SCIENCE INFORMATION SYSTEMS NEWSLETTER

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Welcome to Issue 48

1998

The NASA Science Information Systems Newsletter (SISN) is prepared for the Office of Space Science (OSS), Science Information Systems (SIS) Program through an agreement with the Jet Propulsion Laboratory. The newsletter, which has been an ongoing task for over ten years, is a forum for the space science and applications research community to report research and development activities, outreach activities, and technology transference. SISN offers a venue for articles that are not likely to appear elsewhere and provides the opportunity for information exchange within the science community, as well as a platform for accomplishments by that community. Related articles from other programs and agencies are also published.

Questions or comments regarding this newsletter task may be emailed to Sandi Beck at <sandi.beck@jpl.nasa.gov>.

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The Applied Information Systems Research Program (AISRP) maintains an awareness of emerging technologies applicable to space science disciplines, supports applied research in computer and information systems science and technology to enhance NASA Office of Space Science (OSS) programs, stimulates application development where warranted, and provides for the systems analysis and engineering required to transfer new technology into evolving OSS space science programs through NASA Research Announcements.

Using Client-Side CGI to Implement a PDS Search and Display System

Eliot F. Young, Southwest Research Institute, and Sky Coyote, Intergalactic Reality

Client-Side CGI (CSCGI) is a new technology which allows a web browser (such as Netscape), HTML and Javascript pages, Java applets, and external application programs (e.g. written in C) to interact and exchange real-time data on a local computer, without the use of a web server or Internet connection. As an example of this, an image search and display system was implemented to enhance access to NASA Planetary Data System (PDS) format images. This system allows a forms-based search of a database, and dynamic return of search result pages and thumbnail images/links, and resulting full-scale images and file information.

CSCGI - what is it?

CGI stands for "Common Gateway Interface", which is a World Wide Web protocol by which a web server can call and pass data to and from external programs on a remote computer. Usually this involves calling either CGI scripts (often written in Perl) or binary programs (often written in C). To communicate with a CGI program, the web server uses a set of environment variables, and typically passes HTML form data via the stdin and stdout file handles of the program. That is, the CGI program reads its standard input to get a set of variables to process, and returns results to the web server via its standard output.

CSCGI differs from CGI in that it does not involve a remote system, a web server, an Internet connection, or local Internet software such as TCP or PPP. In CSCGI, HTML form data and results can be passed directly between the web browser and an external CGI program on the local system.

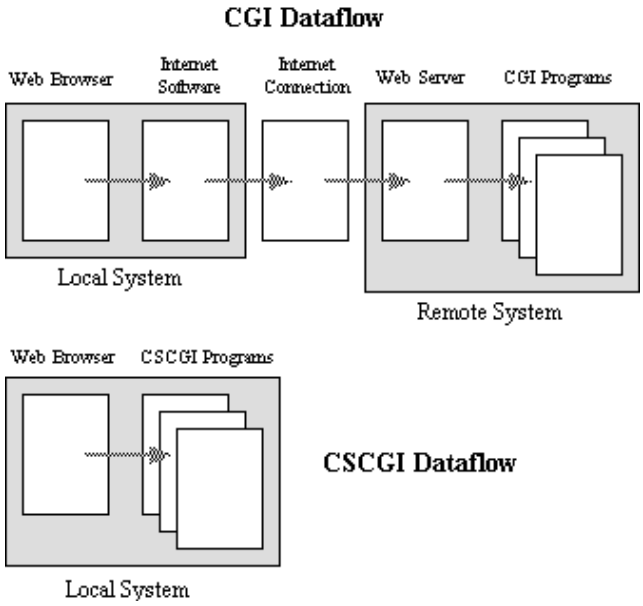

Figure 1. Comparison of dataflow

In CGI, the flow of data goes from the calling HTML page, to the web browser, to the Internet software and hookup, to the remote web server, and then to the remote CGI program. In CSCGI, the flow of data goes from the calling HTML page, to the web browser, to a Netscape plugin, and then directly to the CGI programs on the local system. Some of the important features of this architecture are:

1. By using CSCGI, component applications consisting of several independent C programs can be coordinated and managed as a single program on a local computer.
2. One or more HTML web pages act as the user front-end for such a component system, so that all graphical I/O and control is performed through the standard operations of a web browser. This means that a graphical user interface can be implemented with standard form elements available in HTML.

3. This architecture is transparent to the user, and the overall performance is comparable to that of a stand-alone C program.
4. CSCGI provides access to legacy code written in Fortran, C, etc..., from a browser.

To enable CSCGI, a feature of Netscape 3-4 called LiveConnect is used, which essentially allows the creation of a Java interface for a C plugin. Unfortunately, this means that CSCGI applications currently run only under Netscape 3-4 (version 4 strongly recommended). At present, a Netscape plugin and associated CSCGI programs are written for the Windows95 operating system, although Macintosh support is expected soon.

A CSCGI program (whether it is written in C, Perl, Fortran, etc...) must parse its CGI variables, perform some specific operation, format the result as an HTML page or specific text or binary data, and return the result via stdout. A Netscape CSCGI plugin provides the data interface from the browser, Javascript, and Java, to the external CGI program.

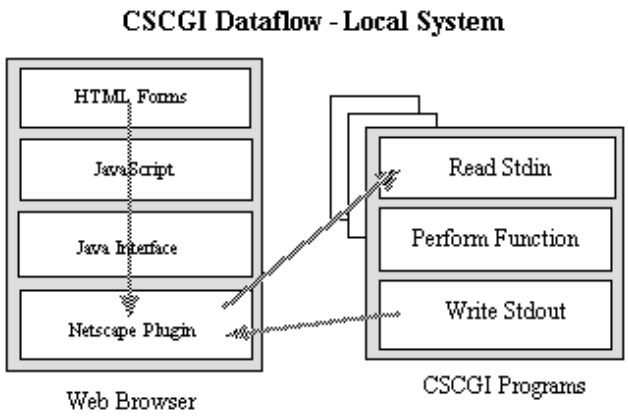

Figure 2. Data interface to external program

During typical use, the browser displays an HTML page that contains form elements. Javascript handlers and functions package this form data (including URL escape encoding), as if it were to be sent to a remote CGI program using the POST method. The CSCGI plugin writes a few CGI environment variables (such as CONTENT_LENGTH), launches an external program by name, and opens pipes to its standard input and output. Nearly every scripting and programming language (e.g. Fortran, Basic, C, Perl, TCL/TK, etc...) can communicate with the CSCGI plugin via the stdin and stdout pipes.

The plugin writes the input data string to the program, and then waits and reads the program's stdout until end of data is received. The resulting string is formated as a Java String, and is returned to the Javascript function in the calling HTML page. In the HTML page, the result from the CSCGI call can be displayed as another HTML page, or used as binary data passed to another Javascript or Java applet function.

CSCGI uses

As a test case example of a CSCGI component application, it was decided to build a Planetary Data System (PDS) CD-ROM image search and display browser. The PDS series contains, among other images, all of the Voyager 1 and 2 images of Saturn on 2 600 Mb CD-ROMs. This catalog consists of just over 4000 images and a text file database of common image information. The PDS image format is unusual (for example, it cannot be opened by Photoshop without a special plugin), and is compressed using variable-length records which require the use of special software to convert an image to binary format.

The goal was to build a turnkey system which would search the text-file PDS database included on the CDs and return images and file information based on search crieteria entered from an HTML page. It was envisioned that this system would work much like a search program on the web such as AltaVista, with the addition of a built-in image and file information viewing capability.

