



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

Marine Scotland  
Science

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## 1. Background and motivation

- There is considerable interest within Scotland in offshore wind farms
- Three areas closer to the Firth of Forth and Tay estuaries, lying between 15 and 50 km off the coast, are currently planned
- There is a need for hydrodynamics modelling of the Firth of Forth and Tay estuary region to support marine spatial planning and environmental impact assessments



With the development of offshore wind farms influencing physical processes? How can wind farms be represented in regional hydrodynamic models?

## 2. Physical processes in the area

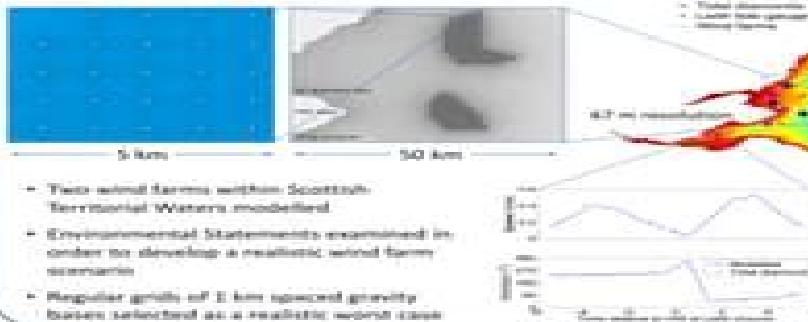
- Large intertidal areas (wetting and drying)
- Morphological evolution of sand banks and barforms
- Shallow water tidal constituents in the Firth lead to prolonged periods of slack water known as tide holes
- Complex currents due to coastlines, shallow water bathymetry, and freshwater input
- Tidal mixing zones are regularly formed and connect with the bathymetry

## 3. Potential impacts on physical processes

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

## 4. FVCOM tidal model and wind farm representation

- Individual gravity base foundations represented as 200 m triangular elements
- Wind speed deficit of 20% applied within wind farm zones

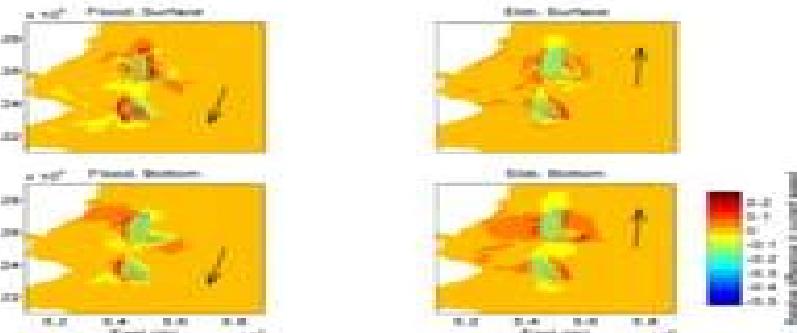


- Two wind farms within Scottish Territorial Waters modelled
- Environmental statements examined under developing realistic wind farm scenarios
- Perpetual grids of 2 km represent gravity bases selected as a realistic worst case

## 5. Examination of impacts

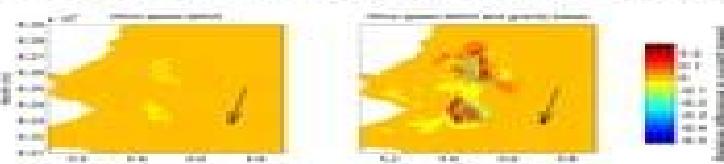
A comparison of current speeds from two model runs:

- 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 20% wind speed deficit or the 200 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 200 m gravity bases
- Modelling foundations in this manner is possible with FVCOM 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 environmental impact assessments

# Modelling The Offshore Environment

**Lauren Gardner**

## **Modelling The Offshore Environment:**

Modelling the Offshore Environment ,1987    **Modelling the Offshore Environment** ,1987    **Modelling the Offshore Environment** Society for Underwater Technology,1987    Modelling the Offshore Environment ,1987    The Future of Geological Modelling in Hydrocarbon Development Adam Robinson,2008 The 3D geological model is still regarded as one of the newest and most innovative tools for reservoir management purposes The computer modelling of structures rock properties and fluid flow in hydrocarbon reservoirs has evolved from a specialist activity to part of the standard desktop toolkit The application of these techniques has allowed all disciplines of the subsurface team to collaborate in a common workspace In today s asset teams the role of the geological model in hydrocarbon development planning is key and will be for some time ahead The challenges that face the geologists and engineers will be to provide more seamless interaction between static and dynamic models This interaction requires the development of conventional and unconventional modelling algorithms and methodologies in order to provide more risk assessed scenarios thus enabling geologists and engineers to better understand and capture inherent uncertainties at each aspect of the geological model s life

