GROUP ON EARTH OBSERVATIONS

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2009-2011 Work Plan Progress Report

Document 5

This document is submitted to GEO-VI for acceptance.

2009-2011 Work Plan Progress Report

This report describes how the GEO 2009-2011 Work Plan has advanced the GEOSS 10-Year Implementation Plan since the GEO-V Plenary meeting. It provides an overall summary of the progress made in each cross-cutting and societal benefit area, and it highlights key outputs and activities to illustrate how this progress was achieved. Consistent with the new Work Plan structure, the Progress report is organized around overarching Tasks to help: (i) highlight key lines of GEOSS implementation; (ii) showcase progress and coordination at the overarching level; and (iii) support the monitoring and evaluation of GEOSS implementation.

As with previous Work Plan Progress Reports, the present report includes an annex featuring an "at-a-glance" summary table. To help the reader more easily evaluate overall progress, the table has been colour-coded to assess the progress made in each Task. Readers interested in greater detail about the progress on specific Tasks are referred to the main body of the report and to the Task Sheets, which are available at http://www.earthobservations.org/geoss_imp.shtml.

HIGHLIGHTS

The year 2009 marked the beginning of a new phase in GEOSS implementation. With the new three-year Work Plan, strategic objectives were introduced along with new proposals and contributions from over 30 GEO Members and Participating Organizations. Moreover the focus of the Work Plan shifted towards actually building GEOSS – developing the GEO Portal, connecting various observing, prediction and information systems, and making environmental data, products and services available to society. Africa in particular benefited from a surge of initiatives designed to better inform decision-making on the continent. User engagement and Communities of Practice also were re-enforced. Some key examples of how GEO Members and Participating Organizations have advanced GEOSS implementation have been selected from across societal benefit and cross-cutting areas and are highlighted below.

The GEO Portal

A 15-month assessment of the three GEO Portals was completed in September. This assessment focused on developing the core capabilities required to use GEOSS resources efficiently, including components and services registries, a search tool known as the "Clearinghouse", and the GEO web portals for searching and accessing the data, imagery, information and services available through GEOSS. Models for sustained Portal operations were examined, and registrations of Earth observations resources in the GEOSS Common Infrastructure encouraged. In particular, the GEOSS Architecture Implementation Pilot Phase 2 (AIP-2) coordinated the incorporation of newly contributed components to GEOSS.

The GEO Portal assessment also provided key opportunities for the GEO community to deliver feedback. In May, during the 33rd International Symposium of the Remote Sensing of the Environment (ISRSE-33), a user assessment of the Portals was conducted. Each portal was tested relative to its overall organization and content, its navigation capabilities, and its functionality. Interest in the GEO Portal turned out to be high, with nearly 20% of the 615 ISRSE participants partaking in the usability testing. 86% of the users responded that they would visit the GEO Portals again in their search for environmental information.

New GEOSS Products and Information

A wide range of new products and information was developed and contributed to GEOSS in 2009. This is now available to the entire GEO community either through the GEO Portal or through dedicated portals that will soon be connected to the GEO Portal. This information serves a wide range of purposes, such as predicting and managing natural disasters, assessing climate variability and change, monitoring ecosystems and biodiversity, planning new infrastructure, and mitigating the impacts of global environmental change. Importantly, many developing countries have for the first time access to information they need for managing disasters. Moreover in 2009:

- Users were given access to the *world's largest collection of land surface imagery* – including Global Landsat data – via the Land Surface Imaging portal; see AR-09-02
- A *new digital topographical map of the Earth* was developed and made publicly available – to respond to the critical need for a comprehensive, highly accurate, fully consistent global Digital Elevation Model (ASTER GDEM); see DA-09-03
- The principle of *"universal access" to the International Charter on Space and Major Disasters* was endorsed by space agencies. In 2008, 45 GEO Member countries still did not have Authorized User status to the Charter; see DI-06-09
- *World seismic* information strongly progressed towards free availability at minimum time delay. Access to the complete Synthetic Aperture Radar (SAR) data holdings was granted through the Supersite website; see DI-09-01. Over *170 geological datasets* were made available by 40 nations through the OneGeology Portal; see DA-09-03
- Major *global reanalysis* datasets were released by national and international prediction centres in Europe, Japan and the USA; see CL-06-01
- Satellite data records were expanded through the launch of the Japanese *Greenhouse Gases Observing Satellite* "IBUKI" (GOSAT) satellite and the development of a new Committee on Earth Observation Satellites (CEOS) virtual constellation to provide *ocean biology and biogeochemistry products;* see CL-09-03
- Numerous *global runoff* products were released through the newly-reworked Global Runoff Data Centre (GRDC) portal – including time series of daily and/or monthly river discharge data of more than 7,300 stations from 156 countries over a period of around 38 years; see WA-08-01
- Long-record (quasi-)global *precipitation climatology* datasets were made available by the Global Precipitation Climatology Centre (GPCC), the Global Precipitation Climatology Project (GPCP), and the TRMM Multi-satellite Precipitation Analysis (TMPA); see WA-08-01
- TIGGE – a global database of *ensemble weather forecasts* originating from 10 major forecasting centers (Australia, Brazil, Canada, China, France, Japan, Korea, UK, USA and ECMWF) – was made a free resource for high-impact weather research in early warning and societal applications; see WE-06-03
- Near-real time and archived measurements of remotely-sensed *ocean-colour products and sea-surface temperature* were made available for South America, Africa and the Indian Ocean through the ChloroGIN portal; see EC-09-01

Africa

In 2009, GEO Members and Participating Organizations fostered the use and development of a number of systems, products and services for Africa:

- The SERVIR monitoring and visualization portal was extended from Central America to East Africa. Primary applications include (i) early warnings of *thunderstorms*, flash floods, and vector-borne *diseases*; (ii) *climate* prediction mapping; and (iii) *air-quality* monitoring; see CB-09-05 and WA-06-07
- *Flood* forecasts were developed, validated and distributed using SensorWeb applications in Mozambique and Namibia. An operational *soil moisture* monitoring service was developed for the region of the Southern African Development Community; see DI-09-02
- New decision-support tools to mitigate *meningitis* outbreaks were developed for Niger and Ethiopia. Space agencies gave high priority to the development of a *malaria* early warning system for Africa; see HE-09-03
- The African *Water Cycle* initiative was launched in January to build upon the successful framework of the Asian Water Cycle Initiative (AWCI) for cooperation and coordination. The TIGER initiative was extended, with a second phase focusing on the use of space technology for water-resource management and capacity-building components; see WA-06-07
- The new GEO Ecosystems Map of Africa was unveiled in October. This new map helps support characterization and monitoring of Africa's ecosystems and the services that they provide; see EC-09-01
- A GEO Biodiversity Observation Network (GEO BON) product was developed compiling information from 741 *protected areas* in Africa. Available online, this product allows users to identify threats to *biodiversity* in national parks; see BI-07-01
- An *energy* service for sitting *solar power plants* was developed and made operational in June to help identify ideal locations for large solar energy systems on African open land; see EN-07-03. Data on *transport* systems in Africa (e.g. railways, airports, roads and ports) were collected, processed and integrated into an infrastructure planning system; see EC-09-02
- GEONETCast moved from a demonstration phase to being fully operational – broadcasting environmental information to Africa, Asia, Europe, the Americas and the Pacific. A GEONETCast Product Navigator and GEONETCast training & alert channels were developed. Training courses were organized in Kenya, South Africa and various Latin American countries; see AR-09-04 and CB-09-02
- The CBERS receiving station in South Africa became operational. A training program involving both technical and postgraduate education was implemented for the African end-users of the CBERS images. Training workshops were organized in May and June to help the African continent better respond to *meteorological disasters* and integrate climate change and variability into public *health* decision-making; see CB-09-05 and CB-09-02

User Engagement and Communities of Practice

Four new Communities of Practice emerged and initiated activities in 2009. These user-led communities provide a framework for cooperation and coordination across GEO activities with a focus on societal benefits and capacity building:

- The *Carbon* Community of Practice was launched in June to design a way forward for the carbon observation and analysis system. The Community facilitates communication between data providers, program managers, and funding agencies and also addresses data management and

sharing issues. Participants include Australia, Canada, France, Germany, Japan, Netherlands, Norway, South Africa, UK, the USA, CEOS, ESA, GCOS, WCRP and WMO; see CL-09-03

- The Global *Agricultural Monitoring* System Community of Practice initiated activities in February. These support the development of a global operational agricultural monitoring system for delivering crop forecasts and information to farmers and policymakers. Participants include Argentina, Australia, Austria, Belgium, Brazil, China, EC, France, India, Italy, Netherlands, South Africa, USA, ESA, FAO, CGIAR and WMO; see AG-07-03
- The *Health* Community of Practice was launched in July to ensure overall coherence in the development of decision-support systems for health and the environment. It ensures that components of end-to-end health systems, including monitoring and prediction systems, are successfully integrated into the GEOSS information framework. Participants include Brazil, EC, France, Senegal, USA, IEEE, UNOOSA, WHO and WMO; see HE-09-01
- The Integrated Global *Water* Cycle (IGWCO) Community of Practice was created in February to provide a coordination framework for water activities within GEO. The IGWCO benefits greatly from the increasing participation of developing countries. Participants include Argentina, Australia, Canada, China, Finland, France, Germany, Japan, Netherlands, Panama, Portugal, Switzerland, UK, the USA, UNESCO and WMO; see WA-08-01

A GEO Call for Proposals was issued in February to promote the *practical application of Earth observations* to improved decision making. 133 concept proposals were received in response representing over 40 countries, half of which were developing countries; see CB-09-01 and US-09-01

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1 BUILDING AN INTEGRATED GEOSS

1.1 ARCHITECTURE

The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata and products. GEOSS interoperability will be based on non-proprietary standards, with preference given to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such systems have interfaces to the shared architecture.

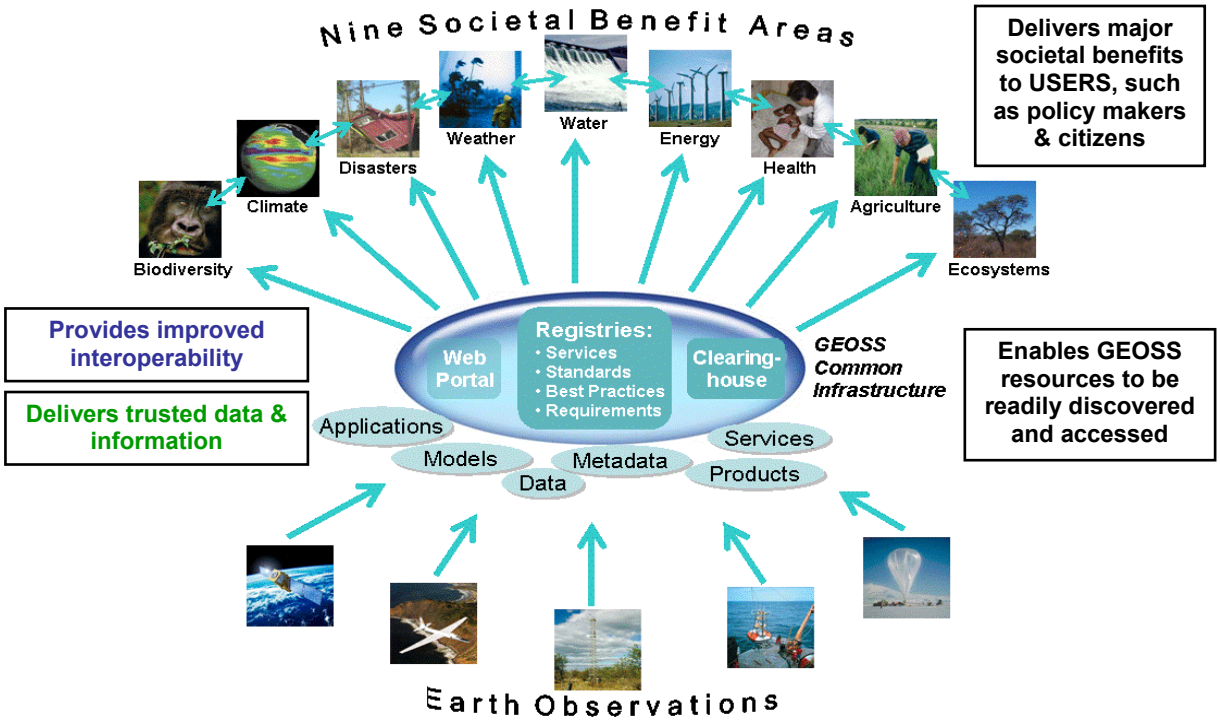
GEOSS 10-Year Implementation Plan, Section 5.3

AR-09-01: GEOSS Common Infrastructure

The one-year assessment of the GEO Portals launched in June 2008 was completed in September 2009, following a three-month extension. The assessment process helped to advance the core capabilities required to use GEOSS resources efficiently – including several registries, a search tool known as the "Clearinghouse," and GEO Web Portals for searching and accessing GEOSS information. The assessment provided several opportunities for the GEO community to deliver feedback. During the recent International Symposium for Remote Sensing of the Environment (ISRSE-33), over 120 users tested the GEO Portals and provided valuable recommendations.

In June 2008, GEO launched a one-year assessment of the GEO Portals and attendant components. This Initial Operating Capability (IOC) demonstration of the GEOSS Common Infrastructure (GCI) reached completion in September 2009, following a 3 month extension. Over its 15 month mandate, the GCI IOC focused on providing the core capabilities that enable users and decision makers to discover, understand and access GEOSS resources, including systems, products and services. The GCI includes a 'yellow pages' facility, a components and services registry, the GEOSS Clearinghouse, a Best Practices Wiki, and three prototype GEO Web Portals (see figure). The Portals provide a Web-based interface for searching and accessing the data, information, imagery, services and applications available through GEOSS. All of the **GCI components are currently operated** through voluntary contributions by Member governments and Participating Organizations (including ESRI, ESA/FAO, and Compusult).

Last May, while the world's remote sensing community was meeting in Stresa, Italy for the 33rd International Symposium of the Remote Sensing of the Environment (ISRSE-33), GEO's User Interface Committee (UIC) conducted a valuable **user assessment of the Portals.** The UIC engaged the Scientific Consulting Group, a US Environmental Protection Agency contractor, to conduct a detailed user assessment of the three prototype GEO Portals. Each portal was tested relative to its overall organization and content, its navigation capabilities, and its functionality. Testers were encouraged to search for information in their area of interest but also were provided step-by-step instructions for some sample searches. Search efforts were recorded to allow portal developers to examine user's needs in detail. Interest in the GEO Portals was high at the ISRSE, with nearly 20% of the 615 participants partaking in the usability testing. Users offered a mixed and sometimes critical review. More importantly, however, they were optimistic about the **future value of the GEO Portals**. In this sense, 86% of the users responded that they would visit the portals again in their search for valuable Earth observations. This, a second usability test in August, and other test results helped to improve the usability and reliability of the GEO Portals.



Operational view of GEOSS Common Infrastructure

In addition, the Task Force investigated models for sustained GCI operations documented in a "Concept of Operations" document. The Task Force also sought to stimulate the registration of Earth observation resources in the GCI through the **GEOSS Architecture Implementation Pilot Phase 2** (AIP-2). AIP-2 coordinated the incorporation of newly contributed components and the preparation of seven demonstration videos recorded on May 4&5, 2009. The videos were subsequently used in GEO meetings (see http://www.ogcnetwork.net/pub/ogcnetwork/ GEOSS/AIP2/index.html).

In the meantime, the **Best Practices Wiki** – designed as an educational resource for the GEO community – remained operational and open to fixes. The editorial team nearly completed an initial review of all entries to date. The development of a user survey and of one or more on-line video tutorials to walk people through the process of submitting practices are ongoing. As part of the Best Practices Wiki activities, a **prototype ontology registry** and a digital gazetteer were developed. The ontology registry collects, compares and analyzes available ontologies and taxonomies (objects and concepts that exist, and their properties and relations). Existing digital gazetteers are being collected and integrated, including names of governmental administrative regions, authoritatively standardized names and widely known place names.

See also a "Tour of the GCI" at http://www.earthobservations.org/art_002_003.shtml

AR-09-02: Interoperable System for GEOSS

Interoperability among the observing, modelling and information systems that together constitute GEOSS progressed on a number of fronts: Space agencies designed virtual constellations in consultation with user communities within the CEOS framework, addressing key observation gaps in the process; South Africa worked to integrate in-situ Sensor Web components into the GEOSS Common Infrastructure; WMO expanded its dissemination capabilities; and the USA and IEEE led the development of a basic concept for a dynamic modelling infrastructure.

The Committee on Earth Observation Satellites (CEOS) continued to work on **virtual constellations** in order to merge and integrate data and derived information. Moreover the CEOS Plenary approved the "CEOS Constellations for GEO Process Paper" boosting space agencies' coordination efforts to realize benefits from reduced redundancy and overlap among missions.

Japan (JAXA) and the US (NASA) formed a CEOS study team to establish the basis for a future Global Precipitation Virtual Constellation. CEOS, its Land Surface Imaging Constellation Study Team, and its Working Group on Information System and Services (WGISS) developed a portal that collects and distributes satellite imagery of the Earth's land surface (see figure). Users can now access images from all ten partners via a single web portal (http://wgiss.ceos.org/lsip/index.shtml). This new portal is a **gateway to the world's largest collection of Land Surface Imagery** and data (LSI) taken from space. The LSI portal is intended to serve as an invaluable tool for predicting and managing natural disasters, monitoring climate change, studying ecosystems and biodiversity, and addressing many other scientific and policy challenges.

The LSI Constellation concept emerged as a priority constellation for implementing the CEOS Space-Based Observations for GEOSS. While recognizing the independence of each space agency, the aim of the portal is to ensure user access to the best possible coverage of the Earth's surface with multi-spectral, space-based imagery and data as a major component of GEOSS. The LSI Constellation provides many images free-of-charge or, in a few instances, for a small handling fee; from some providers only free sample data are available. The portal features active direct links to agency-based imagery and to data-search and order tools for the remote-sensing systems with open access. It also includes fundamental technical and contextual information about the available data and the host systems.

The LSI Constellation started in 2007 by focusing on mid-resolution (10 to 100m) optical images. It now expanded coverage to short-wave infrared and thermal images. In addition to making existing images more easily available, CEOS is defining standards and practices for guiding the development of future imaging capabilities. It is also promoting cooperation on the operation of the space and ground systems needed for gathering land-surface imagery and data. The agencies participating in the LSI portal are the Argentina Space Agency (CONAE), Brazil's National Institute for Space Research (INPE), the China Academy of Space Technology (CAST), the French Space Agency (CNES), the Indian Space Research Organization (ISRO), the Japan Aerospace Exploration Agency (JAXA), Japan's Ministry of Economy, Trade and Industry (METI), Thailand's Geo-Informatics and Space Technology Development Agency (GISTDA), the US Geological Survey (USGS) and the US National Aeronautics and Space Administration (NASA).

WMO extended the **WMO Information System** (WIS) – further improving the existing WMO Global Telecommunications System (GTS) services to ensure the critical exchange of weather, water, climate and hydro-meteorological disaster data, warnings and products. This was done in response to identified user requirements.

The Meraka Institute of South Africa's Council of Scientific and Industrial Research (CSIR) developed a registry of technical terms for **Sensor Web technologies** and best practices. This Sensor Web education and training material supported a series of workshops focused on Sensor Web technologies and open-source implementation. In parallel a strategy for integrating Sensor Web components into the GEOSS Common Infrastructure was planned. A Sensor Web working group was established as part of the CEOS Working Group on Information Systems and Services (WGGIS) to develop space-borne, air-borne, sea-based and ground-based sensing networks. Sensor Web workshops were conducted in South Africa in 2007, Switzerland in 2008 and Japan in May 2009.

The USA (NASA) and IEEE led the development of a **dynamic modelling infrastructure** (Model Web) to serve researchers, managers, policy makers and the general public. The basic concept was developed and discussed with some 20 potential modellers. A tentative "Initial Framework System" was proposed in the Ecosystem area that can act as a core framework system. Discussions are ongoing

with the Monterrey Bay Aquarium Research Institute (MBARI) in connection with marine fisheries forecasting. Also the NASA TOPS model developers received funding to create a Virtual Modelling Environment to foster model and modeller interactions.

AR-09-03: Advocating for Sustained Observing Systems

Good progress was made on the maintenance and expansion of many of the major international observing systems underpinning GEOSS and on the overall implementation of the Global Climate Observing System (GCOS). In addition, the WMO Global Cryosphere Watch (GCW) made significant advances by building upon activities initiated during the International Polar Year (IPY). The CGW should help to meet most of the requirements for data and information on the cryosphere.

Work continued on extending and sustaining the global ocean observing networks and sixty percent of the initial goals specified in the **GCOS Implementation Plan** have been implemented. Guidelines for the research to operations (R2O) transition of satellite missions and the vision for the WMO Global Observing System (GOS) in 2025 have been completed.

Progress continued to ensure that data exchanges adequately cover the data requirements for the terrestrial sector. Discussions have begun on the appropriate structure for an intergovernmental mechanism for coordinating **terrestrial climate observations**. A summary report has been developed on the importance and observational status of the 13 terrestrial Essential Climate Variables (ECVs); see www.fao.org/gtos/doc/pub52.pdf. This follows upon the recommendations of the GTOS/GCOS report to the UNFCC COP to establish a mechanism for creating international standards for global terrestrial observations.

The **Global Cryosphere Watch** (CGW) Scoping document was produced and presented to the 61st Session of WMO Executive Council. Next steps for developing the GCW include: (i) Conduct of pilot or demonstration projects to demonstrate the viability of the GCW; (ii) Initiation of a network of reference sites in cold climate regions operating a sustained, standard, cryosphere observing programme; (iii) Development of a mechanism to implement GEO Cryosphere Community of Practice; (iv) Identification of cryospheric observing data sources and systems to be part of GCW; (v) Establishment of a trial portal to access data and information; and (vi) Development of resource requirements to support the ongoing operation of a GCW nationally and regionally. GCW will also engage pilot and demonstration projects in different regions of the world, including tropical regions with glaciers.

The GCOS **Reference Upper Air Network** (GRUAN) implementation made progress for providing long-term, high-quality climate records; constraining and calibrating data from more spatially-comprehensive global observing systems (including satellites and current radio-sonde networks); and fully characterizing the properties of the atmospheric column.

AR-09-04: Dissemination and Distribution Networks

GEONETCast became operational in 2009, and activities for establishing GEONET were initiated, with the first deliverables expected by end-2009/mid-2010. Synergies between GEONETCast and GEONET are being explored.

China (CMA), USA (NOAA), EUMETSAT and WMO further developed GEONETCast – a low-cost, satellite-based, dissemination system for Earth observation data. **GEONETCast broadcasts environmental information to Africa, Asia, Europe, the Americas, and parts of the Pacific**. In 2009, GEONETCast moved from demonstration to fully operational with near-global coverage through the coordination of the EUMETCast, GEONETCast America and FENGYUNGCast systems. Framework agreements with data providers were made available for dissemination in each of the three Global Network Centers (GNCs). The preparation of draft interface specifications for data providers

was completed. Efforts to engage users and the providers of data and product are ongoing involving existing regional institutions (GEOSS-Americas, EUMETCASTAfrica). Discussions with the Russian Federation regarding its potential involvement as a GEONETCast infrastructure provider are continuing.

GEONETCast developed the GEONETCast **Product Navigator** – the data **discovery component** of the GEONETCast system. By searching with the GEONETCast Product Navigator, information can be found on products disseminated via GEONETCast. Such information includes product descriptions, file formats, dissemination frequency and links to other online resources such as product guides. Users can search using keywords and via themes, such as Societal Benefit Areas. The Navigator is fully GEOSS-metadata compliant and already submitted for inclusion in the GEOSS Component and Service Registry. With regard to capacity building, GEONETCast established the GEONETCast training channel and a GEONETCast Alert Channel capability. It also provided training opportunities for users in Puerto Rico (by NOAA), and Africa & Latin America (by ITC in the Netherlands). The latter should help (i) forge new contacts in academic, policy planning and other communities; (ii) operationalize data sharing and interoperability among the system providers; and (iii) explore options for expanding the global network communication (GNC) coverage into the Pacific region (see also CB-09-02).

ESA worked to establish **GEONET** – a **global communication network** of interconnected networks through which GEOSS-related data, products and information can be distributed in response to the needs of users and providers. GEONET will constitute a network-of-networks within GEOSS – based on terrestrial as well as satellite communication networks as appropriate. GEONET initiated activities in the 2nd quarter of 2009 and a preliminary inventory of available networks for access, exchange and dissemination of data is under development. Planned activities include a report on GEONET Operations Concept, a demo of GEONET prototype (by mid-2010), and the set-up a GEONET demonstrator.

AR-06-11: Radio Frequency Protection

Consistent progress was made in ensuring radio frequency protection, which is critical to Earth observing systems. Continued success is critical to assuring the long-term ability of these systems to measure and collect data upon which analyses and predictions are based and to disseminate critical information to governments, policy makers, disaster management organisations, commercial interests and the public.

The *ad hoc* GEO subgroup on data utilisation continued to stress that Radio frequency protection be recognized as a critically important issue for Earth observations, in particular in frequency bands where passive sensing measurements are performed. Advocating activities continued through national and international bodies in charge of frequency management, such as the International Telecommunication Union (ITU) and the World Radiocommunication Conferences (WRC).

