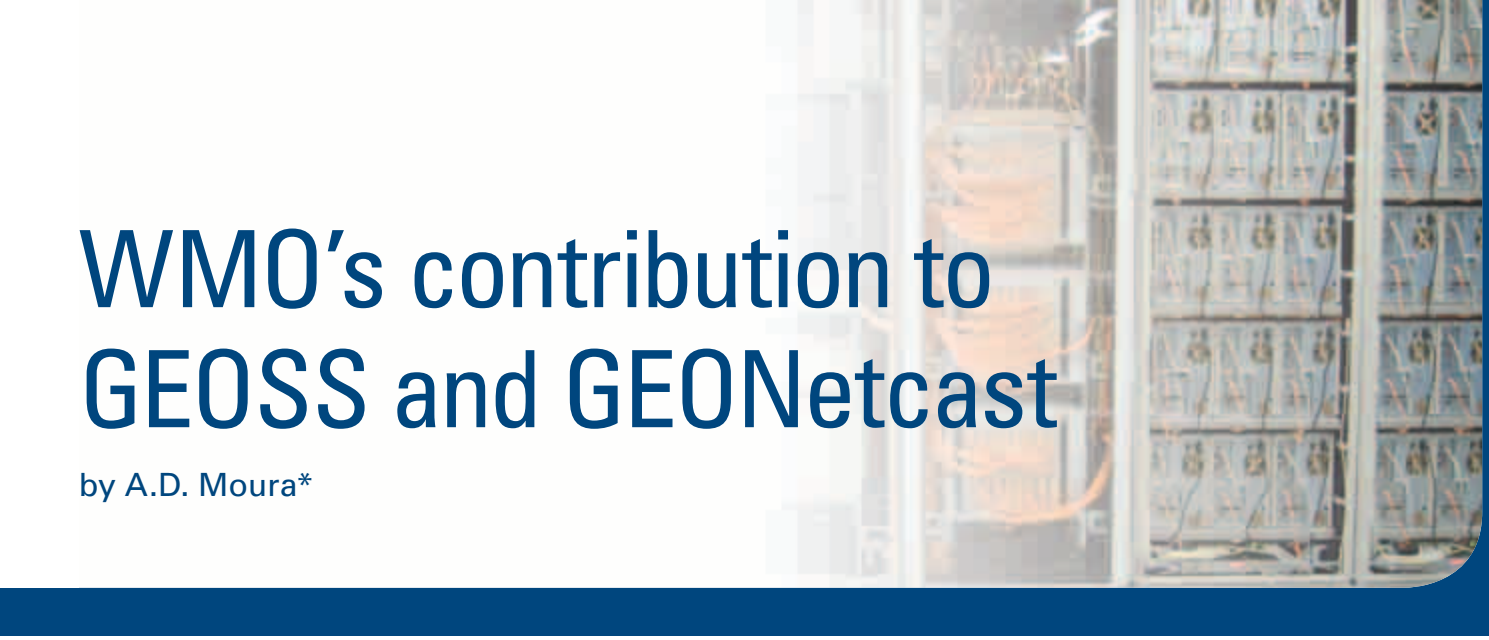

WMO's contribution to GEOSS and GEONetcast

by A.D. Moura*

This article recalls the main characteristics of the WMO Information System (WIS), its relations with the Global Telecommunication System (GTS) and the Integrated Global Data Dissemination Service (IGDDS) and indicates how these WMO systems are expected to contribute to the objectives of Global Earth Observation System of Systems (GEOSS) for environmental data exchange and management. It also indicates WMO's understanding of the GEONetcast initiative within GEOSS and the orientation proposed by WMO for the continuation of the GEONetcast and IGDDS actions within the 2007–2009 GEOSS Workplan.

The Global Telecommunication System (GTS)

The GTS consists of an integrated network interconnecting meteorological telecommunication centres of National Meteorological and Hydrological Services (NMHSs) worldwide. It consists of several types of circuits: point-to-point circuits, point-to-multi-point circuits for data distribution, multi-point-to-point circuits for data collection, as well as two-way multi-point circuits. These circuits are a combination of surface-based and satellite telecommunication links.

