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Seismological models of Earth's Outer Core derived from normal mode data

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The turbulent, convecting outer core is the most massive fluid region of our planet, yet its physical properties are not fully known. The blend of light elements which along with iron and nickel comprise the outer core is uncertain, and mineral physics experiments are extremely challenging at the relevant pressures and temperatures. Published seismological models of the outer core's velocity show some disagreement, and models of the outer core's density are few. The commonly-used seismological Preliminary Reference Earth Model is now more than 35 years old and a wealth of new seismological data are now available.

We use normal mode centre frequencies to estimate both the Equation of State parameters and the velocity and density profiles of the outer core. We assemble a new dataset of more that 300 published mode center frequencies, which contains modes not used when PREM was constructed as well as updated measurements for other modes.

Using a Bayesian parameter-space exploration, we are able to retrieve the coefficients of an isentropic Vinet Equation of State (EoS) which best fits the outer core. The velocity and density prescribed by the EoS predict the normal mode center frequencies better than PREM. Furthermore, they predict body wave measurements closer to those predicted by body-wave based models such as ak135, helping to reconcile a longstanding discrepancy in core seismology.

We also explore the effect of including a seismically distinct layer at the top of the outer core; such a layer has been suggested by some body-wave based seismological studies. While body wave studies have been unable to assess the density anomalies in the uppermost outer core, our use of normal modes enables us to assess them, providing an important, complementary constraint on the nature of any such layer.

SmKS waves are seismic body waves which bounce *m-1* times on the underside of the core-mantle boundary; SmKS differential travel time measurements are particularly sensitive to structure in the upper part of the outer core. We use observations of SmKS waves to independently assess the predictions made using our normal mode-derived models of outer core structure.