Improving water quality forecasting using data assimilation

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Abstract. Population growth increases agricultural, industrial and human activities which threaten the quality of water resources, especially water supply sources such as lakes and reservoirs. In potentially high-impact situations such as algal blooms, active measures such as controlled release from reservoirs may be necessary. To minimize release while meeting the water quality requirements, accurate short-range water quality forecast is necessary. Because watershed water quality models have a large number of state variables most of which are never observed, their initial conditions (IC) are subject to large uncertainties which may propagate into large forecast errors. A data assimilation (DA) algorithm is developed and evaluated which updates the ICs of the watershed water quality model, the Hydrologic Simulation Program – Fortran (HSPF), based on real-time observations of water quality and streamflow. The water quality observations include streamflow, water temperature (TW), ammonium (NH4), nitrate (NO3), phosphate (PO4), chlorophyll-a (CHL-a), total nitrate (TN), total phosphate (TP), total organic carbon (TOC), biochemical oxygen demand (BOD), and dissolved oxygen (DO). The DA technique used is maximum likelihood ensemble filter (MLEF) which combines the strengths of variational assimilation (VAR) and ensemble Kalman filter (EnKF). The resulting DA algorithm is developed into a plugin module, referred to as MLEF-HSPF, for the Water Quality Forecast System at the National Institute of Environmental Research (WQFS-NIER). The results show that MLEF-HSPF consistently improves analysis and prediction of most of the water quality variables and streamflow over the DA-less results, but that the improvement varies significantly from catchment to catchment and from variable to variable.