Moreover GEO Members and Participating Organizations continued in their leadership roles following the excellent results obtained at the last World Radiocommunication Conference (WRC-2007). The world-wide Earth Observation community largely attributes this success to the careful preparation and active participation of WMO, USA (NOAA), EUMETSAT, CEOS and several meteorological and environmental satellite agencies attending and actively participating. A series of schedule meetings has already been planned in preparation of the next World Radiocommunication Conference (WRC-2011).

1.2 DATA MANAGEMENT

In the implementation of GEOSS, increased sharing of methods for modelling and analysis needed to transform data into useful products will be advocated. The implementation of GEOSS will facilitate, within 6 years, data-management approaches that encompass a broad perspective of the observation-data life cycle, from input through processing, archiving, and dissemination, including reprocessing, analysis and visualization of large volumes and diverse types of data. The implementation of GEOSS will establish, within 6 years, international information sharing and dissemination drawing on existing capabilities through appropriate technologies, including, but not limited to, Internet-based services.

GEOSS 10-Year Implementation Plan, Section 5.1&5.2

DA-06-01: GEOSS Data Sharing Principles

A Data Sharing Task Force representing numerous countries and organizations was created. The Task Force has defined a set of clear deliverables, including the preparation of an **action plan for implementing the GEOSS Data Sharing Principles.** The action plan aims to gradually advance the coordination and harmonization of data policies and procedures. This in turn will facilitate the sharing and use of GEOSS data and maximize societal benefits for the widest possible range of users.

The November 2007 Cape Town Declaration called on GEO to reach a **consensus at its 2010 Ministerial Summit** on the practical steps required for implementing the GEO Data Sharing Principles. To advance towards this goal, the GEO Data Sharing Task Team produced draft guidelines on how to implement the principles and a GEO Data Sharing Task Force was established. The latter consists primarily of representatives nominated by their governments. The Task Force co-chairs are from China, the European Commission, India, Japan, and the US, together with a non-governmental representative from the earlier Task Team. The Task Force held its first meeting in May in Geneva.

At the May meeting, the Task Force focused on setting clear objectives and deliverables. These include: (i) Submit an updated draft of the Implementation Guidelines for the GEOSS Data Sharing Principles to the GEO-VI Plenary in November 2009; (ii) Interact with GEO Committees and Task Teams on their data-sharing opportunities and needs; (iii) Promote the harmonization of the various existing data-sharing procedures with the GEO Data Sharing Principles; (iv) Prepare an **action plan for implementing the Data Sharing Principles** and developing working procedures for data sharing within GEOSS; (v) Produce documentation to support the adoption of the Implementation Guidelines and the action plan by the 2010 GEO Ministerial Summit; and (vi) Consider possible recommendations for improving the principles for data sharing within GEOSS.

The Task Force also drafted a communiqué in preparation of intense interactions with the GEO Committees and Communities of Practice. Interactions will be initiated over the 14-18 September series of Committee Meetings in Melbourne, Australia. In addition the Data Sharing Task Team and Data Sharing Task Force refined their terms of reference to ensure full complementarity – with the Task Team addressing solutions and barriers to data sharing, and the Task Force interacting with communities and members to prepare the action plan for the Ministerial Summit.

DA-09-01: Data Management

Activities in quality assurance and data harmonization are growing, thanks to a series of outreach activities targeting activities across the GEO Work Plan and the related user communities. Major interactions within and across the overarching Tasks in Architecture and Data Management are taking place.

The Committee on Earth Observation Satellites (CEOS) designed and documented the **Quality Assurance Framework** for Earth Observation (QA4EO) and submitted this documentation for review to the GEO community. The integration of quality assurance into the GEOSS Common Infrastructure is step-wise and initial integration is underway in the form of a QA4O questionnaire in the dataset registration process. This questionnaire provided initial input in discussions held over a dedicated Quality Assurance Workshop in September in Turkey which also addressed the nine societal benefit areas. Outcomes will help further the integration of quality assurance during the third Architecture Implementation Pilot Phase. In addition, the GEO community was invited to participate in a radiance calibration campaign for surface-viewing imaging spectrometers organised within QA4EO.

Immediately following its creation, the task team for **data**, **metadata and products harmonisation** started analyzing data and products registry entries and scrutinizing these for harmonisation. A joint Workshop to address the multiple linkages with data integration and analysis is in preparation.

The WGCV Land Product Validation (LPV) community worked actively on **land-product harmonisation** with a prototype of the "consensus" project currently under development within the GEOLAND2 project. The efforts of the space agencies are being coordinated by a new CEOS team composed of WGISS and WGCV experts, which will meet in mid-May. The output of this CEOS session will be the starting point for the broader GEO activity, which will incorporate the responses to the GEO Call for Participation.

DA-09-02: Data Integration and Analysis

Data integration and analysis is advancing through a range of approaches, including ensemble and model evaluation. Products, tools, inventories and handbooks are among the key outputs that have been produced in the nine GEO societal benefit areas.

Canada (University of Manitoba), Japan (University of Tokyo) and ESA led efforts towards the completion and analysis of the first inventory of **water cycle data centres**. Inventories for all societal benefit areas were developed in 2009. The next step is to identify data centres with similar objectives and form alliances – in order to progress on interoperability, data integration and analysis systems.

The UK Meteorological Office developed a **Global High Resolution Sea Surface Temperature** (GHRSST) multi-product ensemble system. The system takes data from various independent analysis centres and processes them into ensemble products. A technical advisory group has been formed to manage this activity. The GHRSST-PP-Multi-Product-Ensemble (GMPE) technical advisory group set up within the GHRSST science team in order to manage the GEO activities includes international operational teams working with global and regional Earth observation sea surface temperature data.

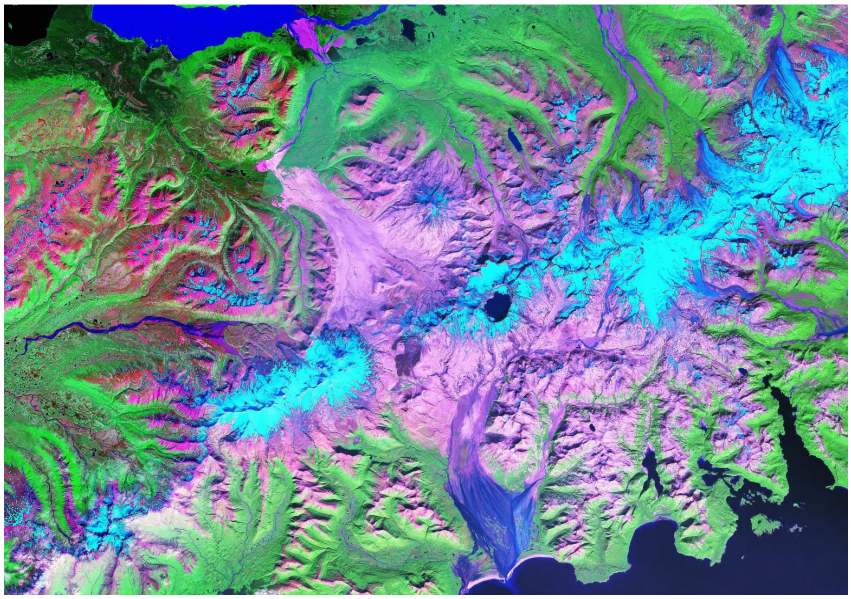
The International Association of Geodesy (IAG) produced and published the Global Geodetic Observing System Handbook (GGOS 2020) in support of **Global Geodetic Reference Frames**. The Handbook documents the requirements for observations of the Earth's shape, gravity field and rotation as well as the requirements for geodetic products from many applications in the nine GEOSS societal benefit areas. Several stakeholder events are planned for 2009 and 2010. They will bring GEO Communities of Practice, GEO Task Teams and other groups together with relevant experts to discuss the potential, benefits, and availability of global reference frames.

Building upon the work of the Task Force on Hemispheric **Transport of Air Pollutants** (www.htap.org), the US Environmental Protection Agency (EPA) created a pilot data network and evaluation tools. This pilot connects the HTAP modelling server to Datafed (www.datafed.net) – a web-based system that supports data sharing and processing for collaborative air quality management and atmospheric science research. Web-based tools have been developed for comparing model estimates and observations, drawing upon the algorithms of the Atmospheric Model Evaluation Tool (AMET). Results will be demonstrated at an air-quality application side event at the GEO-VI Plenary. Progress can be monitored on the HTAP Wiki (http://htap.icg.fz-juelich.de/data/).

DA-09-03: Global Data Sets

Efforts to provide a suite of global datasets based on improved and validated data sources are bearing fruit. The public release of two important global datasets – land cover and digital elevation – represent key advances for GEOSS implementation. These datasets will help to advance the development of monitoring systems in many areas of concern to GEOSS, such as global forests, sea-level rise, storm surges, coastal erosion, floods and hurricanes. This in turn will help decision-makers to define adaptation responses, such as locating barriers and other coastal defenses. Activities are currently underway to coordinate the validation of these datasets.

Global Landsat data were made publicly available. The GLOBCOVER and MODIS500 land-cover datasets were released after validation and high-resolution land-cover requirements were specified as part of the GMES global land monitoring activities. The Land Surface Imaging virtual constellation opened a dedicated portal, which provides access to land-cover data, associated input data and existing data links to land-cover information. Regional workshops were held to support developing countries with the exploitation of the Global Landsat dataset. Consensus on community standards for Global Land-Cover validation was reached and the result is documented at http://nofc.cfs.nrcan.gc.ca/gofc-gold/Report%20Series/GOLD_38.pdf. Several national characterisation and mapping efforts are underway, including in Australia, Italy, Japan, Norway and Spain. Projects developed by the USA, ESA, and the European Environment Agency (EEA) are also in progress.

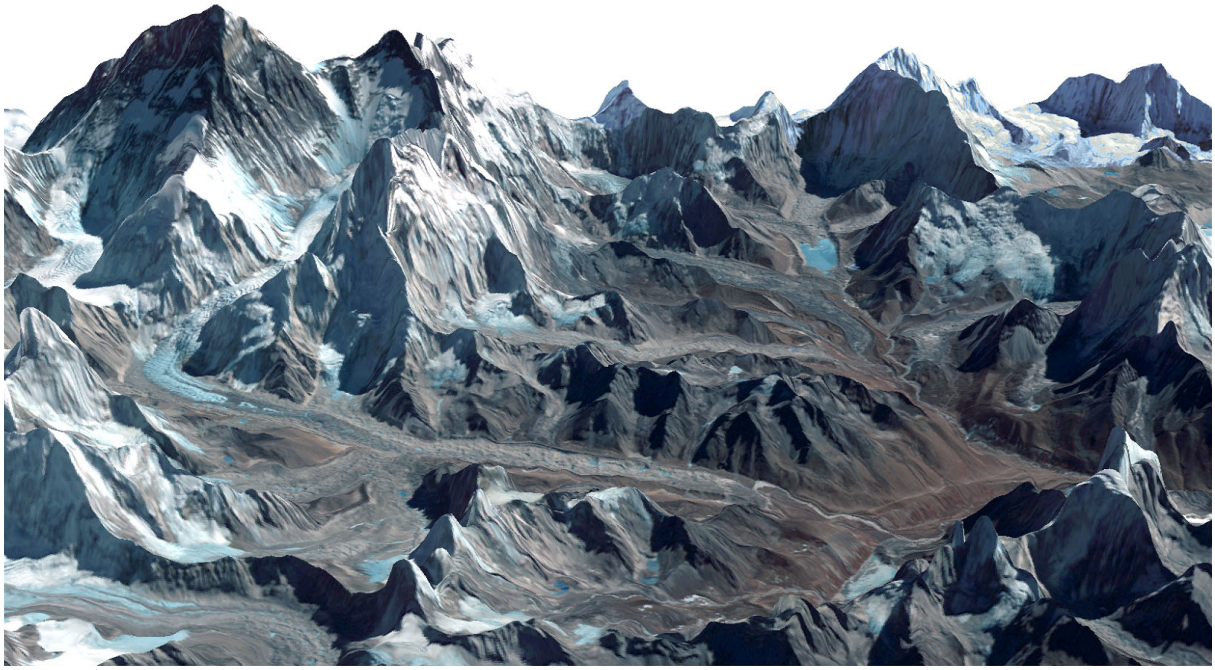


Landsat Image of the Novarupta Volcano region, Alaska, USA

The Chinese Meteorological Administration (CMA) made major progress in the implementation of the **Chinese Meteorological Satellite Programme**. The FY-3A satellite completed its in-orbit commissioning also operationally generating calibrated level 1 data. Level 2 data are still undergoing validation.

The OneGeology project established connections between numerous Geological Surveys worldwide. Forty of the 106 participating nations contributed over 170 datasets to the OneGeology Portal (http://www.onegeology.org/portal/home.html). The project is also now strengthened by the EU-funded OneGeology-Europe project and the US (NSF) funded Geoscience Information Network. It is supported by a well defined organisational structure which oversees the steps required to create the envisaged **dynamic digital geological map data for the world**. OneGeology Level 2 Web Feature Service (WFS) Cookbooks were published on the OneGeology portal.

Japan and the US responded to the critical need for a comprehensive, highly accurate, fully consistent, and **freely available global Digital Elevation Model** (GDEM) by the ASTER GDEM – a new digital topographical map formally launched on 29 June (see figure). Digital Elevation Models are used for a wide range of purposes, such as creating relief maps, modeling water flow to anticipate flooding impacts, predicting land slides, planning new infrastructure, and projecting the likely impacts of global environmental change. Until now, however, topographical grids were marred by internal inconsistencies and large gaps in coverage, particularly over Africa and other developing regions. The ASTER GDEM offers comprehensive coverage of the planet, including 99% of the area between 83°N and 83°S latitude, with data points 30m apart. As a result, many developing countries will for the first time have full access to the detailed topographical information they need for managing floods, landslides and other disasters.



A bird-eye view of Mount Everest (left) based on ASTER GDEM (copyright METI and NASA)

The ASTER GDEM is named after the Japanese Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) remote-sensing instrument that is carried by the NASA satellite Terra. ASTER has made nearly 1.3 million individual stereo-pair images of the planet by combining two images from different angles for each location. The ASTER GDEM "tiles" may be downloaded electronically from www.gdem.aster.ersdac.or.jp or https://wist.echo.nasa.gov/~wist/api/imswelcome/. Validation work for the ASTER GDEM is ongoing in the framework of GEO: Results were presented at the IGARSS2009 Conference and a worldwide assessment was performed by the NGA, see http://www.ersdac.or.jp/GDEM/E/image/ ASTER%20GDEM%20Readme_Ev1.0.pdf

1.3 CAPACITY BUILDING

The GEO capacity-building strategy follows the World Summit on Sustainable Development concept of a global partnership between those whose capacity needs development and those who are able to assist in the process, recognizing that activities have intertwined social, environmental, and economic impacts. The GEO capacity-building strategy will be based on best practices derived from studying successful and less-successful approaches.

GEOSS 10-Year Implementation Plan, Section 5.6

CB-09-01: Resource Mobilization (Seville Roadmap)

The Spanish State Agency for Meteorology (AEMET), together with the EC, the Australian Bureau of Meteorology, EUMETSAT/CEOS and UNOOSA led a major GEO effort to implement the Seville Roadmap and identify resources for building individual, institutional and infrastructural capacity for Earth observations. Significant support was provided through the establishment of an EC-funded capacity-building advisory capability. The UIC and CBC led a GEO Call for Earth Observations Decision Support projects that generated huge interest, providing a concrete basis for resource mobilisation efforts. Work on gathering information on potential resource providers is proceeding.

GEO issued a Call entitled "**Earth Observations in Decision Support** Projects" to identify projects that demonstrate the benefits of Earth observation applications to end-users in developing countries, particularly in the fields of agriculture, energy, human health and water. The CFP was a joint UIC/CBC initiative that made synergies between user engagement and capacity building. The Call received 133 Concept Proposals in response including: Water (57), Health (18), Agriculture (32) and Energy (3). Evaluations are currently underway.

A process was initiated to gather information on **potential resource providers** through a "Resource mobilization organizations GEO card" and an identification and listing of useful web links. The Asia Pacific Networks CAPaBLE Program launched its annual call for proposals for funding (http://www.apn-gcr.org/en/callforproposals/cfp09.htm.) and the European Commission published a number of calls for funding in 2010, some of which are relevant to GEO capacity building efforts (http://cordis.europa.eu/fp7/dc/index.cfm?fuseaction=UserSite.FP7DetailsCallPage&call_id=267).

The European Commission set up a capacity building advisory capability in the framework of FP7. To be soon operational, this capability should play a **"brokering role" between stakeholders and resource providers** and assist stakeholders to work with resource providers to bring Earth observation capacity-building projects to fruition.

Additional activities include the development of the: (i) UN Office for Outer Space Affairs (UNOOSA) fundraising website (www.unoosa.org/oosa/en/fundraising/index.html); (ii) Asia Pacific Networks CAPaBLE Program & Proposal Development Training Workshop; and (iii) EUMETSAT/CEOS WGEdu Portal – an information portal for GEO resource mobilization.

CB-09-02: Building Individual Capacity in Earth Observations

Numerous training activities are underway or are planned, including the UNOOSA Spring School, the IRI Summer School on climate change/variability & health, the GEONETCast training channel, GLOBE, and the CBERS capacity-building network. Coordination between GEONETCast and CBERS was greatly enhanced thanks to the DevCoCast workshops and the use of CBERS imagery in Africa. The Earth observation computer games contest moved towards the selection in late 2009 of a winner for the game development module. Identifying additional resources for implementation remains a priority issue for all of these activities.

Following the first international workshop (co-organized by ITC and ISPRS) on recognition of **cross-border education**, and the decision of the International Society for Photogrammetry and Remote Sensing (ISPRS) 2008 Congress to install two special working groups to deal with frameworks for cross-border education and educational program development, issues of knowledge-sharing were further elaborated at the CODIST meeting in May 2009 and at the ISPRS council in September 2009. Follow up actions are to be taken shortly.

The USA (International Research Institute for Climate and Society (IRI), Center for International Earth Science Information Network (CIESIN) and the Mailman School of Public Health) organized a "Summer Institute on **Climate Information for Public Health**". The 2009 course was held from June 1–12, 2009 in New York and exposed 12 participants to data, methods and tools for integrating climate change, and climate variability into public health decision-making processes. It included presentations, seminars and opportunities for participants to discuss integrated work with leaders in their respective fields, and to gain hands-on experience with analytic tools. The course targeted professionals who play a research role in the operational decision making or public health-care planning, evaluation, surveillance or control of climate sensitive diseases.

UNOOSA supported regional training and capacity building programs related to disaster management and emergency response. Following the Spring School held in Brazil in 2008, Spring Schools will be held in 2009, 2010 and 2011. The focus of these workshops is on developing individual **capacity in drought, desertification and earthquake management**, and establishing regional network of practitioners in Latin America. The schedule is: 2009 - Argentina, 26 to 30 October 2009; 2010 - Spring School in Ecuador on drought & desertification; 2011 - Spring School in Mexico on earthquakes. Identifying resources to enable participation remains a priority.

Brazil (INPE) and China (CRSDA) developed a training program for the **African end-users of the CBERS images**. Two levels of training were considered: technical & postgraduate education, and the accreditation of institutions in Africa for training. One student, from Mozambique, for Masters Degree at the Remote Sensing Postgraduate Program (INPE) was accepted with a fellowship from the Brazilian Government. CENACARTA (National Center for Remote Sensing and Cartography) was identified as the Contact Institution in Mozambique. Identifying resources to enable large scale roll out remains a priority.

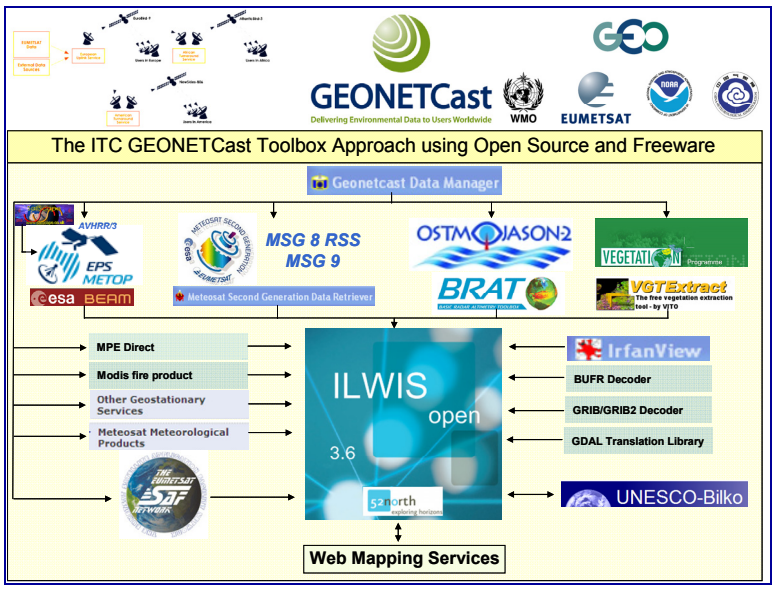
IEEE and its partners launched an international contest to create a **game that emphasizes the impact of Earth observation** on societal conditions. IEEE partners include DigiPen Institute of Technology, the International Game Design Association (IGDA), 1st Playable Productions, Global Learning and Observations to Benefit the Environment (GLOBE), the IEEE Computer Society and others to be announced. IEEE and its partners are providing prize money for the contest and teams for organizing and judging the competition. A first contest for the development of a game concept was finalised. A second contest kicked off on May 2 2009, to design a playable, prototype computer game was initiated. Technical and scientific input from the GEO Committees and Members and Participating organisations is sought.

The GEO community and the worldwide community of educators, students, and partners of the GLOBE (Global Learning and Observations to Benefit the Environment) Program developed a **student research campaign to foster the use of Earth observation** and better prepare the future work force in dealing with changes in the global environment (see picture left). A Global Climate Research and Education workshop (Geneva, 25-28 January 2009) – which convened 43 climate scientists, educators, administrators, and students from Africa, Asia, Australia, Europe, North and South America –

helped (i) develop a draft implementation plan for the GLOBE-GEO SCRC; (ii) identify potential sponsors (governments, corporations, NGOs, foundations, individuals; and (iii) identify a finite number of student research and implementation milestones for pilot student research investigations in 200-300 schools worldwide. Follow up includes GEO Members and Participating Organizations assisting in the identification of regional climate-related data sets and resources.

Both EUMETSAT and USA (NOAA) created and demonstrated **GEONETCast training channels** on their respective regional broadcasts, EUMETCast and GEONETCast Americas. DevCoCast (GEONETCAST Applications For and By Developing Countries) partners organized, together with ITC, a training on GEONETCast, water resource and marine applications as a short course to the IEEE IGARSS conference in South Africa (July) and a first virtual training in Brazil (June). ITC organized a GEONETCast training at the Regional Centre for Mapping Resources for Development (RCMRD) in Nairobi, Kenya, where they also assisted in setting up the GEONETCast receiver. Training materials will be listed on the upgraded GEONETCast Product Navigator (portal), which is compliant with GEO Architecture and Data specifications. Training materials developed in the DevCoCast project will also be shared via the EUMETCAST training channel.

In addition, ITC developed a GEONETCast Toolbox to facilitate easy import of various satellite and environmental products into a common Geographic Information System environment (see figure).



An overview of the GEONETCast toolbox approach, showing how the various satellite and environmental data streams can be incorporated into an open-source software

CB-09-03: Building Institutional Capacity to Use Earth observation

Progress was made in strengthening and coordinating existing capacity-building networks needed to improve the utilization of Earth information, products and services across regions and disciplines. The global network of operational oceanography is a good example of the achievements to date. Stronger synergies are required between activities addressing national & regional capacity building networks.

UNEP organized and conducted workshops in Africa, Latin America and the Caribbean, and the transitional countries of Eastern and South Eastern Europe, the Caucasus and Central Asia to improve **in-country coordination and management of environmental data**. Current activities are focused on securing funding to extend the workshops to other regions and to develop links with other GEO activities such as GEONETCast.

The Netherlands-based International Institute for Geo-Information Science and Earth Observation (ITC) initiated activities to organize and reinforce international capacity-building and training opportunity **networks in Earth observation sciences & Geo information provision.** It is using GEOSS components such as the GEONETcast data-dissemination system and the GEO Portal as well as distance and e-learning technologies. Immediate activities are focused on developing an inventory, reinforcing and extending regional capacity-building initiatives and networks. ITC and partners are also focusing on developing distance education courses using GEOSS components and demonstrating the relevance of Earth observations through education, training and awareness-raising.

IEEE helped consolidate the GEO community through its **GEOSS-focused web-based magazine**, "Earthzine" – aimed at the general public as well as non-technical managers and decision-makers. The magazine publishes articles on the social benefits of Earth observation and has been structured to align with the nine SBAs. It boasts approximately 2,700 readers every month in more than 100 countries. The reach of the magazine is expanding into regions of Africa, South America, and Asia; a regional coordinator for Africa, who will help identify authors and events of interest to the Earthzine readers, was identified.

The Danish Meteorological Institute (DMI) stimulated capacity building in operational oceanography through sharing of knowledge and experience in countries where it is non existent or not yet mature. Progress was made on developing a Yellow Sea weather-ocean-wave forecasting system as a result of the EC-supported Yellow Sea Observation, forecasting and information System (YEOS – see http://ocean.dmi.dk/yeos/). A **global network of operational oceanography** focused on capacity building was established, with involvement from major operational and research centres from Chile, China, Denmark, France, Germany, Republic of Korea, Norway, South Africa and USA, and IOC/GOOS.

