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IGOS

Integrated Global Observing Strategy

For the Monitoring of our Environment from Space and from Earth



July 2003

**An international partnership for
cooperation in Earth observations**



IGOS: the Integrated Global Observing Strategy

Today, our need for information on the current state of the Earth System and its processes is greater than ever before. Recognition of the effects of a growing population and increasing economic development has led to increased public and political awareness of the human and economic significance of the changes in the environment on Earth. Further research and long-term monitoring are required to improve the ability to detect, attribute and understand the various processes - including those involved in climate change - in order to reduce uncertainties, assess impacts, and predict change. The international scientific community is collaborating on an unprecedented global scale to understand the current state of the Earth's environment and to predict its evolution. The information necessary for our improved understanding will require additional systematic and sustained observations of the Earth.

The range of global observations that will be needed to understand and monitor Earth processes and to assess human impacts is beyond the capabilities of any single programme, agency, or government. Effective monitoring of our planet on a global scale requires cooperation on a global scale.

What is the IGOS Partnership ?

OBJECTIVES

The IGOS Partnership was established in June 1998 by a formal exchange of letters among the 13 founding Partners for the definition, development and implementation of the Integrated Global Observing Strategy.

The principal objectives of the Integrated Global Observing Strategy are to address how well user requirements are being met by the existing mix of observations, including those of the global observing systems, and how they could be met in the future through better integration and optimization of remote sensing (especially space-based) and in-situ systems.

The Integrated Global Observing Strategy serves as guidance to those responsible for defining and implementing individual observing systems. Implementation of the Strategy, i.e. the establishment and maintenance of the components of an integrated global observing system, lies with those governments and organizations that have made relevant commitments, for example, within the governing councils of the observing systems' sponsors.

To aid the development of the Strategy, the Partners have adopted an incremental "Themes" approach based on perceived priorities.



MEMBERSHIP

The IGOS Partnership brings together the efforts of a number of international bodies concerned with the observational component of global environmental issues, both from a research and a long-term operational programme perspective.

The partners are:

- **the Global Observing Systems**

The WMO Global Atmosphere Watch (GAW) is integrating a number of WMO's research and monitoring activities in the field of the atmospheric environment, focusing on the long-term measurements of the composition of the global atmosphere such as greenhouse gases, including O3, the main pollutants and aerosols. Within the last decade, the Global Observing System of the World Weather Watch (WWW/GOS) and GAW have been complemented by the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS) to produce a set of Global Observing Systems integrating in-situ and remotely sensed data, with each focusing on a major component of the Earth system. In addition, the Global Climate Observing System (GCOS) has been planned and initiated to integrate the observing needs for climate purposes across all components.

- **the international agencies which sponsor the Global Observing Systems**

The Global Observing Systems are sponsored by a number of international agencies: Food and Agriculture Organization (FAO), International Council for Science (ICSU), Intergovernmental Oceanographic Commission of UNESCO

(IOC-UNESCO), United Nations Environment Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO) and World Meteorological Organization (WMO).

- **the Committee on Earth Observation Satellites (CEOS)**

CEOS coordinates the efforts of space agencies worldwide in the planning of Earth observation satellite missions and their applications.

- **the International Group of Funding Agencies for Global Change Research (IGFA)**

National research funding agencies and ministries involved in programming and funding of global change research collaborate in IGFA.

- **international global change research programmes**

The World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP) are key international frameworks for nations and institutions to cooperate in undertaking research into broad planetary environmental issues and in the funding of such research.

Other organizations prepared to contribute to the development of IGOS may be welcomed as Partners in future. The Partnership provides a continuing mechanism to oversee the development of IGOS. In 2000, an IGOS Partnership Secretariat was established in order to ensure continuity in the process, to provide a focus for external interfaces, and to help promote the visibility of the IGOS Partnership in key arenas, such as the environmental conventions.

What is IGOS ?

IGOS: the Integrated Global Observing Strategy

THE STRATEGY

The Integrated Global Observing Strategy brings together the major Earth and it brings together the major Earth and space-based systems for global environmental observations of the atmosphere, oceans and land in a **strategic planning process**, in order to facilitate the necessary harmonisation and achieve maximum cost effectiveness for the total set of observations. The relevant observing systems encompass a broad range of different networks of satellite-borne and Earth-based sensors, including ocean buoys, weather stations and atmospheric radiosondes. IGOS recognises that many of these observing systems are in need of improvements, some lack the necessary long-term continuity, and all require strengthened links between the space-based and Earth-based components, as well as between the observing programmes and the processes of scientific and environmental policy-making which define the information priorities.

IGOS aims to:

- provide an **overarching view** to help improve understanding by governments of the significance of global monitoring;
- provide a **framework for decisions** to ensure continuity in the observation of key variables;
- offer a **forum for exchange of information** on the Partners' relevant activities and to promote dialogue between space agencies, agencies supporting in-situ observing systems and scientific research programmes;
- **identify gaps in existing observation systems** and to seek to address IGOS-related user requirements, including requirements to strengthen the institutional capacity to implement integrated global observations;
- **encourage specific activities** to develop and enhance individual components that will complement and demonstrate the value of the Strategy;
- promote amongst different user groups all aspects of **Strategy implementation** by national and international agencies, including supporting data policies, enhanced product processing chains, better archiving, improved accessibility to the information products and capacity building for end users.

International community urges the establishment of the strategy for integrated global observations

● AGENDA 21 OF THE UNITED NATIONS CONFERENCE ON THE ENVIRONMENT AND DEVELOPMENT (1992) (d) Improvement of methods of data assessment and analysis

"40.9 Relevant international organizations should develop practical recommendations for coordinated, harmonized collection and assessment of data at the national and international levels."

