Contribution of radiative transfer modelling to a stochastic biogeochemical forecasting system in the Black Sea

A numerical radiative transfer model is coupled with a 3D physical-biogeochemical model of the Black Sea. The development of a stochastic version of this coupled system aims at switching from a deterministic biogeochemical system to a stochastic one, in the scope of future developments in the biogeochemical component of the Black Sea Monitoring Forecast Centre. The radiative transfer model describes the propagation of surface irradiance on a water column in downward (direct and diffuse) and upward streams, with a spectral resolution of 25nm in the visible range. It is forced by the simulated fields of optically active components, taking into account the optical properties of several water constituents such as phytoplankton cells, detrital matter and CDOM. The simulated irradiance and PAR (Photosynthetically Active Radiation) fields are then compared with BGC-ARGO data. Surface fields of irradiance are also used to derive sea surface reflectance fields, which are in turn compared with satellite ocean colour products. Stochastic perturbations are then introduced into the model to account for the uncertainties that exist in its parameterisation: mainly in the optical properties of water constistuents and the surface forcing. Absorption and scattering properties of optically active components and surface radiative forcing are thus perturbed to represent the uncertainties in the model related to their parameterisation. The resulting ensemble experiments are useful to evaluate the ability of the model to reproduce distributions of sea surface reflectance in agreement with remote-sensed reflectance. We also use the model to provide new insights into the comparison between satellite ocean colour products to both chlorophyll fields simulated by the biogeochemical model and those derived from the simulated reflectance using ocean colour algorithms. The uncertainties introduced with the radiative transfer system are also analysed with regard to those that can be introduced in both the physical and biogeochemical components of the modelling framework. For instance, these include physical surface forcing (e.g. wind, temperature) and biological parameters (e.g. growth rate, semi-saturation constants). An extensive study of their influence was performed as part of the ODESSA project, with comparison to in situ data. This shows the potential benefits of running forecasts with a stochastic system and highlighting the additional information provided by such simulations. The relative importance of uncertainties in each component of the framework compared to the radiative transfer model expands on this study by providing additional data and a new validation variable with sea surface reflectance.

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