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Synthesis of National Reports on Systematic Observation for Climate

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Synthesis of National Reports on Systematic Observation for Climate

August 2009

1 Introduction

1. UNFCCC Decision 11/CP.13 requested Annex-I Parties to the Convention to provide detailed reports on systematic observations, in conjunction with their national communications in accordance with the UNFCCC reporting guidelines on global climate change observing systems, as revised by Annex 1 to the Decision[1], and invited non-Annex-I Parties to provide such reports on a voluntary basis. These revised guidelines focus on the contributions of Parties to the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC,*[2] referred to in this document as the 'IP-04'.

As regards the IP-04, the SBSTA had requested the GCOS secretariat to provide, by SBSTA 30 (June 2009) a comprehensive report on progress with the IP-04. Noting that such report would be dependent upon obtaining information on national implementation activities, the SBSTA[3] invited Parties to submit additional information on their national activities with respect to implementing the IP-04, and to use the revised guidelines adopted by decision 11/CP.13 for that purpose. This Synthesis report uses information provided by Parties in response to that invitation (hereinafter referred to as 'National Reports').

This Synthesis of National Reports used National Reports[4] from 23 Annex-I Parties (see Table 1); Belize, a non-Annex-I party, also provided a report and Sri Lanka, also a non-Annex-I Party, responded by letter. In addition, some information from 13 additional Annex-I Parties was used from their Fourth National Communications (4NC) under the sections on "Research and Systematic Observation" (see Table 1).

2. Most Parties followed the general approach to the reporting as suggested in 11/CP.13 Annex 1[5], structuring the reports with a section on **common issues** followed by sections on the **Atmospheric**, **Oceanic** and **Terrestrial** Domain Essential Climate Variables (ECVs) and concluding with a section entitled **additional information** pertinent to GCOS. The table listing the GCOS ECVs is shown in Appendix 1 of this report.

3. The level of detail reported and comprehensiveness of the reporting varied across Parties from very complete reports with great detail and additional information to reports with limited information, concentrating mostly on the tables showing the number of stations and platforms in the various networks and arrays. The more complete and comprehensive reports mostly came from Parties with well developed internal coordination processes and clearly defined institutional arrangements.

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[1] UNFCCC (2008): *Decision 11/CP.13 Reporting on global observing systems for climate*, FCCC/CP/2007/6/Add.2, http://unfccc.int/resource/docs/2007/cop13/eng/06a02.pdf

[2] GCOS (2004): *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (GCOS-92, October 2004) and GCOS (2006): *Systematic Observation Requirements for Satellite-based Products for Climate* ('Satellite Supplement'), GCOS-107, September 2006, http://www.wmo.int/pages/prog/gcos/Publications/gcos-92_GIP.pdf and http://www.wmo.int/pages/prog/gcos/Publications/gcos-107.pdf, respectively.

[3] UNFCCC (2008*): Report of the Subsidiary Body for Scientific and Technological Advice on its twenty-seventh session, held in Bali from 3 to 11 December 2007* (doc. FCCC/SBSTA/2007/16, para. 36); and UNFCCC (2006): *Report of the Subsidiary Body for Scientific and Technological Advice on its twenty-third session, held at Montreal from 28 November to 6 December 2005* (doc. FCCC/SBSTA/2005/10, para. 94)

[4] All National Reports are available at http://unfccc.int/methods_and_science/research_and_systematic_observations/items/4499.php

[5] see footnote 1

Table 1: All reports by Parties on GCOS used in this Synthesis Report (total of 36 out of 41 Annex-I Parties).

Country	Form of reporting used for this Synthesis		Relative country size (km^2)	Region
	Separate GCOS report	Part of 4NC		
Australia	*		♦♦♦♦	Pacific
Austria		*	♦♦	Europe
Belgium	*		♦	Europe
Belize	(*)[6]		♦	Latin America and the Caribbean
Bulgaria		*	♦♦♦	Europe
Canada	*		♦♦♦♦	North America
Croatia		*	♦♦	Europe
Czech Republic		*	♦♦	Europe
Denmark (incl. Greenland)	*		♦/♦♦♦♦	Europe
European Community	*		♦♦♦♦	Europe
Finland	*		♦♦♦	Europe
France	*		♦♦♦	Europe
Germany	*		♦♦♦	Europe
Greece	*		♦♦♦	Europe
Hungary		*	♦♦	Europe
Ireland	*		♦♦	Europe
Iceland		*	♦♦♦	Europe
Italy	*		♦♦♦	Europe
Japan	*		♦♦♦	Asia-Pacific
Latvia		*	♦♦	Europe
Liechtenstein		*	♦	Europe
Lithuania	*		♦♦	Europe
Netherlands	*		♦	Europe
New Zealand		*	♦♦♦	Pacific
Norway		*	♦♦♦	Europe
Poland	*		♦♦♦	Europe
Portugal	*		♦♦	Europe
Romania		*	♦♦♦	Europe
Russian Federation	*		♦♦♦♦	Europe/Asia-Pacific
Slovakia	*		♦	Europe
Slovenia		*	♦	Europe
Spain	*		♦♦♦	Europe
Sweden	*		♦♦♦	Europe
Switzerland	*		♦	Europe
Turkey		*	♦♦♦	Europe/Asia
United Kingdom	*		♦♦♦	Europe
United States	*		♦♦♦♦	North America
TOTAL ANNEX-I Parties	**23**	**13**		

2. Most Parties followed the general approach to the reporting as suggested in 11/CP.13 Annex 1[7], structuring the reports with a section on **common issues** followed by sections on the **Atmospheric**, **Oceanic** and **Terrestrial** Domain Essential Climate Variables (ECVs) and concluding

[6] Belize is a non-Annex-I Party and provided a National Report.

[7] see footnote 1

with a section entitled **additional information** pertinent to GCOS. The table listing the GCOS ECVs is shown in Appendix 1 of this report.

3. The level of detail reported and comprehensiveness of the reporting varied across Parties from very complete reports with great detail and additional information to reports with limited information, concentrating mostly on the tables showing the number of stations and platforms in the various networks and arrays. The more complete and comprehensive reports mostly came from Parties with well developed internal coordination processes and clearly defined institutional arrangements.

4. Under the section on **Common issues**, Parties were asked to report especially on actions or efforts to:

(a) Introduce or enhance national coordination and planning;
(b) Ensure that high-quality climate data records are collected, retained and made accessible;
(c) Ensure that international data centres are established and/or strengthened;
(d) Support capacity building in least developed countries, small island developing states and countries with economies in transition;
(e) Acquire palaeoclimatic data (e.g. extending the record in time and into new regions); and
(f) Identify difficulties encountered (policy level as well as technical level, e.g. in ensuring the continuity of observations), needs that should be met, and steps taken to improve availability of information.

These reports are summarized in Chapter 2.

5. In the section on **Atmospheric Essential Climate Variables**, Parties were requested to complete tables in a common format that provide the information of each Party with regard to the contributing networks as specified in the IP-04 (see Table 2). The Parties were requested to report on the number of stations or platforms currently operating, their compliance with GCOS Climate Monitoring Principles (GCMPs), the number expected to be operating in 2010, the number providing data to international data centres and the number with complete historical record available at international data centres. In addition, Parties with space programmes were requested to state their plans, using a common table format, that address the availability of past and future fundamental climate data records as required to support climate-relevant analysis products. Parties were also requested to provide narrative description on a number of specific IP-04 Actions, as reflected in Chapter 3.

6. In the section on **Oceanic Essential Climate Variables**, Parties were requested to provide, where relevant, a brief narrative report on their actions nominating national focal points for implementing the oceanic observing system for climate. They were requested to describe their national contributions of oceanographic ECVs to the international community utilizing a common table format that provides information covering the same scope as that for the Atmospheric section (both *in situ* networks and platforms and satellite observations) (see Table 2). Parties were also requested to provide a narrative description of any actions they have taken in response to specific issues as reflected in Chapter 4.

7. In the section **Terrestrial Essential Climate Variables** Parties were asked to report, where relevant, on their efforts to introduce international coordination and planning of terrestrial programme activities. As with the Atmospheric and Oceanic sections, the Parties were also tasked with providing information regarding contributing networks or platforms covering Terrestrial ECVs (see Table 2) and satellite observations. Parties were also requested to provide a narrative description of any actions they have taken in response to specific issues as reflected in Chapter 5.

8. In the section on **Additional information**, Parties were asked to provide information on their national climate programmes that contribute to observations of the ECVs not reported elsewhere in their reports, such as climate observations being undertaken in research programmes and/or programmes that provide information at a higher resolution or frequency. These reports are summarized in Chapter 6.

9. The synthesis that follows reflects the structure and guidance provided in UNFCCC Decision 11/CP.13. Many of the responding Parties provided, where possible, the narrative information requested in paragraphs 4 through 8 above. Each responding Party also completed the tables as appropriate and possible (see Table 2). It is clear from some of the information provided by the Parties

that, in some cases, confusion or misunderstandings occurred in interpreting the guidelines pertaining to several of the requested categories of networks and platforms. This is particularly evident in the GCOS Surface Network (GSN), the Ocean Reference Moorings, and the Global Terrestrial Network for Rivers (GTN-R) categories. In future requests for reports on systematic observations, greater care must be given to the specific information requested in the guidelines, and it would be beneficial to have all of the reports follow the same format. The *Progress Report on the Implementation of the Global Observing System for Climate in Support of the UNFCCC 2004-2008*[8], hereinafter referred to as the '2004-2008 GCOS Progress Report', contains a great deal of information on the global performance of the networks, platforms, and systems and should be used as a starting point to develop the future guidelines – with concentration on requesting information in areas where the global performance is lagging the IP-04.

10. In some cases, Parties did not report on stations as being part of the global network, despite an international agreement on their participation. This is a possible indicator of inadequate national coordination or lack of awareness of the internationally-defined needs. There also appeared to be some reluctance to give details on deficiencies and difficulties encountered in gathering and providing the data. Some reports noted the need for capacity-building to support GCOS effectively in countries with economies in transition. In some cases, Parties expected to add significantly to their networks by 2010. Some Parties (e.g., Lithuania and the Russian Federation) reported on major upgrading and modernization of their networks and systems. A number of future commitments were accompanied by qualifying phrases such as 'depending on resources'.

Table 2: Summary of the number of stations and platforms reported by Parties.

Networks and Systems	Number of stations or platforms	Number of Parties reporting
Surface-based Atmospheric Networks		
GCOS Surface Network (GSN)	571	22
Full WWW/GOS Surface Network	4732	22
Baseline Surface Radiation Network (BSRN)	26	8
Solar Radiation and radiation balance network	591	20
Ocean drifting buoys	1295	9
Moored buoys	176	7
Voluntary Observing Ships (VOSClim)	1402	9
Ocean reference moorings and sites on small islands	255	4
Upper-air Atmospheric Networks		
GCOS Upper-air Network (GUAN)	85	16
Full WWW/GOS upper-air network	358	20
Atmospheric Composition Networks		
Global Atmospheric CO_2 and CH_4 Networks	58	5
CO_2	121	14
CH_4	108	14
Other Greenhouse Gases (GHGs)	130	15
WMO/GAW Ozone Sonde network	49	16
WMO/GAW Column Ozone Network	117	22
WMO/GAW Aerosol Network	69	15
Ocean Surface Networks		
Global surface Drifting Buoy Array	1164	9
GLOSS Core Sea level Networks	233	15
Voluntary Observing Ships (VOS)	2699	13
Ship of Opportunity Programme (SOOP)	444	11

[8] GCOS (2009): *Progress Report on the Implementation of the Global Observing System for Climate in Support of the UNFCCC* 2004-2008, GCOS-129, August 2009; http://www.wmo.int/pages/prog/gcos/Publications/gcos-130.pdf

Networks and Systems	Number of stations or platforms	Number of Parties reporting
Ocean Sub-surface Networks		
Global Reference Mooring Network	113	8
Global Tropical Moored Buoy Array	104	2
ARGO Array	2814	11
Carbon inventory survey lines	60	8
Terrestrial Networks		
Global Terrestrial Network – Runoff (GTN-R)	12763	13
Global Terrestrial Network – Lakes (GTN-L)	1216	6
WWW/GOS Synoptic Network – snow observations	3530	12
Global Terrestrial Network – Glaciers (GTN-G)	159	9
Global Terrestrial Network – Permafrost (GTN-P)	256	6

2 Common Issues

Introduce or enhance national coordination and planning

11. The reports exhibit a wide variety of institutional arrangements that Parties have undertaken to coordinate the many government agencies at both the national and state (province) levels, and the academic and research institutions that have roles to play in the Parties' responsibilities in the implementation of GCOS. Table 3 lists the National planning and coordination arrangements relative to GCOS as reported by the responding Parties. Some Parties have instituted GCOS offices with funding authority, others rely more on coordination committees led by a national focal point. Others have placed the coordination responsibility on an individual government entity – usually the National Meteorological Service. Some Parties have prepared National GCOS Plans responding directly to the IP-04, others have embedded the GCOS planning within broader climate programmes. Many of the reports illustrate a high level of national interest in organizing effectively to carry out the demanding set of actions laid out in the IP-04.

