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Identifying geographical patterns of transient deformation in the geological sea level record

Karen M. Simon[1,2], Riccardo E. M. Riva[1], and Taco Broerse[3]
[1]Delft University of Technology, Delft, the Netherlands
[2]NIOZ Royal Netherlands Institute for Sea Research, the Netherlands
[3]Department of Geosciences, Utrecht University, Utrecht, the Netherlands

In this study, we examine the effect of transient mantle creep on the prediction of glacial isostatic adjustment (GIA) signals. Specifically, we compare predictions of relative sea level change from GIA from a set of Earth models in which transient creep parameters are varied in a simple Burgers model to a reference case with a Maxwell viscoelastic rheology. The model predictions are evaluated in two ways: first, relative to each other to quantify the effect of parameter variation, and second, for their ability to reproduce well-constrained sea level records from selected locations. Both the resolution and geographic location of the relative sea level observations determine whether the data can distinguish between model cases. Model predictions are most sensitive to the inclusion of transient mantle deformation in regions that are near-field and peripheral relative to former ice sheets. This sensitivity appears particularly true along the North American west coast in the region of the former Cordilleran Ice Sheet, which experienced rapid sea-level fall following deglaciation between 14-12 kyr BP. Relative to the Maxwell case, Burgers models better reproduce this rapid phase of regional postglacial sea level fall. As well, computed goodness-of-fit values in this region show a clear preference for models where transient deformation is present in the whole or lower mantle, and for models where the rigidity of the Kelvin element is weakened relative to the rigidity of the Maxwell element. In contrast, model predictions of relative sea-level change in the far-field show little or weak sensitivity to the inclusion of transient deformation.