National Space Science Data Center

NSSDCNEWS

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ISTP Data Flow into NSSDC

By Ramona Kessel

Data from the International Solar-Terrestrial Physics (ISTP) satellites continue to flow into NSSDC. These are best accessed through CDAWeb (http://cdaweb.gsfc.nasa.gov), which is a data display and download system. The total data available on CDAWeb amount to about 115 GBytes. Each month, about 5 GBytes of new data are added.

There are over 120 distinct data sets on CDAWeb that make up the ISTP era data. Since September 1992 the Geotail satellite has been contributing approximately 1 min resolution key parameters that now amount to about 6 GBytes of data. Since that same time 1 min key parameter data from the IMP 8, from the NOAA GOES and DOE LANL geostationary satellites, and from the CANOPUS, DARN, SESAME, and Sondestromfjord ground-based stations have been ingested. In late 1994 the NASA Wind satellite and in early 1996 the NASA Polar satellite began submitting key parameter data. Polar data represent the largest volume on CDAWeb (approximated at 75 GBytes) mainly because of the ultraviolet and visible imagers. Most of the key parameter data are now citable with caution, that is, a check with the principal investigator in cases of anomalies. A number of instruments have begun submitting higher resolution definitive data products and/or event data.

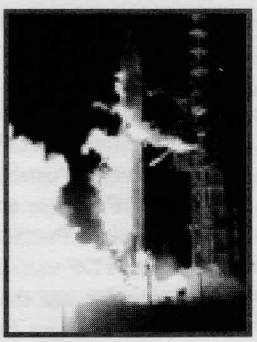
In collaboration with the ESA, the Solar and Heliospheric Observatory (SOHO) and Equator-S satellites have contributed data. SOHO data begin in 1996 and are ongoing; Equator-S data exist for six months in 1998. The Russian Space Research Institute (IKI) is participating through the Inter-Agency Consultative Group (IACG) with Interball Tail (starting in 1995) and Interball Aurora (starting in 1996). In addition other missions have rounded out the ISTP era data including SAMPEX (starting in 1992), FAST (starting in 1996), and ACE (starting in 1997). The FAST data are at 5 sec resolution and currently account for about 16 GBytes on CDAWeb.

The objective of ISTP is to promote further understanding of the Earth's complex plasma environment and the Sun-Earth connection. The underlying data standard of the Common Data Format (CDF) using the ISTP/IACG Guidelines has allowed effective data sharing particularly through the CDAWeb system. The data standard and the growing amount of data available in this standard contribute to the success of the overall ISTP program. With the data available in CDAWeb, the ISTP objective is beginning to be met.

Digging Through Data: HEAO 3 Heavy Cosmic Ray Nuclei

By Joseph King

In contrast to readily used solar wind magnetic field and plasma parameter data sets, a majority of NSSDC space physics data sets is more difficult to use and understand, is often at a "lower processing level," and is relevant to a smaller range of science analyses. However, these data sets often contain still-unmined science potential relevant to key current science questions.



HEAO 3 was launched from Cape Canaveral on September 20, 1979.

An example of a data set that might have such potential is the Heavy Nuclei Experiment (HNE) flown on the High Energy Astrophysics Observatory (HEAO 3) in 1979-1981. The HNE was intended to measure high energy nuclei with atomic number (Z, nuclear charge) between 17 (chlorine) and 100 (fermium) with the ability to resolve individual elements. Such cosmic ray composition data are used in studies of nucleosynthesis (how elements are created) and in studies of the propagation of cosmic rays from their point of origin to the time and place of being observed.

The HNE is a very sophisticated package containing four multiwire hodoscopes for determining path direction, six ionization chambers, and two Cherenkov detectors. A given incident cosmic ray particle will penetrate some or all of these aligned elements. For each such particle is captured the following information: which pair of wires fired in each hodoscope (thus fixing the particle direction of motion), the amount of energy deposited in each of the ion chambers, and the amount of energy recorded in each of eight photomultiplier tubes observing light emitted by the Cherenkov detectors. It is the combination of all these parameters that enables the determination of the atomic number and the energy of any given cosmic ray.

