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REPORT OF THE GCOS REGIONAL WORKSHOP FOR WESTERN AND CENTRAL AFRICA ON IMPROVING OBSERVING SYSTEMS FOR CLIMATE

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FOREWORD

The GCOS Regional Workshop for Western and Central Africa, which is described in this report, is the start of a process. GCOS looks forward to working with the principal stakeholders in the region, building on national, regional, and international efforts, to improve systematic observations for climate. We plan do so in part through working collaboratively with the countries of the region in the development of a Regional Action Plan.

During the workshop, we made progress in identifying national and regional needs for climate as they relate to climate policies, national activities, and sustainable development. We also identified a range of deficiencies in current systems and determined some key regional priorities. We began discussion of developing a Regional Action Plan that can serve as a vehicle to articulate the needs and priorities of the region and to bring these needs and priorities to the attention of the Parties to the United Nations Framework Convention on Climate Change and prospective donor agencies. We also began a discussion of a way forward that includes a resource mobilization strategy without which no Action Plan can succeed.

In the process it is essential that we seek support for the plan from your national authorities and regional bodies. GCOS will work with you, but the plan needs to be yours – regionally focused, regionally motivated, and regionally owned. GCOS values your participation in the Regional Workshop for Western and Central Africa and looks forward to working with you as we seek to improve systematic observations in the region.

I wish to express my appreciation to the Niger government, especially the Ministry of Transport, for its hospitality and the fine reception that we all enjoyed in Niger. I also wish to thank Mr Moussa Labo, the Director of the Niger Meteorological Service, for his efforts and for those of his staff, which were a major factor in the success of the workshop. The active and effective partnership with ACMAD and its Director is most appreciated, and we look forward to future collaboration.

Alan Thomas
Director
GCOS Secretariat

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EXECUTIVE SUMMARY

The Global Climate Observing System (GCOS) held its Regional Workshop for Western and Central Africa in the Palais de Congrès in Niamey, Republic of Niger, from 27–29 March 2003. GCOS organized this fifth workshop in its Regional Workshop Programme in collaboration with the African Centre of Meteorological Applications for Development (ACMAD), the Niger Meteorological Service, and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The Global Environment Facility/United Nations Development Programme (GEF/UNDP), IOC, France, and the United Kingdom provided support.

The goals of the workshop were: (1) to identify gaps and deficiencies in GCOS-related climate observing systems in Western and Central Africa; and (2) to initiate the development of a GCOS Regional Action Plan aimed at improving regional capabilities in atmospheric, oceanic, and terrestrial data collection and production and delivery of climate products and services. The proposed Regional Action Plan will contribute to regional and global efforts to detect climate change, monitor the climate system, plan for and adapt to the impacts of climate variability and climate change and, at the same time, enhance the abilities of nations in the region to address their domestic requirements for climate data and services.

In context-setting, opening remarks, Mr Alan Thomas (Director, GCOS Secretariat) outlined the history and rationale underlying the GCOS Regional Workshop Programme. He stressed the urgent need to enhance systematic observations of the atmospheric, oceanic, and terrestrial components of the global climate system and emphasized that the workshop represented the first step towards the development of a GCOS Regional Action Plan for Western and Central Africa to address identified needs. He encouraged participants to contribute actively to the identification of key regional deficiencies and needs related to GCOS and to propose related, high-priority initiatives for inclusion in the Regional Action Plan. He pointed out that the completion of an Action Plan would provide a solid basis for resource mobilization efforts to achieve significant improvements in climate-related infrastructure, systems, and capacities in the region.

Subsequent workshop presentations and plenary discussions addressed both user needs for climate observations and the status, deficiencies, and needs of atmospheric, oceanic and terrestrial observational networks, including their related telecommunications, data management, data exchange, and archiving systems. Presentations placed substantial emphasis on the vital issue of resource mobilization requirements and strategies, and also addressed a number of crosscutting topics. During their deliberations, workshop participants highlighted the following issues and deficiencies that require high-priority attention during the development of a GCOS Regional Action Plan:

- Given the important role played by observation data in areas such as early warning, disaster preparedness, and detection of climate change, it is desirable to increase the visibility of observational activities within national governments and internationally.
- A need exists to establish or improve GCOS coordination mechanisms at national and regional levels, involving both providers and users of climate-related data/information.
- A need exists to improve climate data collection, quality assurance, data exchange, data management, and archiving.
- It is important to develop a regional strategy and to plan for climate data rescue (using the best technology available).

- Telecommunications represent a continuing problem in some locations, and an urgent need exists to improve the timely transmission of observational data.

- Implementation of the Global Ocean Observing System in Africa (GOOS-Africa) would address important GCOS-related needs in the region. In particular, needs exist for additional sea-level observations from GPS-equipped stations and for the maintenance and expansion of the Pilot Research Moored Array in the Tropical Atlantic (PIRATA) ocean buoy network.

- A need exists to improve monitoring of terrestrial variables such as albedo, soil moisture, and vegetation cover.

- A need exists to address the deterioration of hydrological networks and to enhance groundwater monitoring.

- A need exists for capacity-building in relation to satellite applications.

- Training in the application of the PRECIS (Providing Regional Climates for Impacts Studies) model is important to all countries in the region in planning for adaptation to climate variability and climate change.

- The African Monsoon Multidisciplinary Analyses (AMMA) project has the potential to significantly improve the ability to predict the onset and ending of the African monsoon. The project coordination is invited to encourage/facilitate the participation of countries of the region in project activities.

- The Agency for Air Navigation Safety in Africa and Madagascar (ASECNA) drew attention to the vulnerability to coastal airports and encouraged the further development of regular marine forecast and warning programmes.

- The continued implementation of the RANET (Radio Internet) Project is desirable.

- A need exists to develop a resource mobilization strategy for the region, noting that poverty reduction and economic development are among the current priorities of donor institutions.

At the conclusion of the workshop, Mr Thomas outlined the next steps in the development of a GCOS Action Plan for the region. It was agreed that a small, broadly representative, drafting team would be created to prepare a draft Action Plan and that this draft Plan would then be circulated to all workshop participants for critical review and comment prior to being finalized. The final version of the GCOS Regional Action Plan for Western and Central Africa would be presented to the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the Conference of the Parties to the United Nations Framework Convention on Climate Change and also published on the GCOS web site.

INTRODUCTION

The Global Climate Observing System (GCOS) was established in 1992 as a joint initiative of the World Meteorological Organization (WMO), United Nations Environment Programme (UNEP), Intergovernmental Oceanographic Commission (IOC) of UNESCO and International Council for Science (ICSU). When fully implemented, high-quality global data sets will be available to all countries, enabling nations to improve climate prediction services, mitigate climate disasters, and plan for sustainable development. The specific objectives of GCOS are to promote improvements in observing systems necessary for climate system monitoring, climate change detection and response monitoring, application to the development of national economies, and research. GCOS addresses the total climate system, including physical, chemical and biological properties and atmospheric, oceanic, hydrologic, cryospheric, and terrestrial processes. To this end, GCOS works in partnership with the Global Terrestrial Observing System (GTOS), the Global Ocean Observing System (GOOS), and WMO's World Weather Watch (WWW) and Global Atmosphere Watch (GAW) programmes.

The current global coverage of climate data is not sufficiently comprehensive to validate many characteristics of model-simulated seasonal to inter-annual weather patterns or the details of many regional trends. A 1998 report to the third Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) reaffirmed an urgent requirement to provide global coverage for key atmospheric, oceanic, and terrestrial variables and highlighted the need to reverse the degradation of existing observing networks. GCOS provides the framework for responding to this challenge through implementation of a coherent, comprehensive, global observation system.

At the request of the COP, GCOS has initiated a Regional Workshop Programme to assist countries in developing regions to contribute substantively to the achievement of that objective. The fifth in the series of GCOS regional workshops was held in Niamey, Republic of Niger, from 27 - 29 March 2003 and was organized in collaboration with the African Centre of Meteorological Applications for Development (ACMAD), the Niger Meteorological Service, and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The Global Environment Facility/United Nations Development Programme (GEF/UNDP), IOC, France, and the United Kingdom provided support.

The goals of the workshop were: (1) to identify gaps and deficiencies in GCOS-related climate observing systems in Western and Central Africa; and (2) to initiate the development of a GCOS Regional Action Plan aimed at improving regional capabilities in atmospheric, oceanic, and terrestrial data collection and production and delivery of climate products and services. This Plan would be aimed at ensuring that GCOS requirements for climate system data from the region are met while at the same time enhancing the abilities of nations in the region to address their domestic and regional requirements for such data and related products. The workshop agenda and a list of participants are included as Appendices. Workshop presentations may be viewed on the GCOS web site at http://www.wmo.ch/web/gcos/RWWCA/index.html.

OPENING CEREMONY

The workshop was officially opened by his Excellency Mr Souleymane Kane, Minister of Transport of the Republic of Niger in the presence of Mr Alan Thomas, Director of the GCOS Secretariat, Mr Steven Ursino, Resident Representative UNDP, Mr Justin Ahanhanzo, representative of the IOC, directors of national meteorological services, and national climate change coordinators (CCCs) from the countries of Western and Central Africa.

SUMMARY OF WORKSHOP PRESENTATIONS AND DISCUSSIONS

THEME 1: SETTING THE CONTEXT

Co-Chairs: Hassan Saley (Conseil National de l'Environnement pour un Développement Durable (CNEDD)) and Laoualy Ada (UNDP)

In his opening presentation on Theme 1, Mr Alan Thomas (Director, GCOS Secretariat) began by expressing his thanks to Météo France, the United Kingdom Met Office, the IOC of UNESCO, and the GEF for their financial support for the workshop and to the local organizers of the workshop. He then gave an overview of GCOS, highlighting three key aspects: observing programmes, the linkage between GCOS and the UNFCCC process, and the goals of the Regional Workshop Programme. He emphasized that the GCOS strategy was to work with sponsoring organizations to implement global climate observing systems that meet GCOS standards. He drew attention to various resolutions and recommendations from the UNFCCC COP and SBSTA that stressed the urgent need to enhance systematic observations of the three components (atmospheric, oceanic, terrestrial) of the global climate system. These required remedying identified deficiencies in data quality, data exchange, archiving of historical data and metadata, and provision of free and open access to data and related metadata. This would require that substantial efforts be devoted to building regional and national capacities with consequent needs for resource mobilization. The Regional Workshop Programme was endorsed by SBSTA 15 and COP7 as a mechanism through which improvements in observing systems could be promoted and facilitated. The development of Action Plans would provide a solid basis for resource mobilization to address needs and deficiencies in GCOS-related observational, data management, and data exchange and archiving programmes within the regions of concern.

Mr Desmond O'Neill (GCOS Consultant) presented a synthesis of the framework document GCOS prepared to assist in the preparation of a GCOS Action Plan for Western and Central Africa. He briefly outlined the structure and contents of the document, stressing that its intent was to help workshop participants shape their own GCOS Regional Action Plan by providing a proposed structure and some preliminary text for consideration. He drew attention to questions included in the document, noting that these were intended to encourage participants to contribute actively to the planning process. He closed with a challenge for workshop participants to take ownership of the development of a GCOS Regional Action Plan for Western and Central Africa and encouraged them to identify the key thrusts that should be included and to agree on the structure and content of the document.

In the final presentation of the introductory session, Mr William Westermeyer (GCOS Secretariat) reviewed the UNFCCC guidelines for national reporting. He noted that these guidelines encouraged all countries to prepare national reports on the status of and plans for systematic observations of the climate system as part of their national communications under the umbrella of the UNFCCC process.

Plenary discussion following the above presentations centred around the following points:

- The need to improve communication between national representatives engaged in the UNFCCC process and hydrometeorological services and others involved in systematic observation programmes. It was noted that many countries did not include systematic observations in their national reporting. (Although such information is not required for developing countries, GCOS recommended that all countries provide it and indicated that it is not too late to do so.)
- The process for selecting stations for inclusion in the GSN and GUAN networks. It was pointed out that GCOS expert panels developed the selection criteria with NMHS input and endorsement regarding the designation of such stations within national borders.

THEME 2: USER NEEDS FOR CLIMATE OBSERVATIONS

Co-Chairs: Hassan Saley (CNEDD); Laoualy Ada (UNDP)

Mr Momadou Honadia (Burkina Faso) initiated discussions on user needs with a general overview of user needs from the perspective of a national climate change coordinator. He indicated that systematic climate observations were needed to provide databases for analysis, simulation, and impact studies and to track climatic behaviour. Applications of such data covered a broad spectrum including science, climatology, hydrology, oceanography, and pollution and flood studies.

Discussion following Mr Honadia's presentation drew out the following points:

- The need to designate national focal points or coordinators for systematic observations and to establish an effective networking system related to climate and climate issues.
- The need to establish national committees for GCOS representation from all stakeholders.
- The need for improved coordination at the national level with respect to the various Conventions.

A presentation by Mr Alhassane Diallo (AGRHYMET) addressed the observational needs for early warning and monitoring of extreme climatic events such as droughts and floods. Mr Diallo focused his remarks on the Sahel, where up to 80 percent of the population is reliant on agriculture and, given high variations in rainfall and the absence of irrigation in the region, subject to grave risks to its food supply. He outlined the current status of regional early warning systems for drought, described the approach to the management of flood risk, and drew attention to the role of AGRHYMET in these areas. He then identified shortcomings in observational networks, notably in low station density and obsolescent equipment, in collection and analysis of data, and in the communication and dissemination of information and products. In closing, he highlighted the urgent requirement for investments in improved observational networks, data analysis and database management systems, and in the development of indicators and enhancement hydrometeorological services in the region. He also stressed the vital importance of capacity-building and the development of stakeholder networks.

Discussion following Mr Diallo's presentation centred on:

- The status of the AGRHYMET climate network and related database management, data access, and capacity-building elements.
- The importance of seasonal forecasts and the status of ACMAD initiatives to improve accuracy and dissemination of such products.

A third presentation by Mr Saidou Koala of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) addressed observational needs for agriculture and the challenges of the semi-arid tropics. He drew attention to the need to measure both physical and biological parameters on a variety of scales at agroclimate stations in order to address issues related to crop growth status, disease, etc. He highlighted the increasing use of marginal lands to produce the crops needed to support a growing population and expressed concern regarding the adverse impacts of this trend on soils and productivity. He then described the adaptation options for drought risk (e.g., adjusting planting dates and crop densities, fertilizer rates, irrigation, selection of crop species, cultivar traits, etc) and discussed characteristics of formal and informal early warning systems, drawing attention to the use of indicators, thresholds, vulnerability maps, and famine early-warning products, as well as to the value of indigenous knowledge.

Plenary discussions highlighted the following areas:

- The inadequacy of national operating budgets to support agroclimatological networks, with many stations now being inoperative due to lack of equipment and consumables.
- The need to provide advice on the most cost-effective adaptation options for drought.
- The need to increase emphasis on the provision of support for livestock husbandry, particularly in the Sahel region with its variable climate.
- The need to pursue partnerships to acquire vital biological data.

In the closing presentation under the User Needs Theme, Ms Madeleine Thomson of the International Research Institute for Climate Prediction (IRI) discussed observational needs for climate and health. She drew attention to the impacts of climate on food production, nutritional status, economic performance, and diseases such as meningitis and malaria. She noted that unusual rainfall patterns were associated with malaria epidemics among the vulnerable populations of the Sahel and that meningitis outbreaks also had a relationship to climate. In consequence, the application of climate information to provide early warning for malaria and meningitis epidemics was being actively investigated. In this context, Ms Thomson noted that the World Bank was currently funding climate-observing stations in Ethiopia in association with efforts to control malaria in that country. She emphasized the need to improve communication between the climate and health communities and, in effect, to institutionalize their relationship in order to address the climate-health issue.

Plenary discussion following Ms Thomson's presentation centred on:

- The potential value of the climate-health relationship as a motivator for donor funding for improving climate observing networks and related data management, data analysis and exchange, and climate services activities.
- The need to establish climate-observing stations in populated areas where health concerns exist.

THEME 3: ATMOSPHERE: STATUS, DEFICIENCIES, AND NEEDS

Chair: Régis Juvanon du Vachat (Météo France)

Mr Mahaman Saloum (Meteorological Services, ASECNA-Niger and WMO Rapporteur on Regional Aspects of the Global Observing System) initiated this session with a presentation on the GCOS Surface Network (GSN) and GCOS Upper-Air Network (GUAN). He began by outlining why GCOS is needed, the selection criteria for GSN and GUAN stations and the GCOS "best practices" for operation of these stations. He then described the current GSN and GUAN networks in Western and Central Africa, noting problems in reporting from a considerable number of stations due to telecommunications difficulties or reduced programmes. Identified causes of these problems included inadequately trained staff, lack of equipment and consumables, equipment obsolescence, inoperative circuits and other telecommunications problems, shortage of funds, and social turmoil. To solve these problems, Mr Saloum stressed the need for substantial capacity-building, replacement of equipment, provision of spare parts, enhanced maintenance, increased use of automatic stations, and improved telecommunications and information exchange, including increased use of satellite data.

Mr Richard Thigpen (GCOS Consultant) followed with a related talk on "GSN and GUAN: A GCOS Review of Key Issues." He provided additional background on the development and operations of the GSN and GUAN networks, including the minimum and desired attributes of such stations, reporting requirements for CLIMAT and CLIMAT TEMP messages, the roles of the global monitoring centres, and global archiving requirements for both current and historical data and metadata. He then drew attention to the opportunity provided by a US Climate Change Research Initiative, which would provide funding for renovation of "silent" GUAN stations and the addition of up to 5 new stations. He closed by presenting recommendations to improve the operations of regional GCOS stations. These included bulk purchase of radiosondes, moving to a universal upper-air system (highly cost-effective), increased usage of automatic weather stations, renovation of hydrogen generators, activation of new or replacement GUAN stations, and provision of technical assistance to needy stations.

