UKCP Case Study: Waves in UKCP18 Marine

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Year of Production: 2021

Target Audience: Stakeholders and researchers in climate services and policy sphere

Executive Summary

- The aim of the project was to include the latest wave model science into UKCP18 Marine Projections.
- Fast-tracking the latest research into accessible reports for stakeholders.
- While there are changes in waves through the 21st Century, the response is very regionally specific.

Introduction

The original data plan for UKCP Marine did not include work looking at waves. Therefore, Dr Bricheno received funding from NERC for this research to be undertaken and included as part of the final UKCP Marine products. Working in collaboration with the UKCP Marine team at the Met Office, a new product was delivered to the stakeholders, Department for Environment Farming and Rural Affairs (Defra) and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

Key Results

For the 21st Century, projections of average wave height suggested changes of the order of 10 to 20% and a general tendency towards lower wave heights. Changes in extreme waves are also of the order of 10 to 20%, but there is no agreement in the sign of the change among the model projections. High resolution wave simulations suggest that the changes in the climatology of waves over the 21st Century is sensitive to the position of the storm track, and differs depending on the expose of the coastline.

- For exposed coasts, the changes in waves are dominated by the global response to climate change through the 21st Century.
- For sheltered coastal regions, the changes in waves here remain dominated by the local weather variability over the 21st Century.

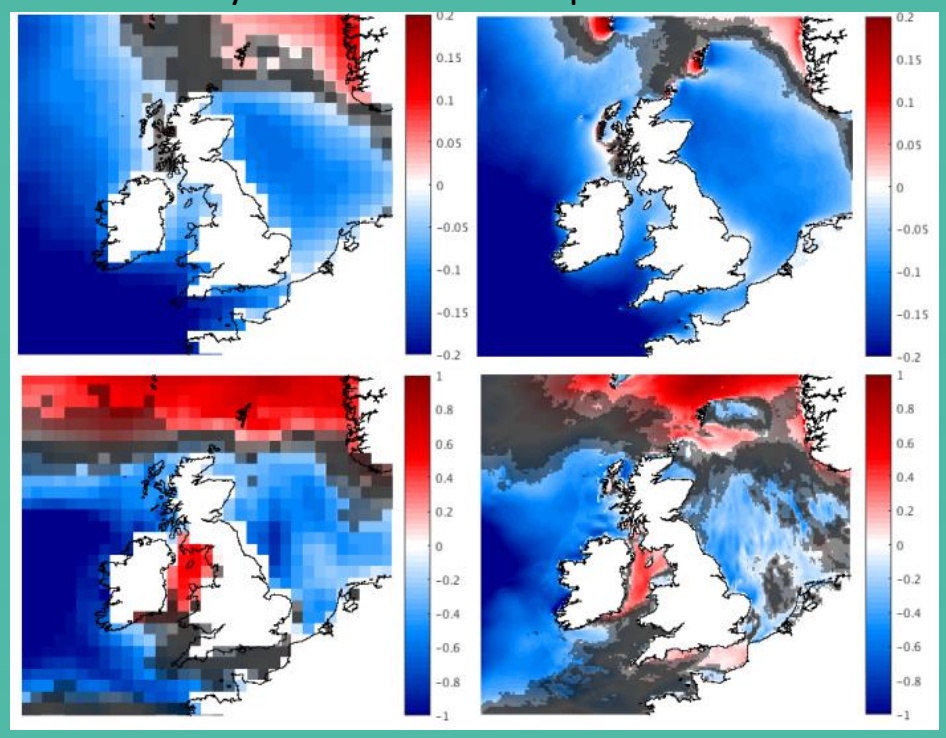

Figure 1: A copy of Figure 3.3.2 from UKCP Marine Report. RCP8.5 end century change in mean SWH (top) and mean AnnMax (below). Global model (left) and regional (right). All plots show an absolute change, in metres.

Using The Waves Data

The data produced as part of this work has been utilised by a range of partners across different sectors, including academic papers, commercial consultancy and the Scottish Government report Scotland's Marine Assessment 2020: Physical Characteristics and Ocean Acidification. Here we focus on the UK Marine Climate Change Impacts Partnerships (MCCIP) report card, the 2020 version is available here. While this report card outlines a range of changes in the marine environment around the UK, it is accompanied by a specific report on Storms and Waves. The report card details the results from the waves data before outline some of the potential impacts that arise from changes in waves. Some key impacts are highlighted from the literature such as the potential for disruption to "lifeline ferry services" and the impacts from extreme events such as the winter of 2013/14 which can drive extreme erosion events and leave areas more exposed to future storm events due to changes from these extreme events.