NSSDC holds a set of 591 9-track HNE "library tapes" (about 100 GBytes) provided by the experimenter with all these parameter values for each heavy cosmic ray observed over the 600-day HNE life. These data include about 20 million iron nuclei and ten thousand nuclei with $Z > 40$. A great deal of documentation and software source code accompany the data. In addition, NSSDC holds two subsets of the data created initially by the principal investigator team to support the majority of the analyses done by them. One, called "gold," contains data on 21 tapes (~ 4 GBytes) for all the cosmic rays reliably identified as $Z > 30$, and the other, called "cobalt," contains data on 11 (~ 2 GBytes) tapes for all cosmic rays passing most closely along the axis of the detector package

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Note: FULL versions of articles are available at http://nssdc.gsfc.nasa.gov/nssdc_news/

See Commonly Used Acronym list on page 4.

Nost News: Formats Evolution Process Update

By Donald Sawyer and Joseph King

This activity was last reported in the June 1999 *NSSDC News*. Since then, new material has been added to the Formats Evolution Process (FEP) WWW site, and the FEP Committee (FEPC) has gained some additional insights. As a reminder, the primary objective of the FEPC is to promote a community dialog that influences the evolution of data formats toward supporting greater cross-discipline access to data and toward a reduction in the number of formats that need support within the Sun-Earth Connection community. New material added to the Web site includes the following: thoughts about levels of complexity and specialization in data types and structures for storing scientific data in files, added by Michael Folk (Hypernews Forum); the description of Advanced Composition Explorer (ACE) Solid State Imaging Spectrometers (SIS) data in HDF 4, added by Andrew Davis (Hypernews Forum); and NSSDC's use of the Common Data Format (CDF) in the archive, added by Joseph King (Archive Forum).

The FEPC has found a lack of sufficient common understanding of terms and concepts to compare and contrast adequately various data formats. Therefore, it has begun to fill this void through the "complex data types..." paper from Michael Folk and comments made to it. Additional revisions are expected, and the community at large is encouraged to provide comments through the Hypernews Forum or submission of additional papers.

At the same time the FEPC recognizes that data formats are only a means toward an end: the objective of understanding, accessing, and using multisource science data effectively. The types of science data objects, such as images, time series, and spectra, that need to be carried by the data formats and the services desired by the users are significant drivers for the evolution of the formats. An initial case study from this perspective is provided by the Description of ACE SIS data in HDF 4 as provided by Andrew Davis. Considerable effort has been expended by the ACE project in mapping its science data objects into HDF 4. Can the community come to agree on how common science data objects should be mapped to such formats? Can they agree on a set of APIs for such science data objects? If so, this agreement would surely reduce project implementation costs and improve science data interchange effectiveness. As the FEPC provides additional materials, the community at large is encouraged to offer their perspectives on all aspects of these issues.

IMF Polarity Figures Available Through OMNIWeb

By Joseph King and Natalia Papitashvili

Solar coronal magnetic fields are drawn out into interplanetary space by the solar wind plasma flowing largely radially away from the Sun. Because the roots of most field lines stay attached to fixed regions of the Sun, each field line acquires a spiral shape by the combined action of the radial plasma outflow and the solar rotation.

The solar magnetic field is quite complex and time-variable but is dominantly of one polarity (i.e., pointing out from or in toward the Sun) over the north hemisphere of the Sun and of the opposite polarity over the other hemisphere. Once each 11-year solar activity cycle the solar magnetic polarity reverses.

In the solar wind a heliospheric current sheet separates regions of opposite interplanetary magnetic field (IMF) polarity. This boundary is not flat but is tilted and non-planar. It is frequently likened to a ballerina's skirt with standing waves rotating with the 27-day solar rotation period, although both the tilt and degree of non-planarity vary over an 11-year solar activity cycle.