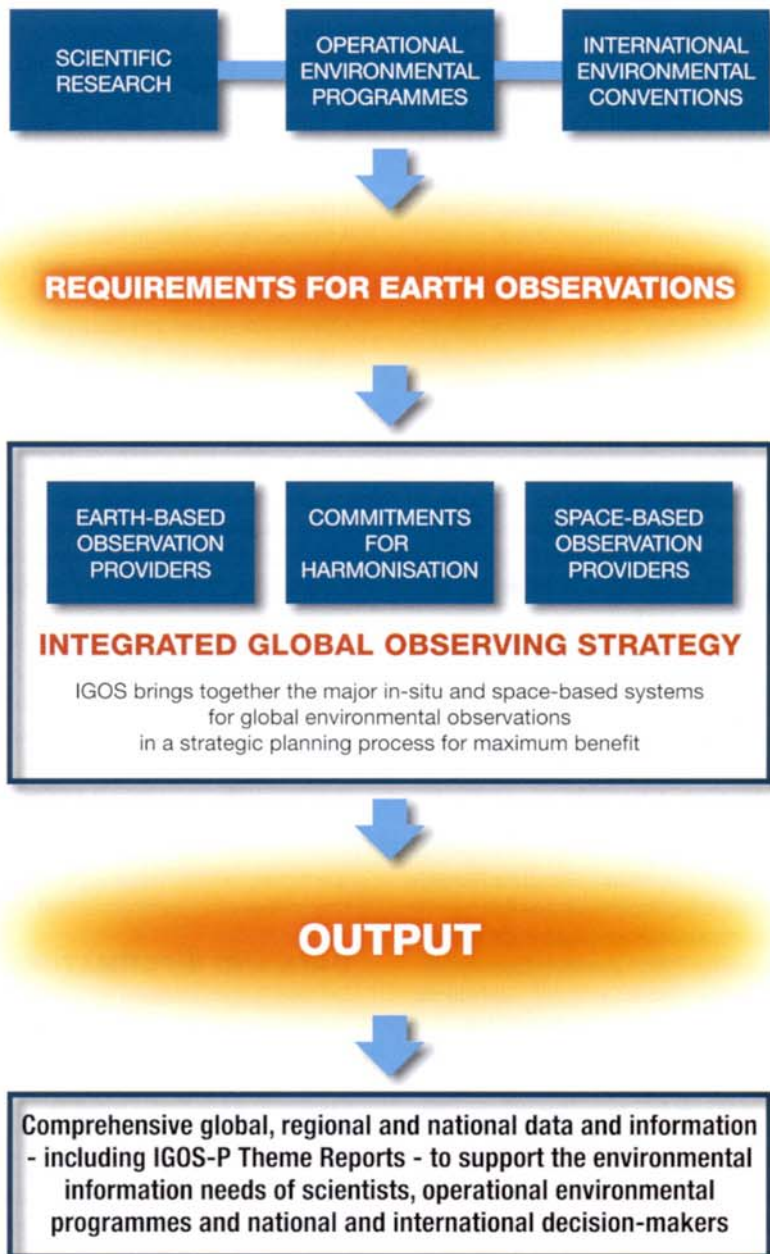
● THE NINTH SESSION OF THE COMMISSION ON SUSTAINABLE DEVELOPMENT (CSD9: APRIL 2001) Decision 9/2 (Atmosphere)

"8. The Commission emphasizes the importance of:
(d) Encouraging relevant international organizations, especially the United Nations specialized agencies, to jointly plan and implement a **strategy for integrated global observations** to monitor the Earth's atmosphere."

Decision 9/4 (Information for Decision-making and Participation)

"The Commission: ...

(d) Urges strengthened cooperation and coordination among global observing systems and research programmes **integrated global observations** taking into account, the need for sharing, among all countries, of valuable data such as ground based observation data and satellite remote sensing data."





The IGOS Themes

The Partners recognise that it is not practical to attempt to define a comprehensive global system that would in a single step satisfy all needs for environmental information. Rather, they have adopted a process - **The IGOS Themes** - which allows for the coherent definition and development of an overall global strategy for observing selected fields of common interest among a group of the Partners. Selection of the Themes is based on an assessment of the relevant scientific and operational priorities for overcoming deficiencies in information, as well as analysis of the state of development of relevant existing and planned observing systems.

The IGOS Themes Process involves:

- **agreement by the Partners** on a Theme proposal which must respect certain specified criteria;
- **establishment of a Theme team with appropriate leadership and resources;**
- **approval by the Partnership of the theme Team's report,** including agreement on a common set of essential observations and their technical characteristics (such as accuracy and frequency), and commitments from providers of space-based and in-situ observations;
- **establishment of an Implementation Team** with the responsibility and capacity required for the long-term implementation of the necessary operational networks;
- **a formal declaration of commitment to Theme Team** recommendations by the governments and organizations who actually implement, maintain and operate the relevant observing systems;
- **assessment of the value of the Theme.**

The Ocean Theme was the first IGOS Theme report to be approved and published - in January 2001. This Theme is now in the process of being implemented by the governments and organizations who operate the relevant observing systems. IGOS-P gave provisional approval to the reports of the 'Global Carbon Cycle' and 'Geohazards' Themes at its June 2003 meeting in Paris, with the expectation that these Themes can be approved by the end of 2003. The same meeting encouraged the Global Water Cycle Theme to complete necessary development to also have its report approved by the end of 2003. The report of a Coral Reef 'sub-theme' was also approved as the first component of a broader Coastal Theme approved for development. Development of a further Theme on 'Atmospheric Chemistry Observations' is well underway.

OBJECTIVES

The goal of IGOS is to produce comprehensive global, regional and national data and information to satisfy the environmental information needs of policy-makers, and to support scientific and operational environmental programmes. The applications of the information products generated by IGOS Partners are driven by the priorities set by the broader strategic framework of environmental information for decision-making such as:

- **climate change**
- **forecasting seasonal to inter-annual climate variability**
- **sustainable management and protection of oceans and coastal areas**
- **freshwater resources management**
- **bio-diversity**
- **desertification**
- **natural disaster reduction**
- **global forest cover**
- **land-based activities affecting the marine and aquatic environments**
- **food security**

It is hoped that the results under the common strategy will increase scientific understanding, help provide early warning of natural disasters and guide policy-making for sustainable development and environmental protection. At the same time, opportunities will be created for capacity building and assisting countries to obtain maximum benefit from the total set of observations. IGOS will provide governments with an overarching picture of all the components of the observing systems and will enable them to see how their current contributions fit in the overall system for collecting the information required for policy development.

Governments will also receive information that will allow them to target their future contributions most cost-effectively.

DATA AND INFORMATION SYSTEMS

The IGOS Partners recognise that co-ordination of multiple data sources from numerous different providers for the generation of accurate, long-term and consistent information will require special attention to some important issues concerning data and information systems. These include the need to agree on compatible formats, interoperability and principles for the common use of the archives and networks that store and access data. The IGOS Partnership will be working to ensure such issues are addressed within the overall strategy and to remove any obstacles to the effective exploitation of observations.

Context

ENVIRONMENTAL CONVENTIONS

Reflecting their concern with the environmental problems that pose a common threat to all countries of the world, governments have increased their co-ordination on environmental issues. Their decisions on the collaborative efforts, which are necessary to recognise, define and address specific problems, are often formalised as international conventions.

Integrated global observations are not only crucial for understanding the underlying causes and consequences of environmental change, but also for the implementation and verification of the relevant international conventions. Accordingly, they must be global, homogeneous and continual in nature. In this regard, IGOS might be regarded as an essential bridge between the scientific community, environmental policy-makers and bodies responsible for planning the future observing systems.

The IGOS Partners have been working in arenas such as the Conference of the Parties of the United Nations Framework Convention on Climate Change (**UNFCCC**), the Intergovernmental Panel on Climate Change (**IPCC**), and the United Nations Conference on the Exploration and Peaceful Uses of Outer Space (**UNISPACE**), in order to ensure that observing systems are properly considered when defining common strategic goals and concerted actions.

Outreach

To achieve their goals, the IGOS Partners recognise that they must ensure there is a widespread awareness and understanding of IGOS and its benefits among the scientific communities studying the Earth System, policy-makers promoting agreements for action, the funding agencies planning future observing programmes and the public at large.

