more cloud water to the supercooled levels higher in the cloud. The added cloud water and updrafts are the two ingredients that electrify clouds, thereby providing also for more intense and frequent thunderstorms. Such enhancement in thunderstorm activity over and downwind of Houston has been observed, and awaits in situ observations for confirmation of the proposed mechanism, in the form of the proposed HEAT project. In summary, air pollution aerosols can have large impacts on the precipitation and dynamics of the clouds for both suppression and enhancement of precipitation. The pollution tends to suppress precipitation from relatively shallow and short living clouds. In contrast, the delay of precipitation in deep convective clouds that form in tropical air mass can invigorate them and the dynamical feedback can result in overall enhanced precipitation amount.

U51A-03 0900h

Effects of urbanization and global warming on subsurface temperature in the three mega cities in Japan

Makoto Taniguchi[1] (81-75-229-6193; makoto@chikyu.ac.jp)

Yasuo Sakura[2] (81-43-290-2847; ysakura@earth.s.chiba-u.ac.jp)

Takeshi Uemura[3] (81-742-27-9202; a028506@student.nara-edu.ac.jp)

[1]Research Institute for Humanity and Nature, 335 Takashima-cho, Kamigyo-ku, Kyoto, KYO 602-0878, Japan

[2]Department of Earth Sciences, Chiba University, 1-33, Yayoi, Inage, Chiba, CHI 263-8522, Japan

[3]Department of Earth Sciences, Nara University of Education, Takabatake, Nara, NAR 630-8528, Japan

Effects of surface warming due to urbanizations on subsurface thermal regime were found in many cities over the world. Although the effect of global warming is estimated to be 0.5 degree centigrade during the last 100 years, the effects of urbanization on subsurface environment are not evaluated yet. The purpose of this study is to evaluate the effects of surface warming due to urbanization on subsurface temperature in three mega cities, Tokyo, Osaka and Nagoya, Japan. Analyses of subsurface thermal transport have been made using different scenarios with the time of start warming and the ratio of surface warming. Comparisons between observed subsurface temperature and calculated one have been made. According to the comparisons, the effect of urbanization on subsurface environment should be considered since 100, 80 and 60 years ago in Tokyo, Osaka, and Nagoya, respectively. The ratios of surface warming due to urbanization and global warming were estimated to be 2.5, 2.0 and 1.5 degree centigrade in Tokyo, Osaka and Nagoya, respectively.

U51A-04 0915h

Observation and Analysis of the Urban Heat Island in Singapore

Winston T.L. Chow[1] ((65)6874 3831; g0202394@nus.edu.sg)

Matthias Roth[1] ((65)6874 6103; geomr@nus.edu.sg)

[1]Department of Geography, Faculty of Arts and Social Sciences, National University of Singapore., 1 Arts Link, Singapore 117570, Singapore

Until recently, research into the Urban Heat Island (UHI) phenomenon has been primarily focused in cities in temperate climates. In contrast, there has been hitherto relatively little interest in examining UHIs in tropical cities. With the majority of tropical cities undergoing rapid urbanization, knowledge of this aspect of the urban climate modification is essential to mitigate potential climate-related problems in the urban environment. This paper will present preliminary results of an ongoing project based on fixed and mobile observations from 2002 to 2004. This project is one of the first comprehensive studies of temperature and humidity distributions of a tropical city. The focus is on the spatial distribution and temporal dynamics of the temperature and humidity fields of Singapore. Climate parameters are measured in different landuse types (commercial, CBD, industrial, high-rise and low-rise residential areas) and compared with observations taken at a rural area of predominantly secondary rainforest. This data is analyzed over diurnal and seasonal periods and compared with results from temperate and other tropical UHI studies. Preliminary results indicate that there are significant differences in the magnitude and timing of the peak UHI in Singapore compared with work done in mid-latitude cities. There also appears to be a link between the role of moisture and UHI intensity: Drier periods are generally associated with larger UHI intensity differences. The role of different urban canyon geometries in affecting temperature cooling rates is also demonstrated. Lastly, suggestions and measures that can be undertaken to lower UHI stresses on the urban population will be reviewed.

U51A-05 0930h

Assessing Urbanization Impact on Long-term Rainfall Trends in Houston

Parastou Hooshialsadat[1] (phooshi@uark.edu)

Steven J. Burian[2] ((801) 585-5721; burian@eng.utah.edu)

J. Marshall Shepherd[3] ((301) 614-6327; shepherd@agnes.gsfc.nasa.gov)

[1]University of Arkansas, 4190 Bell Engineering Center, Fayetteville, AR 72701, United States

[2]University of Utah, 122 South Central Campus Drive, Suite 104, Salt Lake City, UT 84112, United States

[3]NASA Goddard Space Flight Center, Code 912.0, Greenbelt, MD 20771, United States

Rainfall data from 50 rain gauges within and nearby Houston were analyzed to identify annual and warm season (June, July and August) rainfall trends from 1950 to 2000. Comparison of the mean annual and warm season rainfall amounts in the urban area to those in an upwind control region and a downwind urban impacted region indicates that the urban area has experienced higher average annual and warm season rainfall amounts during the 50-year time period than the upwind control region. The urban-impacted region has also experienced higher rainfall amounts, while the urban area and urban-impacted region do not have a statistically significant difference in rainfall amounts. Trend analyses were also performed on the 50-yr time series of annual and warm season rainfall amounts by calculating a statistic representing the differences in annual and warm season rainfall amount for each year between the urban area and upwind control region, the urban impacted region and the upwind control region, and the urban area and urban impacted region. The trend of the difference statistic versus time and population was assessed using straight-line plots and regression analyses. The regression results suggested that there is an increasing trend for the urban area-upwind control region difference with both time and population growth, but no significant trend for the urban-impacted region-upwind control region and urban area-urban-impacted region difference statistics.

U51A-06 0945h

Monitoing PM2.5 from Space

D. Allen Chu[1] (301-614-6237; achu@climate.gsfc.nasa.gov); Lorraine Remer[2] (301-614-6194; remer@climate.gsfc.nasa.gov); Jim Szykman[3] (757-864-2709; james.j.szykman@nasa.gov); Yoram Kaumfan[3] (301-614-6189; kaufman@climate.gsfc.nasa.gov); Doreen Neil[4] (757-864-8171; d.o.neil@express.larc.nasa.gov); Brad Pierce[4] (757-864-8172; Robert.B.Pierce@nasa.gov)

[1]NASA GSFC code 913/SSAI, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

[2]NASA GSFC code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

[3]Office of Air Quality Planning and Standards, US EPA, Hampton, VA 23681, United States

[4]NASA LaRC, NASA Langley Research Center, Hampton, VA 23681, United States

MODIS sensors onboard the EOS Terra and Aqua satellites launched in 1999 and 2002 provide the revolutionized perspectives to study the Earth systems. MODIS ability to derive the first aerosol product over land has advanced our understanding of aerosols into the source regions. The analysis of MODIS-derived columnar aerosol loading has shown good correlation (correlation coefficient 0.8-0.9) with EPA PM2.5 (particulate matter with particle size less than 2.5 mm) at surface in metropolitan areas (e.g., New York City, Chicago, Houston, etc.) and also over broad regions including 11 states and Washington DC. At present, the EPA, along with Regional Planning Organizations, and state and local governments use a multitude of decision support tools to assess, control, and report the nature of air pollution related to PM. However, the current existing air quality decision processes solely rely on urban scale model and ground-based network. Using MODIS aerosol data can aid significantly in tracking the movement of pollutants, which can be used as a proxy of PM2.5 for regions without ground measurements. NASA (GSFC and LaRC) is collaborating with EPA and NOAA in providing MODIS aerosol data to benchmark PM2.5 forecast in the East US in the summer 2003. This activity is to prototype similar activities in the following years using MODIS direct broadcasting to study transport (national, international, or intercontinental) issues and assess performance effectiveness of existing air quality regulations. Improvements of MODIS aerosol algorithm are planned to achieve better spatial resolution for urban pollution and health-related studies.

