Coupled Hydrologic and Biochemical Modeling of Lake Regions

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ABSTRACT

A test bed of 163 lakes in Wisconsin was examined using publically sourced satellite temperature data from 2002 to 2016. Our objective was to examine the accuracy of the satellite data and fit the data to a more accurate model in order to predict lake volumes. For the Earth Observing System Terra and Aqua satellite, the Moderate Resolution Imaging Spectroradiometer (MODIS) was used to extract Land Surface temperature (LST) values. The MODIS satellite produced both day and night temperature values; we solely utilized the data collected at night. Using a masking geospatial tool in ArcGIS, the LST pixel values were extracted with each lake polygon. The programming language R was used to perform several statistical analyses in order to properly examine the large data set. The curve of the plotted data was used to extract multiple coefficient values. Using the AICc package in R Studio, the most accurate model was determined. Lake area was the most significant parameter. To validate the generated models, the predicted volumes created from the AICc test were plotted against actual volumes. The model we generated provided a more accurate and efficient way to predict lake volumes using land surface temperatures.

RESULTS

Figure 1: All land surface temperatures from 2002 to 2016 for Clear lake (Permanent ID: 03035880)

Figure 2: Temperature Best Fit line (Quadratic) for every lake in Wisconsin region

Figure 3: Validation Plot for Lake Volumes with 1:1 Ratio Linear Fit Line

Figure 4: The Top Five Best Model Parameters Using AICc Test

CONCLUSION

By using land surface temperature, a new model was created. Though the model did not solve the entire problem, the accuracy was increased. The model used both lake area and change in temperatures. The results lead to two main ideas. Lake area is still the most important variable in predicting lake volume and lake volume predictions still require more analysis for depth description and lake size differentiation.

FURTHER STUDIES

Questions to consider following this study:

1. What other variables can be used that are correlated with land surface temperatures?
2. Would an energy budget provide more insight and could it be used on a mass scale model?
3. Does lake size play a larger role in analyzing lake volume models?

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