Access Protocol (OPeNDAP) has approached the problem by focusing on the syntax of the data rather than on their semantics. In particular, the OPeNDAP data access protocol consists of a rigid prescription for the syntax of the data and a mechanism for the communication of the data semantics, but no constraint on semantic content. In this way, the protocol becomes a base on which discipline data systems may be layered - the developers of a discipline data system may specify the form in which the semantic information is to be communicated while using syntactic machinery that is common to other discipline data systems. The advantage is two-fold. First, discipline data systems are interoperable at the syntactic level and, often with little additional effort can be made interoperable at the semantic level. Second, a larger group participates in developing the underlying protocol than would if it were useful by only one discipline. A by-product of this approach is that it is also much easier to make ones data accessible via the system than if rigid constraints were placed on semantic content. The result has been the adoption of the protocol for use in oceanographic, meteorological, and solar/terrestrial data systems with OPeNDAP servers now at over 50 institutions worldwide.

URL: http://opendap.org

U21B-06 1140h INVITED

Data Management in Planetary Exploration and Space Physics

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Planetary exploration and space physics approach data management in very different ways. In this talk we will compare the approaches in these two disciplines with emphasis on how each has dealt with the problems of locating and accessing distributed data. We also will outline the data management challenges each will face in the next decade. Sixteen years ago the NASA Solar System Exploration Division founded the Planetary Data System (PDS) to coordinate the data activities of planetary missions, provide the scientific community with access to planetary data and preserve the data from planetary missions for future analysis. PDS is organized into "nodes" by scientific sub-disciplines (Atmospheres, Geoscience, Plasma Interactions, Rings and Small Bodies) and experimental technique (Imaging and Radio Science). In addition the Navigation and Ancillary Information Facility (NAIF) addresses data issues involving navigation and instrument pointing. All planetary data from NASA missions are prepared to the same metadata standards that include a common data dictionary. Initially access to the data was by sub-discipline although within a sub-discipline the access was to all missions and instrument types. More recently planetary science has become more interdisciplinary and now PDS is moving toward a system that supports cross discipline access. Data are available either on online or on hard media (CDROM or DVD). In recent years space physics data access has been organized by missions. Some missions support data systems through which all of the data from the mission can be accessed while for others the data are available from individual principal investigator sites. In general the space physics missions support an open data policy and much of the data is available online. There are no discipline wide metadata standards. Different missions support different data dictionaries, schemas and interfaces. The data come in a variety of formats. In the near future both planetary science and space physics will be challenged with massive volumes of data from new missions (approximately 10^{15} bytes). In both disciplines the need for comparative research across missions or sub-disciplines is becoming more common. Both will have to support data structures that allow users to readily locate, access, and use data from distributed and diverse sources. Both disciplines must address the issue of how to distribute these massive data sets to the science community. Distributable media (DVD) are too expensive due to their limited storage capacity and the network bandwidth is unlikely to be able to support online distribution.

U21B-07 1200h INVITED

A Virtual Geophysical Network: Using Industry Standard Technology to Link Geographically Distributed Sensors and Data Centers

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The IRIS Data Management System has long supported distributed data centers as a method of providing scientific researchers access to data from seismological networks around the world. For nearly a decade, the NetDC system used email as the method through which users could access data centers located around the globe in a seamless fashion. More recently the IRIS DMC has partnered with the University of South Carolina to develop a new method through which a virtual data center can be created. The Common Object Request Broker Architecture (CORBA) technology is an industry standard distributed computing architecture. Traditionally used by major corporations, IRIS has developed a Data Handling Interface (DHI) system that is capable of connecting services at participating data centers (servers) to applications running on end-users computing platforms (clients). For seismology we have identified three services. 1) A network service that provides information about geophysical observatories around the world such as where the sensors exist, what types of information are recorded on the sensors, and calibration information that allows proper use of the data, 2) an event service that allows applications to access information about earthquakes and seismological events and 3) waveform services that allow users to gain access to seismograms or time series data from other geophysical sensors. Seismological Data Centers operate the servers thereby allowing a variety of client applications to directly access the information at these data centers. Currently IRIS, the U. of South Carolina, UC Berkeley, and a European Data Center (ORFEUS) have been involved in the DHI project. This talk will highlight some of the DHI enabled clients that allow geophysical information to be directly transferred to the clients. Since the data center servers appear with the same interface specification (Interface Definition Language) a client that can talk to one DHI server can talk to any DHI enabled server. This ability allows one to construct a virtual network of data centers giving one the illusion of a single virtual observatory. Some of the features that will be discussed include direct connections to MatLab and the ability to access globally distributed sensor data in real time.

URL: http://www.iris.washington.edu/DHI

U22A MCC: Level 1 Tuesday 1330h

Virtual Observatories in Space and Earth Sciences III Posters

Presiding: **L Paxton,** Applied Physics Laboratory, Johns Hopkins University; **M B Weiss,** Applied Physics Laboratory, Johns Hopkins University

U22A-0001 1330h POSTER

The SuperDARN Data System: An established, Internet Based, Data Access Tool for Ionospheric Physics

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The Super Dual Auroral Radar Network (SuperDARN) is an international network of High Frequency Radars that operate in the Northern and Southern Polar regions in the study of Ionospheric Plasma Convection. Through the SuperDARN web-site hosted at APL (http://superdarn.jhuapl.edu), the network has developed a set of sophisticated, Internet based, data access and analysis tools. The network has also successfully developed real-time data streaming from the Northern Hemisphere radar chain and acts as a space-weather monitor for Ionospheric Convection. Recent work has involved incorporating measurements from a variety of other instruments into the system. The techniques developed for the SuperDARN project can easily be extended to the wider Space Physics Community.

URL: http://superdarn.jhuapl.edu

U22A-0002 1330h POSTER

The Mission Independent Data Layer MIDL Approach to Space Physics Data Interoperability

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We report progress in the development of the Mission Independent Data Layer MIDL, a mechanism for accessing multi-mission magnetospheric and heliospheric datasets. The desire of the space physics community and the LWS program to do Sun-to-Earth integrated science has initiated renewed interest in more capable data systems which can provide simplified access to multiple datasets which are in different formats and from different missions. The first step towards integrated data access is the discovery of data from different datasets, and this aspect of a possible space physics virtual observatory is being addressed by several other projects. The second step in data interoperability is the merging of actual data as discovered by a search engine, and because MIDL provides this capability, it complements other search engine mechanisms. Currently, the MIDL web site (http://sd-www.jhuapl.edu/MIDL) provides visual browsing and direct access to energetic particle data, magnetic field data, and plasma data for 6 missions: ISEE-1, ISEE-2, AMPTE-CCE, Geotail-EPIC, IMP-8, and Cassini. MIDL uses the concept of a data interface to achieve interoperability among datasets with different formats. Details on implementing a data interface for different missions will be discussed, as will the relationship of MIDL to other virtual observatory efforts in space physics.

