SAND2017-5186C

SALSA3D

A Global 3D Velocity Model For Improved Seismic Event Location in Nuclear Explosion Monitoring

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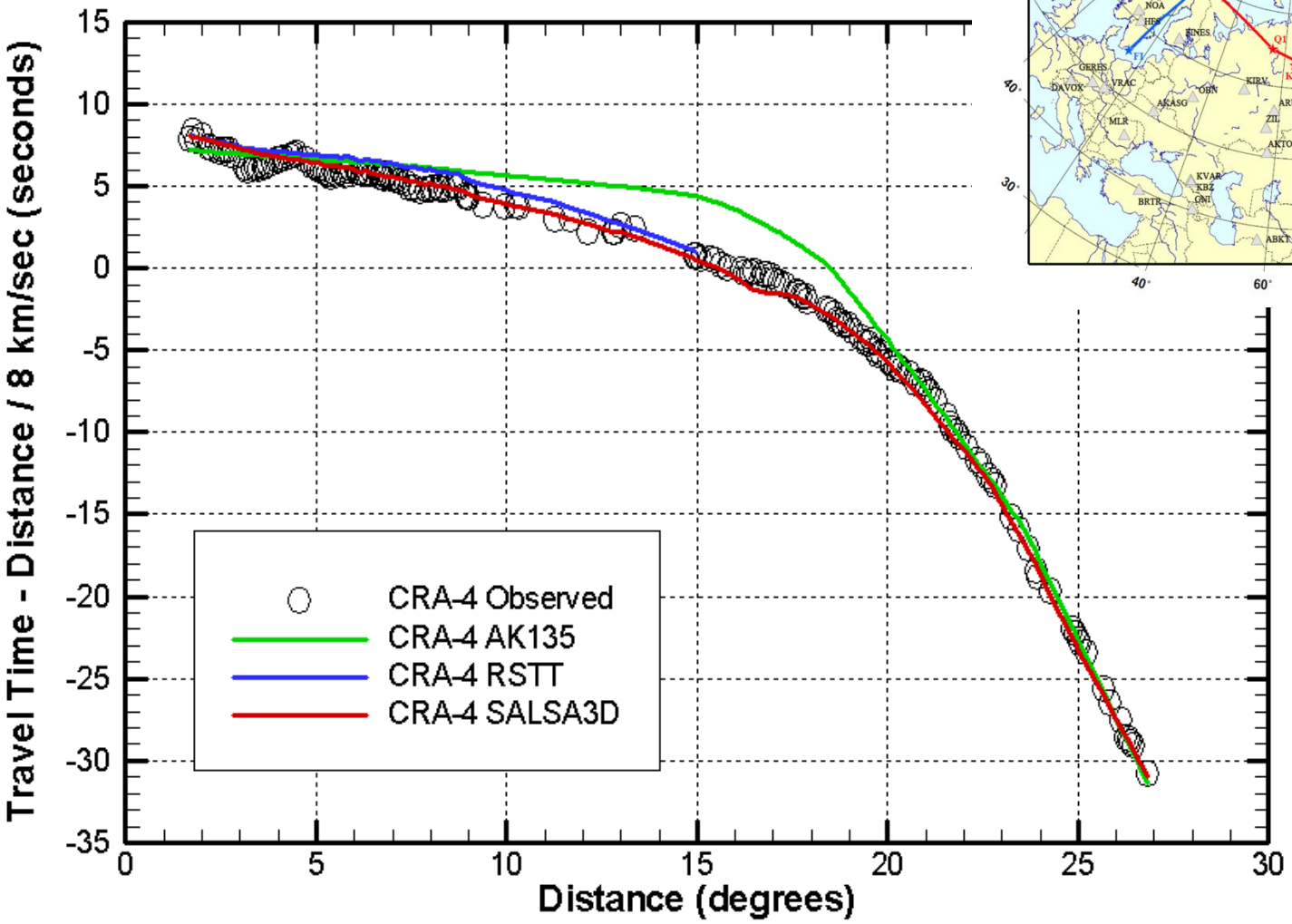
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