Table 3: National planning and coordination arrangements relevant to GCOS reported by Parties.

Party	Information reported
Australia	Bureau of Meteorology (BoM) is the Australian Focal Point for GCOS. The Integrated Marine Observing System (IMOS) is improving coordination in the ocean observing programmes.
Belgium	The Royal Meteorological Institute (KMI-IRM) is designated as GCOS focal point. Public Planning Service (PPS) Policy Science Board has some GCOS-related coordination role.
Belize[9]	National Meteorological and Hydrological Service (NMHS) is the focal point for GCOS.
Canada	Environment Canada's Meteorological Service of Canada is responsible for national coordination of GCOS. Currently there is no national coordinating committee, nor is there a currently relevant national GCOS Implementation Plan. Both are hoped to be instituted soon.
Denmark	The Danish Meteorological Institute (DMI) is the national focal point for GCOS.
European Community	Under its Global Monitoring for Environment and Security (GMES) initiative, the European Community is putting in place operational services that coordinate and sometimes consolidate European efforts for Earth observation both in space and with in situ infrastructures in Europe.
Finland	National GCOS coordination is done under the Finnish Meteorological Institute (FMI).
France	MeteoFrance involved in climate observations, additional contributions by Ministries of Environment and Research; coordination role partially fulfilled by French GMES-GEO coordination group.

[9] Belize is a non-Annex-I Party

Party	Information reported
Germany	The GCOS German Coordinator is contributed by the German Meteorological Service (DWD).
Greece	Several agencies participate. No information on overall national coordination.
Ireland	Assessment group formed involving the Environmental Protection Agency, the Marine Institute, and Met Éireann, which coordinates the development of climate observations in Ireland.
Italy	National GCOS Program Coordinator.
Japan	Office for Coordination of Climate Change Observation which supports the Japanese Alliance for Climate Change Observation.
Lithuania	No specific national coordination mechanism mentioned. The Lithuanian Hydrometeorological Service is the major agency mentioned.
Netherlands	The Royal Netherlands Meteorological Institute (KNMI) leads a project that aims at national coordination and planning of climate monitoring activities, and the development of a national plan. Although not yet fully established, this project will provide recommendations for an integrated national programme for implementing contributions to GCOS.
Poland	No National coordinator. The Institute of Meteorology and Water Management (IMGW) fulfils the role of GCOS communicator, in association with Institutes of the Polish Academy of Sciences (PAN) including the Institute of Geophysics, Institute of Oceanography. Also the Institute of Environmental Protection and several Universities.
Portugal	The Institute for Meteorology (IM) is the only agency mentioned.
Russian Federation	No national coordination mechanism mentioned.
Slovakia	Ministry of Environment and its Slovak Hydrometeorological Institute. Assessment done under the Slovak National Climate Program.
Spain	No National Coordination mechanism mentioned. Several agencies participate. Spanish Meteorological Service (AEMNet).
Sweden	Responsibility is divided between several agencies and organizations. The Swedish Meteorological and Hydrological Institute is the primary agency.
Switzerland	Swiss GCOS Office formed at the Federal Office of Meteorology and Climatology MeteoSwiss in 2006. Interagency coordination and planning is accomplished via “Swiss GCOS Roundtables”.
United Kingdom	UK activities in the science and technology of climate change are coordinated through the Global Environmental Change Committee and its Observations Subgroup.
United States	GCOS Program Coordinator, no integrated GCOS plan but comprehensive plans under various mechanisms such as National Oceanographic Partnership Program.

12. Many of the National Reports provide information on the national agencies responsible and organizational mechanisms used in implementing the climate observing activities in the three domains (Atmospheric, Oceanic and Terrestrial) and in their space programme activities. Table 4 summarises the information provided.

Table 4: National Agencies responsible for different GCOS domains reported by Parties.

Party	Meteorological /atmosphere	Oceans	Terrestrial	Space
Australia	Bureau of Meteorology (BoM) (Federal Government) and Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Several, including BoM, CSIRO and a number of other government agencies. Integrated Marine Observing System (IMOS), BLUElink (CSIRO) and Australian Ocean Data Centre (AODC)	Several different Federal and State agencies	Several Agencies. Committee for Earth Observation Satellites represented via CSIRO.

Party	Meteorological /atmosphere	Oceans	Terrestrial	Space
Belgium	Royal Meteorological Institute (KMI)	Royal Belgian Institute for Natural Sciences, Management Unit of Mathematical 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; (BIRA-ISAB) ; KMI through EUMETSAT and ESA
Belize[10]	National Meteorological and Hydrological Service	National Meteorological and Hydrological Service	National Meteorological and Hydrological Service	
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), DEC and Agriculture and Agrifood Canada (AAFC); Geological Survey of Canada.	The Canadian Space Agency (CSA) supports the federal science departments in a wide variety of space-related activities and applications development, including coordination of all aspects of the Canadian Space Program.
Denmark	Danish Meteorological Institute (DMI)	DMI, and the Royal Danish Administration for Navigation and Hydrography, Danish Costal Authority, and National Environmental Research Institute (NERI)	DMI, and NERI, and Geological Survey of Denmark and Greenland (GEUS)	DMI through EUMETSAT and ESA
European Community	Global Monitoring for Environment and Security (GMES)	GMES	GMES	GMES, ESA, EUMETSAT
Finland	Finnish Meteorological Institute (FMI); Finnish Environment Institute (SYKE)	Finnish Institute of Marine Research, FMI	SYKE; FMI, Finnish Forest Research Institute (WSFS)	FMI through EUMETSAT and ESA
France	Météo-France and several other agencies	Seven agencies	Several agencies	Centre National d'Études Spatiales (CNES) and through EUMETSAT, ESA
Germany	German Meteorological Service (DWD), Federal Environmental Agency (UBA)	German Maritime and Hydrographic Agency (BSH)	DWD, Federal Agency for Nature Conservation (BfN), Federal Institute for Hydrology (BfG), and several others.	DWD and other agencies. Through EUMETSAT and ESA
Greece	Hellenic National Meteorological Service (HNMS) of the Ministry for the Environment Physical Planning and Public Works (MEPPPW) and several other agencies.	Hellenic Centre for Marine Research (HCMR), and the Hellenic Navy Hydrographic Service (HNHS)	Ministry for the Environment Physical Planning and Public Works (MEPPPW), Institute of Geology and Mineral Exploration, and the National Agricultural Research Foundation and other agencies.	

[10] Belize is a non-Annex-I Party.

Party	Meteorological /atmosphere	Oceans	Terrestrial	Space
Ireland	Met Éireann	Marine Institute	Environmental Protection Agency	
Italy	Italian Meteorological Service			
Japan	Japan Meteorological Agency (JMA)	JMA	JMA	JMA, Japan Aerospace Exploration Agency (JAXA)
Lithuania	Lithuanian Hydrometeorological Service		Lithuanian Hydrometeorological Service	
Netherlands	Includes Royal Netherlands Meteorological Institute (KNMI); Laboratory of Air Research; and other institutions	Includes Netherlands Institute for Sea Research (NIOZ); Utrecht University (IAMU); KNMI, others.	Includes KNMI, Rijkswaterstaat Centre for Water Management, TNO Built Environment and Geosciences.	KNMI through EUMETSAT and ESA
Poland	Institute for Meteorology and Water Management (IMGW) and its National Meteorological & Hydrological Service	IMGW Center for Oceanography and Baltic Sea Monitoring, the Institute of Oceanology (IO PAN) and other participating institutions.	IMGW and Institute for Geophysics (IGf PAN)	IMGW and IO Pan and others
Portugal	Portuguese Meteorological Institute (IM)	IM	IM	IM through EUMETSAT and ESA
Russian Federation	National Hydrometeorological Service	National Hydrometeorological Service	National Hydrometeorological Service	
Slovakia	Slovak Hydrometeorological Institute (SHMI)		Slovak Hydrometeorological Institute (SHMI)	
Spain	Agencia Estatal de Meteorologia (AEMet),Puertos del Estado (PE), Instituto Nacional de Tecnica Aeroespacial (INTA),	Instituto Espanol de Oceanografia (IEO) and Purtos del Estado (PE)	AEMet and others	AEMet and Centre for Satellite Applications and Through EUMETSAT and ESA
Sweden	Swedish Meteorological and Hydrological Institute (SMHI); Swedish Armed Forces, Naturvardsverket and universities	SMHI	National Land Survey of Sweden; Geological Survey of Sweden; universities, research institutes	Swedish National Space Board
Switzerland	Federal Office of Meteorology and Climatology MeteoSwiss; Universities, Federal Research Institutes	-	Federal Office for the Environment (FOEN); Federal Statistical Office (FSO); Federal Office for Agriculture (FOAG); Universities, Federal Research Institutes	MeteoSwiss; State Secretariat for Education and Research (SER); FSO; Universities, Federal Research Institutes

Party	Meteorological /atmosphere	Oceans	Terrestrial	Space
United Kingdom	Meteorological Office; National Environmental Research Council British Antarctic Survey , British Geological Survey	Inter-agency Committee for Marine Science and Technology; Meteorological Office; Proudman Oceanographic Laboratory, British Oceanographic Data Centre, several agencies and laboratories	Over 14 government departments and agencies (Environmental Change Network)	Focus through British National Space Centre; 11 government organizations and agencies and through EUMETSAT and ESA
United States	National Oceanic and Atmospheric Administration (NOAA); Department of Energy	NOAA; several agencies and research institutions	NOAA; US Geologic Survey (USGS); Department of the Interior; National Science Foundation and others, particularly research programmes	NOAA, National Aeronautics and Space Administration (NASA); USGS; Department of Defense; several other agencies

Ensure that high-quality climate data records are collected, retained and made accessible

13. With few exceptions the Reports report full and open access to data recognizing the Parties' commitment to the international exchange of atmospheric, oceanic and terrestrial ECVs through arrangements established and coordinated by world bodies. WMO Resolution 40 (Cg-XII)[11] for meteorological data, and WMO Resolution 25 (Cg-XIII) (see footnote 11) for hydrological data were often cited as agreements guiding national data exchange policies. Some Parties stated that because of national policies, some data were available only under specific conditions; however, they acknowledged that such exchanges were permitted for research applications. The one unique exception, reported by Canada, involves data obtained by the satellites RADARSAT-1 and RADARSAT-2 where data rights and exclusivities owned by the private sector preclude fully accessible and free of charge arrangements.

14. Most Parties reported a focused effort to ensure that, as far as possible and practicable, the GCOS Climate Monitoring Principles (GCMPs) were being applied to all observations. In some instances, Parties (Australia, Portugal, UK) reported problems with applying the GCMPs to meteorological surface stations undergoing transformation from manual to automated operations and to certain shipboard marine meteorological observations. Often the time and resources did not allow for a complete application of the GCMPs. Some Parties also noted that ensuring application of the GCMPs in the case of hydrological data presents a special problem because these data are collected by a wide variety of agencies often at a local government level and by private operators that have not followed such standardized procedures and protocols.

15. Several Parties (e.g., Poland, Portugal, Slovakia, Switzerland, UK, Belgium) reported concerted efforts to preserve long-term climate records and to extend the data record in time through digitizing historical data records and compiling individual observations from documentary archives. These are compiled nationally in many instances and are in some cases organized regionally in databases.

International Data Centres

16. Many Parties reported on their sponsoring of international data centres, centres performing global scale analysis and specific reanalysis programs (Table 5). These activities are reported on in more detail in the 2004-2008 GCOS Progress Report. Based on the limited number of responses considered here, the system of international data centres outlined in the IP-04 (principally Atmosphere, Ocean, and Hydrological) are operational. However, as also noted in the 2004-2008 GCOS Progress Report, the provision of data and metadata to these centres from Parties is often uneven and incomplete and requires continued emphasis.

[11] See *Resolutions of Congress and the Executive Council*, WMO-No. 508 (2008rev); ftp://ftp.wmo.int/Documents/MediaPublic/Publications/Policy_docs/508_E.pdf

Table 5: Contributions to International Data Centres reported by Parties.

