MODELLING OFFSHORE WIND FARMS OFF THE EAST COAST OF SCOTLAND USING THE FINITE-VOLUME COASTAL OCEAN MODEL (FVCOM)

The Scottish Government
marinescotland science

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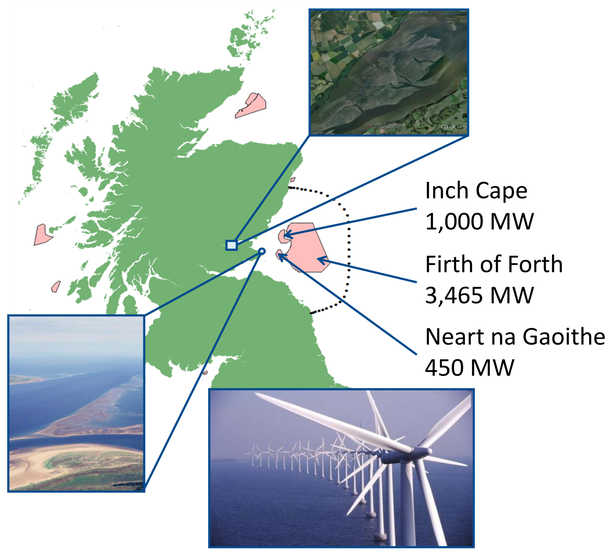
1. Background and motivation

- There is considerable interest within Scotland in offshore wind farms
- Three areas close to the Firth of Forth and Tay estuary, lying between 15 and 60 km off the coast, are currently planned
- There is a need for hydrodynamic modelling of the Firth of Forth and Tay estuary region to support marine spatial planning and environmental impact assessments



Will the development of offshore wind farms influence physical processes ?

How can wind farms be represented in regional hydrodynamic models ?

2. Physical processes in the area

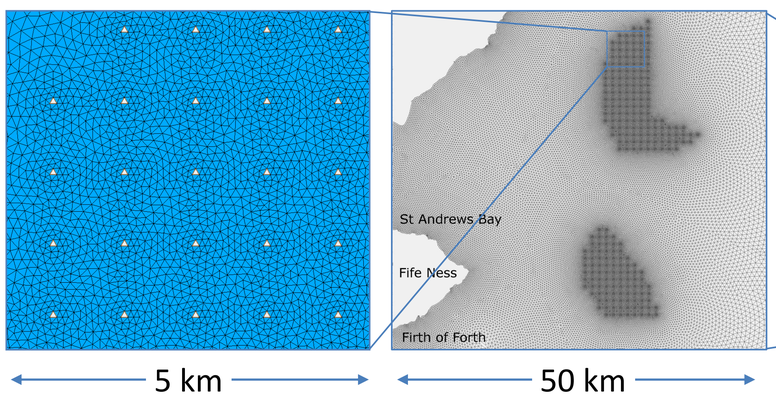
- Large intertidal areas 'wetting and drying'
- Morphological evolution of sand banks and bedforms
- Shallow water tidal constituents in the Forth lead to prolonged periods of slack water known as *lackie tides*
- Complex currents due to coastline, shallow water bathymetry, and freshwater input
- Tidal mixing fronts are regularly formed and interact with the bathymetry

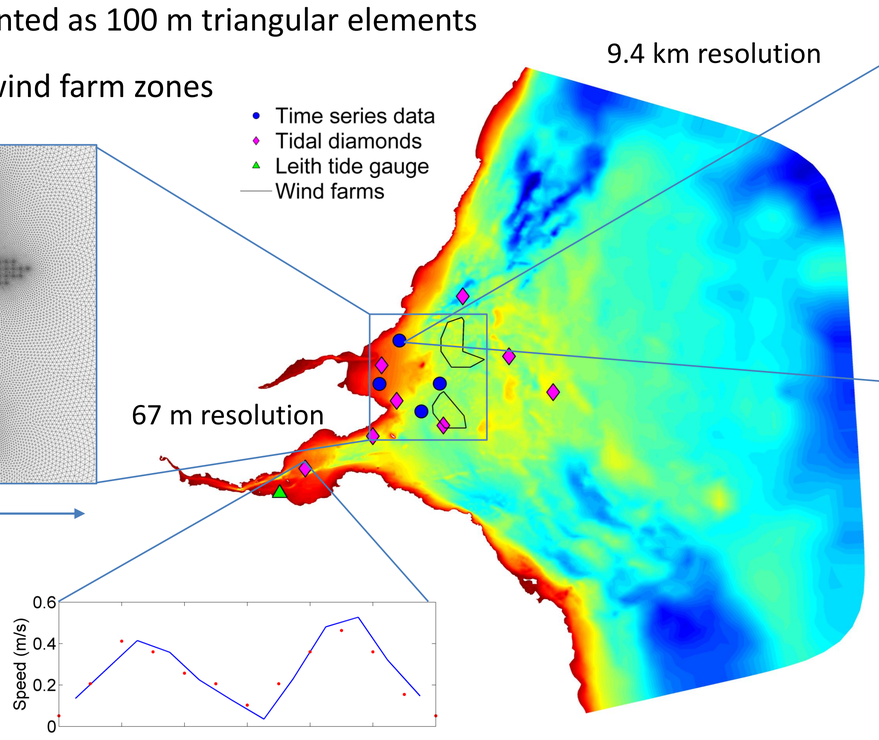
3. Potential impacts on physical processes

