LA-UR-15-24899
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Title: W13_Geonuc “3D Geophysical Modeling Validation and UQ for Ground--based NEM”

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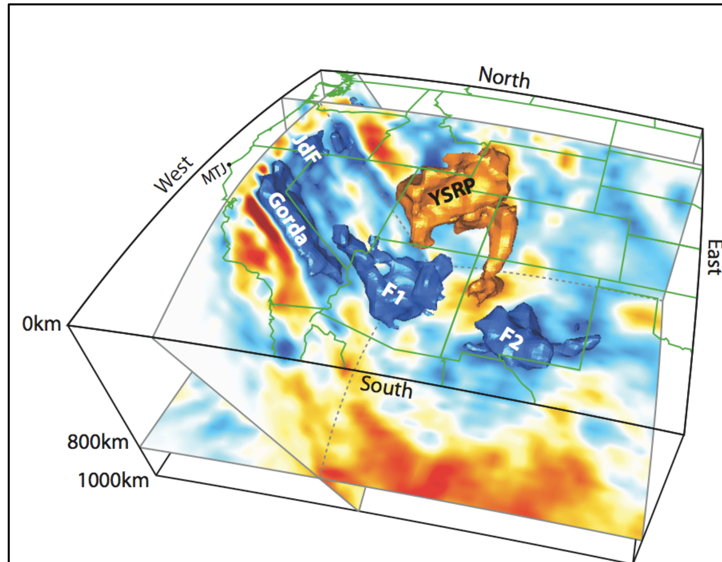
Intended for: Report

Issued: 2015-06-30

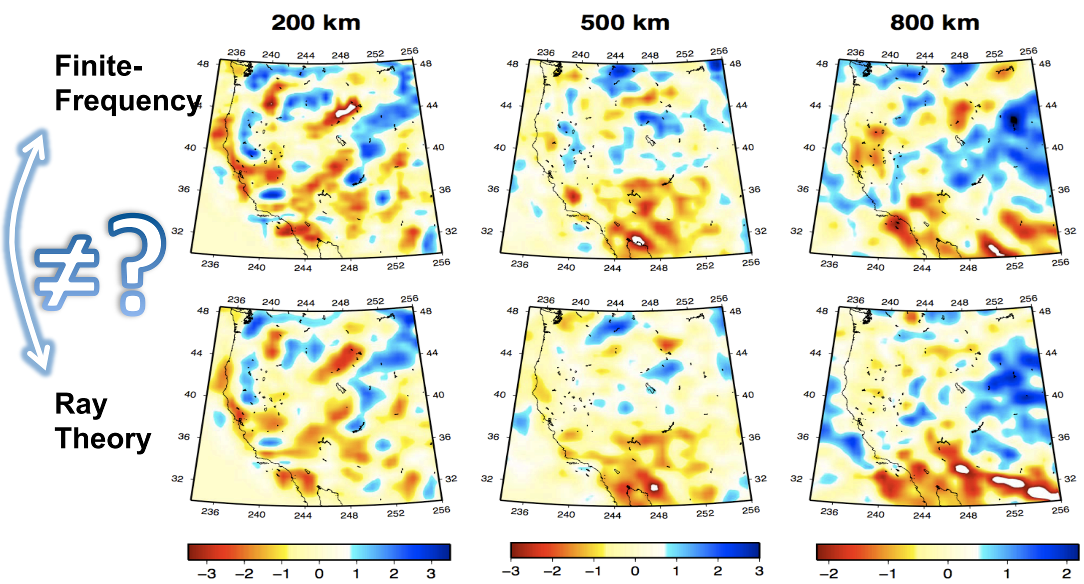
W13_Geonuc "3D Geophysical Modeling Validation and UQ for Ground-based NEM "

PIs: M. Maceira and C. Larmat, EES-17

Validation of 3D high-resolution geophysical models via full waveform requires important HPC resources because the necessary level of accuracy is achieved by considering models with millions of grid points. We use the Spectral Element Method (SEM) which makes no assumptions about the wave propagation equation but requires substantial computational resources. Accuracy in the prediction of seismograms is important in order to understand the limit of current imaging methods (see Ray Theory versus Finite Frequency models below).



DNA09 (UC Berkeley model) allows imaging of geodynamic features with unprecedented resolution. Image above shows the interaction between the Yellowstone mantle plume and the subducting Juan de Fuca plate.



Slices of DNA09 model at different depths. Details of the shear-wave velocity anomalies highlighted by the model differ according to the imaging method used. (top) DNA09 velocity model obtained with Finite-Frequency; (bottom) DNA09 velocity model obtained with Ray Theory.

