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In this issue . . .

EDITOR'S CORNER

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The EOS Data Products Handbook (Volume 2) has recently been completed. This Handbook, edited by Claire Parkinson and Renny Greenstone, provides a brief description of the science data products that will be available from the Earth Observing System Data and Information System (EOSDIS). The objective of this Handbook is to promote a broader understanding of how the EOS data products will contribute to science research in the understanding, analysis, and monitoring of global climate change. This volume describes data products that are currently being produced or soon will be produced from instruments onboard ACRIMSAT, Aqua, Landsat 7, Jason-1, Meteor 3M, QuikScat and QuikTOMS. The data descriptions in this reference have been reviewed by the science teams for accuracy. This follow-on to Volume I, published in 1997 for the Tropical Rainfall Measuring Mission (TRMM), Terra (formerly EOS AM-1), and Data Assimilation, includes information on the size of the individual data products and the number of data files produced per time interval. The Handbook will be distributed to all EOS PI's, Co-I's, Instrument Team members, and DAACs. Printed copies are available from the Project Science Office or electronically via the World Wide Web (eos.nasa.gov).

July marks the one-year anniversary of QuikScat science data availability. All QuikScat data have been reprocessed and are now available from the Physical Oceanography DAAC at JPL. The results of QuikScat data analysis have been broadly presented to both the science and engineering communities, and include a number of QuikScat applications including tropical cyclone and tropical air-sea interaction, land-surface characterization, and sea-ice studies. This unique instrument is enabling unprecedented new scientific research in ocean wind studies worldwide.

The Stratospheric Aerosol and Gas Experiment III (SAGE III) instrument was shipped from NASA Langley Research Center to the Russian space facility in Istra in mid-July, and is currently being integrated on the spacecraft in preparation for launch aboard a Russian Meteor 3M rocket in early 2001. This example of international collaboration is a significant accomplishment,

and is an important component of the EOS program.

An Investigators Working Group (IWG) meeting is being planned for late January or early February 2001. The primary focus of this meeting is to learn of recent progress and exciting accomplishments obtained thus far by various EOS and related Earth science investigations, and to assess plans and expectations for EOS over the next couple of years. The precise location will be determined shortly. Check the Calendar section of the EOS Project Science Office web site at eos.nasa.gov for the latest information.

Finally, I am happy to report that Dr. Jon Ranson has agreed to serve as Terra Project Scientist, replacing Dr. Yoram Kaufman, who has ably served as Project Scientist for the past 4 years. Dr. Ranson is an internationally recognized scientist with a background in forestry and agronomy with a specialization in optical and microwave scattering from vegetation canopies. He has an in-depth understanding of the scientific requirements and impact of the Terra mission, and has served as Deputy Project Scientist under Yoram Kaufman since September 1996. As Deputy Project Scientist he took prime responsibility for assuring that any spacecraft maneuvers were coordinated with the timing and location of planned validation activities, a role that is becoming increasingly important as Terra reaches the point of distributing and archiving its scientific data products for use by the international scientific community. I am confident that he will make a very substantial contribution to the Terra mission and represent the Earth sciences community in an exemplary fashion.

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NASA Unveils New Catalog of Earth Science Images

— Kevin A. Ward (kevin.ward@gsfc.nasa.gov), and David D. Herring, Science Systems and Applications, Inc.

The EOS Project recently unveiled a new, centralized catalog of NASA Earth science-related images, called "Visible Earth" (http://visibleearth.nasa.gov). Visible Earth is a portal to the distributed collection of Earth images and data visualizations that NASA and affiliated institutions produce and store digitally. The Visible Earth will ultimately provide one-stop search and retrieval access to the *superset* of these images gathered from EOS and Earth Science Enterprise missions.

While the World Wide Web promotes the development of distributed resources, this very characteristic can often be an impediment to users who are trying to search for materials that are located on any of perhaps a thousand different sites. The Visible Earth is the beginning of a collaborative effort to collect, index, and provide access to all of the Earth-science related images produced for public release. Moreover, the site stores images at their highest available resolution for anyone who may wish to publish them as such.

Why another image site?

The Visible Earth site is designed to serve three primary purposes: (1) to help visualizers at all NASA and affiliated centers avoid duplication of effort by maximizing the use of materials that already exist; (2) to help outreach personnel at all NASA and affiliated centers to do their job better by providing them access to the superset of all NASA Earth images and animations that are "for public release"; and (3) to provide easy digital access to NASA outreach partners (i.e., museums, public media outlets, educators) who want timely access to new NASA images and data visualizations for exhibits, posters, publications, student lessons, etc. In short, the Visible Earth site provides public access to NASA images and data visualizations at print-quality and/or television-quality (including HDTV when available) resolution.

The Visible Earth is not intended to supercede or eliminate other image galleries. Rather, it is an attempt to tie them all together via one centralized access point so that all of NASA's digital image resources are maximally available for use and re-use. Individuals working in the NASA outreach community are frequently interrupted—often multiple

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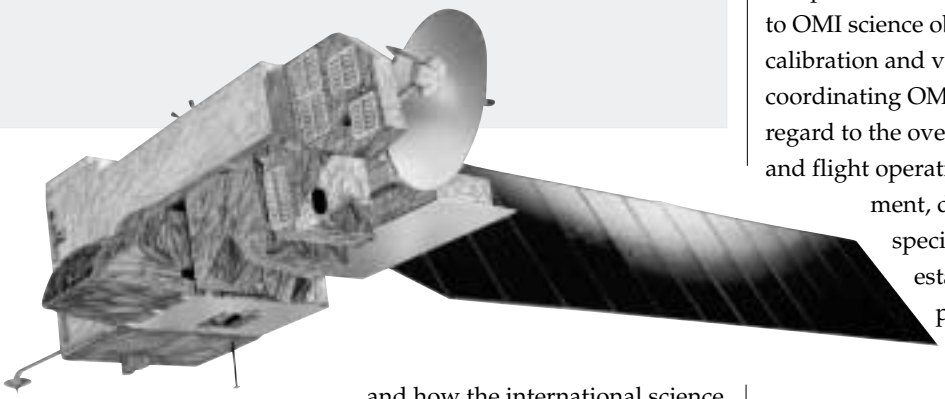
EOS Aura's International OMI Science Team Meets in the Netherlands.

— Ernest Hilsenrath (hilsenrath@ventus.gsfc.nasa.gov), NASA Goddard Space Flight Center



The Ozone Monitoring Instrument (OMI) Science Team met in the Netherlands on June 13-15, 2000. OMI is a contribution from the Netherlands and Finland to the EOS-Aura mission now scheduled for launch in June 2003. Although several science meetings were held earlier, this was the first to include the full U.S. member component. The U.S. OMI Science Team was recently selected via a NASA Research Announcement that solicited members to participate in instrument development, calibration, algorithm development, and some validation.

The meeting was held at the Royal Dutch Meteorological Institute (KNMI) in De Bilt, the Netherlands, and was opened by its director who stated how pleased he was that OMI science activities were centered at his institution. Additional remarks concerning OMI development status were provided by the Netherlands Institute for Aerospace Programs (NIVR) program manager.

Pieternel Levelt, the OMI Principal Investigator, opened the business portion of the meeting to discuss its overall goal and how the international science team would be coordinated. Since there were many new participants, the meeting objectives were to fully acquaint all members on OMI project status, identify areas of collaboration with regard to algorithm development, establish procedures for U.S. involvement in instrument development and calibration, and develop a plan for coordinated validation activities which would be integrated into the overall Aura validation strategy.

The OMI Science Team membership from Finland, the Netherlands, and the United States consists of about 30 members with additional international investigators expected to join in the near future. The team is divided into five working groups to include: Instrument Calibration, Algorithm Development for Ozone (columns, profiles, and tropospheric), Trace Gases (NO_2, BrO, OClO, SO_2 and HCHO), Radiation (clouds, aerosols and UVB), and Validation. The entire team activity would be coordinated by the OMI Science Advisory Board (OSAB) consisting of the PI and the Co-Is from Finland and the United States. This Board would be supported by the OMI Science Coordination Team (OSCT) to include the members of OSAB, the U.S. Science Team Leader and other senior members of the Dutch, Finnish, and U.S. Science Teams for a total of nine members. The responsibilities of these groups include monitoring the compliance of the instrument with respect to OMI science objectives, establishing calibration and validation requirements, coordinating OMI science activities with regard to the overall EOS Aura mission and flight operations, algorithm development, defining standard and special data products, establishing publication protocol, and coordinating initial publications.

