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High resolution analyses of Upper Miocene lake deposits suggest the influence of Gleissberg-band-solar forcing

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A high-resolution multi-proxy analysis was conducted on a 1.5-m-long core of Tortonian age (~10.5 Ma; Late Miocene) from Austria (Europe). The lake sediments were studied with a 1-cm-resolution to detect all small-scale environmental variations based on palynomorphs (pollen and dinoflagellate cysts), ostracod abundance, geochemistry (carbon and sulfur) and geophysics (magnetic susceptibility and natural gamma radiation). Based on an already established age model for a longer interval of the same core the study covers about two millennia of Late Miocene time with a resolution of ~13.7 years per sample.

No major ecological turnovers are expected in respect to this very short interval. Thus, the pollen record indicates rather stable wetland vegetation with a forested hinterland.

Shifts in the pollen spectra can be mainly attributed to variations in transport mechanism, represented by few phases of fluvial input but mainly by changes in wind intensity and probably also wind direction. Even within this short time span, dinoflagellates document rapid changes between oligotrophic and eutrophic conditions, which are frequently coupled with lake stratification and dysoxic bottom waters. These phases prevented ostracods and molluscs from settling, and fostered the activity of sulfur bacteria.

Several of the studied proxies reveal iterative patterns. To compare and detect these repetitive signals REDFIT spectra were generated and Gaussian filters were applied. Significant peaks cluster in two discrete intervals corresponding roughly to 55–82 and 110–123 years. These fit well within the expected ranges of the lower and upper Gleissberg cycles. Thus, solar forcing may have influenced the prevailing wind directions, leading to a change in source area for the input into the lake. Moreover, the filtered data display comparable patterns and modulations, which seem to be forced by the 1000-years and 1500-years-cycles. The 1000-years-cycle modulated especially the lake surface proxies, while the 1500-years-cycle is mainly reflected in hinterland proxies, indicating strong influence on transport mechanisms.