The following points related to GSN and GUAN were highlighted during plenary discussion:

- The vital importance of observations from GSN and GUAN stations was recognized but the high cost of radiosondes was identified as imposing a serious burden on countries in the region.
- Several participants drew attention to telecommunications difficulties that interfere with the reliable and timely relay of observational data.
- The need was emphasized for improved coordination between GCOS Monitoring Centres, station operators, and on-site personnel to ensure that GCOS requirements were clearly understood and that operational problems were resolved as quickly as possible.
- It was suggested that Internet gateways could be used (as is being done in the Galapagos) to access the Global Telecommunication System (GTS) as a means to relay observations and that coding software could be distributed to handle coding problems.
- Installation of a new generation of radiosonde system, which could easily pay for itself in a few years, was recommended for the countries in the region.

In his talk on the contributions of ASECNA to climate observing programmes, Mr Mohamed Sissako (Meteorological Department, ASECNA) began by pointing out that the mission of ASECNA not only included provision of meteorological observations and services for air navigation but also permitted it to manage all or part of a member state's national meteorological services, under contract to the country in question. He then described the extensive observational, telecommunications, satellite data reception, and communications, radar and other facilities managed by his organization. He noted high operational costs, equipment obsolescence, and telecommunications problems as issues that posed management and operational challenges.

Workshop participants subsequently raised several issues and concerns relating to ASECNA operations, including:

- The adverse impact of unreliable telecommunications at some locations. It was emphasized that this was a particular concern in Central Africa and was described by one participant to be "the key issue." Here, Mr Saloum noted that the advent of SATCOM offered real hope for improvement.
- The financial burdens imposed by the very high cost of radiosondes.
- Unsatisfactory liaison and coordination between operators of observing stations, ASECNA, and global Monitoring Centres. This, it was pointed out, reinforced the need for the identification of GCOS Focal Points at the national level and for a mechanism to permit these individuals to meet regularly to resolve problems.

Mr Ryall Jardine (South African Weather Service) next described the Automatic Weather Station developed by the South African Weather Service. Citing an urgent need to upgrade the observational network in Africa, he identified a requirement for about 200 automatic weather stations to support provision of services relating to floods, droughts and other phenomena. He suggested that the South African Weather Service's automatic weather station represented an African solution for Africa, pointing out major features such as low cost, ease of maintenance, readily exchangeable components, and utilization of internationally-accepted sensors. He then explained that the system was currently being deployed in the United Republic of Tanzania, Lesotho, and Namibia as well as at locations in South Africa. Further expansion of the automatic station network to other countries would, however, require external funding. Mr Jardine indicated that the South African Weather Service provided both a manual and training in the operation of their automatic weather station.

The important requirement for data rescue was introduced by Mr Daniel Roux (Météo France) in a presentation entitled "A French Contribution to DARE: Development of a Climatological Database Using CLICOM Format Based on Historical Data from 14 Countries in Central and Western Africa." In his presentation, he outlined the rationale for data rescue and the benefits to be gained by preserving and digitizing historical observational records that were at risk. He then went on to describe the project undertaken by Météo France in collaboration with 14 countries in West Africa. He noted that rescued data in both raw and processed form was provided to the participating countries, thereby facilitating many local applications in addition to providing extended time series for detecting and quantifying climate change and climate variability, as illustrated in an example from Senegal. He ended his talk by noting that it was planned to supply rescued historical data records from countries agreeing to their release to the World Data Centre (WDC) (located at the National Climatic Data Center in the United States) later this year. GCOS recommends that all 14 countries allow this important historical data to be sent to the WDC.

Mr Thigpen also addressed data rescue with a presentation entitled "Data Rescue Africa," which was prepared by Ms Claudia Liautaud who was unable to attend the workshop. He described an ongoing NOAA project aimed at rescuing historical upper-air and surface data from various locations around the globe. The project involves a partnership between participating countries and NOAA whereby digital photography is used on-site to capture images of original observational records. This imagery is then stored on CD ROMs and forwarded to NCDC (USA) for keyboard input and digitization. Important aspects of the project include the return of copies of the original and digitized data to the participating country and the provision of imaging and digitizing equipment and training to local staff to ensure the continuing digitization of current and future data. Mr Thigpen suggested that a GCOS Regional Action Plan might take advantage of this NOAA initiative in addressing needs for data rescue, giving priority to GCOS stations.

Plenary discussions following the preceding talk addressed both automatic weather stations and data rescue. Participants made the following points during these discussions:

- Maintenance costs associated with automatic weather stations are often not well understood and repair costs can be high, for example in the face of lightning damage. In response, Mr Jardine pointed out that replacement of damaged components with spares was a simple matter in the South African system.
- In Africa, automatic weather stations could be particularly useful in providing observations at night when few human observations were available and potentially represented a valuable supplementary source of data where manual observation programmes were in place.
- It was stressed that data rescue must involve the preservation of original records as well as the digitization of these records and must be carried out in collaboration with the countries involved to ensure accurate transcription of data. The WMO DARE project emphasizes the preceding considerations.
- There is a need to ensure that rescued data are readily portable to future technologies, as current electronic storage media are likely to become obsolete within a few years.
- There is a need for coordination between data rescue activities related to climate and hydrological data.

THEME 4: OCEANS: STATUS, DEFICIENCIES, AND NEEDS

Chair: Kwame Koranteng, IOC, GOOS-Africa

In opening the session of the Oceans Theme, the Chair emphasized that GCOS addresses the total climate system--atmosphere, oceans and terrestrial regimes--and their physical and biological components. Consequently, the GOOS and GCOS programmes work closely together to address climate and the oceans, with the climate component of GOOS being the ocean component of GCOS. Mr Koranteng drew attention to the fact that, in 1998, the Pan African Conference on Sustainable Integrated Coastal Management formally initiated GOOS-Africa as the African contribution to the global GOOS programme and that GOOS-Africa was subsequently endorsed by the World Summit on Sustainable Development held in Johannesburg, South Africa in 2002.

Mr Justin Ahanhanzo (IOC/UNESCO) presented an overview of GOOS-Africa. He began by outlining the background to the establishment of this regional component of GOOS, highlighting the political endorsement it has received from African Heads of State. The GOOS-Africa Framework for Action, he indicated, is a vital mechanism for achieving improvements in operational oceanographic data collection, processing, analysis and provision of ocean services. Mr Ahanhanzo then described the process by which GOOS-Africa priorities were converted into project proposals for a Regional Ocean Observing and Forecasting System for Africa (ROOFS-AFRICA). The goal of ROOFS-AFRICA is to supply timely advice and information to the user community in order to assist in addressing issues arising from the development and management of the marine and coastal environment of

Africa, including those associated with environmental trends and extreme events. ROOFS provides a Pan-African framework for the provision of a common base of coastal and ocean services to Africa. The programme will place emphasis on improving *in-situ* ocean observation programmes in African waters, pursuing expanded oceans applications of satellite remote sensing data, and working with partners and stakeholders to enhance information delivery and share operating costs. Mr Ahanhanzo indicated that ROOFS-AFRICA was endorsed by African Heads of State at the 2002 Johannesburg Conference, is entirely country driven, and is linked to other regional programmes, such as PIRATA, Mediterranean-GOOS, and Large Marine Ecosystem Studies in African Waters. In closing, he drew attention to the potential for close collaboration with GCOS in working groups, in workshops, and in planning and undertaking joint activities.

Mr Angora Aman (IOC, Côte d'Ivoire) addressed monitoring of sea level rise and its impacts in Africa. He began by emphasizing that rising sea levels posed a serious threat to vulnerable coastal cities and infrastructure, small islands and coastal environments in Africa. The rate of sea level rise along the coast of Africa was similar to the global picture (1-2mm/year), with the IPCC estimating that about 0.7mm/year could be attributed to warming global climate. He drew attention to the relatively short record (about 20 years) of African sea level observations and the general absence of altimetry data for African tide gauge sites, pointing out that gauge records of 60 years or longer and supporting data on changes in gauge elevation were needed for studies of sea level trends. He then identified some important applications of sea level data, including early warning systems (e.g., for seasonal upwelling in the Gulf of Guinea), validation of climate predictions, calibration of satellite observations, support for harbour and coastal navigation, protection of coral reefs, and studies of erosion and salt water intrusion.

Mr Aman noted that not all African sea level stations were in the GLOSS network, stressed that most had no GPS capability, and indicated that many had poor telecommunications support. Installation of new GLOSS stations was, however, planned at eight locations in Western and Central Africa to provide enhanced spatial resolution, adequate time series for navigation, and to monitor sea level behaviour in relation to currents. These new observing stations would include meteorological instruments, also contributing to the atmospheric database. In ending his presentation, Mr Aman underscored the need for collaborative global, regional, and national efforts to address issues related to sea level and to make vital observational data available to assist in preventing future disasters.

Mr Mark Majodina (South African Weather Service) followed with a presentation on PIRATA in Africa. He described the origins of the PIRATA network of moored buoys in the tropical Atlantic as a multi-national project designed by scientists involved in the Climate Variability and Predictability Programme (CLIVAR) with the objective of understanding the evolution of oceanic features such as SST, salinity, and air-sea interactions and fluxes in the tropical Atlantic. He then briefly reviewed the current buoy network and subsequently focused his remarks on the proposed southeastern extension of PIRATA. This extension of the network was aimed at improving understanding of the mechanisms controlling variability in sea surface temperature, ocean-atmosphere interaction, and upper-ocean structure in the region off Namibia and Angola. He outlined a feasibility study for the addition of two moorings in that region, drawing attention to the resourcing and operational challenges associated with implementation of this initiative. The additional buoys would, he indicated, produce an important database with which to address the modulation of South African rainfall and its impacts in addition to improving understanding of oceanic behaviour off the Southeast African coast. Mr Majodina concluded by emphasizing needs to develop partnerships with mariners, the fishing industry, the meteorological community, and others for capacity-building and to support the PIRATA extension and ensure its long-term sustainability.

Mr John Mungai (Kenya Meteorological Department) addressed observations and requirements for the modelling component of GOOS-Africa. In his opening remarks, he pointed out that over 60 percent of the African population lives along the coast and that various stresses and conflicts were being experienced in the coastal zone. He then underscored the value of ocean modelling in assessing coastal vulnerability. He stressed that ROOFS-AFRICA must be developed in order to support improved management of coastal and ocean resources. Among priority requirements for the implementation of ROOFS were an adequate infrastructure of computers, analysis and prediction centres, and other facilities, along with the availability of well-trained staff. Related needs existed to develop atmospheric and ocean observational networks, telecommunications systems, data processing capability, and data exchange and dissemination mechanisms and to integrate satellite data into models. He pointed out the need to assess available ocean models, select the most appropriate for application in Africa, and to build African capacities to develop and operate such models. Mr Mungai stressed the importance of strengthening partnerships between GOOS-AFRICA and global data centres as a means of building capacity and enhancing infrastructure. In his concluding remarks, he drew attention to the important contribution that GOOS-AFRICA could make to GCOS and to the user community by improving understanding of ocean behaviour and producing and disseminating products from ocean-atmosphere models.

During extended plenary discussion following the presentations on oceanographic topics, the following points were raised:

- In view of the inadequate database of sea level observations, modelling must be used to assess risks of coastal flooding and to facilitate planning for adaptation to higher sea levels in Africa. In addition, models provide a tool with which to address pollution issues such as oil spills at sea. It is important, therefore, to select the most appropriate models and to build capacity related to their application. A critical requirement exists in Africa for training in ocean modelling and its applications, with provision of university fellowships cited as an effective means of addressing this need.
- Several workshop participants emphasized the need for a multi-disciplinary approach involving all stakeholders in addressing the challenge presented by climate change and climate variability. It was pointed out that GOOS-Africa is pursuing networking as an approach to obtaining observational data that exist but are not being exchanged. It was also noted that IOC and WMO cooperate closely on ocean matters with the establishment of JCOMM reinforcing this collaborative approach.
- The need was stressed for greatly improved coordination at national and international levels in relation to sea level and other ocean observational programmes. It was suggested that the identification of national focal points for ocean programmes would be a positive step in this direction.
- The value of workshops involving the user community was underlined as a means of increasing government and public awareness of the threat that rising sea level poses to small islands, coastal cities, airports and other infrastructure, and vulnerable coastal environments such as deltas. It was suggested that coastal development might need to be restricted in the face of this threat.
- Interveners highlighted the need to produce useful ocean products and to disseminate them to users, taking advantage of dissemination mechanisms such as ACMAD's RANET, the Internet and others.
- A need was identified to undertake data rescue for oceanographic data in Africa.
- Integrating or rolling-up the impacts of sea level rise on small islands and island nations was suggested as a means of increasing the visibility of the threat to these smaller entities.

– It was suggested that ocean evaporation had an important influence on weather patterns over Africa and on upwelling in regions such as the Gulf of Guinea.

THEME 5: TERRESTRIAL OBSERVATIONS: STATUS, DEFICIENCIES, AND NEEDS

Chair: Kwame Koranteng

Ms Yamna Djellouli (ACMAD and the University of Le Mans) initiated a discussion on the terrestrial component of the climate system with a presentation on ecological observations for climate impacts. She pointed out that terrestrial observations should not only represent each ecosystem but also incorporate environmental, economic, and social components. She indicated that climate-related changes were most easily seen in vulnerable or fragile areas or margins. This made the operation of long-term monitoring stations north and south of the Sahara very important. She drew particular attention to the Réseau d'Observatoires de Surveillance Ecologique à Long Terme (ROSELT) network in that region.

Ms Djellouli also stressed the need to undertake monitoring at local as well as regional scales. Important terrestrial indicators that should be measured included precipitation, temperature, wind, solar radiation, albedo, and others along with soil characteristics and vegetation parameters such as biological diversity, coverage and biomass. Useful socio-economic indicators included demographics in relation to food security and settlement patterns. She highlighted the importance of *in-situ* measurements in resolving ambiguities in satellite remote sensing data. Ms Djellouli also drew attention to the contributions of soil erosion and bush fires in the region to atmospheric aerosol concentrations and thence to climate change. She concluded by reiterating the need to improve terrestrial observation programmes in fragile areas, to use both regional and local indicators and to maintain regular ongoing tracking of these indicators. She also emphasized that active involvement of the local population was essential for a successful monitoring programme.

A presentation by Mr Oumar Aly of the Niger Basin Authority addressed the impact of climatic variability on water resources in the Niger Basin. After briefly outlining the regional importance of the Niger River system, he compared the hydrological and other impacts of the drier conditions experienced since 1970 with conditions during the wetter climatic regime prior to that date. During the recent drier period, decreased flows were recorded at Niamey, a corresponding reduction occurred in freshwater discharge to the ocean, and groundwater storage declined. Moreover, invasion of water bodies by floating vegetation, notably water hyacinths, increased siltation, and erosion presented growing problems. At the same time, increased pollution was generated by domestic, industrial, mining, and agricultural sources. He then discussed the hydrometeorological observation networks in the Niger Basin, highlighting problems related to maintenance and increasing obsolescence of observing equipment and inoperative stations. He stressed the needs for simultaneous monitoring of hydrological and climatic parameters in real time using up-to-date equipment and for enhanced, real-time processing and dissemination of hydrometric data. This, he indicated, would require investments in equipment and capacity-building and in the development of improved coordination and synergy between water resources and climate monitoring programmes.

Plenary discussions on terrestrial observations followed the preceding presentations. Participants raised the following points during interventions:

- Ms Djellouli's presentation stressed the vulnerability and fragility of vegetation and soils in desert margin areas. In more humid regions of Western and Central Africa, however, deforestation is also a major concern.
- An ecological monitoring network has been established around the Sahara desert, supported by local and regional infrastructure.
- The atmospheric and hydrological communities face similar issues and share many concerns. A more integrated approach and much closer cooperation between these disciplines is essential to avoid duplication and to increase the efficiency and effectiveness of their observational programmes.
- Efforts are being made to obtain donor support to replace inoperative and obsolescent observing equipment in the Niger Basin and, with WMO assistance, to utilize METEOSAT to improve telecommunication links needed for data collection.
- Serious concerns exist regarding the potentially severe impacts of future climate in the Niger Basin. Terms of reference are being developed for scenario studies with impacts on water resources being the first target.
- Efforts are underway to obtain real-time water quality data from the Niger River system in order to address concerns related to pollution.
- While limited studies of groundwater have been carried out in selected locations, some countries in the Niger Basin have no groundwater monitoring stations and no Basin-wide assessment of groundwater has as yet been made.

THEME 6: CROSSCUTTING TOPICS

Chair: Christophe Besacier (MAE France)

Mr Geoff Jenkins (UK Met Office) opened the session with an overview of the PRECIS model and discussion of observational needs to support regional climate prediction in Africa. He emphasized that the PRECIS model (the Hadley Centre's portable regional climate model) was a "state of the art" regional model that will run efficiently on a fast personal computer and produce fine-scale outputs suitable for use in climate impact and adaptation studies. PRECIS provides improved representation of smaller scale climatic patterns and influences and of extreme events, including the effects of topography, islands, tropical cyclones and hurricanes. It can also support other applications, such as providing input to a storm surge model. The major features of the model, its operating requirements, and its application to the development of future climate scenarios were then described. In its present form, the model apparently does a good job of representing monthly mean temperature patterns and a reasonable job for monthly mean precipitation. Further improvements in performance are being sought, including enhanced resolution and versatility. Mr Jenkins noted that the PRECIS model is available on DVD and will be supplied free of charge to developing countries to assist them in developing the climate scenarios needed for impact and adaptation studies at the national level. He stressed, however, that completion of a training course was required to operate the model, noting that this course could be made available through ACMAD.

Messrs. Daniel Roux (Météo France) and Arona Diedhiou (IRD/LTHE Grenoble) described the African Monsoon Multidisciplinary Analysis (AMMA) Project. Noting that the West African Monsoon had been the subject of many previous studies, Mr Roux outlined the background to AMMA, its multi-national, multi-agency, and multi-disciplinary nature, and its relationship to global initiatives such as CLIVAR and the Global Energy and Water Cycle Experiment (GEWEX). AMMA is a multi-year project involving research and systematic observation to improve understanding of climate change and its impacts on health, food security, and water resources. Its three principal goals are to:

(1) Develop observational strategies for improved description of climate change in West Africa;
(2) Enhance understanding of the West African Monsoon and its influence on the physical, chemical, and biological environment at regional and global scales; and
(3) Improve knowledge and understanding of the relationships between climate variability and climate change and problems related to health, water resources, and food security in the nations of West Africa.

