Heliophysics Data Environment Enhancements
Abstracts of selected proposals
(NNH11ZDA001N-ROSES 2011)

Below are the abstracts of proposals selected for funding for the Heliophysics Data Environment Enhancements program. Principal Investigator (PI) name, institution, and proposal title are also included. 23 proposals were received in response to this opportunity. On January 5, 2012, 9 proposals were selected for funding.

Scott Budzien/Naval Research Laboratory
VITMO Data Services Upgrade to Add Remote Atmospheric and Ionospheric Detection System (RAIDS) Mission Lower Thermosphere Products

The proposed program will process recent measurements of the Earth's lower thermosphere acquired by the Remote Atmospheric and Ionospheric Detection System (RAIDS) experiment from the International Space Station (ISS) during 2009-2010. These data products will be delivered the the Virtual Ionosphere Thermosphere Mesosphere Observatory(VITMO) for distribution to the heliophysics community. From its unique vantage point on the ISS, RAIDS provides significant new measurements of thermospheric temperature in an undersampled altitude region (120-165 km); new measurements of the chemically and thermodynamically important gas nitric oxide; and two million ultraviolet and near-infrared spectra which can address a range of modeling and space weather topics relevant to the thermosphere. The thermospheric temperature data product can be used to improve empirical and physics-based models of the upper atmosphere, characterize the thermosphere response to solar flux, geomagnetic storms, and dynamical effects from the lower atmosphere. The NO data product provides new observations of mid- and low-latitude NO at a variety of solar illumination conditions suitable for improving thermospheric chemistry models. RAIDS data complement, extend, and fill crucial gaps in other of NASA data sets for the upper atmosphere. The heliophysics community would benefit from access to RAIDS data while they remain current.

Jack Ireland/ADNET Systems, Inc.
Expanding visual interfaces to the Virtual Solar Observatory: a value added service for the Virtual Solar Observatory

The Virtual Solar Observatory (VSO) is a service that allows users to query multiple distributed archives of solar data through a single interface. The advantage of this approach is that users query a single service to access data from many different instruments. A typical query begins with a user picking one or more instruments and an

observation time range. The user can vary the query by changing instruments, providers, time range or observable. There are a large number of different data, each with their own duty cycles, availability, and scientific goals. The new, easy availability of this vast amount of diverse data presents a new challenge: how does a user find the particular data they are interested in? In order to make full use of all the VSO-provided data, the user must have a guide to assist them in finding the data they really want, whilst also having the flexibility and the opportunity to find other data that they didn't know was relevant before they started. This leads to the rationale for this proposal: by providing simple and intuitive services to explore the data, the user is better able to find the data they need to attain their science goals. We propose to create superlative data browsing and acquisition tools by combining the data provision capabilities of the VSO and other services, with expanded data visualization services delivered by the Helioviewer Project.

Thomas Narock/ADNET Systems, Inc.
Value Added Services for VxOs: Advanced Data Queries Using Parameter Values

Heliophysics Virtual Observatories provide a number of novel methods for finding data sets and time periods of interest. However, current search methods don¿t capture much about the underlying physical processes of interest to heliophysicists. Virtual Observatories search over such things as spacecraft position, coincidences, parameter values, and measurement types. While certainly useful, these methods, and the Heliophysics Data Environment (HPDE), lack the ability to perform more in-depth analysis such as correlations and occurrence rates, and do not easily facilitate data-model comparison. As a result, users are often forced to retrieve all the data themselves and manually perform such analysis to find the time periods they need defeating the purpose of Virtual Observatories.

In order to resolve these difficulties we propose a new service that will immediately extend the scientific utility of the Virtual Observatories. This service will be multi-disciplinary and provide much needed, but currently lacking, detailed search over parameter values and occurrence rates.

Xiaoqing Pi/Jet Propulsion Laboratory
Data Services Upgrade: Ionospheric Irregularities Measured Using GNSS

The proposed project will upgrade the current GPS TEC data source at the Coordinated Data Analysis Web (CDAWEB) of the heliophysics virtual observatories by providing global ionospheric irregularity measurements characterized using the widely used rate of TEC index. The measurements will be derived from observables of global navigation satellite systems (GNSS) collected from ground-based global and regional GNSS networks, including the International GNSS Service (IGS) and Continuously Operating

Reference Station (CORS) as well as other accessible regional GNSS stations. An operation process will be developed to produce the ionospheric irregularity measurements routinely on a daily basis. The data will be archived at and distributed through CDAWEB, and made available to space science research communities and technology applications. These continuously available globally distributed ionospheric irregularity measurements will serve research and application programs of NASA, NSF, DoD, FAA, etc., and benefit space and Earth science research communities and technology applications in areas of ionospheric plasma physics, space weather research and monitoring, coupling of magnetosphere, ionosphere, and thermosphere, communications and navigation systems, spaceborne remote sensing radar systems, ionospheric scintillation prediction and forecast.

