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Enhancing model-based predictions of chlorophyll-a, turbidity and temperature in surface water reservoirs through the assimilation of earth-observation-derived water quality parameters

Evangelos Romas (1), Kyriakos Kandris (1), Apostolos Tzimas (1), Ilias Pechlivanidis (2), Claudia Giardino (3), Mariano Bresciani (3), Karin Schenk (4), and Hendrik Bernert (4)

(1) EMVIS, Agia Paraskevi, Greece (romasvag@emvis.gr), (2) Swedish Meteorological and Hydrological Institute SMHI), Sweden, (3) National Research Council of Italy (CNR), Italy, (4) EOMAP, Germany

The application of earth observation (EO) data to retrieve water quality for inland water bodies has attracted severe attention over the last years. Thereby, water quality products derived from EO data include significant ecological parameters such as turbidity, suspended matter, chlorophyll concentrations, or water temperature. This work investigates how EO-derived water quality data can be combined with data assimilation (DA) techniques to improve model-based predictions of (a) temperature variations, (b) outbreaks of chlorophyll-a concentrations, or (c) events of increased turbidity in surface water reservoirs. Specifically, EO-derived water temperature, chlorophyll-a and inorganic suspended matter were assimilated in coupled hydrodynamic and water quality models using two alternative DA schemes: a simple direct insertion (DI) scheme and the Ensemble Kalman Filter (EnKF) scheme. The two candidate DA techniques were benchmarked against a DA-free simulation in two case studies for one-year long simulations.

EO-derived water temperature improved the corresponding model-based predictions; mean temperature errors were reduced by 0.2 oC to 1.2 oC for the respective case studies. Yet, improvements in model-based temperature predictions were inadequate to enhance the predictive abilities of the water quality models regarding chlorophyll-a or turbidity. The assimilation of EO-derived chlorophyll-a was a prerequisite for improving chlorophyll-a predictions. In that case, the reduction of mean chlorophyll-a errors was sizeable (in the range of 30%-50%), while DA-enabled predictions safeguarded against extreme errors; maximum errors dropped from 12 μg/l to almost 6 μg/l. Finally, the assimilation of EO-derived chlorophyll-a and inorganic suspended matter did not impact turbidity predictions substantially. Model results indicated that turbidity is a complex water quality parameter that is influenced by parameters, such as dissolved inorganic substances or detrital particulate matter, that are not assimilated in the model. Finally, results from the benchmark analysis of the two DA schemes indicated that the DI scheme was superior to the EnKF scheme when both prediction improvement and computational burden are considered. The low computational budget required for the DI scheme makes it particularly appealing for operational modeling applications.