



➤ **Converting EOS Data From HDF-EOS to netCDF**

A C-language computer program accepts, as input, a set of scientific data and metadata from an Earth Observing System (EOS) satellite and converts the set from (1) the format in which it was created and delivered to (2) another format for processing and exchange of data on Earth. The first-mentioned format can be either HDF-EOS 2 or HDF-EOS 5 (“HDF” signifies “Hierarchical Data Format”). The second-mentioned format is netCDF (“CDF” signifies “Common Data Format”), which is an open-standard, machine-independent, self-describing format for scientific-data files. In the absence of this or a similar program, incompatibilities among the three file formats can cause loss of metadata upon conversion.

This program preserves as many of the metadata as possible upon conversion. The program opens the input HDF-EOS 2 or HDF-EOS 5 file, queries the components of the file by use of the HDF-EOS 2 and HDF-EOS 5 Compatibility Library (which is described in the immediately following article and provides uniform access to HDF-EOS 2 and HDF-EOS 5 files), and writes the data and metadata components into a netCDF file following the Climate and Forecast (CF) metadata conventions.

This program was written by Richard Ullman of Goddard Space Flight Center; Bob Bane of Global Science & Technology, Inc.; and Jingli Yang of Earth Resources Technology, Inc. Further information is contained in a TSP (see page 1). GSC-15007-1

➤ **HDF-EOS 2 and HDF-EOS 5 Compatibility Library**

The HDF-EOS 2 and HDF-EOS 5 Compatibility Library contains C-language functions that provide uniform access to HDF-EOS 2 and HDF-EOS 5 files through one set of application programming interface (API) calls. (“HDF-EOS 2” and “HDF-EOS 5” are defined in the immediately preceding article.) Without this library, differences between the APIs of HDF-EOS 2 and HDF-EOS 5 would necessitate writing of different programs to cover HDF-EOS 2 and HDF-EOS 5. The API associated with this library is denoted “he25.”

For nearly every HDF-EOS 5 API call, there is a corresponding he25 API call. If a file in question is in the HDF-EOS 5 format, the code reverts to the corresponding HDF-EOS 5 call; if the file is in the HDF-EOS 2 format, the code translates the arguments to HDF-EOS 2 equivalents (if necessary), calls the HDF-EOS 2 call, and retranslates the results back to HDF-EOS 5 (if necessary).

This program was written by Richard Ullman of Goddard Space Flight Center; Bob Bane of Global Science & Technology, Inc.; and Jingli Yang of Earth Resources Technology, Inc. Further information is contained in a TSP (see page 1). GSC-15008-1

➤ **HDF-EOS Web Server**

A shell script has been written as a means of automatically making HDF-EOS-formatted data sets available via the World Wide Web. (“HDF-EOS” and variants thereof are defined in the first of the two immediately preceding articles.) The shell script chains together some software tools developed by the Data Usability Group at Goddard Space Flight Center to perform the following actions:

- Extract metadata in Object Definition Language (ODL) from an HDF-EOS file,
- Convert the metadata from ODL to Extensible Markup Language (XML),
- Reformat the XML metadata into human-readable Hypertext Markup Language (HTML),
- Publish the HTML metadata and the original HDF-EOS file to a Web server and an Open-source Project for a Network Data Access Protocol (OPeNDAP) server computer, and
- Reformat the XML metadata and submit the resulting file to the EOS Clearinghouse, which is a Web-based metadata clearinghouse that facilitates searching for, and exchange of, Earth-Science data.

This program was written by Richard Ullman of Goddard Space Flight Center; Bob Bane of Global Science & Technology, Inc.; and Jingli Yang of Earth Resources Technology, Inc. Further information is contained in a TSP (see page 1). GSC-15011-1

➤ **HDF-EOS 5 Validator**

A computer program partly automates the task of determining whether an HDF-EOS 5 file is valid in that it conforms to

specifications for such characteristics as attribute names, dimensionality of data products, and ranges of legal data values. [“HDF-EOS” and variants thereof are defined in “Converting EOS Data From HDF-EOS to netCDF” (GSC-15007-1), which is the first of several preceding articles in this issue of *NASA Tech Briefs*.] Previously, validity of a file was determined in a tedious and error-prone process in which a person examined human-readable dumps of data-file-format information.

The present software helps a user to encode the specifications for an HDF-EOS 5 file, and then inspects the file for conformity with the specifications: First, the user writes the specifications in Extensible Markup Language (XML) by use of a document type definition (DTD) that is part of the program. Next, the portion of the program (denoted the validator) that performs the inspection is executed, using, as inputs, the specifications in XML and the HDF-EOS 5 file to be validated. Finally, the user examines the output of the validator.

This program was written by Richard Ullman of Goddard Space Flight Center; Bob Bane of Global Science & Technology, Inc.; and Jingli Yang of Earth Resources Technology, Inc. Further information is contained in a TSP (see page 1). GSC-15015-1

➤ **XML DTD and Schemas for HDF-EOS**

An Extensible Markup Language (XML) document type definition (DTD) standard for the structure and contents of HDF-EOS files and their contents, and an equivalent standard in the form of schemas, have been developed. (“HDF-EOS” and variants thereof are defined in the first two of four related articles immediately preceding this one.) More specifically, this standard describes the structure and contents of a single HDF-EOS 5 file based on the HDF-EOS model as published in Volumes 1 and 2 of the HDF-EOS Library Users Guide. The DTD and schemas are easy-to-use representations of a complex file format, enabling display of data in multiple ways.

