PREVAILING-FREQUENCY APPROXIMATION OF THE COUPLING RAY THEORY FOR S WAVES ALONG THE SH AND SV REFERENCE RAYS

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The coupling-ray-theory S-wave tensor Green function is frequency dependent. Its prevailing-frequency approximation removes this frequency dependence and allows us to introduce the coupling-ray-theory travel times and the coupling-ray-theory amplitudes, and to process the coupling-ray-theory wave field in the same way as the anisotropic-ray-theory wave field. This simplification may be decisive when storing the tensor Green function at the nodes of dense grids.

The coupling ray theory is usually applied to anisotropic common reference rays, but it is more accurate if it is applied to reference rays which are closer to the actual wave paths. In a generally anisotropic medium, the actual wave paths may be approximated by the anisotropic-ray-theory rays if these rays behave reasonably. In an approximately transversely isotropic medium, we can define and trace the SH and SV reference rays, and use them as reference rays for the prevailing-frequency approximation of the coupling ray theory.

We test the accuracy of the proposed prevailing-frequency approximation of the coupling ray theory numerically in the model with a split intersection singularity. The anisotropic-ray-theory S-wave rays crossing the split intersection singularity are smoothly but very sharply bent. While the initial-value rays can be safely traced by solving Hamilton's equations of rays, it is often impossible to determine the coefficients of the equations of geodesic deviation (paraxial ray equations, dynamic ray tracing equations) and to solve them numerically. As a result, we often know neither the matrix of geometrical spreading, nor the phase shift due to caustics. We demonstrate the abrupt changes of the geometrical spreading and wavefront curvature of the fast anisotropic-ray-theory S wave (Figure 1). We also demonstrate the formation of caustics and wavefront triplication of the slow anisotropic-ray-theory S wave (Figure 2).

Since the actual S waves propagate approximately along the SH and SV reference rays in this velocity model, we compare the anisotropic-ray-theory S-wave rays with the SH and SV reference rays (Figures 1 and 2). Since the coupling ray theory is usually calculated along the anisotropic common S-wave rays, we also compare the anisotropic common S-wave rays with the SH and SV reference rays.

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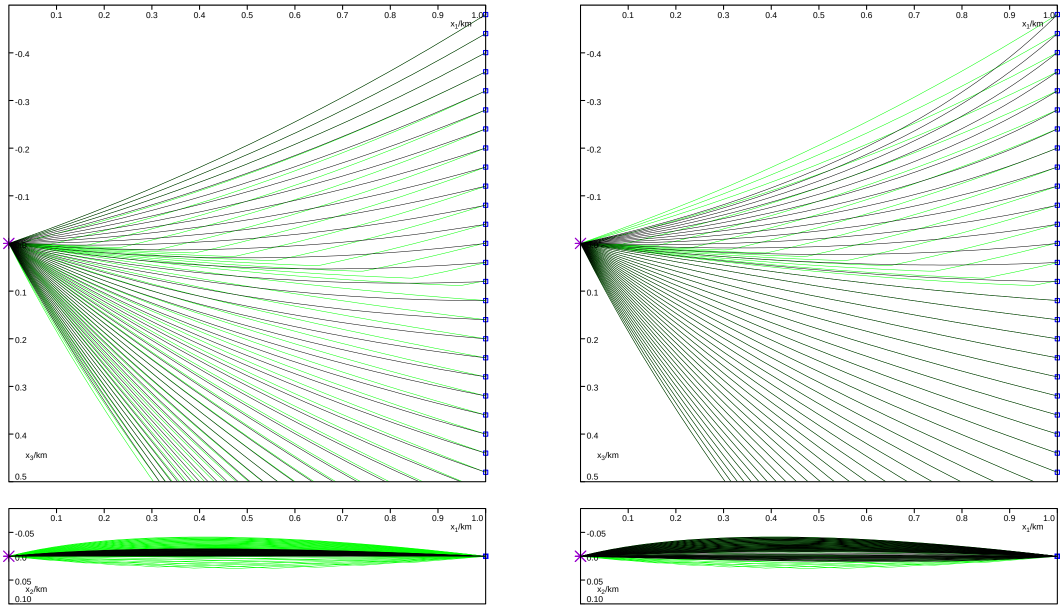

Figure 1: Left: Comparison of the anisotropic-ray-theory rays of the fast S wave (**green**) with the SH reference rays (**black**, plotted later on). The anisotropic-ray-theory rays of the fast S wave are very close to the SH reference rays for the deepest receivers, and are situated above them up to the third receiver below the surface. The anisotropic-ray-theory rays of the fast S wave are sharply bent from the second receiver below the surface to the ninth receiver above the surface, and considerably differ from the SH reference rays there. The anisotropic-ray-theory rays of the fast S wave nearly coincide with the SH reference rays from the tenth receiver above the surface.
Right: Comparison of the anisotropic-ray-theory rays of the fast S wave with the SV reference rays.

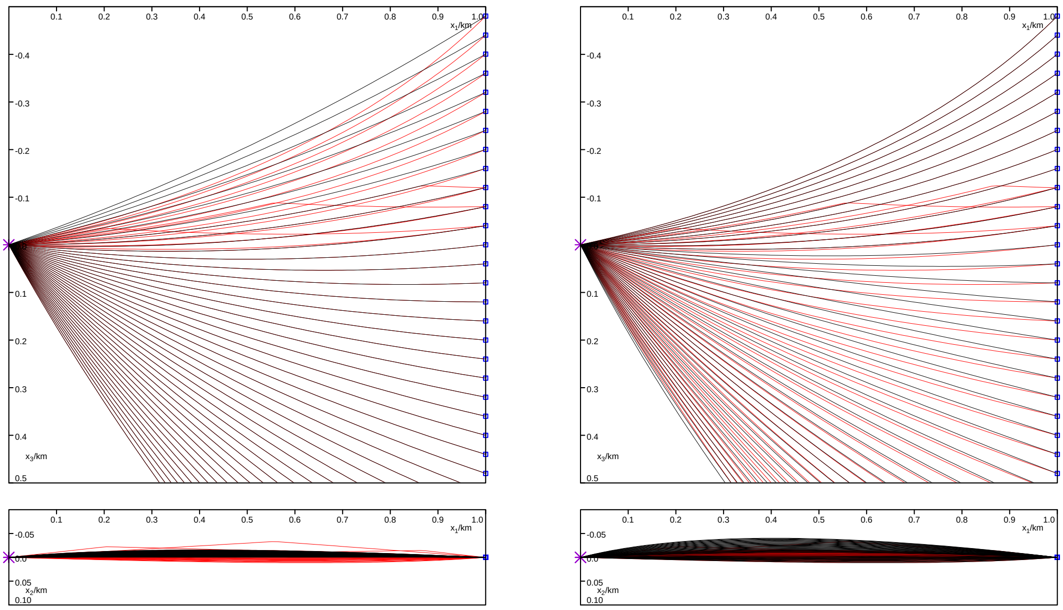

Figure 2: Left: Comparison of the anisotropic-ray-theory rays of the slow S wave (**red**) with the SH reference rays (**black**, plotted later on). The anisotropic-ray-theory rays of the slow S wave nearly coincide with the SH reference rays up to the surface receiver. The anisotropic-ray-theory rays of the slow S wave display a triplication due to sharply bent rays from the first to the third receiver above the surface. The anisotropic-ray-theory rays of the slow S wave are situated considerably below the SH reference rays from the fourth receiver above the surface.
Right: Comparison of the anisotropic-ray-theory rays of the slow S wave with the SV reference rays.