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Defining the moment of erosion: a challenge for geomorphology addressed with the novel principle of Thermal Consonance Timing

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There is strong need in geomorphological process research for quantitative information on erosion and deposition event timing and magnitude, in relation to fluctuations in the driving forces. This paper discusses a new measurement principle and technique - Thermal Consonance Timing (TCT) - which delivers clearer, continuous and quantitative information on erosion and deposition event magnitude, timing and frequency. This can help develop a better understanding of the driving processes because controls and geomorphological responses can both be monitored on the same time base. TCT of erosion events is based on monitoring the switch from strong to weak temperature gradients that occurs when sediment is removed from a space. Specifically, the paper (1) derives the TCT principle through soil micrometeorological theory; (2) describes how the TCT concept has been made initially operational for field and laboratory use; (3) presents experimental data for a simple soil erosion simulation; and (4) discusses the successful application of the TCT principle to Yorkshire rivers, where timing solutions have been obtained to river bank erosion events in relation to the hydrograph. Knowledge of event timing assists process inference.

River bank thermal regimes are shown to respond as classic soil temperature and energy balance theory would predict, and show very strong thermal gradients. TCT fixed the timing of some erosion events to before and after the discharge peak, sometimes many hours *after* re-emergence from the flow. The latter application confirms that delayed bank erosion can occur, quantifies the time-lag involved, and suggests a mass failure process rather then fluid entrainment. This adds to the very few directly quantified examples of *delayed* bank retreat events in the literature. Considerable potential exists to apply TCT approaches throughout many geomorphological contexts for: validating process models; improving process identification through simultaneous analysis of erosion events and driving forces; defining thresholds; discriminating between competing hypotheses of process dominance; refining dynamic linkages in event-based sediment budget investigations; and deriving closer approximations to 'true' erosion and deposition rates, especially in scour-and-fill systems. Also, the future integration of TCT with digital photogrammetric approaches would facilitate further useful advances in spatiotemporal dimensions of geomorphological process understanding.