NG23A-09 1330h POSTER

Spatio-Temporal Complexity of Geospace Disturbances

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Earth's magnetosphere is a key region of geospace involving a broad range of interacting scales, a complex geometry and many physical processes with overlapping space and time scales. The observational time series data from the ground and space based observatories have been used extensively to develop data-derived models of the magnetospheric dynamics. The coherence in the magnetosphere on the global scale, obtained in terms of low dimensionality of its dynamics, and the consequent predictability of its dynamics, has been used to develop space weather tools for forecasting geomagnetic indices. The multi-scale properties, on the other hand, can not be predicted dynamically and the methods of nonlinear dynamics and statistical physics have been combined to develop comprehensive models that yield deterministic predictions of the global component of the dynamics and probabilistic predictions of its multi-scale features. The next challenge lies in the understanding of spatio-temporal complexity of the geospace disturbances. These disturbances consist of magnetic storms and magnetospheric substorms and are monitored by more than 100 ground magnetometer stations and many spacecraft in the magnetosphere. The solar wind variables, which drive these disturbances, are monitored by spacecraft such as ACE at the Lagrange point and others at different locations in geospace. The data from these ground and space-borne platforms are used to develop an integrated spatio-temporal model of geospace disturbances during storms and substorms.

NG23A-10 1330h POSTER

Pattern Scaling in Quasihexagonal Fracture

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Quasihexagonal fracture processes in nature produce such interesting geophysical phenomena as columnar jointing and ice-wedge polygons. The Giant's Causeway is an example of the former, while surface polygons on Mars may be an example of the latter. This pattern has been observed across eight orders of magnitute in scale, prompting the obvious question as to what sets the absolute scale of quasihexagonal fracture. We have sudied columnar jointing in desiccated corn starch, a lab-friendly medium which sustains joints on the mm to cm scale. Columnar joints form as fractures advance into a shrinking body, and it is known qualitatively that the joint spacing increases with decreasing rate of fracture advance. Our research quantifies this observation by correlating the drying power with the fracture scale, and by using feedback control to maintain constant fracture advance conditions. The feedback experiments also model the hydrothermal convection thought to dominate the cooling of deep basaltic columnar joints. Our results may be compared to recent theoretical models (E. A. Jagla, xxx.lanl.gov/abs/cond-mat/0311481), based on energy minimization schemes.

URL: http://www.physics.utoronto.ca/~goehring/research1.htm

NG23A-11 1330h POSTER

Kinking Nonlinear Elastic Solids, Nanoindentations and Geology

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Many materials near Earth's surface are believed to be nonlinear mesoscopic elastic (NME) solids that exhibit nonlinear elastic behavior, hysteresis and discrete memory. Currently, these solids are modeled phenomenologically (e.g. P-M space model) and the underlying physical mechanism of hysteresis remains elusive. On the other hand, it has long been established that kink bands (KBs) play an important role in the deformation of geologic materials. However, because the response of NME solids is fully reversible, the two were never linked. Herein we report on the response of mica single crystals - loaded parallel to their c axis - to a 13.5 micrometer radius spherical diamond nanoindenter. Up to loads of 5mN, corresponding to stresses of 0.5 GPa, fully reversible hysteresis loops are observed. At stresses less than 0.5 GPa, the first loops are slightly open; subsequent loops, in the same location, are fully reversible and harder than the first. Simple compression experiments on polycrystalline cylinders yielded qualitatively similar results. Our results, together with much of the literature on the mechanical properties of mica, can be explained by invoking the formation of incipient kink bands, IKB's, that give way to mobile dislocation walls that, in turn, coalesce into kink boundaries with increasing stress. The IKB's are by definition fully reversible; the dislocation walls result in plastic deformation, and the kink boundaries explain the hardening. Since the dislocations are confined to the basal planes, they cannot entangle and can thus move reversibly over relatively large distances resulting in the dissipation of substantial amounts of energy during each cycle. Examination of the craters formed provided direct evidence for kink bands and the formation of a multitude of subgrains under the indenter. Based on this work, there is little doubt that the IKBs and KBs are the hysteretic mesoscopic units invoked to explain the behavior of NME's. We further claim that regardless of their type of bonding, solids with high c/a ratios - which per force are plastically anisotropic - will deform by kinking. These kinking nonlinear elastic (KNE) solids - include layered silicates and minerals such as mica, ternary carbides and nitrides, layered oxides, graphite, high Tc oxides, BN and the active elements in NME solids. The implications of this work on geology are obvious and will be discussed.

NG23B CC: 220 C-E Tuesday 1330h

Nonlinear Phenomena in Fluid Dynamics With Implications for Climate II Posters

Presiding: **M Stastna,** University of Toronto**; F Poulin,** Scripps Institution of Oceanography

NG23B-01 1330h POSTER

Wave Disturbances Spectral Characteristics Changes due to Interaction of Solar Radiation Field and Atmospheric Gas

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The structure and dynamics of atmosphere is obtained by non-linear interaction of solar radiation and atmospheric gas. With the aim to study the character of this non-linear interaction of solar radiation and atmosphere the spectral characteristics of acoustic-gravitational wave's disturbance in a two-component medium consisting of gas and radiation are studied in this work. One of the sources of disturbances in atmosphere, including the ionosphere, is the spatial and temporal difference of flux of solar radiation in the atmosphere. By characteristics, the disturbances generated by those sources, are naturally attributed as radiating class, as the primary factor determining structures and scale of disturbances generated by them, are characterized by the transformation of the solar radiation in various forms into the atmosphere, including energy of atmospheric waves generated by them. That is why for such sources, it is important to consider both the processes of transformation and the transport of solar radiation into the atmospheric gas. For studying influence of atmospheric energy transport processes in spatial and temporal structure of disturbances generated by radiating class sources, we constructed the equation of energy taken into account the heat conductivity of gas, heat radiation and heating of gas by solar radiation. Besides the above system of the equations additional equation of transport of the solar radiation with atmospheric gas is used. The dispersion equation of atmospheric waves is obtained.The numerical calculations of obtained dispersion equation and analysis of comparison these spectra with corresponding spectra for equilibrium atmosphere were made. The heights and character wave scales where non-equilibrium effects are stronger are determined.

