

**G** GLOBAL  
**C** CLIMATE  
**O** OBSERVING  
**S** SYSTEM



WORLD METEOROLOGICAL  
ORGANIZATION

INTERGOVERNMENTAL  
OCEANOGRAPHIC COMMISSION

**REPORT OF THE SEVENTH SESSION OF THE**

**GCOS/WCRP**

**ATMOSPHERIC OBSERVATION PANEL**

**FOR CLIMATE (AOPC)**

**(Geneva, Switzerland, 30 April – 3 May 2001)**

**December 2001**

**GCOS - 68**

**(WMO/TD No. 1093)**

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# **REPORT OF AOPC-VII**

## **1. OPENING OF THE MEETING**

The Seventh Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) began at 09:00 on Monday 30 April 2001 at the headquarters of the World Meteorological Organization (WMO) in Geneva, Switzerland. Dr Mike Manton, AOPC Chairman, welcomed participants to the meeting (see Annex I for list) and introduced Mr Michel Jarraud, WMO Deputy Secretary-General, who welcomed attendees on behalf of the WMO.

## **2. OPERATION OF THE MEETING**

Dr Hans Teunissen reviewed the operating procedures and logistics for the meeting on behalf of the GCOS Secretariat.

## **3. AGENDA**

Dr Manton reviewed the proposed agenda and requested suggestions for any additions or modifications. The final agenda and workplan is presented as Annex II to this report.

## **4. REPORT FROM THE CHAIRMAN**

Dr Manton briefly reviewed the structure and strategy of GCOS for the benefit of new members of the Panel, focussing especially on the role of AOPC. The aim of GCOS is to ensure the availability of global data and products for climate applications including climate change detection and attribution, climate prediction, and climate simulation and understanding. The GCOS/AOPC strategy is to promote the development and maintenance of end-to-end systems to provide consistent high-quality data and products using a dual-stream approach of (a) baseline and (b) comprehensive systems. The baseline systems are to provide long-term, high-quality, consistent, homogeneous data at the surface (e.g. GSN, VOSCLim) and in the free atmosphere (e.g. GUAN, ASAP, Satellite/MSU), and for determining climate forcing (e.g. GAW, Satellite/TOMS, BSRN). Comprehensive systems are those that provide all other available data for assimilation in models, including real-time data used for routine weather prediction. Components of the baseline systems include the observing networks and their operators that collect, quality-control, store and transmit data to the GCOS Monitoring Centres; the Monitoring Centres which provide the data collection and performance statistics and liaise with the operators to maximize this performance; the GCOS Analysis Centres which homogenize and quality-control the data, generate GCOS products and transmit the data and products to the GCOS Archives; and the World Data Centres, which serve as the GCOS Archives to store and provide access to the GCOS baseline datasets.

Dr Manton reminded the group of the importance of satellite measurements for providing many of the observations needed by GCOS, and the additional responsibilities for satellite issues placed on the AOPC and other GCOS panels as a result of the dissolution of the Global Observing Systems Space Panel. He also noted the establishment by WMO and relevant satellite agencies of the Consultative Group on High-Level Policy on Satellite Matters, to which AOPC would be expected to provide input on needs for satellite observations on behalf of GCOS. Dr Manton concluded by summarizing his view of AOPC priorities as:

- generation of GCOS products (performance indicators, datasets, climate indicators);
- implementation of baseline systems (links with WMO and satellite agencies);
- extension of systems (climate-forcing data, assimilation and reanalysis); and

- supporting GCOS activities relating to the United Nations Framework Convention on Climate Change (UNFCCC) process (GCOS regional workshops, synthesis of national reports to the Conference of the Parties (COP), development of a second report on the adequacy of climate observing systems).

## **5. REPORT FROM THE DIRECTOR**

Dr Alan Thomas, Director of the GCOS Secretariat, reviewed the activities of the GCOS programme since the last meeting of the AOPC, highlighting the progress in implementation of the various networks and summarizing the outcomes of the relevant meetings that had taken place. He noted in particular the results from the Ninth Session of the GCOS Steering Committee (Beijing, China 12-14 September 2000) as well as outcomes of the preceding WMO and IOC Executive Council meetings which had adopted resolutions strongly supporting GCOS. A major decision of the Steering Committee meeting had been the dissolution of the two GCOS cross-cutting panels (the Global Observing Systems Space Panel, GOSSP, and the Joint Data and Information Management Panel, JDIMP) and the transition of their respective responsibilities to the Science Panels, thereby adding a considerable additional load to AOPC and the other panels. He summarized the most significant issues on which AOPC assistance was needed, in the view of the GCOS Secretariat (and exclusive of UNFCCC-related issues discussed in Section 6 below) as: future interactions with the WMO Technical Commissions, especially the Commission for Basic Systems (CBS), the Commission for Climatology (CCI) and the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM); the current effort to establish a global hydrological observing system for climate (GTN-H); and coordination of activities with CEOS and individual satellite agencies. Details of Dr Thomas's presentation are given in Annex III to this report.

Following extensive discussions on the issues highlighted in the presentations of both Dr Manton and Dr Thomas, the meeting approved the following decisions:

### **DECISIONS**

**1. AOPC noted with appreciation the reports of the AOPC Chairman and the Director of the GCOS Secretariat, reviewing the main developments and issues of concern to AOPC during the past year and those which would be of highest priority in the coming year. The Panel agreed that its priorities for the next 1-2 years would be:**

**(i) to develop and generate GCOS products, through**

- increased availability of GSN and GUAN data;
- increased availability of GSN and GUAN performance indicators;
- the generation of key climate indicators related to GSN and GUAN data;
- the investigation of the utility to GCOS of large-scale atmospheric circulation indicators;

**(ii) to enhance the implementation of baseline systems, through**

- links to WMO Commissions and Members;
- links to satellite agencies; and

**(iii) to promote the benefits and needs of GCOS, through**

- support for the GCOS regional workshops;
- participation in the GCOS adequacy analysis.

2. AOPC recognized the need, and expressed strong support, for the implementation of a global hydrological observing network for climate (GTN-H, a global terrestrial network for hydrology). The Panel agreed five specific recommendations with respect to a strategy for such implementation:

(i) analyse existing data for the each of the initial variables proposed at the Geisenheim Workshop (26-30 June 2000), with respect to:

- current availability;
- observational issues (methods used and consistency between countries);
- representativeness;
- temporal resolution;
- density of coverage (spatial resolution and number of stations);
- availability of historic time series;
- required improvements;

(ii) define categories for the proposed variables, with respect to:

- operational, research or project measurements/observations;
- point or areal data or large-scale fields;

(iii) propose a stepwise implementation plan to:

- begin using existing available operational data;
- prioritize the list of variables in order of achievability;
- promote improvements of existing data availability and quality as required;
- develop potential ways to set up data collection if required data are not readily available;
- determine the role of project and research data;

(iv) identify a lead institution (and person) to be the designated centre for monitoring and analysing the data; and

(v) establish a joint panel between GTOS (TOPC) and GCOS (AOPC) to oversee GTN-H.

AOPC requested that the GCOS Secretariat formally present these recommendations to the forthcoming GTN-H implementation workshop to be held at the Global Runoff Data Centre (GRDC) in Koblenz, Germany from 21-22 June 2001. It also requested that B. Rudolf attend that meeting on behalf of the Panel.

## 6. UNFCCC AND RELATED ISSUES

Dr Thomas reviewed the most recent meetings of the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA-12 and 13, June and November 2000, respectively) and the Sixth Session of the Conference of the Parties (COP-6, November 2000) in which GCOS had participated on behalf of the global observing systems for climate. Status reports had been provided on the observing systems and the activities being carried out by GCOS in support of UNFCCC/COP and in response to decisions taken at the previous COP session. Particularly notable among these were the GCOS Regional Workshop Programme, of which one workshop had already been held in the South Pacific region in August 2000, and the need to assist the UNFCCC Secretariat in synthesizing and analysing the information to be submitted on systematic observation of climate as part of the Parties' national communications to COP in late 2001. In addition, GCOS SC-IX had requested that this synthesis and analysis

process be extended to include other information on climate observations in order to develop a second report on the adequacy of the global observing systems for climate. It was planned to submit a prospectus on this process to the next SBSTA/COP sessions (SBSTA-14/COP-6bis in July 2001) to seek their concurrence. AOPC participation and advice in these activities was extremely important and was being sought at this Panel meeting.

In discussion of these issues, AOPC expressed its full support for the activities being carried out at the request of UNFCCC. It agreed that it should participate fully in the development of a second adequacy report and was pleased by the opportunity presented. Specifically, the Panel approved the following decisions:

## **DECISIONS**

- 3. AOPC reiterated its support for the GCOS Regional Workshop Programme and recommended that discussion of the GCOS surface and upper air networks (GSN and GUAN) should be a standard component of each workshop, including presentation and discussion of the latest regional monitoring results for each of these networks. The Panel suggested that GCOS seek the views of the GSN and GUAN Monitoring Centres to determine what issues these centres would wish to have raised at the workshops. AOPC also recommended that the importance of networks to measure atmospheric constituents, especially the Global Atmosphere Watch (GAW), should be stressed. AOPC emphasized the importance of providing workshop participants a clear idea of the benefits that can flow to countries if they improve these and other GCOS networks.**
- 4. AOPC reviewed the plans and schedule for the development of an updated assessment of the adequacy of the global observing systems for climate, to be presented to the Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC). The Panel generally endorsed the detailed outline presented (Attachment to Annex III) while suggesting that the aims of the exercise be made more specific, viz: to update the 1998 "Report on the Adequacy of the Global Climate Observing Systems" (GCOS-48); to summarize enhancements to the climate observing systems and progress in monitoring their performance since GCOS-48; and to identify capabilities of the climate observing systems that appear adequate and those which require enhancement. The Panel also suggested that the length of the document be limited to about 25 (rather than 50) pages, and that the development schedule be adjusted to reflect current realities and possibilities.**

## **7. GSN AND GUAN**

### **7.1 Performance Monitoring Results for GSN**

Mr Stefan Rösner, Head of the GSN Monitoring Centre (GSNMC) at the Deutscher Wetterdienst (DWD), reviewed the latest performance monitoring results for the GSN using data from the recently-published fourth GSN Monitoring Report, prepared jointly by DWD and the Japan Meteorological Agency (JMA). These results covered the period July-December 2000 and indicated only a very slight improvement in the CLIMAT reporting percentage (55% of the 989 stations, cf. 52% for the previous period). In addition, this performance was still below that of the WMO/WWW Global Observing System (GOS) CLIMAT network as a whole (about 2500 stations), of which the GSN is a subset (64% reporting, cf. 60% for the previous period). There were various reasons for the poor reporting performance, including the continuing existence of discrepancies between station identifiers in various lists, incorrect coding of messages, transmission problems, etc. Mr Rösner noted that the DWD had volunteered to host a meeting between representatives of the GSN Monitoring Centres, the WWW/GOS infrastructure, GCOS

and other relevant parties aimed at identifying specific problems and establishing actions and procedures which would lead to overcoming them. This was welcomed by AOPC members.

## **7.2 Performance Monitoring Results for GUAN**

Mr David Parker reviewed the ongoing activity at the UK Met Office Hadley Centre (which acts as the GUAN Analysis Centre) in analysing and publishing performance data for the 150 stations in the GUAN. Monthly maps identifying the CLIMAT TEMP reporting status for all GUAN stations were being regularly published on the Analysis Centre Web site. Reporting percentages were typically in the range of 65-70%, which was about the same as those for the WWW/GOS upper-air network as a whole. It was intended that this activity would be expanded in the near future to include results from monitoring of the daily TEMP messages (carried out by ECMWF in its capacity as the GUAN Monitoring Centre) as well as the monthly CLIMAT TEMP reports, with details of the process to be agreed between ECMWF and the Hadley Centre.

## **7.3 Guide on the GSN and GUAN**

Mr Harald Daan presented the latest draft of a guide on the GSN and GUAN ("Guide on the GCOS Surface and Upper-Air Networks") which he had prepared in response to the request from the previous session of AOPC. The guide reviewed the background to the development of the GSN and GUAN, station selection criteria, required commitments of operators who agreed to join the networks, best practices, etc. Such a document was considered extremely important as a means of maintaining the historical record of GSN and GUAN development and demonstrating in a concise and clear manner the obligations and responsibilities expected of current and potential new stations. The AOPC expressed its appreciation to Mr Daan for having carried out this task and endorsed publication of the document as a formal GCOS report following a final review and comments by panel members.

## **7.4 Review of GSN and GUAN Network Composition**

Mr Daan, on behalf of the AOPC Advisory Group on GSN and GUAN (AGG), presented the results of a critical review of the composition of the GSN and GUAN which he had led in response to the request from AOPC-VI. This review considered data reporting performance of each station using the results from both GCOS and WWW/GOS monitoring activities, historical records from each site, geographical location, potential replacement stations in the case of non-performance, and other relevant criteria in order to produce a list of possible modifications to the composition of the networks. The Panel briefly discussed the proposals and decided to establish a small task team at the meeting to review them in detail and develop an agreed list of recommended changes for consideration by the Panel as a whole. A list of immediate changes approved by the Panel is presented as Annex IV to this report. AOPC also agreed that further and continuing review should be carried out by a more formally-constituted AGG (see 7.7 below) which would provide AOPC with ongoing advice regarding the detailed composition of the GSN and GUAN.

## **7.5 GSN Historical Data**

Dr Tom Peterson reported on the status of the GSN Archive at the World Data Centre (WDC) for Meteorology in Asheville, USA (at the National Climatic Data Center, NCDC). Historical GSN data had been received from a total of 28 countries to date, representing some 250 of the 989 GSN stations, in response to the request for such data from the WMO Secretary-General to WMO Members in late 1999. There had been some difficulties in ingesting some of the data submitted due to formatting and similar problems, and some of the data carried restrictions regarding onward distribution. Uniform quality control had not yet been carried out by WDC, so only that performed by the submitting countries had been applied to the data. The

data themselves were now available via a dedicated Web site (<http://lwf.ncdc.noaa.gov/servlets/gsn>), and additional data would be added as they became available. It was suggested that additional correspondence from the WMO might be helpful in encouraging the submission of outstanding historical data from the GSN stations.

## **7.6 WCP/WCDMP**

Mr Bill Kininmonth of the WMO World Climate Data and Monitoring Programme (WCDMP) reviewed the activities of that programme in climate system monitoring and climate data management. Included were the work in support of climate change detection, automated weather stations, data exchange, rescue of climate data from meteorological and public archives, and computerized management of climate data within the national meteorological services. Many of these activities overlapped directly with the objectives of AOPC, and it was agreed that close cooperation and mutual support is needed between AOPC and WCDMP in order to achieve the objectives of both.

## **7.7 AOPC Advisory Group on GSN and GUAN (AGG)**

Mr Daan presented a draft of possible Terms of Reference for the ad-hoc group (i.e. the AGG) which had been regularly reviewing the composition and performance of the GSN and GUAN on behalf of AOPC. It was felt that the activities being performed by this group were essential to the ongoing implementation of these networks on behalf of AOPC. The Panel considered the recommendations and agreed that the AGG should continue and that its Terms of Reference should be as presented in Annex V of this report.

After detailed discussion of the various issues involved, the Panel approved the following decisions:

### **DECISIONS**

- 5. AOPC reiterated its appreciation to the DWD and JMA for their support in providing the ongoing performance monitoring activity for GSN. It noted with concern the lack of improvement in overall reporting percentages indicated by the most recent monitoring report (typically 55%), and particularly the continuing decrease in performance in RA-II displayed since mid-1999. The Panel welcomed the support of CBS and the WWW Secretariat, in cooperation with the GSNMC, in taking actions aimed at improving this performance.**
- 6. AOPC expressed its appreciation to the DWD and JMA for offering to support direct liaison between NMHSs and the GSNMC. It noted in particular the meeting to be hosted by DWD, on behalf of CBS, in September 2001 to address this and related GSN implementation and coordination issues. The Panel endorsed the plans for strengthening ties between the GCOS and World Weather Watch monitoring centres, noting the intention to include representatives of all WMO Regional Associations as well as other appropriate participants at the DWD meeting. The Panel was pleased that the meeting would facilitate the establishment of both formal and informal mechanisms which would lead to improved availability of CLIMAT and CLIMAT TEMP messages, particularly insofar as format errors and transmission problems are concerned.**
- 7. AOPC requested the Chairman to encourage informal communication between the national contact persons from the Asia-Pacific Network (APN) Climate Indices Workshop networks and the GSNMC.**

8. AOPC endorsed the GSNMC policy of providing monthly updates of the CLIMAT reports received at the GSNMC to the GSN Analysis Centre (NCDC, Asheville, USA). The Panel strongly supported the proposal to make a 12-month rolling archive (updated monthly) available through the GSNMC Web site, while encouraging the GSNMC to extend such an archive so as to continue indefinitely from the beginning of the formal monitoring period (January 1999), if feasible.
9. AOPC strongly endorsed the concept of interactive querying of the GSNMC archive via the GSNMC Web site which would, for example, permit any user to identify the performance of any GSN station using either predefined or self-defined time periods.
10. AOPC expressed its support and appreciation to the CBS Rapporteur for Volume A (H. Daan) for his ongoing efforts to correct the inconsistencies in the GSN stations identified in that publication, through a combination of formal and informal contacts with the station operators. It noted that several inconsistencies in station location had been identified through comparisons with data contained in other databases (e.g. GPCC) and requested that the GSN Monitoring Centre and the WMO Secretariat continue to work together to rectify these inconsistencies.
11. AOPC reiterated its appreciation of the support provided by the National Climatic Data Center (NCDC), Asheville, USA, in acting as the Analysis Centre and Archive for the GSN. The Panel noted in particular the special identification of GSN and GUAN stations in the regularly-published lists of Monthly Climatic Data of the World (MCDW).