CB-09-04: Capacity Building Needs and Gap Assessment

Implementation proceeded steadily, with significant outputs produced in the second half of 2009. Links between various workshops were established to address outreach and identify gaps and needs. Engaging the users of capacity building activities is proceeding**.** Outreach on the use of GEOSS and efforts to identify needs are proceeding through the User Orientated Workshop Series.

The International Institute for Geo-Information Science and Earth Observation (ITC) worked on **engaging the global user base for Earth observations** together with the providers of capacity building. This served the larger goal of identifying capacity-building needs and improving the efficiency of GEOSS capacity-building support in the nine Societal Benefit Areas. Meanwhile, the identification of best practices proceeded through funded projects such as the EC-funded Aida and DevCoCast projects (led by the Belgium-based Flemish institute for technological research, or VITO), the European Space Agency's TIGER activities, and the recent deployment of SERVIR in East Africa.

The identification of best practices and gaps & needs progressed through short dissemination and mini-training events linked to major conferences. Examples of workshops and activities addressing dissemination and gaps & needs analysis include the IEEE's International Geoscience & Remote Sensing Symposium (IGARSS) Conference held in July in Cape Town, South Africa and the AfricaGIS conference to be held in October in Kampala, Uganda.

The UNESCO Intergovernmental Oceanographic Commission (IOC) led efforts to develop reliable and widely accepted **qualitative and quantitative metrics** for measuring (i) the efficacy of Earth observation capacity-building programs, and (ii) the implementation of GEO capacity-building strategy. Outputs include developing standardized methodologies and the GEO Capacity building indicators.

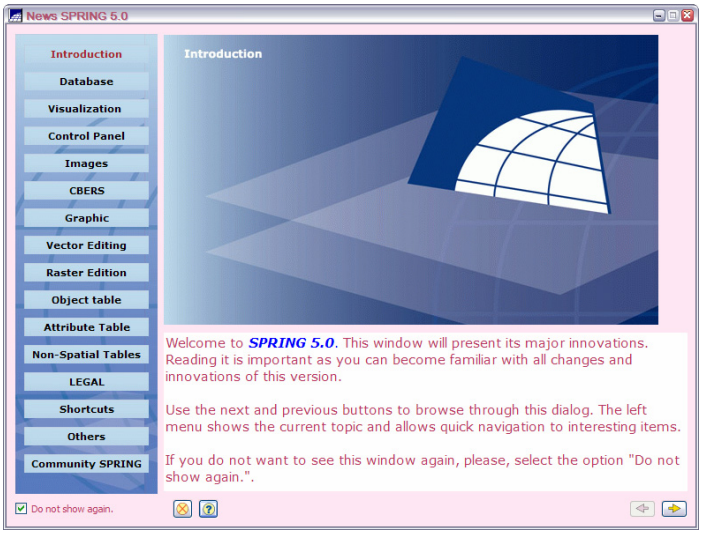
The IEEE and various partners (including CEOS, the US EPA, the World Health Organization, the International Society for Photogrammetry and Remote Sensing and the Open Geospatial Consortium)

organized a series of workshops to **demonstrate the GEOSS Common Infrastructure to users** in all Societal Benefit Areas. Capacity-building workshops exposed regional and local stakeholders to best practices in capacity building and to the benefits of using the GEONETCast data-dissemination system in combination with open source web-based applications and service deliveries. Five or six workshops are typically held every year. The most recent one, entitled "Toward a global forest carbon monitoring system", was held in May in Stresa, Italy.

CB-09-05: Infrastructure Development and Technology Transfer for Information Access

The China-Brazil Earth Resources Satellite (CBERS) downlink station in Hartebeeshoek, South Africa, has become operational and is now receiving data. Access to the Malindi receiving station in Kenya, however, remains uncertain, which could pose a risk to full African coverage by CBERS. The possibility of establishing an antenna in Gabon is being explored. Work on developing products, applications and training services proceeded well for the SERVIR-Africa node. Investigations are continuing to determine SERVIR's access to and distribution of CBERS data. The possibility of disseminating AEGOS information through SERVIR is also being explored. A new version of the Terralib open-source software is being developed by the Brazilian Space Research Agency (INPE), and an inventory of open-source solutions was produced.

Brazil (INPE) encouraged the development of **open-source solutions** across the Earth observation value chain by drawing upon networks of Open Source Software (OSS) developers (see figure). TerraView, TerraLib and SPRING training material, courses, tutorials, homepages and documentation for both programmers and end-users were made available in Portuguese, English and French. Work continued on a new version 4.0 of TerraLib to ensure interoperability, full OGC compliance and efficiency. Making an open-source version of SPRING available is also being considered. The South Africa's Council for Scientific and Industrial Research (CSIR) prepared a preliminary list of Open Source Earth Observation software (the Open Source Inventory).



Open-source software supports, amongst others, the processing of CBERS images

Brazil (INPE), China (China Center for Resource Satellite Data and Applications - CRESDA) and South Africa (CSIR, on behalf of the Committee on Earth Observation Satellites) worked to establish and upgrade the **capacity of ground stations** with a footprint in Africa to receive, process, store and distribute CBERS imagery (see figure). The two ground stations initially selected are Maspalomas in the Canary Islands, operated by Spain's National Institute for Space Technology (INTA), and Hartebeeshoek in South Africa operated by CSIR. A Brazilian delegation visited Libreville, Gabon to

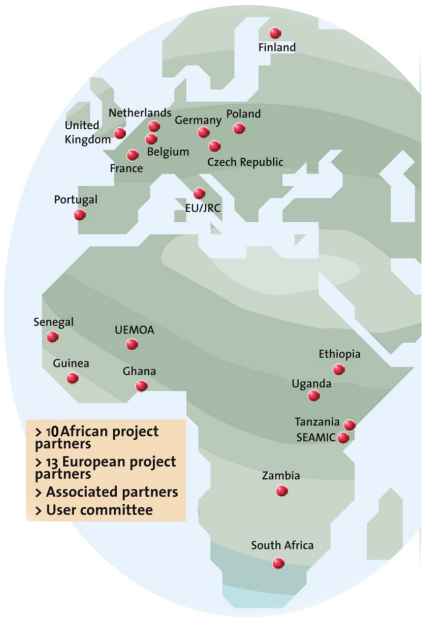
investigate the possibility of using an antenna in Gabon (controlled by IRD – France). Gabon also indicated an interest in creating a center for research and capacity building in remote sensing.

The Hartebeeshoek station is now fully operational with assistance and funding from China and is **receiving CBERS data**. Tests were performed in 2008 at the INTA facility, and problems with the antenna are currently being resolved. Tests have also been performed in Aswan, Egypt to explore the possibility of establishing an additional receiving station there. An unresolved issue remains the availability and access to the Italian-operated Malindi ground station in Kenya. This station is key to providing full CBERS coverage in Africa.The USA (NASA and USAID) established SERVIR regional hubs

CBERS ground stations

in geographic regions beyond MesoAmerica, starting with eastern Africa. They developed additional SERVIR tools that can provide (i) early warnings of thunderstorms, flash floods, and vector-borne diseases; (ii) climate prediction mapping; and (iii) air-quality monitoring. SERVIR-Africa is a US-funded project established at the Regional Centre for Mapping of Resources for Development (RCMRD) in Nairobi. SERVIR-Africa was launched in November 2008 and the initial installation included a Climate Mapper tool. Work is being conducted to include **early warning tools for flood and Rift Valley Fever** and the development of a climate change impacts on biodiversity application.

The African European Georesources Observation System (AEGOS) made progress towards a pan-African **geo-resources information system** to support geo-scientific communities and institutional decision-makers in Africa. Funded through the European Commission's FP7 programme, the project was launched in February at a conference in Cape Town, South Africa. The conference included the public launch of AEGOS, the first meeting of the project's steering committee, and several days of joint working meetings amongst the European and African partners. The public launch was held in parallel with the first day of the Mining Indaba conference, which brought the geological surveys together with the mining companies. Work is proceeding to determine the "state of the art" and design the components of the AEGOS infrastructure, including standards, data, models, networks, training practices, products, services, test beds, and contributions to international programs such as INSPIRE and Global Monitoring for Environment and Security (GMES). Workshops were conducted to identify: "Existing initiatives, infrastructures and technical standards"; "Identification of data themes, user-oriented data products and services"; and "Interoperability and interdisciplinarity in support of GEOSS".



AEGOS Partners

1.4 SCIENCE AND TECHNOLOGY

ST-09-01: Catalyzing R&D Funding for GEOSS

The Science & Technology Committee (STC) has launched new actions to encourage national governments and international organizations to support the science and technology needs of GEOSS implementation. A kick-off meeting was organized by the EC, the USA, and ESA to set activities in motion as quickly as possible. Action items, along with outputs and responsible parties, were identified. The next implementation meeting will be held in November 2009 on the sidelines of the GEO-VI Plenary.

Many new contributors joined R&D funding activities including: COST (European Cooperation in Science and Technology) Programme, the European Environment Agency (EEA), the International Association of Geodesy (IAG), the International Council for Science (ICSU), the International Institute for Applied Systems Analysis (IIASA), the Open Geospatial Consortium (OGC), and the nations of Cameroon, China, Denmark, Germany, South Africa, Spain, and the UK.

At the request of the STC, the European Commission offered to host a kick-off meeting during July 2009. Outputs were produced with the aim to further define required activities, identify other inputs to be sought from the GEO community, and also assign actions and set deadlines. Key outputs include:

1) Identify a set of key Science & Technology programmes needed in the context of the development of GEOSS as well as targeted funding and other resource mechanisms. Funding of GEO activities in Europe has improved in the last 3 years mainly thanks to a targeted sub-activity of the EC FP7. However, the situation is different according to the region of the world considered. The US NASA and NOAA started referencing GEO Tasks in their own Work Plans but no specific GEO line was included in the US scientific budget.

2) Identify a set of key commercial/industrial companies with substantial science, technology or application interests in GEOSS or datasets of broad scientific value. The private sector could help meet some of the needs identified by gap analyses in terms of funding. However the nature of the relationship between GEO and the private sector needs to be clarified before proceeding further with entraining commercial interests into GEO.

3) Report on Science & Technology gaps, priorities and continuity needs to support GEO. The STC Roadmap calls for a review of the GEO Work Plan on grounds of scientific and technological soundness and completeness against the outstanding questions and challenges in each of the Societal Benefit Areas.

4) Establishment of effective forum/network of funding agencies, Members and POs supporting key Science & Technology programmes to exchange views on current actions and discuss overcoming Science & Technology gaps, priorities and continuity needs. This will build upon the resource mobilization work of the Capacity Building Committee.

ST-09-02: Promoting Awareness and Benefits of GEO

The Science and Technology Committee endorsed a plan to engage the research community and foster scientific collaboration around GEOSS implementation A well-attended kick-off meeting, hosted by ESA and co-organized by IAG, discussed plans and activities and identified action items and responsible persons. The next implementation meeting will most likely be organized at the time of the STC meeting in the first part of 2010.

Key action items include:

1) Establish links with major scientific research enterprises. Prepare a high-level list of major scientific research enterprises necessary for GEOSS. Identify key organizations currently not linked to GEO and development of mechanisms for linkage to these organizations. Organize workshops to network with the new organizations.

2) Encourage scientists and technical experts to contribute to GEOSS. Get GEOSS acknowledged: Propose by the end of 2009 a GEOSS citation standard which would provide visible acknowledgment of scientific contributions to GEOSS whenever GEOSS products or services are used. Establish a scientific "GEO label". Enhance registration of relevant scientific data sets.

3) Outreach to diverse scientific and technological communities in order to make GEOSS more visible and attractive. Support outreach of GEO Principals, Committee members and other delegates to Science & Technology communities by the provision of a slide library. Compile a set of compelling examples showing how GEOSS serves science and technology communities in their work. Show "GEOSS at Work" through games using GEOSS products.

4) Initiate specific efforts to contact universities and research laboratories with the goal to involve them in GEO activities. Develop outreach to major university cooperation programs and research network. Develop proactive collaboration between GEO Tasks and science and technology activities at universities and labs. Foster transition from research to operational. A first step is to screen information (web-based, survey with the Participating Organizations, other means) for candidate research activities that are relevant for a transition.

5) Increase GEO's presence at major symposiums and meetings at different levels. Prepare plenary presentations on GEO and GEOSS in relevant sessions at major science events. Organize specific sessions on GEOSS-related topics at major scientific meetings.

1.5 USER ENGAGEMENT

The needs of users, and the technical solutions to those needs, change with time. GEO will organize regular GEOSS User Fora among and within societal benefit areas or sub-areas, making use of user communities where they exist and catalyzing the formation of new ones where they do not. It will also create an appropriate mechanism for coordinating user requirements across societal benefit areas. The function of the User Fora will be to document and review user requirements, assess the extent to which they are being met, and make recommendations to GEO with the objective of improving the delivery of information appropriate to user needs.

GEOSS 10-Year Implementation Plan, Section 4.2

US-09-01: User Engagement

Users have been actively engaged in reviewing and assessing requirements for Earth observation data, products and services. User needs described in publicly-available documents have been identified and analyzed. Partnerships were fostered among and within societal benefit areas, in part by promoting the concept of user communities and GEO Communities of Practice (CoPs). The transition of the IGOS themes into GEO has strengthened the new and emerging Communities of Practice. However there is still room for increased efforts on selected themes, such as atmospheric chemistry.

The US National Aeronautics and Space Administration (NASA) and Environmental Protection Agency (EPA), the International Association of Geodesy (IAG) and the IEEE led the GEO effort on identifying critical **Earth observations priorities common to many Societal Benefit Areas** (SBAs). This involved (i) identifying existing publicly-available documents, published by GEO Members and Participating Organizations from 2000-present, that specify observation needs, (ii) performing a meta-analysis across the documents, and (iii) preparing interim and final reports. Analysts were identified for the nine SBAs and each Analyst formed an *ad hoc* Advisory Group of experts (including CoP members) to help identify documents, assess findings, and review reports. Altogether, activities involved 121 people in the Advisory Groups, and the Analysts examined over 670 documents.

Earth Observation Priorities (Task US-09-01a)

Documents Reviewed & ad hoc Advisory Groups Members, by SBA
(figures as of 4-August-2009)

GEO Societal Benefit Area	Advisory Group Members	Documents in Meta-Analysis
Agriculture	11	15
Biodiversity	8	55
Climate	7	35
Disasters	13	40
Energy	14	53
Ecosystems	11	71
Human Health: Aeroallergens	16	117
Human Health: Air Quality	10	35
Human Health: Infectious Disease	17	165
Water	9	56
Weather	5	34
Total	***121***	***676***

Moreover analysts completed final reports for five SBAs (Disasters, Energy, Climate, Weather, Ecosystems) and preliminary reports for four SBAs (Health, Water, Agriculture, Biodiversity). The Task Team started summarizing information and identifying observation priorities common to many SBAs. It also established a website (http: //sbageotask.larc.nasa.gov) to support activities and report results. Analysts and Advisory Group members originate from various GEO Members and Participating Organizations, including Australia, Austria, Canada, China, Costa Rica, Denmark, Germany, Finland, France, Ghana, India, Iran, Italy, Kenya, Japan, Mexico, Norway, Paraguay, Russia, USA, Senegal, South Africa, Thailand, Tunisia, CEOS, DIVERSITAS, ECMWF, ESA, FAO, GCOS, IEEE, UNESCO and WMO.

New **Communities of Practice** emerged and matured building upon the IGOS transition into GEO: The Carbon Community of Practice (CoP) was established in June 2009 bringing together all the actors of the Global Carbon Observation and Analysis System. The Health and Environment

Community of Practice was launched in July in Geneva and will hold its first workshop in Washington DC in November 2009. The Integrated Global Water Cycle (IGWCO) Community of Practice was formalized in February in Kyoto. With the active support of the User Interface Committee, new and existing Communities of Practice (Air Quality and Health, Coastal Zone, Energy, Forest, Geohazards, and Water and Health) kept developing to ensure that GEOSS meets user needs.

GEO issued a Call for Proposals (CFP) in February inviting organizations to propose or participate in projects that apply Earth observations to decision-support activities. Managed by the Capacity Building and User Interface Committees (CBC-UIC), the CFP sought to promote **practical applications of Earth observations** for improved decision making and to highlight specific examples of how Earth observations can benefit society (in relation to the sub-task "Identifying Synergies between Societal Benefit Areas"). 133 Concept proposals were received in response. CBC-UIC representatives and GEO Secretariat experts organized panels to review the proposals, providing feedback to proposal teams in early September. Full proposals are due in November 2009; the final selections will be announced in January 2010.

US-09-02: Socio-Economic Indicators

The development of methods, models and tools required to produce socio-economic indicators is making good progress, particularly in the areas of Earth observation benefits, the Millennium Development Goals (MDGs) and human settlements.

The GEOBENE project (Global Earth Observation-Benefit Estimation: Now, Next and Emerging), led by the International Institute for Applied Systems Analysis (IIASA), produced methodologies and tools to assess **Earth observation benefits**. Applications of these methodologies were conducted in concrete case studies in all nine Societal Benefit Areas (SBAs). Socio-economic benefits were assessed in selected sub-SBAs (e.g. improved weather forecasts in agricultural production planning). Most assessments were carried out in research mode. A variety of approaches and methods have been developed to carry out benefit assessments. A template on how to conduct cost-benefit assessments was produced. GEOBENE is a 6th Framework Project of the European Commission.

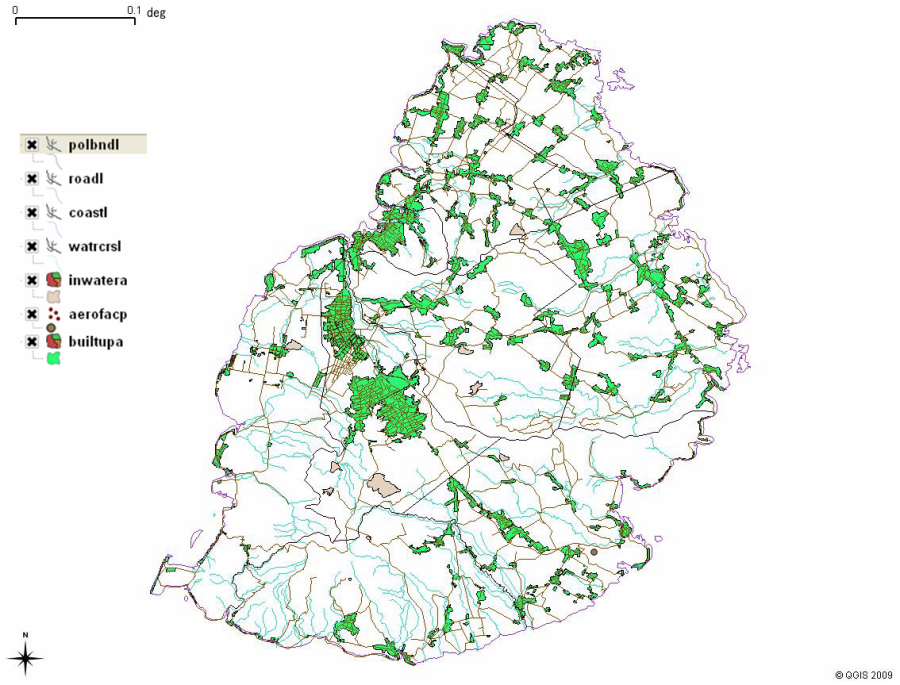
The UN Economic Commission for Africa (UNECA) developed global socio-economic databases with an initial focus on Africa. Progress was made on the collection, validation, and publication of administrative boundaries for several African member States. In addition, national-level socio-economic data and indicators relevant to the Millennium Development Goals (MDGs) were the collected and validated. A first version of the **MDG Mapper Tool** was developed. With this tool, one can navigate through the MDG goals, targets, and over 80 indicators and generate maps dynamically showing the progress of member States at various points in time, an estimated value for 2015, and hence off-target estimates at 2015. The tool provides an option for saving images of the maps for possible insertion into documents. The site also includes spreadsheets showing the annual improvements on each indicator, together with the utility application developed in Visual Basic for Applications for download.

Japan's National Institute of Advanced Industrial Science and Technology (AIST) developed an initial algorithm for the extraction of **human-settlement information** from high-resolution satellite images. AIST developed GEO Grid to offer various data in an IT environment for safe and secure use by enterprises and research communities. The initial version of the software to extract road vectors from satellite images was developed and implemented as a Web GIS tool – now in the evaluation phase. The Web GIS tool was demonstrated at the CODATA Global Roads Data Development Working Group Workshop in June 2009, in New York, USA. This system will further the implementation of Web Processing Service in accordance with Transactional Web Feature Service.

US-09-03: Cross-Cutting Products and Services

Initial efforts were made to foster the use and development of Earth observation products and services. These include the development of the Global Map, bio-geophysical soil data, and global phenology data.

Japan's Geographical Survey Institute (GSI) and other member organisations of the International Steering Committee for Global Mapping (ISCGM) as well as national mapping organizations fostered the use of Global Map in societal benefit areas such as Disasters, Health, Agriculture, Biodiversity and Water. In December 2008, a questionnaire was sent to national mapping organizations on specifications and web map services – to identify the needs for **basic geographic data** and reflect these needs in new specifications. In February, an outline of activities was presented to the GEO Architecture and Data Committee in Kyoto. Draft version 2 Global Map specifications were sent to National Mapping Organizations twice for review. The Needs for high-quality Global Map were discussed over the UN Regional Cartographic Conference for Americas in August. A workshop on the revision of specifications considering climate change, flooding and biodiversity was held in September. The Global Map of Mauritius was updated and released in June (see figure).



The Global Map (digital map data) of Mauritius – released in 2009. Urban areas appear in green and river networks in blue providing valuable base map information for resource management

The European contribution to the Global Soil Information System (GLOSIS) – the e-SOTER project – took key steps towards building a **global soil and terrain database**. The project, which uses remote sensing to validate, augment and extend existing data, will eventually deliver a web-based regional pilot platform with data, methodology, and applications. The funding of "GlobalSoilMap.net", which features soil maps in various regions and at various scales, is in final negotiations with the Gates Foundation. Window studies are ongoing and will be delivered in 2010. A meeting was held in September 2009 with major players in global soil mapping discussing contributions to the global database. The project is a collaborative research project of 14 partners in Europe, China and Morocco, with European Commission funding through the FP7 mechanism.

With regard to phenology, the Austrian Central Institute for Meteorology and Geodynamics (ZAMG) coordinated efforts to ensure open access to the pan-European phenological database for research and education. A **plant phenological database** was developed by European networks, and observational phenological guidelines were unified throughout Europe. Many scientific publications were issued, and a "Guidelines for plant phenological observations" was published. The US-based National Phenology Network drafted plant monitoring protocols for around 150 species also scoping a new animal phenology program. The COST 725 International Conference was held in Germany in March. Task participants for a Global Phenology Network Workshop planned for December 2009 were assembled. Project PEP725 on a pan-European phenological database was submitted to the EUMETNET Council for evaluation in March.

2 THE 9 GEOSS SOCIETAL BENEFIT AREAS

2.1 DISASTERS

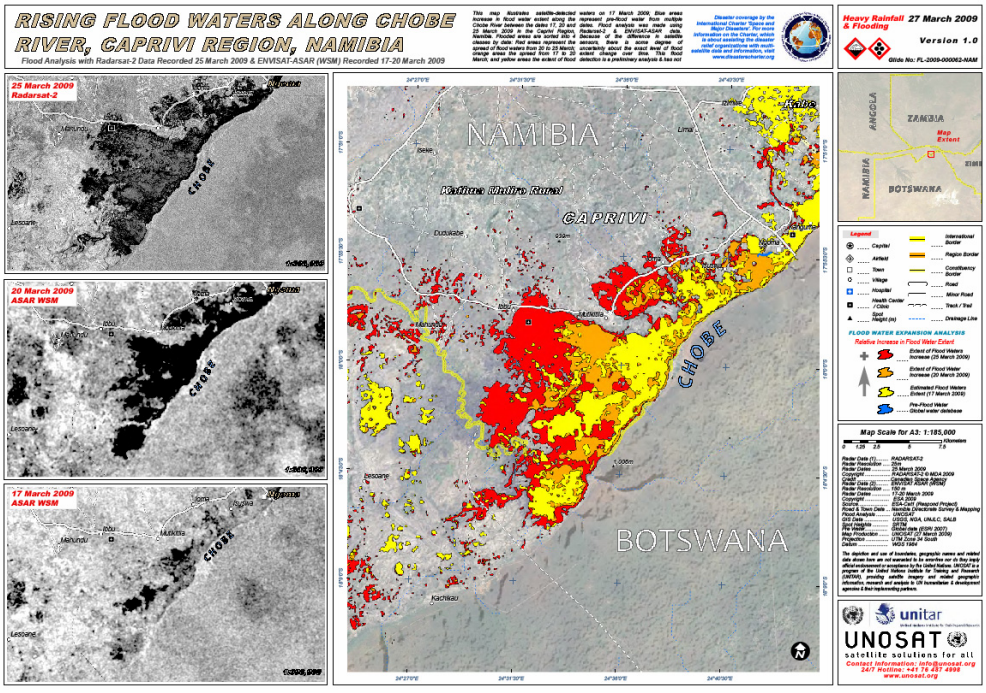
Disaster-induced losses can be reduced through observations relating to hazards such as: wildland fires, volcanic eruptions, earthquakes, tsunamis, subsidence, landslides, avalanches, ice, floods, extreme weather, and pollution events. GEOSS implementation will bring a more timely dissemination of information through better coordinated systems for monitoring, predicting, risk assessment, early warning, mitigating, and responding to hazards at local, national, regional, and global levels.

