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Agenda item 6

Research and systematic observation

Research and systematic observation

Draft conclusions proposed by the Chair

Addendum

**Recommendation of the Subsidiary Body for Scientific
and Technological Advice**

The Subsidiary Body for Scientific and Technological Advice, at its twenty-seventh session, decided to recommend the following draft decision for adoption by the Conference of the Parties at its thirteenth session:

Draft decision -/CP.13

Reporting on global observing systems for climate

The Conference of the Parties,

Recalling decisions 4/CP.5, 5/CP.5, 11/CP.9 and 5/CP.10,

Noting the need to revise the “UNFCCC reporting guidelines on global climate change observing systems”¹ in order to reflect the priorities of the Global Climate Observing System implementation plan and incorporate the reporting on essential climate variables,

Recognizing the proposals made by the secretariat of the Global Climate Observing System,

Having considered the recommendations of the Subsidiary Body for Scientific and Technological Advice on this matter at its twenty-third, twenty-fifth and twenty-seventh sessions,²

¹ See decision 5/CP.5 and document FCCC/CP/1999/7, chapter III.

² FCCC/SBSTA/2005/10, paragraph 97; FCCC/SBSTA/2006/11, paragraph 95; and the draft conclusions to be adopted under agenda item 6 of the SBSTA.

1. *Adopts* the revised UNFCCC reporting guidelines on global climate change observing systems as contained in the annex to this decision;
2. *Decides* that these revised guidelines should take effect immediately for the preparation of detailed technical reports on systematic observations in accordance with the provisions of decisions 4/CP.5 and 5/CP.5;
3. *Requests* Parties included in Annex I to the Convention to continue providing such reports in conjunction with their national communications;
4. *Invites* Parties not included in Annex I to the Convention to provide such reports on a voluntary basis.

ANNEX

Revised UNFCCC reporting guidelines on global climate change observing systems¹

I. Introduction

A. Objective

1. The purpose of these guidelines for reporting on systematic observation of the global climate system for Parties included in Annex I to the Convention (Annex I Parties) and, as appropriate, Parties not included in Annex I to the Convention (non-Annex I Parties), is to assist Parties in reporting their actions with regard to global climate observing systems; development of observational networks; and, as appropriate, providing support for non-Annex I Parties, as defined in Articles 4, paragraphs 1(g) and (h), 5 and 12, paragraph 1(b), of the Convention.

B. Structure

2. The information identified in these guidelines should be communicated by the Party in a single document and submitted to the Conference of the Parties through the secretariat, and shall be in one of the official languages of the United Nations. Parties may include a reference to a national focal point and/or website from which additional copies of the report may be obtained. The submitting Party may decide on the length of the report but every effort should be made to limit its length. Parties should also provide an electronic version of their reports to the secretariat.

II. Reporting

A. General approach to reporting on systematic observation

3. Parties should describe the status of their programmes for contributing observations of the essential climate variables (ECVs) to the international community² (for a complete list of the ECVs see appendix 2). The Implementation Plan³ for the Global Climate Observing System ('GCOS implementation plan'), which was developed specifically for the Convention, identifies those global observations of the climate system required by the Parties to the Convention. When preparing their reports, Parties should take note of the performance indicators that were included with each action contained in the GCOS implementation plan. Parties may, if they so wish, provide additional information to that covered in these guidelines, including maps of networks and details of participation in other programmes that will contribute observations of the ECVs, such as work on climate observations being undertaken in climate research programmes.

4. Parties may wish to prepare the report in five chapters. Chapter 1 would deal with a number of common elements, as outlined in paragraphs 5–11 below. Paragraphs 5, 6 and 7 deal with planning, implementation, quality control, international data exchange and data analysis. Paragraph 8 requests

¹ A list of acronyms used in these guidelines is given in appendix 1.

² While these guidelines focus on the global requirements, the same observations are also required to support national and regional activities.

³ Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (WMO, 2004, available at <http://www.wmo.int/pages/prog/gcos/Publications/gcos-92_GIP.pdf>). The implementation plan was prepared by the GCOS secretariat at the request of the Conference of the Parties at its ninth session (decision 11/CP.9) and considered by the COP at its tenth session (decision 5/CP.10).

