

Influence of Dynamic Topography on Sea Level and its Rate of Change

Clinton P. Conrad (*University of Hawaii at Manoa, Honolulu, Hawaii*)

Laurent Husson (*Université Rennes 1, CNRS, Rennes, France*)

Mantle flow likely supports up to 2 km of long-wavelength topographic relief over the Earth's surface. Although the average of this dynamic support must be zero, a net deflection of the ocean basins can change their volume and induce sea level change. By calculating dynamic topography and the geoid (including self-gravitation effects) using a time-dependent global mantle flow model (the CIG-supported spherical convection code *CitcomS*), we find that continents preferentially conceal depressed topography associated with mantle downwelling (background field, Fig. 1E), leading to net seafloor uplift and $\sim 90 \pm 20$ m of positive sea level offset. Upwelling mantle flow is currently amplifying positive dynamic topography and causing up to 1.0 m/Myr of sea level rise, depending on mantle viscosity (Figs. 1A & 1C). Continental motions across dynamic topography gradients also affect sea level, but uncertainty over the plate motion reference frame permits sea level rise or fall by ± 0.3 m/Myr, depending on net lithosphere rotation (Figs. 1E & 1F). During a complete Wilson cycle, sea level should fall during supercontinent stability and rise during periods of dispersal as mantle flow pushes continents down dynamic topography gradients towards mantle downwellings. We estimate that up to ~ 1 m/Myr of sea level rise may have occurred during the most recent continental dispersal. Because this rate is comparable in magnitude to other primary sea level change mechanisms, dynamic offset of sea level by mantle flow should be considered a potentially significant contributor to long-term sea level change.

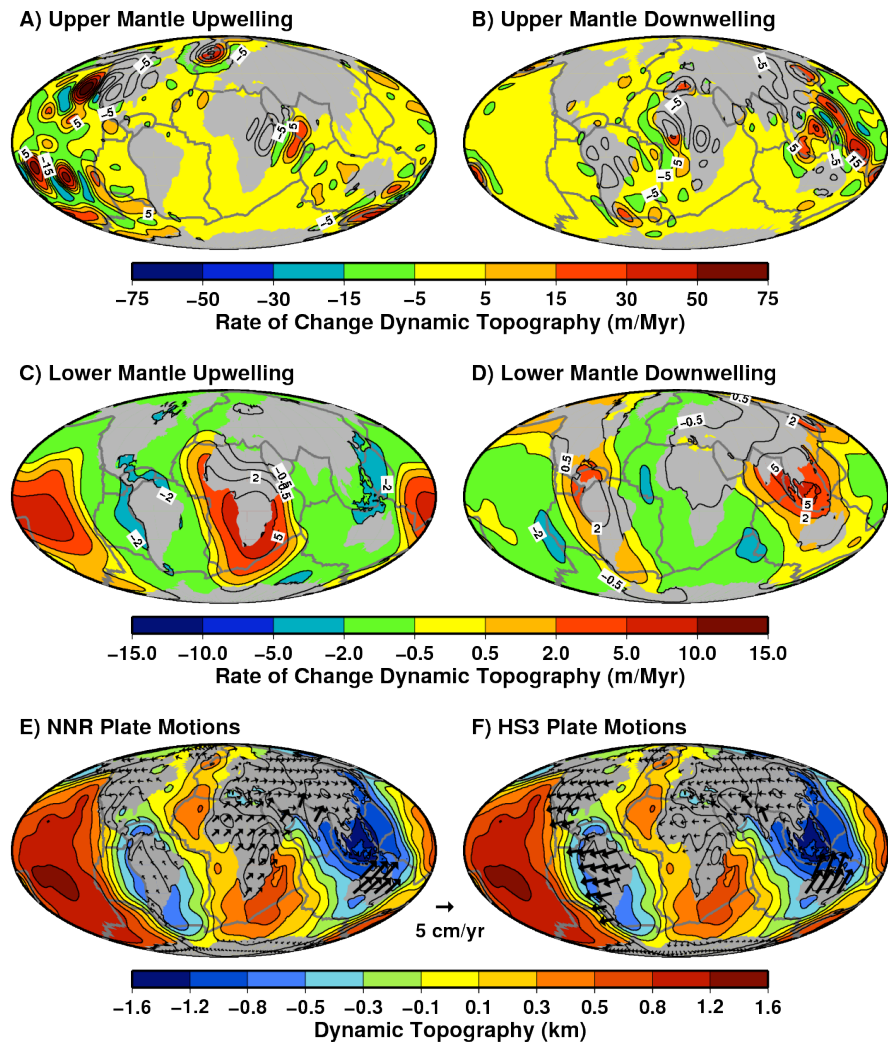


Figure 1. Rate of change of present-day dynamic topography determined from time-dependent mantle flow models driven by (A) negative and (B) positive density anomalies in upper mantle, and (D) negative and (E) positive density anomalies in the lower mantle. Thus, parts (B) and (D) show the time-dependence of topography associated with active upwelling flow, while (B) and (D) are driven by downwelling flow. Sea level change is also caused by continental motions over the full dynamic topography field, as shown here for plate motions in the (E) no-net-rotation (NNR) and (F) HS3 reference frames.

Reference

Conrad, C.P., and L. Husson, Influence of dynamic topography on sea level and its rate of change, *Lithosphere*, in press, 2009.