GEOSS 10-Year Implementation Plan, Section 4.1.1

DI-06-09: Use of Satellites for Risk Management

GEO's interactions with many of the key disaster-related communities are increasing, which is encouraging greater contributions to the Disasters SBA. Important advances were also made in enhancing the use of space observations in supporting disaster reduction.

In response to GEO initiatives, the Board of the International Charter on Space and Major Disasters Charter unanimously endorsed the principle of **"universal access" for GEO Members to the Charter**. The International Charter on "Space and Major Disasters" provides a unified system for delivering space-based data to countries struck by natural and man-made disasters. The Charter was initiated in 1999 by the European and French space agencies (ESA and CNES); the Canadian Space Agency (CSA) joined the following year. Access to the Charter used to be available solely through the network of Authorized Users and cooperating bodies or through a bilateral agreement with an Authorized User country.



Satellite-detected flood water-extent along the Chobe river, Namibia: 25 March 2009 (red); 20 March 2009 (orange); 17 March 2009 (yellow). Charter activated by UNOOSA on behalf of Namibia

Moreover the number of Authorized Users and cooperating bodies was limited; 45 GEO Member countries did not have Authorized User status. To be soon formally adopted by the Charter Board, the "universal access" principle is already being gradually implemented – helping more and more GEO Members to access a unified system for acquiring space data and delivering them to those affected by natural or man-made disasters. Meeting in Argentina on 16-17 April, 2009, Charter Members reviewed a detailed plan for implementation, agreeing that good progress was being achieved towards broader access.

In particular, the Charter Board reported significant improvement in Central America thanks to the creation of a Project Manager (PM) regional pool (facilitated country access through a sponsoring authorized user country in the region) and a training course for PMs held in Costa Rica. For the Asia-Pacific region, the Charter Board agreed to Japan (JAXA) proposal to establish a mechanism with Sentinel Asia for enhancing access to the Charter. For Africa, the Board took good note of the proposal to provide access to African countries but requested further investigation. ESA proposed to hold a first consultation meeting with African countries in the framework of GEO. Efforts will build upon the Charter Metadata catalogue (under development).

The CEOS Disasters Area Team and the United Nations Office for Outer Space Affairs (UNOOSA) led a major international effort towards identifying **user requirements in the use of satellites** for risk management. The resulting report was used as a starting point for several disaster-specific initiatives, such as the GEOSS Architecture Implementation Pilot (AIP-2) Disaster demonstration. In addition, the CEOS Disasters Area Team began similar work on architecture requirements – aiming to match specific existing and new satellite missions with user requirements, analyzing priorities for disaster-management information as well as gaps in existing and planned mission coverage. The first draft of the report is expected shortly.

DI-09-01: Monitoring for Geohazards Risk Assessment

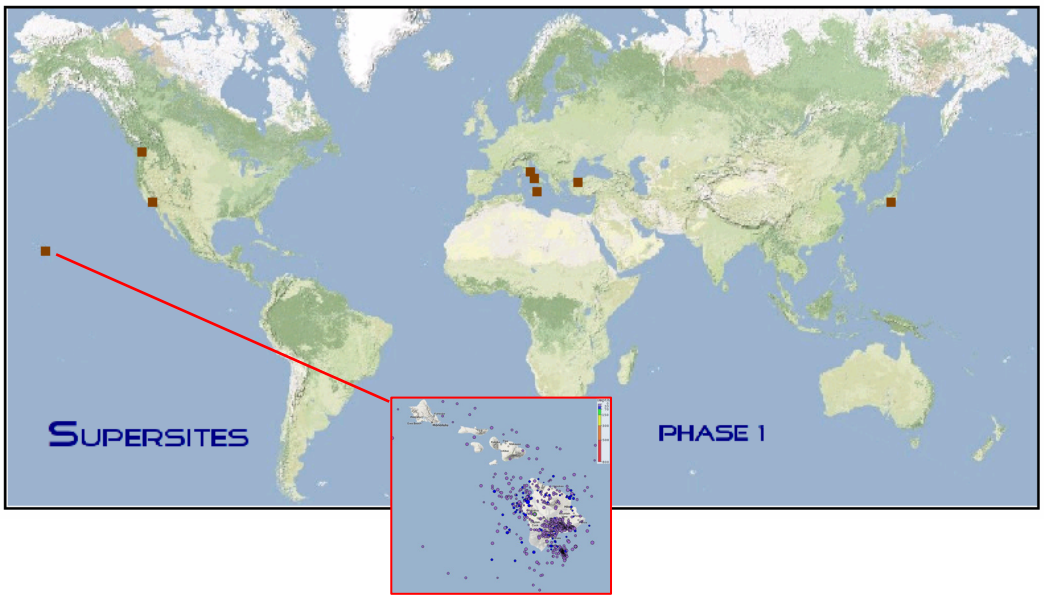
The Geohazards Community of Practice is now leading the Supersites initiative and thereby developing a unified and integrated approach to geohazards risk assessment. A new model to assess vulnerability is being developed, and access to Synthetic Aperture Radar (SAR) data is being greatly enhanced. World seismicity information is becoming freely available with minimum time delay.

Focusing on the risks and vulnerabilities of geohazard hotspots, the **Geohazards Supersites Initiative** implemented a number of actions to (i) stimulate scientific progress, (ii) maximize the beneficial use of and access to Earth observation data, (iii) foster the development of new applications, (iv) allow for the integration and assimilation of observations into models for hazard mapping and forecasting, (v) facilitate the exchange of knowledge and experience in the scientific community, and (vi) provide an ideal framework for building capacity.

Coordinated by France (BRGM) until December 2008, the Supersite initiative is now being coordinated through the GEO framework. At the 2nd Workshop on the Use of Remote Sensing Techniques for Monitoring Volcanoes and Seismogenic Areas – USEReST (Naples, Italy, November 2008), more than 25 participants agreed to contribute ground-based and space-based data to the initiative – including the German Research Centre for Geosciences (GFZ Postdam); the Italian National Institute for Geophysics and Volcanic Studies (INGV) and the Institute for Electromagnetic Sensing of the Environment (IREA); the Spanish University of Madrid; the Swiss University of Zurich; the Bristish University of Leeds; the US National Aeronautics and Space Administration (NASA), the US Geological Survey (USGS), and Universities of Miami and of Purdue; and the European Space Agency (ESA).

The Geohazards Community of Practice played a key role in the successful completion of several Supersites actions such as data collection and the development of IT infrastructure and webportals. Italy (EUCENTRE) led the development of a **vulnerability model** applied to selected Supersites. Using Earth observation data as input, the model is helping develop various methods for extracting

(i) building footprints from high resolution optical images, and (ii) the number of floors from radar images. Preliminary tests of these methods are being performed on the site of Messina, Italy, where airborne Synthetic Aperture Radar (SAR) observations are acquired, and very high resolution QuickBird images are purchased. The possibility to obtain free images from Geoeye-1 and COSMO/SkyMed is also being explored; this was announced during the ISRSE 33 Conference in Stresa, Italy (4-8 May 2009), and an official request was filed.



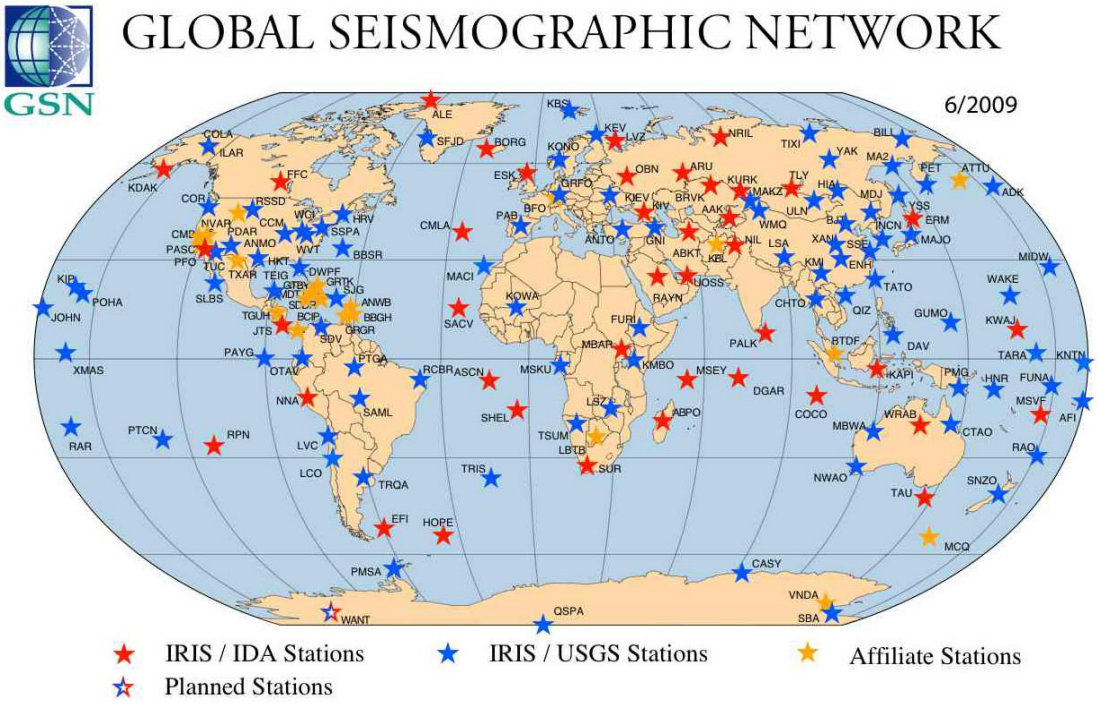
The Supersites Phase 1: Mt Etna, Vesuvius/Campi Phlegreii, Hawaii, Istanbul, Tokyo, Vancouver/ Seattle and Los Angeles. SAR, GPS and earthquake data (see Hawaii) are regularly acquired over the Supersites.

A Supersite website was set up (http://supersites.unavco.org) to facilitate **access to the complete ESA SAR data holdings** as well as to the publicly available GPS and seismic data. Community members contributed archived SAR data and ESA provided new imagery. ESA also provided key IT infrastructure for an online SAR data archive (known as ESA's "Virtual Archive"). Currently based at Unavco (Boulder, USA), the website should be moved by 2010 to the GeoForschungsZentrum (GFZ Potsdam, Germany) in the framework of the European Plate Observing System program (EPOS).

With regard to the coordination of seismographic networks, the International Seismological Centre (ISC) made strong progress on a variety of fronts: (i) 120 seismic networks, observatories and data centres around the world contributed seismic bulletins and data products to produce a definitive and **freely available summary of world seismicity**; (ii) 24 data centres and networks moved to contribute provisional bulletin information to be freely available to the seismological community within days of a seismic event; and (iii) station data were included for events in the period 1960-1963 as an ongoing effort to increase the time span of the ISC bulletin data. The ISC, jointly with European Seismological Commission, conducted a training course for young seismologists to promote the production of bulletin products and their distribution to international data centres.

Contributing to the ISC information, the Federation for Digital Seismograph Networks (FDSN) brought the participation of many local, regional, national, and global seismic networks into the GEO framework. FDSN stations are listed on the web (www.fdsn.org) and a station list is available from http://www.fdsn.org/FDSNwgI.htm. Incorporated Research Institutions for Seismology (IRIS) Consortium and the U.S. Geological Survey (USGS), through collaboration and cooperation with national and international partners, worked to increase the capability and capacity of global earthquake and tsunami monitoring networks, by expanding the Global Seismographic Network (GSN) and

affiliated networks (see figure), by upgrading their telemetry, through the development of software to enhance product quality and delivery, and through participation in workshops and training programs with regional partners. The IRIS Consortium operates a Data Management System, archiving data from over 5,000 seismic stations – of which over 1,000 are available in near-real-time – and a wide range of other geophysical sensor channels. All data are freely and openly available from www.iris.edu.



Moreover work continued by the US Geological Survey to improve post-earthquake information products, including a rapid estimate of the impact of an earthquake on the local population. PAGER (Prompt Assessment of Global Earthquakes for Response) and ShakeMap products were made publicly available– to provide rapid estimates of societal impact from major earthquakes worldwide, based on estimates of people and property exposed to potentially damaging levels of ground motion.

DI-09-02: Multi-Risk Management and Regional Applications

Multi-hazard early warning systems are developing worldwide thanks to a new set of guidelines and good practices. Coordination and collaboration around regional end-to-end applications are making strong progress with significant outcomes for flood prediction in Africa and the Caribbean.

WMO led substantive initiatives in **multi-hazard Early Warning Systems** (EWS). WMO face lifted the documentation of good practices in early warning systems with multi-hazard approach in four countries, including: 1) The French Vigilance System; 2) Bangladesh Multi-Hazard Early warning System Programme with focus on Bangladesh Cyclone Preparedness Programme; 3) Shanghai Multi-Hazard Early Warning and Emergency Preparedness Programme; and 4) Early Warning System For Tropical Cyclones in the Republic of Cuba.

WMO together with MétéoFrance hosted the Second International Experts' Symposium in Multi-Hazard Early Warning Systems, in Toulouse, France (May 5-7, 2009). The Expert meeting brought together experts from the National Meteorological and Hydrological Services, National Disaster Risk Management Agencies, Red Cross and Red Crescent Societies, and other international and regional agencies, with the goals to: (i) Review and synthesize lessons learned from documented "good practices" in EWS, focussing on institutional collaboration and coordination in EWS and specific roles

of National Meteorological and Hydrological Services and how they can best support disaster risk management agencies and other stakeholders within the EWS operational framework at national to local levels; (ii) Review and provide expert input into the draft guidelines on the "Role of NMHS in Multi-Hazard Early Warning Systems with Focus on the Governance, Institutional Coordination and Cooperation," which would be developed based on the synthesis of good practices in EWS, and; (iii) Provide recommendations to improve coordination and collaboration among agencies responsible for different aspects of early warning systems (national to local levels) for hydro-meteorological and climate-related hazards. The four documented good practices and the guidelines produced through this extensive expert process have been published in mid 2009, and they are being utilized in training programmes linked to national EWS development projects in Asia, South Eastern Europe, Africa and Central America.

Numerous countries and organizations jointly initiated projects to demonstrate data and service integration for **regional end-to-end applications**. These include Canada, France, Germany, Italy, Japan, Portugal, South Africa, USA, Cathalac (Water Center for the Humid Tropics of Latin America & the Caribbean), CEOS, UNOOSA, the World Bank and WMO. Moreover several space agencies including the Canadian Space Agency (CSA), the Italian Space Agency (ASI), NASA and ESA expressed interest in contributing data to ensure that near-real-time information is available on floods and landslides. Additional contributions are being discussed. The German Space Agency (DLR) is also organizing a system development workshop (August 25-27, Bonn, Germany), and together with UN-SPIDER a user feedback workshop (October 20, Bonn, Germany).

In this context, the **African and the Caribbean regions** were selected for initial work. The NASA SensorWeb application was used to develop flood forecasts and target specific areas for satellite-data acquisition from a wide range of sensors including EO-1, RADARSAT-2, Envisat and Formosat-2. The 2008/2009 flood events covered included those in Mozambique and Namibia. Results from the January 2009 flooding season were validated and the flooding extent products were distributed. In June the project was presented to the Namibian Ambassador to the UN.

In the Caribbean, an ambitious plan was developed for the 2009 **hurricane season**. Countries and organizations worked closely with the Caribbean Disaster and Emergency Relief Agency (CDERA, which represents 16 Caribbean nations) to identify user requirements. The entire Caribbean region, including countries in Central and northern South America, will be monitored on a regular basis using the **flood-prediction** software developed through NASA SensorWeb. Five National Partners were selected for Phase 1: Barbados, British Virgin Islands, Grenada, Jamaica and Saint-Lucia. They will contribute resources to develop common applications and work with the regional Caribbean Institute for Meteorology and Hydrology (CIMH) and CDERA.

DI-09-03: Warning Systems for Disasters

The implementation of a global wildland fire warning system is progressing; the supporting activities, however, are in strong need of funding. Progress on the development of a Tsunami Early Warning System of Systems is difficult to assess due to limited reporting.

The GEO wildfire team, led by the Canadian Forest Service and the GOFC/GOLD Fire team, worked to improve and coordinate existing wildland fire warning systems and risk models. It presented the **Global Early Warning System for Wildland Fire** at the Second Global Platform for Disaster Risk Reduction (16-19 June, Geneva) and submitted a GEO Concept Proposal on "A sub-Sahara Africa Early Warning System for Wildland Fire Threat and Air Quality Hazard" in response to the Call for Proposals jointly lauched by the GEO User Interface Committee (UIC) and Capacity Building Committee (CBC). Other funding proposals are in preparation.

The Canadian Forest Service and GOFC/GOLD also developed an information website (to be completed by Nov 2009) for the global fire warning system and related activities including: (i) Development of prototype regional systems and models; (ii) Integration of data collection networks;

(iii) Data processing for active fire monitoring; (iv) Fire danger modeling and fire weather forecasting; and (v) Dissemination of early-warning information. It is also to address information gaps and the need for training and capacity building.

The Intergovernmental Oceanographic Commission (IOC) organized the Global Meeting of the Intergovernmental Coordination Groups (ICGs) for **Tsunami Warning Systems** (GLOBAL TWS) in March to discuss current tsunami warning systems, future developments, technical issues and global standards for monitoring, detection and preparedness. The meeting was mainly organised to address the recommendations of the Working Group on Tsunamis and other Ocean Hazards Warning and Mitigation Systems (TOWS-WG), as adopted by the IOC's 41st Executive Council. The meeting focused on the global framework for tsunami forecasting, including the need for a global approach to operational standards and to cooperation on research and development.

2.2 HEALTH

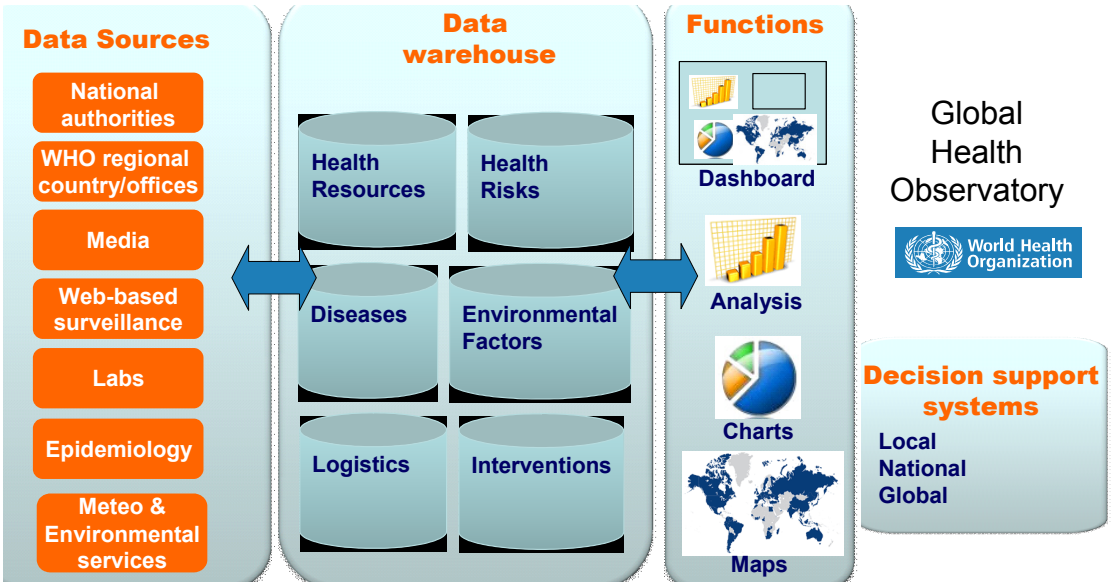
Health issues with Earth-observation needs include: airborne, marine, and water pollution; stratospheric ozone depletion; persistent organic pollutants; nutrition; and monitoring weather-related disease vectors. GEOSS will improve the flow of appropriate environmental data and health statistics to the health community, promoting a focus on prevention and contributing to continued improvements in human health worldwide.

GEOSS 10-Year Implementation Plan, Section 4.1.2

HE-09-01: Information Systems for Health

Activities to develop a global public-health information network database are gradually taking shape under the leadership of the World Health Organization (WHO).

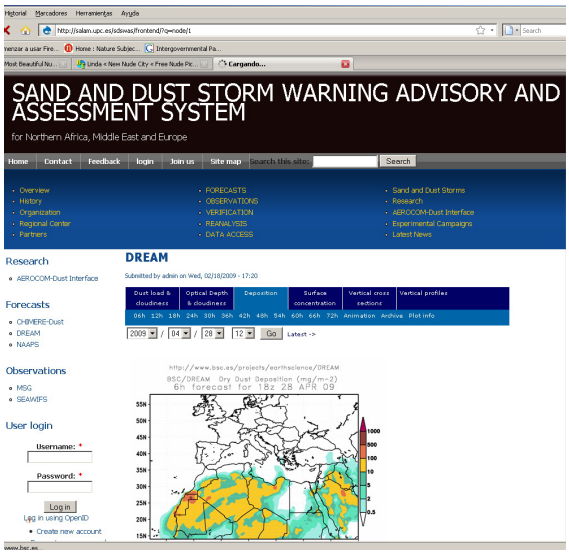
The French Space Agency (CNES), IEEE and WHO refined plans for collaboration at a meeting held in Geneva in April. A major output was the definition and progressive implementation of a GEOSS health "environmental module" within a global public **health information network**. This module is being developed through the effective interconnection of relevant GEOSS systems that support the WHO Open Health Platform (see figure).



Additional activities were kicked off with a three-day IEEE-co-sponsored workshop on "Health and Environment" in Geneva in July. This event brought together all the partners involved in GEO Health activities and helped (i) consolidate and activate activities, and (ii) launch a **GEO Health Community of Practice** to ensure overall coherence in the development of health-related environmental and decision support systems. For instance, the Health Community of Practice will ensure that components of end-to-end health systems, including monitoring and prediction systems, are successfully integrated into the main information system framework. To follow upon the Geneva Workshop and further accelerate advances, a meeting of the GEO Health and the Environment Community of Practice "Using Earth Observations for Health" will be held on Nov 12-13 2009 in Washington DC, USA, immediately prior to the GEO- VI Plenary.

HE-09-02: Monitoring and Prediction Systems for Health

Activities to connect established and emerging systems for monitoring and prediction for health made progress on a variety of fronts, notably sand and dust storm warning, persistent organic pollutants monitoring, and global atmospheric mercury monitoring.



The World Meteorological Organization (WMO) led the development of the international global **Sand and Dust Storm Warning** Advisory and Assessment System (SDS-WAS, see figure), which involves elaborating daily products capable of reducing risks from SDS through effective cooperation between the research community, data producers and users. Key progress relates to (i) the Asian node of the global network initiating activities and joining up with the European/African node; and (ii) the system providing information to the Meningitis Environmental Risk Information Technologies (MERIT) project. New applications associated with the presence and transport of viruses and bioaerosols that affect human health, livestock and cultivations are also being studied and supported.

Regarding air-quality observations and forecasts, the AIRNow-International pilot partnership between the US Environmental Protection Agency and the Shanghai Environmental Protection Bureau (EPB) made progress, and technical and programmatic agreements were put in place. The consolidation of the **Air Quality Community of Practice** is also underway. A related event took place back to back with GEO-V in Bucharest in November. New potential areas for development were identified during the July Workshop in Geneva, such as air pollution (aeroallergens health).

The Secretariat of the Stockholm Convention on **Persistent Organic Pollutants** (POPs) monitored the implementation of a global monitoring plan for the POPs. The baseline levels of POPs in ambient air and human milk or blood were adopted by the Conference of the Parties to the Stockholm Convention on the basis of regional monitoring reports (Geneva, 4-8 May 2009).

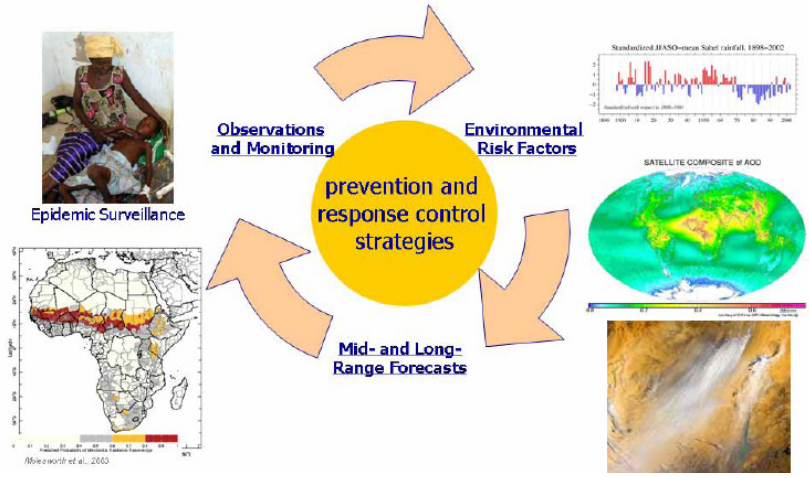
The Italian National Research Council's Institute for Atmospheric Pollution (CNR-IIA) ensured worldwide coordination for a **Global Atmospheric Mercury Monitoring Programme** (GAMMP). Contributions to the Programme were proposed from all regions of the world, and the team put together a plan of action.

HE-09-03: End to End Projects for Health

The health and environment communities have been interacting more strongly with one another. There are encouraging signs of progress on meningitis and malaria projects, and the field testing of those projects has provided a major contribution to the Health SBA. The Health Community of Practice is proving itself to be essential for ensuring a common framework for the definition and development of the projects.

