the one that maximizes alongshore flux, in concave-seaward shoreline segments sediment flux will diverge, causing erosion. Similarly, convex regions such as the crests of perturbations on an otherwise straight shoreline will experience accretion; perturbations will grow. When waves approach from smaller angles, the sign of the relationship between shoreline curvature and shoreline change is reversed, but any deviation from a perfectly straight coastline will still result in alongshore-inhomogeneous shoreline change.

A numerical model designed to explore the long-term effects of this instability operating over a spatially extended alongshore domain has shown that as perturbations grow to finite amplitude and interact with each other, large-scale coastline structures can emerge. The character of the local and non-local interactions, and the resulting emergent structures, depends on the wave climate. The 100-km scale capes and cuspate forelands that form much of the coast of the Carolinas, USA, provides one possible natural example. Our modeling suggests that on such a shoreline, continued interactions between large-scale structures will cause continued large-scale change in coastline shape. Consequently, some coastline segments will tend to experience accentuated erosion. Communities established in these areas face discouraging future prospects. Attempts can be made to arrest the shoreline retreat on large scales-for example through large beach nourishment projects or policies that allow pervasive hard stabilization (e.g. seawall, jetties) along a coastline segment. However, even if such attempts are successful for a significant period of time, the pinning in place of some parts of an otherwise dynamic system will change the large-scale evolution of the coastline, altering the future erosion/accretion experienced at other, perhaps distant, locations.

Simple properties of alongshore sediment transport could also be relevant to alongshore-inhomogeneous shoreline change (including erosion 'hot spots') on shorter time scales and smaller spatial scales. We are comparing predictions arising from the modeling, and from analysis of alongshore transport as a function of shoreline orientation, to recent observations of shoreline change ranging across spatial scales from 100s of meters to 10s of kilometers, and time scales from days to decades (List and Farris, Coastal Sediments,1999; Tebbens et al., PNAS, 2002). Considering that many other processes and factors can also influence shoreline change, initial results show a surprising degree of correlation between observations and predictions.

NG11B-04 1100h INVITED

Ergodicity in Natural Fault Systems

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Attempts to understand the physics of earthquakes over the past decade generally have focused on applying methods and theories developed based upon phase transitions, materials science, and percolation theory to a variety of numerical simulations of extended fault networks. This recent work suggests that the fault system can be interpreted as mean-field threshold systems in metastable equilibrium (Rundle et al., 1995; Klein et al., 1997; Ferguson et al., 1999), and that these results strongly support the view that seismic activity is highly correlated across many space and time scales within large volumes of the earth's crust (Rundle et al., 2000; Tiampo et al., 2002). In these systems, the time averaged elastic energy of the system fluctuates around a constant value for some period of time and are punctuated by major events that reorder the system before it settles into another metastable energy well. One way to measure the stability of such a system is to check a quantity called the Thirumalai-Mountain (TM) energy metric (Thirumalai & Mountain, 1993; Klein et al., 1996). In particular, using this metric and other physical measures, we show that the California fault system is ergodic in space and time for the period in question, punctuated by the occurrence of large earthquakes, and that, for individual events in the system, there are correlated regions that are a subset of the larger fault network.

NG11B-05 1115h INVITED

The role of fluids in nonlinear hysteretic rocks

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In this paper we describe the role of fluids in the mechanical behaviour of non-linear elastic hysteretic materials. Experiments show that the nonlinear quasi-static and dynamic material behaviour primarily changes in the range of low saturation, where high fluid-solid interaction forces are present. Using the Priesach-Mayergoyz space (P-M space) model, we show that micro- to mesoscopic hysteretic entities, that cause the non-linear response, are activated with increasing saturation. The description introduces different macroscopic interaction pressures for the reversible and hysteretic elements and provides quantitative agreement with experiment This allows us to delineate populations of mechanical elements, where moisture induced activation is most pronounced and to correlate the observations in perspective of the material composition.

NG11B-06 1130h INVITED

Thermal–Stochastic Properties of Hysteretic Elastic System

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Recent experiments of dynamical stress–stain measurements draw attention to the presence of broad time scales in the elastic response of rocks and other systems. These experiments are complementary to some quasi–static experiments, where applying a constant force, one observes a logarithmic recovery in time. This phenomena has been termed *slow dynamics*, one of the most intriguing nonlinear phenomena of these materials.

The goal of this work is to establish a model that provides an explanation of these experimental results and to provide a means to describe the time evolution to equilibrium. In particular in this paper the effects of the temperature on these systems in terms of slow dynamics are studied numerically and analytically and the elastic response in a fluctuating thermal environment are reproduced.

