A comprehensive examination of previously derived focal mechanisms from the Tibetan Plateau indicates an abrupt change in dominant focal mechanism type from normal faulting south of about 32° to strike-slip faulting in the central and northern plateau. This change occurs near the surface expression of the Banggong-Nujiang Suture Zone (BNSZ), which separates the Lhasa block from the Qiang Tang terrane. Some previous authors have suggested tractions on the base of the Eurasian lithosphere created by oblique subduction of Indian mantle lithosphere along the curved Himalayan Arc are the driving force behind the development of the large normal faults and rift systems of southern Tibet. In this model, the northern limit of the these normal faults, i.e. the BNSZ, could be interpreted as the northern limit of mechanical coupling between the Indian and Eurasian lithospheres. This change in focal mechanism type may also correspond with changes in shear-wave splitting parameters, Pn velocity, crustal shear-wave velocity, and upper mantle P-wave velocity estimates from INDEPTH III data. Taken together, these data are consistent with ascribing the change in tectonic regime at the surface to the decoupling of Indian lithosphere from Tibetan crust in the middle of the Tibetan plateau.

S51B-1051 0830h POSTER

A Surface Wave Dispersion Study of the Yellow Sea and Korean Peninsula

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We have performed a study of surface-wave group-velocity dispersion across the Yellow Sea and Korean Peninsula. We primarily use seismic data from stations INCN and KSAR in South Korea, BJT, MDJ, and SSE in China and INU in Japan. We measure group-velocity using multiple narrow-band filters on deconvolved displacement data. We use a conjugate gradient method to perform a high-resolution group-velocity tomography over the region. Our current results include both Love and Rayleigh wave inversions for periods from 10 to 100 seconds. There is an excellent correspondence between the group velocities and tectonic structure. Our findings indicate that short periods are sensitive to slow velocities associated with large sedimentary features such as the Yellow Sea and Bohai Bay. We find our long period Rayleigh wave inversion is sensitive to crustal thickness, such as fast velocities under the oceanic crust of the Sea of Japan and slow along inland continental crust. We also find slower velocities under portions of the Sino-Korean Paraplatform where the upper mantle has been affected by the back-arc of the subduction of the Pacific and Philippine Plates under the Eurasian continent. In contrast, we generally find fast velocities under the rest of the Cathaysian Craton. Finally, we use the group-velocity results to model the shear-velocity structure of the crust and upper mantle for a few tectonic regions. We employ a grid-search technique to simultaneously fit the Love and Rayleigh wave group-velocities over the whole period range. We are testing and refining these velocity models by waveform modeling some of the larger events using reflectivity generated synthetics.

S51B-1052 0830h POSTER

Surface Wave Tomography in Central Asia

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The improvement of broadband station coverage across most of Asia during the last years, together with the fact that this continent is the one with the most significant intracontinental seismicity, make Asia an ideal site to perform surface wave tomography. This study focuses in the region limited by longitudes 70 E and 95 E and latitudes 35 N and 50 N. We analyzed broadband waveforms from about 1,100 events from 1997 through May 2002 recorded at 13 seismic stations. These seismic records produced about 6,500 paths for which individual dispersion curves were estimated performing a multiple-filter analysis. The estimated group velocity curves have been inverted to compute group velocity maps in the period band between 5 s and 30 s. The resulting maps reveal geologic and tectonic features as never displayed before in similar studies. Our maps delineate clearly the Tien Shan between the sedimentary basins of Tarim and Jungger. More over, the results of this study will improve the resolution of the shear-velocity structure of the crust underlying this part of Asia. They will also contribute to the improvement of regional magnitude estimations, which are so important for seismic discrimination problems.

