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Future offshore windfarm effects on ecosystem productivity: upscaling to the southern North Sea

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The North Sea has become a focus of renewable energy production with an increasingly large number and size of offshore wind farms (OWFs) planned in the German and British sectors in far deeper waters than before. As the North Sea is also a complex ecosystem that is strongly driven by hydrodynamical features such as tidal fronts and seasonal stratification, these large OWFs can be expected to impact the ecosystem dynamics in the area. Here, we use the coupled ecosystem model ECOSMO, previously used and validated for the area, to explore the consequences of large scale OWFs for marine ecosystem productivity. The model is forced with results from two model simulations of a high-resolution regional climate model, one with and one without implemented wind-farm parameterization using a near future wind farm scenario that includes existing and planned OWFs. Our major research focus lies on the large-scale, integrated effects imprinted on the ocean physics and ecosystem by changes in the atmospheric conditions rather than small scale processes. The simulations were integrated over the time period of one year and the average system response was analysed. The model shows a clear and direct response to the modifications in the atmosphere with respect to surface current speed, sea surface elevation and vertical transport depending on the wind direction. However, these immediate impacts are not visible in the ecosystem variables. Instead, the ecosystem shows an integrated (over the year) response related to the general modifications in stratification, transport pattern and bottom shear stress. It becomes evident that we cannot conclude a general increase/decrease pattern of change in ecosystem productivity, instead we can see changes in both spatial distribution and phenology of the lower trophic level ecosystem components, which we expect to be relevant for fish connectivity pattern and early larval survival for economically relevant fish species.