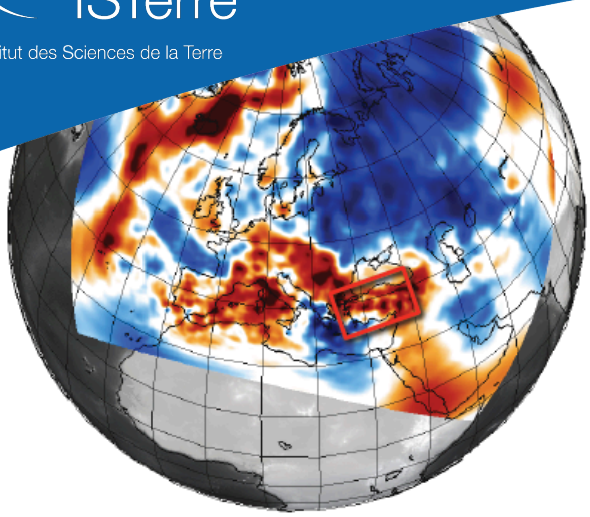
ISTerre
Institut des Sciences de la Terre

Grand Séminaire 2013



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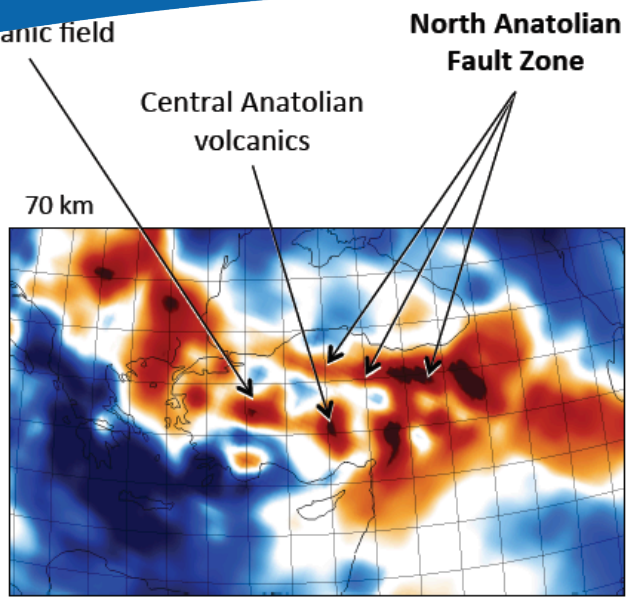

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Multiscale full waveform inversion:
towards a comprehensive seismic Earth model

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Seismic tomography is one of our primary tools to study the structure and dynamics of the Earth's interior. It has drawn the image of a vigorously convecting planet with hot upwelling plumes, descending lithospheric slabs, and numerous other features. Despite the undeniable progress, challenges remain. These include (1) the joint resolution of crustal and mantle structure, required to infer coupling between mantle and convection and near-surface processes, (2) the accurate modelling of wave propagation in complex media across a wide range of spatio-temporal scales, and (3) the combination of different seismic data types in a fashion that fully honours wave propagation physics.

To address these challenges, we develop a multiscale full waveform inversion that assimilates complete teleseismic and regional seismograms in a broad period range (8-200s). Being based on spectral-element modelling and adjoint techniques, our method simultaneously solves multiple regional- and continental-scale inverse problems in order to jointly resolve crustal and mantle structure. Different scales are coupled via non-periodic homogenisation, and tomographic resolution is quantified using second-order adjoints.

We apply our method to Europe and Western Asia, where resolution is particularly high beneath the North Atlantic, the western Mediterranean and Anatolia. The multitude of geologically interpretable features include the Iceland plume which clearly extends into the lower mantle. Furthermore, we observe two low-velocity fingers that extend from the Iceland plume into the North Atlantic asthenosphere, where they correlate with regions of Neogene uplift. Western Anatolia is characterised by the extension-related updoming of lower-crustal material. The deep expressions of volcanic provinces in central Anatolia and the North Anatolian Fault Zone are clearly imaged.

The extension of the multiscale full waveform inversion to the globe is the backbone of an emerging Comprehensive Seismic Earth Model that assimilates the complete range of seismic data into one consistent model of the Earth's interior by combining various tomographic techniques, including full waveform inversion, ray tomography, and normal-mode inversion.

Mercredi 13 novembre 2013 à 11h

Salle de conférences d'ISTerre

OSUG-C, 1381 rue de la piscine, Campus Universitaire
Arrêt Tram B/C Bibliothèques universitaires