Geophysical Research Abstracts
Vol. 20, EGU2018-1928, 2018
EGU General Assembly 2018

Does tidal stream energy extraction locally ameliorate or exacerbate the effects of climate change?

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This study presents a plausible projection of how the hydrodynamic conditions on the NW European continental shelf might respond to climate change and to tidal stream energy extraction.
We numerically simulated changes on the physical marine environment of a shelf sea, induced by both the "business as usual" future climate scenario (RCP8.5) and by hypothetical very large tidal stream arrays in Scottish Waters (UK), able to provide 3.8 GW for electricity generation. This is about 10% of the UK present average instantaneous electricity consumption. Tides have been confirmed to be the most important contribution to energy available from the currents and we found that the energy available does not reduce under future climate conditions. Such large-scale tidal stream energy extraction is realistic, but unlikely to occur in the near future. It is an extreme best (worst in terms of impacts) case scenario to explore the environmental effects.
The Scottish Shelf Model, an unstructured grid three-dimensional ocean model, has been used to reproduce the present and the future state of the NW European continental shelf. A typical annual cycle of the present hydrodynamics was modelled, and compared with output for the same period of time perturbed by very large-scale tidal stream energy extraction developments. In order to determine if the latter may ameliorate or exacerbate the effects of future climate change on the marine system, the hydrodynamic conditions representative of the projected future climate in 2050 were modelled, including two scenarios, one without tidal energy extraction devices and a second with plausible very large scale tidal stream array layouts. This allows us to evaluate the potential effect of climate change on the hydrodynamics and compare it with the future state of the seas modified by large scale energy extraction.
It is found that where tidal range is reduced of by few cm by tidal stream energy extraction, it can help to counter extreme water levels associated with future sea level rise. Tidal velocities, and consequently tidal mixing, are also overall reduced by the action of the tidal turbine arrays. A key finding is that 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 an order of magnitude larger.