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SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE
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Item 6 of the provisional agenda
Research and systematic observation

Proposal for possible revision of the UNFCCC reporting guidelines on global climate change observing systems

Submission from the Global Climate Observing System secretariat

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its twenty-third session, agreed to revise the "UNFCCC reporting guidelines on global climate change observing systems" in order to reflect the priorities of the Global Climate Observing System (GCOS) implementation plan and incorporate the reporting on essential climate variables (FCCC/CP/1999/7, chapter III). Parties also noted the need to revise the more comprehensive supplementary reporting format (FCCC/SBSTA/2005/10, para. 97). The SBSTA agreed to consider this issue at its twenty-fifth session. It invited the GCOS secretariat to submit to the SBSTA, by September 2006, a proposal on ways and means to address these needs. This document contains the above-mentioned proposals from the GCOS secretariat.

2. In accordance with the procedure for miscellaneous documents, this submission is reproduced[*] in the language in which it was received and without formal editing.

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SUBMISSION FROM THE GLOBAL CLIMATE OBSERVING SYSTEM SECRETARIAT

Proposed Guidelines on Systematic Observations of the Global Climate System

The Conference of the Parties, in decision 5/CP.5, adopted the "UNFCCC Reporting Guidelines on Global Climate Change Observing Systems (FCCC/CP/1999/7). These guidelines were developed to assist the Parties in preparing their national communications with regard to global climate observing systems, development of observational networks and, as appropriate, support for non-Annex I Parties to the Convention, as defined in Articles 4.1(g) and (h), 5 and 12.1(b) of the Convention. The guidelines were designed, *inter alia*, to provide information for the preparation of the Second Report[1] on the Adequacy of Global Observing Systems for Climate in Support of the UNFCCC (Second Adequacy Report). At the request of some Parties, a set of "Supplementary Guidance" was published that provided additional guidance on information that could be included in the national reports.

Following consideration of the Second Adequacy Report and the subsequent development of an Implementation Plan[2] for Global Observing Systems for Climate in Support of the UNFCCC (GCOS Implementation Plan), the SBSTA at its 23rd meeting concluded that the guidelines were in need of revision if national reports were to play any useful part in the preparation of the Third Report on the Adequacy of Global Observing Systems for Climate in Support of the UNFCCC that is due for completion in 2009.

Therefore, the SBSTA, in December 2005, invited the GCOS secretariat to provide a report on the ways and means to revise the "UNFCCC reporting guidelines on global climate change observing systems" in order to reflect the priorities of the GCOS Implementation Plan and incorporate the reporting on Essential Climate Variables, as defined in the Second Adequacy Report. The Parties also noted the need to revise the more comprehensive supplementary reporting format.

The GCOS Secretariat, having consulted with its observing system partners and a number of national GCOS representatives has prepared a set of revised guidelines[3] that, if adopted, would replace both the existing guidelines and the supplementary guidance. The new guidelines are based on the Essential Climate Variables and are designed to collect information on the action of the Parties in response to the adoption of the GCOS Implementation Plan. National reports based upon these revised guidelines should provide a solid basis for the comprehensive report on progress with the GCOS Implementation Plan due in 2009.

[1] The Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC, GCOS-82, April 2003 (WMO/TD No. 1143).

[2] The Implementation Plan for Global Observing Systems for Climate in Support of the UNFCCC, GCOS – 92, October 2004 (WMO/TD No. 1219).

[3] Proposed Revised UNFCCC Reporting Guidelines on Global Climate Observing Systems.

PROPOSED UNFCCC REPORTING GUIDELINES ON GLOBAL CLIMATE OBSERVING SYSTEMS

I. INTRODUCTION

A. Objective

1. The purpose of these guidelines for reporting on systematic observation of the global climate system for Annex I and, as appropriate, non-Annex I Parties to the Convention, 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 to the Convention, as defined in Articles 4.1(g) and (h), 5 and 12.1(b) of the Convention.

B. Structure

2. The information identified in these guidelines shall 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 web site where additional copies may be obtained. The submitting Party may decide the length of the report but every effort shall be made to avoid over-lengthy reports. 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 shall describe the status of their programmes for contributing observations of the Essential Climate Variables (ECVs) to the International Community[4]. (For a complete list of ECVs see Appendix 1). The Implementation Plan[5] 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 sought in these guidelines, including maps of networks and participation in other relevant programmes that will contribute observations of the ECVs, such as relevant work on climate observations being undertaken in climate research programmes. A list of the technical acronyms used in these guidelines is given in Appendix 2.