Ernest Hilsenrath (Aura Deputy Project Scientist and the U.S. OMI Co-I) gave an overview of the Aura mission and discussed its major science themes (ozone depletion, air quality, and climate) and observations. How each of Aura's four instruments (HIRDLS, MLS, OMI, and TES) will collect data to address these issues was then outlined. This review was followed by an in-depth review of the OMI instrument by Bert van den Oord which was of particular interest to the new Science Team members.

The Dutch Science Team was introduced by Pieternel Levelt after which each member gave a five-minute presentation on the background, objectives, implementation, and expected results from his/her investigation. The Dutch science team will focus on developing ozone column and profile, NO_2 column, aerosols, cloud coverage, and cloud-top pressure in collaboration with the U.S. team members. They will draw from their experience with GOME flying on ERS-2 and SCIAMACHY which will fly on ENVISAT in August 2001. KNMI cooperates with ECMWF on using assimilated GOME ozone data for

improving the wind fields in numerical weather prediction models and is developing fast retrieval algorithms for ozone profiles. One of KNMI's objectives is to produce near-real-time retrievals within three hours of data capture for these predictions.

Gilbert Leppelmeier, the Co-I from Finland, reviewed the research activities to be conducted by the Finnish Meteorological Institute. They will draw on their experience with developing data products from GOMOS which will also fly on ENVISAT. They will develop Ultraviolet B (UVB) products in collaboration with investigators at GSFC and also plan to produce fast ozone retrievals. Finland will access Direct Broadcast (DB) data as the spacecraft flies overhead and produce instantaneous ozone amounts and UVB forecasts that cover most of northeastern Europe. Finland is building a ground station in Sodankyla to receive DB data.

The U.S. Science Team Leader, P.K. Bhartia from GSFC, outlined the priorities for his team and discussed the methodology for producing an ozone product which has TOMS heritage to ensure continuity, but employs the hyperspectral capabilities of OMI. The U.S. team leader's initial responsibility is to develop the OMI data products based on TOMS retrieval and integrate all team members' algorithms so that their data products can be processed on the Science Investigators Processing System (SIPS) at GSFC. Bhartia also stressed the need for an ozone and radiance test data base to evaluate new algorithms using the hyperspectral capabilities of OMI. This data base will be developed from radiative and chemical transport models, GOME data, and data assimilation.

The 15 U.S. science team members followed with five minute presentations on their objectives and contributions to OMI in the areas of instrument calibration and characterization, algorithms for gas, cloud, and aerosol retrievals, and validation in collaboration with their Dutch counterparts. These activities were based on experiences with ground-based measurements, TOMS, SBUV/2, SAGE, GOME, the upcoming PICASSO, and data assimilation.

Pepijn Veefkind from KNMI gave a special presentation on Level-1b product requirements to ensure this data product meets all the needs of the SIPS and the algorithm developers. The OMI data will be produced at about 45 Mflops and require 20 Gbytes per day storage. Veefkind outlined the product data fields (radiances, calibration, quality flags, etc.), geolocation and solar angle parameters, file organization, and data packing.

On the second day of the Science Team Meeting, Al Fleig, the U.S. Science Team deputy leader for data products, discussed the planned OMI SIPS which was preceded by an overview of EOSDIS. Fleig outlined what was expected from the algorithm investigators regarding software and explained that OMI SIPS will integrate operational software, process and reprocess standard products, and deliver them to the DAAC. The planned SIPS architecture and interfaces were also reviewed.

This was followed by a detailed presentation by Johan de Vries (Fokker Space) of the Level-1b algorithm and the instrument status since the Critical Design Review (CDR) in October 1999, in preparation for a site visit to view the OMI hardware the following day. The CCD detectors and electronics and the spacecraft interfaces were tested successfully and exceeded their specifications. Some optical components are already completed or in fabrication. Of particular importance is the performance of the "scrambler" (depolarizer). This component must remove polarization from the observed radiances with little ($<3x10^{-4}$) wavelength dependent residuals. Other topics included instrument throughput, linearity, telescope, Field-of-View (FOV), detector smear, and readout noise.

On the second day of the meeting, the working groups met separately and then reported to the plenary session their priorities and action items. The following is a summary of each working group's report.

The Calibration Working Group assigned responsibilities for its members to participate in the Demonstration Model (DM) (breadboard instrument) testing scheduled for September 2000. The team members also agreed to review the Calibration Requirements Document and the Fokker/TPD (the OMI instrument builders) calibration plan which responds to the requirements. Although these requirements have been in existence for over a year, it will be the first exposure for the U.S. team members. A new action item for this group is to develop a post-launch, in-flight calibration plan.

The Ozone Algorithm Working Group outlined its priorities and agreed to a step-by-step evolution towards the final ozone standard product. The first step will be to develop TOMS, SBUV, and GOME (spectral fitting)-based algorithms suitable for OMI. This would ensure that ozone products would be available at launch. An improved algorithm employing the hyperspectral capabilities of OMI would make use of synthetic data and an empirical air mass factor that is needed for spectral fitting retrievals. An OMI performance simulator was suggested as a necessary tool for refined algorithm

development. Three algorithms would be pursued to retrieve tropospheric ozone, one of the major objectives of the Aura mission. These are the tropospheric ozone residual and cloud slicing techniques. The third is a direct profile retrieval which includes the troposphere. All three have a heritage from TOMS and GOME.

The Trace Gas Algorithm Working Group will also direct its initial efforts towards developing synthetic radiances and compiling a spectral data base (HITRAN, Ring, cloud, aerosols, etc.). Compiling and making available several radiative transfer codes (TOMRAD, LIDORT) will also be important for the algorithm developers. Testing of retrievals will also be a priority since there will be competing algorithms for the trace gases (BrO, HCHO, NO_2, OClO, and NO_2) to be observed by OMI. Algorithm test requirements and success criteria will also be considered by the working group.

The Clouds, Aerosol, and Radiation Working Group also recognized the need for synthetic data for development and testing. Cloud heights is a priority OMI data product and two approaches are being considered: observations of the pressure dependent Ring effect and O_2-O_2 absorption. These would be studied by the U.S. and the Dutch team members respectively. Two approaches are being considered for the aerosol algorithm: the first employs a refinement to the TOMS aerosol index plus the visible wavelengths, and the second is based on GOME retrievals and employs multispectral data. Both will be tested using GOME data. Ocean turbidity, a new OMI data product, using the Ring effect in water will also be investigated.

An OMI validation plan is well underway as part of the overall Aura validation activity which began at the Snowmass August 1999 Workshop. A first draft of the Aura validation plan is complete and further refinements will be introduced this October in a follow-on Workshop. The OMI Validation Working Group will develop a more specific strategy that will first focus on validation under quiet atmospheric conditions followed by comparison campaigns under more "challenging" conditions. The available networks (NDSC, balloons, and Dobson/Brewer stations) will be the backbone of OMI validation but targeted campaigns (aircraft and balloon) will be needed for tropospheric products. Level-1 data product validation using ground-based systems will also be considered to sort out calibration and algorithm errors.

On the third day, the science team members met in Delft to hear presentations on the status of critical elements of the instrument optical systems, and view test facilities and newly fabricated hardware. Fokker Space, the prime instrument contractor, and TNO-TPD which is designing and building the optical systems and will perform the preflight calibration, are co-located at TNO-TPD facilities in Delft. The discussions featured the various test light sources to be used for radiometric and wavelength calibration and test results of the polarization scrambler and FOV of the wide field (114 degree) telescope. An overall instrument development Aura Project status review was held in August 2000 and the specific performance of the Demonstration Model will be assessed by the science team in October 2000.

The OMI Science Team will meet in an international venue every June, although additional meetings of the U.S. Science Team will be held at least annually in the U.S. with all team members invited.