#### **GUAN**

12. AOPC expressed its appreciation to the ECMWF for maintaining the GUAN Monitoring Centre, and to the Hadley Centre and NCDC for their progress in establishing the GUAN Analysis Centre. It noted with appreciation the offer of ECMWF to develop maps of performance indicators for GUAN stations based on daily TEMP data, for presentation on the ECMWF and/or Hadley Web sites at regular intervals, with details of the statistics and summary period to be agreed between the centres. The Panel also reiterated the vital importance of maintaining monthly CLIMAT TEMP messages for monitoring climate aloft, and requested the Hadley Centre to continue to provide monthly maps of CLIMAT TEMP receipt on its GUAN Web site.

#### **GSN and GUAN (General)**

13. AOPC expressed its appreciation to Harald Daan for his efforts in developing a 'Guide on the GSN and GUAN'. It requested all Panel members to perform a final review of the document and provide comments to H. Daan (cc GCOS Secretariat) by 18 May, following which the document would be formally published as a GCOS publication and subsequently distributed to all WMO Members.
14. AOPC expressed its appreciation to the WMO Secretary-General for his recent communications with WMO Members aimed at improving the reporting and performance of GSN and GUAN stations, including the identification of national focal points for upper-air observations.
15. AOPC expressed its appreciation to Harald Daan and the Advisory Group on GSN and GUAN (AGG) for their draft review of the GSN and GUAN networks. The Panel endorsed the specific recommendations resulting from the further review undertaken during this meeting (Annex IV). The Panel also noted the suggestion that there may be some GUAN stations in central Africa which could contribute to filling gaps in the

network in that area and encouraged R. Okoola to work with the AGG in investigating that possibility.

16. AOPC strongly reiterated the need to maintain and improve the availability of CLIMAT and CLIMAT TEMP messages, noting that climate monitoring, prediction and research all rely heavily on such messages because their monthly statistics are often based on more complete and comprehensive data than are available for daily messages transmitted via the GTS.
17. AOPC endorsed the proposed terms of reference for the AGG (Annex V), and confirmed P. Jones as the Chairman of the Group.

#### ***GSN Historical Data***

18. AOPC expressed its appreciation to the GSN Archive (WDC/NCDC) for its efforts in compiling and making available the historical data from GSN stations received in response to the September 1999 request from the WMO Secretary-General. The Panel requested NCDC to modify this interactive Web interface to allow easy identification and retrieval of the full GSN dataset.
19. AOPC noted that some countries have submitted only minimal amounts of GSN historical data, if any, to the GSN archive, and encouraged strong efforts to rectify this limitation. It requested in particular that the GCOS and WCP Secretariats arrange for a follow-on request to WMO Members which would encourage them to submit GSN historical data, if not already done, as well as to identify focal points for assisting in the process of overcoming obstructions to routine reporting of CLIMAT data from these stations.
20. AOPC noted with appreciation the offer of C. Nobre to pursue the provision to NCDC of historical daily data from GSN stations located in Brazil.
21. AOPC recognized that digitization of historical records is a major problem in many countries and recommended that assistance be made available to overcome such difficulties to the extent possible. It noted that problems of this nature could be highlighted as part of the agenda of the regional workshops being organized by the GCOS Secretariat.
22. AOPC noted with appreciation the plans for the WCP and GCOS Secretariats to cooperate closely in issues of climate data collection, analysis and management, and requested that action be taken to establish formal recognition of such cooperation at the CCI session in November 2001.

## **8. CLIMATE FORCING BASELINE OBSERVATIONS**

### **8.1 Clouds, Radiation and Atmospheric Composition**

Dr Manton led a discussion of issues related to the identification of baseline and comprehensive systems needed for the measurement and monitoring of climate forcing parameters, including ozone, radiative fluxes, clouds, water vapour, aerosols and greenhouse gases. For ozone, he commended the recent WMO/GAW-CEOS Report on a Strategy for Integrating Satellite and Ground-based Observations of Ozone (WMO/TD No. 1046, January 2001) and noted the need for broader coverage of the GAW network, especially in the tropics and the southern hemisphere. The Integrated Global Atmospheric Chemistry Observations (IGACO) theme under the Integrated Global Observing Strategy (IGOS) Partnership would be carrying this effort forward and it was important that AOPC interests be considered there. For

water vapour, Dr Manton noted the completion of the comprehensive SPARC Assessment of Upper Tropospheric and Stratospheric Water Vapour (WMO/TD No. 1043, WCRP-113, December 2000) and highlighted the need for multiple-instrument measurements in the upper troposphere and more tropical tropopause observations. He also reviewed a number of ongoing observation activities for clouds, aerosols and greenhouse gases and emphasized the need for greater cooperation between GCOS and GAW in many of these areas. After discussion of the issues involved, the following decisions were approved by the Panel:

## **DECISIONS**

- 23. AOPC requested the Chairman to contact M. Chanin to ask that she represent AOPC on the Coordinating Group for the Integrated Global Atmospheric Chemistry Observations (IGACO) Theme being developed under the IGOS Partnership, with a view to ensuring the measurement of *in situ* and satellite baseline observations for stratospheric ozone.**
- 24. AOPC requested G. Stephens, J. Schmetz and M. Suzuki to develop a statement for the Panel regarding the identification or development of baseline observations for top-of-atmosphere and surface radiation fluxes.**
- 25. AOPC requested that the Chairman contact the International Project Manager of the BSRN (E. Dutton) with a view to exploring the recognition of BSRN as a contributing network to GCOS.**
- 26. AOPC noted that the comprehensive SPARC Assessment of Upper Tropospheric and Stratospheric Water Vapour had recently been published (D. Kley, J. Russell and C. Phillips, WCRP-113, December 2000) and provides useful guidance on the requirements for measurement of water vapour. The document concluded in particular that:**
  - multiple-instrument measurements are needed for UT water vapour;**
  - more tropical tropopause measurements are needed;**
  - monthly balloon measurements should be flown at various latitudes (in addition to Boulder);**
  - satellite instruments should have continuity;**
  - past observations are not fully understood (e.g. HALOE trends); and**
  - there is a need for an archive of UTLS water vapour data.**

**AOPC requested the Chairman to liaise with SPARC to develop recommendations on the requirements for baseline observations for UTLS water vapour.**

- 27. AOPC noted the potential for GPS retrievals of total water to provide additional data on the water in the atmosphere above land areas.**
- 28. AOPC requested the Chairman to liaise with the WMO EC Panel/CAS Working Group on Environment and Atmospheric Pollution to develop recommendations on the requirements for baseline *in situ* measurements of greenhouse gases.**

## **8.2 Land Cover**

Prof. Phil Jones discussed the issue of climate forcing through land-use changes, noting that such changes over the last 200 years had been postulated as a significant factor that needs to be considered by modelling groups in simulations of 20<sup>th</sup> century climate change. Until recently, information about land-use changes had been considered only at regional scales. At

least one high-resolution dataset of historic changes in global land cover had recently been developed. Such a dataset could be used within Global Climate Models (GCMs) and global ecosystem models to understand the impacts of land-use change over time on both climate and on the cycling of carbon and water. At present, no such experiments had been performed, although GCM integrations were planned at the Hadley Centre. The global mean radiative forcing by anthropogenic surface albedo change relative to the natural change was estimated to be  $-0.2 \text{ Wm}^{-2}$ , which should translate to a global mean temperature change of  $-0.02^\circ\text{C}$  but would be significantly larger in regions severely impacted by the changes. This forcing is significant in global terms and is comparable to that due to  $\text{N}_2\text{O}$ .

## **DECISION**

**29. AOPC encouraged the undertaking of global climate and ecosystem model integrations which incorporate historical changes in global land cover with the aim of improving understanding of the impacts of land-use change over time on both climate and the cycling of carbon and water.**

## **9. MARINE SYSTEMS**

### **9.1 SST/Sea-Ice Working Group**

Dr Ed Harrison reviewed the latest activities of the joint AOPC-OOPC Working Group on Sea-Surface Temperature and Sea-Ice, as well as other activities that had been reported at the recent sixth meeting of the Ocean Observations Panel for Climate (OOPC) in Melbourne, Australia (2-5 April 2001). Details of this and latest OOPC developments are available in the report of that meeting (GCOS-70, to appear on <http://ioc.unesco.org/goos/docs/doclist.htm>).

### **9.2 Surface-Pressure Working Group**

Dr Manton reviewed efforts that had been underway to establish a joint AOPC-OOPC Surface Pressure Working Group, whose overall objective would be to promote the development of long-term, high-quality analyses of atmospheric surface pressure. Draft Terms of Reference for the group included:

- promote the analysis of global surface pressure from both real-time and historical sources using both daily and monthly data;
- record and evaluate differences among surface pressure analyses through comparison of basic products;
- recommend actions needed to ensure the quality and consistency of surface pressure analyses based on analysis of those differences;
- promote the recovery of atmospheric pressure data, including issues associated with data access, archiving and maintenance;
- promote comparison of the various types of barometers and pressure sensors (including satellite estimates) used to measure surface pressure; and
- report annually to AOPC and OOPC on progress, recommendations and future plans of the group.

The group would be led by AOPC and would normally operate through e-mail, as was the case for the OOPC-led SST/Sea-Ice Working Group. The Panel strongly supported the establishment of such a group and requested that a work plan be prepared based on the draft ToR, under the leadership of R. Allan and E. Harrison.

### **9.3 JCOMM Status Report**

Dr Peter Dexter reviewed the latest activities and status of the newly-established WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). His full report is presented as Annex VI to this document.

### **9.4 CLIVAR-Pacific Panel**

Dr Manton briefly reviewed some conclusions from a recent workshop held by the WCRP CLIVAR Pacific Panel in Hawaii, USA, regarding atmospheric observational needs for CLIVAR issues including the study of ENSO dynamics and predictability (including decadal time scales); ocean-atmosphere coupling covering seasonal-interannual to decadal time scales; processes on heat storage, mixing and coupling; and parameterisations in atmospheric GCMs and coupled models.

Following discussions on the above and related marine issues, the AOPC approved the following decisions:

#### **DECISIONS**

- 30. AOPC noted the excellent progress being made in the implementation of JCOMM, including the first formal session of the Commission to be held in Iceland in June 2001, and the benefit that this commission will provide to GCOS through its role in overseeing the implementation and operation of many of the networks relevant to GCOS (e.g. VOSclim, ASAP, DBCP and TAO/TRITON). The Panel expressed its appreciation for the efforts of, *inter alia*, the OOPC, IOC and WMO in effecting this progress.**
- 31. AOPC was particularly pleased to note the implementation of the WRAP (Worldwide Recurring ASAP Project) to provide ASAP observations on ships regularly traversing the globe, especially through the data-sparse Southern Ocean.**
- 32. AOPC commended the progress of the AOPC/OOPC Working Group on SST/Sea-Ice, and endorsed the plans to strengthen its focus on sea-ice and to commence a project to clarify the impacts of individual quality-control and data-selection processes on SST analyses.**
- 33. AOPC noted the intention of the GODAE project to establish a high-resolution SST pilot project which seeks to produce daily global SST sets at a resolution of 1km x 1km and an accuracy of 0.5°C.**
- 34. AOPC endorsed the establishment of an AOPC/OOPC Working Group on Surface Pressure (WG-SP) to be co-convened by R. Allan (Hadley Centre) and E. Harrison (PMEL). The Panel requested the group to prepare a work plan based on its draft terms of reference.**
- 35. AOPC strongly supported the initiatives of OOPC to establish a Working Group on ocean time-series stations and, with the Partnership for Observation of the Global Oceans (POGO), to seek to maintain existing high-quality ocean reference sites and to establish additional ones where needed. The Panel recommended that these stations be used to provide baseline data on air-sea interaction as well as on ocean conditions.**
- 36. AOPC noted that the WCRP/CLIVAR Pacific Panel had endorsed the importance of the GSN and GUAN data and had especially emphasized the need for reliable upper**

air data from the GUAN sites at San Cristobal (Galapagos Islands) and Easter Island, as well as at the Midway Islands, for example.

37. AOPC expressed strong support for objectives of the WGNE Surface Flux Analysis Project (SURFA), which will evaluate and intercompare surface flux products from the main global NWP centres, and looked forward to receiving a progress report on the project at the next meeting of AOPC.
38. AOPC strongly endorsed the continuation of full support for the ENSO Observing System, noting with some concern the potential weakening of some of this support.

## 10. SATELLITE ISSUES

### 10.1 ET-ODRRGOS Activities

Dr Donald Hinsman reviewed the recent activities of the WMO/CBS Expert Team on Observational Data Requirements and Redesign of the Global Observing System (ET-ODRRGOS), including the Third Meeting of the ET in June 2000 and a special meeting of a reduced group of the ET which had taken place during the week preceding this AOPC meeting and in which the AOPC Chairman had participated. The June 2000 meeting had resulted in completion of the third iteration of the Rolling Requirements Review of observational requirements and data availability, and the development of a corresponding Statement of Guidance (SOG) for data producers, in seven application areas, including Seasonal-to-Interannual Forecasting (SIA). The SIA SOG represented an initial draft and the ET looked forward to working closely with AOPC and other components of the climate community on refining that statement and on developing SOGs for other climate applications. This approach had been reiterated at the reduced-group meeting, where the focus had been on the development and use of Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) for examining the impact of potential modifications to the GOS on various applications dependent on it. The ET had incorporated several suggestions from the AOPC Chairman in its Guidelines for OSEs/OSSEs at that meeting, in particular recognizing some of the specific limitations of OSEs and OSSEs and the great care that must be taken in interpreting their results for many applications.

### 10.2 WMO/CEOS Database

Dr Hinsman briefly reviewed the status of the WMO/CEOS database of requirements for space-based and *in situ* observations in support of applications of interest to CEOS members and IGOS Partners, including results from a recent (1-2 March 2001, Southampton, UK) meeting to update the database manual. He noted that several definitions contained in the present database manual had been expanded. In addition, several new geophysical parameters had been added. He also noted that the database now contained expected performances for several additional observing systems. Finally, Dr Hinsman noted that GCOS/AOPC requirements for climate applications had last been reviewed in May 1999 and invited the Panel to update these components of the database as it felt appropriate.

### 10.3 Potential Satellite Agency Support for GUAN and GSN Stations

Dr Teunissen introduced the suggestion that had been made by the Chairman of the CBS Open Programme Area Group (OPAG) on the Integrated Observing System that certain GUAN and GSN stations might merit special support from the operators of earth observation satellites in view of their importance to the problem of calibration and validation of the satellite observations, for example. Specifically, the OPAG Chairman had suggested at the preceding ET meeting that satellite operators might choose to 'adopt' some stations in data-void areas, thereby supporting the surface and upper-air stations needed to establish ground-truth for their

observations as a part of their operational programmes while at the same time solidifying support to the GOS, the GSN and the GUAN. The AOPC felt that this was an excellent suggestion and requested that the AGG pursue the development of a list stations which might benefit from such potential support.

