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Three-dimensional Edge-Driven Convection and Dynamic Topography at the Western Atlantic Passive Margin

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The Bermuda Rise, located in the western Atlantic region, is associated with a long wavelength topography anomaly that trends approximately parallel (NE-SW) to the passive margin of eastern North America. In conjunction to this topography high are topographic lows along the margin that manifest as a series of sedimentary basins such as the Scotian Basin, Georges Bank Basin, Baltimore Canyon Trough and Carolina Trough. A significant portion of the topography cannot be explained by ocean plate cooling or sediment loading. Instead, it has been postulated that the anomalous topography may be a result of the dynamic response of the surface to "edge-driven convection" in the mantle. We use three-dimensional numerical mantle flow experiments to investigate this possibility. The models show that time-dependent edge-driven convection develops as a small-scale cell of downwelling and adjacent upwelling at the lithospheric ocean-continent discontinuity. This causes proximal dynamic subsidence at the ocean-continental margin, juxtaposed with a topographic high located on the oceanic plate. In the 3D model, however, the vigour of the convection varies along the strike of the modeled plate margin and this is reflected as spatial variations in the amplitude of the surface topography. We compare the amplitude and wavelength of predicted dynamic topography with computed residual topography in the western Atlantic and along eastern North America. Timescales for the pulses of subsidence along the margin can be derived from the sedimentary record and can be interpreted with the ephemeral flow-related topography anomalies.