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Smoothing of millennial scale climate variability in European Loess (and other records)

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Millennial scale climate variability is seen in various records of the northern hemisphere in the last glacial cycle, and their expression represents a correlation tool beyond the resolution of e.g. luminescence dating. Highest (correlative) dating accuracy is a prerequisite of comparing different geoarchives, especially when related to archaeological findings. Here we attempt to constrain the timing of loess geoarchives representing the environmental context of early humans in south-eastern Europe, and discuss the challenge of dealing with smoothed records.
In this contribution, we present rock magnetic and grain size data from the Rasova loess record in the Lower Danube basin (Romania), showing millennial scale climate variability. Additionally, we summarize similar data from the Lower and Middle Danube Basins. A comparison of these loess data and reference records from Greenland ice cores and the Mediterranean-Black Sea region indicates a rather unusual expression of millennial scale climate variability recorded in loess.
To explain the observed patterns, we experiment with low-pass filters of reference records to simulate a signal smoothing by natural processes such as e.g. bioturbation and pervasive diagenesis. Low-pass filters avoid high frequency oscillations and focus on the longer period (lower frequency) variability, here using cut-off periods from 1-15 kyr. In our opinion low-pass filters represent simple models for the expression of millennial scale climate variability in low sedimentation environments, and in sediments where signals are smoothed by e.g. bioturbation and/or diagenesis.
Using different low-pass filter thresholds allows us to (a) explain observed patterns and their relation to millennial scale climate variability, (b) propose these filtered/smoothed signals as correlation targets for records lacking millennial scale recording, but showing smoothed climate variability on supra-millennial scales, and (c) determine which time resolution specific (loess) records can reproduce. Comparing smoothed records to reference data may be a step forward especially for last glacial stratigraphies, where millennial scale patterns are certainly present but not directly recorded in some geoarchives.
Interestingly, smoothed datasets from Greenland and the Black Sea-Mediterranean region are most similar in the last ca. 15 ka and again from ca. 30-50 ka. During the cold phase from ca. 30-15 ka records show dissimilarities, challenging robust correlative time scales in this age range. A potential explanation may be related to the expansion of Northern European and Alpine ice sheets influencing atmospheric systems in the North Atlantic and Eurasian regions and thus leading to regionally and temporally differentiated climatic responses.