Heliophysics Data Environment Enhancements
Abstracts of selected proposals
(NNH12ZDA001N-HDEE)

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. 29 proposals were received in response to this opportunity. On January 16, 2013, 10 proposals were selected for funding.

Craig DeForest/Southwest Research Institute
Data Services Upgrade for Calibrated Heliospheric Imagery and Integrated Data from STEREO-B/SECCHI

We propose to upgrade, integrate, and index into the VSO the heliospheric imagery from the STEREO-B spacecraft. Heliospheric imaging data requires delicate post-processing to extract the Thomson-scattered light from background sources that exceed the desired signal by a factor of 1,000. We have recently developed data processing techniques to do exactly that from STEREO-A, yielding the first quantitative photometric studies of plasma clouds as they cross the inner solar system. To enable broad community use of this important resource, we are currently developing a pipeline (under separate funding from the SHP-GI program) to process the entire STEREO-A data set and make it available to the scientific community. Due to optical differences between the heliospheric imagers on STEREO-A and STEREO-B, the reduction software needs modification and validation to be able to operate on STEREO-B. We propose, under this program, to take exactly those steps and augment the existing effort to make all the heliospheric data from the whole mission available.

Dual-channel heliospheric imaging of Thomson scattered light from CMEs and other wind disturbances was and remains a primary goal of the STEREO mission; with a small amount of software development funding to adjust the extraction code for STEREO-B's different focal characteristics, we can realize this goal and enable for the first time quantitative, stereoscopically integrated 3-D measurements of the solar wind at distances over 0.3 AU from the Sun. These measurements are central to many goals of the heliophysics program and the STEREO mission, but are not possible without preprocessing of the data.

Because the proposed work makes use of existing infrastructure and pipeline modules already in development for our STEREO-A reduction and dissemination effort, we can accomplish a great deal in a single-year project, augmenting that pipeline to carry out full analysis for both STEREO spacecraft. Under this project, we will develop a new pipeline module to background-subtract the HI-2 data from STEREO-B and merge it into our existing STEREO image post-processing pipeline. Taking advantage of economy of scale and the existing project, we will process and disseminate the entire STEREO/SECCHI heliospheric imaging data set over a two-year period, completing at minimum one year of data during the period of performance of this one-year augmentation and the remainder

afterward as part of the existing effort, using tools developed under this proposed project. STEREO data are searchable and available via several browsing tools including the VSO; we will work with the SDAC and the VSO to ensure that the new reduced products are properly indexed and retrievable via the VSO.

Timothy Guild/The Aerospace Corporation
TWINS-ES Data Services Upgrade: Process / Provide to VxO

The stated intent of the Data Services Upgrade proposals is to improve the quality, utility, and accessibility of datasets relevant to heliophysics research. We propose to improve the quality of existing Aerospace observations (DOS) made on the TWINS host vehicles by inter-calibrating the dataset to other radiation belt sensors and verify the data yield science-quality proton and electron fluxes in the radiation belts. We will improve the utility of the dataset by merging it with Cartesian and magnetic ephemeris. Most significantly, this proposed effort will make the dataset accessible to NASA virtual observatories (VxOs) with a sufficient amount of meta-data for science community use; presently it is not accessible to the broader heliophysics community. As the Radiation Belt Storm Probes (RBSP) mission begins, these TWINS-ES/DOS radiation belt measurements will provide critical additional local time and L-dependent coverage, as well as a continuous dataset connecting the RBSP era to historical radiation belt dynamics.

Donald Hampton/Geophysical Institute
Data Services Upgrade - Geophysical Institute Magnetometer Array

The key objectives of this project are to 1) improve the real-time processing and display of the Geophysical Institute Magnetometer Array (GIMA) data to support NASA sounding rocket projects launched out of Poker Flat Research Range, 2) modify the database and metadata products for seamless incorporation of the GIMA data into UCLA s Virtual Magnetospheric Observatory, and, 3) improve the long-term storage and dissemination of the magnetometer data so that they can be used in the interpretation of data from previous and future flight and ground-based studies.

Description: Magnetometer data from 8 remote stations across Alaska have been collected continuously since the mid 1990 s. These three-axis, 1Hz data are used to determine the currents associated with auroral activity in the polar regions, and specifically to help determine the optimal time to launch sounding rockets from Poker Flat Research Range. The collection pipeline has changed little since the inception of the array, and many aspects are inefficient and difficult to troubleshoot due to the lack of documentation. This affects the ability to support real-time operations for rocket projects and our ability to supply the data to end users, including Virtual Observatories, such as the Virtual Magnetospheric Observatory at UCLA.

Relevance to NASA: The aurora is a key coupling mechanism between the Earth s magnetosphere and ionosphere, and the magnetometers are used to remotely sense the currents associated with aurora. Therefore this project is related to any of the Heliophysics Roadmap Research Focus Areas having to do with Magnetosphere-Ionosphere (M-I) coupling.