URL: http://sd-www.jhuapl.edu/MIDL

U22A-0003 1330h POSTER

A Data Grid Framework for Sharing Data Across Distributed Heterogeneous Repositories

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As the volume and diversity of science data sets continues to expand, the ability to share and correlate data across distributed heterogeneous repositories remains a serious challenge. An architectural data grid framework has been developed by the Object Oriented Data Technology (OODT) project to address this challenge and has been successfully deployed in several diverse scientific domains. Characterized by separate technology and data architectures, this framework was used by NASA's Planetary Data System (PDS) to develop the PDS-D distribution infrastructure to provide timely delivery of 2001 Mars Odyssey data to the science community as soon as the data were released from the Odyssey project. PDS-D is now being extended to address the huge data volume increases expected for the Mars Reconnaissance Orbiter (MRO). Based on the success of PDS-D, the Space Physics Archive Search and Extract (SPASE) effort is considering the framework to support a data search and retrieval system for the Space Physics science community. Further demonstrating its flexibility, the framework is also currently being used by the National Cancer Institute's Early Detection Research Network to establish a virtual specimen database by connecting together data from multiple cancer research centers across the country. This paper will highlight achievements and lessons learned from several of the deployments, identify new scientific, technical, and programmatic challenges, and describe how the OODT architectural framework is evolving to meet those challenges.

U22A-0004 1330h POSTER

Space Physics Metadata Searching Using Space Physics Data Markup Language (SPDML)

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The Space Physics Data Markup Language (SPDML) defines an eXtensible Markup Language (XML) for expressing Space Physics Metadata. The purpose is to develop an extensible standard for next generation multi-mission catalog searching capabilities such as those proposed for use in Virtual Observatories. SPDML provides a standard method for expressing Space Physics metadata and is being utilized in a prototype system that provides a standard method of data querying enabling multi-instrument comparison to TIMED data and tracing the Sun-Earth connection. SPDML is using a data dictionary that is compatible with the developing Space Physics Archive Search and Extract (SPASE) data dictionary. A testbed is being developed using data from the NASA TIMED spacecraft and ground-based SuperDARN radars to demonstrate the multi-mission search capabilities (http://sd-www.jhuapl.edu/SPDML). Examples from this testbed will be presented.

URL: http://sd-www.jhuapl.edu/SPDML

U22A-0005 1330h POSTER

Metadata and Services Clearinghouse Support for the Virtual Observatory

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Astronomy in the next twenty years will be powered by diverse new observing capabilities. Huge gains in instrument sensitivity covering a broad range of wavelengths for ground and space-based observatories promise abundant data for making unique discoveries, finding solutions to fundamental astrophysical problems, and expanding the frontiers of astrophysical knowledge. These anticipated advances in astronomy will also depend largely on new capabilities for archiving, accessing, analyzing, and using observational data. New concepts are also required for registering and making large volumes of distributed data easily available to a world community of astronomers. The concept of the virtual observatory (VO) anticipates an era of integrated data, information, and services managed in a distributed but cooperative infrastructure. Joining observatory data archives and catalogs into one uniform logical (i.e. virtual) entity with a rich variety of services for discovery, access, and analysis promises to revolutionize astronomy. A virtual astronomy archive, containing observational data gathered in the past, present and into the future, affords a new basis for the science community to "observe" the "sky" through shared digital data and information from desk top computers. New kinds of discoveries and studies become possible because collective observations that include objects cataloged in the entire sky can be indexed across spectrum, time, resolution, and space for instance. In this concept the archive becomes the sky that the community of astronomers accesses through new interface services. We explore the role of a metadata clearinghouse and order broker service in achieving the goals of a VO. We discuss various functional capabilities and operations of a clearinghouse based on extensive experience developing NASA's EOS Clearinghouse (ECHO). Reusable software components of ECHO can readily be applied to VO development. After presenting an examination of key requirements for developing a VO we identify which elements and capabilities of ECHO best support the VO vision.

U22A-0006 1330h POSTER

Metadata Standards for Atmospheric Science Virtual Observatories Based on Experiences with the Madrigal/Cedar Databases

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The concept of Virtual Observatories as distributed islands of measured data, accessed so that they appear to the user as a single instrument, is a compelling one for Atmospheric Science. Given the coupled nature of the various regions of the solar system, the ability to query data in a simple way from numerous instruments to study a single event would greatly enhance our understanding of these couplings. One key tool in such a Virtual Observatory is a well-defined metadata standard, which defines as precisely and succinctly as possible what data is available. Our experience with the Madrigal and Cedar databases, which also depend on a metadata standard, has taught us a number of important lessons. These include the need for well-defined measured parameters, and a method for easily adding new parameters. Since a number of different frames of reference are used for different regions of the solar system, well-defined standards for position and time are also required. Standards are also needed for describing regions of space, since the metadata cannot contain too much detail about the exact position of the measurements. These and other lessons learned from our database experience will be discussed.

U22A-0007 1330h POSTER

SPASE - The Space Physics Archive Search and Extract - Status and Plans

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The Space Physics Archive Search and Exctract (SPASE) is a collaborative development effort among multi-institution, international, space physics data holding organizations intended to allow science users to find space physics data of interest, intercompare the data, and retrieve selected data sets or portions of data sets. The search would be done across multiple data centers through a single search initiated through a network accessible interface. The effort involves creation of a common space physics data dictionary and development of an intermediate level of software that will translate queries into the search mechanisms specific to each of the data centers. The results of the search are then put in a common format to present to the user. Thus, there is no need to change the software and search procedures used at the individual institutions. Data set intercomparisons will enable determination of which data sets or portions of data sets are useful for the purposes of the scientist/user and need to be requested from the data provider. The present status of the efforts and plans for the future will be discussed. We welcome discussion of the needs of the community and how to assure fulfillment of those needs.

