Virtual Observatories for Solar and Space Physics Data
Abstracts of selected proposals.
(NNH05ZDA001N-S3CVO)

Below are the abstracts of proposals selected for funding for the Virtual Observatories for Solar and Space Physics Data Program. Principal Investigator (PI) name, institution, and proposal title are also included.

Jan Merka / University of Maryland, Baltimore County
Rapid development of a focused Virtual Magnetospheric Observatory and its integration with VxOs for S3C data

We propose the rapid development of a focused Virtual Magnetospheric Observatory (VMO) that will facilitate query-based discovery and access of data from past, current and future NASA magnetospheric missions. This VMO's intelligent magnetospheric search capability is highly relevant to NASA programs and interests because it will decrease data discovery efforts and, thus, improve the efficiency of magnetospheric research and enable many faster (and cheaper) complex multi-spacecraft studies. Ultimately, the VMO has the potential to become a distributed data and service environment with Google-like context search capabilities. As a demonstration of the VMO's utility, we will focus on plasma and magnetic field measurements from widely used and harder to access databases. The selection of initial data providers was driven by the need to demonstrate the distributed nature of the VMO, to develop and document standards for data providers, and to give the proposed VMO a scientific focal point, namely "Multispacecraft correlative studies of the dayside magnetospheric interactions and substorms". The core VMO part called Middleware will be responsible for composing queries, sending them to data and service providers, interpreting query results and returning them to the VMO users. An extended SPASE-based data model will be created to describe participating data sets which will not only provide metadata necessary for performing data queries, it will also represent a unified layer between the various data sets and users. The VMO will also take advantage of an existing data mining service RemoteMiner, that will be used to create event lists such as magnetopause crossings or FTEs, to enable more intelligent searches as, for example, "When were FTEs observed at the dayside magnetopause while other spacecraft were gathering data nearby?". The VMO team will collaborate with other VxOs towards a standard for inter-VxO queries and, in particular, we will demonstrate such inter-VxO queries by providing the VMO users information about relevant solar wind/IMF conditions obtained by sending queries between the VMO and VHO Middleware. It is expected that the VMO will become an important part of the VxO environment enabling intelligent access to ever increasing number of data products and services. The modular architecture of the VMO environment will assure high flexibility and extensibility of the functionality to satisfy the space physics community's evolving needs. We perceive the VMO as an extremely important data discovery tool that is highly relevant to the U.S. National Goal "Study the Earth system from space and develop new space-based and related capabilities for this purpose" and to the NASA's Strategic Objectives as specified in Table of 1 in the Summary of Solicitation of this NRA because the VMO is a new technology and tool that will

improve scientific understanding of the space environment and conditions experienced by human explorers near Earth.

Daniel Morrison / Johns Hopkins University Applied Physics Lab
VITMO: A VxO for S3C Data for the Ionosphere-Mesosphere-Thermosphere Community

VITMO: A VxO for S3C Data for the Ionosphere-Mesosphere-Thermosphere Community 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. 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 a data system with efficient access to all data sets (present and historical) relevant to disciplines across agencies, including NASA, NSF, NOAA and others. We present a Virtual ITM Observatory (VITMO) implementation for such a data system that leverages current resources. The design incorporates a modular framework that accepts distributed data and services from across the community and encourages widespread participation. Data can be added as both new missions and historical holdings become available, and services added or replaced as technologies and standards evolve. The core VITMO system is based upon a set of services: 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. The VITMO will specifically tie together data from TIMED, AIM, C/NOFS, SuperDARN, and services such as CDAWeb, SSCWeb, and ModelWeb. The VITMO will have vastly improved data search and location capabilities allowing multidisciplinary and multisatellite studies to be performed. The VITMO approach is easily extensible to future data sets and will be able to tie into other VxO as either a peer node or a service.