Following discussions on the above and related satellite issues, the AOPC approved the following decisions:

## **DECISIONS**

- 39. AOPC expressed its appreciation for the work of the ET-ODRRGOS in developing Statements of Guidance (SOG) for application areas relevant to WMO and WMO-supported programmes, including GCOS. It noted in particular the progress made in developing the first iteration of an SOG for Seasonal-to-Interannual Forecasting (SIA) and welcomed the opportunity to work closely with the ET in developing future iterations of that SOG as well as those needed for other climate applications, such as Climate Change Detection. AOPC requested the Chairman to liaise with OOPC and WCRP to review the SIA SOG.**
- 40. AOPC noted the work being undertaken by the ET-ODRRGOS on Observing System Experiments (OSEs) as a tool to assist in the redesign of the GOS. The Panel reiterated that for climate purposes, the GOS must be able to provide homogeneous coverage over the whole globe and to detect extreme weather and climate events. It also noted that a measure of the value of an observing system can be obtained from studies of the capability of the system to capture the variability of the observed climate on a range of time and space scales.**
- 41. AOPC noted the research that is being carried out by NOAA and other organizations on the homogeneity of the upper-air network and recommended that such studies should include all relevant GUAN stations.**
- 42. AOPC requested the AGG to review the performance of all GUAN stations with a view to identifying those which (a) would benefit from targeted assistance in order to overcome obstacles in their reporting performance, and (b) might be shown to provide observations which are of particular benefit to the operators of space-based earth observation system components. A prioritized list of such stations would be provided from the AOPC, through its Chairman, to the Chairman of the WMO/CBS OPAG on the Integrated Observing System for subsequent consideration by the satellite-operating agencies with a view to providing possible support for these stations.**
- 43. AOPC noted the requirement for input on climate issues to the next session of the WMO Consultative Group on High-Level Policy on Satellite Matters (February 2002). It recognized the need for the GCOS Science Panels to participate in the preparation of appropriate material for this purpose and noted the intention of the GCOS SC Chairman to contact the Panel Chairmen in this regard.**

## **11. COMPREHENSIVE OBSERVING SYSTEM**

### **11.1 Data Assimilation and Reanalysis**

Dr Manton outlined the concept of the GCOS comprehensive observing system, in which a real-time component provides data for assimilation in global models for real-time prediction and routine monitoring of specific parameters, while a delayed-mode component involves the reanalyses of global climate. The comprehensive networks continue to evolve in scope as the

capabilities of the models increase. Mr Roger Newson then reviewed the activities of the WCRP in reanalysis of global datasets, particularly those of the Working Group on Numerical Experimentation (WGNE), and Dr Manton provided, on behalf of Dr Phil Arkin, an overall summary of the current reanalyses underway and some thoughts on the future. Specifically, five reanalysis activities were in some sense ongoing, with one earlier effort currently inactive:

- (i) The original NCEP/NCAR reanalysis (RE1) was completed for the period 1948 onward. The data have been extensively distributed and are being widely used. A thorough description of the various aspects of RE1 is available at <http://wesley.wwb.noaa.gov/reanalysis.html>. The model/assimilation system used in RE1 is continuing to run with current observations as the CDAS (Climate Data Assimilation System), the products of which are used for climate monitoring at the Climate Prediction Center and elsewhere;
- (ii) The NCEP/DOE AMIP-II Reanalysis (Reanalysis-2, or, here, RE2) is intended to fix certain errors and improve some of the physical parameterizations used in RE1. Further information is available at <http://wesley.wwb.noaa.gov/reanalysis2/index.html>. RE2 begins in 1979, and will, sometime during 2001, be brought forward to the present and will continue to be run in real time. A publication (lead author M. Kanamitsu) describing RE2 has been submitted to the Bulletin of the American Meteorological Society;
- (iii) The ECMWF 40-year reanalysis (ERA-40) will cover the period 1957-2001. Preparatory work has been completed and operational processing has recently begun, with completion planned for late 2002. Details of the plan and current status of the processing, as well as many monitoring products, can be found at <http://wms.ecmwf.int/research/era/>;
- (iv) NCEP is beginning a regional reanalysis (RR) that will cover the period 1982-2003. It will use a version of the eta model with a spatial resolution of 32 km covering North America and adjacent oceanic regions. Testing is currently proceeding, with operational processing planned to begin in 2002. A 14-month old set of slides describing the project can be found at <ftp://ftp.ncep.noaa.gov/pub/emc/wd20er/regreanl/index.htm>; and
- (v) The NASA Data Assimilation Office (DAO) is conducting a GEOS-1 reanalysis. Details of the project can be found at <http://dao.gsfc.nasa.gov/experiments/assim54A.html> and current status is shown at [http://dao.gsfc.nasa.gov/experiments/experiment\\_status.html](http://dao.gsfc.nasa.gov/experiments/experiment_status.html). The completed period extends from 1980-1994, and 1995 is currently in progress.

The original ECMWF ERA-15, which covered the period 1979-1993, is presently inactive and will be subsumed into the ERA-40. Details can be found at <http://wms.ecmwf.int/research/era/Era-15.html>.

The future of reanalysis activities is somewhat uncertain. A workshop was held during June 2000 at the University of Maryland to bring together the interested U.S. scientific community for discussions of future reanalyses. The meeting concluded that a more coherent interagency "Reanalysis Program" was required. This new programme would sponsor atmospheric and oceanic reanalysis activities in several U.S. agencies, along with research in the academic community.

Following these presentations and further discussions regarding data assimilation and reanalysis issues, the Panel approved the following decisions:

## **DECISIONS**

- 44. AOPC reiterated that data assimilation plays a crucial role in providing atmospheric datasets for climate studies. Reanalysis datasets are an excellent tool for analysis of inter-annual variations and for creation of diagnostics to improve understanding of climate processes and to explore seasonal to inter-annual predictability. Although reanalyses do not provide realistic assessments of long-term trends, owing to historical variations in data input, these aspects are improving as techniques for assimilation and data quality control are being upgraded. AOPC encouraged the continuation of efforts such as those of the WCRP to foster the development of global atmospheric reanalysis.**
- 45. AOPC recognized the recent progress in carrying out global reanalysis projects in major centres in Europe, the USA and Japan and strongly encouraged their continuation, noting that the development of several reanalysis efforts allows the substantial load to be shared while making use of a common input dataset, as well as comparative studies that can highlight the strengths and weaknesses of each reanalysis. The Panel suggested that new reanalyses should be carried out at approximately 5-year intervals to take advantage of advances in assimilation techniques and improvements in the availability and quality of current and historical data. It also suggested that reanalyses should extend back as far as practicable in time (e.g. 1958) and should ensure the use of baseline datasets, such as GSN and GUAN, so that the products could be optimised for climate purposes. AOPC requested the Chairman to bring these views and suggestions to the attention of the WCRP.**
- 46. AOPC noted that reanalyses are only one aspect of the use of models to synthesise global products. Products such as GPCP outputs, SST analyses and ozone analyses are generated through the synthesis of a range of data using appropriate modelling and analysis techniques. These synthetic products are currently developed for the most part as research products. However, as the techniques and products become stable, it is no longer clear that they should be classified as research activities, since research funds are unlikely to be sustainable as the synthetic products become routinely used by communities. In recognition of these considerations, the AOPC requested P. Arkin to work with the Chairman and the WCRP Secretariat to consider appropriate international action to enhance understanding of and support for these activities.**

## **12. CLIMATE INDICATORS**

### **12.1 GSN and GUAN Analysis Centres**

Dr Parker discussed the latest developments at the GUAN Analysis Centre (GUAN AC) (Hadley, UK), including the results of recent efforts to develop an enhanced dataset of monthly data at standard levels which is temporally and spatially as homogeneous and complete as possible. Temporal and spatial completeness were approached by bringing together data from a number of sources, while removal of gross biases due to known changes in observation hour was conducted by cross-reference of data sources during overlap periods. Detailed results are available through the GUAN AC Web site. Dr Peterson reviewed developments at the GSN Analysis Centre (GSN AC) and noted that the GUAN datasets were not as yet accessible as a distinct entity, but that this could be arranged if so desired.

## 12.2 Precipitation (GPCC, GPCP)

Mr Rudolf presented an overview of the Global Precipitation Climatology Centre (GPCC) at the DWD in Offenbach, Germany. The GPCC was established in 1989 and is a contribution of Germany to both the WCRP and to GCOS. A full review of the centre is presented in the paper 'The GPCC: Analysis of Precipitation Based on Rain gauge Observations' by B. Rudolf, T. Fuchs and U. Schneider, which was tabled at the meeting and which is available via the GPCC Web site at <http://www.dwd.de/research/gpcc>.

GPCC data are one component of the input data for the Global Precipitation Climatology Project (GPCP), which was described by Mr Rudolf and Dr Manton on behalf of Dr Arkin. The GPCP (<http://www.gewex.com/gpcp.html>) had issued two new products during the past year:

- (i) GPCP v2 covers the globe, with a monthly time resolution and 2.5° spatial resolution, for the period January 1979 – December 2000. It uses the same data sources as v1 for the period from 1987 onward. For the earlier period it uses the OLR-based Precipitation Index (OPI) together with an estimate derived from TOVS (TIROS Operational Vertical Sounder) infrared observations to supplement gauge observations. More information is available at [http://rsd.gsfc.nasa.gov/912/gpcp/gpcp\\_v2\\_comb.html](http://rsd.gsfc.nasa.gov/912/gpcp/gpcp_v2_comb.html); and
- (ii) For the period 1997-2001, a 1°x1° global daily analysis based on a combination of geostationary and polar orbiting infrared and TOVS data is available. No gauge or SSM/I observations are used explicitly in the analysis, but it is calibrated on monthly time scales to the operational GPCP merged analysis that uses both. More information can be found at [http://rsd.gsfc.nasa.gov/912/gpcp/gpcp\\_daily\\_comb.html](http://rsd.gsfc.nasa.gov/912/gpcp/gpcp_daily_comb.html).

A third new product had completed the development process and would be issued shortly. It has the same temporal coverage, spatial resolution, and observational basis as the GPCP v2 dataset, with a temporal resolution of 5 days.

GPCP was in the process of producing a specialized dataset for the use of the International Land Surface Climatology Project. It consists of 10 years (1986-1995) of high spatial (1°x1°) resolution precipitation on time scales of monthly, pentad and daily. For more information, see: [http://islscp2.gsfc.nasa.gov/overview\\_documents/data\\_set\\_hyd\\_sol.html](http://islscp2.gsfc.nasa.gov/overview_documents/data_set_hyd_sol.html).

The geostationary infrared observations used in the GPCP began in January 1986. The International Satellite Cloud Climatology Project (ISCCP) had made available its DX archive of geostationary IR observations for the period July 1983 onward, and GPCP was investigating the possibility of using those data to improve the accuracy of its tropical analyses during that period. Two issues were currently being investigated: the impact of the spatial sampling (approximately 30km) used in the DX dataset; and the source and significance of apparent inter-satellite calibration differences.

## 12.3 WGCCD

Dr Peterson, Chairman of the CCI/CLIVAR Working Group on Climate Change Detection (WGCCD), briefly reviewed the activities of that group over the past three years, with reference to a summary report which had just been completed (Report on the Activities of the Working Group on Climate Change Detection and Related Rapporteurs, 1998-2001, March 2001, available at [http://www.clivar.org/publications/wg\\_reports/wgccd/wgccd\\_report\\_3.pdf](http://www.clivar.org/publications/wg_reports/wgccd/wgccd_report_3.pdf)). Of particular note were the two regional workshops on climate indices and extremes which had been held in the Caribbean (Kingston, Jamaica, January 2001) and African (Casablanca, Morocco, February 2001) regions, and the ClimDex climate index software which had been

presented and used at these workshops. Full details of the workshops and related WGCCD activities can be found in the summary report.

## **12.4 APN Workshops**

Dr Manton reviewed progress in the series of Workshops on Climate Extremes being sponsored by the Asia Pacific Network (APN) on Global Change Research. The third workshop had just been successfully completed (16-18 April 2001, Melbourne Australia - see <http://www.apn.gr.jp/pub026.htm#Third> APN Workshop on Climate Extremes M.J. Man) and plans had been developed for continuing this activity. The focus to date had been on temperature and precipitation data, and quantitative results from the second workshop (December 1999) had been published in the refereed literature and quoted in the IPCC Third Assessment Report. A major benefit of such workshops was the establishment of networks of contacts in each country having similar objectives and appropriate training to contribute to reaching those objectives. The APN model had been used by the CCI/CLIVAR WGCCD for their regional workshops and was also contributing to the START (System for Analysis, Research and Training) programme on Monitoring of Extreme Climate Events (MECE). The aim of MECE is to promote the rehabilitation and analysis of climate data and to detect and monitor trends and variations in climate extremes in developing countries through linking the capacity-building activities of START with the relevant international programmes of GCOS, WCRP and WMO.

As a result of the presentations noted above and the discussions on these and related issues on climate indicators, the Panel approved the following decisions:

### **DECISIONS**

- 47. AOPC requested the NCDC to identify and make available the GUAN dataset as a distinct entity through the GUAN Analysis Centre Web site, in a manner similar to that recommended for the GSN dataset.**
- 48. AOPC noted with appreciation the ongoing activity of the Global Precipitation Climatology Centre (GPCC) (operated by DWD) in integrating *in situ* precipitation observations from all available sources into a comprehensive global analysis, including data from the WWW/GTS, other contributions of WMO Members, and global/regional historical data collections. The Panel strongly encouraged the continuation of this activity.**
- 49. AOPC noted with appreciation the activities of the CCL/CLIVAR Working Group on Climate Change Detection (WGCCD) as described in the report of that group and summarized for this meeting by its Chairman (T. Peterson). It congratulated the group on its many successful initiatives to date, especially the recent workshops on climate extremes (Caribbean, Africa) which had been modelled after the similarly successful workshops of the Asia-Pacific Network (APN) for Global Change Research.**
- 50. Recognizing the successful results of the APN and WGCCD workshops on climate extremes, AOPC encouraged the implementation of a number of specific capacity-building activities to further stimulate progress in this area, including:**
  - scientific regional workshops to rehabilitate and analyse daily climate data;**
  - inclusion of GSN data in regional studies of climate extremes;**
  - development and dissemination of specific software that supports consistent analysis of climate extremes across and within regions;**

- **development of specific software to relate indices of climate extremes to the large-scale circulation;**
  - **digitisation of historical daily climate data for archival and analysis by NMHSs; and**
  - **development of basic forms of metadata to support the analysis of daily climate data.**
51. **AOPC requested the NCDC to display on the GSN Analysis Centre Web site the 13 key daily-data climate indicators that had been developed in conjunction with the ClimDex activity, as determined from only GSN data. It also requested that similar indicators be developed and displayed for GSN monthly data.**
52. **AOPC requested the GUAN Analysis Centre to develop and display on its Web site a set of climate indicators for the free atmosphere based on GUAN data.**
53. **AOPC requested E. Harrison and the Chairman to consult with relevant experts to investigate the potential for developing a suite of key indicators to characterize the large-scale atmospheric circulation. Such indicators could be routinely evaluated and presented in the context of historical conditions as routine GCOS products.**

### **13. DATA MANAGEMENT**

Mr David McGuirk briefed the Panel on the findings of a recent review of the Global Observing Systems Information Centre (GOSIC), in which he had participated as the WMO (and GCOS) representative. Such a review and/or advisory committee had been requested by GCOS SC-IX in light of the dissolution of JDIMP, which had had responsibility for oversight of GOSIC. The six-person review team had held its first meeting on 23-24 April 2001 at the current location of GOSIC at the University of Delaware in Lewes, Delaware. The review team was generally supportive of the work done to date, especially considering the limited resources dedicated to the work of GOSIC (slightly more than \$100K/year over the past three years), and recommended in general that GOSIC continue its functions. The team made some fifteen specific recommendations which would be presented to the GCOS (and GOOS and GTOS) SC at its next meeting. These recommendations focussed on direction and communication with the three observing systems, improving the GOSIC Web site, and outreach and visibility.

Mr McGuirk also informed the Panel of activities underway within WMO to review its current information system in light of the dramatic advances associated with infrastructures such as the Internet, with specific reference to a document recently developed by the President of CBS ('Summary of WMO Information Systems Development') and the establishment by CBS of appropriate Expert Teams to address the issue of the future WMO information system.

During the ensuing Panel discussions regarding data management, including metadata, paleoclimatic data and data recovery, the Panel agreed the following decisions:

### **DECISIONS**

54. **AOPC noted the findings of the recent meeting of the Review Team set up to review and provide oversight to GOSIC, subsequent to the dissolution of JDIMP. The Panel, noting the considerable progress being made by the GCOS Centres in disseminating GCOS data, results and information, urged that the needs of the GCOS Monitoring Centres and Data Centres be included in considerations of augmenting the support being made available for data management and coordination activities related to GCOS.**

55. AOPC noted that the WMO is considering the implications of developing the next generation of data management infrastructure, which will make use of internet technologies. It also noted that JCOMM is likely to commence pilot projects to demonstrate the capability of such systems. The Panel noted with appreciation the establishment of a CBS Expert Team on Integrated Data Management, which has been tasked to develop a high-level metadata standard to be used in future WMO information systems.
56. AOPC emphasized the great importance of metadata when preparing data to be used for purposes of climate change analysis, while noting that there is no readily-available standard for storing and accessing such metadata in electronic form. The Panel encouraged the CCI Rapporteur on Metadata to guide the development of such a standard, with possible reference to a pro-forma request for metadata that had been produced by WMO experts (including P. Jones and T. Karl) some years ago.
57. AOPC noted that most high-frequency (i.e. annual resolution) paleoclimatic data from natural archives (trees, corals, ice cores, marine and lacustrine varves) are archived at the National Geophysical Data Center (NGDC) in Boulder, Colorado (<http://www.ngdc.noaa.gov> and the mirror site in France). Funding agencies in the U.S. and Europe now demand that researchers lodge their paleoclimatic data and reconstructions with NGDC. Submission of data to NGDC is also actively encouraged by the IGBP/CLIVAR PAGES (Past Global Changes) Group. In Europe and the Far East (China, Japan, Korea), historical documentary data are an important source for high-frequency climate information for the last millennium. AOPC recognised the importance of these data and encouraged all researchers to make their data widely available.
58. AOPC noted with appreciation the long-running WMO/WCDMP Data Rescue (DARE) to archive and digitize observational data held on paper/cards at NMHSs where storage facilities are not ideal. The DARE project has proved very successful in the Caribbean, Central and South America, where considerable data have been archived on microfilm/fiches and ongoing work will begin the process of digitization of relevant material, with particular reference to GSN and GUAN. The Panel was informed that the African DARE project has microfilmed data from most countries, stored at the Belgian Met. Service, for which no comprehensive inventory (stations, years, variables, etc.) has as yet been created, thus making it difficult to assess the value of the project. AOPC recommended that an inventory be developed and steps initiated to digitize this material, especially from GSN and GUAN stations. This would require liaison between the WMO Secretariat and the particular WMO Members concerned.