The Partnership has four main outreach activities:

- **the IGOS website (<http://www.igospartners.org>)** which provides an accessible and up-to-date source of information on IGOS, its activities, events and output;
- **the IGOS Bulletin** which is produced and distributed twice a year;
- **the IGOS Brochure** of which this document is the third edition;
- **special sessions or exhibits at key events.**

IGOS Partners have made special efforts to develop discussions on possible contributions to help meet the information and data needs of the various environmental conventions, including:

- reporting to the IPCC and to the Conference of the Parties of the UNFCCC, and its Subsidiary Body for Scientific and Technological Advice (SBSTA), on the adequacy of existing and planned climate observing systems;
- organising information events on IGOS, for example at the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) in Vienna (July 1999) and the ninth session of the UN Commission on Sustainable Development (CSD9) in New York (April 2001);
- exploring possible contributions of IGOS to the Scientific and Technological Subsidiary Bodies of international environmental conventions, including how to encourage co-ordinated approaches and so reduce the burden on national governments of reporting to many different conventions;
- participation in the preparatory process for the World Summit on Sustainable Development (WSSD 2002), including registering as a 'Type 2 partnership' – with the aim of supporting future initiatives to implement Agenda 21.

“The Integrated Global Observing Strategy” in the intergovernmental agreements

- UNISPACE III, SBSTA 13 and IPCC TAR -

- **THE VIENNA DECLARATION, ADOPTED IN 1999 AT THE THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE (UNISPACE III) - endorsed by the UN General Assembly through Resolution 54/68**

... Action should be taken:

"(i) To develop a comprehensive, worldwide, environmental monitoring strategy for long-term global observations by building on existing space and ground capabilities, through the co-ordination of the activities of various entities and organizations involved in such efforts;

...

(iii) To develop and implement the **Integrated Global Observing Strategy** so as to enable access to and the use of space-based and other Earth observation data;"

...

- **THE SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE IN THE SECOND PART OF ITS 13TH SESSION (SBSTA13 PART 2, THE HAGUE, NOVEMBER 2000)**

CO-OPERATION WITH RELEVANT INTERNATIONAL ORGANIZATIONS

2. Conclusions

"The SBSTA recognised **the importance of the Integrated Global Observing Strategy Partnership** in developing the global observing systems for the oceans and terrestrial carbon sources and sinks in the global carbon cycle, and in promoting systematic observation."

- **INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 17TH SESSION (IPCC17, NAIROBI, APRIL 2001)**

**IPCC Third Assessment Report
(TAR WG1 Summary for Policymakers)**

...

"Further research is required to improve the ability to detect, attribute and understand climate change, to reduce uncertainties and to project future climate changes. In particular, there is a need for additional systematic and sustained observations, modeling and process studies. A serious concern is the decline of observational networks. The following are high priority areas for action.

Systematic observations and reconstructions:

- Reverse the decline of observational networks in many parts of the world
- Sustain and expand the observational foundation for climate studies by providing accurate, long-term, consistent data including **implementation of a strategy for integrated global observations**
- Enhance the development of reconstructions of past climate periods
- Improve the observations of the spatial distribution of greenhouse gases and aerosols."

....

World Summit on Sustainable Development (Johannesburg, 26 August - 4 September 2002)

Implementation Plan

CEOS and IGOS participated in the political negotiations of the Johannesburg World Summit on Sustainable Development. The Plan of Implementation, adopted by Heads of State and Government, contains a number of specific references to the importance of global observations in support of sustainable development. To support the political action, IGOS was registered as a WSSD Type-2 Partnership. The Plan of Implementation recognised that sustainable development must be based on comprehensive information and that there was a need for increased co-ordination of integrated global observations:

"119.septies Promote the development and wider use of earth observation technologies, including satellite remote sensing, global mapping and geographic information systems, to collect quality data on environmental impacts, land use and land-use changes, including through urgent actions at all levels to:

- (a) Strengthen cooperation and coordination among global observing systems and research programmes for integrated global observations, taking into account the need for building capacity and sharing of data from ground-based observations, satellite remote sensing and other sources among all countries;
- (b) Develop information systems that make the sharing of valuable data possible, including the active exchange of Earth observation data;
- (c) Encourage initiatives and partnerships for global mapping."

Science and Technology for Sustainable Development

**(G8 Summit, Evian les bain, June 2003) :
A G8 Action Plan**

1. Strengthen international co-operation on global observation
We will:
 - 1.1 Develop close co-ordination of our respective global observation strategies for the next ten years; identify new observations to minimise data gaps;
 - 1.2 Build on existing work to produce reliable data products on atmosphere, land, fresh water, oceans and ecosystems;
 - 1.3 Improve the world-wide reporting and archiving of these data and fill observational gaps of coverage in existing systems;
 - 1.4 Favour interoperability with reciprocal data-sharing;
 - 1.5 Develop an implementation plan to achieve these objectives by next spring's Tokyo ministerial conference.

The IGOS Themes

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The Ocean Theme

IGOS OCEAN THEME TEAM MEMBERSHIP

Centre National d'Etudes Spatiales (CNES/CEOS)

European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT/CEOS)

European Space Agency (ESA/CEOS)

Global Ocean Observing System (GOOS) (Lead)

Indian Space Research Organization (ISRO/CEOS)

Nansen Environmental and Remote Sensing Centre (NERSC)

National Aeronautics and Space Administration (NASA/CEOS) (Lead)

National Oceanic and Atmospheric Administration (NOAA/CEOS)

National Space Development Agency of Japan (NASDA/CEOS)



Final Report from the Ocean Theme Team

In early 1999, the IGOS Partnership recognised the need and the opportunity for converging existing efforts to develop a global observing strategy for the oceans. Such a strategy would build on the major developments in observing systems initiated within the major oceanographic research programmes over the previous decades, notably: the Tropical Ocean Global Atmosphere (TOGA) Project and the World Ocean Circulation Experiment (WOCE) of the World Climate Research Programme (WCRP). Through these pioneering efforts, the Oceanography community was already well advanced in their studies of observation needs, and was therefore in the best position to initiate the development of the Ocean Theme.

OBJECTIVES

The overall goal of the Ocean Theme is to develop a strategy for an observing system for the oceans that serves the research and operational oceanographic communities and a wide range of users of marine data and information, such as scientists, policy-makers, port and coastal zone managers, the tourism industry, the fisheries and aquaculture industry, shipping, offshore mining, and the general public.

Scientists need continuous and long-term observations to develop and test hypotheses about how the ocean works and in order to monitor changes. Operational oceanographers require the same observations to create products and services for a variety of uses, such as forecasts of ocean surface conditions and marine weather.

MEMBERSHIP

The Ocean Theme team membership is shown in the table.

