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Quantifying depositional processes in sediment archives using end-member modelling of grain size data

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Key proxies in sedimentary archives typically are derived from detrital grain size distributions, precisely measured by particle size analysers with often more than 80 grain size classes. Although grain size distributions contain a lot of information on past depositional environments, research typically neglects the complete distribution and uses instead only integrated measures of moments (i.e. mean sand/silt/clay content, sorting, skewness, kurtosis). These are biased, when applied to multi-modal distributions. Such distributions indicate different sources and sorting by different transport processes. To decipher the genetic fingerprints of sources and transport processes, grain size distributions need to be unmixed. Principles of eigenspace analysis and several scaling procedures are integrated in an end-member modelling algorithm (EMMA), which aims to reduce redundancy in the large grain size datasets producing only limited numbers of meaningful end-member distributions related to sedimentary processes. Their contribution to each sample in space and time as well as associated uncertainties can be quantified and the most robust sedimentation processes can be derived from several similarly-likely model runs.

Here we present the application of EMMA considering sediment archives in Donggi Cona lake system at the north-eastern Tibetan Plateau, China. Quantitative reconstructions of lacustrine, littoral, fluvial and aeolian sediment end-members are provided from modern and fossil offshore lake sediments and from onshore sequences of lake high-stand sediments. Knowledge on local catchment configuration is embedded in the conceptual frame of a catchment-wide sediment cascade. In a synthesis, Late Quaternary lake level changes, related sedimentary processes, and further regional reconstructions allow first inferences of dominant driving forces (i.e. climate, geomorphological, and neo-tectonic dynamics).