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RESEARCH AND SYSTEMATIC OBSERVATION

First compilation and synthesis of national reports on global climate observing systems

Note by the secretariat

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Annexes

I. INTRODUCTION

A. Mandate and scope of the report

1. Article 5 of the UNFCCC requires Parties to fully participate in global climate observing systems and requests them, in carrying out their commitments under Article 4, to support international and intergovernmental efforts to strengthen systematic observation.

2. The Conference of the Parties (COP), by its decision 5/CP.5, adopted the UNFCCC guidelines for reporting on global climate observing systems[1] by the Parties included in Annex I to the Convention (Annex I Parties). It invited all Parties to provide detailed reports on systematic observation in accordance with these guidelines, for Annex I Parties in conjunction with their national communications, pursuant to decision 4/CP.5, and for Parties not included in Annex I to the Convention (non-Annex I Parties) on a voluntary basis. It also invited the secretariat, in conjunction with the secretariat of the Global Climate Observing System (GCOS), to develop a process for synthesizing and analysing the information submitted in accordance with the UNFCCC reporting guidelines on global climate observing systems.

3. In response to the above mandate, the GCOS and UNFCCC secretariats prepared syntheses of the national information on actions with regard to GCOS. The GCOS secretariat summarized, in the interim report, information available by April 2002 in national reports on global climate observing systems from Annex I Parties, and some information on systematic observation provided by non-Annex I Parties (FCCC/SBSTA/2002/MISC.10).

4. This document presents an additional compilation and synthesis of the national reports submitted by Annex I Parties by 30 September, 2002. It is based on 12 separate reports and 11 reports provided as a part of the third national communications. In addition to the report by the GCOS secretariat (FCCC/SBSTA/2002/MISC.10),[2] the GCOS web site[3] provides further reference material.

5. This report analyses the information from Annex I Parties on their actions regarding global climate observing systems; the status and development of the networks; international data exchange; provision of metadata;[4] adherence to GCOS monitoring principles and GCOS best practices; achievements, deficiencies and characteristics of the systems; and support for non-Annex I Parties. It also provides an assessment of compliance of the submitted information with the UNFCCC guidelines on global climate observing systems, identifies good practices in reporting, and provides some views on the possibility of using the information to assess the state of climate observing systems globally.

6. This report follows the structure recommended in the UNFCCC guidelines for individual Party reports. It describes the general approach taken by Parties to meet the needs identified by the GCOS and its partner programmes, and analyses information on meteorological and atmospheric, oceanographic, terrestrial and space-based observations. The annexes contain lists of compilation tables and of abbreviations used in the report.

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[1] See FCCC/CP/1999/7.

[2] Comparative analysis of the reports showed that whereas small differences in inputs led to some differences in some numbers provided in the reports, they are broadly consistent.

[3] http://www.wmo.ch/web/gcos/ and http://www.wmo.ch/web/gcos/gcoshome.html

[4] Metadata, the term used by the GCOS and WMO, means information about data to ensure its utility for all applications that can be envisioned. For meteorological, oceanographic and terrestrial observations, this includes information about sites, instruments and observing procedures. Metadata also refer to the documentation of all relevant details about data sets.

7. This report is one of the series of reports complementing those identified above that aims to inform Parties about current efforts to monitor the Earth's systems. A future report under preparation by the GCOS secretariat on adequacy of the global climate observing system[5] should further assist Parties in defining gaps and priorities for consideration. The reports also complements other efforts to analyse the information from the third national communications of Annex I Parties. The third compilation and synthesis of the third national communications from Annex I Parties will be considered by the Subsidiary Body for Implementation (SBI) at its eighteenth session.[6]

B. Possible actions by the SBSTA

8. The Subsidiary Body for Scientific and Technological Advice (SBSTA) may wish to conduct a preliminary consideration of this report at its seventeenth session. It may wish to further consider this report, together with the reports mentioned in paragraphs 3 and 7, in a more comprehensive manner at its eighteenth session. At the eighteenth session, the SBSTA may wish to consider the issues relating to the reporting of information and ways of improving the global observing systems for climate.

C. Background

9. Different documents relating to GCOS sometimes use different terminology. This section provides some background information on generally accepted GCOS terminology and terminology and notions used in this report. Some explanatory information to assist Parties in their reporting may also be found at the GCOS web site.

The Global Climate Observing System (GCOS) was established in 1992 to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users. GCOS is intended to be a long-term, user-driven operational system capable of providing the comprehensive observations required for monitoring the climate system, for detecting and attributing climate change, for assessing the impacts of climate variability and change, and for supporting research toward improved understanding, modelling and prediction of the climate system. It addresses the total climate system including physical, chemical and biological properties, and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes.

GCOS itself neither directly makes observations nor generates data. It stimulates, coordinates and otherwise facilitates the taking of the needed observations by national or international organizations in support of their own requirements as well as of common goals. It also provides an operational framework for integrating, and enhancing as needed, observational systems of participating countries and organizations into a comprehensive system focused on the requirements for climate issues.

GCOS builds upon, and works in partnership with, other existing and developing observing systems such as the Global Ocean Observing System (GOOS), the Global Terrestrial Observing System (GTOS), and the Global Observing System (GOS) and Global Atmospheric Watch (GAW) of the World Meteorological Organization (WMO).

10. The UNFCCC guidelines request Parties to describe their actions with regard to GCOS (see box above), dividing the observing systems as follows: meteorological and atmospheric, oceanographic, terrestrial and space-based.

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5 The SBSTA, at its fifteenth session, endorsed the preparation by the GCOS secretariat of a second report on the adequacy of the global climate observing systems. The SBSTA noted the need to complete the adequacy report in the shortest possible time in order to provide a framework for further work to improve global monitoring systems (FCCC/SBSTA/2002/8, para. 41).

6 The Subsidiary Body for Implementation, at its sixteenth session, noted that, owing to delays in the submission of national communications, the compilation and synthesis report would be prepared by the secretariat for the eighteenth session of the SBI (FCCC/SBI/2002/6, para. 11(b)).

11. In this report, each of these observing systems will be called a *domain* of GCOS, as accepted in some GCOS documents and used by a number of reporting Parties. Networks or programmes within each domain will be called *components*. Table 1 summarizes information on domains and components of GCOS.[7] Some components (e.g. GSN, GUAN, GAW, VOS, SOOP) are core to GCOS and others constitute national networks from which the core network is drawn, or provide additional valuable climate information.

Table 1. Domains and components of the global climate observing systems

Domain of GCOS	Description	GCOS core components
Meteorological and atmospheric observations	In situ atmospheric observations based on a designated set of GCOS stations. The stations are a subset of existing national and international networks.	**GSN** – the GCOS Surface Network: a global network of high-quality meteorological observing stations specifically selected for monitoring global temperatures. **GUAN** – the GCOS Upper-Air Network: upper air stations that meet specific record length and homogeneity requirements and collect profiles of temperature, winds, humidity, etc. **GAW** – the Global Atmosphere Watch network: monitoring stations that measure atmospheric constituents and surface meteorological data and have an upper air station nearby.
Oceanographic observations	Ocean observations based on requirements of the Global Ocean Observing System (GOOS). There are programmes and fixed observing sites for ocean observations.	**VOS** – Voluntary Observing Ships **SOOP** – Ship of Opportunity Programme **Tide Gauge observations** **SFC (Surface) Drifters** **Sub-Surface Floats** **Moored Buoys** **ASAP** – Automated Shipboard Aerological Programme Optimum mix of measurements needed to meet the goals of climate programmes, including GCOS, providing surface and marine data, upper ocean, deep ocean and remotely sensed data.
Terrestrial observations	Terrestrial climate observations are based on requirements developed jointly between GCOS and the Global Terrestrial Observing System (GTOS). There are a few designated GCOS stations.	**GTN-G** – Global Terrestrial Networks for glaciers **GTN-P** – Global Terrestrial Networks for permafrost **FLUXNET** – terrestrial carbon flux measurements **Other** – monitoring networks with observations of vegetation, biogeochemistry, land cover/land use and disturbance, soil properties, hydrology, cryospheric properties, radiation, trace gases and ancillary variables.
Space-based observations	Space-based observations based on requirements developed by GCOS, and joint GCOS/GOOS, and GCOS/GTOS panels.	Space-based observing programmes or programmes using satellite data to derive climate-related information on atmospheric, oceanographic and terrestrial variables.

12. Space-based observing programmes contribute to systematic observation in the other three domains of GCOS. For example, satellite systems monitor climate-related features such as short-term climate variability associated with the EI Niño – Southern Oscillation, extreme events such as floods and droughts, vegetation cycles, the ozone layer hole, solar fluctuations, changes in snow cover and ice,

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7 Source: http://www.gos.udel.edu, http://www.wmo.ch/web/gcos

ocean surface properties, sea level, deforestation, forest fires and volcanic activity. Some information on satellite observations is therefore considered under the other domains.

13. There are several ways to contribute to space-based observations. Countries that own satellite operations participate in satellite observations by producing “raw” observation data. These data must then be processed using retrieval algorithms to generate data relevant to some property of the Earth’s atmosphere, ocean or land surface. Other participants in space-based observations contribute through other related activities, such as research, instrument development, algorithm development, quality assurance/quality control (QA/QC), hosting satellite ground stations and data analysis, that help to create the data sets relevant to climate. The climate variable in space-based observations is not a direct measurement, but a derivative of the data from the satellite. Satellite-based observations are often now combined with in situ observations to produce data sets of relevance to climate (such as sea surface temperatures).

II. SYNTHESIS OF REPORTED INFORMATION

A. Overview

14. Twenty-three Annex I Parties provided reports on their climate observing systems and actions related to GCOS. Table 2 presents the status of reporting by the Parties.

