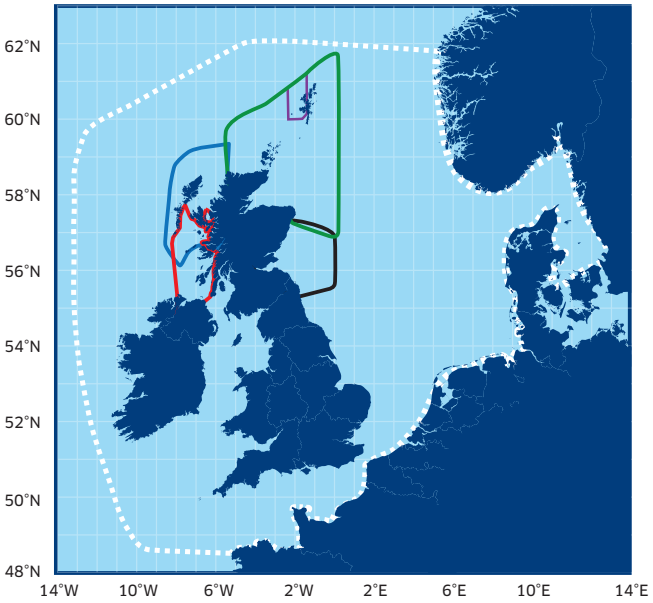
marinescotland
TOPIC SHEET NUMBER 137 V1

Scottish Government
Riaghaltas na h-Alba
gov.scot

THE SCOTTISH SHELF MODEL (SSM)



THE BOUNDARIES OF THE WIDER SCOTTISH SHELF MODEL AND THE SMALLER CASE-STUDY MODELS

Background

Hydrodynamic models are computer programs that simulate the movement, temperature, salinity and other properties of our seas. These models can complement observations to describe the physical marine environment in the past and the present, and provide forecasts.

Marine Scotland has led the development of a model for the Scottish continental shelf waters called the Scottish Shelf Model (SSM). The model domain extends from our firths and sea lochs at the coast, out past the edge of the continental shelf, and includes the Norwegian Trench, the North Sea and even the English Channel. However, the focus of the model calibration and validation was for our main area of interest – Scottish waters.

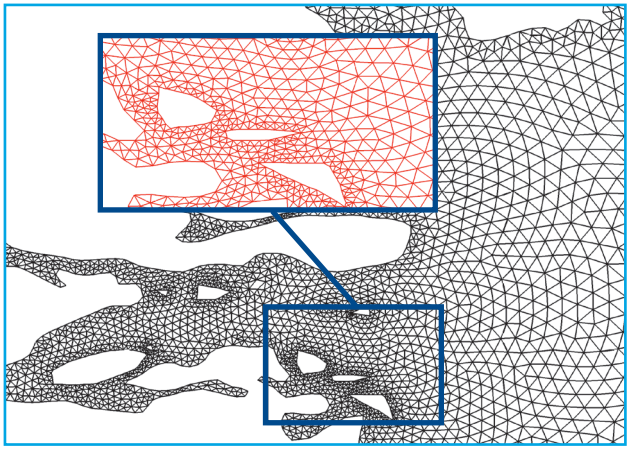
The SSM also includes a number of smaller scale **Case Study sub-models** of particular areas of interest to specific socio-economic sectors such as aquaculture and marine renewable energy. These sub-models have a higher spatial resolution, which is necessary to adequately understand the complex physical processes within these areas. The resolution in these areas goes down to hundreds or tens of meters, depending on the Case Study.

To date, five case study areas have been developed and the sub-models are nested within the wider SSM:

- Wider Loch Linnhe System
- East coast of Lewis and Harris
- Pentland Firth and Orkney Waters
- St. Magnus Bay, Shetland
- Firth of Forth and Tay

Unstructured grid

Numerical models are divided up into a large number of elements where the motion of the sea is modelled by the computer. The SSM is based on the Finite Volume Community Ocean Model (FVCOM), which has a grid made up of many triangular elements, making it unstructured and able to adapt to complex shapes easily. This allows complex areas of interest, such as near the coast, to be represented at a high horizontal resolution and for the open sea to be modelled at a lower resolution. This minimises the computational expense and, despite the change in resolution, the model remains as one unified system.