4. Parties may wish to prepare the report with five (5) chapters. Chapter 1 would deal with a number of common elements, as outlined in paragraphs 5-10. Paragraphs 5,6 and 7 deal with planning, implementation, quality control, international data exchange, and data analysis. Paragraph 8 requests Annex 1 Parties to report on their capacity-building activities. 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 (3) chapters of the report deal with the technical aspects of the GCOS Implementation Plan and request the Parties to provide detailed

[4] While this report focuses, as it must, on the global requirements, the same observations are also required to support national and regional activities.

[5] Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (GCOS – 92, WMO/TD No. 1219), prepared by the GCOS Secretariat at the request of the UNFCCC (Decision 11/CP.9) and considered by them in Decision 5/CP.10.

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 focuses on atmospheric ECVs as outlined in paragraphs 11-14. Chapter 3 focuses on oceanic ECVs as outlined in paragraphs 15-19. Chapter 4 focuses on terrestrial ECVs as outlined in Paragraphs 20-24. The final chapter is optional and could contain information on national climate programmes that are additional to that sought in these guidelines, such as relevant 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 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 the current and future generations of scientists and decision-makers of all Parties by reporting on:

- Any national policy or guidance that has been promulgated relevant to the international exchange of ECV data;
- Any policy-level barriers to the international exchange of climate data and their provision to International Data Centres;
- Efforts undertaken to ensure that ECV-observing activities adhere to the GCOS Climate Monitoring Principles (GCMPs) (adopted by the Convention in decision 11/CP.9; see Appendix 3), including efforts undertaken to ensure that inhomogeneities resulting from changes in technology and observing practices are (a) kept to a minimum, and (b) capable of being effectively calculated and allowed for in the long-term climate record; and
- Difficulties being 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 ECVs. (See Appendix 4). Specifically: (relevant actions from the GIP are in quotes and parentheses)

- Parties with responsibility for ECV International Data Centres, including those with responsibility for the World Data Centres, may wish to report on the actions undertaken to “prepare the data sets and meta-data, including historical data records, for climate analyses and reanalyses”; (C11)
- 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)
- 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) and
- Parties supporting World Meteorological Organization /Commission on Basic Systems (WMO/CBS) Lead 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 utilization 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 both multilateral and bilateral technical cooperation programmes, including participation in the GCOS Cooperation Mechanism as encouraged 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 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 facilitate improved reporting, and steps taken to improve availability of information.

C. Chapter 2: Atmospheric ECVs

11. Parties shall, where relevant, describe their national contributions of atmospheric ECV observations to the international community, paying specific attention to requirements outlined in the GCOS Implementation Plan.

12. To facilitate integration of national reports, Parties should complete Tables 1a,b, and c. These tables are focussed on the national contributions of observations from well-established systems and networks whose current operations can be quantified. A narrative report is requested in paragraph 14 on those atmospheric elements of the GCOS Implementation Plan that are less quantifiable and were aimed at making changes and improvements to the overall climate observing system so that it meets the requirements of the Convention.

Table 1a. National Contributions to the Surface-based Atmospheric ECVs

Contributing Networks specified in the GCOS Implementation Plan	ECVs[6]	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/ Direction Water Vapour					
	Precipitation					
Baseline Surface Radiation Network (BSRN)	Surface Radiation					
Sunshine networks	Surface Radiation					
Ocean drifting buoys	Air-Temperature Air-Pressure					
Moored buoys	Air-Temperature Air-Pressure					
Voluntary Observing Ship **Climate Project (VOSClim) ships**	Air-Temperature Air-Pressure Wind Speed/ Direction Water Vapour					
Ocean Reference Mooring Network and sites on small isolated islands	Air-Temperature Wind Speed/ Direction Air-Pressure					
	Precipitation					

[6] Parties should note that the list of ECVs given for each network is indicative of the expected observations from that network. A single response is expected for the network except in the case of precipitation where a separate response is requested due its particular importance to the Convention.

