WMO Information System (WIS)

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WMO

Data, comprising in-situ and remote sensed measurements and observations as well as value-added information derived there from, is the foundation on which our knowledge of the Earth environment[1] is built. Data exchange systems and data management practices ensure effective and efficient international use of the data regardless of location or language. Nearly all programmes collect data, transmit data to one or more processing centres, perform quality control, generate products, transmit products to users, and archive data and products for future use.

Already near the end of the 1990's it became apparent that the WMO Programmes either had their own information systems, or were in the process of developing them independently of each other. The resulting multiplicity of systems has since then generated incompatibilities, inefficiencies, duplication of effort and higher overall costs for Members. Therefore, Fourteenth World Meteorological Congress (Cg-XIV, 2003) approved the plan for developing an overarching, integrated WMO Information System (WIS) that could meet the requirements of all WMO Programmes, affiliated international organizations [2], programmes and centres [3], as well as relevant national non-NMHS users such as disaster prevention and mitigation agencies and research facilities.

In the aftermath of the December 2004 Tsunami catastrophe relevant international organizations and Governments emphasized the importance of WIS (and its basic service network, the WMO's Global Telecommunication System (GTS) [Diagram 1]) as the 24/7 operational backbone information exchange network in support of multi-hazard natural disaster early warning systems. The WMO Executive Council (2005) recognized that the role of WMO was closely interlinked with the provision of a global, modern, cost-effective and comprehensive ICT service through the WIS and urged Members to accelerate development and implementation of key components of WIS and ensure that the WIS requirements and implementation plans of all relevant programmes are synchronized and full interoperability is achieved. It also identified the WIS as a major contribution of WMO to the GEOSS [4] with respect to data exchange and management services.

The WMO Technical Commission for Basic Systems (CBS) is the lead technical commission and the other technical commissions have incorporated WIS in their working programmes to ensure that their programme activities and centres will derive optimal benefit from the evolving WIS.

WIS concept

The WIS architecture, functions and services will provide the solution for the information exchange needs of NMHSs, and other relevant non-NMHS agencies/users [Diagram 2]. WIS offers:

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[1] Environment in the context of WMO comprises weather, climate, water and the atmospheric environment

[2] The priority organizations are: CTBTO, European Union and its relevant Institutions, FAO, GEO, IAEA, IOC, ISDR, WHO, UN/OCHA;

[3] The WMO and WMO-cosponsored international programme centres include among others WMCs, RSMCs, ACMAD, Drought Monitoring Centres, IRI, Regional Climate Centres, CIIFEN, GAW Data Centres, Global Data Run-off Centre, Regional Meteorological Training Centres, Regional Instrument Centres, World Radiation Centre, World Data Centers, CBS Lead Centres for GOS and GCOS observations;

[4] Global Earth Observation System of Systems (GEOSS)

- Routine collection and automated dissemination of operation-critical data (e.g., meteorological, climatological, environmental and hydrological in-situ and satellite observations, forecasts, and warnings), ("GTS function");
- Timely delivery of high-volume data and processed products including satellite data and products ("push");
- Ad-hoc discovery/access/retrieval services for operation-critical data and value-added information ("pull")
- Discovery, access, and retrieval services for all data stored by every WMO programme regardless of location of the archive or the querying user;
- Common procedures for real and non-real time data exchange and standardized data formats and metadata.

The GTS is being progressively improved and evolves into the core network of the WIS. This approach protects Members' past and current investments in the GTS and ensures operational continuity specifically with respect to the developing countries.

By using industry standards, off-the-shelf hardware and software, including open source software and the free-of-charge provision of portable software packages by some Members, WIS is a cost-effective solution for all Members and their NMHSs. This means that the initial investment is determined by the cost of a personal computer, Internet, VPN /[5]/ and VSAT connections, and environmental satellite receiving stations, if required. Several of these components are already implemented under the GTS.

WIS complies with the WMO data policy (Res. 40 (Cg-XII) and Res. 25 (Cg-XIII)), and its flexible design can follow an evolution of that policy. In particular, the handling of essential and additional meteorological data and products with respect to Res. 40 (Cg-XII) is realized. Procedures for managing access rights, control of data retrieval, registration and identification of users, etc. can be defined as and when required. Anonymous downloading is technically possible. WIS has no system-inherent features that would defy international legal frameworks, laws, conventions, copyrights, or patents.

