collaborations that are bound together by a common goal. While existing collaboration tools, such as video conferencing, mailing lists and web servers, can support some of the workflow associated with a VO, many of the Project tasks require a more fundamental sharing of all elements of the IT infrastructure associated with the participants, including data, simulation models, computing and storage resources, visualization resource, etc. During the past eight years, Grid technology has emerged as an infrastructure that supports this type of resource sharing. Building on these advances, SCEC has undertaken activities in which Grids can be used to integrate the various modeling, simulation, and data collection activities of SCEC, with the goal of providing a seamless, integrated computational environment in which all aspects of geophysical elements of earthquakes can be studied, in which important information about earthquakes can be delivered to the community at large, and which promotes education and outreach about geophysics. In this presentation, we will describe the SCEC Community Modeling Environment (SCEC/CME) Grid-based infrastructure that is being built to support the scientific and education mission of SCEC. We will focus on three aspects of the current environment: (1) distributed data management, which is being used to support model validation, (2) knowledge based tools for model description, which are being used to support high-level interfaces to sophisticated modeling tasks, and (3) a distributed visualization facility, which enables remote exploration of large-scale simulation data sets. We will conclude with a description of future directions in which this environment will be taken.

URL: http://www.scec.org/cme

NG11A-0181 0830h POSTER

Earthquake Source Simulations: A Coupled Numerical Method and Large Scale Simulations

Geoffrey P Ely[1] (gely@ucsd.edu); Qiao Xin[2]; Marcio Faerman[2]; Steven Day[3]; Bernard Minster[1]; George Kremenek[2]; Reagan Moore[2]

[1]Institute of Geophysics and Planetary Physics, University of California, San Diego 9500 Gilman Drive, La Jolla, CA 92093-0225, United States

[2]San Diego Supercomputer Center, University of California, San Diego 9500 Gilman Drive, La Jolla, CA 92093-0505, United States

[3]Department of Geological Sciences, San Diego State University 5500 Campanile Drive, San Diego, CA 92182-1020, United States

We investigate a scheme for interfacing Finite-Difference (FD) and Finite-Element (FE) models in order to simulate dynamic earthquake rupture. The more powerful but slower FE method allows for (1) unusual geometries (e.g. dipping and curved faults), (2) nonlinear physics, and (3) finite displacements. These capabilities are computationally expensive and limit the useful size of the problem that can be solved. Large efficiencies are gained by employing FE only where necessary in the near source region and coupling this with an efficient FD solution for the surrounding medium. Coupling is achieved through setting up and an overlapping buffer zone between the domains modeled by the two methods. The buffer zone is handled numerically as a set of mutual offset boundary conditions. This scheme eliminates the effect of the artificial boundaries at the interface and allows energy to propagate in both directions across the boundary. In general it is necessary to interpolate variables between the meshes and time discretizations used for each model, and this can create artifacts that must be controlled. A modular approach has been used in which either of the two component codes can be substituted with another code. We have successfully demonstrated coupling for a simulation between a second-order FD rupture dynamics code and fourth-order staggered-grid FD code. To be useful earthquake source models must capture a large range of length and time scales, which is very computationally demanding. This requires that (for current computer technology) codes must utilize parallel processing. Additionally, if larges quantities of output data are to be saved, a high performance data management system is desirable. We show results from a large scale rupture dynamics simulation designed to test these capabilities. We use second-order FD with dimensions of 400 x 800 x 800 nodes, run for 3000 time steps. Data were saved for the entire volume for three components of velocity at every time step and six components of stress at every tenth time step. This generated a 10 terabyte data set that was handled with the SDSC Storage Resource Broker (SRB). Run time was approximately 12 hours on SDSC Blue Horizon machine, and data archival to SRB took approximately 5 days.

