Evaluation of multispectral air- and space-borne Chlorophyll-a products for remote monitoring of eutrophication in Western Lake Ontario

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Lake eutrophication is a rising global problem with negative environmental, economic, and health impacts. Western Lake Ontario (WLO) provides drinking water to over nine million people, primarily from the Greater Toronto Area (GTA). In recent decades, due to rapid urbanization in the GTA which increases urban phosphorous loads (primary factors contributing to algal blooms), as well as anthropogenic ecosystem changes, climate change, and discharges from the eutrophic Lake Erie, comprehensive water quality monitoring has become increasingly important in WLO. While traditional in-situ measurements are costly and laborious, satellite- or drone-based remote sensing (RS) can provide frequent and spatially distributed data; however, the reliability of the RS estimates has always been a concern. In this study, we examine the accuracy of multiple sources of RS imagery (five satellites and one drone) in estimating Chl-a concentrations (a proxy for phytoplankton blooms) in WLO. As a first step, more than 200 images (within the last 20 years) with more than 600 corresponding in-situ matchups have been collected and preprocessed. Secondly, the raw (level 1) images were corrected using ten different atmospheric correction methods. We then generated Chl-a products using various reflectance indicators on each atmospherically corrected set. As a final step, regression-based cross-validation was used to assess the accuracy of different Chl-a modelled compared to the matching measurements. In the end, using a variety of statistical metrics (i.e. lowest RMSLE), the best retrieval schemes (atmospheric correction plus spectral indicator) for each source were selected. The selected retrieval models proposed in this research may be helpful in future RS studies of WLO or any similar (oligo-mesotrophic) lake environments.