WIS architecture

The main components of WIS [Diagram 3] are: National Centres (NC), Data Collection or Product Centres (DCPC), Global Information System Centres (GISC) and data communication networks connecting the components [Diagram 4]. The term "Centre" describes functions, not actual organizational entities. For example, a NMHS may combine all three functions within one of its centres.

NC (National Centre)
WIS requires a reliable national centre in each country which is referred to as NC. Several NCs per countries can exist. The NC collects and distributes observational data and products on a national basis and for providing relevant data to its associated GISC or DCPC. A "master" NC, normally operated by the NMHS, coordinates and authenticates access of the other national users. Globally, 187 NCs (i.e., one per Member country or territory) will eventually be part of the WIS infrastructure.

DCPC (Data Collection and Production Centre)
Centres that fulfil, within specific international responsibility, for the generation and provision of data, forecast products, processed or value-added information, and/or for providing archiving services, are referred to as Data Collection and Production Centres. DCPCs also provide metadata catalogues, Internet portals and data access management. Examples of DCPCs are the Regional Specialized Meteorological Centres (RSMC) with activity specialization or geographic specialization, as well as the Regional Climate Centres, the Hadley Centre (UK), ECMWF and EUMETSAT. About 150 centres worldwide are eventually expected to perform DCPC functions.

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[5] Virtual Private Network

GISC (Global Information System Centre)
The regional and global connectivity of the WIS structure is guaranteed by the existence of a small number (less than 10) of node centres called Global Information System Centres (GISC). They collect and distribute the information meant for routine global dissemination, and 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 WIS. Like the DCPCs, 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 WIS is based on an agreed technology that is commonly available to the participating centres and capable of handling the foreseen traffic. There are satellite communication channels as well as terrestrial links or managed data network services. Generally TCP/IP is the preferred transmission protocol, but other agreed protocols would be possible, 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 WIS would make it possible for programmes to present their data to their users in a programme-specific query format.

WIS and the Integrated Global Data Dissemination Service (IGDDS)

As in the GTS, the IGDDS is also a component of WIS. It comprises satellite two-way systems and satellite-based alternative dissemination services. Operated by the Satellite Operators and coordinated by the WMO, the IGDDS facilitates within the WIS a cost-effective and reliable data dissemination service for large-volume data sets (i.e., in-situ and satellite data, satellite images, operational and research data and products). The IGDDS also disseminates operational-critical information in countries where GTS links and the Internet have low band widths. IGDDS relies on Advanced Dissemination Methods (ADM), including Digital Video Broadcast by telecommunications satellite (DVB-S) and Direct Broadcast from the meteorological satellites. This includes access to data catalogues and metadata. It allows data discovery and delivering data on request (PULL mode) to authorized users.

WIS and GEO-Netcast

GEO-Netcast is an initiative led within the GEO framework by EUMETSAT, NOAA and WMO to address the global dissemination needs [Diagram 5] of GEOSS. The GEO-Netcast is to use the multicast capability of a global network of communication 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 data sets to be handled in parallel regardless of the source. The use of a data encryption enables to respect the data policy of each data provider and to target the distribution at individuals or groups of users as appropriate, within the footprint of each satellite. GEO-Netcast 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 true global dissemination system responding the needs of all the nine GEO societal benefit areas. WMO will contribute through WIS information exchange services to GEOSS

Implementation

A series of pilot projects [Diagram 6], under the auspices of several WMO technical commissions, have been implemented by several volunteering WMO Member countries. A summary description of current pilot projects is given in Annex I. Several

WIS functions, including the core services to be provided by WIS centres, are being tested and evaluated in the course of 2006. By the end of 2007 it should be possible to achieve, in a few countries, a smooth transition from the current GTS-based systems to the new WIS structures running in a semi-operational or even operational mode. The targeted functions include:

- Reference implementation WMO Core Profile version of metadata;
- Integration of metadata structures into pilot GISCs and DCPCs;
- Internet portal;
- Basic data acquisition using metadata;
- Data discovery service;
- Agreement on specification of data access rights;
- Data distribution service: push and pull services;
- Exchange of monitoring information in agreed format.