U22A-0008 1330h POSTER

Using Rulesets to Build and Manage Data

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The construction and maintenance of a data system involves a coordinated effort by data producers, data engineers and archive managers. An effective data system has rich metadata content which is used to document, track and locate data within the archive. Much of the metadata is derived from the actual data, such as the range of values, structure of the data, and the position and pointing direction of the instrument. Other metadata is common across large collections of data, such as the project under which the data were collected, version and release information, the properties of the instrument, and how the data were processed. Active archives are built incrementally and often over a considerable length of time. Occasionally archives must be migrated to new environments. This can be a daunting task and automation makes it viable. In both situations maintaining consistency is the most important factor. Our group has been involved with NASA's Planetary Data System continuously since its inception in 1985. This long-term experience guided the development of a formal ruleset language to create a standardized method to build new archive components and to maintain our existing archive. A ruleset is an ordered list of rules. Each rule provides a concise description of how to acquire, process and store desired information. The ruleset language we have developed has two components. First there are variables which serve as storage points for information. Second there are directives which detail how to set variables, flow control, branching, inclusion of other rulesets, and output. The ruleset language and the companion ruleset processor support the extraction of information from external sources. This is accomplished through external applications that adhere to a standardized convention: information is passed to the application through the command line and the application outputs any results or messages to the standard output channel (display) formatted in the ruleset language. The output ruleset is then processed "in-place". When an application adheres to this convention it is called a plug-in. The ubiquitous support of the convention allows a plug-in to be written in any programming or script language and makes it easy to test. A growing set of plug-ins already exists to perform many common tasks. This set includes time format conversion, string manipulation, text formatting, table lookup and simple math.

U22A-0009 1330h POSTER

Antelope: A Software Infrastructure for the Support of Virtual Observatories

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A clear requirement for the realization of virtual observatories across the broad scientific community is a software infrastructure, sometimes referred to as middleware, that will support the many-to-many information connections necessary for effective virtual observatory operations. There are increasing demands for virtual observatories that can deal with real-time and archive data, that can handle raw observations from a variety of sensors, processed results and metadata seamlessly, that can cross disciplinary boundaries, that can support custom user software/web development, that can be operated in a wide range of institutional settings and that uses scalable software which can be operated using a wide range of computer hardware, from small PDA class machines to massively parallel mega-machines. Antelope is a software infrastructure for support of virtual observatories that is in use throughout the world today. In our presentation we show the history of the development of Antelope and the basic requirements that were used in its development. We cover issues that are paramount for virtual observatories; interoperability, ease of development and extensions of functionality, robustness, reliability, ease of operations and scalability across a variety of hardware and mission settings. We briefly summarize the current uses and users of Antelope. We finish by discussing the technical and scientific challenges that we face today and how we imagine these will be addressed in the future.

U22A-0010 1330h POSTER

Virtual Observatories: A Peer-to-Peer Semantic Approach for Efficient Sharing of Scientific Data

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A recent initative on the *electronic Geophysical Year (eGY)* calls for the establishment of a series of *virtual geophysical observatories* now being "deployed" in cyberspace. The *eGY* concept creates the means for a free and transparent data access to remote, worldwide distributed databases through the Internet and World Wide Web. However, current forms of sharing scientific data are either highly centralized or require intensive personal communication. Centralized distribution schemes need continuing maintenance and support that somewhat counteracts the rationale of a free access to such data repositories. Here we argue for the development of a *peer-to-peer* semantic approach focused towards efficient sharing of scientific data via the Internet. Our proposed data distribution model aims to simplify the process of data acquisition and storage by tapping the vast potential of end user machines. At the same time, the data integrity and publisher accountability should be an integral design goal of any platform that aims

to provide distributed, yet reliable, means of sharing such high-implication data amongst a rapidly increasing and widespread scientific community. Current design philosophies of the file-sharing networks model the data files as "once injected, never modified" objects, which are shared through a set of pre-specified interfaces. On the contrary, scientific data sets are often multidimensional and the same object can be published through multiple dynamically changing interfaces. Furthermore, from time to time the user-specific analyses of these data often generate additional summaries and even new datasets. Publishing these derived datasets may introduce more complexity and challenges, but the appropriate authentication and signing of the "original" and "modified" datasets can resolve the problem. We explore the possibility of the semantic-oriented information modeling of the scientific data objects for enhancing real-time, machine-to-machine search capabilities of the proposed scheme.

URL: http://maggy.engin.umich.edu/mist/vgmo.html

U22A-0011 1330h POSTER

Virtual Solar Observatory Distributed Query Construction

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Through a prototype implementation (Tian *et al.*, this meeting) the VSO has already demonstrated the capability of unifying geographically distributed data sources following the Web Services paradigm and utilizing mechanisms such as the Simple Object Access Protocol (SOAP). So far, four participating sites (Stanford, Montana State University, National Solar Observatory and the Solar Data Analysis Center) permit Web-accessible, time-based searches that allow browse access to a number of diverse data sets. Our latest work includes the extension of the simple, time-based queries to include numerous other searchable observation parameters. For VSO users, this extended functionality enables more refined searches. For the VSO, it is a proof of concept that more complex, distributed queries can be effectively constructed and that results from heterogeneous, remote sources can be synthesized and presented to users as a single, virtual data product.

URL: http://virtualsolar.org/docs/AGU200312/query_construction.html

U22A-0012 1330h POSTER

The Virtual Solar Observatory – the Why, What, How and Where

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Observational solar physics almost always involves the comparison of several data sets obtained by different instruments and stored in a variety of archives. Currently a researcher must laboriously locate the relevant archives, search them with idiosyncratic interfaces, and retrieve the data by a number of methods. The VSO is a tool to streamline this process by providing a single unified interface and search tool for solar archives. Eventually this will be supplemented by distributed computing tools which will enable queries based on data itself, in addition to standard queries on metadata. The VSO will enable a new class of solar research – large-scale correlative statistical studies on many data sets, thereby facilitating space weather studies. An example of a use case is a helioseismic study of the subsurface structure of cornal hole boundaries and possible predictive links between the solar interior and the solar wind. An intital prototype has been built linking archives at GSFC, Stanford, MSU, and NSO. This prototype has been constructed using a combination of XML, SOAP, and Perl technologies, and a beta release is available now. The initial set of archives will soon be expanded to include archives at HAO, NGDC, and selected NOAA feature and event catalogues. In the next 2 years, additonal service providers will be added, the user interface will be fully developed, and distributed computing tools will be initiated.