SALSA3D

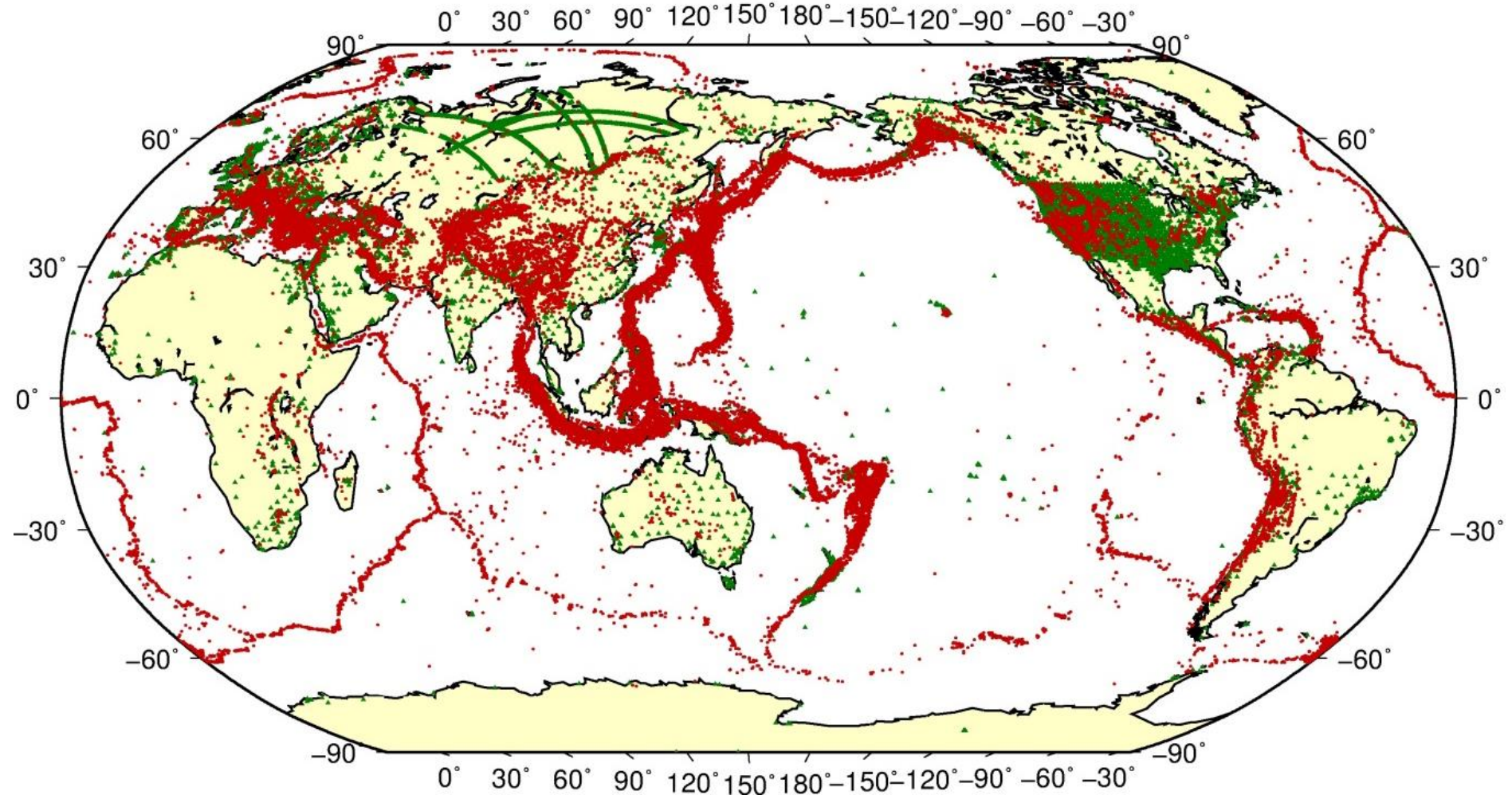
- The accuracy and precision of seismic event locations depends heavily on the accuracy can precision of predictions of observed travel time.
- Travel time predictions depend in turn on the accuracy and precision of the Earth models used to predict them.
- The CTBTO currently uses a 1D radially symmetric Earth model with empirical corrections applied to regional predictions at some stations.
- RSTT is an attempt to improve on the current practice by using a tomographic model of the Earth's crust and upper-most mantle to improve the accuracy of regional travel time predictions. It currently uses 1D distance dependent travel time prediction uncertainty.
- Further improvements are possible by using a full 3 dimensional model of the P and S velocity of the Earth's mantle.