NG11A-0182 0830h POSTER

Examples of Linking Codes Within GeoFramework

Eh Tan[1] (626-3956971; tan2@gps.caltech.edu); Eun-seo Choi[1] (ces74@gps.caltech.edu); Pururav Thoutireddy[2] (puru@cacr.caltech.edu); Michael Aivazis[2] (aivazis@caltech.edu); Luc Lavier[3] (luc@utig.ig.utexas.edu); Steve Quenette[4] (steve@vpac.org); Michael Gurnis[1] (gurnis@gps.caltech.edu)

[1]Seismological Laboratory, Caltech, 1200 E. California Blvd., Pasadena, CA 91125, United States

[2]Center for Advanced Computing Research, Caltech, 1200 E. California Blvd., Pasadena, CA 91125, United States

[3]Institute for Geophysics, University of Texas, Austin, 4412 Spicewood Springs Rd., Bldg. 600, Austin, TX 78759, United States

[4]Victorian Partnership for Advanced Computing Ltd., 110 Victoria Street, PO Box 201, Carlton South, VIC 3053, Australia

Geological processes usually encompass a broad spectrum of length and time scales. Traditionally, a modeling code (solver) is written to solve a problem with specific length and time scales in mind. The utility of the solver beyond the designated purpose is usually limited. Furthermore, two distinct solvers, even if each can solve complementary parts of a new problem, are difficult to link together to solve the problem as a whole. For example, Lagrangian deformation model with visco-elastoplastic crust is used to study deformation near plate boundary. Ideally, the driving force of the deformation should be derived from underlying mantle convection, and it requires linking the Lagrangian deformation model with a Eulerian mantle convection model. As our understanding of geological processes evolves, the need of integrated modeling codes, which should reuse existing codes as much as possible, begins to surface. GeoFramework project addresses this need by developing a suite of reusable and re-combinable tools for the Earth science community. GeoFramework is based on and extends Pyre, a Python-based modeling framework, recently developed to link solid (Lagrangian) and fluid (Eulerian) models, as well as mesh generators, visualization packages, and databases, with one another for engineering applications. Under the framework, a solver is aware of the existence of other solvers and can interact with each other via exchanging information across adjacent boundary. A solver needs to conform a standard interface and provide its own implementation for exchanging boundary information. The framework also provides facilities to control the coordination between interacting solvers. We will show an example of linking two solvers within GeoFramework. CitcomS is a finite element code which solves for thermal convection within a 3D spherical shell. CitcomS can solve for problems either within a full spherical (global) domain or a restricted (regional) domain of a full sphere by using different meshers. We can embed a regional CitcomS solver within a global CitcomS solver. We not that linking instances of the same solver is conceptually equivalent to linking to different solvers. The global solver has a coarser grid and a longer stable time step than the regional solver. Therefore, a global-solver time step consists of several regional-solver time steps. The time-marching scheme is described below. First, the global solver is advanced one global-solver time step. Then, the regional solver is advanced for several regional-solver time steps until it catches up global solver. Within each regional-solver time step, the velocity field of the global solver is interpolated in time and then is imposed to the regional solver as boundary conditions. Finally, the temperature field of the regional solver is extrapolated in space and is fed back to the global. These two solvers are linked and synchronized by the time-marching scheme. An effort to embed a visco-elastoplastic representation of the crust within viscous mantle flow is underway.

URL: http://geoframework.org

NG12A MCC: 2010 Monday 1340h

Nonlinear Processes in Geomorphologic Organization and Natural Hazards I *(joint with B, H, OS, AE)*

Presiding: **E Foufoula,** St. Anthony Falls Laboratory, University of Minnesota**; I Rodriguez-Iturbe,** Princeton University**; C Paola,** St. Anthony Falls Laboratory, University of Minnesota**; S Burroughs,** University of Tampa

NG12A-01 1340h INVITED

Order without a cause

Brad Werner[1] (bwerner@ucsd.edu)

A Kitluk[1] (akitluk@ucsd.edu)

L J Plug[2] (lplug@dal.ca)

[1]Complex Systems Laboratory, Cecil and Ida Green Institute of Geophysics and Planetary Physics University of California - San Diego, La Jolla, CA 92093-0225

[2]Surface Process and Pattern Laboratory, Department of Earth Sciences Dalhousie University, Halifax, NS B3H4H6, Canada

