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YASEIS: Yet Another computer program to calculate synthetic SEISmograms for a spherically multi-layered Earth model

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Although most researches focus on the lateral heterogeneity of 3D Earth nowadays, a spherically multi-layered model where the parameters depend only on depth still represents a good first order approximation of real Earth. Such 1D models could be used as starting models for seismic tomographic inversion or as background model where the source mechanisms are inverted. The problem of wave propagation in a spherically layered model had been solved theoretically long time ago (Takeuchi and Saito, 1972). The existing computer programs such as Mineos (developed by G. Master, J. Woodhouse and F. Gilbert), Gemini (Friederich and Dalkolmo 1995), DSM (Kawai et. al. 2006) and QSSP (Wang 1999) tackled the computational aspects of the problem.
A new simple and fast program for computing the Green's function of a stack of spherical dissipative layers is presented here. The analytical solutions within each homogeneous spherical layer are joined through the continuous boundary conditions and propagated from the center of model up to the level of source depth. Another solution is built by propagating downwardly from the free surface of model to the source level. The final solution is then constructed in frequency domain from the previous two solutions to satisfy the discontinuities of displacements and stresses at the source level which are required by the focal mechanism. The numerical instability in the propagator approach is solved by complementing the matrix propagating with an orthonormalization procedure (Wang 1999). Another unstable difficulty due to the high attenuation in the upper mantle low velocity zone is overcome by switching the bases of solutions from the spherical Bessel functions to the spherical Hankel functions when necessary. We compared the synthetic seismograms obtained from the new program YASEIS with those computed by Gemini and QSSP. In the range of near distances, the synthetics by a reflectivity code for the horizontally layers are also compared with those from YASEIS. Finally the static displacements in the source region are computed by choosing a very small frequency value in YASEIS which is designed for computing the dynamic response, and compared with the results in a homogeneous half-space model (Okada 1992).

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