Table 2. Status of national reporting on GCOS by Annex I Parties

Country	Form of reporting		Relative country size (km^2)	Region
	Separate GCOS report	Part of NC3		
Australia	*		♦♦♦♦	Pacific
Austria	*		♦♦	Europe
Belgium		*	♦	Europe
Bulgaria		*	♦♦♦	Europe
Canada	*		♦♦♦♦	North America
Croatia		*	♦♦	Europe
Czech Republic		*	♦♦	Europe
European Community	*		♦♦♦♦	Europe
Finland		*	♦♦♦	Europe
France	*		♦♦♦	Europe
Hungary		*	♦♦	Europe
Japan		*	♦♦♦	Asia-Pacific
Latvia		*	♦♦	Europe
Liechtenstein		*	♦	Europe
Netherlands	*		♦	Europe
New Zealand	*		♦♦♦	Pacific
Norway		*	♦♦♦	Europe
Poland		*	♦♦♦	Europe
Spain	*		♦♦♦	Europe
Sweden	*		♦♦♦	Europe
Switzerland	*		♦	Europe
United Kingdom	*		♦♦♦	Europe
United States	*		♦♦♦♦	North America
TOTAL	**12**	**11**		

Notes: Country size: ♦ = less than 50,000 sq km; ♦♦ = between 50,000 and 100,000 sq km; ♦♦♦ = between 100,000 and 1million sq km; ♦♦♦♦ = greater than 1million sq km.

15. The level of detail reported and comprehensiveness of the reporting varied across Parties. Several Parties (Australia, Canada, Sweden, Switzerland, United Kingdom and the United States) prepared very comprehensive reports with much detail and additional information on their GCOS participation and their national observing systems that underpin GCOS. Other Parties (e.g. Bulgaria, Czech Republic, Finland, France, Norway) provided less information, limiting their reporting to necessary information requested by the guidelines. Table 3 presents an overview of reporting against the information requested by the UNFCCC guidelines.

Table 3. Overview of information reported

Party	Reporting on general approach				Reporting on domains															
	National policy	Data exchange	Barriers and difficulties	Adherence to GCOS Best Practice Monitoring System	GSN	GUAN	GAW	Ocean coverage	VOS	SOOP	Tide Gauges	Surface Drifters	Sub-Surface Floaters	Moored Buoys	ASAP	GTNP	GTNG	FLUXNET	Other terrestrial networks	Space
Australia	■	■		■	■	■	■	**O**	■	■	■	■	■	■	■	■	■	■	■	**P**
Austria	■	■		■	■		■	**N**									■		■	**P**
Belgium	■	■						**C**											■	**P**
Bulgaria	■	■	■	■	■			**C**	■	■	■									
Canada	■	■		■	■	■	■	**O**	■	■	■	■	■	■		■	■	■	■	**I**
Croatia	■		■					**C**											■	**P**
Czech Republic		■			■		■	**N**												
European Community		■																	■	**I**
Finland	■	■			■	■	■	**C**											■	**P**
France	■	■		■	■	■	■	**B/G**	■	■	■	■	■	■			■	■	■	**I**
Hungary								**N**											■	
Japan	■	■			■	■	■	**B**	■	■	■	■	■	■	■				■	**I**
Latvia		■						**O**												
Liechtenstein								**N**											■	
Netherlands	■	■		■	■		■	**O**	■		■			■					■	**P**
New Zealand		■		■	■	■	■	**O**	■		■		■				■		■	
Norway	■	■			■	■	■	**C**											■	**P**
Poland		■	■		■	■	■	**C/O**	■	■	■			■		■			■	**P**
Spain		■		■	■	■	■	**C**			■			■				■	■	**P**
Sweden	■	■		■	■		■	**O**	■		■			■	■				■	**I**
Switzerland	■	■		■	■	■	■	**N**								■	■		■	**P**
United Kingdom	■	■		■	■	■	■	**B/G**	■	■	■	■	■	■	■			■	■	**P**
United States	■	■		■	■	■	■	**G**	■	■	■	■	■	■	■	■	■	■	■	**I**

Notes: 1. Ocean coverage type: N = no coastline; C = coastal coverage; O = offshore sites; B = basin-wide sites; G = near-global coverage;
2. Space programmes: I = in situ programmes, including satellite operations; P = participation in regional grouping or similar trans-national program

16. Reporting Parties produced useful information at a good level of standardization. Some Parties recognized that preparing the reports had served a useful purpose in their own countries.[8] In most cases the reports revealed that Annex I Parties are taking several positive actions in support of the GCOS, including additional network planning, raising the profile of GCOS in their communities, fostering greater coordination between domains and implementing upgrades such as achieving better balloon heights and putting extra effort into metadata and best practices. A number of good practices in reporting can be highlighted and recommended in preparing future reports (see section G).

17. In most cases Parties broadly followed the UNFCCC guidelines and therefore generally much of the information is comparable and easy to synthesize. The reporting tables that summarize the status of the atmospheric, oceanic, and terrestrial contributions to GCOS especially added to the degree of consistency. Seventeen Parties submitted these tables. In addition, 11 Parties submitted supplementary information.[9] On their general approach to systematic observations, Parties reported information that is appropriate to their national circumstances, such as size of country, size of national networks, and local climate specialization.

18. There were few cases of deviation from the guidelines and misreporting. Some Parties provided only textual information without presenting it in the form of core tables as requested by the guidelines. In two cases Parties did not supply relevant information on the GCOS designated GSN station. There was also some misreporting on meteorological observations (see section C). A few Parties noted that not all of their national terrestrial monitoring programmes were reported, but they did not indicate what was omitted. Reporting on space observation was diverse because of different forms of contribution noted in paragraph 13.

19. The area where reporting was limited and not very transparent was adherence to GCOS monitoring principles and best practices. Although many Parties recognized the importance of them, they seemed to have difficulties in reporting in accordance with best practice and for the different GCOS domains. From the reporting it is clear, however, that achieving the standards identified by GCOS climate monitoring principles will need continuing effort in all countries. More detail or simple benchmarks may be useful in this area, to identify common problems and key areas of weakness.

20. There also appeared to be some reluctance to give details on deficiencies and difficulties encountered in gathering and providing the data, although some Parties (Bulgaria, Croatia, Poland) reported that resource restrictions were a barrier to data exchange. Some reports noted the need for capacity-building to support GCOS effectively in countries with economies in transition. Integration across the networks was identified as an issue in most countries, and many of the components in all domains needed work on quality control, best practice and metadata. A number of future commitments were accompanied by qualifying phrases such as “depending on resources”.

21. In the global context, the reports did provide a means of gauging the status of global climate observing systems in many developed countries (see section H). They are not representative enough for assessment of the state of GCOS as refers to the meteorological and atmospheric domain and to most components of the terrestrial domain. The reports provide a good representation for the assessment of global space and ocean observations, and some atmospheric constituents.

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[8] The SBSTA, at its sixteenth session, also noted that many Parties had found the process of preparing the national reports to be a useful means of drawing attention both to the deficiencies in monitoring systems in key areas and to the diversity of data and systems that do exist, many established for research purposes (FCCC/SBSTA/2002/6).

[9] The SBSTA, at its thirteenth session, welcomed the information provided by Australia on a supplementary reporting format to the UNFCCC reporting guidelines on global climate observing systems. It encouraged Parties to consider this information in preparing their national communications (FCCC/SBSTA/2000/14, para. 60). The supplementary guidelines can be found on the GCOS web site http://www.wmo.ch/web/gcos/gcoshome.html

B. General approach to systematic observation

1. National programmes and plans

22. Thirteen Parties reported on the status of national plans and/or national policy guidance on systematic observation. Table 4 provides a compilation of information reported by Parties relating to plans and coordination. Two Parties (Australia, Canada) reported the existence of specific GCOS-related national plans.

Table 4. National planning and coordination arrangements relevant to GCOS reported by Annex I Parties

Party	Information reported
Australia	Participation planned through the Australian GCOS/GOOS/GTOS Joint Working Group (JWG). The JWG reports to a Steering Committee (Australian representatives of the principal international sponsoring organizations of GCOS, GOOS and GTOS). Australian GCOS/GOOS secretariat provides support. Plan exists for the "Australian Climate Observing System (ACOS), a contribution to GCOS"
Belgium	No specific national GCOS policy, no GCOS focal point, proposal for an operational oceanography task force
Canada	Canadian National GCOS Committee, national GCOS plan (accelerated by Canadian Climate Change Action Fund), recent review of the nation's ocean observing networks, Federal Government Action Plan 2000 on Climate Change
Croatia	Reported a National Climate Programme (no specific GCOS plan)
European Community	Elements under European Community research or environmental policies contribute to development of global observation systems
France	Defining and putting in place networks for GCOS coordinated through National Research Programme on Climate Dynamics (PNEDC)
Japan	No specific GCOS plan; comprehensive planning under Science and Technology Basic Law and Council of Ministers for Global Environmental Conservation
Netherlands	Integrated national programme for implementing contributions to GCOS not yet established – steps are being taken
Norway	Does not have a separate national GCOS programme, Norwegian Council for Operational Oceanography coordinates activities with international GOOS-related activities, and some other planning through Research Council
Sweden	Responsibility is divided between several agencies and organizations, a national GCOS focal point may be created in 2002
Switzerland	No specific GCOS plan but relevant planning mostly embedded in other plans for air and pollution
United Kingdom	No national GCOS plan, coordination under Global Environmental Change Committee, GCOS coordinator in United Kingdom Meteorological Office
United States	GCOS Program Coordinator, no integrated GCOS plan but comprehensive plans under various mechanisms such as National Oceanographic Partnership Program

23. Some Parties (Belgium, Canada, Norway, United States) noted recent or current network reviews that are providing assessments to underpin the development of new plans. A national GCOS focal point, coordinator or secretariat was reported by four Parties (Australia, Sweden, United Kingdom, United States). Several Parties (Australia, Canada, France, Japan, Sweden, United Kingdom, United States) have instituted internal mechanisms to ensure coordination of climate activities generally, although not necessarily specific to GCOS.

