

Using bolides for planetary seismology: study of atmospheric sources and strong crust scattering.

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Abstract

Planetary seismology presents several noticeable changes compared to Earth seismology. Earth has a vigorous mantle convection generating earthquakes at the origin of most of the seismic signal recorded on our planet. The situation is different for other planets, such as Mars, where impact by meteors and bolides is expected to be a primary source of seismic signal. In such event, seismic waves are generated at the moment of the impact but also, prior to that, by the transmission to the ground of the shock wave generated in the atmosphere. This makes these sources complex and they can be described as a single source point. We present studies of the Chelyabinsk bolide, one of the best recorded bolide event, using normal modeling with coupled solid Earth-atmosphere and spectral element modeling. We are also presenting a numerical study of the effect of scattering on seismic waves. This work is particularly relevant for understanding Moon seismic records. The strong scattering happening in Moon's crust was discovered on November, 20, 1969 when the Apollo 12 Lunar Module was set to impact the Moon. The scientists reported then that the crust of the Moon was "still ringing" like a church bell, even as the press conference was hold, 30mn after the impact. Our study will focus on the evolution of the amplitude and duration of the coda for direct P and S waves and the interaction between scattering and intrinsic attenuation.

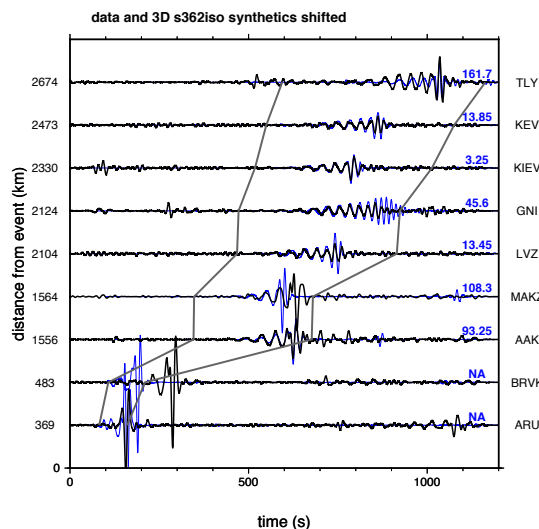


Figure 1. Waveforms between 10 and 50s of the vertical component modeled for Chelyabinsk using a single source moment and a 3D Earth model. The time-series were shifted by the opposite of the time-lag of the cross-correlation of synthetic with data so that their arrival time coincide.

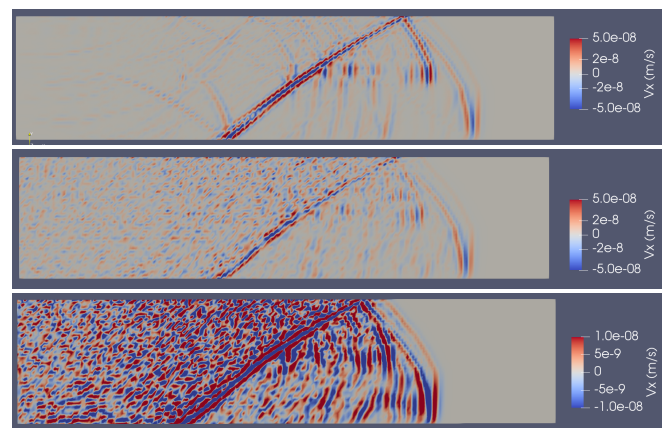


Figure 2. Snapshot of the vertical component of the wavefield generated by a single source at time 77s. The dominant frequency is 0.8Hz. Top: model with no heterogeneity, middle: uncorrelated heterogeneity, bottom: spatially correlated heterogeneity with a correlation length of 300m.