Proposed Upgrades: We propose to simplify the current magnetometer data processing by reducing the number of separate processors used from three to one, using an open source, stable development environment (Python), and clearly documenting the upgrades. We will also implement automated data quality checks to reduce the current workload, freeing personnel time to develop new data products. The upgrades will also produce products compatible with seamless integration into the Virtual Magnetospheric Observatory (VMO, UCLA), compatible with SPASE guidelines. The changes will result in simpler interface to both real-time displays and access to archival data by direct users to our public website, as well as users accessing data via the VMO.

Deliverables and Data Products: We will deliver a simplified data pipeline, with metadata descriptions compatible with SPASE guidelines. The new data products will be seamlessly integrated with the VMO, and therefore available to a broader heliophysics audience.

Syau-Yun Hsieh/Johns Hopkins University Applied Physics Laboratory
Data Services Continuation: Resident Archive for IMAGE High Energy Neutral Atoms (HENA) Imager Instrument

This proposal seeks funding to continue the data services of the IMAGE High Energy Neutral Atom (HENA) imager instrument as a Resident Archive. The one-of-its kind HENA images of the global hot plasma around Earth offer the one of the few ways to understand the global dynamics of near-Earth space weather phenomena by providing the only validation to global physical models. The operation of the HENA instrument has been terminated, as well as the IMAGE mission, by the loss of the spacecraft near the end of 2005. The lack of funding support has greatly constrained our efforts to permanently preserve the integrity of the HENA data, convert these data into a community standard data format, and prepare for a transition to a Final Archive.

Therefore, we propose to establish a Resident Archive for HENA. The primary objectives of HENA Resident Archive are (1) to preserve the integrity of HENA data, (2) to continue serving the valuable HENA data products to the space science community, (3) to continue providing the expert assistance to the community in the interpretation and use of HENA data, (4) to convert the HENA legacy datasets into community standard data format while providing appropriate and adequate documentation to ensure the independent use of the data, and (5) to transition the HENA

legacy data products with associated documentation to a Final Archive for permanent preservation.

Rick Niciejewski/University of Michigan
Data Services Upgrade: Neutral thermospheric winds measured using DE2-FPI and DE2-WATS

PROPOSAL SUMMARY

Proposal title: Data Services Upgrade: Neutral thermospheric winds measured using DE2-FPI and DE2-WATS

Key objectives
1. Generating daily netCDF files from the resolved neutral horizontal wind database at high resolution acquired by the FPI and the WATS experiments onboard the DE2 mission. High-resolution neutral temperatures and OI (6300Å) brightness acquired by the FPI will also be included.
2. Placing the entire netCDF DE2-FPI catalogue online at the VITMO virtual observatory

Methods/techniques

The DE2-FPI experiment acquired Doppler line of sight winds of the upper atmosphere throughout the operational life of the Dynamics Explorer 2 satellite. The co-manifested DE2-WATS instrument performed measurements of the orthogonal wind component. The University of Michigan developed a technique to combine both datasets to resolve the neutral horizontal wind in the thermosphere. These were the first space borne measurements of thermospheric winds on a global basis in 1981 and continue to be of interest today in conjunction with dynamics observations by TIMED/TIDI and C/NOFS CINDI.

The available DE2 wind catalog has a coarse temporal resolution restricting it s utility. We propose to make available to the community via VITMO a newly reprised dataset with as much as 6x better resolution (8 second temporal). Initial examination of the datasets suggests favourable comparison with original analysis going back 30 years. These data are now restored at the University of Michigan for use with validation studies with comparable TIMED/TIDI OI (6300Å) scans of the thermosphere at similar solar cycle levels. Higher resolution DE2 wind data are useful for documenting ionospheric and magnetospheric phenomena with today s improved general circulation models and faster processors permitting studies of smaller scale disturbances.

Perceived importance of the research problems and significance to NASA Strategic Goals

This proposal supports Strategic Goal 2: expand scientific knowledge of the Earth and the universe in which we live. Specifically, this proposal will a) advance scientific

understanding of the changing Earth system, b) promote the understanding of the Sun and its interactions with the Earth, and c) contribute basic research to potentially understand the hazards and resources available as humans explore space.

Jonathan Niehof/Los Alamos National Lab
Data Services Upgrade: CAMMICE/MICS improved access and recalibration

Although data collection terminated in 2002, data from the CAMMICE/MICS sensor on the Polar spacecraft continue to form the basis for several scientific studies.