A new phenomenological model termed the *DMG* (Dynamical McCall Guyer model) describes most of the nonlinear features seen in dynamical experiments, but not the slow dynamics. In the model a rock is represented as a chain of N particles (rigid units) connected by hysteretic elastic elements (bond system) that describe the mesoscopic nonlinear elastic properties. Two quantities are used used in the model, the displacement $u_i(t)$, describing the displacement for the $i - th$ particle and $\eta_i(t; u_i, u_{i+1}, u_{i-1})$ the state variable associated with $i - th$ elastic units describing the nonlinear behavior of the system. We propose a generalization of the DMG where a fluctuating thermal environment has been included in the system. The time evolution of the system has been studied to analyze how the system reaches equilibrium and to show how the slow dynamics can be described in terms of thermal properties. Numerical results agree well with experimental results.

NG11B-07 1145h INVITED

Low temperature elastic behavior of rocks

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The resonant frequencies of a material sample are directly related to the elastic constants characterizing the sample. Thus, by studying trends in resonant frequencies as a function of temperature, the elastic behavior of the sample may be inferred, and changes in the physical properties of the material may be tracked (for example, phase changes). Historically, tracking the resonant frequencies of a crystalline sample as a function of temperature is one of the most sensitive methods for identifying phase changes in the sample. We are using Resonant Ultrasound Spectroscopy (RUS) to track the resonant frequencies of rock samples at low temperatures. Our initial measurements showed unexpected behavior in a millimeter-sized sample of Berea sandstone in the temperature range from 77 K to 300 K [Ulrich and Darling, 2001], including hysteresis in the temperature dependence of the resonant frequencies, and softening rather than hardening as the temperature decreases. A second experimental apparatus has been developed to make RUS measurements on samples up to 2 cm by 3 cm by 8 cm in size, and over the temperature range 77 K 400 K. RUS measurements using the new experimental system have been made on several rock samples, as well as several standards, and will be described in this talk. In general, the rock samples exhibit anomalous elastic behavior, consistent with the initial measurements on much smaller samples. Similar elastic phenomena, with similar activation energies, are seen in these rocks in room temperature measurements of resonant frequency versus strain [Tencate and Shankland, 1996]. Thus, low temperature measurements could provide insight into the mechanisms for the nonlinear elastic behavior of rocks and other materials.

Ulrich T.J., Darling T.W., *Observation of anomalous elastic behavior in rock at low temperatures.* Geophys. Res. Let., Vol. 28, No. 11, pgs. 2293-2296, June 1, 2001.

Tencate J.A., Shankland, T.J., *Slow dynamics in the nonlinear response of Berea sandstone.* Geophys. Res. Let., Vol. 23, pgs. 3019-3022, 1996.

NG12A MCC: Hall C Monday 1330h

Visual Computing in Nonlinear Geophysical Phenomena II Posters

(joint with G, GP, OS)

Presiding: **D A Yuen,** University of Minnesota**; G Erlebacher,** Florida State University**; B J Travis,** Los Alamos National Laboratory

NG12A-1016 1330h POSTER

Visualization of P-T Paths Derived From Numerical Thermomechanical Experiments: new Insights Into Geodynamic Problems

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The pressure (P)-temperature (T)-time (t) path of a rock is a direct record of its movement within the Earth's interior. Thus P-T-t paths are powerful tools for understanding geodynamic processes, and in the last 25 years many P-T-t paths have been worked out for rocks of the crust and upper mantle. Although one-dimensional modelling of P-T-t paths during regional metamorphism (e.g., [1]) has allowed many important features of the P-T-t evolution of metamorphic rocks to be explained, and the necessary further progress can be achieved with 2D and 3D numerical approaches (e.g., [2-5]), the majority of numerical studies on geodynamic processes at present do not specifically address the details of P-T-t trajectories. Thus, the huge amount of empirical data available on the P-T-t evolution of crustal and mantle rocks is at present not adequately used to check and interactively optimize numerical models of geodynamic processes. This is especially true in those geodynamic settings where rocks must evolve contrasting P-T-t trajectories within the same rock complex (e.g., [3-4]). We suggest that there is a general major problem in visualizing the results of numerical geodynamic modelling in terms of the P-T-t evolution of the rocks involved. We have developed a user-friendly dynamic visualisation and animation technique to allow direct interactive comparison between P-T-t paths and numerical experiments of