The pervasiveness of order in landscapes, from striking patterns such as fields of sand dunes to less eye-catching examples such as tussock tundra, motivates efforts to find its cause. However, studying order as an abstract, overarching structure common to many similar systems or as emerging from fundamental physical processes reveals little about the dynamics of specific landscapes, because order is an irreducible property of the dynamics of a system and not a product of causal relations between different aspects of the system. This hypothesis is based on the view that the order of a landscape is the extent to which it is organized into a hierarchy of scale-separated behaviors. With increasing level in the hierarchy, time scale increases and the number of degrees of freedom decreases. The lone relations between adjacent levels connect only the fast-scale variables of the lower level with the slow-scale dynamics of the upper level (through self-organization/slaving). The dynamics at each level is an independent property of the system, not an effect caused by dynamics at any other level. Order is quantified using the number and time scales of levels in the hierarchy. Ice-rich permafrost terrain of the Kitluk drainage basin in Bering Land Bridge National Preserve, Alaska, illustrates a highly developed hierarchical order without a cause. The terrain has numerous levels, ranging from soil particle motion (seconds) to integrated lake drainage networks (10 ka). Using our concept of order, measurements over a range of locations reveal that this seemingly unpatterned landscape contrasts with many patterned systems, such as fields of sorted patterned ground in Western Spitsbergen, where order is less developed. Supported by the Andrew W. Mellon Foundation.

NG12A-02 1355h INVITED

Comparative geomorphologic organization of river and tidal networks

Andrea Rinaldo[1] (+39 049 8275431; rinaldo@idra.unipd.it)

Stefano Lanzoni[1] (lanzo@idra.unipd.it)

Marco Marani[1] (marani@idra.unipd.it)

[1]International Centre for Hydrology "Dino Tonini" University of Padua, via Loredan 20, Padova I-35122, Italy

We address a comparative analysis of certain features observed in river and tidal networks, chiefly to explore the dynamic origin of the extraordinary diversity and yet the deep symmetry that one observes in such particular landforms. It seems of particular interest to compare network structures and a few geomophic features because of the vast diversity (and the relatively high degree of understanding) of the morphologic, hydrologic and ecobiologic processes at work in such eartscapes. River networks are indeed a paradigm of scale-invariant landforms from open, dissipative systems with many degrees of freedom quite ubiquitous in nature, and are described by a noteworthy body of observational and theoretical work, which is briefly reviewed in this context. Tidal networks bear mixed signatures of dynamic processes acting at different scales and are vastly more susceptible to environmental factors. Salt marshes in tidal environments, home to such networks, are thus characterised by complex patterns both in their geomorphic and ecological features. Such patterns arise through the elaboration of a network structure driven by the tidal forcing and through the interaction between hydrodynamical, geophysical and ecological components (e.g. microphytobenthos and vegetation). Therefore similarities and departures from observed features in fluvial and tidal environments are deemed of interest, in particular because we find that some purported similarities are artefacts of the measuring tools. This is not uncommon in networks studies. We show that remote sensing (and ancillary data) may be used to monitor vegetation and morphological changes of tidal landforms at different spatial and temporal scales. We use accurately georeferenced field observations coupled to aerial (ROSIS, MIVIS, CASI, and LiDar) and satellite (IKONOS and QuickBird) remotely sensed data. We then analyze the spatial distribution and variability of some vegetation indicators (e.g. NDVI) and the typical patterns of vegetation clusters obtained through classification and unmixing techniques. Finally, we study the relationships between vegetation species and organisation and various topographic/geomorphic parameters (e.g. soil elevation, proximity to the channel network, etc.). The remotely sensed data are radiometrically calibrated, atmospherically corrected and accurately georeferenced to allow the comparison with ground truth observations. Thus we claim that observations in both the river basin and the tidal earthscapes are equally accurate across their range of scales. Classification and unmixing techniques are then used to derive the spatial distribution of salt marsh vegetation species, which are also characterised through the use of vegetation indexes, allowing an objective and quantitative analysis of vegetation patterns. The set of observations available are further used, together with mathematical models, to describe channel meandering characteristics, drainage densities and branching properties yielding an accurate and spatially distributed description of the tidal network. Our observations and the proposed geometrical descriptors also allow a comparative morphological characterization of tidal and fluvial meanders, with unexpected similarities and sharp differences.