Richard Schwartz/Catholic University of America
Data Services Upgrade: Creating Science-Ready RHESSI Images, Spectra, and Lightcurves

For the more than 50,000 RHESSI flares detected since launch, we plan to automatically generate scientifically useful time profiles, images, and spectra in optimal time and energy bins, with all instrumental artifacts removed. These products will be archived as FITS and plot files, and accessible through the VSO, Helioviewer, and other internet tools, as well as by IDL or other software environments. A catalog will be created as a guide to all of these products including pointers and the necessary referencing metadata for localization in time, space, and energy.

The current RHESSI quicklook archive includes images, spectra, and time profiles that have served their purpose well: locating the flare source on the Sun, providing a first look at the time, intensity, and energy structure of flares, and the relative importance of thermal and non-thermal emissions. However, due to insufficient time sampling, low image quality, and lack of optimization, they are only marginally useful for scientific purposes. To make higher quality images or time profiles, a user starts with the RHESSI Level-0 telemetry files and the RHESSI IDL software, sets up options as desired, and generates the product. This requires an IDL license, some knowledge of the RHESSI software and instrument, and time. We hope to obviate the need for those steps for many potential users by providing science-ready products. This will be particularly useful for scientists from other missions who wish to incorporate RHESSI results with their analysis without the need to become intimately familiar with the RHESSI instrument and data analysis software.

Wilbert Skinner/University of Michigan

Data Services Upgrade: A Seamless System for Accessing Upper Atmosphere Research Satellite/High Resolution Doppler Imager (UARS/HRDI) and TIMED Doppler Imager (TIMED/TIDI) data

Studies of long term variations and possible anthropogenic effects on the upper atmosphere (above the stratopause) are difficult because of the relatively short duration of the available data records. Data sets from sounding rockets, ground based radar, and optical instrumentation rarely extend back earlier than the late 1950's or 1960's. Additionally, data sets are often not continuous, geographically limited, and researchers must contend with possible effects of changes in instrumentation and/or analysis techniques. Satellite data often provide extensive geographical coverage and instrumentation and processing tends to be very stable over the instrument lifetime, but records are typically of even shorter duration than ground based systems. Often measurements of the same quantity over time are obtained by instruments using different techniques with minimal or no overlap. A notable exception is the wind data sets from the High Resolution Doppler Imager (HRDI) on the Upper Atmosphere Research Satellite (UARS) and TIDI (TIMED Doppler Interferometer) instrument on TIMED (Thermosphere Ionosphere Mesosphere Energetics and Dynamics). Both of these instruments determine winds by measuring the Doppler shift of the molecular oxygen Atmospheric band emission lines by Fabry-Perot interferometry. The HRDI instrument measured MLT winds from late 1991 until early 2005. TIDI began collecting MLT wind measurements in early 2002 and continues to operate flawlessly at this writing. The instruments operated with a three year overlap allowing extensive cross-calibration. Between the two a data set of MLT winds of nearly 2 decades long exists with a good chance several more years will be added before TIMED ceases operation. We propose to generate a seamless system allowing scientists to obtain either HRDI or TIDI data from a single location, to provide generalized readers for the data, and to merge and organize the metadata.

In spite of the inherent difficulties in studying long term upper atmosphere trends, careful analysis has revealed tantalizing clues about changes in the upper atmosphere. For example, Emmert et al. (2008) have used the rate of decay of satellite orbits to infer a decrease in atmospheric density at 400 km of about 2.7%/decade, in reasonable agreement with theoretical studies described by Roble and Dickinson (1989). She et al. (2009) found a cooling of the atmosphere at 91 km of about 1.5K/decade from lidar measurements in Colorado. Portnyagin et al. (2006) used wind data from three radars located in Germany, Russia, and Canada to estimate trends in the mesosphere lower thermosphere (MLT) wind field and conclude "there are clear long-term changes visible in the mid-latitude MLT wind time series, but that these trends are non-uniform." It is clear that long, consistent, and well validated time series are required to make significant progress. The combined HRDI and TIDI data could directly contribute to the understanding of the long term variations in the MLT region. The set would also be valuable as a means to cross-calibrate widely spaced ground-based systems. Maintenance of the TIDI data is currently supported but there is no funding for the HRDI data. The current HRDI data server is maintained at a minimal level with internal funds

and it is not possible to repair functions when they cease to work or to improve the site. The two data sets are very complementary to each other and it would be a disservice to the community to force researchers to retrieve the HRDI data from a deep archive where only limited levels of the data would be available with incomplete metadata. This work proposed here would "rescue" the HRDI data and metadata and bring it into a 21st century environment. TIDI is involved only as a new home for HRDI and this does not conflict with existing TIDI funding.