Annex I Parties to report on their capacity-building activities related to climate observations. Paragraph 9 requests those Parties with palaeoclimate programmes to report on their activities in setting current climatic changes within a historical context. Paragraph 10 requests information on any difficulties encountered in using these guidelines and preparing the required report. The next three chapters of the report would deal with the technical aspects of the GCOS implementation plan; in them, Parties would provide detailed information on the ECV networks and/or systems they are operating and their response to the actions identified in the GCOS implementation plan. Chapter 2 would focus on the atmospheric ECVs as outlined in paragraphs 12–15 below. Chapter 3 would focus on the oceanic ECVs as outlined in paragraphs 16–20 below. Chapter 4 would focus on the terrestrial ECVs as outlined in paragraphs 21–25 below. The final chapter would be optional and could contain information on national climate programmes that is additional to that covered in these guidelines, such as work on climate observations being undertaken in climate research programmes and/or programmes that provide climate information at a higher resolution or frequency.

B. Chapter 1: common issues

5. In describing their national programmes, Parties should, where relevant, report on actions they have undertaken to introduce and/or enhance national coordination, as well as planning activities for the production and adoption of their own national implementation plans for observing, archiving and analysing their national contribution of observations of the ECVs.
6. Parties should describe the efforts being undertaken to ensure that high-quality climate data records are collected, retained and made accessible for use by current and future generations of scientists and decision-makers of all Parties by reporting on:
 - (a) Any national policy or guidance that has been promulgated relevant to the international exchange of ECV data;
 - (b) Any policy-level barriers to the international exchange of climate data and their provision to international data centres;
 - (c) Efforts undertaken to ensure that ECV-observing activities adhere to the GCOS climate monitoring principles (GCMPs) adopted by the Conference of the Parties (COP) in decision 11/CP.9 (see appendix 3), including efforts undertaken to ensure that inhomogeneities resulting from changes in technology and observing practices are kept to a minimum and are capable of being effectively calculated and allowed for in the long-term climate record;
 - (d) Difficulties encountered in protecting the integrity of their long-term climate data records and steps being taken or required to address those difficulties.
7. Parties should report on efforts undertaken to ensure that international data centres are established and/or strengthened for all the ECVs (see appendix 4). Specifically (full names and numbers of relevant actions in the GCOS implementation plan are given in quotes and parentheses):
 - (a) Parties with responsibility for ECV international data centres, including those with responsibility for the World Data Centres (WDCs), may wish to report on actions undertaken to “prepare the data sets and meta-data, including historical data records, for climate analyses and reanalyses” (C11);
 - (b) Parties supporting data centres that undertake ECV analysis may wish to report on the actions undertaken to “establish sustainable systems for the routine and regular analysis of the ECVs ... including measures of uncertainty” (C12);

- (c) Parties supporting data centres that undertake reanalysis may wish to report on steps taken to “establish a sustained capacity for global climate reanalysis and ensure coordination and collaboration between reanalysis centres” (C13);
- (d) Parties supporting World Meteorological Organization (WMO) and Intergovernmental Oceanographic Commission (IOC) centres for GCOS may wish to report on their experiences in diagnosing quality, availability and communications issues with climate data.

8. Parties should describe actual and/or planned activities for capacity-building in least developed countries, small island developing States and countries with economies in transition related to the collection, exchange and/or use of observations of the ECVs, including implementation of the regional action plans developed from the GCOS regional workshop programme. Included in this regard are activities undertaken through multilateral and/or bilateral technical cooperation programmes, including participation in the GCOS cooperation mechanism as encouraged by the COP in decision 5/CP.10.

9. Recognizing the importance of setting current climatic changes within a historical context, Parties are requested to report on initiatives undertaken to acquire palaeoclimate data, in particular activities to extend the data record in time and into new regions, and to improve the synthesis of these data.

10. Where information required in these guidelines cannot be provided, Parties should report on any difficulties encountered, needs that should be met to enable the reporting of such information in future, and steps being taken to improve the availability of information.

