IEOS/GEOSS IMPLEMENTATION ISSUES

A study developed by the

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December 22, 2004

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Dear Ghassem, Cliff, and Greg:

I am pleased to transmit to you the paper that finalizes the study: "IEOS/GEOSS Implementation Issues" which NOAA sponsored. As you know, the study considered three of the major Earth observing system implementation issues, stated briefly: 1) establishment of a framework to involve stakeholders, 2) IEOS/GEOSS management and funding arrangements to ensure long-term support, 3) facilitating a system of IEOS/GEOSS maximum data exchange. The paper documents the rationale for, as well as the advantages and disadvantages of options for resolution of those issues that were considered by the 23 external and six AMS study participants. Most importantly, it presents the five recommendations to address the issues on which the study participants developed a consensus.

The study, although focusing largely on the implementation issues of IEOS, has also considered the international aspects involved with GEOSS. An important conclusion of the study is that GEOSS can only be effectively implemented if the U.S. successfully implements IEOS.

In my judgment, the two most important and imperative recommendations are:

RECOMMENDATION 4.1: In the U.S. an IEOS secretariat should be established as soon as possible to oversee the administration and management of ongoing IEOS activities and operations.

and

RECOMMENDATION 1: There should be ongoing, comprehensive stakeholder evaluations of IEOS value to U.S. interests and future needs that are initiated as part of the earliest planning efforts. The comprehensive evaluations should consist of a forum series combined with periodic stakeholder conferences, and coordinated multi-year studies of IEOS data and information value.

Of course, we believe that all of the recommendations should be implemented, but these two should be considered by the IEOS participating agencies for immediate action.

Let me close by bringing to your attention the concluding remarks of the study paper:

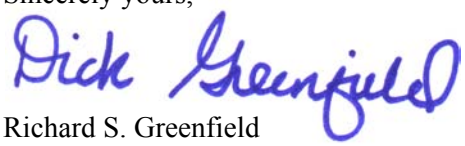
"GEOSS is an undertaking of significant international importance. GEOSS can only succeed if the U.S. effectively implements IEOS. Long-term, global scale observations of the components of the Earth system have long been the goal of the Earth science communities. As a result, IEOS and GEOSS have captured the attention and support of those communities.

The issues that are the focus of this study must be resolved if the long-term vision of systematic observation of the Earth system is to be fully realized. In addition to enabling implementation of IEOS and GEOSS, resolution of these issues could lead to a new era of global cooperation that will steadily expand the community of effective users of Earth system information resulting in ever-greater benefits for humanity.

The American Meteorological Society (AMS), as the leading atmospheric and related sciences professional society, is very pleased to have been the organizer of this study. The Atmospheric Policy Program of the AMS would be pleased to assist in the implementation of the study recommendations."

We look forward to further discussion of the study results and future actions to support IEOS.

Sincerely yours,



Richard S. Greenfield
Study Director
Senior Policy Fellow and Associate Director

IEOS/GEOSS IMPLEMENTATION ISSUES

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ACKNOWLEDGEMENTS

We want to thank every study participant listed in the Appendix for their contributions to this paper by reviewing the text, providing constructive comments and suggestions, and considering and giving final endorsement to the recommendations. We would like to offer a deep expression of gratitude to several of the participants who provided substantial ideas and specific suggestions that improved the analyses and the recommendations. These individuals are: William Anderson, Robert Corell, Mike MacCracken, Norm Rosenberg, Robert White, and John Zillman. This study could not have been successfully completed without the active participation and contribution of the staff of the Atmospheric Policy Program, American Meteorological Society: Genene Fisher, Richard Hallgren, and William Hooke.

Richard Greenfield
Study Director
Atmospheric Policy Program
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EXECUTIVE SUMMARY

Observations of the phenomena that occur in the Earth system — its atmosphere, oceans, land masses, biosphere and natural and human resources and hazards— could expand understanding of those phenomena and enable a safer, more efficient society. An extraordinary international effort is now underway to promote and plan "the development of a comprehensive, coordinated, and sustained Earth observation system of systems among governments and the international community to understand and address global environmental and economic challenges." In recognition of the crucial role data from those systems could play in protecting human health and safety, alleviating human suffering and poverty, and achieving sustainable development, 51 nations have agreed to cooperatively implement a Global Earth Observation System of Systems (GEOSS) to collect those data for the purpose of providing information for decision makers. GEOSS has the potential to provide substantial benefits to all nations. An *ad hoc* interagency Group on Earth Observations (GEO) is developing a 10-year implementation plan for GEOSS.

In parallel with this coordinated international planning, the U.S. has established the Interagency Working Group on Earth Observations (IWGEO) to prepare a strategic plan for the development and implementation of the U.S. Integrated Earth Observation System (IEOS). The strategy will reinforce U.S. leadership in GEOSS. Currently, the international GEO and the U.S. IWGEO are developing cases for an integrated system of Earth observations; characterizing some of the societal benefits and requirements; and addressing a range of issues, such as the need for convergence of observations, the opportunities for synergy, requirements for interoperability and architecture, data access and use, capacity building, outreach, governance and resourcing, performance indicators, and schedule.

The level and nature of investments made in this area in the coming few years will either sustain or limit – perhaps for decades – our ability to meet growing national and international needs for effective earth observations, science and services. The ultimate international response to the proposed effort to implement and, in the future, strengthen GEOSS will depend on how effectively global thinking, dialogue, and planning address a range of challenges.

While much of the planning effort is directed at the scientific and technical aspects of the task, there are a host of policy issues that must be resolved if the implementation of an integrated Earth observing system is to be successful. The IEOS and GEOSS planners must come to grips with these issues that are largely if not wholly external in character. They reflect far broader national and international political and economic realities, and must be addressed by a range of individuals, institutions, and nations. Of course, the effort to fully realize IEOS/GEOSS will extend over a decade, at least, and will require a commensurate evolutionary approach to resolving the associated policy issues.

The success of IEOS/GEOSS is clearly dependent on community efforts that complement and enhance governmental planning. The American Meteorological Society (AMS), with the support of the IEOS planners, organized this study of three key policy issues that must be resolved in order to successfully implement IEOS/GEOSS. In undertaking this study, the AMS Atmospheric Policy Program solicited the participation of experts from a broad range of disciplines. The study participants examined a series of options to resolve each of the issues. After considering the options, the participants agreed on a set of recommendations to respond to the issues.

For the purpose of discussing the policy issues, it is useful to define several important terms (see box).

IMPORTANT DEFINITIONS
(In the context of this study)

- **Stakeholders** – those who have an interest, involvement, and investment in IEOS/GEOSS data and information. The stakeholders encompass these groups:
  - **Information users** — those who use IEOS/GEOSS-based information to make decisions or conduct research in societal benefit areas ranging from reduction of life and property risks to natural resource management
  - **Information providers** — those who analyze and produce user needed information based on IEOS/GEOSS data (includes public and private sector providers of services, as well as researchers who advance understanding that leads to new products and services)
  - **Data Users** — those who make use of IEOS/GEOSS data to conduct research, characterize the state of the Earth system or produce Earth system information for use by information providers
  - **Data providers** — those who are directly involved in the collection, quality control, transmission, and archiving of IEOS/GEOSS data essential for users
- **Value** — measure of usefulness and importance to the users of IEOS/GEOSS data and information. Value contains quantitative elements (e.g., disease pathways tracked; lives not lost; injuries avoided; profits increased; enhanced crop yields; improved natural resource management) and qualitative elements, in terms of non-quantified, social benefit (e.g., improved human health and well being; addressing issues of hunger and poverty; enhanced capacity to anticipate and respond to environmental changes)

This study, although focusing largely on the implementation issues of IEOS, has also considered the international aspects involved with GEOSS. **In the final analysis, GEOSS can only be effectively implemented if the U.S. successfully implements IEOS.**

INVOLVING IEOS/GEOSS STAKEHOLDERS

Involving the full range of stakeholders in the planning, implementation, and continuing development is critical for the success of IEOS/GEOSS. A structured framework and an associated, ongoing process for stakeholder involvement is necessary for demonstrating the practical applications of Earth observations and their relevance to government policy, societal well-being, and the interests of citizens. This will in turn encourage support for the continuing operation and enhancement of IEOS and GEOSS. Moreover, IEOS and GEOSS enhancements must be aimed at satisfying unmet needs of the users that can only be documented through such a process. **The process to involve stakeholders in IEOS/GEOSS planning to satisfy unmet information needs should be implemented as early as possible in the initial planning.**

This study concentrated on the process to be considered for stakeholder involvement in IEOS. Clearly, the requirement to involve stakeholders in assessing the value of GEOSS data and information and identifying unmet needs for future enhancements extends to all nations. Therefore, whatever process is adopted for U.S. stakeholder involvement could be applied internationally.

Finally, it is clear that the process to involve stakeholders should be iterative. An initial requirement is to identify the range of stakeholders, to clarify their roles in IEOS development and operation, and to determine in consultation with them the most effective mechanisms for assuring effective communication. The first step is to identify sufficient representatives of the information provider and user communities to capture an initial sense of the larger communities. Subsequent steps would provide for successively greater breadth of stakeholder and decision maker participation.

RECOMMENDATION 1: There should be ongoing, comprehensive stakeholder evaluations of IEOS value to U.S. interests and future needs that are initiated as part of the earliest planning efforts. The comprehensive evaluations should consist of a forum series combined with periodic stakeholder conferences, and coordinated multi-year studies of IEOS data and information value.