URL: http://umbra.nascom.nasa.gov/vso/

U22A-0013 1330h POSTER

A Virtual Observatory for the Ionosphere, Thermosphere and Mesosphere Community

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The ionosphere, thermosphere and mesosphere (ITM) community studies an area of the atmosphere that is a transition region between the atmosphere and space, where many important physical and chemical processes change dramatically temporally and spatially. The ITM region is where energetic solar radiation is absorbed, energy input from the aurora maximizes, intense electrical currents flow and upward propagating waves and tides break. As a result, the areas of studies within the ITM community span a wide spectrum of scientific subjects in geophysics and space physics. The relevant data for the community collected during the past few decades consequently come from a variety of sources including ground and space-based instruments as well as from modeling and data assimilation. As the different sub-fields mature, a system-oriented approach to understand the ITM as a whole and its relationship to the sun and the surrounding geospace environment is critical. This approach requires efficient access to all data sets (present and historical) relevant to disciplines across agencies, including NASA, NSF, NOAA and others. One of the data systems to be considered is a NASA Sun-Earth Connections Virtual Observatory - the prototype Virtual Solar Observatory. There clearly is a need for a data system to not only serve the ITM community but also to integrate cross-discipline studies with other programs such as CEDAR and GEM. A preliminary VIO concept is presented based on a set of principles: centralized browse and query/retrieval of distributed resources, access to data reader software and other tools, and integration of current data with data from previous missions and long-term data sets. Drawing upon the design of the Virtual Solar Observatory (VSO), the VIO concept is expanded to meet the needs particular to the ITM community. It is developed as an introduction to the community for discussion and community-wide input as part of a VIO definition phase. The VSO design is summarized, and the preliminary VIO design is described with its unique characteristics.

U22A-0014 1330h POSTER

Building a Virtual Space Physics Observatory for Easy Access to and Novel Visualization of Distributed Data

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Progress in space physics has become strongly dependent on the simultaneous analysis of data from multiple spacecraft, each with many instruments. Historically, these data have been stored by different investigators in a variety of formats and with widely varying metadata describing the datasets. We are working on many fronts to integrate this "data universe" such that a researcher will ultimately be able to obtain data using a uniform terminology through a variety of interfaces, obtaining either specifically formatted files or a direct stream into an application. Our main accomplishments to date include a general data dictionary (working with the SPASE group), a well-developed front-end visualization tool, and the beginnings of a simpler interface and "middleware" to access the data directly from various repositories. We are working with as many other groups as we can to assure that the resulting system is made useful through the incorporation and coordination of many applications and ideas. This talk will give an overview of our status and plans.

U22A-0015 1330h POSTER

A Prototype for a Virtual Solar-Terrestrial Observatory

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The VSTO is proposed to be a scalable environment for searching, integrating, and analyzing databases distributed over the Internet. The VSTO would comprise a system of data, model, tool and material archives containing items from space- and ground-based instruments, individual and community modeling efforts, taken from NCAR, US universities and international sources, and from NSF- and NASA-funded groups. A key element of the VSTO is an integrated data-mining and analysis capability that can be applied both across and within databases. The capabilities of a VSTO are intended to be available to a wider community of scientists, educators, and the public and thus is intended to be a natural conduit for education and public outreach in solar solar-terrestrial and space physics. This presentation will outline the key functionality, proposed architecture and technologies that will be used in assembling the VSTO. We will also present past experience in building elements of data and collaborations system and the lessons learned.

U22A-0016 1330h POSTER

Towards a Virtual Heliospheric Observatory: A Prototype Example of Distributed Data Sharing

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In the current space science paradigm it is likely that various data sets will be available from different data providers (often located in different countries), hence, necessitating the development of methods and standards that would allow for effortless search and retrieval of this vast distributed data. Constraining funding levels and varying agency requirements mandate that any methods and services must ingest different data formats and standards. Such a system has been developed using IMP8 and WIND magnetometer data sets and we aim to discuss its design, use, and expansion to incorporate all L1 spacecrafts.

U22A-0017 1330h POSTER

SECAA Web Services for Space Physics Research

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The distributed components of a space physics virtual observatory work together via standard interfaces and metadata agreements to form a system that appears as a single super-instrument providing geophysical measurements and models across time and space, enabling researchers to easily and seamlessly analyze data from many more sources than possible before. The lower level components of this observatory are a set of interoperable services that can be strung together in many combinations, forming an integrated system that is much greater than the sum of its parts. We are providing a critical set of these lower level components, leveraging our data format translators and upcoming Data Format Translation webservice, and leveraging our existing and very popular science and orbit data web-based services, Coordinated Data Analysis Web [CDAWeb] and Satellite Situation Center Web [SSCweb], by adding web services for orbit location, data finding across FTP sites and in CDAWeb, data file format translation, and display. Unlike with previous custom or proprietary protocols, these easily extendable services are open to other systems and external applications by using standard distributed Application Program Interfaces (APIs) based on XML and Simple Object Access Protocol [SOAP] standards and a simple HTTP calling interface. These services tie together existing data holdings, standardize and simplify their use, and enable much enhanced interoperability and data analysis. We have developed an orbit display client, TIPSOD (Tool for Interactive Plotting, Sonification and 3-D Orbit Display), based on Java3D as an example of using these web services. CDAWeb, SSCWeb, CDF tools, and web services are a joint effort of the Sun-Earth Connections (SEC) Active Archive (SECAA) in the NASA GSFC Space Physics Data Facility (SPDF) and the National Space Science Data Center (NSSDC).

URL: http://spdf.gsfc.nasa.gov

U22A-0018 1330h POSTER

The Living With a Star Scientific Resource Access System: A Concept for Getting the Information to Do Science

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Answering complex science questions often means that a scientist must find and use a variety of scientific resources. These resources can include static data in various formats, complex data assimilation models, and conversion and analysis tools. Although the wide acceptance of the Internet has led to an explosion of accessible scientific resources, it has also created a Babel of incompatible formats, data descriptions, and access methods. At the Johns Hopkins University Applied Physics Laboratory, we have devised a concept that uses metadata and commonly understood scientific concepts to provide easier discovery and access to these necessarily heterogeneous resources for "doing science". This concept simplifies the integration of resources in a single system, and enables the interconnection of complex data systems including virtual observatories. Frequently, adding resources to data systems requires the development of specialized software to identify and supply data. Our goal is to eliminate the need to create this specialized software and instead utilize existing protocols, formats, and metadata. We will present the status of our efforts to demonstrate this concept.