24. National planning is at different stages among the reporting Parties. While a sizeable national effort is required to produce and integrate national plans and to establish national GCOS focal points, the effort appears to bring benefits such as improved integration and information flow. Parties which reported on national policy guidance (e.g. Canada, France, Japan), noted that this tied their observational programmes more directly to their national needs.

25. None of the Parties noted formal adoption of their national plans for global observation of the climate system. There was also little reporting on the schedules for implementation of plans other than in

very general terms. However, the countries with larger economies (Australia, Canada, United States,) reported they are making steady progress with GCOS within their large national observing systems, and are able to report schedules for some elements (e.g. Argo floats). Some of the countries with economies in transition (Bulgaria, Croatia, Poland) reported severe resource problems and appear to be struggling to maintain their national networks for their own purposes. For these Parties, progress relating to the GCOS is less steady and more of a challenge, and schedules are more difficult to implement.

2. Responsibilities of ministries and agencies

26. Most Parties identified an agency or ministry responsible for each of the GCOS domains. Table 5 provides a summary of the information reported. Almost all Parties reported that there were several governmental bodies, agencies and research institutes involved in systematic observation, as well as different levels of governance within the country.

27. One of the benefits of the national effort on GCOS, noted by a number of countries, is the exchange of information and ideas between ministries and agencies responsible for different domains and the resultant improved coordination. Generally the lines of responsibility are clear between agencies responsible for specific domains. Space agencies, being relatively new, appear to be more centralized (European Community, Japan, United States).

28. Several Parties noted the importance of integrating observations from both in situ and satellite observing platforms, particularly observations over the oceans. This has led to new inter-agency coordinating mechanisms for oceanographic systems, e.g. National Oceanographic Partnership Program (United States), Norwegian Council for Operational Oceanography, a joint system of operational oceanography (France) and a proposal for a task force on operational oceanography (Belgium).

29. Many oceanographic and terrestrial networks, as well as a few of the atmospheric ones, are managed by research programmes and agencies and are supported out of research funds. There was a concern that this will have significant implications for their long-term continuity and homogeneity.

3. Data exchange

30. Parties supplied information on data exchange in the general approach section of their reports and in the sections on different GCOS domains. A few general observations can be made regarding data exchange.

Table 5. Agencies responsible for the different GCOS domains

Party	Meteorological /atmosphere	Oceans	Terrestrial	Space
Australia	Bureau of Meteorology (BoM) (Federal Government) GAW: BoM and Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Several, including BoM, CSIRO and a number of other government agencies	Many different Federal and State agencies	Several (Committee for Earth Observation Satellites) represented via CSIRO
Austria	Central Institute for Meteorology and Geodynamics (ZAMG); Federal Environment Agency Austria		Hydrographical Central Office ZAMG	Austrian Space Agency ZAMG
Belgium	Royal Meteorological Institute (RMI)	Royal Belgian Institute for Natural Sciences, Management Unit of Mathe-matical Model of the North Sea and Estuary of the Sheldt	Federal Office for Scientific, Technical and Cultural Affairs (OSTC); Flemish Institute for Technological Research	OSTC; Belgian Institute for Space Aeronomy; RMI
Bulgaria	National Institute on Meteorology and Hydrology		Ministry of Environment and Water	
Canada	Meteorological Service of Canada of Department of Environment Canada (DEC)	Marine Environmental Data Service (MEDS) of Fisheries and Oceans Canada (DFO)	Provincial jurisdictions, many provincial and university groups; Federal agencies have a national coordination role, e.g. Natural Resources Canada (NRCAN) and DEC	
Croatia	Meteorological and Hydrological Service of Croatia	Ministry for Oceanography and Fisheries; Hydrographic Institute and research institutes	Ministry of Environmental Protection and Physical Planning and research institutes	
Czech Republic	Czech Hydrometeorological Institute; Mileöovka observatory; solar and ozone observatory		Observatory for monitoring the quality of the natural environment	
Finland	Finnish Meteorological Institute (FMI); Finnish Environment Institute (SYKE)	Finnish Institute of Marine Research, FMI	SYKE; FMI	
France	Météo-France and several other agencies	Seven agencies	Several agencies	Centre National d'Études Spatiales
Hungary	Hungarian Meteorological Service; Eötvös Loránd University			
Latvia	Latvian meteorological service (SHMB)	Includes SHMB	Latvian Environment Agency	
Liechtenstein			Office of Civil Engineering; Office of Environmental Protection	

Table 5. Agencies responsible for the different GCOS domains *(continued)*

Party	Meteorological /atmosphere	Oceans	Terrestrial	Space
Netherlands	Includes Royal Netherlands Meteorological Institute (KNMI); Laboratory of Air Research	Includes Netherlands Institute for Sea Research; Utrecht University (IAMU); KNMI	Includes KNMI	
New Zealand	Meteorological Service of New Zealand and National Institute of Water and Atmospheric Research			
Norway	Norwegian Meteorological Institute; Norwegian Institute for Air Research	Norwegian Institute for Marine Research and other institutes	Various monitoring programmes	
Poland	Institute of Meteorology and Water Management (IMGW); two universities	IMGW, Institute of Oceanology and Institute of Hydroengineering	Adam Mickiewiez University	IMGW
Spain	National Institute for Meteorology (NIM) and several other institutes	Spanish Institute for Oceanography and the Port Authority	NIM and others	NIM and Centre for Satellite Applications
Sweden	Swedish Meteorological and Hydrological Institute (SMHI); and universities	SMHI	National Land Survey of Sweden; Geological Survey of Sweden; universities, research institutes	Swedish National Space Board
Switzerland	MeteoSwiss; Swiss Agency for Environment, Forest and Landscape; Swiss Federal Institute of Technology		Several agencies	Swiss Space Office
United Kingdom	Meteorological Office; British Antarctic Survey; Department for Environment, Food and Rural Affairs	Inter-agency Committee for Marine Science and Technology; Meteorological Office; several agencies and laboratories	Over 14 government departments and agencies (Environmental Change Network)	Focus through British National Space Centre; 11 government organizations and agencies
United States	National Oceanic and Atmospheric Administration (NOAA)	NOAA; 12 agencies	Department of the Interior, National Science Foundation and others, particularly research programmes	National Aeronautics and Space Administration; Department of Defense; several other agencies

31. All Parties noted that international agreements regarding data exchange were adhered to in principle and that much of the GCOS data was being exchanged and, in particular, supplied to international data centres (IDCs). This was particularly the case for the operational systems.

32. A number of Parties provided information on some of their activities on management and operation of data and on collaborative efforts in this area. One initiative of note is the establishment by the European Community of common European databases, to facilitate the data exchange and lodgement efforts of a large region. Other examples of data management coordination include the Canadian development of a broad national archive system, the Global Change Data and Information System in the United States and recent efforts to develop a national information system in Bulgaria.

33. Ten Parties (see table 6) reported undertaking additional responsibilities on behalf of all Parties (in the provision of data archiving, data monitoring and/or quality control, secretariat support, etc.) through the establishment and operation of world or international data centres (and associated web sites), quality assurance or calibration centres, and secretariat offices.

Table 6. Contributions to international centres or offices

Party	Information reported
Australia	International project office of the Global Ocean Data Assimilation Experiment (GODAE), SCAR Global Change Programme Office
Belgium	Hosts a vegetation image processing centre; plans to host an operational thematic service centre for GMES, of relevance to GTOS (GCOS)
Canada	Operating the World Data Centre for Ozone and Ultraviolet Radiation and the World Calibration Centre for Brewer Instruments
European Community	European Information and Observation Network on Environment (EIONET); World Fire Web (WFW)
France	A Tropical Ocean and Global Atmosphere/World Ocean Circulation Experiment (TOGA/WOCE) database
Japan	GCOS Surface Network Monitoring Centre (GSNMC) (jointly)
Norway	European database for stratospheric ozone
Switzerland	World Optical Depth Research and Calibration Centre; Quality Assurance / Scientific Activity Centre (QA/SAC) and World Calibration Centre for surface ozone, carbon monoxide and methane; World Radiation Monitoring Centre; two world data centres and a metadata centre
United Kingdom	ICSU World Data Centre for Glaciology; GUAN Data Analysis Centre; approval to host a regional Argo Data Centre for the Southern Ocean
United States	GSN database and web site; Global Observing System Information Centre (GOSIC); EOS data and information systems; Global Change Data and Information System (GCDIS); GUAN Data Analysis Centre

34. It was noted that some research systems have more detailed rules and conditions governing the exchange of data. More terrestrial and oceanographic systems are currently research-based and appear to be subject to such conditions. Generally, the exchange of meteorological and atmospheric data tends to be more straightforward and not subject to such conditions.

35. The ability to meet the GCOS requirements for metadata varied between domains and components. Generally, Parties reported that only a few networks had adequate, sufficient and well-archived metadata. However, a number of upgrade efforts were being undertaken in this area (Australia, Sweden, Switzerland, United States). Nevertheless, achieving full compatibility between GCOS data exchange requirements and national data policies is an ongoing effort. In general, the reports suggest that data exchange problems can be resolved with some additional effort.

