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Landscape signatures of time varying erosion rates

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Both tectonics and climate exert strong controls on erosion rates, and both of these forcings vary in time. Here we use simple numerical models to examine how landscapes respond to transient forcing, and if this time varying signal is preserved in the landscape. We specifically examine preservation that can be quantified using both topographic metrics and in situ cosmogenic radionuclides (CRN). We find that two end member scenarios of variable forcing lead to vastly different landscape response: variable base level change (causes, e.g., by fluctuating sea level or time varying fault displacement) leads to distinct waves of erosion that propagate upslope; evidence of several base level change oscillations may be preserved in a landscape. In contrast, variation in forcing that affects the entire landscape simultaneously (e.g., changes in rainfall) results in minimal preservation of oscillations. The relative timescale over which oscillations can be preserved increases with increasing hillslope relaxation time (proportional to the square of the length of the hillslope divided by hillslope diffusivity) and decreasing erodability of channels. Even in small catchments (i.e., <5km channel lengths) transient signals can be preserved for hundreds of thousands to millions of years.