NG12A-03 1410h

On the coupled geomorphological and ecohydrological organization of river basins

Kelly K Caylor[1] (kcaylor@princeton.edu)

Salvatore Manfreda[1,2] (manfreda@princeton.edu)

Ignacio Rodriguez-Iturbe[1] (irodrigu@princeton.edu)

[1]Princeton University, Department of Civil and Environmental Engineering, Princeton, NJ 08844, United States

[2]University of Basilicata, Department of Environmental Engineering and Physic, Potenza 85100, Italy

This paper examines the linkage between the drainage network and the patterns of soil water balance components determined by the organization of vegetation, soils and climate in a semi-arid river basin. Research during the last 10 years has conclusively shown an increasing degree of organization and unifying principles behind the structure of the drainage network and the 3-dimensional geometry of river basins. This cohesion exists despite the infinite variety of shapes and forms one observes in natural watersheds. What has been relatively unexplored in a quantitative and general manner is the question of whether or not vegetation, soils, and climate also display a similar set of unifying characteristics among the very different patterns they presents in river basins. A recently formulated framework for the water balance at the daily level is used to link the observed patterns of basin organization to the soil moisture dynamics. Using available geospatial data we assign soil, climate, and vegetation properties across the basin and analyze the probabilistic characteristics of steady-state soil moisture distribution. It is shown here that the drainage network acts as a template for the organization of both vegetation and hydrological patterns. The signatures of such organization appear in the structure governing the spatial patterns of the steady-state soil moisture distribution, as well as in the distribution of hydrological fluxes such as transpiration and runoff.

NG12A-04 1425h

Instantaneous Initiation of Bedforms from a Flat Sand Bed

Jeremy G Venditti[1] (604-822-5870; venditti@geog.ubc.ca)

Michael A Church[1] (604-822-6959; mchurch@geog.ubc.ca)

Sean J Bennett[2] (716-645-2722 ext. 65; seanb@buffalo.edu)

[1]University of British Columbia, Dept. of Geography, Vancouver, BC V6T 1Z2, Canada

[2]State University of New York at Buffalo , Dept. of Geography, Buffalo, NY 14261, United States

Sediment transport in sand bedded alluvial channels is strongly conditioned by bedforms, typically ripples or dunes. Consequently, the origin of bedforms has attracted interest for over a century. Recent research has suggested that there may be several bedform initiation modes. Bedform fields may be produced by the propagation of defects via flow separation processes and local sediment transport. Alternatively, bedform fields have been observed to develop instantaneously, covering the entire bed surface under general sediment transport conditions. This latter initiation mode has not been investigated extensively. A series of experiments were designed to examine bedform initiation on a flat sand bed composed of homogeneous 0.5 mm sand. The narrowly graded sand bed was subjected to a 0.155 m deep, non-varying mean flow ranging from 0.30 to 0.55 m/s in a 1 m wide flume. Bedform initiation was monitored using overhead video. At lower flow strengths, with sporadic sediment transport, the defect propagation process was observed to dominate. At larger flow strengths, where general sediment transport occurs, bedform initiation began with the imprinting of a cross-hatch pattern on the flat sediment bed which leads to chevron shaped forms that migrate independently of the initial structure. The chevron shapes are organized and form incipient crestlines that quickly develop into two-dimensional (2D) bedforms. Once the 2D bedforms are organized, it appears that flow separation processes dominate subsequent growth. A Kelvin-Helmholtz model of interface instability between two superimposed fluids of different densities is introduced to explain this organization. In the model, the water column is the upper, less dense but faster moving fluid and the active sediment transport layer is the lower, more dense and slower moving fluid. Measurements of near-bed fluid velocities, sediment velocities and bedload transport rates allow for calculations of a predicted wavelength for the initial 2D bedforms. At all flow strengths with intense and widespread sediment transport the predicted instability wavelengths are nearly identical to observed initial bedform lengths. This suggests that the origin of instantaneously developed bedforms is a Kelvin-Helmholtz instability formed at the interface between the fluid flow and the active transport layer.