Aki Takeda/Montana State University
Data Services Continuation: Resident Archive Services of the Yohkoh Legacy data Archive

This proposal is to continue to provide data maintenance and user support services of the Yohkoh Legacy data Archive, currently supported as one of the Resident Archives selected for funding through ROSES-2007 solicitation.

Elsayed Talaat/The Johns Hopkins Universtiy Applied Physics Laboratory
Value Added Services for VxOs: Magnetic Mapping from ITM Perspective

We propose to develop a series of light weight web services for use by the Virtual Ionosphere-Thermosphere-Mesosphere Observatory (VITMO http://vitmo.jhuapl.edu) and other VxOs that allows magnetic mapping between different geospace regions from groundbased instrumentation and low Earth orbit instrumentation. Recent and upcoming observational missions produce simultaneous observations from disparate geospace regions that cannot be properly interpreted without addressing how to magnetically map between them. Global models and simulations imply mappings that need to be correct in order for the models to be as useful as possible for science and prediction. Techniques for such mapping include empirical and event-based models, simulations, using auroral boundaries and phenomena, magnetoseismology, and multi-point in situ particle observations. Currently, magnetic mapping is almost exclusively done from the spacecraft that sample the magnetosphere down into the ionosphere. What distinguishes the ITM perspective from the magnetosphere perspective is that many of the ionospheric and thermospheric measurements are made through remote sensing techniques. Therefore mapping the satellite location or ground station location is not sufficient to magnetically locate the observations. A needed web service is one that will map ITM assets onto the magnetosphere allowing ionosphere and thermosphere scientists to quickly relate their measurements to magnetospheric phenomena and studies.

The field of views of multiple satellite and groundbased data sets will be determined, allowing the VxO to map these into the magnetosphere. These web services will allow search capabilities in the magnetosphere, allow searching for overlaps between satellite instruments and also allow ¿near misses¿, where products that are only close in time

and/or geographical overlap to be optionally selected by the user based on criteria that the user provides. This proposal is focused on providing a generalized set of services that will initially support mapping and magnetic coordinate coincidences from and between the SuperDARN radar network, SuperMAG magnetometer network, incoherent scatter radars (AMISR, EISCAT 3D, Jicamarca, Arecibo, Sondrestrom, Millstone Hill) and SABER, TIDI, and GUVI instruments on the TIMED satellite, the SOFIE and CIPS instruments on the AIM satellite, the SUSSI instruments on DMSP F16, F17, and F18, as well as C/NOFS and COSMIC satellites, GOES, THEMIS, CLUSTER, and RBSP. This proposal will also develop a sufficiently general system that can be easily extended to support additional satellites and instruments and additional ground-based sites.

This proposal will add Value-added Services that incorporate significant enhancements to the services provided by one or more of the VOs. These services are based on the existing coincidence service in VITMO that calculates satellite data set and ground site coincidences for various remote-sensing instruments. The service will be exposed to other VxOs as a web service (with WSDL and REST interfaces) with the outputs as an event list compatible with the SPASE HELM program. The proposed services will allow the non-specialist user to select data that they were previously unable to locate, opening up analysis opportunities beyond the instrument teams and making it much easier for future students who come into the field. This value added search service is an excellent follow-on to the existing search strategies in the Virtual ITM Observatory.

Jon Vandegriff/Johns Hopkins University Applied Physics Lab
Data Services Upgrade: Conversion of AMPTE and ISEE Datasets to CDF

We will convert four legacy datasets to CDF: energetic particle data from the Medium Energy Particle Analyzer (MEPA) instrument on the AMPTE/CCE spacecraft, magnetometer data also from AMPTE/CCE, and the energetic particle data from instruments on ISEE-1 and ISEE-2. The energetic particle datasets are currently only available in a custom binary format, and so converting them to CDF will significantly increase their usability. The magnetic field data is already available online in ASCII format, and we will create a CDF equivalent. For each dataset, we will convert existing binary or ASCII files to ISTP-compliant CDF, create product-level and granule-level SPASE descriptions, create static summary plots, and will transfer all data and metadata to the Space Physics Data Facility at Goddard for archiving and for distribution through the popular CDAWeb system. The metadata for each dataset will also be registered with the Goddard VMO. Scientists from all relevant instrument teams and data centers are collaborators on the proposal. Now is an especially good time to do the conversion, because there is significant interest in comparing the AMPTE and ISEE particle measurements of the radiation belts with new data from the upcoming Radiation Belt Storm Probes (RBSP) mission, to be launched in 2012.