S51B-1053 0830h POSTER

Pn tomography of China

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Pn travel times are affected by crustal velocity and thickness and by mantle velocity and anisotropy, thus useful to study crustal and uppermost mantle structure and regional tectonics. We obtained over 51810 Pn travel-time picks from 5660 earthquakes and 199 stations in Chinese national and provincial earthquake bulletins, to invert for Pn velocities beneath China. Checkerboard tests suggest that the resolution is about 1 by 1 degree, but in some areas where ray coverage is dense, such as Yunnan and Sichuan, the resolution is higher than 0.5 by 0.5 degrees. Our main results are as follows. (1) Assuming crustal velocity of 6.3 km/s, the average crustal thickness of China is about 45 km and the average Pn velocity is 8.0 km/s. (2) The delay times of stations and events suggest large variations in crustal thickness. The average thickness for western China is 49 km; the average for eastern China is 39 km. Almost all stations in the eastern China have negative delays, indicating a relatively thinner crust in the east. High elevations of Tibetan Plateau and Tian Shan are associated with large positive station delays of a thicker crust. (3) The Pn velocities are high in major basins (Sichuan, Qaidam, Junggar, and western Tarim) and low in areas of active volcanoes (Tengchong) and quaternary volcanisms in northern Tibet, and the tectonically active areas of the North China Platform. (4) The Pn anisotropy appears to have a rotational pattern near the eastern margin of the Tibetan Plateau, which may be related to the deformation of the region.

S51B-1054 0830h POSTER

Crustal structure of the northern margin of the Tien Shan, China and its Tectonic Implications for the 1906 M = 7.7 Manas Earthquake

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We describe an 86-km-long, N-S-trending deep seismic reflection profile, which passes through the Urumqi depression (southern Junggar basin) of the northern Tien Shan piedmont. Two distinct anticlines beneath the northern margin of the Tien Shan are clearly imaged in the seismic section. In addition we have imaged two detachment surfaces at depths of about 10 km and about 20 km. The detachment surface at 20 km depth corresponds to the main detachment that converges with the steep angle fault (the Junggar Southern Marginal Fault) on which the M = 7.7 1906 Manas earthquake occurred. A 12-14 km thick sedimentary basin is imaged beneath the southern Junggar basin near Shihezi. The crust beneath the northern margin of the Tien Shan is about 50 km thick, and decreases beneath the Junggar basin to about 45 km thick. The image on the deep seismic reflection profile is consistent with models from seismic refraction data and Bouguer gravity anomalies in the same region. The faulting associated with the 1906 Manas earthquake can be explained in the framework of this crustal model, which suggests that both a high-angle fault and a sub-horizontal detachment surface moved during that event.

Present day micro-seismicity shows a hypocentral depth-distribution between 5 and 35 km, with a peak at 20 km. We suggest that the 1906 Manas earthquake initiated at a depth of about 20 km and propagated upwards to cause northward slip on the sub-horizontal detachments beneath the southern Junggar basin.

S51C MCC: 121 Friday 0830h

Welcome to the Machine: Advances in Seismic Waveform Simulation

Presiding: **G Nolet,** Princeton University**; I M Tibuleac,** Weston Geophysical Corporation

S51C-01 0830h

Simulation of the Planar Free Surface in Media with Near-surface Lateral Discontinuities in the 3D 4th-order Staggered-grid Finite-difference Modeling of Seismic Motion

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Recently, Kristek et al. (2002) have developed a new technique to simulate planar free surface in the 3D 4th-order staggered-grid finite-difference (FD) modeling of seismic motion. The technique directly prescribes zero values of the stress-tensor components Tzx and Tzy at the free surface (in one formulation or zero value of Tzz at the free surface in the alternative formulation), applies adjusted 4th-order FD approximations to the z-derivatives at the grid points at and below the free surface, and uses neither virtual values above the free surface nor stress imaging. Numerical tests for a homogeneous halfspace and 1D layered models against the DWN (discrete wavenumber) method proved very good accuracy (also for Rayleigh waves) and efficiency of the technique which requires not more than 6 grid spacings per wavelength in the range of epicentral distances up to 22 times the wavelength.