Deep Seismic Sounding (DSS) Lines

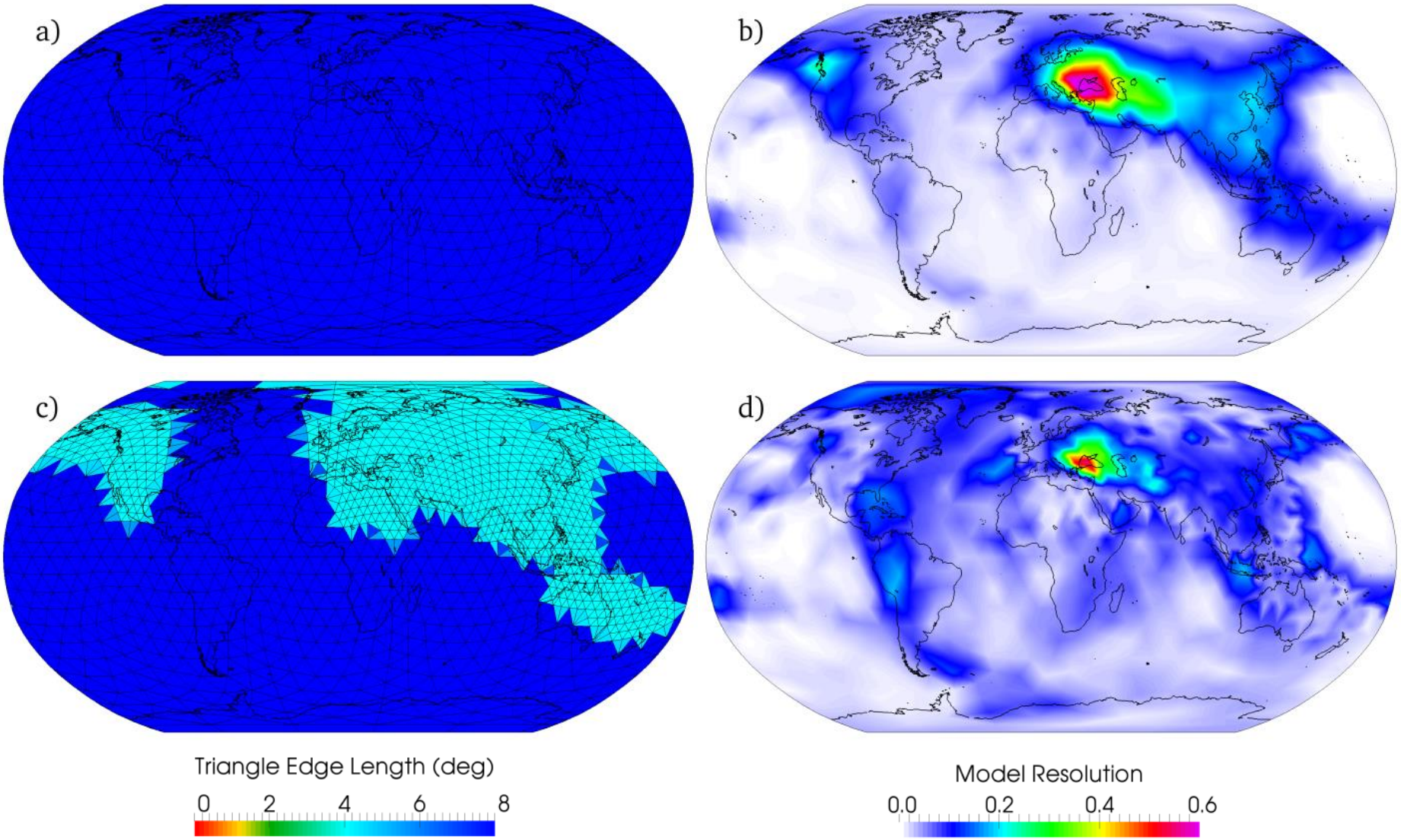


Tomography Data

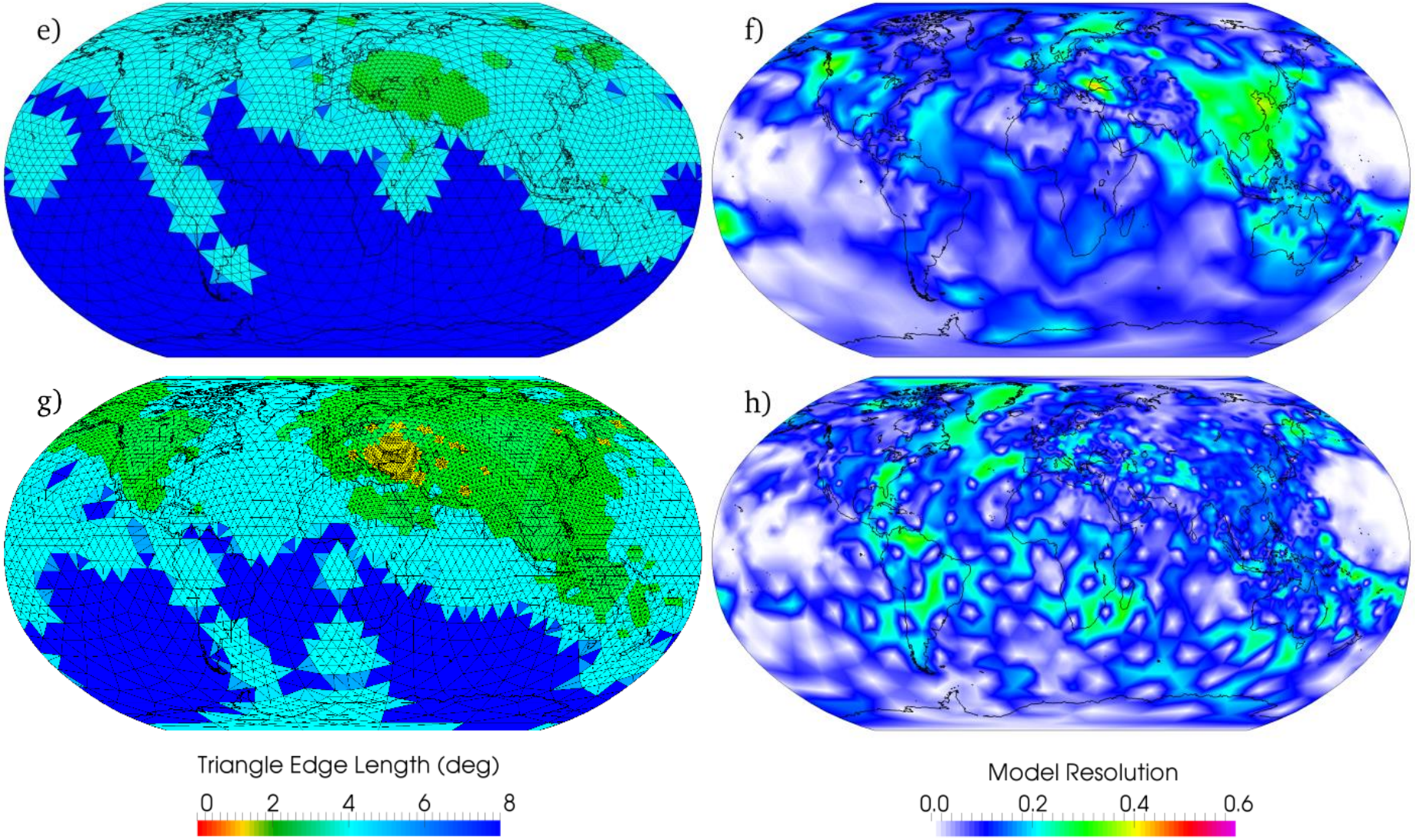
117K events **12K stations** **12M ray paths**



