Impact of assimilating biogeochemical data from multiplatform observing systems on ecosystem indicators

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Abstract

Data assimilation is a key component of several operational systems for ocean biogeochemistry, largely contributing to the quality and reliability of the resulting forecasts. The integration of multiple observation platforms and the provision of robust uncertainty estimates are two critical aspects of marine biogeochemical data assimilation.

Considering three European regional seas that represent different trophic regimes (the oligotrophic Mediterranean Sea, the eutrophic North-West Shelf and the Arctic seas), we apply ensemble-based data assimilation approaches to integrate multiplatform chlorophyll observations from remote sensing and in situ measurements. The assimilation is performed in both one-dimensional (1D) and three-dimensional (3D) frameworks, and the results are investigated in terms of impact on the uncertainty of a set of key ecosystem indicators (phytoplankton productivity and phenology, and carbon cycle). In the 1D numerical framework, impacts are evaluated across a range of assimilation configurations that explore different settings of observation type, frequency or coverage, and error. In the 3D simulations, a single multiplatform assimilation configuration is implemented in each of the three European regional seas.

The results consistently indicate a reduction in uncertainties across key ecosystem indicators, including subsurface processes and summer conditions. In particular, the combined assimilation of ocean colour and in situ profile observations substantially decreases uncertainty in primary production dynamics across all systems. However, the differences in impacts on ecosystem indicators estimated in the 1D and 3D simulations indicate that transferability from 1D to 3D configurations should be approached with caution.

Overall, our findings support the effective integration of satellite and in situ observations within current operational systems, enhancing the prediction of indicators relevant to ocean health monitoring and ecosystem management.