APPROACH

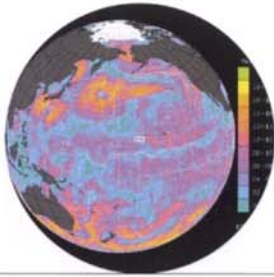
The Ocean Theme was the first of the IGOS Themes to be developed. The Theme team analyzed:

- the variety of needs for global ocean observations and the scientific and observational challenges for understanding and predicting the behaviour of the ocean and climate;
- the existing and planned observing systems, including both in-situ and space-based observation programmes;
- the necessary co-ordination between the various observing system components to meet the needs of the user community and to avoid both duplication of efforts or gaps in the system;
- the planning commitments required to ensure long-term continuity of the observations.

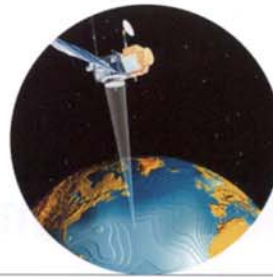
The team's analysis led to a Report, published in January 2001, which outlines the need for satellite and in-situ observations and focuses on some of the immediate decisions required by satellite agencies to proceed to a fully operational ocean observing system. The Ocean Theme is now in the process of being implemented.

BENEFITS AND APPLICATIONS

The availability of regular, global observations of the oceans for commercial purposes and for those who study myriad marine phenomena represents the next large step in the development of international oceanographic research and the Global Ocean Observing System (GOOS). The applications of the global ocean observations include:



First wind data from Scatterometer captures Pacific typhoon



Measurements of sea height and winds, including those from satellite sensors, provide valuable operational safety information to shipping and offshore industries.

- Operational Marine Coastal and Ocean Short-range Forecasting and Analysis: ocean surface and sub-surface forecasts and warnings in the 0-10 day range;
- Seasonal-to-Interannual Climate Prediction: analyses of data fields for monitoring and predicting El Niño and La Niña phenomena;
- Numerical Weather Prediction: marine weather forecasts in the 1-5 day range (coastal) and global atmospheric forecasts in the 1-10 day range;
- High- Quality Products for Climate Study;
- Biodiversity and Habitats: monitoring habitat quality and the abundance and diversity of living marine resources;
- Natural and Man-made Hazards: forecasts and warnings of natural disasters including coastal flooding, storm surges and tsunami;
- Environmental Indices: monitoring of sea-state or environmental conditions affecting the coastal zone, port areas and offshore operations;
- Fishery Productivity: including measurement of catches and fishing intensity.

Observations of the global ocean will also help satisfy the information needs of international conventions and agreements, such as:

- The UN Convention on the Law of the Sea;
- The International Convention for the Safety of Life at Sea (SOLAS);
- The UN Framework Convention on Climate Change (UNFCCC);
- The UN Convention on Biological Diversity;
- Agenda 21, the Programme of Action for Sustainable Development;
- The Implementation Plan of the World Summit on Sustainable Development
- The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

Having developed the Ocean Theme strategy, the IGOS Partnership has its first powerful tool, based on the consensus of the international community, that identifies priorities and goals for ocean observations. Within the Partnership, the GOOS sponsoring

agencies are taking the lead in overseeing implementation of the Ocean Theme, with support from CEOS agencies for the space-based sector. The GOOS sponsoring agencies will play an important role as coordinator and critical liaison between governments, funding

agencies, operational agencies, and scientists so they can move forward together on a global scale with Earth observations.

STATUS

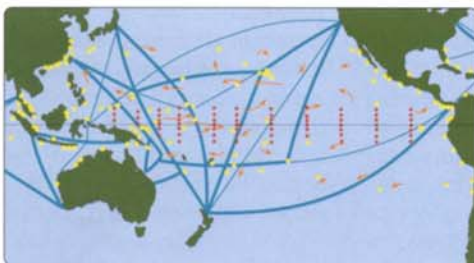
The Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) is currently implementing the in-situ component of the Ocean Theme strategy. In addition, the Ocean Theme Team is working to define a data system strategy that will 1) assure the quality of observational data for assimilation into models and for the creation of data products and services and 2) support improved interaction with the end users.

The Ocean Theme has already resulted in a demonstration of the value of IGOS collaboration and the transition from research and development cooperation into operational monitoring. In November 2001, the CEOS agencies CNES, EUMETSAT, NOAA and NASA committed to support the continuation of high precision ocean altimetry data in a follow-on satellite mission to Jason-1. Jason-1, a joint US-French mission, was successfully launched in December 2001 and is the first in a 20-year series of operational oceanographic satellites.

FURTHER INFORMATION

The Ocean Theme Report can be obtained via the IGOS Partnership website: <http://www.igospartners.org>

The Ocean Theme team can be contacted via:
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 (c.summerhayes@unesco.org)
 Eric Lindstrom
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ENSO Observing System:
 A vast array of different Earth-based and Space-based sensors and data systems is employed to assist in the monitoring and prediction of El Niño.

The Global Carbon Theme

IGOS GLOBAL CARBON THEME TEAM MEMBERSHIP

Food and Agriculture Organization of the United Nations (FAO)

Global Climate Observing System (GCOS)

Global Ocean Observing System (GOOS)

Global Terrestrial Observing System (GTOS)

International Council for Science (ICSU)

International Geosphere-Biosphere Programme (IGBP) (Lead)

National Aeronautics and Space Administration (NASA/CEOS)

National Space Development Agency of Japan (NASDA/CEOS)

United Nations Educational, Scientific and Cultural Organization (UNESCO)

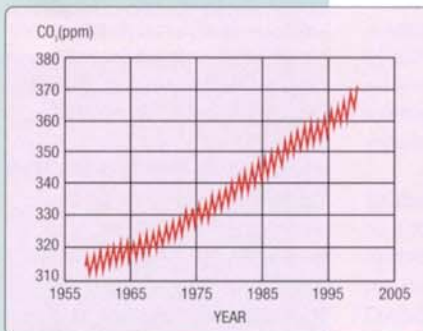
The realisation that human activities are already affecting climate, and that the emission of greenhouse gases is the primary cause, has focused attention on the global carbon cycle. Effective management of the carbon cycle poses a major challenge to policy-makers and to the observation and research communities. The IGOS Partners have responded to this challenge by the development of an Integrated Global Carbon Observation (IGCO) Theme.

The IGOS Partnership has taken a phased approach to the carbon observational challenge, building on comprehensive strategy documents prepared for the terrestrial, atmosphere, and ocean components of the carbon cycle and integrating them into a single, unified strategy, closely linked with the research agenda being developed by the Global Carbon Project within IGBP, IHDP (International Human Dimensions Programme), and WCRP.

OBJECTIVES

The overall objective of the IGCO Theme is to develop a flexible and robust strategy for international global carbon observations over the next decade. The aim is to build integrated approaches that combine both remote and in-situ observations and bring together observational strategies in the terrestrial, oceanic, and atmospheric compartments; to build close collaboration with the international carbon cycle research community; and to be flexible enough to incorporate new observational requirements, as measurement technologies and science develop and as requirements evolve. More specific objectives over the next decade include the determination of terrestrial and oceanic carbon sources and sinks with increasing accuracy and spatial resolution.

