2009 SCEC Annual Report

Project 09148

Towards Strong Ground Motion Prediction Using Amplitude Information from the Ambient Seismic Field

Gregory C. Beroza, Jesse F. Lawrence, Marine Denolle
Department of Geophysics, Stanford University, Stanford, CA.

Germán A. Prieto
Universidad de los Andes, Bogotá, Colombia

Under this grant we have extended our use of the ambient seismic field for several aspects of ground motion prediction, including: validation of the ambient-field response against moderate earthquakes, developing a library of Green's functions for improving southern California velocity models, and developing a preliminary attenuation model for the southern California crust.

Validation against earthquakes

We have validated the approach using several well-recorded earthquakes that occurred in the vicinity of continuously recording seismic stations to compare amplification effects in sedimentary basins from the ambient field to observed ground motions. An example of such a validation is shown in Figure 1. We are working to improve such comparisons by making corrections for earthquake depth, and for the radiation pattern.

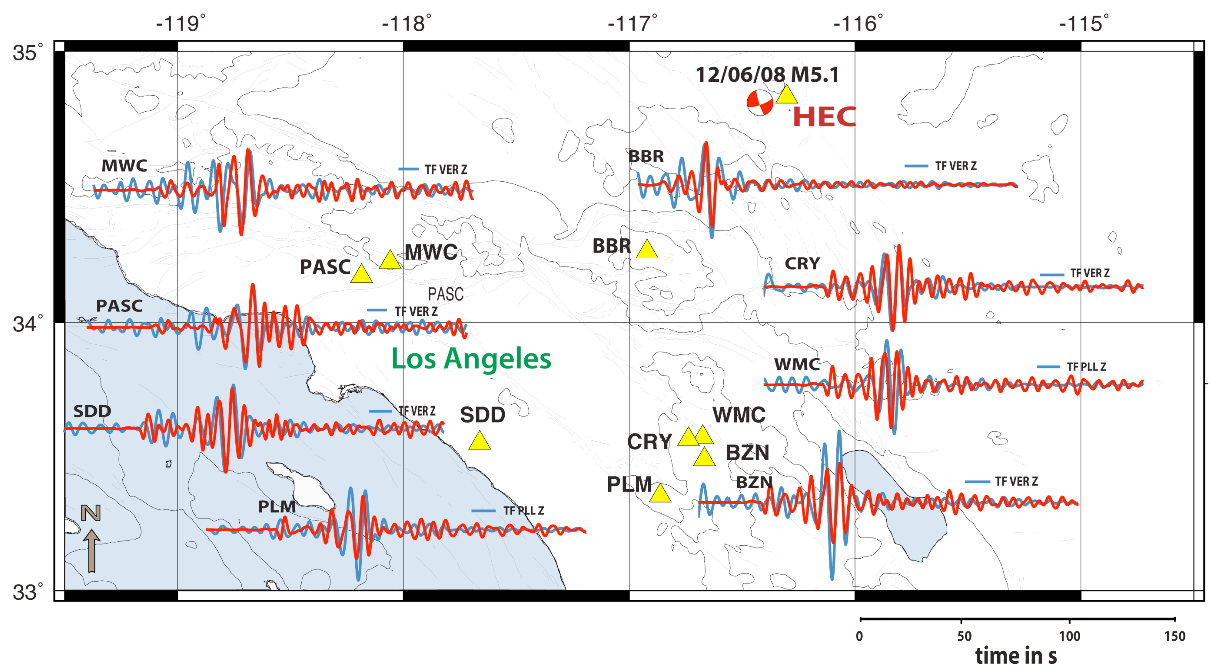

Figure 1. *Comparison of vertical component ambient-field ground motion prediction (blue) with recorded earthquakes seismograms (red) for M 5.1 December 6, 2008 earthquake. The strong similarity of earthquake and "virtual earthquake" seismograms validates this approach.*

A Green's Function Library

We have used the inter-station complex coherence derived through deconvolution and stacking to extend the analysis that we performed previously for Rayleigh waves on vertical components (*Prieto et al.*, 2009a) to all three components, and hence to Love waves. We are currently refining a library of Green's functions to refine crustal wavespeed models in southern California. Figure 2 shows an example of the ambient-noise response for station-component pairs.

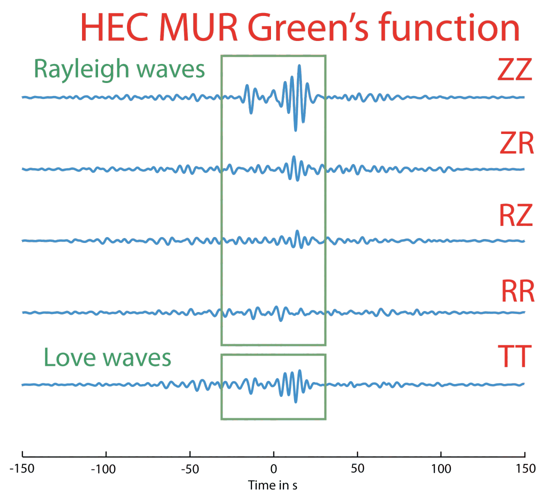

Figure 2. *Ambient-noise response for station-component pairs that have been rotated into vertical, radial, and transverse coordinates (Z, R, T). Five of nine combinations are shown. The upper four reflect the Rayleigh-wave response while, the TT reflects the Love-wave response. The Rayleigh wave shows up most clearly in the vertical component.*

The horizontal component waveforms appear to have more local noise than the vertical components (Fig. 3), so we need to increase the amount of data being used to construct the ambient-field response in order to extract the weakly coherent station-to-station signal.

