Simulation of 3D Global Wave Propagation

Possibilities to Improve Geophysical Earth Models

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Motivation

Tomography

S20RTS implemented in SEM
(Ritsema et al., CalTech 2000)

Wave Propagation

http://garnero.asu.edu/research/gallery/index.html

Geodynamics

Simulation of Sumatra Earthquake Dec. 2004
Outline

Forward Problem
• Global Wave Propagation
• Models

Methods
• Spectral Element Method
• Adjoint Method

Inverse Problem
• Earth Structure
• Dynamic Behaviour

Publications – Conferences – Workshops
Tokachi-Oki M8.1, Japan – Station Wettzell, Germany

Estimated phase velocity: Data (black), Synthetic (red)
2D Traveltime and Waveform Kernels

Synthetic displacement

Adjoint source = velocity!
Forward Problem – Model Conversion

SPECFEM3D Grid → TERRA Grid

Spherical Harmonics

Fixed visualization geometry

Flexibility in Model Visualization
Mantle Convection Model

Demeaned Temperatures
(-1566° to 1243°)
Comparison of Models

Seismic velocities derived from simple linear scaling
\[ \frac{\partial V_p}{\partial T} = -0.2 \cdot 10^{-3} \text{ ms}^{-1} \]

Mantle Convection Model

Tomography Model S20RTS
Comparison of Models

West Pacific Region

Mantle Convection Model

Tomography Model S20RTS
Comparison of Models

True Amplitude Colorscale

Mantle Convection Model

Tomography Model S20RTS
Simulations – Very First Results

Tokachi-Oki M8.1 Simulation
Station Wettzell, Germany

Time [s]
Displacement [m]

MCM
S20RTS

Wettzell
Hokkaido
Next Steps – Improving $V_p$ and $V_s$

Temperatures from MCM

In collaboration with Antonio Piazzoni
Outlook

• More realistic conversion from temperatures to seismic velocities by mineral physics calculations.
• Quantitative understanding of differences in seismograms of tomographic and geodynamic models.
• Primarily focus on different MCM.
• Explore seismological aspects – event/receiver configuration.
• Temperature fields from more realistic simulations (soon available).

→ time dependence
Thanks for your Attention!