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The Attempt to Model Rotations in the Coda with Radiative Transfer Theory

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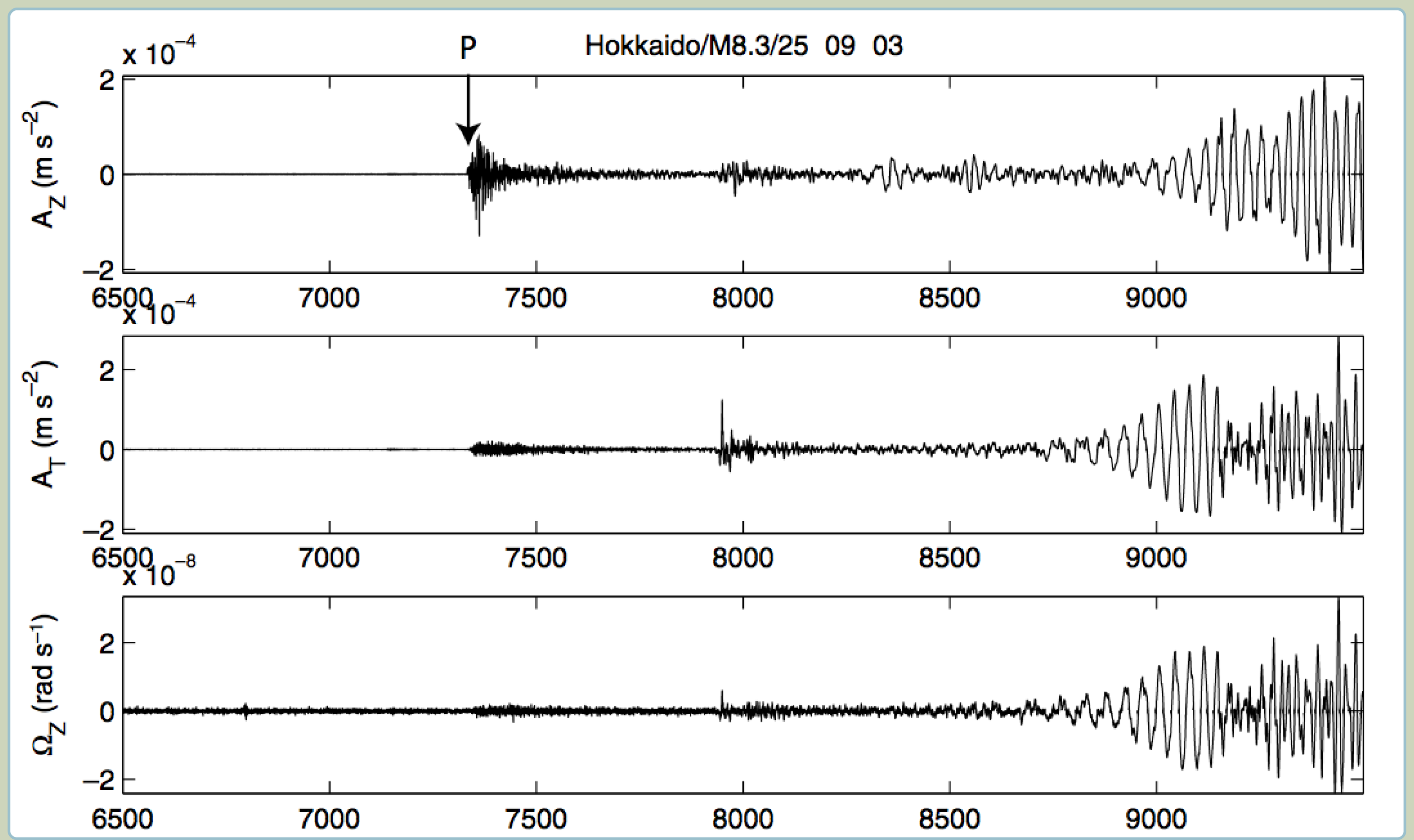