The GTS has a hierarchical structure at three levels:

- The Main Telecommunication Network (MTN) links together three World Meteorological Centres and 15 Regional Telecommunication Hubs, and is the core network for global exchange;
- The seven Regional Meteorological Telecommunication Networks (RMTNs) covering the six WMO Regions and the Antarctic;
- The National Meteorological Telecommunication Networks (NMTNs) of each of WMO's 187 Members, enabling them to collect observational data and to receive and distribute meteorological and hydrological information at the national level.

As a fundamental support to meteorological operations worldwide, the GTS is operated round the clock with the objectives of timeliness, operational continuity and reliability. The GTS handles a volume of traffic in the range of 10 Mbytes to more than one GByte per day, depending on the various parts of the network.

GTS rules

The GTS is designed for the selective transmission of information coded along internationally agreed format and identified by "bulletin headers" indicating, in a coded form, the originating centre and the type of data contained. The information is routed so as to meet the requirements of NMHS centres.

GEO, GEOSS and GEONetcast

GEO: Group on Earth Observations (http://www.earthobservations.org/)

GEOSS: Global Earth Observing System of Systems

GEONetcast: a worldwide, operational, end-to-end Earth observation data collection and dissemination system (GEO)

Responsibility and funding

It is successfully operated through voluntary commitments of all WMO Members at various levels of responsibility. It relies on data exchange. Each WMO Member bears the cost of its telecommunications centres, while the cost of point-to-point communication links are shared between the two ends. The GTS is implemented and operated by Member countries and is coordinated by WMO. Procedures, implementation and development plans are coordinated by the Commission for Basic Systems (CBS) on the global level and by the six WMO regional associations (RAs) on the regional level.

All environment-related programmes collect and exchange data, generate products, transmit information to

* Director, National Meteorological Institute, Brasilia, Brazil

users and archive data. Beyond the GTS that is dedicated to time-critical operational data, products and warning, the various WMO programmes developed information systems, with a resulting multiplicity of systems and practices, generating incompatibilities. In 2003, Fourteenth World Meteorological Congress (Cg-XIV) adopted the concept of a WMO Information System (WIS) as an overarching, integrated system which would meet the requirements of all WMO programmes, affiliated international organizations and programmes, as well as relevant national non-NMHS users such as disaster prevention and mitigation agencies and research facilities, with respect to:

- Routine collection of observation data;
- Automated dissemination ("push") for timely delivery of data and products (e.g. meteorological, climatological, environmental and hydrological observations, forecasts and warnings);
- Ad hoc requests for data and products ("pull");
- Data discovery, access and retrieval service for all data stored by any WMO programme, regardless of location.

The main functional components of the WIS are: National Centres (NCs), Data Collection or Product Centres (DCPCs), Global Information System Centres (GISCs) and data communication networks connecting the components.

National Centres

The WIS requires reliable national centres, referred to as NCs. An NC is responsible for collecting and providing observational data and products and distributing them on a national and international basis. The NCs coordinate or authorize the use of the WIS by eligible national users. Depending on national policy, more than one NC can exist in a country. Normally, the Permanent Representative of the country with WMO establishes the national policy and practice and coordinates the various users. Globally, 187 NCs (i.e. one per Member State or Territory) plus some 100 other NCs with national responsibilities will be part of the WIS infrastructure.

Data Collection or Product Centres

Centres that fulfil within specific WMO Programmes an international responsibility for the generation and provision for international distribution of data and/or products, are referred to as Data Collection or Product Centres. DCPCs also provide basic WIS products and perform functions such as metadata catalogues, Internet portals and data access management. Examples of DCPCs are the Regional Specialized Meteorological Centres (RSMCs) with activity specialization or geographic specialization, as well as the Regional Climate Centres, the World Data Centres, the Meteorological Satellite Operator centres, etc. In total, about 150 centres are expected to perform DCPC functions.