4. Capacity-building in developing countries

36. Ten Parties reported specifically on their capacity-building contributions (see table 7). These included support to observing networks, equipment, training and assistance with GCOS workshops. Such support was often related to the wider global observing system and/or WWW networks.

Table 7. Capacity-building activities

Party	Contribution
Australia	With the member countries of the South Pacific Forum, manages a network of sea level stations in 11 Pacific island countries
Austria	Within an IHP-UNESCO project, supports the start of a glacier mass balance monitoring network in the Himalayas
Canada	Assists China in maintaining a GAW station
Finland	Cooperative projects in meteorological technology transfer and education/ training in some 30 countries in the past 10 years. A programme to enhance systematic climatic observations took place in 1987–1993 in the SADC countries of southern Africa. Assistance to Mozambique in reconstructing meteorological institute after devastating floods in 2000
France	Research programme on tropical glaciers (Bolivia, Ecuador and Peru – with Andean partners)
Japan	Promotes the Asia-Pacific Network for Global Change Research (APN) and facilitates implementation of observation and monitoring throughout the Asia-Pacific region
New Zealand	General assistance to Kiribati, Tuvalu, Samoa, Tokelau, Tonga, Niue and the Cook Islands in weather and climate observing systems; technical training in the Cook Islands, Tuvalu and Tokelau; support to upper air observations (part of GUAN) at Tuvalu, Kiribati and Penrhyn through WMO trust fund; APN (Asia-Pacific Network) workshops for South West Pacific island countries; monthly *Island Climate Update*
Netherlands	KNMI operates an ozone station in Paramaribo, Suriname
Sweden	Institutional cooperation in human resource development, technical assistance and consultancy. Training programmes, including GIS (Geographical Information System) and remote sensing for participants from developing countries, e.g. the United Nations International Training Course on Remote Sensing, held in Sweden for more than 10 years
Switzerland	Support to the GAW Nairobi Ozonesonde Station; international comparisons of Dobson spectrophotometers for GAW region VI at Arosa; an FOWG hydrological project related to the Aral Sea
United Kingdom	Financial contributions are provided in support of four foreign GUAN stations, located at Seychelles and at Tarawa, Funafuti and Penrhyn in the Pacific; financial support is also provided to the Global GAW station at Mace Head, Ireland
United States	Will provide resources to help build climate observation systems in developing countries throughout the world

37. Several Parties noted their new and planned commitments, such as a willingness to provide new financial resources to support the provision of essential observations (United States), new funding recently allocated to help a restructuring effort in Mozambique (Finland), continuing support to GCOS-related workshops for the Asia-Pacific Network (New Zealand), and/or general strengthening of capacity-building (Switzerland).

5. Difficulties encountered and steps taken to improve the availability of information

38. These items were sparsely reported on. Several efforts were reported in all the domains that aimed to improve data access and metadata information; however steps taken to improve availability of other metadata (the information about the broad status of the networks) were not generally indicated. Nevertheless, the production of the reports themselves is a contribution in this area.

6. Adherence to GCOS climate monitoring principles and best practices

39. Parties are requested to describe the extent to which their observation practices comply with GCOS/GOOS/GTOS climate monitoring principles and relevant best practices, referred to in the guidelines. Many Parties noted the value of the principles and best practices, or stated that they were becoming increasingly accepted, but they provided very limited information on compliance. Australia provided information about how its GCOS system adheres to the 10 GCOS monitoring principles relating to meteorological and atmospheric observations; and the United States gave summary information on its “other surface networks”. Some Parties made a general comment that the principles were met to a degree. Ten Parties (Belgium, Czech Republic, Croatia, Finland, Japan, Latvia, Liechtenstein, Norway, Poland and Slovakia) provided no information.

40. Some Parties (Australia, Belgium, Bulgaria, Canada, United States) noted that the networks that now contributed to the GCOS domains had been established to meet requirements other than climate and/or that they continued to be multi-purpose networks, serving research or routine weather operations as well as climate purposes. Therefore adoption of relevant GCOS best practices required upgrades and changes to established practice and required time and effort to implement them.

7. Additional information

41. Most Parties provided a great deal of additional information, showing a comprehensive approach to monitoring weather, climate and related environmental impacts, the use of information in real time and the retention of information for research and climate purposes. The reports also included information on the achievements, deficiencies and characteristics of systems, which may be useful in assessing current status and reviewing progress. Some Parties supplied additional information in the form of tables as suggested in the supplementary guidelines, while others used different formats. Table 8 presents a summary of supplementary information reported.

Table 8. Supplementary information

Party	Supplementary tables											Other
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	
Australia	■	■	■	■	■		■	■	■	■	■	Space participation
Austria	■	■	■		■				■	■		Examples of projects
Canada	■		■		■		■					
Japan	■	■	■	■	■							
Latvia												Databases of the Latvian Environment Agency
Netherlands	■	■	■	■	■	■	■	■	■	■	■	
New Zealand	■	■	■	■	■	■	■	■	■	■	■	
Spain	■	■	■	■	■	■	■	■	■	■		
Sweden	■	■	■	■	■	■	■	■	■	■	■	

Table 8. Supplementary information *(continued)*

Party	Supplementary tables											Other
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	
Switzerland	■	■	■	■	■	■			■	■	■	Responsibilities and long-term commitments at the national level
United Kingdom	■	■	■	■	■	■	■	■	■	■	■	Atmospheric observations – radiation
United States	■	■	■	■	■	■	■	■	■	■	■	Satellite series, observational requirements

Note: S1: Atmospheric observing systems for climate at the land surface (meteorological land surface observations); S2: Available homogeneous data sets for meteorological land surface observations; S3: Atmospheric observing systems for climate above the surface (meteorological upper air observations); S 4: Available homogeneous data sets for meteorological upper air observations; S5: Atmospheric constituent observing systems for climate; S6: Available homogeneous data sets for atmospheric constituents; S7: Oceanographic observing systems for climate; S8: Available homogeneous data sets for oceanographic observations; S9: Terrestrial observing systems for climate; S10: Ecological observing systems for climate; S11: Available homogeneous data sets for terrestrial and ecological observations

42. Examples of additional information included ozone and surface deposition monitoring (Belgium, Canada, the Netherlands, United States) environmental monitoring in the high Alps (Switzerland), and Antarctic programmes (Australia, Japan, New Zealand, United Kingdom, United States). Some Parties (Australia, Austria, Spain, United Kingdom, Japan, the Netherlands, New Zealand, Sweden, Switzerland, United States) also provided information on available homogeneous data sets in different domains. As an example, table 9 lists the number of available homogeneous data sets reported by Parties in the supplementary tables.

Table 9. Available homogeneous data sets

GCOS domain/area of interest	Number of homogeneous data sets reported
Surface meteorology	38
Upper air meteorology	11
Air constituents	22
Ocean	34
Terrestrial/ecological	43

Note: Many terrestrial/ecological data sets are for locations, areas or regions, whereas the others are often national or near-global data sets.

C. Meteorological and atmospheric observations

43. Table 10 summarizes the information on the status of meteorological and atmospheric networks (GSN, GUAN and GAW). Table 3 shows what Parties reported on these components.

Table 10. Participation in the global meteorological and atmospheric observing systems for climate

	GSN	GUAN	GAW	Total units
Q1. How many stations are the responsibility of the Parties?	307	79	109	495
Q2. How many of those are operating now?	307	79	108	494
Q3. How many of those are operating to GCOS standards now? (% of number in Q1)	~ 283 (92)	~ 59 (~ 75)	96 (88)	438 (88)
Q4. How many are expected to be operating in 2005? (% of number in Q1)	< 307 (< 100)	< 68 (< 86)	< 97 (< 89)	472 (95)
Q5. How many are providing data to international data centres now? (% of number in Q1)	306 (99)	72 (91)	101 (93)	479 (97)
Total number of stations in the global network	989	150	22 global and 300 regional were reported	1461
Number of Parties reporting	17	11	16	

Note: These numbers include stations operated by the Parties in Antarctica and overseas islands and territories.

44. According to the designated GCOS lists (www.wmo.ch/gcos/), 19 of the 22 reporting countries have responsibility for GSN stations. Two of these Parties did not supply information (Hungary, Latvia). There was also some misreporting on GSN stations: along with their GSN stations, two Parties (Poland, Spain) included their synoptic weather (WWW) stations in the reporting tables. Table 10 contains only the designated GSN stations for these two Parties.

45. The information provided in the reports relating to the Global Atmosphere Watch is a mixture of the GAW global observatories and GAW regional stations (including ozone monitoring stations, etc.). In general, the global observatories contribute directly to global estimates of atmospheric composition, while the regional networks focus on regional variations. Several Parties (Australia, Canada, Sweden) provided the sum of their GAW and regional stations, while the United States presented only its four designated GAW stations in the corresponding table of the guidelines, providing in addition extensive descriptive information on its regional networks. Table 10 shows both the global and the regional number of stations.

46. Parties generally reported difficulties in answering question 3. The reported figures probably represent a best estimate of the number that comply in a broad sense with the monitoring principles and generally meet best practice (see also section 2).

47. Parties expected that their future GSN networks would remain at the current level, while the number of GUAN stations was expected to be reduced in 2005. Several Parties (Australia, Canada, United States) expressed concern about the possibility of maintaining all GUAN stations in the future because of their relatively high cost. The GAW network is also expected to decline slightly in 2005, although the United States indicated that most of its regional constituent networks would be operating in 2005.

1. Data exchange, quality control and archiving

48. The meteorological and atmospheric stations of this GCOS domain have a very high level of data exchange with international data centres (averaging over 90 per cent). Only a small number of GSN and GUAN stations do not provide data to international data centres in a timely fashion, and a small percentage of GAW observations do not reach relevant data centres.

