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The Evolution of the Fluvial Storm Pulse Particulate Organic Carbon Signal

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Precipitation events trigger a series of organic C inputs to fluvial systems creating a propagating storm pulse signal. This signal evolves with transport downstream as it integrates inputs and interacts with the river corridor. Ultimately the fluvial material is delivered to depositional sinks and the signal is preserved. But what does the signal represent? Is it a watershed-scale integration of processes, and if so, how is the integration weighted? Previous studies have indicated that watershed size and topographic gradient are important controls on particulate OC composition.

To delve into this problem further, we have attempted to address a first order question “How does a storm pulse signal change with propagation downstream?”. This was done by sampling nested sites over a reach of ~30 km on a small creek in Iowa, USA with multi-hour resolution through multiple storm events. The OC was monitored using elemental (C, N), isotopic ($^{13}C/^{12}C$, $^{15}N/^{14}N$), and broad spectrum molecular (e.g. lipids, lignin, carbohydrates) measurements.

The particulate OC signal was highly dynamic through storms. Distinctive temporal patterns were found that correlated with the onset of precipitation and the subsequent increase in discharge. In-channel sources, such as algae, and eroded row crop surface soils were early inputs, followed by an upstream discharge-dependent signal. The temporal sequence became less well-resolved with transport downstream because of the integration of tributary inputs by the main channel, and a change in valley morphology. The row crop soil input was most pronounced in the upper portion of the watershed that had better connectivity between hillslopes and the channel. Bank inputs, which release previously trapped and now aged OC, become increasingly more important downstream.

This experiment illustrates a mechanism by which basin size influences storm signal composition. Downstream transport facilitates the spatial and temporal integration of inputs. The inclusion of pre-aged materials within preserved depositional 'Sink' signals is likely the result of this process. The preservation of upland signatures is expected to be limited to small riverine systems.