11. Multinational and international projects and organizations conducting climate observations, including multinational satellite agencies, are encouraged to report through the Party in which they are based.

C. Chapter 2: atmospheric essential climate variables

12. Parties should, where relevant, describe their national contributions of the atmospheric ECV observations to the international community, paying special attention to the requirements outlined in the GCOS implementation plan.

13. To facilitate integration of the information contained in the national reports, Parties should complete tables 1a, b and c. These tables are designed to record information on the national contributions of observations from well-established systems and networks whose current operations can be quantified. Parties should also provide a narrative report on those atmospheric elements of the GCOS implementation plan that are less quantifiable with the aim of making changes and improvements to the climate observing system as a whole so that it meets the requirements of the Convention (see para. 15 below).

Table 1a. National contributions to the surface-based atmospheric essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs^a	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
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					

^a Parties should note that the list of ECVs given for each network is indicative of the expected observations from that network. A single response/data entry is expected for each network except for those networks for which precipitation is reported, where a separate response/data entry is requested owing to its particular importance with regard to the Convention.

Table 1b. National contributions to the upper-air atmospheric essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
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					

Table 1c. National contributions to the atmospheric composition

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Meteorological Organization/ Global Atmosphere Watch (WMO/GAW) Global Atmospheric CO₂ & CH₄ Monitoring Network	Carbon dioxide					
	Methane					
	Other greenhouse gases					

Table 1c (continued)

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
WMO/GAW ozone sonde network ^a	Ozone					
WMO/GAW column ozone network ^b	Ozone					
WMO/GAW Aerosol Network ^c	Aerosol optical depth					
	Other aerosol properties					

^a Including SHADOZ, NDACC, remote sensing and ozone sondes.

^b Including filter, Dobson and Brewer stations.

^c Including AERONET, SKYNET, BSRN and GAWPER.

14. Satellite observations are essential to complete the information base for atmospheric observations. Therefore, Parties with space programmes involving Earth observations should comment on their plans to ensure availability of past and future data and metadata records of the satellite measurements for the atmospheric ECVs and associated global products contained in table 2.⁴

Table 2. Global products requiring satellite observations – atmospheric essential climate variables

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

⁴ Derived from the document entitled *Systematic Observation Requirements for Satellite-based Products for Climate: Supplemental Details to the Satellite-based Component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*, WMO, 2006.

Table 2 (continued)

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for product generation (from past, current and future missions)
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 CO ₂ and CH ₄ , 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

15. Parties are also requested to provide a narrative description of any actions they have taken in response to the following recommended actions on the atmospheric ECVs contained in the GCOS implementation plan (numbers of relevant actions in the plan are given in parentheses):

- (a) Applying the GCMPs to all surface climate networks (A3);
- (b) Incorporating atmospheric pressure sensors into drifting buoy programmes (A5);
- (c) Ensuring availability of three-hourly mean sea level pressure and wind speed and direction data from GSN stations (A10);
- (d) Implementing a reference network of high-altitude, high-quality radiosondes (A16);
- (e) Operating the WWW/GOS radiosonde network in full compliance with the GCMPs and coding conventions (A17);
- (f) Submitting metadata records and inter-comparisons for radiosonde observations to the specified international data centres (A18);
- (g) Developing a network of ground-based Global Positional System (GPS) receivers for measuring water vapour (A21);
- (h) Sustained measurements of the atmospheric composition ECVs, supplementary to those activities implicit in table 1c.

D. Chapter 3: oceanic essential climate variables

16. Parties should, where relevant, describe their national contributions of oceanographic ECV observations to the international community, paying special attention to the requirements outlined in the GCOS implementation plan.

17. A brief narrative report is requested on their actions in nominating national focal points for implementation of the oceanic observing system for climate and establishing partnerships between the ocean research and operational communities.

18. To facilitate integration of the information contained in the national reports, Parties should complete tables 3a and b. These tables are designed to record information on the national contributions of observations from well-established systems and networks whose current operations can be quantified. Parties should provide a narrative report on those oceanic elements of the GCOS implementation plan that are less quantifiable with the aim of making changes and improvements to the climate observing system as a whole so that it meets the requirements of the Convention (see para. 20 below).

