GEOPHYSICAL IMPLICATIONS OF IMPROVED DYNAMIC TOPOGRAPHY ESTIMATES USING ASPECT

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Dynamic topography (DT) is defined as the deflection of Earth's surface due to the convecting mantle. ASPECT (Advanced Solver for Problems in Earth's ConvecTion) is a continually evolving, finite element code that uses modern numerical methods to investigate problems in mantle convection. Austermann et al. (2017) computed changes in DT using ASPECT version 1.4.0 to analyze the effects of DT on local peak sea level markers. Following the release of ASPECT version 2.2.0 a consistent boundary flux (CBF) algorithm, used to calculate radial stresses at boundaries, was implemented into ASPECT. It has been suggested that the CBF algorithm improves the accuracy of DT calculations by approximately one order of magnitude. We aim to quantify and illustrate the influence of the CBF algorithm by reproducing the DT experiments performed in Austermann et al. (2017) using the new CBF algorithm. Further, we explore the geophysical implications of our modified DT calculations in several regions including Africa, Hawaii, Iceland, and the Pitcairn Islands and surroundings. We constrain our initial temperature conditions using the tomography models SAVANI, S40RTS, and TX2008, each tested with a corresponding radial viscosity profile (2 for TX2008), and 3 different boundary conditions for a total of 12 experiments. We use the average instantaneous and rate change of DT for comparison with the earlier Austermann work. Our DT calculations show spatial consistency with results from Austermann et al. (2017), but generally indicate a decrease in magnitude for both instantaneous and rate change of DT. Our absolute mean present-day instantaneous DT and absolute mean rate change of DT is -16.928 m and -0.019 mm/yr, respectively, while the mean instantaneous and rate change of DT calculated in Austermann et al. (2017) is -49.524 m and -0.007 mm/yr. We conclude that the implementation of the CBF algorithm significantly influences DT calculations in ASPECT. This enhanced accuracy in DT calculations can be used to better evaluate the effects on surface processes including vertical motions, sea-level change, sedimentation, and erosion. Further, relevant publications that calculated DT using ASPECT without the CBF algorithm may need to be readdressed.
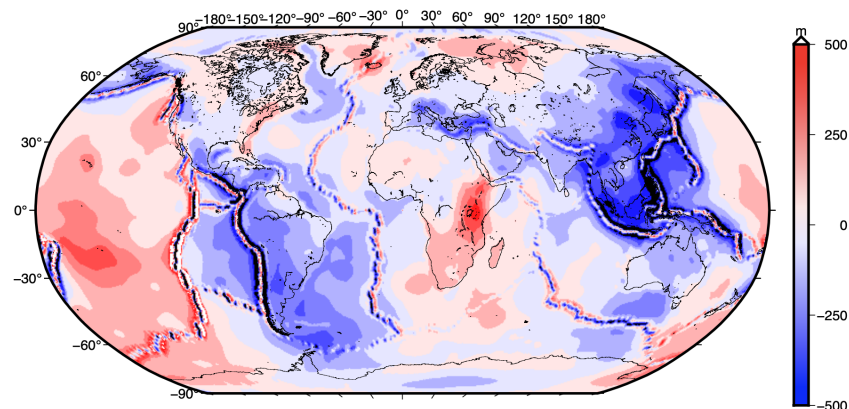
Figure 1. Residual plot differencing our mean present-day instantaneous DT estimates and estimates from Austermann et al. (2017)