Introduction

This auxiliary material contains results from a global back-projection of P waves, similar to what was presented in Lay et al. [2010a]. It is redone here using a smaller, more coherent, subset of stations and the same methodology that was used for the TA back-projections (described in the main text) in order to facilitate comparisons. The global results support the idea that coherent, short-period energy is radiated down-dip of longer-period energy associated with the majority of the slip.

Back-Projection of P waves from a Global Array of Seismometers

The station distribution and the coherency of the signals are shown in Figure S1. The azimuthal coverage to the west of the epicenter is limited because of lack of stations in the Pacific Ocean. The correlation of the 15-second long segments of waveforms is high enough to acquire reasonable back-projection results. Similar to the Transportable Array (TA) back-projection configuration, the waveforms are cross-correlated using a multi-channel cross-correlation algorithm on 15-second long segments of unfiltered seismograms. The polarities of three island stations in the Pacific Ocean were flipped to account for the radiation pattern and increase the correlation among the stations. The AK135 velocity model and final NEIC epicenter were used to do travel time corrections and trace alignment during cross-correlation. Next, the aligned traces were combined using 4th root stacking, and beam power was measured from 15-second long and 7.5 second long sliding windows for the pass-bands of 0.1-0.3 Hz and 0.3-0.5 Hz respectively. The calculated beam power was back-projected to the gridded source region with 0.05° increments in both latitude and longitude. For the post-processing, the results were time-averaged over a 20 second window.

The results of both pass-bands are shown in Figure S2. The lower frequency band (0.1-0.3 Hz)
shows down-dip motion between 0-40 seconds, which is consistent with the TA results. However, the locations of short-period radiators between 60 and 80 seconds are found to the southwest of the epicenter, ~40 km offset from the location found in the TA results (Figure 4), and off-shore of the Paracas peninsula. This location is consistent with the back-projection of GSN stations at 0.05-0.4 Hz from Lay et al. (2010a) and similar to some slip models (Biggs et al., 2009; Motagh et al., 2009, Sladen et al., 2010, Lay et al., 2010a). On the other hand, the results in the higher frequency band (0.3-0.5 Hz) are significantly down-dip of the lower-frequency sources, much nearer the locations in the TA back-projections. Therefore, the down-dip high frequency enrichment of the Pisco rupture is observable with a global array as well as with the TA.

The differences between the TA back-projections (in either band) and the global array back-projections at 0.1-0.3 Hz for the radiators at 60-80 s are probably caused by unaccounted Green function differences among stations in the global array, and we consider the TA results to be more accurate in an absolute sense. While global arrays can sometimes provide similar back-projection results to those derived from regional arrays, artifacts (sometimes severe) can also be present.

Figure Captions

Figure S1. P waves from 55 globally distributed seismometers. The unfiltered, velocity waveforms are shown after alignment and normalization with a multi-channel cross correlation algorithm. Three of the stations, indicated by squares, had polarity flipped prior to the alignment. The minimum mean correlation coefficient for inclusion in the back-projection was 0.64, and only four of the stations had values smaller than 0.7. This leads to a smaller global back-projection network than used in previous back-projections for the Pisco earthquake [Lay et al., 2010a].

Figure S2. Results of back-projecting data from the seismometers shown in Figure S1. The left panel shows results from a lower frequency band of 0.1-0.3 Hz that are quite similar to previous back-projections of global data done in a frequency band of 0.05-0.4 Hz [Lay et al., 2010]. The right panel shows results from a higher frequency band of 0.3-0.5 Hz. The locations of the energy
maxima near 60-80 s in the higher frequency band are 20-30 km down-dip (horizontal, ENE) of corresponding maxima in the lower frequency band. Each circle is the location of a local maximum in beam power with circle size proportional to the power and color indicating lapse time. The trench is indicated by the serrated line, contours of slab depth [Hayes et al., 2012] in 10 km increments are shown by the dashed lines, the NEIC epicenter is shown by the white star, and the gCMT solution is shown by the focal mechanism.
Frequency Band of 0.1-0.3 Hz

-77.5° -77° -76.5° -76° -14.5° -14° -13.5° -13° -12.5°

50 km

Sladen et al. [2010]
Pritchard and Fielding [2009]

Frequency Band of 0.3-0.5 Hz

-77.5° -77° -76.5° -76° -14.5° -14° -13.5° -13° -12.5°

50 km

Sladen et al. [2010]
Pritchard and Fielding [2009]