Adam Szabo / NASA Goddard Space Flight Center
Virtual Heliospheric Observatory - a VxO for S3C Data

Through the decades of robotic space exploration, heliospheric physics missions have accumulated vast amounts of data from just about all corners of the interplanetary medium. However, the different data sets, collected by different spacecraft, were not designed to be mined as a single system. The resulting various data products are archived and distributed in widely different formats using radically different services requiring a considerable level of expertise from the end users. With the implementation of the Living With a Star (LWS) program, an even larger influx of data is expected from sources that will include foreign partners and planetary missions for which interplanetary observations will be only a secondary objective increasing the complexity and variety of the available

data products. At the same time, new multi-source investigations cutting across discipline boundaries require simple, reliable and rapid access to all of the collected data. Making the various data sets easily accessible is not sufficient by itself to facilitate scientific research. Software tools for data ingest, visualization, and analysis are necessary. Therefore, the development of a heliospheric data environment standard, leading to a unified heliospheric software library, is essential to increase the effective use of heliospheric data. Here we propose that a Virtual Heliospheric Observatory (VHO) be developed that has the following key features: - A fully distributed system where individual data nodes can range from data centers to individual instrument sites of current and future heliospheric missions. - A common interface to access all participating heliospheric data either through a web browser or through an application programming interface (API). - The ability to query participating data sources based on industry-standard protocols. - The ability to exchange queries with other VxOs. - A standard heliospheric data environment for software tools that access and use the data. - Standards for services that allow access to value-added functionalities. The primary objective of the VHO is to enable scientists to search for, locate and efficiently use distributed heliospheric data sets. This can be accomplished with a middleware architecture that will accept user queries and redirect the user to the corresponding data products combined with the establishment of community standards for data environment and services. Our design philosophy is to build only the minimum necessary functionality as part of this proposed work, and to focus on establishing community accepted standards that will allow later seamless extension of the system. We also seek to involve the largest possible set of data providers to maximize the early utility of the VHO.

Raymond Walker / University of California, Los Angeles
VMO for S3C data: A Virtual Magnetospheric Observatory

The successful management of space science measurements requires a combination of the appropriate expertise in both science and information technology. The UCLA VMO is built on decades of experience gathering space physics measurements, providing stewardship for the data and distributing them to the greater scientific community. UCLA scientists have contributed greatly to the understanding of the magnetosphere and are committed to continue those advances through this effort. The VMO creates robust links to the world’s relevant data bases thus providing one-stop shopping for the magnetospheric researcher seeking data. The framework for building the VMO is based on a Representational State Transfer architecture and is implemented by using existing and widely adopted technologies. A prototype search portal for the data has been developed and can be accessed at http://vmo.igpp.ucla.edu. Since data are very dynamic, especially during the early phases of a mission, the VMO portal design allows frequent and asynchronous updating. Like the data, services which aid data analysis such as format translation, data sub-setting, coordinate transformation, and display are available through widely distributed sources. The VMO portal provides access to value-added services developed both locally and remotely. The VMO registries for both data and services are designed to make it easy for suppliers to make their resources available and update information regarding the resources. Magnetospheric data are useful long after spacecraft missions end. The VMO works with investigators to design data products that

will remain scientifically useful even when the investigators are no longer involved. The financial resources available to data and service suppliers are extremely limited. Therefore the VMO requires only a small effort to get started and has minimal on-going costs. The VMO development and implementation approach is very cost effective since it unites innovative approaches with many existing resources.

Robert Weigel / University of Colorado
VxO for S3C data: The Virtual Radiation Belt Observatory (ViRBO)

The radiation belt community consists of satellite engineers, operators, and scientists who share a common desire to understand and predict the structure and variability of Earth's radiation belts. In this community, there is a need for improved scientific understanding of the radiation belts, more accurate dynamic and climatological models, and a mechanism for more efficient transfer of scientific understanding and models within both the scientific community and to the space technology and operational community. Currently, the resources necessary to meet these needs are beyond the scope of an individual because there is no centralized repository for radiation belt information or an organized support community. To address these needs, we propose a Virtual Radiation Belt Observatory (ViRBO). This virtual observatory will offer synthesized and open access to historical data, analysis and visualization software, near-real-time measurements, and the predictions of empirical models. The proposed observatory will foster scientific discovery and provide improved tools for satellite engineers and operators. The developers of ViRBO will capitalize on modeling and data collection efforts that exist or are currently in development at institutions throughout the country while at the same time supporting the goals of the electronic geophysical year (www.egy.org) that have been endorsed by the world-wide community. Much of the existing and under-development Space Physics Interactive Data Resource (SPIDR) architecture and code base will be used to meet the needs of the software infrastructure of ViRBO. Besides providing a specific instance of a virtual observatory for the radiation belt community, the ViRBO software development effort will result in a system extensible to any VxO which will enable rapid and compatible implementations of virtual observatories in other scientific communities.