The US Heath and Climate Foundation (HCF) and International Research Institute for Climate and Society (IRI) coordinated efforts around the development of **Meningitis Environmental Risk Information** Technologies (MERIT). Two country-specific projects, initiated in Niger and Ethiopia, progressed well thanks to the direct support of those countries. The Niger project, activated in 2007, developed a new decision-support tool including key environmental factors. The tool was tested

offline during recent outbreaks and results will be made available later in the year (the next international MERIT meeting will be held in November in Niamey, Niger). The Ethiopia project, launched in December 2008 through meetings and a workshop in Addis Ababa, focused on four areas: (i) Socio-economic impacts of meningitis; (ii) Determinants and risk factors of epidemic outbreaks (bringing together environmental, socio-economic, epidemiological and biological factors); (iii) Education and training; and (iv) Disease surveillance. Activities are being led by the Ethiopian Ministry of Health through an Ethiopian Climate and Health Working Group.



The MERIT approach, cross-cutting and user-driven

Space agencies gave high priority during the CEOS Strategic Implementation Team meeting in March to the development a **malaria early warning system** (see figure) and confirmed their support to the required activities. Building on existing work by the WHO, this initiative was one of the main topics for discussion and action at the workshop on "Health and Environment" held in Geneva in July.

The US Environmental Protection Agency led efforts to develop decision tools linking relevant aspects of ecosystems, biodiversity and health. A health session on "**Land Use/Condition and Emerging Disease Monitoring**" was organized at the International Symposium on Remote Sensing of the Environment (ISRSE) in Stresa, Italy in May. Moreover a session on emerging diseases was organized over the GEO "Health and Environment" Workshop in Geneva in July. Synergies were made with User Engagement activities (US-09-01a) – identifying data and observation types needed in Health as well as other Societal Benefit Areas.

The July Geneva Workshop confirmed the priority within the Community to deal with malaria at global level. A list of new potential end-to-end pilot projects – including Rift Valley Fever Early Warning system in east and west Africa, Dengue in South-America, Vibrio/Cholera in India/Bangladesh, Respiratory and cardio diseases in developing countries – was discussed in view of possible inclusion in the GEO Work Plan.

2.3 ENERGY

GEOSS outcomes in the energy area will support: environmentally responsible and equitable energy management; better matching of energy supply and demand; reduction of risks to energy infrastructure; more accurate inventories of greenhouse gases and pollutants; and a better understanding of renewable energy potential.

GEOSS 10-Year Implementation Plan, Section 4.1.3

The **GEO Energy Community of Practice** remains very active and committed to advancing the Energy SBA. This includes outreach activities such as organizing a special session entitled "Energy Management: The contributions of Earth Observations to the Energy Sector", during the 33rd International Symposium on Remote Sensing of Environment (33ISRSE) in Stresa, Italy in May. This special session discussed the contribution of Earth observations to the development of the energy sector, with examples in wind, solar and biomass energy. Also recently, US (NASA and NOAA) researchers organized four sessions exploring the use of atmospheric observations and models for renewable energy management at the American Meteorological Society Summer Community Meeting. The meeting brought together 160 researchers and practitioners from US and international government agencies, academia, and the private sector to explore the increased uptake of Earth observations to support the renewable energy industry.

Other **outreach activities** include the publication of the article "Getting solar energy to work: resource assessment by remote sensing as a base for investment decisions" in the May issue of the Earthzine online magazine. Several articles were also published in the Journal of Selected Topics in Applied Earth Observation and Remote Sensing (IEEE-JSTARS), including contributions on the use of Earth observation for integrating renewable energy sources into existing electricity grid structures, spatial assessment of solar resources, wind and turbulence profile measurements using Doppler Lidar, regional mapping of offshore wind resources, and the use of radar for offshore wind farming. The authors were from Canada, Denmark, Germany, Greece, Italy and the US.

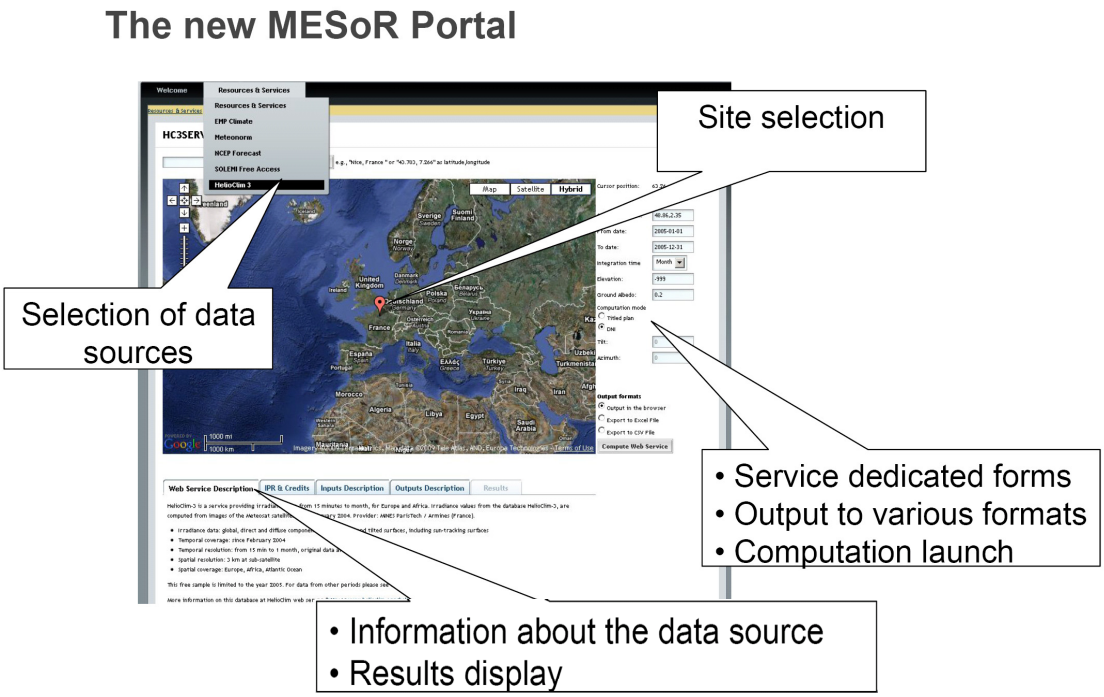
EN-07-01: Management of Energy Sources

Key contributions to the management of energy sources include (i) the development of a prototype web portal to assess different surface solar irradiance databases and (ii) the publication of a study on solar energy resource assessment using remote sensing as a basis for investment decisions.

Substantial progress was made within the scope of the European Union funded MESOR project (Management and **Exploitation of Solar Resource** Knowledge). A prototype broker portal to assess different surface solar irradiance databases was established and opened to the public (see figure and http://project.mesor.net). It was also **integrated into the GEO Portal** as a contribution of Ecole des Mines de Paris (France) in collaboration with NASA (USA), JRC (EC) and DLR (Germany). Other recent activities include (i) a snow-cover validation with respect to solar energy plant monitoring needs (DLR) and (ii) nowcasting and forecasting of solar irradiance for solar energy electricity grid integration. DLR is also preparing a report on "Deriving biomass using remote sensing products" (funded within the framework of a project assessing bio-energy potential on a global and regional scale) to present the modeling of biomass potentials of energy crops in Germany and Austria using remote-sensing data.

Two new studies were also conducted in the framework of the MESOR Project: "Future research objectives and priorities in the field of solar resources" and "Needs for new solar radiation services to faster deploy the market for solar energy applications and optimize grid integration". In addition, a series of important documents was made available to the public in July: (i) a handbook of quality control procedures for solar energy data sets; (ii) procedures for **standardizing and validating**

worldwide solar resource data sets; and (iii) roadmaps for future research priorities in the field of solar resources, including new solar radiation services and an improved Earth observation system to better support solar energy. Background information and outcomes of the MESOR project can be found at www.mesor.net and www.webservice-energy.org. The project is led by the German Space Agency (DLR) and partners from the EC Joint Research Center (JRC), France, Italy, the Slovakian Republic, Spain, Switzerland and Russia.



Access to irradiance resources for solar energy management

New activities include the development of solar and surface meteorological projects derived from NASA space-borne observations and reanalyses of global models; and the publication of new studies on future needs of solar radiation services and solar research. NASA is enhancing long-term solar resource data sets for use in the U.S. National Renewable Energy Laboratory's (NREL) National Solar Radiation Data Base (NSRDB) and its Solar Advisor "In My Backyard" decision support tool. NASA-derived datasets continue to be used in a several freely-available decision support systems, including Natural Resources Canada's RETScreen clean energy project analysis tool and NREL's HOMER micropower optimization model. RETScreen has over 210,000 registered users in 222 countries.

EN-07-02: Energy Environmental Impact Monitoring

Activities in the development of Earth observation systems for monitoring the environmental impacts of energy production and use have the potential to progress very strongly through the implementation of a major European project. The project is in final negotiation, and work should be initiated shortly.

The funding of the EnerGEO project on "Earth observation for monitoring and assessment of the **environmental impact of energy use**" was approved by the European Commission's 7th Framework Program. Negotiations with the European Commission are in the final phase and work will be initiated in the coming months. EnerGEO is a multiyear (2009-2013), multi-institutional project for evaluating the environmental impact of producing, transporting and consuming various energy resources through state-of-the-art environmental, energy and scenario models and datasets. Contributors include the Netherlands (TNO), France (Mines Paris), Germany (DLR), IIASA and the Netherlands-based

ARGOSS consulting company. In particular, EnerGEO aims at providing a versatile modelling platform that will enable planners, environmentalists and governments to calculate, forecast and monitor the environmental impact of changes in the energy mix, on the local, regional and global scale. The platform will integrate Earth observation data with different state of the art modelling tools and packages allowing for the calculation of socio-economic impact and environmental cost. It will not only focus on real time and near real time impact, but also on continuously recycled pollutants (longer time scale). The global up-take of the methodology will be achieved by building a portal in the context of GEO and based on GEO Architecture and Data Committee recommendations.

EN-07-03: Energy Policy Planning

A service for siting solar plants was developed. This service should help foster the use of Earth observations for informed energy-policy planning in developing and developed countries.

Building upon MESOR, a service for **sitting solar power plants** was developed and made operational in June. This service provides data on time-averaged values of solar irradiance from which basic economic assessments can be made. In particular it supports the site selection process for large solar energy systems such as photovoltaic installations placed on open land. A comprehensive GEOSS Renewable Energy Scenario Script is now available on the Energy Community Portal (http://project.mesor.net/web/guest/geoss_re_ scenario). This scenario illustrates how a data provider and a consulting company looking for the best place to site a solar-power plant can benefit from the use of a centralized point of access such as the GEO Web Portal and Clearinghouse.

In addition, an energy efficiency project was launched to assess the utility of NASA data sets to produce improved climate zone maps for use in improved building design. The project is exploring the potential of providing NASA-derived meteorological values in areas that lack ground site observations thereby allowing a more realistic assessment of localized climate zones and a more realistic application of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) buildings design standards. These ASHRAE standards, currently based on ground-based data, are used extensively in the US and other countries.

2.4 CLIMATE

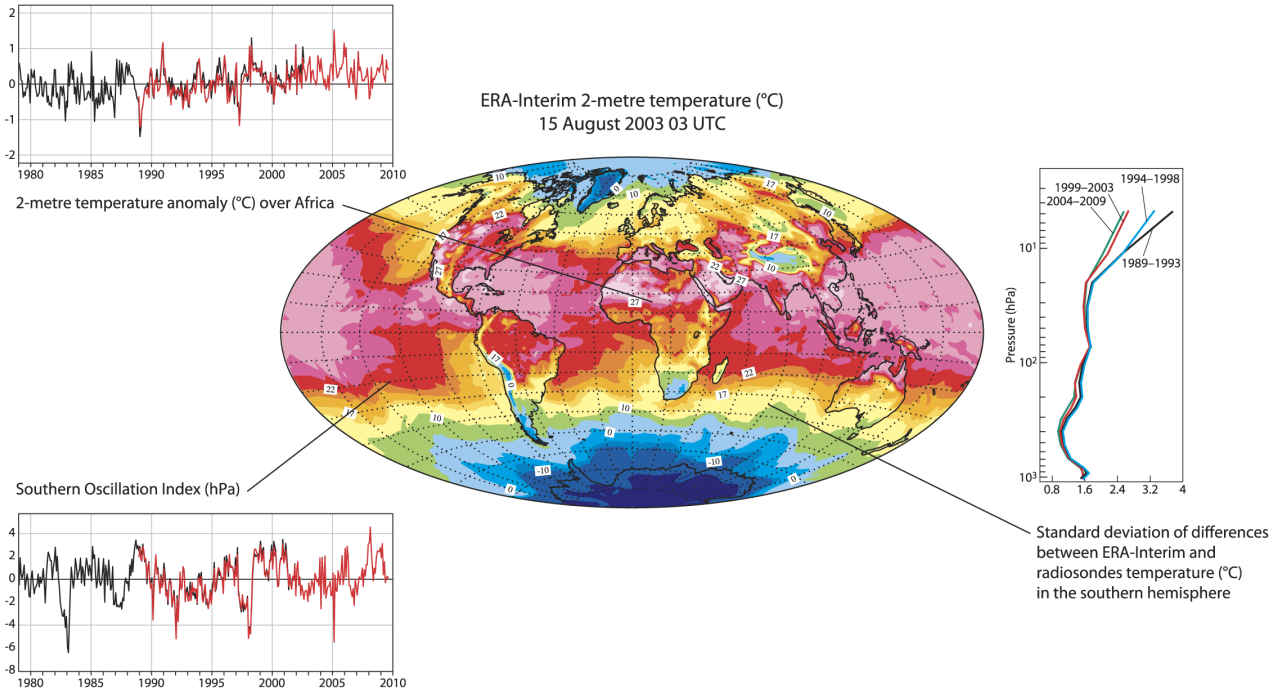
The climate has impacts in each of the other eight societal benefit areas. Coping with climate change and variability demands good scientific understanding based on sufficient and reliable observations. GEOSS outcomes will enhance the capacity to model, mitigate, and adapt to climate change and variability. Better understanding of the climate and its impacts on the Earth system, including its human and economic aspects, will contribute to improved climate prediction and facilitate sustainable development while avoiding dangerous perturbations to the climate system.

GEOSS 10-Year Implementation Plan, Section 4.1.4

CL-06-01: A Climate Record for Assessing Variability and Change

Good progress continues on improving the quality of the past and present climate record, particularly in the areas of data reanalysis and reconstruction in the atmosphere, ocean, land and sea ice domains, where assessments of climate variability are being improved.

The World Climate Research Programme (WCRP) Observation and Assimilation Panel (WOAP) helped coordinate a number of actions towards enhancing the **availability of reanalysis data.** As a result, the Japanese Reanalysis (JRA-25) data 1979-2004 was made available; the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA-Interim products, from 1989 to present, became available (see figure); MERRA (NASA/Goddard) data were used to produce new outputs; and NCEP (US National Centers for Environmental Prediction) products were updated. These newly-available reanalysis data provide a comprehensive, physically consistent, high-quality observational record of the global atmosphere and surface conditions. Produced by state-of-the-art data assimilation systems, they have numerous users in atmospheric sciences and in the wider scientific community, and form the backbone for the development of climate prediction models.



Climate variability analyses based on ECMWF global reanalysis products: ERA-Interim (1989-present) and ERA-40 (1957-2001); both available at http://www.ecmwf.int/research/era (copyright ECMWF)

With regard to reanalysis funding– a critical issue often raised by the GEO Science and Technology Committee – a major step was taken in July by the European Commission (EC). The EC issued a Framework Programme 7 (FP7) Call on "Building observational datasets for the predictability of local atmospheric, oceanic and terrestrial processes using reanalysis techniques". The Call emphasizes the role of the present Work Plan Task in promoting and coordinating reanalysis activities. Although not a long-term solution for reanalysis funding, the EC Call will have significant implications for reanalysis performance in Europe and possibly other continents over the period 2011-2015.

The **availability of satellite data records** to underpin the assessment of climate variability and change improved. The US (NOAA) announced plans to enhance its civil Earth observation capabilities, including the climate sensors on the National Polar-orbiting Operational Environmental Satellite System (NPOESS). The Japan Aerospace Exploration Agency (JAXA) successfully launched the Greenhouse Gases Observing Satellite "IBUKI" (GOSAT) satellite, which enables the precise monitoring of the density of carbon dioxide by combining global observation data sent from space, data obtained on land, and simulation models. In addition, CEOS approved a new virtual constellation to provide calibrated ocean-color radiances to provide data products related to ocean biology and biogeochemistry. The most common products are phytoplankton chlorophyll, which is a concentrated, colored organic matter that is a significant component of dissolved organic carbon in the ocean.

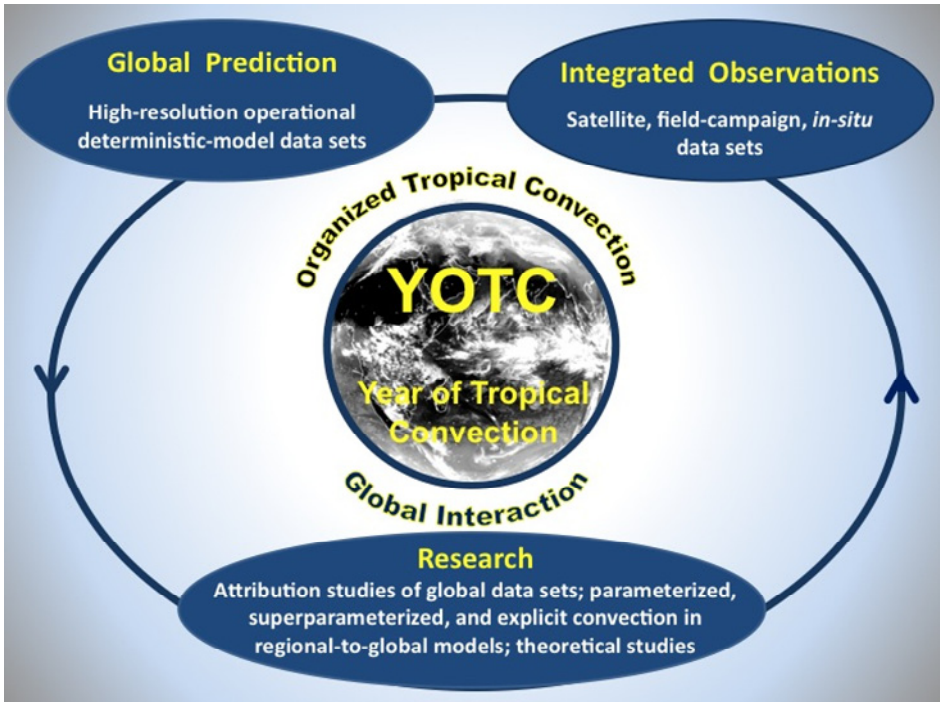
The International Geosphere-Biosphere Programme's (IGBP) Past Global Changes project (PAGES) coordinated activities around the **extension of the paleo-climate record**. Regional meta-databases were developed to provide collections of proxy datasets covering the last 2,000 years. These databases provide meta-information of proxy sites of different natural and human archives, suitable for climate reconstructions at seasonal to multidecadal time scales. This progress was reported upon in a special January issue of the Journal of Paleolimnology on "Climate change in the Arctic over the last two millennia with results from the Arctic System Sciences (ARCSS) project".

CL-09-01: Environmental Information for Decision-making, Risk Management and Adaptation

Final plans were put into place for integrating climate and environmental risk management information into adaptation processes. Efforts to coordinate the development of tailored climate product and services are underway.

The weather (WMO-WWRP), climate (WCRP), and biosphere (IGBP) communities jointly developed a series of articles to lay out the foundations of an "**Earth-System Prediction Initiative for the 21st Century"**. The articles – now submitted for publication to the Bulletin of the American Meteorological Society (BAMS) – build upon the outcomes of the Cape Town GEO Plenary & Summit and directly refers to GEO as "an international coordination framework across disciplines, and observational, prediction, and information systems, that will advocate for advancing climate, weather, water and Earth-system prediction" (opening article by Shapiro *et al*.). The Earth System Prediction Initiative was presented and discussed over the World Climate Conference (WCC-3), Geneva, 31 Aug-4 September 2009.

In support of this initiative, WMO (WWRP-THORPEX) and WCRP guided and co-sponsored the implementation of the **Year of Tropical Convection** (YOTC, see figure). This one-year intensive programme is intended to exploit the vast amounts of existing and emerging observations and computational resources in conjunction with the development of new, high-resolution modelling frameworks, with the objective of advancing the characterization, diagnosis, modelling and prediction of multi-scale convective/dynamic interactions and processes, including the two-way interaction between tropical and extra-tropical weather and climate.



The Year of Tropical Convection (YOTC) is an international project jointly coordinated by WMO (WWRP-THORPEX) and WCRP, and focused on understanding tropical convection and its interaction with the global circulation. It has three components: (i) High-resolution deterministic global model analysis, forecasts, and diagnostics; (ii) Integrated satellite, field-campaign, and in-situ observations; and (iii) Research involving attribution, parameterized and explicit representation of tropical convection, and multi-scale dynamics.

Moreover this initiative provides a reliable physical basis for improving convective parameterizations for global weather and climate models and contains a new element: the representation of organized precipitation systems. Identifying appropriate funding channels for YOTC research is critical. Because the YOTC project is *integrative* it may not appeal to traditional disciplinary funding channels.

WMO also set up an Executive Council Research Task Team (EC-RTT) to address the research aspects of an enhanced climate, weather, water and **environmental prediction framework**. This framework should include effective mechanisms for combining observations, data and analysis, research, modelling, assessment and prediction, services and capacity building. A draft report from the EC- RTT was presented to the WMO Executive Council in June.

With regard to the Climate for Development in Africa Programme "**ClimDev Africa"**, start up funding was received from several donors and African partners started hiring staff. An initial "mapping exercise" shed light on who is currently active in climate activities in Africa. A first Steering Committee meeting is expected by the end of 2009. The ClimDev Africa Programme represents a major opportunity to improve climate observations and services in Africa in the course of the next five to ten years. Those improvements will significantly aid management of climate risks related to agriculture, health, water supplies, energy production, and various other economic activities.

CL-09-03: A Global Carbon Observation and Analysis System

An outstanding coordination effort was initiated to ensure the implementation of a global observation and analysis system that addresses the three components of the carbon cycle (atmosphere, land and ocean) and provides high-quality information on carbon dioxide and methane concentrations, carbon storage and emission variations. A GEO Carbon Community of Practice was established to coordinate international initiatives and demonstrate that coordinated observations, processing tools and models can provide the basic capability for carbon monitoring, reporting, and verification required by regulatory frameworks. Significant progress was made on Forest Carbon Tracking (the Demonstration phase started in July) and Global Monitoring of Greenhouse Gases from Space (GOSAT observations are already available).

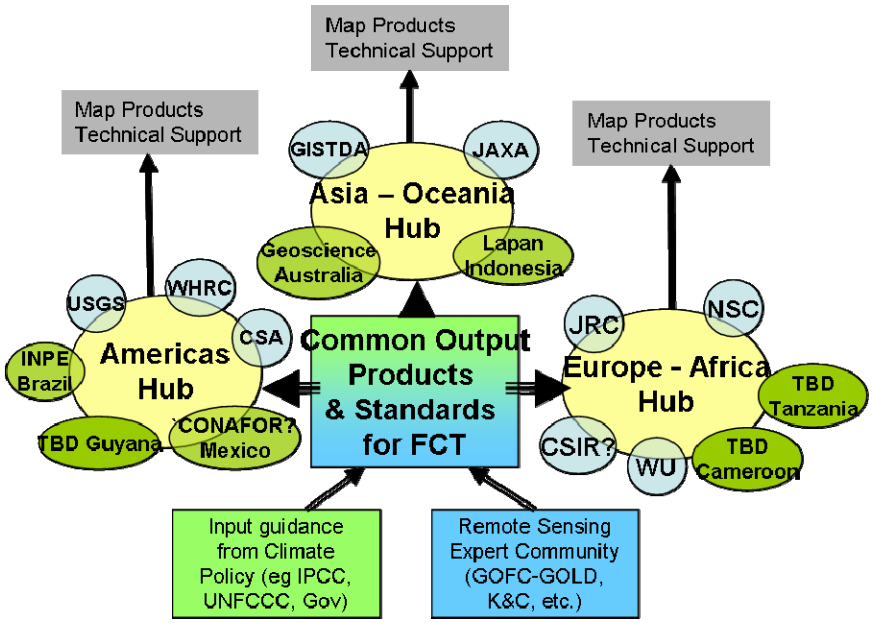
A large number of GEO Members and Participating Organizations (Australia, Canada, France, Japan, Netherlands, Norway, UK, USA, CEOS, ESA, FAO, GCOS, GTOS, WMO, and WCRP) joined forces to develop a global carbon observation and analysis system. Moreover the **GEO Carbon Community of Practice (CoP)** was established as an open group of scientists, program managers, funding agencies and policy makers to (i) design a way forward for the carbon observing system, (ii) facilitate communication between those making observations and those developing models, and (iii) foster the integration of observations using sophisticated modeling techniques (i.e. Carbon Cycle Data Assimilation System (CCDAS), Global Earth Monitoring System (GEMS) and CarbonTracker). Data management and sharing policies are also addressed. The Carbon Community of Practice held its first workshop in June and organized dedicated events at the 8th International Carbon Dioxide Conference (ICDC8, 13-19 September, Jena, Germany) and GEO-VI (Washington DC). It has already established an initial plan of activities to coordinate national and regional actions.