A spacecraft held permanently near the Earth but just outside the Earth's magnetosphere will typically pass through the heliospheric current sheet twice or occasionally four times every 27-day solar rotation interval according to the extent of tilt and non-planarity of this current sheet and according to the Earth's location north or south of the solar equatorial plane. Studies of the time history of the IMF polarity yield insights into the evolution of the heliospheric current sheet that in turn yields insights into processes in the solar atmosphere where the IMF originates.

The NSSDC multisource OMNI data set is intended mainly to simulate a long-lived spacecraft stationed just outside the Earth's magnetosphere making hourly resolution measurements of the IMF and of such solar wind plasma parameters. NSSDC has very recently created a compact figure illustrating the evolution of IMF polarity over the 1965-1999 period as captured in the OMNI data set. This figure is accessible through the OMNIWeb interface at http://nssdc.gsfc.nasa.gov/omniweb/. For this figure daily resolution IMF polarity is computed from OMNI's hourly resolution data and is then represented simply via color coding on vertically-stacked, horizontal bars of 54-day (two solar rotation periods).

CDF FTP Statistics and Evolution Status

By David Han

NSSDC's Common Data Format (CDF) Office has developed CDF FTP statistics software and processed the raw FTP logs from March 1996 through September 1999. Over this period there were 6,812 user sessions during which was downloaded the CDF library or its related software with the monthly session rate doubling from 1996 to 1999. For the same period there were about 5,200 distinct users. More detailed statistics are available on the CDF home page at http://nssdc.gsfc.nasa.gov/cdf/cdf_home.html.

The CDF Office also produced versions of CDF documents in Adobe's Portable Document Format (PDF). These now coexist with the previous PostScript versions. The new PDF versions seem very popular, and there may be other such changes that require little effort but that can greatly benefit the user community. Readers with any such changes are encouraged to suggest them to this author at davidh@xfiles.gsfc.nasa.gov.

The CDF Office is now in the process of developing the Java version of the CDFexport and CDFedit tools, and they are expected to be completed in mid-February 2000. The user interfaces for these tools are revamped from the scientist's perspective for a simpler and intuitive navigation and for ease of use. Once the tools are completed, they will be made available for feedback by a wider user community.

Digging Through Data: HEAO 3 Heavy Cosmic Ray Nuclei

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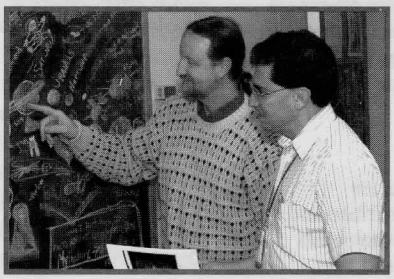
and thus having the best resolution in atomic number. These HNE data (along with contemporaneous data from the United Kingdom Ariel 6 spacecraft) remain unique in terms of the range of atomic number and energy covered.

While NSSDC has provided electronic access to many recent data and selected older data in the past several years, the center wants to identify and prioritize additional older data sets in its archive for promotion to electronic accessibility based on the likelihood of their contributing to significant new scientific results. If any readers are interested in the promotion of this HEAO 3 HNE data set or of any other NSSDC data set still held off line identified in the Web-accessible NSSDC Master Catalog, please let this author know. Expressions of even latent interest in the full HNE data set (as distinct from the much smaller "gold" and "cobalt" subsets) would be useful. Information on who the key HNE scientists were and what the main HNE science results have been are found in the Web-accessible full version of this article.

SSDOO Scientists Receive Raytheon Sabbatical Research Award

By Kirk Borne and Louis Mayo

Raytheon Information Technology and Scientific Services (RITSS) company is the support services contractor that provides scientific and technical support to the operation of the NSSDC and the SSDOO. One of the benefits offered by RITSS to its scientist employees is the Sabbatical Leave Program. This year, two RITSS scientists at the SSDOO, Dr. Kirk Borne and Louis Mayo, were selected as sabbatical award recipients. Following the presentation of an initial sabbatical research idea to senior management, each of these scientists submitted a detailed research proposal for review. Following a careful review, these two were selected for the six-month sabbatical leave: Kirk Borne began in February 1999 and used the time to study the origin and fate of ultraluminous galaxies in the universe; Louis Mayo began in May 1999 to study the complex atmosphere of Saturn's largest moon, Titan.



