

A very simple criterion for the orbital-scale occurrence of interglacials and glacial inceptions over the last 800 kyr

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Past Interglacials Working Group of PAGES (2016) identifies eleven interglacials during the last 800 kyr based on a sea level definition: Marine Isotope Stage (MIS) 1, 5e, 7a-7c (as a single interglacial), 7e, 9e, 11c, 13a, 15a, 15e, 17c, and 19c. An important aspect of this definition is the occurrence of more than one interglacial within an MIS. Recently, the authors of this study proposed a simple rule to determine which insolation cycles lead to interglacials (Tzedakis et al. in press). During the last 800 kyr, interglacial onsets occur when a peak of caloric summer half-year insolation at 65°N exceeds a certain threshold which decreases with time. On the other hand, Ganopolski et al. (2016) proposed a criterion to diagnose the glacial inceptions over the last 800 kyr. Based on the experiments with CLIMBER-2, they derived a critical insolation-CO₂ relation curve, below which a glacial inception occurs. It is consistent with all the glacial inceptions happened, but incompatible with the lack of glacial inception near the insolation minimum at 209 kyr BP (MIS 7b). While the summer solstice (or mid-June) mean daily insolation at 65°N has about 20 % of variance in obliquity band, the caloric summer half-year insolation at 65°N has about 50 % of variance in the obliquity band. In this study, we show that the critical insolation-CO₂ relation in terms of caloric summer-half year insolation successfully diagnoses all the glacial inceptions over the last 800 kyr and its lack near MIS 7b. This is due to the fact that, near MIS 7b, the effect of precession maximum (boreal summer solstice at aphelion) is counteracted by the effect of average-above obliquity more strongly in the caloric summer insolation than in the summer solstice insolation. Unifying those two theories with the single caloric summer insolation metric, we present a particularly simple criterion for the orbital-scale occurrence of interglacials and glacial inceptions over the last 800 kyr. We also discuss how this criterion constrains the natural length of current interglacial.

References

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