Table 3a. National contributions to the oceanic essential climate variables – surface

Contributing Networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
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					

Table 3b. National contributions to the oceanic essential climate variables – water column

Contributing Networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
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					

19. Satellite observations are essential to complete the information base for oceanic ECV observations. Therefore, Parties with space programmes involving Earth observations should comment on their plans to ensure availability of past and future data and metadata records of the satellite measurements for the oceanic ECVs and associated global products contained in table 4.⁵

Table 4. Global products requiring satellite observations – oceans

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

⁵ Derived from the document entitled *Systematic Observation Requirements for Satellite-based Products for Climate: Supplemental Details to the Satellite-based Component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*, WMO, 2006.

Table 4 (continued)

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for product generation (from past, current and future missions)
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

20. Parties are also requested to provide a narrative description of any actions they have taken in response to the following recommended actions on the oceanic ECVs contained in the GCOS implementation plan (numbers of relevant actions in the plan are given in parentheses):

- (a) Improving metadata acquisition and data management for the VOSclim subset of the VOS (O6);
- (b) 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 (O13);
- (c) Including sea level objectives in the capacity-building programmes of GOOS, JCOMM, WMO, other related bodies and the system-improvement programme of GCOS (O14);
- (d) Developing a robust programme to observe sea surface salinity, to include VOS ships, research ships, reference moorings and drifting buoys (O15);
- (e) Implementing a programme for measuring surface pCO₂ (O17);
- (f) Implementing a wave measurement component as part of the Surface Reference Mooring Network (O19);
- (g) Improving in situ sea ice observations from buoys, visual surveys (Ship of Opportunity (SOOP) and aircraft) and upward-looking sonars, and implementing observations in the Arctic and Antarctic (O23);
- (h) Conducting the systematic global full-depth water column sampling of 30 sections repeated every 10 years (including ocean carbon inventory change) (O25);
- (i) Performing the 41 SOOP XBT/XCTD trans-oceanic sections (O26);
- (j) Developing capability for systematic measurement of biogeochemical and ecological ECVs (O30);
- (k) Supporting data rescue projects and implementing regional, specialized and global data and analysis centres (O36 and O37);

- (l) 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 (O24, O41 and O40).

E. Chapter 4: terrestrial essential climate variables

21. Parties should, where relevant, describe their national contributions of terrestrial ECV observations to the international community, paying special attention to the requirements outlined in the GCOS implementation plan.
22. As part of their report describing their national programmes, Parties should, where relevant, report on their efforts to introduce national coordination and planning of terrestrial programme activities.
23. To facilitate integration of the information contained in the national reports, Parties should complete table 5. This table is designed to record information on the national contributions of observations from well-established systems and networks whose current operations can be quantified. Parties should also provide a narrative report on those terrestrial elements of the GCOS implementation plan that are less quantifiable with the aim of making changes and improvements to the climate observing system as a whole so that it meets the requirements of the Convention (see para. 25 below).

Table 5. National contributions to the terrestrial domain essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
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					

Table 5 (continued)

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
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 thickness					

24. Satellite observations are essential to complete the information base for terrestrial ECV observations. Therefore, Parties with space programmes involving Earth observations should comment on their plans to ensure availability of past and future data and metadata records of the satellite measurements for the terrestrial ECVs and their associated global products contained in table 6.⁶

Table 6. Global products requiring satellite observations – terrestrial

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

⁶ Derived from the document entitled *Systematic Observation Requirements for Satellite-based Products for Climate: Supplemental Details to the Satellite-based Component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*, WMO, 2006.

Table 6 (continued)

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for product generation (from past, current and future missions)
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^a Research towards global near-surface soil moisture map (up to 10 cm soil depth)	Active and passive microwave

^a Soil moisture is not listed as an ECV, but has been recognized in the GCOS implementation plan as an emerging ECV.