Grid and Model Resolution



Grid and Model Resolution



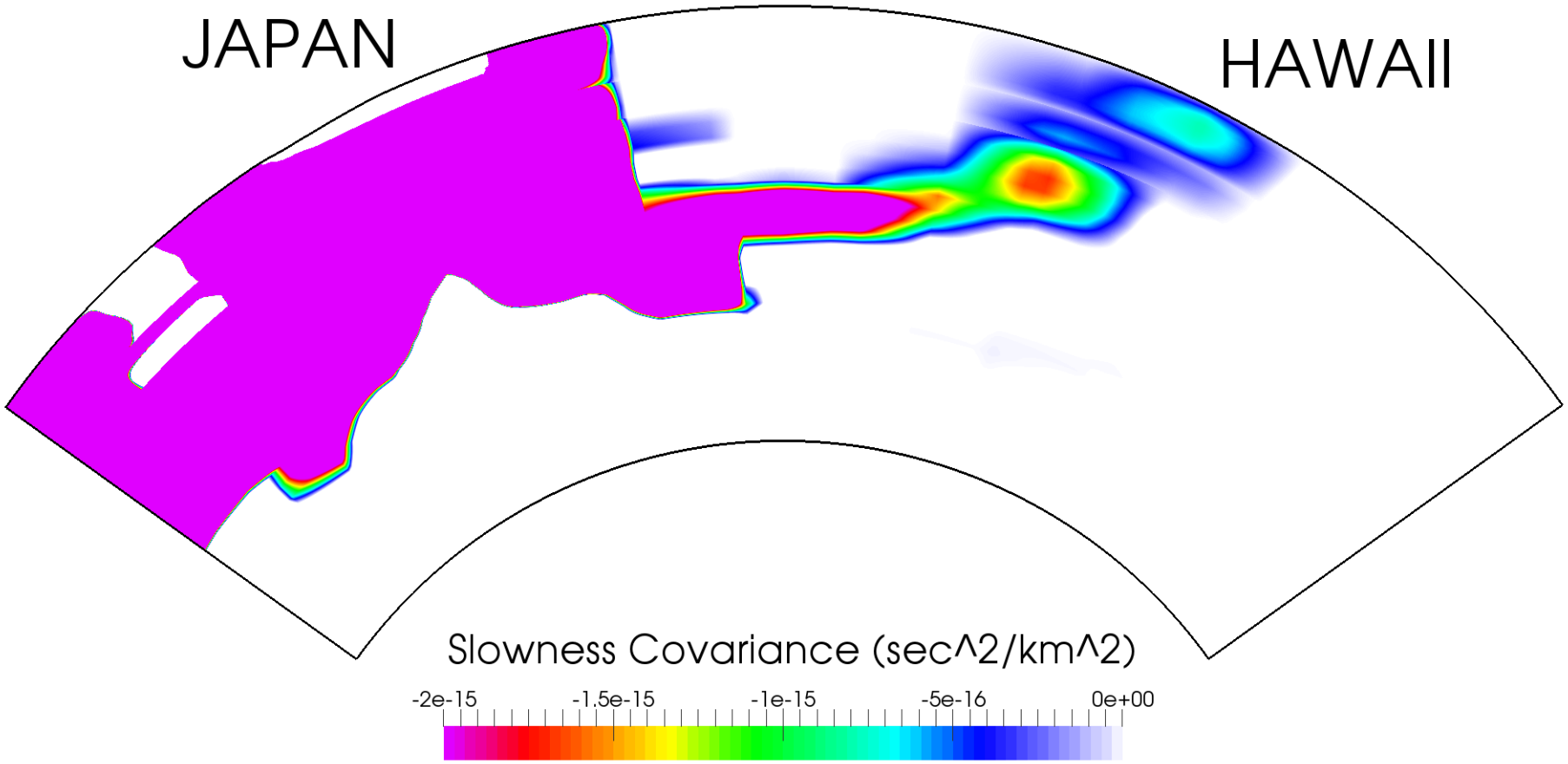
Mantle Slowness and Slowness Uncertainty

