

Testing seismic tomography models using numerical simulation of wave propagation

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It is very well known that Earth's crust has a very strong influence on surface waves. Therefore, crustal corrections are a crucial step in surface wave tomography to enhance mantle structures. In Bozdağ & Trampert [2008], we investigated crustal effects on tomographic mantle images. We estimated crustal corrections using first order ray theoretical and finite frequency approximations and compared them to those obtained from full 3-D wave simulations with the spectral element method. We observed that crustal effects cannot be completely removed from seismograms and produce errors larger than those in phase velocity measurements at periods shorter than 60 and 80 s for Rayleigh and Love waves, respectively. In addition, Rayleigh and Love waves are affected by the crust in a different way. As a consequence, our observations indicate that imperfect crustal corrections could have a large impact on inferences of radial mantle anisotropy. Part of mantle anisotropy could be uncorrected crustal signal. Possible solutions are to use 3-D reference models or to invert crust and mantle together instead of applying crustal corrections.

In Bozdağ & Trampert [2009], we investigated to what extent current tomographic mantle images represent the real Earth's mantle. For this purpose, we compared real seismograms to those computed by the spectral element method in some 3-D mantle models. In particular, we examined the effect of damping on our interpretation of the mantle by choosing differently damped mantle models. Surprisingly, synthetic seismograms are statistically insensitive to differently damped models. These observations point to a crustal signal which could not be properly removed from the data by corrections. In addition, we observed a large amplitude signal which is usually ignored in classical mantle tomography. The amplitude mismatches are most likely due to our ignorance in attenuation. Body wave amplitudes however are more sensitive to focusing/defocusing effects than surface waves.

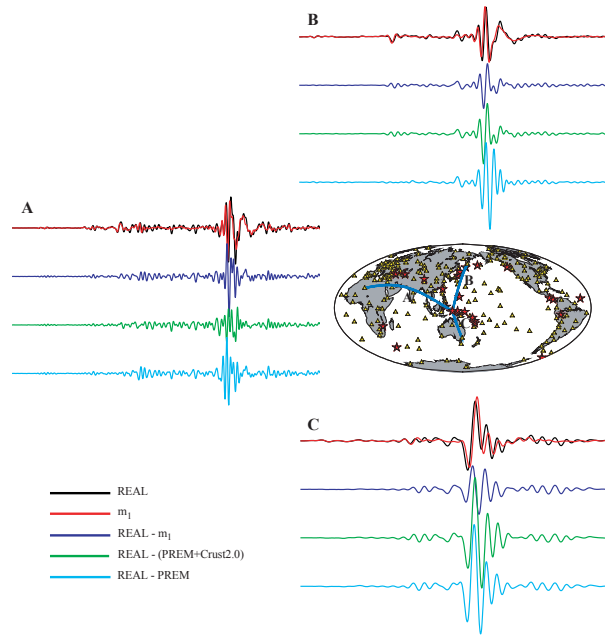


Figure An example for comparison of real seismograms with the synthetic ones computed in 1D (PREM) and 3D crust (Crust2.0) and mantle (m_1) models by SPEC-FEM3D. Blue, green and cyan seismograms show the waveform differences.

The computation of synthetic seismograms in these studies was performed by SPEC-FEM3D-GLOBE package that we obtained from CIG.

References

- Bozdağ, E. & Trampert, J., 2008. On crustal corrections in surface wave tomography, **Geophysical Journal International**, 172, 1066-1082.
- Bozdağ, E. & Trampert, J., 2009. Assessment of tomographic mantle models using spectral element seismograms, **Geophysical Journal International**, under revision.