Economists, social scientists, political scientists, and policy analysts working with representative stakeholders would carry out value analyses. These analyses would provide basic information for periodic conferences among the IEOS data and information stakeholders spanning the full breadth of IEOS applications across the societal benefit areas. Initially, these conferences should be held annually, but after several years, as IEOS improvements are implemented to meet stakeholder needs, the conference cycle should be lengthened. The conference reports would summarize the results of the dialogues on the current values of IEOS information, as well as, on the unmet stakeholder needs that could be addressed by further development of IEOS. The conference reports and value studies

would then provide the foundation for discussions at a series of forums, each focused on a societal benefit area, that would add the vital participation of academics and decision makers. The forum reports would document detailed value estimates of the current IEOS data and products and discuss recommendations to address infrastructure enhancements; research and technology developments and applications; and educational innovations to improve IEOS information for public and private decision support systems in each societal benefit area.

RECOMMENDATION 2: A clearinghouse of IEOS user applications and services should be established.

The communities of stakeholders should be greatly expanded within the U.S. by establishment of a IEOS clearinghouse effort to gather and disseminate information about successful IEOS applications (unless an appropriate institutional capability already exists). By regular dissemination of information about IEOS capabilities through publications, Internet pages, and/or periodic conferences, potential users would be made aware of the value of IEOS data and related services. An additional, important benefit of such a system would be to provide high-level decision makers with evidence of effective application of IEOS data and information thereby encouraging their support and enhancement of IEOS. As the inventory of effective applications of IEOS information grows, support for the system would be expected to grow significantly over time. The IEOS clearinghouse would be a very effective outreach effort that could encourage implementation of the clearinghouse concept on an international scale. Of course, the clearinghouse would have to adopt procedures to encourage application developers to contribute information and documentation about their application. By utilizing modern technologies for archiving and communication, a distributed international clearinghouse could be developed that would permit each nation to monitor access and subsequent utilization of their GEOSS contributions.

RECOMMENDATION 3: An IEOS stakeholder advisory group should be established.

As a *supplement* to the ongoing comprehensive stakeholder evaluations developed under Recommendation 1, an IEOS stakeholder advisory group should be formed. The group members should be appointed to serve specified terms. The group should periodically meet with decision makers to discuss GEOSS benefits and identify unmet needs. The group could use electronic communication approaches to involve much wider stakeholder participation. The group's activities could serve to reduce the number of forums and conferences that might be needed for the comprehensive evaluations. In addition, such a group would provide a sustained focus on relevant issues, as opposed to participants at periodic forums. The latter could then be used to build on the advice that comes from the more long-running advisory group.

If the IEOS planners implement these three recommendations, stakeholders will be deeply and effectively involved in the evaluation of benefits from the systems' output and the

planning of enhancements to the systems. Moreover, through U.S. leadership, there should be a steady expansion of the benefits to all GEOSS member nations.

ENSURING LONG-TERM IEOS AND GEOSS SUPPORT

If IEOS and GEOSS are to have continuing support, administrative oversight and financial stability are essential. For administrative stability, formal oversight arrangements for IEOS and GEOSS, policies, rules, and procedures will have to be negotiated and established. A fully staffed and supported IEOS Secretariat that is responsive to the participating executive agencies and Congress would serve that function effectively. *Sound oversight will provide the administrative stability necessary to ensure continuing financial support for IEOS.*

For financial stability, IEOS and GEOSS will always depend on the value that is demonstrated for the data and information that are produced by the systems. **As a result, whatever support mechanism is instituted, an ongoing process for evaluating the value of the IEOS and GEOSS products must be established. Moreover, there will have to be a continuing, robust research program to add value to IEOS and GEOSS products.**

The study participants make the following recommendations for IEOS and GEOSS administrative and financial mechanisms:

RECOMMENDATION 4.1: In the U.S. an IEOS secretariat should be established as soon as possible to oversee the administration and management of ongoing IEOS activities and operations.

Within the U.S., there is a pressing need for a mechanism to oversee the operation and management of IEOS. A secretariat that is responsive to the participating executive agencies and Congress would serve that function effectively. Sound oversight will provide the administrative stability necessary to ensure continuing financial support for IEOS. This oversight, through a full-time, fully staffed secretariat, must be instituted as soon as possible to assure successful initiation and subsequent effective implementation of IEOS.

RECOMMENDATION 4.2: A GEOSS secretariat and funding mechanism should be established in association with an intergovernmental organization that presently exists or is developed through suitable international arrangements and, ideally, a negotiated collaborative relationship with a scientific, non-governmental organization, such as ICSU.

In the final analysis, the selection of a GEOSS support mechanism will depend on the ability of the planners to convince the member nations that the mechanism is sound and responsive to GEOSS funding and operating requirements. Obviously, a secretariat must also be established to oversee the administration and management of ongoing GEOSS activities and operations.

An international agency/organization, which is deeply committed to environmental issues or a consortium of such agencies, could systematically gather voluntary funding, as well as provide oversight for the management of GEOSS. For example, the UN system and other international organizations with global Earth observation mandates could formally establish, via identical resolutions, a joint intergovernmental subsidiary body and joint secretariat which will be accepted by all the key organizations and by all countries as the single high level coordination mechanism for GEOSS implementation. Another possible approach is an intergovernmental successor to GEO, with its own operating procedures and Secretariat established either as a fully independent organization or as a part of the United Nations system.

Finally, the established intergovernmental organization should seek a collaborative arrangement with a non-governmental organization such as the International Council for Science (ICSU), formerly the International Council of Scientific Unions. ICSU provides scientific advice and oversight for activities they coordinate. ICSU is very sensitive to the needs of the developing nations.

The resulting collaborative organization would gather funding from the GEOSS member nations in accordance with their ability to contribute. Many developing nations that will be member nations of GEOSS are not in a position to make financial contributions. As a result, the financing of GEOSS observational capabilities, especially equipment and personnel, in developing nations will depend, at least in part, on voluntary or assessed contributions of developed nations. It is imperative that the developed nations accept that responsibility. The mechanism recommended by this study will provide a vehicle for ensuring that those responsibilities will be met. The mechanism will also provide internationally credible oversight of GEOSS management.

FACILITATING GEOSS DATA EXCHANGE

A major GEOSS challenge is to establish a system of data and information exchange that is as close as possible to "full and open" in order to realize the global benefits that can flow from an integrated global Earth observation system of systems. The U.S. is committed to full and open exchange of IEOS data. The appropriate U.S. agencies will have to review the data sets to decide which data cannot be exchanged due to national security or proprietary concerns. Access to all other IEOS data will be without restrictions.

GEOSS participating nations must be convinced that a successful sharing of Earth system information will enhance the physical and economic well being of their citizens. U.S. leadership in providing IEOS data on a full and open basis, except for security or proprietary limitations, should encourage international adoption of that principle. As a result, it is anticipated that the GEOSS participants will be strongly motivated to ensure that a maximum amount of information is made available to all. There are counter balancing forces at work, however, that will give rise to inhibitions to full and open data exchange. Among these forces are national security concerns, intellectual property rights laws, proprietary pressures from the private sectors, and political pressures to recapture some of the costs of GEOSS participation through marketing of national data and products,

etc. In the final analysis, the selection of a GEOSS data sharing mechanism will depend on the ability of the planners to convince the participating nations that the mechanism is sound and responsive to GEOSS goals. The study participants make the following recommendation for the GEOSS data sharing mechanism:

RECOMMENDATION 5: A process of negotiation should be developed to explore actions to be taken to move data sets from any restricted categories to full and open sharing status.

GEOSS planners, following U.S. leadership, should be urged to take the view that part of the GEOSS charge is to expand, over time, the range of data types that are freely shared internationally.

The study participants believe that a negotiation process is the best way to maximize the amount and types of data that GEOSS member nations will share on a full and open basis. In implementing this process, data types would be categorized according to whether they are: (1) currently being fully shared; (2) not shared because they are highly sensitive or for reasons of compelling national security; or (3) not shared currently, but where sharing is not outside the realm of possibility, i.e., an intermediate sharing category. Attention would then focus on negotiations – an exploration of what actions might be taken to convince member nations to move data sets in this intermediate category into the "fully shared" category.

There is a strong likelihood that increasing amounts of observations and information will be available to meet all users' needs, thereby confirming GEOSS data as a "global good" contributing to significantly to economic and social well being of the world's citizens.

GEOSS is an undertaking of significant international importance. GEOSS can only succeed if the U.S. effectively implements IEOS. Long-term, global scale observations of the components of the Earth system have long been the goal of the Earth science communities. As a result, IEOS and GEOSS have captured the attention and support of those communities.

The issues that are the focus of this study must be resolved if the long-term vision of systematic observation of the Earth system is to be fully realized. In addition to enabling implementation of IEOS and GEOSS, resolution of these issues could lead to a new era of global cooperation that will steadily expand the community of effective users of Earth system information resulting in ever-greater benefits for humanity.

The American Meteorological Society (AMS), as the leading atmospheric and related sciences professional society, is very pleased to have been the organizer of this study. The Atmospheric Policy Program of the AMS would be pleased to assist in the implementation of the study recommendations.