Fundamental issues that have needed to be addressed include the causes of rainfall and runoff deficits in West Africa during the past 30 years, the tendency of present Global Climate Models to start seasonal rains too early and their poor representation of daily values, weak skills in weather and seasonal forecasting in the region, and the relationship of regional climate to atmospheric chemistry and aerosols. Two major difficulties in addressing these issues have been the weak observational network in the region and the reality that many interactions, on a range of scales, were involved in the Monsoon phenomenon.

Messrs. Roux and Diedhiou then summarized experimental aspects of AMMA, drawing attention to the extended nature of the project and the planned inclusion of enhanced observational periods during which more intensive observations and studies would be carried out. In concluding remarks, it was indicated that AMMA would build national and regional capacities in West Africa, enhance atmospheric, hydrologic and oceanographic observing networks, improve operational products, and encourage multidisciplinary approaches.

Mr Abdallah Nassor (ACMAD) delivered a presentation on "Dissemination of Climate Predictions to the Rural Communication System and Community-Climate Observing System." He described the RANET system being implemented by ACMAD in partnership with National Meteorological Services and other organizations in Africa. RANET is an effort to make climate and weather related information accessible to rural populations and communities. In Africa one of the more successful systems has been an integration of new and existing analogue (FM/AM) radio stations with new digital radio satellite technologies. RANET's inclusion of radio in its network design helps to ensure that the programme builds upon existing capabilities, is community owned and operated, locally relevant and, therefore, more sustainable.

Mr Abdelhak Trache of the Centre Régional Africain des Sciences et Technologies de l'Espace en Langue Française (CRASTE-LF) gave the final presentation under the crosscutting topics theme. He spoke on the topic of remote sensing in the service of meteorology and climate. He began by presenting a concise overview of the environmental applications of satellites and remotely-sensed data. He then explained that CRASTE-LF is a training and research institute established under United Nations sponsorship to promote the utilization of space science and technology and develop related national and regional capacity. Twelve African countries are current members of CRASTE-LF, and several others have indicated their intention to join. The Centre has broadly based expertise in satellite remote sensing, telecommunications, space, and atmospheric science. It offers graduate and postgraduate training in these fields, carries out research and sponsors seminars, workshops and conferences. CRASTE-LF also has partnerships with international organizations and with institutions in advanced countries that are involved in space applications. Drawing attention to a recent accord between CRASTE-LF and ACMAD, Mr Trache concluded his presentation by indicating that CRASTE-LF represented a valuable training resource that could support space-related activities in Africa, including initiatives arising from the workshop and subsequent development of a GCOS Regional Action Plan.

Plenary discussion following the preceding three presentations centred on the following topics:

- Several participants reiterated the urgent and broad ranging requirements for training and capacity-building and for investments in observational infrastructure.
- The significant potential of RANET for dissemination of additional useful products was noted and its flexibility in coupling to other dissemination mechanisms such as amateur radio was highlighted.
- Speakers emphasized the potential of satellites to provide greatly improved telecommunications in Western and Central Africa.
- Participants underlined the valuable resource represented by CRASTE-LF in developing regional satellite-related capabilities.
- The opportunity presented by the AMMA project to create synergies and develop expertise in the region was cited.
- The importance to agriculture of accurate seasonal forecasts and the need to disseminate such products to rural communities was stressed.

Following the preceding discussion period, participants were given a demonstration of the operation of the PRECIS model by Mr Jenkins, who illustrated its various outputs and other features.

THEME 7: RESOURCE MOBILIZATION

Chair: Steve Palmer (UK Met Office)

On the final day of the workshop, Mr Jim Williams (UK Met Office) delivered the opening presentation on the theme of Resource Mobilization. He began by stressing the need for National Meteorological Services to re-invent themselves to become more attractive to both donors and their own governments. He suggested that a two-pronged resource mobilization strategy could be useful: (1) focus on what he called the "global meteorological partnership" of advanced Meteorological Services to achieve improvements in observational networks, telecommunications, and data systems, and (2) target donors for support to enhance production and delivery of useful services to client communities. He pointed out that when approaching donors it is vitally important to be aware of their priorities and to tailor resource requests to these priorities. In this context, he noted that the OECD's long-term development agenda places priority on reducing poverty and supporting economic growth, with associated goals relating, among others, to education, health, women, and good government and with environment and sustainable development near the bottom of the priority list. He also stressed that donors were, to an increasing extent, providing their assistance to national governments that were then free to decide how to use these resources ("tied aid" was becoming illegal). This development meant that National Meteorological Services and the climate community must develop much closer relationships with their own nation's finance ministries.

Mr Williams went on to identify several donor nations who are increasing their development funding and to suggest a number of themes that might be emphasized in seeking resources. In developing a GCOS Regional Action Plan, themes that might usefully be highlighted include the establishment of sustainable institutions, provision of services to the poor and (more broadly) to the client community, and the need for good observational networks. In his closing remarks, he indicated that ACMAD represented a particularly valuable environmental information and communications partnership for Africa and proposed that each sub-region and each National Meteorological Service should become a partnership or institution for *development*. He advised "thinking forward" and striving to become institutions totally adapted to the 21st century. He also suggested that out-of-date working practices and facilities should be traded-off in return for resources for new infrastructure projects.

In a second presentation on resource mobilization, Mr Christophe Besacier (France) began by reminding participants that meteorology/climatology was a "public good" requiring long-term investments, but that it was also one with low political visibility. This made it difficult to obtain resources for systematic observations. The climate change community was, however, a special user of climate data and products, one that was relied upon by decision-makers for information to support decision-making. Consequently, its needs for scenarios and related information provided an opportunity for Hydrometeorological Services. Mr Besacier also pointed out that the climate change issue has generated a significant new requirement for cooperation and collaboration between developed and developing nations, imposing on the developed nations a new and real need for assistance from less developed countries. The shared concerns and this new need justified the provision of support to developing countries, providing a real opportunity to obtain resources for worthwhile climate related initiatives in these countries. In consequence, there were two key themes that usefully could be highlighted by the climate community in Africa in seeking resources:

1. Responsiveness to the needs of developed countries for observational data, supporting adaptation policies, and contributing to debate on the issue; and
2. Responsiveness to the needs and interests of the developing countries themselves, for example through technology transfer and implementation of adaptation policies that facilitate equitable and sustainable development in the nations of the South.

The final resource mobilization presentation was prepared by Messrs. Saidou Koala and Bruno Gerard (ICRISAT) and addressed the African experience in mobilizing resources. Reiterating the importance of "donor intelligence," Mr Gerard outlined a series of pragmatic considerations and guidelines that need to be kept in mind when preparing proposals to funding institutions and donors. The content of proposals should target a donor priority, represent a useful and feasible project, lie within the proponent's field of expertise and be linked to a global strategy. Equally important, the format of the proposal should match the requirements established by the donor and it should be clear and well presented. Preparation of long documents with many annexes should be avoided. The advice of external reviewers could be useful in finalizing submissions and proponents should not be afraid to seek such advice. Marketing and follow-up with donors is, he pointed out, very important, and a personal approach sometimes proved effective in obtaining support. Mr Gerard also noted that proposals for small projects could consume as much time as larger initiatives and that pursuit of larger projects could sometimes be more cost effective. The value of a team approach in seeking support for integrated projects was also emphasized. As an example, national hydrometeorological services might work with client sectors to establish teams and develop joint projects.

The plenary discussion that followed the resource mobilization presentations was lively. The following issues and considerations were highlighted:

- It was emphasized that it was important to sensitize the population regarding the need for observational networks to support the provision of warnings and other important services. This was seen as an effective means of influencing decision makers to provide adequate resources for climate networks and programmes.
- The particular challenge presented by the total destruction of observational networks and related facilities during wars and civil disturbances in some countries was highlighted. Participants suggested that the experience of others who had dealt with similar circumstances could prove useful in rebuilding infrastructure and capacity. Other advice included the following: (1) identify which donors were

providing reconstruction assistance in the country in question and target these donors, (2) seek the most cost-effective systems for production and delivery of useful products to the client communities, (3) demonstrate a serious intent to deliver services to rural areas, and (4) develop a small, effective, NMS oriented toward the future.

- Output, or "what will be done with the money," was identified as a key consideration of funding agencies in assessing project proposals. Other important factors included coordination, consistency, and partnerships with civil society, including the private sector.
- Project evaluation should be kept in mind when developing project proposals. It should address: (1) the results to be expected from the project, (2) the potential for learning from it, (3) possible follow-on projects, and (4) consistency of projects. It was also stressed that proposals should be as concise and as brief as possible.
- Interveners also cited the need to emphasize the linkage between proposed project activities and the outcome of the project, addressing such questions as: Why this project? What will it do? What will be the outcome in relation to a particular priority? How can it be made sustainable?
- Proposals designed on a regional basis and with funding directed at regional or multi-national activity may have a better chance of success with some donors. The GEF, for example, prefers regional projects and, while it can take up to 3 years to obtain a project approval, the GEF provides as much as $1 million to assist in developing good project proposals.
- Conversely, it was pointed out that since national or sub-regional projects are easier to prepare, they may offer a better benefit-to-cost ratio to some. However, they must be clearly linked to global priorities to maximize their likelihood of success.
- The advice, assistance and involvement of ACMAD, WMO and other sub-regional offices and bodies should be sought to strengthen project proposals and enhance their sustainability.

THEME 8: TOWARDS A GCOS REGIONAL ACTION PLAN

Chair: Hassan Saley

Mr Alan Thomas, Director GCOS Secretariat, delivered the opening remarks on this theme by outlining some major considerations in developing a GCOS Regional Action Plan. He reiterated that, from a GCOS perspective, systematic observations encompassed climate system observational, telecommunications, data management and data exchange infrastructure, and the production and dissemination of climate products to users. He then briefly drew attention to several key issues stressed by workshop participants, including the need to enhance visibility, to improve coordination, to enhance and sustain the performance of GSN and GUAN stations, and to pursue improvements in data management, data exchange, and data rescue. He noted the vital importance of *in-situ* observations and networks, both in their own right and in providing ground-truth for satellite data, and the critical challenge presented in mobilizing resources. He indicated that GCOS, in cooperation with ACMAD, planned to convene a small, well-balanced, writing group of approximately 15 people to prepare a first draft of a GCOS Regional Action Plan for Western and Central Africa. He also indicated that his office, along with regional partners, would facilitate and support the planning and writing process. Noting that the draft plan would address high-priority issues identified during the Niamey workshop, Mr Thomas encouraged participants to submit related project proposals, to give thought to potential sources of funding to implement these projects, and to take ownership of the development and implementation of the GCOS Regional Action Plan for Western and Central Africa. He indicated that the draft Plan prepared by the writing group would be distributed to all workshop participants for review and comment prior to its finalization. The final Action Plan would be presented to SBSTA and placed on the GCOS web site. In closing, Mr Thomas reiterated the need for a GCOS Regional Action Plan to be sharply focused on the highest priority needs and deficiencies.

Following Mr Thomas's remarks, Mr Mama Konate (Mali Meteorological Service) presented a concise overview of issues raised during the workshop, drawing upon information from session rapporteurs. His summary reinforced the following points:

- Given the important role played by observational data in areas such as early warning and disaster preparedness, detecting climate change, etc., it is desirable to increase the visibility of observational activities within national governments and internationally.

- A need exists to establish or improve GCOS coordination mechanisms at national and regional levels, involving both providers and users of climate related data/information.

- A need exists to improve climate data collection, quality assurance, data exchange, data management, and archiving.

- It is important to develop a regional strategy and to plan for climate data rescue using the best technology available.

- Telecommunications represent a continuing problem in some locations, and an urgent need exists to improve the timely transmission of observational data.

- Implementation of GOOS-Africa would address important GCOS-related needs in the region. In particular, needs exist for additional sea level observations from GPS-equipped stations and for the maintenance and expansion of the PIRATA ocean buoy network.

- A need exists to improve monitoring of terrestrial variables, such as albedo, soil moisture, and vegetation cover.

- A need exists to address the deterioration of hydrological networks and to enhance groundwater monitoring.

- A need exists for capacity-building in relation to satellite applications.

- Training in the application of the PRECIS model is important to all countries in the region in planning for adaptation to climate change.

- The AMMA project has the potential to significantly improve the ability to predict the onset and ending of the African Monsoon and to better describe climate change and its impacts through reinforcement of the existing network by adding systematic observations in key sensitive areas.

- ASECNA drew attention to the vulnerability of coastal airports and encouraged the further development of regular marine forecast and warning programmes.

- The continued implementation of RANET is desirable.

- A need exists to develop a resource mobilization strategy for the region, noting that poverty reduction and economic development are among the current priorities of donor institutions.

During discussion following Mr Konate's summary, workshop participants raised or re-emphasized the following topics:

- The vital importance of achieving improved coordination and partnership between National Meteorological Services and other regional and national institutions involved in climate-related activities. In this context, the need to establish national Focal Points for GCOS was stressed. It was suggested that Directors of National Meteorological Services might assume this role.
- The need to address the difficulties faced within many countries in mobilizing internal domestic resources for systematic observations.
- The need to ensure the participation of national authorities in identifying user needs for climate system data and information.
- The need to optimize climate system observing networks at the national and regional level and to improve collaboration between operators of the various networks.
- The importance of ensuring sustained improvement in the operation of GUAN stations in the region.
- The need to reorient National Meteorological Services towards sustainable development objectives and to link proposed initiatives to high-priority issues such as poverty, health and climate change.
- The need for the oceanographic and meteorological communities to work closely together on issues of common interest within the framework of GCOS.
- The importance of closer cooperation between the atmospheric and hydrological communities in their observational activities.
- The importance of enhancing multidisciplinary approaches at the national and regional level.
- The importance of ensuring stakeholder and community involvement in programmes. It was pointed out that an important feature of the automatic weather station programme in South Africa is that it empowered rural communities by providing information they could use and reimbursed them for assistance in operating stations.

CLOSING CEREMONY

Mr Moussa Labo, Director of the Meteorological Service of Niger officiated at the workshop's formal closing ceremony. He indicated that the Minister of Transport of the Republic of Niger had relayed to him the positive response of attendees at the workshop and conveyed his thanks to all participants for their contribution to its success. In formally declaring the workshop closed, Mr Labo expressed his personal desire that the process initiated in Niamey would continue and that it would lead to the timely completion of an effective GCOS Regional Action Plan for Western and Central Africa.

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Annex 1

AGENDA FOR THE
GCOS REGIONAL WORKSHOP FOR WESTERN AND CENTRAL AFRICA

Niamey, Niger 27-29 March 2003

DAY 1

8:30-9:30 **Opening Ceremonies - Moussa Labo: Master of Ceremonies**

GCOS/WMO, Alan Thomas, Director
UNDP, Steven Ursino, Resident Representative
IOC, Justin Ahanhanzo
Minister of Transport, Niger, Souleymane Kane

9:30-9:45 **Break**

9:45-10:45 **Theme 1 Setting the context**
Co-Chairs: Hassan Saley (CNEDD) Laoualy Ada (UNDP)

1. Overview of GCOS--Alan Thomas, Director, GCOS
2. Developing a Regional Action Plan: goals for the meeting—Desmond O'Neill, Consultant to GCOS
3. GCOS, the UNFCCC, and the importance of national reporting on systematic observation—William Westermeyer, GCOS
4. Discussion

10:45-11:15 **Break**

11:15-13:15 **Theme 2 User Needs for Climate Observations**
Chairmen: Hassan Saley (CNEDD) Laoualy Ada (UNDP)

1. General overview of user needs from the perspective of a national climate change coordinator—Momadou Honadia, Burkina Faso
2. Observational needs for early warning; monitoring extreme climate events (droughts and floods)—Alhassane Diallo, AGRHYMET
3. Observational needs for agriculture: addressing the challenges of the semi-arid tropics—Saidou Koala, ICRISAT
4. Observation needs for climate and health issues—M. Thomson, IRI and I. Jeanne, CERMES
5. Discussion and Workshop Recommendations

13:15-15:00 **Lunch**

15:00-18:00 **Theme 3 Atmosphere: Status, Deficiencies, and Needs**
Chair: Régis Juvanon du Vachat (Météo France)

1. GSN and GUAN: A regional perspective—Mahaman Saloum, Met Services, ASECNA-Niger and WMO Rapporteur on Regional Aspects of the Global Observing System
2. GSN and GUAN: A GCOS review of key issues—Richard Thigpen, NOAA

3. The contributions of ASECNA to climate observing systems—Mohamed Sissako, Met Department, ASECNA

Break

4. Automatic weather stations in Tanzania: an example—Rydall Jardine, South African Weather Service
5. A French contribution to DARE: development of a climatological database using CLICOM format based on historical data from 14 countries in Central and Western Africa - Daniel Roux, Météo France
6. Data Rescue Africa - Richard Thigpen, NOAA/NWS
7. Discussion and workshop recommendations

DAY 2

8:30-10:30 **Theme 4** **Oceans: Status, Deficiencies, and Needs**
Chair: **Kwame Koranteng (IOC, GOOS-Africa)**

1. Overview of GOOS-Africa—Justin Ahanhanzo, GOOS
2. Monitoring sea level rise and impacts in Africa—Angora Aman, IOC Cote d'Ivoire
3. PIRATA in Africa—Mark Majodina, South African Weather Service
4. Observations and Requirements for Modelling Component of GOOS-Africa—John Mungai, Kenya Met. Dept.
5. Discussion and Workshop Recommendations

10:30-11:00 **Break**

11:00-13:00 **Theme 5** **Terrestrial Observations: Status, Deficiencies, and Needs**
Chair: **Kwame Koranteng (IOC, GOOS-Africa)**

1. Ecological observations for climate impacts—Yamna Djellouli, SACOM-ACMAD and University of Le MANS
2. The impact of climatic variability on water resources: the case of the NigerBasin—Niger Basin Authority
3. Discussion and workshop recommendations

13:30-15:30 **Lunch**

15:30-19.00 **Theme 6** **Crosscutting Topics**
Chair: **Christophe Besacier (MAE France)**

1. Overview of the PRECIS model: observational needs to support regional climate prediction in Africa—Geoff Jenkins, Hadley Centre, UK Met Office
2. African Monsoon Multidisciplinary Analysis (AMMA Project)—Arona Diedhiou (IRD/LTHE, Grenoble) and Daniel Roux, Météo France

16.30-16.50 **Break**

3. Dissemination of climate predictions to the rural communication system and community-climate observing system—A. Nassor, Climate Unit, ACMAD
4. Remote sensing in the service of meteorology and climate—AbdelhakTrache (CRASTE-LF)
5. Discussion—key needs and priorities

6. Demonstration of the PRECIS model—Geoff Jenkins, Hadley Centre, UK Met Office

19:00-20:00 **Event hosted by the Niger Met Service**

DAY 3

8:30-10:00 **Theme 7 Resource Mobilization**
Chair: Steve PALMER (UK Met Office)

1. Resource mobilization issues 1—Jim Williams (UK Met Office)
2. Resource mobilization issues 2—Christophe Besacier (MAE France)
3. African experience—Saidou Koala and Bruno GERARD (ICRISAT)
4. Discussion

10:00 -10:30 **Break**

10.30 -12.30 **Theme 8 Towards a GCOS Regional Action Plan**
Chair: Hassan Saley (CNEDD)

1. Major Considerations in developing an GCOS Action Plan—A. Thomas,Director, GCOS Secretariat
2. Reports by Rapporteurs
3. Synthesis of Key Issues—Mama Konate, Mali Meteorological Service
4. Discussion of Priorities and Next Steps.