#### **14. AOPC STRATEGY AND ORGANIZATION**

As requested by GCOS SC-IX in Beijing, the Panel reviewed its Terms of Reference in light of decisions taken by the SC at that session and other recent developments. The revised Terms of Reference agreed by the Panel are attached as Annex VII and will be presented to the GCOS SC and WCRP Joint Scientific Committee (JSC) for comment and approval at their next sessions.

Dr Manton briefly described the current status of the draft AOPC Plan and the need for a focussed effort to complete it. The Panel noted the importance of the plan and its completion and requested that the Chairman work with the GCOS Secretariat to develop a strategy toward this end.

## **15. SUMMARY OF DECISIONS AND ACTION ITEMS**

A consolidated list of the decisions, recommendations and action items from the meeting is presented as Annex VIII to this report.

## **16. NEXT MEETING**

The Panel considered issues associated with its regular meetings, and concluded that, given the scope of AOPC activities, it should make every effort to continue to meet annually. It also considered that the advantages of the opportunity to interact with staff at the WMO Secretariat make it desirable to continue to meet in Geneva, other factors being equal. The Panel also recommended that, in order to ensure that the science content of AOPC meetings can continue to grow, the duration of AOPC meetings should be extended to 5 days. It was agreed that the exact dates and location of the next meeting would be determined as soon as possible, taking account of these considerations.

The Chairman thanked all participants in the meeting and formally closed the Seventh Session of the AOPC at 13:00 on Thursday 3 May 2001.

## **ANNEXES**

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ANNEX I

**LIST OF PARTICIPANTS**

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## ANNEX II

### AOPC-VII: FINAL AGENDA/WORKPLAN

#### Monday 30 April

#### Doc. No.

- |    |   |           |
|----|---|-----------|
| 1. | Welcome and introductions ( <i>Manton</i> )                 | [INF. 1]  |
| 2. | Operation of meeting ( <i>Secretariat</i> )                 |           |
| 3. | Adoption of agenda ( <i>Manton</i> )                        | [1,2]     |
| 4. | Report from the Chairman ( <i>Manton</i> )                  |           |
|    | 4.1 Background on AOPC                                      |           |
|    | 4.2 Review of issues for meeting                            |           |
|    | 4.3 Matters arising   | [3]       |
| 5. | Report from Director ( <i>Thomas</i> )                      | [4]       |
|    | 5.1 GCOS Steering Committee                                 | [GCOS-61] |
|    | 5.2 Relevant WMO meetings                                   |           |
|    | 5.3 Priorities of Secretariat                               |           |
| 6. | UNFCCC and related issues ( <i>Thomas</i> )                 |           |
|    | 6.1 Outcome of COP-6  |           |
|    | 6.2 Regional workshops                                      |           |
|    | • AOPC role   |           |
|    | 6.3 National and synthesis reports                          | [6]       |
|    | 6.4 Adequacy analysis                                       |           |
|    | • AOPC role   |           |
| 7. | GSN and GUAN  |           |
|    | 7.1 Performance indicators for GSN ( <i>Rösner</i> )        | [7,25,26] |
|    | 7.2 Performance indicators for GUAN ( <i>Parker</i> )       |           |
|    | • Liaison with ECMWF  |           |
|    | 7.3 Draft guidelines for GSN and GUAN ( <i>Daan</i> )       | [9]       |
|    | 7.4 Review of GSN sites ( <i>Daan</i> )                     | [8]       |
|    | • Feedback from APN climate network ( <i>Manton</i> )       |           |
|    | 7.5 Historical GSN data ( <i>Peterson</i> )                 | [11]      |
|    | 7.6 Review of GUAN sites ( <i>Daan</i> )                    | [8]       |
|    | 7.7 Liaison between GCOS and NMHSs ( <i>Thomas/Rösner</i> ) |           |
|    | 7.8 Project support for GSN and GUAN                        |           |
|    | • Role of WCP   |           |
|    | 7.9 Operation of Advisory Group ( <i>Daan</i> )             | [10]      |

**Tuesday 1 May**

- 8. Climate forcing baseline observations
  - 8.1 Radiative transfer
  - 8.2 Clouds and water vapour
  - 8.3 Aerosols
  - 8.4 Ozone/Trace Gases/Chemical Composition
    - WMO/CEOS Ozone report, IGACO Theme [31]
  - 8.5 Carbon dioxide
    - IGBP proposal
  - 8.6 Land cover (Jones)
  
- 9. Marine systems
  - 9.1 SST-SI working group (Harrison)
  - 9.2 Surface pressure working group (Manton, Harrison)
  - 9.3 Surface flux reference sites (Harrison)
  - 9.4 VOSclim, ASAP, JCOMM (Dexter) [15]
  - 9.5 CLIVAR Pacific Panel (Manton)
  - 9.6 Sampling issues for marine baseline data
  
- 10. Satellite issues
  - 10.1 Baseline observations (Manton)
  - 10.2 ET-ODRRGOS Activities
    - Recent Meeting Results (Hinsman, Manton) [18,19]
    - WMO/CEOS database (Hinsman) [17]
    - Statements of Guidance (Schmetz)
  - 10.3 Use of current operational satellites for climate applications and monitoring (Schmetz)
  - 10.4 Reconciliation of satellite and in situ data (Peterson/Parker) [29]
  - 10.5 Potential satellite agency support for GUAN (Teunissen)

**Wednesday 2 May**

- 11. Comprehensive observing system
  - 11.1 Assimilation
    - Climate applications
    - Liaison with CBS
  - 11.2 Reanalysis [27]
    - AOPC requirements
    - Liaison with WCRP and WGNE
  
- 12. Climate indicators
  - 12.1 Report of GUAN analysis centre (Parker) [14]
  - 12.2 Report of GSN analysis centre (Peterson) [11]
  - 12.3 GPCP (Manton/Arkin) [28]
  - 12.4 GPCC (Rudolf) [12]
  - 12.5 High-resolution rainfall analysis (Jones)

- 12.6 WGCCD (Peterson) [23,30]
- 12.7 APN workshops (Manton)
- 12.8 START working group (Manton)
- 12.9 Indicators based on point data (Jones and Peterson)
  - Monthly and daily data
- 12.10 Large-scale indicators (Harrison)
- 13. Data management
- 13.1 GOSIC review (McGuirk) [16]
- 13.2 JCOMM and OOPC initiatives (McGuirk)
- 13.3 Paleoclimate data
- 13.4 Data recovery
- 13.5 Metadata

### **Thursday 3 May**

- 14. AOPC strategy and organisation
- 14.1 Terms of reference [21]
- 14.2 AOPC plan [22]
- 14.3 Priorities
- 15. Summary of decisions and actions
- 16. Next meeting

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## ANNEX III

### **GCOS SECRETARIAT DIRECTOR'S REPORT TO AOPC-VII**

#### **1. Background**

The activities of GCOS were extended substantially by the revised 1998 MOU to address issues of implementation and by the decisions of the 5th session of the Conference of Parties (COP-5) of the UN Framework Convention on Climate Change (UNFCCC). GCOS has pursued a strategy emphasizing:

- Implementation and further planning of the GCOS Baseline Networks and cooperation with partner global observing systems and IGOS;
- Interactions with GCOS Sponsors and the United Nations Framework Convention on Climate Change

#### **2. Implementation of the Atmospheric Baseline Networks**

Under the leadership of the AOPC, there has been significant progress in the implementation of the GCOS Surface Network (GSN) and the GCOS Upper Air Network (GUAN). Specifically:

- The GSN Monitoring Centres at the Japan Meteorological Agency for temperature and at the Deutscher Wetterdienst for precipitation have produced their initial semi-annual reports on the availability of GSN data. The report for the January to June 2000 period is being sent to all WMO Members with a letter from the Secretary-General (see draft in Doc. 25).
- For GUAN, the ECMWF is providing semi-annual monitoring reports on its performance as a part of its overall monitoring of upper air observations. The UK Met. Office/Hadley Centre and the U.S. National Climatic Data Center (NCDC) are cooperating in the analysis of the GUAN data. NCDC is responsible for managing and archiving both GSN and GUAN data.
- WMO EC-LII adopted a Resolution supporting GCOS activities, including the development of closer ties between the WMO Technical Commissions and GCOS. There has been an exchange of letters between the Chair of the GCOS Steering Committee (SC) and the Presidents of the Technical Commissions on areas of common interest.
- The AOPC Chair addressed CBS-XII at its session in November 2000 and reiterated the need for the support of CBS regarding the availability of GSN and GUAN data. Several actions have resulted from CBS-XII, including:
  1. Designation of Stefan Rösner as CBS Rapporteur to GCOS;
  2. Request for the existing monitoring centres of CBS and GCOS to take steps to review how the existing formal and informal arrangements (e.g. technical-level contacts between centres and operators) can be used to improve the monitoring of CLIMAT and CLIMAT TEMP reports; two letters have been sent by the WMO Secretary-General to all Members in this regard (see Doc. 25);
  3. Recognition of the need for closer cooperation between GCOS/AOPC and the CBS Expert Teams.

Advice from AOPC on GCOS efforts with regard to CCI-XIII in November would be appreciated.

### **3. Highlights from other Networks, Panels, and Activities**

Ocean Observations Panel for Climate (OOPC) – jointly sponsored by GOOS, GCOS, and WCRP. Solid progress has been made in establishing an operational ocean observing system for climate:

- The WMO/IOC Joint Commission for Oceanography and Marine Meteorology (JCOMM) will hold its initial meeting this June in Iceland. GCOS prepared an action document for JCOMM-I and the Chair of the GCOS-SC will participate in the meeting.
- Based on the consensus on an optimum mix of measurements needed for a global ocean observing system for climate from the International Conference on the Ocean Observing System for Climate, the Ocean Theme report prepared by the IGOS partners has defined the satellite requirements for ocean observations.

Terrestrial Observation Panel for Climate (TOPC) - has begun two major initiatives:

- TOPC initiated a Terrestrial Carbon Observation (TCO) proposal, which would provide information needed to document and understand the role of terrestrial carbon sources and sinks in the global carbon cycle. Atmospheric and flux measurements are included as well. This TCO initiative will become a part of an Integrated Global Carbon theme under IGOS. IGBP has agreed to lead and the participants include GTOS, GCOS, and WCRP.
- An initial global hydrological observing network for climate (GTN-H), involving measurement of eleven specific variables, was defined at an international workshop hosted by the Deutscher Wetterdienst in June 2000. Phil Jones attended for AOPC. The network will be based on existing centres which collect and quality control the data in near real time, produce products, and disseminate both data and products. The workshop included participants from existing centres such as GRDC, GPCC and GEMS Water, and programmes, such as GEWEX, WHYCOS, and the Flow Regimes from International Experimental and Network Data Set (FRIEND) of UNESCO. An implementation workshop is planned for 21 - 22 June 2001 at the GRDC.

High Level Meeting between WMO and Satellite Operators

- GCOS, through its vice-chair Dr. Paul Mason, participated in the first High Level Meeting between WMO and Satellite Operators. A paper initiated by Mike Manton was prepared by the Secretariat and submitted to the meeting.
- One result from the meeting is the proposal to highlight requirements for climate and oceanography at the second meeting next January, including the development of 'Statements of Guidance' for these applications.

### **4. UNFCCC/COP Decision 5/CP.5 and its influences**

As reported last meeting, the 5th session of the Conference of Parties adopted two decisions important to GCOS. In particular, from Decision 5/CP.5:

- All Parties are to provide detailed national reports on systematic observation in accordance with UNFCCC Reporting Guidelines (voluntary for non-Annex 1 Parties);
- The UNFCCC Secretariat, in conjunction with the GCOS Secretariat, is to develop a process for synthesizing and analyzing the information in the reports;
- The GCOS Secretariat is to organize regional workshops to identify the capacity building needs of developing countries, in cooperation with other entities;

- Parties are to address deficiencies in the climate observing networks and, in consultation with the GCOS Secretariat, to bring forward proposals and to identify needs and funding for developing countries;
- The GCOS Secretariat is to facilitate an intergovernmental process to identify priorities for action and options for financial support.

These decisions have led to a number of related actions relevant to GCOS, which will be discussed in the following sections.

## 5. Interactions with GCOS Sponsors

WMO Executive Council (EC-LII) - In May 2000, the Chair of the GCOS-SC reported on the status of GCOS to the WMO EC-LII and the Secretariat submitted an Action Document. Based on an initiative by EC members, a resolution was prepared and adopted by the EC. The Resolution, *inter alia*, urged Members to:

- Involve their National Meteorological and Hydrological Services (NMHS) in preparing national reports to UNFCCC-COP;
- Ensure that their delegations to the UNFCCC-COP are informed of the key role that these Services play in implementing and operating observing systems necessary to meet national obligations under the Convention; and
- Include representatives of NMHS in national delegations to UNFCCC-COP to provide appropriate scientific advice.

The Resolution also requested:

- The WMO Secretary General to consult with the other GCOS sponsoring agencies to develop effective strategies to implement GCOS;
- The GCOS Secretariat to develop an implementation strategy and report back to the EC; to organize regional workshops to improve climate observing systems; and to assist Members, especially developing countries, in the preparation of implementation plans to improve their observing systems for climate.

IOC Executive Council (EC-XXXIII) - In June 2000, the IOC EC adopted a similar resolution to that from the WMO EC, tailored to its Members.

## 6. GCOS Interactions with COP/SBSTA and Responses to Decision 5/CP.5

The GCOS Secretariat has continued its interaction with the UNFCCC/COP and its Subsidiary Body for Scientific and Technological Advice (SBSTA). The Director, GCOS Secretariat, presented a statement to the 12<sup>th</sup> session of SBSTA in June 2000 that discussed an intergovernmental process for GCOS, the proposed actions by the GCOS pursuant to Decision 5/CP.5 and recent developments in global observing systems for climate. SBSTA-12 subsequently adopted four conclusions of its Chairman in support of GCOS, including support for regional workshops and requesting periodic reporting by the GCOS Secretariat to SBSTA and COP.

In response to Decision 5/CP.5, the GCOS Secretariat will launch a Global Programme of ten regional workshops and follow-up activities, including development of Regional Action Plans. The first phase consists of two regional workshops, one in the South Pacific and the second in Africa, which will address capacity-building and reporting needs of non-Annex I Parties for systematic observation within National Communications to the UNFCCC. The workshops will train national experts to prepare reports for National Communications and to address regional needs in meteorological, atmospheric, oceanographic, and terrestrial observing systems for climate. The workshops will also identify a range of training needs for

systematic observations to predict and provide 'early' warnings of future climate changes, to assess both current and future climate, and to plan adaptation measures.

The initial regional workshop was held in August 2000 in the South Pacific in cooperation with the South Pacific Regional Environment Programme (SPREP) and the WMO Sub-regional Office for the Southwest Pacific, using support from the WMO, UNEP, USA and Australia. The workshop adopted a resolution outlining subsequent actions to develop a regional action plan. A meeting is being planned for the July-August period to draft the plan.

The Global Environment Facility has agreed to fund the initial phase of the GCOS Regional Workshop programme. The first two regional workshops (the first in the South Pacific and the second planned for eastern and southern Africa in October 2001) will be the models for a full proposal to GEF for eight additional workshops.

The Secretariat prepared a report to COP-6/SBSTA-13 entitled "Global Climate Observing System: progress report on developments in the global observing systems and activities related to decision 5/CP.5". This report covered the deficiencies in GSN and GUAN, developments in the Global Ocean Observing System for Climate including the IGOS Ocean Theme report and the development of a terrestrial carbon theme as proposed by TOPC and then adopted by IGOS.