NG23B-02 1330h POSTER

Signs of Life Below the GCM Gridscale

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In this talk we will discuss several climate simulations performed with the NCAR CSM in our laboratory at the University of Toronto. We will focus primarily on two equilibrium climates, namely a Modern climate and a climate with the model parameters chosen in accord with what is believed to be appropriate for the Last Glacial Maximum (approx. 18,000 years ago). By focusing on the North Atlantic region we will contrast the thermohaline circulation of the two climates, and this will in turn allow us to speculate on the role of processes below the grid scale in determining the thermohaline circulation. In particular we will comment on convective processes, mixing, and sea-ice interactions. In each case we will outline what we feel are the issues that cannot, for the forseeable future, be handled by GCMs. Time permitting we will show some results from a small-scale, nonhydrostatic model. These simulations show rather poignantly that on the scale of kilometers nonlinearity can have surprising consequences.

NG23B-03 1330h POSTER

Simulating the climate system through an interglacial-glacial transition

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Physical phenomena are sometimes characterized in terms of self-organized criticality theory (e.g. phase transitions) and require passing a threshold to initiate an instability, which in turn drives the physical process. Major changes in northern hemisphere glaciation are thought to involve changes from one climate state to another by a series of concurrent feedback mechanisms that initiate the instability. In particular, the transition from a non-glaciated or interglacial state to a glaciated state may involve such a rapid transition on the millennial time scale. Most current climate simulations of past geological epochs require global modelling at relatively low resolutions and therefore neglect subgrid scale behaviour that may be instrumental in driving these feedbacks. Some examples of how sub grid scale phenomena may impact the initiation of glaciation in global climate models will be presented. In particular, the influence of spectrally decomposed topography and low resolution primitive vegetation modelling on glacial inception climate will be discussed.

NG23B-04 1330h POSTER

Greenland tip jets and implications for climate

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Greenland lies in close proximity to the northern branch of the North Atlantic storm track, and as such can be a point of strong orographic interaction with atmospheric flow. The major climatological consequence of this is the location of the Icelandic Low in the lee of Greenland. However, the tip of Greenland is also frequently the source of high wind speed events called tip jets. These events can occur in a situation of westerly synoptic flow in the normal case, or they can be observed in easterly synoptic flow situations that produce a reverse tip jet event. The tip jet generally has a zonal extent of about 1000 km, but has a meridional extent of 100–200 km. The air-sea interaction associated with tip jet event has been proposed to be of importance to the thermohaline circulation because of the potential for deep ocean convection connected with the high wind speeds that characterize the tip jet. Because of their mesoscale nature, tip jets are not well resolved, or even at all resolved by most GCMs. In

addition, the surface heat fluxes associated with these events are not well estimated by boundary layer parameterizations that are more suited to air-sea interactions at mid-latitudes. Consequently, it is very important to simulate these events with a fairly high-resolution mesoscale model in order to better understand the processes associated with the Greenland tip jet. In this presentation, we will show model output of some tip jet events, as well as discuss some climatological aspect of the tip jet. In addition, model output will be compared to available observations in order to validate the model results and constrain the heat flux and wind stress associated with the events.

NG23B-05 1330h POSTER

The Impact of the Sea-ice Zone on the Atmospheric Boundary Layer Development

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High latitude air-sea-ice interactions are important components of the earth's climate system. The exchanges of mass and energy over the sea ice zone are very complicated processes that are not well understood. In this paper, a series of sensitivity experiments are undertaken to examine the effect of sea ice concentration and extent on the development of atmospheric boundary layer both over and downstream of the sea ice zone. The experiments are performed with a cloud-resolving model run at a very high resolution in a large domain so that we are able to resolve the individual convective roll clouds as well as their downstream development. The current work reveals some interesting characteristics that have not been addressed in the previous work as a result of limitations arising from coarse resolution and/or limited domain size. In particular, our results show the spatial variations in sea-ice concentration can result in a different exchange process over the sea ice zone and the downstream ocean, which lead to different boundary layer development schemes. We find that the exchange of momentum, moisture and heat fluxes are different due to the spatial variations in sea-ice concentration, which suggest a more realistic representation of the process over sea ice are necessary in climate models.

NG23B-06 1330h POSTER

A Simple Model for the Skewness of Global Sea-Surface Winds

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A strong linear relationship between the mean and skewness of global sea-surface winds (both zonal and meridional) is shown to exist, such that where the wind component is on average positive, it is negatively skewed (and vice versa). This relationship is observed in reanalysis, satellite, and buoy data. The relationship between the mean and skewness fields of sea-surface winds will be shown to follow from the nonlinear surface drag predicted for a turbulent boundary layer by Monin-Obukhov similarity theory, as forcing perturbations speeding the wind up are subject to a stronger drag force than perturbations slowing it down.

Reference Style for Abstracts

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Pfister, R. G., and M. S. Nestler (2004), Sharing community data, services and tools using the EOS clearinghouse (ECHO), *Eos Trans. AGU, 85*(17), Joint Assembly Suppl., Abstract OS41B-06.

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