49. Almost all Parties reported wide involvement in the collection and exchange of atmospheric observations required for climate purposes. These networks were well developed and often relatively stable and long-standing. In almost all cases, well-established national organizations were in existence for the management of these programmes. Many Parties (Australia, Canada, France, Japan, Latvia, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States) also noted the involvement of WMO in the international coordination of data. Bulgaria mentioned the role of WMO in training and the development of technical manuals.

50. Generally speaking, few barriers to the exchange of GCOS data were reported. However, Bulgaria noted that financial restrictions limited telecommunications and therefore the transmission of data and Croatia noted the need for capacity-building for collection and exchange of data.

51. Several Parties (Australia, Canada, the Netherlands, New Zealand, Sweden, United Kingdom, United States) indicated improvements in data access systems, e.g. by digitizing historical data and Internet access, as well as improvements in submitting data to international data centres. Some commitments to reduce backlogs (Canada, Switzerland) were also reported.

52. Many Parties reported the use of standard quality control procedures for data, e.g. as specified in the WMO Manual on the Global Observing System, and retention of these data in accessible data archives. Australia, Austria, Canada, France, Japan, the Netherlands, New Zealand, Switzerland, United Kingdom, and the United States reported that some of their metadata were available (although not usually online). However, most reported that their QC procedures and metadata are not fully adequate for GCOS requirements. Some Parties reported that their metadata systems were improving, e.g. with new software for QC and access (Australia, Switzerland, United States). The United States noted that digital metadata were available for some of its constituent monitoring programmes.

53. The United States noted that it is responsible for an archive of long-term GSN daily and monthly data, which is of interest to the UNFCCC and GCOS communities, and provided information on the archive’s status. The Party stressed that only 250 of the 989 GSN stations had all the historical daily and monthly records in the archive. This represents less than 30 per cent of GSN stations.

2. Adherence to GCOS climate monitoring principles and best practices

54. Fourteen Parties (see table 3) reported in general terms on adherence of their systems to the GCOS best practices and climate monitoring principles. It is clear, however, that not all monitoring principles and best practice guidelines are being met and that they represent a challenge for even the most developed countries.

55. For the underpinning national observing systems in a country, best practices as recommended by WMO are usually followed: a few Parties made reference to WMO manuals or standards in regard to their national networks. For the designated GCOS components, most Parties reported adherence to the additional GCOS standards in very broad terms. These Parties reported general adherence to most of the principles for the GSN. Only one Party (Australia) provided an assessment of the level of adherence to each of the 10 GCOS principles (see also section G). Bulgaria noted consistency with best practice “to the extent possible given available technologies and devices”, and Poland mentioned interruptions to a large fraction of observing sites. Parties provided less description of adherence in the GUAN and GAW networks.

56. Several activities were mentioned to improve adherence to the GCOS principles. In order to achieve or maintain the spatial density of observing sites required by GCOS, offers of new or substitute stations were made by Canada and Sweden; Australia and Canada had recently introduced changes to their GCOS Upper Air Network (GUAN) programmes in order to achieve the balloon heights required at GUAN stations.

57. Continuity of homogeneous time series is one of the GCOS principles that appears to be at risk. It was recognized by Parties that ongoing automation and site relocations have the potential to disrupt the homogeneity of the data record. For example, the United States reported recent site changes to around 35 per cent of its national upper air network (a network of 102 NWS-operated stations, of which 20 are GUAN stations) with instrument changes planned over the next five years. Sweden and Switzerland also mentioned significant changes in networks. It was recognized that maintaining overlapping measurements for a transition period can be a difficult exercise (Australia, for example, reported some unsatisfactory data during overlap periods).

3. Achievements, deficiencies and characteristics of systems

58. Many reports included information on achievements, and some on deficiencies and characteristics of their systems.

59. In terms of achievements, many of the Parties noted that their GSN stations made a wider range of observations than the temperature and precipitation elements specified by GCOS. Some Parties reported holding among the longest time series (United Kingdom, United States), making significant contributions to international calibration (Switzerland), participating in European air composition programmes (Hungary) or monitoring for the high Alps (Austria). In addition, some Parties (Canada, Sweden, Switzerland, United States) contributed to the Baseline Surface Radiation Network, or other surface radiation, atmospheric radiation and sunshine observations (Canada, United Kingdom, United States). A number of Parties (Australia, Canada, Hungary, Poland, United Kingdom United States) were involved in measuring the local composition and quality of the atmosphere (e.g. deposition (Canada, United Kingdom, United States), ozone (Belgium, the Netherlands), turbidity (Sweden) or CO_2 monitoring (Finland, Poland)). Most Parties reported on high quality data sets available for use by the climate change community, including a number of very long-period time series (Poland, Slovakia, United Kingdom, United States).

60. Pointing to deficiencies, Poland expressed doubt about its ability to continue long time series in the future because of resource pressures. Some concern was expressed regarding maintaining GUAN networks in the future, as mentioned in paragraph 47. The need for new equipment and training was noted by Bulgaria, and for capacity-building by Croatia.

61. Most Parties noted the changing nature of their atmospheric and meteorological systems, particularly in terms of automation as a characteristic of the system, although some networks are not fully operational, particularly the GAW networks.

D. Oceanographic observations

62. Many reporting Parties are maintaining the key elements of the Global Ocean Observing System. A summary of information is presented in table 11. Parties reported on each of the related GCOS components presented in table 3.

Table 11. Participation in the global oceanographic observing systems

	VOS	SOOP	Tide Gauges	Surface Drifters[a]	Sub-Surface Floats	Moored Buoys	ASAP	Total system units
Q1. For how many platforms are the Parties responsible?	3322	173	446	~898	280	266	10	5175
Q2. How many are providing data to international data centres? (% of number in Q1)	~2300 (~82)	161 (~93)	382 (86)	~898 (~100)	256 (91)	221 (83)	9 (90)	4661 (90)
Q3. How many are expected to be operating in 2005? (% of number in Q1)	2901 (~87)	153 (~88)	421 (94)	~855 (~95)	1960 (700)	244 (92)	11 (110)	6545 (126)
Number of Parties reporting	10	7	12	6	7	10	5	

[a] *The numbers for surface drifters are estimates, because some Parties (e.g. United States) appeared to report annual deployments, while others (e.g. Australia, United Kingdom) estimated actual live units.*

63. Ten Parties currently participate in the Voluntary Observing Ship (VOS) programme, providing ocean surface meteorological data and some sub-surface ocean data. This programme has been scaled down in recent years; some Parties (Australia, Canada, Sweden) reported difficulties in maintaining numbers due to technological changes in shipping. Seven countries contribute to the Ship of Opportunity Programme (SOOP), which has over many years contributed considerable temperature and salinity data on shipping routes. The tide gauge network, providing important sea-level data, is represented by 12 Parties.

64. Six countries are currently deploying the buoys of the surface drifters programme, providing sea surface temperature and surface velocity data. Sub-surface floats are relatively new but seven countries are already contributing to this programme. Several Parties (Australia, Canada, France, Japan, New Zealand, United Kingdom, United States) indicated that they were making new commitments to the sub-surface float programme. The Automated Shipboard Aerological Programme (ASAP) provides valuable upper air soundings over open ocean areas. It is a small but important component, with a capacity for automatic transmission of high quality observations.

65. An analysis of the data in table 11, along with comments made by a number of Parties, shows that the number of ships participating in the VOS and SOOP programmes is undergoing a slow decline, and their use is expected to be lower in five years' time. The tide gauge component is projected to remain reasonably stable, with a small decline in numbers. The Surface Drifting Buoys programme is a fairly well established programme that appears to have a commitment for the next five years, although the long-term availability of funding was reported as an issue.

66. The Sub-surface Profiling Floats programme is a significant new contribution to ocean observing. At the present time, most of the investment comes from research funding. The planned growth over the next five years will improve spatial coverage across ocean basins as well as within the important ocean thermocline. Seven Parties (Australia, Canada, France, Japan, New Zealand, United Kingdom, United States) plan to contribute to the new sub-surface floats (Argo) programme. In addition, some expansion in the surface drifter programme (Japan, United States) appears to be planned

over the next few years. At the same time, some Parties (Canada, Poland, Spain, Sweden, United Kingdom, United States) reported that some of the traditional observing platforms are at risk of reductions.

67. Apart from the network components listed in table 11, some Parties (Australia, Canada, nited Kingdom and United States) reported field programmes or routine surveys for plankton, other biogeochemical observations and deep ocean sections that contribute to carbon flux information.

68. It should be noted that Parties made very little differentiation among the components of the ocean (GOOS) domain when reporting on such areas as data exchange, GCOS monitoring principles and best practice, deficiencies, etc. Therefore further analysis will not provide much detail in these areas.

1. Data exchange, quality control and archiving

69. The oceanographic data under the GCOS umbrella are being successfully exchanged, although to a slightly lesser extent than atmospheric data. Some of the data are available in real time and almost all are available to international data centres. The standard of QC was generally rated by Parties as acceptable.

70. Several Parties (Australia, Canada, United Kingdom, United States) noted that there were a number of agencies responsible for archiving, leading to separate databases. The European Community noted, however, a project that will deliver a European directory of ocean-observing sites and metadata. A planned new information system was noted by Belgium, and United Kingdom reported on the OceanNet data portal.

71. There are some apparent variations in data provision to IDCs among ocean GCOS components. As can be seen from table 12, VOS, tide gauges and moored buoys appear to have lower provision rates, although no explanatory information was supplied by Parties, except for Sweden, which reported that its VOS data should get to the IDCs indirectly. It should be noted also that not all Parties provided information on VOS data provision. Several Parties reported that the real time exchange on VOS and Surface Drifting Buoys was routine. Canada noted that quality control activities (including metadata) in the VOS programme were at levels below what was needed, but that some rationalization effort was under way in order to ensure that a high quality core of observations could be maintained for climate purposes.

