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Multiphase Regional Attenuation and Improved High-Frequency Regional P/S Discriminants

Michael Pasyanos, William Walter, Eric Matzel, Arthur Rodgers, and Sean Ford
Lawrence Livermore National Laboratory, Livermore, United States (pasyanos1@llnl.gov)

We are working towards regional phase discriminants between earthquakes and nuclear explosions that will have universal applicability over broad and tectonically diverse regions down to very small magnitude. First, we have developed and are continuing to improve methods that use the amplitudes of the major regional phases (Pn, Pg, Sn, Lg) to determine the attenuation structure of the lithosphere. The tomography makes use of the MDAC earthquake source model. The amplitudes are inverted simultaneously for Qp and Qs of the crust, Qp and Qs of the upper mantle, event source terms, and station site terms, which ensures that parameters, such as seismic moment and apparent stress, are consistent among the various phases. Next, we are using these models to correct events for the observed variations of these regional phases due to earth structure. While regional P/S amplitudes have been recognized as an effective discriminant between earthquakes and explosions, path effects due to attenuation can greatly distort observed amplitudes. Amplitude corrections can be demonstrated to improve high-frequency regional P/S discriminants (e.g. Pn/Lg, Pg/Lg, Pn/Sn) by reducing scatter in the earthquake population and increasing separation of the explosions. The corrections also appear to extend the discriminants to lower frequencies, allowing them to be applied to more events. We are also using the attenuation models to explore the limitations of the discriminants. Because the absence of S-waves can indicate an explosion source, it is critical to establish for a given path that S-waves would have been observed had the source been an earthquake. We are making use of earthquake source spectral models and attenuation tomography results to map out by magnitude for a given station where regional P/S will work as a discriminant. Lastly, while we initially applied our method to the Middle East and Western Eurasia, we have also applied the method to areas in East Asia that include mixed continental and oceanic crust (which block certain regional phases) and subducting slabs (which complicate the propagation of mantle paths). Our aim is to be able correct for source and path effects in these regions in order to apply discriminants to a wide range of events over broad and tectonically complex regions.