NG12A-05 1440h

Dynamic Interaction of Bedforms at low Transport Stage

Douglas J Jerolmack[1] (1-617-253-1949; douglasj@mit.edu)

David Mohrig[1] (1-617-253-9429; mohrig@mit.edu)

[1]Earth, Atmospheric and Planetary Science, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139, United States

Results are presented examining the control of initial spacing between two sandy bedforms on their subsequent behaviors when subjected to flow of Froude number = 0.2 (mean velocity = 0.30m/s) in a channel 10m long by 0.16m wide by 0.20m deep. Temporal evolution of bedforms was monitored using time-lapse photography to characterize the pathways by which bedforms adjusted to the given flow field. Medium and coarse-grained bedforms had median grain sizes of 0.35 and 0.77mm, respectively, and initial dimensions: length = 0.40m, height = 0.07m, stoss angle = 13 degrees and lee angle = 33 degrees. Cases were examined of (1) one bedform alone, and two bedforms with crests spaced (2) 0.40, (3) 0.67 and (4) 1.40m apart. Flow conditions were chosen such that time-averaged sediment flux was nearly zero for the first case of one bedform and bed deformation was minimal, allowing the kinematic effects caused by the presence of additional bedforms to be unambiguously quantified. The presence of another bedform with crest 0.40m downstream, placed mainly in the recirculation zone of the upstream bedform, induced deformation of both bedforms, and increased sediment flux by an order of magnitude. Changing initial spacing to 0.67m decreased the activity of the upstream bedform but enhanced deformation of the downstream bedform, which was placed mainly in the growing internal boundary layer downstream of the point of reattachment. At a spacing of 1.40m, with the downstream bedform placed beyond the zone of flow disturbance from the upstream bedform, sediment flux was reduced and deformation of both bedforms was small. Sediment fluxes were comparable for medium and coarse sand trials. For medium sand, small reductions of lee-face slopes and the filling of bedform troughs with sand often preceded rapid adjustments in bed geometry, with turbulent bursts and sweeps visibly important in ejecting and advecting sediment grains. Evolution of course grained bedforms was more uniform with little or no bedform splitting, probably because turbulent bursts and sweeps could not effectively lift larger sediments so bed evolution was dominated by grain rolling and sliding. Velocity measurements taken over rigid bedforms using an Acoustic Doppler Profiler were used to characterize velocity vectors and turbulence production for several bed configurations, simulating snapshots in time of bed evolution. Results show that placement of a solid plate in the bedform trough enhances turbulence production by a factor of 5, by forcing the recirculation zone in the trough and the free shear zone at the crest to merge. Increased turbulence caused by changes in trough geometry suggests a pathway by which small-scale topography can induce larger-scale structural adjustment of bedforms. It is likely that local topography, turbulent bursting and sensitivity to boundary conditions play an important role in determining the geometry of bedform systems through dynamic bedform interaction. Experiments challenge the commonly held assumption that bedform geometry asymptotically approaches equilibrium with flow and sediment transport fields. Comparison with field studies shows the mechanisms described herein are likely active in natural systems, suggesting laboratory results are relevant to understanding bedform adjustment in real systems, where flow is neither steady nor uniform.

NG12A-06 1455h INVITED

An Approach for Forecasting Shoreline Stability Based on Fractal Persistence

Christopher C Barton[1] (727-803-8747 ext. 3014; barton@usgs.gov)

Sarah F Tebbens[2] (727-553-1538; tebbens@marine.usf.edu)

Stephen M Burroughs[3] (sburroughs@ut.edu)

Robert A Morton[1] (727-803-8747 ext. 3080; rmorton@usgs.gov)

Jeffrey S Dismukes[1] (727-803-8747 ext. 3127; jdismukes@usgs.gov)

[1]U.S. Geological Survey, 600 4th St., South, St. Petersburg, FL 33701, United States

[2]College of Marine Science, University of South Florida, 140 7th Ave., South, St. Petersburg, FL 33701, United States

[3]Department of Chemistry and Physics, University of Tampa, Tampa, FL 33606, United States