U22A-0019 1330h POSTER

SPASE prototype : an example application for the interoperability in Space Physics

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With the development of numerous independent data access systems across the world, a new need has recently appeared: the ability to query several systems simultaneously. This is interoperability, the ability to access multiple sites as if they were part of the local site. An international consortium, Space Physics Archive Search and Extract, is studying issues regarding interoperability for Space Physics. A prototype query system was developed two years ago, using XML technology. The concept is to implement interoperability between "participating data centers", via a unified interface. The use scenario then is: - The user defines a query. - The user's center contacts all other participating data centers, using a URL (and dictionaries to convert keywords). - Participating data centers each query their services(s) and generate a reply in XML in conformity with a given "results" DTD (Document Type Definition). - The user's center then parses all responses and produces a homogeneous presentation of the results. The present prototype implements basic, but important, search criteria: (1) Spacecraft, Instrument keywords; and, (2) Start/stop date and time. The result is a list of compliant data sets with a name, description (in HTML, with links to further information), and a URL to request each data set (or, at least, the data center relevant home page). This prototype uses a very simple protocol based on http and XML. It manages for each participating center a "resource description" which describes the services available (data set query, data granules query, ...), how (Protocol, Format, Parameter), and the format of the response. All descriptions are written in XML and are shared using http. The prototype will be presented with its probable evolution: the use of Web Services.

U22A-0020 1330h POSTER

The 40-year OMNI 2 Data Set: Challenges in Building Virtual Multi-source Data Products

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"Virtual observatories" aspire to enable the finding, retrieval and possibly display of data from distributed sites. To our awareness, none (at least in space physics) yet strives to support the on-the-fly creation of multi-source data products where the data have been cleaned and normalized to a fiducial data set. We address some challenges of such an activity by describing the building of the OMNI 2 data set using data gathered at NSSDC from multiple sites. OMNI 2 is a 40-year, hourly resolution, multi-spacecraft compilation of near-Earth solar wind magnetic field and plasma data, energetic proton fluxes, geomagnetic activity indices and sunspot numbers. The primary sources for recent years are the IMP 8, Wind and ACE spacecraft. Data cleaning procedures are described, especially for IMP 8 using a recently created database of IMP 8 bow shock crossings. A new approach to the time-shifting of high-resolution ISEE 3, Wind and ACE data is discussed. Extensive comparisons between pairs and triads of data from concurrently operating missions are described, with an emphasis on IMP 8, Wind and ACE. Normalizations of 1971-2003 plasma densities and temperatures to those from Wind/SWE are discussed. OMNI 2 may be considered a multi-decadal data set from a "virtual spacecraft" located in front of the Earth's magnetosphere. The OMNI 2 data set is accessible from the reference below, which also links to detailed OMNI 2 documentation and to the hourly and higher resolution data contributing to OMNI 2.

URL: http://nssdc.gsfc.nasa.gov/omniweb

U22A-0021 1330h POSTER

Common Requirements For Data Center Data Providers: Lessons Learned From the NEAR Science Data Center

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There are common requirements for data centers serving as data providers, which greatly influence the capabilities of a virtual observatory. The NEAR Science Data Center (SDC) provided all of the common data distribution and archive services for the science teams and Mission Operations and subsystem engineering teams for the Near Earth Asteroid Rendezvous mission. Lessons learned in determining and meeting these requirements will be presented. The SDC was able to meet the NEAR mission's requirements to minimize costs while maintaining high quality, by combining the software development and operational costs for providing these services. The SDC provided core services for telemetry data handling at launch and then extended these services during the cruise to Eros, to include science, engineering and supporting data products, from all spacecraft data sets. Mission Operations will be described from SDC user's view. These include the major products and services provided to the Science teams, Mission Operations Center, engineering teams and pubic network data users through the course of the mission.

U22A-0022 1330h POSTER

Preservation of Digital Data From High Volume Data Repositories

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Preservation, archive, and distribution of data products are essential requirements within the functions of the Planetary Data System (PDS) as well as any other data archive organization. Traditionally within the PDS, data products are and have primarily been distributed via physical portable media such as Compact Disc (CD) or Digital Versatile Disc (DVD). However, due to increasing data volumes, data products are also now housed on local hard drive disks or disk farms and distributed through on-line Internet services. Developing and future technologies will impact current and future requirements for data distribution. Although on-line data distribution services are expected to be the primary method for product distribution to the science community, interim and long-term hard-media archives will be desired for most if not all distributed datasets. In developing long-term hard-media archives for future Earth and Space Science missions, several issues must be addressed. Increased data returns result in very large datasets; for these data sets, current physical recording media are impractical, as storage requirements greatly exceed current recording capacities. Hardware, software, computer platform, media, and end-user considerations impact the design and format of data products intended for wide distribution; the technical and evolving nature of these and related factors require utilization of the latest and appropriate technologies in order to meet archive and distribution requirements in serving all data users. The ability to access data products across multiple computer platforms and varying operating systems is essential, true for both on-line and hard-media distribution. Issues remain for current and near-term datasets intended for hard media archive. Continued evaluation of factors such as industry and file system formats, media quality and longevity, recording hardware and software, and media storage requirements is essential. The PDS, in a collaborative effort with other government agencies and industry, has begun to research many of the evolving archive / distribution technologies and standards in an attempt to address many of the factors mentioned above and provide a viable solution to the development of a long-term hard-media archive for future Earth and Space Science missions.