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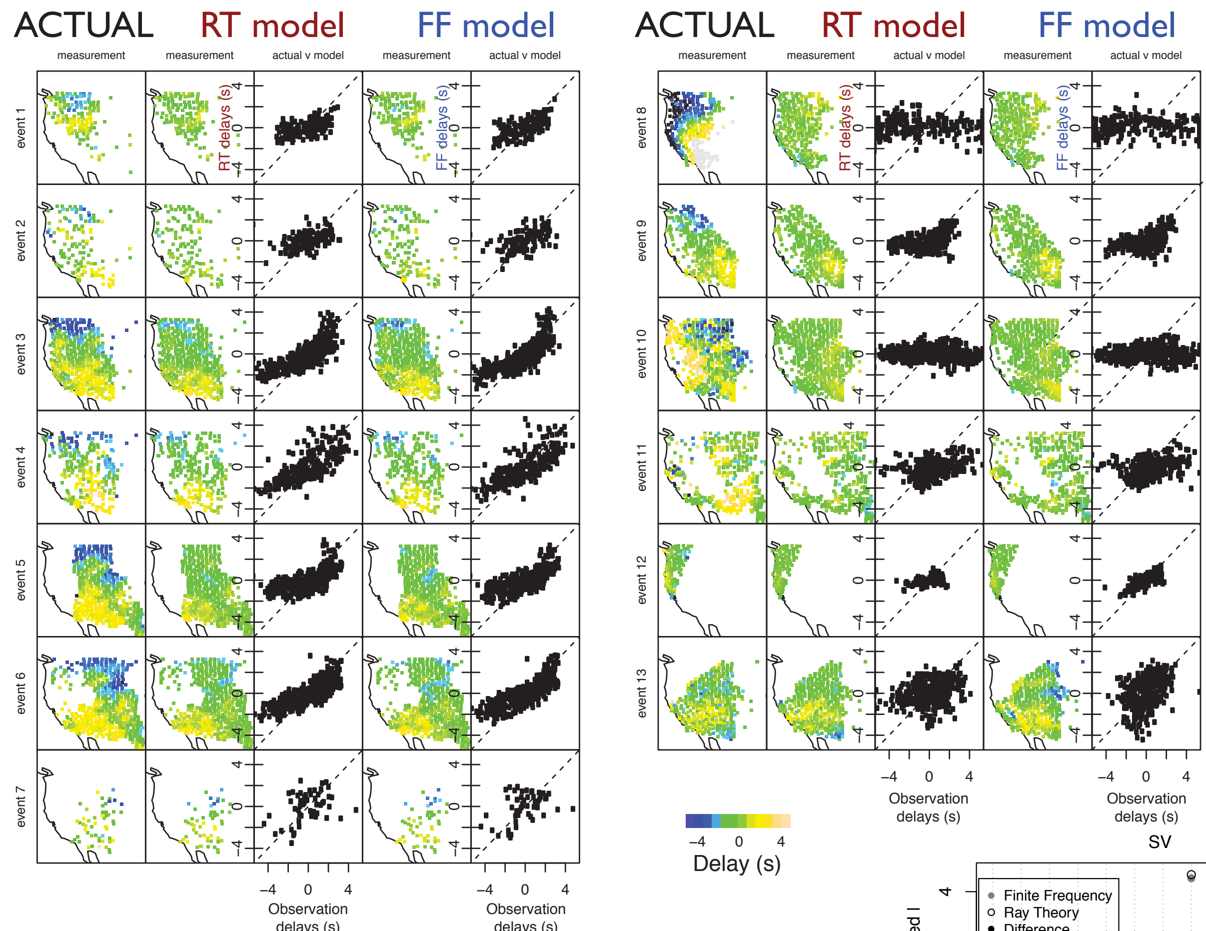
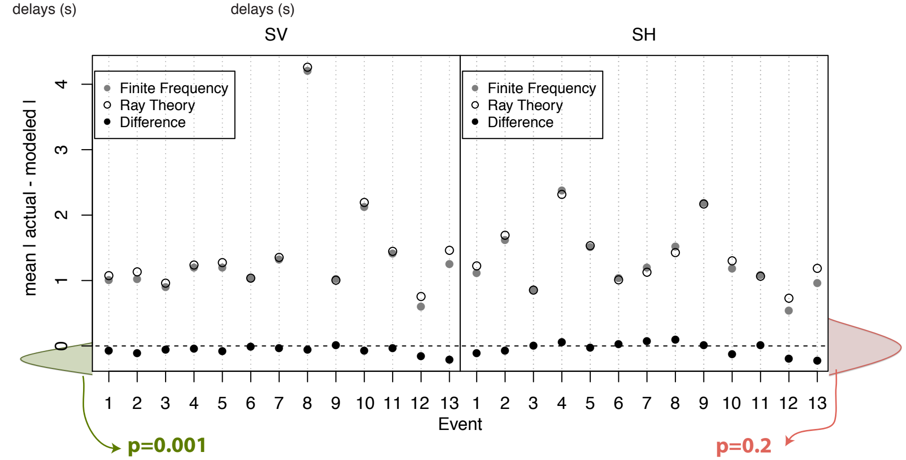


Are the two models statistically different?