12.20 **Formal Closing** Ceremony—Moussa Labo, Director, Niger Meteorological Service and WMO Permanent Representative

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Annex 2

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THE GLOBAL CLIMATE OBSERVING SYSTEM AND THE GCOS REGIONAL WORKSHOP PROGRAMME

Alan Thomas
Director, GCOS

Mission of GCOS

The Global Climate Observing System (GCOS) was established in 1992 to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users. It is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU). GCOS is intended to be a long-term, user-driven operational system capable of providing the comprehensive observations required for monitoring the climate system, for detecting and attributing climate change, for assessing the impacts of climate variability and change, and for supporting research toward improved understanding, modelling and prediction of the climate system. It addresses the total climate system including physical, chemical and biological properties, and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes. Although GCOS does not make observations or generate data products itself, it does stimulate, encourage, coordinate and otherwise facilitate the taking of the needed observations by national and international organizations in support of both their own requirements and of common goals.

Purpose of the Workshop

The United Nations Framework Convention on Climate Change (UNFCCC) has recognized the importance of research and systematic observation. Further its Conference of Parties (COP) has noted that high-quality data for climate-related purposes is not available in many instances due to inadequate geographic coverage, quantity and quality of the data produced by current global and regional observing systems. Most of the problems occur in developing countries, where lack of funds for modern equipment and infrastructure, inadequate training of staff, and the high costs of continuing operations are often the major constraints. Decision 5/CP.5 in 1999 invited the Secretariat of the Global Climate Observing System, in consultation with relevant regional and international bodies, to organize regional workshops to facilitate improvements in observing systems for climate. The central goals of the GCOS Regional Workshop programme are:

- To assess the contribution of the region to GCOS baseline networks;
- To help participants understand guidelines for reporting on observations to the UNFCCC;
- To identify national and regional needs and deficiencies for climate data (including needs for assessing climate impact and conducting vulnerability and adaptation studies; and
- To initiate the development of Regional Action Plans for improving climate observations.

Expected Outcome

The GCOS Regional Workshop for Western and Central Africa is designed to help participants identify deficiencies in climate observing systems and to focus their attention on developing a regional strategy to address priority needs for observing systems. Given the strong recognition by the UNFCCC Conference of the Parties (COP), a substantial opportunity now exists to obtain the support of the Parties to make much needed improvements in observing networks that will benefit not only the global concerns of COP but also national and regional purposes. GCOS would like to see participants develop a regional strategy—a Regional Action Plan—that identifies high-priority observing system needs for the region and that can be used as the basis for seeking funding to address these needs. The first steps in developing such a plan can be taken at this workshop, and a draft version of the plan could be prepared and circulated for approval by perhaps July 2003. With resources limited both nationally and internationally, a regional plan for improving observing systems is practical, achievable, and fundable.

Annex 4

UNFCCC REPORTING GUIDELINES ON GLOBAL CLIMATE OBSERVING SYSTEMS

William Westermeyer
GCOS

The Conference of the Parties (COP) to the 1992 UN Framework Convention on Climate Change (UNFCCC) recognized the importance of systematic observations in Articles 4 and 5 of the Convention to further the understanding of climate change and to reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude, and timing of climate change. In a series of decisions related to systematic observation following the entry into force of the UNFCCC, the COP has reaffirmed the importance of systematic observation and noted the inadequate state of observing systems, particularly in developing countries.

Recognizing the inadequacy of climate observations in many parts of the world, the COP in 1998 urged nations to undertake programmes of systematic observation and requested them to submit information on national plans and programmes related to observations (Decision 14/CP.4). The issue was addressed again in 1999 when the COP urged Parties to address deficiencies in climate observing networks and adopted guidelines for reporting on systematic observations. The COP further invited Parties to provide detailed reports on systematic observation in accordance with the guidelines (Decision 5/CP.5).

The preparation of detailed national reports is voluntary for Parties not included in Annex I, that is, for most developing countries. However, GCOS is encouraging all countries to provide such reports, either as stand-alone documents or in conjunction with national communications. GCOS regards reports from developing countries as important for three reasons. First, the reports will help raise the level of awareness among the delegates to the UNFCCC about needed improvements in observing systems. Second, individually and collectively, the reports will provide essential information that can be used in making the case for upgrading climate-observing systems and will increase the visibility of observing system issues at COP meetings. And third, the reports will help form the basis for the development of national observing system plans.

The UNFCCC guidelines are a set of general instructions that outline the preferred approach for reporting to the COP on the national status of meteorological, atmospheric, oceanographic, and terrestrial observing systems. GCOS has also produced some notes on the guidelines that provide additional information on the preparation of national reports. Both the UNFCCC guidelines and the GCOS notes are available on the GCOS website (http://www.wmo.ch/web/gcos).

There is no deadline for the preparation of national reports for non-Annex I countries. However, GCOS urges that reports be prepared as soon as feasible in order that observing system issues can be adequately addressed by the Parties to the UNFCCC. It would be useful to include a statement in the Regional Action Plan that will be developed at this workshop encouraging countries to complete their national reports as soon as possible, if they have not already done so.

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Annex 5

THE STATE OF AND NEEDS OF WESTERN AFRICAN STATES IN SYSTEMATIC OBSERVATIONS OF CLIMATE

Momadou Honadia
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General

Systematic observations of climate appeared several hundred years ago in conjunction with certain natural sciences in order to be able to explain various phenomena. They were also developed for strategic and military reasons. The concept could be defined in simple terms as a collection of techniques and means required to record the development of the climate system. Systematic Observations are a key topic in the WMO's annual programme and are an important pillar in the research undertaken by the Intergovernmental Panel on Climate Change (IPCC).

In the framework of international negotiations, the adoption of decisions 14/COP4 and 5/COP5 of the UNFCCC relative to systematic observations of climate testifies to the importance given to this subject by the international community. The parties urged the GCOS Secretariat to undertake a programme of assistance to developing countries in the field of systematic observations. This is therefore an important matter for developing states.

Why systematic observations?

Past, present and future scientific studies on the evolution of climate and climate change have and continue to have as the basis of their calculations and evaluation the information provided by various observation systems. Furthermore, they enable and facilitate the setting up of a number of activities, such as:

- Establishment of data banks
- Feasibility of analyses, simulations, various evaluations, studies of impact on the environment and socio-economic impacts.
- Follow-up on climate change and state of the environment.
- Definition of policy and measures
- Decision making

Field of application

Systematic observations of the climate involve several types of applications and extend to several areas in science and development. To this end, we can distinguish, without being too exhaustive, the following fields, which are themselves a function of the level of change and development of states.

- **Sciences**
  - ♦ Climatology, meteorology, oceanography, astronomy;
  - ♦ Hydrology and water resources
  - ♦ Pollution

- **Sectors of development**
  - ♦ Agriculture/

- Forestry, animals
- Hydraulic resources
- Health
- Fishing, etc. water

- **Techniques of teledetection**
  - Private geographical IT firms
  - Satellite images

- **Applied sciences**
  - Statistical units or institutes
  - Population dynamics, etc.

Link with Climate Change

Negotiations on climate change have identified systematic observations as an important and unavoidable area for the protection of the climate system. In Article 4, UNFCCC invites contracting parties to develop cooperation in view of understanding the causes, effects and extent and time scale of climate change in relation to research; which a direct link between systematic observation and scientific research.

In the application of this provision, States have also taken into account the close link to Article 5 of the convention and the production of information required for Articles 4.1.a and 12 of the same convention, i.e.,

-National communications
Biophysics information
Inventory of GES
Evaluation of the vulnerability and adaptation options
Studies of reduction in development sectors
Policy and measures
- The reference for capacity reinforcement
- Important for the transfer of rational and ecological technologies

A glance at national reports

From the experience obtained during the setting up of the UNCCC, developing nations treated this matter quite differently in view of the means at their disposal, time to execute a project for the preparation of the national communication and of course, other imponderables. Thus, we can note:

- **At the approach level**
  - Certain parties have a chapter on systematic observation
  - Others have opted for research and systematic observations
  - Remaining countries did neither

- **At the research level**
  - Certain parties have mentioned research activities
  - And other programmes of which the execution is linked to the availability of funds. Among other there are themes related to
    - Climate systems
    - Ocean-atmosphere interactions
    - Ecosystems and biological diversity

- Biochemical cycles
- Climate forecasts
- The El Niño and La Niña phenomena
- Studies on the vulnerability and adaptation of models of general circulation
- Studies on the reduction of greenhouse gases.

- **At the level of systematic observations**

Certain countries have mentioned for information purposes the logistic heritage and activities undertaken or underway. The following information has been collected.

-The state of observation networks
-Plans and programmes for observations (meteorological, atmospheric, oceanographic)
-Lists of stations (meteorological, climatologic, synoptic, satellite, maritime, hydrological, flood forecast, storm and tides, radar, etc.).

- **At the level of requirements**

--Capacity-building
- ♦ Production of maps
- ♦ Setting of data bases
- ♦ Training at different levels
- ♦ Research and finance activities

--Financial means needed for the acquisition of tools, training and the application of programmes
--Equipment and … to make reliable observations.
--Enlarging the network in order to constitute as large and varied a database as possible.

Problems and constraints

These are well known in all developing countries. The problems can be seen through the following insufficiencies:

Irregular observations without follow-up
Insufficient data collection
Archaic data collection systems
Unqualified personnel
Outdated software
Some have expressed their membership with organizations such as GCOS, WMO, PCM, etc.

Methodology of evaluation of needs

In the framework of the setting up of the UNDP FEM project Top-UP for the preparation of the national communication on climate change in the countries of the West African sub region, the following methodology was applied:

Organization of teams – several options are possible
Multi disciplinary team of researchers
Study office
Independent consultants

Preparation of grills with an end to preparing recapitulative tables containing the following variables

Establish a list of structures in function to their domain
Classification in function to the frequency of observation (stand-by, daily, monthly, quarterly, twice yearly, on request, etc.)
Allocation in function to the mode of collection (direct measures, inquiries/samplings, teledetection, other)

Elaboration of a programme--collection of information on the variables – (wind, P°, T°, etc.)

Utilization and analyses
Institutional needs/expression of needs (human resources, logistics and equipment)

Parameters for evaluation

Evaluation presents characteristics based on the parameters grouped around diagnostics, the expression of needs and the institutional framework, which enables sustaining acquisitions. The most frequent and simple are:

Diagnosis of the existing

Human resources
Level of training
Type, number and quality of equipment
Adequate premises
Access to information

The expression of needs
Training
Recruitment
Equipment
Finances

Definition of an institutional and legal framework
Focal point for structure and/or networking
Diffusion of information under conditions (contracts, conventions, etc.)
Legal texts for managing the networks and sharing data, etc.

Characteristics of institutions in Western Africa

Western Africa has many facets with regard to the languages spoken and the level of development of States, however, in the domain of systematic observations as in other fields, gaps and insufficiencies are quite similar. The following inventory describes the characteristics of this region, the needs of which are enormous and urgent.

Heritage

Insufficiency of essential and performing equipment
Aged /decrepit tools, when available
Inadequate premises
NTIC not prevalent as out of reach of States
Outdated software
Reduced qualified personnel

Data banks insufficiently maintained and often diversified and multiple – problem of reliability

Needs (national and regional)

Adequate hardware and software
Equipment for observations and interpretation (satellite, stereoscope, ink jet.)
Tools for:
Rolling equipment
Training for personnel at all levels
Information needs

Conclusion

The systematic observation of climate and research are sensitive fields and are the basis of a better understanding of climate change. Statistics and data banks are corollaries; which enable good national communications and to be equipped for international negotiations on climate change.

The evaluation of needs for systematic observations in developing countries, particularly in Western Africa presents an unenviable image. Software is obsolete and impoverished, and personnel are inadequately trained. Furthermore, needs are huge in all areas, from equipment up to the institutional framework, including recruitment and training. Almost the whole sector of development is interested in this question, the main limiting factor of which is finance.

Bilateral and multilateral cooperation, FEM and capital should be used to participate actively to attenuate the effects of climate change, which are recognised as a global ecological problem with responsibility for all concerned.

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GLOBAL CLIMATE OBSERVING SYSTEMS AND THEIR RELEVANCE TO HEALTH IN WEST AFRICA

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Climate impacts on human health directly through, for example, heat stress or UV induced melanomas, and indirectly through its role in determining:

a) agricultural output and consequently food security, which directly effects nutritional status.
b) economic output via agricultural exports, hydrological power etc., which affects the ability of individuals, communities and national governments, to maintain nutritional status and prevent or treat disease.
c) seasonal and inter-annual demographic processes (e.g. seasonal labour migration and environmental refugees) and associated changes in risk of infection.
d) the spatial and temporal distribution of climate related infectious diseases (e.g. malaria, rift valley fever, meningococcal meningitis).

Climate observing systems have been designed around the needs of the climate science community and major economic sectors in society such as agriculture. The recent recognition of the importance of ill-health as a determinant of poverty as well as an outcome suggests that the climate community has an increasing role to play in reducing the social and economic burden of ill-health. This can be achieved through the development of climate products designed to improve our understanding the spatial and temporal dynamics of climate related ill-health. The integration of climate information, derived from ground and space-based observations, into health decision-making processes is today a challenge for both the research and policy making communities.

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Annex 7

GCOS SURFACE AND UPPER-AIR NETWORKS: AN UPDATE

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The GCOS Surface and Upper-Air Networks (GSN and GUAN) were established in 1999 and 1996 respectively to form a critical baseline calibration network for use in a variety of climate activities. The identification process that was followed was similar for the two networks. A small group of scientists used lists of existing stations around the world and then developed a ranking process that rated each station on its geographic location and its historical record. The objective was to identify stations that provided a good geographic coverage of the globe and also had long histories of operation so that there would be a good long-term historical database. A description of the identification process for GSN was reported by Peterson, Daan, and Jones in the Volume 78, No. 10 October 1997 issue of the Bulletin of the American Meteorological Society.

Recent interest in remote observing systems, satellite data, aircraft-mounted instruments, and the like has resulted in several WMO commissions reiterating the importance of the operation of these networks. These networks will be needed to calibrate and reconcile these other observing systems. Yes, new technology may change the way we observe the climate around the globe but these backbone calibration networks will be essential for many years to come.

The identified stations are by definition an integral part of the existing WMO World Weather Watch / Global Observing System. They are listed in WMO Volume A and further identified in the Regional Basic Synoptic Networks (RBSN) and the Regional Basic Climate Networks (RBCN). The GSN is comprised of 981 stations as of January 2003 and the GUAN has 152. The performance of these networks has not yet achieved the level that is needed from such important networks. There are a variety of reasons for this.

First, observing stations around the world do not forever remain in operation. The host country may make changes in the operation or locations of their stations, errors have existed in the identification of stations and the maintenance of the lists, equipment has become obsolete and supplies have become prohibitively expensive for some operators.

Also stations may not prepare and send the monthly summary bulletins (CLIMAT and CLIMAT TEMP) upon which the primary monitoring activities are based. Thus some stations are identified as “silent” for GCOS purposes when in fact they are operating on a fairly regular schedule. It has been reported for some time that roughly 40% of the stations in these two networks are “silent”, although more recent analyses indicates that the networks are actually working somewhat better. A good example is that in the most recent report from the Hadley Centre based on reports transmitted on the GTS, 34 of the 152 GUAN stations did not send CLIMAT TEMP reports while a report based on individual soundings prepared by NCDC showed only 10 “silent” stations. In addition network stations are generally not achieving the target performance requirements especially for the GUAN that specifies soundings twice a day and levels of 5 hPa.

Network performance requirements, both minimum and target are found in the “Guide to GCOS Surface and Upper-Air Networks: GSN and GUAN (GCOS-73).” This guide also contains the GCOS Climate Monitoring Principles as well as the format for the submission of historical data and explanations of the performance indicators used by the monitoring centres. This Guide may be found on the GCOS Secretariat home page. (http://www.wmo.ch/web/gcos/gcoshome.html).

Another serious deficiency in the implementation of these networks so far is the lack of historical data from many of the stations. The issue may be either political, as some countries do not want to make their historical data available or it may be a technical issue as the historical data are either lost or not in a suitable form. In any case of the 981 stations in the GSN, historical data for only 361 stations is in the NCDC archive today making the GSN substantially less useful for long-term climate analyses. There are current initiatives, from France and the US, that are intended to address the rescue of historical data. This historical data are important to the host country, to countries within the region, and to the global climate community.

Recently there has been a good deal of attention directed at the operation of these critical networks. Progress, though slow, is being made through a variety of means, such as the regional workshops (like this one) conducted by the GCOS Secretariat, the efforts of the World Weather Watch and GCOS to correctly identify network stations, the analysis of operational problems, and improvements to the monitoring functions.. Regional Action Plans have been developed and our knowledge of the problems and operational issues has improved. Working together, we can insure that these globally important networks operate well.