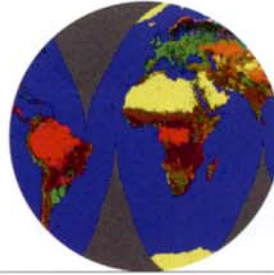
Remote sensing technology is advanced in being able to provide imagery from space for many of the measurements of carbon-related variables, with global and repetitive coverage. However, the in-situ networks that are needed to validate and provide direct measurements of carbon fluxes and pools from the terrestrial ecosystems and the oceans are still in their infancy. Designing, building and efficiently operating an operational system will require significant investment in developing the required technology, commitment to long term systematic observations, and capacity to exchange and manage carbon data. In parallel, comprehensive carbon cycle data assimilation systems are being developed to combine in-situ and remotely sensed data streams.



Mauna Loa Monthly Mean Carbon Dioxide:
The graph shows measurements of atmospheric carbon dioxide (from Scripps Institute of Oceanography before 1974 and from NOAA after 1974).



Direct measurement of the carbon exchange between terrestrial ecosystems and the atmosphere



Satellite data is used to generate global maps of land cover classifications.

MEMBERSHIP

The membership of the Carbon Theme team, which is led by IGBP, is shown in the table. The TCO component is led by GTOS and includes in its composition FAO, IGBP, ICSU and UNESCO, as well as a number of CEOS members. The Ocean component is led by GOOS and includes IOC, IGBP and UNESCO.

APPROACH

The IGCO Theme team has adopted some common approaches among the three components in developing the carbon observation strategy, which aim to:

- identify key global products that can be delivered within a reasonable time and at an acceptable quality to help international bodies formulate policy and action programmes;
- build upon existing efforts to identify priority observational requirements in terrestrial, oceanic and atmospheric components of the carbon cycle;
- foster the development of cheaper and lower maintenance in-situ sensors that could be deployed in areas with low observational coverage;
- develop strategy in close collaboration with the carbon cycle research community, greatly enhancing the 'fit' between the observations and other parts of the research approach;
- efficiently combine both remote and in-situ observations;
- identify 'multiple constraint techniques' that assimilate observations from a wide variety of sources into a single analysis and synthesis framework;

- promote an end-to-end process identifying products, services and their end users;
- be flexible enough to incorporate new observational requirements as both science and measurement technologies develop and requirements evolve;
- be robust enough to meet the challenges of continuity and consistency.

BENEFITS AND APPLICATIONS

The IGCO Theme is aimed at delivering the following benefits:

Improved knowledge base for better policy-making

The IPCC has highlighted an improved understanding of carbon dynamics as vital in tackling one of the biggest environmental problems facing human societies. The IGOS carbon observation effort is an essential component in a co-ordinated international approach to providing better understanding for the implementation of the UNFCCC and better ability to forecast future CO₂ levels and climate change. This has become even more important given the discussions in the Conference of the Parties of the UNFCCC on the role of natural sinks in meeting the targets of the Kyoto protocol.

Enhanced scientific understanding of the global carbon cycle

This requires better understanding of the current patterns of carbon stocks and flows and prediction of their changes in the future. The IGOS carbon themes are being carried out in close collaboration with IGBP and its partner global environmental change programmes, which have launched an international

carbon research project that integrates multiple approaches, process studies, manipulative experiments, observations and models.

Advanced Earth System observation capability

The global carbon cycle lies at the heart of Earth's metabolic processes. The observational challenge of developing an integrated global system, both remotely sensed and in-situ, will undoubtedly accelerate the development of new observation technologies and data handling systems within the context of Earth System observation.

STATUS

The IGCO report was provisionally approved by IGOS-P at its June 2003 meeting in Paris, subject to final revision to address the final comments. Final approval is expected in the second half of 2003, with implementation beginning shortly thereafter. Implementation of parts of the theme by GTOS and GOOS are already underway.

FURTHER INFORMATION

Integrated Global Carbon Observation (IGCO) Theme:

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Report: <http://www.igospartners.org>

Specific Elements:

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Report: <http://ioc.unesco.org/iocweb/co2panel>
- Terrestrial: Shaun Quegan (S.Quegan@sheffield.ac.uk)
<http://www.fao.org/gtos/TCO.html>
- Global Carbon Project: Pep Canadell (pep.canadell@csiro.au)
Science Framework: <http://www.globalcarbonproject.org>



The Global Water Cycle Theme

THE GLOBAL WATER CYCLE THEME TEAM MEMBERSHIP

European Space Agency (ESA/CEOS)

Global Climate Observing System (GCOS)

Global Terrestrial Observing System (GTOS)

International Geosphere-Biosphere Programme (IGBP)

International Human Dimensions Programme (IHDP)

National Aeronautics and Space Administration (NASA/CEOS)

National Oceanic and Atmospheric Administration (NOAA/CEOS)

National Space Development Agency of Japan (NASDA/CEOS)

United Nations Educational, Scientific and Cultural Organization (UNESCO)

World Climate Research Programme (WCRP) (Lead)

World Meteorological Organization (WMO)

In the summer of 2000, the IGOS Partnership identified the water cycle as a critical area where a Theme was needed to meet the anticipated requirements for water cycle observations to support global initiatives such as Agenda 21, the Programme for Action for Sustainable Development and the UN Convention on Climate Change. In addition, the Integrated Global Water Cycle Observations (IGWCO) theme is needed to provide monitoring data and contribute to improved predictions for variables such as precipitation, soil moisture and runoff over many times scales and spatial scales from local to global. IGWCO is also needed to address several critical science questions regarding the role of the water and energy cycle in maintaining the stability of the Earth's climate system, feedback processes involving clouds and land surfaces that influence regional and global climate change, and the availability of fresh water resources.

The observations required to advance our understanding and modeling of these and other science questions cannot be adequately addressed through continued reliance on ad-hoc observing systems. In August 2002, the World Summit for Sustainable Development (WSSD) in Johannesburg recognized the paramount importance of water issues and encouraged supporting global observations for improved understanding of the global water cycle. The Water Cycle Theme will be built on the experience of projects, such as the WCRP's Global Energy and Water Cycle Experiment (GEWEX), that deal with the development of global data sets for clouds, precipitation and other important water-cycle variables such as soil moisture, evaporation/evapotranspiration, energy and radiation budget parameters, among others.

OBJECTIVES

The IGWCO Theme will provide a framework for guiding decisions regarding priorities and

strategies for the maintenance and enhancement of water cycle observations to support:

- monitoring of climate variability and change;
- effective water management and sustainable development of the world's water resources;
- societal application for water resource development and environmental management;
- specification of initial conditions for numerical weather and water forecasts and monthly to seasonal climate predictions;
- research directed at priority water cycle questions.

The Theme will also promote strategies that will facilitate the acquisition, processing and distribution of data products needed for effective management of the Earth's water resources.