Because in the modeling of the earthquake ground motion material discontinuities reaching the free surface have to be included, we performed numerical tests of our technique for models with vertical and oblique material discontinuities reaching the planar free surface. We compared the synthetics with those calculated by the standard finite-element (FE) method. We used the FE method because, unlike the FD method, satisfying boundary conditions at the free surface and at internal material discontinuities poses no problem for the FE method. The numerical comparisons demonstrate level of accuracy of our technique for simulating the planar free surface in media with lateral discontinuities.

We also compare synthetics obtained using our technique with those calculated using the standard stress-imaging technique of Levander (1988).

S51C-02 0845h

Simulations of Strong Ground Motion in the Los Angeles Basin Using the Spectral-Element Method

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We use the spectral-element method (SEM) to simulate strong ground motion in the Los Angeles basin. Our basin velocity model was constructed using sonic log and stacking velocity information provided by oil industry sources. The method includes effects due to attenuation, topography and bathymetry. The basin model is embedded into the regional model of Hauksson (2000).

Our mesh honors the bottom part of the 8.5 km deep sedimentary pocket underneath downtown Los Angeles, as well as topography and bathymetry. We double the mesh twice in the vertical direction based upon a conforming doubling 'brick'. This allows us to increase the

resolution of the SEM calculations near the surface, in low-velocity sediments. We obtain a high-quality mesh based upon a heuristic rule to prevent elements in the doubling regions from becoming too flat.

The SEM is implemented on a parallel computer based upon a message-passing algorithm (MPI), and run on a large PC cluster, a so-called Beowulf machine. This allows us to model wave propagation in a large region that includes most of the TriNet stations. To optimize the efficiency of the simulations and reduce cost, Perfectly Matched Layer (PML) absorbing conditions, formulated as a second-order system in displacement, are used on the edges of the computational grid.

Results are shown for two small events (M = 4.2) that can be treated as point sources, the September 2001 Hollywood earthquake, and the Watts event. We use a three-dimensional centroid-moment tensor inversion based upon the SEM and the basin model to determine the mechanisms and locations of these events.

URL: http://www.gps.caltech.edu/research/jtromp

S51C-03 0900h

Fast modeling visco-elastic seismic responses using thin-slab propagators

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Fast methods of synthesizing seismograms in complex visco-elastic media are important in many areas of seismology. The newly developed dual-domain one-way elastic-wave propagators implement wave propagation in arbitrarily heterogeneous media in mixed domains (space-wavenumber domains) shuttling with fast Fourier transform (FFT) (Wu, 1994, 1996; Wild and Hudson, 1998). These methods are very efficient in computation speed and internal memory saving compared with the full wave finite-difference and finite-element methods. In this study we extend the dual-domain one-way thin-slab propagators to include the effect of visco-elasticity, which is an important factor affecting seismic wave propagation and attenuation, by introducing quality factors (Q_p and Q_s) into the method. Using the Q-incorporated thin-slab method, we calculate the reflection coefficients produced by pure elastic parameter variations (density and velocity), pure quality factor variations, and their combinations, and compare the results with the exact reflection coefficients using the Zoeppritz equations. The accuracy and capability of the method are confirmed. Finally, we use the method to investigate the effects of intrinsic attenuation and elastic parameter heterogeneities on the variation of amplitude of seismic responses with incident angles and show the close relation between seismic angle-responses and the visco-elastic properties of the formation.

S51C-04 0915h

Accurate and fast forward seismic modeling based on the phase-screen approach

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We have developed a fast seismic forward modeling algorithm to handle wide-angle wavefield propagation within realistic background structure. The method is based on geometrical construction of the phase-screen technique (Wild & Hudson 1998) which itself is derived from the elastic complex screen method developed by Wu (1994).

Our new algorithm is no longer limited to the narrow angle approximation, inherent in the original formulation. The new algorithm incorporates both refracted and wide-angle reflected energy and is therefore suitable for modeling large offsets. Furthermore the limitation to first order perturbation of material properties has been removed and we are now able to tackle both weak and strong impedances changes within the background.

Using a fast Fourier transform algorithm, we switch alternatively between wavenumber and spatial domains to propagate the wavefield across the screens. The background velocity is assumed to be constant between two adjacent screens and angular dependent corrections are applied at the successive screens in the presence of lateral velocity variations.

