Broadband Array Processing of the Scd seismic phase

Michael S. Thorne and Nicholas C. Schmerr

Abstract

Arrays of seismic instruments were originally deployed beginning in the 1960's consisting of short-period vertical component sensors designed to analyze P-wave data for detecting nuclear tests. Subsequently, data recorded at these arrays have been used in a variety of studies to examine seismic arrivals from the deep Earth. Although many of these arrays currently have three-component sensors few efforts have utilized the extra components in an array processing sense. Here we present preliminary broadband array processing results for pre-cursors to the ScS phase (Scd) recorded at the High Lava Plains Project (HLP). The full HLP seismic array consisted of a total of 118 3-component broadband seismometers laid out in a cross centered in eastern Oregon, USA, which we use to test array processing techniques on radial and transverse component recordings. We searched for earthquakes in the years 2006 to 2009 with depths ≥ 100 km, moment magnitudes (M_W) ≥ 5.7, and located within an epicentral distance range of 65° to 90°. Our initial search returned 111 events that matched our criteria. Data were rotated to the transverse component, instrument deconvolved to displacement, and bandpass filtered with corners from 1-20 s. The narrow passband of these broadband data was imposed so that we could do later vespagram processing steps. It is imperative for these techniques to work that these data do not contain long period energy. For each event we calculated a signal-to-noise Ratio (SNR) measurement where we defined the signal as the peak amplitude of the direct S-wave arrival, and the noise as the average amplitude level of the seismic energy in a 100 second window prior to the direct S-wave arrival. If the majority of records had a SNR < 10.0 we removed the event. Our final data set consisted of 15 high quality events. We supplemented our dataset with any stations from the Transportable Array (TA) component of the EarthScope experiment found within 2.75° of the HLP array centroid. We analyze recordings from earthquakes in the east Asia, Fiji-Tonga, and S. American regions. Transverse component data recorded from east Asian earthquakes show a strong Scd arrival arising from interaction with a D" discontinuity beneath the Bering Sea (Fig. 1). These data consistently show a D" discontinuity with an average thickness of 250 km. Data from S. America also show a Scd arrival indicating a D" discontinuity beneath Central America with a thickness of 285 km. Data analyzed from the southwest Pacific Ocean region did not show arrivals associated with the D" discontinuity.

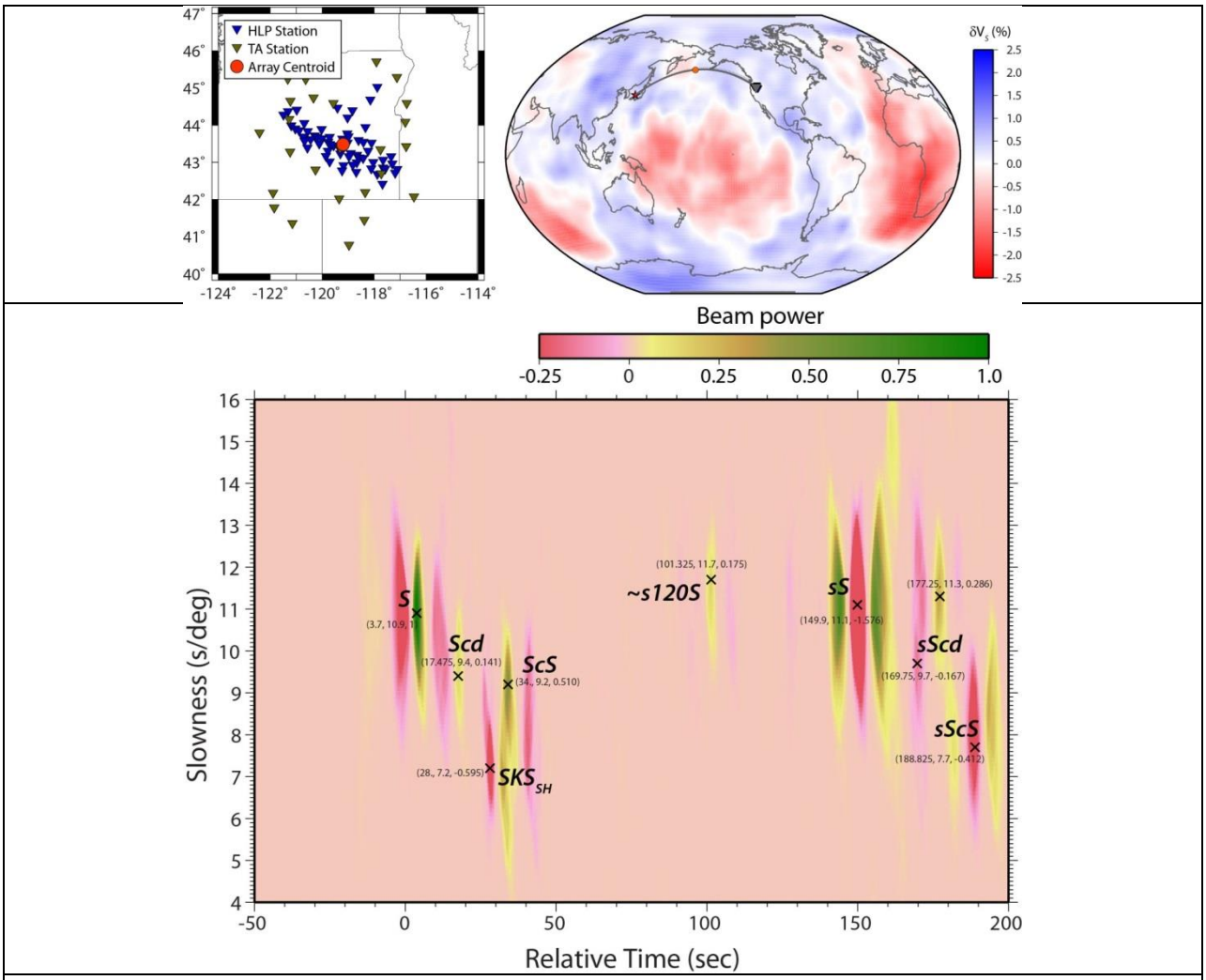

Figure 1. Example data recorded from the east Asia region. Top left: Stations used in the array processing for this event. Blue triangles show High Lava Plains (HLP) stations, green triangles show Transportable Array (TA) stations, and the orange circle shows the array centroid. Top right: The event location (red star) and array centroid (gray triangle) are shown. The ScS bounce point on the CMB is drawn with the orange circle. The background is S-wave tomography model TXBW by Grand 2002 for the D" region. Bottom Plot: Vespagram for this event. Seismic phases seen in this vespagram are labeled. This vespagram is computed for transverse component displacement seismograms.