Table 1b. National Contributions to the Upper-Air Atmospheric ECVs

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/ Direction Upper-Air Water Vapour					
Full WWW/GOS Upper Air Network	Upper-Air-Temperature Upper-Air Wind Speed/ Direction Upper-Air Water Vapour					

Table 1c. National Contributions to the Atmospheric Composition

ECVs 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 (CO_2)					
	Methane (CH_4)					
	Other greenhouse gases					
WMO/GAW ozone sonde network7	Ozone					
WMO/GAW column ozone network8	Ozone					
WMO/GAW Aerosol Network9	Aerosol optical depth					
	Other Aerosol Properties					

13. 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 meta-data records of the satellite measurements for the atmospheric ECVs and associated global products contained in Table 2[10].

[7] Including SHADOZ, NDACC, remote sensing and ozone sondes.
[8] Including filter, Dobson and Brewer stations.
[9] Including AERONET, SKYNET, BSRN and GAWPFR.
[10] Derived from the document entitled "Systematic Observation Requirements for Satellite-based Products for Climate – Supplemental details to the satellite-based component of the GCOS Implementation Plan" (GCOS-107, WMO/TD No. 1338).

Table 2: Global Products requiring Satellite Observations – Atmospheric 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 GHG 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

14. Parties are also requested to provide a narrative commentary on any actions they have taken in response to the following recommended actions on atmospheric ECVs contained in the GCOS Implementation Plan (relevant action numbers from the Plan are given in parentheses):

- Applying the GCMPs to all surface climate networks; (A3)
- Incorporating atmospheric pressure sensors in drifting buoy programmes; (A5)
- Ensuring availability of 3-hourly mean sea-level pressure and wind speed and direction data from GSN stations; (A10)
- Implementing a Reference Network of high-altitude, high-quality radiosondes; (A16)
- Operating the WWW/GOS radiosonde network in full compliance with the GCMPs and coding conventions; (A17)
- Submitting meta-data records and inter-comparisons for radiosonde observations to the specified International Data Centres; (A18)
- Developing a network of ground-based Global Positioning System (GPS) receivers for measuring water vapour; (A21)
- Sustained measurements of the Atmospheric Composition ECVs, supplementary to those activities implicit in the Table 1c.

D. Chapter 3: Oceanic ECVs

15. Parties shall, where relevant, describe their national contributions of oceanographic ECV observations to the international community, paying specific attention to the requirements outlined in the GCOS Implementation Plan.

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

17. To facilitate integration of national reports, Parties should complete Table 3. This table is focussed on the national contributions of observations from well-established systems and networks whose current operations can be quantified. A narrative report is requested in paragraph 19 on those oceanic elements of the GCOS Implementation Plan that are less quantifiable and were aimed at making changes and improvements to the overall climate observing system so that it meets the requirements of the Convention.

Table 3. National contributions to the Oceanic ECVs

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					
Global tropical moored buoy network	All feasible surface and subsurface ECVs					
Voluntary Observing Ships (VOS)	All feasible surface ECVs					
Global reference mooring network	All feasible surface and subsurface ECVs					
GLOSS Core Sea-level Network	Sea level					
Argo network	Temperature, Salinity, Current					

18. 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 meta-data records of the satellite measurements for the oceanic ECVs and associated global products contained in Table 4[11].

[11] Derived from the document entitled "Systematic Observation Requirements for Satellite-based Products for Climate – Supplemental details to the satellite-based component of the GCOS Implementation Plan" (GCOS-107, WMO/TD No. 1338).

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
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

19. Parties are also requested to provide a narrative commentary on any actions they have taken in response to the following recommended actions on oceanic ECVs contained in the GCOS Implementation Plan (relevant action numbers from the Plan are given in parentheses):