U51B MCC: Level 1 Friday 0830h

The Core-Mantle Boundary: Theoretical, Experimental, and Observational Constraints III Posters

Presiding: **A D Brandon,** NASA Johnson Space Center

U

U51B-0001 0830h POSTER

Non Linear Analysis of Differential Travel Times of PKP Phases and D" Structure

Raphael Garcia[1] ((+33) 145114152; garcia@ipgp.jussieu.fr)

Hrvoje Tkalcic[2] (tkalcic1@llnl.gov)

Sebastien Chevrot[3] (chevrot@pontos.cst.cnes.fr)

[1]IPGP DGSP UMR7096 CNRS, 4, Ave de Neptune, Saint Maur 94107, France

[2]Lawrence Livermore National Laboratory, P.O. Box 808, L-206, Livermore CA 94551, United States

[3]LDTP UMR5562 CNRS, Observatoire Midi-Pyrénées 14, Ave E. Belin, Toulouse 31400, France

The triplication of PKP core phases has been widely used to extract information on the structure of both the inner core and the base of the mantle. We present a new method that performs a non linear inversion of the 3 main core phases waveforms (PKP(DF), PKP(BC) and PKP(AB)). The differential travel times between these body waves are measured with high accuracy even when they interfere on the records, or when pPKP depth phases are present. This property allows us to investigate the epicentral distance range 146-149 degrees previously hidden by the interference between the 3 core phases, and new ray paths associated to shallow events. Preliminary results reveal strong variations of the differential travel times residuals involving the PKP(AB) phase, that could be related to short wavelength heterogeneities at the base of the mantle. These observations are presented for particularly well resolved regions of the base of the mantle and interpreted in terms of geodynamic processes at the Core-Mantle boundary.

U51B-0002 0830h POSTER

Anisotropy of S wave velocity in the lowermost mantle using broad-band data recorded at Syowa in Antarctica

Yusuke Usui[1] (81-76-264-5747; yusuke@hakusan.s.kanazawa-u.ac.jp)

Yoshihiro Hiramatsu[1] (81-76-264-5734; yoshizo@hakusan.s.kanazawa-u.ac.jp)

Muneyoshi Furumoto[1] (81-76-264-5733; furumoto@hakusan.skanazawa-u.ac.jp)

Masaki Kanao[2] (81-3-3962-3275; kanao@nipr.ac.jp)

[1]Graduate School of Natural Science and Technology, Kanazawa University, Kakuma, Kanazawa 920-1192, Japan

[2]National Institute of Polar Resaerch, 1-9-10 kaga, Itabashi-ku, Tokyo 173-8515, Japan

We investigate the velocity structure of the lowermost mantle (D") beneath the Antarctic Ocean. We analyze seismograms from 16 deep earthquakes in south Pacific subduction zones from 1990 to 2001 recorded by STS-1 broad-band seismographs at Syowa station in Antarctica. The source-receiver combinations span distances range 85°-95° with associated S waves passing through D" beneath the Antarctic ocean. Differential travel times of split S waves are estimated to be up to 2s, showing that longitudinal components (SV) energy arrives earlier than transverse components (SH) energy. The absence of significant splitting for S waves with turning points more than four hundred kilometers above the core-mantle boundary (CMB) indicates that anisotropy is localized within the D" region.

Differential travel times among S, ScS and SKS phases and waveform modeling are used to construct the velocity structure in D". We calculate synthetic waveforms by the *Direct Solution Method* (DSM: Geller and Ohminato, 1994; Geller and Takeuchi, 1995). SH shows a double arrival at the epicentral distance near 89°. However SV in this range remains a single arrival. Isotropic model an not explain these observation. We find that synthetics for transverse isotropic models with SH velocity discontinuity (SYYM model) explain well the observed differential travel times and waveforms. The thickness of the anisotropic zone, where SH

wave is faster up to 2.0% than SV wave, estimated to be about 350 km.

This study region corresponds to the high velocity region at the lowermost mantle by tomographic studies (Kuo et al., 2000; Masters et al., 2000). This kind of transverse anisotropy correlates with high velocity regions where paleo-slabs may descend into the lower mantle (Kendall and Silver, 1996; Garnero and Lay, 1997). We conclude that these observations may be explained by an anisotropic D" layer and D" layer anisotropy is attributed to the paleo-slab material subducted during 120Myr-180Myr.

U51B-0003 0830h POSTER

Investigating the Core-Mantle Boundary and ULVZ Topography with Synthetic FD Seismograms for 3-D Axi-Symmetric Geometries: Predictions and Data

Michael Thorne[1] (480-965-7680; mthorne@asu.edu)

Edward Garnero[1] (garnero@asu.edu)

Gunnar Jahnke[2] (jahnke@geophysik.uni-muenchen.de)

Markus Treml[2] (treml@geophysik.uni-muenchen.de)

Heiner Igel[2] (igel@geophysik.uni-muenchen.de)

[1]Arizona State University, Department of Geological Sciences, Box 1404, Tempe, AZ 85287, United States

[2]Ludwig-Maximilians University, Dept. of Earth and Environmental Sciences, Theresienstrasse 41, Munich 80333, Germany

We are interested in quantifying the effects of core-mantle boundary (CMB) and ultra-low velocity zone (ULVZ) topography on diffracted seismic phases. Such topography is important due to possible focusing/defocusing of energy that may strongly perturb the wavefield. In particular, we model the effects of topography on diffracted core phases such as SPdKS, which is often used to infer the presence, location and structure of ULVZs, which may be of partial melt origin. We model P/SV-wave propagation using a 3-D axisymmetric finite difference (FD) algorithm. The axisymmetric approach is used as we are able to produce synthetic seismograms with dominant frequencies on the order of 0.2 Hz to model detailed regional structures and test important aspects of the model space. Models tested include sinusoidal CMB topography and a range of ULVZ models, including isolated non-periodic features varying in shape from ring-shaped structures with Gaussian or dome shaped cross-sections, to structures with broader boxcar- (or mesa-) shaped cross-sections. We consider ULVZ models with sharp as well as gradational wave-speed transitions. We use Vs:Vp reductions of 1:1 and 3:1, the latter of which is appropriate for the partial melt scenario. Additionally, we study the effects of source versus receiver side ULVZ geometries for the seismic phase SPdKS. These results are compared to broadband data available from the Fast Archive Recovery Method (FARM) database. We utilize a global dataset of deep focus events with simple impulsive source mechanisms for the epicentral distance range of 100 to 130 deg. While CMB and ULVZ topography greatly expands the model space which already contains significant trade-offs, fixing ULVZ velocity and density perturbations allows discussion of possible topographical scenarios. Gradational wave-speed transitions reduces the magnitude of SKS precursors predicted by sharp structures, which have not been observed in data. We also produce high resolution snap shots of the wave propagation in our structures, allowing delineation of additional arrivals due to complex structures.