IEOS/GEOSS IMPLEMENTATION ISSUES

1 Introduction

> *"Understanding the Earth system—its weather, climate, oceans, land, geology, natural resources, ecosystems, and natural and human-induced hazards—is crucial to enhancing human health, safety and welfare, alleviating human suffering including poverty, protecting the global environment, and achieving sustainable development. Data collected and information created from Earth observations constitute critical input for advancing this understanding. In 2003, a consensus emerged among governments and international organizations that, while supporting and developing existing Earth observation systems, more can and must be done to strengthen global cooperation and Earth observations."*[1]

An extraordinary international effort is now underway to plan the development of a comprehensive, coordinated, and sustained system of Earth observing systems to understand and address global environmental and economic challenges. On July 31, 2003, at Earth Observation Summit I (EOS I), thirty-three nations, plus the European Commission adopted a Declaration that commits them to the development of a comprehensive, coordinated, and sustained Earth observation system. The Summit participants affirmed the need for timely, high-quality, long-term, global information as a basis for sound decision making. In order to continuously monitor the state of the Earth, to increase understanding of dynamic Earth processes, to enhance prediction of the evolution of the Earth system, and to further implement environmental treaty obligations, participants recognized the need to support the creation of a comprehensive, coordinated, and sustained Earth observing system of systems. The system of systems subsequently was named the Global Earth Observation System of Systems (GEOSS). EOS I established the *ad hoc* interagency Group on Earth Observations (GEO) to develop a 10-Year Implementation Plan for GEOSS. Ministers and Ministerial representatives from 43 nations and representatives from 25 international organizations met for Earth Observation Summit II (EOS II) in Tokyo, Japan, on 25 April 2004, where they adopted the Framework Document for a 10-Year Implementation Plan for this initiative. The plan itself will be presented at Earth Observation Summit III (EOS III) in February 2005. The number of GEOSS member nations is now 51 and there are now 29 international organizations that are participants.

In parallel with this coordinated international planning, the U.S. Interagency Working Group on Earth Observations (IWGEO) has been established to prepare a strategic plan for the development and implementation of the U.S. Integrated Earth Observation System (IEOS). The strategy will

[1] Framework for a 10-year Implementation Plan, Earth Observation Summit II, 25 April 2004.

reinforce U.S. leadership in GEOSS. Currently, the international GEO and the U.S. IWGEO are developing cases for an integrated system of Earth observations; characterizing some of the societal benefits and requirements; and addressing a range of issues, such as the need for convergence of observations, the opportunities for synergy, requirements for interoperability and architecture, data access and use, capacity building, outreach, governance and resourcing, performance indicators, and schedule.

While extensive, the GEO documentation (and the writers themselves) acknowledges that much more planning and action is needed if the world's peoples are to make fullest use of Earth system observations. Several policy challenges to successful implementation, both in the U.S. and abroad, of GEOSS are highlighted in the EOS I Declaration adopted on July 31, 2003 and the Framework for a 10-year Implementation Plan, adopted by EOS II on 25 April 2004.

This study, although focusing largely on the implementation issues of IEOS, has also considered the international aspects involved with GEOSS. **In the final analysis, GEOSS can only be implemented if the U.S. successfully implements IEOS.**

The success of IEOS will require community efforts that complement and enhance the government-driven activities involved in their planning and execution. Both the ultimate users of IEOS and many of those who are most knowledgeable in the definition of its requirements exist in the community of academia and industry outside of government. It is essential that formal channels be created to garner the expertise in this community, a task that is best led by the community itself. The American Meteorological Society (AMS) has been a community leader for many decades in issues concerning weather and the environment, and has organized this study with the endorsement of the IWGEO planners to provide a community channel that focuses on important policy issues influencing IEOS. This study complements two other community efforts to gather information from the community: the decadal study of Earth science and applications from space led by the National Research Council (www.nas.edu), and the industry perspective organized by the Alliance for Earth Observations (www.strategies.org/alliance).

In undertaking this study, the AMS Atmospheric Policy Program solicited the participation of experts from a broad range of disciplines. The list of participants is shown in the Appendix.

Prior to considering the policy issues, it is useful to define several terms that are used repeatedly in the analyses. These terms are:

- **Stakeholders** – those who have an interest, involvement, and investment in IEOS/GEOSS data and information. The stakeholders encompass these groups:
    - **Information users** — those who use IEOS/GEOSS-based information to make decisions or conduct research in societal benefit areas ranging from reduction of life and property risks to natural resource management
    - **Information providers** — those who analyze and produce user needed information based on IEOS/GEOSS data (includes public and private sector providers of services, as well as researchers who advance understanding that leads to new products and services)
    - **Data Users** — those who make use of IEOS/GEOSS data to conduct research, characterize the state of the Earth system or produce Earth system information for use by information providers
    - **Data providers** — those who are directly involved in the collection, quality control, transmission, and archiving of IEOS/GEOSS data essential for users
- **Value** — (in the context of this study) measure of usefulness and importance to the users of IEOS/GEOSS data and information. Value contains quantitative elements (e.g., disease pathways tracked; lives not lost; injuries avoided; profits increased; enhanced crop yields; improved natural resource management) and qualitative elements, in terms of non-quantified, social benefit (e.g., improved human health and well being; addressing issues of hunger and poverty; expanded understanding of the Earth's system, its resources, and its ability to sustain life; enhanced capacity to anticipate and respond to environmental changes)

IEOS-related Policy Issues

IEOS brings with it a number of new and often subtle policy concerns, and the community has yet to fully evaluate the breadth of these issues and their relative importance. This study focuses on

three of the key issues that must be resolved to facilitate the development of a robust IEOS implementation framework. These issues were selected because they are known to be both important and representative of the many issues that will arise during the IEOS implementation process. By focusing a community spotlight on these three issues, we will begin laying the foundation for their solution. We, however, will suggest a methodology for addressing the wider range of policy issues associated with GEOSS.

The policy issues analyzed in this paper are:

- Development of an ongoing process to involve actual and potential stakeholders in the effort to identify the value of present applications and future needs for IEOS observations and information.

- Establishment of infrastructures, arrangements, and procedures that will ensure program continuity, enhancement, and support over periods long compared with political time horizons.

- Development of required national and international arrangements to facilitate both development and long term operations of complementary systems, optimal levels of availability, and exchange of Earth system data.

These issues are complex and intertwined. Policies that resolve these issues must be responsive to national and international political and economic realities far broader than IEOS and GEOSS. Moreover, a range of individuals, institutions, and nations must address those policies. Left unresolved, these issues will limit near-term implementation and future enhancement of Earth observations, science, and services. However, if appropriate policies are developed and adopted, they have the potential to go a long way toward supporting successful IEOS/GEOSS implementation, which is a key to improved human health and safety, a prosperous world economy, protection of the global environment, and national and international security.

Each nation that participates in GEOSS will be contributing to an effort that meets the needs of all nations in our interconnected world. As a result, by taking their share of GEOSS observations, each national society will benefit from the products and information derived from a global network of observations.

The effort to fully realize the initial implementation of IEOS/GEOSS will extend over a decade, at least, and will require an evolutionary approach to resolving a series of associated policy issues.

The study participants considered a series of policy options to resolve each of the issues. The options are presented in the next three sections, followed by a section that details the recommendations to respond to each issue.

2 Involving IEOS/GEOSS Stakeholders

> *"The GEOSS 10-Year Implementation Plan ... will provide generally for: ... c. Involvement of user communities; ... e. Co-ordination and facilitation of the development and exchange of observations and products between members and relevant international and regional organizations."* [2]

Current and potential IEOS/GEOSS stakeholders must be increasingly involved in an ongoing process to identify:

- present and potential uses and socio-economic value of Earth observations and information for public health and safety, economic development, protection of the environment and ecosystems, national security, and policy formulation in these areas;
- future needs for additional Earth observations, research, and information within these areas; and
- policy implications for the applications and value of Earth observations and information.

This process must also provide for continuous improvement of the systems, increasingly enabling users to apply Earth system information to make better decisions, and provide policy makers and the public with an increased understanding of the benefits flowing from that information. The process should be implemented as early in the initial planning as possible. Moreover, there will have to be a long-term, robust research program designed to sustain and add value to the implementation of IEOS/GEOSS.

Early and frequent stakeholder participation can provide important benefits and help to ensure successful IEOS/GEOSS implementation. Governments, corporations, NGOs, and the research community need to be in continuous and interactive communication on the kinds of additional information, products, and services IEOS/GEOSS should provide.

To date, however, such efforts have only scratched the surface; many of the Earth system information providers and users do not appear to have been involved sufficiently in the planning, consideration of priorities, or design of potential products. Stakeholders must become active early and ongoing participants in a broad-based effort to ensure that IEOS/GEOSS services and

[2] Framework for a 10-year Implementation Plan, Earth Observation Summit II, 25 April 2004.

products can and will be widely used to improve overall economic performance, social well being, environmental quality, and scientific advancement. To make the challenge more difficult, users' needs as well as the technology and science that lead to advances in observation and applications can be expected to be constantly evolving, requiring that user participation be continuous and ongoing. Clearly, IEOS/GEOSS services and information must be responsive to user needs. This is an important and often overlooked element of the process linking science and services to societal benefit.

Within the U.S., providers will require user support in both the legislative and executive branches if IEOS and supporting research activities are to achieve and maintain needed continuity in the face of competing demands for limited funds. For this and other reasons, users and providers of information must engage decision-makers at all levels in their dialogues. Moreover, the reports of those dialogues must be communicated to decision-makers at all levels. Ongoing and expanding stakeholder involvement can provide indications of how important a comprehensive observation and research effort will be for carrying through the larger elements of the U.S. agenda and national priorities.

