2014 Annual Progress Report

Assimilating Ocean Bottom Seismometer (OBS) Data into the Next-Generation SCEC Community Seismic Velocity Models (Award #14099)

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Abstract

The goal of this continuing project is to assimilate ocean bottom seismometer (OBS) data collected off the coast of southern California into the next-generation SCEC Community Velocity Model through full-3D waveform tomography (F3DT). This work is being done in collaboration with the University of Wyoming. From August 2010 to September 2011, passive seismic data were collected using 24 broadband and 10 short-period OBSs in the Continental Borderland during the ALBACORE project. The 12-month passive seismic experiment provided numerous seismic waveform recordings that will be used for constraining subsurface seismic velocity structures through F3DT not only directly below the OBS array but also in much larger regions in onshore southern California. The OBS array recorded waveform data from local onshore and offshore earthquakes, teleseismic earthquakes, and ambient noise. Those waveform data will be assimilated into seismic velocity models. The teleseismic data will be modeled and inverted by assuming an input wave-field composed of one or a few plane waves. We are continuing the project throughout the next year, and are reporting here on work completed to date. This work focused on processing the OBS data in preparation for the inversions.

Intellectual Merit

The focus of work completed to date was on preparing the OBS data for analysis. The 12 months of data from all OBS components were examined for flat-line or single-digit bit-level output, harmonic spikes, square waves, and other anomalous signals. As a result of this analysis, data from four stations for the entire year (and one station for part of the year) had to be discarded. Working with technicians at Scripps Institution of Oceanography, we also discovered that the polarity of the vertical components of all short-period instruments was reversed. The polarity correction was applied to the data in preparation for the inversions.

For local earthquake recordings, the seismograms for the vertical and two horizontal components (with initially unknown orientations with respect to north) were cut into three-minute files based on known local events with source parameters obtained from the SCSN earthquake catalog. Local events were limited to those with M>3.0, resulting in 548 earthquakes used in the file cutting. The instrument response appropriate for each OBS was removed through deconvolution in the frequency domain.

Next, the horizontal components were rotated through angles found from analysis of surface wave polarization data so that the horizontal components reflect north-south and east-west velocities. At the IRIS DMC where the ALBACORE data are archived, channel BH1 is assigned

an azimuth of 0° (pointing north), and BH2 is assigned an azimuth of 90° (pointed east). This would imply for the ALBACORE OBSs that the instruments have a left-handed orientation where the BH1 channel is oriented 90° counterclockwise to BH2. However, examination of teleseismic surface wave data in preparation for horizontal orientation calculations revealed that the channel orientations were mislabeled in a right-handed fashion so that BH2 has 0° azimuth and BH1 has 90° azimuth. We subsequently worked with a data quality control specialist at IRIS for independent confirmation of the handedness and orientation angles required to rotate the horizontals into north and east. That analysis confirmed our initial observation that the ALBACORE horizontals are right-handed, and further confirmed most of our initial measurements of axis azimuth with respect to north. We both found that the horizontal orientation code produced better results when BH2 has 0° azimuth and BH1 has 90° azimuth. There are some stations where no estimate could be determined either because the data were anomalous due to instrument malfunction or because there were not enough high-correlation events to determine which handedness was the more appropriate solution for that station.

After applying the instrument response corrections, rotating, and correcting polarities on the vertical, short-period OBSs, the three-minute files for the 548 events were packaged into a tarball and made available for inclusion in the inversion analysis component to be performed at University of Wyoming. The plans for the coming year are to compute synthetic seismograms for local earthquakes using the AWP-ODC code and the latest CVM available. Those synthetic seismograms will be compared with observed earthquake recordings. Discrepancies between synthetic and observed seismograms will be used to assess the quality of the source and structure models used in the simulations and will also be used to invert for improvements in the source and structure models.