The new Carbon Community of Practice is an **evolution of the IGOS-P Carbon Theme**. It covers the entire carbon cycle including atmosphere, terrestrial and ocean domains and integrates the significant coordination efforts of groups such as Global Atmospheric Watch (GAW), the International Ocean Carbon Coordination Project (IOCCP), FLUXNet, the Global Carbon Project (GCP), the Global Terrestrial Observing System (GTOS), CarboEurope, the Coordinated Action Carbon Observing System (COCOS), the Integrated Carbon Observation System (ICOS), the North American Carbon Program (NACP) and many others. The Carbon Community of Practice serves the implementation needs of the strategies published in the IGOS-P Carbon Theme Report (2002) and the IGACO-GHG Atmospheric Chemistry Theme Report (2004). The Community of Practice will therefore produce a new GEO Carbon Report during 2009-2010 outlining how far we have come and what steps still need to be taken.

With regard to '**Forest Carbon Tracking**", activities were initiated as planned following the GEO-V Plenary under the co-leadership of Australia's Department of Climate Change and Commonwealth Scientific and Industrial Research Organisation (CSIRO), Japan's Space Agency (JAXA), the Norwegian Space Center (NSC), CEOS, FAO and the Global Terrestrial Observing System (GTOS, through GOFC-GOLD). The latter were recently joined by Canada and the Netherlands. Also space agencies confirmed through a Communiqué issued in early March the **full support of CEOS to GEO carbon tracking activities**. CEOS will coordinate the necessary space data in terms of data provision and interoperability and validation of products, and also secure the interoperability of the optical and SAR sensors that, together with in-situ monitoring, are essential to forest monitoring.

Key progress was achieved in 2009 through GEO activities: (i) A list of "National Demonstrators" was established and activities for in-situ measurements and remote-sensing data processing were planned. Requests for satellite data over these sites were prepared and provided to CEOS; (ii) Satellite data acquisition over the National Demonstrators was started (see figure); (iii) A kick-off meeting for National demonstrator activities was held; (iv) Forest information products, data processing, management and access provisions were tentatively identified; (v) Coordination with national and regional forest initiatives was consolidated at the 2nd GEO Forest Monitoring Symposium (Chiang-

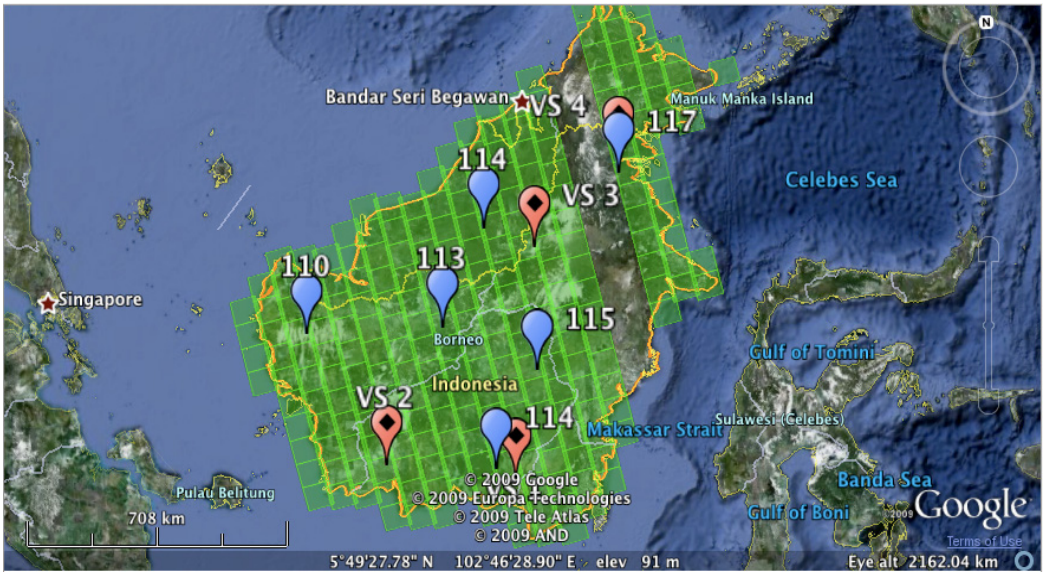
Rai,Thailand, July 1-3, 2009); and (vi) The development of a prototype "GEO Forest Carbon Tracking Portal" providing access to forest information products will be demonstrated at GEO-VI and COP15.



The network of regional nodes ensuring the production of forest and carbon products over the "National Demonstrator" countries.

Participation of "National Demonstrator" Countries to relevant regional nodes is mandatory, as the network also constitutes an interim measure that supports transfer of knowledge and capacity building where requested

Peru and Colombia requested to become "**National Demonstrators**" and discussion are underway to optimize the implementation of those requests. Peru and Columbia would join the other seven Countries already providing support to National Demonstrators: Australia (Tasmania), Brazil, Cameroon, Guyana, Indonesia (Borneo), Mexico and Tanzania. An understanding with UN-REDD was developed and agreed to foster practical implementation.



Satellite-data acquisition and verification over one National Demonstrator (Indonesia), initiated as part of the dedicated GEO Forest and Carbon Portal

On **Global Monitoring of Greenhouse Gases (GMGG) from Space,** plans developed to implement the end-to-end utilization of space-based greenhouse gas data, coming from Japan's GOSAT mission and NASA's replacement OCO mission. First datasets from GOSAT were released, showing good quality and great potential to fill observational gaps. A specific demonstration is planned for GEO-VI.

2.5 WATER

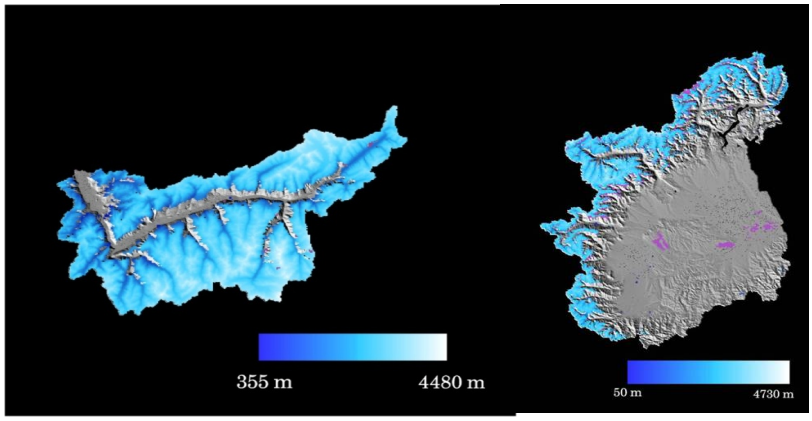
Water-related issues addressed by GEOSS will include: precipitation; soil moisture; streamflow; lake and reservoir levels; snow cover; glaciers and ice; evaporation and transpiration; groundwater; and water quality and water use. GEOSS implementation will improve integrated water-resource management by bringing together observations, prediction, and decision-support systems and by creating better linkages to climate and other data. In situ networks and the automation of data collection will be consolidated, and the capacity to collect and use hydrological observations will be built where it is lacking.

GEOSS 10-Year Implementation Plan, Section 4.1.5

WA-06-02: Droughts, Floods and Water Resource Management

Progress in the area of flood and water resource management mainly relates to the implementation of the European project ACQWA and the ongoing experimental contributions to the HEPEX project. Activities related to drought impacts and monitoring are still in the initial stages, and quantifiable progress is not anticipated until the first half of 2010.

The project **Assessing Climate Impacts on the Quantity and Quality of Water** (ACQWA) closed its first year of operation and produced a key deliverable: The establishment of a database infrastructure by the United Nations Environment Programme's Global Resource Information Database (UNEP/GRID). The database is designed to house both the General and Regional Climate Model data sets used to drive hydrological and other process models (biosphere, glacier balance), as well as provide an exchange platform for subsequent output from modelling activities. Other deliverables include the development of the project website (www.acqwa.ch) and a publication on the project's data policy – including data requirements for the hydrological, climatological, and GIS components of the project. The ACQWA project is funded by the European Commission 7th Framework Programme (FP7) for €6.5 million over five years and is being run by a consortium of over 30 research partners led by the University of Geneva.



Weekly distribution of snow cover height (in meters, grey area is snow free) – in the Rhone valley (left) and Po valley (right). ACQWA generates remote-sensing products for the validation of climate and hydrological models

With regard to drought and flood forecasting, project teams were formed as a result of the 1st HEPEX (Hydrological Ensemble Prediction Experiment) workshop (June 2008). Ongoing test-bed experiments in developing and using ensemble prediction systems may be viewed at http://hydis8.eng.uci.edu/hepex/.

WA-06-07: Capacity Building for Water Resource Management

GEO's efforts to build capacity on water issues are progressing well. The various activities are well coordinated across continents, as illustrated by a few examples: (i) NASA, the US Agency for International Development (USAID) and several international partners expanded the SERVIR information portal from Latin America to Africa; (ii) ESA announced an extension of the TIGER initiative for Africa, focusing on the use of space technology for water resource management; (iii) The University of Tokyo and the Japan Aerospace Exploration Agency (JAXA) launched the African Water Cycle Initiative building upon the success of the Asian Water Cycle Initiative (AWCI); and (iv) several space agencies, including JAXA, NASA and ESA, expressed interest in working together to help maximize their capacity-building assistance to data-poor parts of the world.

Water capacity-building in **Latin America** became part of the "GEOSS in the Americas" initiative. Discussions were held to encourage the interest and support of USAID and the Organization of American States. Plans were developed for a capacity building workshop to be held in Lima, Peru from 30 November to 4 December 2009. Partners include Peru (CONIDA), Argentina (CONAE), Canada (Environment Canada) and the USA (NASA, NOAA, and USAID). The primary objective of the symposium will be to inform both users (national water resource managers) and providers of Earth observation data on new developments, capabilities and services in using Earth observations, and how these innovations could be of benefit to them. In addition, individual agencies will demonstrate the value of information tools such as NASA's Global Land Data Assimilation System (GLDAS) for improved decision making in an effort to broaden the user base for such tools.

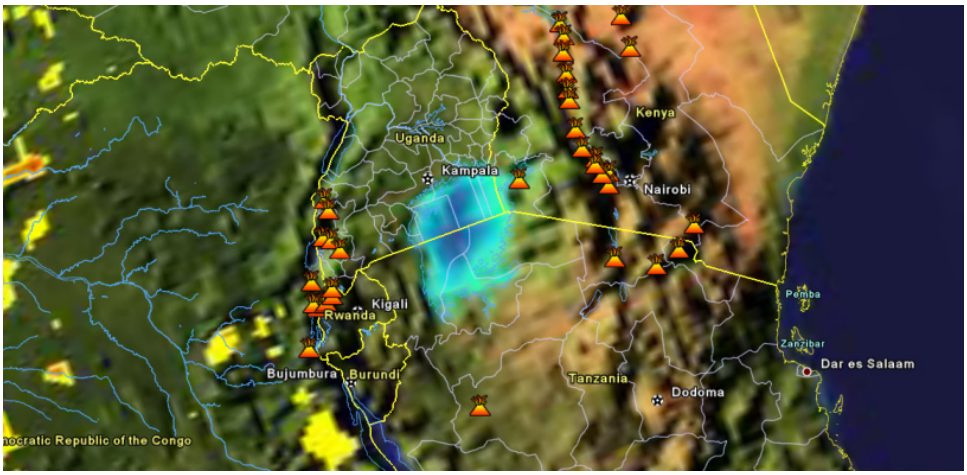
CEOS developed, through the Brazilian Institute for Space Research (INPE), a web-based Geographic Information System (GIS) called SIGMA (Sistema de Informação Geográfica Aplicado ao Meio Ambiente - Geographic Information System Applied to the Environmental). SIGMA is a dedicated environmental application designed to integrate different types of data related to the environment, and will be especially useful in handling products and data received by GEONETCast.

The **African Water Cycle initiative** was launched in Tunis in January to address African water issues such as floods, droughts, environmental degradation, and water deficits. Priorities for the initiative include the convergence and harmonization of observational activities, techniques and interoperability arrangements, and to effective and comprehensive data management. An international task team, composed of GEO representatives and authorities of African river basins, was formed to prepare an: (i) Assessment of water-related issues in Africa; (ii) Inventory of capabilities and activities in each country in terms of observation, modelling and information systems; (iii) Assessment of the data policies of governments and scientific communities; and a (iv) Draft implementation plan, including the definition of a set of preliminary actions. Contributors include Japan (University of Tokyo, JAXA), the USA (NASA), ESA, the Food and Agriculture Organization (FAO), the UN Economic Commission for Africa (UNECA), the UN Environment Programme (UNEP), the UN Educational, Scientific and Cultural Organization (UNESCO) and the WMO.

The second phase of the TIGER initiative helped further develop **water-related geo-information for Africa** – including scientific, service and capacity building facilities set up in connection with the International Institute for Geo Information Science and Earth Observation (ITC). The official launch of the second phase was announced by ESA, the African Minister's Council on Water (AMCOW), and the African Wildlife Foundation (AWF) in a dedicated side event at the recent 5th World Water Forum that took place in Istanbul in March.

The USA (NASA) extended its successful monitoring and visualization tool, SERVIR, from Central America to East Africa (www.servir.net/africa). The SERVIR system integrates multi-national satellite resources into a **web-based Earth information system for Africa**. Two primary applications relate to flooding (see figure) and disease management. In addition, NASA and USAID in cooperation with the World Bank and the Arab Water Council are using Earth science information to assist with water-related problems in the Middle East and North Africa. The primary application builds upon the NASA

Land Information System component for monitoring regional water balance estimates. These estimates draw on (i) terrestrial water and aquifer monitoring from the Gravity Recovery and Climate Experiment (GRACE), (ii) precipitation analyses from the NASA/JAXA Tropical Rainfall Measuring Mission (TRMM) and EUMETSAT's Meteosat satellites, and (iii) vegetation and soil characteristic analyses from NASA's Moderate Resolution Imaging Spectroradiometer project (MODIS).



SERVIR Africa flood-potential map for the Lake Victoria region (Kenya, Tanzania and Uganda); home to 30 million people. Orange triangles designate flood risk areas

Good progress was reported on the **Asian Water Cycle Initiative** (AWCI) demonstration projects over the 4th International Coordination Group (ICG) Meeting of the AWCI in February in Kyoto, Japan. Demonstrations of the data and metadata upload system and data quality-control tools were provided during the meeting. The United Nations University (UNU) announced the development of an on-line repository (http://unufms.net:8080/seaside/gcs/AWCI) to facilitate effective planning of capacity-building activities. Other activities include capacity development in flood management in developing countries by means of training courses, such as ICHARM's "Disaster Management Policy Program Water-related Risk Management Course" (one year master course).

WA-08-01: Integrated Products for Water Resource Management and Research

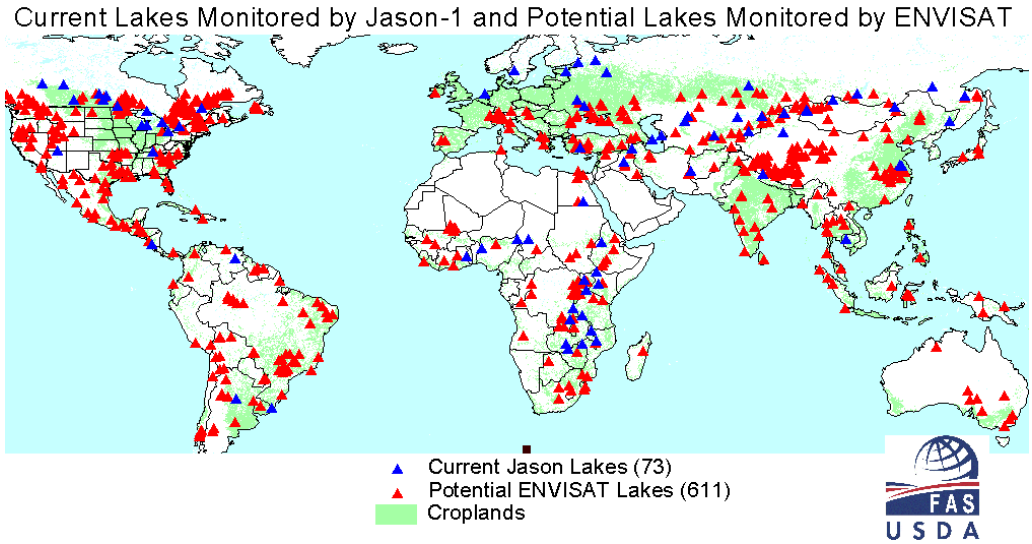
The water cycle community reached a consensus and agreed to join and create in February the Integrated Global Water Cycle Observation (IGWCO) Community of Practice. This new CoP promises to build an excellent framework for coordinating activities and making optimal use of natural connections. The IGWCO CoP will bridge GEO water activities, including those of the WMO Technical Commission for Hydrology (CHy), and benefit greatly from the increasing participation of developing countries. In this context, access to soil moisture, runoff, precipitation and water cycle data was greatly improved in 2009, opening new avenues for research and tools development. The WMO/GCOS-sponsored Global Terrestrial Network – Hydrology (GTH-N) was further developed through research and products & services, representing key contributions to the GEO Water activities.

Monthly **soil moisture maps** were routinely produced for the first time by the Institute of Photogrammetry and Remote Sensing (IPF) at the Vienna University of Technology, a member of the International Soil Moisture Working Group (ISMWG). The IPF's SHARE project started producing an operational soil moisture monitoring service for the region of the Southern African Development Community (SADC). The service uses data delivered by ENVISAT's ASAR sensor operated in global mode and the METOP scatterometer sensors. SHARE was also extended to Australia, and related soil

moisture maps will soon be available. At global levels, data from scatterometers onboard satellites are currently being used to produce monitoring of soil moisture, mapping wetlands, and freeze-thaw monitoring in high-latitude regions.

Australia (CSIRO) and Japan (ERSDAC) undertook a study involving the future HYPER satellite, which is to be launched in 2013. As part of the calibration and research campaign, activities are focussed on two main areas: soil mapping and potential of yield estimation of wheat using satellite hyperspectral remote sensing. Plans include obtaining soil moisture estimations from satellite hyperspectral data as part of the research project.

Numerous **global runoff data** sets and products were made available through the newly-reworked website: http://www.bafg.de/GRDC/Home/homepage__node.html. Currently, the Global Runoff Data Centre (GRDC) database contains time series of daily and/or monthly river discharge data of more than 7300 stations from 156 countries, comprising around 280,000 station-years with an average time series length of about 38 years. New data products (see figure), such as global river discharge and global freshwater fluxes to the oceans are being discussed. Work is also progressing on specifications for a generic metadata standard format in line with ISO and the WMO metadata standards. Additionally, improved access to data and information of the hydrological cycle is being planned through the Global Terrestrial Network – Hydrology (GTN-H) and the development of the International Data Centre for the Hydrology of Lakes and Reservoirs (HYDROLARE).



In addition, national meteorological and hydrological services are gradually committing themselves to contributing to the Global Terrestrial Network - Rivers (GTN-R), which will form the terrestrial backbone of the **Hydrological Applications and Run-off Network (HARON) projec**t. The Global Terrestrial Network Hydrology (GTN-H), sponsored by WMO and the Global Climate Observing System (GCOS), already improved access to hydrological data and information. Plans for submitting the HARON project to the European Commissions 7th Framework Programme (FP7) during the second half of 2009 were discussed over GEO Committee Meetings in Stresa, Italy in May. More recently, at the Global Runoff Data Centre (GRDC) Steering Committee meetings (23-26 June 2009), a decision was made to decouple the runoff station upgrade portion of the HARON project (phase 1) from the integration of hydrological data streams and production of services and applications (phases 2 and 3). The HARON consortium members took this decision in order to render the project more suitable for submission under the requirements of upcoming FP7 Calls. Separate sources of funding will be sought by the GRDC for runoff station upgrades.

Work continued on advancing the **Global Groundwater Monitoring** Network (GGMN), spearheaded by the International Groundwater Resource Assessment Centre (IGRAC), a GTN-H network partner. The Aristotle University of Thessaloniki (Greece) recently contributed to this effort through data collection and evaluation efforts, classification of different water types, and the production of regional thematic maps using GIS. Through its website (http://www.igrac.nl/), IGRAC is refining a number of tools for global groundwater assessment, such as the Global Groundwater Information System (GGIS).

Numerous (quasi-)global, **long-record precipitation climatology** data sets were made available, and contributed by research projects and data centres such as the Global Precipitation Climatology Centre (GPCC), the Global Precipitation Climatology Project (GPCP), and the TRMM Multi-satellite Precipitation Analysis (TMPA). All of these initiatives operate under the guidance of Coordination Group for Meteorological Satellites (CGMS)/International Precipitation Working Group (IPWG). Numerous other datasets were made available, including a number of research, regional, and single-sensor products. One example is the IPCC's near real-time First Guess of monthly precipitation anomalies based on reports of approximately 6,500 stations received at the German Weather Service (DWD). Maps (GIF) are available within 5 days after observation month (http://www.dwd.de/). In addition, JAXA (Japan) made available near-real time **global rainfall products** with high-spatial and high-temporal resolutions (http://sharaku.eorc.jaxa.jp/GSMaP/).

The Coordinated Energy and **water cycle Observations** Project (CEOP) fulfilled its goal of addressing a number of key scientific issues through a comprehensive improvement in access to integrated observational (in-situ and satellite) and model data. It also successfully implemented a data policy allowing the sharing of in situ reference site data, model output data, and satellite data. Several archival centres were set up at the National Center for Atmospheric Research (NCAR, USA), the Max Planck Institute (MPI, Germany) and the University of Tokyo (UT, Japan); also offering a central data archive where data can distributed to interested users (see http://monsoon.t.u-tokyo.ac.jp/ceop-dc/ceop-dc_top.htm).

The IEEE developed 14 proposals for pilot projects on **water discovery and quality assessments,** e.g. Africa-Asia climate change vulnerability, Amazon water quality, aquifer health assessment, Bangladesh arsenic removal, drilling in Mozambique, Ghana Weija reservoir management, irrigation management, Lake Nicaragua water quality, and Limpopo water and sanitation. Current efforts focus on presenting the numerous proposals received in response to the IEEE "Water for the World" call to sponsor organizations for funding. A status report entitled *Water for the World* was produced and disseminated at the International Symposium for Remote Sensing of the Environment (ISRSE) in May 2009 (http://www.ieee-earth.org/).

A number of water-quality experts joined forces and created an Inland and Coastal Working Group. The Working Group helps coordinate activities and support programs such as (i) the UNEP Global Environment Monitoring System (GEMS/Water) aimed at understanding inland water quality issues around the world and partly funded by Canada; and (ii) the **GEO Water Quality Road Map**, a joint effort to build on the outcomes of the GEO Near Coastal Remote Sensing Algorithm Workshop held in May in Washington DC. The Workshop focussed on algorithms as the critical link in the production of credible data products. In developing an action plan, a two stream approach was adopted: (i) Short-term/readily developed (testing and value demonstration of simple products e.g. water clarity, eutrophication indices) and (ii) Longer-term/research-based (value demonstration of best knowledge with algorithm development). Additional contributions include the newly-launched HYPOX project, funded under the European Commission 7th Framework Programme, to build oxygen monitoring capacities in shelf & open seas, and land locked water bodies.

2.6 WEATHER

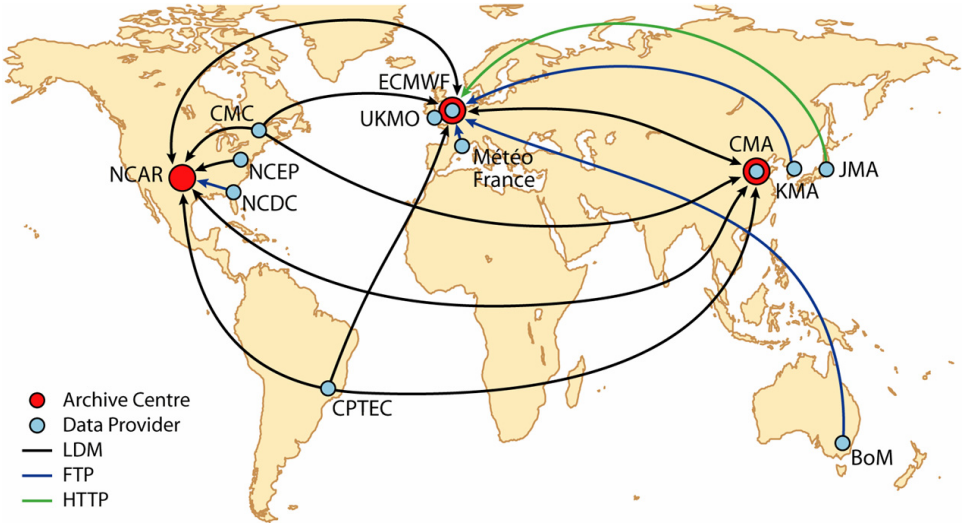
The weather observations encompassed by GEOSS are based on the requirements for timely short- and medium-term forecasts. GEOSS can help fill critical gaps in the observation of, for example, wind and humidity profiles, precipitation, and data collection over ocean areas; extend the use of dynamic sampling methods globally; improve the initialization of forecasts; and increase the capacity in developing countries to deliver essential observations and use forecast products. Every country will have the severe-weather-event information needed to mitigate loss of life and reduce property damage. Access to weather data for the other societal benefit areas will be facilitated.

