RH: Dissolved oxygen prediction in reservoirs

Title: Do polymictic mixing regimes complicate prediction of dissolved oxygen in lakes and reservoirs?

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**Abstract**

As lake and reservoir ecosystems transition across major regimes as a result of anthropogenic change, it is increasingly important to set predictive expectations. In particular, mixing regimes are projected to shift in many lakes and reservoirs and can strongly control the dynamics of dissolved oxygen (DO), a major control on aquatic biogeochemistry, fauna, and general water quality for numerous ecosystem services. We tested the hypothesis that DO is more predictable in monomictic reservoirs that thermally stratify throughout the summer, warm season compared to polymictic reservoirs that stratify intermittently during the summer. We generated predictions of DO with random forest models and compared errors, aggregated at the daily scale, of DO across two monomictic and two polymictic reservoirs in the South-Central (subtropical) USA. Although one monomictic reservoir was typically more predictable than the polymictic reservoirs, the hypereutrophic and small monomictic reservoir had surprising DO patterns potentially related to rapid algal production in the epilimnion and intrusions of oxygenated waters in the hypolimnion without convective mixing. Daily mixing did not relate strongly to model errors. Water temperature, depth, and wind were the most important predictors, but were not clearly related to season or mixing. Lastly, we compared predictions across multiple model types (e.g., linear regression, the process-based model GOTM-WET (Water Ecosystems Tool), long short-term memory neural network) in one polymictic reservoir, finding that the models generally agreed, except GOTM-WET had difficulty predicting DO at the middle depth where the mixed layers vacillated above and below. Predicting reservoir DO dynamics may be easier in stratified reservoirs with a stably anoxic hypolimnion and consistent diel swings in the epilimnion, but we hypothesize that eutrophication and complex hydrodynamics may cause forecasting surprises for those who use or manage reservoir water resources.

**Key Words**: recurrent neural network, forecasting, Shapley Additive exPlanation (SHAP), variable importance, LASSO