Finally the GCOS Director presented a statement at SBSTA-13 that reinforced the major issues presented in the report to COP-6/SBSTA-13. The session adopted the following conclusions under the agenda item "COOPERATION WITH RELEVANT INTERNATIONAL ORGANIZATIONS":

- The Subsidiary Body for Scientific and Technological Advice (SBSTA) welcomed the report made by the Director of the Global Climate Observing System (GCOS) Secretariat, on behalf of the agencies participating in the Climate Agenda, on developments in the global observing systems and activities related to decision 5/CP.5. It noted with concern continued degradation in some components of the Global Climate Observing System, and recognized the need for Parties to work actively to reverse that situation.
- The SBSTA recognized the importance of the Integrated Global Observing Strategy Partnership in developing the global observing systems for the oceans and terrestrial carbon sources and sinks in the global carbon cycle, and in promoting systematic observation.
- The SBSTA took note of the outcome of the first GCOS regional workshop to identify capacity-building needs in the South Pacific region, held in Samoa in August 2000. The SBSTA expressed appreciation to Australia, the United States of America, the World Meteorological Organization, the United Nations Environment Programme and the South Pacific Regional Environment Programme for providing support for the workshop. It also noted the plans for a second regional workshop in Africa in early 2001.
- The SBSTA welcomed the information provided by Australia on a supplementary reporting format to the UNFCCC reporting guidelines on global climate observing systems. It encouraged Parties to consider this information in preparing their national communications.

In response to recommendations of an informal meeting on an intergovernmental process for GCOS hosted by Canada, GCOS has developed an Implementation Strategy which addresses a number of issues including a possible intergovernmental process for GCOS.

This strategy also responds to the WMO EC resolution and to UNFCCC Decisions 14/CP.4 and 5/CP.5. The strategy is built on the following principles:

- Build on existing operational and scientific observing, data-management, and distribution systems, but use GCOS standards based on established principles;
- Obtain commitments from national governments for the implementation of the global climate observing system. This will require extensive involvement with intergovernmental processes of the UNFCCC and GCOS Sponsors and with national entities;
- Address deficiencies in the current implementation of GCOS networks at the regional level, where many known deficiencies in observing systems occur;
- Keep GCOS relevant to the user communities and maintain its cost-effective nature by incorporating new understanding and new technology to address requirements across domains.

At its Ninth Session held in Beijing on 10-12 September, the GCOS Steering Committee (SC) requested the GCOS Secretariat, in consultation with the science panels and individual SC members, to develop possible methods to synthesize and analyze the National Communications on systematic observations for climate. The attachment below contains a draft prospectus for such a process, which was proposed by the AOPC chairman at the SC session. This process would lead to the preparation of a second "Report on the Adequacy of Global Observing Systems for Climate". This is an important issue for discussion by the AOPC.

Finally COP-6 will reconvene in Bonn on 16 July to discuss its future and that of the Kyoto Protocol. The importance of systematic observations is not in doubt, although its priority must be constantly reinforced at COP / SBSTA. In addition, engaging UNFCCC/COP is a continuing process but one that needs to develop new and more effective ways to present the issues and needs for observations for climate on all time scales and to seek the support of countries through the UNFCCC mechanisms.

## **7. GCOS Steering Committee (Ninth Session)**

The GCOS-SC session in Beijing adopted a range of decisions, recommendations and actions (see GCOS-61 for the full report of the session). Document 24 contains the list of decisions, recommendations and actions agreed at the meeting. The AOPC chairman will discuss the recommendations relevant to AOPC. Other highlights from the GCOS SC-IX include:

- Agreement in principle to the strategic approach contained in the GCOS Implementation Strategy. The SC requested several additions - to stress the urgency of implementing GCOS, to outline the longer-range actions and priorities and to emphasize outreach and communication as a marketing tool for the GCOS programme;
- Dissolution of the JDIMP. Data and information management to be handled by a small expert group for each system;
- Endorsement of a small advisory committee for guidance and oversight for GOSIC. This committee would consist of six members, two representing each domain. For the atmosphere, one would be selected by AOPC and the other would represent the non-climate observation interests;

- Dissolution of GOSSP, with its responsibilities to be carried out by:
  - (1) including at least two experts on space-based observations on the Science Panels;
  - (2) having the science panels fully responsible to identify the requirements for space-based observations in their domains;
  - (3) Incorporating identified requirements in the CBS OPAG ET-RR (through membership on that ET) for incorporation into the WMO Statements of Guidance for the satellite operators or in relevant IGOS theme activities (through participation on the IGOS Theme Teams);
  - (4) Convening appropriate experts of each panel to provide cross-domain advice and to prepare an integrated GCOS perspective on space-based observations.
- Formalization of a process for designating a network, centre, database or other entity as a 'GCOS' entity. The Secretariat is to work with the science panels to develop appropriate criteria for such designation;
- Need to strengthen the interaction between GCOS and UNEP. SC Chairman requested to participate in appropriate sessions of the UNEP executive bodies, as authorized in the GCOS Memorandum of Understanding;
- Enhancement of participation and visibility in the CEOS arena through increasing interaction between Chairpersons and Secretariats respectively.

**8. In conclusion**, the past year has involved active efforts by many to further the cause of global observing systems for climate. GCOS is focusing its attention on mechanisms for implementation. In particular, the GCOS Secretariat is intent on working with its Panels, observing system partners, Sponsoring Agencies and the UNFCCC-COP and its subsidiary bodies to build support for the global observing systems for climate.

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**Issues for AOPC from the Secretariat's perspective:**

- Future interactions with CBS, CCI, JCOMM and other Commissions (issues for CCI in November 2001)
  - Global Hydrological Observing System for Climate (GTN-H)
  - Coordination with CEOS and satellite agencies
  - Second Report on the Adequacy of the Global Climate Observing System and the synthesis process for UNFCCC
  - Issues for future reports to COP / SBSTA
  - AOPC input into Regional Workshop Program
-

## Attachment

### **SYNTHESIS of REPORTS by PARTIES to the UNFCCC/COP and ADEQUACY ANALYSIS from these REPORTS and RELATED MONITORING DATA**

Decision 5/CP.5 adopts the UNFCCC reporting guidelines on global climate observing systems and invites all Parties to provide detailed reports on systematic observation in accordance with these guidelines, for Annex I Parties in conjunction with their national communications, pursuant to decision 4/CP.5, and on a voluntary basis for Parties not included in Annex I to the Convention. The Decision also invites the Convention secretariat, in conjunction with the Global Climate Observing System secretariat, to develop a process for synthesizing and analysing the information submitted in accordance with the UNFCCC reporting guidelines on global climate observing systems.

At its ninth session in September 2000, the GCOS Steering Committee (SC) requested the GCOS Secretariat, in consultation with the science panels and individual SC members, to develop, as a matter of urgency, possible methods which could be used to synthesize and analyze the information on systematic observations which are to be submitted to the UNFCCC/COP by 30 November 2001. It also requested that this process be extended to include other information on climate observations in order to prepare a second report on the adequacy of global observing systems for climate.

This document outlines a process for responding to Decision 5/CP.5 discussed at the GCOS SC meeting. This process includes the preparation of a second report on the adequacy of global observing systems for climate, which is consistent with the request of COP-4, Decision 14/CP.4. It would involve international experts in analysing the adequacy of the current global observing systems for climate in light of the national reports<sup>1</sup> and any additional data and information on observing systems that is available from operational agencies and the research community.

The following is an outline of a suggested process that the GCOS Secretariat could undertake on the requisite process to meet the requirements of Decisions 5/CP.5 and 14/CP.4, subject to agreement by the UNFCCC Secretariat and review/comment by individuals who are involved with systematic observations.

#### **A. Synthesis Report**

- Based on information submitted by Parties, using GCOS/UNFCCC Guidelines (i.e. 'national reports')
- Collate and aggregate basic data in national reports
- Use to highlight successes, on the assumption that many countries will highlight positive aspects.
- Use to identify deficiencies where possible
- Provide an analysis of support by the Parties for systematic observation using the national reports

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<sup>1</sup> The term 'national reports' includes both the summary information on systematic observation provided by Annex I Parties in accordance with the UNFCCC guidelines and the detailed reports on systematic observation that were invited from all Parties.

## **B. Adequacy Analysis**

- Complement synthesis report
- Present either as attachment to synthesis report or as a subsequent analysis document
- Utilize additional data on systematic observation, not available in the national reports, which themselves will:
  - Not cover all countries, i.e. not global, since these reports are voluntary for non-Annex I Parties
  - Not have detailed monitoring and QC information
  - Not cover climate products
  - Generally be based on raw inputs rather than outputs and outcomes
- Will be more comprehensive than synthesis report.
- Will be based on responsibility assigned to GCOS by COP (14/CP.4 Par. 9 for Adequacy Report, 5/CP.5 Par.9 for Synthesis Report)

### **Aim: To provide**

- Scientific specification of the observing systems needed to meet UNFCCC objectives
- Scientific analysis of the adequacy of the current global observing system against the specification
- Analysis of full end-to-end systems based on the two points above.

### **Form**

- Scientific document, with political credibility
- Succinct, with supporting documents, e.g. GCOS plans
- Relatively short document, ca. 50 pages with 5-page executive summary.

### **Process**

- Preparation by science team covering GCOS spectrum (ca. 10-20 people)
- Review by international workshop of scientists from Parties
- Leadership by internationally known scientists (e.g., from WCRP or GCOS Panels)
- Team endorsed by GCOS sponsors
- Framework endorsed by SBSTA/COP.

### **Schedule**

Nov 2000	Consultation with UNFCCC Secretariat
Dec 2000	Proposal and working team to sponsors
Mar 2001	Team drafts outline of report
Jun 2001	Report outline and process to SBSTA
Nov 2001	National reports to COP
Mar 2002	Team commences assessment
Aug 2002	Complete Synthesis Report
Oct 2002	International science workshop to review information in national reports and to consider other available information on systematic observations
Nov 2002	Report to COP-8 (re Synthesis Report)
Jun 2003	Preliminary findings to SBSTA
Aug 2003	Complete Adequacy Analysis Report
Nov 2003	Report to COP-9 (re Adequacy Analysis)

## ANNEX IV

# **RECOMMENDATIONS OF THE AGG REGARDING THE COMPOSITION OF THE GSN AND GUAN NETWORKS**

### **1. GSN**

The AGG concluded that, in general, proposals for significant changes to the GSN (and GUAN) should be delayed until sufficient time has passed for the impact of the publication and distribution of monitoring results to be demonstrated. In some cases, however, immediate action does seem appropriate, including, informal contacts by the Monitoring Centre to clarify some situations.

(i) The following renumbering of stations at the same position can be carried out without further contact with WMO Member States:

- 41141 to 41140
- 41764 to 41765
- 91930 to 91929
- 93845 to 93844
- 93947 to 94945
- 95314 to 94317
- 94516 to 94517
- 95574 to 94570
- 94322 to 95322
- 94719 to 95719
- 94916 to 95916
- 94965 to 95964
- SENTANI (no index) to 97690 JAJAPURA SENTANI.

(ii) The following changes can be made without delay in response to the requests of the Member States concerned:

- Replace 02418 KARLSTAD to 02410 MALUNG (both in Sweden)
- Delete OKTJABRSKIJ (no WMO index number)
- Delete 34163 OKTJABRSKIJ GORODOK.

(iii) Inclusion of three stations in the Central African Republic can be proposed to the Member concerned:

- 64600 BERBERATI
- 64656 BANGASSOU
- 64659 OBO

(iv) Formal contacts should be made by the Secretariat with:

- Sweden, regarding replacement of 02142 JOKKMOKK by 02128 GUNNARN or STENSELE;
- Japan, regarding replacement of 47821 ASOSAN by 47898 SHIMIZU.

(v) Informal contacts will be made by the Monitoring Centre with:

- Iceland, regarding the situation with 04094 TEIGARHORN and eventual replacement by 04092 AKURNES;
- USA, regarding the continuity of CLIMAT reports from 91245 WAKE ISLAND.

In due time, contacts may be necessary with other countries from which poor performing stations are listed in Annex A of the Review of the GSN and GUAN (Doc. 8, AOPC-VII).

## **2. GUAN**

(i) The following Member States should be contacted formally:

- Bangladesh: possible inclusion of 41923 DHAKA;
- Canada: possible inclusion of 71081 HALL BEACH;
- Brazil: prospects of station 83650 TRINDADE ILHA, with a view to possible future inclusion;
- Russian Federation: possible inclusion of 24959 JAKUTSK, 25913 MAGADAN and 29572 EMELJANOVO and on the prospects of 21982 OSTROV VRANGELJA;
- Argentina: possible inclusion of 87576 EZEIZA;
- Central African Republic: possible inclusion of 64650 BANGUI (currently standby station);
- Mali: possible inclusion of 61291 BAMAKO;
- Saudi Arabia: replacement of 41114 KHAMIS MUSHAIT by 41112 ABHA;
- Chile: replacement of 85543 QUINTERO by 85586 SANTO DOMINGO;
- Fiji: possible inclusion of 91680 NANDI;
- France: possible inclusion of 91948 RIKITEA;
- Iran: possible inclusion of 40754 TEHRAN.

Informal contacts should be made to clarify the future of 70414 SHEMYA.

(ii) ECMWF should be requested to add the above stations to the monitoring list as standby stations for the time being (64650 BANGUI is already included). The following stations should also be added:

- 43150 CWC VISHAKAPATNAM
- 83208 VILHENA AP.

(iii) 64201 KINSHASA N'DILI should be added to the standby list.

(iv) ECMWF should be provided with an updated list of stations, including some which are currently not monitored:

- 89055 BASE MARAMBIO
- 89571 DAVIS
- 89592 MIRNYJ
- 92035 PORT MORESBY (new index number)

(v) Station 91801 PENRHYN should be deleted from the GUAN list.

(vi) The following stations can be deleted from the monitoring list:

- 22271 SOJNA
- 42809 CALCUTTA
- 43003 BOMBAY
- 43279 MADRAS
- 43599 GAN
- 68992 BOUVET ISLAND
- 71072 MOULD BAY
- 85585 JUAN FERNANDEZ
- 89050 BELLINGSHAUSEN
- 91245 WAKE ISLAND
- 91530 NAURU AP
- 91700 KANTON ISLAND
- 94035 PORT MORESBY (obsolete index number)

## ANNEX V

### **AOPC ADVISORY GROUP ON GSN AND GUAN (AGG)**

#### **Terms of Reference**

The general task of the AGG is to support AOPC in carrying out its responsibility, in relation to the definition and performance of the GSN and GUAN baseline networks, to promote the establishment and maintenance of an overall system to provide long-term, high-quality consistent data and information to meet the requirements it has defined. The AGG is therefore tasked to:

- Collect and analyse information from the GSN and GUAN Monitoring Centres on the reception and quality of CLIMAT, CLIMAT TEMP and TEMP reports and the information gathered through liaison with national centres;
- Collect and analyse information from the GSN and GUAN Analysis Centres on the availability of historical data and metadata;
- Consider recommendations from WMO Member States for changes to the GSN and GUAN and examine the desirability and feasibility of improvements in the network performance by other potential changes to their composition;
- Make recommendations to the WWW Secretariat, on behalf of the AOPC, on necessary changes in the composition of the networks with a view to enhancing and improving network performance;
- Maintain the GSN and GUAN station lists in co-ordination with the GSN and GUAN Monitoring Centres and make necessary adjustments to index numbers, names and geographical co-ordinates as required;
- Report annually to AOPC.

The group will be composed of:

- A Chairman, designated by AOPC *(P. Jones)*
- A representative from GSN/GUAN Analysis Centres *(T. Peterson, D. Parker)*
- A representative from GSN/GUAN Monitoring Centres *(S. Rösner)*
- A representative from the WMO/WWW Observing System Division *(A. Karpov)*
- A representative from the GCOS Secretariat *(H. Teunissen)*
- Other members as deemed appropriate by the AOPC *(H. Daan)*

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## ANNEX VI

# **JCOMM STATUS REPORT** (March 2001)

### **Establishment of JCOMM and interim arrangements**

1. It will be recalled that, after just three years of planning, JCOMM was formally established by resolutions of Congress and the IOC Executive Council in 1999. In giving this approval, the Governing Bodies recognized that JCOMM was now the coordinating body for all present and future operational marine activities of WMO and IOC. A major initial priority will be the implementation of an operational ocean observing system for climate, and to be successful JCOMM will require an equal engagement and commitment from meteorologists and oceanographers alike.

2. Clearly the formal establishment of JCOMM at the international level is just the first step in what will necessarily be a long and delicate process, not least at the national level. The essential requirement for JCOMM to be truly interdisciplinary may pose problems in many countries, where meteorology and oceanography are dealt with through different organizational structures. At the same time, the need for cooperation and coordination in the nomination of a balanced membership for JCOMM and in the support of its work programme will hopefully lead to an eventual greatly enhanced integration of operational oceanography and marine meteorology at the national level, including institutionally.