**Optimisation and Modelling of Offshore Safety and Environment** Francis Kynoch Crawley,2004    *Marine Renewable Energy Technology and Environmental Interactions* Mark A. Shields,Andrew I.L. Payne,2014-02-12 It is now widely recognized that there is a need for long term secure and suitable sustainable forms of energy Renewable energy from the marine environment in particular renewable energy from tidal currents wave and wind can help achieve a sustainable energy future Our understanding of environmental impacts and suitable mitigation methods associated with extracting renewable energy from the marine environment is improving all the time and it is essential that we be able to distinguish between natural and anthropocentric drivers and impacts An overview of current understanding of the environmental implications of marine renewable energy technology is provided

**Ecological and Environmental Modelling (ECOMOD 2001)** ,2003    **Renewable Energy in Marine Environment** Eugen Rusu,2020-03-25 The effects of human caused global warming are obvious requiring new strategies and approaches The concept of business as usual is now no longer beneficial Extraction of renewable energy in marine environments represents a viable solution and an important path for the future These huge renewable energy resources in seas and oceans can be harvested including wind tide and waves Despite the initial difficulties related mostly to the elevated operational risks in the harsh marine environment newly developed technologies are economically effective or promising Simultaneously many challenges remain to be faced These are the main issues targeted by the present book which is associated with the Special Issue of Energies Journal entitled Renewable Energy in Marine Environment Papers on innovative technical developments reviews case studies and analytics as well as assessments and papers from different disciplines that are relevant to the topic are included From this perspective we hope that the results presented are of interest to for scientists and those in related

fields such as energy and marine environments as well as for a wider audience Hydraulic and Environmental Modelling of Coastal, Estuarine, and River Waters R. A. Falconer, P. Goodwin, R. G. S. Matthew, 1989 **Hydraulics in Civil and Environmental Engineering** Andrew Chadwick, John Morfett, Martin Borthwick, 2021-06-07 This classic text now in its sixth edition combines a thorough coverage of the basic principles of civil engineering hydraulics with a wide ranging treatment of practical real world applications. It now includes a powerful online resource with worked solutions for chapter problems and solution spreadsheets for more complex problems that may be used as templates for similar issues. *Hydraulics in Civil and Environmental Engineering* is structured into two parts to deal with principles and more advanced topics. The first part focuses on fundamentals such as hydrostatics, hydrodynamics, pipe and open channel flow, wave theory, physical modelling, hydrology, and sediment transport. The second part illustrates engineering applications of these principles to pipeline system design, hydraulic structures, river and coastal engineering, including up to date environmental implications, as well as a chapter on computational modelling illustrating the application of computational simulation techniques to modern design in a variety of contexts. New material and additional problems for solution have been added to the chapters on hydrostatics, pipe flow, and dimensional analysis. The hydrology chapter has been revised to reflect updated UK flood estimation methods, data, and software. The recommendations regarding the assessment of uncertainty, climate change predictions, impacts, and adaptation measures have been updated, as has the guidance on the application of computational simulation techniques to river flood modelling. Andrew Chadwick is an honorary professor of coastal engineering and the former associate director of the Marine Institute at the University of Plymouth UK. John Morfett was the head of hydraulics research and taught at the University of Brighton UK. Martin Borthwick is a consultant hydrologist, formerly a flood hydrology advisor at the UK's Environment Agency and previously an associate professor at the University of Plymouth UK. **Modelling the Offshore Environment**, 1987 *Inventory of Federal Energy-related Environment and Safety Research for FY 1979*, 1980

*Inventory of Federal Energy-related Environment and Safety Research for ...*, 1980 **Hydraulics in Civil and Environmental Engineering, Fifth Edition** Andrew Chadwick, John Morfett, Martin Borthwick, 2013-02-19 Now in its fifth edition, *Hydraulics in Civil and Environmental Engineering* combines thorough coverage of the basic principles of civil engineering hydraulics with a wide ranging treatment of practical real world applications. This classic text is carefully structured into two parts to address principles before moving on to more advanced topics. The first part focuses on fundamentals including hydrostatics, hydrodynamics, pipe and open channel flow, wave theory, physical modeling, hydrology, and sediment transport. The second part illustrates the engineering applications of these fundamental principles to pipeline system design, hydraulic structures, and river, canal, and coastal engineering, including up to date environmental implications. A chapter on computational hydraulics demonstrates the application of computational simulation techniques to modern design in a variety of contexts. What's New in This Edition: Substantive revisions of the chapters on hydraulic machines, flood

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