Tomography without travel times: seismic inverse problems with 6C ground motion observations

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With recent advances in observing rotational ground motions (and increasing availability of strain observations, e.g., in boreholes) we pose a general question how seismic inverse problems (for structure and source) behave in the presence of more than three components of translation (>3C) as is now standard in broadband seismology. For the structural inverse problem one can formulate the problem in terms of an optimization in which a combination of observables is sought that maximizes sensitivity with respect to certain geophysical parameters at depth (e.g., density, elastic parameters) or certain regions (e.g, near receiver structure). With this general formulation we can reproduce previous results for the inverse problem including rotation (or strain) in which strong sensitivity near the receivers is obtained by inverting the amplitude ratio of translations and rotations (or strain), thus seismic tomography without travel times! Recently, we investigated the kinematic source inversion problem and analysed the resolving power of 3C vs. 6C sensors (incl. rotations). Surprisingly, some of the finite source parameters are (almost always) better resolved, when a seismic network of N 3C stations around a finite source is replaced by N/2 6C stations keeping the overall number of observed traces constant. Finally, we will report on planned observational strategies in rotational seismology for observatory (ring laser) and field (portable sensors) situations.