100 km
± 3%

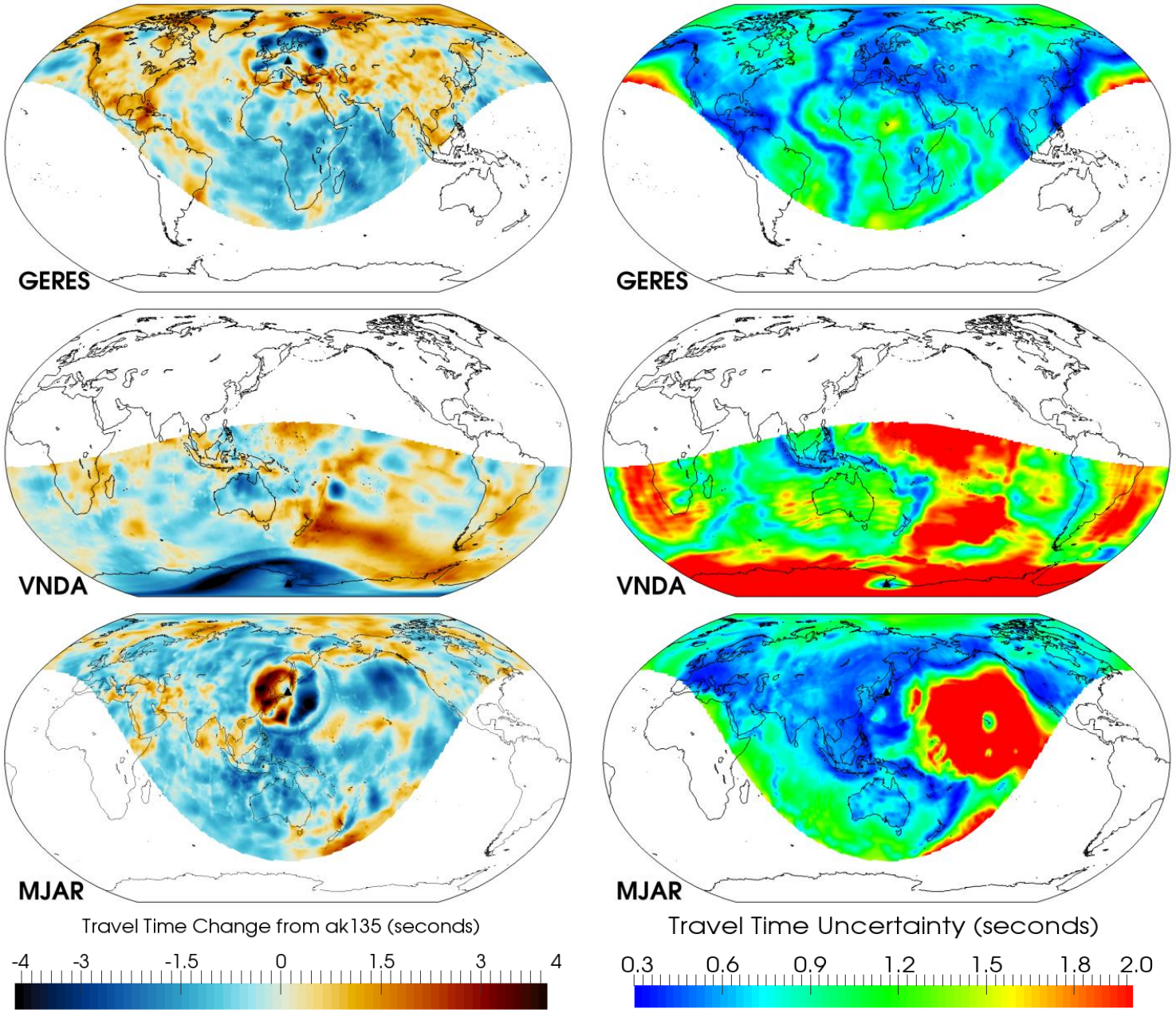
500 km
± 1.5%

2500 km
± .8%

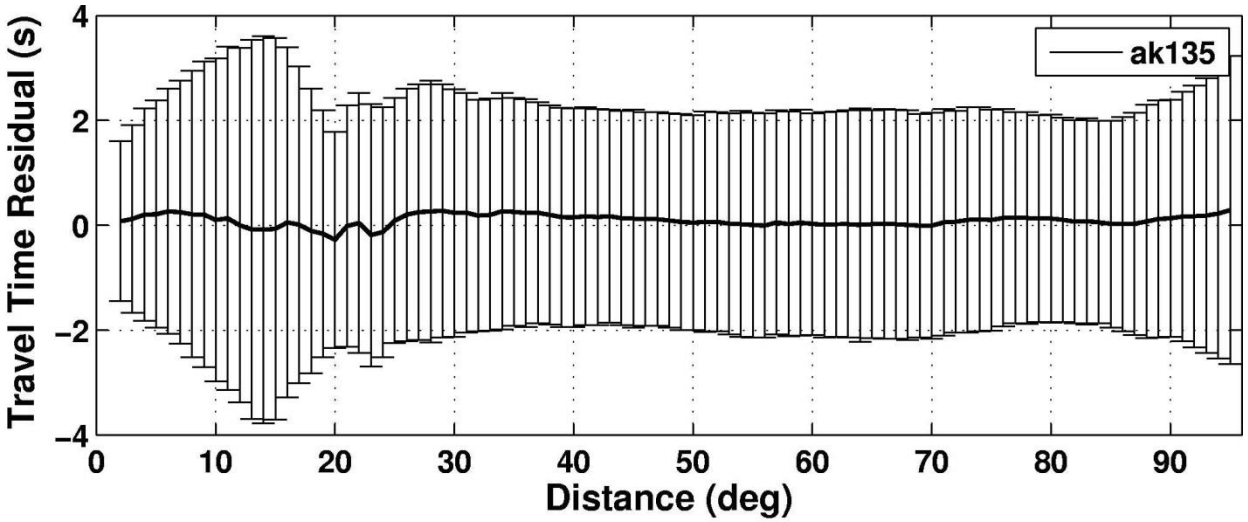
Importance of Model Covariance

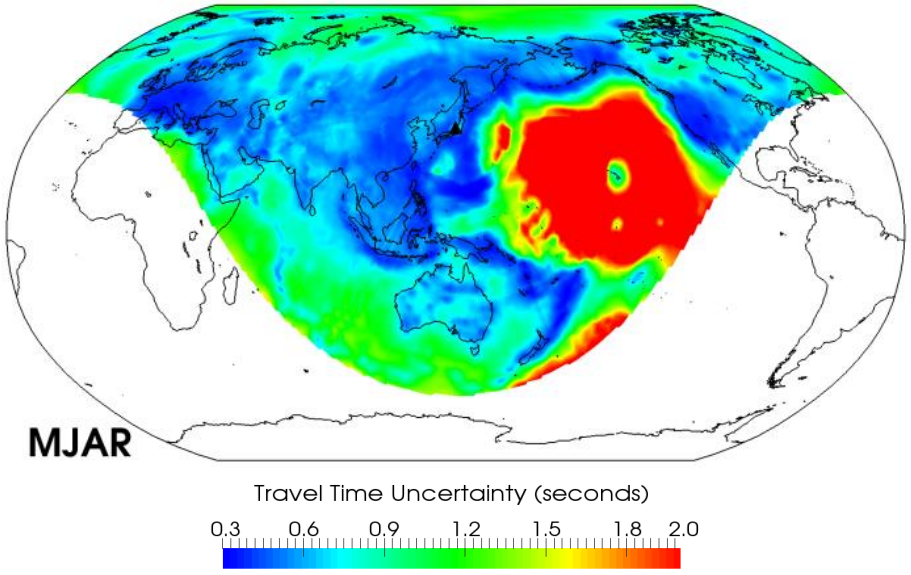


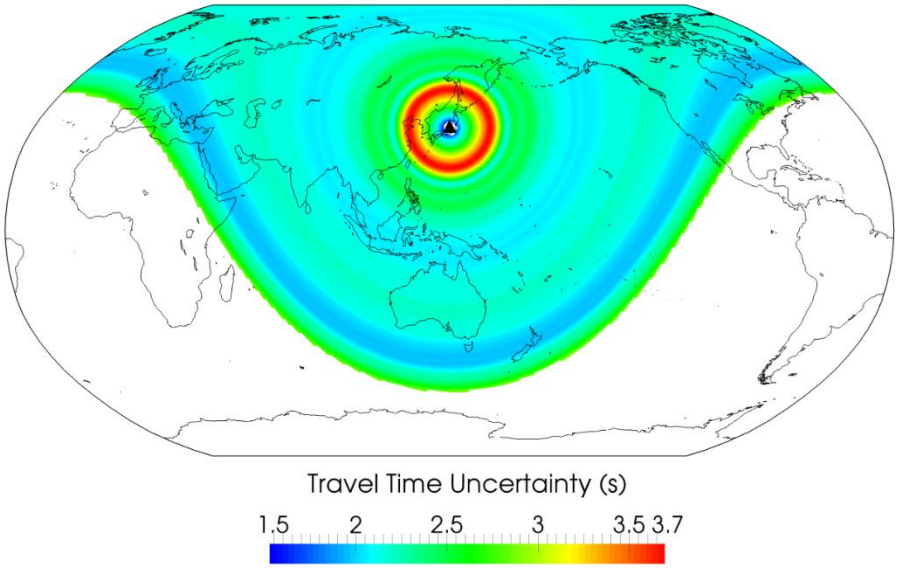
Travel Time Prediction and Uncertainty



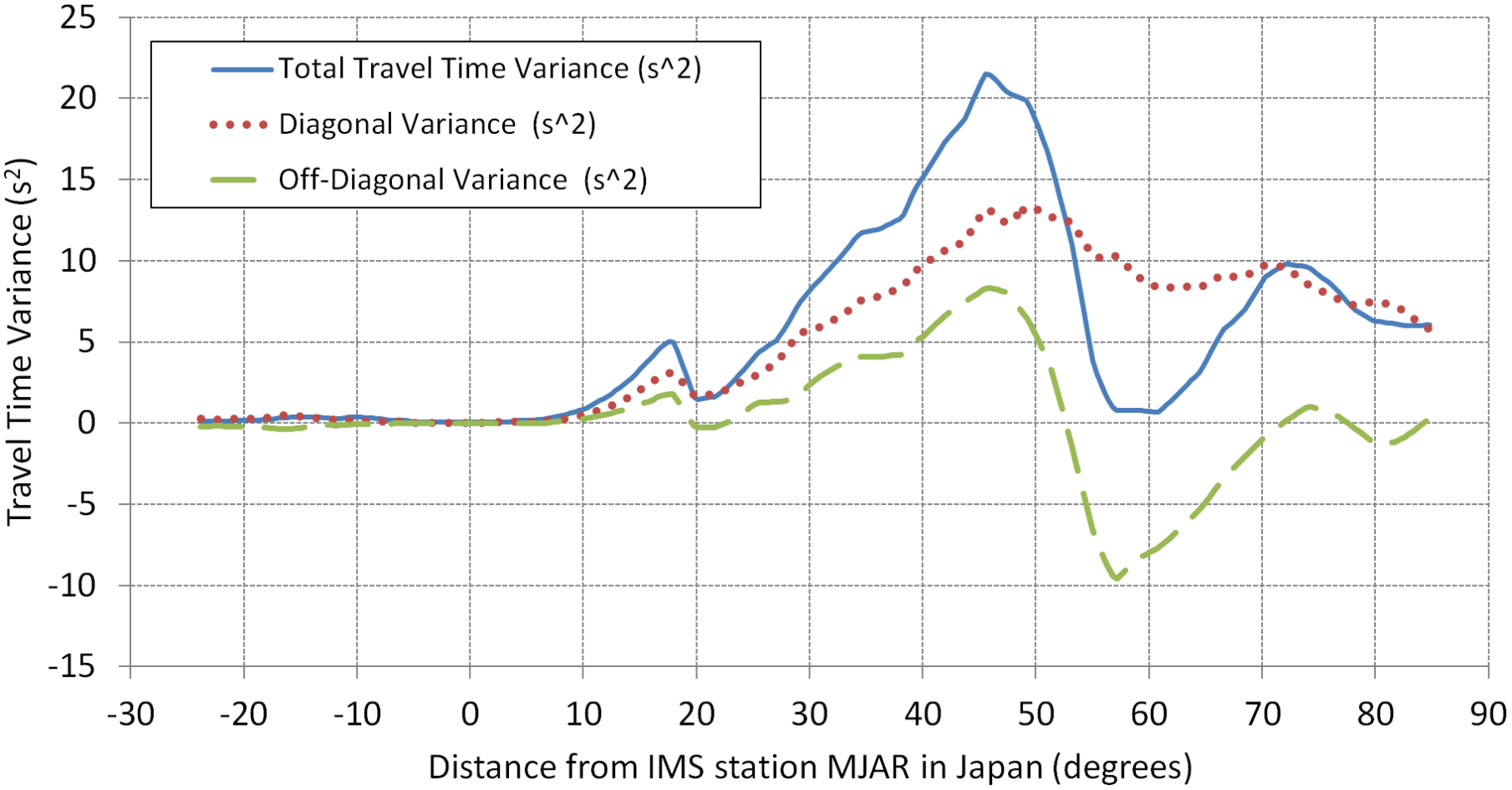
Comparison with Standard Uncertainty



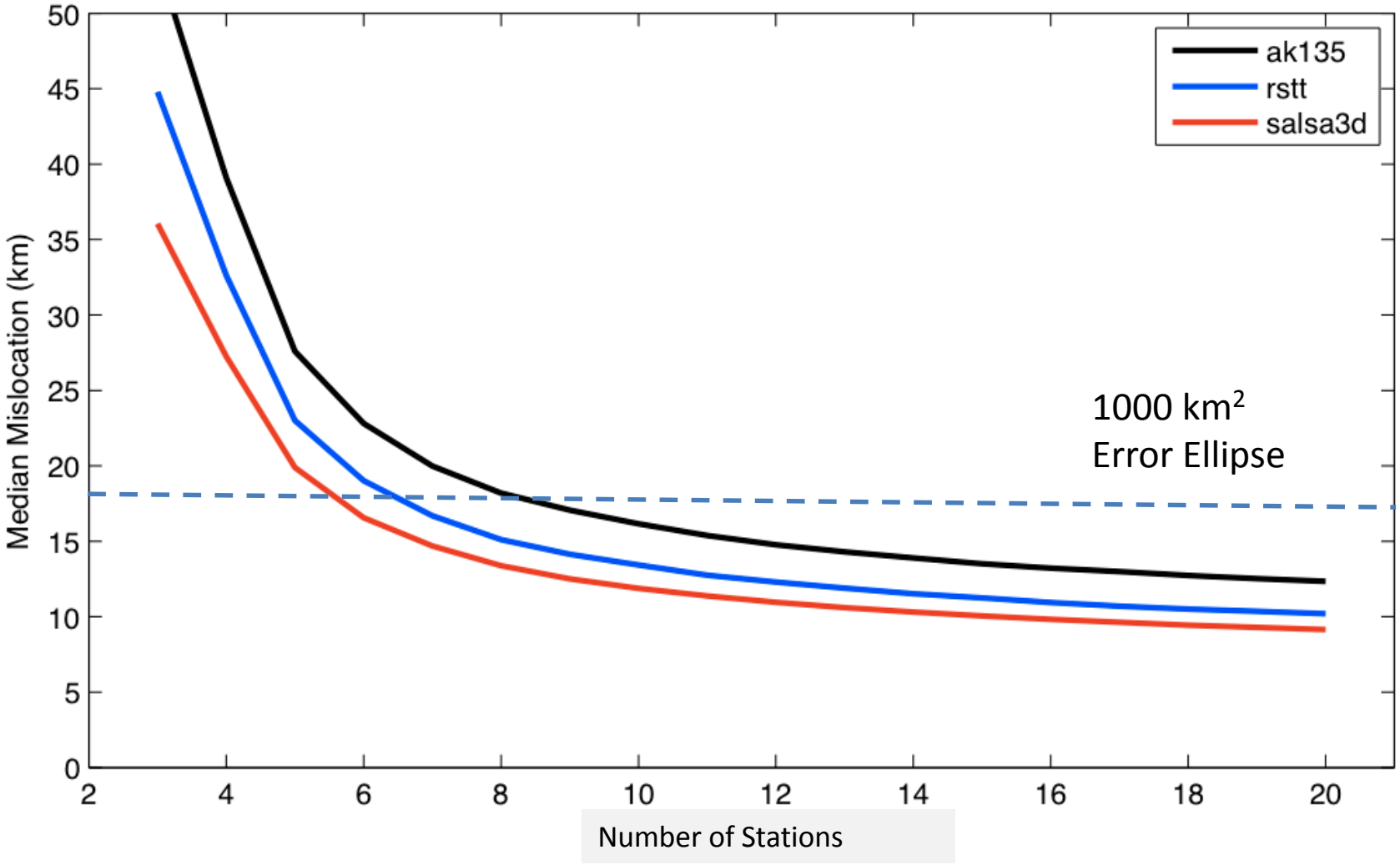




Importance of Model Covariance

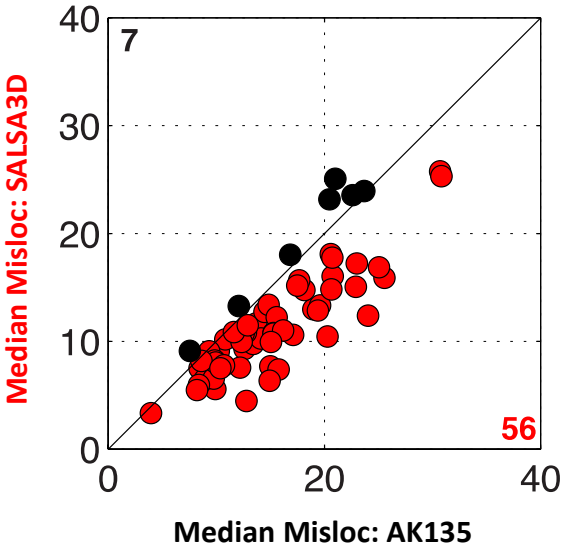


Mislocation vs. Number of Stations

