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Shear-wave velocities to depths greater than 1 km using the krSPAC microtremor array method: examples from Seattle,Washington and Charleston, South Carolina, USA

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Characterizing earthquake ground motions through 3-D simulations is becoming standard practice for seismic hazard assessment in urbanized regions. However accurate ground motion prediction requires shear-wave velocity (Vs) data at depths that capture the extent of the sedimentary column (usually greater than 100 m), which can be difficult to obtain. We describe the application of the wavenumber-normalized spatial autocorrelation method (krSPAC) to obtain Vs at depths as great as 2500 m in two distinct geologic regions: Seattle, Washington, and Charleston, South Carolina. In a traditional SPAC approach, modeling high wavenumbers within the SPAC spectrum requires array symmetry. By contrast, in the krSPAC approach we transform observed coherency-versus-frequency spectra to coherency-versus-kr (where k and r are wavenumber and station separations, respectively) prior to Vs-versus-depth modeling. Through this transformation the requirement for array symmetry is eased. In the Seattle basin we acquired microtremor data at 11 sites to characterize Vs at depths of the Quaternary and upper Tertiary sedimentary deposits. We deployed seven-sensor nested asymmetrical triangular arrays, with interstation distances that varied from 170 m to 2000 m. From our microtremor data we interpret Vs to depths over 2200 m. Comparison of krSPAC Vs to previous interpretations from regional ambient noise tomography suggests a broadly comparable Vs structure in the 250 to 1000 m depth range. In the Charleston urban area, situated on Atlantic coastal plain sediments exposed to potential earthquake ground shaking, we acquired microtremor data at 10 sites using up to 10 nested but irregularly spaced sensors in each deployment, with interstation distances that varied from 60 m to 1000 m. Preliminary analysis of these data suggest that the base of the coastal plain sediments is resolved in the 500 m to 800 m depth range, and Vs of these sediments varies from ∼200 m/s to ∼750 m/s.