For the past several decades, with only intermittent exceptions, governments have not given sufficiently high priority to Earth observation investments. By involving the users in the valuation of GEOSS products and services, as well as the identification of evolving observational needs, governments will be provided national benefits documentation that can be used to support the decisions to make the necessary investments.

We concentrate, now on the processes to be considered for stakeholder involvement in IEOS development within the U.S. Clearly, the requirement to involve stakeholders in an ongoing process of assessing the value of GEOSS data and information and identifying unmet needs for future enhancements extends to all nations involved in the system. Therefore, whatever process is adopted for U.S. stakeholder involvement will have applicability on an international level.

It is clear that the process to involve stakeholders should be iterative. An initial requirement is to identify the range of stakeholders, to clarify their roles in IEOS development and operation, and to determine in consultation with them the most effective mechanisms for assuring effective communication. The first step is to identify sufficient representatives of the information provider and user communities to capture an initial sense of the larger communities. Subsequent steps would provide for successively greater breadth of stakeholder and decision maker participation.

Several options are available to involve actual and potential stakeholders in the effort to identify the value and importance of IEOS observations. An analysis of these options, including the advantages and disadvantages of each, are given below:

2.1 Forum Series For Dialogues Among IEOS Stakeholders and Decision Makers

One approach to building a consensus on the value of IEOS is to develop a series of dialogues. These dialogues would need to involve users and providers of IEOS data and information *as well as decision makers*. The dialogues should involve participants from a range of user and scientific/professional organizations representing the various disciplines that can enable effective use of IEOS data and information. These dialogues could be organized with either an annual general forum, a series of forums each focused on societal benefit areas, or comprehensive annual forums designed to combine those approaches. In all cases, substantial preparatory activities and analyses would be needed prior to any forum.

Each forum, and the series as a whole, would have several aims, specifically to:

- provide estimates of IEOS value to a variety of users;
- help define unmet user needs to guide continual improvements in observations and services;
- help set priorities among these; and
- recommend needed policy changes for improvement of system operations and product delivery.

2.1.1 General IEOS Annual Forum

An annual forum designed to evaluate needs for future IEOS products and services could be an important means of gaining information for improving the efficiency of important national activities across the societal benefit areas identified by the IEOS planners. Such a forum would provide a venue for discussion of the uses, benefits, and value of present and future IEOS data and information. Moreover, by spanning the full breadth of IEOS applications across the societal benefit areas, the discussions could provide the various stakeholder communities with information that could lead to a synergy that would produce an overall enhancement of IEOS value. A forum report would summarize the qualitative and quantitative value estimates of current IEOS data and the needed future enhancements to IEOS infrastructure and information. The report would also offer policy recommendations to address infrastructure enhancements; research and technology developments and applications; and educational innovations to improve IEOS information for public and private decision support systems.

PROS: Stakeholders can exchange vital information to improve IEOS

IEOS value will be enhanced through the synergy of comprehensive discussions of applications

Scientists can provide a broad perspective on expanding present and future application of Earth system data and information

Decision makers are integrated into the discussion of present and future value of IEOS

Forum report documents present and future national IEOS benefits

Representatives of all societal benefit areas are brought together to exchange views on IEOS status and growth potential

CONS: The broad diversity of stakeholder representatives will preclude an in-depth discussion of value resulting in a lack of sufficient depth in the forum report

An annual forum cycle may be shorter than the IEOS-improvement time scale

2.1.2 Series of Societal Benefit Area Forums

Another option to implement a dialogue process would be to establish a forum series focused on in-depth discussions of Earth system data and information among stakeholders from various sectors. The forums could be based on the IEOS societal benefit areas or the economic, environmental, public safety, and national security sectors. Each forum would provide a venue for in-depth discussion of the uses, importance, significance, and value of present IEOS data and information in that particular area. In addition, each forum would be organized to discuss unmet user needs that could be addressed by further development of IEOS infrastructure and capabilities. A report would summarize the qualitative and quantitative value estimates of the current Earth system data and the needed future enhancements to IEOS infrastructure and information. Clearly, it would be necessary to conduct at least one complete set of forums across the areas to gather this information from the full range of stakeholders served by IEOS. Unlike the general annual forum, each forum in the series would allow for more in-depth discussion and focus on a particular societal benefit area.

PROS: Each forum would enable in-depth discussion of IEOS value for individual societal benefit areas

Stakeholders can exchange vital information to improve Earth system information and services

Scientists can provide a broad perspective on expanding present and future application of Earth system data and information

Decision makers are integrated into the discussion of present and future value of IEOS

Forum report documents present and future national IEOS benefits

CONS: Repeat cycle of forum series could be too long to provide timely estimates of increasing IEOS value and needs

2.1.3 Comprehensive Annual Forum

An annual forum of stakeholders and decision makers could be organized as a combination of 2.1.1 and 2.1.2 to facilitate both general and societal benefit area-specific dialogues. General dialogues would be facilitated at a preliminary plenary session in which all stakeholder groups are represented and informed by IEOS management on the scientific, technical and policy issues that require resolution if IEOS is to meet expectations. In one to two day breakout sessions, stakeholders from each area would address such issues as: critical data needs, value of Earth system information, analysis and extension of findings, research priorities, mechanisms for gaining public awareness and support of IEOS activities and others.

For example, as agriculture depends greatly on water resources, energy and transportation, cross-sectoral discussions with these groups might occupy another day. A final day might be devoted to a plenary in which reports are presented on findings of the sectoral and cross-sectoral meetings and to developing grand strategies for the overall efficiency and sustainability of the IEOS enterprise.

PROS: Information needs and concerns of each societal benefit area are provided

Information providers and researchers learn directly of the needs and limitations of information users within the areas they serve

Decision makers learn the value of IEOS

Commonalities in information needs in multiple sectors could amplify value of information and help policy makers prioritize IEOS activities

CONS: Time may be too short for in-depth discussion and prioritization of individual societal benefit area needs

An annual conference/forum cycle may be shorter than the IEOS-improvement time scale

2.2 IEOS Stakeholders Annual Conference

An alternative approach would be to organize an annual stakeholders conference for an effective dialogue among IEOS stakeholders and representatives from the scientific/professional

organizations representing the various disciplines that can enable effective use of Earth system data and information. The conference would provide a venue for discussion of the importance, significance, and estimates of value of present IEOS data and information across all sectors. In addition, the conference would be organized to discuss unmet user needs that could be addressed by further development of IEOS infrastructure and capabilities. This approach would avoid any inhibitions for a frank discussion possibly imposed by the presence of high-level decision makers. A conference report would be prepared that summarizes the qualitative and quantitative value estimates of the current IEOS data and the needed future enhancements to IEOS infrastructure and information.

PROS: Establishes opportunity for stakeholders to provide frank analysis of value and vital information to improve IEOS

Scientists can provide a broad perspective on expanding present and future application of Earth system data and information

Conference report documents present and future national IEOS benefits

CONS: Decision makers are not integrated into the discussion of present and future value of IEOS output

The broad diversity of stakeholder representatives could preclude an in-depth discussion of value

An annual forum cycle may be shorter than the IEOS improvement time scale

2.3 Coordinated, Multi-year Studies of the Value of IEOS Data and Information

One problem of long standing that has inhibited U.S. investments in major observational systems has been the relative paucity of in-depth analyses evaluating potential benefits that might result. Depending on the sector, such analyses could be economic (as in the case of the agriculture or energy sectors), or sociological (as in the valuation of lives not lost and reductions to societal disruption resulting from natural hazards), or policy-oriented (as in the case of policies proposed to assure societal or economic sustainability or preserving environmental quality). While some

excellent research has been done in these areas, the fact remains that most economic, social, and policy research has focused on other areas (biotechnology and health, for example), where more research resources are made available from federal agencies. Agencies have never worked together to formulate a strategic plan and to provide significant, sustained funding streams within a comprehensive framework for such user-oriented research. Such a program is sorely needed.

Studies of the value of Earth system data should include demonstration projects, development of prototype decision systems, test bed activities and many other related "hands-on, trial-and-error" types of efforts to evaluate decision-making value from applications of IEOS-based information. To get optimal value from IEOS, the United States will need to formulate, fund, and implement a research program aimed at obtaining expert estimates of the quantitative value of Earth system data and information. Economists, social scientists, political scientists, and policy analysts could be supported to work with targeted providers and users to regularly conduct in-depth studies of the value of IEOS data and information.

The focus, however, should not be only on social science and policy, but also could include studies of the value arising from research and technology developments, and educational innovations. In addition, research support would be needed to develop tools for carrying out the analyses. These studies could be commissioned and overseen by a council comprised of representatives from IEOS stakeholders and policy makers, who would supervise the design and execution of the studies. The reports of these studies would provide quantitative estimates of the value obtained from IEOS data and information, and might also be used to illuminate the policy forum series.