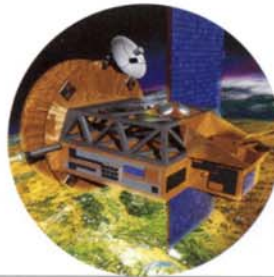
APPROACH

The development of the Water Cycle Theme, led by WCRP, is being carried out by a writing group that receives guidance and review comments from an advisory committee before submitting materials to the IGOS Partnership. The IGWCO is focused on three priority areas, namely: precipitation (and clouds); surface hydrology (including soil moisture, evaporation/evapotranspiration, ground water, surface energy budgets, etc.); and applications. In developing the report the writing team is:

- reviewing the needs for terrestrial and atmospheric water-cycle observations, also observations of the exchange fluxes of water/energy between the atmosphere and the oceans, and between the terrestrial and ocean components of the Earth system;
- reviewing plans for existing and planned observational systems;
- coordinating with other IGOS-P Themes to identify how they could support the needs of the Water Cycle Theme;



Ground-based 3D Doppler Radar in Tibet for validation of satellite measurements of rainfall



Global Precipitation Measurement (GPM) satellite (planned)

- reviewing the mechanisms for coordinating among the observing system components and the user community.

Four functional groups are viewed as being critical to the development of water-cycle products and must be represented in these discussions. They include in-situ observation groups, remote sensing groups, data assimilation centres and water resource managers.

BENEFITS

The IGWCO will produce or contribute to:

- products for improved water management decisions at a variety of time and space scales;
- initialization fields for weather and climate forecasting;
- enhanced understanding of the global water and energy cycle;
- advanced capabilities for measuring the Earth system;
- the scientific and observational basis for the sustainable development of the world's water resources;

- information that can be used within appropriate decision making processes to assist in negotiations between regions and between nations over water.

STATUS

The Water Cycle Theme proposal was approved by the IGOS partners in November 2001 and a writing team is preparing the Water Cycle Theme Report. Three workshops have been held (in USA, Europe, Japan) in order to gather community inputs for this report. Through the workshops, the vast scope of the water issue and the importance of water cycle observations for more efficient water management have been recognized. Based on these workshops a draft Water Cycle Theme report was prepared and submitted to the June 2003 meeting of the IGOS Partnership in Paris. Based on the feedback from this meeting and subsequent comments from IGOS Partners and others, the report will be finalized by October 2003 for approval at a special session of the IGOS Partnership.

Subsequently, the Theme will move into the implementation phase - to establish an

international framework for long-term monitoring of the water cycle and for maximizing the use of new water cycle information for societal benefit. International administrative expertise and governmental cooperation from all countries will be needed to achieve the next steps:

- establishment of an international ground-based observation network for the water cycle by engaging a broad group of participants - beyond those currently contributing to CEOP (a WCRP/GEWEX project described below);
- a comprehensive and continuous satellite observing strategy for the water cycle, especially for global rainfall;
- information systems and services for integration and distribution of data and products, and for application of scientific results to actual social applications.

FURTHER INFORMATION

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CEOP: First element of the Water Cycle Theme

The Coordinated Enhanced Observing Period (CEOP), a WCRP project initiated by the Global Energy and Water cycle Experiment (GEWEX), has been adopted by the IGOS Partnership as the first major component of the Global Water Cycle Theme. It is a highly anticipated opportunity for providing global water cycle data sets for two full years (2002-2004), after a preliminary data-gathering period from July to September, 2001.

The project supports the collection of uniformly formatted ground-based water cycle data sets from 36 reference sites with globally consistent coverage for observing climate variability. Space agencies provide data sets of all aspects of the water cycle by contributing products from the newest Earth observing satellites e.g., TRMM, Terra,

ENVISAT, Aqua and ADEOS-II, in addition to Landsat-7, NOAA and DMSP series and geostationary satellites. Numerical weather prediction centers provide physically consistent model outputs of the water cycle on both regional and global scales. A key component of CEOP is to address the compilation and integration of the extremely high volume of new satellite data and model outputs and the very heterogeneous reference site data into coherent, related data sets focused on the CEOP science issues - to facilitate research in water and energy cycles, improved weather and climate predictions, and applications for water resource management. CEOP integrated

data sets will be open to the international community for use in understanding monsoon systems and the temporal and spatial variation of the water budget and for improving numerical prediction models. Successful achievement of CEOP is the first step toward establishing the IGOS Water Cycle Theme.



The Geohazards Theme

IGOS GEOHAZARDS THEME MEMBERSHIP

British Geological Survey (BGS)
(Lead)

British National Space Centre
(BNSC/CEOS)

Bureau de Recherches Geologiques
et Minieres (BRGM)

Canadian Center for Remote Sensing
(CCRS/CEOS)

Centre National d'Etudes Spatiales
(CNES/CEOS)

Consiglio Nazionale delle Ricerche
(CNR)

Centre National de la Recherche
Scientifique (CNRS)

Deutsche Montan Technologie (DMT)

European Space Agency (ESA/CEOS)
(Lead)

Geological Applications of Remote
Sensing (GARS) Programme

International Institute for Geo-
Information Science and Earth
Observation (ITC)

Musée Royal de l'Afrique centrale
(MRAC)

Nigel Press Associates (NPA)

Russian Academy of Sciences (RAS)

United Nations Educational,
Scientific and Cultural Organization
(UNESCO) (Lead)

United States Geological Survey
(USGS)

Universita' della Basilicata

Universität Bonn

The societal impact of geological and geophysical hazards is enormous. Every year volcanoes, earthquakes, landslides and subsidence claim thousands of lives, injure many thousands more, devastate peoples' homes and destroy their livelihoods. The costs of damaged infrastructure are taken higher still by insurance premiums and run into the billions in any currency. This affects rich and poor alike, but with a disproportionate impact on the developing world. As the human population increases and more people live in hazardous areas, this impact grows unsustainably. It must be reduced and that requires increased understanding of the geohazards, improved preparedness for disasters and better ways to manage them when they occur.

The inter-related disasters that comprise geohazards are all driven directly by geological processes and share ground deformation as a common thread. This means that they can be addressed using similar technology and understood using related scientific modelling processes. Geohazards are a complex phenomenon and no one method can provide all the necessary information

and understanding. It is essential that Earth Observation data are *integrated* with airborne data, in-situ observations and associated historical data archives, and then analysed using Geographic Information Systems (GIS) and other modelling tools if these hazards are to be understood and managed. Geohazards occur in one form or another in every country. They do not respect national boundaries and have the potential to cause changes in the atmosphere that will be truly *global* in effect, requiring a global *observing* infrastructure to monitor them. There are also human issues in organising the Earth Science community to meet these challenges that demand an appropriate *strategy* if they are to be addressed successfully.

