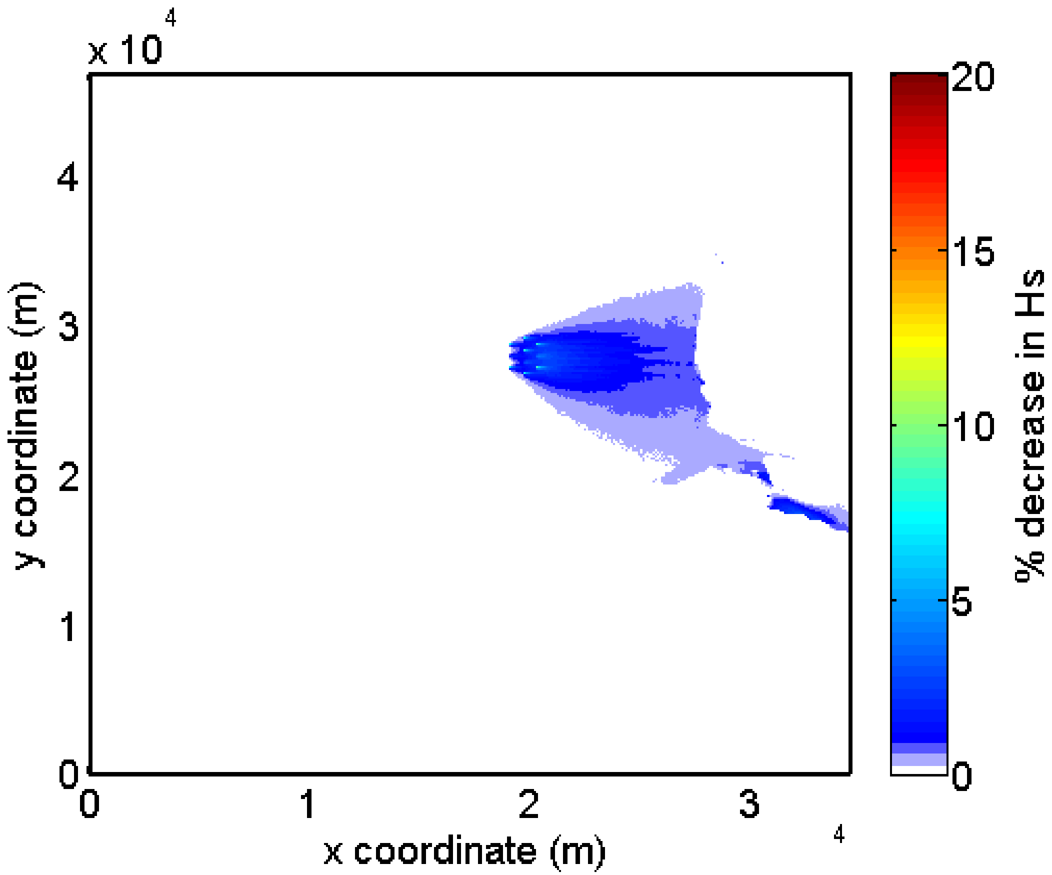
EMEC case study

Location 1



EMEC case study

Sea state corresponding to ‘small’ sea state, 20/3/05 15:00:
H_s = 1.56m, T_m = 5.3s, D = 275°