Carsten Denker / New Jersey Institute of Technology
Data Services Upgrade: Web and Data Server for Ulysses HI-SCALE Data

We request short-term (1 year) support from the Virtual Observatories for Solar and Space Physics Data (NNH05ZDA001 N-53CVO) program to provide a web and data server, and associated web interface, for Ulysses HI-SCALE data. The data service upgrade will significantly enhance both research and educational use. The server will also provide a needed upgrade to data services of the Center for Solar-Terrestrial Research (CSTR) at the New Jersey Institute of Technology (NJIT), to enhance serving and analysis of data from the Big Bear Solar Observatory (BBSO) and the Owens Valley Solar Array that provide crucial support to NASA missions. Throughout the entire Ulysses mission, the Heliosphere Instrument for Spectra, Composition, and Anisotropy at Low Energies (HI-SCALE) has collected measurements of low energy interplanetary ions

and electrons. Time-series of electron, proton, and ion fluxes have been obtained since 1990. The data are carefully calibrated and are available in lower (energy and temporal) resolution at various data centers, e.g., the National Space Science Data Center (NSSDC), the Coordinated Data Analysis Web (CDAWeb), and the Ulysses HI-SCALE mission web sites at the Johns Hopkins University Applied Physics Laboratory (JHUAPL) and Fundamental Technologies (FTecs), Lawrence, Kansas. These services provide access to the time-series data and basic query functions. We propose to make the Ulysses HI-SCALE data much more readily accessible in their entirety with full energy and temporal resolution for more immediate science analysis and interpretation. As part of the data services upgrades, we will explore and develop various methods and techniques that enable on-line, on-the-fly data analysis of one-dimensional time-series data. These techniques will include spectral analysis, correlation studies, statistical functions, automatic event detection, and visualization tools. One-dimensional data are common to many observatories and spacecrafts studying the Sun-Solar System Connection, e.g., GOES X-ray flux, ACE particles and fields, sunspot numbers, indices of ultra-violet and extreme ultra-violet emission (Mg and Ca II K indices, ... Therefore, the explorative part of this project will significantly aid in developing synergies between these observatories and spacecraft, and has the potential to integrate data from many diverse data providers. The goal of the Virtual Solar Observatory (VSO, Hill et al. 2000, 2004) and Virtual Solar-Terrestrial Observatory (VSTO, Fox et al. 2005) is to provide data uniformly and efficiently to a diverse user community. However, data dissemination can only be a first step, which has to be followed by a suite of data analysis tools that are tailored towards a wide user community in science, technology, and education. The widespread use and familiarity of spreadsheets, which are available at low cost or open source for many operating systems, make them an interesting tool to analyze HI-SCALE time-series data. The HI-SCALE data will be stored in a MySQL database. Web-based queries will be developed to access the data, provide tools for data sub-setting, averaging, filtering, and merging, and convert the data to formats suitable for spreadsheet programs. We have already developed some spreadsheet templates that provide a variety of features for time-series analysis. In addition, we will develop tools based on Java Server Pages, Java Servelets, and IDL ION for more complex tasks such as generating animated sequences of the time-series data from HI-SCALE and from other relevant data sources.

Natchimuthuk Gopalswamy / NASA Goddard Space Flight Center
Data Services Upgrades: Integration of Type II radio burst and CME data

The primary scientific objective of this proposal is the integration of data on solar disturbances affecting Earth across Wind and SOHO missions. This effort will link the multi-spacecraft data to scientific users, which will enable and enhance the scientific return from NASA’s missions. The key aspect of this effort is to bring combined dynamic spectral and imaging information on solar disturbances to scientific users through familiar software for easy access across the internet without going through the complexity of reducing disparate datasets. The integration of the radio dynamic spectral data service at the Wind/WAVES web site and the coronal mass ejection (CME) data service at the CDAW Data Center will greatly simplify the conduct of research of solar disturbances that significantly affect the conditions at Earth and other locations in the

heliosphere. The proposed work enhances the existing data services at the CDAW Data Center, which participates in the Virtual Solar Observatory already in existence. The objectives of this proposal are consistent with the goals of NASA's Strategic Plan, which includes understanding the influence of the Sun on Earth's atmosphere. The data product will enable tracking solar disturbances into the interplanetary medium, which is not possible at present using in situ observations. This will also enable research leading to an understanding the science behind space weather. The proposed data product has direct relevance to STEREO, which has similar data output.