What's New in eos.nasa.gov

We're continuing to refine the new eos web site. If you have problems or would like to suggest new features, please feel free to let us know through our feedback form at the bottom of each page. Some things of note that have been updated/or added recently:

- All of *The Earth Observer* issues are back online at eospso.gsfc.nasa.gov earth_observ.html
- The ATBD's are back online at eospso.gsfc.nasa.gov/atbd/pg1.html
- Updated Mission Profile and science Chart (August 8, 2000): eospso.gsfc.nasa.gov/eos_homepage/missions.html
- JASON Calibration/Validation Plan has been added at eospso.gsfc.nasa.gov/validation/jasonval.html
- New Earth Science image link: visibleearth.nasa.gov/
- Updated the general DAACs link: nasadaacs.eos.nasa.gov/
- There are currently 9 press releases in our EOS Highlights Archive at eospso.gsfc.nasa.gov/eos_homepage/eharchive/. You can submit EOS highlights at eospso.gsfc. nasa.gov/eos_homepage/submission.html.
- There are currently 58 bibliographic references in our Research Paper Archive at eospso.gsfc.nasa.gov/eos_homepage/rparchive/. You can submit bibliographic references at eospso.gsfc.nasa.gov/eos_homepage/submission.html.
- Subscribe to the EOS Web Newsletter to get weekly updates of the happenings on the EOS website at eospso.gsfc.nasa.gov/eos_homepage/newsletter.html.
- Subscribe to the electronic Earth Observer Notification Mailing at eospso.gsfc.nasa.gov/earth_observ.html.

The CEOS Land Product Validation (LPV) Subgroup

Summary of May 23-25th Meeting

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— A. Belward, Joint Research Centre, Ispra, Italy
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Background

The Committee on Earth Observing Satellites (CEOS) is composed of the world's civil agencies responsible for Earth observation satellite programs, along with agencies that receive and process data acquired remotely from space. CEOS seeks to optimize benefits of space observations through member-cooperation in mission planning, products, standards, and activities, to serve as a focal point for international coordination of missions, and to exchange technological and policy information to promote complementarity and compatibility of missions and products. Details are available at http://www.ceos.org/.

Introduction

A number of space agencies will be supporting global moderate resolution imaging systems over the decade. These systems are planned to provide similar land surface products. Many of these products will be operational, and there is a need to quantify their accuracy. Product validation is the process of assessing by independent means the accuracy of the data products derived from the moderate resolution imaging systems outputs.

To provide a forum for coordinating product validation, a new subgroup is proposed for the CEOS Working Group on Calibration and Validation (WGCV). The Land Product Validation (LPV) Subgroup met in May 2000 at the Joint Research Centre, Ispra, Italy. The agenda focused on reviewing current approaches to validating moderate resolution remote sensing products being developed for the Global Observation of Forest Cover (GOFC) program. GOFC, as a panel of the Global Terrestrial Observing System, contributes to the International Global Observing Strategy falling under the Carbon Theme of the IGOS-Partners.

The 29 meeting participants discussed validation methods, guidelines, protocols, and issues for land cover classification/continuous fields, fire products and biophysical parameters (e.g. albedo, leaf area index [LAI], and fraction of absorbed photosynthetically active radiation [FPAR]). In addition, participants addressed the accuracy assessment of land surface products and the revisit accuracy requirements for GOFC products in the context of validation activities.

The workshop was also intended to identify opportunities for international cooperation among validation groups using different instruments and techniques, and to identify potential activities for agency support. Further, organizers sought recommendations for GOFC and its data users, the international community, the CEOS WGCV, CEOS member agencies, and international funding agencies.

Breakout Group Summary

After reviewing current and planned moderate resolution satellite sensors and validation activities, participants held breakout discussions on the three product suites: land cover classification/continuous fields, fire products, and biophysical parameters.

The breakout group summaries made clear that the level of maturity in validation coordination and activity varies significantly with the product. Well-orchestrated projects have been completed at the national, and sometimes international, scale with land cover and fire products; however, mostly discrete, instrument-based activities have been used to validate biophysical parameters. An obvious next step is for the latter to borrow the relevant lessons learned from the more mature validation programs. The formal assessment of past activities, as suggested by the fire group, will greatly facilitate this exchange.

Nevertheless, the breakout groups shared multiple outstanding challenges. The need for ongoing, standardized, and statistically robust validation of operational satellite products was repeatedly heard. Clearly, it is very difficult for end-users to properly qualify their own results and conclusions when their models ingest unvalidated satellite products. Indeed, the end-users are needed to help articulate validation program goals (e.g., target uncertainty

criteria). Further, the breakout groups felt that guidelines and minimum standards must be developed, preferably with expert consultation and peer review, such that the space agencies can share data and results efficiently. The group recommends convergence to and the establishment of a consistent set of global test sites, with routine targeting and data archiving for both fine- and moderate-resolution satellite systems. These recommendations will facilitate multi-product and platform comparisons, avoid redundant efforts, and reduce overall costs.

generation and minimize differences between like products. Finally, the need for common but comprehensive metadata, and central storage and/or cataloging, was unanimously supported. Current efforts towards this end were welcomed and endorsed.

LAI Comparison Activity

The Biophysical Parameters Breakout Group developed plans for a short-term study as a starting point towards internationally consistent LAI validation and reporting. The study will include a comparison of operational and experimental LAI products from different space sensors over about 15 test sites already slated for year 2000 field data collection. Further, existing tools and infrastructure, such as the EOS Land Validation Core Sites' internet-based information and data access system, or the Oak Ridge DAAC's Mercury field data archive and retrieval system, would be used. Participants will contact the various "tasked" satellite teams, such as Landsat 7, SPOT, and IKONOS immediately to ensure simultaneous sampling during field campaigns. Particular effort will be made to determine the most suitable methods for scaling point measurements to coarser scales. Moreover, moderate resolution data will be archived throughout the campaign period. Investigators will report progress of this intercomparison at the October WGCV meeting in Gaithersburg, MD, and the next annual LPV meeting in 2001.

Next Steps

With the recent advances in remote sensing instruments and operational algorithms, it is reasonable for product users to expect consistent quantitative validation of all products. While validation programs are in their infancy, careful and rigorous work now can set a strong precedent that can improve all future research using these products.

To meet these goals, the LPV co-chairs proposed a series of topical meetings, coordinated with the help of experts in the given subject areas. In the year 2001, two joint meetings of GOFC and the LPV on fire validation and fine resolution land cover change product validation would provide important coordination opportunities. A third meeting is planned to report results from the LAI product intercomparison as described by the breakout group on biophysical parameters. Themes suggested for validation coordination meetings in 2002 and beyond include fine resolution GOFC land-cover and biomass products, albedo and bidirectional reflectance, snow cover and available water, land-surface temperature, and geostationary satellite land products.

In addition, the LPV will continue to promote and facilitate community activities designed to address outstanding issues in validation. The LAI intercomparison is one such activity. As appropriate, LPV will also coordinate special sessions and journal issues on validation. Key to this plan is ongoing communication and coordination with the sensor calibration and process modeling (e.g., climate) communities, as well as field data collection experts. Finally, the LPV will promote consistent definitions, error budgeting, documentation, and open and timely availability of validation data sets via the Internet. A global set of validation test sites will be formally proposed to WGCV to facilitate rapid cross-platform efforts and comparisons.

Through these efforts, the co-chairs envision a consensus report on "best practices" in validation of different land products, to serve as a guideline and standards document for the community. Interim guidelines and draft reports will be posted on the LPV Web site as they become available.

Recommendations to the CEOS WGCV

Recognizing that quantitative validation is essential if land products are to be used in an operational context as envisioned by the Integrated Global Observing System (IGOS), the expense and logistics involved in collecting validation data (*in situ*, airborne, high resolution satellite), the lack of community consensus on approaches to such validation, the gaps in current global land validation resources, shortcomings in some areas of institutional support for such validation, the need for coordination to improve the efficiency and cost effectiveness of validation campaigns, and the need for technology transfer for validation work have all led to a recommendation that a subgroup on land-product validation be formed within the WGCV.

The list of Earth observation-derived land products requiring validation is potentially very large, and some focus and prioritization of activities is required. In line with the WGCV three-year work plan,

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The CEOS Working Group on Information Systems and Services (WGISS) and Global Observation of Forest Cover (GOFC)

— Ken McDonald (ken.mcdonald@gsfc.nasa.gov), NASA Goddard Space Flight Center,
— Chris Justice, University of Virginia
— Yonsook Enloe, SGT Inc.
— David Skole, Michigan State University,
— Matt Schwaller, NASA Goddard Space Flight Center

Introduction

Over the last nine months, considerable progress has been made in the formation of a partnership between the Committee on Earth Observation Satellites (CEOS) Working Group on Information Systems and Services (WGISS) and an international science initiative, the Global Observation of Forest Cover (GOFC). This partnership provides an indication of the importance that the international science community is giving to the securing of the necessary flows of data and information and exploring the role that can be played by new information technology and improved data services.