Persistence is a fractal measure of the degree of internal correlation in the stochastic portion of a self-affine time series. We use persistence to characterize internal correlations between shoreline positions and then to forecast a probability envelope bounding future shoreline positions. The envelope is the standard deviation determined as a function of three variables: the number of time increments, N; the activity level determined from the power spectral density; and persistence. The persistence of a 20-year time series of the mean-high-water (MHW) shoreline positions is calculated for four profiles surveyed by the U.S. Army Corps of Engineers at the Field Research Facility (FRF), Duck, NC. The four MHW shoreline time series signals are nonlinear and self-affine with persistence values ranging between 0.8 and 0.9, which indicates that the shoreline position is weakly internally correlated, slightly nonstationary, and has highly varying trends at all time scales sampled. Forecast envelopes based on the 20-year record are extrapolated to 50 years from the start of the record. The forecast envelopes are controlled by the persistence and activity level measured from the 20-year time series and by the initial shoreline position. The forecasts describe the 20-year data sets well and indicate that within a 96% confidence envelope, future decadal MHW shoreline excursions should be within $\mp$ 14.6m of the initial position in 1981. We also applied the traditional method of characterizing and forecasting future positions by fitting linear trend lines to the historic shoreline positions and extrapolating to forecast future positions. The traditional method results in a linearly increasing mean that breaks the envelope eight years into the future and continues to increase, forecasting net accretion indefinitely into the future for a shoreline that has been oscillatory-stable for the past 150 years. We find the traditional method to be a poor representation of the observed pattern of change in shoreline position and a poor basis for extrapolating future shoreline positions.

NG12A-07 1510h INVITED

Tails of Natural Hazards

Bruce D Malamud (bruce@malamud.com)

Environmental Monitoring and Modeling Research Group, Department of Geography, King's College London, Strand, London WC2R 2LS, United Kingdom

There is increasing evidence that many natural hazards satisfy power-law frequency-size statistics. Examples include earthquakes, volcanic eruptions, landslides, snow avalanches, forest and wildfires, meteorite impacts, and possibly floods. Although power-law (fat-tail) distributions are commonly associated with the frequency-size distribution of earthquakes, the frequency-size statistics of many other natural hazards are presently associated (e.g. by government agencies and reinsurance companies) with distributions that are

NG

more thin-tailed. The occurrence risk for large and very-large events using power-law frequency-size distributions is often much more conservative, with a greater chance of a large event occurring in a given period of time, compared to thinner tail distributions. One potential explanation for the frequent occurrence of power-law (fractal) frequency-size distributions among natural hazards lies in cellular-automata models, and their association with self-organized criticality and inverse cascades. The power-law behavior of the sandpile cellular-automata model has been associated by some with landslides, the forest-fire model with actual forest fires, and the slider-block model with earthquakes. A relatively simple inverse-cascade of metastable regions can explain the behavior of both models and the actual natural hazards. Metastable regions grow by coalescence and are lost in 'avalanches'. However, the losses are dominated by the largest events and have little influence on the inverse cascade of metastable region coalescence. This inverse cascade of metastable regions is self-similar and the number-area statistics are power-law. Although the theoretical explanations are still being debated, the increasing evidence for power-law statistics means that government agencies and reinsurance companies should include this much more conservative frequency-size distribution when calculating the occurrence risk of large natural hazards.

NG12A-08 1525h

Coping with climate noise: Long-range dependence and weather derivatives

Stephen Jewson[1] (stephen.jewson@rms.com)

Rodrigo Caballero[2] (rca@geosci.uchicago.edu)

[1] RMS, 10 Eastcheap, London, IL EC3M 1AJ, United Kingdom

[2] Department of the Geophysical Sciences, University of Chicago, 5734 S Ellis Av, Chicago, IL 60637, United States

Random day-to-day changes in weather lead to random year-to-year fluctuations in monthly and seasonal means, a feature known as "climate noise". Such climate noise has direct economic impact on a wide variety of businesses. A typical example is energy vendors, whose annual revenues are closely correlated with seasonal mean temperatures. To deal with this risk, a form of insurance known as weather derivatives has been developed in recent years. We discuss a Monte Carlo approach to the pricing of weather derivatives based on stochastic modeling of daily temperature. It will be shown that this approach can only be succesful if the time-series model correctly captures the autocorrelation structure of the data even at very high lags. Evidence will be presented that observed daily temperatures exhibit long-range dependence, i.e. power-law decay of the autocorrelation. This means that classical Box-Jenkins ARMA models are unequal to the task, since their autocorrelations decay exponentially. ARFIMA, a generalisation of ARMA explicitly incorporating long-range dependence, does however prove to be suitable. We also briefly discuss the physical mechanisms which give rise to the power-law scaling found in the data.