This system was built using the CSCGI technology described above. The search and display engines are stand-alone C programs which do not require an Internet connection, a remote computer, nor a web server. The overall system consists of a small number of HTML pages, Java applets, and C programs, rather than a large monolithic application. The main components of the system are an HTML search form, one or more search result pages created by the search engine, and a Java-based PDS image and file viewer.

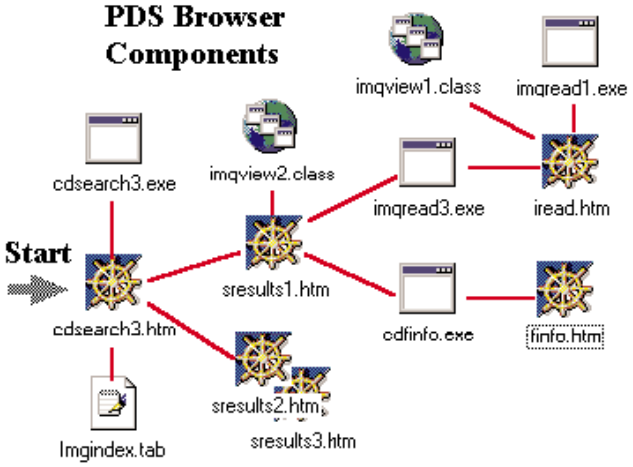

Figure 3. PDS browser components

The web pages consist of:

- cdsearch3.htm: The search form page
- sresults#.htm: One or more pages of search results
- iread.htm: The PDS image display page
- finfo.htm: The PDS file information page

The Java applets of the system consist of:

- imqview1.class: A Java applet to display a full-size PDS image
- imqview2.class: A Java applet to display a thumbnail PDS image

Finally, the CSCGI programs consist of:

- cdsearch3.exe: The search engine which produces HTML result pages
- imqread3.exe: The program which produces the image display page
- imqread1.exe: The program which decompresses the PDS image
- cdfinfo.exe: The program which writes the HTML file info page

Figure 4. An example of a simple search criteria form page

Below is an example of one of the search result pages created by the search engine. These pages are written "on the fly" by the stand-alone search program called by the search form. They contain a summary of the search query, and an ordered list of those PDS records which best match the search criteria. Search results are saved to disk (e.g. "sresults1.htm") so that the most recent search can be revisited by simply loading an HTML page. Thumbnail images of each PDS image are also decompressed from the CD-ROM and displayed "on the fly" by a set of Java applets embedded in the page. One or more such pages can be returned:

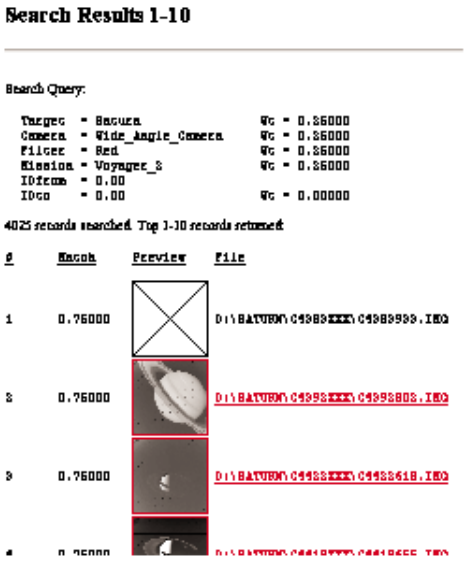

Figure 5. An example of search results.

Selecting one of the thumbnail images or links in a search result page launches a PDS image viewer and file information page (those images which are in the database, but are not on the currently mounted CD-ROM, do not create links or thumbnails). Again, the PDS image is decompressed from CD-ROM and displayed by a Java applet, at one of several magnifications. Another CSCGI program reads the text database, and creates an HTML page containing a listing of the record that corresponds to the displayed image:

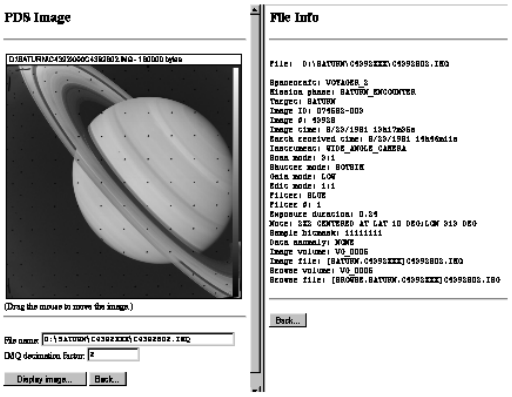

Figure 6. A listing of record that corresponds to the image

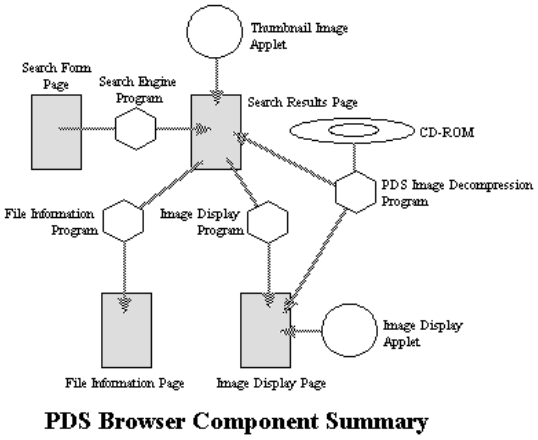

Figure 7. A graphical summary of how this system fits together

This PDS example was meant only as a test case for CSCGI, although it may become an independent product or a prototype for a more generic on-line image database search and display system. Other examples of using a component CSCGI system might also include adding file reading and writing capabilities to normal Java applets, or maintaining and interacting with a large, live, database using "continuous connect" CSCGI mode.

Please note that this system only works under Netscape 3-4, and that version 4 is strongly recommended. Please also note that this system uses Java 1.0.2. Additional examples and documentation will be available in Summer of 1998.

Get CSCGI or learn more about CGI programming and learn more about the Applied Information Systems Research Program by emailing Dr. Eliot at <efy@everest.boulder.swri.edu> or by accessing the Intergalact link for CSCGI plugins and programs <http://www.intergalact.com/cscgi/> or the CGI programming link <http://www.intergalact.com/hp/part3/part3.html>. ■

Researchers Increase Understanding of Earth and Space Phenomena Through Simulations

Jarrett Cohen, Science Writer, Goddard Space Flight Center

A critical tool for Earth and space sciences research is high-performance computing and communications (HPCC). Simulations on the most powerful computers provide evidence for how phenomena evolved by filling in gaps left by observations and also describe the behavior of as-yet unobserved objects whose existence is surmised by theory.

In August 1996, NASA HPCC's Earth and Space Sciences (ESS) Project awarded three-year cooperative agreements to nine "Grand Challenge" investigator teams from across the United States. A simultaneous agreement with Silicon Graphics, Inc., supplies world-class computational resources in the form of a 512-processor CRAY T3E at Goddard Space Flight Center. In the first-ever Science Team Symposium, team principal investigators and co-investigators presented their latest findings at NASA Headquarters on April 2.

Testing general relativity

Einstein's theory of general relativity insists that space and time are dynamic. A strong test for the theory is neutron star mergers, involving pairs of objects packing our sun's mass into a city-sized space! The principal investigator is Paul Saylor, University of Illinois at Urbana-Champaign. Presenting was co-investigator Doug Swesty, also of the University of Illinois. Swesty related a major accomplishment: the first model of a neutron star's evolution with full relativisitic behavior was completed by team members from Washington University in St. Louis.

