Using a coupled model to downscale the effects of climate change and human offshore installations until the year 2100 on the North Sea ocean services

The effects of global climate change are expected to be more pronounced in the coastal ocean. Changes in regional weather patterns, dominant winds and air temperature dynamics will act as a pressure on the quality of ocean services, such as primary production and carbon sequestration. Understanding of the future impact of climate change is crucial for management of those pressures, and currently possible on the global scale through running long-term prediction scenarios using Earth System Models (ESMs). However, they are generally too coarse to accurately estimate the impact for the European coastal regions, therefore finer scale models are required to make more accurate and detailed predictions. The JPI Climate & Oceans CE2COAST project targets estimation of the climate change impact on the scale of the European coastal seas using the downscaling approach, i.e. running fine scale regional models specifically tailored for each coastal region forced by data from the ESMs. For the project, we have built a new regional model, covering the North Sea. Our coupled model includes a hydrodynamic model ROMS, a wave model SWAN, a sediment model CSTMS, a biological model Fennel and a diagenetic model OmexDia, running interactively. The coupled model is forced at the open ocean boundaries with NorESM2 model outputs and with regional atmospheric model MAR outputs at the air-sea boundary. It has been run and validated for the hindcast period (1993 - 2022) and then has been run until the year 2100 to quantify the impact of various pressures of climate change (according to SSP370 “upper-middle” scenario) on the North Sea primary production dynamics and its ability to sequester carbon. An additional study was conducted on the ability of the blue mussels, fouling artificial offshore installations such as wind farms (which total number for the region is projected to exceed two hundred by the year 2035), to sequester carbon through filter feeding and rapid excretion on the regional scale. Their regional impact has been assessed by running our model coupled with a simple filter feeder model. The study shows how carbon deposition by the blue mussels affects the long-term transfer of the regional organic carbon flux towards the Norwegian Trench, the deepest part of the North Sea which acts as a major player in the regional carbon sequestration.

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