3. Internationally, to guide the transition from CMM/IGOSS to JCOMM, and to plan a coherent structure and work plan for the Commission, two transition planning meetings took place, the first in St. Petersburg in July 1999 and the second in Paris in June 2000. Participation in these meetings included members of the CMM Advisory Working Group and IGOS Bureau as well as representatives of all the bodies to report to and be coordinated by JCOMM. As such, the meetings constituted essentially sessions of an interim JCOMM Management Committee. Issues dealt with by these two meetings included the development of an integrated work plan for JCOMM, to encompass the ongoing CMM/IGOSS work, as well as the urgent new tasks to be addressed, in particular in relation to GOOS and GCOS implementation. Additional major issues considered by the meetings included the future sub-structure for the Commission, capacity building, membership, and preparations for JCOMM-I. In particular, the issue of structure was discussed intensively. One new structural principle to be applied to JCOMM is the use of Programme Areas, which allows clearer responsibilities and reporting procedures. In the interim, however, existing working groups and other activities decided upon by previous sessions of CMM and IGOS have been retained, to continue to address major ongoing activities.

### **Inter-sessional highlights**

4. With all the excitement surrounding the establishment of JCOMM, it should not be forgotten that there are major ongoing work programmes now under the Commission, and that there have been major achievements under these programmes in the past four years. The highlights of these include:

#### *Observing networks*

- (i) Establishment of the VOSclim Project;
- (ii) Continued expansion of surface buoy networks, of the work and status of the DBCP, and of the quality and quantity of buoy data on the GTS;
- (iii) Consolidation of SOOP as an operational programme;

- (iv) Establishment of a new round world Automated Shipboard Aerological Programme (ASAP) line as a cooperative international programme;
- (v) Consolidation of the sea level core network and blending of in situ and altimeter sea level data in support of global climate studies;
- (vi) Direct involvement with CBS in interactions with satellite operators, the rolling requirements review process and the redesign of the Global Observing System;
- (vii) Demonstration of the operational value of ground-based radars.

#### *Data management*

- (i) Substantial enhancements to the Marine Climatological Summaries Scheme in support of the WCP and the convening of a major international workshop on applications of marine climatology (CLIMAR99);
- (ii) Full establishment of the Global Temperature Salinity Profile Programme as an operational end-to-end ocean data management system, and its extension to support the WCRP and Argo;
- (iii) Improvements to marine data quality through enhanced quality control procedures and follow-up actions;
- (iv) Substantial expansion to the data holdings of the Global Digital Sea Ice Data Bank (GDSIDB).

#### *Services*

- (i) Full implementation of the WMO marine broadcast system for the Global Maritime Distress and Safety System (GMDSS);
- (ii) Enhanced guidance material on wave forecasting and support for the tropical cyclone programme in storm surge forecasting;
- (iii) Consolidation of the Marine Pollution Emergency Response Support System (MPERSS);
- (iv) Enhanced guidance on sea ice forecasting and applications;
- (v) Further development of the electronic JCOMM Products Bulletin.

#### *Capacity building*

- (i) Three regional training workshops for Port Meteorological Officers, and other workshops on wave analysis and forecasting; on storm surge forecasting; on sea ice remote sensing; and on MPERSS;
- (ii) Development of detailed regional cooperative projects in South-east Asia and the Western Indian Ocean;
- (iii) Preparation and publication of a comprehensive JCOMM Capacity Building Strategy.

### **Future priorities for JCOMM**

#### *The vision of JCOMM*

5. In providing the international coordination, regulation and management mechanism for an operational oceanographic and marine meteorological observing, data management and services system, JCOMM might be considered in some sense as a "CBS of the ocean". Yet in some ways, JCOMM is even more than this, since it is inherently multi-disciplinary and multi-organizational in concept and operation. It seeks to pool the expertise and resources of the meteorological and oceanographic communities, both nationally and also internationally through WMO and IOC, to coordinate operational oceanography in support of the requirements of governments, industry, commerce, global climate studies and individual marine users for marine data, products and services.

The vision of JCOMM is thus of a dynamic, forward looking body, which coordinates a fully integrated marine observing, data management and services system, responsive to the evolving needs of all users of marine data and products as well as the development of new technologies and capabilities. The vision also includes close coordination with GOOS, GCOS and the WWW, as well as a major outreach programme to enhance the capacity of all maritime countries, both to contribute to JCOMM activities and also to benefit to the maximum extent from the outcome of these activities.

### *Priority activities*

6. The first formal session of JCOMM will take place in Akureyri, Iceland, immediately following the WMO Executive Council session (19-29 June). The following are among the priority activities for JCOMM for the next four years, which are likely to be identified and agreed by the Commission during these two weeks:

- (i) Implementation of an integrated operational ocean observing system for climate, in response to the expressed requirements of GOOS and GCOS, to include an integration of ship-based activities (VOS, SOOP and ASAP); transition of Argo to operational status, its integration into the system and the evolution of SOOP in response; evaluation and integration of new instrumentation and techniques; implementation of new ASAP lines; and new operational remote sensing data and products;
- (ii) Implementation of a JCOMM Observing Platform Support Centre (JCOMMOPS);
- (iii) A fully integrated end-to-end data management system, to include marine meteorological, ocean and sea ice data streams, and the convening of a second CLIMAR workshop;
- (iv) Implementation of new, integrated services for marine users, including satellite-based graphics delivery, climate products, and enhanced wave and surge products;
- (v) Development of internet-based services and data exchange;
- (vi) Full operational implementation of MPERSS;
- (vii) Enhanced interactions with GOOS, in particular regarding non-physical variables, integrated coastal area management and capacity building;
- (viii) New cooperative regional project development, ongoing specialized workshops, and the identification of new sources and procedures for capacity building support, in coordination with other programmes and within the guidelines of the JCOMM Capacity Building Strategy.

### **150<sup>th</sup> Anniversary of the Brussels Conference of 1853**

7. The international conference on marine meteorology, convened in Brussels in 1853 by Lt. Matthew Maury, was almost certainly the first serious attempt to standardise and coordinate internationally both meteorological observations and the provision of services to users. It led eventually, albeit indirectly, to the Vienna Conference of 1873, and thus may be regarded as the forerunner of the International Meteorological Organization and of WMO itself. The 150<sup>th</sup> anniversary of the Brussels Conference falls in 2003, and a proposal is now being developed to commemorate this anniversary in an appropriate way, perhaps through the convening of a major international conference on marine meteorology and oceanography. It would seem highly appropriate that WMO, and also IOC, should join other potential cosponsors, such as the International Maritime Organization and various national meteorological and oceanographic societies, in such a commemoration.

8. As noted above, the priority issues for JCOMM over the next four years will revolve around the implementation of an integrated ocean observing and data management system for climate. The first twelve months following the first session of JCOMM will involve primarily an initialisation and consolidation of the JCOMM sub-structure and work programme, and a commencement of the integration process. Issues for consideration in 2002 will include:

- (i) Possible refinements to the requirements for in situ ocean data for climate (OOPC);
- (ii) JCOMM/IODE end-to-end data management support to GOOS;
- (iii) Non-physical ocean variables;
- (iv) Ocean remote sensing.

## ANNEX VII

# **GCOS/WCRP ATMOSPHERIC OBSERVATION PANEL FOR CLIMATE (AOPC)**

### **Terms of Reference**

The Atmospheric Observation Panel for Climate (AOPC) was established by the GCOS Steering Committee (then the Joint Scientific and Technical Committee) in recognition of the need for specific scientific and technical input concerning atmospheric observations for climate. The Joint Scientific Committee of the World Climate Research Programme, recognizing the benefits of the AOPC, agreed in 1995 to co-sponsor the Panel, which was therefore renamed as the GCOS/WCRP Atmospheric Observation Panel for Climate.

The goal of the AOPC is to plan and promote the atmospheric component of GCOS. Its specific Terms of Reference are as follows:

1. To liaise with relevant research, operational and end-user bodies in order to determine the requirements for data to monitor, understand and predict the dynamical, physical and chemical state of the atmosphere and its interfaces on seasonal to multi-decadal time scales.
2. To promote the establishment and maintenance of an overall system to provide long-term, high-quality, consistent data and information to meet those requirements.
3. To review the current state of the atmospheric component of the global observing system for climate
4. To identify gaps and inadequacies in the atmospheric component of the current global observing system for climate.
5. To propose and promote the establishment of new systems, or enhancements to current systems and practices, to eliminate deficiencies.
6. To promote the transfer, as appropriate, of research observing systems to operational networks.
7. To promote the rehabilitation of historical observational and proxy climate datasets.
8. To promote and review institutional arrangements to ensure that:
  - GCOS observations are of the highest quality and are collected in accordance with the highest standards of practice;
  - GCOS data products are relevant and of the highest quality;
  - GCOS data are archived and accessible to the user community.
9. To liaise with the other GCOS panels, WCRP steering groups and other relevant entities, such as WMO Commissions and CEOS, on atmospheric climate observing system issues.
10. To report regularly to the GCOS SC and the JSC for WCRP on issues related to the atmospheric component of GCOS.

*Revised at AOPC-VII, 2 May 2001*

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## ANNEX VIII

### **CONSOLIDATED LIST OF DECISIONS, RECOMMENDATIONS AND ACTION ITEMS**

#### **Item 4 - Report from the Chairman; Item 5 - Report from the Director**

1. AOPC noted with appreciation the reports of the AOPC Chairman and the Director of the GCOS Secretariat, reviewing the main developments and issues of concern to AOPC during the past year and those which would be of highest priority in the coming year. The Panel agreed that its priorities for the next 1-2 years would be:

(i) to develop and generate GCOS products, through

- increased availability of GSN and GUAN data;
- increased availability of GSN and GUAN performance indicators;
- the generation of key climate indicators related to GSN and GUAN data;
- the investigation of the utility to GCOS of large-scale atmospheric circulation indicators;

(ii) to enhance the implementation of baseline systems, through

- links to WMO Commissions and Members;
- links to satellite agencies; and

(iii) to promote the benefits and needs of GCOS, through

- support for the GCOS regional workshops;
- participation in the GCOS adequacy analysis.

2. AOPC recognized the need, and expressed strong support, for the implementation of a global hydrological observing network for climate (GTN-H, a global terrestrial network for hydrology). The Panel agreed five specific recommendations with respect to a strategy for such implementation:

(i) analyse existing data for the each of the initial variables proposed at the Geisenheim workshop (26-30 July 2000), with respect to:

- current availability;
- observational issues (methods used and consistency between countries);
- representativeness;
- temporal resolution;
- density of coverage (spatial resolution and number of stations) ;
- availability of historic time series;
- required improvements;

(ii) define categories for the proposed variables, with respect to:

- operational, research or project measurements/observations;
- point or areal data or large-scale fields;

(iii) propose a stepwise implementation plan to:

- begin using existing available operational data;

- prioritize the list of variables in order of achievability;
- promote improvements of existing data availability and quality as required;
- develop potential ways to set up data collection if required data are not readily available;
- determine the role of project and research data;

(iv) identify a lead institution (and person) to be the designated centre for monitoring and analysing the data; and

(v) establish a joint panel between GTOS (TOPC) and GCOS (AOPC) to oversee GTN-H.

AOPC requested that the GCOS Secretariat formally present these recommendations to the forthcoming GTN-H implementation workshop to be held at the Global Runoff Data Centre (GRDC) in Koblenz, Germany from 21-22 June 2001. It also requested that B. Rudolf attend that meeting on behalf of the Panel.

#### Item 6 - UNFCCC

3. AOPC reiterated its support for the GCOS Regional Workshop Programme and recommended that discussion of the GCOS surface and upper air networks (GSN and GUAN) should be a standard component of each workshop, including presentation and discussion of the latest regional monitoring results for each of these networks. The Panel suggested that GCOS seek the views of the GSN and GUAN Monitoring Centres to determine what issues these centres would wish to have raised at the workshops. AOPC also recommended that the importance of networks to measure atmospheric constituents, especially the Global Atmosphere Watch (GAW), should be stressed. AOPC emphasized the importance of providing workshop participants a clear idea of the benefits that can flow to countries if they improve these and other GCOS networks.
4. AOPC reviewed the plans and schedule for the development of an updated assessment of the adequacy of the global observing systems for climate, to be presented to the Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC). The Panel generally endorsed the detailed outline presented (Attachment to Annex III) while suggesting that the aims of the exercise be made more specific, viz: to update the 1998 "Report on the Adequacy of the Global Climate Observing Systems" (GCOS-48); to summarize enhancements to the climate observing systems and progress in monitoring their performance since GCOS-48; and to identify capabilities of the climate observing systems that appear adequate and those which require enhancement. The Panel also suggested that the length of the document be limited to about 25 (rather than 50) pages, and that the development schedule be adjusted to reflect current realities and possibilities.

#### Item 7 - GSN and GUAN

##### **GSN**

5. AOPC reiterated its appreciation to the DWD and JMA for their support in providing the ongoing performance monitoring activity for GSN. It noted with concern the lack of improvement in overall reporting percentages indicated by the most recent monitoring report (typically 55%), and particularly the continuing decrease in performance in RA-II displayed since mid-1999. The Panel welcomed the support of

**CBS and the WWW Secretariat, in cooperation with the GSNMC, in taking actions aimed at improving this performance.**

- 6. AOPC expressed its appreciation to the DWD and JMA for offering to support direct liaison between NMHSs and the GSNMC. It noted in particular the meeting to be hosted by DWD, on behalf of CBS, in September 2001 to address this and related GSN implementation and coordination issues. The Panel endorsed the plans for strengthening ties between the GCOS and World Weather Watch monitoring centres, noting the intention to include representatives of all WMO Regional Associations as well as other appropriate participants at the DWD meeting. The Panel was pleased that the meeting would facilitate the establishment of both formal and informal mechanisms which would lead to improved availability of CLIMAT and CLIMAT TEMP messages, particularly insofar as format errors and transmission problems are concerned.**
- 7. AOPC requested the Chairman to encourage informal communication between the national contact persons from the Asia-Pacific Network (APN) Climate Indices Workshop networks and the GSNMC.**
- 8. AOPC endorsed the GSNMC policy of providing monthly updates of the CLIMAT reports received at the GSNMC to the GSN Analysis Centre (NCDC, Asheville, USA). The Panel strongly supported the proposal to make a 12-month rolling archive (updated monthly) available through the GSNMC Web site, while encouraging the GSNMC to extend such an archive so as to continue indefinitely from the beginning of the formal monitoring period (January 1999), if feasible.**
- 9. AOPC strongly endorsed the concept of interactive querying of the GSNMC archive via the GSNMC Web site which would, for example, permit any user to identify the performance of any GSN station using either predefined or self-defined time periods.**
- 10. AOPC expressed its support and appreciation to the CBS Rapporteur for Volume A (H. Daan) for his ongoing efforts to correct the inconsistencies in the GSN stations identified in that publication, through a combination of formal and informal contacts with the station operators. It noted that several inconsistencies in station location had been identified through comparisons with data contained in other databases (e.g. GPCC) and requested that the GSN Monitoring Centre and the WWW Secretariat continue to work together to rectify these inconsistencies.**
- 11. AOPC reiterated its appreciation of the support provided by the National Climatic Data Center (NCDC), Asheville, USA, in acting as the Analysis Centre and Archive for the GSN. The Panel noted in particular the special identification of GSN and GUAN stations in the regularly-published lists of Monthly Climatic Data of the World (MCDW).**

#### **GUAN**

- 12. AOPC expressed its appreciation to the ECMWF for maintaining the GUAN Monitoring Centre, and to the Hadley Centre and NCDC for their progress in establishing the GUAN Analysis Centre. It noted with appreciation the offer of ECMWF to develop maps of performance indicators for GUAN stations based on daily TEMP data, for presentation on the ECMWF and/or Hadley Web sites at regular intervals, with details of the statistics and summary period to be agreed between the centres. The Panel also reiterated the vital importance of maintaining**

monthly CIMAT TEMP messages for monitoring climate aloft, and requested the Hadley Centre to continue to provide monthly maps of CLIMAT TEMP receipt on its GUAN Web site.

#### ***GSN and GUAN (General)***

13. AOPC expressed its appreciation to Harald Daan for his efforts in developing a 'Guide on the GSN and GUAN'. It requested all Panel members to perform a final review of the document and provide comments to H. Daan (cc GCOS Secretariat) by 18 May, following which the document would be formally published as a GCOS publication and subsequently distributed to all WMO Members.
14. AOPC expressed its appreciation to the WMO Secretary-General for his recent communications with WMO Members aimed at improving the reporting and performance of GSN and GUAN stations, including the identification of national focal points for upper-air observations.
15. AOPC expressed its appreciation to Harald Daan and the Advisory Group on GSN and GUAN (AGG) for their draft review of the GSN and GUAN networks. The Panel endorsed the specific recommendations resulting from the further review undertaken during this meeting (Annex IV). The Panel also noted the suggestion that there may be some GUAN stations in central Africa which could contribute to filling gaps in the network in that area and encouraged R. Okoola to work with the AGG in investigating that possibility.
16. AOPC strongly reiterated the need to maintain and improve the availability of CLIMAT and CLIMAT TEMP messages, noting that climate monitoring, prediction and research all rely heavily on such messages because their monthly statistics are often based on more complete and comprehensive data than are available for daily messages transmitted via the GTS.
17. AOPC endorsed the proposed terms of reference for the AGG (Annex V), and confirmed P. Jones as the Chairman of the Group.