U22A-0023 1330h POSTER

The MapApp Virtual Seabed Explorer

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MapApp is a downloadable, open source, prototype client application running in a desktop personal computing environment with the capability to explore two hundred million years of global ocean floor geology and geochemistry. It accomplishes the exploration and discovery in an integrated data environment of bathymetry, gravity, magnetic anomalies, reflection profiles, crustal ages, sediment composition, bedrock petrology and chemistry. Exploration is undertaken in a single visual interface with spawned windowpanes that communicate with each other. These panes provide the viewport for charting subsea landscapes, the spreadsheet for examination and manipulation of data discovered either by direct encounter or by query, the notebook for recording and downloading either original data or derived products, and dialog boxes to set parameters for models. All data are real measurements and their metadata reside in relational databases. The data come from decades of marine geological and geophysical surveys, coring, dredging, deep-sea drilling, and submersible dives. The lessons learned include the importance of rigorous data management, the need for quality-control of data accuracy, the discipline to keep the interface simple and intuitive, and the requirement to be functional over large scales of variable spatial and temporal resolution. A technical challenge is the programming difficulties presented by continuously changing versions of the PC client operating systems. The greatest scientific challenge is cost-effective mining of published textural data and convincing competitive researchers to contribute their data that is often already many years old. To retain and expand the user community of students, educators and researchers, we are discovering that it is equally as important to grow content as to add functionality.

URL: http://ocean-ridge.ldeo.columbia.edu/MapApp/MapAppJava.html

U22A-0024 1330h POSTER

UCLA Ground Magnetometer Data Server

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The UCLA Ground Magnetometer Data Server is an online server that provides an interactive environment for scientists to freely access geomagnetic field data collected in the United States, China, and other parts of the world. All data are 1-sec samples of the geomagnetic field, and therefore they are useful for studying various phenomena of the magnetosphere, such as substorms, sudden impulses, and Ultra-Low-Frequency (ULF) waves. The online data are stored in a uniform flat file format. In addition to providing online geomagnetic data, the web server also contains all basic information of the ground experiment and the data archives that an off-site scientist needs when exploring the data. The location of the interested observatory is displayed on the web browser, where a map as well as the location in geographical and geomagnetic coordinates are given. The data availability for each station and for a given day can also be searched for convenience. The magnetometer data are provided in two forms: the ASCII listing and interactive time series plots. The time series plots can overlay data from up to four stations at the same time for comparison. Online instruction is also available for users to learn all included functions. The future plan to expand the capability of this data server includes providing time series plots in longer time scales, enhancing the connection with other standalone ground magnetometer data servers, and supplying online data to relevant virtual observatories. The URL address of the UCLA Ground Magnetometer Data Server is http://www-ssc.igpp.ucla.edu/uclamag/data_center/.

U22A-0025 1330h POSTER

Dynamic Dataflow Topology Monitoring for Real-time Seismic Networks

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Complex real-time seismic networks often develop an extensive set of dataflow connections, especially when one includes the virtual networks established by data-sharing. As these systems grow, the task of managing existing connections and adding new ones has the potential to rapidly overwhelm network operators and system architects. This is amplified by data-source deletions and additions and temporary network problems, to say nothing at all of the the changing presence of individual data streams. We have created dynamic status-monitoring tools for Antelope-based seismic networks, expanding on capabilities of the Antelope system, which allow us to monitor the topology of orbserver connectivity and the dynamic dataflow for individual streams. These tools are important for monitoring network health, avoiding common traps such as data loops, and engineering sensible data-flow architectures. Status monitors run on each orbserver, delivering metadata about server connectivity, clients, and data streams to a central site. These metadata are saved in a near-real-time relational database. We generate directed-graphs from this database. From these, using the GraphViz graphical processor, we create interactive overview images of connectivity and dataflow. We present the current status of this technology; challenges we have encountered in its development; and application to multi-signal-domain sensor grids. We discuss the potential for further growth, including more sophisticated analysis algorithms and the possibility of automated, dynamic sensor-network reconfiguration.

U22A-0026 1330h POSTER

Providing Networking to the DEOS Fleet of Moored Ocean Observatories: High-Seas ROADNet.

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Recent advances in the technologies associated with computation, data telemetry and multidisciplinary sensors, have motivated the scientific community to develop a plan for long-term ocean observatories' where sensors are deployed at the air-sea interface, within the water column, and on and beneath the seafloor. The establishment of a fleet of moored ocean buoy observatories will be an important element of the DEOS initiative, conceived as part of NSF's larger, more inclusive Ocean Observatories Initiative (OOI). These buoys will provide the infrastructure to connect the Internet to a network of ocean-bottom and ocean-column instruments. The most important requirements driving moored observatory design are the amount of power delivered to the seafloor and moored instruments and the telemetry rate that the buoy system must support between the instruments and the shore. Two designs have been developed, a wave-following discus and a spar buoy capable of delivering 500 W to the seafloor and telemetering at least 500 Mbytes of data per day to shore. The only cost-effective alternative for continuous moderate-bandwidth communication (>64 kbps) currently available is a C-Band or Ku-Band satellite system. A prototype C-Band system has been installed on the R/V Roger Revelle, the R/V Melville, and the R/V Thomas Thompson with a teleport hub at the San Diego supercomputer Center. This system provides full-period shipboard Internet connection as the ships operated over wide areas of the Pacific Ocean. The system has proved very effective in providing data, video, and voice communications for the ships' scientists and crew. The data connections to/from the ships are managed by the ROADNet (Real-time Observatories, Applications, and Data management Network) virtual object ring buffer (VORB) technology discussed in other papers in this session.

U22A-0027 1330h POSTER

Creating Access to Data of Worldwide Volcanic Unrest

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We are creating a pilot database (WOVOdat - the World Organization of Volcano Observatories database) using an open source database and content generation software, allowing web access to data of worldwide volcanic seismicity, ground deformation, fumarolic activity, and other changes within or adjacent to a volcanic system. After three years of discussions with volcano observatories of the WOVO community and institutional databases such as IRIS, UNAVCO, and the Smithsonian's Global Volcanism Program about how to link global data of volcanic unrest for use during crisis situations and for research, we are now developing the pilot database. We already have created the core tables and have written simple queries that access some of the available data using pull-down menus on a website. Over the next year, we plan to complete schema realization, expand querying capabilities, and then open the pilot database for a multi-year data-loading process. Many of the challenges we are encountering are common to multidisciplinary projects and include determining standard data formats, choosing levels of data detail (raw vs. minimally processed data, summary intervals vs. continuous data, etc.), and organizing the extant but variable data into a useable schema. Additionally, we are working on how best to enter the varied data into the database (scripts for digital data and web-entry tools for non-digital data) and what standard sets of queries are most important. An essential during an evolving volcanic crisis would be: 'Has any volcano shown the behavior being observed here and what happened?'. We believe that with a systematic aggregation of all datasets on volcanic unrest, we should be able to find patterns that were previously inaccessible or unrecognized. The second WOVOdat workshop in 2002 provided a recent forum for discussion of data formats, database access, and schemas. The formats and units for the discussed parameters can be viewed at http://www.wovo.org/WOVOdat/parameters.htm. Comments, suggestions, and participation in all aspects of the WOVOdat project are welcome and appreciated.