By means of HDF5 XML software tools from the National Center for Supercomputing Applications, the user can transform HDF5 files into XML files or vice versa. Inasmuch as HDF-EOS 5 files are HDF5 files, the same software tools can

be used to (1) transform any HDF-EOS 5 file into an XML file or vice versa or (2) convert, into an HDF-EOS 5 file, any XML file that conforms to the DTD or schemas.

This program was written by Richard Ullman of Goddard Space Flight Center; Jingli Yang of Earth Resources Technology, Inc.; and Muhammad Rabi of Global Science & Technology, Inc. Further information is contained in a TSP (see page 1). GSC-15016-1

Converting From XML to HDF-EOS

A computer program recreates an HDF-EOS file from an Extensible Markup Language (XML) representation of the contents of that file. (“HDF-EOS” and variants thereof are defined in the first of five related articles that immediately precede this article.) This program is one of two programs written to enable testing of the schemas described in the immediately preceding article to determine whether the schemas capture all details of HDF-EOS files. (The other program converts an HDF-EOS file into an XML file.) This program uses a General Purpose Language (GPL) parser called “expat” to parse XML and control extraction of data from an input XML file.

This program was written by Richard Ullman of Goddard Space Flight Center; Bob Bane of Global Science & Technology, Inc.; and Jingli Yang of Earth Resources Technology, Inc. Further information is contained in a TSP (see page 1). GSC-15017-1

Simulating Attitudes and Trajectories of Multiple Spacecraft

A computer program called “42” simulates the attitudes and trajectories of multiple spacecraft flying in formation anywhere in the Solar System. The rotational dynamics are represented by high-fidelity models of spacecraft, each comprising as many as three connected rigid bodies and containing as many as four flywheel mechanisms for storing angular momentum for controlling attitude. The translational dynamics are represented partly by Encke’s method of orbit perturbation, which enables the use of a reference trajectory shared by multiple spacecraft and, in so doing, enables separation of gigameter-scale trajectory features from nanometer-scale formation adjustments to preserve the numerical accuracy needed for simulating precise multi-spacecraft formations.

Other models include planetary

ephemerides and models for solar-radiation pressure, effects of the terrestrial magnetic field, effects of the terrestrial atmosphere, and non-spherical components of the geopotential. The program provides a graphical display that facilitates visualization of individual behaviors of, and interactions among, the spacecraft in a formation. Models of spacecraft sensors, control laws, and control-actuator dynamics are included; these models can be customized (this can include linking to real flight software) to enable high-fidelity simulation.

This program was written by Eric Stoneking of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14817-1

Specialized Color Function for Display of Signed Data

This Mathematica script defines a color function to be used with Mathematica’s plotting modules for differentiating data attaining both positive and negative values. Positive values are shown as shades of blue, and negative values are shown in red. The intensity of the color reflects the absolute value of the data value.

The quantization is the same for both positive and negative values, so that comparable intensities accurately reflect comparable data magnitudes. Customization is done through several software switches. The number of color bins to be used is selected by “nshades.” “Linear” is set to 1 for a linear mapping of data magnitudes to color, and set to 0 for nonlinear mapping. The nonlinear choice uses a cube root data-mapping to encompass a large data range while accentuating the smaller data values. This innovation allows nonlinear stretching of data to enhance visualization at the low end of the scale while still viewing the entire data range (the data range set by the user).

This work was done by Virginia Kalb of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15128-1

Delivering Alert Messages to Members of a Work Force

Global Alert Resolution Network (GARNET) is a software system for delivering emergency alerts as well as less-urgent messages to members of the Goddard Space Flight Center work force via an intranet or the Internet, and can be adapted to similar use in other large organizations. Messages can be presented

in visible and audible forms on such diverse terminals as desktop computers, portable alphanumeric pagers, telephones, fire alarms, and closed-circuit television. GARNET includes client components running on workers’ desktop computers, and server components running on redundant computers behind firewalls.

An authorized user enters a message, selecting its degree of urgency and the group of intended recipients. The message is then disseminated to the recipients along with a link to more-detailed information. GARNET can deliver a message by server push (in which it interrupts a user’s work to present the message on the user’s computer or other device) or client pull (in which a user’s computer polls the server periodically). GARNET determines whether a given client receives alerts via client pull or server push when the client logs onto the server. To reduce network traffic, GARNET gives preference to server push.

This program was written by Julia Loftis and Stephanie Nickens of Goddard Space Flight Center and Melissa Pell and Vince Pell of Science Systems and Applications, Inc. Further information is contained in a TSP (see page 1). GSC-14927-1

Delivering Images for Mars Rover Science Planning

A methodology has been developed for delivering, via the Internet, images transmitted to Earth from cameras on the Mars Explorer Rovers, the Phoenix Mars Lander, the Mars Science Laboratory, and the Mars Reconnaissance Orbiter spacecraft. The images in question are used by geographically dispersed scientists and engineers in planning Rover scientific activities and Rover maneuvers pertinent thereto.

The methodology, which effects a compromise among levels of image detail, fidelity, and delivery speed, combines image compression with an adaptive level-of-detail image-delivery strategy that scales very well up to larger images that can include mosaic and high-resolution orbital images. In this methodology, images are tiled at multiple levels of detail. An image-browsing application program makes requests for tiles instead of entire images, thereby greatly accelerating delivery of images. At one extreme, a tile could contain a low-resolution representation of what originated as a large mosaic or high-resolution image. At the other extreme, a