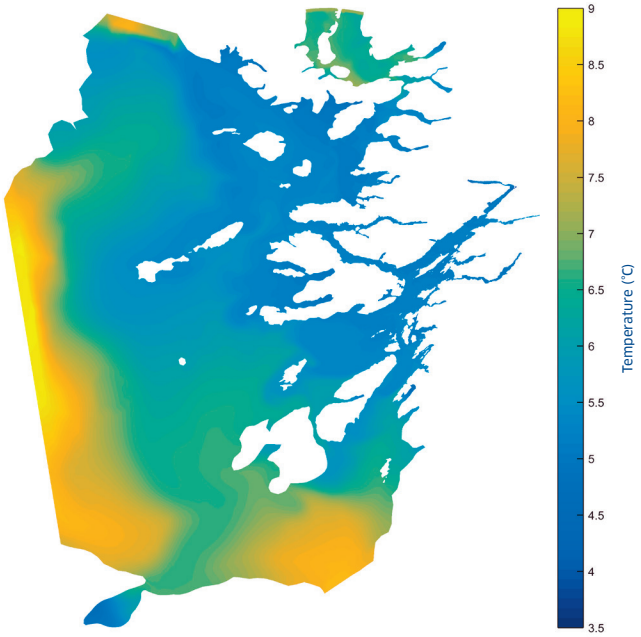
A SECTION OF THE UNSTRUCTURED GRID FROM THE EAST COAST OF LEWIS AND HARRIS MODEL

marinescotland

Typical model outputs

Standard model outputs include water levels, current speeds, temperature and salinity but other parameters, such as turbulent kinetic energy can also be calculated. The models have also been configured to produce a yearlong climatology to represent an 'average' year.

This figure shows the modelled sea surface temperature from the wider Loch Linnhe system model at the end of February. The sea close to the coastline is generally colder due to shallower water being cooled by the atmosphere and the cold winter rain water entering the system.



WIDER LOCH LINNHE SYSTEM SEA SURFACE TEMPERATURE

Combined grid

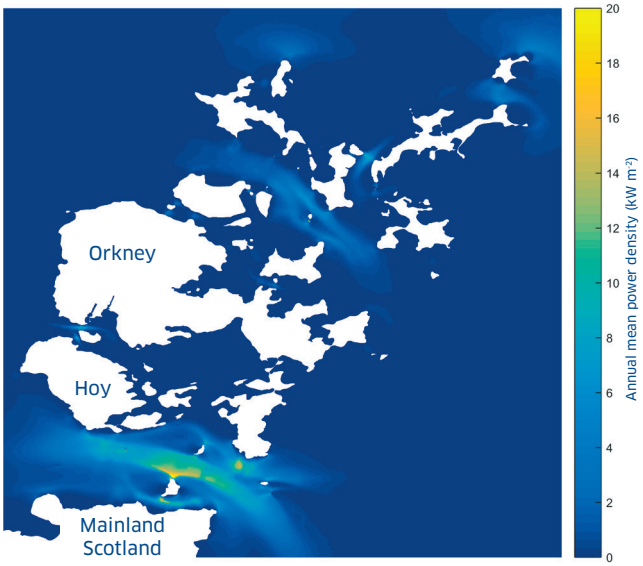
The output from the wider SSM and the smaller Case Studies has been combined to produce model output across the whole shelf and at very high resolution in the case study areas, to be used in particle tracking-based applications.

Model applications

The SSM has a vast array of potential applications to all areas of marine science. The SSM can give a detailed spatial picture of the physical water properties, which would be unobtainable from observations alone. So far, the model has been used to provide resources for aquaculture and marine renewables scientists, including:

- Tidal energy resource maps
- Wave resource maps for the Pentland Firth Orkney Waters case study
- Connectivity indices between aquaculture finfish farm management areas within the combined high resolution Scottish shelf waters domain

Work is currently underway to use the SSM to model tidal stream energy extraction and to quantify its potential effects on the physical marine environment. Other potential future applications include assisting with marine spatial planning, studying connectivity between marine protected areas, population dynamics of marine organisms, sediment transport studies and even incident response and search and rescue.



TIDAL ENERGY RESOURCE MAP FOR THE PENTLAND FIRTH AND ORKNEY WATERS