Swesty also explained how the team is challenged by the new generation of orbiting astronomical observatories. Last September, the Hubble Space Telescope captured a gamma-ray burst in an optical wavelength for the first time. The observation showed that bursts can originate in other galaxies besides our own. Because of the distance and the tremendous energy involved, some scientists believe neutron star mergers cause the bursts. The difficulty is that mergers occur in a few milliseconds while a burst can last as long as 1,500 seconds, a mystery the team is trying to unravel.

A complicated sun

Strong magnetic activity in the sun and sun-like stars leads to many spectacular and well-observed phenomena like sunspots, solar flares, the solar cycle and the solar wind. The University of Chicago's Andrea Malagoli, principal investigator, said that the most likely underlying mechanism is turbulent convection interacting with magnetic fields below the sun's surface.

The team has carried out large-scale simulations of this magneto-convection as well as dynamo processes, which convert kinetic energy into magnetic energy. Malagoli said they use three computer codes because the sun is so complicated that it is necessary to model a local zone applying as much resolution as possible to get credible answers. Together with observations, the models suggest that the sun rotates differentially, convection occurs in the star's upper third, and energy is generated in the core. Malagoli called the results "novel and unique" in that they explore complex physical regimes where the underlying equations are strongly nonlinear.

Modeling solar activity

Studying the sun's outer atmosphere, or corona, is a Naval Research Laboratory (NRL)-based team, which was represented by Spiro Antiochos. Led by NRL's John Gardner, they have developed three codes for modeling coronal activity. Antiochos presented results from simulations of solar prominences and the initiation of coronal mass ejections (CMEs). The key features of the phenomena lie in the 3-D complexity of the solar magnetic field, he said.

Scientists had been baffled as to how material can be held far above the sun's surface in a prominence. NRL models show a tug of war between two sets of magnetic field lines forcing material to bulge outwards. The resulting s-shaped structure agrees with observations. In the CME studies, the team found that magnetic field lines can travel in four different directions. Antiochos likened coronal masses to helium balloons held down by tethers. As "tether" magnetic field lines are moved out of the way through breaking up and reconnecting with other field lines, a CME can be released and erupt through the surface.

The streaming solar wind

CMEs travel out from the sun riding the solar wind, a gaseous mixture of protons, helium atoms and ions. As a CME interacts with Earth's magnetic field, it can fuel magnetic storms that knock out satellites and power grids. A University of Michigan team, headed by Tamas Gombosi, has built a versatile code to simulate CMEs and a variety of other solar wind phenomena, including interactions with

comets, Mars and Venus. Their largest model to date follows a CME's path from formation for 40 hours.

Co-investigator Ken Powell explained how their code uses adaptive mesh refinement. The mesh on which the governing equations are being solved adapts, on the fly, to the gas flow. In this way, under-resolution of high-gradient regions and over-resolution of low-gradient regions are avoided, leading to highly efficient use of computer resources. In addition, they took a "start from scratch" approach with their model code, designing with maximum parallel performance in mind. The resulting code has high single-processor performance and scales with very high efficiency.

Fluid behavior in microgravity

Another original code was developed by University of Texas at Austin researchers for studying coupled viscous fluid flow and heat transfer in microgravity environments. Surface tension rather than buoyancy becomes a dominant factor, and there are interesting nonlinear free surface effects that still are not understood, explained Principal investigator Graham Carey. For example, nonlinear instabilities can lead to flow patterns that depress or raise the surface. In a related problem called the "liquid bridge," a thermal band rotates around the surface like the stripe on a barber pole; a thermal probe applied near the surface can control the behavior.

Carey said their primary interests are manufacturing and life support processes on the International Space Station, NASA's space shuttle, and future space projects. The simulations also have close interplay with terrestrial experiments involving free surface phenomena on thin films, which are used to manufacture computer chips. Carey also mentioned the possibility of modeling fires with the code, particularly oil fires on water, where surface tension plays a role.

Probing the geodynamo

Like the sun, the Earth is among the majority of solar system planets possessing magnetic fields that originate from self-sustaining dynamos. Principal investigator Peter Olson, Johns Hopkins University, said the Earth has the three necessary ingredients for a dynamo: a sufficiently large volume of electrically conducting fluid in its iron-rich outer core, energy from core-to-mantle heat transfer to circulate the fluid and planetary rotation to impart helicity to the fluid motions.

A major finding is that the Earth's inner core rotates faster than the outer core, matching seismological observations for the first time. Simulations show the inner core setting outer core fluids in motion to create the dynamo. The team's dynamo models exhibit occasional reversals in magnetic polarity when the heat flow on the boundary between the liquid core and solid mantle is spatially heterogeneous. These results suggest that thermal coupling between the core and the mantle may be the ultimate cause of geomagnetic polarity reversals. Olson said they will be investigating this "holy grail of magnetic fields" more closely.

Observing Earth with radar

Synthetic aperture radar (SAR) is an anytime, all-weather instrument. The sheer mass of collected data makes for a computational challenge. For instance, it has taken five years to process the ten-day SIR-C mission flown on the space shuttle, according to principal investigator Dave Curkendall, Jet Propulsion Laboratory (JPL). His team is moving towards giving scientists real-time processing capabilities with a Scalable SAR Software Suite that works with multiple types of SAR data and in a heterogeneous computing environment.

Advancing the Suite are three critical SAR applications. One involves Southern California tectonic plate movements during and between earthquakes. Scripps Institution of Oceanography researchers developed a technique to better interpret and average data from multiple SAR satellite passes. University of California, Santa Barbara scientists recently found multiple satellites useful for globally forecasting water produced by melted snow. JPL made significant progress in identifying flooding and deforestation in the Amazon rain forest and built the Digital Light Table software to display very large SAR mosaics.

Simulating the climate system

Roberto Mechoso, University of California, Los Angeles (UCLA), leads a team developing an Earth system model, including chemical tracers that are found in, and may be exchanged between, the atmosphere and the oceans.

UCLA colleague John Farrara described their atmospheric general circulation model (AGCM) and its coupling with an oceanic general circulation model (OGCM). A 50-year run of the coupled model produced El Ni–o conditions every three to four years, although their magnitude was not as big as reality. A higher-resolution AGCM, with prescribed sea surface temperatures, agreed reasonably well with United States precipitation amounts observed during the recent El Ni–o.

JPL's Yi Chao discussed a North Atlantic version of the OGCM, run at 1/6-degree resolution for 40 years, the longest simulation of its kind. Additional unique aspects are the production of a realistic Gulf Stream and narrow ocean currents known as eddies. The correct ocean heat transport is impossible without resolving eddies, which also bring nutrients up from the deep ocean. Chao said the team probably can do a 1/6-degree model of the global ocean.

Better atmospheric data assimilation

Data assimilation combines actual observations with climate model simulations to produce a more accurate description of the Earth system than the observations alone provide. Principal investigator Peter Lyster, University of Maryland, related that 80 percent of atmospheric observations come from satellites; other sources include weather balloons, aircraft, ships and surface instruments. This team aids NASA's Data Assimilation Office in its mission to provide data sets for climate research and to support agency satellite and aircraft missions.

Team research falls into two areas: a large-scale data assimilation system and the Kalman filter. Lyster described performance gains with the system, which includes an analysis routine and a climate model. The system currently can process six days of data in 24 hours; the goal for 1999 is 30 days. The more computationally demanding Kalman filter evolves observations and their errors through space and time. A study of methane gas showed less-than-expected mixing occurring in the stratosphere.