Global Information System Centre

The regional and global connectivity of the WIS structure is guaranteed by the existence of a small number of node centres called Global Information System Centres (GISCs). There will be less than 10 in total, whose combined areas of responsibility cover the whole world. They collect and distribute the information intended for routine global dissemination. In addition, they serve as collection and distribution centres in their areas of responsibility and provide entry points for any request for data held within the WIS. They maintain metadata catalogues of all information available within the WIS and provide a portal for data searches.

Network structure

The data communication network connecting the various parts of the WIS is based on an agreed technology that is commonly available to the participating centres. There are satellites communication channels, as well as terrestrial links and managed data network services.

Generally, TCP/IP is the preferred transmission protocol and the WIS can adjust to any evolving international protocol according to the technological progress. While the WMO code formats will be used for real-time exchange of operation-critical data, the user will be able to select from a wide variety of optional data representation formats. Metadata information should be available in a standard format, e.g. XML.

The current diversification of access points and methods would be replaced by a common approach. Furthermore, the portal structure provided by the WIS would make it possible for programmes to present their data to their users in a programme-specific query format. The time and operation-critical exchange will be provided through dedicated communication means ensuring the required high-level quality of service. In this respect, the GTS will continue, and be further improved, as a basic component within the WIS. As a WIS component the IGDDS will also provide for the exchange of data and products related to the WMO Space Programme. The other exchanges will be provided mainly through the Internet.

WIS complies with the data policies of participating programmes (especially WMO Resolution 40 (Cg-XII) and Resolution 25 (Cg-XIII)) and its flexible design can follow an evolution of data policies. Procedures for managing access rights, control of data retrieval, registration and identification of users, etc. can be defined as and when required.

Implementation

By using information and communication technology (ICT) industry standards, off-the-shelf hardware and software, including open source software, the WIS is a cost-effective solution for all Members and their NMHSs. Implementation of the WIS builds upon the most successful components of existing WMO information systems and a smooth and coordinated transition is crucial. The WIS concept requires development of the following major functions and the necessary software packages:

- Metadata catalogues;
- Internet portal;
- Data acquisition service;
- Data discovery service;
- Data distribution service: push and pull;
- Monitoring;
- Operational aspects such as data synchronisation, back-up and administrative issues.

To that end, valuable work is being undertaken by the various pilot projects in the different programmes, such as:

- JCOMM GISC-E2EDM prototype (Obninsk, Russian Federation);
- CBS VPN Pilot Project in Regional Associations II (Asia) and V (South-West Pacific);
- CCI CliWare (Obninsk, Russian Federation);
- EUMETNET UNIDART project;
- CBS/RA VI VGISC project, including SIMDAT (GRID project);
- CAgM-WAMIS (Republic of Korea);
- THORPEX Interactive Grand Global Ensemble (TIGGE).

It is planned to introduce in a few countries, by the end of 2006, new WIS structures running in a semi-operational mode by consolidating pilot projects:

- RA VI-VGISC project as a GISC prototype;
- DCPCs prototypes including the ECMWF and EUMETSAT DCPC projects associated with the VGISC project;
- DCPC for JCOMM-related data (Obninsk, Russian Federation);
- DCPC at NCAR (Boulder, USA).

Acronyms

ADM:	Advanced dissemination method
ATOVS:	Advanced TIROS Operational Vertical Sounder
CAgM:	Commission for Agricultural Meteorology
CBS:	Commission for Basic Systems
CCI:	Commission for Climatology
CGMS:	Coordination Group for Meteorological Satellites
DCPC:	Data Collection or Product Centre
EUMETNET:	Network of European Meteorological Services
EUMETSAT:	European Organisation for the Exploitation of Meteorological Satellites
GISC:	Global Information System Centre
IGDDS:	Integrated Global Data Dissemination Service
JCOMM:	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
NCAR:	National Center for Atmospheric Research (Boulder, Colorado, USA)
NOAA:	National Oceanic and Atmospheric Administration (USA)
SIMDAT:	Data grids for process and product development using numerical simulation and knowledge discovery
THORPEX:	The Observing System Research and Predictability Experiment
TIROS:	Television and InfraRed Observation Satellite (USA-NOAA)
UNIDART:	Uniform Data Request Interface
VGISC:	Virtual Global Information System Centre
VPN:	Virtual private network
WAMIS:	World Agrometeorological Information Service