NG12B MCC: 3005 Monday 1340h

Visualization, Analysis, and Distributed Computing in Nonlinear Geosciences II *(joint with OS, V, AE, DI)*

Presiding: **G Erlebacher,** Florida State University**; D A Yuen,** University of Minnesota

NG12B-01 1340h INVITED

Earth Sciences, GeoInformatics and Visualization and Analysis of Distributed Databases

Walter S. Snyder (703-292-4742; wsnyder@nsf.gov)

Division of Earth Sciences National Science Foundation, 4201 Wilson Blvd, Rm 785, Arlington, VA 22230, United States

GeoInformatics is part of NSF's larger cyberinfrastructure initiative that broadly targets the earth sciences. GeoInformatics as a system encompasses the development and maintenance of databases, but it must also provide the mechanisms to mine, synthesize, and visualize these data in new ways, and to seamlessly use old and new numerical and statistical tools on hereto-fore inaccessible data sets. It includes high-level as well as desk-top modeling. The entire system must be accessible to the entire community - from the large research universities to the smallest college. Finally, it must provide real opportunities for wide participation - a few cannot do this for the many - it must be a community system. The overall system will include legacy as well as new data. Vast amounts of data will stream in from sensors, in particular as we establish more natural observatories. Data mining and other methodologies have to be developed and refined to allow researchers to easily, rapidly, and accurately access these data. Visualization, numerical, and statistical tools boxes have to be developed that allow the users to easily but exhaustively assess and synthesize these data as they ask a myriad of questions. Many of these questions will be new - the system will allow the researcher to ask questions they have never before thought about - that is the key for the future of our science. These tools have to be maintained and updated, and new ones developed as users ask questions in different ways, as the databases expand, and as information technology advances. Some of the computational modeling efforts will be very intensive and require significant resources; the role of the system is to connect the models with the data that they must ultimately be tested with, to insure that the models are available to the entire community, and insure that the codes are updated as necessary and archived. Thus the GeoInformatics system, indeed, the cyberinfrastructure system as a whole, starts with the mundane process of data acquisition and database construction and ends with the tools and models that will help define the next generation of science.

NG12B-02 1400h INVITED

NaradaBrokering as Middleware Fabric for Grid-based Remote Visualization Services

Shrideep Pallickara[1] (812-856-1311; spallick@grids.ucs.indiana.edu)

Gordon Erlebacher[2] ((850) 644-0186; erlebach@csit.fsu.edu)

Dave Yuen[3] ((612) 624-1868; davey@krissy.geo.umn.edu)

Geoffrey Fox[1] (812-856-7977; gcf@indiana.edu)

Marlon Pierce[1] (812-856-1212; marpierc@indiana.edu)

[1] Community Grids Lab, Indiana University 501 N Morton St., Suite 224, Bloomington, IN 47404, United States

[2] School of Computational Science & Information Technology, Florida State University, Tallahassee, FL 32306-4120, United States

[3] Department of Geology & Geophysics, Minnesota Supercomputing Institute, University of Minnesota, Minneapolis, MN 55455, United States

Remote Visualization Services (RVS) have tended to rely on approaches based on the client server paradigm. The simplicity in these approaches is offset by problems such as single-point-of-failures, scaling and availability. Furthermore, as the complexity, scale and scope of the services hosted on this paradigm increase, this approach becomes increasingly unsuitable. We propose a scheme based on top of a distributed brokering infrastructure, NaradaBrokering, which comprises a distributed network of broker nodes. These broker nodes are organized in a cluster-based architecture that can scale to very large sizes. The broker network is resilient to broker failures and efficiently routes interactions to entities that expressed an interest in them. In our approach to RVS, services advertise their capabilities to the broker network, which manages these service advertisements. Among the services considered within our system are those that perform graphic transformations, mediate access to specialized datasets and finally those that manage the execution of specified tasks. There could be multiple instances of each of these services and the system ensures that load for a given service is distributed efficiently over these service instances. Among the features provided in our approach are efficient discovery of services and asynchronous interactions between services and service requestors (which could themselves be other services). Entities need not be online during the execution of the service request. The system also ensures that entities can be notified about task executions, partial results and failures that might have taken place during service execution. The system also facilitates specification of task overrides, distribution of execution results to alternate devices (which were not used to originally request service execution) and to multiple users. These RVS services could of course be either OGSA (Open Grid Services Architecture) based Grid services or traditional Web services. The brokering infrastructure will manage the service advertisements and the invocation of these services. This scheme ensures that the fundamental Grid computing concept is met - provide computing capabilities of those that are willing to provide it to those that seek the same.
[1] The NaradaBrokering Project: http://www.naradabrokering.org