The pilot projects are supplemented by an action plan for 2006-2008 of the WMO Secretariat , which is targeted to achieving the following results:

(i)   WMO programmes, associated programme centres and agencies have determined and communicated their WIS requirements; WMO Members' experts and high-level managers are able to factor WIS into their national planning.

(ii)   Relevant non-NMHS user communities are aware of WIS, see value in the collaboration with WMO on WIS, and have defined and communicated their requirements. In reverse, WMO is fully informed of non-NMHS user community developments and has taken action to integrate appropriate non-NMHS functions and services into the WIS.

(iii)   A developing country outreach programme, intended primarily, but not only for their NMHSs, has ensured these countries' effective participation in WIS. With priority on LDCs, developing countries are advised on WIS and possibilities of participation, and receive corresponding support and assistance. ICT staff of developing country NMHSs is knowledgeable in operating WIS facilities in their centres.

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WIS-related Pilot Projects

- JCOMM GISC-E2EDM prototype (Obninsk, Russian Federation);
- CCI CliWare (Obninsk, Russian Federation);
- CAgM WAMIS (World Agrometeorological Information Service, Replublic of Korea);
- CBS VPN Pilot Project in RAs II and V;
- EUMETNET UNIDART project (Uniform data request interface);
- CBS RA VI – SIMDAT Virtual GISC project;
- CAS THORPEX/TIGGE (THORPEX Interactive Grand Global Ensemble)

JCOMM GISC-E2EDM (end-to-end data management) system is a "virtual marine data centre" involving product generation, assembly, archiving and collection, based on the best data management practices. Included are: Grid technology metadata management concept, DiGIR (OBIS) request/response protocol database access service, OPeNDAP (NetCDF) format for "transport" data files, utilities for coding/encoding data, ESIMO (Russia) data model, navigation services, data search mechanism and visualization tools, data file access service, NercDG object segmentation ideology, Sea Sea-Search CDI (Common Data Index), WMO Core Search CDI (Common Data Index), WMO Core Metadata and the E2EDM Global XML Schema.

CCI CliWare (Obninsk, Russian Federation):
CliWare is an information system for climate data providing a 24/7 operational mode via public Internet. Included are formats such as MeteoXml, HTML, text tabulated data, graph images, GML features, Map coverage, Geo images, and WMO FM codes. CliWare retrieves requested data from its database and generates an output data set in the requested form and format. The dissemination service can use HTTP (request reply method), WMO FTP (request reply method), SMTP (push method by e-mail) and SMS (push method by cell phone).

CAgM WAMIS (World Agrometeoroloigcal Information Service, Republic of Korea)
CAgM established a Web portal called WAMIS. Participating countries are Italy, Republic of Korea and the USA. It provides an extension of WIS functions and services tailored to meet the needs of the agrometeorological community. This includes databases, simulation models, and tools for GIS.

CBS–coordinated Regions II/V Pilot Project on Internet Virtual Private Network
Led by Japan, 11 countries participate in that project. It has already demonstrated the feasibility of using Internet-VPN in WIS; further studies will address simplified VPN techniques suitable for very small National Centres, encryption, authorization, privilege levels and authentication to ensure security of data; the capability for an NC to request data, e.g., satellite imagery or NWP output suitable for display under SATAID ([1]); interfaces to RA VI VGISC and UNIDART in Europe.

EUMETNET UNIDART project
UNIDART (UNIform DAta Request InTerface) is a Data Communication Programme that services data requests between users and meteorological data centres. The programme will be implemented as a Web portal application where registered users can log on and access the data stored in more than one data centre. The data access will remain under the control of each data centre. Participants are Finland (FMI),

Norway (DNMI), The Netherlands (KNMI), UK Met Office and MeteoSwiss and Germany (DWD).