Louis Mayo (left) and Dr. Kirk Borne (right) were chosen for sabbatical awards.

Kirk Borne took a Sabbatical Visitor position at the Space Telescope Science Institute in Baltimore, Maryland, for the duration of his leave. He worked on Hubble Space Telescope (HST) observations of the brightest galaxies in the local universe: the so-called UltraLuminous InfraRed Galaxies (ULIRGs, for short). Kirk Borne is the principal investigator on two large HST projects to study ULIRGs and recently received a major NASA grant to conduct numerical simulations of these galaxies on the Goddard Cray supercomputer. The study of ULIRGs is now one of the hottest topics in extragalactic astrophysics: ULIRGs may hold the key to understanding the quasar phenomenon, galaxy formation and evolution, cosmic star formation history, and metal enrichment in the universe. One of the major results from Kirk Borne's studies is the recognition that a large fraction of all ULIRGs has probably originated from the collision and merger of small compact groupings of three or more galaxies.

For his research project Louis Mayo worked at the Goddard Laboratory for Extraterrestrial Physics (LEP). With colleagues there he studied the lower atmosphere of Titan, Saturn's largest moon. Titan is a unique moon in this solar system because it has a thick nitrogen-based atmosphere that obscures its surface and it has a rich diversity of hydrocarbon and nitrite gases that contribute to pre-biotic chemistry. Louis Mayo used Voyager I infrared limb spectra gathered at closest approach to study the precipitation and condensation processes in Titan's lower stratosphere and troposphere. Through modeling of continuum opacities, he has identified contributions to the IR spectrum from stratospheric aerosols and condensates as well as collisionally-induced absorption in the troposphere. The results of this study are shedding light on Titan's cloud structure, seasonal variations in precipitation, and tropospheric methane saturation values as well as possibilities for the existence of liquid hydrocarbon lakes(!) on Titan.

New Parameters and Options for the IRI Web Interface

By Dieter Bilitza and Natalia Papitashvili

The Web interface to the International Reference Ionosphere (IRI) model (IRIWeb) continues to be one of NSSDC's very popular services with over 2,000 accesses per month. The IRIWeb lets users list and plot output parameters for specified input parameters.

Inputs are the date, time, and location, while outputs are the ionospheric electron density; ion composition (O+, H+, He+, NO+, O2+, N2+, Cluster-ions); and the electron, ion, and neutral temperatures. Profiles can be generated with altitude, latitude, longitude, year, month, day of year, or time of day (UT or LT) as the independent variable.

As a new output parameter IRIWeb now allows users also to list and plot the column-integrated Total Electron Content (TEC) from the start of the ionosphere at 60 km vertically up to a user-specified upper boundary. TEC is the most important ionospheric parameter for many space applications since the time delay of electromagnetic signals is directly proportional to TEC.

In addition the percentage of electron content above the F peak is given so that users can get an estimate of the relative importance of the bottomside and topside ionosphere for the TEC.

For several of its parameters, IRI gives users a choice between a standard representation and a model for specific applications. So far, IRIWeb only provides the standard model. The new interface now also includes the different model options.

These options include (1) the choice between the standard International Union of Radio Science (URSI) model and the older International Radio Consultative Committee (CCIR) model for the F2 peak density — the URSI generally provides better results over the oceans, and the CCIR model has slight advantages CCIR over the Northern Hemisphere continents; (2) the choice between two models for the bottomside thickness parameter B_0: Of the two the Table-option is based on a larger set of data and recommended as the standard, whereas the Gulyaeva-option has proven to be more reliable at low latitudes; (3) the choice between the old and new models for the ion composition in the middle and lower ionosphere — the newer DANILOV-95 option is the recommended standard. The earlier model, IRI-86, has been kept as an option for test and evaluation purposes.