Motivation

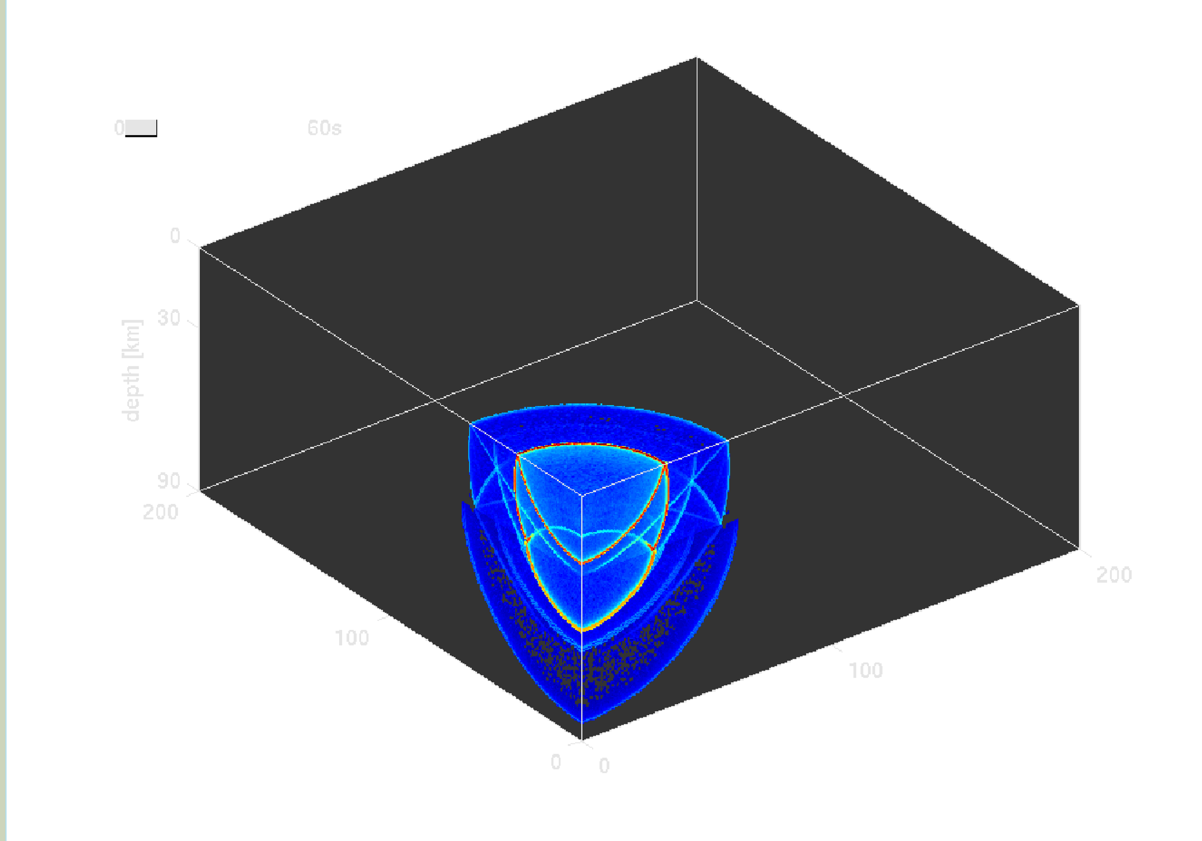
The idea for this project originated from the discovery of rotational motions excited by teleseismic P-waves. Since P and SV waves can not excite rotations a round a horizontal axis the measurement is a direct indication of conversion scattering in a 3D sturcture. From this conversion scattering we can derive information about the small scale heterogeneity in the medium.