Recommendations/Suggested Projects
For Inclusion in the Regional Action Plan

1. Establish Regional and National Focal Points for the RBSN and RBCN, especially the GSN and GUAN Stations

Objective: To establish regional coordination that will insure that the stations in these networks are correctly identified and operating to expected standards.

Project Description: Each host country should identify a national focal point to work with a regional focal point and the World Weather Watch (WWW) to validate that the information in these lists is correct. At the WMO, the WWW maintains and publishes the RBSN and RBCN lists, which include the GSN and GUAN stations. This validation effort will be very important but should not require an extensive effort. After this validation process, the same focal points would become the points of contact for the operation of the stations in their host country. These focal points should assist in the analysis of the root causes of problems at stations in their country. Countries can and should assist each other, and the regional focal point could be the facilitator/coordinator of these activities.

Expected Outcome of this Project: The objective would be the correct identification of every station in the RBSN and RBCN and then the operation of every station up to the expected standard of operation. Performance reports from the various monitoring centres would be routinely used to insure the successful operation.

Risk and Sustainability: There is very little risk with a project of this nature. All countries benefit if all stations are working well and the data are shared, since a regional and global data base is needed for climate impact and vulnerability analyses. Many regions around the world are beginning to take the initiative and develop action plans that address the specific causes of problems in their region.

2. Develop a Regional Plan for Rescuing and Sharing RBSN and RBCN Historical data with Emphasis on GSN and GUAN Stations

Objective: To systematically rescue and then share this important historical data.

Projective Description: A Regional Action plan would benefit greatly if each host country would identify and describe the status of its historical data. Depending on the status and need, corrective action/rescue efforts could be initiated. Both the US and France have recently identified data rescue opportunities that host countries could use.

Expected Outcome of this Project: Host countries would benefit from having their own data in a machine-readable form, and thus they could conduct their own climate analyses. Assuming that all participating countries share the resulting rescued data then regional studies could also be done.

Risk and Sustainability: There is very little risk with such a project except where some countries do not participate. It is generally accepted around the world that climate change is a global issue with regional impacts, not a national issue so there should be strong incentives for sharing this historical data. As noted before, there are sources of assistance available to host countries.

3. Develop a Regional Network Improvement Plan/Proposal

Objective: To develop a prioritized list of regional network Improvement plans/proposals.

Project Description: The National focal points working with the Regional focal point should develop an overall plan for improving the operation of the RBSN and RBCN with special emphasis on the GCOS networks. This plan/proposal should identify specific deficiencies and include cost estimates; then it could be distributed among potential donor organizations and countries for support. (A draft of such a plan has been prepared by the GCOS Secretariat, which could serve as an advisor to this project, if needed.)

Expected Outcome of this Project: An accurate list of network improvements would provide an effective basis for use with potential donor sources and therefore improve the likelihood of funding.

Risks and Sustainability: There is very little risk with such a project except for the possibility that donor/sponsors will not be found. At the present time several potential donor sources are known and if a good case is made perhaps funding for network enhancements can be found.

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Annex 8

CURRENT STATUS AND NEEDS FOR STRATEGIC ACTIONS TO IMPROVE OBSERVING NETWORKS IN AFRICA IN THE FRAMEWORK OF THE REDESIGN OF THE GOS

Mahaman Saloum
Service Météorologique du Niger
Rapporteur for the Regional Aspects of GOS in RA-I
Co-Chairman of OPAG/IOS

Over the past decades, the meteorological community has witnessed an increasing demand for current and historical data related to climate, climate change, and extreme weather events. Such high quality and reliable data are necessary for seasonal and interannual climate prediction, climate change detection as well as for other climate researches. However, the poor performance of Observing System especially in Africa, is a real obstacle for climate research and related activities.

The global observing system (GOS) is one of the three essential components of the World Weather Watch (WWW) programmes. It consists of facilities and arrangements for making measurements and observations at stations on land, at sea and from aircraft, meteorological satellites and other platforms. The Global Climate Observing System (GCOS) was established to improve the availability of climatological data, especially in those areas with poor observational data.

CURRENT OPERATIONAL STATUS OF OBSERVING SYSTEMS IN AFRICA

NATIONAL COMPONENT OF THE RBSN

The results of monitoring exercises on the reception and availability of African meteorological and climate data showed that the availability of these data is very poor. Only very few stations have a good rate of reports, while the availability of reports from the bulk of the stations is either unsatisfactory or completely absent. The situation is worse in those countries undergoing civil war or experiencing social unrest. The latest monitoring results of SYNOP reception are shown in the figure contained in the Annex.

However, the overall implementation of the surface stations in the Regional Basic Synoptic Network (RBSN) has shown an increasing positive stability; for instance, the percentage of synoptic stations with a fairly complete programme is 32% (1999), 17% (1998), 18% (1997), 13% (1996) and 17% (1997).

In view of the poor performance of the African Observing System, and in order to improve the availability of climatological data, the last session of the Commission for Basic Systems (CBS) held in Geneva from 11-15 September 2000 recommended several actions related to its area of responsibility. Thus, the meeting felt that, it seemed better to define the network of CLIMAT and CLIMAT TEMP reporting stations separately and call such a network a Regional Basic Climatological Network (RBCN). It also noted that the list of stations for RBCN could be prepared by the Rapporteur on Regional Aspects of GOS.

THE GLOBAL CLIMATE OBSERVING SYSTEM (GCOS)

The mission of GCOS is to ensure the availability and quality of the atmospheric, oceanographic, and terrestrial data critical to a wide variety of climate users. Such data, obtained through the RBSN and the RBCN from both and space measurements, are needed for:

- Detecting and attributing climate change;
- Monitoring the climate system;
- Modelling, understanding and predicting climate change and its impacts;
- Developing strategies to mitigate potential harmful effects of climate variability (such as response to El Nino conditions) and to adopt human activities to climate change;
- Assessing the potential impacts on natural and man-made systems; and
- Advancing sustainable development.

As integrated parts of the GCOS Initial Operational System, the GCOS Upper-Air Network (GUAN) and the GCOS Surface Network (GSN) have been established to accommodate observed data from most land areas, including many mid-oceanic islands.

The list of the stations in the next RBCN should include GSN and GUAN stations within the Region and be supplemented by other CLIMAT and CLIMAT TEMP reporting stations needed for the description of regional climate features and selected through the same criteria that were used for the selection of GSN stations. Non-RBSN stations which are reporting CLIMAT messages should be taken into consideration

THE GCOS UPPER-AIR NETWORK (GUAN)

STATUS OF THE GUAN IMPLEMENTATION IN AFRICA

A GUAN station is supposed to carry best practices of observation of upper air variables and the provision of TEMP and CLIMAT TEMP data.

Analysis on the implementation of the GUAN in Africa was based on the monitoring results from GUAN monitoring centres (January -July 2001). The results of the analysis are presented in Table 1 below.

Table 1: Percentage of CLIMAT TEMP reports from RBSN and GUAN stations received at GUAN Monitoring Centre.

	Percentage of stations from which reports are received	Percentage of stations from which reports are not received
All CLIMAT TEMP stations	47	53
GUAN stations	17	83

Monitoring period: January-July 2001

Table 1 shows that more than half of GUAN stations are silent while CLIMAT TEMP reports were received from only about 1/6 of the whole stations that are supposed to provide such reports. The non-availability of CLIMAT TEMP reports does, however, not necessarily mean that all the stations in the silent category are not operational, but for different reasons their CLIMAT TEMP reports have not been received.

THE GCOS SURFACE NETWORK (GSN)

STATUS OF IMPLEMENTATION OF THE GSN IN AFRICA

A GSN station is supposed to carry best practices in the observation of surface variables and the provision of CLIMAT data.

As in the case of GUAN, analysis on the implementation of the GSN in Africa, which results are presented in table 2 below, was based on the monitoring results from the GSN Monitoring Centre (January-June 2001).

Table 2: Percentage of CLIMAT reports from all CLIMAT and GSN stations received at at least one GSN Monitoring Centre.

	100%	76-99%	51-75%	26-50%	1-25%	No record received
All CLIMAT stations	5	14	12	6	8	55
GSN stations	6	14	14	7	8	52

Monitoring period: January-June 2001

Table 2 shows that the reception of CLIMAT reports from both GSN and RBSN stations is very poor. In both two cases, only about 1/20 of the stations have a reception rate of 100%, while reports are not received from more than half of both GNS and non-GSN stations. The latter does not mean that all the stations were not operational; they may be making SYNOP observations, but for one reason or the other their CLIMAT reports were not received. The percentage of unsatisfactory stations from which between 1 to 50% were received is about 15% and that of satisfactory stations from which 50 to 89% were received is about 33%.

PROBLEMS OF CLIMATE OBSERVING SYSTEMS IN AFRICA

The inadequacies of the present Climate Observing Systems can, in part, be attributed to the lack of priority given to the gathering, processing and dissemination of climate data. This has led to a number of key deficiencies. The main problems reside in the following areas: i) satisfactory global coverage for many of the essential climate variables has not been archived; ii) regional coverage is not adequate in many areas; iii) observations of selected variables often do not have adequate accuracy or precision to be reliably used as indicators of climate change; and iv) key data sets, although collected are often not effectively exchanged.

REASONS FOR AN INSUFFICIENT LEVEL OF GUAN AND GSN IMPLEMENTATION

There are several reasons for the low/non availability of CLIMAT and CLIMAT TEMP reports from GSN and GUAN stations from Africa. Many African stations have problems maintaining stations because available funds are insufficient to buy new, modern equipment or to carry out day-to-day operations due to lack of consumables, spare parts and qualified staff. Other problems include reports that are generated but are not properly communicated to the related Regional Telecommunication Hub (RTH); reports that are communicated but not according to formatting and prescription; reports that are submitted too late in the month to be included and reports that are otherwise in good order but that are not properly transmitted between RTHs.

WAYS TO IMPROVE THE GUAN AND GSN PROGRAMMES OF OBSERVATION

There is a critical need to develop and or improve the African climate observing system to better understand the role of Africa in the global climate system and the African climate variability and change. This will also enable a better climate monitoring in the continent and thus a better mitigation of the effects of extreme climate events.

The recent strategic plan for the improvement of the GOS in Africa recommended the following actions:

The redesign of observing systems in Africa is important because in many areas the system simply does not exist, whereas in other areas it is satisfactory or could be improved. The issues to be addressed have been identified; they essentially fall into three categories:

- Lack of public infrastructure (electricity, telecommunication, transport facilities, etc.);
- Lack of expertise (lack of staff, lack of training, etc.); and
- Lack of funding (equipment, consumables, spare parts, manpower, etc.).

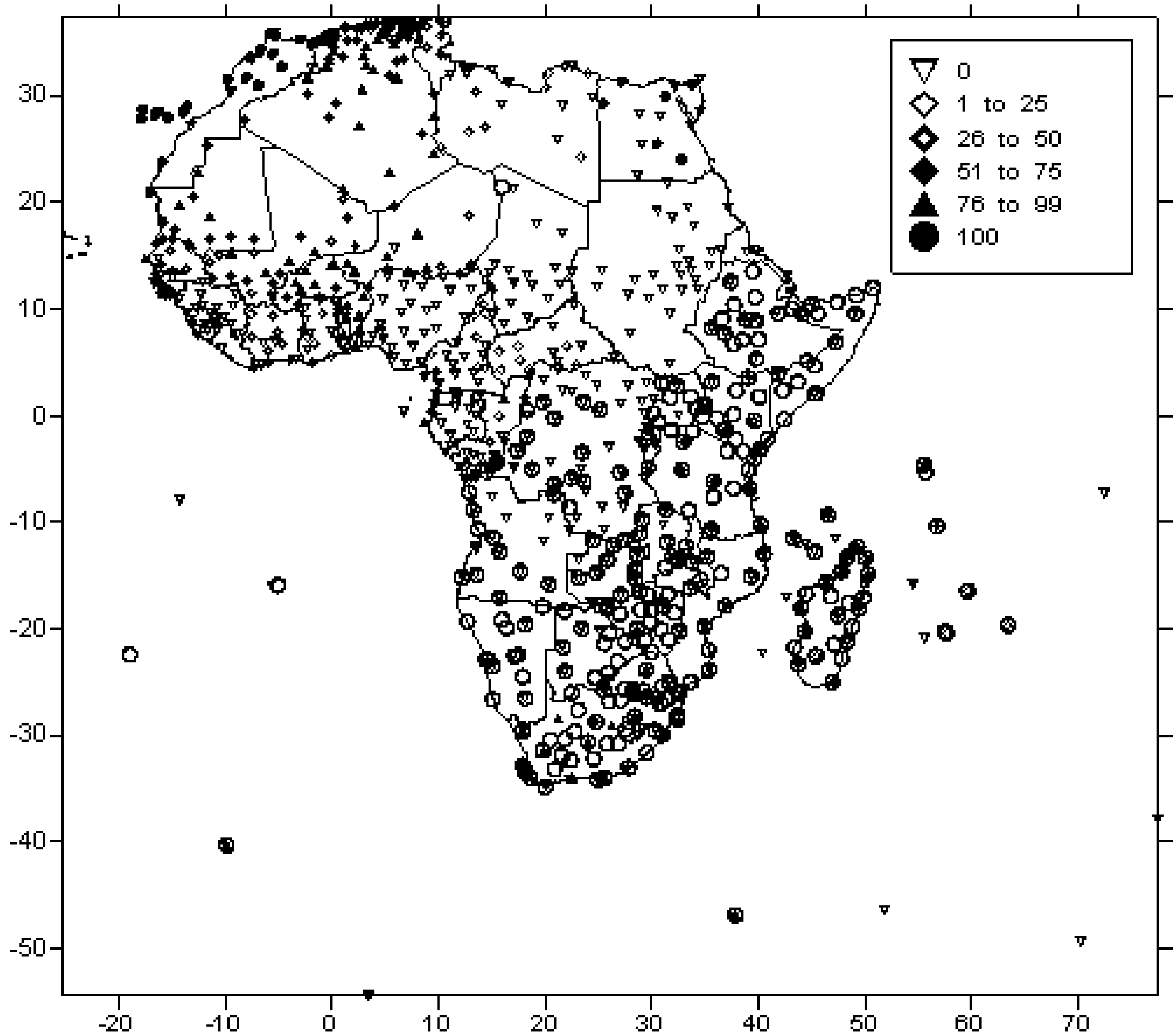
To enable Africa's full participation in the Observing Programmes, due consideration must be given to these three issues. Attention must specially be given to improving current telecommunication facilities in those countries with poor telecommunication infrastructure. The needs for improvement may call for upgrading, restoring, substitution and capacity-building.

It is also expected that many of the problems of the GCOS stations will be overcome as feedback from network monitoring is provided to the stations concerned. The information received also makes it possible for some African countries to receive assistance to maintain their GUAN and GSN stations through appropriate channels, such as through the Voluntary Co-operation Programme.

However, the improvement and full implementation of the GCOS in Africa pass necessarily by the formulation and implementation of national programmes for:

- The reinforcement of the upper air network;
- The implementation of GUAN and GSN stations,
- The reception of satellite and aircraft data;
- The measurement of mid-level temperature;
- The reinforcement of the network for cloud and precipitation observations;
- The creation of a national centre of climate analysis and prediction.

Percentage of CLIMAT reports from all CLIMAT stations received at at least one GSNMC. Monitoring period: January-June 2001



Note: Circled stations are GSN stations in Eastern and Southern Africa

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Annex 9

DATA RESCUE ISSUES & PROGRAM

Claudia Liautaud
U.S. National Weather Service, International Activities Office
Silver Spring, Maryland

The U.S. National Oceanic and Atmospheric Administration (NOAA) embarked on an ambitious program to preserve hydrometeorological data around the world. NOAA, through its National Weather Service (NWS) and its National Environmental Satellite, Data, and Information Service (NESDIS) seeks to preserve and make electronically available to the world community historical, current, and future hydrometeorological data. These observations are the only existing records of directly measured observations at and above the surface and are critical for research and operations in weather and climate detection and prediction. Many of these data sets are currently inaccessible and are in a state of extreme vulnerability and in danger of being lost.

Through this program, the NWS will provide for digital photographing of all available paper-based observational records; the digitization of these data and microfiche and microfilm captured data into ASCII files; and the combination of these newly digitized data with other existing electronic data sets to provide one database with all existing hydrometeorological data. Additionally, based on a country's need and the availability of funding, NESDIS and NWS will provide digital camera systems and digitizing equipment and training so that current and future data can be saved on CD-ROMs and added to the new database for use by the world hydrometeorological community.

The Program will provide the world hydrometeorological community with an inexpensive, sustainable and simple process to rescue hydrometeorological observations and to provide those data in a secure media and an easy-to-use format. The initial Program effort involves the following countries: upper-air data rescue in Kenya, Malawi, Mozambique, Niger, Senegal and Zambia; surface data rescue in the Dominican Republic, Nicaragua and Uruguay. To date, over 100,000 upper-air observations alone have been photographed and stored on CD-ROMs awaiting digitization.

The program has five basic activities:

(1) Assemble and inventory all available hydro-meteorological observational data;
(2) Provide for digital photographing and digitization of all available original historical observational data;
(3) Provide the capability in each project country to photograph and digitize current and future observations;
(4) Establish procedures for data quality control, updating the comprehensive digitized data sets and distributing data sets;
(5) Assist countries in ensuring the digitization and quality control programs continue.

For additional information concerning this project, please contact:

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PROJECT PROPOSALS

Proposal I

Priority Need / Objective:	**Save decaying historical hydro-meteorological data in danger of being lost.**
Recommendation:	**Expand the existing Data Rescue Program to include more African and other countries whose data are not currently available or accessible and are in danger of being lost.**

Proposal II

Priority Need / Objective:	**Make historical hydro-meteorological data readily accessible for use by the world community, either free of charge or at a nominal cost of reproduction.**
Recommendation:	**Expand the existing Data Rescue Program to only include countries adhering to WMO Resolution 40.**

Project Summary

The U.S. National Oceanic and Atmospheric Administration (NOAA) embarked on an ambitious program to preserve hydro-meteorological data around the world. NOAA, through its National Weather Service (NWS) and its National Environmental Satellite, Data and Information Service (NESDIS) seeks to preserve and make electronically available to the world community, historical, current and future hydro-meteorological data. These observations are the only existing records of directly measured observations at and above the surface and are critical for research and operations in weather and climate detection and prediction. Many of these data sets are currently inaccessible and are in a state of extreme vulnerability and in danger of being lost.