Background

CEOS was created as a forum for all nations that operate Earth observation satellites to coordinate their activities in data acquisition, processing, analysis, and exchange. In addition to those nations that operate Earth observation satellites, organizations with environmental science and operational charters also participate in CEOS as affiliate members (e.g., United Nations Environmental Program [UNEP], World Meteorological Organization [WMO], and International Geosphere/Biosphere Program [IGBP]). WGISS (URL: wgiss.ceos.org), a working group of CEOS, concentrates on the development of guidelines and approaches that enable the data processing, archiving, and distribution systems of the members to interoperate and easily exchange data and information.

Within WGISS, there are three sub-groups that address particular technology areas that can be applied to information systems and services. An Access Subgroup investigates and promotes standard approaches to the catalog services that allow users to identify and access data from the community of international data providers. A Data Subgroup focuses on data formats and archival standards, global data sets, and data visualization techniques that facilitate data use and inter-use. The WGISS Network Subgroup addresses issues associated with the establishment and operation of international networks, including performance measurement, security, and network resource planning and coordination.

GOFC (URL: www.gofc.org) was originally formed as one of the six initial Pilot Projects of the Integrated Global Observation Strategy (IGOS) and it has now become a Panel of the Global Terrestrial Observing System (GTOS). GOFC is a coordinated international effort with the goal of developing and implementing a suite of securely funded, ongoing observational programs, which will provide timely and consistent information about forests worldwide, using an appropriate combination of spaceborne and *in situ* data. GOFC is designed to help provide information needed to address questions of global change research associated, for example, with the carbon cycle, as well as information for improved natural resource management. The design phase of GOFC has been completed with three foci: land cover, fire, and forest biophysical attributes. GOFC is now moving into an implementation phase and teams are currently being formed for land cover and fire observations. GOFC has built upon existing regional networks of scientists and foresters to develop operational data and information requirements and to contribute for regional implementation, using the System for Analysis Research and Training (START), for example. Recent GOFC regional network coordination meetings in Southeast Asia and in Central and Southern Africa have shown enthusiasm for improving the flow of satellite and ground-based information and data for improved forest monitoring.

Early in the design of GOFC it was recognized that issues of data and information management and services would need to be addressed in the implementation phase. As satellite data volumes and the number of higher-order products have increased to meet user needs, the development of efficient and cost effective data systems emerges as one of the biggest challenges for data producers and providers. As a result of two meetings, a new partnership has devel-

oped between GOFC and WGISS with a charter for cooperation.

Meeting summaries

The WGISS Joint Subgroup Meeting in Charlottesville, Virginia, in September 1999 provided the first opportunity for WGISS and GOFC representatives to begin to familiarize themselves with each other's activities. Also in attendance at that meeting were participants in the Global Operational International Network (GOIN), a bilateral initiative of the U.S. and Japan to illustrate the application of emerging data-systems technology to Earth science studies through a series of targeted demonstrations. The GOFC participants wished to pursue a similar "bottom-up" approach, but rather than culminating in demonstrations, they wanted to see persistent, quasi-operational systems capabilities that could provide ongoing services to the GOFC community. The result was the concept of a GOFC/WGISS test environment.

At the more recent WGISS Joint Subgroup Meeting at the University College London in April, more detailed plans for the first phase of the GOFC/WGISS collaboration were developed. Aspects of GOFC data and information management were presented and discussed in the light of WGISS technological developments including cataloging, networks, archiving, and Web-based GIS. The capabilities of existing systems supported by WGISS members and GOFC participants were discussed and demonstrated. Scenarios that would extend and tailor these to meet the immediate needs of GOFC were also developed. A representative of the IGOS Disaster Management Support Group was also in attendance and expressed interest in using WGISS technology to satisfy its project requirements.

WGISS Test Facility

The plan to apply WGISS technologies to the needs of the GOFC project was reviewed and discussed at the last WGISS meeting in Canberra, Australia, in May and at the GOFC Science and Technology Board (STB) meeting in Ottawa, Canada, in June. At both meetings, the members endorsed the continuation of the planned collaboration. WGISS recognizes the importance of bringing its expertise in the area of satellite data management and services to address real problems of international data and information exchange at the project level. GOFC views the WGISS offerings as a resource that can assist its members in meeting the science goals and objectives of their project. To this end WGISS has developed the concept of a test facility and has chartered its subgroups with its implementation.

The WGISS Test Facility (WTF) is being designed to make WGISS infrastructure-related services and tools accessible, to provide the capability for defining profiles of WGISS services to support thematic/project views, to provide network facilities in support of selected projects and specific services for rapid response needs, and to provide for rapid prototyping of applications. The integrated team of information technologists supplied by WGISS, and scientists supplied by GOFC will design and implement the WTF components. While the initial focus of the WGISS Test Facility is to support the GOFC science program, it is envisioned that additional science programs will be able to form similar collaborations in the future.

Currently, the WTF/GOFC team is working with CEOS agencies and affiliated organizations to determine an initial set of system capabilities and relevant data sets that will begin to form the foundation of the test facility. These capabilities, with some preliminary tailoring to the GOFC project needs, will be demonstrated at an upcoming workshop that precedes the next WGISS Joint Subgroup Meetings in Bangkok, Thailand, in September. Following the workshop, the definition and role of the WGISS Test Facility and its support to the GOFC project will be further developed in the subgroup sessions.

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The CEOS Land Product Validation (LPV) Subgroup

this focus will be provided through the IGOS themes, and initial focus will come from the GOFC program in the context of the IGOS carbon theme.

It is recommended that Stephan Dech (DLR) and Jeff Privette (NASA) be appointed Co-Chairs, and Jeff Morisette as Deputy Chair, with tenure of three to five years.

Conclusions

The enthusiastic discussions and wide participation in this first meeting set a promising tone for future LPV endeavors. It is important that formal LPV approval be obtained from the WGCV to ensure that this early momentum is continued uninterrupted. The rapidly expanding field of operational global land products and the ambitious launch schedule for further Earth-viewing satellite missions suggest that validation coordination should not be delayed. The full meeting report is available at wgcv.ceos.org/docs/other_meetings/lpv/summary.html

Sustaining Earth's Life Support Systems — The Challenge For The Next Decade And Beyond

— *Berrien Moore III (b.moore@unh.edu) Chair, Institute for the Study of Earth, Oceans and Space (EOS), University of New Hampshire, Durham, New Hampshire*

Reprinted with permission from Global Change Newsletter, No. 41, May 2000, a publication of The International Geosphere-Biosphere Programme (IGBP)

Integration, interdiscplinarity, and a systems approach mark the emerging ethos in IGBP as the Programme evolves rapidly into its second decade of international global change research.

In late February in Cuernavaca, Mexico, the Scientific Committee of the IGBP held a landmark meeting in which it was decided that the strength and maturity of the Programme would allow an increased emphasis on the systemic challenges of Global Environmental Change. The strength has been made particularly apparent in the developing Core Project syntheses.

This strength and capability of the IGBP at this point in time is extraordinarily valuable since the SC-IGBP also recognised that the challenges of Global Environmental Change demand a treatment of the full Earth System. It is simply a reality that a scientific understanding of the Earth System is required to help human societies develop in ways that sustain the global life support system.

The core of the IGBP Programme for the next decade will be built around three interlocking and complementary structures:

- Core projects that focus on key processes will continue to be the foundation for the IGBP;
- A formal integrated study of the Earth System as a whole, in its full functional and geographical complexity over time, and
- A focus on three cross-cutting issues where advances in our scientific understanding are required to help human societies develop in ways that sustain the global life support system.

The research will be undertaken in the context of an expanding and strengthening collaboration with the International Human Dimensions Programme on Global Environmental Change (IHDP) and the World Climate Research Programme (WCRP). The new challenge is to build, on our collective scientific foundation, an international programme of Earth System Science. This effort will be driven by a common mission and common questions, employing visionary and creative scientific approaches, and based on an evercloser collaboration across disciplines, research themes, programmes, nations, and regions.