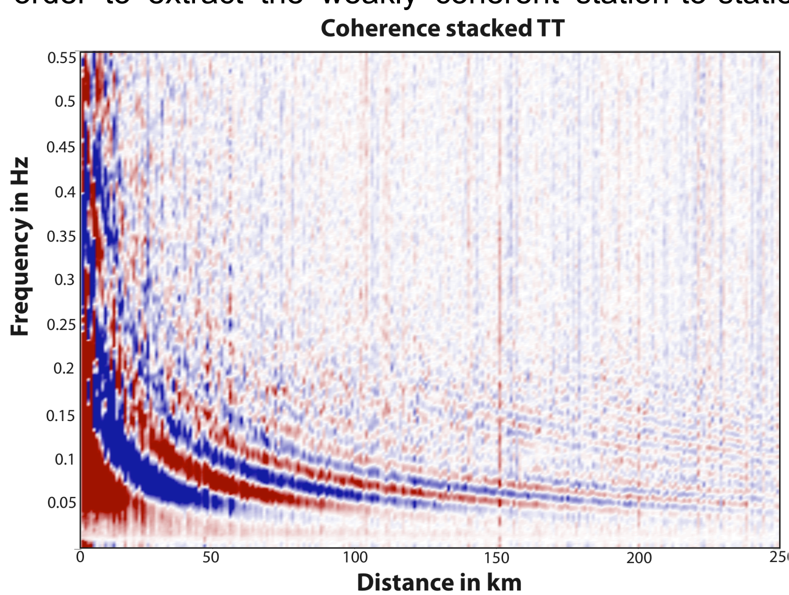

Figure 3. *The real part of the complex coherence for the ambient field in southern California plotted as a function of frequency and inter-station distance for the transverse-transverse case. These observations provide an important complement to information from the vertical components. Lower snr for horizontal components led us to increase the duration of data used in the averaging.*

Towards an Attenuation Model for Southern California

Previously we reported on a strong difference between paths with strong sensitivity to major sedimentary basins, and paths that have little sensitivity to basins (*Prieto et al.*, 2009a). We have made substantial progress towards quantifying these observations to develop a laterally varying attenuation model for southern California (Fig. 4).

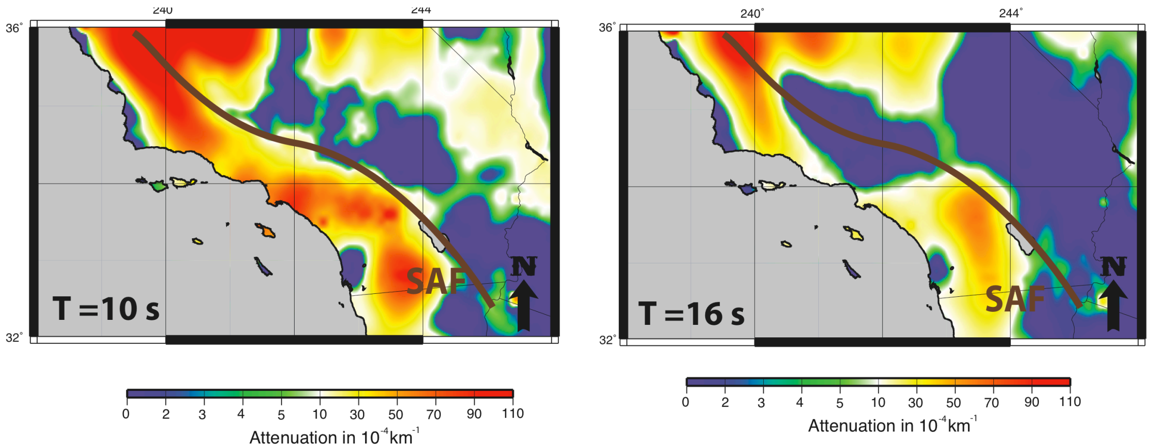

Figure 4*. Preliminary maps of attenuation based on analysis of vertical component data at periods of T =10 and T=16s.*

We presented the results outlined above at the 2009 SCEC annual meeting (*Denolle et al., 2009a*), as well as the Fall AGU (*Denolle et al.,* 2009b; *Prieto et al.,* 2009b) and annual SSA meeting (*Denolle*, 2010). We are collaborating to use ambient noise Green's functions as data in the scattering integral approach for estimating velocity structure (*Lee et al.,* 2010).

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