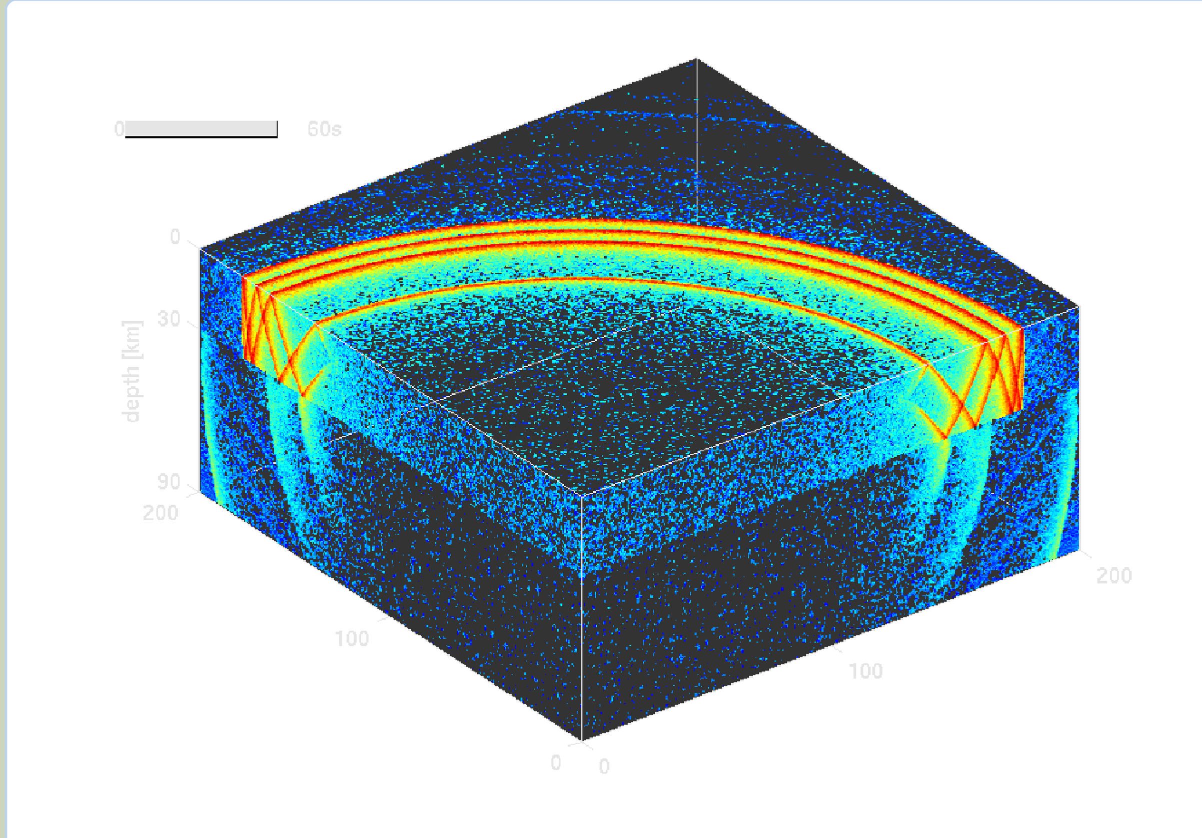
Goal

The goal of this investigation is to use the information about rotational motion as an additional information to constrain the properties of the small scale heterogeneity.