Learn more about the ESS Project by accessing the ESS Project <http://sdcd.gsfc.nava.gov/ess/> and Grand Challenge investigator team <http://sdcd.gsfc.nasa.gov/ESS/grand.st2.html>. ■

A Registration Toolbox: Towards a Quantitative Evaluation of Automatic Image Registration Algorithms

Jacqueline Le Moigne, USRA/CESDIS, and Wei Xia, RSTX

The Goddard Space Flight Center (GSFC) Image Registration Research group is developing image registration algorithms integrated into a Toolbox, under support of the Applied Information Science Branch (AISRB) of GSFC's Earth and Space Data Computing Division. The objectives of this work are to:

1. develop an operational toolbox which consists of some of the most important registration techniques
2. provide a quantitative evaluation of the different image registration methods, which will allow a user to select desired registration techniques

The first prototype of the Image Registration Toolbox contains seven different image registration methods. The Toolbox has been developed under Khoros, which is an object-based data analysis, data visualization, and application development environment. Khoros is also an open software system, which will enable our group to widely distribute the Toolbox and get feedback from a variety of users. The Toolbox will first be distributed with the Regional Application Centers' software. Several scientific groups at GSFC also have expressed interest in utilizing this prototype. Feedback from the scientific community as well as results of on-going evaluation will be later integrated in the design of future versions of the Toolbox.

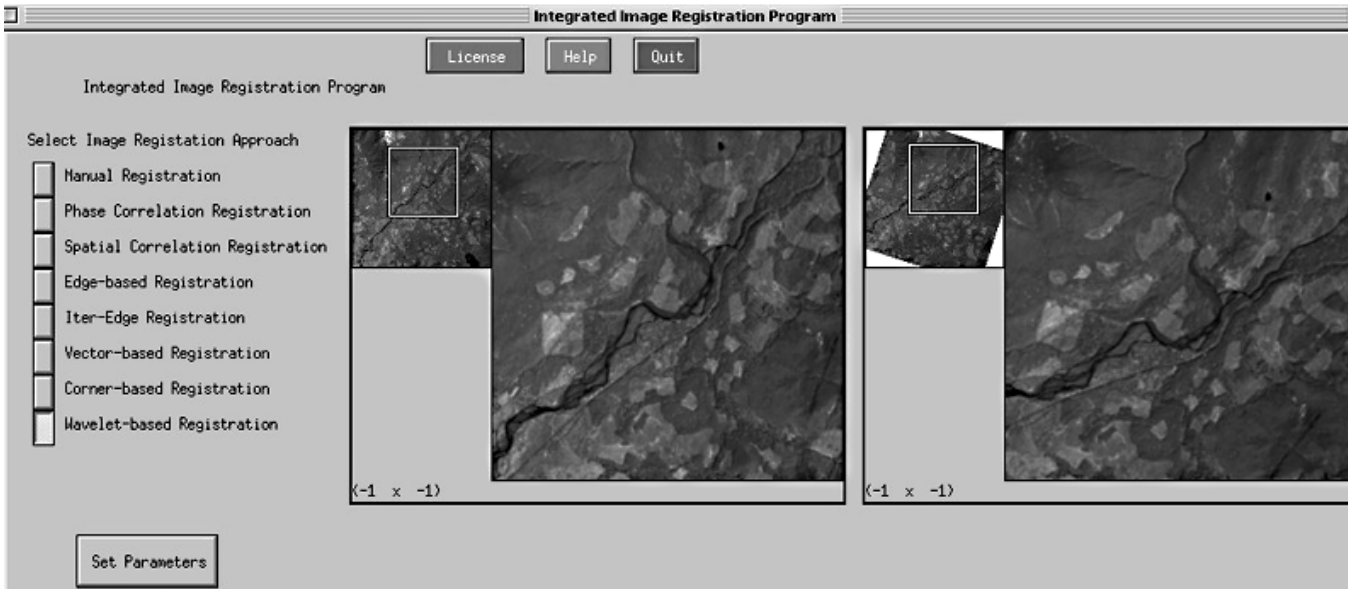

Figure 1. Toolbox Graphic User Interface. Visualization of Images to be Registered and Selection of an Image Registration Method

It is unlikely that a single registration technique will satisfy all different applications. Although automated registration has been developed for a few Earth science applications, there is no general scheme which would assist users in the selection of a registration tool. By providing the results of an intercomparison of multiple registration techniques, we will enable the users to choose the method which is the most appropriate for their particular application. Having all the algorithms implemented in a single toolbox will reinforce their ease of use and will provide the visualization capabilities that will facilitate this choice.

Applicable algorithms

The first step in the integration of multiple data is registration, either relative image-to-image registration or absolute geo-registration, to a map or a fixed coordinate system. Currently, the most common approach to registration is to extract a few outstanding characteristics of the data, which are called contro l points (CP's), tie-points, or reference points. The CP's in both images (or image and map) are matched by pair and used to compute the parameters of a geometric transformation. Most available systems follow this registration approach, and because automated procedures do not always offer the needed reliability and accuracy, current systems assume some interactive choice of the CP's. But such a point selection represents a repetitive, labor- and time-intensive task which becomes prohibitive for large amounts of data. Also, since the interactive choice of control points in satellite images is sometimes difficult, too few points, inaccurate points, or ill-distributed points might be chosen thus leading to large registration errors. As this need for automating registration techniques is recognized, we feel that there is a need to survey all the registration methods which may be applicable to Earth and space science problems and to evaluate their performances on a large variety of existing remote sensing data as well as on simulated data of soon-to-be-flown instruments.

Image Registration Toolbox

The first version of the toolbox includes the following techniques:

- semi-manual registration where pairs of corresponding control points are manually selected, followed by the transformation computation (with choice of polynomial, rotation, translation, rigid or affine transformations)
- correlation-based methods including phase correlation and spatial correlation
- feature-based methods with edge-, corner-, and wavelet-based methods. Other region- and contour-based methods are being integrated as well. Future versions will also include pre-processing tools, such as cloud masking, and post-processing tools, such as the interpolation of the matching functions, matching based on moment invariants, as well as statistical robust matching of control points

When first interacting with the Toolbox, the Khoros graphic user interface (Figure 1) enables you to visualize the pair of images to be registered, with zooming and pointing capabilities, as well as to see the choice of registration methods which you can select from. When one particular automatic image registration method is selected, parameters can either be tuned by the user or default values are utilized. Then, you select the "perform registration" button and a new window appears on your screen. This new window (Figure 2) corresponds to the execution of the automatic method and the results of the chosen method; in this example, "wavelet-based registration" has been selected.

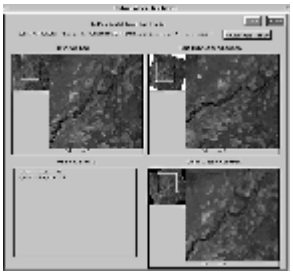

Figure 2. Toolbox Graphic User Interface. Running the Automatic Wavelet-Based Image Registration

Quantitative evaluation and intercomparison

Intercomparison of the current tools is underway and evaluation criteria will include accuracy, computational requirements, level of automatization, as well as applicability of the various algorithms. The Toolbox algorithms will first be evaluated on a large variety of NASA datasets. They will represent at least three main types of applications:

1. multi-Temporal Studies with multi-temporal datasets of one sensor over the same areas collected at different times such as AVHRR/LAC, Landsat/TM, GOES
2. multi-Instrument Data Fusion with multi-sensor datasets representing multiple spatial, temporal and radiometric resolutions, such as AVHRR/LAC versus Landsat/TM or MSS, GOES versus Landsat/TM or AVHRR/LAC, Landsat/TM versus SPOT, and MAS versus Landsat/TM
3. channel-to-Channel Co-Registration with multiple radiometric and spatial resolutions of the different channels of one given sensor, such as GOES, MAS, and an hyperspectral instrument such as ASAS

After a first evaluation, the Toolbox with the results of the evaluation will be made available to the scientific community. From comments and feedback, new evaluation criteria as well as new registration techniques might be defined and will give rise to a new version of the Toolbox.

