Abstracts of the June 15 workshop on solid-earth geophysics

Barbara Romanowicz (IPGP, Collège de France, Paris, France and U.C. Berkeley, CA, USA),
Challenges in global seismic waveform tomography in the era of numerical wavefield computations.

Abstract. I will first present some historical background and some key scientific motivations for constructing seismic tomographic models of the earth's mantle at the global scale. Then I will give a brief introduction of the data we collect, the equations that govern our problem, and the physical parameters that we aim at constraining. I will review "classical" approaches and some results obtained in the last 30 years based on first order theoretical approximations for the forward problem. I will introduce the principles of waveform tomography, originally based on normal mode perturbation theory, but more recently benefitting from the availability of powerful methods for numerical wavefield computations, and discuss the new computational challenges and different ways to approach them. I will illustrate this with recent results from our group and discuss current and future directions.

Robert van der Hilst (Massachusetts Institute of Technology, Cambridge, MA, USA),
TBA.

Abstract.

Johan Robertsson (ETH Zürich, Switzerland),
Finite-difference boundary conditions for processing and imaging of broadband seismic data.

Abstract. It is well known that recomputing modelled wavefields after local model alterations can be done efficiently by employing the method of FD-injection proposed by Robertsson and Chapman (2000) or the method of exact boundary conditions (van Manen et al., 2007) along the edge of the truncated model. In this presentation we discuss how these boundary conditions also have important applications outside modelling of wave propagation.
First, we show that by carefully considering the models (medium parameters and boundary conditions) for injection, wavefield injection of multicomponent data can be used to solve a number of long-standing challenges in marine seismic data processing by means of conventional time-space-domain finite-difference propagators. We outline and demonstrate several of these applications including up-down separation of wavefields (deghosting), direct wave removal, source signature estimation, multiple removal and imaging using primaries and multiples. Exact boundary conditions provides a robust and stable time-space solution for multi-dimensional deconvolution without the need to invert large matrices. We show how a combination of FD-injection and exact boundary conditions can be used to directly obtain an estimate of all surface-related multiples that then can be adaptively subtracted from recorded seismic data.
Second, at ETH we propose to build a new wave propagation laboratory in which a physical experiment is fully immersed inside a virtual numerical environment by means of using a real-time implementation of exact boundary conditions through transmitting and recording transducer surfaces surrounding a target. Specific applications include time reversal and focussing experimentation in 3D and the study of wave propagation in media where the physics of wave propagation is poorly understood such as the effect of fine scale heterogeneity on broadband propagating waves.

Miaki Ishii (Harvard University, Cambridge, MA, USA),
Some Examples on How to Study Earthquakes and the Earth's Interior.

Abstract. There are a variety of seismological data that can be used to investigate properties and structure of the Earth's interior. Of these, free oscillations or normal modes of the Earth are at the lowest seismological frequency, typically below 3 mHz. In the first part of the presentation, I focus on how these data can be used to investigate the Earth's interior and how they complement more popular body wave and surface wave data sets. Because these modes, and any other seismological observations, are excited

by a source (typically an earthquake but could be artificial explosion or ocean currents or anything that imparts momentum into the Earth), the data contain information about the source as well as the interior. The second part of the presentation will examine how behaviour of earthquakes are investigated using seismic recordings and challenges associated with them.