GEOSS 10-Year Implementation Plan, Section 4.1.6

WE-06-03: TIGGE and the Development of a Global Interactive Forecast System for Weather

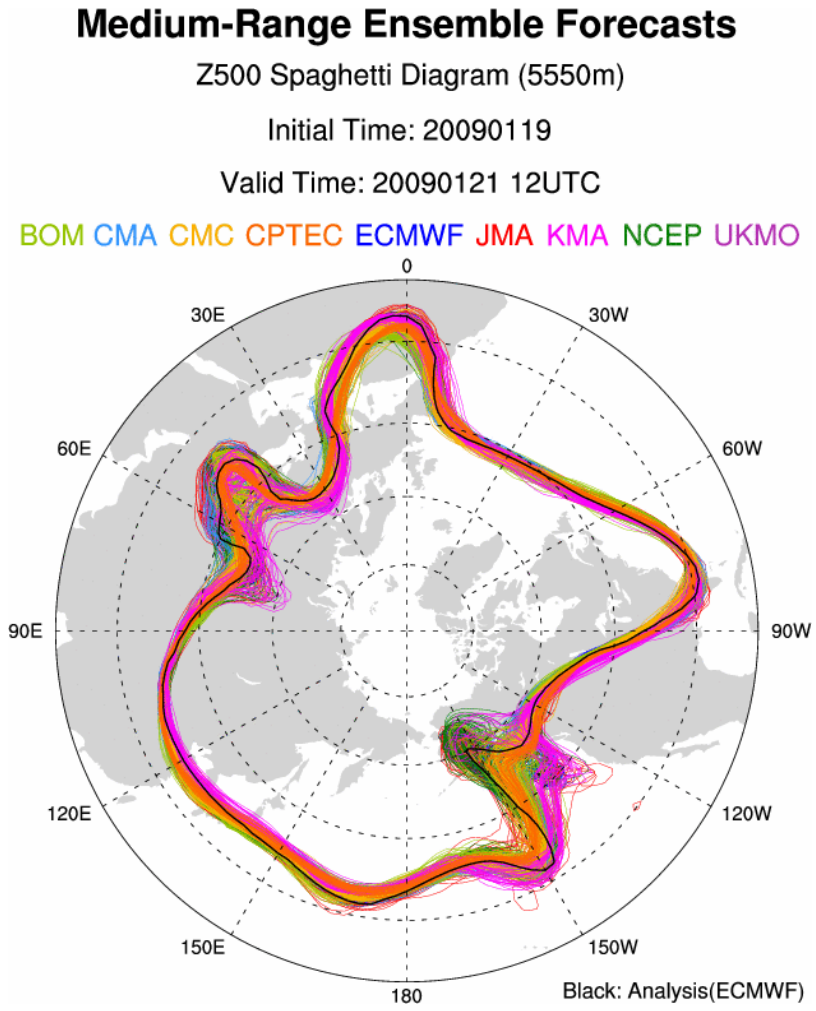
The TIGGE database is becoming a key resource for weather research, with hundreds of scientists, institutes and organisations retrieving ensemble forecasts regularly. Exploratory applications are also underway to extend the benefits of improved warnings and forecasts of high-impact weather to all GEO societal benefit areas.

The WMO's World Weather Research Programme (WWRP) further progressed on the implementation of TIGGE (THORPEX Interactive Grand Global Ensemble) – a **global database of ensemble weather forecasts.** The number of regular forecasts providers grew to 11 global production centers (see figure): Australia (BOM), Brazil (CPTEC), Canada (CMC), China (CMA), France (MétéoFrance), Japan (JMA), Korea (KMA), UK (UKMO), USA (NCDC, NCEP) and ECMWF. TIGGE data was made freely available in near real-time for research purposes via the three archive centres: (i) European Centre for Medium-Range Weather Forecasts (ECMWF, http://tigge-portal.ecmwf.int/); (ii) US National Center for Atmospheric Research (NCAR, http://tigge.ucar.edu/); and (iii) China Meteorological Administration (CMA, http://wisportal.cma.gov.cn/tigge/). Throughout 2009, the number of TIGGE users steadily increased to include several hundreds research scientists and organizations. Real-time access was also granted for specific applications such as the THORPEX Pacific Asian Regional Campaign (T-PARC).



Flow of ensemble forecast data from the 10 TIGGE data providers to the 3 archive centres. Users can register with one of the archive centres and access the data for a variety of research projects (copyright WMO THORPEX/WWRP)

In March and April, the WMO Commission for Basic Systems (CBS) reviewed the vision and concept for the Global Interactive Forecast System for Weather (GIFS). CBS experts worked closely with WWRP-THORPEX and the GIFS-TIGGE working group to develop plans for a GIFS Forecast Demonstration Project (GIFS-FDP). The Project will help deliver missing data fields to the archive, provide metadata information and encourage further research on the application of multi-model global ensembles to weather forecasting. Prototype products and applications will be developed (see figure), including tropical cyclone tracks and heavy precipitation forecasting. These products will be evaluated for possible operational implementation.



This "spaghetti plot" illustrates the uncertainty in the atmospheric flow two days after each TIGGE forecast was initialised. Each contour shows the mid-tropospheric flow field from a single forecast from each TIGGE data provider. An ensemble of forecasts from each data provider is indicated by a set of lines of the same colour. The actual flow pattern is shown in black (copyright WMO THORPEX/WWRP)

Moreover GIFS-TIGGE will engage the forecast user community. It is planned that GIFS-FDP will be focused on particular regions, running in parallel with the WMO/CBS Severe Weather Forecast Demonstration Project (SWFDP). GIFS products will be used to supplement forecast products supplied through the SWFDP, and their benefit in improving warnings of severe weather will be evaluated both objectively and with the help of operational forecasters.

WE-09-01: Capacity Building for High-Impact Weather Prediction

Korea, WMO and other partners remain fully committed to building capacity for severe weather impact mitigation. The Korea Meteorological Administration (KMA) is supporting the development of operational systems for numerical weather prediction, while WMO is leading a major effort for developing a high-impact weather information system for Africa. Several approaches to building synergies between those activities have been discussed, including identifying and conducting possible joint projects in the THORPEX African Implementation Plan with the support of Korea. KMA will explore mobilizing resources through Korean funding agencies.

The Korean Meteorological Administration developed fact sheets on how to develop **numerical weather prediction (NWP) capabilities**. These provide strategic guidelines for developing numerical weather prediction (NWP) in any country according to local capabilities. The fact sheets were introduced to developing countries at various meetings and training events, such as the KMA Training Workshop on Capacity Building in the African Region for Responding to Meteorological Disasters (16-30 May 2009, Seoul, 15 participants from 15 countries) and the Training Course on Information and Communication Technologies for Meteorological Services (23 May-27 June 2009, Seoul, 14 participants).

The courses helped improve the infrastructure of weather services in developing countries, including the capacity for making numerical weather predictions. Moreover KMA provided National Meteorological and Hydrological Services (NMHSs) in developing countries with computing facilities, free software for meteorological modeling for regional forecasts through the national and international aid agency channels and WMO programmes. It also introduced the NMHSs of developing countries to the best ways of becoming a NWP Operating Service. KMA also supported the National Agency for Meteorology, Hydrology and Environmental Monitoring of Mongolia, in its upgrade from the NCAR MM5 mesoscale model to the WRF (Weather and Research Forecast) and web-based Forecast Analysis System in July 2009.

WMO, the African Centre of Meteorological Application for Development (ACMAD) and Senegal's National Meteorological Service coordinated the development of the Science and Implementation Plans for THORPEX Africa. The plans were designed to address (i) Predictability and Dynamical Processes; (ii) Observing Systems/Strategies and Data Assimilation; and (iii) Societal and Economic Research and Applications. Plans were translated into French for outreach purposes and distributed to all of WMO's African member countries with a request to nominate experts to act as focal points for national and continental implementation. A dedicated workshop will be hosted by the Abdus Salam International Centre for Theoretical Physics (ICTP) in October. The workshop will consider issues of **high-impact weather prediction and information system for Africa**. Relevant synergies will be pursued with GEO initiatives such as the African Water Cycle Initiative and GEONETCast.

In addition, the African forecasters' handbook project was initiated in the framework of AMMA (African Monsoon Multidisciplinary Analyses). This project includes long-term documentation of existing forecasting methods, testing of existing forecasting tools, new methods and data sources, and development of new tools for forecasters' training and wider meteorological education. Evaluation of seasonal forecasts are planned in collaboration with major NWP centres (e.g. ECMWF, NCEP) and the AMMA – Phase 2 (the extension of the AMMA programme). Predictability and Dynamic Processes (PDP) and Societal and Economic Research and Application (SERA) working groups will also conduct demonstration projects to provide a continuum of weather/climate applications. Basic research will be conducted to improve understanding of intra-seasonal variability in Africa.

2.7 ECOSYSTEMS

Observations are needed on the area, condition, and natural-resource stock levels of ecosystems such as forests, rangelands, and oceans. GEOSS implementation will seek to ensure that methodologies and observations are available on a global basis to detect and predict changes in ecosystem condition and to define resource potentials and limits. Ecosystem observations will be better harmonized and shared, spatial and topical gaps will be filled, and in situ data will be better integrated with space-based observations. Continuity of observations for monitoring wild fisheries, the carbon and nitrogen cycles, canopy properties, ocean colour, and temperature will be set in place.

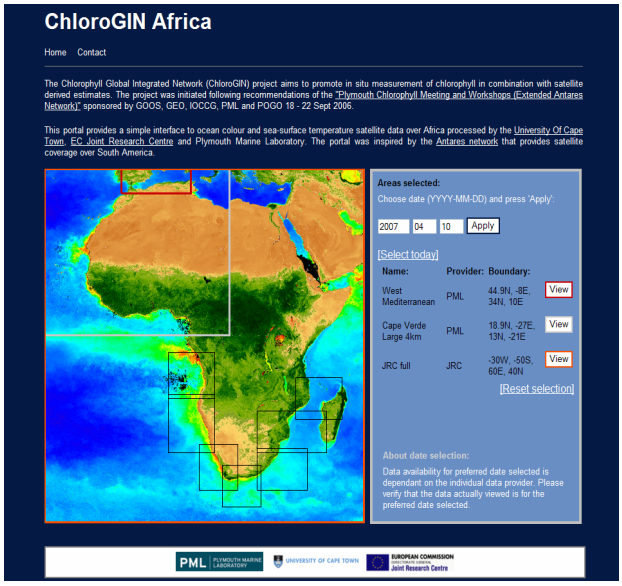
GEOSS 10-Year Implementation Plan, Section 4.1.7

EC-09-01: Ecosystem Observation and Monitoring Network (GEO EcoNet)

Significant results were achieved on classifying and mapping ecosystems and on building regional capacity-building networks. In particular, terrestrial ecosystems maps were completed for South America and the coterminous United States. The map for Africa was also completed and launched in October. Mapping was initiated for Australia and China. Strong progress was also achieved on establishing the Indian Ocean Region node of ChloroGIN and generating related products. Nodes in Canada and Europe were successfully included in the network. The ChloroGIN web portal was established.

The US Geological Survey and Guyra Paraguay led the GEO effort to produce **maps of terrestrial, freshwater, and marine ecosystems** for the entire planet. A consensus-based methodology was developed to produce: (i) Standardized ecosystems and (ii) Terrestrial ecosystem maps. Mapping was completed for South America and the conterminous United States at finer spatial resolutions than any existing eco-regionalizations. The mapping phase for terrestrial ecosystems was also completed for Africa and initiated for China and Australia. An expert's workshop was held in Nairobi in September and the launch of the new Africa ecosystems map will take place in Kampala in October at Africa GIS 2009.

The Partnership for Observation of the Global Oceans (POGO) developed the **Chlorophyll Global Integrated Network** (ChloroGIN) by promoting in-situ measurements of chlorophyll in combination with satellite-derived estimates. ChloroGIN networks were established in Canada, South America, Africa, Europe and the Indian Ocean region. The Global Ocean Observing System (GOOS) Regional Alliance in the Indian Ocean (IOGOOS) endorsed the Indian Ocean ChloroGIN project as one of its pilot projects and identified the Indian National Centre for Ocean Information Services (INCOIS) as the coordinating and implementing agency. An automatic data-processing chain was set up at INCOIS to process NASA's Aqua MODIS data. ChloroGIN participation in DevCoCast is currently underway.



The ChloroGIN web portal (www.chlorogin.org) was also set up to provide **near-real time and archived measurements of remotely-sensed ocean-colour and sea-surface temperature** (SST) for South America, Africa and the Indian Ocean. Daily images and weekly/monthly composites of chlorophyll, SST, and suspended sediments are also being disseminated through the INCOIS website (http://www.incois.gov.in/Incois/pfzarchiveimages1.html). Current efforts are focused on integrating these products from the upcoming OCM2 data of ISRO and the MERIS data from ESA into the processing chain. Full-resolution products (1 km) are being provided for the IOGOOS member institutions in Iran, Kenya, the Maldives, Oman Sri Lanka, Tanzania and Thailand. Eight time-series stations have been established in coastal waters off the Indian coast to make monthly measurements of chlorophyll, sea-surface temperature and total suspended matter, as well as the bio-optical properties using profiling radiometers. Establishing possible links with freshwater networks are being discussed under the common theme of water quality.

In support of Protected Areas Assessment and Monitoring, UNEP (WCMC) led a collaborative project to create a **prototype protected area online tool** that allows non-remote sensing specialists to be able to use satellite imagery from different dates to measure change in and around a sample of African protected areas. This project builds upon a similar project managed by Birdlife/Joint Nature Conservation Committee (JNCC) to measure change in African Important Bird Areas (IBAs). To support the development of a concept paper and budget proposal, several parameters were estimated including: (i) Overlap between the FAO Forest Resource Assessment (FAO FRA) grid, African protected areas and IBAs; (ii) Number of African protected areas in the latest version of the World Database on Protected Areas (WDPA); and (iii) Cost of creating the satellite images and evaluating change for the average IBA.

EC-09-02: Ecosystem Vulnerability to Global Change

Significant results were recorded on the vulnerability of mountain regions, with agreements signed or in progress with key local stakeholder institutions, including the Nepal Department of Hydrology and Meteorology, the Kathmandu University, the Pakistan Meteorological Department, and Karakorum International University. Activities have been initiated to investigate the impacts of tourism and infrastructure development on ecosystems.

The Greek Mariolopoulos-Kanaginis Foundation for Environmental Sciences worked towards **mapping the potential impacts of global change** on key sectors of the Eastern Mediterranean's economy and society. Anticipated outputs include an inventory of the existing socio-economic data and a strategy for boosting research in these sectors. A final report was produced outlining: (i) Climate change impacts on socio-economic sectors in the Eastern Mediterranean and (ii) Potential measures for mitigating impacts and creating a network of scientists to develop competitive proposals to the European Commission and other European Union bodies for strengthening this research domain.

The UN Economic Commission for Africa progressed towards the completion of comprehensive geo-spatial databases and applications to support the preparation of a transport infrastructure master plan for Africa. In particular, a **spatially-enabled database on transport infrastructures (roads, ports and airports)** was initiated. Work also started on the collection, processing and integration of spatial data on all existing and planned transport components and networks in Africa, including railways, airports, roads, ports, harbors and waterways, and related socio-economic information.

The Italy-based scientific research association Ev-K2-CNR and the WCRP's Coordinated Energy and water cycle Observation Project – High Elevations Initiative (CEOP-HE) developed a **mountain climate and environment monitoring network.** The network provides high-quality, reliable, long-term data for the

scientific community and decision makers. This data in turn supports assessments of climate change and its impacts, especially in terms of water and energy supplies, tourism, food, and vital human and economic resources from mountain areas already adversely affected by global change. The project SHARE (Stations at High Altitude for Research on the Environment) thus far produced a network of high altitude monitoring stations (see figure), scientific studies in various environmental disciplines and data for several international programs. SHARE project's scientific results include:

- Ongoing monitoring of glaciers in the Himalaya and Karakorum mountains to understand the complex relationship between climate and debris-covered glaciers, plus the glaciers' response to climate change;
- Contribution of data to numerous international scientific programs and networks e.g. UNEP Asian Brown Cloud study, WMO GAW, WCRP-GEWEX-CEOP, NASA-AERONET, ILTER, the EU-funded EUropean Supersites for Atmospheric Aerosol Research (EUSAAR);
- Two observatories for the study of atmospheric composition and climate and eleven meteorological stations, all sited in high mountain or glacier areas.

2.8 AGRICULTURE

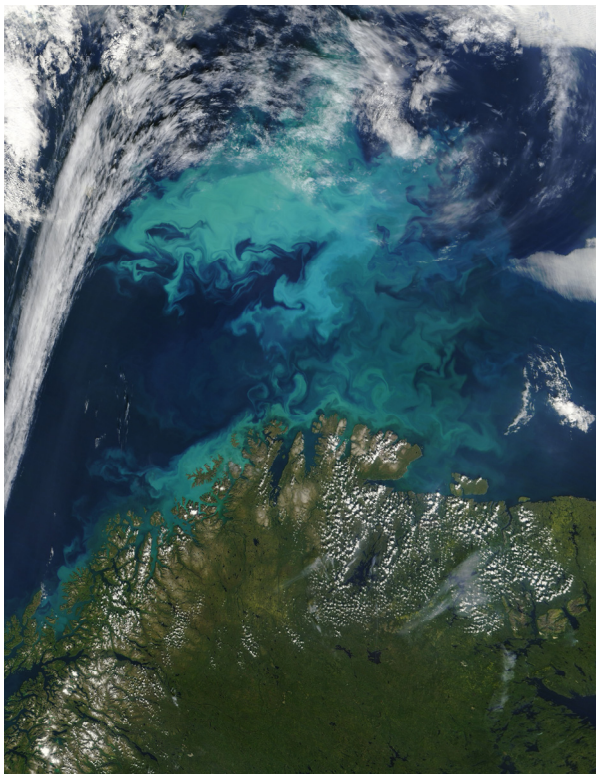
Issues addressed by GEOSS will include: crop production; livestock, aquaculture and fishery statistics; food security and drought projections; nutrient balances; farming systems; land use and land-cover change; and changes in the extent and severity of land degradation and desertification. GEOSS implementation will address the continuity of critical data, such as high-resolution observation data from satellites. A truly global mapping and information service, integrating spatially explicit socio-economic data with agricultural, forest, and aquaculture data will be feasible, with applications in poverty and food monitoring, international planning, and sustainable development.

GEOSS 10-Year Implementation Plan, Section 4.1.8

AG-06-02: Data Utilization in Fisheries and Aquaculture

Numerous activities were organized to accelerate advances in Societal Applications in Fisheries & Aquaculture using Remotely Sensed Imagery (SAFARI). Scientists and experts from the fishery, aquaculture, coastal zone management and Earth observation communities joined forces to integrate remote-sensing applications into fishery research and management.

The Canadian Space Agency (CSA), the Bedford Institute of Oceanography and the US National Oceanographic and Atmospheric Administration (NOAA) led the development of fishery applications for the SAFARI project (Societal Applications in Fisheries and Aquaculture using Remote Sensing). SAFARI is to accelerate the pace of **Earth observation assimilation into fishery research** and fishery management worldwide (see figure). SAFARI will help to build capacity at both research-level and operational-level, and facilitate the application of rapidly evolving satellite technology to fishery management questions.



Details of progress are available on the SAFARI website (http://www.geosafari.org/index.html). The first SAFARI international Workshop (New Caledonia, November 2008) brought together about 30 fishery-research and remote-sensing experts to address the particular needs and issues of Western and Central Pacific Island countries. Practical recommendations were presented and the final report was published in the Proceedings of SPIE (an international society advancing light-based research).

Also a Special Session of the American Society of Limnology and Oceanography (ASLO) Aquatic Sciences Meeting was held to address "Applications of Satellite Remote Sensing in Fisheries Oceanography and the Ecosystem Approach to Fisheries" (Nice, France, January 2009). This helped advance current research and operations in (i) fishery oceanography based on remotely-sensed data and (ii) applications to stock assessments, stock management, and fisheries harvesting methods.

Bright blue swirls in the water suggest blooms of phytoplankton off the Norwegian coast (copyright NASA)

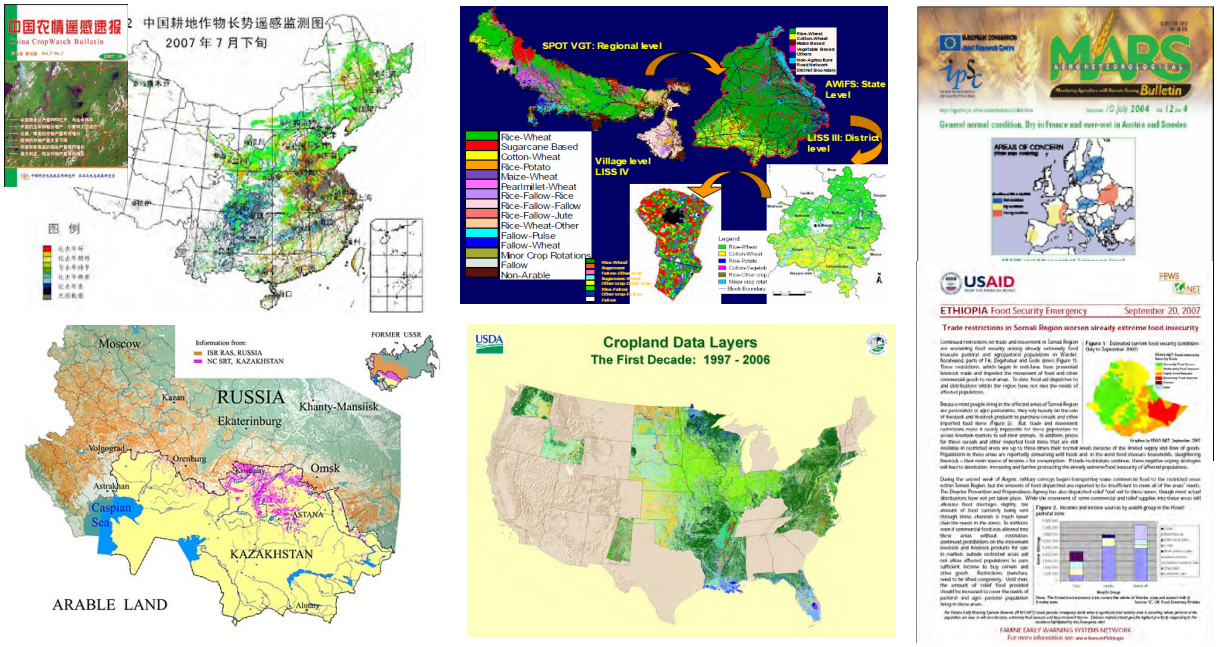
In March 2009, a Canadian information session was organised to inform the fishery industry and government representatives about the use of remotely-sensed data for fishery applications, and the current progress in research and ecosystem-based fishery management. In September 2009, a presentation entitled "Societal Application in Fisheries and Aquaculture using Remotely-Sensed Imagery – the SAFARI project" (OceanObs'09, Venice, Italy, September 2009) reviewed the performance of the global ocean observing system, highlighting various societal benefits, and setting the vision for further development.

To further address the operational use of remote sensing for fish harvesting, fish health assessment, climate change implications and other themes, the SAFARI initiative will organize an international symposium on Remote Sensing and Fisheries in Kochi, India from 15-17 February 2010 (see www.geosafari.org/kochi).

AG-07-03: Global Agricultural Monitoring

The Global Agricultural Monitoring (GLAM) Community of Practice (CoP) was created to improve sustainable agriculture management and food security monitoring. Its primary objective is to develop a global operational agricultural monitoring system for delivering forecasts and relevant information on crop production to farmers and policymakers. See the recently launched website at www.earthobservations.org/cop_ag_gams.shtml.

Work on developing a **global agricultural monitoring system of systems** was initiated in Beijing in February at a GEO workshop. The workshop focused on assessing the practical requirements for satellite and in-situ observations, and identifying the necessary components and data policies of a global agricultural monitoring system of systems. It brought together about 80 participants from 20 countries and organizations, and emphasized the need for (i) collaboration within the GLAM Community of Practice, and (ii) coordination and further development of capacity-building activities. The US-based University of Maryland is leading the GLAM with support mainly from the United States Department of Agriculture (USDA), EC Joint Research Center (JRC) and Chinese Academy of Sciences (CAS) and the Indian Space Research Organization's Space Applications Center (ISRO/SAC). The latter is also hosting the GLAM Secretariat.



Towards a Global Agricultural Monitoring System of Systems, connecting and coordinating existing systems with common standards and protocols

With regard to activities, four lighthouse initiatives were launched: (1) Multi-source **Production, Acreage and Yield (PAY) Database** – to enable inter-comparison of crop statistics forecasts from different reporting agencies; (2) Joint **Experiment on Crop Assessment and Monitoring** (JECAM) – to enable modelling and monitoring method inter-comparisons, accuracy assessments, data fusion, and product integration, for agricultural monitoring based on multi-source satellite and in-situ data; (3) **Coordinated Data Initiative** for Global Agricultural Monitoring (CDIGAM) – to ensure the on-going acquisition and accessibility of satellite data during the growing season and the continuity of observations necessary for agricultural monitoring; and (4) GLAM Thematic Workshop Series (GTWS) – to organize workshops to improve communication amongst the Community of Practice, develop best practices and standards as well as encourage cooperation, coordination and data sharing.

The PAY database is currently under development for internet sharing and following its initial design phase, it will be evaluated for inclusion in the GEO Portal. With regard to JECAM, five experiments are planned in Argentina, Canada, China, Europe, and Ukraine and expected to be implemented in 2010. Two workshops are also scheduled for the end of 2009.