Integrated Global Data Dissemination Service

The WMO Integrated Global Data Dissemination Service (IGDDS) is both a system and a project.

- As a system, the IGDDS is the circulation scheme of space-based observation data and products for WMO programmes. The IGDDS concept was initially proposed by WMO satellite user expert groups and refined by satellite operators within CGMS. Since WMO has defined the concept of a WMO Information System as an overarching framework for all its data exchange and management, IGDDS is now one of the components of WIS.
- As a project, the IGDDS is the set of activities directed towards the definition and operational implementation of the IGDDS system. It addresses the specific requirements and issues posed by space-based observation data and products, such as the large volume of current and

planned satellite data, as well as the commitment of satellite operators to deliver an end-to-end service from acquisition to dissemination.

The IGDDS addresses different functions, as required for a consistent approach:

- Data acquisition (raw data from satellites, higher-level products, interregional data exchange);
- Data dissemination (via telecom satellite broadcast, via direct broadcast, or via point-to-point networks);
- Data access, on request, allowing data discovery and delivery to authorized users;
- Data and user management, including user requirements review and interoperable catalogue, ensuring service quality and user support.

The baseline for IGDDS is a collection of regional[1] components linked in a global network for interregional data exchange. Each regional component will include a Data Collection or Product Centre as defined in WIS and will ensure routine dissemination by various means, including an ADM covering its region.

Activities under the IGDDS project include the expansion of the rolling requirements review process to express regional data needs, the expansion of the Regional ATOVS Retransmission System concept towards a global coverage, the implementation of a global ADM coverage and the appropriate global coordination among CGMS satellite operators and WMO to ensure interoperability along WIS-agreed standards.

The WIS contribution to GEOSS

The meteorological, hydrological and other environmental data handled by the WIS worldwide on an operational basis will represent a significant part of the overall amount of data of interest for GEOSS. These data being exchanged to serve the needs of WMO programmes contribute directly to many GEO objectives, in particular in the weather, climate and water resources and disaster societal benefit areas, but also indirectly in most of the other five societal benefit areas.

Thanks to its open design, the WIS can serve various user communities. It is thus expected to be a core component of the GEO Information "system of systems", concerning weather-, climate- and hydrology-related data and products serving not only WMO programmes but also any GEO user community requiring these data.

From a wider perspective, in view of the unique experience of WMO in operating a globally coordinated, rapidly evolving and fully operational system, it is anticipated that the WIS can also contribute to GEOSS in two ways:

- In potentially supporting the exchange and management of non-meteorological datasets provided by other communities, if compatible with the primary objectives of WIS and if such an arrangement proves beneficial through synergy or economy of scale;
- In being a model case for the development of other networks within GEOSS, for serving the needs of other communities which would have different data needs but requiring similar functionalities. It is expected that the GEOSS information system will have to address all the core functions identified in the WIS description above, i.e. data collection, data dissemination, data discovery and retrieval. As concerns dissemination, GEONetcast is seen as a possible mechanism for providing this function within GEOSS in a coordinated fashion through satellite broadcast.

GEONetcast

GEONetcast is an initiative led within the GEO framework by EUMETSAT, NOAA and WMO to address the global dissemination needs of GEOSS environmental data in a coordinated way.