The data currently available via CDAWeb were prepared in 2003 and consist of spin-averaged fluxes through 2000. The proposing PI has prepared a preliminary data set in calibrated fluxes with full pitch angle information for all species, covering the entire MICS mission from 1996 through 2002. This data set combines information for a given species across all energies. (A slightly different measurement technique was used at lower energies and combining measurements at high and low energies requires some care.) The calibrations will be updated based on the data acquired while on-orbit. An easy-to-use, medium-resolution (3 minutes) data set is planned, as well as a more complex, high resolution set. Preliminary data are currently hosted on a standalone server at Boston University, with no ties to the larger heliophysics data infrastructure. Making this larger, more robust data set readily available will improve the productivity of the data and ensure its accessibility for the future.

These MICS data provide an excellent complement to the upcoming RBSP mission and support several fields of study:

* Polar's orbit samples the off-equatorial population, where the loss cone is larger and thus the effects of loss processes are easier to see.

* Anisotropies in the thermal and ring-current energy plasma are considered a likely source of energy for the formation of EMIC waves and subsequent loss of radiation belt particles; thus, pitch angle information is critical.

* The energy range sampled by MICS overlaps with the ion composition instruments on RBSP: ECT-HOPE on the low energy end of the MICS range and RBSPICE on the high end. Despite the decade between the MICS measurements and RBSP, the six-year MICS dataset provides important off-equatorial context under a wide range of conditions.

* Heavy ions can substantially alter ring current dynamics. Ring current modelling thus requires accurate composition information, readily provided by MICS

* The dominant process for trapped ions at the high end of the MICS energy range is radial diffusion. Transforming to phase space density at constant adiabatic invariants will eliminate adiabatic changes and allow for a characterization of radial diffusion effects only.

We propose to:
1) Further refine calibrations based on the experience of the AP9 effort.
2) Transition the data to a final archive. This will include access to the medium-resolution data from CDAWeb.
3) Provide SPASE metadata to integrate this data set into the Goddard Virtual Magnetospheric Observatory.

4) Convert to phase space density at constant adiabatic invariant for easy comparison with RBSP data.

This work will be performed at Los Alamos, with support from the instrument PI at Boston University and consultation from the VMO to ensure appropriate SPASE metadata.

Robert Pfaff/NASA Goddard Space Flight Center
Data Services Upgrade: Archiving the AC Electric Field, Magnetic Field, and Plasma Density Data Gathered with Goddard s VEFI Instrument Suite on the C/NOFS Satellite

The Air Force Communications/Navigation Outage Forecast System (C/NOFS) satellite is a unique mission dedicated to advancing our knowledge of, and ability to predict, equatorial spread-F (ESF). C/NOFS measures both the drivers (DC electric fields, neutral winds, plasma density) and consequences (irregularities and scintillations) of ESF in unprecedented detail. The Vector Electric Field Investigation (VEFI) on C/NOFS was built by Goddard under a reimbursable arrangement for the Air Force. VEFI includes DC and AC electric field detectors, a flux gate magnetometer, a fixed-bias Langmuir probe, an optical lightning detector (designed by the Univ. of Washington), and a programmable burst memory to record high time resolution measurements of all the VEFI sensor outputs when the desired events are encountered. As the Air Force mandate only supported the processing of the 1 s/sec DC electric and magnetic field data for input to their ionosphere prediction model, we present a plan to document and archive, and make available to the community, the higher time resolution DC electric field (16 s/sec) and wave electric field, density, and magnetic field data. We review the C/NOFS satellite and VEFI instrument

and outline a proposed, detailed plan to archive portions of the VEFI AC data and disseminate them to the community.

Jolene Pickett/The University of Iowa
Data Services Upgrade: Calibrated CDF Archive of Wave Data from ISEE-1 and DE-1

The University of Iowa holds digital, uncalibrated wave data obtained from multiple receivers mounted on the NASA International Sun Earth Explorer 1 (ISEE-1, 1977-1987) and Dynamics Explorer 1 (DE-1, 1981-1984) spacecraft. We will port software previously written to read and calibrate the wave data on (now) obsolete computer systems to modern Linux systems. We will then write these calibrated data to Common Data Format (CDF) files and work with the Virtual Wave Observatory (VWO) to register these files utilizing SPASE metadata in order to facilitate distribution of the data to the scientific community.

The primary components of each data set are already restored from archival media to online files. Ancillary files and original project source code and binaries will be restored from VMS backup savesets utilizing a software emulator running VAX OpenVMS, which is currently operational. This approach will allow calibrations to be verified using original programs. Software to process the uncalibrated binary files into calibrated standard CDF files will be written for current Linux systems and a complete set of survey plots will be generated from the product files using the leading-edge data analysis package das2/Autoplot, developed at The University of Iowa. Configuration files for das2/Autoplot will be provided to the VWO to allow PI-caliber interactive analysis of the restored data sets.