Simple synthetic examples are presented in order to show the capability to model the full wavefield. Also, in order to account for absorption during wavefield propagation in visco-elastic media, we have introduced attenuation parameters in the phase-screen algorithm. Finally, to show the capability of the method to handle diverse wave propagation problems, we present an application of the phase-screen to model transmission losses for sonar data, calibrated against other more computationally intensive methods.

S51C-05 0930h

Contribution of Higher Modes in Long-Period Rayleigh Wave Envelopes at Large Lapse Time

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Vertical component seismograms in long periods are mostly composed of multiple Rayleigh wave arrivals and wave trains scattered by medium heterogeneities and topographical variations. Recently, we proposed a model to synthesize the mean squared envelope based on scattering of the fundamental-mode Rayleigh waves. The synthesized envelope well explains the observed envelopes until 20,000s in lapse time. However, there is a systematic discrepancy between them after 30,000s, even if multiple scattering processes are taken into account. To clarify the cause of the difference, we measured the constituents of waves with lapse time increasing up to 60,000s by applying the f-k analysis to array data recorded by the F-net in central Japan for events whose magnitudes are more than 7.3 with various focal depths. We identified the slowness and the arrival direction of wavelets by estimating the f-k power spectra at the center period of 128s. It is confirmed that direct and scattered fundamental-mode Rayleigh waves whose velocity is about 3.7km/s are dominant at lapse times earlier than about 30,000s, which has small dependence of focal depth. But at lapse times later than 30,000s, the fundamental-mode waves disappear and higher modes with larger phase velocities become dominant. Arrival directions of higher modes become random in large lapse time for shallow events, while remain along the great circle path for deep events.

Based on the above analysis, we interpret that the whole envelope up to 60,000s in lapse time consists of two components: direct and scattered Rayleigh waves of the fundamental mode and uniformly distributed higher modes of Rayleigh wave. Higher modes are spread by its strong velocity dispersion and scattering effects. The earlier envelope is theoretically well predicted by scattering of fundamental-mode Rayleigh waves and the later envelope by the exponential decay controlled by small intrinsic attenuation of higher modes as predicted by the PREM. The smaller decay gradient of the later envelope is consistent with the small attenuation of higher modes.

Acknowledgments We are grateful to the IRIS consortium and NIED (F-net) for providing us with broadband waveform data.

S51C-06 0945h

Realistic Synthetic Seismograms in a 3D Anelastic Rotating Earth.

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Seismic tomography has become a major concern to the seismological and geophysical community, because it is a unique tool to investigate geodynamical processes. Global networks have expanded worldwide and provide high quality data. But to refine our knowledge of the Earth's interior, it is now necessary to improve the direct problem, that is the computation of realistic synthetic seismograms for the global Earth.

Several approaches can be used, such as variational schemes on one hand, and perturbation theories on the other hand. We have chosen the latter because of its tractability. All our programs run on a single common workstation, and, because of its structure, our code can be dispatched on several stations to increase performances.

We present the results of a two step computation. In the first step, we compute normal modes for the Earth, including the effects of rotation and ellipticity, as well as a 3D elastic model (SAW12D) for the whole mantle and a 3D anelastic model (QR19) in the upper mantle, using PREM as the reference 1D model. We then use these modes in a second step to compute realistic synthetic seismograms and corresponding spectra in a very reasonable computation time. These finite frequency seismograms take into account a real Fresnel zone, as well as the competitive effects of elastic gradients and 3D anelastic structure.

We show that the effect of anelastic heterogeneities is small, but the models currently available are thought to underestimate the contrasts in the real Earth's structure. Also, we show that the Fréchet derivatives of these seismograms with respect to anelastic structure are strongly dependant on the background 3D elastic model. It is therefore critical to model those two effects at the same time. With this tool, it is now possible to use long period datasets to perform whole mantle joint inversions for elastic and anelastic parameters.

