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# Towards a comprehensive earth model across the scales

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We present the first iteration of the 'Comprehensive Earth Model' (CEM), a solver-independent multi-scale model of the global distribution of density and visco-elastic parameters. The model is based on a 3-D tetrahedral spectral-element mesh, which allows for the meshing of complicated geometries; topography, ocean bottom bathymetry, and major discontinuities are included in this first iteration. The accurate treatments of complex slab subduction models, as well as the topography of discontinuities, are planned for future iterations. The CEM currently contains detailed models of Europe, Australia, and Japan, embedded within the global shear velocity model S20RTS. There are immediate plans to integrate a new full waveform model of the South Atlantic, South America, and Africa, and to move towards global multi-scale full waveform tomography.

The multi-scale nature of the CEM is driven by recent developments in homogenization theory. In the context of an elastic Earth and broadband seismic waveforms, homogenization attempts to find an 'effective medium' at large scales which accurately predicts the response of long-period waves to fine-scale structure. For example, users will be able to select a specific scale length of interest, extract a homogenized model that is valid for waves larger than this scale length, and use the resulting single-scale model in a forward/inverse routine of their choosing. User updated models may then be added back into the CEM, which will be re-meshed and re-released at periodic intervals. Model quality metrics, constructed from traveltime, normal mode, and full waveform datasets, will be evaluated, and must be satisfied prior to the inclusion of updated models.

We encourage the integration of geomodels obtained from a variety of inversion techniques (i.e. normal mode methods, waveform methods, traveltime methods, gravity methods), and from a variety of research teams. We also focus on the inclusion of multiple data types (i.e. body waves, surface waves, etc.) in an effort to mitigate biases stemming from the inclusion of a single type. The consolidation of many models and data will provide a fertile testing ground for problems in seismology, geodynamics, and inverse theory.

The multiscale sensitivity of seismic waves to Earth's internal structure motivates this construction of a multiscale Earth model: one which contains detailed, fine-scale structure in regions where reliable short-period data are available, and one which presents the broad, low-wavenumber Earth in regions that don't enjoy significant short-period sampling. At present, the state of our knowledge of Earth's internal structure is scattered amongst an array of different models, and it is difficult to present, as a community, a model that best represents our multi-parametric tomographic achievements across the scales. We hope that the CEM makes a stride towards this goal.