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The effect of offshore wind farms on the ocean dynamics

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Wind farms use the wind energy to produce electrical energy. A side effect of this energy transformation is a reduction of wind speed in and downwind of the wind farm, also called wind wake. In the case of offshore wind farms such a wind speed reduction impacts the oceanic dynamic. The resulting effects were investigated by idealized simulations with a shelf sea model of 3 km resolution. The atmospheric forcing was provided by a mesoscale model of same resolution that considers the impacts of wind turbines on the atmospheric flow. Thus impacts of the wind farms are considered in the oceanic forcing. Due to the wind wake the Ekman transport is locally reduced which causes a convergence/divergence dipole of the water mass transport within the wake zone in the surface Ekman layer. In conjunction with this upwelling and downwelling cells are induced which lead to a new distribution of the hydrographic conditions including an excursion of the thermocline by several meters. The vertical cells of upwelling and downwelling mainly depend on the size and structure of the wind farm and the meteorological conditions and can have horizontal dimension of several kilometres.
At the end a comparison with observational data is presented which shows a satisfactory agreement between model results and high-resolution CTD-data obtained for the first time in the vicinity of an operating windfarm.