Party	Information reported
Canada	▪ DFO's Integrated Science Data Management Branch (ISDM) is the Responsible National Oceanographic Data Centre assisting the designated World Data Centre for Drifting Buoys. ▪ Several Canadian Forest Service (CFS) specialists working with the GTOS Panel for Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) have contributed to the formulation of draft standards for the land cover, biomass and fire disturbance ECVs. ▪ Canada, through NRCan's Geological Survey of Canada (GSC), hosts the Global Terrestrial Network for Permafrost (GTN-P) website. ▪ Environment Canada continues to operate the World Ozone and UV Radiation Data Centre (WOUDC). Also associated with the WOUDC is the Brewer Data Management System which is a primary data repository serving the Brewer Spectrophotometer community. ▪ EC operates the WMO World Calibration Centre Brewer reference triad, which provides the calibration reference for Brewer instruments in the global ozone observing network.
European Community	Seeks to ensure standards and protocols.
France	▪ A Tropical Ocean and Global Atmosphere/World Ocean Circulation Experiment (TOGA/WOCE) database ▪ Establishment of ARGO/GODAE Data Centre under the CORIOLIS project for operational oceanography
Germany	▪ Global Precipitation Climatology Centre (GPCC) at DWD ▪ WMO Commission for Basic Systems (CBS) Lead Centre for GCOS Data – Europe at DWD ▪ World Radiation Monitoring Centre (WRMC) at AWI ▪ Global Runoff Data Centre (GRDC) at BfG ▪ EUMETSAT Satellite Applications Facility (SAF) on Climate Monitoring (CM-SAF) at DWD ▪ World Data Centre for Remote Sensing of the Atmosphere (WDC-RSAT) at German Aerospace Centre (DLR)
Japan	▪ World Data Centre for Greenhouse Gases (WDCGG) at JMA ▪ GCOS Surface Monitoring Centre (GSNMC) jointly with DWD ▪ GAW Quality Assurance/Science Activity Centre (QA/SAC) for Asia and S-W Pacific at JMA ▪ GAW World Calibration Centre (WCC) for methane at JMA ▪ GAW Regional Dobson Calibration Centre (RDCC) at JMA
Netherlands	▪ WMO Regional Climate Centre (RCC) for WMO Region VI (Europe) at KNMI
Portugal	▪ EUMETSAT SAF Land Surface Analysis (LSA) (LSA-SAF) at IM
Russian Federation	▪ International Data Centre on the Hydrology of Lakes and Reservoirs (HYDROLARE) at SHI ▪ World Radiation Data Centre
Switzerland	▪ Global Earth Balance Archive (GEBA) at ETH Zurich ▪ World Glacier Monitoring Service (WGMS) at University of Zurich ▪ World Radiation Centre (WRC) which includes: Solar Radiometry Section (SRS) and Infrared Radiometry Section (IRS); and the World Optical Depth Research and Calibration Centre (WORCC) and the European Radiometer Calibration Centre (EUVC) at PMOD/WRC Davos ▪ World Calibration Centre (WCC) for surface ozone, carbon monoxide, and methane (WCC-Empa) ▪ GAW QA/SAC at Empa
United Kingdom	▪ The Met Office Hadley Centre (MOHC) global climate data archive and global gridded climate data sets. ▪ The international Atmospheric Circulation Reconstruction over the Earth (ACRE) project, hosted by MOHC, linking international meteorological organisations and data rescue infrastructure to facilitate the recovery, extension, quality control, consolidation, and accessibility of global historical terrestrial and marine instrumental surface data covering the last 250 years ▪ Climate Impacts LINK Project (LINK) provides climate simulations from the Met Office Hadley Centre to the UK and international academic communities. ▪ Global Collecting Centre for Marine Climatological Data (GCC). UK Met Office with Germany (DWD). ▪ Permanent Service for Mean Sea Level (PSMSL) at Proudman Oceanographic Laboratory. ▪ Antarctic Environmental Data Centre (AEDC) of the British Antarctic Survey. ▪ European Centre for Medium-Range Weather Forecasts (ECMWF) produces re-analyses used in climate change studies.
United States	▪ World Data Center at the National Climatic Data Center (NCDC) of NOAA in Asheville, NC. Comprehensive archive of global climate data.

	▪ National Snow and Ice Data Centre (NSIDC) in Boulder, CO. ▪ Global Land Cover Characteristics database. US Geological Survey.[12] ▪ Global Change Master Directory (NASA). An extensive directory re data sets relevant to global change research.[13] ▪ Earth Observing System Data and Information System (EOSDIS). NASA ▪ Carbon Dioxide Information Analysis Center (CDIAC). Department of Energy (DOE). Comprehensive global CO2 data and analysis products. ▪ Comprehensive Large Array-data Stewardship System (CLASS) of NOAA. On line facility for distribution from the library of NOAA environmental data.[14] ▪ Cooperative Arctic Data and Information Service (CADIS). UCAR, NSIDC, and NCAR. Service serving the Arctic Observing Network (AON) ▪ World Data Center for Precipitation Chemistry. State University of New York at Albany. GAW archive centre for precipitation chemistry data. ▪ Group for High Resolution Sea Surface Temperature (GHRSST) Long Term Stewardship and Reanalysis Facility. NOAA NODC. Access to SST analysis products. ▪ Global Observing Systems Information Center (GOSIC) at NOAA NCDC. Information and on-line access to GCOS, GOOS and GTOS data. ▪ WMO CBS Lead Centre for GCOS for North and Central America. NOAA NCDC. ▪ GCOS GSN and GUAN Archive. NOAA NCDC. Archive and access to all GSN and GUAN data. ▪ World Data Center for Palaeoclimatology NOAA, NCDC Boulder, Colorado. Archive and distribution of palaeoclimatology data and analyses.[15]

Capacity Building

17. Parties reported on a wide range of capacity building efforts ranging from cooperating in setting up or strengthening observatories (e.g., GUAN and GSN stations and GAW facilities), designing and implementing data management systems, providing training and education, and undertaking expert advisory services. Table 6 lists the various projects and programmes undertaken by Parties reporting on this occasion. Special multilateral efforts such as the ClimDev programme which follows up on the GCOS Regional Workshop Programme and the Regional Action Plan for Africa will be an important step in implementing GCOS in ways that contribute effectively to regional needs. Several Parties are cooperating in setting up or refurbishing GUAN stations in developing countries, principally in the tropical and semi-tropical zone. Research driven projects such as the African Monsoon Multidisciplinary Analysis Project (AMMA)[16] have assisted in the important task of rebuilding the observing networks over data sparse regions like West Africa. Building on such initiatives will be an important objective to reach the IP-04 requirements. Several Parties (Netherlands, Switzerland, USA) indicate that they will utilize the GCOS Cooperation Mechanism in the future as part of their capacity building efforts. Whilst there has been considerable activity in capacity building programmes, the overall progress continues to be slow. New and innovative ideas and programmes will continue to be required.

Table 6: Capacity building activities relevant to GCOS reported by Parties.

Party	Information reported
Australia	▪ Pacific Island – Climate Prediction Project (PI-CPP) ▪ Pacific Islands Climate Data Rescue Project ▪ Building Robust Infrastructure Project ▪ Climate Data Management System for Pacific Island Countries (ClimSoft) Project
Belgium	▪ CLIMLAKE (2000-2006) and CLIMFISH (2004-2006) projects in cooperation with Zambia and Tanzania focusing on monitoring Lake Tanganyika. ▪ Bilateral cooperation with Ile de la Réunion carried out spectrometric observations of several atmospheric composition ECVs ▪ Climatic and Anthropogenic Impacts on African Ecosystems (CLANIMAE) project – a

[12] http://landsat.usgs.gov

[13] http://globalchange.nasa.gov

[14] http://www.nsof.class.noaa.gov/saa/products/welcome

[15] http://www.ncdc.noaa.gov/paleo/

[16] Initiated by France with participation of UK, USA and operational agencies in the countries of West Africa (ASECNA, Senegal, Nigeria, Benin, Ghana). See Parker, D.J. et al. (2008): *The AMMA Radiosonde Program and its Implications for the Future of Atmospheric Monitoring over Africa.* Bull. Am. Met. Soc. **89**, 1015-1027 (July 2008).

Party	Information reported
	cooperative palaeo-environmental project with Uganda and Kenya to use lake-sediment cores to reconstruct past climatic variability and impacts. ▪ ENSO-Chili project analyzed sedimentary records of two Chilean lake basins to investigate natural ENSO cycles in a long geologic history
Canada	▪ The Canadian Forest Service (CFS) provides financial, technical and secretariat support to the GTOS Panel for GOFC-GOLD, which has a focus on the terrestrial ECVs of land cover, biomass and fire disturbance. GOFC-GOLD works with eight regional networks in Africa, Asia and South America, representing approximately 30 developing countries. ▪ The CFS is working with the Canadian Space Agency to make imagery available from the RADARSAT-1 archive for land and forest cover mapping in tropical regions where significant cloud cover limits the use of optical imagery. ▪ Environment Canada (EC) scientists conduct biennial workshops and tutorial sessions to provide support for the operators of Brewer ozone Spectrophotometers in the WMO global ozone and UV observing systems.
European Community	▪ PUMA Project - Preparation for the Use Of Meteosat Second Generation in Africa. Assists sub-Saharan African countries with equipment and training for use of advanced satellite data. ▪ AMESD Project - African Monitoring of the Environment for Sustainable Development. Follow-on to PUMA which introduces other applications of satellite data e.g. land use, desertification, deforestation, fresh water resources, agricultural production etc. ▪ CARBOAFRICA Project. Quantification, understanding and prediction of carbon cycle, and other GHG gases in Sub-Saharan Africa. Enhancement of observing systems and strengthening understanding. ▪ AMFIC Project - (Air quality monitoring and forecasting in China). ▪ DRAGONESS Project - support for harmonizing European and Chinese marine monitoring for Environment and Security System. ▪ MONRUK Project - Monitoring the marine environment in Russia, Ukraine and Kazakhstan using satellite synthetic aperture radar). ▪ VGT4-Africa - Project - Distribution of vegetation data in Africa through EUMETCAST.
Finland	▪ Preparedness to Climate Variability and Global Change in Small Island Developing States, Caribbean Region. Project involved 18 countries and included rehabilitation and upgrading of observing systems, telecommunication system, improvements, data management and training.
France	▪ African Monsoon Multidisciplinary Analysis (AMMA) Project and its follow-on called RIPESCA. Project, aimed at recovering upper air, and surface meteorological observing stations and hydrological and aerosol observations in West Africa. (Project in cooperation with West African nations, USA, UK and Germany).
Germany	▪ Mali – Training and capacity building to digitize and distribute Mali climate data. ▪ Croatia – Support for a satellite training workshop ▪ Tunisia – Support for a Climate Information and Prediction Services Workshop ▪ Global Atmospheric Watch (GAW) Training and Education Centre (GAWTEC) – provides scientific guidance and training to GAW station personnel from any country. ▪ GCOS cooperation mechanism.
Ireland	▪ Bilateral development programmes with Lesotho, Ethiopia, Mozambique, Tanzania, Uganda, Zambia, Vietnam, Timor Leste, and Malawi. Aid programmes also in South Africa, Liberia, and Sierra Leone. Activities include agriculture, health, infrastructure, water resources management, and disaster prevention which have positive impacts in terms of adaptation to climate change. ▪ Support to multilateral programmes including the Least Developed Countries Fund and the Special Climate Change Fund
Japan	▪ The Japan Meteorological Agency (JMA) operates the Quality Assurance/Science Activity Centre (QA/SAC) for Asia and the South-West Pacific under the GAW programme. ▪ JMA exchanges experts with observing sites in the region to give technical support for observation and data quality assurance: JMA received experts from Malaysia and the Republic of Korea in 2005 and 2007, respectively. ▪ JMA also hosts the World Calibration Centre (WCC) for Methane in Asia and the South-West Pacific and the Regional Dobson Calibration Centre (RDCC) for Asia for total ozone measurement in the framework of GAW to maintain calibration standards and provide instrument calibration.
Netherlands	▪ Participates in the GCOS Cooperation Mechanism. Through this mechanism the Netherlands will participate in the GCOS Action Plans for Africa. ▪ Royal Netherlands Meteorological Institute (KNMI) supports the operation of a GAW station in Surinam.
Poland	▪ Training events and workshops

Party	Information reported
Spain	▪ AEMet support to Iberio-american trust fund to improve climate service capacities ▪ AEMet support to International Investigation Centre of the El Nino phenomenon (CIIFEN), Equador. ▪ AEMet support to activities in Africa through ACMAD. ▪ AEMet support to education and training.
Sweden	▪ Project to support the Botswana National weather Service with guidance on operations, facilities, technical infrastructure, and automatic weather stations. ▪ Training programmes focusing on climate change and its consequences. Courses located in Asia, Latin America and Africa.
Switzerland	▪ Swiss institutions have programmes to enhance observations for ozone (Kenya), trace gases (Algeria, Kenya, Indonesia), and glaciers (world-wide). ▪ Participate in the GCOS Cooperation Mechanism (Swiss Agency for Development and Cooperation (SDC))..
United Kingdom	▪ GCOS Upper-air Network (GUAN) activities. Cooperation with a project funded by the US the UK through "in kind" contributions assists in implementing projects supporting 13 GUAN Stations. ▪ Direct support of GCOS and GSN stations (a GSN station on Pitcairn Island, and GUAN sites at Seychelles, Penrhyn, Tarawa, and Funafuti). ▪ Training workshops for radiosonde operations in Africa (Namibia). ▪ ClimDev Africa support to planning activities. ▪ Cape Verde Atmospheric Observatory. Cooperative project with Germany and the Cape Verde National Meteorological and Hydrological Service (INMG) supports a major GAW station on Sao Vicente including a training and continuing education component.
United States	▪ NOAA Integrated Data and Environmental Applications (IDEA) Center. Object to improve climate data integration in the Pacific Islands region and produce more useful, end-user-driven climate products. ▪ Bilateral projects with China, South Africa, and south Korea. Projects deal with climate prediction, ocean observation, stratospheric detection, water vapour measurements, training and communication of information. ▪ GCOS Upper-air Network (GUAN) Project to fund a major effort and work cooperatively with donor partners (Australia, UK) and recipient Nations to implement a refurbishment programme for non-operational GUAN stations especially in the tropical belt of Africa, South America and the Island States. ▪ Support to the French led African Multidisciplinary Monsoon Analysis (AMMA) Project.

