The Role of Lake Physical Variables and Atmospheric Forcing on the Change in Algal Biomass in North American Great Lakes

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The perceived rise in algal biomass/bloom trends globally is assumed to be a result of climate change, however the assessment of interactions with atmospheric forcings are often limited to lab/mesocosm experiments and small-scale observational studies due to limited in situ data. This study utilizes new remote sensing data products (ESA CCI Lakes+, version 2.0.1) and gridded climate reanalysis data (ERA5 land hourly) to analyze daily time series of lake surface chlorophyll-a (Chl-a), and lake surface water temperatures (LSWT) for five North American Great Lakes (Great Bear Lake, Great Slave Lake, Lake Athabasca, Lake Winnipeg, Lake Erie) and their basins (2002-2020). Using a Dynamic Gaussian Bayesian Network (DBN), this research identifies the drivers of change in agal biomass trends. The DBN integrates past time series observations for predicting current and future Chl-a concentrations and provides Directed Acyclic Graphs outlining the direction of interactions. The DBN model returned a predictive RMSE of 0.32-4.63 μg L-1 (NRMSE = 0.73-0.98), where a timestep of 5 days most commonly returned the lowest error across all lakes. Lake Mixing Level Depth (LMLD) and LSWT were the most frequently occurring parameters in the best performing DBN models, with LMLD typically exhibited a negative slope while LSWT exhibited a positive slope in Chl-a concentration change. This study outlines the potential of remote sensing data to better understand the impact of changing climate on algal biomass and improve future projection models.