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Learn more about the Earth and Space Data Computing Division And AISB by accessing the ESDCD at <http://esdcd.gsfc.nasa.gov/> and AISB at <http://code935.gsfc.nasa.gov/>. ■

Mars Program Honored at Planetary Society's "An Evening on Mars"

A benefit reading of Ray Bradbury's science fiction was presented by the Planetary Society on May 18. The event, which was open to the public, was a showcase for the annual presentation of the Society's Thomas O. Paine Memorial Award for the Advancement of Human Exploration of Mars. The sold-out event, a celebration of the excitement of traveling to the Red Planet (in fiction and in fact), was hosted by Bradbury himself, who also compiled the selections of his writings.

Well-known actors, representing a cross section of stage, screen, and television, performed the readings for the special event, which was held at the Pasadena Playhouse in Pasadena, California. The cast included veteran film actors Charleton Heston and John Rhy-Davies, as well as several members of various television science-fiction series (Star Trek, Deep Space 9, and Babylon 5) Nichelle Nichols, Tim Russ, Robert Picardo, John de Lancie, and Peter Jurasik. Stage actress Barbara Beckley, who has appeared in Bradbury's The Martian Chronicles, was also part of the company. Additionally, comedian Stan Freberg, with his "Martian friend," Orville, made an appearance. Michael Wadler directed the company.

Thomas Paine fervently hoped that one day people will settle Mars, making the human race a multi-planet species. Planetary Society President, Bruce Murray, described Paine as a man of extraordinary vision who saw clearly both the benefits and need of a future where humanity extended its presence to Mars.

This year's award was presented to members of the Mars Program participating in the Mars Pathfinder and Mars Global Surveyor projects at Jet Propulsion Laboratory. Recipients were Donna Shirley, head of Mars Programs, Tony Spear, project manager for Mars Pathfinder, and Glenn Cunningham, project manager for Mars Global Surveyor, each of whom accepted the award on behalf of the Mars teams. Selected members of these teams were invited guests to the special event.

Previous winners of the Thomas O. Paine award include NASA Administrator, Daniel Goldin, Christopher McKay, NASA scientist at Ames Research Center, and the crew of the Apollo-Soyuz mission. ■

Grand Challenge Investigators Achieve Breakthrough Use of High Performance Networks for Collaborative Research

J. Patrick Gary, Network Projects Leader - Science communications Technology Branch, and Judy Laue, Science Writer - Raytheon STX, Goddard Space Flight Center

In a high-performance networking "first," a Grand Challenge team of NASA's High Performance Computing and Communications (HPCC) Earth and Space Science (ESS) program has begun reaping the benefits of plans to set up and utilize an interconnection of several high performance networks. Throughput over 20 times faster than existing connections will allow the transfer of large data sets from the HPCC/ESS Cray T3E computer at Goddard Space Flight Center (GSFC) to visualization sites local to the Principal Investigators (PI's), and will involve real-time reliable multicast remote visualizations simultaneously with interactive collaborations among these sites.

The NASA HPCC/ESS Turbulent Convection and Dynamos in Stars project (Andrea Malagoli/University of Chicago, PI) runs parallel applications on GSFC's Cray T3E. A multisite team from the Universities of Chicago, Minnesota, and Colorado manage these applications, which generate data sets up to 1.5 TB. Malagoli, in conjunction with his team, proposed that remote visualizations to a CAVE or ImmersaDesk be done with the T3E-generated data sets, as well as other experiments including remote steering, and teleconferencing/collaborations, using the National Science Foundation (NSF)-sponsored very high speed Backbone Network Service (vBNS), the NASA-managed NASA Research and Education Network (NREN), and the Department of Energy (DoE)-managed Energy Science network (ESnet). Wanting faster throughput for their applications, Malagoli committed his team's core network experts to work with similar experts at GSFC, NREN, vBNS, and ESnet to create end-to-end high performance interconnections through these networks. Already the joint network team has:

Established new peering agreements at the Next Generation Internet Exchange in Chicago among the NASA/NREN, National Science Foundation/vBNS, Department of Energy/ESnet, and University of Chicago/MREN, Enabled ATM-based 155 Mbps virtual circuits among GSFC and each of the remote sites, and Obtained end-to-end throughput performances of nearly 80 Mbps in large data set transfers from the T3E at GSFC. This throughput is over 20 times faster than the existing connection to the T3E over the Internet.

Later in this project's first stage, which is expected to be completed by August 1998, the investigators will use the network infrastructure to multicast visualization data among GSFC and the three PI sites. The results of the network team effort are also serving as a prototype for other researchers in the Earth and space sciences to follow. GSFC's lead participant in the network team is William Fink, together with Lisa Bernard. ■

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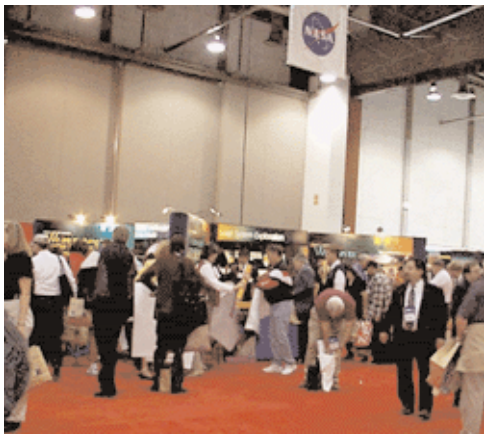
NASA Big Contributor to Science Teachers' Convention

Science is the best game in town!

Such was the motto of the National Science Teachers Association (NSTA), which held its 46th annual convention in Las Vegas, Nevada, in April. An estimated 16,000 plus educators from every state in the US and from 23 foreign countries convened in what is called the "Jewel of the desert" to "unlock untold adventures in science." Each year the NSTA convention offers a multitude of opportunities for science teachers and other educators and interested persons to continue training in various science disciplines through workshops, panel and lecture sessions, short courses, and exhibits.

Exhibiting NASA

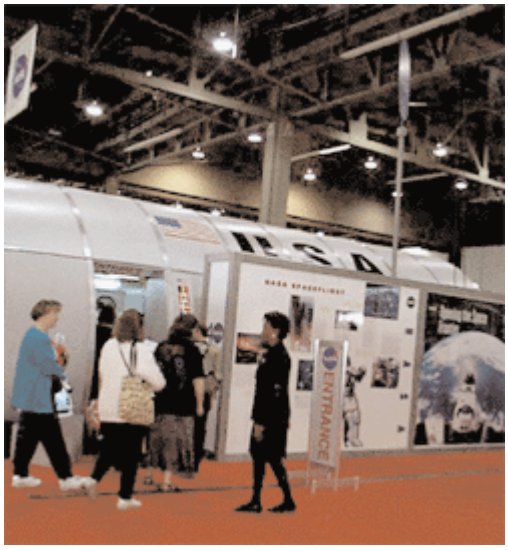
Each year NASA hosts one of the most popular, and traditionally the largest, exhibit arenas at the conference, representing the Human Exploration and Development of Space Enterprise, the Office of Space Science, the Earth Science Enterprise, the Mobile Aeronautics Education Laboratory, The Aeronautics and Space Transportation Technology Enterprise, NASA Technology Transfer, and the NASA Education Program. The NASA exhibit provided thousands of free Earth and space science hand-outs to attendees.These materials, which include photos, posters, brochures, CD-ROMs, activity packets, are always a big hit and distribution goes quickly, like the proverbial "hotcake."