S51C-07 1020h

Simulation of Large-Scale Seismic Wave Propagation with the 3-D Voxel FEM

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We have developed the 3-D Voxel FEM (Finite Element Method) for large-scale seismic wave propagation. 'Voxel' is a hexahedron element, which has been used widely in various fields of engineering for reducing computational efforts in numerical simulation. Since natural boundary conditions are automatically satisfied in the FEM because of its weak formulation, no special treatment is necessary for irregular surface topography or a mesh with variable spacing. However, the FEM often requires much larger memory, longer computation time and farther complicated mesh generation than the Finite Difference Method (FDM).

We limit element shapes to voxels only, so that the mesh generation becomes as easy as that in the FDM. We then divide the structure into homogeneous subdomains and repeatedly use a single stiffness matrix in a subdomain. This domain partition significantly reduces the memory requirement in cooperation with the explicit FEM formulation. The explicit formulation also reduces the computation time. If we assume an isotropic medium, the stiffness matrix can be simplified and its symmetry further reduces the memory requirement and computation time. Compared with the FDM, the 3-D Voxel FEM requires a similar amount of memory and takes only 1.4 times longer computation time in an isotropic medium.

For seismic sources we apply force couples represented by the moment tensors to elements in a source region. We have already implemented parallel computation in our method using the Message Passing Interface (MPI) on Linux. We show some numerical examples for typical structures and applications to the 1995 Kobe earthquake and others including the effects of surface topography.

S51C-08 1035h

Spectral-Element Simulations of Global Seismic Wave Propagation using the Earth Simulator

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We simulate global seismic wave propagation throughout a 3-D model, which includes a 3-D velocity and density structure, a 3-D crustal model, ellipticity as well as topography and bathymetry. We use the spectral-element method (SEM) developed by Komatitsch and Tromp (2002) on the Earth Simulator, which is the world's largest and fastest parallel supercomputer recently built in Yokohama, Japan. The Earth Simulator has 640 nodes, each consisting of eight vector processors with 16 GB of memory. Peak performance of each node is estimated to be 64 GFLOPS. Total measured sustained LINPACK performance is 35 TFLOPS on the new Top500 list of supercomputers, on which the Earth Simulator ranks #1. Because the parallel SEM code is implemented using a message-passing technique (MPI), it is well adapted to the architecture of the Earth Simulator, except that loops need to be vectorized to take advantage of the vector processors. We have modified the software such that we obtain a

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high vectorization ratio and optimal performance on the Earth Simulator.

Preliminary results on 54 processors, i.e., only one percent of the machine, show that the calculations run several times faster than on a two-year old Pentium-III PC-cluster which was used to develop the SEM package. We will discuss a variety of synthetic seismograms that are accurate down to periods of several seconds by taking full advantage of the Earth Simulator to drastically increase the resolution of the mesh. Effects related to anisotropy, attenuation, self-gravitation, rotation and the oceans are included in the simulations.

S51C-09 1050h

The Spectral-Element Method, Beowulf Computing, and Global Seismology

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Progress in global seismology is to a large extent due to the tremendous growth in seismic data acquisition, particularly with the worldwide deployment of digital broadband networks over the past two decades. Based upon this wealth of data, models of shear and compressional velocity heterogeneity, anisotropy, and attenuation have provided important constraints on the Earth's composition and physical processes. While data acquisition continues to be a priority, it is clear that improving seismic models also requires the development, implementation, and application of theories and numerical methods that accurately incorporate the effects of mantle and crustal heterogeneities on wave propagation.

The recently developed spectral-element method enables us to accurately simulate global seismic wave propagation in three-dimensional models of the Earth without intrinsic restrictions on the level of heterogeneity nor the frequency content. The method accounts for effects due to lateral heterogeneity, anisotropy, attenuation, variable crustal thickness, topography, ellipticity, rotation, and self-gravitation. We review the development of the method and present seismograms computed on a PC cluster, a so-called Beowulf machine, that illustrate the sometimes profound waveform complications due to three-dimensional heterogeneity. Mantle shear-velocity model S20RTS combined with crustal model CRUST2.0 satisfactorily explain body-wave traveltime anomalies at periods of 18 seconds and greater, but surface-wave dispersion is only accurate at periods of 45 seconds and greater. Amplitude anomalies, which complement traditional traveltime measurements, need to be carefully corrected for three-dimensional elastic focusing effects before they can be interpreted in terms of lateral variations in attenuation.