Palaeoclimate

18. The Parties report on an impressive list of research projects focused on an wide range of palaeoclimate indicators or proxy records derived from tree-rings, ice cores, speleothems, corals, boreholes, sediments, pollens etc. While most studies are stand-alone research projects focused on a single location, there is growing interest in expanding the studies to larger areas, such as an ocean-basin scale or a continental scale, requiring substantial international cooperation and collaboration. One example of international collaboration is the Arctic Palaeoclimate and its Extremes (APEX) programme. Here, 17 European and North American countries coordinate their palaeoclimatic research aiming at understanding Arctic climatic changes beyond instrumental records utilizing field observations and modelling. The International Polar Year (IPY) has highlighted this activity. Another example is the EU Millennium Project which is focusing on the reconstruction of the climate variability in Europe during the last millennia.

19. The synthesis of the individual palaeoclimatic research reports into a systematic global picture of past climate and its relevance to the historical instrumental record remains an important objective. The World Data Center for Paleoclimatology[17] has the goal to make palaeoclimate data and information as useful as possible in understanding climate variability and change. The Center relies on the contributions from the extramural scientific community around the world to archive, in a standardized and accessible way, their data and the results of their published research. Table 7, extracted from the US National Report, provides an overview of the current holdings in the World Data Center.

[17] http://www.ncdc.noaa.gov/paleo/

Table 7: International contributions to the World Data Center for Paleoclimatology (source: US National Report on Systematic Observations for Climate - September 2008).

	Total Number of Available Datasets	Number of Available Datasets per Length of Time Series	
Palaeoclimatic Data		**>100 years**	**>300 years**
Borehole Data	837		837
Corals	147	108	39
Fauna	220		220
Ice Cores	23		23
Insects	7		7
Paleolimnology	78		78
Palaeoceanography	1434		1434
Plant Macrofossils	296		296
Pollen	1661		1661
Tree Ring	2860	1185	1675
Other Paleoclimatic Data	5		5
Total	**7568**	**1293**	**6275**

Satellite based observations

20. Improved instruments, international coordination and exploitation of datasets have led to an increasingly important contribution of satellite systems to global climate monitoring. Almost all Parties report substantive participation in the acquisition and/or application of satellite data in their climate programmes. Reprocessing and analysis of satellite-based climate data records is an ongoing activity required to improve the description of climate variability and trends. Observational capabilities of future satellite systems need to ensure continuity of the climate record, as well as provide new or improved measurements of some ECVs, such as cloud properties, aerosols and greenhouse gases.

21. Several Parties reported on their contributions to monitoring climate from space, in areas such as research, instrument development, algorithm development, QA/QC, hosting satellite ground stations, calibration/validation activities, and data analysis, that help to create the data sets relevant to climate (see Table 8). Some Parties reported on the build-up of operational user services targeting ECV satellite products, particularly in the atmospheric and oceanic domains. There is increasing use of satellite-based data in routine monitoring of ECVs for various application areas outside the atmospheric/meteorological domain, e.g., monitoring of ozone, aerosols, land cover, snow cover, forests, sea ice etc.

22. The satellite operators working through CEOS, CGMS, and the WMO Space Programme have carefully set a path for the future to ensure a viable and homogenous flow of global remote sensing data which covers the highest priority needs of GCOS. In addition, they have developed important initiatives to ensure better calibration of instruments and reprocessing of the past climate record. All this requires extraordinary international cooperation, collaboration and commitment, which needs to be continued and expanded. It equally requires an active and focused research programme and funding commitments by nations providing satellites, as well as targeted capacity building in countries where take-up of satellite data for climate monitoring is limited.

Table 8: Contribution to space-based observations as reported by Parties.

Party	General Remarks	Atmosphere	Oceans	Terrestrial
Australia		Use of satellite data for meteorological/atmospheric analyses.	Use of satellite data (SST, ocean colour, altimetry and sea ice).	Use of satellite data (vegetation indices).

Party	General Remarks	Atmosphere	Oceans	Terrestrial
Belgium		Contribution to retrieval and validation of satellite-derived profiles of temperature, greenhouse gases (including water vapour), ozone profiles, and ozone total column.	Belcolour Project: SST, Chlorophyll and Total Suspended Matter maps and images.	Partner in relevant satellite missions (e.g., multispectral imagers) including support to ground segment; user of data for biomass, land cover, fire disturbance, LAI. Flanders Marine Institute hosts the SPOT Vegetation Image Processing and Archiving Centre.
Canada	Mission development by Canadian Space Agency and private sector, and through international collaboration; wide use of satellite by national agencies.	Provider and user of data for ozone, GHG, aerosol and cloud retrieval; development of new missions for meteorological applications.	Provider and user of satellite data for sea-ice mapping.	Product development and generation for snow cover, land cover, biomass, vegetation indices, albedo, fire; development of new missions (for albedo, snow cover, vegetation, fire).
Denmark	Use of satellite data mainly through EUMETSAT.	Generation of products for upper-air temperature, water vapour and ozone in EUMETSAT SAFs.	Generation of products for sea ice, SST within EUMETSAT SAFs and participation in ocean reanalyses.	
European Community	Support to establishment of user services in GMES initiative; support to research activities in support of Earth observation.	Support to routine product generation of ECVs through targeted services, with strong satellite component.	Support to routine product generation of several ECVs through targeted services, with strong satellite component.	Support to routine product generation of several ECVs through targeted services, with strong satellite component.
Finland		Participation in satellite mission for ozone and other atmospheric composition parameters.	Routine sea-ice cover and SST monitoring using SAR and imaging spectrometers.	Participation in development of snow cover and albedo products; use of imagery for lake, snow and coastal water monitoring, as well as land cover and land use change detection.
France	Development and operation of satellite missions, nationally and through European participation; international coordination through CEOS; strong involvement in satellite ground-segment activities, and service provision.	Participation in European satellite programmes for monitoring of all atmospheric ECVs; support to satellite missions for the observation of cloud properties, precipitation, aerosols; use of satellite-based data for products on cloud properties, precipitation, aerosols.	Support to satellite missions for the observation of ocean altimetry.	Support to satellite missions for the observation of lakes, snow cover, glaciers, land use; use of satellite-based data for products on lakes, snow cover, glaciers, land use.

Party	General Remarks	Atmosphere	Oceans	Terrestrial
Germany	Strong involvement in satellite ground-segment activities, and service provision. DWD hosts the EUMETSAT Satellite Application Facility on Climate Monitoring (CM-SAF).	Participation in European satellite programmes for monitoring of all atmospheric ECVs.	Use of imagery for SST information.	Support to satellite mission for sea-ice observations; use of satellite-based data for land cover, biomass, and forestry information.
Greece		Participation in European satellite programmes for monitoring of all atmospheric ECVs.	Use of satellite-based for monitoring of sea level, sea state. SST, ocean colour, ocean salinity.	Use of satellite-based for forest and carbon monitoring.
Ireland		Participation in European satellite programmes for monitoring of all atmospheric ECVs.		
Italy	Involvement in satellite instrument development through European programmes.	Participation in European satellite programmes for monitoring of all atmospheric ECVs.		
Japan	Undertakes major operational and research and development space programmes.	Operation and development of satellite missions addressing all atmospheric ECVs except ozone, upper-air temperature.	Operation and development of satellite missions addressing sea ice, SST, ocean colour.	Operation and development of satellite missions addressing all terrestrial ECVs.
Lithuania				Use of satellite data for fire monitoring.
Netherlands		Development of satellite missions to address ozone and other atmospheric composition ECVs; Use of satellite-based data for surface wind speed and direction, water vapour, cloud properties, precipitation, ozone and aerosols.	Use of satellite data for sea state retrievals (ocean stress).	
Poland	Associated with EUMETSAT and ESA.	IMGW Center of Teledetection (OTS). User of satellite information for both research and operational weather forecasting and climate applications and archive of data.	Analysis of sea-surface temperature, wind at surface, altimetry, and research in sea surface salinity.	Use of satellite data for snow cover and water content, use of EUMETSAT Land-SAF analysis, use of satellite data in research into observing soil moisture.
Portugal			Host of Land Surface Satellite Application Facility (LSA SAF) of EUMETSAT processing and distributing land surface temperature and lake temp, snow cover, albedo, and fAPAR, and fire radiative power from MSG images.	

Party	General Remarks	Atmosphere	Oceans	Terrestrial
Spain	Participation in ESA and EUMETSAT programmes; facilities for data processing, distribution and product generation.	Observation of atmospheric and meteorological ECVs through EUMETSAT satellites; utilization of data from a broad range of sensors.	Observation of oceanic ECVs through EUMETSAT satellites; utilization of a broad range of sensors for product generation (waveheight by altimetry, sea state, sea surface temperature, ocean colour).	Observation of terrestrial ECVs through EUMETSAT satellites; utilization of a broad range of sensors for product generation (surface albedo, soil moisture, vegetation).
Sweden		EUMETSAT CM SAF. Processing satellite data for cloud properties, earth radiation budget and ODIN ozone analysis.	OSI SAF for sea ice in Baltic Sea and sea level. JASON 2 optional PGM. EUMETSAT.	Research towards using satellite data for biomass.
Switzerland	Member State of ESA and EUMETSAT; Participation in ESA and EUMETSAT programmes. Strong involvement in EUMETSAT CM-SAF.	Use of satellite-based data for climatological analysis of clouds, water vapour, radiation, ozone, trace gases, aerosols, with particular focus for the Alpine region (e.g. Alpine radiation product within CM-SAF).	-	Use of satellite-based data for climatological analysis of lake temperature, snow cover, glaciers, land cover, ecosystem (fAPAR), and forest fires.
Turkey		Utilizing satellite data for meteorological analyses and forest fires.		
United Kingdom	Contribution to space-based observations in EUMETSAT and ESA framework.	Systematic use of satellite data by MetOffice and ECMWF (reanalyses)	Mission for SST monitoring in the ESA framework; SST, sea-ice and sea level analyses.	
United States	Operational and research global observing systems from space (NOAA, NASA, USGS and international collaboration).	Provision and use of all atmospheric ECVs from space, from both operational and research-type missions.	Provision and use of all oceanic ECVs from space, from both operational and research-type missions.	Provision and use of all terrestrial ECVs from space, from both operational and research-type missions.

3 Atmospheric Essential Climate Variables

23. Most Parties responding provided, in tabular form, a summary of their atmospheric observing programmes for surface meteorological, upper-air and atmospheric composition ECVs (see Table 2). Overall, there has been steady progress in maintaining and enhancing the atmospheric observing systems for climate. This is largely based on efforts by the national operators of networks and systems (both ground and space-based) providing surface and upper-air meteorological observations, and measurements of greenhouse gases and other aspects of atmospheric composition. The global trends of declining in-situ meteorological network performance prevailing through the 1990s has been halted or reversed in all regions. In spite of the overall progress, it must be stressed that some regions of the world have seen no significant improvement in observational coverage.

24. One facet of the progress made has been improved reception of observational data in international data centres. This is at least in part due to enhanced engagement by centres dedicated to monitoring in-situ network performance, acting in liaison with both the network operators and the programmes responsible for the networks. For example, the work of the existing GSN and GUAN Monitoring, Analysis and Archive Centres has been complemented by the establishment of nine WMO/CBS Lead Centres for GCOS covering all regions worldwide. Nevertheless, there remain significant gaps in both network coverage and the frequency of reporting from existing stations, which

is of particular concern with respect to understanding and predicting regional climate and climate change.

25. A new development since 2004 has been increased emphasis on establishing reference-type networks that would provide anchor points for broader GCOS surface and upper-air networks. In particular, for observing the atmospheric column, important steps have been taken towards establishment of the GCOS Reference Upper Air Network (GRUAN). In addition, several Parties are in the process of setting up national climate networks of geographically well-distributed surface stations that exhibit high-quality observations of many, if not all, of the surface-based climate variables.

26. Meeting the full range of objectives expressed in the IP-04 will require much more attention on building capacity in developing and least-developed countries, to ensure better observational coverage and use of climate data, especially on regional and national scales where required for the purposes of adaptation.

27. The following sections discuss the Parties' response to the issues raised in the guidelines relative to the Atmospheric Domain as reflected in UNFCCC Decision 11/CP.13. (see paragraph 5. above).

