Improving Stoneley-mode constraints on the structures near the core-mantle boundary

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Although observations of seismic normal modes provide constraints on the structure of the entire Earth, the core-mantle boundary region remains poorly understood. Stoneley modes should offer better constraints, because they are confined near to the fluid-solid interface, but this property also makes them difficult to detect. In this study, we use recently-developed finite-element approach to show that Stoneley modes can be excited and detected, but only in certain special cases. We first investigate the physical explanation for these cases. Next, we describe how they could be detected in seismic data, and the sensitivity of these data to the material properties. We illustrate this sensitivity by calculating the modes of a three-dimensional Earth model containing a large low-shear-velocity province (LLSVP). Finally, we present some preliminary observations. We hope that this new understanding will lead to new constraints on the material properties and morphology of the core-mantle boundary region. In turn, this information, especially the constraints on density, should help to answer questions about the Earth, for example in mantle convection (are LLSVPs thermally or chemically buoyant? Primordial or slab graveyards? Passive or active?) and core convection (does the outermost core have a stable stratification?).