URL: http://www.gps.caltech.edu/research/jtromp

S51C-10 1105h

The Coupled Spectral Element/Normal Mode Method: Application to the Testing of Several Approximations Based on Normal Mode Theory for the Computation of Seismograms in a Realistic 3D Earth.

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The spectral element method (SEM) has recently been adapted successfully for global spherical earth wave propagation applications. Its advantage is that it provides a way to compute exact seismograms in a 3D earth, without restrictions on the size or wavelength of lateral heterogeneity at any depth, and can handle diffraction and other interactions with major structural boundaries. Its disadvantage is that it is computationally heavy. In order to partly address this drawback, a coupled SEM/normal mode method was developed (Capdeville et al., 2000). This enables us to more efficiently compute bodywave seismograms to realistically short periods (10s or less).

In particular, the coupled SEM/normal mode method is a powerful tool to test the validity of some analytical approximations that are currently used in global waveform tomography, and that are considerably faster computationally. Here, we focus on several approximations based on normal mode perturbation theory: the classical "path-average approximation" (PAVA) introduced by Woodhouse and Dziewonski (1984) and well suited for fundamental mode surface waves (1D sensitivity kernels); the non-linear asymptotic coupling theory (NACT), which introduces coupling between mode branches and 2D kernels in the vertical plane containing the source and the receiver (Li and Tanimoto, 1993; Li and Romanowicz, 1995); an extension of NACT which includes out of plane focusing terms computed asymptotically (e.g. Romanowicz, 1987) and introduces 3D kernels; we also consider first order perturbation theory without asymptotic approximations, such as developed for example by Dahlen et al. (2000).

We present the results of comparisons of realistic seismograms for different models of heterogeneity, varying the strength and sharpness of the heterogeneity and its location in depth in the mantle. We discuss the consequences of different levels of approximations on our ability to resolve 3D heterogeneity in the earth's mantle.

S51C-11 1120h

ACCURATE FINITE DIFFERENCE CALCULATIONS FOR TRAVEL TIMES AND AMPLITUDES IN 3D HETEROGENEOUS MEDIA

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Finite frequency inversions of body wave travel times and amplitudes require the knowledge of travel times, geometrical spreading and Maslov index from all points in the Earth to both source and receiver. In models with low velocity zones or extensive heterogeneities, the highly efficient paraxial approach (Dahlen et al., GJI 2000) may become invalid and needs to be replaced by more brute force computational methods. Early attempts in seismology to compute the complete travel time field using finite difference techniques (Vidale, Geophysics, 1990) or graph theory (Moser, Geophysics, 1991) have since long been superseded by developments, many outside of seismology, to find fast, efficient solutions of the eikonal equation.

In this talk I shall compare results obtained with various upwind finite difference techniques. Fast marching methods (Sethian and Popovici, Geophysics, 1999) which combine the accuracy of upwind finite difference schemes with the optimal evolution approach of Moser's method are extremely fast and their accuracy can be improved by adopting higher order finite differences, but still fall short of that needed to obtain correct amplitudes or geometrical spreading.

The most accurate results are obtained by combining several characteristics of finite difference methods that have been used separately and mostly in 2D, but that are here presented in combination for full 3D computations: we use algorithms of the Weighted Essentially Non Oscillatory type (WENO - Qian and Symes, Geophysics 2002), with variable grid size near the source and apply post sweeping to guarantee that first arrivals are chosen even if the wave has strong turning points (Kim and Cook, Geophysics 1999).