Through this program, the NWS will provide for digital photographing of all available paper based observational records; the digitization of these data and microfiche and microfilm captured data into ASCII files; the combination of these newly digitized data with other existing electronic data sets to provide one database with all existing hydro-meteorological data. Additionally, based on a country’s need and the availability of funding, NESDIS and NWS will provide digital camera systems and digitizing equipment and training so that current and future data can be saved on CD-ROMs and added to the new database for use of the world hydro-meteorological community.

The Program will provide the world hydro-meteorological community with an inexpensive, sustainable and simple process to rescue hydro-meteorological observations and to provide those data in a secure media and an easy-to-use format. The initial Program effort involves the following countries: upper-air data rescue in Kenya, Malawi, Mozambique, Niger, Senegal and Zambia; surface data rescue in the Dominican Republic, Nicaragua and Uruguay. To date, over 100,000 upper-air observations alone have been photographed and stored on CD-ROMs awaiting digitization.

The program has five basic activities:

(1) Assemble and inventory all available hydro-meteorological observational data;
(2) Provide for digital photographing and digitization of all available original historical observational data;
(3) Provide the capability in each project country to photograph and digitize current and future observations;
(4) Establish procedures for data quality control, updating the comprehensive digitized data sets and distributing data sets;
(5) Assist countries in ensuring the digitization and quality control programs continue.

Expected Project Outcome

The expected project outcome is to preserve hydro-meteorological data around the world and to make electronically available to the world community, historical, current and future hydro-meteorological data. These data will enable us to better baseline global climate models to provide the entire world with more accurate long-term and seasonal forecasts. The additional data will provide a better basis for hydro-meteorological studies of regional weather and climate, which can help mitigate the economic impact of severe weather events on local economies. Additionally, the effort will provide each participating country with CD-ROMs of the digital images of their original data sets, which in many countries meet the legal definition of original data.

The sequence of anticipated program results would be as follows:

1. Saving the data from additional decay and eventual disintegration/disappearance;
2. Obtaining a complete historical dataset from all participating countries;
3. Establishing digitization capacity within each participating country;
4. Digitizing the historical datasets;
5. Merging the data into existing database for easy access by the world community.

Please note that countries participating in the Data Rescue Program are expected to provide the historical data either free of charge, or at a nominal charge for reproduction, for future use by the world community. It is a prerequisite for admission into the program.

Sustainability Issues

The key to the success of this Data Rescue Program is first and foremost the participating country's recognition of the true merits of this endeavor, otherwise known as "buy-in." Countries have to be convinced that their participation in the program will benefit both their own country and the world community. Without that "buy-in" into the idea that the free and open exchange of hydro-meteorological data will benefit all parties involved, the program will not endure the test of time and/or inevitable leadership changes. But the program also depends on multiple factors not necessarily within our immediate control. More specifically, these factors include:

1. Need of the user community for the data;
2. Willingness of countries to provide data free of charge, or at a nominal charge, for use by the world community;
3. Willingness of the participating country to provide enthusiastic and dedicated in-country staff to manage and execute the program (i.e. identify, assemble, organize, and photograph decaying data, and eventually digitize future data);
4. Commitment by participating countries to provide both human and financial resources to continue the work after the "end" of the project and in case of change in the leadership of the NMS;
5. Continuous donor funding to provide equipment and training for the program. Currently, the Data Rescue Program is being funded by multiple sources, on a case-by-case basis.

Indicative Budget

The total cost of the data rescue project will depend on the total number of upper-air and surface observations available in each country that will require digitization by our US based contractors. Nevertheless, the following cost estimates will provide a general idea of the budget required to undertake data rescue efforts in each country:

Digitization – **N/A**
- USD $3.00 per radiosonde observation
- USD $0.50 per piball observation
- USD $1.00 per surface observation

Equipment - **$9,000**
Each participating country will receive a kit consisting of the following components:
- 2 digital cameras;
- 2 camera stands;
- 2 personal computers with read/write CD-ROM drives (including keyboard, mouse, etc.);
- 2 computer monitors;
- Surge protectors;
- Supply of CD-ROMs to begin the project;
- Supply of pre-addressed postage paid envelopes for shipping of photographed data on CD-ROMs;
- 1 UPS unit (battery) in countries with electrical power source is unstable.

Please note that the Data Rescue Program is currently being funded on a case-by-case basis, by multiple sources. Additionally, the selection of future data rescue countries will be coordinated with the GCOS secretariat and will be based, in part, on the list of GCOS sites identified as priority sites.

Annex 10

CLIMATOLOGICAL DATA RESCUE IN WEST AND CENTRAL AFRICA (SURFACE AND UPPER AIR DATA)

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Scientific Officer
WMO/World Climate Programme

Data Rescue Long-term Strategy

The International Data Rescue meeting held in Geneva in September 2001 has agreed that Data Rescue is:

> An ongoing process of preserving all data at risk of being lost due to deterioration of the medium, and the digitization of current and past data into computer compatible form for easy access.

1. Data should be stored as image files onto media that can be regularly renewed to prevent the deterioration of the medium (cartridges, CDs, DVDs etc.).
2. Data already in computer compatible media should be routinely migrated to storage facilities that conform to changing technologies.
3. Data should be key-entered in a form that can be used for analyses.

These rescued data combined with already available data will enable authorities to have access to better projections that can be used to mitigate loss due to natural disasters and will provide increased information for economic development.

Two types of data need to be rescued: climatological paper archives (upper air and surface data) and data on old computer media not readily readable.

The meeting recommended that paper records be converted in digital images files and archived on CD-ROMs with two copies being kept in different locations. Nearly all WMO Member countries have climatological records in paper form that need to be preserved and accessed.

In December 2002, a Data rescue project supported by NOAA was implemented in Vietnam with the following goal:

> Create an archive of images files of climatological paper data on CD-ROMS in Vietnam by a trained team and proceed to keying the data in a Database Management System. A copy of the CD-ROMS will be sent to NCDC in Asheville, North Carolina where the data will be keyed in.

The new strategy will try to combine parts of the Data Rescue and Archiss activities with the Climate Database Management Systems (CDMSs). It is therefore expected that all new CDMSs being offered to countries will also include equipment for Data Rescue: digital cameras with accessories, PCs, camera stands, etc.

Data Rescue Projects in West and Central Africa

The data rescue in West and Central Africa should be accomplished through:

- The upgrading of hardware and software for the national climatic databases and archives.

- The provision of advanced training to local staff in database management and in the use of national climate data for climate change analyses.

In the framework of the Africa Upper-Air Data Rescue Project supported by the US National Weather Service and NOAA, two countries in West Africa were equipped with digital cameras : Niger and Senegal.

The following countries would need to be equipped with similar equipment:

Benin, Burkina Faso, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania and Nigeria in West Africa

and

Cameroon, Central African Republic, Congo, Gabon, Sao Tome and Principe in Central Africa.

The huge amount of data to be keyed in will necessitate that each country proceeds to enter the data in a CDMS.

Future Climate Database Management Systems (CDMSs)

Systems been evaluated:

Each system was thoroughly tested by an independent team of four experts, with the resultant report summarizing the strengths and weaknesses, the administration requirements and the associated cost of the systems. A comparative criteria table was also produced with respect to the CDMS' evaluation criteria defined by a Commission for Climatology expert *team.*

Name of system	Member offering system
iADAM	**Australia**
CLIDATA	**Czech Republic**
JCDMS	**Jordan**
CLISYS	**France**
CLIWARE	**Russian Federation**
SDCLIM	**Tunisia**
CLIMSOFT	**Zimbabwe**

The reports and the criteria comparison table are posted on the WMO web site at the following address:

http://www.wmo.ch/web/wcp/wcdmp/cdmsfuture/html/evaluation.html

Annex 11

OBSERVATIONS AND REQUIREMENTS NEEDED FOR THE MODELLING COMPONENT OF THE GOOS-AFRICA

John G. Mungai

1.0 INTRODUCTION AND PROBLEM ANALYSIS

Most of the world population lives along the coastal zones. Due to the large population concentration, we have mega cities developing along the coastal zones, and hence industrial complexes and factories many of which emit toxic effluents resulting in pollution of the coastal zones and marine ecosystems. Most marine and oceanographic experts believe that what happens in coastal seas is commonly an interaction of the ocean and atmospheric processes occurring on regional or global scales, and that therefore the potential of the Global Ocean Observing System (GOOS-AFRICA) to address the needs of sustainable integrated Coastal Ocean management in Africa should be accorded priority consideration. Excessive tourism and anthropogenic activities like exploitation of mangrove forest and oil spills have direct adverse effects including coastal erosion, death of coral sub-system and subsequent imbalance in the coastal and marine environment. It should be noted that oil spills inject excessive hydrocarbons into the ocean and coastal seas thus causing serious damage to coral reefs and **Living Marine Resources**.

Ocean processes, like weather and climate, do not confine themselves to political or national boundaries. Thus, the vision guiding GOOS-AFRICA is one of a world where the information needed by governments, industry, science and the public to deal with oceanographic and marine related issues, including the effects of the ocean upon climate, is supported by a ***unified global network*** to systematically acquire, integrate and distribute oceanic observations, and to generate analyses, forecast and other useful end-user products.

In order to detect environmental changes in such a way as to use the information for forecasting, there is a requirement to observe and develop knowledge of oceanographic processes including understanding the predictive skill of replicating (reproducing) these processes through modelling. **Knowledge** comes from observing oceanographic and marine meteorological phenomena, and implies the **need** for data observation, acquisition, analysis, forecasting and dissemination systems. **Understanding** comes from studying the underlying processes that cause these phenomena, and implies the existence of skilled workforce. **Prediction** comes about by using knowledge and understanding through building models that forecast outcomes, and also implies access to appropriate computing and communication infrastructure and the appropriate skills possessed by a critical mass of human resource base.

In establishing an oceanic observing and forecasting system (ROOFS-AFRICA) it has to be remembered that the ocean does not obey political boundaries. Single Ocean Current Ecosystems, like the upwelling of the Somalia Current, which causes huge gyres off the Kenyan and Somalia coasts, cover hundreds of kilometers that cross several boundaries. Other similar examples include the Benguela and the Gulf of Guinea Currents. The temporal and spatial scale of these tele-connections leads to the recognition that regional programmes of data collection, networks for data exchange, analysis and forecasting are a priority requirement.

2.0 JUSTIFICATION

Coastal areas and eco-systems, including small islands, are among the most intensively used regions in all countries. More than 60% of today's world population of approximately six billion people lives there. Coastal areas are not only among the most densely populated

regions of the earth through human settlement, they are also subjected to intensive use through planting of industrial and commercial sites, harbors for marine transport, agriculture, aquaculture, recreation and tourism. This intensive exploitation of the coastal zone environment and bio-diversity has considerable impact on hydrological conditions in coastal regions. Problems arise from conflicts between different uses of coastal land and waters, overexploitation of coastal resources, discharge of toxic wastes and injection of poisonous effluents into coastal waters, elevated risk of storm surge damage, increasing stress by sea level change and accelerated growth of coastal population.
It is therefore essential to develop and strengthen a Regional Ocean Observing and Forecasting System in order to obtain the necessary and relevant marine and oceanographic data in order to build up a pool of knowledge that will help to address the need for judicious utilization of coastal zones resources without destroying their ecosystem balance.

3.0 GOALS AND OBJECTIVES

The overall objective is to create and sustain monitoring and forecasting the behavior of the coastal ecological and marine system for better management of: Coastal erosion; pollution transport for the protection of sustainable living marine resources, recreation and tourism and pristine ecosystems.

4.0 PRIORITY NEEDS AND RECOMMENDATIONS

Objective 1: Creation of Basic Modelling and Forecasting Network in Africa.

TASK/Activities	Expected Output
Identification of Centres and Research Teams interested in participation in Oceanic Modelling and Forecasting	List programmes and products of relevant marine and oceanographic institutions e.g. (i) Western Indian Ocean Directory of Marine Scientist (WIODIR) of the IOCINCWIO; (ii) IOC's Global Directory of Marine (and freshwater) Professionals (GLODIR); (iii) IOCEA; (iv) WIOMAP, etc.
Capacity-building in the requisite marine and oceanographic fields relevant to coastal ocean modelling	• The number and regional distribution of professional/researchers who need specialized training and the field of training. • Training curriculum and material e.g. the BILKO Package. • Training system i.e. workshop, distance learning. • Infrastructure: Data processing systems e.g. computing platforms, Internet, Websites, etc.
Consolidate the network of National and Regional Capacities in Coastal Ocean Modelling and Forecasting.	• Directory and activities of all the network members • Coordinating workshops organized • Virtual discussion Forum established

Objective 2: Develop an Atmospheric and Oceanic Monitoring Database and Communication System.

TASKS/Activities	Expected Output
Ensure the provision of high quality digital bathymetry for the African coastal ocean.	• Map and/or database on bathymetry established • Training to update the bathymetry database completed.
Build historical databank on coastal oceans from relevant National Meteorological and Hydrological Services (NMHSS), coastal Oceanographic institutions and environmental agencies	• Historical databank on coastal ocean established. • Directory of institutions relevant to HOME network and potential field of collaboration (in technology, modelling, databank, etc)
Improve Global Data Processing System (GDPS), data exchange and dissemination.	• List of the relevant data archiving institutions and sources e.g.: RECOSCIX, ODINAFRICA, NODC, IODE, etc.
Incorporate Meteorological Satellite data to fill in the missing Gaps over the Atlantic and Indian Ocean	• List Meteorological Satellites e.g.: ENVISAT, MSG, INDOEX, etc.

Objective 3: Identification and Evaluation of Performance of existing Ocean Models

Tasks/Activities	**Expected Output**
Current state of Coastal Ocean modelling	• Workshop organized and proceedings published
Identify and adapt models that can be customized for the coastal ocean environment	• List of available coastal ocean models Published
Assessment of actual coastal ocean models performance over African sub-regional economic groupings.	Assessment report of Coastal Ocean Models published.

Objective 4: Implementation of Regional and Local Coastal ocean models

Tasks/Activities	**Expected Outputs**
Build African capacities to develop and operate regional and limited area numerical models	• Pilot project conducted in one sub-region/economic grouping.
Identify the adequate observing network for optimum performance of the COMs	• Study conducted and recommendation published and discussed in a workshop.
Develop Application from the Coastal Ocean Models	• Model outputs (Applications) for the different social-economic (Warnings and Advisory) sectors and coastal ocean Environment Protection produced routinely to address mainly

	coastal erosion, pollution, key habitat and ecosystem, tourism and LMR. • Communication system with coastal ocean communities established.

5.0 RISKS AND SUSTAINABILITY

There is the risk of decline of the project due to lack of skilled staff and the necessary infrastructure including Research and Development. The risk could be minimized through:

- Capacity-building by having well motivated and trained staff;
- Provision of the relevant computing facilities to enable the staff generate the required products;
- Establishment of linkages of the various institutions for the exchange of data;
- Collaboration within Africa in research and development together with forecasting activities;
- Political will in Africa between the member states sharing coastal waters for the promulgation of protocols geared towards the protection of the coastal and marine ecosystems.
- Partnerships between established GOOS-AFRICA centres in Africa and those in the developed world need to be initiated and strengthened for the benefit (e.g. through technology transfer, financial support, etc.) of all communities that reside and depend on the exploitation of coastal zone resources.

Annex 12

ASECNA'S CONTRIBUTION TO THE IMPLEMENTATION OF OBSERVING SYSTEMS IN CENTRAL AND WEST AFRICA AND MADAGASCAR

Mohamed Sissoko
ASECNA

Abstract: This presentation addresses the implementation of the Global Observing System (GOS) in Western and Central Africa and will focus primarily on the organization and missions of ASECNA and secondarily on the implementation of the GOS in member States.

Observation Networks

The network is made of a set of surface and upper air stations in airports and for those in which the management has been given to ASECNA in particular contracts. These observing stations are well equipped and use the GPS system in wind estimation. The evaluation of these stations shows a mean performance of 85% in 2002.

The difficulties encountered are:

- The aging of optical theodolites used in the stations making lower level observations,
- The difficulties in providing the necessary products used in preparing hydrogen for sounding balloons.

Telecommunication networks

The national network of member States uses BLU, DCP, telephone, Fax and VSAT installed in some upper air stations.
The regional and international networks use PTT special lines and ASECNA's satellite telecommunication network.

Economic aspects

ASECNA has invested a lot of money to realize the receiving system and data processing equipment of the upper air observing stations.
However, ASECNA is preoccupied by the budget needed to provide a smooth functioning of these stations, mainly the high cost of soundings.

Needs

The needs of ASECNA for atmospheric observations for climate are:

- The renewal of optical theodolites in lower level observing stations,
- The acquisition of hydrogen generators (electrolysers) to lower the management cost of the networks,
- The rehabilitation of classic equipment in the meteorological observing parks (barometers, wind stations, and recording machines).

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Annex 13

A FRENCH CONTRIBUTION TO DARE: DEVELOPMENT OF A CLIMATOLOGICAL DATABASE USING CLICOM FORMAT BASED ON HISTORICAL DATA FROM 14 COUNTRIES IN CENTRAL AND WESTERN AFRICA

Daniel Roux
Météo France

Météo-France archives contain surface and upper-air climatological data for 14 African countries. This "African database" results from collaboration between Météo-France, ASECNA, and CNRS. Work started in June 2001 to transform a combination of low-documented files into a data base structure in international format (CLICOM). Interests in the African database are numerous, from local utilization to climate change studies. This database will be furnished to the NCDC once agreement is obtained from each African country.

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Annex 14

THE GLOBAL OCEAN OBSERVING SYSTEM FOR AFRICA (GOOS-AFRICA): TOWARDS BUILDING A REGIONAL OCEAN AND FORECASTING SYSTEM FOR AFRICA

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Summary

1 - Background and Justification

The Global Ocean Observing System for Africa (GOOS-AFRICA) is a Pan-African initiative and programme.

