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The role of tectonics, geodynamics and surface processes in shaping Australian topography since the Pangea supercontinent

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The Eromanga Sea is an epeiric, epicontinental seaway that flooded central-eastern Australia during the Cretaceous in response to high eustatic sea levels and dynamic topography from deep Earth processes. We present new work that links mechanisms driving topographic change across the Australian continent, including global sea level change, erosion, sediment transport and deposition to better constrain the evolution of the Eromanga Sea in a tectonic, geodynamic and surface processes framework across a range of spatiotemporal scales. We implement continental-scale landscape evolution models with the aim of reproducing the northern drainage of the Eromanga Sea during the Cretaceous, and the southern drainage of the Murray-Darling Basin from the Late Cretaceous to the present-day. Plate tectonic reconstructions from the open-source cross platform GPlates software (www.gplates.org) are applied to drive forward numerical models of mantle convection to model the time-dependent contribution of mantle flow to surface topography. This predicted dynamic topography is linked to temporally and spatially varying tectonic and surface process parameters to generate landscape evolution models of the Australian continent using the open-source Badlands surface process modelling code (https://github.com/badlands-model). We test a range of initial and boundary conditions to place new constraints on the evolution of this inland sea, including the paleotopography of the Australian continent during the Late Triassic, and the magnitude and distribution of tectonic and dynamic topography following Pangea break-up. In addition, we explore the variability of precipitation and erodibility across the Australian continent and the combined effect of these parameters on erosion and sediment transport through time. Following iterative refinement, our preferred model requires initial topography that incorporates the influence of the African mantle superswell on the elevation of western Australia throughout the mid-Mesozoic, as well as differential erosion to the west and east of the Tasman Line that separates Proterozoic/Archean (western) and Phanerozoic (eastern) terranes. Our models reproduce the northern drainage of the Eromanga Sea without a connection to the embryonic Southern Ocean, as suggested by geological observations, by incorporating an Australia-Antarctic rift shoulder during the Late Cretaceous. In order to reproduce the subsequent southern drainage of the Murray-Darling Basin, the rift shoulder needs to be sufficiently eroded, thus constraining both its initial elevation ($\sim$100 $\pm$ 50 m) and its erodibility. Importantly, this study also presents a new and flexible workflow for the development of continental-scale landscape evolution models that capture erosion, drainage network evolution, and sediment deposition on geological timescales. Such an approach provides new avenues to study evolving paleogeographies of large regions through deep time, as well as explore the influence of tectonics, mantle convection, sea level and climatic influences (rainfall, etc.) on surface processes.