Driving the new structures and approaches are two critical messages that have become ever clearer through the past decade plus of global change research.

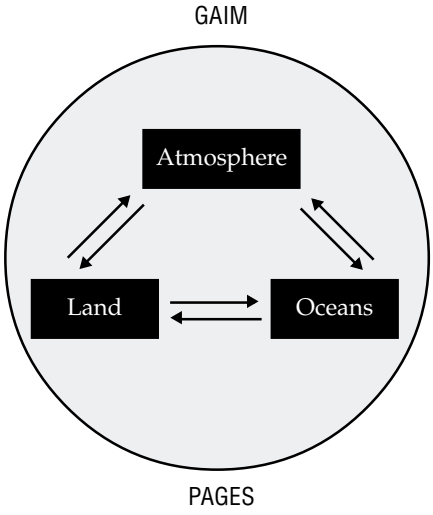
First, the Earth functions as a system, with properties and behaviour that are characteristic of the system as a whole. These include critical thresholds, 'switch' or 'control' points, strong nonlinearities, teleconnections, and unresolvable uncertainties. Understanding components of the Earth System is critically important, but is insufficient on its own to understand the functioning of the Earth System as a whole.

Second, humans are a significant force in the Earth System, altering key process rates and absorbing the impacts of global environmental changes. In fact, the environmental significance of human activities is now so profound that the current geological era can be called the 'Anthropocene' epoch (see article by Paul Crutzen and Eugene Stoermer on page 12).

Global biogeochemical cycling will remain at the core of IGBP research, but the Programme will evolve towards a more systematic structure with major activities located in the three compartments—atmosphere, oceans, and land—and in the three interfaces between them. These six domains will more formally guide the emerging Core Projects for the next decade. This theme is already apparent within the IGBP. For instance, LOICZ is positioned well at the Land-Ocean interface, and the emerging Surface Ocean Lower Atmosphere Study (SOLAS) is clearly headed in this direction. We are asking, in this formulation, hard and challenging questions. How can we join better JGOFS science with GLOBEC science? How can we bridge more strongly and with less duplication the

scientific agendas of BAHC and the Global Energy Water Experiment (GEWEX) within the WCRP? Similarly, how do we better link in the future IGAC with SPARC (Stratospheric Processes and their Role in Climate)? What should be the nature of the future GCTE, and how does it tie more closely with LUCC?

GAIM is being reoriented towards integrating across this structure to focus on the Earth System as a whole (see John Schellnhuber's article in *Global Change Newsletter* vol. 41, May 2000). PAGES work provides an essential longer time context for the dynamics of the Earth System as well as for parts of it. The accompanying figure shows the new structure.



It is hoped that at least three new joint projects will be launched with WCRP and IHDP on crosscutting issues of major societal relevance. Three linked issues are currently in the planning stages—the Global Carbon Cycle, Water Resources, and an initiative on Global Change and Food and Fibre, with an emphasis on food vulnerability/security and opportunity analysis. Additional major issues, such as human health and ecosystem goods and services, are under consideration.

These joint projects, which are clearly crosscutting in nature, will depend critically upon the research in the Core Projects of the IGBP, IHDP and WCRP that is already being undertaken or is planned. Considerable co-ordination is needed, however, to bring these elements into a more integrated framework, and some new work will need to be initiated where gaps are identified. Strategic partnerships are being developed with other research institutions outside the three programmes and with policy and management institutions to ensure that the work is designed and implemented in ways that facilitate its application.

The Global Carbon Cycle joint project is the most advanced, with a series of activities planned for the rest of 2000. A small scoping meeting in April developed much of the human dimensions contributions to the effort, while additional meetings in May (Lisbon, Portugal) and October (Durham, New Hampshire, USA) will complete the definition of a common international framework to help guide research at national, regional and global scales, and will design a series of focused activities for 2001 and beyond.

For the Food and Fibre joint project, a scoping meeting with IHDP and WCRP was held in Paris in early March, which began to define the overall structure for the research. Further planning meetings are proposed for June/July (Reading, UK), October (London), November/December (Stockholm) and February 2001 (Washington) to complete the preparation of a science plan and implementation strategy.

The initial coordination meeting for the Water Resources joint project is tentatively scheduled for September.

These initiatives will place great demands on the IGBP. The strength of the Programme will be tested and new structures will be demanded. The recently expanded role of the IGBP-DIS with its important work in both regional and global studies will add essential new capabilities, including support for our key regional studies (see Wolfgang Cramer's article in the *Global Change Newsletter*, vol. 41, May 2000).

This continuing evolution of the IGBP in concert with the WCRP and the IHDP is important and merits the thoughts of all. We continue to welcome and need insights on directions, processes, objectives, and goals and the processes by which they may be realised. These pages are genuinely open to your contributions. The challenges of global environmental change are not going to vanish.

The "Anthropocene"

— *Paul J. Crutzen (air@mpch-mainz.mpg.de), Max-Planck-Institute for Chemistry Division of Atmospheric Chemistry Mainz GERMANY*
— *Eugene F. Stoermer Center for Great Lakes and Aquatic Sciences University of Michigan Ann Arbor, Michigan 48109-1090 USA*

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The name Holocene ("Recent Whole") for the post-glacial geological epoch of the past ten to twelve thousand years seems to have been proposed for the first time by Sir Charles Lyell in 1833, and adopted by the International Geological Congress in Bologna in 1885 (1). During the Holocene mankind's activities gradually grew into a significant geological, morphological force, as recognised early on by a number of scientists. Thus, G.P. Marsh already in 1864 published a book with the title 'Man and Nature', more recently reprinted as 'The Earth as Modified by Human Action' (2). Stoppani in 1873 rated mankind's activities as a 'new telluric force which in power and universality may be compared to the greater forces of earth' [quoted from Clark (3)]. Stoppani already spoke of the anthropozoic era. Mankind has now inhabited or visited almost all places on Earth; he has even set foot on the moon.

The great Russian geologist V.I.Vernadsky (4) in 1926 recognized the increasing power of mankind as part of the biosphere with the following excerpt '... the direction in which the processes of evolution must proceed, namely towards increasing consciousness and thought, and forms having greater and greater influence on their surroundings'. He, the French Jesuit P. Teilhard de Chardin and E. Le Roy in 1924 coined the term 'noısphere', the world of thought, to mark the growing role played by mankind's brainpower and technological talents in shaping its own future and environment.

The expansion of mankind, both in numbers and per capita exploitation of Earth's resources has been astounding (5). To give a few examples: During the past 3 centuries human population increased tenfold to 6000 million, accompanied e.g. by a growth in cattle population to 1400 million (6) (about one cow per average size family). Urbanisation has even increased tenfold in the past century. In a few generations mankind is exhausting the fossil fuels that were generated over several hundred million years. The release of SO_2 , globally about 160 Tg/year to the atmosphere by coal and oil burning, is at least two times larger than the sum of all natural emissions, occurring mainly as marine dimethyl-sulfide from the oceans (7); from Vitousek et al. (8) we learn that 30-50% of the land surface has been transformed by human action; more nitrogen is now fixed synthetically and applied as fertilizers in agriculture than fixed naturally in all terrestrial ecosystems; the escape into the atmosphere of NO from fossil fuel and biomass combustion likewise is larger than the natural inputs, giving rise to photochemical ozone ('smog') formation in extensive regions of the world; more than half of all accessible fresh water is used by mankind; human activity has increased the species extinction rate by thousand to ten thousand fold in the tropical rain forests (9) and several climatically important 'greenhouse' gases have substantially increased in the atmosphere: CO_2 by more than 30% and CH_4 by even more than 100%. Furthermore, mankind releases many toxic substances in the environment and even some, the chlorofluorocarbon gases, which are not toxic at all, but which nevertheless have led to the Antarctic 'ozone hole' and which would have destroyed much of the ozone layer if no international regulatory measures to end their production had been taken. Coastal wetlands are also affected by humans, having resulted in the loss of 50% of the world's mangroves. Finally, mechanized human predation ('fisheries') removes more than 25% of the primary production of the oceans in the upwelling regions and 35% in the temperate continental shelf regions (10). Anthropogenic effects are also well illustrated by the history of biotic communities that leave remains in lake sediments. The effects documented include modification of the geochemical cycle in large freshwater systems and occur in systems remote from primary sources (11-13).

