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Assimilation of ocean colour to improve the simulation and understanding of the North West European shelf-sea ecosystem

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Shelf-seas and coastal zones provide essential goods and services to humankind, such as fisheries, aquaculture, tourism and climate regulation. The understanding and management of these regions can be enhanced by merging ocean-colour observations and marine ecosystem simulations through data assimilation, which provides (sub)optimal estimates of key biogeochemical variables. Here we present a range of applications of ocean-colour data assimilation in the North West European shelf-sea. A reanalysis application illustrates that assimilation of error-characterized chlorophyll concentrations could provide a map of the shelf sea vulnerability to oxygen deficiency, as well as estimates of the shelf sea uptake of atmospheric carbon dioxide (CO_2) in the last decade. The interannual variability of CO_2 uptake and its uncertainty were related significantly to interannual fluctuations of the simulated primary production. However, the reanalysis also indicates that assimilation of total chlorophyll did not improve significantly the simulation of some other variables, e.g. nutrients. We show that the assimilation of alternative products derived from ocean colour (i.e. spectral diffuse attenuation coefficient and phytoplankton size classes) can overcome this limitation. In fact, these products can constrain a larger number of model variables, which define either the underwater light field or the structure of the lower trophic levels. Therefore, the assimilation of such ocean-colour products into marine ecosystem models is an advantageous novel approach to improve the understanding and simulation of shelf-sea environments.