URL: http://www.wovo.org/wovodat.htm

U22A-0028 1330h POSTER

The GEOSCOPE Program: state of the art in 2003 and perspectives

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The GEOSCOPE program was launched in 1982 by the National Institute of Sciences of Universe (INSU), a department of the French National Center of Scientific Research (CNRS), at the instigation of the Institute of Physics of the Earth of Paris (IPGP). The purpose of the GEOSCOPE program was the installation of about 25 stations well distributed worldwide, in particular in the southern hemisphere, in the standard configuration defined by the FDSN (very broad-band 24 bit, continuous recording at 20sps). The GEOSCOPE program is operating 28 digital very-broadband stations. Data from large events are teletransmitted for some stations (by phone line or through internet) and made available within one day. A satellite transmission system is now working, in cooperation with the french military agency CEA/DASE, in cooperation with CTBTO (Dzumac in New Caledonia). An agreement between GEOSCOPE and CTBTO allows us to get data continuously and with a low gain. The next CTBTO stations to be installed are ATD (Djibouti) and MBO (Senegal) in 2004. In terms of siting locations, the aim of the GEOSCOPE program is almost fulfilled; we plan to install a new station in MARQ (Marquesas Islands), one in Russia at high latitude at VOR (Vorkouta), one in Patagonia (COY in Chile), a joint station with IRIS at TRIS (Tristan Da Cunha) in order to fill some geographical gaps in the southern hemisphere. DCC in Antarctica is a joint EOST-Strasbourg/Concordia-Italy station. Our goal is now to replace our old digitizers by Quanterra ones, and to transmit all data in near real-time. An inversion method for the fundamental mode Rayleigh wave spectra has made possible the rapid determination of the mechanism and the seismic moments.This determination is done routinely for all events with Ms>6.8 from the teletransmitted stations data. The estimate Power Spectral Density plots have been computed for each station and are available on the Web site. Some small to medium earthquakes are not detected and thus are not referenced in the earthquake catalogues. Most of these eve nts are in the southern hemisphere where the lack of seismic stations creates a detection sensitivity gap. We estimate that more than a hundred southern hemisphere events per year with magnitude between 4.5 and 5.5 go undetected by the worldwide networks. We use a surface wave analysis method to effectively detect and locate these earthquakes, particular ly near-ridge events. Most GEOSCOPE stations are equipped with STS1 seismometers, only a few ones with STS2 seismometers. We are planning to move some stations from the northern hemisphere to the southern one. We are equipping all stations with thermometers, and also

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with microbarometers in order to clean routinely the signal from the atmospheric pressure effect.

URL: http://geoscope.ipgp.jussieu.fr

U22B MCC: 2002-2004 Tuesday 1340h

Estimating the Consequences of Severe Geophysical Events I

Presiding: **A Nur,** Stanford University; **R L Wesson,** U.S. Geological Survey

U22B-01 1340h

Oil & War: Revisiting M. King Hubbert's predictions.

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Oil is, unlike almost any other natural resource on earth, not only finite but also irreversibly consumed. At the same time worldwide data shows that at least at present and for the foreseeable future oil consumption rate is directly proportional to the national standard of living. In 1956 and again in 1962, M. King Hubbert predicted, using a simple model based on the logistic equation, that oil production in the lower 48 United States will follow a bell shaped curve with a production peak around the year 1971 and a production level of 3 billion barrels per year, followed by a rapid decline. While his model approach was ridiculed at the time production data to date reveals a remarkable agreement with this prediction: US oil production did peak in 1971 at a level of 3.2.10 barrels a day and has been declining ever since. M. King Hubbert similarly estimated also the future of oil production worldwide - predicting peak production sometime between 1995-2010 (now!) at a level of 25 to 35 billion barrels per year. Current worldwide production is 27 billion barrels per year. Thus because about half of the oil in earth has already been discovered, the world is destined to face more and bigger conflicts over the control of global supplies. Although many economists and political scientists tend to dismiss the significance of Hubbert's thinking about the finiteness of recoverable oil as well as the consequent implications, it appears that without careful management these conflicts could turn into wars much bigger than in Kuwait in 1991 or in Iraq in 2003. It is therefore imperative for us as earth scientist to try to educate the public and our leaders about the basic geological reality of finite fossil energy resources, and the serious consequences of this fact.

U22B-02 1405h INVITED

Large Earthquakes in Developing Countries: Estimating and Reducing their Consequences

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Recent efforts to reduce the risk of earthquakes in developing countries have been diverse, earnest, and inadequate. The earthquake risk in developing countries is large and growing rapidly. It is largely ignored. Unless something is done - quickly - to reduce it, both developing and developed countries will suffer human and economic losses far greater than have been experienced in the past. GeoHazards International (GHI) is a nonprofit organization that has attempted to reduce the death and suffering caused by earthquakes in the world's most vulnerable communities, through preparedness, mitigation and prevention. Its approach has included raising awareness, strengthening local institutions and launching mitigation activities, particularly for schools. GHI and its partners around the world have achieved some success: thousands of school children are safer, hundreds of cities are aware of their risk, tens of cities have been assessed and advised, and some local organizations have been strengthened. But there is disturbing evidence that what is being done is insufficient. The problem outpaces the cure. A new program is now being considered that would attempt to improve earthquake-resistant construction of schools, internationally, by publicizing well-managed programs around the world that design, construct and maintain earthquake-resistant schools. While focused on schools, this program might have broader applications in the future.

