Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11536

Biomarker heatmaps to unravel the storm-induced source dynamics of fluvial particulate organic carbon: identification, transition, and conditional activation

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Rivers and streams mobilize and integrate particulate organic carbon (POC) from various sources during storm events, resulting in a complexly dynamic fluvial POC composition. The storm-induced dynamics of POC is often characterized by its rapidly changing nature that is dependent on multiple controlling factors such as storm hydrograph and source supply. However, few studies have investigated that behavior with sufficient temporal resolution to detect rapid changes in POC composition. This study uses high-temporal-resolution monitoring on POC compositions at the molecular level. Samples were collected in Clear Creek, an agricultural watershed in Iowa, at three sampling stations from upstream to downstream to trace the downstream transport of POC. Sampling was performed with approximate 2-hr intervals during two storm events distinct in seasonality (spring and fall) and antecedent precipitation history. Biomarker contents were analyzed using a broad-spectrum approach, TMAH-assisted thermochemolysis. Biomarker heatmaps were constructed to seek patterns in identification, transitions, and conditional activations of different POC sources during/between storm events. Our results demonstrated a clear molecular transition from algal and microbial OC to surface soil OC at all three sampling stations during both storm events. An additional molecular transition was identified by the long-chain fatty acid to lignin ratio (long FA/lignin) in the spring storm and most notably in the lower reach of the watershed where bank inputs have been hypothesized to be dominant. Biomarker analysis on soil and plant samples suggests that herbaceous (non-woody) bank vegetation and associated soils with high long FA/lignin ratios may be an important transient source at times. The accumulation of plant debris on banks during an extended low-discharge period prior to the spring storm may be the source of the transient input. Together, this study emphasizes the importance of high-temporal-resolution monitoring and a holistic understanding of various controlling factors such as stream morphology, antecedent conditions, and seasonality to gain a better picture of POC source dynamics during storm events.