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Characterizing Louisville Wetlands from Above and Below to Better Predict Wetland Carbon Sink-Source Status

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There are 2.6-9 million small artificial ponds (surface area <10,000 m^2) that contribute at least 20% of the total standing water area across the conterminous United States. Given their ubiquitous presence, these small ponds may make important contributions to carbon (C) budgets across North America, and mounting evidence suggests that they emit greenhouse gases (GHG) at substantially higher rates per unit area when compared to larger bodies of water. However, these small ponds are challenging to measure and monitor consistently both on the ground and from above due to constraints in their practical implementation over space and time. To address those challenges, we explore the application of multi-scale land imaging techniques to capture higher spatiotemporal data from a remote sensing perspective and associate observed patterns with concurrent ground measurements. We leverage information from two different sensors, Sentinel 2 (10m) and PlanetScope SuperDove (3m) and we compare different atmospheric corrections for the optimal surface reflectance signal over water. In addition, we identify the most useful vegetation indices for correlating the remote sensing signal to in-situ field measurements of chlorophyll-*a*.

On each sampling date, algal biomass and presence of floating vegetation (*Lemna* and *Wolffia* spp.) are quantified along with turbidity. Data collection is done across a set of small ponds (n=24 fall/winter, n= 36 spring/summer) in Louisville, KY. Initial results using the high resolution (3m) imagery show that the choice of atmospheric correction influences the relationship between a remote sensing vegetation index and in-situ chlorophyll-*a* measurements. However, indices that leverage the green portion of the electromagnetic spectrum (550nm) seem the most promising overall as it is more sensitive to variation in chlorophyll-*a* than other ranges. The chlorophyll-*a* signal is important as it may provide a proxy for floating plants and algal blooms and therefore might be used for the determination of GHG emission hotspots. Notably, the data from the 2022-2023 fall/winter season reveal a stark contrast in surface emissions of CH_4 between ponds dominated by floating plants versus those with open water, with significantly higher emissions in duckweed-dominated sites. Complementary to the 3m spatial resolution of the Planet imagery, we potentially can link that signal to a remotely-sensed vegetation signal over time using the Sentinel 2a data in Google Earth Engine. We present ongoing work mapping the temporal signature of these small wetland ponds with observed differences in floating plants, open water, and duckweed coverage. We argue these are the first necessary steps in order to link a remote sensing signal to the appropriate wetland conditions that underlie GHG characteristics of small wetland ponds.

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