U51B-0004 0830h POSTER

Generalized Radon Transform Inversion of Coda Waves: Imaging Selected Neighborhoods of the CMB

Png Wang[1] (617-253-3589; wangp@mit.edu)

Maarten V. De Hoop[2] (mdehoop@mines.edu)

Robert D. van der Hilst[1] (hilst@mit.edu)

[1]Massachusetts Institue of Technology, 54-526, 77 Mass. Ave., Cambridge, MA 02139, United States

[2]Colorada School of Mines, CWP, Golden, CO 80401, United States

Different forward and inverse methods have been used to image the multi-scale heterogeneity in the lowermost mantle. In this paper we use generalized Radon transform,which is developed from microlocal analysis and the theory of Fourier integral operators, to carry out inversion of scattered seismic body waves, such as ScS and SKKS. We believe this method can better characterize the variations of acousto-elastic properties of the physical shell that encompasses Earth's lowermost mantle (the so-called D" region), the core-mantle (CMB), and Earth's outer core. We assume that the structure of the mantle outside this shell is sufficiently well known from seismic body wave transmission tomography and from the free oscillation frequencies. To illustrate the concepts of the generalized Radon transform method, we apply it to a particular downwelling region - Central America. In this study we choose a bin of size of $12^o \times 12^o$ (600 km × 600 km). All the rays that have a mid point in this bin will be used to get image of the center (longitude: -90, latitude: 15) of this bin. Our final image gathers indicate: i) the inversion of both ScS and SKKS results a clear CMB; ii) there exists a clear discontinuity at about 260 km above the CMB; iii) there is probably a discontinuity (or scatteres) at about 50 km above the CMB; iv) the S-wave velocity of the lowermost mantle is higher than the globally estimated average S-wave velocity model.

U51B-0005 0830h POSTER

Lower Mantle Anisotropy Beneath the Cocos Plate

Juliana M Rokosky[1] (jrokosky@es.ucsc.edu)

Thorne Lay[1] (tlay@es.ucsc.edu)

Edward J Garnero[2] (garnero@asu.edu)

[1]University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA 95064

[2]Arizona State University, Dept. of Geological Sciences Box 871410, Tempe, AZ 85287

Shear wave anisotropy exists across a broad region in the lowermost mantle beneath Central America and the Caribbean, causing splitting of ScS and diffracted S phases. We use shear wave signals from 16 intermediate and deep South American earthquakes recorded by the dense network of broadband seismographic stations in California to perform a high resolution analysis of the anisotropic structure in a localized region above the core-mantle boundary beneath the Cocos Plate. Our data include 162 ScS splitting measurements and 230 ScS-S differential travel times. Broadband ground displacement recordings are corrected for near-receiver lithospheric anisotropy and for a small phase shift in the ScSV reflection coefficient. ScS splitting measurements are made between the peak amplitudes on the transverse and longitudinal components; the SH and SV signals appear to be decoupled, with SH typically corresponding to the fast polarization arrival. Deconvolution of a source wavelet obtained by stacking of the SH signals for a given event is used to equalize the signals between events and to improve the temporal resolution of splitting. The deconvolved spike-trains generally support complete separation of the ScSH and ScSV wavefields, compatible with vertical transverse isotropy (VTI) at near-grazing incidence. Splitting measurements are also made between ScS peaks in the deconvolved traces. The two sets of splitting measurements are assigned quality ratings based on consistency between raw and deconvolved measurements and our overall confidence in the ScS signals. Only data of high quality are retained. In general, the process of deconvolution improves the precision of splitting measurements in cases where the receiver coda is strong or the source wavelet is complex. The average ScSV-ScSH differential arrival time is 1.2 s, with little distance or spatial dependence. Transverse component ScS-S differential travel times were calculated relative to PREM and corrected for a mantle shear wave tomography model (Grand, 2003) to a depth 250 km above the core-mantle boundary. The residuals indicate a strong lateral gradient in positive shear velocity anomalies, increasing toward the north beneath the Cocos Plate. The anisotropy measurements have a weak negative correlation with velocity anomalies overall, but show little evidence for a spatial gradient. The magnitude of splitting does not appear dependent on path length within the D" region, suggesting a relatively thin region of anisotropy. S wave triplication arrivals from a shear velocity discontinuity 250 km above the core-mantle boundary show minor splitting in deconvolved traces for a few high quality signals. This appears independent of ScS splitting in the same traces, suggesting that the anisotropic layer in which the ScS splitting originates lies below the D" discontinuity.

U51B-0006 0830h POSTER

Small-scale structure of the core-mantle boundary beneath four regions of the Pacific and Indian Ocean

Sebastian Rost[1] (480-965-7653; srost@es.ucsc.edu)

Edward Garnero[1] (480-965-7653; garnero@asu.edi)

Justin Revenaugh[2] (612-624-7553; justinr@umn.edu)

[1]Arizona State University, Department of Geological Sciences Box 871419, Tempe, AZ 85287-1404, United States

[2]University of Minnesota, Department of Geology and Geophysics 310 Pillsbury Drive SE, Minneapolis, MN 55455, United States

Core reflected phases offer an unique probe to the structure of the core-mantle boundary (CMB). Using high quality, short-period array datasets, waveform modeling and amplitude information it is possible to identify structural changes in seismic wave-speeds at the CMB on very short scale-lengths of ten's of km's. Especially, the resolution of ultra-low-velocity zones at the CMB (ULVZ) can be increased tremendously using these datasets. We collected data from three small-aperture, short-period, vertical arrays in Canada (Yellowknife), Australia (Warramunga) and India (Gauribidanur). Using earthquakes from different Pacific subduction zones and core-reflected (*PcP*) and converted phases (*ScP*) we are able to probe the CMB in different locations around the Pacific and Indian ocean that have not been probed for CMB structure with high-resolution before. We find a multitude of different structures including ULVZ, core-rigidity zones, scattering and possible CMB topography, but also regions where the data indicates a simple (IASP91-like) CMB or structure well beneath the resolution level of the short-period data. Using both *P*-wave and *S*-wave data we are able to set better constraints on possible generation mechanisms of ULVZ than is possible with diffracted phases like $SP_{diff}KS$. A comparison with large-scale studies will help us to better understand the dynamics of the core-mantle boundary.

U51B-0007 0830h POSTER

Complexities in D" anisotropy beneath the Caribbean: Evidence for a tilted symmetry axis of transversely isotropic media from data and synthetics

Edward J Garnero[1] (480-965-7653; garnero@asu.edu)

Valerie Maupin[2] ((47) 228 55756; valerie.maupin@geo.uio.no)

Thorne Lay[3] (831-459-3164; thorne@es.ucsc.edu)

Matthew J. Fouch[1] (480-965-9292; fouch@asu.edu)

[1]Arizona State University, Department of Geological Sciences 871404, Tempe, AZ 85287-1404, United States

[2]Department of Geology, University of Oslo PO Box 1047, Blindern, Oslo 0316, Norway

[3]University of California, Department of Earth Sciences 1156 High Street, Santa Cruz, CA 95064, United States

The goal of this study is to evaluate detailed seismic anisotropy in D" for a broad region beneath the Caribbean Ocean. Our dataset consists of broadband core-grazing and diffracted shear waves for deep South American earthquakes recorded by the Canadian National Seismic Network. The motivation for this work is to ultimately better constrain lowermost mantle dynamics and rheological properties. High quality data containing simple source-time functions and strong SH and SV energy are utilized, instrument-deconvolved to displacement, and rotated to the plane of the incident S wave using all 3 components to minimize any possible SV-P conversions. Finally, data are corrected for upper mantle anisotropy using either published or newly derived parameters. For most of our dataset, S and Sdiff phases exhibit differential lag times between the SH and SV components. Variations are generally simple, with SV energy arriving later relative to SH, but many records also show SV energy initiating with the wrong polarity compared to focal mechanism predictions. Small rotations in the plane of the incident S wavefield cause the precursory SV energy to dissipate in our cleanest data. This observation suggests the presence of anisotropy beyond the common assumption of transverse isotropy (TI) with a vertical axis of symmetry (VTI). To evaluate the complex nature of our observations, we have constructed synthetic seismograms for several end-member models of mantle seismic velocities, including (a) isotropy, (b) VTI, and (c) a simple anisotropic case: tilted TI. For case (c), SV behavior relative to SH depends heavily on the focal mechanism, azimuth of the incoming wavefield, and the tilt angle of the TI system. To first order, the eastern portion of our study area contains significantly more data that are incompatible with the simple VTI geometry. We will present data and synthetic comparisons, and the geographic distribution of data sampling locations best supported by either VTI or tilted TI.