25. Parties are also requested to provide a narrative description of any actions they have taken in response to the following recommendations on the terrestrial ECVs contained in the GCOS implementation plan (numbers of relevant actions in the plan are given in parentheses):

- (a) 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 (T3);
- (b) Maintaining and expanding programmes for monitoring groundwater and aquifers;
- (c) Archiving and disseminating information related to irrigation and water resources (T9);
- (d) Strengthening existing sites for observing snow cover and snowfall and recovering and submitting historical data to the specified international data centres (T10);
- (e) Maintaining sites for observing glaciers and adding additional sites and infrastructure in Africa, the Himalayas, New Zealand and South America (T13);
- (f) 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 (T16);
- (g) Reanalysing historical data concerning the terrestrial ECVs.

F. Chapter 5: additional information

26. Parties may, if they wish, provide additional information on their national climate programmes that contribute observations of the ECVs not reported elsewhere in their reports, such as climate observations being undertaken in climate research programmes and/or programmes that provide climate information at a higher resolution or frequency.

Appendix 1**Definition of acronyms used in the guidelines**

AERONET	Aerosol Robotic Network
AOPC	Atmospheric Observation Panel for Climate
Argo	Global Array of Profiling Floats
ASDAR	aircraft to satellite data acquisition and relay
AVHRR	Advanced Very High Resolution Radiometer
BSRN	Baseline Surface Radiation Network
CAS	Commission for Atmospheric Sciences of the WMO
CBS	Commission for Basic Systems of the WMO
CCI	Commission for Climatology of the WMO
CDIAC	Carbon Dioxide Information Analysis Center
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CHy	Commission for Hydrology of the WMO
DWD	Deutscher Wetterdienst (German Meteorological Service)
ECMWF	European Centre for Medium-Range Weather Forecasts
ECVs	Essential Climate Variables
ETHZ	Eidgenössische Technische Hochschule Zürich (Swiss Federal Institute of Technology Zurich)
FAGS	Federation of Astronomical and Geophysical Data Analysis Services
fAPAR	Fraction of Absorbed Photosynthetically Active Radiation
FCDR	fundamental climate data record
GAW	Global Atmosphere Watch of the WMO
GAWPFR	Global Atmosphere Watch Precision Filter Radiometer Network
GCMPs	GCOS climate monitoring principles
GCOS	Global Climate Observing System
GDPS	Global Data-Processing and Forecasting Systems of the WMO
GEO	Group on Earth Observations
GEOS	Global Earth Observation System of Systems
GLOSS	Global Sea Level Observing System
GOOS	Global Ocean Observing System
GOS	Global Observing Network
GPCC	Global Precipitation Climatology Centre
GPS	Global Positioning System
GRDC	Global Runoff Data Centre
GSICS	Global Space-based Inter-Calibration System
GSN	GCOS Surface Network
GTN-G	Global Terrestrial Network – Glaciers
GTN-L	Global Terrestrial Network – Lakes
GTN-P	Global Terrestrial Network – Permafrost
GTN-R	Global Terrestrial Network – Rivers
GTSP	Global Temperature-Salinity Profile Program
GTOS	Global Terrestrial Observation System
GOS	Global Observing System of the WMO
GUAN	GCOS Upper Air Network
ICADS	International Comprehensive Ocean-Atmosphere Data Set
ICSU	International Council for Science
IDC	international data centre
IGBP	International Geosphere-Biosphere Programme

IOC	Intergovernmental Oceanographic Commission
IOCCG	International Ocean-Colour Coordinating Group
IOCCP	International Ocean Carbon Coordination Project
IPCC	Intergovernmental Panel on Climate Change
IP	implementation plan
IR	infrared
ISCCP	International Satellite Cloud Climatology Project
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
JRC	Joint Research Centre
LAI	leaf area index
MSC	Meteorological Service of Canada
MSU	microwave sounding unit
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NDACC	Network for the Detection of Atmospheric Composition Change
NIR	near-infrared
NOAA	National Oceanic and Atmospheric Administration
NSIDC	National Snow and Ice Data Center
RA	Regional Association of the WMO
RO	radio occultation
SAR	synthetic aperture radar
SHADOZ	Southern Hemisphere Additional Ozonesondes
SKYNET	Sky Radiometer Network
SLP	sea level pressure
SOOP	Ship of Opportunity Programme
SST	sea surface temperature
SWIR	short-wave infrared
TCDR	thematic climate data record
TIR	thermal infrared
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UV	ultraviolet
VIS	visible
VOS	voluntary observing ship
VOSclim	Voluntary Observing Ship Climate Project
WCRP	World Climate Research Programme
WDC	world data centre
WDC-GG	World Data Center for Greenhouse Gases
WGMS	World Glacier Monitoring Service
WMO	World Meteorological Organization
WOAP	WCRP Observation and Assimilation Panel
WODC	World Ocean Database Centre
WOUDC	World Ozone and Ultraviolet Radiation Data Centre
WRDC	World Radiation Data Centre
WWW	World Weather Watch of the WMO
XBT	expendable bathythermograph
XCTD	expendable conductivity, temperature and depth system