PROS:

- Establishes opportunity for IEOS stakeholders to provide information for in-depth analyses of value
- Expert approach to development of quantitative, in-depth estimates of IEOS value
- The reports document quantitative estimates of IEOS benefits
- Body of analyses of IEOS benefits grows and is updated yearly

CONS: No provision for translating study results into IEOS improvements

Stakeholders will not have opportunities to synergistically interact to improve IEOS

Decision makers are not integrated into any discussion of present and future value of IEOS output

2.4 Comprehensive Stakeholder Evaluation of IEOS Value and Future Needs

The previous subsections discussed approaches that are not mutually exclusive. There is an opportunity to combine these options in different ways, thereby enhancing advantages and minimizing disadvantages. For example, a forum series could be combined with annual stakeholder conferences, and coordinated multi-year studies of Earth system data and information value. The value analyses would serve as the basis for each annual conference among the stakeholders and providers of IEOS data and information. This would facilitate initial synergistic dialogues on the current values of Earth system information as well as the unmet stakeholder needs that could be addressed by further development of IEOS. The resulting conference reports and value studies would then provide the foundation for discussions at a series of forums that would add the vital participation of academics and decision makers. The output from the forums would be reports on the value estimates of the current IEOS data and products and recommendations to address infrastructure enhancements; research and technology developments and applications; and educational innovations to improve Earth system information for public and private decision support systems in each societal benefit area. The IEOS improvement time scale would dictate the frequency of the value studies, stakeholders' conferences, and series of forums.

PROS: Users and providers synergistically exchange vital information to improve IEOS

Decision makers are integrated into the discussion of present and future value of IEOS output

Forum report documents current and future national IEOS benefits

Establishes opportunity for users to provide information for an in-depth analysis of value

Professional approach to development of quantitative, in-depth estimates of current and potential IEOS value

Study reports document present quantitative national IEOS benefits

Decision makers interact with stakeholders on IEOS needs

CONS: Repeat cycle is dictated by practical considerations including levels of agency support and staffing and scheduling demands rather than IEOS timing requirements

2.5 Clearinghouse of User Applications and Services

The system of involving IEOS/GEOSS stakeholders will evolve over time and must be implemented not only regionally and nationally, but also internationally. The socio-economic value of IEOS/GEOSS can only be maximized if there are optimized services enabled by applications of IEOS/GEOSS data.

As an option to broaden stakeholder involvement within the U.S. in a synergistic manner, a clearinghouse effort to gather and disseminate information about successful IEOS applications could be developed. Dissemination of this important information could be done through regular publications, Internet pages, and/or periodic conferences. Procedures would have to be instituted to encourage developers to contribute application information to the clearinghouse activity. Such a system would provide decision makers with evidence of effective application of IEOS data and information providing a basis for their decision to support and enhance IEOS. As the inventory of effective applications of IEOS information grows, support for the system would be expected to grow rapidly over time.

Ideally, U.S. leadership in establishing such a clearinghouse would provide an incentive to extend the concept internationally. By utilizing modern archiving and communication capabilities, an international GEOSS products and services clearinghouse could be established in a distributed formulation that would permit each nation to monitor access and subsequent utilization of their GEOSS contributions.

PROS: Effective applications of IEOS information would be widely available

Decision makers would be made aware of successful application of IEOS information

Recognition of value of IEOS will be given wide exposure

GEOSS member nations would be encouraged to adopt the clearinghouse concept internationally

CONS: Priorities for application of IEOS/GEOSS information may not be consistent from nation to nation

May be difficult to overcome proprietary obstacles to making successful applications widely available

2.6 Stakeholder Advisory Group

As a supplement to the Comprehensive Stakeholder Evaluation of Value and Future Needs of IEOS Data and Information, establish a stakeholder advisory group whose members could be appointed to serve specified terms. The group could periodically meet with decision makers to discuss Earth systems benefits and unmet needs. The group could use electronic communication approaches to involve much wider stakeholder participation. This could reduce the number of forums and conferences that might be needed. Such a group could provide a sustained focus on relevant issues, as opposed to participants at forums. The latter could then be used to build on the advice that comes from the more long-running advisory group.

PROS: Could provide sustained advice not possible by relying only on annual forums and stakeholder conferences

Gives high visibility to stakeholder involvement

Indicates IEOS commitment to fully integrate stakeholders in the enterprise

CONS: Could develop conflicts-of-interest situations for the members of the group acting in self-interest

May be difficult to develop and maintain appropriate mix of representatives from each of the diverse societal benefit areas

2.7 Conclusion

The process of involving stakeholders is critical for the ongoing long-term success of IEOS and GEOSS. In order to encourage continuous investment in Earth observations, decision makers must see evidence of the socio-economic benefits derived from an integrated Earth observation system. This information is not available presently and a process for developing the information cannot be put into place overnight. A structured framework and an associated, ongoing process for stakeholder involvement is necessary for demonstrating the practical applications of Earth observations and their relevance to government policy, societal well-being, and the interests of citizens. This will in turn encourage support for the continuing operation and enhancement of an integrated Earth observation system. Moreover, IEOS enhancements must be aimed at satisfying unmet needs of the stakeholders that can only be documented through such a process.

In the final analysis, it is not a matter of whether a stakeholder involvement process is supported, rather it is a matter of which is the most effective process. Within the U.S., there must be a commitment to support an appropriate process. Internationally, the choice of a process will, of necessity, depend on the resources the GEOSS nations are willing to devote to support this vital effort.

3 Ensuring Long-term IEOS and GEOSS Support

> *"[W]e recognize the need to support: A coordinated effort to involve and assist developing countries in improving and sustaining their contributions to observing systems, as well as their access to and effective utilization of observations, data and products, and the related technologies by addressing capacity-building needs related to Earth observations."*[3]

The long-term success of GEOSS is fundamentally dependent upon establishing 1) societal benefit of the information and 2) international collaboration. However, on a political level, individual nations may vary in their level of support. In many cases, political leaders are constrained in the power they have to deal with problems that extend beyond the next election. Therefore, national and international policy and procedures are needed to ensure financial support and continuity for the GEOSS. It is critical that mechanisms be instituted to secure long term, national and international funding commitments required to underwrite the implementation and sustained operation of GEOSS components within developed and developing nations.

Within the U.S., long-term support for IEOS will depend on decision makers being convinced that an integrated, comprehensive, and sustained Earth observation system enables a healthy public and economy. *Options in section 2 are suggestions to ensure sustained user support and therefore are fundamental to long-term continuity of IEOS. Moreover, there will have to be a long-term, robust research program designed to add value to the operation of IEOS.* In addition, there is a pressing need for a mechanism to oversee the operation and management of IEOS. A fully staffed and supported IEOS Secretariat that is responsive to the participating executive agencies and Congress would serve that function effectively. *Sound oversight will provide the administrative stability necessary to ensure continuing financial support for IEOS.*

Internationally, ensuring sustained support for GEOSS is considerably more complicated. Much of the GEOSS funding for the launching and operation of Earth orbiting satellites, radar, and other facilities, as well as financing for *in situ* observations in developed nations will be provided through appropriations by national governments. GEOSS will provide the potential for far reaching benefits to developing nations. Not only could they be forewarned about imminent

[3] First Earth Observation Summit Declaration, July 31, 2003.

natural disasters to minimize loss of life and property, but, GEOSS will offer information to be used to enhance a country's critical food supply and water resources and potentially to develop an effective natural resource exploitation (e.g., fisheries, oil, and gas) capability. GEOSS could enable capabilities that may even allow developing nations to become more self-reliant and less dependent on other countries and international aid agencies. In many ways, not enough has been done to promote the leveraging of the investment in the technology that will be adapted for GEOSS by extending the benefits to developing countries. However, GEOSS will require participation of many developing nations that are not in a position to make financial contributions. As a result, the financing of GEOSS observational capabilities, especially equipment and personnel, in developing nations will depend, at least in part, on voluntary or assessed contributions of developed nations (e.g., World Bank). It is imperative that the developed nations accept that responsibility.

Two different kinds of funding for GEOSS will be required:

a) Funds appropriated by national governments for such capabilities as Earth orbiting satellites and for observing systems deployed over the global commons (e.g., oceans and polar regions).
b) Funds required by developing nations unable to participate financially in the acquisition operation, and communication of observational systems within their national territories. In this case, funds must be provided voluntarily or by assessment.

Many international programs have floundered due to lack of sustained financial support. On the other hand, there are programs and models that have weathered the vicissitudes of time that offer models of stable financial support that are applicable to the GEOSS program. The option selected will be dependent fundamentally upon the total amount of funds that will be required to make GEOSS a reality. Some global observation systems already exist which will be central to GEOSS. As a *sine qua non,* it will be necessary for a funding estimate to be made of needs over the next decade. Under the best of circumstances, the amount of funding that will be required can only be estimated.

We now consider some of the options that are available to ensure long-term, stable financing of GEOSS. Each option has advantages and disadvantages and the selection of the appropriate option for GEOSS will depend on negotiations, interagency within the United States, as well as with international organizations.

3.1 Intergovernmental Agreements

The developed countries will be responsible for providing the major support for GEOSS. Finances of individual nations, large or small, are normally appropriated on an annual basis, or for relatively short periods of time and are subject to sudden changes up to and including termination. International agreements, memoranda of understanding (MOUs), and, on rare occasions, treaties among developed nations, however, have successfully served to provide long term funding commitments for specific projects.

3.1.1 Memoranda of Understanding

Nations can enter memoranda of understanding directed at defining management policies and levels of resource commitments to mutually beneficial programs. A good example is the Ocean Drilling Program (ODP). The U.S. and 22 international partners fund ODP to conduct basic research into the history of the ocean basins and the overall nature of the crust beneath the ocean floor. ODP is governed by and funded through a series of memoranda agreed to by the various international participants. These memoranda detail management arrangements, policies, decision procedures, time frames, and levels of commitments. The memoranda are renegotiated every five years. Of course, GEOSS will involve many more nations and will operate within and above the territories of individual nations, as well as over the oceans. Nevertheless, such international agreements may be used to ensure the necessary long-term GEOSS organizational arrangements and funding commitments. A venue for national commitments must be constituted through an intergovernmental body that will continue as the forum for coordinating GEOSS.