URL: http://garnero.asu.edu/research/earthslowermantle.html

U51B-0008 0830h POSTER

Lower-Mantle Seismic Discontinuities and the Thermal Structure of Subducted Slabs.

Christine Thomas[1] (+44 151 794 5143; tine@liv.ac.uk)

J. Michael Kendall[2] (+44 113 343 5258; kendall@earth.leeds.ac.uk)

Julian Lowman[2] (+44 113 343 5212; j.lowman@earth.leeds.ac.uk)

[1]University of Liverpool, Department of Earth and Ocean Sciences Herdman Laboratories 4, Brownlow Street, Liverpool L37 3HD, United Kingdom

[2]University of Leeds, Department of Earth Sciences, Leeds LS2 9JT, United Kingdom

A long-standing debate in geophysics has revolved around the degree of mass exchange between the upper and lower mantle. Tomographic images show slab structures extending well into the lower mantle, and in some places to the core-mantle boundary (CMB), thereby supporting the whole-mantle convection paradigm. However, it is that tomography results have also formed the basis for arguments for a compositionally distinct layer at the base of the mantle, which could explain the source for the primordial geochemical signature observed in oceanic basalts. The nature of the D" region, the lowermost few 100kms of mantle, holds insights into these issues. The complexity of this region has often been used as an argument for chemical heterogeneity at the base of the mantle. Here we investigate the fine structure of this region beneath Eurasia using seismic migration of shear-waves reflecting from velocity discontinuities in the lowermost mantle and recorded by a dense network of European seismic stations. Two main features are found. One structure exhibits large-scale topography and can be explained by a sharp increase in velocity 206-316 km above the CMB. The second structure lies 55-85 km above the CMB and marks a sharp reduction in seismic velocity. To explain the origin of these discontinuities we appeal to recent numerical simulations of mantle convection, which show that a retained thermal anomaly in subducting slabs will produce such upper and lower discontinuities, the former with considerable topography. The results suggest that, in places, complexity in D" discontinuity structure may be due to the thermal structure of cold slabs accumulating at the CMB.

U51B-0009 0830h POSTER

Differential Response Functions: A *ScS-S* Case Study

Jesse Fisher Lawrence[1] (314 322-6277; jfisher@levee.wustl.edu)

Michael E Wysession[1] (314 322-5625; michael@mantle.wustl.edu)

[1]Washington University, Campus Box 1169 One Brookings Drive, St Louis, MO 63130, United States

We develop and demonstrate the differential response function (DRF), which is a new class of waveform that corresponds to isolated earth responses. Differential response functions are easily calculated by solving for the transfer functions between particular pairs of seismic waves (e.g. *PcP-P, ScS-S, SS-S*, etc). We can model a localized earth response by comparing observed and synthetic DRFs. For example, we can isolate lower mantle structure by examining the *ScS/S* transfer function. Each seismic phase may be considered as a convolution of 5 functions: 1) seismic source, 2) near source structure, 3) mid path structure, 4) near receiver structure, and 5) instrument response function. In this case, the deconvolution of the *S* phase from the *ScS* phase effectively removes all functions but the lower mantle (mid-path) structural response. This is due to the similarity of the *ScS* and *S* paths through the upper mantle and crust. The remaining signal retains impulses corresponding to reflective interfaces, time shifts associated with velocity anomalies, and attenuation due to quality factor variations. Each of these observable variations in waveform results from the localized structure, with little outside contamination. In this study we produce synthetic *ScS-S* differential response functions to model several examples of divergent lower mantle earth response. We then compare several examples of real *ScS-S* differential response functions to the synthetics to isolate distinct structural models for several regions within the lowermost mantle. We observe changes in the shape and amplitude of the main pulse corresponding to the reflection from the core mantle boundary. We also observe the absence and presence of other secondary pulses corresponding to interfaces at other depths. Despite stringent signal-to-noise requirements, the DRF provides several advantages over differential measurement techniques and waveform modeling methods. The source, receiver, near source, and near receiver response functions do not contaminate the system, effectively isolating only the desired earth response. The DRF directly corresponds to seismic models, and therefore retains more information than traditional differential travel-time or differential attenuation studies.

URL: http://epsc.wustl.edu/seismology/jfisher/DRF/

U51B-0010 0830h POSTER

Imaging D" Beneath Mexico Using American P Wave Data

Alexander Hutko[1] (831-459-2830; ahutko@es.ucsc.edu)

Justin Revenaugh[2] (612-624-7553; justinr@umn.edu)

[1]Earth Sciences/CSIDE, University of California, 1156 High St., Santa Cruz, CA 95064, United States

[2]Department of Geology and Geophysics, University of Minnesota, 310 Pillsbury Drive SE, Minneapolis, MN 55455, United States

Broadband data from North American permanent and temporary stations recording events 20-60 degrees away in Central America and northern South America are used to study the lower mantle by analyzing PcP, ScP and their precursors (topside reflections and back-scattered arrivals). The lowermost few hundred km of the mantle, D", is physically and chemically more heterogeneous than the overlying bulk of the mantle and contains wavespeed variations rivaling those of the crust. Core-reflected and mid and lower mantle scattered P and S waves are typically low energy phases and some form of stacking is necessary to raise their signal-to-noise ratios to levels suitable for modeling and interpretation. We use two methods. Where data is limited, we bin data according to their reflection point on the CMB, and then perform simple 1D time-to-depth analysis of PcP (or ScP) precursors. P is used as a reference phase in order to reduce the travel time variations caused by upper mantle and crustal velocity heterogeneity. All data are source-normalized by deconvolution of a source-time function calculated from the data. Using this method, we hope to constrain $\sim$ 100 km variations in the height and strength of a D" reflector recognized regionally in earlier studies using stacks of short-period data. We will atempt to better characterize the strength and thickness of ultra low velocity zones found in this region in previous studies. In areas of greater data density, we will also use a stochastic migration method patterned after the Kirchhof Regional Migration method of Revenaugh (2000). This approach to migration offers greater immunity to artifacts than simple diffraction stacking, but offers similar resolution of scatterers and specular reflectors. Preliminary results reveal several bright reflections whose depth and strength change significantly between bins suggesting that the D" layer in this region is quite complex at scale lengths as small as one to two hundred km. The data also indicate high levels of D" scattering throughout the study region. To investigate shorter length scale variations, we are examining a 20 year span of short period data from the Pacific Northwest Seismograph Network.