Joseph King / QSS Group Inc.
Data Services Upgrade: Geotail Solar Wind Magnetic Field and Plasma Merged Data Sets

We propose to create three new Geotail data sets containing merged magnetic field and plasma data. Unlike currently available Geotail data, they will include only data taken in the solar wind. All will be for the time period April, 1995, through current. One data set will be at 48-sec resolution at Geotail observation times and locations. The second will be an hourly averaged version of the first. The third will be at 1-min resolution and will be time-shifted to the bow shock nose (BSN). This last data set will be similar to 1-min, BSN-shifted IMP 8, Wind and ACE data sets now being prepared by us under a previous grant to create a 1-min-resolution version of the hourly, multi-spacecraft OMNI data set. The hourly averaged Geotail data set can be used in seeking systematic differences between parameters from Geotail and the other spacecraft mentioned above and in filling gaps in the hourly OMNI data set. These Geotail data sets will be made community-accessible in ASCII from FTPBrowser. They will available to the Virtual Heliospheric and Magnetospheric Observatories and will be ready for conversion to CDF and ingest to CDAWeb.

Joey Mukherjee / Southwest Research Institute
Virtual Observatories: Legacy Data System Upgrade

SwRI has several data sets in our archive that are useful to the science community. These include various items from the UARS PEM/SUSIM/SOLSTICE instruments, the DMSP probes, several instruments of the Dynamics Explorer satellites, the CRRES/LOMICS instrument, the SPES and DIFF probe from the TSS data, and approximately 30 years of IMP-8 data. Currently all data sets are held on an archive accessible only within the Southwest Data Display and Analysis System (SDDAS) software. For the Cluster mission, SwRI developed a comprehensive web-based system for making use of the high resolution PEACE data without requiring the end user to download and install SDDAS. Although the full capabilities of SDDAS are not available from the website, a significant portion of the most commonly used functions, including plotting, data inventory, and downloading in several formats are available. This web based data system has received high praise and active usage by many Cluster scientists. We were able to reuse much of our website for the Mars Express mission and were also able to partly develop a framework by which other websites could be built. What we propose is to capitalize on our success with Cluster and develop an identical interface as the Cluster web site

through code reuse for our other legacy data sets. This involves reengineering our existing code base to work with multiple projects as well as updating the layouts through which data is downloaded and plotted. The benefits to NASA for such a system is to give scientists the ability to quickly and easily plot or download data from the web for these older data sets without having to install SDDAS. Furthermore, having our old archive expanded to the newer archiving system will enable scientists to make use of older data sets for future missions and other data mining or similarly related activities, such as the Space Physics Archive Search Engine (SPASE) or the VxO initiatives.

Martin Snow / University of Colorado
LASP Interactive Solar IRadiance Datacenter (LISIRD) Data Services Upgrade

The LASP Interactive Solar IRadiance Datacenter (LISIRD) will provide a centralized gateway to solar irradiance data products and model results generated at the Laboratory for Atmospheric and Space Physics (LASP) for a variety of NASA missions. LASP has been serving solar irradiance data products for over 20 years from the SME, UARS, SNOE, TIMED, and SORCE missions but in mission-unique formats and disjoint interfaces. In addition, LASP is planning new data products of the solar irradiance for the SDO and Glory future missions. The motivation for LISIRD is to make solar irradiance measurements and models easy to use and thus enable advanced studies of the Sun-Earth connections. We are soliciting funds to purchase a computer server system that will be shared by these multiple satellite missions.

Jon Vandegriff / Johns Hopkins University Applied Physics Lab
Data Services Upgrades: Geotail and ACE Energetic Particles

We will connect the highest time resolution energetic particle datasets available for the ACE/EPAM, Geotail/EPIC, AMPTE/MEPA, ISEE-1/WAPS, and ISEE-2/WAPS instruments to both the Virtual Heliospheric Observatory (VHO) and the Virtual Magnetospheric Observatory (VMO). For all but the EPAM datasets, existing data files will be modernized, making them easier for non-expert users to read and analyze. Each file in all of the datasets will be described by meta-data which will be compliant to the VHO and VMO systems. Furthermore, our meta-data generation and delivery mechanism will use a highly flexible approach in order to allow for 1) easy adaptation to likely future changes in and/or expansion of meta-data requirements, and 2) a natural way to support registration of the data with multiple Virtual Observatories (VOs), even if each VO has different meta-data requirements. Our efforts will ensure that the high science value contained in each dataset is even easier to access and use, and we will contribute significant, high time resolution data holdings to the emerging VO environment.