PROS: Stable commitments over a fixed period (5 years, at least)

Defines operating policies, decision procedures, and management arrangements

Establishes conditions for renewal

Requires government agency level agreements rather than higher level, political agreements

Possibly implemented relatively quickly

CONS: Renewals can be problematic

MOUs are usually bilateral, necessitating multiple, potentially complicated negotiations

Developing nations' needs may not be fully represented or addressed adequately

Support may vary due to evolving governmental priorities

3.1.2 Intergovernmental Treaty Organizations

Another possible option is an ongoing intergovernmental successor to GEO with its own operating procedures and Secretariat established at treaty level, either as a fully independent organization or as a part of the United Nations system. The treaty organization members would be assessed a certain amount of money each year for the conduct of the GEOSS program. Of course, there is a wide range of options for a support contribution scale in a treaty organization. One option would be a version of the UN model of financing.

PROS: Assures long term existence

Defines operating policies, decision procedures, and management arrangements

Treaty can ensure full representation of developing nations

No renewal required

CONS: Requires high level, political negotiation and approval

Each nation's contributions can be subject to political controversies and instability

Often involves increasingly high order of bureaucratic rules inhibiting innovation, creativity, and flexibility

3.2 International Institutional Structures

The necessary management and coordination of GEOSS could be accomplished by organizing a program within an established international body or as joint mechanism of a number of

established international bodies. Moreover, the resources necessary to support the participation of the developing nations could be secured under the aegis of the international body.

3.2.1 Intergovernmental Organizations

United Nations agencies with experience in managing international programs, as well as systematically gathering voluntary funding could act as focus for the program. For example, an international agency/organization, which is deeply committed to environmental issues or a consortium of such agencies, could serve that purpose. If this course of action were followed, the selected agency would have to establish a suitable mechanism for allocation and distribution of funds.

A good example of this approach is the World Weather Watch (WWW) of the WMO. The WWW constitutes a global network of *in situ* observations of atmospheric variables in all countries of the world and remote sensing satellites. It is carried out by all Member States and territories of WMO that undertake the observing program, run the telecommunications system and provide a coordinated data processing function which is designed to benefit all Members. These global observations are supplemented by observations from research satellites and other national networks and programs. Ground level receiving systems and communications are needed as well as funds for training and payment of personnel. Agreement was reached for the archiving of global observations by the establishment of three World Meteorological Centers – in Moscow, Melbourne, and Washington. Associated World Data Centers for the purpose of data archiving were established in Moscow and Asheville, North Carolina. In the early design of the WWW system, agreements among the developed nations of the WMO established a Voluntary Assistance Program (VAP), now called the Voluntary Cooperation Program (VCP). VCP enables coordinated bilateral arrangements between donor and receiving nations in order to implement the internationally agreed plan. In addition, contributions from developed nations are made to a fund maintained by WMO. The over-all VCP program, including dispersions from the fund is managed under the guidance of the WMO Executive Council. This program enables nations financially unable to participate to acquire observations, communicate, and receive such observations.

Of course, GEOSS involves a substantially wider spectrum of observational capabilities. In microcosm, many international organizations could serve as useful models. For example, WWW blends national meteorological observation systems into a global system of systems. Similarly, the Food Agricultural Organization relies on national estimates of crop production to produce global figures. In the case of GEOSS, an analogous management, coordination, and funding program could be established.

A further possible approach would be for the UN System and other international organizations with global earth observation mandates to formally establish, via identical resolutions, a joint intergovernmental subsidiary body and joint secretariat which will be accepted by all the key organizations and by all countries as the single high level coordination mechanism for GEOSS implementation.

PROS: Assures long term existence

Defines operating policies, decision procedures, and management arrangements

Assures full representation of developing nations

No renewal required

CONS: Each nation's contributions are subject to political controversies and instability

High order of bureaucratic rules

Voluntary contributions not stable

May raise problems with nations that have issues with the U.N.

3.2.2 A Consortium of Interested Governments

A consortium could be formed among interested governments who perceive the significant benefits of having a global Earth observation system. *Presently the GEOSS member nations already constitute a consortium of governments*. This arrangement is much looser than the previous models cited. The evolving Earth observing consortium is likely to involve a group of

governments whose individual interests in the GEOSS program could wax and wane as the years pass. This consortium of governments would have to decide upon the amount of resources that would be required internationally and agree on the proportion of the total resources that would be provided by each participating government. Reaching that agreement would involve negotiation, and the consortium would depend on a voluntary system of funding. The negotiations would have to presuppose the absolute requirement to consider the interests of *all* participating governments.

An example of such a funding mechanism is the Census of Marine Life (CML), originally stimulated by the Sloan Foundation and which the Committee on Ocean Research and Education (CORE) presently administers on behalf of the United States. In this case, CML has caught the interest, imagination, and needs of many countries dependent on marine life for sustenance and protection. It is a direction that could be considered as a mechanism for long term funding of GEOSS.

PROS: Minimal bureaucracy

No renewal required

Assures that nations will participate based on value received from GEOSS data and information

CONS: Could be very unstable in response to national political, economic or other pressures

Totally voluntary funding could lead to wholly inadequate resource levels

Little, if any, stable definitions of operating policies, decision procedures, and/or management arrangements

3.2.3 Non-Governmental International Organizations

A non-governmental organization such as the International Council for Science (ICSU), formerly the International Council of Scientific Unions, would be a feasible way to establish a GEOSS funding organization. U.S. funding for the International Council of Science comes from the National Science Foundation. Presently, the adhering body to the ICSU is the National Academy

of Sciences. A principal U.S. national agency could be designated to secure resources from other U.S. agencies. Traditionally the method of obtaining those resources in the U.S. has been through an external review process carried out by the principal funding U.S. agency.

National contributions would be made to this new organization, which would be a sub element of the International Council of Science. This structure has the advantage of not being bound by UN regulations or the formula-driven financial contributions required by the UN and its specialized agencies. Moreover, ICSU provides scientific advice and oversight for activities they coordinate. A prime example is the Global Atmospheric Research Program (GARP), which was a major cooperative undertaking of the ICSU and the WMO and involved 70 nations. Such a non-governmental operation may be suitable for the funding of GEOSS. The ICSU is very sensitive to the needs of the developing nations. It may be necessary for the ICSU to establish a new entitity for the receipt of the money as well as the allocation of the money to various countries for the purposes of GEOSS.

PROS: Assures periodic scientific review of the value of GEOSS products and operations

Many nations including developing nations are ICSU members

Ensures oversight and guidance for GEOSS research efforts

Minimal bureaucratic rules

CONS: Does not necessarily define operating policies, decision procedures, and management arrangements

Funding subject to proposal review and possible instability of available funds

Voluntary contributions (or membership dues) are not stable

ICSU not designed to fund major activities nor oversee information services

3.3 Conclusion

Both administrative and financial stability are essential for the long-term continuity of IEOS and GEOSS. The need for stability, of course, extends to all of the Earth observing system elements,

including: a stakeholder involvement process, a robust research program, and systems that ensure the precision, standards, accuracy of the observations, and an accessible data archival system. There are several models or options for securing commitments for long-term management, coordination, and financing for GEOSS. Most of the funding arrangements outlined here would require the involvement and agreement of the U.S. Department of State as well as foreign affairs departments of the other GEOSS member nations. For the formal international arrangements for GEOSS, policies, rules, and procedures will have to be negotiated and established by an international group. Within the U.S., as well as some other nations, public-private-academic partnerships will have to be established to facilitate efficient development and application of GEOSS information. Such partnerships will be influential in securing ongoing support for GEOSS.

Of course, continuing support for IEOS and GEOSS will always depend on the value that the participating nations place upon the data and information that are produced by the System. **As a result, whatever support mechanism is instituted, an ongoing process for evaluating the value of the GEOSS products must be established. Moreover, there will have to be a long-term, robust research program designed to add value to the operation of IEOS/GEOSS.**

In the final analysis, the selection of a GEOSS support mechanism will depend on the ability of the planners to convince the participating nations that the mechanism is sound and responsive to GEOSS funding and operating requirements.

4 Facilitating Earth System Data Exchange

> *"[W]e recognize the need to support: The exchange of observations recorded from in situ, aircraft, and satellite networks, dedicated to the purposes of this Declaration, in a full and open manner with minimum time delay and minimum cost, recognizing relevant international instruments and national policies and legislation."*[4]

Clearly, the nations participating in the first Earth observation summit recognized that the long-term success of the Global Earth Observation System of Systems (GEOSS) is critically dependent upon the establishment of policies and procedures that will maximize data sharing. The data management components of the GEOSS must include data processing, quality control, dissemination, archiving, and access to integrated data sets. Of course, GEOSS must also have an agile data management system to accommodate increasing volumes of data and information due to advances in technology. In the face of these requirements, the GEOSS challenge is to establish a system of data and information exchange that is as close as possible to "full and open" in order to realize the global benefits that can flow from an integrated global Earth observation system of systems.

"Full and open data exchange" is defined as non-discriminatory sharing of ***all*** data with a ***maximum*** charge not to exceed the cost of reproduction and distribution.

