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Identifying transient dynamics in landscape evolution by inverse modelling of continental proxy-data

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Climate change can trigger transient responses of landscapes, which produce fluctuations in sediment supply to continental sediment archives. These fluctuations are a consequence of landscape-internal adjustments of the sedimentary-process-system to changes in climatic boundary conditions. Physical experiments and forward models predict, that such internal adjustments affect the preservation of climatic signals in sediment archives. However, approaches to decipher transient landscape responses from external forcing in proxy-data records from natural landscapes are missing. Here we present an inverse modelling approach to identify proxy variations in response to transient landscape dynamics from sedimentary records of continental archives. The approach is structured into (1) the synthesis of diverging proxy-records from sediment archives in similar environmental conditions, (2) the identification of common sedimentary processes via multivariate statistics of high-resolution geochemical data and (3) the identification of generic dynamical system models, which reproduce divergent proxy-variations under the assumption of a common forcing function. The approach was tested on Holocene proxy-records of three lakes situated in Tibet and lead to the identification of autogenic oscillations in sediment supply in response to abrupt climate change. We further discuss implications for the recovery of climatic signals from continental sediment records and the evolution of natural landscapes in response to climate change.