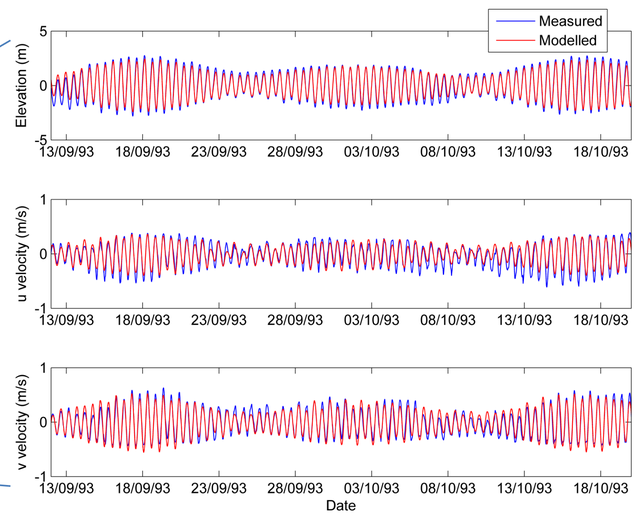
- Near-field changes to local wind driven **circulation** and **sand banks**
- Far-field changes to **wave, tidal and sediment regimes** within the estuaries

4. FVCOM tidal model and wind farm representation

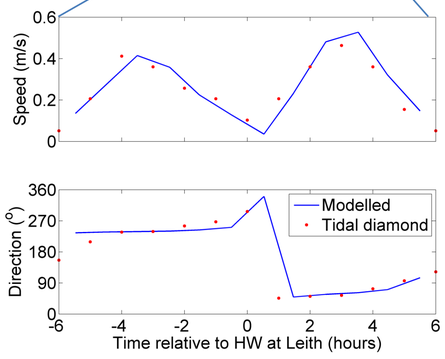
- Individual gravity base foundations represented as 100 m triangular elements
- Wind speed deficit of 10 % applied within wind farm zones

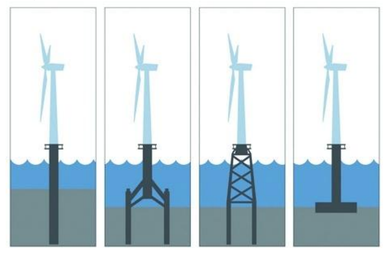






- Two wind farms within Scottish Territorial Waters modelled
- Environmental Statements examined in order to develop a realistic wind farm scenario
- Regular grids of 1 km spaced gravity bases selected as a realistic worst case