Applying the GCMPs to all surface climate networks

28. All Parties reported on their implementation of the GSN and indicated that they were complying as far as possible with the GCMPs. The GSN is a subset of the of the WMO Global Observing System (GOS) basic synoptic surface network of about 10 000 meteorological stations worldwide. The GOS includes the Regional Basic Synoptic Network (RBSN) of about 4000 stations which is regularly monitored (see Table 9). All networks are operated by National Meteorological Services and coordinated by the WMO Commission for Basic Systems. Global reception rates at World Data Centres have gradually improved for the synoptic network (RBSN), reaching 80% in October 2008, while substantial regional differences persist, e.g., relatively low data reception rates in Africa (56%), in South America (65%) and in Australia/Pacific region (73%).

Table 9: Reception rate of standard surface meteorological data in the Regional Basic Synoptic Network in WMO Regions (RA) during annual monitoring exercises of WMO.

	Oct 2004	Oct 2005	Oct 2006	Oct 2007	Oct 2008
Africa (RA I)	53 %	55 %	54 %	54 %	56%
Asia (RA II)	84 %	88 %	89 %	89 %	91%
South America (RA III)	62 %	58 %	61 %	63 %	65%
North America, Central America and the Caribbean (RA IV)	86 %	81 %	79 %	79 %	83%
South-West Pacific (RA V)	69 %	69 %	72 %	73 %	73%
Europe (RA VI)	94 %	93 %	95 %	95 %	96%
Total	**77 %**	**78 %**	**79 %**	**78 %**	**80%**

29. WMO continues to emphasize the importance of the GCMP in its efforts at standardization of observations through its Technical Commissions.

Incorporating atmospheric pressure sensors into drifting buoy programmes

30. The observation of surface air pressure from the synoptic networks discussed above are complemented over the oceans by Voluntary Observing Ships (VOS) and buoy measurements. Parties deploying drifting buoys report renewed efforts to ensure all buoys are equipped with pressure sensors. As of February 2009, 549 buoys measure sea level pressure (SLP) from a total of 1122 drifting surface buoys. This is a significant improvement on the situation in 2003, when only 272 out of 913 drifters measured sea level pressure. Most of the buoys measuring sea level pressure are located in the middle and high latitudes where the pressure measurements are much more critical to the global analysis. There is nevertheless still scope for improvement.

Ensuring availability of three-hourly mean sea level pressure and wind speed and direction data from GSN stations

31. In July 2008, WMO sent a letter to all National Meteorological Services emphasizing the importance of high-frequency ground-based observations (beyond the standard three to six hour reporting for synoptic observations) in order to improve regional climate modelling and the prediction and analysis of extreme events. Furthermore, the letter asked for real-time submission of synoptic data as well as submission of historical climate records to the International Data Centres. Almost all Parties reported compliance with the request for the routine exchange of at least three-hourly data from GSN stations. The current situation has it that roughly a quarter of the stations in the RBSN (the full network), i.e. around 2000 stations, report on a 3-hourly or hourly basis. There has been a sharp rise in the past five years.

Reference climate networks

32. A new dimension in monitoring climate involves utilizing "Reference Climate Networks" that are networks of geographically well distributed surface stations, dedicated to monitoring the climate, that exhibit homogeneity, stability and accuracy in a complete set of variables including all of the atmospheric surface ECVs and which include others such as soil moisture and soil temperature, and often are located where atmospheric composition ECVs are also observed. Examples are the US Climatic Reference Network (USCRN) and the Polish Climate Reference Network and Swiss National Basic Climatological Network (NBCN), the latter two having very long historical records as a selection criterion. One might consider these as "anchor stations" for larger, less rigorous networks, such as the GSN and RBSN networks.

Implementing a reference network of high-altitude, high-quality radiosondes

33. Over the last four years, the concept of a GCOS Reference Upper-Air Network (GRUAN) has been developed and will begin to be implemented[18]. Under the auspices of the AOPC Working Group on Atmospheric Reference Observations (WG ARO), the concept of the GRUAN was expanded to include a number of other reference measurements, such as ozone, GPS delay, and lidars. The Meteorological Observatory Lindenberg – Richard-Aßmann-Observatory (DWD, Germany) was selected as the Lead Centre. The selection of an initial set of 14 GRUAN candidate sites has been made. Several Parties (France, Germany, Australia, UK, USA) have indicated their intent to implement GRUAN sites.

Operating the WWW/GOS radiosonde network in full compliance with the GCMPs and coding conventions

34. Parties generally reported compliance with the requirement. One measure of the performance of the global network is to look at the receipt of data operationally at the international data and processing centres. The GUAN is a subset of the WMO Global Observing System (GOS) basic synoptic upper-air network of about 1300 upper-air meteorological stations worldwide. The GOS includes the Regional Basic Synoptic Network (RBSN) which is regularly monitored (see Table 10) and coordinated by the WMO World Weather Watch. For the RBSN, receipt of radiosonde data has improved over the last eight years and reached the 1994 level of about 600 ascents at 00 and 12 UTC. The percentage of data available from the RBSN increased from 63% in 2003 to 72% in October 2008. Data availability was relatively satisfactory for the northern and eastern parts of Asia, North America, and many countries in Europe and the Pacific region, but generally insufficient for most of the other parts of the world. A number of Parties, principally in Europe, operate the Automated Ship-borne Aerological Programme (ASAP) which uses commercial ships to launch radiosondes while underway thus supplementing the land based network on a sustained basis.

[18] GCOS (2007): *GCOS Reference Upper-Air Network: Justification, requirements, siting and instrumentation options.* GCOS-112, April 2007, http://www.wmo.int/pages/prog/gcos/Publications/gcos-112.pdf and GCOS (2008): *Report of the GCOS Reference Upper-Air Network Implementation Meeting*. GCOS-121, February 2008, http://www.wmo.int/pages/prog/gcos/Publications/gcos-121.pdf

Table 10: Reception rate of standard upper-air radiosonde data in the Regional Basic Synoptic Network in WMO Regions (RA) during annual monitoring exercises of WMO.

	Oct 2004	Oct 2005	Oct 2006	Oct 2007	Oct 2008
Africa (RA I)	36 %	36 %	33 %	29 %	29%
Asia (RA II)	66 %	77 %	80 %	81 %	80%
South America (RA III)	46 %	47 %	43 %	49 %	45%
North America, Central America and the Caribbean (RA IV)	86 %	88 %	89 %	88 %	90%
South-West Pacific (RA V)	63 %	57 %	59 %	71 %	63%
Europe (RAVI)	80 %	80 %	79 %	78 %	83%
Total	**67 %**	**70 %**	**71 %**	**71 %**	**72%**

35. There has been a significant rise in the number of soundings reaching 10 hPa, indicating improvements in radiosonde operation. Many Parties reported the compliance of their upper-air observational programmes with the GCMPs. Overall quality of observations has been improved, for example through a reduction in reported bias of upper-level temperatures. Coding errors of synoptic radiosonde data does not present a problem, but the transition from the traditional TEMP coding to the more comprehensive BUFR format has been slow.

Submitting metadata records and inter-comparisons for radiosonde observations to the specified international data centres.

36. Many Parties reported that they were complying with this action. Data centres report that some progress has been made in the submission of metadata. For example, radiosonde metadata for Russia, including its Antarctic stations, have been provided to the GUAN Lead Centre, NCDC. Metadata records have been updated for 109 GUAN stations since 2004. The updated records are stored in the IGRA (Integrated Global Radiosonde Archive) metadata database at NCDC. The IGRA metadata database contains at least some metadata records for 161 GUAN stations.

37. In 2005, a radiosondes intercalibration and intercomparison campaign was organized on Mauritius, since a new generation of radiosondes is being introduced into most of the global upper air network. Six operational radiosonde systems participated in this intercomparison. The Intercomparison in Mauritius demonstrated that errors identified in the WMO Intercomparison of GPS Radiosondes in Brazil (2001) have mostly been rectified. A major radiosondes intercomparison campaign is planned for 2010, including operational and research instruments, under WMO CIMO and GRUAN auspices.

Developing a network of ground-based Global Positioning System (GPS) receivers for measuring water vapour

38. Several Parties (Germany, Netherlands, Switzerland, Japan, Australia, UK, USA) reported on implementation of national networks of ground-based Global Positioning System (GPS) receivers with processing systems designed to provide measurements of water vapour. These systems are often in the test and evaluation stage. To date, a global standard for the exchange of data from GPS networks has not been developed, although guidelines providing the basis for such a standard exist. There are a number of national and regional networks, for example, in the framework of the EUMETNET E-GVAP project, data from more than 400 GPS sites are used the UK Met Office, who run a pre-operational network, mainly intended and used for scientific purposes.

Sustained measurements of the atmospheric composition ECVs, supplementary to those activities implicit in the ECV list (see Appendix 1).

39. In response to this item Parties (UK, Switzerland, Poland, Netherlands, Germany, Finland, Denmark, Belgium) report sustained observations of a variety of variables, including surface ozone, surface carbon dioxide, NO, NO_2, N_2O, SO_2, HCFC, HCHO, SF_6, Halocarbons, Rn and H_2, aerosol mass concentrations, and pollen.

4 Oceanic Essential Climate Variables

40. In many countries, ocean observations fall under the responsibility of several agencies and institutions. As with the atmospheric domain, many Parties have created coordination mechanisms so that a focused and efficient implementation of the IP-04 can be attained. The reporting Parties, with ocean observing programmes, also filed completed tables as requested in the revised reporting guidelines (UNFCCC Decision 11/CP.13, see footnote 1). The responses illustrate a dynamic and growing oceanic component of GCOS. Global summaries of the progress in implementation the individual actions called for in the IP-04 are given in the 2004-2008 GCOS Progress Report.

41. The narrative information pertaining to certain actions as requested by Decision 11/CP.13 was largely missing from many reports. However; based on the reports of some Parties and inferring from information provided in the tables and also from evidence from data centres, the following summary statements can be made about progress toward the recommended actions.

Improving metadata acquisition and data management for the VOSClim fleet

42. Several Parties (Australia, Japan, Germany, Netherlands, USA, Ireland, Sweden, France, Canada) report improving metadata acquisition and data management for the VOSClim subset of the Voluntary Observing Ship fleet. Overall the number of ships recruited to the VOSClim programme, providing enhanced metadata for climate purposes, has progressed to beyond the original goals (now 259 ships out of 200 originally targeted). Not all of the ships recruited report the additional elements required. The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) has also developed a pilot project for the real-time serving of metadata on ocean temperature measurements taken by all the observing networks. The National Marine Data and Information Service of China has taken primary responsibility for serving the data archive function.

Ensuring that high-frequency (hourly or less) sea level observations are available for all coastal tide gauges, including historical records, are corrected for sea level pressure and are submitted to the specified international data centres.

43. Many Parties (e.g. Australia, Canada, Ireland, Japan, Netherlands, Poland, Sweden, UK, USA) report that high-frequency (hourly or less) sea level observations are available for coastal tide gauges, and that the historical records are corrected for sea level pressure and are submitted to the specified international data centres. There is a growing number of real-time reporting sea level stations, primarily funded for tsunami warning purposes, with 108 near real-time reporting stations as part of the global tsunami warning network, a significant increase from the 70 in 2004. Considerable network gaps still exist in the Caribbean, South America and North Africa.

Including sea level objectives in the capacity-building programmes of GOOS, JCOMM, WMO, other related bodies and the system-improvement programme of GCOS.

44. Several Parties (e.g., Australia, USA, Greece) report on capacity building projects aimed at implementing and upgrading sea level observations. Since 2003, IOC/GLOSS has directly carried out several implementation and capacity building activities. These include:

(a) 8 technical visits to provide advice on feasibility of installations/upgrades of national sea level station networks;[19]
(b) 4 training course in sea level observation and analysis;[20]
(c) 31 visiting fellowships in the IOC "Fellowship programme in sea level science and applications" (2007-2009);
(d) publication of the Manual on Sea Level Measurement and Interpretation;[21]
(e) upgrade/installation of 25 real time sea level stations in Africa and the Indian Ocean.

[19] The Global Sea Level Observing System, Reports on Technical Missions, http://www.gloss-sealevel.org/publications/tech_mission_reports.html

[20] The Global Sea Level Observing System, GLOSS Activities and Technical Training, http://www.gloss-sealevel.org/training/

[21] Intergovernmental Oceanographic Commission (IOC) (2006): *Manual on Sea Level Measurement and Interpretation -- Volume IV: An Update to 2006.* IOC Manuals and Guides 14 / JCOMM Technical Report No. 31 / WMO/TD No. 1339, June 2006, http://unesdoc.unesco.org/images/0014/001477/147773e.pdf.

The importance of factors other than initial investment in hardware including technical training, infrastructure and regular calibrations are seen as critical elements of the capacity-building activity.

Developing a robust programme to observe sea surface salinity, to include VOS ships, research ships, reference moorings and drifting buoys.

