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The Paleocene astronomical tuning, state of the art and insights from Bulgarian and Basque marine pelagic successions

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The development of orbital timescales has made notable and decisive steps in the last 10 years. The GTS2004 Geological Time Scale included an astronomical tuned timescale comprising the entire Neogene (i.e back to ∼23 Ma). Tuning for older ages is hampered by inaccuracy of the numerical solutions for the Solar System despite the advent of full numerical solutions in 2003 (R7 solution from Varadi et al) and the La2004 solution (Laskar et al.) one year later. The two solutions differ notably in the Paleocene due to the uncertainty arising from the chaotic behaviour of the inner planets to some resonant argument that limits an accurate age determination of successive minima in the very long eccentricity cycle. The knowledge of the duration and ages of strata that compose climatic archives containing an array of events becomes critical in Earth Sciences and climatic modeling communities and precise dating and timing of fluxes is also required. The ∼10 My long Paleocene Epoch is bracketed by two of the most dramatic and best studied chronostratigraphic limits, the K/Pg boundary at its base and the Paleocene-Eocene Thermal Maximum at the top. The Paleocene embraces, in addition, several short-lived climatic events or so called "hyperthermals", the Mid Paleocene Biotic Event (MPBE) or ELPE, the Danian-Selandian transition, the "top C27n event" and the Dan-C2 event. In an effort to provide astronomical tuned ages for the Paleocene, the Danian stage (∼4 My long) was first tuned from the (hemi)-pelagic Zumaia succession in 2003 to the R7 solution. A reduced eccentricity amplitude node at about 62.2 Ma in the numerical solution was used as starting tuning point of a prominent carbonatic interval at Zumaia, arriving at an estimated age of ∼65.83 Ma for the K/Pg. This node of the ∼2.25 My long-term eccentricity cycle at 62.2 Ma is the only one shared between the R7 and La2004 solutions but this may be coincidental and tuning should be better carried out using the more stable ∼404 ky eccentricity cycle However, the Paleocene still remains "floating" as a gap in the continuous tuned time-scale still exists in the middle Eocene. An independent constraint is provided by radio-isotopic numerical dating of the K/Pg boundary and, recently, intercalibration of radioisotopic and astronomical clocks has been put forward. A revised 40Ar/39Ar age of 65.95 Ma for the K/Pg boundary using the astronomical age of 28.202 ±0.023 Ma for the FCT sanidine standard seems to tight-constraint the tuning to a particular 404 ky eccentricity cycle but estimation of the full error propagation has not been properly emphasized. Furthermore, a full astronomical-tuned Paleocene is not yet achievable as no consensus exists in cycle-identification in Zumaia and correlation to an anticipated Paleocene tuned timescale constructed from Fe and magnetic susceptibility records of Ocean Drilling Program cores from the Pacific and Atlantic Ocean.

Here we evaluate new integrated magneto- bio- and cyclostratigraphic data of the Tethyan-Boreal Bjala succession in the Black Sea coast in Bulgaria that is correlated to Zumaia and Loubieng Basque sections substantiated by a low-field magnetic susceptibility and carbonate record in an attempt to further constraint global intercorrelation and shed light to some of the problems outlined above.