Global Paleogeogeographic Constraints on Dynamic Topography Change: Implications for Long-Term Sea Level and Variations in Mean Age of the Oceanic Lithosphere

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Internally consistent estimates of long-term sea level and changes in mean depth of the oceanic crust are derived from the assumption that the mean radius and corresponding mean elevation are unchanging aspects of Earth's short-term evolution. Changes in mean depth of the deep oceans, corresponding with changes in mean age of the oceanic lithosphere, acting over the area of the oceanic crust represent a volume change that is required to be balanced by a compensating equal but opposite volume change under the area of the continental crust. Models of paleo-cumulative hypsometry derived from a starting GIA-corrected ice-free hypsometry that conserve mean elevation provide a basis for understanding how these compensating changes impact hypsometry. The paleo-shoreline height and areal extent of flooding can be defined as the height and corresponding cumulative area of the solid surface of the Earth at which the integral of area as a function of elevation, from the maximum depth upwards, equals the volume of ocean water filling it. Present height of the paleo-shoreline is the height on the GIA-corrected cumulative hypsometry with an area equal to the areal extent of flooding. Paleogeographic estimates of global extent of ocean flooding from the Middle Jurassic to end Eocene, when combined with conservation of mean elevation and ocean water volume allow an explicit estimate of the paleo-height of the paleo-shoreline, and present height of the paleo-shoreline. The best-fitting estimate of present height of the paleo-shoreline, equivalent to a sea level curve, implying very modest (25±22m) changes in long-term sea level above the ice-free sea level height of +40m. These, in turn, imply quite limited changes in mean depth of the oceanic crust (15±11m), and mean age of the oceanic lithosphere (~8±6 my) since the middle Jurassic.