Geophysical Research Abstracts
Vol. 20, EGU2018-16259, 2018
EGU General Assembly 2018

Effects of Precipitation Calculation Method on an Urban Water Temperature Study

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Precipitation is a control on a multitude of water quality variables such as water temperature in urban systems, yet the choice of precipitation calculation method may substantially impact analysis. Urban water quality studies often fail to adequately characterize rain event dynamics at high spatial and temporal resolution; recent advances in the availability of citizen science and radar rainfall data may seek to address these issues. Here we examine the effect of using different precipitation measuring methods in the analysis of urban river water temperature.

Water temperature data was collected for 12 sites within the River Rea, a small, headwater, highly urbanized catchment in Birmingham, UK over summer 2016. Corresponding precipitation data was gathered from a quality checked weather station, citizen science rainfall database, and from rainfall radars. The citizen science and radar datasets were separated into point, and catchment estimates of rainfall. Generalised additive models (GAM) were used to model the relationship between the daily and sub-daily water temperature metrics against precipitation. Spatial variations between the rainfall calculation methods for a sample storm and water temperature surges during storms were visualised in GIS.

High variation in precipitation estimates between the different methods over the monitoring period was found. Of the point data, only the point radar dataset was suitable for modelling. This showed a significant relationship with low predictive capability ($P < 0.01$, $R2 = 0.18$). In contrast, catchment precipitation methods produced significant results for both radar ($P < 0.001$; $R2 = 0.66$) and citizen science methods ($P < 0.001$; $R2 = 0.60$) with strong predictive relationships. In the spatial relationship between precipitation and water temperature surges, citizen science and radar methods yield substantially different spatial patterns of storm events. For GAM models of precipitation against daily water temperature metrics, all models were significant ($P < 0.001$). Predictive capability was high for the weather station (Deviance Explained = 70.1%), and moderately high for the point citizen science methods (Deviance Explained = 53%) and catchment method (Deviance Explained = 51.7%) however predictive capability was for low for both point (Deviance Explained = 36.1%) and catchment (Deviance Explained = 34.1%) radar methods.

The results highlight the potential to use new forms of precipitation estimation methods in water quality studies, and raises questions over the suitability of point precipitation data as representative of catchments.