Considering these and many other major and still growing impacts of human activities on earth and atmosphere, and at all, including global, scales, it seems to us more than appropriate to emphasize the central role of mankind in geology and ecology by proposing to use the term 'anthropocene' for the current geological epoch. The impacts of current human activities will continue over long periods. According to a study by Berger and Loutre (14), because of the anthropogenic emissions of CO_2 , climate may depart significantly from natural behaviour over the next 50,000 years.

To assign a more specific date to the onset

of the 'anthropocene' seems somewhat arbitrary, but we propose the latter part of the 18th century, although we are aware that alternative proposals can be made (some may even want to include the entire holocene). However, we choose this date because, during the past two centuries, the global effects of human activities have become clearly noticeable. This is the period when data retrieved from glacial ice cores show the beginning of a growth in the atmospheric concentrations of several 'greenhouse gases', in particular CO_2 and CH_4 (7). Such a starting date also coincides with James Watt's invention of the steam engine in 1784. About at that time, biotic assemblages in most lakes began to show large changes (11-13).

Without major catastrophes like an enormous volcanic eruption, an unexpected epidemic, a large-scale nuclear war, an asteroid impact, a new ice age, or continued plundering of Earth's resources by partially still primitive technology (the last four dangers can, however, be prevented in a real functioning noısphere) mankind will remain a major geological force for many millennia, maybe millions of years, to come. To develop a worldwide accepted strategy leading to sustainability of ecosystems against human induced stresses will be one of the great future tasks of mankind, requiring intensive research efforts and wise application of the knowledge thus acquired in the noısphere, better known as knowledge or information society. An exciting, but also difficult and daunting task lies ahead of the global research and engineering community to guide mankind towards global, sustainable, environmental management (15).

We thank the many colleagues, especially the members of the IGBP Scientific Committee, for encouraging correspondence and advice.

"Arctic-Climate Findings Defrost Global Warming Doubters," (August 17) *Christian Science Monitor.*
Mark Serreze (University of Colorado at Boulder) and other scientists have reviewed 40 years of polar research that shows consistency with climate change model forecasts. Among the conclusions of the study were rising arctic temperatures since 1961 and a rise in precipitation in northern Canada during the past 40 years.

"Practical Solutions Urged To Reduce Greenhouse Gases," (August 16) *CNN, The London Daily Telegraph* and *the Environmental News Network.*
New research from **Dr. James Hansen** (NASA Goddard Institute for Space Studies) and his colleagues suggests that climate change in recent decades has been mainly caused by air pollution containing non-CO_2 greenhouse gases, and suggests a global effort to reduce air pollution to slow global warming.

"Global Warming May Worsen Allergies," (August 16) *Associated Press, Reuters,* and *USA Today.*
Cynthia Rosenzweig (Columbia University's Center for Climate Systems Research) concurred with the USDA research that concluded ragweed and other plants produce significantly more pollen as carbon dioxide increases in the atmosphere, greatly affecting allergy sufferers.

"Terra Exposes Thin Snow Cover," (August 4) *Environmental News Network* and *States News Service.*
Dorothy Hall (NASA Goddard) presented a paper and a MODIS image from NASA's Terra satellite that identified the winter of 1999-2000 as one that brought relatively little snow to parts of the North American continent. **Richard Armstrong** (University of Colorado, National Snow and Ice Data Center) noted that MODIS better differentiates snow from clouds providing more accurate data.

"Pacific Mood Swings Last for Decades," (August 1) *Reuters.*
Yi Chao (NASA Jet Propulsion Laboratory), **James McWilliams** (NASA Jet Propulsion Laboratory) and another colleague discovered long-term shifts in the temperature of the Pacific Ocean, which could help scientists better predict climate change.

"Warmer Tropical Ocean Temps Alarm Scientists," (July 30) *The Washington Post and the Seattle Times.*
James O'Brien (Florida State University)

called for a more extended data set on research from 1984 to 1996 that concluded ocean temperatures changed. The study noted that tropical waters in the Southern Hemisphere have cooled slightly, but Northern Hemisphere waters have warmed, endangering coral reefs.

"Greenland is Skating on Thinner Ice," (July 21) *The Washington Post* and *the Associated Press.*
Waleed Abdalati (NASA Goddard), co-author of this recent study, concluded with other researchers that the massive Greenland ice sheet is melting.

"Climate Change, Population Threaten Water Resources," (July 17) *Environmental News Network.*
Charles Vorosmarty (University of New Hampshire's Institute for the Study of Earth, Oceans, and Space) and his colleagues have concluded that population growth and global climate change will adversely impact the availability of water over the next 25 years.

"Diary of a Cloud Hunter," (July 15) *New Scientist.*
Robert Cess (State University of New York at Stony Brook) and other researchers took to the air in Oklahoma in the spring of 2000 to try to solve a debate about whether or not clouds are absorbing more sunlight than physics can predict.

Attention EOS Researchers:
Please send notices of recent media coverage in which you have been involved to:
Rob Gutro, EOS Project Science Office
Code 900, Goddard Space Flight Center
Greenbelt, MD 20771
Tel. 3910 441-4217; fax (301) 441-2432
e-mail: rgutro@pop900.gsfc.nasa.gov

NASA Scientists Detect Rapid Thinning Of Greenland's Coastal Ice

— David E. Steitz (dsteitz@mail.hq.nasa.gov), NASA Headquarters, Washington, DC
— Lynn Chandler (lynn.chandler.1@gsfc.nasa.gov), NASA Goddard Space Flight Center

Scientists who want to monitor the state of our global climate may have to look no farther than the coastal ice that surrounds the Earth's largest island.

A NASA study of Greenland's ice sheet reveals that it is rapidly thinning. In an article published in the July 21 issue of *Science*, Bill Krabill, project scientist at the NASA Goddard Space Flight Center's Wallops Flight Facility, Wallops Island, VA, reports that the frozen area around Greenland is thinning, in some places, at a rate of more than three feet per year. Any change is important since a smaller ice sheet could result in higher sea levels.

"A conservative estimate, based on our data, indicates a net loss of approximately 51 cubic kilometers of ice per year from the entire ice sheet, sufficient to raise global sea level by 0.005 inches per year, or approximately seven percent of the observed rise," Krabill said.

"This amount of sea-level rise does not threaten coastal regions, but these results provide evidence that the margins of the ice sheet are in a process of change," Krabill said. "The thinning cannot be accounted for by increased melting alone. It appears that ice must be flowing more quickly into the sea through glaciers."

Greenland covers 840,000 square miles and 85 percent of the island is covered by ice, some of which is up to two miles thick. With its southern tip protruding into temperate latitudes, monitoring this portion of the ice sheet may be one of the best ways to measure changes in our climate, at least in the Northern Hemisphere.

The ice mapping was completed by NASA, which has been surveying the Greenland ice sheet for nearly seven years. In 1993 and 1994, NASA researchers surveyed the ice sheet using an airborne laser altimeter and precision global positioning satellite receivers. Those same areas were surveyed again in 1998 and 1999.

Now, for the first time, portions of the entire ice sheet covering Greenland have been mapped with sufficient accuracy to detect significant changes in elevation.

Krabill noted that, while some internal areas of Greenland show slight ice thickening, most areas along the coast show significant thinning."Why the ice margins are thinning so rapidly warrants additional study," according to Krabill. "It may indicate that the coastal margins of

(Continued on page 19)

Earth Science Enterprise Education Program Update

GSFC To Assume Lead Center Responsibility For Earth Science Education

Responsible NASA Official: Blanche Meeson (bmeeson@see.gsfc.nasa.gov), Earth Science Enterprise Education Program Manager, NASA Goddard Space Flight Center

Editor and Writer: Theresa Schwerin (theresa_schwerin@strategies.org), Associate Director, Education, Institute for Global Environmental Strategies (IGES)

As part of the implementation of the Applications, Commercialization and Education (ACE) Division strategic plan (URL: esx.hq.nasa.gov/), GSFC assumed the Lead Center responsibility, beginning August 1, 2000, for the Earth Science Enterprise Education Program under the direction of Blanche Meeson, Assistant Director of Earth Sciences for Education, Outreach, and Applications. This Lead Center responsibility includes the implementation and integration of all Earth Science related activities in formal and informal education, and in professional development in support of a viable applications workforce, as well as inter-Center coordination. The program office has the primary responsibility for interactions with individuals and organizations performing education-related activities supported by the Earth Science Enterprise.