U51B-0011 0830h POSTER

Attenuation at the base of the mantle: Global mapping using core-reflected and core-diffracted waves

Kurt Solander[1] (314-935-6310; kurtsolander@hotmail.com)

Jesse Fisher Lawrence[1] (314-935-6619; jfisher@levee.wustl.edu)

Michael E Wysession[1] (314-935-5625; michael@wucore.wustl.edu)

[1]Washington University, Department of Earth and Planetary Sciences, St. Louis, MO 63130, United States

We use ScS-S and Sdiff data to examine the shear-wave attenuation in the lowermost part of the mantle (the D" layer). There is significant lateral variation in the shear-wave attenuation, as sampled by long- and intermediate-period wavelengths. Maps of attenuation show some degree of correlation with shear-wave velocity anomalies, but a greater degree of uncorrelation. There is significant coherence to the maps of D" attenuation at lateral spatial scales of hundreds to thousands of kilometers. The ScS-S study involved more than 40,000 high-quality digital broadband measurements using IRIS GSN and PASSCAL data from 1990-2001. All data had simultaneous ScSH-SH and ScSV-SV traveltime measurements obtained as well, using the attenuation measurements as an important correction. The attenuation values were obtained from differential t* measurements taken using spectral division of the S and ScS signals. At closer epicentral distances (less than 70 deg) the ScS waveform usually displayed a greater deal of attenuation than the S waveforms, as to be expected from the greater path lengths. However, as the raypaths of ScS and S approach each other (beyond 70 deg) the ScS pulse usually displayed less attenuation, indicative of generally high Q values at the base of the mantle. To a first order, shear-wave attenuation agrees with the large degree-2 anomalies observed in seismic tomographic models, with high D" attenuation beneath the Pacific and lower attenuation around the rim of the Pacific and beneath Asia. This is also evident in maps that show regions of slow velocities and high attenuation (and regions of fast velocities and low attenuation). There is also a significant amount of smaller-scale features that could represent a combination of chemical, thermal, or structural variations. Interestingly, the attenuation observed for ScSH waves differed from ScSV waves, being generally higher but also varying at smaller scales. Only in D" beneath eastern Asia was the ScSV attenuation significantly higher than for ScSH waves. These results compare interestingly with global maps of D" attenuation obtained from Sdiff waves. Here, the amplitudes of Sdiff waves are compared to predicted amplitudes from synthetic counterparts. There is an added complication with the diffracted wave amplitude variations, however, in that the amplitudes are actually more sensitive to the vertical velocity gradient across D" than to the intrinsic attenuation within it. There is a significant trend of larger Sdiff amplitudes with increased diffraction distance around the core, suggesting a negative velocity gradient is more appropriate for an averaged D" model than a zero gradient. Because of the anomalously high amplitudes of Sdiff waves, it is not possible to support a large amount of attenuation at the base of the mantle, agreeing with the ScS-S results.

U51B-0012 0830h POSTER

Simulated geomagnetic reversals and preferred VGP paths

Carsten Kutzner[1] (+49-5556-979-437; kutzner@linmpi.mpg.de)

Ulrich R Christensen[1] (+49-5556-979-542; christensen@linmpi.mpg.de)

[1]Max-Planck Institute for Aeronomy, Max-Planck Strasse 2, Katlenburg-Lindau 37191, Germany

The question if virtual geomagnetic poles (VGPs) recorded during reversals and excursions show a longitudinal preference is discussed controversially in the palaeomagnetic community. One possible mechanism for such VGP clustering is the heterogeneity of heat flux at the core-mantle boundary (CMB). We use three-dimensional convection-driven numerical dynamo models with imposed non-uniform CMB heat flow that show stochastic reversals of the dipole field. We calculate transitional VGPs for a large number of token sites at the Earth's surface. In a model with a simple heat flux variation given by a Y_{22} harmonic, the VGP density maps for individual reversals differ substantially from each other but the VGPs have a tendency to fall around a longitude of high heat flow. The mean VGP density for many reversals and excursions shows a statistically significant correlation with the heat flow. In a model with an imposed heat flux pattern derived from seismic tomography we find maxima of the mean VGP density at American and East Asian longitudes, roughly consistent with the VGP paths seen in several palaeomagnetic studies. We find that low-latitude regions of high heat flow are centres of magnetic activity where intense magnetic flux bundles are generated. They contribute to the equatorial dipole component and bias its orientation in longitude. During reversals the equatorial dipole part is not necessarily dominant at the Earth's surface, but is strong enough to explain the longitudinal preference of VGPs as seen from different sites.

U51B-0013 0830h POSTER

Thermal histories of earth models as constrained by the present-day heat flux across the core-mantle boundary

Ban-Yuan Kuo[1] (byk@earth.sinica.edu.tw)

Peng Cheng-Chien[2] (searchforhome@yahoo.com.tw)

Yang Hsin-Ying[2] (ysinging@earth.sinica.edu.tw)

[1]Institute of Earth Sciences,Academia Sinica, POB 1-55 Nankang, Taipei 12345, Taiwan

[2]Department of Geosciences, National Taiwan University, #1 Roosevelt Road section 4, Taipei 12345, Taiwan

The overall way Earth releases heat by convection can be parameterized into a relation between the Nusselt number and the Rayleigh number to the power of beta. The parameter beta for isoviscous convection is approximately 0.3. For Earth, there have been arguments in favor of a much lower beta, or even a negative one, on the ground that such models avoid thermal catastrophe in the early time of the planet. We follow the common procedure in the study of the thermal history of Earth in that we search for acceptable models by testing different initial temperatures and let the model cools until the present-day constraints are satisfied. These constraints include core-mantle boundary temperature, temperature at 660 km, surface heat loss by mantle convection, and viscosities in lithosphere, mid-mantle, and lower mantle. In this study, a constraint on the core heat flux is introduced, which is

assumed to be 3-10 TW. We found that, with different degrees of layering in the mid-mantle, a beta of 0.3 yields acceptable models with a set of reasonable initial temperatures (no catastrophe). Smaller beta on the contrary cannot lead to an earth-like present-day status as described above. If the thermal boundary layer at the core-mantle boundary is eliminated from the model, i.e., the core heat flux is assumed adiabatic, no acceptable solutions have been reached. We are carrying out seismological effort to nail down the present-day core heat flux and will also examine the effect of radiogenic heating in the core.

U51B-0014 0830h POSTER

High-Pressure Melting of Mg-Perovskite and its Assemblage With Periclase From Shock Temperature Measurement

Sheng-Nian Luo[1,2] ((505) 664 0037; sluo@lanl.gov)

Joseph A Akins[2] (jakins@gps.caltech.edu)

Thomas J Ahrens[2] (tja@gps.caltech.edu)

Paul D Asimow[3] (asimow@gps.caltech.edu)

[1]Plasma Physics P-24, Los Alamos National Laboratory, MS E526, Los Alamos, NM 87545, United States

[2]Seismological Laboratory, California Institute of Technology, MC 252-21, Pasadena, CA 91125

[3]Division of Geological & Planetary Sciences, California Institute of Technology, 170-25, Pasadena, CA 91125, United States

Optical emission of $MgSiO_3$ glass, enstatite and olivine under shock wave compression were investigated with optical pyrometry at discrete wavelengths ranging from visible to near infrared. At individual wavelengths, the optical linear absorption coefficients (a) and black-body spectral radiances ($L_{\lambda b}$) of shocked and unshocked materials were obtained by non-linear fitting to the time-resolved radiance from the target assembly. The absorbtion spectra of unshocked samples corresponding to the measured values of a reproduce those from independent static optical spectroscopic measurements. The measured values of a for shocked samples indicate that shock-induced high-pressure phases (including melt) can be regarded essentially as black body in the optical range investigated, although starting phases such as enstatite and olivine have band-like spectra at ambient conditions. High-pressure melting curves of Mg-perovskite and its assemblage with periclase are deduced with their melting temperatures near the core-mantle boundary being 6000 $\pm$ 500 K and 4200 $\pm$ 300 K, respectively.