NG12B-03 1420h INVITED

Visualization Techniques in Laboratory Experiments: Resolving the Mechanics of Mixing in Complex flows

Mark Jellinek (markj@physics.utoronto.ca)

University of Toronto, Geophysical Laboratories Department of Physics, Toronto, ON M5S 1A7, Canada

Many geological phenomena such as the emplacement of lava flows, the cooling and solidification of magma chambers, and the thermal evolutions of the core and mantle of the Earth involve mixing processes operating in a large range of dynamical regimes and acting over a wide range of time and length scales. Whereas turbulent stirring can play a role, say, in magma mixing processes that lead to volcanic eruptions, the compositional evolution of planetary mantles is largely due to three-dimensional (3D) unsteady laminar flow. Moreover, all such flows can involve fluids with strongly contrasting viscosities and densities. Inherent difficulties with simulating such flows numerically under appropriate conditions makes analog experiments essential to their understanding, the results of which may be incorporated into parameterized numerical models. In this talk I review some invasive and noninvasive laboratory approaches to visualizing and quantifying both the time-evolution and end result of mixing processes in complex convective flows. A particular experimental challenge is the precise resolution of 3D time-dependent overturning motions leading to mixing. Accordingly, I discuss some 2D and 3D particle image velocimetry (PIV) and particle tracking velocimetry (PTV) techniques for flow visualization that have been developed and applied to extract detailed information about the mechanics of mixing in a number of situations.

NG12B-04 1440h INVITED

The international Solid Earth Virtual Research Observatory (iSERVO) institute seed project

Peter Mora[1,2] (morap@quakes.uq.edu.au); Andrea Donnellan[3] (donnellan@jpl.nasa.gov); Geoffrey Fox[4] (gfc@indiana.edu); Marlon Pierce[4] (marpierc@indiana.edu); Mitsuhiro Matsu'ura[5] (matsuura@eps.s.u-tokyo.ac.jp); Denis McLeod[8] (mcleod@pollux.usc.edu); Xiang-chu Yin[6,7] (xcyin@public.bta.net.cn)

[1] QUAKES, Earth Systems Science Computational Centre, The University of Queensland, St Lucia, Brisbane, Qld 4072, Australia

[2] Australian COmputational Earth Systems Simulator MNRF, Earth Systems Science Computatioinal Centre, The University of Queensland, Brisbane, Qld 4072, Australia

[3] NASA/JPL, 4800 Oak Grove Drive, Pasadena, CA 91109-8099, United States

[4] Community Grid Labs, Indiana University, 501 N. Morton Street, Suite 224, Bloomington, IN 47404-3730, United States

[5] Department of Earth and Planetary Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

[6] Laboratory of Nonlinear Mechanics, Institute of Mechanics, 15 Zhong Guan Cun, Beijing 100080, China

[7] Centre for Analysis and Prediction, China Seismological Bureau, LNM, Institute of Mechanics, 15 Zhong Guan Cun, Beijing 100080, China

[8] PHE 406, Computer Science Department, University of Southern California, Los Angeles, CA 90089-0781, United States

Numerical simulation models that capture the essential physics and dynamics of the solid earth system provide a critical means to probe the earth's complex system behaviour. The APEC Cooperation for Earthquake Simulation (ACES) was established to develop simulation models for the complete physics of earthquakes and related processes, to foster collaboration between complementary national programs, and to foster development of research infrastructure. Research by ACES participants is summarised in 3 special issues of PAGEOPH (2000, 2002, and in press). Solid earth simulator programs linked via ACES include a new 5 year program to establish a national facility in Australia (Australian Computational Earth Systems Simulator MNRF), USA programs being developed by NASA JPL in collaboration with science centers, and Japan's new Centre of Excellence in predictability of the evolution and variation of the multi-scale earth system. Plans are now commencing to establish the framework for an international institute for computational earth system simulation to maximise benefits of these international efforts. The institute will make extensive use of the World Wide Web, computational Grid technologies, and multi-tiered information architectures to allow simulation models and data to be manipulated by symbolic means in a way not previously possible. A