Functional Forecasting of Dissolved Oxygen Lake Profiles

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Abstract

Predicting dissolved oxygen (DO) in lakes is important for assessing environmental conditions as well as reducing water treatment costs. High levels of DO often precede toxic algal blooms, while low DO causes carcinogenic metals to precipitate in water treatment. Typically, DO is predicted from limited data sets using hydrodynamic modeling or data-driven approaches like neural networks. However, functional data analysis (FDA) is also an appropriate modeling paradigm for measurements of DO taken vertically through the water column. In this analysis, we build FDA models for a set of profiles measured every two hours and forecast the entire DO percent saturation profile from two to twenty-four hours ahead. First, functional smoothing and Functional Principal Components (FPC) are applied, and then a vector autoregressive model predicts the FPC scores, which are used to create forecasts. Rolling training windows adapt to seasonality, and multiple combinations of window sizes, model variables, and parameter specifications are compared using both functional and direct root mean squared error metrics. We find that the FPC model outperforms a baseline persistence model and that including pH and conductivity variables improve the forecasts. Special attention is given to evaluating unusually shaped profiles or those with overall high or low DO.

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