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A Wind-Derived Upwelling Index for Lake Michigan

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ABSTRACT

Coastal upwelling is a phenomenon that occurs along coastlines throughout the world, and has been shown to be strongly correlated with large fish populations in these areas. Coastal upwelling occurs when strong coastal winds drive water transport away from the coast, causing colder, often nutrient-rich water to upwell in its place. While coastal upwellings can be detected with satellite imagery or in situ temperature measurements, these datasets are neither continuous nor long-term. A wind-derived upwelling index was created for Lake Michigan to continuously quantify upwellings over multiple decades, and to allow for further understanding of the impact of upwelling in the Great Lakes region. Following work on oceanic upwelling, directional upwelling indices were calculated by taking wind velocity data from both buoys and land stations in Lake Michigan and estimating the off-shore transport of water as predicted by standard dynamical arguments (Ekman transport). Indices were calculated on episodic, daily, monthly, and seasonal timescales. The calculated indices were then validated with direct metrics of upwellings, including *in situ* water temperature and velocity data and satellite-derived sea surface temperatures (SST). The results of these validations show that there is a strong qualitative correlation between the upwelling index model and the other sources of data, suggesting that the wind-derived index is a robust metric of coastal upwelling, at least for Muskegon. Historical calculations of interannual variability in the derived upwelling index show that the Muskegon coast is downwelling favorable for the middle of the year, but can vary greatly from year to year in magnitude. Future work will include validation of additional locations in Lake Michigan in order to provide a more complete picture of upwelling in the lake.

KEYWORDS

upwelling, Lake Michigan, Great Lakes

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