The ISEE-1 and DE-1 data are directly relevant to the Data Services Upgrade component of the Heliophysics Data Environment Enhancements program. These missions provide data that are applicable to understanding how the Sun affects Earth s environment during a solar cycle that was considered to be more normal than the current and just past cycles. The ISEE-1 orbit (~1 RE x 23 RE, 28.8 degree inclination) was such that it crossed all of Earth s major boundaries (foreshock, bow shock, magnetosheath, magnetopause, plasma sheet, and plasmapause), which are sensitive to changes in the solar wind and to major solar eruptions. The DE-1 spacecraft was in an inner magnetosphere/upper ionosphere polar orbit (1.1 RE x 4.7 RE, 89.9 degree inclination) that allowed for the study of 1) fundamental auroral processes in the heart of the acceleration region and along magnetic field lines connecting to it, 2) coupling of the hot magnetosphere plasma with the cold ionosphere plasma, and 3) various waves, such as chorus, which are now believed to interact with particles in the inner magnetosphere to accelerate electrons to the energies observed in the outer radiation belt. Making the wave data from these two spacecraft easily accessible and available will allow for event-based and statistical studies in connection with solar activity and cycles. These wave data will also be invaluable for eventual direct comparison to data obtained by future NASA missions, most notably

Radiation Belt Storm Probes (RBSP) for inner magnetosphere/radiation belt studies and Magnetospheric MultiScale (MMS) for magnetopause/reconnection studies, as well by ongoing missions such as the multi-satellite NASA THEMIS and ESA Cluster missions and the single satellite Japanese Geotail mission, all of which cross similar regions and boundaries to those of ISEE-1 and DE-1.

David Siskind/Naval Research Laboratory
Data Services Upgrade for the Spatial Heterodyne Imager for Mesospheric Radicals (SHIMMER)

We propose to format, document and archive data from the Spatial Heterodyne Imager for Mesospheric Radicals (SHIMMER) experiment which completed a 30 month mission from March 2007 to October 2009 on a DoD/Space Test Program (STP) satellite, known as STPSat-1. SHIMMER produced two specific science products of interest to the NASA Heliophysics Division. First, global measurements of the hydroxyl radical (OH) are important for constraining photochemical models of mesospheric ozone. Ozone, in turn, is a key measurement objective of the SABER experiment on the TIMED satellite. Second, SHIMMER has provided the first measurements of the diurnal cycle of Polar Mesospheric Clouds (PMCs) from a satellite, only some of which has, at present, been analyzed. PMCs are the focus of the NASA AIM small explorer. Thus SHIMMER data are synergistic with both TIMED and AIM. While SHIMMER received partial funding from NASA for mission operations, it has received no funding for public release of its data. Thus this proposal represents an ideal opportunity to leverage off of its previous NASA support and provide data to support both TIMED and AIM.

Michael Turmon/Jet Propulsion Laboratory
MDI Active Region Patches: Data Services Upgrade to Catalog Active Regions in MDI LOS Magnetograms

We will compute and publish two new data products derived from the Solar and Heliospheric Observator (SOHO) Michelson Doppler Imager (MDI) instrument, both covering the entire range of availability of synoptic MDI data (1996-2010), which encompasses more than the entirety of Solar Cycle 23. ===P===
The first product is a catalog of active region (AR) patches. The catalog will consist of approximately 3500 tracked active regions, each of which will be tracked across the entire disk passage up to a handful of pixels from the limb. For each appearance of each region (typically 200 appearances) we will produce summary statistics including centroid, longitude/latitude extent, area, and integrated flux, as well as a region-extent mask which is essential for complex or decaying active regions. Each region will also have cumulative measures including overall lifetime and matching NOAA AR numbers. The second, ancillary, product is a full-disk activity mask identifying magnetically active pixels for each of the roughly 84000 synoptic magnetograms. ===P===

Key MDI Resident Archive personnel are co-investigators of this proposal, which ensures that the best archival data from MDI are used for these data products (e.g., the final plate scale calibration will be used for both magnetograms and intensitygrams). This involvement also ensures the long-term availability of these data products through the Virtual Solar Observatory (VSO) and the Data Record Management System (DRMS) serving the Joint Science Operations Center (JSOC) at Stanford University for the Solar Dynamics Observatory (SDO). ===P===

The proposed data product is analogous to the HMI Active Region Patches (HARPs) we have already developed and published for HMI. The use of similar methods and availability of comparable metadata for both MDI and HMI tracked-region data products will provide continuity across Solar Cycles 23 and 24. The use of similar methods and availability of comparable metadata will enable statistical studies of active region properties which were not before possible, addressing a key Living With a Star (LWS) objective to understand solar variation and space weather. This data product will also allow intelligent subsetting for automated per-active-region studies, and enable new proxies for modeling irradiance effects of individual active regions.