EGU25-11637, updated on 19 Apr 2026
https://doi.org/10.5194/egusphere-egu25-11637
EGU General Assembly 2025

Control of simulated ocean ecosystem indicators by biogeochemical observations.

Stefano Ciavatta[1], Paolo Lazzari[2], Eva Alvarez[2], Laurent Bertino[3], Karsten Bolding[4], Jorn Bruggeman[4], Arthur Capet[5], Gianpiero Cossarini[2], Farshid Daryabor[6], Lars Nerger[6], Mikhail Popov[7], Jozef Skakala[8,9], Simone Spada[2], Anna Teruzzi[2], Tsuyoshi Wakamatsu[3], Çaglar Yumruktepe[3], and Pierre Brasseur[7]

[1]Mercator Ocean International, Operational oceanography, Toulouse, France (sciavatta@mercator-ocean.fr)
[2]National Institute of Oceanography and Applied Geophysics, Italy
[3]Nansen Environmental and Remote Sensing Center, Norway
[4]Bolding and Bruggeman ApS, Denmark
[5]Royal Belgian Institute of Natural Sciences, Belgium
[6]Alfred-Wegener-Institut Helmholtz-Zentrum für Polar und Meeresforschung, Germany
[7]Université Grenoble Alpes, France
[8]Plymouth Marine Laboratory, United Kingdom
[9]National Centre for Earth Observation, United Kingdom

To protect marine ecosystems threatened by climate change and anthropic stressors, it is essential to operationally monitor ocean health indicators. These are metrics synthetizing multiple marine processes relevant to the users of operational services. Here we assess if selected ocean indicators simulated by operational models can be controlled (here meaning constrained effectively) by biogeochemical observations, by using a newly proposed methodological framework. The method consists in firstly screening the sensitivities of the indicators with respect to the initial conditions of the observable variables. These initial conditions are perturbed stochastically in Monte Carlo simulations of one-dimensional configurations of a multi-model ensemble. Then, the models are applied in three-dimensional ensemble assimilation experiments, where the reduction of the ensemble variance corroborates the controllability of the indicators by the observations. The method is applied for ten relevant ecosystem indicators (ranging from inorganic chemicals to plankton production), seven observation types (representing data from satellite and underwater platforms), and an ensemble of five biogeochemical models of different complexity, employed operationally by the European Copernicus Marine Service. We demonstrate that all the indicators are controlled by one or more types of observations. In particular, the indicators of phytoplankton phenology are controlled and improved by the merged observations from the surface ocean colour and chlorophyll profiles from biogeochemical-ARGO floats. Similar observations also control and reduce the uncertainty of the plankton community structure and production. However, the uncertainty of the trophic efficiency and POC increases when assimilating chlorophyll-a data, though observations were not available to assess whether that was due to a worsen model skill. We recommend that the assessment of controllability proposed here becomes

a standard practice in designing operational monitoring, reanalysis and forecast systems, to ultimately provide the users of operational services with more precise estimates of ocean ecosystem indicators.