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Cosmolian: High-resolution Integrated OSL and CN modelling Program for Sand Transportation in Eolian Realms (HIPSTER)

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The extensivity of sand dunes in continental interiors makes the understating of their morphodynamical properties valuable for palaeoenvironmental reconstructions and the interpretation of landscape evolution. Nevertheless, the study of aeolian landscape development at the million-years timescale is hampered by the complex interaction of factors determining dune migration and the inherently self-destructive nature of their chronostratigraphy, thus limiting the applicability of traditional luminescence-based dating methods for configuring processes beyond ~300 Ka. In this study, we present a standalone program that simulates aeolian transport based on luminescence-derived chronologies coupled with numerical modelling of cosmogenic nuclides accumulation. This integrative approach reveals ancient phases of sand irruption and provides a data-based scheme facilitating the morphodynamical study of aeolian processes over multiple timescales. We present a case study of the program application by analyzing data from the Australian Simpson Desert, unfolding several phases of aeolian vitality since the late Pliocene. The synchronicity of the results with drastic changes in environmental settings exemplifies the applicability of process-based modelling in constructing a timeframe of key landscape evolution events in arid environments by studying aeolian landforms. Finally, the relationships between model parameters used to determine environmental settings on sand migration patterns make the program a powerful tool to further investigating triggers and mechanisms of aeolian processes.