High accuracy in travel times is needed because calculations of amplitude A (or geometrical spreading) from the transport equation $2\nabla A \cdot \nabla T + A\nabla^2 T = 0$ requires the travel time field T to be three orders of magnitude more precise than the amplitudes. We found that the source differencing scheme of Vidale and Houston (Geophysics 1990), which we extend here to 3D, avoids the propagation of instabilities and generally produces amplitudes of sufficient accuracy for finite frequency tomography when combined with the WENO scheme. The Maslow index is obtained by projecting $\nabla^2 T$ on a plane perpendicular to ∇T and diagonalizing.

S51C-12 1135h

A Hybrid Finite-Difference Method for Global Wave Propagation

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Calculation of global wave propagation using numerical methods is undergoing a fast progress due to dynamically growing computation power. However, to achieve high frequencies in full 3D for arbitrary models, hybrid approaches are necessary.

In this study we combine finite-difference based solutions to the elastic wave equation in spherical coordinates in the axisymmetric approximation and the complete 3D solution for spherical sections. Wave propagation is initiated in the axisymmetric code with sources centered on the symmetry axis. Thus a high-frequency teleseismic wavefield with correct 3D geometrical spreading (but 2D computational domain) can be used as an input (boundary condition) to a spherical section at (e.g. large) distance from the source. The directly scattered wavefield from any structures inside the 3D block can be studied. This approach enables the simulation of scattering effects above plumes or subduction zones from teleseismic wavefields.

The advantage of this method is, that it avoids some drawbacks of the individual methods. The axisymmetric method suffers from the restriction that either the source or the desired mantle structure must have the form of a ring due to the axisymmetry. By placing a regional 3D domain at the place of the desired structure it is possible to model the structure as extended but local deviation of a background model (PREM). Moreover, the scattered waves can be observed in full 3D. On the other hand, a pure 3D-FD method would require a large amount of memory if one wants to model the global wavefield at large distances, thus limiting the frequency range of the calculation.

We will present the combination of these methods to a hybrid method in detail and show examples of results for a mantle plume in PREM

URL: http://www.geophysik.uni-muenchen.de/seismology

S51D MCC: 134 Friday 0830h

Something in the Way She Moves: Earthquake Process *(joint with G, T, MR)*

Presiding: **P Silver,** Carnegie Institution of Washington**; D D Jackson,** University of California, Los Angeles

S51D-01 0830h

The Spatial and Temporal Pattern of Shear Wave Splitting Along the Hector Mine Rupture Zone

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Extensive measurements of shear-wave splitting from aftershocks along the Hector Mine rupture zone show a broadly consistent fast direction, but also temporal and spatial variations in local stress directions.

Aftershocks were recorded by several deployments in the year following the mainshock. A week-long 20-station, 100m array (Geom99) was deployed a few days after the mainshock. A second deployment with two arrays was in place November, 1999. NA99 was located near Geom99, 5km south of the mainshock and SEA99 was 10km farther south. In 2000, these two arrays were redeployed (NA00 and SEA00) and a third array (SWA00) was deployed on a fault strand 2km west of SEA00. Each array had a 20-station, 500-m line normal to the fault. The deployment of NA and SEA in 1999 and 2000 allows for examination of temporal changes in splitting. The wide distribution of the arrays allows for investigation of spatial variations.

Rotation of the maximum compressive stress direction along fault strike is inferred from splitting measurements determined by cross-correlation technique. NA and SEA events were binned into three subsets based on local fault strike. The average measured splitting parameters indicate a 14.5 fast direction and a 33ms time lag. Significant rotation of the fast direction over one year was observed for the northern and central bins; however, sense of rotation varies along the fault. Also, measured time delays were lower in 2000 than 1999. Some spatial variation of splitting is observed. While splitting parameters measured at NA00 and SEA00 are fairly uniform, events recorded at SWA00 show very different fast directions and delay times. Delayed P and S arrivals indicate SWA00 is located atop low velocity material that appears to affect splitting measurements. Additionally, aftershocks within 0.25km of the fault have roughly fault-parallel fast directions.

The rotation of fast azimuth with fault strike and time should help constrain the stress field evolution in