SALSA3D – A Global 3D P-Velocity Model of the Earth's Crust and Mantle for Improved Event Location

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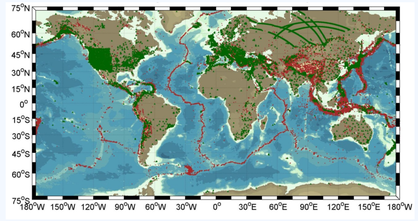
BACKGROUND AND MOTIVATION

The goal of this study is to develop a global, seamless, variable resolution model of the 3D velocity distribution in the crust and mantle of the Earth which can be used to predict the travel time of all crust and mantle body wave phases for seismic events at all hypocentral distances and depths.

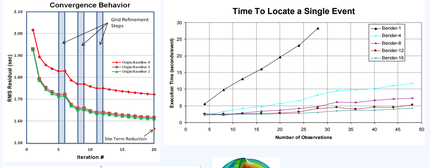
Effectively monitoring for small nuclear tests using seismic data requires utilizing regional phases whose characteristics vary greatly between different geographic areas. Current approaches typically use separate models developed for different geographic areas or for regional vs. teleseismic data, causing problems when transitioning between the models. Ultimately, what is needed is a single global 3D model derived from a single simultaneous inversion of a global data set encompassing both regional and teleseismic data. Several such models have been developed, but generally with the intent of providing insight into the structure of the inner Earth, not of improving treaty-monitoring capability. In this paper, we present our preliminary global P-velocity model developed specifically to improve event location using both teleseismic and regional phases.

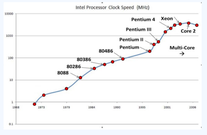
DATA

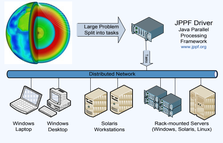
113K Events, 12K Stations, 12M P and Pn ray paths, GT 25 and better



