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Upscaling bedrock erosion laws from the event to the year

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There is strong evidence that the physical processes of the bedload tools and cover effects drive the fluvial detachment of bedrock. However, it is unclear how representative the general long term and overall calibrations of the existing bedrock erosion process models are to predict individual erosion events. Evaluation of model robustness in terms of process capture and model parameterization for different temporal scales, therefore, would elucidate scalability of the governing processes and help improve future modelling efforts.

Here, we use a two-year comprehensive data set from a small Swiss pre-alpine stream to evaluate the temporal scaling of erosion model parameters. Continuous measurements of water discharge, bedload transport, normal stress at the streambed, and at-a-point erosion data in one minute resolution, supplemented with repeated sub-millimetre-resolved spatial erosion surveys of an in-stream 0.2m2 bedrock slab, are exploited to analyse the adequacy of erosion model parameterization. With this data set, we explore the time-dependent parameter space of the model-specific calibration factors and test whether bedrock erosion under sediment-starved conditions is linearly dependent on sediment flux. By this, at least for the field experiment on hand, we are able to constrain the rates of bedrock erosion over different temporal scales, to assess temporal stationarity of erosion model parametrization, and to verify the robustness of the governing equations used in landscape evolution models.