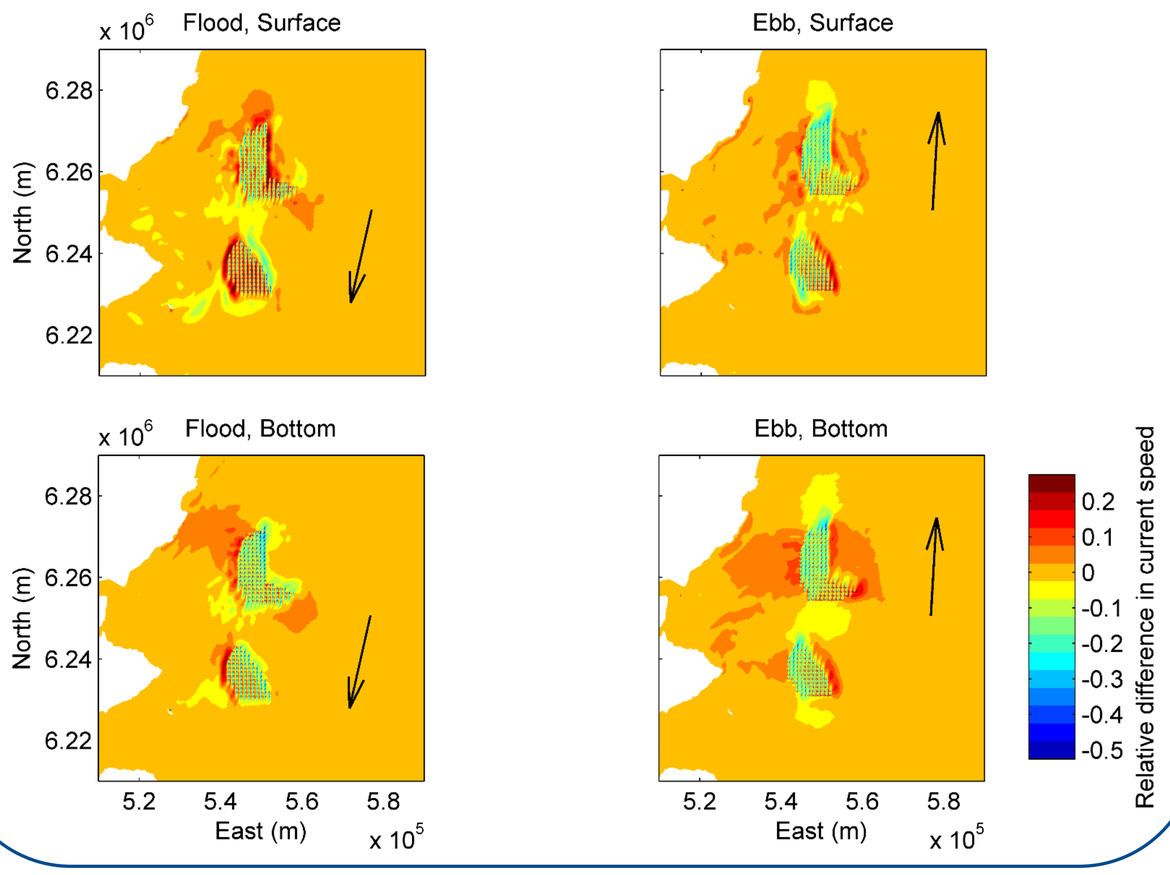


Example foundations:
monopile, tripile, jacket and gravity base
From www.theengineer.co.uk

5. Examination of impacts

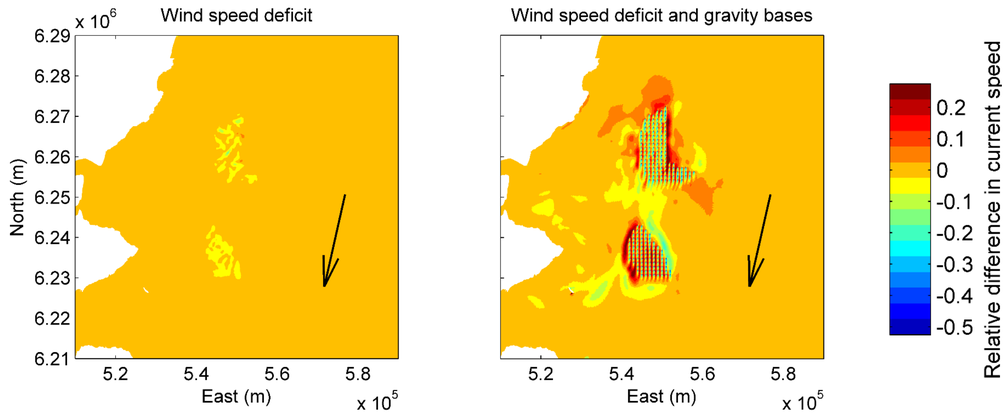
A comparison of current speeds from two model runs:

- Baseline model with no turbine foundations or wind speed deficit
- Wind farm model with turbine foundations and wind speed deficit



6. Model sensitivity to different changes

Are the changes due to the 10 % wind speed deficit or the 100 m gravity bases?



The array of gravity base structures appear to have the dominant effect

7. Conclusions and future work

- Wind farms have the potential to change current speeds
- These results consider a worst case scenario of 100 m gravity bases
- Modelling foundations in this manner is possible with FVOCM but comes at a computational cost
- Smaller gravity bases and other foundations would potentially have less impact – this is future work
- These results can be used for wider ecosystem impact assessments