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Only pick the right grains: Modelling the bias due to subjective grain-size interval selection for chronometric and fingerprinting approaches.

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Many modern approaches of radiometric dating or geochemical fingerprinting rely on sampling sedimentary deposits. A key assumption of most concepts is that the extracted grain-size fraction of the sampled sediment adequately represents the actual process to be dated or the source area to be fingerprinted. However, these assumptions are not always well constrained. Rather, they have to align with arbitrary, method-determined size intervals, such as “coarse grain” or “fine grain” with partly even different definitions. Such arbitrary intervals violate principal process-based concepts of sediment transport and can thus introduce significant bias to the analysis outcome (i.e. a deviation of the measured from the true value).

We present a flexible numerical framework (numOlum) for the statistical programming language R that allows quantifying the bias due to any given analysis size interval for different types of sediment deposits. This framework is applied to synthetic samples from the realms of luminescence dating and geochemical fingerprinting, i.e. a virtual reworked loess section. We show independent validation data from artificially dosed and subsequently mixed grain-size proportions and we present a statistical approach (end-member modelling analysis, EMMA) that allows accounting for the effect of measuring the compound dosimetric history or geochemical composition of a sample. EMMA separates polymodal grain-size distributions into the underlying transport process-related distributions and their contribution to each sample. These underlying distributions can then be used to adjust grain-size preparation intervals to minimise the incorporation of “undesired” grain-size fractions.