#### ***GSN Historical Data***

18. AOPC expressed its appreciation to the GSN Archive (WDC/NCDC) for its efforts in compiling and making available the historical data from GSN stations received in response to the September 1999 request from the WMO Secretary-General. The Panel requested NCDC to modify this interactive Web interface to allow easy identification and retrieval of the full GSN dataset.
19. AOPC noted that some countries have submitted only minimal amounts of GSN historical data, if any, to the GSN archive, and encouraged strong efforts to rectify this limitation. It requested in particular that the GCOS and WCP Secretariats arrange for a follow-on request to WMO Members which would encourage them to submit GSN historical data, if not already done, as well as to identify focal points for assisting in the process of overcoming obstructions to routine reporting of CLIMAT data from these stations.
20. AOPC noted with appreciation the offer of C. Nobre to pursue the provision to NCDC of historical daily data from GSN stations located in Brazil.

21. AOPC recognized that digitization of historical records is a major problem in many countries and recommended that assistance be made available to overcome such difficulties to the extent possible. It noted that problems of this nature could be highlighted as part of the agenda of the regional workshops being organized by the GCOS Secretariat.
22. AOPC noted with appreciation the plans for the WCP and GCOS Secretariats to cooperate closely in issues of climate data collection, analysis and management, and requested that action be taken to establish formal recognition of such cooperation at the CCI session in November 2001.

#### **Item 8 - Climate forcing baseline observations**

23. AOPC requested the Chairman to contact M. Chanin to ask that she represent AOPC on the Coordinating Group for the Integrated Global Atmospheric Chemistry Observations (IGACO) Theme being developed under the IGOS Partnership, with a view to ensuring the measurement of *in situ* and satellite baseline observations for stratospheric ozone.
24. AOPC requested G. Stephens, J. Schmetz and M. Suzuki to develop a statement for the Panel regarding the identification or development of baseline observations for top-of-atmosphere and surface radiation fluxes.
25. AOPC requested that the Chairman contact the International Project Manager of the BSRN (E. Dutton) with a view to exploring the recognition of BSRN as a contributing network to GCOS.
26. AOPC noted that the comprehensive SPARC Assessment of Upper Tropospheric and Stratospheric Water Vapour had recently been published (D. Kley, J. Russell and C. Phillips, WCRP-113, December 2000) and provides useful guidance on the requirements for measurement of water vapour. The document concluded in particular that:
  - multiple-instrument measurements are needed for UT water vapour;
  - more tropical tropopause measurements are needed;
  - monthly balloon measurements should be flown at various latitudes (in addition to Boulder);
  - satellite instruments should have continuity;
  - past observations are not fully understood (e.g. HALOE trends); and
  - there is a need for an archive of UTLS water vapour data.

AOPC requested the Chairman to liaise with SPARC to develop recommendations on the requirements for baseline observations for UTLS water vapour.

27. AOPC noted the potential for GPS retrievals of total water to provide additional data on the water in the atmosphere above land areas.
28. AOPC requested the Chairman to liaise with the WMO EC Panel/CAS Working Group on Environment and Atmospheric Pollution to develop recommendations on the requirements for baseline *in situ* measurements of greenhouse gases.
29. AOPC encouraged the undertaking of global climate and ecosystem model integrations which incorporate historical changes in global land cover with the

aim of improving understanding of the impacts of land-use change over time on both climate and the cycling of carbon and water.

#### **Item 9 - Marine systems**

30. AOPC noted the excellent progress being made in the implementation of JCOMM, including the first formal session of the Commission to be held in Iceland in June 2001, and the benefit that this commission will provide to GCOS through its role in overseeing the implementation and operation of many of the networks relevant to GCOS (e.g. VOSCLim, ASAP, DBCP and TAO/TRITON). The Panel expressed its appreciation for the efforts of, *inter alia*, the OOPC, IOC and WMO in effecting this progress.
31. AOPC was particularly pleased to note the implementation of the WRAP (Worldwide Recurring ASAP Project) to provide ASAP observations on ships regularly traversing the globe, especially through the data-sparse Southern Ocean.
32. AOPC commended the progress of the AOPC/OOPC Working Group on SST/Sea-Ice, and endorsed the plans to strengthen its focus on sea-ice and to commence a project to clarify the impacts of individual quality-control and data-selection processes on SST analyses.
33. AOPC noted the intention of the GODAE project to establish a high-resolution SST pilot project which seeks to produce daily global SST sets at a resolution of 1km x 1km and an accuracy of 0.5°C.
34. AOPC endorsed the establishment of an AOPC/OOPC Working Group on Surface Pressure (WG-SP) to be co-convened by R. Allan (Hadley Centre) and E. Harrison (PMEL). The Panel requested the group to prepare a work plan based on its draft terms of reference.
35. AOPC strongly supported the initiatives of OOPC to establish a Working Group on ocean time-series stations and, with the Partnership for Observation of the Global Oceans (POGO), to seek to maintain existing high-quality ocean reference sites and to establish additional ones where needed. The Panel recommended that these stations be used to provide baseline data on air-sea interaction as well as on ocean conditions.
36. AOPC noted that the WCRP/CLIVAR Pacific Panel had endorsed the importance of the GSN and GUAN data and had especially emphasized the need for reliable upper air data from the GUAN sites at San Cristobal (Galapagos Islands) and Easter Island, as well as at the Midway Islands, for example.
37. AOPC expressed strong support for objectives of the WGNE Surface Flux Analysis Project (SURFA), which will evaluate and intercompare surface flux products from the main global NWP centres, and looked forward to receiving a progress report on the project at the next meeting of AOPC.
38. AOPC strongly endorsed the continuation of full support for the ENSO Observing System, noting with some concern the potential weakening of some of this support.

### **Item 10 - Satellite issues**

39. AOPC expressed its appreciation for the work of the ET-ODRRGOS in developing Statements of Guidance (SOG) for application areas relevant to WMO and WMO-supported programmes, including GCOS. It noted in particular the progress made in developing the first iteration of an SOG for Seasonal-to-Interannual Forecasting (SIA) and welcomed the opportunity to work closely with the ET in developing future iterations of that SOG as well as those needed for other climate applications, such as Climate Change Detection. AOPC requested the Chairman to liaise with OOPC and WCRP to review the SIA SOG.
40. AOPC noted the work being undertaken by the ET-ODRRGOS on Observing System Experiments (OSEs) as a tool to assist in the redesign of the GOS. The Panel reiterated that for climate purposes, the GOS must be able to provide homogeneous coverage over the whole globe and to detect extreme weather and climate events. It also noted that a measure of the value of an observing system can be obtained from studies of the capability of the system to capture the variability of the observed climate on a range of time and space scales.
41. AOPC noted the research that is being carried out by NOAA and other organizations on the homogeneity of the upper-air network and recommended that such studies should include all relevant GUAN stations.
42. AOPC requested the AGG to review the performance of all GUAN stations with a view to identifying those which (a) would benefit from targeted assistance in order to overcome obstacles in their reporting performance, and (b) might be shown to provide observations which are of particular benefit to the operators of space-based earth observation system components. A prioritized list of such stations would be provided from the AOPC, through its Chairman, to the Chairman of the WMO/CBS OPAG on the Integrated Observing System for subsequent consideration by the satellite-operating agencies with a view to providing possible support for these stations.
43. AOPC noted the requirement for input on climate issues to the next session of the WMO Consultative Group on High-Level Policy on Satellite Matters (February 2002). It recognized the need for the GCOS science panels to participate in the preparation of appropriate material for this purpose and noted the intention of the GCOS SC Chairman to contact the Panel Chairmen in this regard.

### **Item 11 - Comprehensive observing system**

44. AOPC reiterated that data assimilation plays a crucial role in providing atmospheric datasets for climate studies. Reanalysis datasets are an excellent tool for analysis of inter-annual variations and for creation of diagnostics to improve understanding of climate processes and to explore seasonal to inter-annual predictability. Although reanalyses do not provide realistic assessments of long-term trends, owing to historical variations in data input, these aspects are improving as techniques for assimilation and data quality control are being upgraded. AOPC encouraged the continuation of efforts such as those of the WCRP to foster the development of global atmospheric reanalysis.
45. AOPC recognized the recent progress in carrying out global reanalysis projects in major centres in Europe, the USA and Japan and strongly encouraged their continuation, noting that the development of several reanalysis efforts allows the

substantial load to be shared while making use of a common input dataset, as well as comparative studies that can highlight the strengths and weaknesses of each reanalysis. The Panel suggested that new reanalyses should be carried out at approximately 5-year intervals to take advantage of advances in assimilation techniques and improvements in the availability and quality of current and historical data. It also suggested that reanalyses should extend back as far as practicable in time (e.g. 1958) and should ensure the use of baseline datasets, such as GSN and GUAN, so that the products could be optimised for climate purposes. AOPC requested the Chairman to bring these views and suggestions to the attention of the WCRP.

46. AOPC noted that reanalyses are only one aspect of the use of models to synthesise global products. Products such as GPCP outputs, SST analyses and ozone analyses are generated through the synthesis of a range of data using appropriate modelling and analysis techniques. These synthetic products are currently developed for the most part as research products. However, as the techniques and products become stable, it is no longer clear that they should be classified as research activities, since research funds are unlikely to be sustainable as the synthetic products become routinely used by communities. In recognition of these considerations, the AOPC requested P. Arkin to work with the Chairman and the WCRP Secretariat to consider appropriate international action to enhance understanding of and support for these activities.

#### Item 12 - Climate indicators

47. AOPC requested the NCDC to identify and make available the GUAN dataset as a distinct entity through the GUAN Analysis Centre Web site, in a manner similar to that recommended for the GSN dataset.
48. AOPC noted with appreciation the ongoing activity of the Global Precipitation Climatology Centre (GPCC) (operated by DWD) in integrating *in situ* precipitation observations from all available sources into a comprehensive global analysis, including data from the WWW/GTS, other contributions of WMO Members, and global/regional historical data collections. The Panel strongly encouraged the continuation of this activity.
49. AOPC noted with appreciation the activities of the CCI/Clivar Working Group on Climate Change Detection (WGCCD) as described in the report of that group and summarized for this meeting by its Chairman (T. Peterson). It congratulated the group on its many successful initiatives to date, especially the recent workshops on climate extremes (Caribbean, Africa) which had been modelled after the similarly successful workshops of the Asia-Pacific Network (APN) for Global Change Research.
50. Recognizing the successful results of the APN and WGCCD workshops on climate extremes, AOPC encouraged the implementation of a number of specific capacity-building activities to further stimulate progress in this area, including:
  - scientific regional workshops to rehabilitate and analyse daily climate data;
  - inclusion of GSN data in regional studies of climate extremes;
  - development and dissemination of specific software that supports consistent analysis of climate extremes across and within regions;
  - development of specific software to relate indices of climate extremes to the large-scale circulation;

- digitisation of historical daily climate data for archival and analysis by NMHSs; and
  - development of basic forms of metadata to support the analysis of daily climate data.
51. AOPC requested the NCDC to display on the GSN Analysis Centre Web site the 13 key daily-data climate indicators that had been developed in conjunction with the ClimDex activity, as determined from only GSN data. It also requested that similar indicators be developed and displayed for GSN monthly data.
  52. AOPC requested the GUAN Analysis Centre to develop and display on its Web site a set of climate indicators for the free atmosphere based on GUAN data.
  53. AOPC requested E. Harrison and the Chairman to consult with relevant experts to investigate the potential for developing a suite of key indicators to characterize the large-scale atmospheric circulation. Such indicators could be routinely evaluated and presented in the context of historical conditions as routine GCOS products.

#### Item 13 - Data management

54. AOPC noted the findings of the recent meeting of the Review Team set up to review and provide oversight to GOSIC, subsequent to the dissolution of JDIMP. The Panel, noting the considerable progress being made by the GCOS Centres in disseminating GCOS data, results and information, urged that the needs of the GCOS Monitoring Centres and Data Centres be included in considerations of augmenting the support being made available for data management and coordination activities related to GCOS.
55. AOPC noted that the WMO is considering the implications of developing the next generation of data management infrastructure, which will make use of internet technologies. It also noted that JCOMM is likely to commence pilot projects to demonstrate the capability of such systems. The Panel noted with appreciation the establishment of a CBS Expert Team on Integrated Data Management, which has been tasked to develop a high-level metadata standard to be used in future WMO information systems.
56. AOPC emphasized the great importance of metadata when preparing data to be used for purposes of climate change analysis, while noting that there is no readily-available standard for storing and accessing such metadata in electronic form. The Panel encouraged the CCI Rapporteur on Metadata to guide the development of such a standard, with possible reference to a pro-forma request for metadata that had been produced by WMO experts (including P. Jones and T. Karl) some years ago.
57. AOPC noted that most high-frequency (i.e. annual resolution) paleoclimatic data from natural archives (trees, corals, ice cores, marine and lacustrine varves) are archived at the National Geophysical Data Center (NGDC) in Boulder, Colorado (<http://www.ngdc.noaa.gov> and the mirror site in France). Funding agencies in the U.S. and Europe now demand that researchers lodge their paleoclimatic data and reconstructions with NGDC. Submission of data to NGDC is also actively encouraged by the IGBP/Clivar PAGES (Past Global Changes) Group. In Europe and the Far East (China, Japan, Korea), historical documentary data are an important source for high-frequency climate information for the last millennium.

AOPC recognised the importance of these data and encouraged all researchers to make their data widely available.

58. AOPC noted with appreciation the long-running WMO/WCDMP Data Rescue (DARE) to archive and digitize observational data held on paper/cards at NMHSs where storage facilities are not ideal. The DARE project has proved very successful in the Caribbean, Central and South America, where considerable data have been archived on microfilm/fiches and ongoing work will begin the process of digitization of relevant material, with particular reference to GSN and GUAN. The Panel was informed that the African DARE project has microfilmed data from most countries, stored at the Belgian Met. Service, for which no comprehensive inventory (stations, years, variables, etc.) has as yet been created, thus making it difficult to assess the value of the project. AOPC recommended that an inventory be developed and steps initiated to digitize this material, especially from GSN and GUAN stations. This would require liaison between the WMO Secretariat and the particular WMO Members concerned.

#### **Item 14 – AOPC strategy and organization**

59. AOPC reviewed its Terms of Reference in response to recent changes in the organisation of GCOS, as had been requested by the GCOS SC. The revised Terms of Reference will be presented by the AOPC Chairman to the GCOS SC and the WCRP JSC for approval.
60. AOPC noted the importance of completing the AOPC plan and requested that the Chairman liaise with the Director of the GCOS Secretariat to develop a strategy to achieve this end.
61. AOPC considered issues associated with its regular meetings, and concluded that, given the scope of AOPC activities, it should make every effort to continue to meet annually. It also considered that the advantages of the opportunity to interact with staff at the WMO Secretariat make it desirable to continue to meet in Geneva, other factors being equal. The Panel also recommended that, in order to ensure that the science content of AOPC meetings can continue to grow, the duration of AOPC meetings should be extended to 5 days. It was agreed that the exact dates and location of the next meeting would be determined as soon as possible, taking account of these considerations.