Appendix 2**Essential climate variables****Table 7. Essential climate variables that can be feasibly measured globally and are highly relevant to the Convention**

Domain	Essential climate variables
Atmospheric (over land, sea and ice)	<p>Surface: Air temperature, precipitation, air pressure, surface radiation budget, wind speed and direction, water vapour</p> <p>Upper-air: Earth radiation budget (including solar irradiance), upper-air temperature (including MSU radiances), wind speed and direction, water vapour, cloud properties</p> <p>Composition: Carbon dioxide, methane, ozone, other long-lived greenhouse gases,^a aerosol properties</p>
Oceanic	<p>Surface: Sea surface temperature, sea surface salinity, sea level, sea state, sea ice, current, ocean colour (for biological activity), carbon dioxide partial pressure</p> <p>Sub-surface: Temperature, salinity, current, nutrients, carbon, ocean tracers, phytoplankton</p>
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 ($\text{m}^3 \text{s}^{-1}$), groundwater extraction rates ($\text{m}^3 \text{yr}^{-1}$) and location, snow cover extent (km^2) and duration, snow depth (cm), glacier/ice cap inventory and mass balance ($\text{kg m}^{-2} \text{yr}^{-1}$), glacier length (m), ice sheet mass balance ($\text{kg m}^{-2} \text{yr}^{-1}$) 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 3

Global Climate Observing System climate monitoring principles

1. Effective monitoring systems for climate should adhere to the following principles:¹
 - (a) The impact of new systems or changes to existing systems should be assessed prior to implementation;
 - (b) A suitable period of overlap for new and old observing systems is required;
 - (c) The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e. metadata) should be documented and treated with the same care as the data themselves;
 - (d) The quality and homogeneity of data should be regularly assessed as a part of routine operations;
 - (e) Consideration of the needs for environmental and climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities;
 - (f) Operation of historically-uninterrupted stations and observing systems should be maintained;
 - (g) High priority for additional observations should be focused on data-poor regions, poorly-observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution;
 - (h) Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation;
 - (i) The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted;
 - (j) Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.
2. Furthermore, operators of satellite systems for monitoring climate need to:
 - (a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system;

¹ The 10 basic principles (in paraphrased form) were included as an appendix to the UNFCCC reporting guidelines on global climate change observing systems which were adopted by decision 5/CP.5. The complete set of principles was adopted by the Congress of the WMO through Resolution 9 at its fourteenth session in May 2003, and agreed by the CEOS at its 17th Plenary Meeting in November 2003. The COP, by its decision 11/CP.9, requested that the 10 basic principles (in paraphrased form) be replaced by the complete set of principles in the UNFCCC reporting guidelines on global climate change observing systems.

- (b) Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be resolved.

3. Thus satellite systems for climate monitoring should adhere to the following specific principles:

- (a) Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained;
- (b) A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations;
- (c) Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured;
- (d) Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured;
- (e) On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored;
- (f) Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate;
- (g) Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained;
- (h) Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when these exist on decommissioned satellites;
- (i) Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation;
- (j) Random errors and time-dependent biases in satellite observations and derived products should be identified.

Appendix 4

International data centres

International data centres have been established for many of the ECV networks and systems. Additional centres will be added over time. The GCOS secretariat maintains a current list of all international data centres associated with GCOS together with a list of current contacts at those centres.