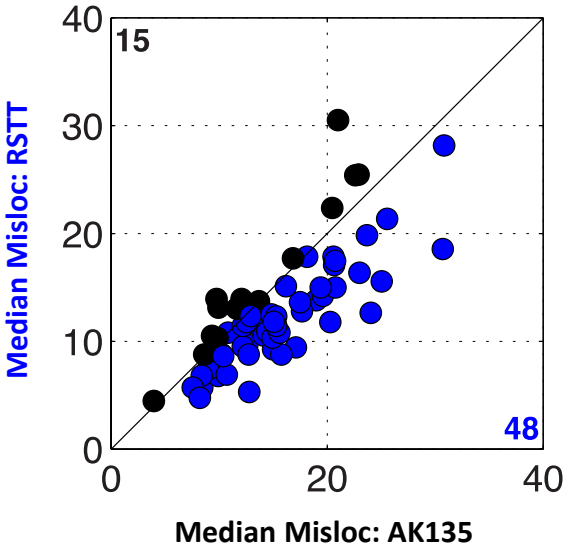


Event Mislocation Comparisons

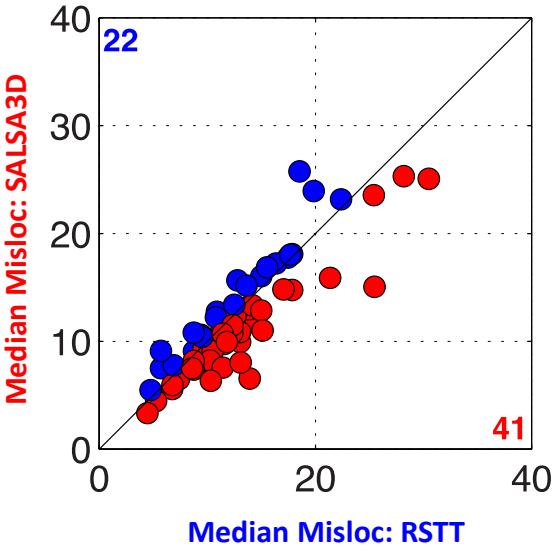
SALSA3D vs. ak135



RSTT vs. ak135



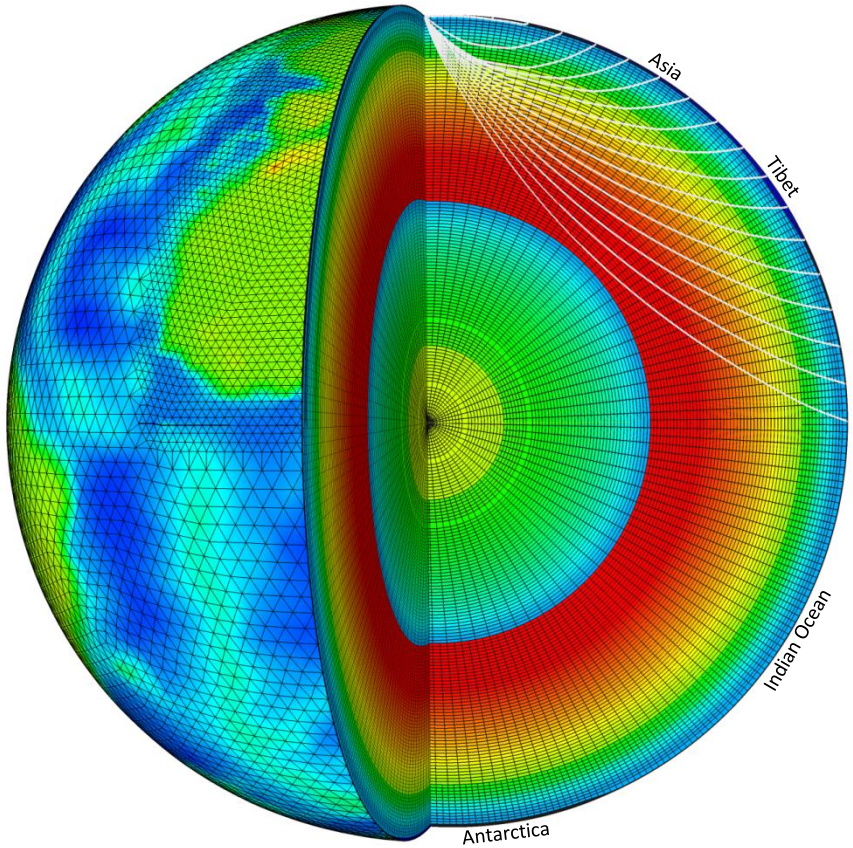
SALSA3D vs. RSTT



GeoTess

A model parameterization and software support system that implements the construction, population, storage and interrogation of data stored in 3D Earth models.

- Grid based on triangular tessellations
- Variable resolution in both geographic and radial dimensions
- Supports internal radial discontinuities with variable topography.
- Wide variety of data types for storage of information at grid nodes
- Linear and natural neighbor interpolation of values
- Open source software in C, C++ and Java
- Compiled for Linux, Mac, Windows and SunOS.
- Software available at www.sandia.gov/geotess



Sandia National Laboratories

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National Nuclear Security Administration

Summary

- We have developed a global 3D model of the compressional wave speed distribution in the Earth's crust and mantle.
- We successfully computed the model covariance matrix for our model which allows us to calculate path-dependent travel time uncertainty estimates.
- The model significantly improves the accuracy and precision and seismic event locations.
- We have developed 3D travel time lookup tables for the IMS network to mitigate performance issues related to the use of 3D models in operational systems.
- Our grid management software has been released as open source software and can be accessed at www.sandia.gov/geotess

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