In addition, this newest version of IRI includes several technical corrections that were noted by users. Also updated was the IRI indices file with the most recent observations and predictions of the 12-month smoothed values of the sunspot number (Rz12) and the Ionospheric Global (IG) index.

BU Space Science Students Visit NSSDC

By Joseph King

A group of 14 students from Dr. Ted Fritz's solar and space physics class at Boston University (BU) visited Goddard on October 6, 1999. They attended part of a Polar spacecraft science team meeting in which Dr. Fritz was participating. Among the other Goddard areas they visited were a particle accelerator facility where an instrument for the Cluster II spacecraft mission was being calibrated and the National Space Science Data Center. While at NSSDC they heard an overview of the organization, saw NSSDC's data archive and data operations areas, and received copies of NSSDC's *Planetary Images* CD-ROM. Some of the students had previously exercised NSSDC's Web pages. A mutually stimulating exchange occurred between the students and NSSDC staff. Reports back from BU after the one-day Goddard visit concluded that the students were very excited to have experienced the scientific and technical working environment at Goddard.

Newcomers from Mars Arrive at NSSDC

By David Williams

NASA's revived interest in Mars has led to new missions and a resulting flood of new data to NSSDC. Recently, NSSDC has received new CD-ROMs from the Mars Global Surveyor (MGS) Camera, Thermal Emission Spectrometer (TES), and Mars Orbiter Laser Altimeter (MOLA) as well as new high resolution mosaics from the Viking Orbiters. The MGS Camera CDs contain an archive of the raw images taken from orbit. The images have been decompressed and stripped of headers but are otherwise unprocessed and uncalibrated. There is a set of HTML documents that support a Web browser interface to the CD and browse images in JPEG format. For more detail on this set and information on ordering the CD-ROMs, readers can go to http://nssdc.gsfc.nasa.gov/cd-rom/web_store.cgi?category=mgsmocarc.

The MGS TES data are also archived on CD-ROMs. The data are measurements of the thermal infrared spectra of the Martian surface and atmosphere. They consist of raw and calibrated radiance measurements and atmospheric and surface properties, such as temperature and heat capacity, derived from the radiance data. The data are stored in the form of tables. Software for reading the tables are included. More information can be found at http://nssdc.gsfc.nasa.gov/cd-rom/web_store.cgi?category=mgstesarc.

The MGS MOLA has been taking measurements of the Martian topography since the MGS began its orbit. The CD-ROMs in the MOLA archive contain tables with raw and corrected timing and positions of laser shots and returns and GIF images of topography profiles derived from the data. For more on this data set, readers can go to http://nssdc.gsfc.nasa.gov/cd-rom web_store.cgi?category=mgsmolaarc.

These sets are not complete, and more CD-ROMs will continue to arrive at NSSDC as data continue to come in from the MGS mission. To support current and future Mars missions, Viking Orbiter data are also being processed. A set of high resolution digital mosaics of portions of the surface of Mars has been created as a complement to the lower resolution mosaics (1/256 degrees/pixel [231 m/pixel]) created earlier. These mosaics, at 1/1024 degree/pixel (~ 58 m/pixel), cover 5 x 5 degree regions on the surface and are contained on eight volumes. For details on these CD-ROMs and the areas covered, readers can go to http://nssdc.gsfc.nasa.gov/cd-rom/web_store.cgi?category=mdim.

NSSDC Makes IMP 8 LANL PLasma Data Uniform

By Joseph King and Natalia Papitashvili

For many years NSSDC has offered electronic access through the Space Physics Catalog (SPyCAT) to two sets of solar wind plasma parameter data from the Los Alamos National Laboratory (LANL) electrostatic analyzer on the Interplanetary Monitoring Platform (IMP) 8 spacecraft. These are called LANL16 and LANL19 and covered the intervals 1973-1986 and 1986-current, respectively. The numbers 16 and 19 reflect the numbers of data words per two-minute data record. The difference of three occurred because in the early years of data preparation at LANL spacecraft position information was not included, in part because IMP moves very little in two minutes. The judgement was that such information was otherwise accessible with sufficient convenience.