NASA exhibit arena

The Human Exploration and Development of Space Enterprise exhibit demonstrated human activity to build a better future for all humankind by exploring, using, and enabling the development of space. The life sciences experiences included STELLAR, a teacher workshop project; Neurolab, a experiment aboard the Space Shuttle orbiting during the conference; and BioBlast, which focuses on advanced human life support technologies. Amateur radio specialists were on hand to answer questions about the Space Amateur Radio Experiment (SAREX). A drop tower demonstration illustrated basic principles fundamental to the disciplines of fluid physics, combustion science, and materials science. Flight hand-controllers of a docking simulator, a robotic arm simulator, and a fly through of the International Space Station were available, along with live videoconferences with the Johnson Space Center in Houston showing the mock-up of the Shuttle and International Space Station facilities.

Getting info on the space shuttle



Teachers tour the space shuttle

The Office of Space Science hosted a 900 square foot booth based on NASA's four main science themes: the Sun-Earth connection, Structure and Evolution of the Universe, Solar System Exploration, and the Astronomical Search for the Origins of Life and Planetary Systems. The consortium of Jet Propulsion Laboratory, Goddard Space Flight Center, Ames Research Center, Johnson Space Center, Space Telescope Science Institute, Lunar Planetary Institute, and the Space Science Institute participated in this exhibit.

The Earth Science Enterprise presented the latest news about a major initiative to understand our home planet. Visitors were able to talk with Earth scientists and managers about their latest research results and exciting new education programs and observe demonstrations of uses for Earth science imagery available over the Internet and on CD-ROM.

The Mobile Aeronautics Education Laboratory provided a mobile, state-of-the-art classroom that uses new technologies to excite students about science, mathematics, and technology. At 10 workstations, visitors explored these technologies through hands-on/minds-on activities that modeled real world challenges in aviation. Each workstation provided essential data for the completion of a simulated cross-country flight.

The Aeronautics and Space Transportation Technology Enterprise provided curriculum supplements using NASA programs as examples of principles in mathematics, science, and technology, such as Exploring Aeronautics. This CD-ROM, primarily for grades 4-6, explores the why and how of aircraft design and flight.

The NASA Technology Transfer booth highlighted a variety of consumer products and devices resulting from space program research. Emerging technologies and their implications for the 21st century were focal points.

NASA Education Program booth presented continuous hands-on mini workshops and technology demonstrations for Earth, life, physical, and space sciences. NASA provides a universe of educational programs, materials, and services for kindergarten through post-graduate levels.

Featured speakers

Donna Shirley, manager of the Mars Exploration Program at JPL, and Bruce Murray, former director of the Jet Propulsion Laboratory and current president of the Planetary Society were featured speakers at this year1s conference. In her talk "Learning from Mars," Ms. Shirley discussed how the Mars Exploration Program will provide a unique opportunity for a continuous stream of science and educational information over at least the next 10 years. The information is designed to interest and inform students and should provide a potent base of material for science teachers. The Mars Exploration Program is designed to support the training of and supply information to America's community of science teachers.

Murray spoke on "The Search for Life Elsewhere." For hundreds of years scholars have debated the possibility of life existing elsewhere in the universe. Murray presented an intriguing look at current research in the field, as well as a preview of what may be in store with upcoming missions of exploration in the next millennium.

In addition to Shirley and Murray, Christopher Mckay, a planetary scientist with the Space Science Division os Ames Research Center, presented a special session, sponsored by the American Geophysical Union. McKay, who has been involved with polar research in the Antarctic dry valleys and the Siberian and Canadian Arctic (Mars-like environments) spoke on "Life in Extreme Environments." According to Mckay, although the Viking mission results may indicate that Mars has no life today, there is direct geomorphologicl evidence that, in the past, Mars had large amounts of liquid water on its surface, possibly due to a thicker atmosphere. From a biological perspective, the existence of liquid water by itself mottivates the question of the origin of life on Mars. McKay stated that ecosystems, such as the Antarctic, in cold, dry locations on Earth provvide examples of how life on Mars might havve survived and where to look for fossils. ■

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NASA Embraces Space Day '98

Renee N. Juhans, NASA Headquarters, Washington, DC

NASA Administrator, Daniel S. Goldin, held "chats" with students around the world on May 21 as part of this year's Space Day celebration. Cyber Space Day,1998's annual interactive webcast devoted to space, was broadcast from the Mall in Washington, DC, allowing students to conduct live interviews with prominent figures from the public and private sectors who have made significant contributions to space exploration. In addition to Goldin, other "chat" participants included Senator John Glenn; Barbara Morgan, astronaut candidate/education mission specialist; David Levy, amateur astronomer, author and comet discoverer; and Dr. Mae Jemison, former astronaut and college professor.

Space Day, sponsored by the National Advisory Board, was co-chaired by Senator Glenn and the Chairman of the Board of Lockheed Martin, Norman Augustine, to stimulate interest in science, math and technology education through the excitement of space exploration. NASA, along with more than 34 partner organizations in the educational, scientific, public and private sectors joined to celebrate this national event.

"I am pleased to see Space Day focus on education and embrace children as well as their parents and teachers," said Goldin. "NASA appreciates the role Space Day plays in helping to communicate the importance of science, mathematics and technology education. These efforts help lay the foundation for inspiring the children of the world to reach for the stars."

In recognition of Space Day, NASA Centers around the country hosted a variety of events:

At NASA Headquarters Senator Glenn, Payload Specialist on STS-95, was the featured speaker at the NASA Research and Human Health Symposium at George Washington University. His talk focused on his return to space.

At Ames Research Center 1250 elementary school students and their teachers participated in over twenty-five activities about the Moon and space exploration. Students were able to participate in the building of a Lunar Prospector model, a mission simulation, and the construction of a lunar habitat. They were also able to make their own craters and meet astronauts.

Jet Propulsion Laboratory presented "A Day on Europa," which took place over two days because daylight on Europa lasts about two Earth days. The scheduled activities in numerous American cities were transformed into global village events via the Internet. Highlights included new imagery of Europa taken by the Galileo spacecraft and a panel discussion entitled "Europa - Another Water World?"

Kennedy Space Center Visitor Complex hosted Discover magazine, Star Trek, Fox 35 Kids, and Cool 105.9 Day. These events featured exhibits, a scavenger hunt, and appearances by former astronauts, including Captain Alan Bean, Dr. Ed Gibson, Colonel Mike Mullane, Colonel Buzz Aldrin, Captain Gene Cernan, Commander Scott Carpenter, Captain Wally Schirra, and Dr. Story Musgrave, as well as special character appearances.

At Goddard Space Flight Center more than 100 fourth grade students participated in a variety of activities that included Space Bingo, Send Your Name to Mars, Planet Garden, How to Calculate Your Age and Weight on Another Planet, Exploring Earth From Space, Cyber Space Day, 101 Reasons to Explore Space, and tours of the center.

At Johnson Space Center the Challenger Center for Space Science Education took fourth through eighth grade students on a special electronic field trip that celebrates the human spirit of exploration. The event, which was broadcast via satellite, brought youngsters behind the scenes to witness first-hand how robotic, human, and ground-based missions are used to unveil the mysteries of our universe.

Credit: Image courtesy of Space Day homepage.