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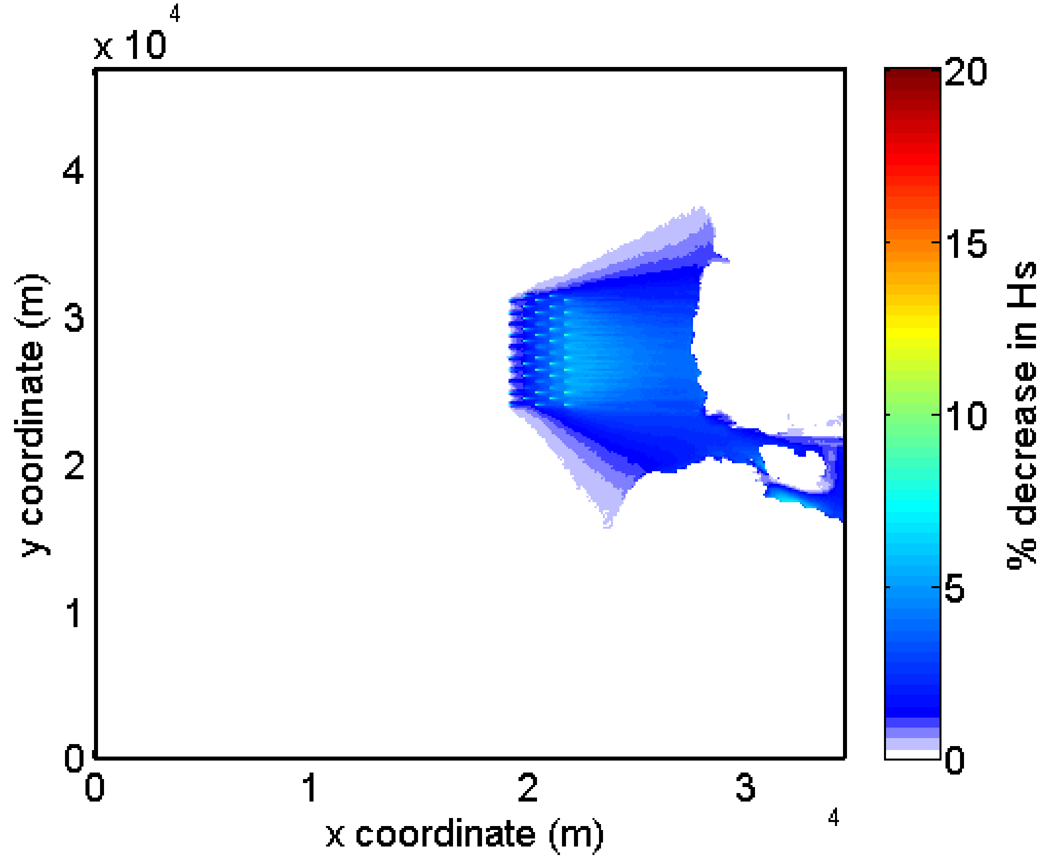

EMEC case study

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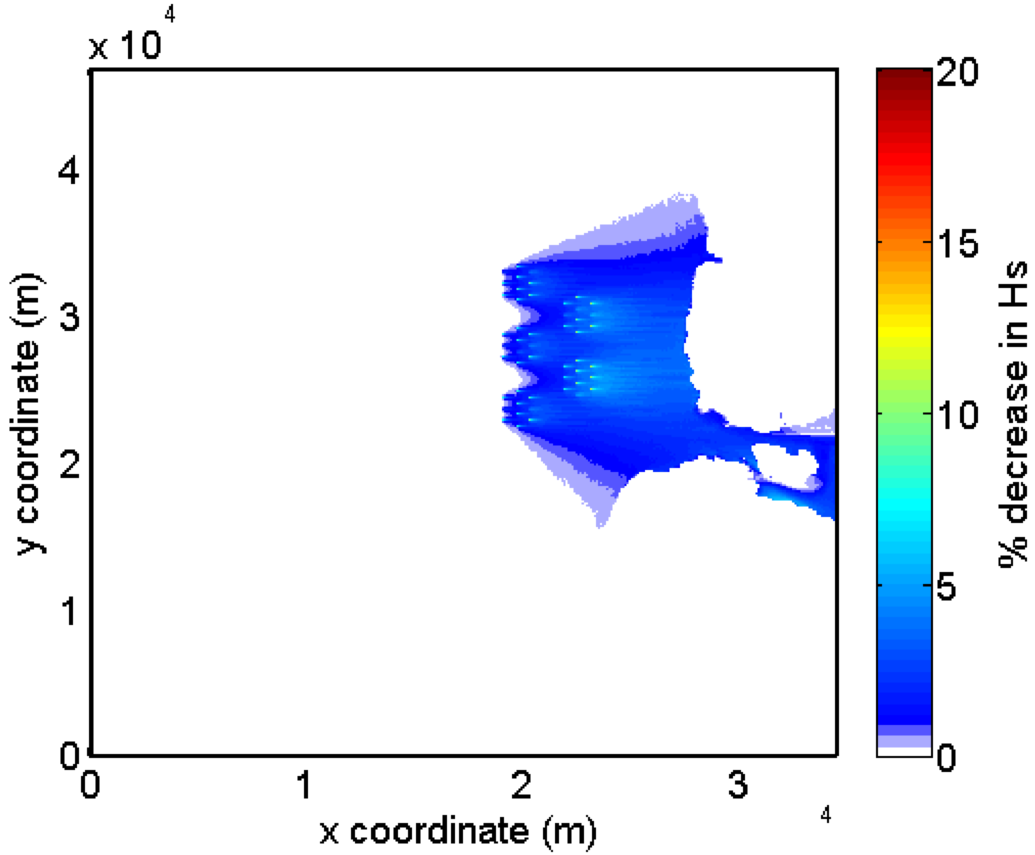

Conclusions

- Array layout is important for near-field effects, less so for the far-field
- Local wind and wave conditions more influential on the scale of the impact
- Next stage is to examine how these impacts affect wider physical and ecological scenarios
- Further work ongoing to develop the capability of spectral wave models to prediction such impacts – need validation!

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Thank you!

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