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The role of solar forcing on paleoecological changes in calcareous nannofossils assemblages in the Early Miocene

AUER, G.[1], PILLER, W.E.[1], HARZHAUSER, M.[2]

[1] University of Graz, Institute of Earth Sciences, NAWI Graz, Heinrichstraße 26, 8010 Graz, Austria
[2] Geological-Paleontological Department, Natural History Museum Vienna, Burgring 7, 1010 Wien, Austria

Within a 5.5-m-thick succession of Upper Burdigalian (Karpatian) sediments in the North Alpine Foreland Basin (NAFB; Austria), dated to CNP-zone NN4, a high-resolution section was logged continuously. 100 samples were taken with a resolution of ~10 mm per layer and analyzed using an integrated multi-proxy approach. Analyses of geochemistry and calcareous nannoplankton assemblages hint at small-scale, short-term variations in paleoenvironmental conditions, such as water-column stratification, primary productivity, organic matter flux, bottom-water oxygenation, freshwater influx and changes in relative sea level. These variations reflect a highly dynamic shallow marine setting that was subject to high frequency environmental changes on a decadal to centennial scale. Our results allowed the reconstruction of short-term climate variability on a decadal to centennial scale for the first time in Lower Miocene shallow marine laminated sediments in a land-based section.

Time-series analyses on nine proxy-datasets using REDFIT-analysis and Wavelet spectra resolved a possible cyclic nature of these variations. A best-fit adjustment of the likely sedimentation rates resulted in periodicities fitting well with the Lower (~65 yr) and Upper (~113 yr) Gleissberg cycle as well as the Suess/de Vries (~211 yr) cycle, resulting in an estimated sedimentation rate of 575 mm kyr^{-1} with ~1190 yrs covered by the section. Different proxies for precipitation, upwelling intensity, and over all productivity were controlled by different cyclicities. Accepting these hypotheses, precipitation was driven by the two Gleissberg cycles, while upwelling was driven by the Suess cycle. Furthermore, proxies for primary productivity were influenced by both cycles, although the Suess cycle exerts dominant control, reflecting a stronger influence of upwelling on primary productivity. This hints at a close relationship between climate variability and solar forcing during the Late Burdigalian.