Learn more about Space Day '98 by accessing the Space Day web site <http://www.spaceday.com/>. ■

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Students Get Real-Time Moon Data Via Internet

John Bluck, Information Systems Liaison - Public Affairs, Ames Research Center

For the first time, students and the general public are viewing continuous, real-time science data and spacecraft telemetry on the Internet as it is sent back from a mission orbiting another planetary body, courtesy of NASA's Lunar Prospector website. The website audience is viewing actual data coming from the Moon-orbiting spacecraft. The Internet audience can also view NASA documentaries, short video clips and hundreds of thousands of archived Moon pictures from all previous lunar missions. In addition, the website audience is able to monitor the health of the Lunar Prospector spacecraft while it orbits our closest neighbor in space.

First-hand data

"For most past missions, data belonged to the principal investigator for up to a year or two before being released," said Deputy Lunar Prospector Mission Manager, Sylvia Cox, of Ames Research Center (ARC). "Now, with Prospector and many other new missions, we are releasing data at the same time the scientists see it."

"We have received thousands of e-mails from students, teachers, professors, and scientists around the world about the website and the instant release of mission information and Moon data," said Lunar Prospector outreach specialist, Lisa Chu-Thielbar, also of ARC. "We have made an educational impact because students can experience the thrill of space and discovery first-hand."

"We are using technologies in ways they have never been used before," said Roger Smith, Lunar Prospector webmaster at ARC. "Real-time science data graphs from an orbiting spacecraft are being distributed world wide via the Internet."

Using the site

Although the website can be viewed with a variety of Internet browser software programs and most kinds of computers, the site works best with Netscape 4.0 software using connections with 28.8 Kbps-modem to T1 speeds. To view data, you select the "DATAVIZ" button on the website and then click on "Science Data." After following directions, you can see spacecraft data in computer "windows" that remain visible even while other windows are open. By clicking on the "Location/Position" link, you can see archived pictures that represent the Moon's surface immediately below the space vehicle.

"Because the spacecraft has no camera, we have synchronized high-resolution Moon images from previous missions with the orbiter's real-time location. By watching data and location windows, you can relate science data directly to locations on the Moon," said Kenneth Bollinger, Lunar Prospector website project manager. "We expect to have millions of images on line in a month or so."

Bollinger added that they are uploading into their archives complete electronic books that include all of NASA's Special Publications related to the Moon that are in print. The Internet audience can also see graphical satellite instrument readings indicating spacecraft health, including antenna, battery, thruster, solar panel and fuel tank readouts.

Website features

The website is capable of handling more than 100-million computer "hits" daily. ARC partnered with Goddard Space Flight Center (GSFC), Kennedy Space Center (KSC), the NASA Software Independent Verification & Validation Facility, and Lucent Technologies to provide mirror websites that enable greater public access. Key website elements include a unique design and an ARC-written browser software engine. Additional features are live-event coverage and a well-designed computer network structure .

"The integrated design of the computer hardware, software and networking make this website possible. It is

unique because it employs a lot of new technology not previously used on a public Internet site," Smith said.

The browser software engine is a computer program that quickly takes a snapshot of data from vast stores of information. "We've eliminated the need to 'talk to' a data base, to get the information we need faster," Smith explained.

Lunar Prospector is orbiting 63 miles above the lunar surface on a year-long mission that began last January. The compact spacecraft is mapping the surface composition, internal structure and volatile activity of the Moon, as well as its magnetic and gravity fields.

Learn more about the ARC-based website at <http://lunar.arc.nasa.gov/>. ■

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JASON Students Explore Ocean Environments

Without leaving the Bay Area, a group of students joined scientists as they explored kelp forests, coral reefs, hydrothermal vents, the ocean's floor and the universe beyond Earth. During an electronic field trip, the fourth through ninth grade students took turns controlling remotely-operated underwater vehicles and cameras in Monterey Bay, Bermuda, and the Guaymas Basin on March 19 of this year. The virtual field trip was conducted from an auditorium at ARC during a live one-hour broadcast.

It was all part of a science educational opportunity called JASON IX "Oceans of Earth and Beyond," an international educational outreach program that took place March 16-27. During the two-week period, approximately 13,000 Bay Area students at ARC joined hundreds of thousands of students worldwide on the JASON expedition.

ARC, along with 28 other locations throughout the country, served as a Primary Interactive Network (PIN) site for the JASON Project from March 16-27. Five times each day, live one-hour televised broadcasts from Monterey Bay, Bermuda and the Guaymas Basin transformed ARC's auditorium into a satellite command center with giant television screens. Computer consoles enabled students to question scientists in each location during the live broadcasts.

"This is a good example of the partnership between government and the corporate world to bring quality education to thousands of students in the Bay Area," said Thomas Clausen, Education Officer at ARC. "Putting students together with scientists in the field was an exciting adventure and one they will remember for years to come."

Gene Felman, a NASA oceanographer from the Goddard Space Flight Center, worked with the JASON students at Monterey Bay during the expedition as they study underwater volcanoes and other points of interest along the ocean floor.

"El Nino is playing such an important role in this year's weather and is changing the condition of the ocean's floor; scientists simply can't predict what's going to happen," said Lisamarie Gonzales, JASON PIN site coordinator at ARC.

During the 11-day JASON expedition, five live 60-minute televised broadcasts were produced each day. Following the broadcasts, the students assembled at "JASON Harbor" in historic Hangar One at Moffett Field to continue working with the JASON educational curriculum. Volunteers from NASA and EDS/HDS Corporation assisted students in dissecting squid, building coral reefs and exploring a deep ocean environment.

The JASON Foundation for Education's national corporate sponsors include the EDS/HDS Corporation, a founding sponsor and technology provider; the National Geographic Society; the National Science Center Foundation; Bechtel; Sprint; Sun Microsystems Inc.; Eastman Kodak Company and ICI Worldwide.

Oceans of Earth and Beyond is the ninth annual JASON project. Dr. Robert Ballard, the scientist who discovered the wreckage of the R.M.S. Titanic, started the project in 1989. The JASON Project is administered by the JASON Foundation for Education whose mission is to excite and engage students in science and technology and to motivate and provide professional development for their teachers.

Excerpted from NASA press release, #PR 98-16, written by Michael Mewhinney, ARC. ■

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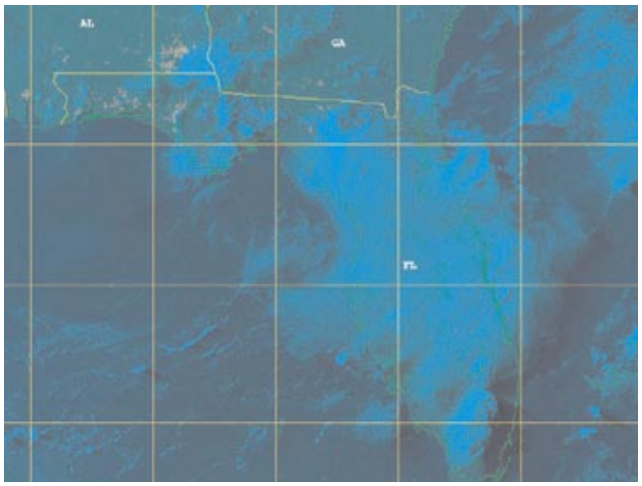
NASA Unveils Global Fire Monitoring Web Site

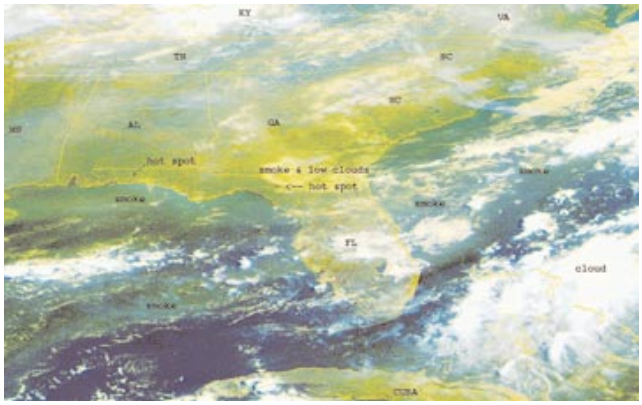
A new NASA public web site now provides up-to-date information about terrestrial fires and their effect on global climate change. In June NASA unveiled a new presence on the World Wide Web that features satellite images and animations depicting wildfires across the globe. The Global Fire Monitoring web site provides synopses on current fires and analysis of data from the early and mid-1990s, utilizing a range of satellite information resources from several US agencies and international partners. This web site is intended to serve the needs of the scientific community and the general public.

