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Sometimes processes don't matter: the general effect of short term climate variability on erosional systems.

Eric Deal and Jean Braun
GFZ, Section 5.5, Potsdam, Germany (edeal@gfz-potsdam.de)

Climatic forcing undoubtedly plays an important role in shaping the Earth's surface. However, precisely how climate affects erosion rates, landscape morphology and the sedimentary record is highly debated. Recently there has been a focus on the influence of short-term variability in rainfall and river discharge on the relationship between climate and erosion rates. Here, we present a simple probabilistic argument, backed by modelling, that demonstrates that the way the Earth's surface responds to short-term climatic forcing variability is primarily determined by the existence and magnitude of erosional thresholds. We find that it is the ratio between the threshold magnitude and the mean magnitude of climatic forcing that determines whether variability matters or not and in which way. This is a fundamental result that applies regardless of the nature of the erosional process. This means, for example, that we can understand the role that discharge variability plays in determining fluvial erosion efficiency despite doubts about the processes involved in fluvial erosion. We can use this finding to reproduce the main conclusions of previous studies on the role of discharge variability in determining long-term fluvial erosion efficiency.

Many aspects of the landscape known to influence discharge variability are affected by human activity, such as land use and river damming. Another important control on discharge variability, rainfall intensity, is also expected to increase with warmer temperatures. Among many other implications, our findings help provide a general framework to understand and predict the response of the Earth's surface to changes in mean and variability of rainfall and river discharge associated with the anthropogenic activity. In addition, the process independent nature of our findings suggest that previous work on river discharge variability and erosion thresholds can be applied to other erosional systems.