45. Several Parties (e.g. Australia, Japan, Germany, Netherlands, Poland, USA, Canada, UK and Ireland) report on activities to develop and deploy capability to observe sea surface salinity utilizing platforms such as VOS ships, research ships, SOOP ships including ferry ships, reference moorings and drifting buoys. These are mostly research-funded activities investigating the feasibility of accurate long-term surface measurements of sea surface salinity, all in pilot project phase at present. Plans will depend on the success of these pilot projects. The global ocean surface underway data (GOSUD) project is preparing to archive data.

Implementing a programme for measuring surface pCO_2.

46. The space and time sampling requirements for a global surface pCO_2 network have been determined and reviewed internationally. Several Parties (e.g., Australia, Belgium, Germany, Ireland, Japan, and UK) report active research and development activities for observing pCO_2. The Surface Ocean CO_2 Atlas (SOCAT) project has been initiated to compile new and archived data into a common format quality-controlled database and to make data streams interoperable. New data is publicly released according to regional or national policy; in near-real time by US-funded programmes, and after two years by European-funded programmes. Regional multi-platform observing networks have been developed in the North Atlantic and North Pacific. Projects are being developed to expand the network to other ocean regions. Regional and global CO_2 flux maps are being produced on a regular basis. Comparison of the various flux map products and evaluation of the associated uncertainties is just beginning.

Implementing a wave measurement component as part of the Surface Reference Mooring Network.

47. A few Parties (e.g., Australia, Germany, Ireland, UK) report on activities leading to implementing a wave measurement component as part of the Surface Reference Mooring Network. Small-scale pilot projects for the measurement of some wave parameters from drifting buoys and for the evaluation of wave measurements from a variety of fixed moorings were established in October 2008, growing from a continuing dialogue between JCOMM and the OceanSITES team as well as the Data Buoy Cooperation Panel (DBCP). No open-ocean reference sites measuring wave heights/frequency have yet been established.

Improving in situ sea ice observations from buoys, visual surveys (Ship of Opportunity Programme (SOOP) and aircraft) and upward-looking sonars, and implementing observations in the Arctic and Antarctic.

48. Several Parties have reported improved sea ice observations (e.g., Canada has reinstated 9 stations). In addition, there has been improvement in sea ice concentration algorithms from satellite data on the part of several space agencies and associated groups, such as USA/NOAA, the EUMETSAT Ocean and Sea Ice Satellite Application Facility, and the ESA GlobIce programme. Important contributions regarding a wide range of observations in the Arctic and Antarctic as part of the International Polar Year (IPY) have been made and some of these initiatives may be made permanent features of the observing systems (USA and Canada).

Conducting the systematic global full-depth water column sampling of 30 sections repeated every 10 years

49. Several Parties (Australia, Japan, Germany, Netherlands, USA, Russia, Canada, UK, France and Ireland) reported their participation in systematic global full-depth water column sampling of 30 sections repeated every 10 years (including ocean carbon inventory change) and the recommended 41 SOOP XBT/XCTD trans-oceanic sections. The ocean community reports that the scheduled percentage of the decadal survey has been completed. A revised international hydrography programme is being planned called GOSHIP.

Performing the 41 SOOP XBT/XCTD trans-oceanic sections

50. Parties report continued participation in the trans-oceanic section programme. . In 2008, 62% of the number of XBTs targeted in the IP-04 were carried out, with 30 out of 45 lines having been sampled The evolution of the plan based on changing patterns of maritime commerce will be undertaken as part of the updated IP-04 activity.

Developing capability for systematic measurement of biogeochemical and ecological ECVs

51. Several Parties (Australia, Belgium, Finland, Ireland, UK) report on developing the capability for systematic measurement of biogeochemical and ecological ECVs including plankton, nutrient samples, particulate organic carbon, specific biomarkers (lipids), bulk organic matter, algal blooms etc. The existence and further development of promising new sensors with improved long-term performance are being validated for extended autonomous moored or float deployment for oxygen, pH, pCO_2, and chlorophyll.

Supporting data rescue projects and implementing regional, specialized and global data and analysis centres

52. A few Parties (e.g., Australia, Netherlands, Poland and Ireland) report active programmes in data rescue including the digitization of log book records. JCOMM has developed a strategy for implementing regional, specialized and global analysis centres but further input from IODE and the World Data Centres is required. The GODAR project of the IODE has continued successful rescue of historical oceanographic profile and plankton data from before 1992, resulting in a continuing increase in the number of profiles available online through the World Ocean Database. These have been helped by a number of national programmes, notably in the USA, UK, the Netherlands and Germany.

Developing plans and pilot projects for the production of global products based on data assimilation into models for all possible ECVs, including undertaking pilot projects of reanalysis of ocean data.

53. Several Parties (Australia, UK, France, Sweden, US and Canada) are actively developing plans and pilot projects for the production of global products based on data assimilation into models for all possible oceanic ECVs, including undertaking pilot projects of reanalysis of ocean data. Many of these activities are in response to the formal deactivation of the Global Data Assimilation Experiment (GODAE) and the creation of a new permanent international data analysis and data management strategy and institutional arrangement. Currently, about 10 different groups are producing ocean climate reanalyses. These efforts are organized around CLIVAR GSOP, with regular intercomparison exercises. The development of these intercomparisons, of ocean climate indices from the reanalysis products, and investigation of observing system requirements are all underway, and research into improved methods continues. Several studies have been published on the initiation of coupled ocean-atmosphere forecasts with ocean reanalyses.

5 Terrestrial Essential Climate Variables

54. The terrestrial observation system has in the past been less well-established than the atmospheric or oceanic ones. The reason is that most of the terrestrial observations are not part of international observation routines with a regular exchange of data, such as the World Weather Watch and Global Atmospheric Watch or the Global Ocean Observing System. Of the three domains, the terrestrial ECVs are the most diverse and the observing systems and institutional arrangements within countries that support the observing networks are the most complex and present real challenges to coordination efforts. The Parties reporting have listed considerable activity in the hydrological related ECVs but less national effort in the areas of observing land cover, land use and other eco-system related observations.

55. Except for hydrological variables much of the terrestrial observation strategy is based on the use of satellite observations as the principal observing tool supported by calibration and validation data from networks of *in-situ* surface observations.

56. The narrative information pertaining to certain terrestrial domain Actions as requested by Decision 11/CP.13 was missing from many reports. However, based on the reports of some Parties and inferring from information provided in the tables, and also from evidence from data centres as reflected in the 2004-2008 GCOS Progress Report the following summary statements can be made about progress toward the recommended actions.

Developing a global network of approximately 30 sites based on a progressive evolution of existing reference sites to monitor key biomes and provide the observations required for the calibration and validation of satellite data.

57. There has been little global coordination on the setup of the 30 primary sites. In the USA, 26 Long Term Ecological Monitoring Sites are part of a national network. The National Ecological Observatory Network (NEON) is a US continental-scale research platform for discovering and understanding the impacts of climate change, land-use change, and invasive species on ecology. In the rest of the world, progress in setting up these in situ networks is slow, but in the planning stage. Some FLUXNET sites are planned to become long term observatories for satellite validation and carbon observations, some are used on a more ad hoc basis for calibration/validation activities. The CEOS Land Product Validation (LPV) group is coordinating the use of the sites for, amongst other, qualitative validation and intercomparison purposes. They deal with four areas, fire and burned scar detection, biophysical products, land cover mapping, albedo and surface radiation.

Maintaining and expanding programmes for monitoring groundwater and aquifers.

58. Several Parties (UK, Canada, Switzerland, Sweden, Netherlands, Ireland, Germany, Finland, Greece, and Australia) report national networks for ground water. Often these networks are under the responsibility of local or regional entities. Several Parties report activities designed to improve the observational networks, data exchange and archiving including National Groundwater Databases. Several Parties referenced the international coordination of the joint UNESCO/WMO GTN-H initiative for global information exchange, the International Groundwater Resources Assessment Centre (IGRAC). Regionally in Europe there is a data and information network, EUROWATERNET, operated by the European Environment Agency (EEA).

Archiving and disseminating information related to irrigation and water resources.

59. Australia, for example, is developing a national Water Resources Information System that is intended to be the authoritative national repository for water data and reporting. Such national networks and activities will assist in providing national contributions to global networks and archives. Programmes with somewhat similar objectives are reported by Greece, Ireland, Netherlands, and Switzerland. A global database on water resources and irrigation is available on the FAO AQUASTAT website.[22] FAO is developing a new set of guidelines and protocols for national reporting.

[22] http://www.fao.org/nr/water/aquastat/main/index.stm

Strengthening existing sites for observing snow cover and snowfall and recovering and submitting historical data to the specified international data centres.

60. Whilst there is a continuing overall decline in snow observations, there has been a growing interest on the part of certain Parties in reversing that trend. For example, several Parties (UK, Canada, Switzerland, Poland, Netherlands, Finland) report the utilization of the WWW/GOS surface observing network, often supplemented by more dense networks of snow measurements, as their principal source for snow cover observations. Some specific higher density observation schemes exist; Finland, for example, operates a systematic snow-survey network of very high density. Canada and the USA have a cooperative programme underway to improve the measurement of depth and derivation of snowfall from automatic stations. The USA operates two comprehensive networks (SNOTEL and SCAN) that provide continuous automated information on snowpack. Many Parties report their information to the National Snow and Ice Data Centre (NSIDC) in the USA but a concerted effort is needed for reporting snow cover and snowfall data both in real-time and for historical records.

Maintaining sites for observing glaciers and adding additional sites and infrastructure in Africa, the Himalayas, New Zealand and South America.

61. Several Parties (Canada, Denmark, France, Netherlands, Poland, Russian Federation, Spain, Sweden, Switzerland, UK and USA) report specific activities regarding the maintenance and expanding of glacier and ice-cap monitoring activity. Overall performance of glacier monitoring within the GTN-G is stable. The World Glacier Monitoring Service (Switzerland) reports that observational networks are improving in South America and New Zealand. For example, Canada reports scientific exchanges with Chile aimed at glacier observations and assessments. France, through GLACIOCLIM in Grenoble monitors glaciers in France, and cooperates in projects in Bolivia and Ecuador, and Antarctica. France also reports cooperating in monitoring a glacier in the Indian Himalaya. Re-establishment of observations at Mt. Kenya have begun but large gaps continue to exist in Central Asia. An important ESA project (GlobGlacier[23]) under the lead of University of Zurich is speeding up satellite-based glacier inventory work and further developing analysis tools involving full digital terrain information (from SRTM, ASTER, SPOT etc.).

Adding the 150 additional permafrost sites identified by GTN-P to cover the high mountains of Asia, Europe and the southern hemisphere, and the North American alpine lands and lowlands, and providing data to the specified international data centres.

62. The Global Terrestrial Network for Permafrost (GTN-P) is the primary international programme concerned with monitoring permafrost parameters. Efforts have been made over the past decade to re-establish a borehole temperature monitoring programme under the auspices of GTN-P to monitor, detect, and assess long-term changes in the active layer and the thermal state of permafrost, particularly on a regional basis. The International Polar Year (IPY)-International Permafrost Association (IPA) legacy includes a sustainable database and establishment of a permanent network of observatories. Several Parties (USA, Switzerland, Russian Federation, Denmark, and Canada) report participation in the GTN-P activities (including sites from the Circumpolar Active Layer Monitoring (CALM) programme, the EU Permafrost and Climate in Europe (Pace) project, and national networks, such as the Permafrost Monitoring Switzerland (PERMOS) network. Borehole metadata and summary data are available on the GTN-P website[24] hosted by the Geological Survey of Canada. The CALM network is currently coordinated through the University of Delaware. Metadata and ancillary information are available for each site, including climate, site photographs, and descriptions of terrain, soil type, and vegetation. Data are transferred or linked periodically to a permanent archive at the National Snow and Ice Data Centre (NSIDC) in Boulder, Colorado.

Reanalysing historical data concerning the terrestrial ECVs.

63. Australia is undertaking extensive reanalysis of historic data through its Water Availability Project,[25] the project re-analyses and grids meteorological drivers and calculates full terrestrial water

[23] http://www.globglacier.ch
[24] www.gtnp.org
[25] www.eoc.csiro.au/awap

balances. The ECMWF undertakes reanalysis work which is highly relevant to the IP-04 (reported through the UK).

6 Additional Information

64. Several Parties provided material under the "additional information" heading, for complete details refer to the individual national reports:

(a) Belgium – Building a new Antarctic research station, the Princess Elisabeth Research Station. Several projects are to be undertaken including monitoring atmospheric constituents and UV radiation and aerosols; surface hydrological mass balance, ice dynamic surveying with ice-modelling and geochemical studies; and microcosm experiments.

(b) Belgium – Undertaking a phenology project called MODIRISK studying the endemic and invasive mosquitos to determine the biodiversity of mosquito vectors.

(c) Denmark – Participates in the EUMETNET programme Climate Support Network (ECSN) and contributes to the European Climate Assessment and Data Set (ECA&D).

