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Assimilation of remotely-sensed diffuse attenuation data to improve the simulation of a marine ecosystem model

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Biogeochemical processes in shelf seas and coastal areas can determine the health and productivity of local systems and are important terms of the global carbon budget. The quantitative characterization of the spatial-temporal evolution of biogeochemical variables in shelf-seas is thus relevant in the framework of marine system management and climate change studies

In this work we evaluate, for the first time, whether the assimilation of remotely-sensed diffuse attenuation coefficient data into a marine ecosystem model can improve the simulation of key biogeochemical variables and processes in a shelf sea.

A localized Ensemble Kalman filter was used to assimilate weekly SeaWiFS data of diffuse light attenuation coefficient, i.e. Kd(443), into an ecosystem model of the western English Channel, for the simulation of year 2006. The spatial distributions of (unassimilated) surface chlorophyll from SeaWiFS, and eighteen time series of biogeochemical and optical data measured weekly at the monitoring station L4 were used to evaluate the system performance. A comparative assimilation experiment was run by using SeaWiFS chlorophyll data.

We found that Kd(443) assimilation reduced the root mean square error and improved the correlation with the assimilated satellite observations in the largest part area of the WEC. The error for the (unassimilated) chlorophyll tended to decrease as well, but the estimates deteriorated in some parts of the study area.

Assimilation of Kd(443) provided better estimates of the (unassimilated) in situ data when compared with both the reference simulation and chlorophyll assimilation. Indeed, model RMSE and bias of the estimates decreased for more than a half of the variables, and the skill metrics resulted in general better for the assimilation of the optical data.

Importantly, assimilation of Kd(443) impacted the simulation of biogeochemical fluxes and ecosystem processes (e.g. shifted the simulated food web towards the microbial loop), and in some cases this impact contributed in improving the estimation of the in situ data, e.g. total particulate carbon.

Our results indicate that the assimilation of remotely-sensed optical properties can support more traditional approaches, e.g. chlorophyll assimilation, to improve the simulation of biogeochemical and optical variables that are relevant for ecosystem functioning, management and climate change studies.