U22B-03 1430h INVITED

Consequences of Predicted or Actual Asteroid Impacts

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Earth impact by an asteroid could have enormous physical and environmental consequences. Impactors larger than 2 km diameter could be so destructive as to threaten civilization. Since such events greatly exceed any other natural or man-made catastrophe, much extrapolation is necessary just to understand environmental implications (e.g. sudden global cooling, tsunami magnitude, toxic effects). Responses of vital elements of the ecosystem (e.g. agriculture) and of human society to such an impact are conjectural. For instance, response to the Blackout of 2003 was restrained, but response to 9/11 terrorism was arguably exaggerated and dysfunctional; would society be fragile or robust in the face of global catastrophe? Even small impacts, or predictions of impacts (accurate or faulty), could generate disproportionate responses, especially if news media reports are hyped or inaccurate or if responsible entities (e.g. military organizations in regions of conflict) are inadequately aware of the phenomenology of small impacts. Asteroid impact is the one geophysical hazard of high potential consequence with which we, fortunately, have essentially no historical experience. It is thus important that decision makers familiarize themselves with the hazard and that society (perhaps using a formal procedure, like a National Academy of Sciences study) evaluate the priority of addressing the hazard by (a) further telescopic searches for dangerous but still-undiscovered asteroids and (b) development of mitigation strategies (including deflection of an oncoming asteroid and on- Earth civil defense). I exemplify these issues by discussing several representative cases that span the range of parameters. Many of the specific physical consequences of impact involve effects like those of other geophysical disasters (flood, fire, earthquake, etc.), but the psychological and sociological aspects of predicted and actual impacts are distinctive. Standard economic cost/benefit analyses may not apply due to the exceptional rarity of major impacts.

U22B-04 1455h

Hurricanes: The Consequences of the Energy Equivalent of a 10-megaton Nuclear Bomb Exploding Every 20 Minutes

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Through the ages tropical cyclones have killed and maimed millions of people, devastated economies, and profoundly altered physical and political landscapes. Both the nature of the threat and the human response have evolved. The largest losses of life have shifted with the population, from on the sea during the era of global exploration, to the coastline and, now, increasingly to inland areas. At the same time, the primary threat has changed from winds and waves to storm surge and freshwater floods. An international and multidisciplinary collaboration over the past half century has focused on identifying and minimizing tropical cyclone risks through advancing operational hurricane forecasting, improving communications systems, and heightening public awareness. In the United States, meteorologists and emergency managers work together closely to reduce the frequency of the most catastrophic outcomes. This paper reviews the most significant historical impacts, the contemporary challenges, and highlights of the most successful current mitigation strategies of the U.S. hurricane warning program.

U22B-05 1520h

Volcanic Catastrophes

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The big news from 20th century geophysics may not be plate tectonics but rather the surprise return of catastrophism, following its apparent 19th century defeat to uniformitarianism. Divine miracles and plagues had yielded to the logic of integrating observations of everyday change over time. Yet the brilliant interpretation of the Cretaceous-Tertiary Boundary iridium anomaly introduced an empirically based catastrophism. Undoubtedly, decades of contemplating our own nuclear self-destruction played a role in this. Concepts of nuclear winter, volcanic winter, and meteor impact winter are closely allied. And once the veil of threat of all-out nuclear exchange began to lift, we could begin to imagine slower routes to destruction as "global change". As a way to end our world, fire is a good one. Three-dimensional magma chambers do not have as severe a magnitude limitation as essentially two-dimensional faults. Thus, while we have experienced earthquakes that are as big as they get, we have not experienced volcanic eruptions nearly as great as those preserved in the geologic record. The range extends to events almost three orders of magnitude greater than any eruptions of the 20th century. Such a calamity now would at the very least bring society to a temporary halt globally, and cause death and destruction on a continental scale. At maximum, there is the possibility of hindering photosynthesis and threatening life more generally. It has even been speculated that the relative genetic homogeneity of humankind derives from an evolutionary "bottleneck" from near-extinction in a volcanic cataclysm. This is somewhat more palatable to contemplate than a return to a form of Original Sin, in which we arrived at homogeneity by a sort of "ethnic cleansing". Lacking a written record of truly great eruptions, our sense of human impact must necessarily be aided by archeological and anthropological investigations. For example, there is much to be learned about the influence of volcanism on humankind in the North Pacific, where Holocene time saw many caldera-forming eruptions in an area of comparatively intense human activity.

U22C MCC: 2002-2004 Tuesday 1600h

Estimating the Consequences of Severe Geophysical Events II

Presiding: **A Nur,** Stanford University; **R L Wesson,** U.S. Geological Survey

U22C-01 1600h

"Dangerous" Climate Change

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Current climate change mitigation policy decisions must be made despite layers of uncertainty. Modeling of future climate, projections for future economic growth and greenhouse gas emissions, and characterizations of the interactions and feedbacks within the coupled social-natural system all contain uncertain components. Researchers communicating with policymakers have learned that, instead of presenting "best guesses" or other point estimates, uncertainty assignments require such techniques as probability distributions of outcomes and quantitatively defined descriptions of subjective confidence. We present a quantification of "dangerous" climate change, a term important in policy discussions. Article 2 of the United Nations Framework Convention on Climate Change expresses the opinion of the signing Parties that steps be taken to "prevent dangerous anthropogenic interference with the climate system," but the Convention did not specify what constitutes the value judgment of being "dangerous." We present one possible definition. A threshold for "dangerous" climate change is a clear tool for evaluating the need for and impact of proposed climate policy. Monte Carlo analyses with a simple integrated assessment model demonstrate that endogenously calculated climate policy controls appreciably reduce the probability of "dangerous" climate change. Under mid-range assumptions, climate policy reduces the probability of "dangerous" climate change by 30-50%.

URL: http://www.stanford.edu/˜shs

U22C-02 1615h

A "CLIPER" Risk Model for Insured Losses From US Hurricane Landfalls and the Need for an Open-Source Risk Model

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To plan for the consequences of hurricanes, earthquakes, and other natural hazards the public and private sectors use a variety of risk models. Model output is tailored for specific users and includes a range of parameters including: damage to structures, insured losses, and estimates of shelter requirements to care for people displaced by the catastrophe. Extensive efforts are made to tune risk models to past events. However, model "forecasts" of losses are rarely verified through a comparison with new events. Instead, new events generally are used to further tune a new version of the model. In addition, there has been no public attempt to determine which model has the most predictive skill, in part because there is no agreed upon reference forecast, and in part because most risk models are proprietary. Here I describe a simple risk model that can be used to provide deterministic and probabilistic exceedance probabilities for insured losses caused by hurricanes striking the US coastline. I propose that loss