Geophysical Research Abstracts
Vol. 21, EGU2019-16512, 2019
EGU General Assembly 2019

Effects of Climate Change and Tidal Stream Energy Extraction on the Ecosystem of a Shelf Sea

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Ocean energy technologies offer the possibility of lowering CO_2 emissions, reducing the need for the use of fossil fuels, thus mitigating the effects of climate change, however their large-scale deployment is not without potential impacts on the marine environment including habitats for marine plants and animals. The aim of this work is to analyse these impacts for large-scale tidal energy extraction on the marine environment, which should be considered when planning future tidal energy exploitation. Here, we present how very large (hypothetical) tidal stream arrays and a ”business as usual” future climate scenario can change the hydrodynamics and biogeochemistry of a seasonally stratified shelf sea, and consequently modify ecosystem habitats and animals' population level distributions.

The Scottish Shelf Model, an unstructured grid three-dimensional FVCOM (Finite Volume Community Ocean Model) implementation, has been used to reproduce the present and the future state of the NW European continental shelf. In separate work, the marine biogeochemical/ecosystem model ERSEM (European Regional Seas Ecosystem Model) has been used to describe the corresponding biogeochemical conditions, coupled with the structured-grid NEMO model. Four scenarios have been modelled: present conditions and projected future climate in 2050, each with and without very large scale tidal stream arrays in Scottish Waters (UK). This allows us to evaluate the potential effect of climate change on the hydrodynamic and ecosystem variables, and compare it with the future state of the seas modified by large scale energy extraction.

As previously found (De Dominicis et al., 2018), climate change and tidal energy extraction both act in the same direction, in terms of increasing stratification due to warming and reduced mixing, however, the effect of climate change is ten times larger. By coupling the ERSEM model with FVCOM, we have the ability to more directly model the effects of the physical changes on primary productivity, focusing on levels of plankton production. Through the understanding of bio-physical habitat preferences of a range of forage-fish and top predator species (Sadykova et al., 2017) we can directly link the changes in the characteristics of plankton abundance with the predicted future distributions of mobile marine species..

REFERENCES

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