Table 8. International data centres and archives – atmospheric domain

Network or system	International data centres and archives	Coordinating bodies
Atmosphere surface		
GCOS Surface Network (GSN)	GSN monitoring centre (DWD, JMA), GSN analysis centre (NCDC, Hadley Centre), GSN archive (WDC Asheville), CBS GCOS lead centres (JMA, NCDC and others), Global Precipitation Climatology Centre (GPCC, DWD)	AOPC with CBS
Full WWW/GOS synoptic network	Integrated Surface Hourly (WDC Asheville), Global Precipitation Climatology Centre (DWD)	CBS
National surface networks	National responsibility; submission to WDC, Global Precipitation Climatology Centre (DWD)	CCI, CBS, RAs
Baseline Surface Radiation Network (BSRN)	World Radiation Monitoring Centre (ETHZ)	WCRP
Solar radiation and radiation balance data	World Radiation Data Centre (WRDC St Petersburg)	CAS
Atmosphere upper-air		
GCOS Upper Air Network (GUAN)	GUAN monitoring centres (ECMWF, Hadley Centre), GUAN analysis centres (Hadley Centre, NCDC), GUAN archive (WDC Asheville), CBS GCOS lead centre (NCDC)	AOPC with CBS
Full WWW/GOS Upper-Air Network	GDPFS world centres, GDPFS regional/specialized meteorological centres, WDC Asheville	CBS
Reference network high-altitude radiosondes	GUAN centres (proposed)	AOPC with WCRP
Aircraft (ASDAR etc.)	GDPFS world centres, GDPFS regional/specialized meteorological centres, WDC Asheville	CBS
Profiler (radar) network	GDPFS world centres, GDPFS regional/specialized meteorological centres, WDC Asheville	CBS

Table 8 (continued)

Network or system	International data centres and archives	Coordinating bodies
Ground-based GPS receiver network		
Atmosphere composition		
GAW CO ₂ and CH ₄ monitoring network	WDC-GG (JMA), Carbon Dioxide Information Analysis Center (Oak Ridge National Laboratory)	CAS
WMO/GAW Ozone sonde Network WMO/GAW Column Ozone Network	WOUDC (MSC), NDACC archive, Norwegian Institute for Air Research, Southern Hemisphere Additional Ozone sondes (SHADOZ – NASA) archive	CAS
WMO/GAW Aerosol Network	AERONET, SKYNET, BSRN and GAWPFR data centres, World Data Centre for Aerosols (JRC Ispra)	CAS

Table 9. International data centres and archives – oceanic domain

Network or system	International data centres and archives	Coordination bodies
Surface drifting buoys	NCDC	JCOMM, ICOADS
Moored buoys	NCDC, WODC	JCOMM, ocean sites
Voluntary observing ships	VOSclim Data Centre, NCDC	JCOMM, ICOADS, VOSclim
Delayed-mode monthly and annual mean tide gauges	Permanent Service for Mean Sea Level, Proudman Laboratory	JCOMM, GLOSS
Real-time tide gauges	University of Hawaii Sea Level Center	JCOMM, GLOSS
Argo floats	Argo data centres, GTSPP, WODC	Argo science team
Repeat XBT sections	GTSPP, WODC	JCOMM, GTSPP
Repeat hydrography/carbon sections	WODC, CDIAC	IOCCG, GCOS, WCRP
Sea ice variables	NSIDC	JCOMM, GCOS, WCRP
Ocean colour	None at present (GLOB COLOUR Pilot Project)	IOCCP

Table 10. International data centres and archives – terrestrial domain

Network or system	International data centre and archives	Coordinating bodies
Global Terrestrial Network – Glaciers	WGMS, NSIDC	ICSU, FAGS
Global Terrestrial Network – Lakes	None designated ^a	CHy
Global Terrestrial Network – Permafrost	NSIDC	International Permafrost Association
Global Terrestrial Network – Rivers	GRDC	CHy
Snow cover (WWW/GOS synoptic network)	NCDC, NSIDC	CBS

^a International data centre responsibilities are in the process of being developed.