Orbital forcing of the Devonian climate? A search for Milankovic cycles in the magnetic susceptibility record of a km-thick Eifelian-Frasnian section (Belgium)

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The importance of orbital forcing for climate changes and sea level variations is well established for an icehouse world. In a greenhouse world, feedback mechanisms responsible for the translation of minor solar-energy variations into climate change are far less genuinely. A better understanding of orbital forcing under greenhouse condition is needed. This study outlines the role of orbital forcing in the Devonian climate, using magnetic susceptibility as a proxy. Magnetic susceptibility is the degree of magnetization of a material in response to an applied magnetic field and therefore is a good proxy for the rate of supply of the iron-bearing lithogenic or detrital fraction to the marine system. The main controlling factor of the lithogenic or detrital input is continental erosion, induced by climate related processes or adjustments in base level. Both erosion-inducing factors may be controlled by orbital forcing cycles, and thus magnetic susceptibility is thought to be a suitable proxy to identify these cycles. The studied section spans from Upper Eifelian up to the Middle Frasnian. The section is split up according to sedimentary environment, and spectral analysis (using the Blackman-Tuckey method) is carried out on magnetic susceptibility data. The sedimentary cycle-frequencies, proposed by the spectral analysis, are filtered out (using Gaussian filtering) and plotted against the raw data to ascertain the presence of this cycle.

This study hypothesizes that the sedimentary-cycles are orbital forced, which implies 3 scenarios: The dominant sedimentary cycle either is precession, obliquity or 100ka-eccentricity driven. Logically, each scenario has implications about sedimentation rate, climate-signal modulation and palaeogeography, which affect its probability. Using assumptions about sedimentation rate based on conodont zones and isotopic dates one the one hand, and the frequency-ratios, on the other, this study searches for the most probable scenario. First results are pointing to a precession-controlled sedimentary environment with a more modest influence of the 100-ka eccentricity cycle. These results confirm the important role of orbital forcing in a greenhouse world and give rise to hypotheses about feedback mechanisms responsible for these significant orbital forced climate changes. Besides, these results offer another estimation of the Devonian periodicity of the precession cycle, which is thought to be shorter than today due to the slowing of the earth's rotation (Berger, 1992). Furthermore, a floating time scale for this section is provided and cyclostratigraphy allows timing resolution up to ± 10 ka within the section.