Significant!

Delay times from FF model are closer to the observed delay times.



Focusing on the *S phase delay times*.

On average, the delay times produced by the FF model are closer to the actual delay times. A simple paired t-test is used to assess the significance of this observed difference.

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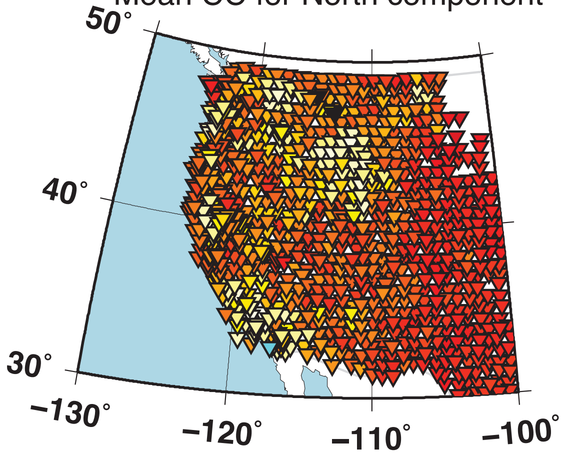
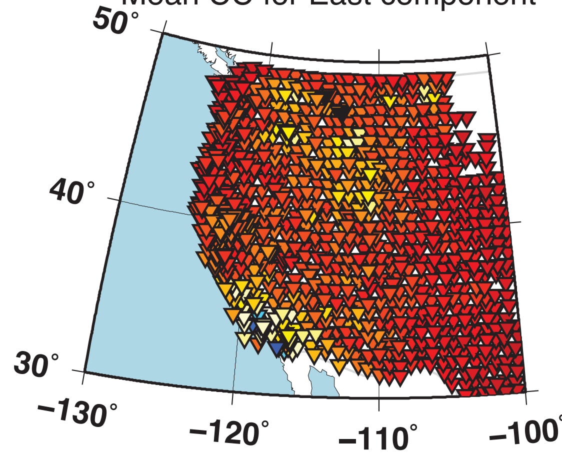
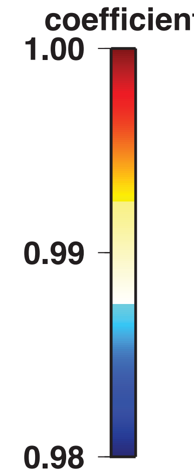
Different but more significant difference in some particular areas?

Mean CC for North component

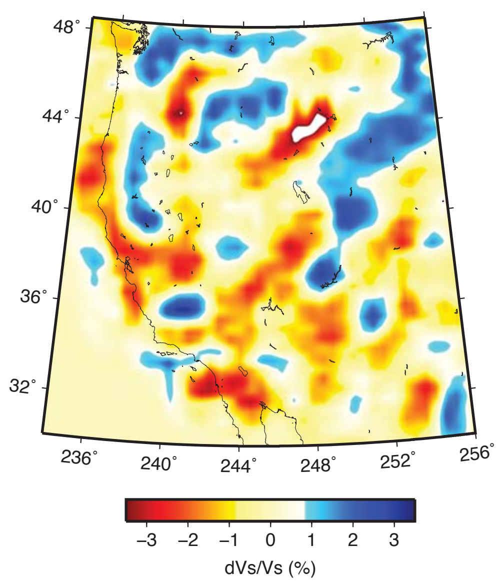


Mean CC for East component

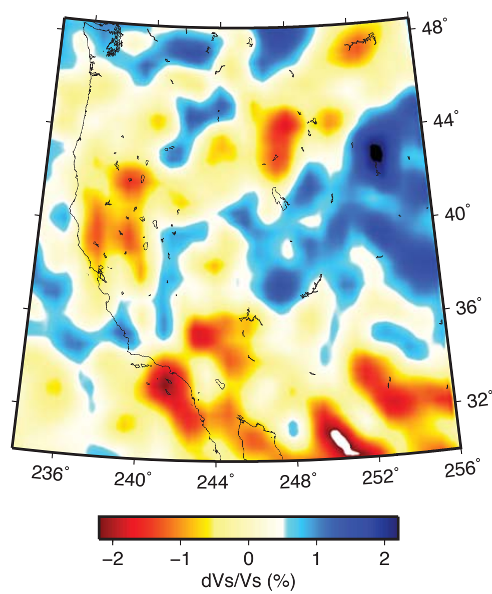




DNA09 - 200km



DNA09 - 800km



Focusing on the S phase wiggles

Waveform cross-correlation coefficients between RT and FF synthetic seismograms, show that ***Finite Frequency*** makes a difference for ***large amplitude low velocity*** anomalies such as mantle plumes.

