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Testing the interplay of eustacy and mantle driven dynamic topography in Australia

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It is known that mantle convection-induced topography can affect paleogeography, but the amplitude and spatio-temporal patterns of this process are controversial. We combine a plate kinematic and global mantle convection model with paleogeographic maps and geological data constraining continental subsidence, uplift, erosion and sedimentation to model the combined effects of eustacy and mantle convection on Australian paleogeography. We use the well-established analytical flow model approach for mantle convection modelling for the Tertiary, based on mantle density anomalies derived from the S20RTS shear-wave tomography model for the present day and backward advection for past times. Time-dependent dynamic surface topography is computed from this convection model using a free upper surface, and combined with a global sealevel curve to model continental inundation. Sediments in two major Tertiary depocentres, the Murray-Darling and Eucla basins, are backstripped through time to adjust the topographic baseline of the elevation model. We show that a combined eustacy and mantle-driven dynamic topography effect, validated with published geological observations including denudation estimates from fission-track data, can successfully reconstruct Australia's changing paleogeography through time. The model accounts for regional episodes of subsidence and uplift, whose origin were previously unknown. We find that eustacy and scaled mantle-driven dynamic topography are of similar magnitude for the Late Tertiary in Australia. As first-order sea level dropped due to progressive glaciation, much of Australia was drawn down as it moved towards the southeast Asian slab burial grounds, alleviating the eustatic effect for much of Australia during it's northward motion away from Antarctica. We demonstrate that understanding the interplay between eustasy and mantle-driven dynamic topography

is critical for understanding hinterland uplift, basin subsidence, the formation and destruction of shallow epeiric seas and lakes and their facies distribution.