- Improving meta-data acquisition and data management for the VOSClim subset of the VOS; (O6)
- Ensuring that high-frequency (hourly or less) sea-level observations are available for all coastal tide gauges, including historical records, corrected for sea level pressure and are submitted to the specified International Data Centre; (O13)
- Including sea-level objectives in the capacity-building programmes of GOOS, JCOMM, WMO, other related bodies, and the system-improvement programme of GCOS; (O14)
- Developing a robust programme to observe sea-surface salinity including VOS ships, research ships, reference moorings, and drifting buoys; (O15)
- Implementing a program for measuring surface pCO_2; (O17)
- Implementing a wave measurement component as part of the Surface Reference Mooring Network; (O19)
- Improving the *in situ* sea-ice observations from buoys, visual surveys (Ship of Opportunity (SOOP) and Aircraft), and upward looking sonars; implementing observations in the Arctic and Antarctic; (O23)
- Conducting the systematic global full-depth water column sampling of 30 sections repeated every 10 years (including ocean carbon inventory change); (O25)
- Performing the 41 Ship-of-Opportunity XBT/XCTD trans-oceanic sections; (O26)
- Developing capability for systematic measurement of biogeochemical and ecological ECVs; (O30)
- Supporting data rescue projects; implementing regional, specialized and global data and analysis centres; (O36, O37)
- Developing plans and pilot projects for the production of global products based on data assimilation into models for all possible ECVs; (O40) including undertaking pilot projects of reanalysis of ocean data. (O24, O41)

E. Chapter 4: Terrestrial ECVs

20. Parties shall, where relevant, describe their national contributions of terrestrial ECV observations to the international community, paying specific attention to the requirements outlined in the GCOS Implementation Plan.

21. 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.

22. To facilitate integration of national reports, Parties should complete Table 5. This table is focussed on the national contributions of observations from well-established systems and networks whose current operations can be quantified. A narrative report is requested in paragraph 24 on those terrestrial elements of the GCOS Implementation Plan that are less quantifiable and were aimed at making changes and improvements to the overall climate observing system so that it meets the requirements of the Convention.

Table 5 National Contributions to the Terrestrial Domain ECVs.

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					
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					

23. 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 meta-data records of the

satellite measurements for the terrestrial ECVs and their associated global products contained in Table 6[12].

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; and 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	Multi-spectral 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 multi-spectral VIS/NIR imagery; High-resolution multi-spectral 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 multi-spectral imagery
Soil Moisture[13] Research towards global near-surface soil moisture map (up to 10cm soil depth)	Active and passive microwave

24. Parties are also requested to provide a narrative commentary on any actions they have taken in response to the following recommendations on terrestrial ECVs contained in the GCOS Implementation Plan(relevant action numbers from the Plan are given in parentheses):

- Developing a global network of some 30 sites based on a progressive evolution of existing reference sites to monitor key biomes and providing the observations required for the calibration and validation of satellite data; (T3)
- Maintaining and expanding programmes for ground water and aquifer monitoring;
- Archiving and disseminating information related to irrigation and water resources; (T9)
- Strengthening existing snow-cover and snowfall observing sites, and recovering and submitting historical data to the specified International Data Centres; (T10)
- Maintaining current glacier observing sites and adding additional sites and infrastructure in South America, Africa, the Himalayas and New Zealand; (T13)
- Adding the 150 additional permafrost sites identified by GTN-P to cover the high mountains of Asia, Europe, Southern Hemisphere and North American alpine and lowlands; and providing data to the specified International data Centres; (T16)

[12] Derived from the document entitled "Systematic Observation Requirements for Satellite-based Products for Climate – Supplemental details to the satellite-based component of the GCOS Implementation Plan" (GCOS-107, WMO/TD No. 1338).

[13] Soil moisture is not listed as an ECV, but has been recognized by the GCOS Implementation Plan as an emerging ECV.

- Reanalyzing historical data concerning terrestrial ECVs.

F. Chapter 5: Additional Information

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

Appendix 1
Essential Climate Variables

Table A1. Essential Climate Variables that are both currently feasible for global implementation and have a high impact on UNFCCC requirements.

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[14], 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[15]	River discharge, Water use, Ground water, 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.

[14] Including nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and perfluorocarbons (PFCs).

[15] Includes runoff (m3 s-1), ground water extraction rates (m3 yr-1) and location, snow cover extent (km2) 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 (km2), permafrost extent (km2), temperature profiles and active layer thickness, above ground biomass (t/ha), burnt area (ha), date and location of active fire, burn efficiency (%vegetation burned/unit area).