(d) Finland – Points to the issue of maintaining the best possible systematic observations while taking advantage of technical advances while at the same time protecting the consistency of observations.

(e) Ireland – Points to its active climate research programme[26] and is also active in linked regional research programmes, e.g., the EU Framework programme.

(f) Netherlands – The CESAR consortium (seven Dutch Institutes) operates various ground based remote sensing systems at the Cabauw site that measure cloud and aerosol properties in view of monitoring and research. Also improved measurement techniques are being developed.

(g) Netherlands – The Netherlands are at the forefront of the development of the Integrated Carbon Observation System (ICOS), both nationally and internationally.

(h) Poland along with other European Countries (e.g. Germany, Belgium (see (b) above), Switzerland, among others) mention a long history of phenological observations some with a very long record, that relate to the observance of climate change and could become an important tool in evaluating the impact of and the adaptation to climate change.

(i) Sweden – Emphasises the need for "completeness and the completing of GCOS". This means that GCOS objectives address goals at some level as geographic completeness, completeness in time and completeness in disciplines (physical, chemical and biological). These three dimensions are needed and an awareness of the needs in the whole chain of process to provide diagnoses for IPCC and for other political and societal planning.

(j) Sweden – Emphasises the importance of reanalysis using consistent assimilation systems – a way to determine the future GCOS requirements.

(k) Sweden – Points to the importance of GCOS to GMES and GEOSS objectives.

(l) Switzerland – Homogenization efforts of time series of ground-based meteorological data, upper air and ozone data, as well as of forest ecosystem monitoring data.

(m) UK – Calls attention to three research facilities that have specialized climate observing programmes and state-of-the-art instrumentation: (1) The Met Office Research Unit at Cardington; (2) Weybourne Atmospheric Observatory (WAO); and (3) the NERC-Chilbolton Facility for Atmospheric and Radio Research.

(n) UK – Points to the Rothera Oceanographic and Biological Time Series (RaTS) project, which includes long time series (since 1997) of precision salinity measures, CTD casts, sea ice, biological oceanography measurements etc.

(o) Several Parties (e.g., Germany and Switzerland) report on having Phenological networks (contributing to the European Phenology Network (EPN)) that provide potentially useful data for climate change and climate change impact studies. Some initial steps toward observation standards and protocols for international exchange of these data are being taken.

[26] www.epa.ie

APPENDIX 1 GCOS Essential Climate Variables

GCOS Essential Climate Variables that can be feasibly measured globally and are highly relevant to the UNFCCC (IP-04):

Domain	Essential Climate Variables	
Atmospheric (over land, sea and ice)	**Surface**:	Air temperature, precipitation, air pressure, surface radiation budget, wind speed and direction, water vapour
	Upper-air:	Earth radiation budget (including solar irradiance), upper-air temperature (including MSU radiances), wind speed and direction, water vapour, cloud properties
	Composition:	Carbon dioxide, methane, ozone, other long-lived greenhouse gases[a], aerosol properties
Oceanic	**Surface:**	Sea surface temperature, sea surface salinity, sea level, sea state, sea ice, current, ocean colour (for biological activity), carbon dioxide partial pressure
	Sub-surface:	Temperature, salinity, current, nutrients, carbon, ocean tracers, phytoplankton
Terrestrial[b]	River discharge, water use, groundwater, lake levels, snow cover, glaciers and ice caps, permafrost and seasonally-frozen ground, albedo, land cover (including vegetation type), fraction of absorbed photosynthetically active radiation (fAPAR), leaf area index (LAI), biomass, fire disturbance	

[a] Including nitrous oxide, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, sulphur hexafluoride and perfluorocarbons.

[b] Includes run-off ($m^3 s^{-1}$), groundwater extraction rates ($m^3 yr^{-1}$) and location, snow cover extent (km^2) and duration, snow depth (cm), glacier/ice cap inventory and mass balance ($kg\ m^{-2} yr^{-1}$), glacier length (m), ice sheet mass balance ($kg\ m^{-2} yr^{-1}$) and extent km^2), permafrost extent (km^2), temperature profiles and active layer thickness, above-ground biomass ($t\ ha^{-1}$), burnt area (ha), date and location of active fire, burn efficiency (percentages of vegetation burned per unit area).

APPENDIX 2 Networks contributing to GCOS

Network	ECV
Atmosphere (in-situ)	
GCOS Surface Network (GSN)	Air temperature Precipitation
Full World Weather Watch/Global Observing System (WWW/GOS) surface network	Air temperature, air pressure, wind speed and direction, water vapour, precipitation
Baseline Surface Radiation Network (BSRN)	Surface radiation
Solar radiation and radiation balance data	Surface radiation
Ocean drifting buoys	Air temperature, air pressure
Moored buoys	Air temperature, air pressure
Voluntary Observing Ship Climate Project (VOSClim)	Air temperature, air pressure, wind speed and direction, water vapour
Ocean Reference Mooring Network and sites on small isolated islands	Air temperature, wind speed and direction, air pressure, precipitation
Atmosphere (upper-air)	
GCOS Reference Upper-Air Network (GRUAN)	All feasible surface and upper-air ECVs
GCOS Upper-Air Network (GUAN)	Upper-air temperature, upper-air wind speed and direction, upper-air water vapour
Full WWW/GOS Upper Air Network	Upper-air-temperature, upper-air wind speed and direction, upper-air water vapour
World Meteorological Organization/ Global Atmosphere Watch (WMO/GAW) Global Atmospheric CO_2 & CH_4 Monitoring Network	Carbon dioxide Methane Other greenhouse gases
WMO/GAW ozone sonde network	Ozone
WMO/GAW column ozone network	Ozone
WMO/GAW Aerosol Network	Aerosol optical depth Other aerosol properties
Oceans (in-situ)	
Global surface drifting buoy array on 5x5 degree resolution	Sea surface temperature, sea level pressure, position-change based current
GLOSS Core Sea level Network	Sea level
Voluntary observing ships (VOS)	All feasible surface ECVs
Ship of Opportunity Programme	All feasible surface ECVs
Global reference mooring network	All feasible surface and subsurface ECVs
Global tropical moored buoy network	All feasible surface and subsurface ECVs
Argo network	Temperature, salinity, current
Carbon inventory survey lines	Temperature, salinity, ocean tracers, biogeochemistry variables
Terrestrial (in-situ)	
GCOS baseline river discharge network (GTN-R)	River discharge
GCOS Baseline Lake Level/ Area/Temperature Network (GTN-L)	Lake level/area/ temperature
WWW/GOS synoptic network	Snow cover
GCOS glacier monitoring network (GTN-G)	Glaciers mass balance and length, also ice sheet mass balance
GCOS permafrost monitoring network (GTN-P)	Permafrost borehole-temperatures and active-layer

APPENDIX 3 Space-based datasets and products required by GCOS

The following satellite-based fundamental climate data records and ECV products have been identified as GCOS requirements in the Satellite Supplement to the IP-04.

1 Atmosphere ECVs

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for product generation (from past, current and future missions)
Surface wind speed and direction Surface vector winds analyses, particularly from reanalysis	Passive microwave radiances and scatterometry
Upper-air temperature Homogenized upper-air temperature analyses: extended MSU-equivalent temperature record, new record for upper-troposphere and lower-stratosphere temperature using data from radio occultation, temperature analyses obtained from reanalyses	Passive microwave radiances, GPS radio occultation, high-spectral resolution IR radiances for use in reanalysis
Water vapour Total column water vapour over the ocean and over land, tropospheric and lower stratospheric profiles of water vapour	Passive microwave radiances, UV/VIS radiances, IR imagery and soundings in the 6.7um band, microwave soundings in the 183 GHz band
Cloud properties Cloud radiative properties (initially key ISCCP products)	VIS/IR imagery, IR and microwave soundings
Precipitation Improved estimates of precipitation, both as derived from specific satellite instruments and as provided by composite products	Passive microwave radiances, high-frequency geostationary IR measurements, active radar (for calibration)
Earth radiation budget Top-of-atmosphere Earth radiation budget on a continuous basis	Broadband radiances, spectrally-resolved solar irradiances, geostationary multi spectral imagery
Ozone Profiles and total column of ozone	UV/VIS and IR microwave radiances
Aerosol properties Aerosol optical depth and other aerosol properties	VIS/NIR/SWIR radiances
Carbon dioxide, methane and other long-lived greenhouse gases Distribution of greenhouse gases, such as CO2 and CH4, of sufficient quality to estimate regional sources and sinks	NIR/IR radiances
Upper-air wind Upper-air wind analyses, particularly from reanalysis	VIS/IR imagery, Doppler wind lidar
Atmospheric reanalyses	Key FCDRs and products identified in this report, and other data of value to the analyses

2 Ocean ECVs

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for product generation (from past, current and future missions)
Sea Ice Sea ice concentration	Microwave and visible imagery
Sea Level Sea level and variability of its global mean	Altimetry
Sea Surface Temperature Sea surface temperature	Single and multi-view IR and microwave imagery
Ocean Colour Ocean colour and oceanic chlorophyll-a concentration derived from ocean colour	Multi-spectral VIS imagery
Sea State Wave height and other measures of sea state (wave direction, wavelength, time period)	Altimetry
Ocean Salinity Research towards the measurement of changes in sea surface salinity	Microwave radiances
Ocean Reanalyses Altimeter and ocean surface satellite measurements	Key FCDRs and products identified in this report, and other data of value to the analyses

3 Terrestrial ECVs

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for product generation (from past, current and future missions)
Lakes Maps of lakes, lake levels, surface temperatures of lakes in the Global Terrestrial Network for Lakes	VIS/NIR imagery and radar imagery, altimetry, high-resolution IR imagery
Glaciers and ice caps Maps of the areas covered by glaciers other than ice sheets, ice sheet elevation changes for mass balance determination	High-resolution VIS/NIR/SWIR optical imagery, altimetry
Snow cover Snow areal extent	Moderate-resolution VIS/NIR/IR and passive microwave imagery
Albedo Directional hemispherical (black sky) albedo	Multispectral and broadband imagery
Land cover Moderate-resolution maps of land-cover type, high-resolution maps of land-cover type, for the detection of land-cover change	Moderate-resolution multispectral VIS/NIR imagery, high-resolution multispectral VIS/NIR imagery
fAPAR Maps of fAPAR	VIS/NIR imagery
LAI Maps of LAI	VIS/NIR imagery
Biomass Research towards global, above-ground forest biomass and forest biomass change	L band/P band SAR, Laser altimetry
Fire disturbance Burnt area, supplemented by active fire maps and fire radiated power	VIS/NIR/SWIR/TIR moderate-resolution multispectral imagery
Soil moisture Research towards global near-surface soil moisture map (up to 10 cm soil depth)	Active and passive microwave

APPENDIX 4 Acronyms

AEMNet	SPANISH METEOROLOGICAL SERVICE
AMMA	AFRICAN MONSOON MULTIDICIPLENARY ANALYSIS Project
AOPC	ATMOSPHERIC OBSERVATION PANEL FOR CLIMATE
APEX	ARCTIC PALAEOCLIMATE AND ITS EXTREEMES
AQUASTAT	INFORMATION SYSTEM ON WATER AND AGRICULTURE (FAO)
ARGO	ARRAY for REAL-TIME GEOSTROPHIC OCEANOGRAPHY - GLOBAL ARRAY OF PROFILING FLOATS
ASAP	AUTOMATED SHIPBOARD AEROLOGICAL PROGRAMME
ASTER	ADVANCED SPACEBOURNE THERMAL EMISSION AND REFLECTION RADIOMETER
AWI	ALFRED WEGENER INSTITUTE (Germany)
BoM	BUREAU of METEOROLOGY (Australia)
BSRN	BASELINE SURFACE RADIATION NETWORK (WMO)
CAL/VAL	CALIBRATION/VALIDATION
CALM	CIRCUMPOLAR ACTIVE-LAYER MONITORING
CAS	COMMISSION FOR ATMOSPHERIC SCIENCES (WMO)
CBS	COMMISSION FOR BASIC SYSTEMS (WMO)
CCl	COMMISSION FOR CLIMATOLOGY (WMO)
CEOS	COMMITTEE ON EARTH OBSERVATION SATELLITES
CFC	CHLOROFLUOROCARBON
CGMS	COORDINATION GROUP FOR METEOROLOGICAL SATELLITES
CHy	COMMISSION FOR HYDROLOGY (WMO)
CIMO	COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION (WMO)
CliC	CLIMATE AND CRYOSPHERE PROJECT (WCRP)
CLIVAR	CLIMATE VARIABILITY AND PREDICTABILITY PROJECT (WCRP)
CM-SAF	CLIMATE MONITORING – SATELLITE APPLICATION FACILITY (EUMETSAT)
CNES	CENTRE NATIONAL D'ETUDES SPATIALES
COP	CONFERENCE OF THE PARTIES (TO UNFCCC)
CSA	CANADIAN SPACE AGENCY
CSIRO	COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION (Australia)
DBCP	DRIFTING BUOY COOPERATION PANEL
DEC	DEPARTMENT OF ENVIRONMENT CANADA
DMI	DANISH METEOROLOGICAL INSTITUTE
DWD	DEUTSCHER WETTERDIENST (Germany)
ECMWF	EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS
EC	EUROPEAN COMMUNITY
ECV	ESSENTIAL CLIMATE VARIABLE (AS DEFINED BY GCOS SECOND ADEQUACY REPORT (GCOS-82))
EEA	EUROPEAN ENVIRONMENT AGENCY
ENSO	EL NIÑO SOUTHERN OSCILLATION
EO	EARTH OBSERVATION
ESA	EUROPEAN SPACE AGENCY
EU	EUROPEAN UNION
EUMETSAT	EUROPEAN ORGANISATION FOR THE EXPLOITATION OF METEOROLOGICAL SATELLITES
EUROWATERNET	EUROPEAN WATER DATA AND INFORMATION NETWORK
FAO	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
fAPAR	fRACTION OF ABSORBED PHOTOSYNTHETICALLY ACTIVE RADIATION
FRA	FOREST RESOURCES ASSESSMENT PROJECT (FAO)
FLUXNET	FLUX AND ENERGY EXCHANGE NETWORK
FMI	FINNISH METEOROLOGICAL INSTITUTE
GAW	GLOBAL ATMOSPHERE WATCH (WMO)
GCM	GCOS COOPERATION MECHANISM
GCMP	GCOS CLIMATE MONITORING PRINCIPLES