CBS RA VI – SIMDAT Virtual GISC project
SIMDAT /[6]/ is a technique that facilitates the synchronized interconnention of several computer centrer within a grid with a view to optimizing load sharing and data interoperability. A SIMDAT portal will be installed on each site and gives users a single view of all the data available at the participating centres. This capability makes SIMDAT potent solution for WIS. The objective of SIMDAT for the meteorology sector is to develop a virtual and consistent view of all meteorological data distributed in the real-time and archived databases of the partners and to provide a secure, reliable and efficient mechanism to collect, exchange and share these distributed data, in order to support research and operational activities of the meteorological community [Diagram 7]. DWD, ECMWF, EUMETSAT, Météo-France and the UK Met Office, with the help of SIMDAT technology specialists, develop and deploy a common system for the collection and sharing of distributed meteorological data. The V-GISC partners will form a cluster, with partners enjoying equal rights and supporting one another. By the use of SIMDAT software and techniques, as well as standards for metadata, data discovery, transport and on-line browsing, the V-GISC infrastructure will improve the load distribution and availability of the system and provide a uniform external interface to the users allowing them to easily locate, access and use the diverse distributed forms of data and their associated metadata.

TIGGE: THORPEX Interactive Grand Global Ensemble
Under the auspices of CAS, this project develops multi-model ensemble systems. Currently (2006), this prototype global multi-model ensemble system consists of three models (CMA, ECMWF, NCAR). It is expected to be distributed over a number repository sites and offer the user transparent and efficient access to the products. One goal is to tailoring sets of products to the needs of end users distinguishing specific geographic areas and operational requirements, as this would minimise routine data transfer demands. However, the challenge with respect to data exchange and management is formidable and important insights are expected from this project as regards the required operational capabilities of WIS.

[1] SATAID is a satellite data presentation software package provided by JMA

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[6] Data Grids for Process and Product Development Using Numerical Simulation and Knowledge Discovery (EU-funded project No. IST-2004-511438)

Diagrams

Diagram 1: WMO Global Telecommunication System (GTS)
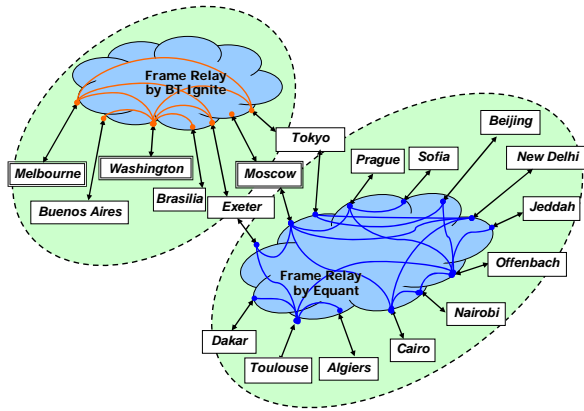Main Telecommunication Network (MTN)

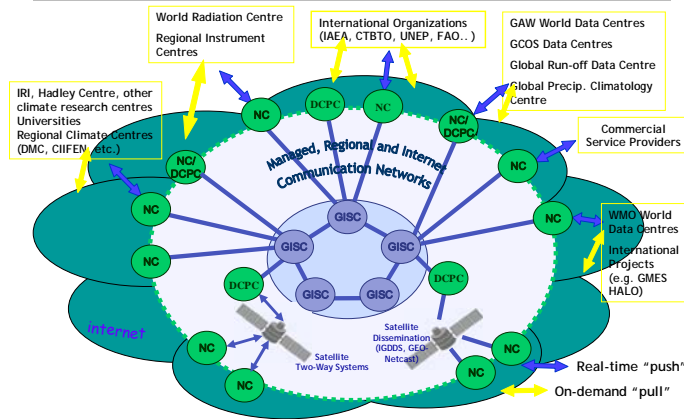## Diagram 2: WMO Information System (WIS)
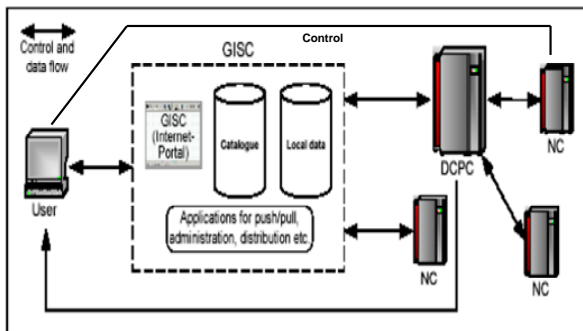

