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A 15-year global biogeochemical reanalysis with ocean colour data assimilation

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A continuous global time-series of remotely sensed ocean colour observations is available from 1997 to the present day. However coverage is incomplete, and limited to the sea surface. Models are therefore required to provide full spatial coverage, and to investigate the relationships between physical and biological variables and the carbon cycle. Data assimilation can then be used to constrain models to fit the observations, thereby combining the advantages of both sources of information.

As part of the European Space Agency's Climate Change Initiative (ESA-CCI), we assimilate chlorophyll concentration derived from ocean colour observations into a coupled physical-biogeochemical model. The data assimilation scheme (Hemmings et al., 2008, J. Mar. Res.; Ford et al., 2012, Ocean Sci.) uses the information from the observations to update all biological and carbon cycle state variables within the model.

Global daily reanalyses have been produced, with and without assimilation of merged ocean colour data provided by GlobColour, for the period September 1997 to August 2012. The assimilation has been shown to significantly improve the model's representation of chlorophyll concentration, at the surface and at depth. Furthermore, there is evidence of improvement to the representation of pCO_2, nutrients and zooplankton concentration compared to in situ observations. We use the results to quantify recent seasonal and inter-annual variability in variables including chlorophyll concentration, air-sea CO_2 flux and alkalinity. In particular, we explore the impact of physical drivers such as the El Niño Southern Oscillation (ENSO) on the model's representation of chlorophyll and the carbon cycle, and the pros and cons of the model reanalyses compared to observation-based climatologies.

Furthermore, we perform a comparison between the GlobColour product and an initial version of a new merged product being developed as part of the ESA-CCI. Equivalent year-long hindcasts are performed with assimilation of each data set, and compared to a control run. Differences in the products are discussed, along with their impact on model accuracy compared to in situ observations, and the representation of the carbon cycle in each hindcast.