Master Student project: Seismic source inversions in 3-D heterogeneous media

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Source inversions help to investigate the focal mechanism (beachballs), magnitude, location, and time shift of an event that can be observed in seismological data, e.g. earthquakes. Knowing accurate source properties of events can further our understanding of different aspects of the Earth system.

Applications of critical societal importance using source properties include earthquake and tsunami early warning systems, nuclear monitoring, and volcano monitoring. The quality of source inversions for source properties is critically dependant on the quality of the Earth model used to solve the inverse problem. There are numerous Earth models, differing in data, resolution and the inversion scheme.

Figure 1 shows an example, where moment tensor (MT) inversions using two different Earth models are compared. In this project, we would like you to do, in a similar approach, a detailed investigation of source properties through MT inversions with different 1-D and 3-D Earth models. You will have the chance to get more familiar with earthquake data and computational seismology while using state-of-the-art software in the form of **Salvus**, a suite for high-performance full-waveform modelling and inversion. You will also be able to improve your programming skills and also get to know more about inversion problems in general. The project can potentially lead to a successive Master thesis project for real-data applications on source inversions in 3-D heterogeneous media.
A tentative roadmap of this summer project includes:

1. Getting familiar with software and literature. Setting up a small pilot simulation.
2. Outline code workflow structure for source inversions
3. Use this code workflow for different inversions and building up your code. Inversions would first compare 1-D models and then 3-D models with synthetic test cases and then interpreting results.
4. If there is additional time: Building up a data set with real earthquake data

If you are interested, contact me over this E-Mail: **carl.schiller@erdw.ethz.ch**

For more information on the numerical fundamentals of Salvus' implementation refer to: **"Modular and flexible spectral-element waveform modelling in two and three dimensions"**

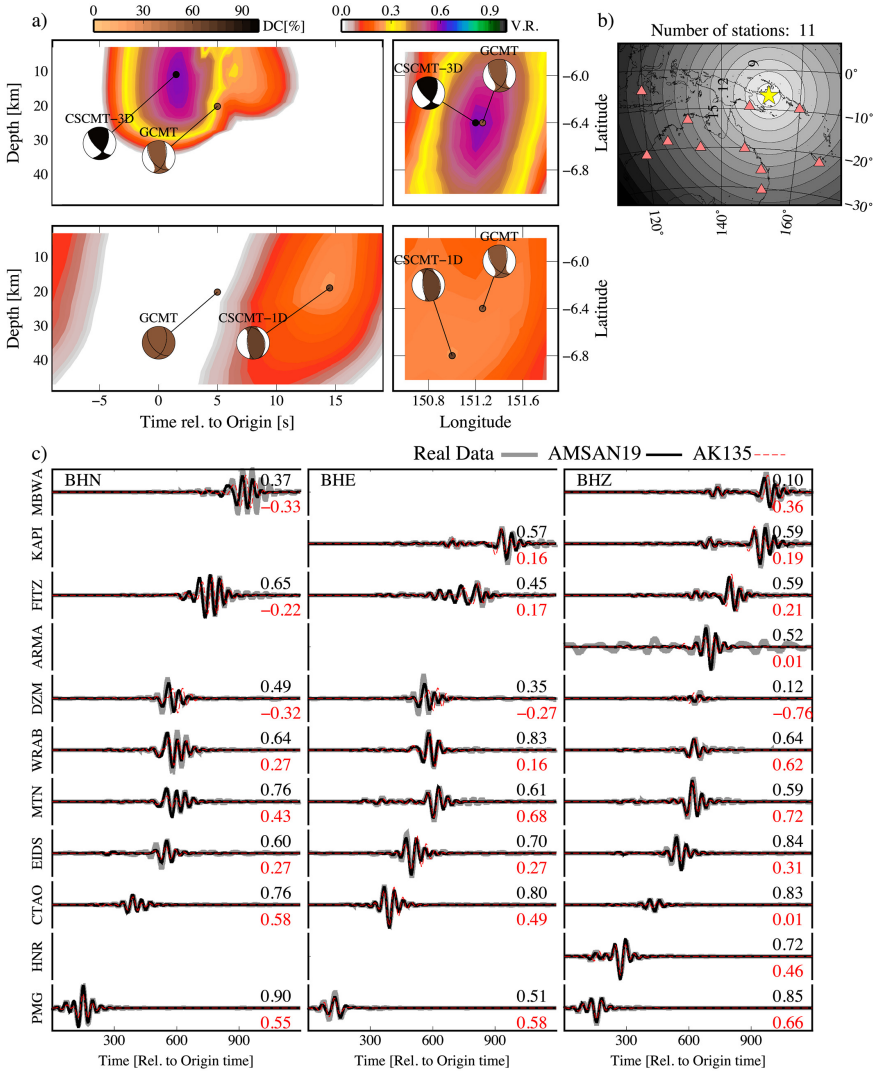

Figure 1: Figure 9 from Hejrani et al. 2017 "Centroid moment tensor catalogue using a 3-D continental scale Earth model: Application to earthquakes in Papua New Guinea and the Solomon Islands". **a)** Shows contour maps and MT results of depth, time, and horizontal location between two different Earth Models. **b)** Location of earthquake (yellow star) and 11 seismometers (red triangles) used for the inversion. **c)** waveform fits between observed data and simulation data of the different Earth Models with time shift rel. to origin time of the Earthquake