

Ray-theory based modelling: software packages of the SW3D consortium

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SUMMARY

We present description, discussion of advantages and limitations, and examples of applications of FORTRAN ray-tracing program packages, developed within the consortium project "Seismic waves in complex 3-D structures (SW3D)", <http://sw3d.mff.cuni.cz>. Purpose of the packages is modelling of seismic wavefields in 3-D layered, laterally varying, isotropic or anisotropic structures. The packages are based on the ray theory. Packages are regularly updated. Updated versions are immediately available to the sponsors of the SW3D consortium or to research institutions/individuals who plan to use them for research, and who sign a non-disclosure agreement. Updated versions become public two years after their appearance.

BASIC PACKAGES

The basic ray-tracing packages are CRT (Červený et al., 1988) and ANRAY (Gajewski & Pšenčík, 1990).

Both packages can be used to trace rays and to calculate along them travel times, slowness vectors and dynamic-ray-tracing quantities necessary for calculation of geometrical spreading and vectorial ray amplitudes as well as for two-point ray tracing and other important applications. The calculated quantities can be used to evaluate the elastodynamic ray-theory Green function, and to compute ray synthetic seismograms. Arbitrary types of elementary seismic body waves can be considered: P, S, (in anisotropic layers S1 and S2), direct, multiply reflected, converted. Various types of sources can be situated in arbitrary parts of models. Several acquisition schemes are allowed: surface seismics (land and marine), VSP, cross-hole, OBS, OBC. The packages differ by models of structures, in which considered waves propagate.

Package CRT can be applied, through the use of an independent package MODEL, to very general 3-D layered and block isotropic or weakly anisotropic structures, containing isolated bodies, pinchouts, etc. Inside the layers and blocks, the elastic parameters may vary in all three dimensions. Dissipation and non-planar topography can be considered. The package also allows computations based on the coupling ray theory along isotropic or anisotropic common S-wave rays.

Package ANRAY can be applied to 3-D laterally varying structures containing isotropic and anisotropic non-vanishing layers. The elastic parameters inside layers may vary in all three dimensions. In a smooth model, the package allows S-wave computations based on the quasi-isotropic approximation of the coupling ray theory.

In addition to the above three packages, we also describe several other packages and planned innovations, which include use of Gaussian beams and packets, first-order ray tracing for inhomogeneous weakly anisotropic media, etc.

ACKNOWLEDGEMENTS

The research has been supported by the Grant Agency of the Czech Republic under contracts 205/01/0927, 205/01/D097 and 205/04/1104, 205/05/2182, by the Grant Agency of the Academy of Sciences of the Czech Republic under contract A3012309, by the European Commission under contract MTKI-CT-2004-517242 (project IMAGES), and by the members of the consortium “Seismic Waves in Complex 3-D Structures” (see “<http://sw3d.mff.cuni.cz>”).

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