In 1998 the African countries enthusiastically embarked on the Process now known as the African Process on Co-operation for the Development and Protection of the Coastal and Marine Environment, particularly in sub-Saharan Africa. Two political settings underpin that Process at the highest level: **(i)** the Pan-African Conference on Sustainable Integrated Coastal Management, held in Maputo, Mozambique, in July 1998, which adopted the Maputo Declaration with specific scientific and technical recommendations on environmental priority issues in Africa (see the PACSICOM Proceedings No.165 and the GOOS-AFRICA Report No. 152, GOOS-AFRICA: Global Ocean Observing System for SICOM); **(ii)** the Cape Town Conference, in December 1998, aimed at promoting intra-African co-operation, the revitalization and implementation of the Abidjan and Nairobi Conventions, and Programmes and Actions Plans to protect, manage and develop Africa's marine and coastal environment. This Conference adopted the Cape Town Declaration that called for a Partnership Conference.

As part of these recommendations, the African States approved the Global Ocean Observing System for Sustainable Integrated Management of Coastal and Marine Environment and Resources in Africa (GOOS-AFRICA). This mechanism, for taking forward the development of observing, forecasting and management of environmental data systems, will serve the interests and needs of the forty coastal and eight Island States of Sub-Saharan Africa, with subsequent benefits even for African landlocked countries in improving the understanding of the climate variability in the whole of Africa.

GOOS- AFRICA brings an African dimension **and contribution** to the Global Ocean Observing System already established as part of Agenda 21 of the United Nations Conference on Environment and Development (UNCED) in Rio in 1992. The detailed recommendations of the GOOS-AFRICA Framework for Action are given in the IOC Workshop Report No.152 as well as in the PACSICOM Proceedings No.165.

The GOOS-AFRICA Framework for Action is now one of the major mechanisms for achieving the objectives of the African Process, in that it deals with the proper provision and wise use of Marine Data and Information. This is particularly important to the sub-Saharan Africa, bounded as it is by the Atlantic and Indian Oceans. Improvements in operational oceanographic data collection and acquisition, processing, analysis and interpretation will improve operational services. The transformation of these data into information and management tools for decision-makers will help to meet social and societal goals and needs inherent to the coastal areas and populations.

The GOOS-AFRICA Framework for Action recognized immediate priorities in *in-situ* ocean measurements and validation, remote sensing, and training and education in marine science and technology with particular emphasis on the use of numerical modelling techniques. A series of workshops was held from 1998 to 2002 to convert these recommendations into a coherent project proposal aimed at developing a Regional Ocean Observing and Forecasting System for Africa (ROOFS-AFRICA). The ROOFS-AFRICA project proposal was submitted to and endorsed by African Fora and institutions including: **(i)** the Sixth Conference of the Contracting Parties **(COP-6)** to the Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, held in Abidjan from 16-17 May 2000, **(ii)** the Super Preparatory Committee Meeting for the Partnership Conference of the African Process, held in Abuja from 17-19 June 2002, and the Partnership Conference of the Heads of African States in the framework of the World Summit on Sustainable Development, held in Johannesburg on the 2 September 2002.

The United Nations agencies including the IOC/UNESCO, UNEP, UNDP and The World Bank and overseas partners including France, United States of America, United Kingdom, Netherlands, Finland, EUMETSAT and ESA have been supporting these efforts.

2 - Objectives

The ROOFS-AFRICA proposal is a viable scientific and technical tool to ensure sustainable development of the coastal and marine environment of the African continent.

Decision-makers and stakeholders concerned with marine and coastal activities require information in the form of comprehensive descriptions of the state of the environment and accurate forecasts of future events. This need to be distilled from detailed observations and meaningful comparisons with the historic record.

The ultimate goal is to provide timely and quality information needed by governments, industry, all stakeholders including local communities and the public, to deal effectively with all issues arising from management and development of marine and coastal environment of Africa.

The immediate objective is to build up a Regional Ocean Observing and Forecasting System for Africa (ROOFS-AFRICA) based on existing relevant systems on Hydrology, Oceanography, Meteorology and Environment (HOME), and sub-regional programmes and projects. ROOFS-AFRICA will facilitate the adoption of a holistic and integrated approach linking *in situ* measurements, remote sensing and ocean and coastal numerical modelling and forecasting to provide a common platform of coastal and ocean services to Africa through recognized supported **OCEAN REFERENCE CENTRES** in marine and coastal issues in the principal economic regions (e.g. the Economic Community of West African States, the Central Africa Community, the East African Community, the Southern Africa Development Community and the Indian Ocean Commission).

Provision of a sound information base for local and regional planning requires:

(i) Upgrading and expanding the present African network of *in situ* measurements and observations validation

(ii) Creating a network of specialists trained in the use of data acquired by remote sensing from earth observation satellites

(iii) Facilitating the further implementation of modern electronic communication systems such as Internet connections and data transfer mechanisms

(iv) Training and education in marine sciences and technology and their application to sustainable development

(v) Institutional strengthening

(vi) Sustainable funding.

Specific Objectives

- Strengthen the institutional capacities of national oceanographic institutions to build greater collaboration and co-operation in joint programming.
- To create a regional oceanographic database.
- To network with existing regional programmes and projects with a view to establishing co-operation.
- To enhance national & regional awareness levels and to make available to stakeholders oceanographic data to aid marine and coastal environmental management.

3 - Expected Results

The achievement of the above objectives will lead to the following results.

- Upgraded *in-situ* ocean measurements and validation network in Africa, to the levels found in the other regions of the world.
- Improved near real-time acquisition and exchange of ocean observations and satellite remote sensing data.
- Regional coastal sensitivity maps, e.g. pollution, coastal erosion, etc; are produced and updated regularly.
- Extreme events warnings (flooding, drought, storm event, surges), distributed timely through the electronic and mass media including rural communication system.
- Established and strengthened capabilities in the national and regional oceanographic centres and reinforced networking among relevant centres.
- Established basic ocean and coastal modelling and forecasting network.
- Completed professional upgrade training in Oceanography, Meteorology and appropriate technologies in the relevant sciences.
- Enhanced human resource capacities in the relevant sciences and appropriate technology
- Increased awareness of the stakeholders especially the local communities on the social-economic importance and sensitivity of the coastal ocean.
- Improved contribution of African continent to the Integrated Global Observing Strategy (IGOS).
- Improved livelihood of local communities.

4 - Project Work Packages

The ROOFS-AFRICA project would consist of 6 work packages:

Work package 1. The African network of *in situ* ocean observing systems including sea level records for monitoring coastal zones and global change.

Work package 2: Application of Remote Sensing to Marine and Coastal Environment.

Work package 3: Modelling and Forecasting based on *In situ* and Satellite Data

Work package 4*:* Effective Involvement of Different Stakeholders at different stages of Project development and implementation

Work Package 5: End-User interactive Communication and Information Delivery System: *The ACMAD Communication System-Radio and Internet - RANET: A Quantum Leap in Closing the Information Gap Provides Missing Links in Chain of Development*

Work Package 6: Industry and Business Partnerships towards reinforcing of a Regional Ocean and Forecasting System for Africa

Work Package Zero: Project Integration and Co-ordination.

5 - Linkages to other national or regional activities/transboundary aspects

ROOFS-AFRICA will work interactively with relevant regional and national programmes such as the GCOS and GEF/LME projects in Africa.

The ROOFS-AFRICA project incorporates elements of Abidjan and Nairobi Conventions work programmes and will ensure the revitalization of these conventions. Partnership will be reinforced with the United Nations agencies as well as with other donors and technical organizations, in particular with UNIDO, WMO and the UNEP, which acts as an overall co-coordinator of the regional seas programme and Secretariat of the Conventions and Protocol (Article 16, ibid.) and the regional Co-coordinating Units (Article 31).

These linkages and collaboration will ensure the generation of credible data using advanced observation and forecasting systems to assist existing programmes formulate regional action plans and strategies for management.

6 - Risks and Sustainability

- **Quality of electronic communication among the participating centres.** However, the various countries have adopted national plans to upgrade the telecom infrastructures. In addition ACMAD/RANET programme would facilitate the exchange of information in the short term.
- **Major problems could arise through attempt to convert this integrated proposal into narrow traditional sectoral project by dividing them up into separate mini-project**. This risk could be minimised through a strong effective co-ordination unit.
- **Capacity-Building as a key to a success.** Africa starts from a severe lack of capacity in infrastructure and a shortage of personnel with current training in the technical areas needed to fully implement this proposal. Any project of this kind should integrate human capacity-building, application of natural and social sciences and new information technologies to the integrated management of coastal and marine environment in the perspective of sustainable development. Consequently, continuing education and training should be considered as a key contributor to poverty alleviation.
- **The implementation of this project will reinforce institutional capacity that is in the process of being built by the countries through the various collaboration programmes with international organisations**.

Annex 15

ECOLOGICAL OBSERVATIONS NECESSARY TO CLIMATE CHANGE IMPACT ASSESSMENTS ON NATURAL RESOURCES

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Member of SACOM ACMAD, Niger

Climate changes result both from an internal variability of the climate system and external, natural and anthropogenic factors. Human gas certainly modify, significantly, gas concentrations in the atmosphere, which affect the climate by changing the earth radiation balance.

At the global level, greenhouse effect gases have a significant impact, they tend to heat the surface of the Earth by absorbing some infrared rays which are given out. These are mainly the carbon dioxide (CO_2) whose concentration is increasing, and the other gases like methane (CH_4), nitrous oxide (NO_2) Halocarbons (CFCs) and their substitutes.

At the regional level, anthropogenic sprays whose lifetime is short, constitute an important factor especially in the drop in temperature at the ground. Other natural factors such as changes in solar radiations contribute, though little, to radiation forcing.

At a local level, other parameters should enable us to better understand some phenomena which have significant impact and that contribute to climate changes.

In Africa, zones under desertification process are located at the level of arid margins (S./.) Desertification is characterized by the destruction of the grass, the decrease of natural resources and the biodiversity, of available water and land. Thus, there is a necessity to make a follow up and evaluation of indicators having an impact on natural resources.

Experiences carried out, for a couple of years, in the field in tropical arid and semi-arid dry and Mediterranean zones show that these territories, very vulnerable, are affected by the desertification process which tends to extend further. Many indicators (socio-economic and physical) in addition to climate factors contribute to the impact of climate changes on natural resources.

It is by acting at the local and regional levels and with a participatory action of all concerned stakeholders and notably the most affected populations that one will succeed in contributing to reduce (at medium and long terms) the impacts on climate changes.

Terrestrial observations

Within the framework of GCOS and the NMSs, it is important to consider indicators in relation to sustainable development at both:

- Regional level in the various production systems and ecosystems, and
- Local level for monitoring and evaluating the main natural resources.

The physical indicators require surface and satellite measurements of climate, soil and biocenosis parameters, particularly vegetation:

- Additional meteorological parameters to be measured: solar radiation, albedo, mineral aerosols (sand-bearing wind) and organic aerosols (carbon from bush fires),
- Soil parameters: state of the soil surface, soil moisture, brightness index, etc.
- Biological parameters: plant cover, phenology, biomass and biodiversity.

The socio-economic indicators concern demography, households, output, goods produced, water resources, sedentarization and migration (movement) of populations.

The land concerned, which covers the most vulnerable and fragile, arid and semi-arid zones, is subject to desertification processes (UNCCD), where monitoring of ecological indicators is very important for the coming years especially as regards their impact on climate change.

The establishment of monitoring networks (including the strengthening of ROSELT[*] for example) is indispensable in other areas in addition to those around the Sahara (such as the southern Sahel at the various Sudanese and Guinean bioclimatic levels, Cameroon, Central Africa, etc.).

[*] ROSELT: Réseau d'Observatoires de Surveillance Ecologique à Long Terme [Long-term ecological observing and monitoring network]

Annex 16

MOBILISATION OF RESOURCES FROM DONORS: A STRATEGY FOR GCOS-WCA REQUIREMENTS

Jim Williams

1. Introduction to Donors, their Priorities and the way they Work

Most donors are becoming more determined, organised and coordinated in their approach to development. The Organisation for Economic Co-operation and Development (OECD) is setting a **common development agenda for reducing poverty**. Together the donors 'encourage each other' into a coordinated and rigorous approach towards achieving their shared objectives, *the Millennium Development Goals*, setting clear targets to help measure success along the route.

The International Development Targets set out a vision for reducing world poverty by 2015. They have now been endorsed by the entire membership of the United Nations.

One Agenda: OECD countries are ever more focused on **economic and social development**, with environment considerations something of an after-thought. Donors are becoming more homogeneous in their approaches and also more selective about working in countries with governments that are not corrupt and that are serious about development.

Types of Aid: There are also different kinds of aid including Project aid, Area Wide Support, Sectoral Aid, Programme Aid, Budgetary aid, and Debt Relief for the Heavily Indebted Poor Countries.

2. Linking Donor Priorities and GCOS Interests in W&CA

GCOS objectives may be summarised as:
1) Reliable and sustainable **network of observations** from Atmosphere, Ocean and Land
2) Healthy and sustainable Meteorological Institutions to maintain these networks and transmit data.

Donor Objectives, which are similar to those of government, are more concerned with
1) Reliable and sustainable **client services to assist poverty reduction** and sustainable development
2) Sustainable (weather) institutions to maintain these services, as long as necessary.

Donors are increasingly unlikely to support any improvements to any observation network if the institution itself is uninterested in national development priorities. Thus while both donors and the Global Meteorological Partnership have a shared interest in sustaining meteorological institutions in Africa, **a fundamental prerequisite** for any approach to donors requires NMHS to re-orientate their functions towards national development priorities and to re-invent themselves as institutions actively working in partnerships to ensure sustainable development and reduction in poverty.

3. Basic Strategy Proposed

Generally, NMHS receive support from a) their national Governments, b) the Global Meteorological Partnership, c) donors and development banks, and in some cases d) paying clients. A strategy to optimise income from the first three of these sources of support requires that:

- NMHS reinvent themselves to become more attractive to donors and governments
- Donors be approached to support well focused projects delivering services to the poor

- Support for observations necessary to these services be included as part of sustainability
- Support from the Global Meteorological Partnership be ring-fenced to support the basic observational network.

4. Options for Delivering the Strategy:
In order to make oneself attractive to donors one needs to see what kind of development themes donors prioritise today.

Most Promising Development Themes
Meteorology is not a development priority for any donor. The most prominent themes mentioned in donor web-sites that have any pertinence to weather services and observations, include:

- Basic Infrastructure (as Congo and World Bank, Mozambique and Finland)
- Climate Change
- Environmental Sustainability and Environmental change
- Information and Communication Technologies (ICT) and rural communications
- Information for Development, i.e. Informing the development process
- Institutional Development (as Namibia and Sweden?)
- Security: The poor environment (food security, disaster security, pollution etc)
- The Water Crisis

Most Promising Approaches
Meteorology and climatology are often perceived as rather narrow 'academic' fields of little pertinence to poverty and development. NMHS must embrace the above changes in donor orientation and adapt accordingly, going beyond their previous boundaries, where their competences are, or could be, pertinent. Possible approaches for institutional reorientation include:

1. Environment Information Partnership/Network: SOE monitoring and Evaluation of Change
2. Information for (Rural) Development ➔ Information Extension Service (e.g. RANET)
3. All about water: real time national information resource centre
4. Security of the citizen: food, environmental change, disaster mitigation and humanitarian support
5. Cost effective NMHS for C21; small nodes in efficient International Partnership

Most Promising Donors
If one is to systematically seek donor support for GCOS W&CA objectives then one should explore opportunities (listening very carefully) with:
a) donors already involved in meteorological support in Africa as World Bank, EC and Finland
b) less evolved donors with a good orientation towards Africa: e.g. Italy
c) donors that are seeking new programmes, e.g., Sweden for regional projects in West Africa
d) donors which are expanding their aid budgets in Africa e.g. Canada, Japan
e) donors concerned about poverty and the African environment e.g. Netherlands??

Special cases: France, UK and USA already provide much meteorological support for meteorology in Africa through the Global Weather Partnership and overseas aid organisations.
World Bank: worth exploring for an Africa wide basic infrastructure initiative based on efficiency savings through networking Africa wide.
UNDP: years ago used to provide much infrastructural support but now much more poverty focused.

Regional projects: Much encouraged by EC but must be clear prioritisation of sector.

5. Action Plan Tactics

1. **Sustainable institutions**: Only the NMHS themselves can affect this. They need to develop a Strategic Plan to re-orientate their service towards national development priorities. If the national situation is not sufficiently strong to be able to sustain a fully functional weather service, then thought should be given to networking with neighbours in the sub-region so as to be able to provide more service for less resource. Does Africa really need 53 NMHS?

2. **Sustainable services**: Seek donor support for developing and enhancing a range of information services to poor rural clients. Perhaps the ultimate objective for a weather service would be to participate in setting the national and local development agendas. In many countries there is a need for technical institutions to help set and monitor environmental sustainability indicators at national and local level. If the weather service also participated in producing regular state of the national environment reports and updates, they would be well on the way to becoming the lead environmental institution in their country, and problems with GCOS, GTOS and GOOS in Africa would be much reduced.

A wide range of other possible project proposals needs to be developed in a portfolio of options to see which ones are of interest to donors (ideas developed in table not included here).

3. **Sustainable observation networks**: Donors are often intrigued by the Global Meteorological Partnership and the fact that observations taken in Africa are so important for forecasting European weather. Playing the global partnership card with donors is useful however to ascertain where the donor is 'coming from' and indicates the amount of observational support one might be able to incorporate into a project.

6. Conclusions & Recommendations

Donors are increasingly serious about poverty reduction and economic development.
Recommendation 1. Weather services in Africa must make real changes in their orientation and become institutions pertinent to national poverty reduction and sustainable development, if they wish to attract sufficient government and donor funding to sustain themselves.

Attracting sufficient donor funds to keep the basic observational networks going is not easy.
Recommendation 2a: Weather services need to propose/participate in a number of poverty focused projects to maintain/build their capacities from multiple small contributions if necessary and/or
Recommendation 2b: Weather services need to obtain donor support for multiple service level projects and reserve 'Meteorological Partnership' resources for sustaining the basic networks on land, sea and air.