U51B-0015 0830h POSTER

Fe-Mg interdiffusion in magnesiowustite up to 35 GPa

Daisuke Yamazaki[1] (+81-89-927-8408; yamazaki@sci.ehime-u.ac.jp)

Tetsuo Irifune[1] (irifune@dpc.ehime-u.ac.jp)

[1]Geodynamics Research Center, Ehime University, 2-5 Bunkyo-cho, Matsuyama 790-8577, Japan

Fe-Mg interdiffusivities in (Fe,Mg)O magnesiowustite have been measured in experiments conducted at pressures of 7-35 GPa and temperatures of 1573-1973K using a Kawai type high-pressure apparatus. The diffusion profiles were measured across the interface between MgO and $(Fe_{0.5},Mg_{0.5})O$ samples by electron microprobe analysis, and the Fe-Mg interdiffusivities were determined as $D_{Fe-Mg}=D_0\exp[-E^*(1+PV^*_{Mg}/E^*_{Mg})/RT]$, where $D_0=4.0 \times 10^{-7}$ m^2/s, $E^*=(1-C_{Mg})E^*_{Fe}+C_{Mg}E^*_{Mg}$ (activation energy for the concentration of Mg, where E^*_{Fe}=113 kJ/mol and E^*_{Mg}=226 kJ/mol), the activation volume $V^*_{Mg}=1.8 \times 10^{-6}$ m^3/mol. By extrapolating these results to the P-T conditions of the core-mantle boundary, we conclude that the interdiffusivity of Fe-Mg in magnesiowustite at the bottom of the lower mantle is at least one order of magnitude larger than that at the top of the lower mantle.

U51B-0016 0830h POSTER

Basalt-Iron Reactions at High Pressures and Temperatures

Victoria E. Lee[1] (510-643-8325; vlee@eps.berkeley.edu)

Kanani K.M. Lee[1] (510-643-8325; leeka@uclink.berkeley.edu)

Raymond Jeanloz[1] (510-642-2639; jeanloz@uclink.berkeley.edu)

[1]University of California, Berkeley, Dept. of Earth & Planetary Science 307 McCone Hall, Berkeley, CA 94720-4767, United States

New experiments designed to simulate the core-mantle boundary, as well as the differentiation of the primordial Earth into silicate- and metal-rich regions, illuminate the reaction of mantle minerals with iron at high pressures and temperatures. Previous investigations have laid the groundwork for documenting reaction products between iron and individual silicate phases (e.g., Knittle & Jeanloz 1991; Dubrovinsky et al. 2001, 2003), but the Earth's mantle is likely composed of multiphase silicate assemblages that depend on pressure and temperature. In addition, oceanic slabs that have subducted to the core-mantle boundary may provide a source of mineralogically complex rock material that could interact with the outer core. To investigate the reaction products formed between core metal and a natural mineral assemblage at high pressures and temperatures, the laser-heated diamond anvil cell was used to study samples of iron and basalt. These two starting materials were mechanically coupled as single foils and compressed in a quasi-hydrostatic argon pressure medium. High-resolution synchrotron x-ray diffraction was used to determine the mineral assemblages for three distinct regions of the sample: basalt, iron, and the basalt-iron interface. Initial results indicate a lower-mantle mineral assemblage for basalt consisting predominantly of stishovite plus a $CaSiO_3$-$(Mg,Fe)SiO_3$-Al_2O_3 orthorhombic perovskite, in accord with previous results (Funamori et al. 2000). As expected, iron regions consist wholly of ϵ-iron at high pressure. The interface region between metal and silicate shows evidence for the phases found in the distinct basalt and iron regions, and likely FeSi; there are also several as-yet unidentified diffraction peaks. These results could be interpreted as being due to chemical reactions between iron and basalt. Such reaction products may contribute to the long-term geochemical evolution of the core and mantle, as well as to the observed seismic heterogeneity at the core-mantle boundary.

U51B-0017 0830h POSTER

Argon Partitioning Between Metal and Silicate Liquids in the Laser-Heated DAC to 25 GPa

M. Ali Bouhifd[1] (Ali.Bouhifd@earth.ox.ac.uk)

Andrew P Jephcoat[2] (+44 1865 272067; andrew@earth.ox.ac.uk)

[1]University of Oxford, Department of Earth Sciences Parks Road, Oxford OX1 3PR, United Kingdom

[2]Diamond Light Source Ltd. and University of Oxford, Department of Earth Sciences Parks Road, Oxford OX1 3PR, United Kingdom

The accretion of the Earth from primordial material and its subsequent segregation into core and mantle are fundamental problems in terrestrial and solar system science. Many of the questions about the process, although well developed as model scenarios over the last few decades, are still open and much debated, and include, for example, whether the core is, or was, a reservoir for the noble (rare) gases. In the present study we use for the first time the laser-heated diamond-anvil cell (LHDAC) to study the Ar partitioning at high-pressure and temperature between metal and silicate liquids. Little work has been reported on noble gas partitioning at pressure since a single multi-anvil experiment to 10 GPa (Matsuda et al., 1993). We used either compacted glass powders simulating that of a model C1 chondrite and iron metal, or pure metal alloys (pure Fe, FeNiCo alloy, FeSi). Thermal insulation from the diamonds was achieved with solid argon as pressure medium. The samples were heated by a multimode YAG laser for an average of 15 minutes and temperatures were determined spectro-radiometrically with a fit to a grey-body Planck function. Samples recovered after the runs were analysed by electron microprobe with spatial resolution near 1 μm. The argon melts by conductive heating from the molten sample dissolving into the metal/silicate melt. Preliminary results on Ar solubility at lower pressures show good agreement with data reported by White et al. (1986) for Ar solubility in sanidine ($KAlSi_3O_8$). With sanidine melt, Ar solubility increases up to around 5-6 GPa where it reaches about 2.5 wt%, and remains roughly constant to higher pressures, suggesting that a threshold concentration is reached. Similar behavior is observed for a mix of C1-chondrite composition and iron and the results imply that the solubility of Ar is intimately related to liquid structure at high pressure. We also present results on Ar solubility into pure silicate liquids of varying composition in the absence of metal phases together with the partitioning of Ar between C1-chondrite and iron-rich metal liquids to 25 GPa.

