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Interplay between dynamic topography and flexure along the U.S. Atlantic passive margin: Insights from Landscape Evolution Modeling

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Abstract

Global backwards-in time models of mantle convection have resulted in vastly different interpretations of the transient state of dynamic topography on the U.S. Atlantic passive margin (Moucha et al., 2008; Spasojević et al., 2008; Rowley et al., 2013; Rovere et al., 2015). However, reconciling these geodynamic models with the observed offshore sedimentary record directly is complex because the sedimentary record integrates changes in climate, sea level, lithology, and tectonics. To circumvent this, we instead focus on modeling the observed deformation of the Orangeburg scarp, a well-documented 3.5 million year old mid-Pliocene shoreline (e.g. Rovere et al., 2015). Herein, we present results from a new landscape evolution model and demonstrate that flexural effects along this margin are comparable to changes in dynamic topography and are required to fully explain deformation of the Orangeburg scarp. Moreover, using the Orangeburg scarp as a datum subject to glacial isostatic adjustment, we demonstrate that a 15 m mid-Pliocene sea level above present-day is most consistent with interspersed coastal plain sediment and surface deformation derived from mantle convection and flexural-isostasy.

1. Introduction

The mid-Pliocene warm period (about 2.9 – 3.3 million years ago) was a crucial interval in Earth's history when atmospheric CO_2 concentrations were 350-450 ppmv (Pagani et al., 2009) (similar to present-day amounts), global temperatures were 1.9–3.6 ^{o}C warmer than pre-industrial levels (Dowsett