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Improving Event Locations Using a Global 3D P-Velocity Model of the Earth's Crust and Mantle

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To test the hypothesis that high quality 3D Earth models will produce seismic event locations that are more accurate and more precise than currently used 1D and 2/2.5D models, we are developing a global 3D P wave velocity model of the Earth's crust and mantle using seismic tomography. We call our model SALSA3D. To obtain an optimal model with as few nodes as possible, we use a progressive grid refinement methodology based on the diagonal of the model resolution matrix, resulting in a grid with spatial resolution that varies in both geographic and radial dimensions. To ensure that our data is in synch with our final model, we iteratively perform tomography and relocate the events in our catalog until the event locations stabilize. We use the model covariance matrix computed from our final tomographic model to calculate path-dependent travel time prediction uncertainties.

We compare the location capabilities of our model with the new path-dependent travel-time uncertainties and with a simple distance-dependent travel-time uncertainty model. We also compare SALSA3D against standard 1D and 2/2.5D models with simple distance-dependent travel time uncertainties. Location capability for each model is evaluated using a global event set with GT of 5 km or better. These events generally possess hundreds of Pn and P picks from which we generate different realizations of station distributions, yielding a range of azimuthal coverage and ratios of teleseismic to regional arrivals. The SALSA3D model reduces mislocation over the standard 1D ak135 model regardless of Pn to P ratio, with improvement most pronounced at higher azimuthal gaps.