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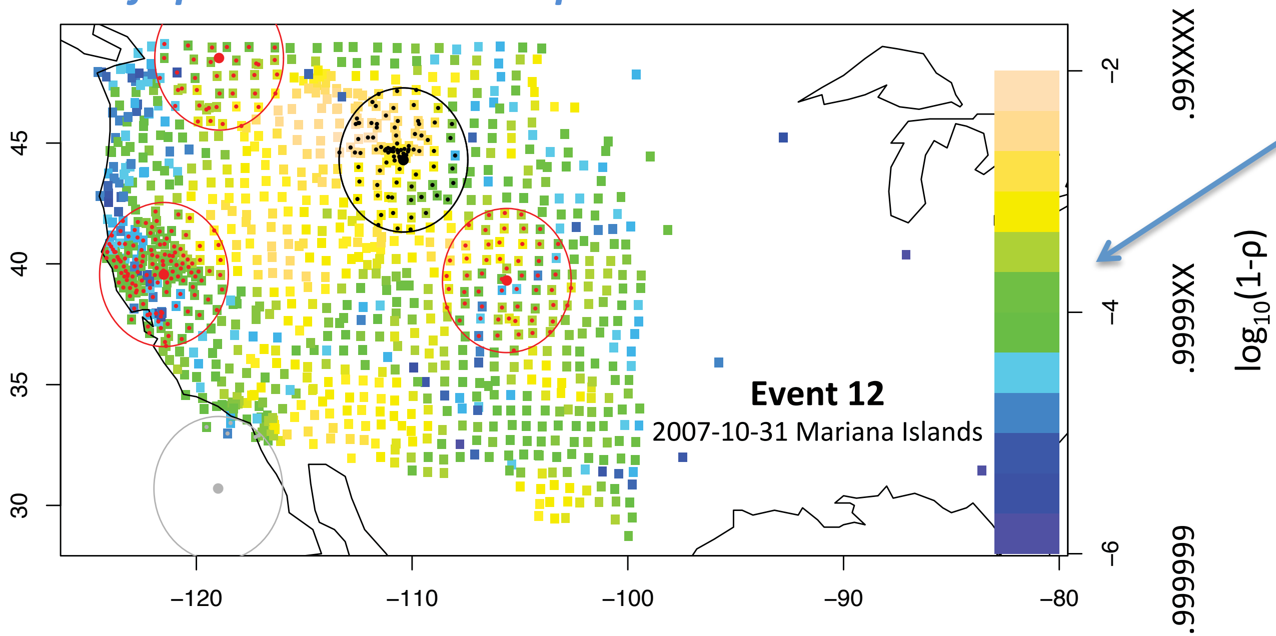
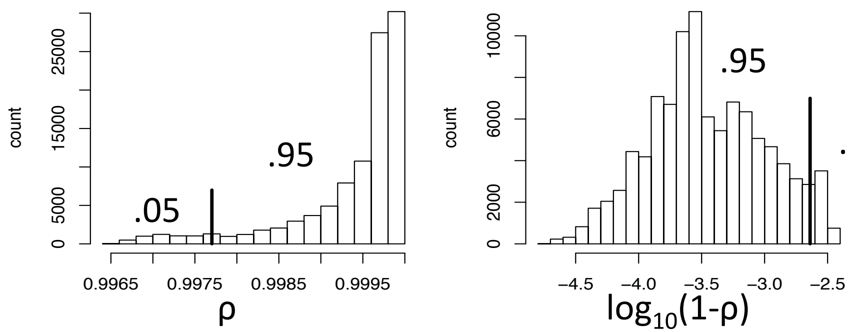
Statistical test of spatial localization: permutation test



Permutation test for waveform cross-correlation coefficients for stations around Yellowstone for one event in our validation dataset.



Histograms of cross correlations from 100,000 random locations indicate the Yellowstone location is at about the 5th percentile of these 100,000 realizations.

Focusing on the S phase wiggles

Permutation tests indicate that the values for stations around Yellowstone are indeed lower than average and the FF and RT models produce synthetics which are statistically different for those stations. For all the events to the west of the model, ***Yellowstone stands out as statistically different***.