Appendix 2

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 on Basic Systems of the WMO
CCl 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
COP Conference of the Parties
DWD Deutscher Wetterdienst (German Weather Service)
ECMWF European Centre for Medium Range Weather Forecasts
ECVs Essential Climate Variables
ETHZ Eidgenössische Technische Hochschule Zurich (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 **C**limate Monitoring Principles
GCOS Global Climate Observing System
GDPFS Global Data Processing and Forecasting Systems of the WWW
GEO Group on Earth Observations
GEOSS Global Earth Observation System of Systems
GHG Greenhouse Gas
GIP GCOS Implementation Plan (Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC)(GCOS-92, WMO/TD 1219)
GLOSS Global Sea Level Observing System
GOOS Global Ocean Observing System
GPS Global Positioning System
GRDC Global Runoff Data Centre
GSICS Global Space-based Intercalibration 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
GTSPP Global Temperature-Salinity Profile Program
GTOS Global Terrestrial Observation System
GOS Global Observing System of the WWW
GUAN GCOS Upper Air Network

ICOADS International Comprehensive Ocean-Atmosphere Data Set project
ICSU International Council for Science
IGBP International Geosphere-Biosphere Programme
IOC Intergovernmental Oceanographic Commission of UNESCO
IOCCG International Ocean Colour Coordination 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 World Meteorological Organization
RO Radio Occultation
SAR Synthetic Aperture Radar
SBSTA Subsidiary Body for Scientific and Technological Advice of the UNFCCC
SFC Drifters Surface Drifters
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
UNFCCC United Nations Framework Convention on Climate Change
UV UltraViolet
VIS Visible
VOS Voluntary Observing Ship
VOSClim VOS Climate Project
WCRP World Climate Research Programme
WDC World Data Centre
WDC-GG World Data Centre 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 3

GCOS CLIMATE MONITORING PRINCIPLES (GCMPs)

Effective monitoring systems for climate should adhere to the following principles:*

1. The impact of new systems or changes to existing systems should be assessed prior to implementation.

2. A suitable period of overlap for new and old observing systems is required.

3. 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.

4. The quality and homogeneity of data should be regularly assessed as a part of routine operations.

5. 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.

6. Operation of historically-uninterrupted stations and observing systems should be maintained.

7. 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.

8. 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.

9. The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted.

10. Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.

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; and

(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.

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

11. Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained.

12. 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.

13. Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured.

14. Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured.

15. On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored.

16. Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate.

17. 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.

18. 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 de-commissioned satellites.

Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation.

19. Random errors and time-dependent biases in satellite observations and derived products should be identified.

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** The ten basic principles (in paraphrased form) were adopted by the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) through decision 5/CP.5 at COP-5 in November 1999. The complete set of principles was adopted by the Congress of the World Meteorological Organization (WMO) through Resolution 9 (Cg-XIV) in May 2003; agreed by the Committee on Earth Observation Satellites (CEOS) at its 17th Plenary in November 2003; and adopted by COP through decision 11/CP.9 at COP-9 in December 2003.*

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 (email address GCOSJPO@wmo.int) maintains a current list of all International Data Centres associated with GCOS together with a list of current contacts at those centres.

Table A4-1. 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 (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)	CCl, CBS and RAs
Baseline Surface Radiation Network (BSRN)	World Radiation Monitoring Centre (ETHZ)	WCRP
Sunshine networks	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
Ground-based GPS receiver network		

Atmosphere Composition		
GAW CO2 and CH4 monitoring network	WDC-GG (JMA) Carbon Dioxide Information Analysis Center (Oak Ridge National Laboratory)	CAS
WMO/GAW Ozonesonde Network **WMO/GAW Column Ozone Network**	WOUDC (MSC) Network for Detection of Atmospheric Composition Change (NDACC) Archive Norwegian Institute for Air Research Southern Hemisphere Additional Ozonesondes (SHADOZ – NASA) Archive	CAS
WMO/GAW Aerosol Network	AERONET, SKYNET, BSRN and GAWPFR data centres, World Data Centre for Aerosols (JRC Ispra)	CAS

Table A4-2. 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 Centre, Honolulu, USA	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 A4-3. International Data Centres and Archives – Terrestrial Domain.

Network or System	International Data Centre and Archives	Coordinating Bodies
Global Terrestrial Network - Glaciers	World Glacier Monitoring Service (WGMS); NSIDC	ICSU, FAGS
Global Terrestrial Network – Lakes	None designated[16]	CHy
Global Terrestrial Network - Permafrost	NSIDC	International Permafrost Association
Global Terrestrial Network – Rivers	GRDC	CHy
Snow Cover (WWW/GOS synoptic network)	NCDC, NSIDC	CBS

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[16] International Data Centre responsibilities are in the process of being developed.