The IEOS data sharing policy states: "The U.S. Integrated Earth Observation System will provide full and open access to all data in accordance with OMB Circular A-130. All data (subject to applicable national security controls and proprietary rights), shall be available for the operational, research, commercial, and academic communities with minimum time delay and at minimal cost."[5]

Clearly, the U.S. is committed to full and open exchange of IEOS data that will be provided to GEOSS. The appropriate U.S. agencies will have to review the data sets to decide which data

[4] First Earth Observation Summit Declaration, July 31, 2003.
[5] Updated Draft Strategic Plan for IEOS, pg 33, Nov. 10, 2004, available at URL: http://iwgeo.ssc.nasa.gov/draftstrategicplan/IEOS_draft_strategic_plan_111004.pdf

cannot be exchanged due to national security or proprietary concerns. All other IEOS data will be provided without restrictions.

As GEOSS is being initiated, the participating nations must be convinced that a successful sharing of Earth system information will enhance the physical and economic well being of their citizens. As discussed in section 2, periodic user assessments of the importance, significance, and value of GEOSS data and information will provide mounting evidence that could convince the nations of that notion. Additionally, U.S. leadership in providing IEOS data on full and open basis, except for security or proprietary limitations, should encourage international adoption of that principle. As a result, it is anticipated that the GEOSS participants will be strongly motivated to ensure that a maximum amount of information is made available to all. There are counter balancing forces at work, however, that will give rise to inhibitions to full and open data exchange. Among these forces are national security concerns, intellectual property rights laws, proprietary pressures from the private sectors, and political pressures to recapture some of the costs of GEOSS participation through marketing of national data and products, etc. Therefore, it will be a substantial challenge to develop a policy structure that could provide for a full and open exchange of GEOSS data and information. **In fact, it may only be possible to approximate that ideal situation, thereby limiting the realization of the potential value of the information and products.**

There are very few policy options available to establish a system that ensures wide sharing of GEOSS data and information. An analysis of these options that includes the associated advantages and disadvantages is presented below. Of course, the selection of the appropriate option for GEOSS will depend on interagency negotiations within the United States as well as with international organizations.

4.1 Mandatory Full and Open Sharing Protocol

A full and open protocol could be established by **requiring** that GEOSS nations adhere to the principle of **sharing all GEOSS data, information, and derived products without any restrictions.** Under this protocol, all GEOSS data, information, and derived products would be

provided either at no cost, or at the cost of reproduction and distribution. It must be recognized that members who want to sell GEOSS information may lose potential income in the face of competition from commercial interests that market GEOSS information.

PROS: Ensures full and open sharing of data among participants

Optimal data and information sharing among participants

Maximum cost efficiencies and benefits to participants

Maximizes private sector use and dissemination of GEOSS information

CONS: National security concerns could require nations to withdraw from GEOSS

Enforcement could be problematic

Potential loss of some members' potential income from marketing GEOSS-related products

A number of potential members would opt out because of data policy conflicts

4.2 Voluntary Full and Open Sharing Protocol

Under this protocol, GEOSS participating nations would be **encouraged** to adhere to the principle of **sharing all GEOSS data, information, and derived products without any restrictions.** Although the voluntary nature of this protocol presumably would permit the application of certain restrictions on data sharing, GEOSS participants should be required to provide data, without restriction, to the research and education communities and, where necessary, to protect life and property. All GEOSS data, information, and derived products should be provided either at no cost, or at the cost of reproduction and distribution. Any restrictions that might be applied on the sharing of GEOSS data should be merely in accordance with the data policies of the contributors.

Although, this protocol is a voluntary approach, the understanding of the mutual benefits that flow from GEOSS data and information should encourage the acceptance of full and open sharing among the participants.

PROS: Resolves national data policy conflicts

Maximizes participation and resulting data and information sharing

Maximizes provision of products

CONS: Removes pressure to adhere to full and open data sharing

Some members could experience loss of income from ceding marketing rights of GEOSS-related products

Limits potential availability of services

4.3 Limited Restrictions Protocol

This option would create a protocol adapted from the World Meteorological Organization (WMO) policy regarding the exchange of meteorological and related data and products. Under this protocol, GEOSS participating nations could place limited restrictions on the distribution and application of the data that they provide and the recipient GEOSS participating nations would accept those restrictions.

To a great extent, such a protocol would seek to accommodate the concept, supported by some nations, that the costs of making environmental observations, at least partially, should be recovered through commercial marketing of the data and derived products. In an effort to foster successful application of this concept, those nations seek to restrict external competition from those able to develop applications without the overhead costs involved in making the observations.

The protocol involves three principles:

I. Participating nations will provide, *without any restrictions*, all GEOSS data and products necessary for services that protect life and property and support the well-being of all nations;

II. Participating nations may restrict recipient nations from allowing the re-export, for commercial purposes, of additional GEOSS data and *directly derived* products; and

III. Participating nations will provide all GEOSS data and products, *without any restrictions*, to the research and education communities for non-commercial activities, subject to principle II.

PROS: Resolves national data policy conflicts

Expands number of members that provide data and information

Permits participants to recover some of the observational costs

Increases observational coverage and, as a result, applicability of products

CONS: Obviates full and open sharing of data and products

National security could be compromised

Limits availability of products and services

Reduces application development due to commercial restrictions

4.4 Negotiation Process

Nations support their observational systems to meet their operational, security, economic and policy needs. Analysis of cost-recovery schemes that impede international cooperation reveals that often the result is a greater cost to the unwilling sharer of environmental data than to the unsatisfied requester. Moreover, in the present era of electronic communications, it is virtually impossible to control the distribution of environmental data once it is shared. GEOSS nations, over time, can be made aware of these factors and, thus, be willing to broaden the level of full and open exchange of data and information. GEOSS planners should take the view that part of the GEOSS charge is to expand, over time, the range of data types that are freely shared internationally.

This principle could be applied through a negotiation process. Data types would be categorized according to whether they are: (1) currently being "fully shared"; (2) not shared because they are highly sensitive or for reasons of compelling national security; or (3) not shared currently, but where sharing is not outside the realm of possibility, i.e., an intermediate sharing category. There would be periodic negotiations to explore actions that might move data sets from this intermediate category into the fully shared category.

The negotiation process should contribute significantly to the economic and social value of GEOSS by increasing the likelihood that increasing amounts of observations and information will be available to meet users' needs. Enhancements in GEOSS value resulting from shifts from category 3 to category 1 would be documented in the stakeholder evaluations proposed in Section 2. The increases in value resulting from expansions of fully shared GEOSS data and information would be offered as incentives in subsequent negotiations.

PROS: Expands full and open sharing of data and products

Reduces national data policy conflicts through negotiation

Increases number of members that provide data and information

Increases observational coverage and, as a result, applicability of products

CONS: Does not totally remove limits on availability of products and services

4.5 Conclusion

U.S. leadership in providing IEOS data on a full and open access basis should encourage other nations to adopt that principle for GEOSS. The First EOS Summit Declaration also recognizes the need to support that principle. However, formal international data and product sharing arrangements for GEOSS, policies, rules, and procedures will have to be negotiated and established by an appropriate international group. In the final analysis, the selection of a GEOSS data sharing mechanism will depend on the ability of the planners to convince the participating nations that the mechanism is sound and responsive to GEOSS goals.

5 Recommendations

The study participants (see Appendix), after considering the options in the previous sections, developed a consensus on the recommendations. The recommendations are summarized in this section.

5.1 Involving IEOS/GEOSS Stakeholders

The study participants, as do the IEOS/GEOSS planners, recognize that involving users is critical for the success of IEOS and, consequently, GEOSS. Decision makers should have evidence of the socio-economic benefits derived from Earth system data and information. Details of such benefits are not available presently, but a process for developing the information must be developed. Moreover, continued enhancement of IEOS and GEOSS to meet evolving stakeholder needs can only be assured through ongoing stakeholder involvement. **The process to involve stakeholders in IEOS/GEOSS planning to satisfy unmet information needs should be implemented as early as possible in the initial planning.**

A structured framework and an associated, ongoing process for user involvement is necessary for demonstrating the practical applications of Earth observations and their relevance to government policy, societal well-being, and the interests of citizens. This will in turn encourage international support for the continuing operation and enhancement of GEOSS. Moreover, GEOSS enhancements must be aimed at satisfying unmet needs of the users that can only be documented through such a process.

The requirement to involve stakeholders in an ongoing process of assessing the value of Earth system data and information and identifying unmet needs for future enhancements of the complex infrastructure extends to all nations involved in the systems. Therefore, whatever process is adopted for U.S. stakeholder involvement could be applied internationally.

Finally, it is clear that the process to involve stakeholders should be iterative. An initial requirement is to identify the range of stakeholders, to clarify their roles in IEOS development and operation, and to determine in consultation with them the most effective mechanisms for

assuring effective communication. The first step is to identify sufficient representatives of the information provider and user communities to capture an initial sense of the larger communities. Subsequent steps would provide for successively greater breadth of stakeholder and decision maker participation.

After reviewing the options described in Section 2, the study participants made the following recommendations regarding involvement of U.S. stakeholders:

RECOMMENDATION 1: There should be ongoing, comprehensive stakeholder evaluations of IEOS value to U.S. interests and future needs that are initiated as part of the earliest planning efforts. The comprehensive evaluations should consist of a forum series combined with periodic stakeholder conferences, and coordinated multi-year studies of IEOS data and information value.

