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Spatial and Temporal variability in Dynamic Topography in East Antarctica

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Recent aerogeophysical exploration has provided novel views of the Gamburtsev Subglacial Mountains and the Wilkes and Aurora subglacial basins in East Antarctica. Reconstructing the evolution of East Antarctic topography through time is a critical next step for developing new coupled climate and ice sheet models (e.g. http://www.antscape.org/). Insights into tectonic and isostatic components driving the uplift of the Gamburtsevs have emerged from geophysical investigations and modeling (Ferraccioli et al., 2011, Nature). However, our knowledge of the larger-scale consequences of dynamic topography in East Antarctica remains poor compared to other continents. Seismic tomographic models provide a tool to derive large-scale models of convection in the Earth's mantle, which can then be used to reconstruct dynamic topography through time. By analyzing grids of global dynamic topography from present-day to 100 Ma based on the tomographic models S40RTS & S20RTS (Ritsema et al. 1999, 2011) we assess for the first time the potential space-time variability in dynamic topography in East Antarctica. We acknowledge that there are significant limitations when compared to similar studies over other continents, such as the relatively poor seismic resolution of the lithosphere and asthenosphere beneath East Antarctica and the lack of geological and geophysical data to constrain surface movements through time. However, currently available global datasets do reveal several new insights. Our models reveal that at ca 65 Ma the Gamburtsev Province and Dronning Maud Land regions were elevated. This was followed by at least 500 m of subsidence throughout the Cenozoic. The increased regional elevation likely facilitated ephemeral ice cap development in the early Cenozoic, which was followed by ice cap coalescence to form the East Antarctic Ice Sheet at ca 34 Ma. In contrast, a major and more rapid increase in elevation (up to 1,000 m) is observed over the Transantarctic Mountains (TAM) and the adjacent Wilkes Subglacial Basin, in particular over the last 15 Ma. Neogene dynamic topography in the TAM region may be related to the flow of warm mantle from the West Antarctic Rift System and/or the Balleny plume.