GCOS	GLOBAL CLIMATE OBSERVING SYSTEM
GDPFS	GLOBAL DATA PROCESSING AND FORECASTING SYSTEMS (WMO/WWW)
GEO	GROUP ON EARTH OBSERVATIONS
GEOSS	GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS
GEWEX	GLOBAL ENERGY AND WATER CYCLE EXPERIMENT (WCRP)
GHG	GREENHOUSE GAS
GLOSS	GLOBAL SEA LEVEL OBSERVING SYSTEM
GMES	GLOBAL MONITORING FOR ENVIRONMENT AND SECURITY (EC)
GODAE	GLOBAL OCEAN DATA ASSIMILATION EXPERIMENT
GODAR	GLOBAL OCEANOGRAPHIC DATA ARCHAEOLOGY AND RESCUE
GOFC-GOLD	GLOBAL OBSERVATION OF FOREST AND LAND COVER DYNAMICS (GTOS)
GOOS	GLOBAL OCEAN OBSERVING SYSTEM
GOS	GLOBAL OBSERVING SYSTEM (WMO/WWW)
GOSUD	GLOBAL OCEAN SURFACE UNDERWAY DATA PILOT PROJECT
GPCC	GLOBAL PRECIPATION CLIMATOLOGY CENTRE (Germany)
GPCP	GLOBAL PRECIPITATION CLIMATOLOGY PROJECT
GPS	GLOBAL POSITIONING SYSTEM
GRDC	GLOBAL RUNOFF DATA CENTRE (Germany)
GRUAN	GCOS REFERENCE UPPER-AIR NETWORK
GSC	GEOLOGIC SURVEY CANADA
GSN	GCOS SURFACE NETWORK
GSOP	GLOBAL SYNTHESIS AND OBSERVATION PANEL (WCRP/CLIVAR)
GTN	GLOBAL TERRESTRIAL NETWORK
GTN-G	GTN - GLACIERS
GTN-H	GTN - HYDROLOGY
GTN-L	GTN - LAKES
GTN-P	GTN - PERMAFROST
GTN-R	GTN - RIVERS
GTN-SM	GTN - SOIL MOISTURE
GTOS	GLOBAL TERRESTRIAL OBSERVING SYSTEM
GTS	GLOBAL TELECOMMUNICATION SYSTEM (WMO/WWW)
GUAN	GCOS UPPER-AIR NETWORK
HYDROLARE	INTERNATIONAL DATA CENTRE ON THE HYDROLOGY OF LAKES AND RESERVOIRS (Russian Federation)
ICSU	INTERNATIONAL COUNCIL FOR SCIENCE
IGACO	INTEGRATED GLOBAL ATMOSPHERIC CHEMISTRY OBSERVATIONS
IGBP	INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME
IGf PAN	INSTITUTE OF GEOPHYSICS of POLISH ACADEMY OF SCIENCE
IMGW	INSTITUTE OF METEOROLOGY AND WATER MANAGEMENT (Poland)
IO PAN	INSTITUTE OF OCEANOLOGY OF POLISH ACADEMY OF SCIENCE
IOC	INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)
IP-04	IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE IN SUPPORT OF THE UNFCCC (GCOS-92, 2004)
IPCC	INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
IPY	INTERNATIONAL POLAR YEAR
ISO	INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
JAXA	JAPAN AEROSPACE EXPLORATION AGENCY
JCOMM	JOINT TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY (IOC/WMO)
JMA	JAPAN METEOROLOGICAL AGENCY
KMI	ROYAL METEOROLOGICAL INSTITUTE (Belgium)
KNMI	ROYAL NETHERLANDS METEOROLOGICAL INSTITUTE
LAI	LEAF AREA INDEX
LPV	LAND PRODUCTION VALIDATION SUBGROUP (CEOS WGCV)
LSA-SAF	LAND SURFACE ANALYSIS – SATELLITE APPLICATION FACILITY (EUMETSAT)
MOHC	MET OFFICE HADLEY CENTRE (UK)
MSC	METEOROLOGICAL SERVICE OF CANADA
MSU	MICROWAVE SOUNDING UNIT (NOAA)

NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (USA)
NCDC	NATIONAL CLIMATIC DATA CENTER (USA/NOAA)
NEON	NATIONAL ECOLOGICAL OBSERVATORY NETWORK (USA)
NESDIS	NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE (USA/NOAA)
NOAA	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (USA)
NODC	NATIONAL OCEAN DATA CENTER (USA/NOAA)
NPOESS	NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (USA/NOAA)
NSIDC	NATIONAL SNOW AND ICE DATA CENTER (USA)
NWP	NUMERICAL WEATHER PREDICTION
O3M-SAF	OZONE AND ATMOSPHERIC CHEMISTRY MONITORING – SATELLITE APPLICATION FACILITY (EUMETSAT)
OOPC	OCEAN OBSERVATIONS PANEL FOR CLIMATE
OSI-SAF	OCEAN AND SEA ICE- SATELLITE APLICATION FACILITY
PSHM	POLISH METEOROLOGICAL AND HYDROLOGICAL SERVICE
PSMSL	PERMANENT SERVICE FOR MEAN SEA LEVEL (UK)
QA/QC	QUALITY ASSURANCE/QUALITY CONTROL
QA/SAC	QUALITY ASSURANCE/SCIENCE ACTIVITY CENTRE (WMO/GAW)
RA	REGIONAL ASSOCIATION (WMO)
RBSN	REGIONAL BASIC SYNOPTIC NETWORKS (WMO/WWW/GOS)
RCC	REGIONAL CLIMATE CENTRE (WMO/RA)
RO	RADIO OCCULTATION
ROSHYDROMET	RUSSIAN FEDERAL SERVICE FOR HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING
SAF	SATELLITE APPLICATIONS FACILITY (EUMETSAT)
SBI	SUBSIDIARY BODY FOR IMPLEMENTATION (UNFCCC)
SBSTA	SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE (UNFCCC/COP)
SCAN	SOIL CLIMATE ANALIS NETWORK (USA)
SMHI	SWEDISH METEOROLOGICAL AND HYDROLOGICAL INSTITUTE
SNOTEL	SNOWPACK TELEMETRY SYSTEM (USA)
SOCAT	SURFACE OCEAN CO_2 ATLAS PROJECT
SOOP	SHIP OF OPPORTUNITY PROGRAMME
SPOT HRV	SATELLITE PROBATOIRE D'OBSERVATION DE LA TERRE HIGH RESOLUTION
SRTM	SHUTTLE RADAR TOPGRAPHY MISSION (USA/NASA)
SSS	SEA-SURFACE SALINITY
SST	SEA-SURFACE TEMPERATURE
SWE	SNOW WATER EQUIVALENT
TAO	TROPICAL ATMOSPHERE OCEAN PROJECT
TOGA	TROIPICAL OCEAN GLOBAL ATMOSPHERE PROJECT
TOPC	TERRESTRIAL OBSERVATION PANEL FOR CLIMATE
TOPEX/POSEIDON	OCEAN SURFACE TOPOGRAPHY ALTIMETER EXPERIMENT (NASA/CNES)
TRMM	TROPICAL RAINFALL MEASURING MISSION (JAXA/NASA)
UNEP	UNITED NATIONS ENVIRONMENT PROGRAMME
UNESCO	UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
UNFCCC	UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE
USGS	US GEOLOGICAL SURVEY
UV	ULTRAVIOLET
VOS	V OLUNTARY OBSERVING SHIP
VOSCLIM	VOLUNTARY OBSERVING SHIP CLIMATE PROJECT
WCC	WORLD CALIBRATION CENTRE
WCRP	WORLD CLIMATE RESEARCH PROGRAMME
WDC	WORLD DATA CENTRE
WDC ASHEVILLE	WORLD DATA CENTRE FOR METEOROLOGY, ASHEVILLE (USA/NOAA/NCDC)
WDC-GG	WORLD DATA CENTRE FOR GREENHOUSE GASES (Japan)

WGCV	WORKING GROUP ON CALIBRATION AND VALIDATION (CEOS)
WGMS	WORLD GLACIER MONITORING SERVICE (Switzerland)
WIGOS	WMO INTEGRATED GLOBAL OBSERVING SYSTEM
WIS	WMO INFORMATION SYSTEM
WOCE	WORLD OCEAN CIRCULATION EXPERIMENT
WMO	WORLD METEOROLOGICAL ORGANIZATION
WOUDC	WORLD OZONE AND ULTRAVIOLET RADIATION DATA CENTRE
WRC	WORLD RADIATION CENTRE (Switzerland)
WRMC	WORLD RADIATION MONITORING CENTRE (Germany)
WWW	WORLD WEATHER WATCH (WMO)
XBT	EXPENDABLE BATHYTHERMOGRAPH
XCTD	EXPENDABLE CONDUCTIVITY, TEMPERATURE AND DEPTH SYSTEM

LIST OF GCOS PUBLICATIONS (SINCE 2008)*

GCOS-119 (WMO/TD-No. 1424)	Report of the Implementation Strategy Meeting for Central America and the Caribbean (Belize City, 28-30 January 2008)
GCOS-120 (GOOS-No. 169)	Report on the Meeting of "IOC Group of Experts on the Global Sea Level Observing System (GLOSS), tenth session (Paris, France, 6-8 June 2007)
GCOS-121 (WMO/TD-No. 1435)	GCOS Reference Upper Air Network (GRUAN). Report of the GRUAN Implementation Meeting (Lindenberg, Germany, 26-28 February 2008)
GCOS-122 (WCRP 9/2008) (WMO/TD-No. 1436)	Fourteenth Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-XIV) – Conclusions and Recommendations (Geneva, Switzerland, 21-25 April 2008)
GCOS-123 (WMO/TD-No. 1444)	Report of the Fourth Meeting of the GCOS Cooperation Board (Bonn, Germany, 12 June 2008)
GCOS-124 (WMO/TD-No. 1463)	Report of the Sixteenth Session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS (Geneva, Switzerland, 14-17 October 2008)
GCOS 125 (WCRP 10/2008)	Report of the WOAP-III Meeting (Boulder, CO, USA, 29 September to 1 October 2008)
GCOS-126 (WMO/TD No. 1464)	GCOS Annual Report 2007-2008
GCOS-127 (WMO/TD No. 1477)	Practical Help for Compiling CLIMAT Reports
GCOS-128 (WMO/TD No. 1488)	Guidelines for the Generation of Satellite-based Datasets and Products Meeting GCOS Requirements (GCOS Secretariat, March 2009)
GCOS-129 (WMO/TD No. 1489)	Progress Report on the Implementation of the Global Observing System for Climate in Support of the UNFCCC 2004-2008
GCOS-130 (WMO/TD No. 1490)	Synthesis of National Reports on Systematic Observation for Climate
GCOS-131 (WMO/TD No. 1492)	Report of the First GCOS Reference Upper Air Network Implementation and Coordination Meeting (GRUAN ICM-1) (Oklahoma City, USA, 2-4 March 2009)
GCOS-132 (WCRP 6/2009) (WMO/TD No. 1497)	Fifteenth Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-XV) – Conclusions and Recommendations (Geneva, Switzerland, 27-30 April 2009)
GCOS-133 (WMO/TD No. 1498)	Summary Report of the Eleventh Session of the GCOS/GTOS Terrestrial Observation Panel for Climate (TOPC) (Rome, Italy, 29-30 October 2008)

*GCOS publications may be accessed through the GCOS website at:
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