Diagram 3: WIS Design Concept

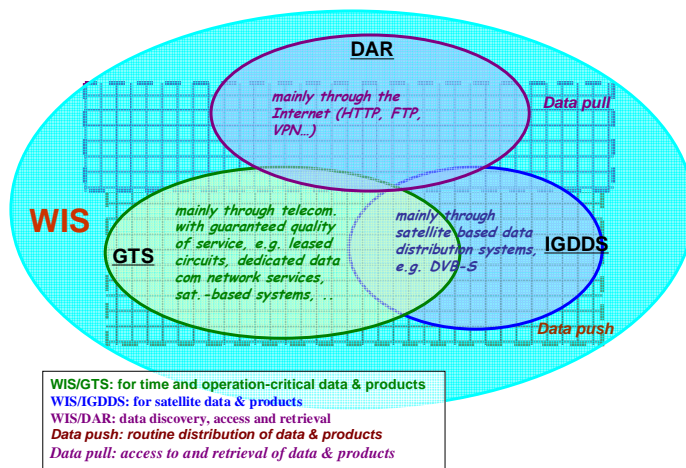**Diagram 4: WIS DATA-COMMUNICATION IMPLEMENTATION**

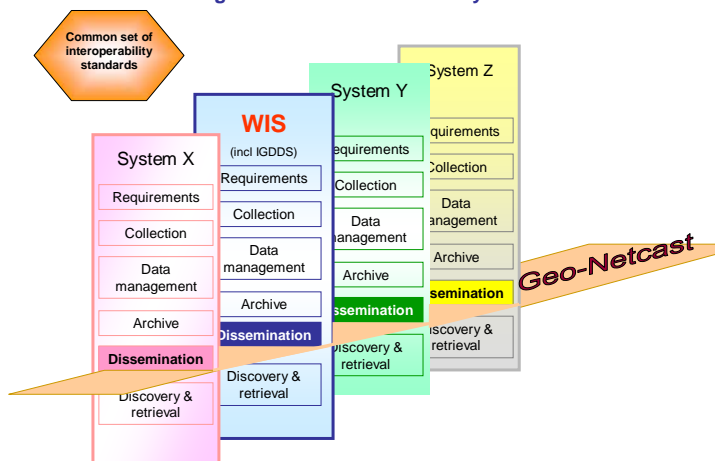**Diagram 5: GEO-Information Systems within GEOSS**

Diagram 6: WIS Implementation 2006-2007

- ✓ Pilot implementation of WMO Core metadata in selected WIS centers;
- ✓ Implementation of Internet portals in selected centres;
- ✓ Improvement of basic data acquisition, discovery and push-pull services;
- ✓ Implementation of European Virtual Global Information Services Center project;
- ✓ Development of WIS center prototypes, including ECMWF, EUMETSAT and NCAR;
- ✓ Implementation of a WIS center prototype for marine meteo. and oceanographic data.

Diagram 7: VGISC Data Communication Infrastructure
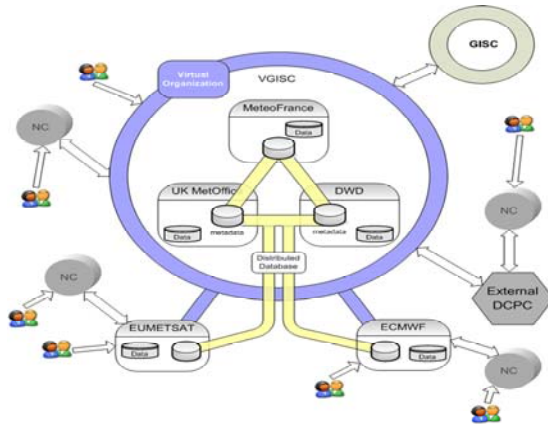
List of acronyms

