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Assimilation of ocean-colour phytoplankton functional types into an ecosystem model of the Mediterranean Sea

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In this work we investigated the spatial-temporal variability of the phytoplankton community structure in the Mediterranean Sea. A regional ocean-colour product of four phytoplankton functional types (PFTs; diatoms, dinoflagellates, nanophytoplankton, picophytoplankton, in chlorophyll concentrations, retrieved from the ESA's Climate Change Initiative Ocean Colour product) was assimilated into a coupled physical-biogeochemical model of the region (POLCOMS-ERSEM) by using the Ensemble Kalman filter (EnKF). The stochastic EnKF variant was applied here with 100 ensemble members, log-transformation of states and observations, and spatially variable localization of the analysis radius. Per-pixel estimates of the ocean-colour PFT uncertainty were applied to define the observational error in the EnKF scheme. We performed an assimilative reanalysis simulation for years 1998-2014. We found that the reanalysis outperformed the reference model simulation in forecasting the ocean-colour PFT distributions. This was demonstrated by increased spatial correlations between EnKF forecasts and the satellite product after PFT assimilation. Crucially, the reanalysis was skilled in reproducing a large in situ dataset of ten physical and biogeochemical variables, including pigment-based PFT data and biogeochemical-ARGO observations (fluorescence chlorophyll, oxygen, nitrate). The skill was evaluated by calculating robust skill metrics for the reanalysis-to-data match-ups. Annual PFT climatologies were obtained from the reanalysis product and their spatial variability was investigated by using a self-organizing-map (SOM) algorithm. We found that the Mediterranean Sea can be subdivided in five regions based on the relative abundance and phenology of the PFTs. The mean values and variability of the carbon export and trophic transfer efficiency were sensibly different in each region, in relation to the most relevant PFTs. The reanalysis and regional mapping presented in this paper offer new insights on the variability of the structure and functioning of the plankton community structure and related biogeochemical fluxes in the Mediterranean Sea, with possible applications in climate studies, as well as for aquaculture and ecosystem health management.