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Coupling particle tracking model and satellite data for trajectories prediction

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Various physical, chemical and biological processes take place three- dimensionally in deep lakes, regulated by complex boundary conditions. Propelled by the rapid development of equipment, technology and computational power, the understanding of deep lakes has steadily advanced. In particular hydrodynamic monitoring and simulation studies have benefitted from combining field observation, numerical simulation and other emerging techniques such as remote sensing. In contrast, water quality parameters are less well investigated by this combination of tools. In this study, we integrate remote sensing techniques with a Lagrangian particle tracking model for lake water quality simulations. Specifically, our goal was to establish a successive individual-based model for health-relevant microorganisms in Lake Geneva. To this end, we combined remote sensing images from the current Sentinel 2 and Sentinel 3 satellites and Delft3D hydrodynamic and particle tracking models. Total suspended matter (TSM), which can both be detected by satellites and simulated by numerical models, is chosen as a parameter of concern. Concentration of TSM in Lake Geneva deduced from remote sensing images is used as observation to compare with particle tracking simulation to support the validation of the numerical model. On the other hand, the model allows to bridge gaps in satellite observations due to cloud coverage. Point source releasing and lake-wide dynamic pattern of TSM are employed as scenario studies to indicate the validation of our particle tracking model, focusing on time spans between 1 to 10 days. Our findings demonstrate that remote sensing images can serve to calibrate and validate the particle tracking water quality model, and in return, the particle tracking model provides the possibilities for data inference and interpolation between satellite images. The flexibility of the Lagrangian particle tracking method poses more possibilities to incorporate flow independent movement, mortality and growth of micro-organisms. It is expected that a more universal and accurate tool for water quality simulation can be created which will facilitate decision making.