different geodynamic situations. In addition, we have implemented a new, robust Gibbs energy minimization approach to allow petrologically oriented internally consistent thermodynamic data bases to be used as independent constraints on P-T-t trajectories (e.g., [6]). References: [1] England, PC & AB Thompson, J. Petrol., 25, 894-928, 1984; [2] Peacock, S, Tectonics, 9, 1197-1211, 1990; [3] Gerya, TV, LL Perchuk, DD van Reenen & CA Smit, J. Geodynamics, 30, 17-35, 2000; [4] Willner AP, E Sebazungu, TV Gerya, WV Maresch & A Krohe, J. Geodynamics, 33, 281-314, 2002; [5] Beaumont, C, RA Jamieson, MH Nguyen & B Lee, Nature, 414, 738-742, 2001; [6] Gerya, TV, LL Perchuk, WV Maresch, AP Willner, DD Van Reenen, & CA Smit, Eur. J. Mineralogy, 14, 687-699.

NG12A-1017 1330h POSTER

Comparison of very high Prandtl Number and Infinite Prandtl Number Plumes Using the Adjoint Equations

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We have studied the growth of plumes from a point heat source in 2-D for plumes with Prandtl numbers of 10^4 and plumes with infinite Prandtl number. We have found that plumes with Prandtl numbers as high as 10^4 are significantly different from those with infinite Prandtl number. The difference in the shape of very high, but finite and infinite Prandtl number plumes increases with Rayleigh number. The difference in behavior in the head region of the plumes are especially evident as the Rayleigh number is increased. Modelling of plume growth in thermal convection involves predicting the state of the system at time t_1 from the initial conditions at time t_0. We have used the adjoint equations and four-dimensional variational data assimilation (4D-VAR) and the adjoint equations to better constrain the development of the plumes in time. This allows us to choose more appropriate inital conditions so that the simulation so results better fit the observations. The results of these studies has shown that plumes may not approach infinite Prandtl number behavior, even at Prandtl numbers as high as 10^4. This leads to the possibility that the approximation of very high, but finite Prandtl number fluids such as magma and mushy ice as infinite Prandtl number fluids may not be as accurate as previously thought.

URL: http://www.msi.umn.edu/˜cathy

NG12A-1018 1330h POSTER

Understanding Time-varying Map Data Using Spatio-Temporal Clustering

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Analyzing high-dimensional data has been traditionally a difficult problem. The data domain can be 2D or 3D, and the data itself can be scalar, vector, or higher dimensional. Coupled with the enormously large amounts of data samples many applications now produce, effective analysis of these high-dimensional data becomes very challenging.

In many applications, the behavior of a variable over time is of prime importance. Scientists studying maps representing geo- and bio-physical variables result from Earth science models often need to compare and understand how the maps change with time. One method to display the time-varying properties of the data is to animate the map data over time. However, this is not the best option in many cases. Consider the following question: "How does the map change from one timestep to the next near the start of the animation, and how does it change near the end of the animation?" To compare the temporal change near the beginning of the animation to the temporal change near the end of the animation, it would be better if the user can see some global representations of the change in one snap-shot, rather than having to deduce the change indirectly by following a movie. Moreover, animation is good if there are a few well-defined regions in the maps that change in time. If the map contains a large number of regions that are changing simultaneously, it becomes difficult for the user to track the changes.

We present a method to visualize the temporal behavior of 2D map data. Our goal is to present the user with information which helps him/her in appreciating the temporal behavior of a given region in the 2D domain. Our algorithm has a multi-resolution nature, that is, the user can dynamically choose the visualization at various levels of detail in both spatial and temporal domains. Our algorithm consists of two main components. First, a hierarchical spatio-temporal clustering algorithm is used to divide the map into disjoint spatial regions. The purpose of clustering is to group together regions that have similar temporal behavior. Second, a theme-river technique is used in our method to display the temporal variation of any property associated with the data at different levels of detail. By visualizing the clustering results and the abstract graphs generated from the theme river technique, it becomes much easier for the scientist to understand the spatial and temporal correlations and the associated data properties in the map.