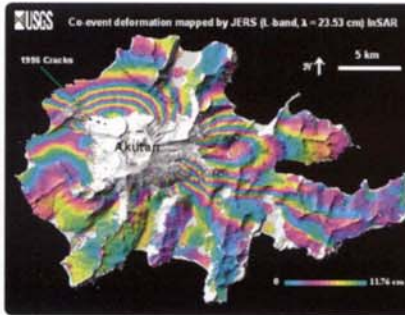
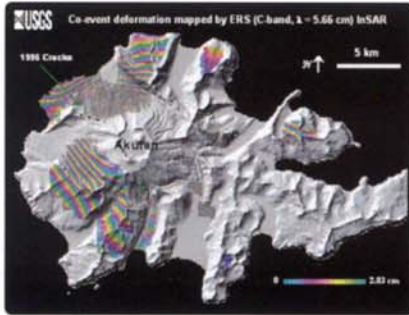
OBJECTIVES

The goal of the Geohazards IGOS is to integrate disparate, multidisciplinary, applied research into global, operational systems by filling gaps in organisation, observation and knowledge over the next decade. The pursuit of this goal will improve the provision of timely, reliable and cost-effective information to those responsible for managing these hazards and increase the capacity of all nations to be resilient in the face of the related disasters.

The strategy addresses the mapping, monitoring, forecasting and related preparedness activities needed to underpin crisis response, via the provision of critical information products to be used by the agencies involved in disaster management initiatives. Addressing this goal will fill key gaps in the provision of long-term observations and in a number of integration issues that are not covered by the disaster response systems set up under the



Geohazards Theme Report



C-band and L-band Interferometry.

Left, interferogram of Akutan Volcano in the Aleutians, made from C-band ERS imagery (Lu and others, JGR, 2000) is only locally coherent (rainbow areas). Right, interferogram made from L-band JERS data (Lu and others, GRL, 2003) has fewer fringes, but achieves coherence over almost the entire surface of the island, allowing the entire deformation pattern to be observed. To date, the JERS SAR mission has not yet been followed up with a new L-band instrument and so such observations are not currently possible.

International Charter on Space and Major Disasters or the United Nations (UN) Action Team on Disaster Management. The strategy identifies four main strategic objectives:

- to build the capacity of the global geohazards community;
- to fill gaps in observations of topography, deformation, seismicity and mapping;
- to increase integrated applications of data from multiple sources and by multidisciplinary approaches;
- to promote the take-up of the defined best practice developed in specific studies on a global basis.

APPROACH

An action plan is proposed to address the objectives in the short, medium and long term over the next ten years. Capacity building will be undertaken by strengthening the Geological Applications of Remote Sensing (GARS) Programme with space agency participation, to create a coordinating mechanism for implementing the Geohazards IGOS. A review will be conducted to identify accelerated exploitation routes for existing observations, for example by securing the release of existing global topographic datasets. It is important that continuity is achieved and maintained for the four key observations identified above. Continuity within existing C-band radar satellite missions has demonstrated the utility of interferometry for measuring deformation over bare surfaces. In the long term, a programme must be established to deliver continuity of L-band interferometry, so that this can be extended to vegetated surfaces (see accompanying example).

On the ground, attention should be paid to the provision of increased coverage and density of seismic networks. Integration will be taken forward by projects designed to release the synergy from coupling such synoptic and periodic observations from space with detailed, continuous point observations on the ground, like those offered by networks of Global Positioning System receivers. These projects require a range of disciplines to work together using modelling and visualisation tools, providing other kinds of integration. The results will be disseminated using workshops, publications and the Internet in order to spread best practice. Geohazards databases containing "strategic datasets" will be promoted and mechanisms for sharing data, information and knowledge on an operational basis streamlined. Curricula will be designed to generate new training courses, extending capacity building to the developing world and promoting knowledge and technology transfer.

BENEFICIARIES

The strategy is aimed primarily at the international geohazards user community, especially scientists working in monitoring and advisory agencies (e.g. volcano observatories, geological surveys, seismic networks) who turn the observations into information products. The strategy also pays close attention to the end users in responsible authorities managing geohazards on a daily basis, to the research scientists developing the underpinning knowledge base and finally to the IGOS partners and others making the observations. It is based on society's need to reduce the impact of geohazards on lives, property and economies over the long term. Assessment will be made

against individual objectives during the lifetime of the strategy but ultimately it must be judged against the following criteria; has it saved lives, reduced damage to infrastructure and saved money, thereby limiting the impact of geohazards on society as a whole?

STATUS

The Geohazards theme was initiated and scoped in 2001 by UNESCO, CEOS and ICSU. An ad-hoc Working Group was formed, held an international Workshop, and delivered a proposal to IGOS P9 in June 2002. A Theme Team with BGS-ESA-UNESCO co-Chairs and ESA-supported Secretariat was set up in summer 2002. The IGOS-Geohazards Website was prepared, a Prospectus and a Bulletin Article were released. The Team met 3 times and issued 4 Progress Reports. The Theme Report (pictured) was delivered in May 2003 for comment and endorsement at IGOS P10 in June 2003. It received provisional endorsement, with full acceptance being subject to the Team's planned consultation during summer 2003 of the wide and dispersed international geohazards community, which is mainly external to the IGOS partnership. The report is due to be finalized by November 2003.

FURTHER INFORMATION

The IGOS Geohazards Website (<http://dup.esrin.esa.it/igos-geohazards/>) provides further information about the Geohazards Theme, including the complete theme report. Enquiries can be sent to the IGOS Geohazards Secretariat (IGOS@esa.int).



The Atmospheric Chemistry Theme

MEMBERSHIP

European Space Agency (ESA/CEOS)
(Lead)

Global Observing System / Global
Atmosphere Watch (GOS-GAW)

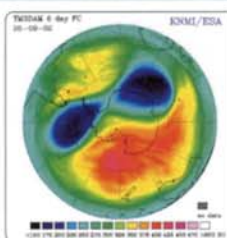
International Geosphere-Biosphere
Programme (IGBP)

National Aeronautics and Space
Administration (NASA/CEOS)

National Oceanic and Atmospheric
Administration (NOAA/CEOS)

National Space Development Agency
of Japan (NASDA/CEOS)

World Meteorological Organization
(WMO) (Lead)



The bifurcation of the Antarctic ozone hole in September 2002 was predicted by KNMI using assimilated GOME data (courtesy H. Eskes)

The chemical composition of the atmosphere is increasingly influenced by human activity, resulting in climate change, stratospheric ozone depletion, degradation of air quality and changes in the atmosphere's oxidising capacity (self-cleansing power). Various environmental and health issues arising from these developments led to the establishment of international conventions limiting the production of anthropogenic emissions, and to national and international scientific measurement programmes. Recognising the need for improvement and continuity of observation programmes and for the integration of observation techniques and data, the IGOS partnership generated the "Integrated Global Atmospheric Chemistry Observations" (IGACO) theme. This follows a precursor activity under the auspices of WMO and CEOS to

assess the needs for observations of ozone and other atmospheric constituents.

OBJECTIVES

The objectives of IGACO are

- to ensure long-term continuity and spatial comprehensiveness of atmospheric composition observations,
- to integrate ground-based and space-borne measurements using models and assimilation tools, and
- to make the integrated data easily accessible to a wide range of users.