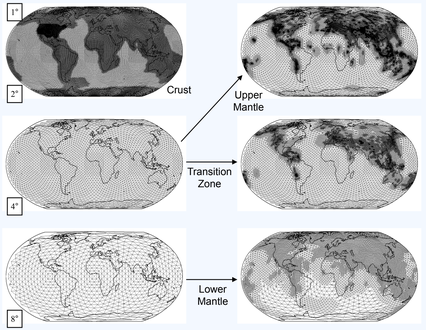
COMPUTATIONAL CONSIDERATIONS

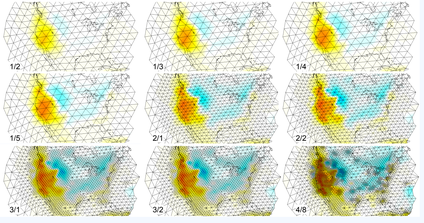


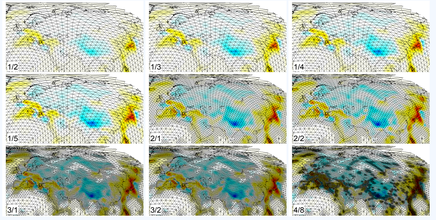


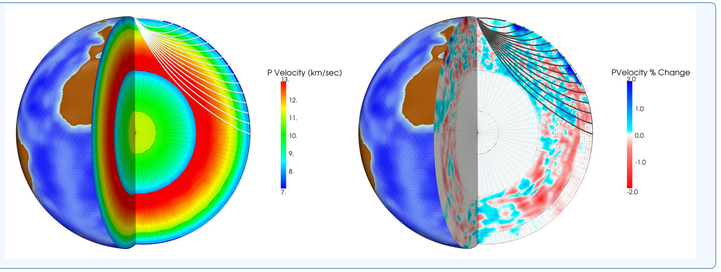


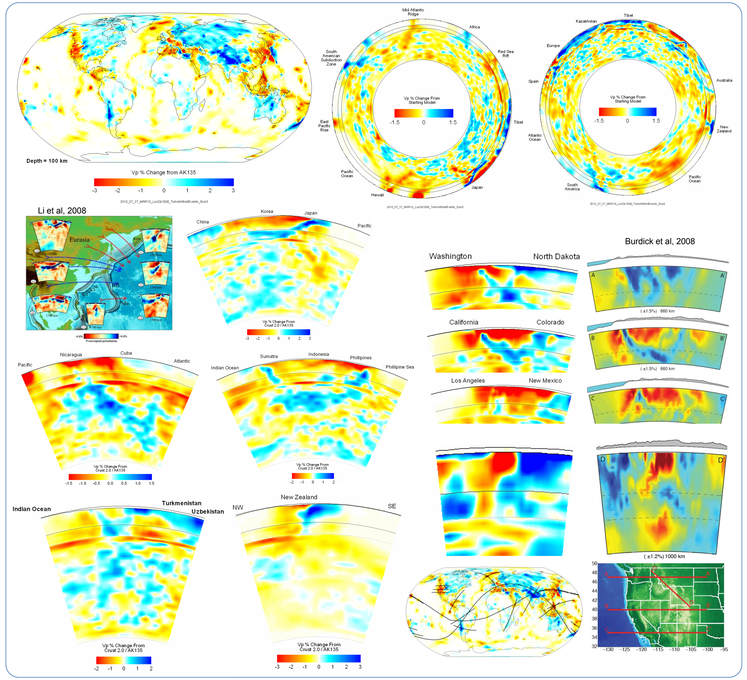
ADAPTIVE GRID



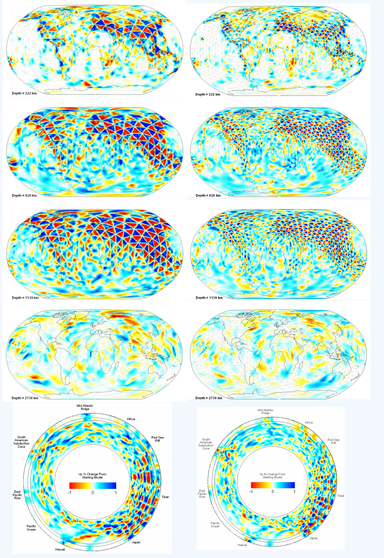




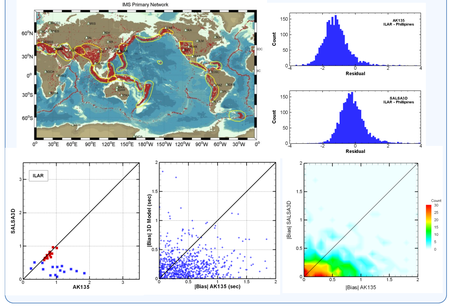




RESOLUTION TESTS (16° and 8° triangles)

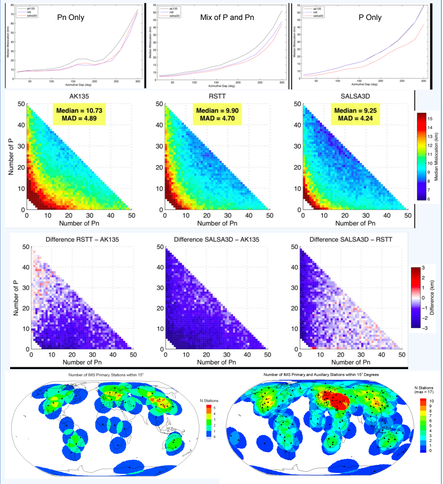


RESIDUAL REDUCTION



EVENT RELOCATION TESTS

We identified 52 seismic events with locations of GT5 or better that were detected at a large number of stations. We generated random realizations of different combinations of P and Pn arrivals, simulating different network configurations and event magnitudes. Realizations consisted of 5 to 50 arrivals with variable ratios of P to Pn detections. We relocated these events (627K origins with 20M arrivals) using 3 different models: AK135/TauPToolkit, RSTT and SALSA3D/Bender.



Conclusions

We have developed a seamless, variable resolution, 3D P wave velocity model of the Earth's crust and mantle designed to improve the accuracy of first P travel time predictions. Seismic event locations calculated with our model are more accurate than those computed by 1D and 2½D models for events observed by primarily teleseismic networks.

Our most significant remaining challenge is to compute the uncertainty of travel time predictions obtained with our model.

References

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