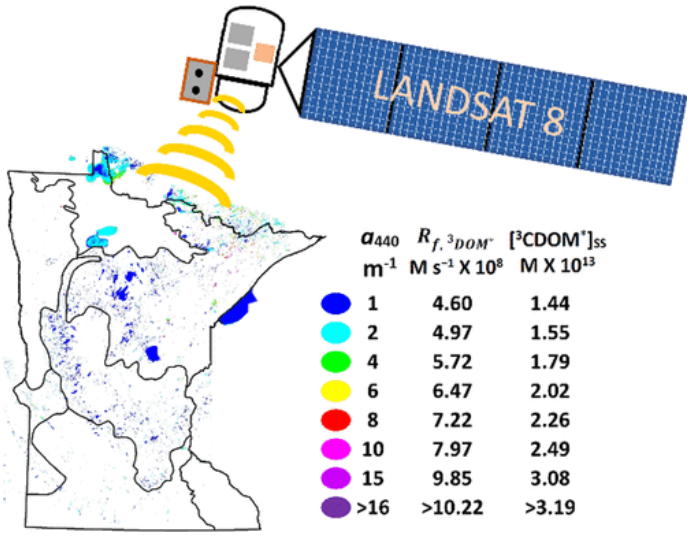
## Prediction of Photochemically Produced Reactive Intermediates in Surface Waters via Satellite Remote Sensing

Absorption of solar radiation by colored dissolved organic matter (CDOM) in surface waters results in the formation of photochemically produced reactive intermediates (here abbreviated as PPRIs) that react with pollutants in water. Knowing the steady-state concentrations of PPRIs ($[PPRI]_{ss}$) is critical to predicting the persistence of pollutants in sunlit surface waters. As demonstrated elsewhere on these pages, CDOM levels ($a_{440}$) can be measured remotely for lakes over large areas using satellite imagery.

As part of our NSF CDOM study, we performed laboratory studies to measure $[PPRI]_{ss}$ and apparent quantum yields (Φ) of three important PPRIs. (Apparent quantum yields represent the fraction of light absorbed that produces chemical change, i.e., in these cases, that produces one of the PPRIs). The three PPRIs studied are: triplet excited dissolved organic matter ($^3DOM^*$), singlet oxygen ($^1O_2$), and hydroxyl radicals (•OH), and all three of them can react very rapidly (but selectively) with various organic contaminants. In some cases, the PPRIs provide an important mechanism for degradation of pollutants in natural waters.

Measurements were made under simulated sunlight on 24 surface water samples collected from lakes across Minnesota with a wide range of CDOM levels. The total rate of light absorption by the water samples ($R_a$), the rates of formation ($R_f$), and $[PPRI]_{ss}$ of $^3DOM^*$ and $^1O_2$ increased linearly with increasing $a_{440}$. In contrast, the production rate of •OH was linearly correlated with $a_{440}$, but the steady-state concentration was best fit by a logarithmic function.

The relationship between measured $a_{440}$ and Landsat 8 reflectance data was used to map $a_{440}$ for all lakes with surface areas > 10 acres (>10,000 lakes) across Minnesota. Relationships of $a_{440}$ with $R_f$, $[PPRIs]_{ss}$, and $R_a$ were coupled with satellite-based $a_{440}$ assessments to map reactive species production rates and concentrations, as well as typical contaminant transformation rates. This study, published by Chen et al. (2020), which provides further details on the findings, demonstrated the potential for using satellite imagery for estimating contaminant loss via indirect photolysis in lakes.




**Reference**:

Chen, Y., R. M. Hozalski, L. G. Olmanson, C. G. Griffin, J. C. Finlay, P. L. Brezonik, and W. A. Arnold. 2020. Prediction of photochemically produced reactive intermediates in surface waters via satellite remote sensing. Environmental Science & Technology 54: 11, 6671-6681. https://pubs.acs.org/doi/10.1021/acs.est.0c00344.