ABIOTIC CAUSALITY OF METABOLIC PROCESSES IN RIVERS

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While ecosystem metabolism, gross primary production (GPP) and ecosystem respiration (ER), is typically strongly coupled with hydroclimatic variations in terrestrial ecosystems, less is known about the controls on metabolism in flowing waters. Temporal patterns of river metabolism are not solely determined by seasonality of climatic conditions but also by local environmental conditions (e.g., microclimate, watershed size, proximal land cover) that cause fine-scale variability and complex interactions of abiotic drivers, such as light, temperature, and flow dynamics. Consequently, riverine metabolic responses on the drivers show strong spatial heterogeneity. To enable dynamic predictions of river metabolism, it is crucial to disentangle individual effects of the drivers from their collective force. In this study, we analyzed the individual effects of three abiotic factors, open-sky light availability, water temperature, and discharge, on river metabolism by applying convergent cross mapping (CCM), a causality detection technique, on long-term metabolism data of 39 US rivers. We specifically tested a systems-level hypothesis about causes of GPP and ER variation at a range of time scales. CCM results support systematic controls of the drivers on metabolic variations in rivers but with varying magnitude and time scales of abiotic causality among sites. Several notable findings included that 1) light did not or weakly caused GPP variation under dense canopy cover, 2) discharge was not causally related with both GPP and ER in rivers with dynamic flow, and 3) there were substantial differences in the time scales of causality for the three abiotic drivers. Predictions of metabolic rates were more accurate with CCM results than by regression models, suggesting that accounting for local environmental conditions and the relevant time scales of causality is crucial for effective forecasting. Our study implies that the causal interactions can be a key structure to explain site-specific controls on ecosystem metabolism in rivers.

PRESENTER BIO: Yuseung Shin is a PhD student studying river ecosystem. He received a master degree on biogeochemistry by studying carbon dynamics between streams and soils. His current works focus on temporal patterns and controls of ecosystem-level photosynthesis and respiration in flowing waters.