U51B-0018 0830h POSTER

NEAR MBAR-LEVEL DYNAMIC LOADING OF MATERIALS BY DIRECT LASER-IRRADIATION

Thomas E Tierney[1] (505 667-6944; tierney@lanl.gov)

Damian C Swift[1] (505 667-1279; dswift@lanl.gov)

J Tinka Gammel[2] (1 505 667 9149; jtg@lanl.gov)

Sheng-Nian Luo[1] (505 667-4879; sluo@lanl.gov)

Randall P Johnson[1] (505 665-5575; rpjohnson@lanl.gov)

[1]P-24 Plasma Physics Group, Los Alamos National Laboratory, PO Box 1663 Mailstop E526, Los Alamos, NM 87545, United States

[2]T-1 Equation of State and Mechanics of Materials Group, Los Alamos National Labora-tory, PO Box 1663 Mailstop B221, Los Alamos, NM 87545, United States

We are developing techniques to perform direct-laser-illumination-driven, dynamic materials experiments at up to Mbar pressures with use of the Trident Laser Laboratory at Los Alamos. By temporally controlling the laser-irradiance, we are able to shape our loading for studies of fast-rise shocks, precursors, or isentropic compression. Laser-driven shock experiments are advantageous when considering the efficiency (fast turnaround), relative ease of sample recovery, taylorable dynamic loading, and in-situ structure diagnostics. Frequently, these experiments last 1-5 nanoseconds, and thus, permit investigation of rate-dependent processes and high strain rate environments. Laser-driven dynamic experiments are an important complement to traditional dynamic (e.g., light-gas gun) and static (e.g., diamond-anvil cell) experiments with certain advantages in studying equation of state, phase transitions and mechanical-chemical properties of Earth and planetary materials. Understanding high-pressure behavior in this regime is critical to phase boundaries for planetary interiors and dynamic properties of impact processes. Although we have studied silicates, oxides, metals, alloys and organic materials, this paper will focus on shocked and isentropically-compressed results obtained for iron in the range of 10-70 GPa (0.1-0.7 Mbar). Free surface velocities are measured using a Velocity Interferometer System for Any Reflector (VISAR). Nanosecond-scale laser experiments were interpreted with careful attention to exaggerated elastic-plastic effects and using accurate new equations of state for the phases of iron. This poster will present our technique, experimental results, and interpretation. *Work performed under the auspices of the US DOE under contract No. W-7405-ENG-36.

U51B-0019 0830h POSTER

Excess Temperature and Heat Transport in Mantle Plumes: a reassessment

Hans-Peter Bunge (+49 89 2180 4226; bunge@lmu.de)

Hans-Peter Bunge, Dept of Geo and Envt Sciences, Ludwig Maximilians University Munich, Theresienstrasse 41, Munich D-80333, Germany

Heat transfer across the core mantle boundary (CMB) is fundamentally important to Earth's internal energy budget, but the amount of heat entering the mantle from the core is poorly known. Classic arguments based on the dynamic topography over mantle hotspots suggest a rather modest core contribution to the mantle energy budget, on the order of 5-10 percent. Recent geodynamic studies, however, favor significantly higher values to overcome the problem of insufficient mantle heat sources, and to satisfy constraints on the power requirements of the geodynamo and estimates of the thermal history of the core. Here we use a high resolution mantle circulation model to explore the evolution of excess temperature in hot upwelling plumes that rise against mantle flow with substantial internal heat generation. We use the 3D spherical mantle dynamics code TERRA implemented on a dedicated network of PCs to achieve spatial resolutions of less than 50 km throughout the mantle, sufficient to resolve highly time-dependent convection at Rayleigh numbers based on internal heating that exceed 10exp8. We explore three relatively simple mantle circulation models having 5, 15, and 45 percent core heating respectively, all of which include a realistic depth variation of thermodynamic parameters following a Murnaghan EOS, as well as a substantial depthwise increase in mantle viscosity. We find the non-adiabatic mantle geotherm, which arises from internal mantle heat generation, has a dramatic effect in lowering the excess temperature of hot upwelling plumes, and in systematically decreasing plume temperatures relative to ambient mantle from the CMB to the surface. This non-adiabatic effect may provide some explanation for unusually low plume excess temperatures inferred from the petrology and isotope geochemistry of hotspot lavas, and we speculate that our results could imply that current estimates on the core heatflux based on hotspot topography should be increased by perhaps a factor of three.

U51B-0020 0830h POSTER

Origin and Evolution of a Thermally Stratified Layer at the Top of the Core

Bruce A Buffett[1] (773-702-8107; buffett@geosci.uchicago.edu)

Hans-Peter Bunge[2] (+49-89-2180-4226; bunge@lmu.de)

[1]Department of Geophysical Sciences, The University of Chicago, 5734 S. Ellis Avenue, Chicago, IL 60637, United States

[2]Department of Geo and Environmental Sciences, Ludwig Maximilians University, Theresienstrasse 41, Munich D-80333, Germany

A substantial amount of heat is transported through the Earth's core by conduction down the adiabatic temperature gradient. Typical estimates for the conductive heat flow near the core-mantle boundary (CMB) are 5 to 6 TW. These values are within a factor of two of the values commonly cited for the heat flow into the base of the mantle. If the heat flow into the base of the mantle exceeds the heat flow conducted doewn the adiabat, then cold, dense fluid at the CMB helps to drive vigorous convection in the core. However, if the heat flow into the mantle is less than the conductive heat flow (e.g. subadiabatic), then a warm stratified layer can develop at the top of the core. Under these circumstances convection in the core is sustained by compositional buoyancy from the inner-core boundary. Light elements gradually accumulate in the convecting region of the core, whereas warm fluid accumulates at the top of the core because heat is conducted toward the CMB faster than it can be removed by mantle convection. A competition between the density deficits in the convecting and stratified regions govern the growth or disappearance of the stratified layer. We investigate the evolution of the stratified layer using estimates of the CMB heat flow from a three-dimensional numerical model of mantle convection in a spherical shell. Geological estimates of plate motions over the past 120 Ma are imposed as boundary conditions in the numerical calculations to quantify the resulting changes in CMB heat flow. The calculations are extended to earlier times by cyclically repeating the plate motion record. Averaging the predictions over several cycles reduces the effect of initial conditions. The results indicate that minima in CMB heat flow occur 40 to 50 Ma after minima in the surface heat flow. An additional time delay is incurred by the time required to develop the stratified layer once the heat flow becomes subadiabatic. The net time delay is sufficient to cause the stratified layer to reach its maximum thickness during or shortly after the peak surface heat flow. The predicted growth of the layer in our simulation reaches a maximum thickness of approximately 50 km about 100 Ma ago. We expect the occurrence of a stratified layer to suppress variability in the magnetic field at the surface due to magnetic screening, and may even promote a stable polarity. The temporal correlation between the maximum layer thickness and the occurrence of the Cretaceous superchron suggests a caustive relationship.

U51C MCC: 3001-3003 Friday 1020h

Human-Induced Climate Variations Linked to Urbanization: From Observations to Modeling II

Presiding: **J Shepherd,** NASA Goddard Space Flight Center**; M Jin,** University of Maryland, College Park

U51C-01 1020h INVITED

Framework for Inclusion of Urbanized Landscapes in a Climate Model.

Robert E Dickinson (404-385-1509; robted@eas.gatech.edu)

Georgia Institute of Technology, 311 Ferst Drive, Atlanta, Ga 30332-0340, United States

Because of concentrated human populations, it becomes necessary to examine the consequences of urban areas for global climate. Urbanization changes the landscape by modifying the natural energy and water cycling processes and may introduce significant additional energy sources. Urban areas can either be considered from the viewpoint as to how their local climates are modified by their specifiic micrometeorological characteristics, or how there effects can be scaled up to the scales addressed by global regional climate models. We address the latter question. The land surfaces under a single atmospheric column of the model is partitioned into tiles with distinct micrometerological properties. However, the model resolution may restrict them to all interacting with the same atmospheric properties. The urban properities that cover the widest areas need to be considered first. These are evidently forests, grass, and pavements. Of these, the forests and grass might be combined with those outside the urban area to populatethe model's gridsquare forest and grass tile. However, urban/suburban lawns may be are sufficiently different from natural grasslands to merit a separte tile, and posibly be represented as irrigated where lawn watering prevails. Pavements are drastically different in their physical properties than natural surfaces, and typicaly cover a few tens of percent of an urban area (road densities of order of 10 km/km2). Largely asphalt, they have very low albedo,and are imperious to infiltration of precipitation. Hence, their characterization may be the most important issue for inclusion of urban effects in a global model. The minimum requirements for their inclusion are : a) global data sets of their relative areas, and b) average properties (e.g. albedo. emissivity, capacity for water storage, roughness, ...) How might these be obtained or what these might be are discussed.

