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The importance of event locations in global tomography

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We utilize the LLNL_G3D procedure to investigate the influence of event locations on global tomography. The LLNL_G3D model extends from the surface to the core and the tomographic data includes P-wave rays with event-station distances ranging from near 0° to approximately 97°. Using the same events and arrival times, we create two tomography data sets for comparison. The first set of locations is determined one event at a time, using the ak135 model. The second set of event locations is determined through simultaneously relocation of the global data set using the Bayesloc procedure, which includes corrections for travel time prediction errors and assessments of data errors. For a selected set of 116 ground-truth events, the median epicenter error is estimated at 3.2 km for the Bayesloc dataset compared to 5.4 km for events located one-at-a-time. For both tomography data sets, we iterate tomographic inversion and event relocation to convergence. We find that epicenter shifts converge after 1 or 2 iterations of tomographic inversion and relocation. After one round of inversion, the median epicenter shifts for the Bayesloc data set is 2.7 km and the directions of epicenter shifts are random. In contrast, the median epicenter shift for the single-event data set is 7.2 km, and epicenters tend to move towards the Bayesloc locations. On average, single-event epicenters move strongly in the direction of the Bayesloc epicenters, but never converge to the same location. The resulting tomography models differ in many regards. The Bayesloc -based tomography model is significantly smoother and fits the data better than the single-event-based tomography model. The first-order pattern of velocity anomalies throughout the mantle is similar for the two models, but there are distinct differences in the shallow mantle from the crust to depths of a few hundred kilometers. As a result, travel times computed using the two models can differ by seconds at regional distances and a significant fraction of a second at teleseismic distances. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.