NG12A-1019 1330h POSTER

Web-Based Interrogation of Large-Scale Geophysical Data Sets and Clustering Analysis of Many Earthquake Events From Desktop and Handheld Computers

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The size of datasets in the geosciences is growing at a tremendous pace due to inexpensive memory, increasingly large storage space, fast processors and constantly improving data-collection instruments. However, the available bandwidth increases at a much slower rate and consequently cannot keep up with the size of the datasets themselves. Coupled with our need to explore the large datasets in a simplified point of view, the current approach of transferring full datasets from one machine to another in order to analyze it is fast becoming impractical and obsolete. We have previously developed a web-based interactive data interrogation system that allows users to remotely analyze geophysical data over the Internet using a client-server paradigm (Garbow et al., Electronic Geosciences, Vol. 6, 2001). To further our idea of interactive data extraction we have used this interrogative system to explore both high-resolution mantle convection data and earthquake clusters involving up to tens of thousands of earthquakes. In addition, we have ported this system to work from handheld devices via wireless connections. Our system uses a combination of Java, Python, and C for running remotely from a desktop computer, laptop, or even a handheld device, while incorporating the power and memory capacity of a large workstation server. Because of the limitations of the current generation of handheld devices in terms of processing power, screen size, memory and storage, they have not yet become practical vehicles for useful scientific work. Our aim is to successfully overcome the limitations of handheld devices to allow them in the near future to be used as portable scientific research laboratories, particularly with the new, more powerful processors (e.g. Transmeta Crusoe) just over the horizon.

URL: http://www.msi.umn.edu/∼lilli/zack-wireless.pdf

NG12A-1020 1330h POSTER

Multi-Resolution Clustering Analysis and Visualization of Around One Million Synthetic Earthquake Events

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The study of seismic patterns with synthetic data is important for analyzing the seismic hazard of faults because one can precisely control the spatial and temporal domains. Using modern clustering analysis from statistics and a recently introduced visualization software, AMIRA, we have examined the multi-resolution nature of a total assemblage involving 922,672 earthquake events in 4 numerically simulated models, which have different constitutive parameters, with 2 disparately different time intervals in a 3D spatial domain. The evolution of stress and slip on the fault plane was simulated with the 3D elastic dislocation theory for a configuration representing the central San Andreas Fault (Ben-Zion, J. Geophys. Res., 101, 5677-5706, 1996). The 4 different models represent various levels of fault zone disorder and have the following brittle properties and names: uniform properties (model U), a Parkfield type Asperity (A), fractal properties (F), and multi-size-heterogeneities (model M). We employed the MNN (mutual nearest neighbor) clustering method and developed a C-program that calculates simultaneously a number of parameters related to the location of the earthquakes and their magnitude values .Visualization was then used to look at the geometrical locations of the hypocenters and the evolution of seismic patterns. We wrote an AmiraScript that allows us to pass the parameters in an interactive format. With data sets consisting of 150 year time intervals, we have unveiled the distinctly multi-resolutional nature in the spatial-temporal pattern of small and large earthquake correlations shown previously by Eneva and Ben-Zion (J. Geophys. Res., 102, 24513-24528, 1997). In order to search for clearer possible stationary patterns and substructures within the clusters, we have also carried out the same analysis for corresponding data sets with time extending to several thousand years. The larger data sets were studied with finer and finer time intervals and multi-scaled spatial intervals, using a scripting language within the AMIRA module. The synthetic data sets pose an exciting challenge for both the visualization and cluster analysis standpoints, since the computational time lengthens considerably. We can zoom into the large data set, see directly various features in a multi-parameter domain, and develop causal relations between assumed fault properties and loading and the type and details of the response. The cluster and visualization analyses can be done repeatedly as in downscaling. Initial results show that the models self-organize to distinct clusters consisting of small, medium, and large earthquake patches, and that large earthquake cycles are associated with very enormous stress relaxation across the entire fault region.

NG12A-1021 1330h POSTER

Multiscale reconstruction of shallow marine sediments using wavelet correlation

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The subject of studying surface waves is receiving new attention because of the potential in using surface waves for prediction of physical properties of near surface marine sediments. However, processing of surface waves normally relies on algorithms, which are do not allow sufficient discrimination between surface waves modes. This work extends and recast the results of our previous studies on the wavelet cross-correlation analysis of surface waves. To perform a better resolution in the group and phase velocities inversion now we introduce multiscale cross-correlation in the spatial and time domains. We applied the wavelet transform to seismic traces 'Wa(t[ime],f[requency])' and 'Wb(t[ime],f[requency])' and then calculate the cross-correlation function in the time domain < Wa(t,f,X)*Wb(t-tau,f,X)> and additionally carry out the cross correlation of wavelet fields in horizontal direction X (distance along the interface) <WCR(tau,f,X)*WCR(tau,f,X-X')>. The moduli and phases of multiscale cross-correlation function present the group and phase velocities values at given frequencies and time delay with the spatial resolution defined as a minimum spatial lag X' (minimum distance between receivers). The advantage of using the cross-correlation in both spatial and time domains is obvious as it extracts the information of coherent strength (moduli) and phase in terms of periods (frequencies), time delay and spatial shift and allows to monitor the changes of these parameters in both time and horizontal distance. We present a comparison of using 1D and 2D multiscale cross-correlation techniques in terms of resolving the phase and group velocities of surface waves. We also show the shear velocity profile as a function of depth for the top part of the sediments along the field area. These results also were compared with existing geological data from the field area.