The GEONetcast concept is to use the multicast capability of a global network of communications satellites to transmit environmental satellite and in situ data and products from providers to users within GEO. Commercially available technology provides cost-efficient solutions with easy to implement terminals, which are widely used for direct to home digital television. The multicast capability allows different datasets to be handled in parallel, regardless of the source. The use of a key access capability enables the data policy of each data provider to be respected and the distribution at individuals or groups of users, as appropriate, to be targeted within the footprint of each satellite.

GEONetcast builds on the experience gained by EUMETSAT with the EUMETCast operational dissemination system and on the WMO IGDDS concept. It proposes to expand this approach in order to establish a truly global dissemination system responding to the needs of all the nine GEO societal benefit areas.

It is recalled that, in the IGDDS project, WMO has set an objective

1 In this article, the words "region" and "regional" without a capital "R" are understood in a general meaning and do not necessarily match a WMO Region. The geographical extent of each region depends on technical constraints such as footprints of available telecommunication satellites.

to implement a globally coordinated data-dissemination system relying primarily on telecommunications satellites using digital video broadcast by satellite (DVB-S) standard. As a baseline, global coverage could be reached in relying on 5 to 10 satellites operating in K_u band for mid-latitudes and in C band for intertropical regions. A Data Collection or Product Centre would be identified in each region and, among other tasks, would concentrate the data and forward them in agreed format to the dissemination uplink.

The GEONetcast initiative proposes to set up arrangements between GEO Members and commercial satellite providers in order to use a similar scheme and, possibly, the same infrastructure, in an expanded form for disseminating any data of interest to GEO Members. Using a common multicast file broadcast system worldwide would simplify data transfer between regions.

In the framework of the GEO Workplan 2006, GEONetcast is the subject of a Capacity Building Task with the particular objective to perform demonstration actions in 2006. These demonstrations were successfully performed on the basis of EUMETCAST and highlighted several important features of relevance to GEOSS:

- Scalability of the bandwidth;
- Flexibility of the data feed and data stream content definition;
- Easy interregional data relay through "turn-around" capability;
- Applicability over all continents (excluding the Antarctic).

Envisaged WMO contribution to data dissemination issues in future GEO workplan

WMO is currently involved in two particular tasks related to data management and dissemination within the GEO workplan 2006:

- "Support the development of ADM within IGDDS, as a component of WIS, and a contribution of the WMO Space Programme to GEONetcast" (WE-06-04);

- "GEONetcast: an operational service delivering data and products based on the use of communications satellites" (CB-06-04).

In the preparation for the 2007–2009 GEO workplan, it will be proposed to refocus these activities in order to enhance the linkage and complementary nature of the GEONetcast and WIS initiatives.

Regarding GEONetcast (continuation of CB-06-04), it is proposed to maintain current emphasis on the satellite-based dissemination function and, specifically, to explore the possible scenarios for providing a unique user interface to a dissemination system relying on multiple data providers, depending on the level of integration and implementation of interoperability standards.

Regarding the ADM-IGDDS-WIS task (continuation of WE-06-04), assuming that the satellite dissemination aspects will be covered within the GEONetcast task, it is proposed that the main emphasis be laid on the contribution from WIS to GEO on other aspects, in particular:

- Applicability of IGDDS and WIS to serve GEO needs beyond WMO programmes;

- Experience gained from GTS, IGDDS and WIS development relevant to the future GEO information system, on issues such as data requirements, data management (including metadata aspects), data access on request and interoperability standards.

GEOSS societal benefits areas

Reducing loss of life and property from natural and human-induced disasters.

Understanding environmental factors affecting human health and well-being.

Improving management of energy resources.

Understanding, assessing, predicting, mitigating, and adapting to climate variability and change.

Improving water resource management through better understanding of the water cycle.

Improving weather information, forecasting and warning.

Improving the management and protection of terrestrial, coastal and marine ecosystems.

Supporting sustainable agriculture and combating desertification.

Understanding, monitoring and conserving biodiversity.

Acknowledgement

The note is based on material provided by the WMO Secretariat. In special, I thank Don Hinsman for his leadership of the WMO Space Programme and his kindness in providing most of the material support.