The Office of Earth Science at NASA Headquarters has the primary responsibility of program planning and selection; Ming-Ying Wei remains as program lead, and Nora Normandy program specialist.

The NASA Earth Science Education Team sends Nahid Khazenie their sincere appreciation for her outstanding contribution to the crucial development of the program in the last few years, particularly in formal education. Best wishes, also, to Nahid Khazenie in her new post at the Division of Space and Remote Sensing at the Office of Naval Research, Arlington, Virginia.

Cox Assigned To Globe Program Leadership Position

Gregory N. Cox, a Senior Research Scientist in the University of Alabama in Huntsville Earth System Science Center has recently been named the Assistant Director for U.S. Partnerships of the Global Learning and Observations to Benefit the Environment (GLOBE) Program. The GLOBE Program is a hands-on science and education program that unites students, teachers, and scientists from around the world in study and research about the dynamics of the Earth's environment. Hundreds of thousands of GLOBE students in over 9000 schools in over 90 countries are taking important environmental measurements and reporting their data for use by scientists.

GLOBE is a Federal interagency effort led by the National Oceanic andAtmospheric Administration (NOAA), with participation by NASA, the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the Departments of Education and State.

During this one-year, half-time intergovernmental loan assignment to NOAA, Cox will be responsible for coordinating all interactions between the U.S. State and local partner organizations (known as "GLOBE franchises") and the Federal GLOBE Program. In the U.S., GLOBE is managed through over 130 partnerships between the Federal Government and universities and state and local school systems. The universities and local school authorities take responsibility locally for implementing GLOBE in their areas, and the GLOBE Federal agencies provide the science, education, and systems infrastructure for the program.

In addition to his newly created position, Cox will continue his position at the University of Alabama in Huntsville, where he leads GLOBE in Alabama. He is also currently serving as a Space Grant Faculty/Staff Fellow working with the NASA HQ Education Division, the Marshall Space Flight Center Education Department and the Alabama Space Grant Consortium on K-16 math, science, and technology reform issues.

Earth System Science Online Courses Offered This Fall

This fall eight organizations will begin offering online Earth System Science courses that were developed for NASA by the Center for Educational Technologies (CET) at Wheeling Jesuit University. The three available courses (for K-4, 5-8, and 9-12 teachers) use an innovative instructional design model. Delivered over the

Internet, they feature participant-centered, knowledge-building communities. These organizations are supported by the Earth System Science Education Alliance (ESSEA), a partnership between the Institute for Global Environmental Strategies and CET, through a grant with NASA's ESE. For more information on ESSEA, see URL: www.cet.org/essea or contact Claudia Dauksys at claudia_dauksys@strategies.org

Fall 2000 ESSEA Course Offerings

California State University at Northridge
URL: geology.csun.edu/essea
Contact: Dr. Gerry Simila
gsimila@csun.edu
High School course, grades 9-12

Elizabeth City State University
URL: www.ecsu.edu
Contact: Dr. Linda Hayden
lhayden@umfort.cs.ecsu.edu
Middle School course, grades 5-8

Gulf of Maine Aquarium
URL: www.gma.org
Contact: Ms. Justine Glynn
justine@octopus.gma.org
High School course, grades 9-12

University of Minnesota
URL: lrc.geo.umn.edu/
Contact: Dr. Russanne Low
low@csp.edu
High School course, grades 9-12
Middle School course, grades 5-8
Elementary School course, grades K-4

Space Foundation
URL: www.ussf.org
Contact: Ms. Carol T. O'Leary
Carol@ussf.org
Middle School course, grades 5-8

WestEd
URL: www.wested.org
Contact: Ms. Libby Rognier
lrognie@wested.org
High School course, grades 9-12 (Teachers in Arizona, California, Nevada, and Utah)

University of Montana
URL: www.eoscenter.com
Contact: Dr. Wes Snyder
wes_snyder@hotmail.com
Middle School course, grades 5-8

Wright State University
URL: www.wright.edu
Contact: Dr. William Slattery
william.slattery@wright.edu
Middle School course, grades 5-8

June ESSE Meeting Presentations Online

Presentations and links from the NASA/Universities Space Research Association (USRA) Earth System Science Education (ESSE) meeting held in June are now available at URL: www.usra.edu/esse/esse2000/mtglinks.html.

Sponsored by NASA through USRA, ESSE supports the development of undergraduate curricula in Earth System Science and Global Change at 44 participating colleges and universities. For more information on ESSE, including additional news and updates, check the main ESSE page at URL: www.usra.edu/esse/essonline.

Maryland Counties Develop Earth System Science Curriculum

Anne Arundel, MD, County Public Schools have created a new high school Earth and Space Systems Science curriculum in collaboration with NASA GSFC's Education Office. The curriculum addresses the National Science Education Standards and Maryland's "Core Learning Goals," which will provide the basis for high school performance tests. It can be viewed at URL: edmall.gsfc.nasa.gov/aacps.

From August 1-3, a workshop sponsored in part by NASA GSFC was held at Easton High School for teams from nine Eastern shore school systems. Participants learned more about NASA education and science resources and constructed an action plan for developing and implementing a high school Earth Systems and Space Science course. The workshop agenda can be viewed at URL: edmall.gsfc.nasa.gov/agenda.html.

For more information, contact: John Entwistle, jentwist@pop100.gsfc.nasa.gov.

(Continued from page 2)

Editor's Corner

In addition, Dr. Si-Chee Tsay, who has a background both in theoretical radiative transfer in the Earth-atmosphere system as well as in radiation instrumentation both from the ground and aircraft, has agreed to serve as Terra Deputy Project Scientist. His background and experience in atmospheric science and in validation and field campaigns will complement Jon Ranson's strengths in terrestrial ecology and forestry.

Dr. Marc Imhoff has agreed to serve as the ESSP Project Scientist, replacing Dr. Jim Garvin who left Goddard for a position at NASA Headquarters as Mars Program Scientist. In addition, I am happy to report that Peg Luce has been named Aura Project Manager and John Loiacano has been named Deputy Project Manager.

NASA Satellite Technology To Monitor Motor Vehicle Pollution

— Michael Braukus (nasanews@hq.nasa.gov), NASA Headquarters, Washington, DC
— H. Keith Henry, Langley Research Center, Hampton, VA
— Jeri Collins or Craig Rendahl, SPX Service Solutions, Tucson, AZ

Cities and states may soon have a new high-tech tool in the battle against automotive air pollution, thanks to NASA satellite technology originally developed to track global greenhouse gases and the Earth's protective ozone layer.

As envisioned, NASA's atmospheric remote sensing technology will be adapted to an autonomous roadside system to monitor motor vehicle emissions. Cars and trucks will pass through a low-power light beam, without stopping or slowing down. Space-age sensor technology will instantly analyze vehicle exhaust pollutants important to local and state governments working to meet federally mandated air quality standards.

"Taking an accurate reading of several exhaust products as a car passes by is a formidable challenge. We want to take a measurement of all the gases of interest every one thousandth of a second over a period of a half-second. Fortunately, our newest remote sensing technology has that capability," said Glen Sachse, senior research scientist at NASA's Langley Research Center, Hampton, VA. Sachse is one of six team members who invented the highly-sensitive electro-optical system at the core of the technology.

Today, NASA and SPX Service Solutions, Warren, MI, jointly announced that the patented NASA technology has been exclusively licensed to SPX for use in developing a new remote sensing device to monitor motor vehicle exhaust.

"Remote testing of vehicle exhaust will provide governments around the world with a fast, efficient and low-cost method to identify and reduce motor vehicle air pollution and greenhouse gases, which account for approximately one-half of all air pollution," said Craig Rendahl, remote sensing business leader for SPX Service Solutions.

"With the number of vehicles on the road increasing every year, we believe there is a significant global market for technology of this nature," said Rendahl. "SPX will offer a basic unit which will be available at the end of 2000. With the help of NASA, we expect to begin manufacturing a highly enhanced remote sensing device before the end of 2001. This second- generation product will contain many other features, including the capability to test heavy-duty diesel vehicles."