NG12A-1022 1330h POSTER

Investigation of Anisotropy Over the Ethiopian Plateau With Remote Sensing Data: a Scale by Scale Study of the Anisotropy With Fast Fourier Transform and 2D Structure Function

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Scale invariance investigations are now commonly used in a lot of geophysical fields, and the presence of scaling or multiscaling is often revealed over large range of scales. However, most of the time, scaling analyses are done with the assumption of self-similarity, which is inappropriate since anisotropy is a common feature in every aspect of the earth interior and surface. A previous study has shown that remote sensing images from the Ethiopian plateau exhibit scale invariance over range of scales between 35 m and 15 km. Using Fast Fourier Transform and 2D structure functions of remote sensing data (Landsat TM, ERS-1 and ASTER) over different areas (drainage and plateau) and in various bands of the electromagnetic spectrum (visible, SWIR and microwave), we investigate anisotropy scale by scale over the Ethiopian plateau. Distinct anisotropic features (topography, chemical composition, structural features) can be observed depending on the bands of the electromagnetic spectrum inspected. The scale invariance parameters observed over the Ethiopian plateau will be examined using the results of this new investigation.

NG12A-1023 1330h POSTER

Visual Computing of Global Postglacial Rebound in a Spherical Domain

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Postglacial rebound is usually presented as a bunch of static greyscale emotionless images. Yet the process is intrinsically fascinating from a dynamical standpoint because of many interactive physical elements. We present here a visual tour of the postglacial rebound processes taken from an initial value approach applied to a self-gravitating viscoelastic spherical Earth. Our formulation allows us to handle both elastic compressibility and arbitrary style of parameter stratification in the radial direction. We employed pseudospectral techniques on Chebyshev staggered grids. Resulting ordinary differential equations form a numerically stiff initial value problem. We solve it to receive explicit time-dependent Love numbers and subsequently the physical fields. We have developed an Amira data format based on a moving curvilinear mesh and tailored to animate time evolution of the displacement vector in a spherical domain, which consists of an outer half-sphere, a radial cross-section and a CMB half-sphere. Moreover, the format contains one degree of freedom, which allows to save simultaneously responses of any number of independent Earth models and to visualize interactively mutual differences in any time and a spatial point. Color scaling, zooming and changing the view direction provided by the Amira software serve as an enhancement in the inversion. As an example, we computed a set of 360 Love numbers in the PREM mantle discretized by an unevenly spaced Chebyshev grid consisting of 300 nodes. For a given ice coverage, we then combined the Love numbers into the displacement vector on the above described domain with the angular grid of 1 × 1 degree in 100 interpolated time instants. It takes 12 min of 2-GHz CPU time to prepare a resulting binary data set amounting to 300 MB per one Earth model. Even for a hundred different models, we can still visualize Amira 30-GB data sets with a speed allowing truly interactive work. Here we have concentrated on the effects of elastic compressibility, lithospheric depth and asthenospheric width. Special attention is devoted to illustrate the complexity of horizontal displacements of compressible models in the near zone of ice sheets.

NG12B MCC: Hall C Monday 1330h

Fractals, Chaos, and SOC in Natural and Human-Induced Hazards Posters

(joint with A, B, H, OS, S, V, GC)

Presiding: **S Tebbens,** University of South Florida**; S Burroughs,** University of Tampa

NG12B-1024 1330h POSTER

The Ramifications of Meddling with Systems Governed by Self-organized Critical Dynamics