IGACO will support the acquisition and analysis of atmospheric observations in relation to

- the interactions between changing atmospheric composition, chemistry and climate;
- stratospheric chemistry including ozone depletion and its impact on UV-B irradiation;
- air quality on local, regional and global scales;
- the changing oxidising capacity of the atmosphere.

APPROACH

The IGACO team's strategy can be summarised as follows:

- starting from the WMO/CEOS Report 140 "Strategy for Integrating Satellite and Ground Based Observations of Ozone", establish requirements for individual observations and their integration into the entire observing system;
- review the contributions of existing and committed space missions and ground networks to these needs;
- identify gaps and overlaps in future observations, and propose ways to close the gaps;
- encourage an end-to-end data validation process by means of controlled calibration and validation programmes, algorithm refinements and scientific analysis;
- encourage development of refined chemical transport models and data assimilation systems needed to interpret atmospheric chemistry observations and to predict the future

state of the atmosphere;

- adopt a globally integrated prioritised and cost effective approach;
- encourage environmental and health protection agencies to participate in global atmospheric monitoring strategies.

BENEFITS AND APPLICATIONS

The availability of regular global IGACO products will represent a major step forward in the development of atmospheric research. It will contribute to

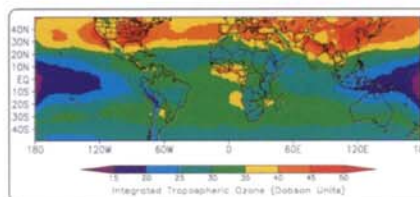
- enhanced scientific understanding of biogeochemical cycles that govern atmospheric composition, of chemistry-climate interactions, and of anthropogenic perturbations to composition, chemistry and climate;
- more precise assessment of the effects of climate change and air pollution on ecosystems, human health and society;
- improved knowledge base for policy-making, i.e. for the design and assessment of effectiveness of emission reduction strategies;
- enforcement of environmental laws and international conventions;
- improved weather forecasting and environmental predictions (air quality, biomass burning, dust storms etc.).

STATUS

The IGACO theme team has identified the major issues, the required data products and integration methods. A detailed review of existing observations was performed. Most of the theme report exists in draft form.

CONTACTS

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June-July-August global tropospheric ozone climatology 1979-2000 derived from TOMS/SBUV (courtesy J. Fishman)

Coastal Theme

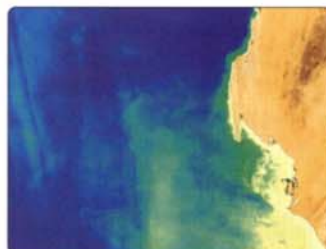
a new IGOS Theme under development

Coastal zones are the sites of some of the most important, productive and unique ecosystems on Earth. They are also centers of human population (upwards of 1 billion people worldwide) and commerce. Both these natural and human elements of coastal zones are vulnerable to disturbances associated with natural climate variability in conjunction with anthropogenic forcing. These disturbances impact the capacity of the coastal zone to support goods and services. Thus, the ability to detect and predict changes in coastal environmental indicators in a timely manner is crucial. This need remains largely unfulfilled, as coastal zones are difficult to observe since they exhibit considerable environmental heterogeneity. For this reason, the IGOS Partnership approved the development of a Coastal Theme in June 2003, under the leadership of CEOS (NOAA/NASA) with key roles also played by GOOS, GTOS and IGBP.

Numerous national and international organizations have established research and monitoring programs that involve acquisition and/or utilization of in-situ measurements, remote sensing, or both. Most of these programs target marine environments or terrestrial environments, but rarely both, and too often their observing efforts are uncoordinated or redundant. In particular, a strategy has yet to be formulated and implemented to coordinate and integrate these diverse observing activities in the coastal zone. Therefore, the IGOS Coastal Theme will coordinate and strengthen present and future coastal observational (in-situ & space-based) capabilities and the attendant decision-making process by developing a strategy for integrated global observations that will provide improved understanding of Earth system variability and change in the coastal zone.



Mississippi River Sediment Plume (NASA/MODIS, March 2001)



Coastal Phytoplankton, West Africa (ESA/MERIS, March 2002)

Coral Reef Sub-theme

the first component of the new Coastal Theme

The global crisis of coral reefs threatens the well-being of many tropical coastal countries and millions of people who depend on coral reef and other coastal resources for their livelihoods. Following approval by the IGOS Partnership in November 2001, UNEP and CEOS/NOAA worked with other IGOS Partners to develop a Coral Reef Sub-theme Report as the first component of the new Coastal Theme. The sub-theme report was approved by the IGOS Partners in June 2003. It provides strategic recommendations for observing requirements covering all available observing technologies, and proposals for new products able to monitor ecosystem health and change on coral reefs.

Coral reefs are a significant coastal ecosystem under major threat. The report highlights the urgent need to improve and coordinate observation capabilities for coral reefs and related coastal ecosystems, and to integrate space-based and in-situ observing programmes in the coastal region, in support of management action. The implementation of the IGOS Coral Reef Sub-theme will be led by GOOS and GTOS and linked to the International Coral Reef Action Network (ICRAN), a partnership of international organizations, Regional Seas programmes and non-governmental organizations working to reverse the decline in coral reefs. This gives it an appropriate user context and partners for implementation. The sub-theme will also

be integrated into the Coastal Theme as it is developed.



FURTHER INFORMATION

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The IGOS Partners

	CEOS Committee on Earth Observation Satellites http://www.ceos.org
	FAO Food and Agriculture Organization of the United Nations http://www.fao.org
	GCOS Global Climate Observing System http://www.wmo.ch/web/gcos/gcoshome.html
	GOOS Global Ocean Observing System http://ioc.unesco.org/goos/
GOS/GAW	GOS/GAW Global Observing System/ Global Atmosphere Watch of WMO http://www.wmo.ch
	GTOS Global Terrestrial Observing System http://www.fao.org/gtos/
	ICSU International Council for Science http://www.icsu.org
	IGBP International Geosphere-Biosphere Programme http://www.igbp.kva.se/
IGFA	IGFA International Group of Funding Agencies for Global Change Research http://www.igfagcr.org
	IOC-UNESCO Intergovernmental Oceanographic Commission of UNESCO http://ioc.unesco.org/iocweb/
	UNEP United Nations Environment Programme http://www.unep.org
	UNESCO United Nations Educational, Scientific and Cultural Organization http://www.unesco.org
	WCRP World Climate Research Programme http://www.wmo.ch/web/wcrp/wcrp-home.html
	WMO World Meteorological Organization http://www.wmo.ch

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CONTACT DETAILS

- You can stay up-to-date with IGOS Theme events via the IGOS website:
<http://www.igospartners.org>
- You can also register to receive copies of **the IGOS Bulletin**, distributed twice a year by CNES by sending an e-mail to Dominique Fourny-Delloye at:
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