72. The new sub-surface floats programme is achieving relatively high data exchange rates. It was noted that there was significant regional and international cooperation in the moored buoys programme and that data exchange was occurring in real time.

2. Adherence to GCOS climate monitoring principles and best practices

73. Parties provided very limited information on GCOS best practices and adherence to GCOS best practice standards and principles in relation to ocean observations. Some Parties (Canada, France, Japan, United Kingdom, United States) reported a substantial effort in improving oceanographic observations, including upgrades to meet GCOS needs such as wider global coverage, integration of satellite and in situ observing methodologies, and recognition of the need to operationalize more of the ocean systems. Most reporting Parties expressed concern that the short-term data gathering programmes for research and the transfer of research programmes to continuous operational efforts negatively impact the quality of observations and data, and in particular continuity.

3. Achievements, deficiencies and characteristics of systems

74. The information reported by the Parties revealed some *achievements* in oceanographic observations. This included improved Internet-based data access systems, regional cooperation (e.g. EUROGOOS), and the already mentioned significant expansion over the next few years of the new

programme of sub-surface floats. Several Parties (Canada, Norway, United Kingdom, United States) reported also that they were undertaking additional ocean observations. Parties reported on the following: deep ocean sections made during hydrographic surveys; biogeochemical surveys (Australia, Canada, United Kingdom, United States); in situ sea ice observations (Canada, Latvia, Sweden), as well as considerable efforts in remote sensing (particularly Japan, European Community and United States).

75. Another achievement was noted within the Moored Buoys component. The Tao/Triton and Pirata arrays of buoys in the Pacific and Atlantic oceans (France, Japan, United States), installed specifically for climate purposes (primarily climate prediction purposes), now have a measure of ongoing operational support.

76. Resource constraints, increasing costs and the high cost of vandalism (particularly noted by the United States) of surface oceanic equipment were named as the main causes of *deficiencies* in systems. The expected reduction in the number of the VOS and SOOP platforms in the next five years, as well as the comparatively low data exchange rate for VOS (around 82 per cent) reveal an existing deficiency and presage a further decline in these components. Nevertheless, several Parties (Australia, Canada, France, Japan, Poland, United Kingdom, United States) reported their intention to continue their activities in obtaining temperature profiles of the ocean through the continued use of SOOP.

77. Given that the reporting countries comprise a significant fraction of the countries that operate basin or global scale oceanographic observing systems, the information available is very representative of the global system. One of the main *characteristics* of the system (particularly evident from the reports from Canada, Japan, France, United Kingdom, United States) is the improving spatial coverage, a feature of great importance to GCOS and the UNFCCC. Other characteristics of the ocean domain are that the integration of in situ and satellite observing appears to be evolving rapidly, and that many research programmes are being converted to firm operational systems.

E. Terrestrial observations

78. The terrestrial domain includes both the formal GCOS network and wider terrestrial networks and activities that have varying degrees of direct relevance and usefulness to GCOS and the needs of the Convention for systematic observation. Twenty-one Parties reported on their terrestrial observations as requested in the guidelines. A summary of the information provided by Parties relating to formal components is shown in table 12.

Table 12. Participation in the global terrestrial observing systems

	GTN-P	GTN-G	FLUXNET	Total number of system units
Q1. How many sites are the responsibility of Parties?	474	315	73	862
Q2. How many of those are operating now? (% of number in Q1)	466 (98)	313 (99)	66 (90)	845 (98)
Q3. How many are providing data to international data centres now? (% of number in Q1)	122 (25)	305 (97)	27 (37)	454 (53)
Q4. How many are expected to be operating in 2005? (% of number in Q1)	192 (40)	312 (98)	76 (104)	299 (35)
Number of Parties reporting	4	7	6	

79. The formal GTN-P, GTN-G and FLUXNET components of the terrestrial domain involve a relatively small number of Parties (Australia, Austria, Canada, France, New Zealand, Norway, Poland, Spain, Switzerland, United Kingdom and the United States contributing to one or more components). In

the case of GTN-P and GTN-G, for permafrost and glaciers, this is clearly linked to the climatic zones where monitoring is undertaken. There is a strong link to the research community with established practices for these two components. Some glacier and permafrost time series of observations are very long, dating back even to the late 19th century. Terrestrial carbon flux measurements (FLUXNET component) have generally operated for a shorter time and are still under development in some places. For example, Canada reported that efforts are currently under way to obtain funding for its contribution (FLUXNET-Canada) to the global network.

80. A wider range of activities is often targeted at specific geographical and local issues. Examples include monitoring of birch forest in Norway, vegetation monitoring in Belgium, paleoclimate data gathering in Sweden, the Environment Change Network in the United Kingdom and a wide range of specialized networks in the United States. Many of these programmes are research-based, and have relatively short lifetimes. Table 13 lists these wider programmes on different terrestrial components as reported by Parties.

Table 13. Terrestrial monitoring activities that support GCOS

Terrestrial monitoring activity	Parties[a]	Number of programmes[b]
Permafrost	AUT, CAN, CHE, POL, USA	5
Glaciers	AUS, AUT, CAN, CHE, FRA, NZL, SWE, USA	8
Carbon and other surface fluxes	AUS, CAN, CHE, ESP, FRA, GBR, HUN, JPN, USA	9
Land use	AUS, HRV, SWE, USA	4
Land cover	AUS, AUT, BGR, GBR, NLD, NOR, NZL, SWE, USA	9
Land-use change and forestry	AUS, CAN, CHE, GBR, FRA, NLD, NOR, NZL, SWE, USA	10
Fire distribution	AUS, EC, HRV, NLD, SWE, USA	6
Snow/ice	AUT, CAN, CHE, FIN, FRA, HRV, NZL, SWE	8
Phenology	AUT, CHE, ESP, HRV, NLD	5
Stream flow and surface water	AUS, AUT, BGR, CHE, FIN, GBR, HRV,LVA, NLD, NZL, SWE, USA	12
Ground water	AUS, CAN, CHE, GBR, HRV, NZL, SWE, USA	8
Soils	AUS, CHE, GBR, HRV, LVA, NZL, SWE, USA	8
Paleoclimate	AUS, AUT, HRV, NLD, NZL, SWE, USA	7
Ecology / biodiversity	AUS, AUT, CAN, GBR, USA	5
Urban	USA	1
Corals	AUS	1
National parks	CAN	1
Satellite monitoring of terrestrial properties (e.g. sea ice, radiation, surface radiation, land cover)	AUS, AUT, CAN, ESP, GBR, JPN, USA	7

[a] *The following ISO codes are used: Australia (AUS), Austria (AUT), Belgium (BEL), Bulgaria (BGR), Canada (CAN), Croatia (HRV), Czech Republic (CZE), Estonia (EST), European Community (EC), Finland (FIN), France (FRA), Hungary (HUN), Japan (JPN), Latvia (LVA), Liechtenstein (LIE), Monaco (MCO), the Netherlands (NLD), New Zealand (NZL), Norway (NOR), Poland (POL), Slovakia (SVK), Spain (ESP), Sweden (SWE), Switzerland (CHE), the United Kingdom of Great Britain and Northern Ireland (GBR) and the United States of America (USA).*

[b] *Some activities are not part of the designated GCOS/GTOS terrestrial networks identified in table 12.*

81. Most Parties reported on hydrology monitoring activities (stream flow, surface water and ground water) as requested in the guidelines, although some noted that historical data were not generally useful for climate change studies. A number of Parties are involved in land cover monitoring, including land use and forestry. All countries with important snow coverage reported on snow mapping and monitoring.

Several Parties reported on other observations, such as soils, ecology, biodiversity and collecting of paleoclimate data.

82. While there is considerable monitoring, and some data sets are available, only six Parties (Australia, New Zealand, Sweden, Switzerland, United Kingdom, United States) reported that they hold relevant homogeneous data sets, and only a relatively small number are reported in the key climate-related areas, such as land use, land cover, land-use change and forestry.

83. In general, while it was relatively straightforward for Parties to provide some requested information (adherence to GCOS/GTOS principles, data exchange, deficiencies, etc.) on the specific components in table 12, it was much more difficult for the wider terrestrial observing programmes listed in table 13.

1. Data exchange

84. Data exchange is limited in the case of terrestrial observations as compared to the other GCOS domains. With some exceptions (observations of fire, snow melt and flooding), the operational imperative to provide day-to-day services does not exist to the same degree as for atmospheric and ocean domains. Also, international data exchange to support routine operations (as for weather, climate and oceanographic services) is not necessarily required. In addition, national data tend to be distributed amongst a greater number of separate archives. Some Parties (e.g. Canada, France, United States) noted that some of the data sets were available under arrangements based on research rather than operational programmes, and therefore available in delayed mode rather than real time.

85. Some information was provided on the quality of, and access to, metadata in the terrestrial domain. Two Parties (Australia, Sweden) noted the availability of good forest biomass data and metadata. Some difficulties with archiving metadata were reported, such as perfunctory archiving and dependence on third parties (United Kingdom), the need for resources to develop accurate digital metadata for its cryosphere network (Canada), and the non-availability of metadata for wider terrestrial programmes (United States).

2. Adherence to GCOS climate monitoring principles and best practices

86. Most Parties did not provide any information on adherence to GCOS best practices and monitoring principles. In cases where such information was provided, it was not easy to determine whether best practice adherence referred only to the networks identified in table 12 or to the wider variety of national networks identified in table 13. Some Parties reported that data quality may be appropriate to the research needs, but that programmes do not fully meet GCOS standards.