Economists, social scientists, political scientists, and policy analysts working with representative stakeholders would carry out value analyses. These analyses would provide basic information for periodic conferences among the IEOS data and information stakeholders spanning the full breadth of IEOS applications across the societal benefit areas. Initially, these conferences should be held annually, but after several years, as IEOS improvements are implemented to meet stakeholder needs, the conference cycle should be lengthened. The conference reports would summarize the results of the dialogues on the current values of IEOS information, as well as, on the unmet stakeholder needs that could be addressed by further development of IEOS. The conference reports and value studies would then provide the foundation for discussions at a series of forums, each focused on a societal benefit area, that would add the vital participation of academics and decision makers. The forum reports would document detailed value estimates of the current IEOS data and products and discuss recommendations to address infrastructure enhancements; research and technology developments and applications; and educational innovations to improve IEOS information for public and private decision support systems in each societal benefit area.

RECOMMENDATION 2: A clearinghouse of IEOS user applications and services should be established.

The communities of stakeholders should be greatly expanded within the U.S. by establishment of a IEOS clearinghouse effort to gather and disseminate information about successful IEOS applications (unless an appropriate institutional capability already exists). By regular dissemination of information about IEOS capabilities through publications, Internet pages, and/or periodic conferences, potential users would be made aware of the value of IEOS data and related services. An additional, important benefit of such a system would be to provide high-level decision makers with evidence of effective application of IEOS data and information thereby encouraging their support and enhancement of IEOS. As the inventory of effective applications of IEOS information grows, support for the system would be expected to grow significantly over time. The IEOS clearinghouse would be a very effective outreach effort that could encourage implementation of the clearinghouse concept on an international scale. Of course, the clearinghouse would have to adopt procedures to encourage application developers to contribute information and documentation about their application. By utilizing modern technologies for archiving and communication, a distributed international clearinghouse could be developed that would permit each nation to monitor access and subsequent utilization of their GEOSS contributions.

RECOMMENDATION 3: An IEOS stakeholder advisory group should be established.

As a *supplement* to the ongoing comprehensive stakeholder evaluations developed under Recommendation 1, an IEOS stakeholder advisory group should be formed. The group members could be appointed to serve specified terms. The group could periodically meet with decision makers to discuss Earth systems benefits and unmet needs. The group could use electronic communication approaches to involve much wider stakeholder participation. The group's activities could serve to reduce the number of forums and conferences that might be needed for the comprehensive evaluations. In addition, such a group would provide a sustained focus on relevant issues, as opposed to participants at forums. The latter could then be used to build on the advice that comes from the more long-running advisory group.

If the IEOS planners implement these three recommendations, stakeholders will be deeply and effectively involved in the evaluation of benefits from the systems' output and the planning of enhancements to the systems. Moreover, through U.S. leadership, there should be a steady expansion of the benefits to all GEOSS member nations.

5.2 Ensuring Long-term IEOS and GEOSS Support

If IEOS and GEOSS are to have continuing support, administrative oversight and financial stability are essential. For administrative stability, formal oversight arrangements for IEOS and GEOSS, policies, rules, and procedures will have to be negotiated and established. A fully staffed and supported IEOS Secretariat that is responsive to the participating executive agencies and Congress would serve that function effectively. *Sound oversight will provide the administrative stability necessary to ensure continuing financial support for IEOS.*

For financial stability, IEOS and GEOSS will always depend on the value that is demonstrated for the data and information that are produced by the systems. **As a result, whatever support mechanism is instituted, an ongoing process for evaluating the value of the IEOS and GEOSS products must be established. Moreover, there will have to be a continuing, robust research program to add value to IEOS and GEOSS products.**

The study participants make the following recommendations for IEOS and GEOSS administrative and financial mechanisms:

RECOMMENDATION 4.1: In the U.S., an IEOS secretariat should be established as soon as possible to oversee the administration and management of ongoing IEOS activities and operations.

Within the U.S. there will be a pressing need for a mechanism to oversee the operation and management of IEOS. A secretariat that is responsive to the participating executive agencies and Congress would serve that function effectively. Sound oversight will provide the administrative stability necessary to ensure continuing financial support for IEOS. This oversight, through a

full-time, fully staffed secretariat must be instituted as soon as possible to assure successful initiation and subsequent effective implementation of IEOS.

RECOMMENDATION 4.2: A GEOSS secretariat and funding mechanism should be established in association with an intergovernmental organization that presently exists or is developed through suitable international arrangements and, ideally, a negotiated collaborative relationship with a scientific, non-governmental organization, such as ICSU.

In the final analysis, the selection of a GEOSS support mechanism will depend on the ability of the planners to convince the member nations that the mechanism is sound and responsive to GEOSS funding and operating requirements. Obviously, a secretariat must also be established to oversee the administration and management of ongoing GEOSS activities and operations.

An international agency/organization, which is deeply committed to environmental issues or a consortium of such agencies, could systematically gather voluntary funding, as well as provide oversight for the management of GEOSS. For example, the UN system and other international organizations with global Earth observation mandates could formally establish, via identical resolutions, a joint intergovernmental subsidiary body and joint secretariat which will be accepted by all the key organizations and by all countries as the single high level coordination mechanism for GEOSS implementation. Another possible approach is an intergovernmental successor to GEO, with its own operating procedures and Secretariat established either as a fully independent organization or as a part of the United Nations system.

Finally, the established intergovernmental organization should seek a collaborative arrangement with a non-governmental organization such as the International Council for Science (ICSU), formerly the International Council of Scientific Unions. ICSU provides scientific advice and oversight for activities they coordinate. ICSU is very sensitive to the needs of the developing nations.

The resulting collaborative organization would gather funding from the GEOSS member nations in accordance with their ability to contribute. Many developing nations that will be member nations of GEOSS are not in a position to make financial contributions. As a result, the

financing of GEOSS observational capabilities, especially equipment and personnel, in developing nations will depend, at least in part, on voluntary or assessed contributions of developed nations. It is imperative that the developed nations accept that responsibility. The mechanism recommended by this study will provide a vehicle for ensuring that those responsibilities will be met. The mechanism will also provide internationally credible oversight of GEOSS management.

5.3 Facilitating Earth System Data Exchange

The long-term success of the Global Earth Observation System of Systems (GEOSS) is critically dependent upon the establishment of policies and procedures that will maximize data sharing. The GEOSS challenge is to establish a system of data and information exchange that is as close as possible to "full and open" in order to realize the global benefits that can flow from an integrated global Earth observation system of systems. The U.S. is committed to full and open exchange of IEOS data. The appropriate U.S. agencies will have to review the data sets to decide which data cannot be exchanged due to national security or proprietary concerns. All other IEOS data will be provided without restrictions.

GEOSS participating nations must be convinced that a successful sharing of Earth system information will enhance the physical and economic well being of their citizens. U.S. leadership in providing IEOS data on full and open basis, except for security or proprietary limitations, should encourage international adoption of that principle. As a result, it is anticipated that the GEOSS participants will be strongly motivated to ensure that a maximum amount of information is made available to all. There are counter balancing forces at work, however, that will give rise to inhibitions to full and open data exchange. Among these forces are national security concerns, intellectual property rights laws, proprietary pressures from the private sectors, and political pressures to recapture some of the costs of GEOSS participation through marketing of national data and products, etc. In the final analysis, the selection of a GEOSS data sharing mechanism will depend on the ability of the planners to convince the participating nations that the mechanism is sound and responsive to GEOSS goals.

The study participants make the following recommendation for the GEOSS data sharing mechanism:

RECOMMENDATION 5: A process of negotiation should be developed to explore actions to be taken to move data sets from any restricted categories to full and open sharing status.

GEOSS planners, following U.S. leadership, should be urged to take the view that part of the GEOSS charge is to expand, over time, the range of data types that are freely shared internationally.

The study participants believe that a negotiation process is the best way to maximize the amount and types of data that GEOSS member nations will share on a full and open basis. In implementing this process, data types would be categorized according to whether they are: (1) currently being fully shared; (2) not shared because they are highly sensitive or for reasons of compelling national security; or (3) not shared currently, but where sharing is not outside the realm of possibility, i.e., an intermediate sharing category. Attention would then focus on negotiations – an exploration of what actions might be taken to convince member nations to move data sets in this intermediate category into the "fully shared" category.

If Recommendation 5 is implemented, there is a strong likelihood that increasing amounts of observations and information will be available to meet all users' needs, thereby confirming GEOSS data as a "global good" contributing to significantly to economic and social well being of the world's citizens.

6 Concluding Remarks

GEOSS is an undertaking of significant international importance. GEOSS can only succeed if the U.S. effectively implements IEOS. Long-term, global scale observations of the components of the Earth system have long been the goal of the Earth science communities. As a result, IEOS and GEOSS have captured the attention and support of those communities nationally and internationally.

The issues that are the focus of this study must be resolved if the long-term vision of systematic observation of the Earth system is to be fully realized. In addition to enabling implementation of IEOS and GEOSS, resolution of these issues could lead to a new era of global cooperation that will steadily expand the community of effective users of Earth system information resulting in ever-greater benefits for humanity.

The American Meteorological Society (AMS), as the leading atmospheric and related sciences professional society, is very pleased to have been the organizer of this study. The Atmospheric Policy Program of the AMS would be pleased to assist in the implementation of the study recommendations.

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