Radiative Transfer Theory

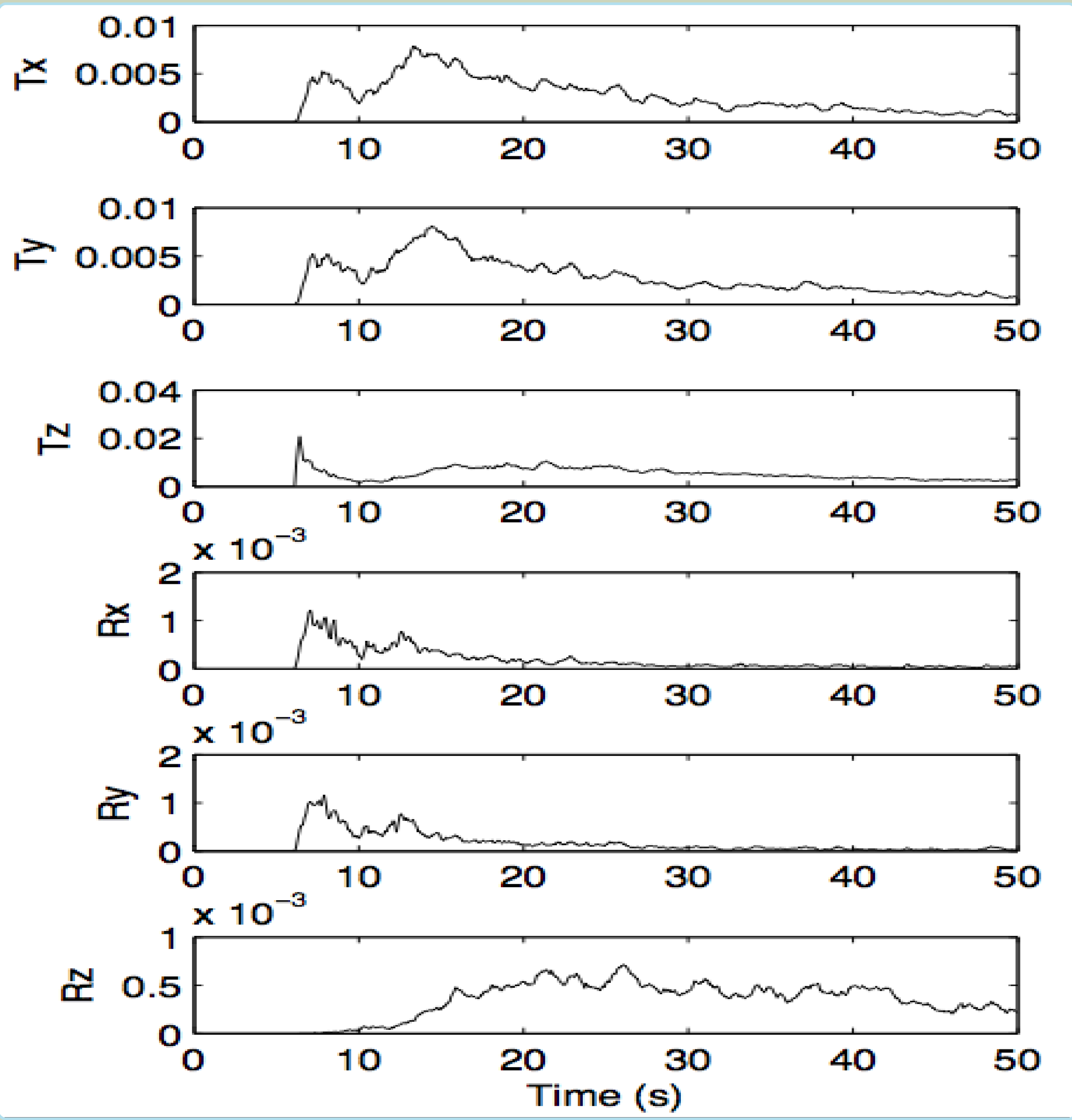
Radiative transfer theory describes the propagation of energy in a heterogeneous medium under the assumption of random phases. This allows to neglect wave effects like interference and results in a prediction of seismogram envelopes only. The underlying radiative transfer equation is solved by a Monte-Carlo technique that simulates the propagation of wave particles. The figures show two snapshots of such simulations in a macroscopic structure similar to the Earth's crust.





Modeling Rotations with RTT

The envelope of the rotation rate is derived from the P- and S-wave intensities with the stress free boundary condition at the surface. The rotation rate around the vertical axis for example is calculated from the horizontal projection of S-wave intensity with horizontal polarization.



First Simulations

To simulate the excitation by a plane P-wave we modified the algorithm for the MC-simulations. First results of the simulations are shown to the left and right. Three upper graphs show mean-square envelopes of translational motions and the lower lines show envelopes of rotation rates.
Scattering is rather strong in both cases as can be seen by the second maximum of horizontal envelopes that is related to P-to-S converted energy.
The special role of the rotation around the vertical axis in the P-coda can be seen in the bottom lines. Since neither P nor SV energy can excite this component of the rotation vector it requires an additional scattering event to convert either scattered P or SV energy into SH energy that can cause rotations around the vertical axis. Therefore the R_Z envelopes increase slower and contain more information on the conversion scattering in the medium.
In the future we will compare the MC-simulations with wave field simulations to verify the validity of the RTT approach before rotation rate measurements will be inverted for properties of the subsurface heterogeneity