The U.S. Clean Air Act mandates that a certain percentage of the U.S. fleet of vehicles be measured each year. The act allows for remote sensing as an option.

In a process called "clean screening," drivers who formerly took their vehicles in for an annual emissions inspection would receive a notice in the mail certifying that their vehicle has passed twice in a 12-month period and that they do not have to submit to an emissions test — at least that's the expected outcome for most drivers. As individual roadside exhaust measurements are taken, the vehicle's license plate would be photographed and the data would be transmitted to a central collecting point.

Those drivers whose vehicles passed would save both time and money. Drivers whose vehicles failed or gave marginal readings would be identified for additional testing and possible emissions-related repairs.

In space, NASA uses remote sensing devices mounted on satellites and back lighting from the sun to take global atmospheric measurements as part of its Earth Science Enterprise program. The program is aimed at expanding knowledge of the Earth's environment in order to provide the scientific basis for sound policy decisions on environmental matters.

Service Solutions, a unit of SPX Corporation, provides special service tools, equipment program management, electronic diagnostics, emissions testing equipment, and technical information services for the global motor vehicle industry.

(Continued from page 2)

NASA Unveils New Catalog of Earth Science Images

times in a single day—with requests for particular images that someone saw or heard about. They must stop what they're doing and find and fetch the image. Hopefully, the Visible Earth will ameliorate this problem and save time for us all.

If the site is to realize its fullest potential, then it will need contributions from the large, distributed community of Earth image gallery curators. To facilitate contributions from the larger community, the next step for the Visible Earth is to provide Web-based forms for easy submission of images and metadata. Key individuals from each mission or project will be identified and given access to the Visible Earth so that they may upload images, captions, all essential metadata, and proper credit information. This way, each mission retains responsibility for timing of release as well as accuracy and image quality.

The Earth science community may be interested to note that the Visible Earth already contains an index of the Global Change Master Directory's keywords, so that images may also be linked to particular data products within the Distributed Active Archive Centers (DAACs), if desired.

Audience

From the outset, the infrastructure and logic of the collection is designed to meet the needs of the interested public who want pretty pictures of the Earth.

NASA Speakers Bureau

There is some interest at NASA Headquarters in establishing an Earth Science Enterprise Speakers Bureau. Persons in the NASA community are often invited to speak in schools, public events, on Capitol Hill, etc. We hope the Visible Earth will provide a rich reference resource for finding materials to enhance such presentations.

NASA Educators

There are many wonderful educational Web sites and other materials produced by the education community. We hope the Visible Earth will provide plenty of new images, animations, and data visualizations that complement student lesson plans while demonstrating NASA's contributions to Earth system science.

Public Media

In the few weeks since Visible Earth was released for public use, already representatives from the media—including newspapers and popular magazines—have visited the site seeking particular images. Media producers are generally interested only in the most recent version of an image, but Visible Earth does not necessarily provide the latest image of an event or location. However, media representatives may use the site to find images of interest and then identify the image creator from whom they may request an updated version.

Museums

There are many museums around the country with exhibits on Earth system science as well as NASA's Earth science missions. Increasingly, these museums are using large display screens and interactive kiosks to inform and entertain their visitors. We hope the Visible Earth will provide a rich resource for museums to enhance their displays.

Direct to At-Home Consumers
NASA image sites are very popular among the at-home browsing public, so a site that provides not just a group of images, but several access vectors (e.g., full-text searching, browsing by location, sensor, or topic) is useful for Web surfers who are searching for types of images—whether of their country or types of events (e.g., hurricanes or floods).

Credits

The site was created by Kevin Ward (kward@pop900.gsfc.nasa.gov), EOS Project Science Office, in consultation with the Goddard Science Visualization Studio and the Goddard Visual Analysis Laboratory. Support for the site was provided by Michael King, EOS Senior Project Scientist, Code 900, and Horace Mitchell, Manager for Scientific Visualization and Virtual Reality, Code 930, Goddard Space Flight Center.

EOS Science Calendar

October 17-19
Aura Science Team Meeting, Tide Water Inn, Easton, MD. Contact Mark Schoeberl, email: schom@zephyr.gsfc.nasa.gov or Kathy Regul, email: kregul@westover-GB.com for information

October 24-26
DAAC Managers Meeting, Goddard Space Flight Center, Greenbelt, MD, building 32, room S241. Contact Steve Kempler, email: kempler@daac.gsfc.nasa.gov

October 30 - November 2
TRMM U.S. Science Team Meeting, Greenbelt Marriott, Greenbelt, MD. Contact Bob Adler, email: Robert.Adler@gsfc.nasa.gov.

Global Change Calendar

October 9-11
Global Disaster Information Society 2001 Annual Conference, Honolulu. Contact Nancy Wallman, e-mail: wallman@erim-int.com, tel. (734) 994-1200, URL: www.erim-int.com/CONF/conf.html.

October 16-20
ERS-ENVISA Symposium "Looking at our Earth in the New Millenium," Gothenburg, Sweden. Contact Prof. J. Askne, e-mail: askne@rss.chalmers.se; URL: www.esa.int/sympo2000/.

October 24-26
Tropospheric Aerosols: Science and Decisions in an International Community—A NARSTO Technical Symposium on Aerosol Science, Querétaro, Mexico. Contact: Norman Mankim, tel. (775) 674-7159; e-mail: normanm@dri.eud; URL: www.cgenv.com/Narsto.

November 6-8
14th International Conference and Workshops on Applied Geologic Remote Sensing, Las Vegas. Contact Nancy Wallman, e-mail: wallman@erim-int.com, URL: www.erim-int.com/CONF/GRS.html.

November 22-24
Vision, Modeling and Visualization 2000, Saarbruecken, Germany. Contact Hans-Peter Seidel, e-mail: hpseidel@mpi-sb.mpg.de, URL: www.mpi-sb.mpg.de.

December 15-19
American Geophysical Union, San Francisco. Contact AGU, tel. (202) 462-6910, Fax: (202) 939-3229.

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January 14-19
American Meteorological Society, Albuquerque. Call (202) 682-9006, Fax: (202) 682-9298, e-mail: ams@ametsoc.org.

February 6-9
AVIRIS Earth Science Workshop, Jet Propulsion Laboratory. Contact Robert Green, e-mail: rog@spectra.jpl.nasa.gov, URL: makalu.jpl.nasa.gov.

April 8-11
GWXII: The XIIth Global Warming International Conference & Expo, 2001 Annual Conference: KYOTO Compliance Review, Cambridge University, UK. Call for Papers. For abstract submission see URL: www.GlobalWarming.Net; tel. (630) 910-1551; Fax: (630) 910-1561; e-mail: gw12@GlobalWarming.Net.

April 23-27
ASPRS: The Imaging and Geospatial Information Society, St. Louis. See URL: www.asprs.org, email: wboge@aol.com, tel. (410) 208-4855, Fax: (410) 641-8341.

July 9-13
International Geoscience and Remote Sensing Symposium, Sydney, Australia. Call for Papers. For abstract submission see URL: www.IGARSS2001.org, tel. 61.2.6257.3299; Fax: 61.2.6257.3256; e-mail: igarss@ausconvervices.com.au.

(Continued from page 14)

NASA Scientists Detect Rapid Thinning Of Greenland's Coastal Ice

ice sheets are capable of responding more rapidly than we thought to external changes, such as a warming climate."

"For the first time, we are seeing evidence that one of the two great ice bodies on the Earth (the other is the Antarctic ice sheet) is contributing, in a modest fashion, to observed sea-level rise," said Dr. Ghassem Asrar, Associate Administrator for NASA's Office of Earth Science. "NASA's ICESat spacecraft, which is scheduled for launch in 2001, will allow us to make similar measurements routinely and keep an eye on both Antarctica and Greenland."

The Office of Earth Science, NASA Headquarters, Washington, DC sponsors the Greenland ice mapping project. NASA's Office of Earth Sciences studies long-term climate trends to learn how human-induced and natural changes affect our global environment.

Further information on the Greenland mapping project, including the technology behind the science, is available at Web-site: aol.wff.nasa.gov/aoltm.html

Imagery supporting this story is available at Web-site: svs.gsfc.nasa.gov/imagewall/greenland.html

More information about the Office of Earth Sciences can be found at Web-site: www.earth.nasa.gov

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