EGU25-13762, updated on 21 May 2025
https://doi.org/10.5194/egusphere-egu25-13762
EGU General Assembly 2025

Unveiling Late Cenozoic Dynamic Topography Evolution Using Non-Linear Adjoint Models

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Mantle convection is the principal driver of Earth's long-wavelength surface structure, manifesting as dynamic topography—surface undulations induced by convective currents within the mantle. Unveiling the temporal evolution of dynamic topography remains a central challenge in **predictive geodynamics**. Adjoint methods have recently gained prominence for reconstructing mantle convection history and correlating it with key geological phenomena, including the cessation of marine inundation in North America, the uplift of Africa, and the tilting of Australia.

In this study, we introduce a new generation of retrodiction models developed using the Geoscientific ADjoint Optimisation PlaTform (G-ADOPT). These models incorporate Earth-like rheological parameters and leverage state-of-the-art Global Full□Waveform seismic tomography to achieve unparalleled resolution of mantle structures. The models are refined through integration with the latest plate reconstruction models, yielding regularised solutions that reconcile tectonic and seismic observations.

For the first time, we unveil the evolution of dynamic topography during the late Cenozoic, as derived from these advanced models. These results provide novel insights into the interplay between mantle convection and surface processes, refining constraints on dynamic topography and illuminating the forces that have governed Earth’s geological evolution.