87. The United States noted that it has few national networks and few of them have climate as an objective, with the result that climate monitoring principles did not have priority in the past. The United States noted that limited continuity existed for its GTN-P programme, and application of best practices was described as uneven by Canada. United Kingdom noted efforts by its Environmental Change Network to be a leader in best practice and QC for all of its environmental networks. The European Community reported that progress is still necessary to ensure comparability of data and information between countries and over time and to facilitate routine reporting to UNFCCC and international data centres.

88. From the limited reporting, it was not easy to gauge where the strong points and greatest weaknesses exist with respect to the monitoring principles and best practice guidelines. In general, it was also noted that, within the terrestrial domain, the standard setting is more specialized and less centralized. It could be noted, however that adherence to such fundamental principles of global observations as continuity and homogeneity is problematic for the terrestrial domain, since the majority of the current terrestrial observing programmes are relatively short-term scientific projects.

3. Achievements, deficiencies and characteristics of systems

89. A number of reported achievements demonstrated an interest on the part of the terrestrial communities in evolving their observing systems and data to meet GCOS needs. Examples include a willingness to develop specialization, contributing to GTOS global demonstration projects (United Kingdom) and development of data access systems (Canada, European Community, France, United Kingdom, United States). The European Community reported on a number of efforts to harmonize provision of data in the European region in the broad environmental area. These efforts include coordinating the collection of FLUXNET data (EUROFLUX programme), and establishing the World Fire Web (WFW) to make daily observations of global active fire distribution publicly available via the Internet.

90. It is a deficiency of the domain that there are few long-term homogeneous data sets for important assessments such as ecological impacts and land-use change. Compared to other domains, there are also fewer long-term data series that might be appropriate for global assessments, since the majority of data sets tend to be more local. Nevertheless, Parties maintain a number of monitoring programmes, and a number of available homogeneous data sets, that have the potential to contribute valuable information to climate change studies if they can be continued in the future to GCOS standards.

91. The following distinguishing features of the terrestrial domain emerge from the reports of the Parties: few homogeneous historical data sets; many observing programmes and activities that are local in nature, fewer operational linkages at the international level and resulting lower levels of data exchange, less centralized and coordinated best practice standards and guidelines. Parties also recognized a growing awareness of GCOS needs as refers to terrestrial networks. In general, the wide variety of terrestrial networks made synthesis more difficult. One area where reporting could be more complete and more uniform for the terrestrial domain is the reporting of standards for QC and best practice.

F. Space-based observing programmes

92. Of the reporting Parties, only four (Canada, Japan, Sweden, United States) are “raw” data producers, two (Japan, United States) having extensive satellite programmes and two operating one specialist satellite each (Canada with a satellite called RADARSAT, and Sweden with satellite ODIN). The European Community report also provided some information on activities of the European Space Agency (ESA), which is the primary raw data producer for the European countries.

93. Other Parties reported on their contributions to the overall space effort for climate, in areas such as research, instrument development, algorithm development, QA/QC, hosting satellite ground stations and data analysis, that help to create the data sets relevant to climate. Almost all Parties reported using satellite data or derived products in their routine weather and climate operations and for various land monitoring purposes. The high level of participation in satellite applications indicates the increasing and fundamental importance of satellite information to the Parties.

94. Several Parties (Australia, Canada, Japan, New Zealand, Sweden, United States) noted the ability of space-based observing programmes to cover remote geographic areas, the oceans and the cryosphere and to provide more detailed information than in situ observations for monitoring in areas such as land cover, forest fires, and biological productivity. Some Parties (European Community, Japan, the Netherlands, Switzerland, United States) noted or commended the establishment of an Integrated Global Observing Strategy (IGOS) as a strategic planning process to assist coordination for integrated global monitoring of the atmosphere, oceans and land.

1. Satellite operations

Programmes and missions

95. The level of reporting on space programmes and missions varied. The United States provided extensive detail on its missions, platforms, sensors/instruments, launch dates and lifetimes, using both descriptive text and detailed tables; the European Community supplied some fragmented information on satellites platforms; and other Parties (Canada, France, Japan and Sweden) supplied some mission-related information on high-resolution imaging programmes.

96. In addition, the United States reported in detail on its major, wide-ranging satellite programmes, Japan reported broadly on its meteorological satellite programme and its newer land observing programme, France reported on its in-house high-resolution imaging sector in conjunction with its contributions to ESA, the European Community reported on its collaboration with ESA on programme development for global monitoring and on its support to new missions of ESA and NASA, and Canada and Sweden reported on their contribution of a specialist satellite each.

97. Although not a satellite operator, United Kingdom provided further information on some of the relevant ESA programmes. Almost all of the European Parties noted their involvement in ESA or their use of data from ESA platforms. This highlights the lack of information available from the current reporting process on the ESA programmes of relevance to climate.

98. The reports on missions (Japan, United States) show that satellites supply extensive and wide-ranging data in all the GCOS domains of interest. In addition, the instruments on satellites are continuing to improve and expand in number and type, thus increasing the potential for wider climate applications (United States).

Data archiving, access, QC and GCOS monitoring principles and best practices

99. Regarding archived data from past satellite missions, it was reported that several of the data series from past operational satellites have been re-processed using improved retrieval algorithms and, therefore, provide high quality global data products for the purposes of GCOS and climate change research and applications. It was stated that these reprocessed data are approaching GCOS standards.

100. A few Parties (Australia, Canada, France, United Kingdom, United States) noted that the ability of space observing programmes to meet GCOS monitoring principles had been of concern in the past, and that the problem hat not yet been completely overcome. Individual satellite lifetimes are short compared to many climate timescales, and agencies are increasingly recognizing the need for forward planning to meet climate needs (Canada, European Community, United States). Concerns over sensor discontinuities, time gaps between satellites and possible spurious climate change detection from instrument and satellite drift have not yet been fully overcome (Australia, United Kingdom), even though they are easing.

101. Concerning new satellites, a number of Parties (Australia, United Kingdom, United States) noted that the major satellite programmes adhered to most of the GCOS climate monitoring principles and that homogeneity needs were now being taken into account in programme planning. The United States report indicated that its current generation of satellite instruments even exceeded the GCOS requirements for the absolute calibration of sensors, an important homogeneity feature that was lacking in the early satellite platforms used for real-time operational purposes. New features of some satellites include overlap of instruments between satellites. In other cases, improved calibration techniques (including on-board calibration systems) are reducing instrument-based errors, including instrument and satellite drift errors.

102. It was stressed that satellite observations cannot measure all parameters of the Earth system, nor can they operate independently of surface-based systems. Surface-based and in situ observing systems

are also needed for the calibration and validation of satellite-derived parameters. Thus, surface and satellite observing are needed in parallel.

Application of satellite data to climate needs

103. Information about archiving of, and access to, the data from the space missions also varied among the Parties. The United States supplied information on type of data held and contact details for all of its relevant data centres; France noted its access policy (mixture of commercial, reduced cost and free); Canada noted the availability of a number of national data sets in research mode.

104. The potential is vast for applying satellite data to climate needs. Over 50 parameters can or could be measured from satellites reported by Parties. The United States report listed many of these in extensive tables that included the operational potential of current satellite sensors to monitor the various parameters to standard. Many of the relevant instruments are only now being developed and therefore will contribute to climate assessments in future decades.

2. Satellite programme participants and data users

105. Sixteen Parties reported their participation in space-based programmes. They mostly reported on the application of satellite data to domains or parameters that were of most interest to local needs or research interests (e.g. glaciers or aerosols), on research activities, and on their contribution to or participation in satellite operations. Table 14 lists the types of application or areas of interest reported by the Parties. Very few Parties (Australia, Canada, the Netherlands, United States) reported on the data sets they produced from these activities, the availability of the data or its level of QC.

Table 14. Examples of satellite data applications

Party	Applications
Australia	Antarctica, radiation, ecology, fire, land surface, ocean surface, ozone, rainfall
Austria	Ice, cryosphere
Belgium	Radiation, solar constant, ozone, forests
Bulgaria	Land cover
Canada	Ice, cryosphere
European Community	Fire, vegetation, land cover
Finland	Ozone
France	Water, snow, vegetation
Japan	Solar winds, ozone layer, upper atmosphere
Netherlands	Ozone, gases
New Zealand	Glaciers, cloud types
Poland	Baltic Sea
Sweden	Cloud anomaly, precipitation, vegetation
Switzerland	Land surface monitoring (Alps), aerosols
United Kingdom	Clouds, sea surface temperature
United States	Large number of applications reported

106. It should be noted that the issue of the GCOS monitoring principles is most relevant to the production of the raw data, while for derived products and applications (and their related data sets), the GCOS-related issue is the level of QC. Therefore, it is not expected that Parties should report on the monitoring principles for the derived products, except for principle 10: "Data management systems that facilitate access, use and interpretation should be included as essential elements of climate monitoring

systems." As noted, very few Parties reported on their derived data sets. United Kingdom expressed concern that there is currently no agreed plan for the long-term maintenance of archives of some of these satellite-derived Earth observation data sets that will enable change over time to be measured.

107. Partnerships and collaborative participation such as membership of or partnership with ESA, and collaborative space programmes, were noted as important. The forms of collaboration included providing ground stations (Australia, Norway, Sweden), instruments (Belgium, Canada, France, the Netherlands), algorithm development (Canada, France, the Netherlands, United Kingdom) and other research and support including mapping, validation and calibration (Australia, Belgium, Canada, France, New Zealand, United Kingdom, United States).