## ANNEX IX

### LIST OF ACRONYMS AND ABBREVIATIONS

AGG	AOPC Advisory Group on GSN and GUAN
AMIP	Atmospheric Model Intercomparison Project
AOPC	Atmospheric Observation Panel for Climate
APN	Asia-Pacific Network
ASAP	Automated Shipboard Aerological Programme
BOM	Australian Bureau of Meteorology
BSRN	Baseline Surface Radiation Network
CAS	Commission for Atmospheric Sciences
CBS	Commission for Basic Systems (WMO)
CCD/A	Climate Change Detection and Attribution
CCI	Commission for Climatology (WMO)
CDAS	Climate Data Assimilation System
CEOS	Committee on Earth Observation Satellites
CLIMAT	Report of monthly means and totals from a WWW land station
CLIVAR	Climate Variability and Predictability (WCRP)
CMA	China Meteorological Administration
CMM	Commission for Marine Meteorology
COP	Conference of the Parties (to UNFCCC)
DAO	Data Assimilation Office
DARE	Data Rescue (WCDMP project)
DBCP	Data Buoy Cooperation Panel
DIM	Data and Information Management
DWD	Deutscher Wetterdienst
EC	European Community
EC	Executive Council (WMO)
ECMWF	European Centre for Medium-Range Weather Forecasts
ENSO	El Niño/Southern Oscillation
ET-ODRRGOS	Expert Team on Observational Data Requirements and Redesign of the Global Observing System
FAO	Food and Agriculture Organization of the United Nations
G3OS	GCOS, GOOS and GTOS
GAW	Global Atmosphere Watch
GCO	Global Carbon Observation
GCOS	Global Climate Observing System
GCMs	Global Climate Models
GDSIDB	Global Digital Sea-Ice Data Bank
GEF	Global Environment Facility
GEMS	Global Environmental Monitoring System
GEWEX	Global Energy and Water Cycle Experiment
GLIMS	Global Land Ice Measurements System
GLOSS	Global Sea Level Observing System
GMDSS	Global Maritime Distress and Safety System
GODAE	Global Ocean Data Assimilation Experiment
GOFC	Global Observation of Forest Cover
GOOS	Global Ocean Observing System
GOS	Global Observing System
GOSIC	Global Observing Systems Information Center

GOSSP	Global Observing Systems Space Panel
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning System
GRDC	Global Runoff Data Centre
GSN	GCOS Surface Network
GSNMC	GSN Monitoring Centre
GTN	Global Terrestrial Network
GTN-E	Ecosystem Monitoring Network
GTN-G	Glacier Monitoring Network
GTN-H	Hydrology Monitoring Network
GTN-P	Permafrost Monitoring Network
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System
GUAN	GCOS Upper-Air Network
HALOE	Halogen Occultation Experiment
HOPC	Hydrological Observation Panel for Climate
HWR	Hydrology and Water Resources (Department, WMO)
ICSU	International Council for Science
IGBP	International Geosphere-Biosphere Programme
IGACO	Integrated Global Atmospheric Chemistry Observations (IGOS Theme)
IGOS	Integrated Global Observing Strategy
IGOS-P	Integrated Global Observing Strategy Partnership
IGOSS	Integrated Global Ocean Services System
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IOS	Initial Operational System (GCOS); Integrated Observing System (GOOS)
IPCC	Intergovernmental Panel on Climate Change
ISCCP	International Satellite Cloud Climatology Project
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM Observing Platform Support Centre
JDIMP	Joint Data and Information Management Panel
JMA	Japan Meteorological Agency
MCDW	Monthly Climatic Data of the World
MECE	Monitoring of Extreme Climate Events
MOU	Memorandum of Understanding
MPERSS	Marine Pollution Emergency Response Support System
MSC	Meteorological Service of Canada
MSU	Microwave Sounding Unit
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NGDC	National Geophysical Data Center
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
NPP	Net Primary Productivity
NWP	Numerical Weather Prediction
OOPC	Ocean Observations Panel for Climate
OPAG	Open Programme Area Group

OSEs	Observing System Experiments
OSSEs	Observing System Simulation Experiments
PAGES	Past Global Changes (within IGBP)
PMEL	Pacific Marine Environmental Laboratory
POGO	Partnership for Observation of the Global Oceans
QC	Quality Control
SBI	Subsidiary Body for Implementation (UNFCCC/COP)
SBSTA	Subsidiary Body for Scientific and Technological Advice (UNFCCC/COP)
SC	Steering Committee
SIA	Seasonal-to-Interannual Forecasting
SIP	Seasonal-to-Interannual Climate Prediction
SIT	Strategic Implementation Team (CEOS)
SOG	Statement of Guidance
SOOP	Ships of Opportunity Programme
SPARC	Stratospheric Processes and their Role in Climate
SPREP	South Pacific Regional Environment Programme
SST	Sea-Surface Temperature
START	System for Analysis, Research and Training
SURFA	Surface Flux Analysis Project
TAO	Tropical Atmosphere-Ocean Array
TCO	Terrestrial Carbon Observations
TEMS	Terrestrial Ecosystems Monitoring Sites
TOMS	Total Ozone Mapping Spectrometer
TOPC	Terrestrial Observation Panel for Climate
ToR	Terms of Reference
TOVS	TIROS Operational Vertical Sounder
TRITON	Triangle Trans-Ocean Buoy Network
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UOP	Upper Ocean Panel (WCRP/CLIVAR)
UTLS	Upper Troposphere Lower Stratosphere
VOS	Voluntary Observing Ship(s)
VOSClim	Voluntary Observing Ships Climatology Programme
WCDMP	World Climate Data and Monitoring Programme
WCP	World Climate Programme
WCRP	World Climate Research Programme
WDC	World Data Centre
WGCCD	Working Group on Climate Change Detection
WGNE	Working Group on Numerical Experimentation
WG-SP	Working Group on Surface Pressure
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WRAP	Worldwide Recurring ASAP Project
WWW	World Weather Watch (WMO)

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## LIST OF GCOS PUBLICATIONS\*

- GCOS-1**  
(WMO/TD-No. 493) Report of the first session of the Joint Scientific and Technical Committee for GCOS (Geneva, Switzerland, April 13-15, 1992)
- GCOS-2**  
(WMO/TD-No. 551) Report of the second session of the Joint Scientific and Technical Committee for GCOS (Washington DC, USA, January 11-14, 1993)
- GCOS-3**  
(WMO/TD-No. 590) Report of the third session of the Joint Scientific and Technical Committee for GCOS (Abingdon, UK, November 1-3, 1993)
- GCOS-4**  
(WMO/TD-No. 637) Report of the fourth session of the Joint Scientific and Technical Committee for GCOS (Hamburg, Germany, September 19-22, 1994)
- GCOS-5**  
(WMO/TD-No. 639) Report of the GCOS Data System Task Group (Offenbach, Germany, March 22-25, 1994)
- GCOS-6**  
(WMO/TD-No. 640) Report of the GCOS Atmospheric Observation Panel, first session (Hamburg, Germany, April 25-28, 1994)
- GCOS-7**  
(WMO/TD No. 641) Report of the GCOS Space-based Observation Task Group (Darmstadt, Germany, May 3-6, 1994)
- GCOS-8**  
(WMO/TD No. 642)  
(UNEP/EAP.MR/94-9) Report of the GCOS/GTOS Terrestrial Observation Panel, first session (Arlington, VA, USA, June 28-30, 1994)
- GCOS-9**  
(WMO/TD-No. 643) Report of the GCOS Working Group on Socio-economic Benefits, first session (Washington DC, USA, August 1-3, 1994)
- GCOS-10**  
(WMO/TD-No. 666) Summary of the GCOS Plan, Version 1.0, April 1995
- GCOS-11**  
(WMO/TD-No. 673) Report of the GCOS Data and Information Management Panel, first session (Washington DC, USA, February 7-10, 1995)
- GCOS-12**  
(WMO/TD-No. 674) The Socio-economic Benefits of Climate Forecasts: Literature Review and Recommendations (Report prepared by the GCOS Working Group on Socio-economic Benefits), April 1995
- GCOS-13**  
(WMO/TD-No. 677) GCOS Data and Information Management Plan, Version 1.0, April 1995
- GCOS-14**  
(WMO/TD-No. 681) Plan for the Global Climate Observing System (GCOS), Version 1.0, May 1995
- GCOS-15**  
(WMO/TD-No. 684) GCOS Plan for Space-based Observations, Version 1.0, June 1995
- GCOS-16**  
(WMO/TD-No. 685) GCOS Guide to Satellite Instruments for Climate, June 1995
- GCOS-17**  
(WMO/TD-No. 696) Report of the GCOS Atmospheric Observation Panel, second session (Tokyo, Japan, March 20-23, 1995)

\*GCOS publications may be accessed through the GCOS World Wide Web site at:  
<http://www.wmo.ch/web/gcos/gcoshome.html>

- GCOS-18**  
(WMO/TD-No. 697)  
(UNEP/EAP.MR/95-10) Report of the GCOS/GTOS Terrestrial Observation Panel, second session (London, UK, April 19-21, 1995)
- GCOS-19**  
(WMO/TD-No. 709) Report of the GCOS Data Centre Implementation/Co-ordination Meeting (Offenbach, Germany, June 27-29, 1995)
- GCOS-20**  
(WMO/TD-No. 720) GCOS Observation Programme for Atmospheric Constituents: Background, Status and Action Plan, September 1995
- GCOS-21**  
(WMO/TD-No. 721)  
(UNEP/EAP.TR/95-07) GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 1.0, November 1995
- GCOS-22**  
(WMO/TD-No. 722) Report of the fifth session of the Joint Scientific and Technical Committee for GCOS (Hakone, Japan, October 16-19, 1995)
- GCOS-23**  
(WMO/TD-No. 754)  
(UNEP/DEIA/MR.96-6)  
(FAO GTOS-1) Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, third session (Cape Town, South Africa, March 19-22, 1996)
- GCOS-24**  
(WMO/TD-No. 768)  
(UNESCO/IOC) Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate, first session (Miami, Florida, USA, March 25-27, 1996)
- GCOS-25**  
(WMO/TD-No. 765)  
(UNEP/DEIA/MR.96-5) Report of the GCOS Data and Information Management Panel, second session (Ottawa, Ontario, Canada, May 14-17, 1996)
- GCOS-26**  
(WMO/TD-No. 766) Report of the Joint CCI/CBS Expert Meeting on the GCOS Surface Network (Norwich, UK, March 25-27, 1996)
- GCOS-27**  
(WMO/TD-No. 772)  
(UNEP/DEIA/MR.96-7) Report of the Expert Meeting on Hydrological Data for Global Observing Systems (Geneva, Switzerland, April 29-May 1, 1996)
- GCOS-28**  
(WMO/TD-No. 793)  
(UNEP/DEIA/MR.97-3) *In Situ* Observations for the Global Observing Systems (Geneva, Switzerland, September 10-13, 1996)
- GCOS-29**  
(WMO/TD-No. 794)  
(UNEP/DEIA/MR.97-4) Report of the Global Observing Systems Space Panel, second session (Geneva, Switzerland, October 16-18, 1996)
- GCOS-30**  
(WMO/TD-No. 795) Report of the sixth session of the Joint Scientific and Technical Committee for GCOS (Victoria, British Columbia, Canada, October 28-November 1, 1996)
- GCOS-31**  
(WMO/TD-No. 803) Proceedings of the fifth meeting of the TAO Implementation Panel (TIP-5) (Goa, India, November 18-21, 1996)

<b>GCOS-32</b> (WMO/TD-No. 796)	GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 2.0, June 1997
<b>GCOS-33</b> (WMO/TD-No. 798)	GHOST - Global Hierarchical Observing Strategy, March 1997
<b>GCOS-34</b> (WMO/TD-No. 799)	Initial Selection of a GCOS Surface Network, February 1997
<b>GCOS-35</b> (WMO/TD-No. 839)	Report of the second Joint CCI/CBS Meeting on the GCOS Surface Network (De Bilt, The Netherlands, June 25-27, 1997)
<b>GCOS-36</b> (WMO/TD-No. 844) (UNESCO/IOC)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate, second session (Cape Town, South Africa, February 11-13, 1997)
<b>GCOS-37</b> (WMO/TD-No. 845) (GOOS-10) & (GTOS-9)	Report of the Global Observing Systems Space Panel, third session (Paris, France, May 27-30, 1997)
<b>GCOS-38</b> (WMO/TD-846) (GTOS-10)	Report of the Meeting of Experts on Ecological Networks (Guernica, Spain, June 17-20, 1997)
<b>GCOS-39</b> (WMO/TD-No. 847) (GOOS-11) & (GTOS-11) (UNEP/DEIA/MR.97-8)	Report of the GCOS/GOOS/GTOS Joint Data and Information Management Panel, third session (Tokyo, Japan, July 15-18, 1997)
<b>GCOS-40</b> (WMO/TD-No. 848)	Report of the GCOS/WCRP Atmospheric Observation Panel for Climate, third session (Reading, UK, August 19-22, 1997)
<b>GCOS-41</b> (WMO/TD-No. 849) (GOOS-33)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC) Ocean Climate Time-Series Workshop, (Baltimore, MD, USA, March 18-20, 1997)
<b>GCOS-42</b> (WMO/TD-No. 857)	Report of the seventh session of the Joint Scientific and Technical Committee for GCOS (Eindhoven, The Netherlands, September 22-26, 1997)
<b>GCOS-43a</b> (GOOS-36)	TAO Implementation Panel, sixth session (Reading, U.K., November 4-6, 1997)
<b>GCOS-43b</b> (GOOS-55)	International Sea Level Workshop (Honolulu, Hawaii, USA, June 10-11, 1997)
<b>GCOS-44</b> (GOOS-61)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC), third session (Grasse, France, April 6-8, 1998)
<b>GCOS-45</b> (WMO/TD-No. 922) (GOOS-58) & (GTOS-16) (UNEP/DEIA/MR.98-6)	Report of the Joint Meeting of the GCOS/WCRP Atmospheric Observation Panel for Climate and the GCOS/GOOS/GTOS Joint Data and Information Management Panel, fourth session (Honolulu, Hawaii, USA, April 28-May 1, 1998)

<b>GCOS-46</b> (GTOS-15)	Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, fourth session (Corvallis, USA, May 26-29, 1998)
<b>GCOS-47</b> (WMO/TD-No. 941) (GOOS-67) (GTOS-20)	Report of the Global Observing Systems Space Panel, fourth session, (College Park, Maryland, USA, October 22-23, 1998)
<b>GCOS-48</b>	Report on the Adequacy of the Global Climate Observing Systems (United Nations Framework Convention on Climate Change, November 2-13 1998, Buenos Aires, Argentina)
<b>GCOS-49</b> (GOOS-64)	Implementation of Global Ocean Observations for GOOS/GCOS, first session (Sydney, Australia, March 4-7, 1998)
<b>GCOS-50</b> (GOOS-65)	Implementation of Global Ocean Observations for GOOS/GCOS, second session (Paris, France, November 30, 1998)
<b>GCOS-51</b> (GOOS-66)	Global Ocean Observations for GOOS/GCOS: An Action Plan for Existing Bodies and Mechanisms
<b>GCOS-52</b> (GOOS-68)	TAO Implementation Panel, 7 <sup>th</sup> Session (Abidjan, Ivory Coast, November 11-13, 1998)
<b>GCOS-53</b> (WMO/TD-No. 958)	GCOS Surface Network (GSN) Monitoring Centre Implementation Meeting (Offenbach, Germany, January 19-20, 1999)
<b>GCOS-54</b> (WMO/TD-No. 953)	Report of the eighth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS (Geneva, Switzerland, February 9-12, 1999)
<b>GCOS-55</b>	Report of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), fifth session (Silver Spring, MD, USA, April 20-23, 1999)
<b>GCOS-56</b> (GOOS-75)	Special Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC), fourth session (May 17, 1999); The CLIVAR Upper Ocean Panel (UOP), fourth session (May 21, 1999); A Joint Planning Meeting of the OOPC and the UOP for the OCEANOBS99 Conference (Woods Hole, MA, USA, May 18-20, 1999)
<b>GCOS-57</b> (WMO/TD-No. 978) (GOOS-79)	Report of the OOPC/AOPC Workshop on Global Sea Surface Temperature Data Sets (Palisades, N.Y., USA, November 2-4, 1998)
<b>GCOS-58</b> (GOOS-71)	Report of the 6 <sup>th</sup> Session of the IOC Group of Experts on the Global Sea Level Climate Observing System (GLOSS)
<b>GCOS-59</b> (GTOS-22)	Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, fifth session (Birmingham, UK, July 27-30, 1999)
<b>GCOS-60</b> (WMO/TD-No. 1004) (GOOS-70)	GCOS/GOOS/GTOS Joint Data and Information Management Plan, Version 1.0, May 2000

- GCOS-61**  
(WMO/TD-No. 1031) Report of the ninth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS (Beijing, China, September 12-14, 2000)
- GCOS-62**  
(WMO/TD-No. 1038) Report of the Pacific Islands Regional Implementation Workshop on Improving Global Climate Observing Systems (Apia, Samoa, August 14-15, 2000)
- GCOS-63**  
(WMO/TD-No. 1047)  
(GTOS-26) Establishment of a Global Hydrological Observation Network for Climate. Report of the GCOS/GTOS/HWRP Expert Meeting (Geisenheim, Germany, June 26-30, 2000)
- GCOS-64**  
(GOOS-107) Report of the eighth session of the TAO Implementation Panel (TIP-8) (St. Raphael, France, October 15, 1999)
- GCOS-65**  
(WMO/TD-No. 1055) Report of the sixth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 10-13, 2000)
- GCOS-66**  
(GOOS-108) Report of the ninth session of the TAO Implementation Panel (TIP-9) (Perth, Australia, November 16-17, 2000)
- GCOS-67**  
(WMO/TD-No. 1072) GCOS Implementation Strategy: Implementing GCOS in the New Millennium
- GCOS-68**  
(WMO/TD-No. 1093) Report of the seventh session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 30-May 3, 2001)

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