U51C-02 1045h

Surface-Atmosphere exchanges in urban areas: Observations and models

Sue Grimmond[1] (812 855 7971; grimmon@indiana.edu)

Tim R Oke[2] (toke@ubc.ca)

[1]Sue Grimmond, Indiana University, Blooomington, IN 47405, United States

[2]T.R. OKe, University of British Columbia, Vancouver, BC V6T 1W5, Canada

Increasing attention is being directed to the climates of urban areas given a large and increasing proportion of the worlds population live in cities, and urban settings are the locations of some of the most profound human impacts on the natural environment. Although understanding of urban effects on climate is incomplete, over the last decade much has been learnt about how urbanization modifies the climate system at micro, local and meso-scales, and the variability both within and between cities. This paper will attempt to summarize the most significant findings of this research. Data on the fundamental energy, mass and momentum exchanges will be presented from measurements campaigns from cities across North America (Vancouver, Mexico City, Los Angeles, Chicago, Sacramento, Tucson, Oklahoma City, Baltimore); Europe (Lodz, Marseille); and Africa (Ouagadougou), along with results of evaluations of simple (LUMPS-NARP and UK Met-Office) to more complex (TEB) surface-atmosphere exchange schemes, appropriate for use in global circulation, numerical weather prediction, and regional land-atmosphere models.

U51C-03 1100h

Detecting and Simulating Urban-induced Climate Changes via EOS observations and NCAR Community Land Model

Menglin Jin[1] (201-405-8833; mjin@atmos.umd.edu)

Christa Peters-Lidard[2] (cpeters@hsb.gsfc.nasa.gov)

[1]Department of Meteorology, University of Maryland, College Park, MD 20742, United States

[2]Hydrological Sciences Branch, NASA-GSFC Code 974 Greenbelt, Greenbelt, MD 20771, United States

Advanced EOS observations provide us an unique opportunity to detect and simulate urban induced climate changes. Using 5km EOS MODIS-observed skin temperature, land cover, albedo, emissivity, LAI, aerosol optical depth, and cloud properties, we examine the surface-atmosphere interactions and urban heat island effects from selected big cities (New York, Beijing, Phoenix, and Houston) to global coverage. These analyses address physical processes modified by urban constructions as well as the general features of urban climate. We find the largest urban impacts in terms of temperature are observed over 30-60N, where most cities are located. In addition, urban regions overall decrease surface albedo by 3-5% and decrease surface emissivity by 1-2%. Focusing on Houston, we develop an urban scheme and couple it into NCAR Community Land Model (CLM-urban) to simulate urban climate. CLM-urban can improve the simulation of water and energy cycles over Houston with the use of observed LAI, albedo and emissivity, as well as urban thermal properties.

U51C-04 1115h

How Has Urbanization Altered the Carbon Cycle in the United States?

Marc L Imhoff[1] (301-614-6628; marc.l.imhoff@nasa.gov)

Lahouari Bounoua[2] (301-614-6631; bounoua@dounia.gsfc.nasa.gov)

Ruth DeFries[3] (rdefries@geog.umd.edu)

William Lawrence[4] (blawrenc@bowiestate.edu)

Taylor Ricketts[5] (taylor.ricketts@wwfus.org)

[1]Biospheric Sciences Branch, NASA's Goddard Space Flight Center, Greenbelt, MD 20771, United States

[2]Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD 20742, United States

[3]Department of Geography, University of Maryland, College Park, MD 20742, United States

[4]Department of Natural Sciences, Bowie State University, Bowie, MD 20715

[5]World Wildlife Fund, 1250 Twenty-fourth St. NW, Washington, DC 20037, United States

Data from two satellites and a terrestrial carbon model were used to quantify the impact of urbanization on net primary productivity (NPP) and its consequences on carbon balance and food production. We found that different classes of urbanization have a recognizable satellite-based NDVI signal at a spatial resolution of 1 km. Our results show that urbanization is taking place on the most fertile lands and hence has a disproportionately large overall negative impact on regional and even continental scale NPP. Urban land transformation in the U.S. has reduced the amount of carbon fixed through photosynthesis by 1.6 percent of the pre-urban value. The reduction nearly offsets the 1.8 percent gain made by the conversion of land to agricultural use, a striking fact given that urbanization covers less than 3 percent of the land in the U.S. while agricultural lands approach 29 percent. At local and regional scales, urbanization increases NPP in resource-limited regions, and through localized warming "urban heat" contributes to the extension of the growing season in cold regions. In terms of biologically available energy, the loss of NPP due to urbanization of agricultural lands alone is equivalent to the caloric requirement of about 6 percent of the US population annually.

U51C-05 1130h

Modeling Urban Surface-Atmosphere Sensible Heat Exchanges

Sarah M. Roberts[1] (604.822.2663; sroberts@geog.ubc.ca)

T. R. Oke[1] (604.822.2900; toke@geog.ubc.ca)

Aude Lemonsu[2] (aude.lemonsu@cnrm.meteo.fr)

C. S. B. Grimmond[3] (grimmon@indiana.edu)

Phoebe Jackson[1] (pjackson@geog.ubc.ca)

[1]Department of Geography, University of British Columbia, 217 - 1984 West Mall, Vancouver, BC V6T 1Z2, Canada

[2]Centre National de Recherches Météorologiques, Météo-France, 42 av Coriolis, Toulouse 31057, France

[3]Atmospheric Science Program, Department of Geography, Indiana University, Student Building 120, Bloomington, IN 47405, United States

Understanding the nature of energy partitioning at the surface of cities is prerequisite to gaining proper insight and ability to model their climatic environment and impacts. Of particular relevance in the urban setting is the surface-atmosphere exchange of sensible heat. The combined conductive-convective exchange of turbulent sensible heat flux (Q_H) and net storage heat flux (ΔQ_S) has been shown to account for over 90% of the daytime net radiation at highly urbanized sites. This relation depends on surface structure, materials and the degree of surface-atmosphere coupling and its understanding is required in many applications; for example, to assess building climates, and to model evapo-transpiration, the urban heat island, and boundary layer growth. Observational studies, while allowing for general awareness of urban surface-atmosphere energetic interactions, are often limited in their applicability to other urban sites and/or processes. To overcome this, numerical models which aim to simulate urban climates have been developed. The Town Energy Balance (TEB) model of Masson (2000) couples the micro- and meso- scales and accurately represents the urban energy budget in meso-scale atmospheric models. TEB uses local canyon geometry together with surface and substrate radiative, thermal, moisture and roughness properties to simulate the effects produced by the presence of buildings. The urban system is simulated by calculating individual energy balances for walls, roads, and roofs, which are then integrated to resolve the local-scale surface energy balance. The model has been independently evaluated using measured fluxes from three dry sites - central Mexico City, a light industrial site in Vancouver (Masson *et al.*, 2002) and the city center of Marseille, France