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Complex natural, well as man-made, systems often exhibit characteristics similar to those seen in self-organized critical (SOC) systems. The concept of self-organized criticality brings together ideas of self-organization of nonlinear dynamical systems with the often-observed near critical behavior of many natural phenomena. These phenomena exhibit self-similarities over extended ranges of spatial and temporal scales. In those systems, scale lengths may be described by fractal geometry and time scales that lead to 1/f-like power spectra. Natural applications include modeling the motion of tectonics plates, forest fires, magnetospheric dynamics, spin glass systems, and turbulent transport. In man-made systems, applications have included traffic dynamics, power and communications networks, and financial markets among many others. Simple cellular automata models such as the running sandpile model have been very useful in reproducing the complexity and characteristics of these systems. One characteristic property of the SOC systems is that they relax through what we call events. These events can happen over all scales of the system. Examples of these events are: earthquakes in the case of plate tectonic; fires in forest evolution extinction in the co evolution of biological species; and blackouts in power transmission systems. In a time-averaged sense, these systems are subcritical (that is, they lie in an average state that should not trigger any events) and the relaxation events happen intermittently. The time spent in a subcritical state relative to the time of the events varies from one system to another. For instance, the chance of finding a forest on fire is very low with the frequency of fires being on the order of one fire every few years and with many of these fires small and inconsequential. Very large fires happen over time periods of decades or even centuries. However, because of their consequences, these large but infrequent events are the important ones to understand, control and minimize. The main thrust of this research is to understand how and when global events occur in such systems when we apply mitigation techniques and how this impacts risk assessment. As sample systems we investigate both forest fire models and electrical power transmission network models, though the results are probably applicable to a wide variety of systems. It is found, perhaps counter intuitively, that apparently sensible attempts to mitigate failures in such complex systems can have adverse effects and therefore must be approached with care.

The success of mitigation efforts in SOC systems is strongly influenced by the dynamics of the system. Unless the mitigation efforts alter the self-organization forces driving the system, the system will in general be pushed toward criticality. To alter those forces with mitigation efforts may be quite difficult because the forces are an intrinsic part of the system. Moreover, in many cases, efforts to mitigate small disruptions will increase the frequency of large disruptions. This occurs because the large and small disruptions are not independent but are strongly coupled by the dynamics. Before discussing this in the more complicated case of power systems, we will illustrate this phenomenon with a forest fire model.

NG12B-1025 1330h POSTER

A Simple Model for the Earthquake Cycle Combining Self-Organized Criticality with Critical Point Behavior

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We have studied a hybrid model combining the forest-fire model with the site-percolation model in order to better understand the earthquake cycle. We consider a square array of sites. At each time step, a "tree" is dropped on a randomly chosen site and is planted if the site is unoccupied. When a cluster of "trees" spans the site (a percolating cluster), all the trees in the cluster are removed ("burned") in a "fire." The removal of the cluster is analogous to a characteristic earthquake and planting "trees" is analogous to increasing the regional stress. The clusters are analogous to the metastable regions of a fault over which an earthquake rupture can propagate once triggered. We find that the frequency-area statistics of the metastable regions are power-law with a negative exponent of two (as in the forest-fire model). This is analogous to the Gutenberg-Richter distribution of seismicity. This "self-organized critical behavior" can be explained in terms of an inverse cascade of clusters. Individual trees move from small to larger clusters until they are destroyed. This inverse cascade of clusters is self-similar and the power-law distribution of cluster sizes has been shown to have an exponent of two. We have quantified the forecasting of the spanning fires using error diagrams. The assumption that "fires" (earthquakes) are quasi-periodic has moderate predictability. The density of trees gives an improved degree of predictability, while the size of the largest cluster of trees provides a substantial improvement in forecasting a "fire."

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Re-examination of the 1975 Kalapana, Hawai'i tsunami using a fractal source model

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The effect of source complexity on the 1975 Kalapana tsunami, triggered by a M_S=7.2 earthquake, is examined using a stochastic, self-affine model (i.e., variance changes with scale) for earthquake and landslide movements. Runup observations for the 1975 tsunami were recorded along the southern and western shores of the Island of Hawai'i with a maximum runup of 7.9 m recorded at Halape, near the center of the earthquake rupture area. The tsunami was also recorded on several tide gauges stations on the Hawaiian Islands, including the Hilo station. Previous analysis of the source processes for the tsunami (Ma et al., 1999) indicated that either the rupture area extended farther offshore than indicated by the aftershock distribution or that localized submarine slumping occurred during the earthquake. Past studies used uniform-slip dislocation models to compute initial conditions for the tsunami generated by the earthquake. To account for earthquake source complexity, a stochastic source model is used with a slip spectrum that decays as a function of k^{-2}, where k is the radial wavenumber within the rupture area. This model corresponds with the generic ω^{-2} decay in the far-field seismic displacement spectrum observed for many earthquakes. Ground displacements from localized landslides offshore are also prescribed to follow a power-law scaling relationship. The initial tsunami wavefield is calculated for