Geophysical Research Abstracts
Vol. 14, EGU2012-4572-1, 2012
EGU General Assembly 2012

Age models and their uncertainties

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The usefulness of a proxy record is largely dictated by accuracy and precision of its age model, i.e., its depth-age relationship. Only if age model uncertainties are minimized correlations or lead-lag relations can be reliably studied. Moreover, due to different dating strategies (^{14}C, U-series, OSL dating, or counting of varves), dating errors or diverging age models lead to difficulties in comparing different palaeo proxy records. Uncertainties in the age model are even more important if an exact dating is necessary in order to calculate, e.g., data series of flux or rates (like dust flux records, pollen deposition rates).

Several statistical approaches exist to handle the dating uncertainties themselves and to estimate the age-depth relationship. Nevertheless, linear interpolation is still the most commonly used method for age modeling. The uncertainties of a certain event at a given time due to the dating errors are often even completely neglected.

Here we demonstrate the importance of considering dating errors and implications for the interpretation of variations in palaeo-climate proxy records from stalagmites (U-series dated). We present a simple approach for estimating age models and their confidence levels based on Monte Carlo methods and non-linear interpolation. This novel algorithm also allows for removing age reversals. Our approach delivers a time series of a proxy record with a value range for each age depth also, if desired, on an equidistant time axis. The algorithm is implemented in interactive scripts for use with MATLAB®, Octave, and FreeMat.