3. Characterization of systems

108. Space-based observations provide significant amounts of information and outstanding global coverage to support the requirements of the climate community. The reports from the satellite operators and their partners broadly indicate an effort on the part of the satellite community to make their systems and products more suited to GCOS needs. Improvements in system design to better meet GCOS monitoring principles were reported.

109. Another characteristic of this domain that the reports reveal is cooperation and partnership in the international community. Examples include the above-mentioned development of European satellite application facilities (SAFs), and partnerships Japan reported in the Asia Pacific network. Another area of cooperation is that national or international research teams often manage the processing, standardization, validation and storage of data. Some Parties stressed the importance of such coordination mechanism as the Integrated Global Observing Strategy (IGOS) for improving space-based observations and meeting climate needs.

G. Good practices in reporting

110. In their reports, many Parties presented information in a form that may be useful for analysing current reports and in considering future reports. Some of the examples of such "good practices" in reporting follow. One example, already noted, is providing supplementary information in the form of tables from the supplementary guidelines. This form of presentation allowed 11 Parties (see table 8) to submit extensive information and show a comprehensive approach to monitoring weather, climate and related environmental impacts, and the use of information in real-time and its retention for research and climate purposes.

111. Several Parties (Austria, Australia, Canada, Switzerland, United Kingdom, United States) supplied maps of both national and specific GCOS networks, diagrams of systems and instruments and organizational architecture or photos of special observing sites or observatories.

112. Another example of "good practice" is the reporting by Switzerland on the responsibilities of its ministries and agencies in relation to participation in GCOS. The Party supplied a table of responsible agencies and ministries that included information on the formal instruments underpinning the long-term commitments presented in table 15.

Table 15. Responsible agencies and legal basis at the national level: Switzerland

Monitoring networks/domains	Responsible agencies	Long-term commitments
Meteorological land surface and upper air observations	MeteoSwiss	Federal Law on Meteorology and Climatology
Atmospheric constituents (GAW and WCRP programmes), including:	MeteoSwiss	Governmental decision (21.12.1994) related to the Climate Convention and GCOS
– Greenhouse gases and oxidants	SAEFL	– Commitment under the Climate Convention
– World Radiation Data Centre	Swiss Federal Institute of Technology, Zurich (ETHZ)	– Agreement between ETHZ and WMO
Hydrological observations	Federal Office for Water and Geology	Federal Law on Water Protection
Glaciers and permafrost monitoring, as well as the World Glacier Monitoring Service	Swiss Academy of Science (Glaciological Commission, Permafrost Co-ordination Group, University of Zurich and ETHZ)	– Partly federal and regional regulations – Partly pending (pilot projects)
Forest ecosystem network and snow observation	SAEFL and Swiss Federal Institute for Forest, Snow and Landscape Research	Federal Forest Law (Art. 33-34), Ordinance on the Federal Institute for Forest, Snow and Landscape Research
Ecological observations and environmental indicators	Different agencies and institutions	Federal laws and regulations
Land-use changes and statistical indicators	Swiss Federal Statistical Office(SFSO)	Federal laws and regulations
Satellite-based observations (ESA, EUMETSAT)	Swiss Space Office, Swiss Academy of Science (Commission for remote sensing) MeteoSwiss	Federal laws and regulations Commitment under ESA/EUMETSAT Convention
Proxy, lake sediments, boreholes, ice cores	Research institutes	Mainly research programmes

113. One of the most challenging areas for most Parties was describing to what extent the observations correspond to the GCOS/GOOS/GTOS climate monitoring principles and relevant best practices. Australia and the United States attempted to assess the level of adherence to each of the ten GCOS monitoring principles in meteorological and atmospheric observations (see table 16). Such analysis may assist in identifying where the greatest difficulties lie within the ten principles.

Table 16. Reporting on adherence to the GCOS monitoring principles in meteorological and atmospheric observation: Australia and the United States of America

Australia
1. **The impact of new systems or changes to existing systems should be assessed prior to implementation.** Comparison tests between old and new instrumentation are undertaken both in the field and in the laboratory. In general, the Bureau of Meteorology's Physics Laboratory must approve all instruments before they are installed in the observation network, but staffing shortages mean that this approval process is sometimes compromised. 2. **A suitable period of overlap of new and old observing systems should be required**. A mandatory comparison observation period of at least two years is required for site moves and instrument changes. However, the quality of comparison observation data is often less than desired. 3. **The results of calibration, validation and data homogeneity assessments and assessments of algorithm changes should be treated with the same care as data.** In recent years, calibration results have been routinely stored within the metadata database. Prior to this, such results were recorded in paper station files. Data homogeneity assessments are published in the scientific literature. Unfortunately, the specific details of algorithm changes have not been routinely maintained in the past, but greater emphasis is now placed on this requirement. 4. **A capability to routinely assess the quality and homogeneity of data on extreme events, including high-resolution data and related descriptive information, should be ensured.** The capability is there, but assessments are not done routinely. 5. **Consideration of environmental climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.** Processes are in place to ensure consideration, in the design and maintenance of observation networks, of the needs of climate research and monitoring. 6. **Uninterrupted station operations and observing systems should be maintained**. Station changes and observation disruptions are minimized, but not always avoidable. All GSN stations should be inspected at least once every six months. 7. **A high priority should be given to additional observations in data-poor regions and regions sensitive to change.** Due to the large area to be covered and the high cost of observation in sparsely populated regions, some networks operate at standards significantly below benchmarks for station density and data accuracy. The most difficult standards to achieve are related to upper air observations. 8. **Long-term requirements should be specified to network designers, operators and instrument engineers at the outset of new system design and implementation.** A Climate Data Quality Issues group, consisting of representatives from the climate monitoring, instruments laboratory and observations operations areas of the Bureau of Meteorology, meets every three months to discuss issues related to both current and developmental observation systems. A variety of other working groups and steering committees are also active on this issue. 9. **The carefully planned conversion of research observing systems to long-term operations should be promoted.** All research observing systems undergo rigorous testing under operational conditions before being transferred to long-term operations. 10. **Data management systems that facilitate access, use and interpretation should be included as essential elements of climate monitoring systems.** Data access has been a problem, but is being addressed with database and Internet interfacing.
United States of America
Surface temperature is adequate with respect to half of the 10 climate monitoring principles (data continuity/quality, integrated environmental assessment, complementary data, continuity of purpose, and data/metadata access). Snow cover and snow depth are adequate with regard to three of the principles (integrated environmental assessment, complementary data, and data/metadata access). Precipitation, wind, water vapour, and sea level pressure are adequate only in terms of one of the principles (continuity of purpose).

H. Global representation

114. The information provided in the national GCOS reports allows some preliminary analysis of its usefulness for assessing the state of observing systems globally. Reports were provided by 23 countries, situated in Europe, North America, and Asia and the Pacific. The level of global coverage in different domains is presented as follows.

115. Meteorological and atmospheric observations: in general about 34 per cent of the total stations in the atmospheric GCOS networks (GSN, GUAN, GAW) are included in the current reporting, although geographical distribution is uneven. All of the reports on the atmospheric GCOS domain came from the regions and countries where routine data exchange is reliable and the data exchange rates are high. The elements of the atmospheric networks are represented in the reports as follows:

(a) GSN: 37 per cent of the formal network is represented. Only 11 per cent of countries with assigned GSN stations reported;

(b) GUAN: 51 per cent of the formal GUAN stations is represented. Only 13 per cent of countries with assigned GUAN stations reported;

(c) GAW network: is well-represented in the reports, covering about 36 per cent of the formal network.

116. Oceanographic observations: reporting covers a large geographical area (near global) because most of the major basin-to-global-scale ocean observation system contributors provided their reports.

117. Space-based observations: reporting covers most of the satellite information production because the major satellite providers reported.

118. Terrestrial observations: reporting of terrestrial networks is geographically confined. However, reports provide a good representation of global GTN-P and GTN-G networks, because reporting countries cover large permafrost and glacier areas.

119. In general, it can be concluded that for the atmospheric domain, the use of the reports for an overall assessment of the global status of global climate observing systems is limited. The reports can be useful to gauge the progress being made in ocean and space-based systems towards meeting GCOS needs. The reports can also be used for some assessment of the global state of some of the terrestrial components, as well as atmospheric constituencies.

120. For all GCOS domains, reports can be used to gauge the status of global climate systems in many of the developed countries, but are not representative enough for assessment of the level of development of global climate observing systems in other parts of the world.

121. Even where the reports are collectively useful for analysis, some weaknesses exist that limit the analysis that can be done on the global status of GCOS networks. For example, sufficient detail is generally not available to assess the extent to which systems meet the GCOS monitoring principles and the relevant best practice guidelines.

Annex I

List of tables

Annex II

Acronyms and abbreviations

ASAP	Automated Shipboard Aerological Programme
ESA	European Space Agency
FLUXNET	Global Terrestrial Network – Carbon
GAW	Global Atmosphere Watch of WMO
GCOS	Global Climate Observing System
GOOS	Global Ocean Observing System
GSN	Global Surface Network
GTN-G	Global Terrestrial Network for Glaciers
GTN-P	Global Terrestrial Network for Permafrost
GTOS	Global Terrestrial Observing System
GUAN	GCOS Upper-Air Network
ICSU	International Council of Scientific Unions
IDC	international data centre
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IOC	Intergovernmental Oceanographic Commission of UNESCO
NASA	National Aeronautics and Space Administration
NOPP	National Oceanographic Partnership Programme
SFC Drifters	Surface Drifters
SOOP	Ship of Opportunity Programme
VOS	Voluntary Observing Ships
WCRP	World Climate Research Programme
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WWW	World Weather Watch of WMO

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