In addition to the foregoing activities, the Canadian GEO in collaboration with the GLAM Community of Practice organized a survey to capture user views on **SAR for agricultural applications**. This helped inform SAR data providers about the requirements for agricultural monitoring. A GEO workshop and training course will also be held to explore how far SAR and SAR/optical sensor information can be used to map agricultural land cover & land use, monitor changes, identify crops, estimate crop area, assess crop condition and estimate soil properties such as soil moisture (Kananaskis, Canada, 31 Oct-4 Nov 2009). The workshop will also identify the needs of the agricultural user community as a next step towards facilitating coordinated access to Earth observation data. Access to the new generation of SAR sensors, including RADARSAT-2, ALOS PALSAR, Cosmo-Skymed, TerraSAR-X, RISAT-1, and Sentinel-1, should greatly improve agricultural monitoring (see www.cgeo.gc.ca).

With regard to risk management, the WMO Commission for Agricultural Meteorology (CAgM) developed analytical tools and methods to establish common standards and formats for **agriculture risk assessment**, particularly for crop failure. The CAgM supports the implementation of pilot projects linking Earth-system (weather and climate) models to end-user application models (such as crop-yield models) to improve food-supply prediction. In addition, the Greece-based Centre of Technological Research developed decision tools for predicting future trends in agricultural production (using for example weather and groundwater-pollution data); and the US-based NOAA provided early drought detection through its STAR website (http://www.star.nesdis.noaa.gov/star/index.php).

Uganda spearheaded the development of an **agriculture capacity building programme for Africa**. The programme aims to develop and disseminate training modules on Earth observation, support capacity building of individuals and African institutions, and promote awareness of the utility of Earth observations. A draft document reviewing the characteristics of Earth observations, and their strengths and weaknesses in each of the various agricultural sectors in Africa was finalized in June. Lessons learned will also be applied to other regions of the world. Proposals were submitted in response to the African, Caribbean and Pacific Call for Proposals and the GEO Call for Proposals.

Also contributing to capacity building activities, China‘s Zhejiang University prepared training modules to expand the use of remote-sensing observations for **rice monitoring in Asia** and Japan’s National Agriculture and Food Research Organization (NARO) supported remote-sensing education. The CEOS Working Group on Education and Training (WGEdu) raises awareness through its portal of forthcoming training events organized by CEOS members and other organisations.

2.9 BIODIVERSITY

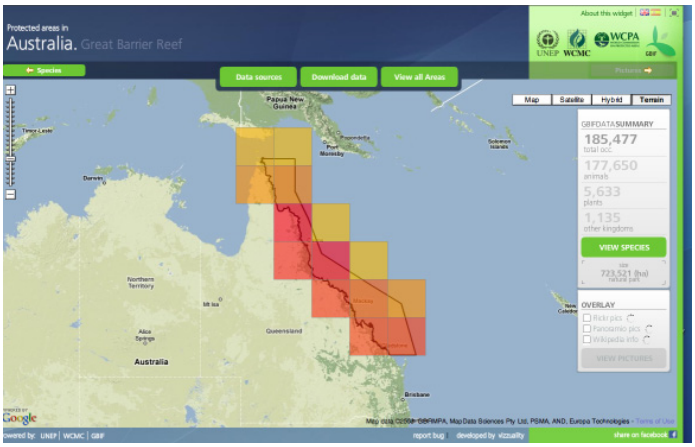
Issues in this area include the condition and extent of ecosystems, distribution and status of species, and genetic diversity in key populations. Implementing GEOSS will unify many disparate biodiversity-observing systems and create a platform to integrate biodiversity data with other types of information. Taxonomic and spatial gaps will be filled, and the pace of information collection and dissemination will be increased.

GEOSS 10-Year Implementation Plan, Section 4.1.9

BI-07-01: Developing a Biodiversity Observation Network

The GEO Biodiversity Observation Network (GEO BON) strengthened coordination amongst the users and providers of biodiversity information. It created a global network for biodiversity observation aimed at helping to slow and then reverse biodiversity loss. The visibility of GEO BON in the biodiversity community increased through various communications and outreach efforts. Thanks to the work of the GEO BON Steering Committee, established in January, coordination amongst existing activities was strongly improved. A GEO BON website for promoting collaboration and communicating products and services was launched in June.

GEO BON launched work on "**early products**". One of these products is based on the proof-of-concept provided by a recent assessment of African protected areas. This assessment of 741 protected areas compiles a huge amount of information drawn from the most up-to-date databases and is available online (http://bioval.jrc.ec.europa.eu/PA/). It also allows users to analyse the value of, and threats to, biodiversity in each park, and compares sites by country and by ecoregion. Every 10 days an alert is issued about any unusual patterns in rainfall, fires, vegetation and seasonal water bodies in each protected area. These alerts are made available as GeoRSS (Geographically Encoded Objects for RSS) feeds to which users can subscribe.

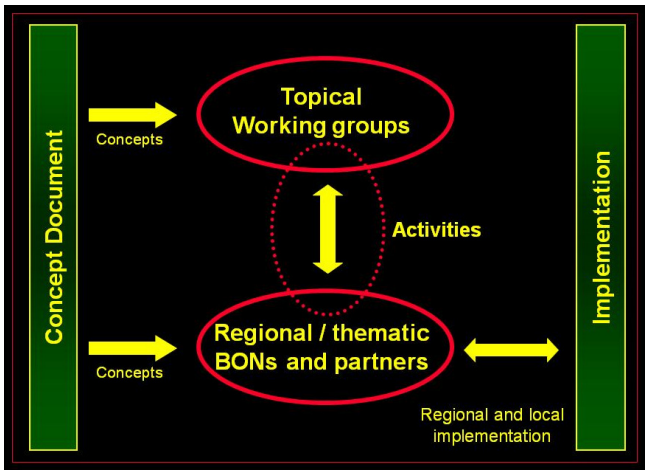


The Global Biodiversity Information Facility (GBIF) and the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) are collaborating on this project, which is supported by a Swiss financial contribution to GEO BON. The project team is developing an internet application for **visualizing information from protected areas** that combines specimen and occurrence data from GBIF and from the World Database on Protected Areas (see figure). The application will be expanded to include taxonomic and geospatial data as well as literature references. This work will be coordinated with the African Protected Areas group at the European Commission's Joint Research Centre (EC-JRC).

GEO BON also advanced through other new projects and activities. The European EBONE project (EU-FP7), for example, was established as a GEO BON pilot. During 2009, EBONE produced an **overview of monitoring initiatives** in Europe, keys for field identification of Annex 1 habitats (habitats protected though the EU Species and Habitats Directive), field sampling strategies, protocols for wider countryside monitoring, and a first effort to quantify the relationship between field habitat data and Earth observation data through inter-calibration. All progress and products of the EBONE project are being reported on the EBONE website (http://www.ebone.wur.nl/UK/).

Together, these GEO BON early products, pilot projects and other activities aim to coordinate and harmonize the diverse biodiversity observation systems being managed today by government agencies, research institutions and non-governmental organizations (NGOs) to ensure the improved sharing, integration and dissemination of biodiversity data and information.

With regard to governance, GEO BON established a Steering Committee and formed several working groups to develop deliverables in a number of areas: ecosystem services, freshwater ecosystem change, genetics, in-situ and remote sensing integration, marine ecosystem change, terrestrial ecosystem change, and terrestrial species monitoring. The Steering Committee, which consists of **representatives from many of the world's leading biodiversity observation organizations**, explored expanding regional and thematic biodiversity networks and invited a number of key organizations to join GEO BON. As a result the Reference Center on Environmental Information (CRIA), the Census of Marine Life (CoLM) and the Royal Netherlands Institute for Sea Research (NIOZ) became members, with other relevant organizations expected to join shortly.



The basic GEO BON implementation approach relies on the Topical Working Groups, working with regional and thematic BONs and other partners, to map the GEO BON concepts to specific implementation activities. Activities are then carried out by partners.

The Steering Committee also discussed the 10th meeting of the Conference of the Parties to the **Convention on Biological Diversity** (CBD), to be held in Nagoya, Japan in October 2010. GEO BON has already been recognized in a number of CBD documents and decisions. It could clearly make a useful contribution to CBD implementation, notably in the development of baselines for the measurement of historical and future trends in biodiversity. The Steering Committee agreed that GEO Bon should fully engage with the Nagoya conference.

With regard to invasive species, the USA (NASA) and partners teamed up with the Taxonomic Databases Working Group (TDWG) to create an invasive species "cook book"; in other words, a simple set of instructions ensuring that related communities (GBIF, Encyclopedia of Life – EOL, Ocean Biogeographic Information System – OBIS, etc.) benefit from the Global Invasive Species Information (GISIN) Network. An Application Service Providers (ASP) toolkit to **share invasive species information** across online databases was created by consultants from Argentina, and added to the Photoshop toolkit resource. Key contacts with potential new partners were initiated with Greece (Laboratory of Zoology Biological Applications and Technology Dept. University of Ioannina), Portugal (Research Center in Biodiversity and Genetic Resources, Azores; University of the Azores - Research Centre on Geographical Information and Land Planning), and India (University of Kashmir).

Meanwhile, as part of its efforts to advance efforts to **capture historical and new biodiversity data**, GBIF constituted two task groups to provide key recommendations by August 2009:

The 'Content Needs Assessment Task Group' to advise on: (i) Scientific and policy questions that GBIF data should be able to address; (ii) Data content needs (volume, depth and density) and fitness

(precision, accuracy and authenticity) for specific uses; (ii) Survey design to determine the profile of biodiversity data users; (iii) Unique scientific and policy contributions of GBIF mobilized data; and (iv) Strategies and priorities for mobilizing GBIF data. In other words, what should GBIF focus on in the short, medium and long-term.

The 'Data Publishing Framework Task Group' to report on: (i) Social, technical and policy barriers to the publication of 'primary biodiversity data'; (ii) Opportunities and mechanisms to encourage the publication of 'primary biodiversity data'; and (iii) Conceptualization of a practical 'Data Publishing/Data Usage Indicator' together with technical implications of its implementation within the GBIF network.

APPENDIX A: PROGRESS TABLE

G	*Green*: Overarching Task progress judged to be very good to excellent (if any sub-tasks, progress judged to be very good to excellent for most sub-tasks; see corresponding text for details)
Y	*Yellow*: Overarching Task is progressing but more effort is required (if any sub-tasks, more effort is required on most sub-tasks; see corresponding text for details)
R	*Red*: Overarching Task is inactive (no reported progress) or progress judged insufficient (if any sub-tasks, progress judged insufficient for most sub-tasks; see corresponding text for details)

Tasks	Status
BUILDING AN INTEGRATED GEOSS	
ARCHITECTURE	
AR-09-01 GEOSS Common Infrastructure (GCI)	G
AR-09-02 Interoperable Systems for GEOSS	G
AR-09-03 Advocating for Sustained Observing Systems	G
AR-09-04 Dissemination and Distribution Networks	G
AR-06-11 Radio Frequency Protection	G
DATA MANAGEMENT	
DA-06-01 GEOSS Data Sharing Principles	G
DA-09-01 Data Management	G
DA-09-02 Data Integration and Analysis	G
DA-09-03 Global Data Sets	G
CAPACITY BUILDING	
CB-09-01 Resource Mobilization (Seville Roadmap)	G
CB-09-02 Building Individual Capacity in EO	G
CB-09-03 Building Institutional Capacity to Use EO	G
CB-09-04 Capacity Building Needs and Gap Assessment	G
CB-09-05 Infrastructure Development and Technology Transfer for Information Access	G
SCIENCE AND TECHNOLOGY	
ST-09-01 Catalyzing R&D Funding for GEOSS	G
ST-09-02 Promoting Awareness and Benefits of GEO in the S&T Community	G
USER ENGAGEMENT	
US-09-01 User Engagement	G
US-09-02 Socio-Economic Indicators	G
US-09-03 Cross-Cutting Products and Services	G

THE 9 GEOSS SOCIETAL BENEFIT AREAS	
DISASTERS	
DI-06-09 Use of Satellite for Risk Management	G
DI-09-01 Systematic Monitoring for Geohazards Risk Assessment	G
DI-09-02 Multi-Risk Management and Regional Applications	G
DI-09-03 Warning Systems for Disasters	Y
HEALTH	
HE-09-01 Information Systems for Health	Y
HE-09-02 Monitoring and Prediction Systems for Health	G
HE-09-03 End-to-End Projects for Health	G
ENERGY	
EN-07-01 Management of Energy Sources	G
EN-07-02 Energy Environmental Impact Monitoring	Y
EN-07-03 Energy Policy Planning	G
CLIMATE	
CL-06-01 A Climate Record for Assessing Climate Variability and Change	G
CL-09-01 Environmental Information for Decision-making and Adaptation	G
CL-09-03 Global Carbon Observation and Analysis System	G
WATER	
WA-06-02 Droughts, Floods and Water Resource Management	Y
WA-06-07 Capacity Building for Water Resource Management	G
WA-08-01 Integrated Products for Water Resource Management and Research	G
WEATHER	
WE-06-03 TIGGE and the Development of GIFS	G
WE-09-01 Capacity Building for High-impact Weather Prediction	G
ECOSYSTEMS	
EC-09-01 Ecosystem Observation and Monitoring Network (GEO EcoNet)	G
EC-09-02 Ecosystem Vulnerability to Global Change	G
AGRICULTURE	
AG-06-02 Data Utilization in Fisheries and Aquaculture	G
AG-07-03 Global Agricultural Monitoring System	G
BIODIVERSITY	
BI-07-01 Developing a Biodiversity Observation Network	G

APPENDIX B: LIST OF ACRONYMS

AARSE	African Association of Remote Sensing of the Environment
ACQWA	Assessing Climatic change and impacts on the Quantity and quality of Water
ADC	Architecture and Data Committee
AeroCOM	Aerosol Comparisons between Observations and Models
AG	Agriculture
AIT	Asian Institute of Technology
AMDAR	Aircraft Meteorological Data Relay
AMESD	African Monitoring of the Environment for Sustainable Development
ANTARES	A Network for the Enhancement of the Education and Scientific Research
APEC	Asia-Pacific Economic Cooperation
APFM	Associated Programme on Flood Management
APN	Asian Pacific Network for Climate Change Research
AR	Architecture
ASCOPE	ESA Active LIDAR
ASEAN	Association of Southeast Asian Nations
ASI	Italian Space Agency
ASSENDS	NASA Active LIDAR
AVHRR	Advanced Very High Resolution Radiometer
AWCI	Asian Water Cycle Initiative
B08FDP	Beijing 2008 Olympic Games Forecasting Demonstration Project
B08RDP	Beijing 2008 Olympic Games Research and Development Project
BGR	German Geological Survey
BI	Biodiversity
BIOMASS	ESA p-band radar for above-ground biomass
BIOSTRAT	Specific Support Action (SSA) funded by the EU Sixth Framework Programme and aims to further develop the EU Biodiversity Research Strategy
BRGM	French Geological Survey
CASTOR	CApture and geological STORage of CO_2
CATHALAC	Water Centre for the Humid Tropics of Latin America and the Caribbean
CB	Capacity Building
CBC	Capacity Building Committee
CBD	Convention on Biological Diversity
CBERS	China-Brazil Earth Resources Satellite
CEOP	Coordinated Energy and Water Cycle Observations Project
CEOS	Committee on Earth Observation Satellites

CFP	Call for Participation
CGIAR	Consultative Group on International Agricultural Research
CGMS	Coordination Group for Meteorological Satellites
ChloroGIN	Chlorophyll Ocean Globally Integrated Network
CIESIN	Center for International Earth Science Information Network
CIMA	(CIMA Foundation) International Center of Environmental Monitoring
CIMO	Joint Commission for Instruments and Methods of Observation
CL	Climate
CMAP	Merged Analysis of Precipitation
CNES	French Space Agency
CO2GeoNET	European Network of Excellence on the geological storage of CO_2
CO2ReMoVe	Research into Monitoring and Verifying Carbon Dioxide geological storage
CoP	Community of Practice
CPC	Climate Prediction Center
CSIR	Council for Scientific and Industrial Research, South Africa
DA	Data Management
DEM	Digital Elevation Model
DevCoCast	Provides processed land and ocean satellite data and value-added products in Developing Countries
DI	Disasters
DIVERSITAS	An international programme of biodiversity science
DLR	German Aerospace Center
EARS	Dutch Remote-Sensing Company
EBONE	European Biodiversity Observation Network
EC	Ecosystems
EC	European Commission
ECDC	European Center for Disease Prevention and Control
ECMWF	European Centre for Medium-range Weather Forecasts
ECV	Essential Climate Variables
EDEN	Emerging Diseases in a changing European Environment
EEA	European Environmental Agency
EN	Energy
EnerGEO	Earth observation for monitoring and assessment of the environmental impact of energy use
EO	Earth Observations
EPS	Ensemble Prediction System
ERSL	Environmental Remote Sensing and Image Processing Laboratory
ESA	European Space Agency
ESRI	Environmental Systems Research Institute

EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organization
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
FDPs	Forecast Demonstration Projects
FDSN	International Federation of Digital Seismograph Networks
FLUXNET	Network of Regional Networks Integrating Worldwide CO_2 Flux Measurements
FOSS4G	Free and Open Source Software for Geospacial
FP6	European Commission funded projects
FP7	European Union 7th Framework Programme
FPAR	Fraction Photosynthetically Available Radiation
FRA	Forest Resource Assessment
GAW	Global Atmosphere Watch
GBIF	Global Biodiversity Information Facility
GBRDS	Global Biodiversity Resources Discovery System
GCI	GEOSS Common Infrastructure
GCOS	Global Climate Observing System
GDEWS	Global Drought Early Warming Systems
GEMS	Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data
GEO	Group on Earth Observations
GEO BON	Group on Earth Observations Biodiversity Observation Network
GEOBENE	Global Earth Observation Benefit Estimation: Now, Next and Emerging
GeoCapacity	Assessing European Capacity for geological storage of Carbon Dioxide
GeoHazData	Interoperable and distributed metadata system for inventorying hazard maps
GEONETCast	Near real time, Global Network of Satellite-based Data Dissemination Systems designed to distribute space-based, air-borne and in situ data, metadata and products to low-cost receiving stations maintained by users
GEOSCHEM	Goddard Earth Observing System-CHEMistry
GEOSS	Global Earth Observation System of Systems
GEWEX	Global Energy and Water Cycle Experiment
GFMC	Global Fire Monitoring Center
GFZ	German National Research Center for Earth Sciences
GGMN	Global Groundwater Monitoring Network
GGOS	Global Geodetic Observing System
GIFS	Global Interactive Forecast System
GIS	Geographical Information System
GISIN	Global Invasive Species Information Network
GLOBCARBON	ESA Global Land Products for Carbon Model Assimilation
GLOBCOLOUR	ESA Node for Global Ocean Colour

GLOBCOVER	ESA Global Land Cover Service
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite System
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GOOS	Global Ocean Observing System
GOS	Global Observing System
GOSAT	Greenhouse Gases Observing Satellite
GPCC	Global Precipitation Climatology Centre
GPM	Global Precipitation Measurement
GPS	Global Positioning System
GRIB	GRIdded Binary
GRUAN	GCOS Reference Upper Air Network
GSN	Global Seismographic Network
GTOS	Global Terrestrial Observing System
HARON	Hydrological Applications and Run-Off Network
HE	Health
HEPEX	Hydrological Ensemble Prediction Experiment
IAG	International Association of Geodesy
IAS	Invasive Alien Species
ICSU	International Council for Science
IEEE	Institute of Electrical and Electronics Engineers
IGACO	International Global Atmospheric Chemistry Observations
IGAC-SPARC	International Global Atmospheric Chemistry - Stratospheric Processes And their Role in Climate
IGBP	International Geosphere-Biosphere Programme
IGCO	Integrated Global Carbon Observation
IGOS	Integrated Global Observing Strategy
IGRAC	International Groundwater Resources Assessment Centre
IGWCO	Integrated Global Water Cycle Observations (former IGOS Water Theme)
IIASA	International Institute for Applied Systems Analysis
ILTER	International Long Term Ecological Research network
ILWIS	Integrated Land and Water Information System
INPE	Brazilian National Institute for Space Research
InSAR	Interferometric Synthetic Aperture Radar
INTA	Instituto Nacional de Técnica Aeroespacial, Spain
IOC	Initial Operating Capability
IOC	Intergovernmental Oceanographic Commission
IOCCG	International Ocean Colour Coordinating Group

IP3	GEOSS Interoperability Process Pilot Projects
IPT	Integrated Provider Toolkit
IPWG	International Precipitation Working Group
IPY	International Polar Year
IRI	International Research Institute for Climate and Society
IRIS	Incorporated Research Institutions for Seismology
ISC	International Seismological Centre
ISCGM	International Steering Committee for Global Mapping
ISDR	International Strategy for Disaster Reduction
ISLSCP	International Satellite Land-Surface Climatology Project
ISO	International Standards Organization
ISPRS	International Society for Photogrammetry and Remote Sensing
ISSG	IUCN/SSC Invasive Species Specialist Group
ITC	International Institute for Geo-Information Science and Earth Observation
ITC	International Training Centre
ITU	International Telecommunication Union
IUCAF	Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science
IUCN	International Union for the Conservation of Nature and Natural Resources (World Conservation Union)
IUGG	International Union of Geodesy and Geophysics
JAXA	Japan AerospaceExploration Agency
JCOMM	Joint WMO-IOC Technical Commission on Oceanography and Marine Meteorology
LAI	Leaf Area Index
LAM	Limited Area Model
LANDSAT	Earth Resources Technology Satellite
LIDAR	Light Detection and Ranging
LIS	Land Information System
MEPS	Meso-scale Ensemble Prediction Systems
MERIS	Medium Resolution Imaging Spectrometer
MERIT	Meningitis Environmental Risk Information Technologies
MODIS	Moderate Resolution Imaging Spectroradiometer
NADM	North American Drought Monitor
NARSS	National Authority for Remote Sensing and Space Sciences, Egypt
NASA	National Aeronautics and Space Administration
NBII	National Biological Information Infrastructure
NCAR	US National Center for Atmospheric Research
NCDC	US National Climatic Data Center
NCEP	US National Centers for Environmental Prediction

NEPTUNE	The North-east Pacific Time-series Undersea Network Experiments
NetCDF	Network Common Data Form
NMHS	National Meteorological and Hydrological Service
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	Net Primary Productivity
NWP	Numerical Weather Prediction
OCO	NASA Orbiting Carbon Observatory
OECD	Organization for Economic Cooperation and Development
OGC	Open Geospatial Consortium
OS	Open Source
OSS	Open Source Software
PAAM	Protected Areas Assessment and Monitoring
PAGER	Prompt Assessment of Global Earthquakes for Response
PAY	Production, Acreage, and Yield
PCTM	Parameterized Chemistry and Transport Model
POGO	Partnership for Observation of the Global Ocean
POPs	Persistent Organic Pollutants
PROMOTE	PROtocol MOniTOring (for the GMES Service Element: Atmosphere)
PUMA	Project supporting African nations in their use of data and services provided by the new Meteosat Second Generation (MSG) family of European weather satellites.
QA4EO	Quality Assurance Framework for Earth Observation
RAMSAR	Convention on Wetlands, Ramsar, Iran, 1971
RDP	Research and Development Project
	resource management in Africa
SAFARI	Societal Applications in Fisheries & Aquaculture using Remotely-Sensed Imagery
SAR	Synthetic Aperture Radar
SBA	Societal Benefit Area
SBSTA	Subsidiary Body for Scientific and Technological Advice
SDI	Space Data Infrastructure
SDI	Spatial Data Infrastructure
SDS	Sand and Dust Storm
SELPER	Sociedad Especialista Latinoamericana en Percepción Remota (Latin-American Specialist Society in Remote Perception)
SIF	Standards and Interoperability Forum
SIT	Strategic Implementation Team
SIT22	CEOS Strategic Implementation Team meeting in Tokyo
SPOT	Système Probatoire d'Observation Terrestre
SPOT-VGT	SPOT Vegetation
SSC	Species Survival Commission

SST	Sea Surface Temperature
STC	Science and Technology Committee
TerraLib	Open source GIS software library
TerraView	GIS application built on the TerraLib GIS library
THORPEX	The Observing-system Research and Predictability Experiment
TIGER	ESA-launched initiative focusing on the use of space technology for water
TIGGE	THORPEX Interactive Global Grand Ensemble
TOVS	NOOA TIROS (Television Infrared Observation Satellite) Operational Vertical Sounder
T-PARC	THORPEX Pacific Asian Regional Campaign
UIC	User Interface Committee
UK	United Kingdom
UN	United Nations
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNESCO-IHE	Institute for Water Education
UNOOSA	United Nations Office for Outer Space Affairs
UNOSAT	United Nations Operational Satellite Applications Programme
US	User Engagement
USA	United States of America
USGS	United States Geological Survey
VENUS	Victoria Experimental Network Under the Sea
VI	Vegetation Index
WA	Water
WCRP	World Climate Research Programme
WDC	World Data Center
WE	Weather
WFPHA	World Federation of Public Health Association
WHO	World Health Organization
WIGOS	WMO Integrated Global Observing System
WIKI	Page or Collection of Web pages designed to enable anyone who accesses it to contribute or modify content, using a simplified markup language
WIREC	Washington International Renewable Energy Conference
WIS	WMO Information System
WMO	World Meteorological Organization
WWRP	World Weather Research Programme