ADM	Alternative dissemination methods
BADC	British Atmospheric Data Centre
BODC	British Oceanographic Data Centre
BUFR	Binary Universal Form for the Representation of meteorological data
CAgM	Commission for Agricultural Meteorology
CBS	Commission for Basic Systems
CDP	Community Data Portal
Cg	WMO Congress
CREX	Character Representation form for data Exchange
DCPC	Data collection or product centre
DMAC	Data Management and Communications of the Integrated Ocean Observing System
DWD	Deutscher Wetterdienst (German Weather Office)
E2EDM	"End-to-End" Data Management System
EC	Executive Council of WMO
ECMWF	European Centre for Medium Range Weather Forecasts
ESG	Earth System Grid
ET	Expert Team
ET-CTS	Expert Team on WIS-GTS Communication Techniques and Structure
ET-DRC	Expert Team on Data Representation and Codes
ET-MTDF	Expert Team on Migration to Table-Driven Code Forms
ET-OI	Expert Team on GTS-WIS Operations and Implementation
ET-WISC	Expert Team on WIS GISCs and DCPCs
EU	European Union
EUMETNET	European Meteorological Network
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites.
FTP	File transfer protocol
FWIS	Future WMO Information System (renamed WIS)
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GDPS	Global Data Processing System
GEOSS	Global Earth Observation System of Systems
GISC	Global information system centre
GO-ESPP	Global Organization for Earth System Science Portal
GOS	Global Observing System
GRIB	FM 92-VII Ext-GRIB (Gridded Binary) processed data in the form of grid-point values expressed in binary form
GTS	Global Telecommunications System
HWRP	Hydrology and Water Resources Programme
ICG-WIS	Intercommission Coordination Group on WIS
ICT-ISS	Implementation Coordination Team on Information Systems and Service
IGDDS	WMO Space Programme Integrated Global Data Dissemination Service
IMOP	Instruments and Methods of Observations programme
IMTN	Improved MTN
INSPIRE	INfrastructure for SPatial InfoRmation in Europe initiative
IPET-MI	Inter-Programme Expert Team on Metadata Implementation
ISO	International Standards Organization
ISS	Information System and Services
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
KMA	Korean Meteorological Agency
MSS	Message Switching System
MTN	Main Telecommunications Network (of the GTS)
NC	National Centre
NCAR	National Centre for Atmospheric Research
NDG	NERC Data Grid
NERC	Natural Environment Research Council
NESDIS	National Environmental Satellite, Data and Information Service
NetCDF	Network Common Data Form
NMC	National Meteorological Centre

WMO Information System

NMHS	National Meteorological or Hydrological Service
NODC	National Oceanographic Data Centre
NVODS	National Virtual Ocean Data System
NWP	Numerical Weather Prediction
OGC	Open Geospatial Consortium
OGSA-DAI	Open Grid Service Architecture – Data Access and Integration
OPAG	Open Program Area Group
OPeNDAP	Open Source Project for a Network Data Access Protocol
PMO	Project Management Office
QoS	Quality of Service
RA	Regional Association
RSMC	Regional Specialised Meteorological Centre
RTH	Regional telecommunications hub
SIMDAT	Data Grids for Process and Product Development using Numerical Simulation and Knowledge Discovery
TCP	Tropical Cyclone programme
TCP/IP	Transport control protocol, internet protocol
TCRP	Tropical Cyclone Research Programme
THORPEX	THe Observing System Research and predictability experiment
TIGGE	THORPEX Interactive Grand Global Ensemble
UCAR	University Corporation for Atmospheric Research
UNIDART	Uniform Data Request Interface
URL	Uniform Resource Locator
VGISC	Virtual Global information system centre
VO	Virtual Organization
VPN	virtual private network
WAMIS	World AgroMeteorological Information Service
WCASP	World Climate Applications and Services Programme
WCP	World Climate Programme
WCRP	World Climate Research Programme
WDM	World Weather Watch Data Management
WIS	WMO Information System
WMC	World Meteorological Centre (Melbourne, Moscow, Washington)
WMO	World Meteorological Organization
WSP	WMO Space Programme
WWRP	World Weather Research Programme
WWW	World Weather Watch
XML	Extensible mark-up language