Methodology

The following outlines the datasets from the UKCP project that were used to create the Waves dataset. The UKCP data used to produce this dataset is available from the Centre for Environmental Data Analysis (CEDA) here: UKCP Data. The methodology here is a summary of information available from the UKCP Marine Report and Bricheno & Wolf (2018).

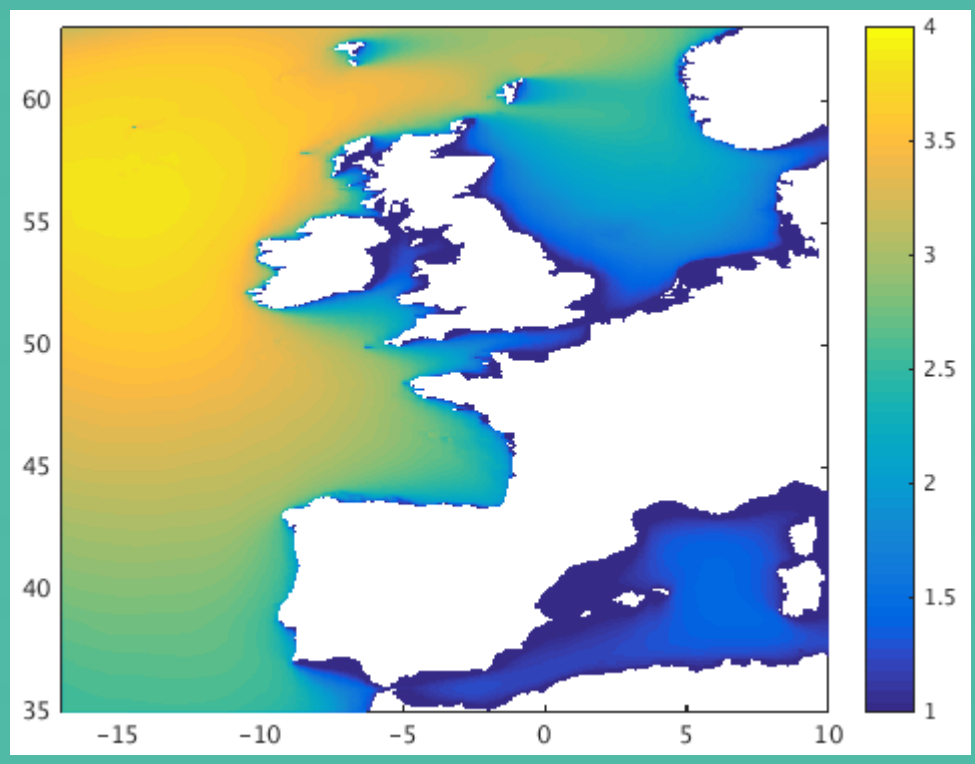

Figure 2:An example of wave-height distribution around the UK based on a 10 year hindcast.

Climate Data Used

An ensemble of 7 CMIP5 models from within the selection used within UKCP18 are drawn on. These models are: ACCESS, BCC, CNRM, GFDL, HadGEM, MRI and EC-EARTH.

The surface wind fields were extracted from these models for two representative concentration pathway (RCP) scenarios: RCP 4.5 and RCP 8.5; with the latter scenario featuring a greater increase in the concentration of greenhouse gases during the 21st Century. To produce driving forcing for the regional wave model, the climate data was dynamically downscaled, using winds for these models downscaled through the EURO-CORDEX project (Giorgi et al., 2009).

Data was extracted for the period 1980-2100 using 20-year climatology blocks.

Wave Model

The WaveWatch III™ spectral wave model, version 3.14 (Tolman, 2009) was used to simulate the changes in wave conditions. Two set ups were initiated, a global model with an approximate horizontal resolution of 80 km by 40 km; which in turn drove a nested North East Atlantic domain, with a horizontal resolution of approximately 9 km.

Available Outputs

The generated outputs produced a global and a high-resolution data for mapping future wave climate under two climate change scenarios and a meta-analysis of future wave projections for UK sea and coastal points from an ensemble of lower-resolution global wave models. Outputs from the global model configuration have contributed to the Coordinated Ocean Wave Climate Project https://cowclip.org/, an international collaborative research project and been published in Morim et al. (2019; 2020)

References

Bricheno, L.M. and Wolf, J. (2018) Future wave conditions of Europe, in response to high-end climate change scenarios. Journal of Geophysical Research, Oceans, 123, 8762–8791, doi:10.1029/2018JC013866

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Morim, J. et al. (2019) Robustness and uncertainties in global multivariate wind-wave climate projections. Nature Climate Change 9.9: 711-718.

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