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A method to consider compressibility in a spherically symmetric, self-gravitating viscoelastic earth model

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We introduce a new method to compute global deformation in a spherically symmetric, self-gravitating viscoelastic earth model. Previous methods are based on simplified earth models that neglect compressibility and/or the continuous variation of the radial structure of Earth. This is because the previous mode summation technique cannot avoid intrinsic numerical difficulties caused by the innumerable poles that appear in an earth model that considers such effects. In contrast, the proposed method enables both of these effects to be taken into account simultaneously. We carry out numerical inverse Laplace integration, which allows evaluation of the contribution from all of the innumerable modes of the realistic earth model. The key of this method is to choose a rectangular integration path which enables us to avoid singularities from those poles and rapid oscillations of the integrand on a path parallel to the imaginary axis at the same time. We apply this method to co- and post-seismic deformation by using a reciprocity theorem to convert internal viscoelastic responses to stress and potential changes given at the Earth's surface into the deformation raised by a prescribed dislocation at the source. To validate this method, we compare obtained results with Green's function used in previous studies. Good agreements are seen in special cases of elastic deformation and viscoelastic one in an incompressible earth model. Using this method, we assess effects of compressibility on postseismic deformation. The result shows that differences caused by considering compressibility are detectable with GPS observations for a typical large earthquake in plate boundary zones. In a future, we will apply this method to surface loading problems to elucidate effects of compressiblity.