As the result of interactions between Principal Investigator Dr. Jack Gosling and NSSDC in the late 1980s, it was determined that adding the spacecraft position information to the plasma data records would be worth the effort. So data past April 1986 started arriving at NSSDC with three extra words per record.

When these data were first made network-accessible through SPyCAT and the NASA Data Archive and Distribution Service (NDADS) some years ago, the 16-word and 19-word versions were made accessible for their respective coverage periods. While NSSDC never received any complaints about this duality, NSSDC judged that it would be user-ineffective for the long term. Accordingly, in anticipation of the migration of data from the NDADS near-line environment to a magnetic disk-based on-line environment, NSSDC added IMP position information to the 1973-1986 data records, thereby creating a single uniformly formatted set of LANL solar wind plasma data. Each record now has time, location, and proton and alpha particle flow speed, direction, density, and temperature information.

Radio JOVE Hears Monster Jupiter Storm

By James Thieman

On October 23, 1999, there was a massive radio storm emitted by Jupiter and received by the telescopes of a number of participants in the Radio JOVE education project. Radio JOVE is an interactive educational activity that brings the radio sounds of Jupiter and the Sun to students, teachers, and the general public. This is accomplished through the construction of a simple radio telescope kit as described in the project Web site at http://radiojove.gsfc.nasa.gov.

One particular school, the Lexington (Kentucky) Traditional Magnet School, was using its equipment for its first Jupiter observations. The sixth graders and their families had gathered at 2:00 in the morning at the farm of their teacher, Wendell Salmons, to set up the antenna and listen to the receiver they had built. As Mr. Salmons put it, "As incredible as it may sound, the Radio JOVE students, parents, teachers, and expert assistant (Dave Sublette) succeeded in receiving and recording radio emissions from Jupiter one half billion miles away early Saturday morning. The kids and parents went wild!!" They even had television coverage of their project. (See Radio JOVE in the News section at http://radiojove.gsfc.nasa.gov/vc/mm_exhibits.htm.) The movie clip is somewhat distorted from the compression necessary to shrink it to a 2.1 MB size, but it still tells very well why NSSDC participates in the Radio JOVE education project.

NSSDCNEWS

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Commonly Used Acronyms

ACE	Advanced Composition Explorer	IRI	International Reference Ionosphere
BU	Boston University	ISTP	International Solar-Terrestrial Physics
CANOPUS	Canadian Auroral Network for the Open Program Unified Study	LANL	Los Alamos National Laboratory
		LEP	Laboratory for Extraterrrestrial Physics
CCIR	International Radio Consultative Committee	LT	Local time
		MGS	Mars Global Surveyor
CDF	Common Data Format	MOSA	Mars Orbiter Laser Altimeter
DARN	Dual Auroral Radar Network	NOAA	National Oceanic and Atmospheric Administration
ESA	European Space Agency		
FAST	Fast Auroral Snap Shot Explorer	PDF	Portable Document Format
FEP	Formats Evolution Process	RITSS	Raytheon Information Technology and Scientific Services
FEPC	FEP Committee		
GOES	Geostationary Operational Environmental Satellite	SAMPEX	Solar Anomalous Magnetospheric Particle Explorer
HEAO	High Energy Astrophysics Observatory	SESAME	Severe Environmental Storms and Mesoscale Experiment
HNE	Heavy Nuclei Experiment	SIS	Solid State Imaging Spectrometers
HST	Hubble Space Telescope	SPyCAT	Space Physics Catalog
IACG	Inter-Agency Consultative Group	SSDOO	Space Science Data Operations Office
IG	Ionospheric Global	TEC	Total Electron Content
IKI	Russian Space Research Insititute	TES	Thermal Emission Spectrometer
IMF	Interplanetary magnetic field	ULIRG	UltraLuminous InfraRed Galaxy
IMP	Interplanetary Monitoring Platform	URSI	International Union of Radio Science
IR	Infrared	UT	Universal time