HIPSTER: A High-resolution Integrated Program for modeling Sand Transport in Eolian Realms by coupling OSL and cosmogenic nuclides (Cosmolian)

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The extensivity of sand dunes in continental interiors testifies to the importance of understanding their morphodynamical properties and their dating for palaeoenvironmental reconstructions and for interpreting landscape evolution. Nevertheless, the study of eolian landscape evolution at the million-years timescale is hampered by the complex interaction of factors affecting dune migration and the inherently self-destructive nature of their chronostratigraphy, thus limiting the applicability of traditional luminescence-based dating methods for configuring processes spanning over ~300 Ka. In this study, a standalone program that simulates eolian transport based on luminescence-derived chronologies coupled with numerical modelling of cosmogenic nuclides accumulation is presented. This integrative approach reveals ancient phases of sand irruption and provides a data-oriented scheme facilitating the study of eolian morphodynamical processes over multiple timescales. The program is applied on a case of the Australian Simpson Desert, where it unfolds multiple pulses of eolian vitality at 3.8-3.4, 2.9-2.5, and 1.5-1 Ma, corresponding to drastic changes in environmental settings. The synchronicity of the results with the independently established environmental framework exemplifies the applicability of process-based modelling in constructing a timeframe revealing key events in landscape evolution in arid environments by studying eolian landforms. Finally, the relationships between the model parameters used for simulating the environmental settings and sand migration patterns demonstrates the potential of the program in further investigating the triggers and mechanisms of eolian processes.