Fires and global change

The recent fires in Florida, Mexico, and Brazil, and last summer's fires in Indonesia, have heightened public awareness of the importance of natural and human-induced wildfire as a contributor both to regional pollution and global change. Nearly 175 million acres of forest and grasslands are burned each year worldwide. Using data from satellite sensors, aircraft, and ground-based initiatives, scientists are working to develop a new global fire-monitoring program that will enable them to better understand the many implications of this growing problem.



Credit: NOAA. Thunderstorms over Florida casting shadows on thin veil of smoke in the late afternoon sun. Image from AVHRR.



Credit: NOAA. Florida fires as seen by GOES-8 on July 7.

Since May 25, 1998, there have been more than 1,900 fires in Florida that, collectively, have burned more than 425 square miles. Florida Fire Information Office spokespersons believe that most of the newest fires were caused by lightning and spread by strong winds. July rain storms have actually intensified the rate of smoke emissions from some fires, while doing little to suppress the fires. An estimated 40,000 Florida residents have been forced to evacuate their homes. The impact of smoke emissions on air quality is of concern to local residents. A 125-mile stretch of Interstate 95, from Jacksonville to Titusville, has been closed due to proximity to flame and thick smoke. - A blurb from the web site.

Specifically, efforts are underway to quantify the total area of forests and grasslands burned each year and to more accurately estimate the amount of resulting emission products. These newer and better data will facilitate development of more robust computer models that will enhance scientists' abilities to predict how biomass burning will impact climate, the environment and air quality.

Satellite resources

Because no single satellite or instrument provides optimal characteristics for fire monitoring, data are currently used from several satellite systems. Each system has different capabilities in terms of spatial resolution, sensitivity/saturation level, spectral frequency, overpass time and repeat frequency. In addition to NASA, the agencies and programs represented on this web page are:

- the International Geosphere Biosphere Program using Advanced Very High Resolution Radiometer (AVHRR) data for 1992/3 from international ground stations
- the National Oceanographic and Atmospheric Administration (NOAA)-National Geophysical Data Center global fire database for 1994/5 using US Air Force Defense Meteorological Satellite Program - Operational Linescan System data
- a near real-time multi-source fire monitoring system being developed for the US to support the Interagency Fire Center in Boise, Idaho
- a near real-time multi-source active fire monitoring system currently being developed at NOAA- National Geophysical Data Center in Boulder, Colorado, for the current burning season as part of its Significant Event Imagery activity
- satellite fire-monitoring systems from Brazil, Russia, and Senegal using the countries' own regional AVHRR systems
- regional examples of trace gas and particulate emissions from fires in Brazil, Southern Africa and Alaska provided by various research groups
- field and aircraft measurements of fires and emissions for satellite data validation as well as new sensing systems and algorithms being developed by various research groups

Reprinted from GSFC press release 98-086, June 9, 1998, written by David E. Steitz, NASA Headquarters, and Lynn Chandler, Goddard Space Flight Center. Images courtesy of the Global Fire Monitoring web site.

Learn more about NASA's Global Fire Monitoring program by accessing the Fires web site <http://modarch.gsfc.nasa.gov/fire_atlas/fires.html>. ■

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Remote Sensing Technologies to Aid in Detecting Oil Spills

Jet Propulsion Laboratory (JPL) and Alyeska Pipeline Service company, the anchorage-based operator of the Trans Alaska Pipeline System, recently signed an agreement to develop technology for detecting oil spills using remote sensing. Currently, Alyeska uses a variety of leak detection technologies to identify possible spills at, or below, levels required by regulations. This agreement calls for the investigation of technologies that can provide remote-sensing detection of oil releases below the present leak detection threshold. A small first effort will identify already existing space program technologies that potentially meet Alyeska's leak detection requirements. A larger second phase involving technology development at JPL may follow.

The agreement, facilitated by JPL's Technology affiliates Program (TAP), came about as a result of an initiative launched by Alyeska last summer to solicit the available technologies of private and public sectors, and the assistance of the Alaska Technology Transfer Center. Alyeska wanted to implement an operational system able to detect leaks as small as 10 gallons. According to the company's conceptual engineering lead, Claude Robinson, none of the systems submitted from other sectors to Alyeska met the specifications of the futuristic pipeline monitoring system envisioned. Joan Horvath, a business alliance manager with TAP who has been working with the Alaska Center to provide Alaskan businesses with access to JPL's solar system exploration technologies, learned of Alyeska's efforts.

"We realized that JPL might be able to help Alyeska understand its options and move forward on a new system," Horvath said. "In particular, we thought that a lot of our instruments for close-up studies of Mars and Europa, a moon of Jupiter, might have some applicability for Alyeska's issues."

With the assistance of the Alaska Technology Transfer Center, Alyeska and JPL's TAP came together and forged the

agreement. The Center's Director, Charles Christy, stated," It's exciting to be able to apply technology and knowledge that would not normally be easily accessible to us in Alaska."

More than 20 percent of US domestic oil production flows through the 1290 kilometer (800 miles) long tran-Alaska pipeline, which stretches from Prudhoe Bay to Valdez, Alaska. A total of 675 kilometers (420 miles) of pipe are above ground on special horizontal supports. The remaining 611 kilometers (380 miles) are buried as much as 15 meters (49) feet underground.

Credit: Image courtesy of JPL's Commercial Technology Program Success Stories Web site

Credit: Image courtesy of JPL's Commercial Technology Program Success Stories Web site

Excerpted from JPL's Universe article," JPL to aid oil spill detection technologies" written by John G. Watson. ■

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JPL Unveils New Commercial Technology Showroom

JPL's Commercial Technology Program's many sucessfully developed products of recent years are now on exhibit in the recently unveiled showroom at the Laboratory's administrative building. Visitors to the Lab, including business people who are considering working with JPL's various technology transfer programs, are now able to view these products first hand. The showroom is a way to inform JPL's many constituencies about ways that space technology can help meet American business needs.

Products on display include a table-top model of the E-Lite system, Mattel, Inc.'s Hot Wheels Sojourner Mars Rover Action Pack Set, the Dubbs & Severino terrain mapping system, and the Photobit "camera on a chip." The E-Lite system warn motorists of approaching police chases, fire enginess, or ambulances through sophisticated traffic signals linked to transponders in goverment vechicles. The Mattel toy is a model of the Mars Pathfinder mission rover that landed on Mars last July 4th. The terrain mapping system aids pilots of small planes in terrain avoidance. The Photobit needs only 1/100 the battery power of of the conventional CCD video camera.

"We're proud of these successes and of this showcase exempllifying the important role that the space program plays in the advancement of American industry," stated Merle Mckenzie, manager of the Commercial Technology Program.

Excerpted from JPL's Universe article," Commercial technolgy showroom unveiled" (author unnamed). ■