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Improved Seismic Event Location and Prediction of P-wave Travel Times using the LLNL_G3D Global Earth Model

S. myers, N. Simmons, G. Johannesson, and E. Matzel
Lawrence Livermore National Laboratory, Earth Science, Livermore, United States (smyers@llnl.gov)

LLNL-G3D is a global-scale model of P-wave velocity from the surface to the core that is designed to accurately predict seismic travel times at regional and teleseismic distances. The latest version of LLNL_G3D is based on $\sim$2.7 million P and Pn arrivals that are re-processed using our Bayesloc global multi-event locator. Bayesloc is a formulation of the joint probability distribution across multiple-event location parameters, including hypocenters, travel time corrections, pick precision, and phase labels. Modeling the whole multiple-event system results in accurate locations and an internally consistent data set that is ideal for tomography. The Bayesloc data set is input into our recently developed inversion approach (called Progressive Multi-level Tessellation Inversion or PMTI), which operates at progressively finer resolution to image regional velocity trends and fine details where data allow. Travel time and location validation tests are based on a globally distributed set of 116 explosions with known locations and earthquakes with locations constrained by a local network. Validation events are not used in the tomographic inversion. The ak135 model is used as a baseline for travel time and location accuracy. Mean P-wave travel time prediction errors are reduced from 1.35 seconds to 0.8 seconds, a 40% reduction. Based on preliminary relocation tests, epicenter errors are reduced from an average of 11 km to 6 km when regional data dominate (a 45 % reduction) and from 10 km to 7 km when teleseismic data dominate (a 30% reduction). This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.