Donor 'commitment' positions sometimes change rapidly from month to month. If a number of major projects are delayed, donors are much more receptive to new project ideas particularly if they can be disbursed quickly and easily.
Recommendation 3: Weather services and their agents need to build up relationships with a number of promising donors, demonstrate their poverty focus and raise awareness over their (potential) contributions to sustainable development, and offer a range of project ideas.

Winning support from donors takes good information, hard work, luck, and ‘confidence’.
Recommendation 4. Weather services need to work together as a network, to exchange experiences over mobilising resources and learn systematically from each other.

AFRICAN MONSOON MULTIDISCIPLINARY ANALYSES (AMMA)

Arona DIEDHIOU and Daniel ROUX
(AMMA International Committee)

The AMMA project, spanning several years and combining research and systematic observation, is aimed at better describing climate change and its impacts on health, food security and water resources. It has three main goals: (1) to define appropriate observing strategies for a better description of climate change in West Africa, (2) to improve our understanding of the West African Monsoon and its influence on regional- and global-scale physical, chemical and biosphere environments, and (3) to develop the knowledge enabling climate variability and change to be linked to problems concerning health, water resources and food security for the countries of West Africa. The observing strategy proposed under AMMA will thus be to create a mixture of measurements from operational networks and specific observations focused on a subregional window, where more intensive, specific observations will be carried out during key periods. We will be testing the contribution of permanent additional observations using the existing modelling and assimilation systems. Recommendations will then be made for future optimal networks to meet a considerable demand from the African national Services. In this respect, the AMMA project should be considered as a framework within which GCOS recommendations can be followed up and applied to improve climate observation as mentioned in the UNFCCC.

Recommendations

(1) To support the AMMA project, which is aimed at capacity-building of the national operational Services and improving the products, by combining research and systematic observation in West Africa;

(2) To maintain and consolidate the current atmospheric, hydrological and oceanographic observing network in West Africa;

(3) To strengthen this network by adding observations in key areas (identified under the AMMA project) in order to better characterise climate change and its impacts;

(4) To continue the rescue, archival and conservation of historical data in order to detect changes which have occurred in the climate and for future generations.

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Annex 18

REMOTE SENSING IN THE SERVICE OF METEOROLOGY AND CLIMATE

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So that knowledge of atmospheric parameters can respond to the increasing needs of analysis and forecasting, it is necessary that forecasts be extended to the entire surface of the earth in a regular manner. Considerable effort has been made to automate meteorological observations, but this is now inseparable from the revolution in meteorological satellites, which supply global observations that are permanent, precise, coherent, and quickly collected and delivered. The necessity of observing the atmosphere of the entire planet to forecast its evolution has resulted in the creation of the National Meteorological Services and in their cooperation with the World Meteorological Organization. This institutional framework has allowed concerted development since the end of the 1970s of a world system with a belt of geostationary satellites and satellites in quasi-polar orbit, which aim to increase the quantity of information collected by ground sub-systems to attain the required world coverage. These considerations have resulted in WMO realization, within the framework of the Global Atmosphere Watch (GAW), of a global observing system, which has a large place for satellite techniques. Interactions between various systems are made within the framework of an Integrated Global Observing Strategy (IGOS), in which one can find:

- The Global Climate Observing System (GCOS)
- The Global Ocean Observing System (GOOS)
- The global system for continuous surveillance of the environment
- The Global Terrestrial Observing System (GTOS).

WEATHER FORECASTING

It is no longer possible to conceive of a meteorology that has no recourse to data from space. For short-term weather forecasting, in addition to global cloud cover data, weather satellites allow the determination, in a practical way, of the temperature at the top of the cloud and of vertical temperature and humidity profiles over the entire surface. To this is added the use of millimeter- and centimeter-length waves for measuring surface temperature and humidity, as well as for evaluating the moisture content of clouds and the location of rainfall zones. Geostationary satellites offer the possibility of determining high altitude winds by comparing cloud motion on successive images. These indirect observations are very important in zones that do not have points of reference (e.g., oceans and deserts).

CLIMATE CHANGE

With respect to climate change, the problem of forecasting the evolution of the climate is added to the problem of weather forecasting. The socioeconomic impact of this phenomenon is potentially immense (desertification, floods, etc.) It is necessary to make very precise and long-term observations of relevant parameters of the climatic system to guarantee an adequate understanding of changes at various spatio-temporal scales. The Earth must be analyzed as a global system through a multidisciplinary approach, using measures made from space and *in situ,* including the constituents of the ground system (atmospheric, hydrologic, oceanic, and terrestrial processes).

1 - Needs of Global Data

It is necessary to evaluate the physical impacts of climate change and its effects on society. The coastal zones are important because about 60% of the world population lives less than 100 km away from the sea and could be affected by the rise of sea level. Also, large concentrations of people live along rivers, and changes of river flow generated by climate change will directly affect these populations. Modifications of the hydrological cycle and of wind regimes must be estimated to study food security, access to water resources, and the dissemination of diseases spread by different vectors. Seasonal weather forecasts will be important to stimulate adaptation and to reduce socioeconomic effects due to climate change.

2 - The Atmosphere

In the field of the atmospheric chemistry and the radiation balance of the Earth, three basic constituents are necessary: determination of the *concentration* in CO_2 and CH_4 by direct measures; the measurement and evaluation of *CO_2* and *CH_4 sinks* at the ecosystem level; and the measurement and evaluation of *CO_2 and CH_4's sources* at the level of each ecosystem.

The radiation balance at the top of the atmosphere, as may be observed by satellites such as the GERB (Geostationary Earth Radiation Budget) on MSG, or the ERM project (Earth Radiation Mission), is considered a key element for global modeling. The Climate Variability and Predictability (CLIVAR) Program also foresees a permanent monitoring of various atmospheric parameters, including radiation, clouds, and aerosols.

3 – Land Surface

When considered at the appropriate geographic scale, elements such as indices of land cover, nitrogen content, photosynthetic activity, and surface and subsurface biomass in forests are also key points in monitoring ecosystems and their impact on the evolution of climate. These indices are monitored from space with different temporal and spatial resolutions (LANDSAT, SPOT, IRS, NOAA-AVHRR, VEGETATION, and MERIS/ENVISAT and MODIS/TERRA instruments).

Changes in land use and land cover, which are the main anthropogenic causes of modification in the GES balance, require four elements of information: vegetation cover reference maps, quantitative evaluation of surface changes, monitoring of disturbances to the landscape, and information about soil use practices. For this, the priority spatial tools to use are those with high resolution (optics and radar) which allow a precise definition of the activity of the ground and its changes on a typically annual base, and medium resolution systems (typically hectometric to kilometric) for observing vegetation characteristics and, more generally, ecosystems on a decadal scale.

4 – The Oceans and the Climate

The oceans play a major role in climate change, and sea level rise is a particularly significant indicator of global climatic changes having a major impact on society. On a global scale, relevant observable parameters of a physical nature are sea surface temperature (SST), cloudiness, circulation, and wind (radiometers, altimeters). The main observing systems are CZCS (the Coastal Zone Color Scanner) (from 1978 until 1986), then POLDER (POLarization and Directionality of Earth Reflectance) and OCTS (Ocean Color and Temperature Surface) on ADEOS, and now SeaWIFS/SeaSTAR, MODIS/TERRA, MERIS/ENVISAT, POLDER-2 (December, 2002), and GLI (Global Imager) on ADEOS-2 (Japan).

The ESA (with ERS-2 and ENVISAT) and CNES (with TOPEX-POSEIDON, then JASON and POLDER-2) can undertake a global oceanic monitoring of concerned parameters. The ERS mission and TOPEX-POSEIDON have formed the spatial component of the observing system and for WOCE (the World Ocean Circulation Experiment), which has allowed characterization of oceanic circulation at different spatio-temporal scales and forcing in the ocean-atmosphere interface. The success of the TOPEX-POSEIDON mission no longer needs to be demonstrated, and an example of its remarkable sensitivity was the early detection of El Niño. This mission continues to function and is being prolonged with JASON-1, launched in December 2001. It contributes to the implementation of the Global Ocean Observing System (GOOS).

5 - <u>Socioeconomic information</u>

Socioeconomic information is necessary for global monitoring, as certain emissions and sinks can only be deduced locally, and certain information derived from satellite observations and\or from *in situ* measurements must be coupled with socioeconomic information to be able to supply required needs.

It is worthwhile mentioning the significant advances for the African continent in spatial technologies, a sign of the emergence of African spatial competence. This is illustrated by the launches and successful operation of micro-satellites such as Morocco's Zarka El Yamama and Algeria's ALSAT 1 and from which earth observation products supply useful complements.

INDISPENSABLE NEEDS FOR TRAINING AND CAPACITY BUILDING

Raw spatial data are generally of little use for a non-specialist user looking for practical and operational information concerning air, ground, water, or vegetation. The relevant use of environmental observations and their transformation into useful information for citizens and governments will require a greater effort of awareness building, training, research, and development.

The Regional Centre for Space Science and Technology Education in Africa (CRASTE-LF), established in 1998 in Rabat, Morocco, is one of the constituents of the training network set up by the U.N. It is a training and scientific animation institution affiliated with the U.N., with the objective of promoting the use of space science and technology by strengthening local competence. Its mission is to organize courses, training, seminars, workshops, and expert technical meetings to improve the competence of specialists and decision-makers and to keep them informed about progress in space science and technology applications. Other objectives are to assist in the development of a local indigenous capability in space science and technology, to supply consultative services for State members and regional institutions, to collect and diffuse information concerning space, and to support any activity that seeks to increase scientific development in the region.

Twelve African countries are members of CRASTE-LF. These include Algeria, Cameroon, Cape Verde, the Central African Republic, the Congo, Gabon, Niger, Morocco, Mauritania, Senegal, Togo, and Tunisia. Other countries have expressed the wish to join (e.g., Benin, Burkina Faso, and Mali). CRASTE-LF's program focuses on Remote Sensing and Geographic Information Systems, Satellite Communications, Space Meteorology, Global Climate, and lastly, Atmosphere and Space Sciences.

In spite of limited financial possibilities and with the support of Moroccan and international scientific institutions, the Centre has to date implemented five post-graduate courses, those in *Remote Sensing and GIS* (2 sessions), in *Satellite Communications* (2 sessions), and in *Space Meteorology and Global Climate (1* session). To date, more than 60 trainees have taken post-graduate courses. These trainees are generally executives at the engineer level or higher who have professional experience and are aware of the needs of their institutions. At the end of two years of training, they are awarded a Master's degree in Space Science and Technology in their selected specialty. The content of courses given at CRASTE-LF is prepared on the basis of an "Education Curricula" edited by the Office for Outer Space

Affairs at the United Nations Office in Vienna. To implement these courses, the Centre relies on a network of regional and international expertise, as well as on expert intervention from institutional partners in advanced countries (e.g., CNES - France, the European Space Agency, and the Canadian Space Agency).

PERSPECTIVES

The need for training is obvious, as well as the will to undertake it. The goal is to establish a well-coordinated program of training and scientific animation and to find the means to implement the program for a judicious exploitation of spatial tools and data. It can already be considered that the recommendations of this workshop will constitute a source of inspiration for research themes that can be pursued by trainees. CRASTE-LF considers itself completely engaged in developing regional scientific products for development, in establishing and strengthening research teams to increase regional scientific cooperation, and in enabling access to and diffusion of information throughout the region.

CRASTE-LF could support space-related activities in Africa, including actions and initiatives arising from this workshop, and it can orient its activities within the general framework and objectives of GCOS. It is seeking the necessary synergies with other organizations for this, and the recent cooperative agreement with ACMAD is a perfect illustration.

Annex 19

QUESTIONNAIRE ON OBSERVING SYSTEMS FOR CLIMATE

Purpose of the questionnaire

The Conference of the Parties to the UN Framework Convention on Climate Change has invited the Parties to the Convention to submit national reports on the status of their observing systems. Although voluntary for developing countries, GCOS considers these reports especially important for these countries and an opportunity to reach high-level policymakers. The following questionnaire has three purposes: first, to help workshop participants begin to focus on compiling the information that will be the basis for national reports to the UNFCCC; second, to prepare workshop participants to actively participate in the workshop; and third, to provide basic information that can be used after the workshop in the development of a regional observing system Action Plan. The questions are intended to elicit information on the adequacy of observing systems and about what is needed to improve them.

Questions pertaining to the status of observing systems

Meteorological

1. If your country has already prepared a national report, could you bring this to the workshop? Otherwise, could you complete Table 1 in the UNFCCC Guidelines? How many GSN and GUAN stations are located in your country? What is the operating status of each of these stations?

2. If requested GSN and GUAN observations are not currently being received by monitoring centres, what is the nature of problems in making and/or transmitting these observations?

3. If your country has not already done so, what are the plans for furnishing historical GSN data and metadata to the National Climatic Data Center in line with the request from the WMO Secretariat in September 1999?

Oceanographic

4. Are you aware of the Global Ocean Observing System? Do you contribute to it?

5. How does your country contribute to oceanographic observations? For example, with respect to sea surface temperature, sea level, temperature and salinity profiles, etc., what type and how many of each type of platform does your country operate? If you have completed Table 2 of the UNFCCC Guidelines, please bring it with you.

6. What problems, if any, do you have operating these platforms?

Terrestrial

7. Are you aware of the Global Terrestrial Observing System? Do you contribute to it?

8. What observations does your country contribute to terrestrial networks, and, in particular, to hydrology and carbon networks? If you have completed Table 3 in the UNFCCC Guidelines, please bring it with you. What other terrestrial programmes are in place or are being contemplated that contribute to observational needs for climate?

9. What problems do you have or foresee related to making terrestrial observations?

Space-based
10. In what ways are you participating in space-based observing programmes? Do you utilize observations from satellites? If so, in what ways? How are these observations received? In what other ways do you participate in space-based programmes?

General
11. If your organization does not have direct access to the information required to answer the above questions, which organizations in your country do have this access? How can we, and you, communicate with these organizations?

Questions pertaining to needs of users

1. What are your observational needs for monitoring local climate change, climate variability, and extreme events. Do you feel observing systems are adequate? If not, what is needed?

2. What types of observations would be valuable for user needs that are not now being made?

3. How useful is the available data for developing regional climate change scenarios? How could it be improved?

4. How useful is the available data for vulnerability and adaptation studies? What additional types of data are needed?

5. What capacity-building needs related to observing systems do you have? What capacity-building needs do you see elsewhere that need to be met?

6. What advice do you have for improving interaction between generators and users of climate data?

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*The **UNFCCC Reporting Guidelines** as well as explanatory notes on the Guidelines that GCOS has prepared can be found at **http://www.wmo.ch/web/gcos/gcoshome.html**. At the site, click on "GCOS and the UNFCCC" and then scroll to below the heading "GCOS Regional Workshops."*

Completed questionnaire should be sent by e-mail to GCOSJPO@gateway.wmo.ch

Annex 20

LIST OF ACRONYMS AND ABBREVIATIONS

ACMAD	African Centre of Meteorological Applications for Development
AGRHYMET	Regional Training Centre for Agrometeorology and Operational Hydrology and their Applications
AMMA	African Monsoon Multidisciplinary Analyses
ASECNA	Agency for Air Navigation Safety in Africa and Madagascar
CCCs	Climate Change Coordinators
CLICOM	CLImate COMputing
CLIMAT	Report of monthly means and totals from a land station
CLIMAT TEMP	Report of monthly aerological means and totals from a land station
CLIVAR	Climate Variability and Predictability (WCRP)
CNEDD	Conseil National de l'Environnement pour un Développement Durable
COP	Conference of the Parties (to UNFCCC)
CRASTE-LF	Centre Régional Africain des Sciences et Technologies de l'Espace en Langue Française
DARE	Data Rescue (WCDMP project)
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GEWEX	Global Energy and Water Cycle Experiment
GLOSS	Global Sea Level Observing System
GOOS	Global Ocean Observing System
GOS	Global Observing System
GPS	Global Positioning System
GSN	GCOS Surface Network
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System
GUAN	GCOS Upper-Air Network
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICSU	International Council for Science
IGOS	Integrated Global Observing Strategy
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IRD/LTHE	Institut de Recherche pour le Développement/Laboratoire d'étude des Transferts en Hydrologie et Environnement
IRI	International Research Institute for Climate Prediction
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
NCDC	National Climatic Data Center
NMS	National Meteorological or Hydrometeorological Service
NOAA	National Oceanic and Atmospheric Administration
OECD	Organisation for Economic Co-operation and Development
PIRATA	Pilot Research Moored Array in the Tropical Atlantic
PRECIS	Providing Regional Climates for Impacts Studies

RANET	Radio Internet
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Synoptic Network
ROOFS-AFRICA	Regional Ocean Observing and Forecasting System for Africa
ROSELT	Réseau d’Observatoires de Surveillance Ecologique à Long Terme
SBSTA	Subsidiary Body for Scientific and Technological Advice (UNFCCC/COP)
SST	Sea-Surface Temperature
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WCDMP	World Climate Data and Monitoring Programme
WCRP	World Climate Research Programme
WDC	World Data Centre
WMO	World Meteorological Organization
WWW	World Weather Watch (WMO)

<u>LIST OF GCOS PUBLICATIONS</u>*

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 second (WMO/TD-No. 765) (UNEP/DEIA/MR.96-5)	Report of the GCOS Data and Information Management Panel, session (Ottawa, Ontario, Canada, May 14-17, 1996)
GCOS-26 (WMO/TD-No. 766)	Report of the Joint CCl/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 session (WMO/TD-No. 794) (UNEP/DEIA/MR.97-4)	Report of the Global Observing Systems Space Panel, second (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)

GCOS-32 (WMO/TD-No. 796)	GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 2.0, June 1997
GCOS-33 (WMO/TD-No. 798)	GHOST - Global Hierarchical Observing Strategy, March 1997
GCOS-34 (WMO/TD-No. 799)	Initial Selection of a GCOS Surface Network, February 1997
GCOS-35 (WMO/TD-No. 839)	Report of the second Joint CCl/CBS Meeting on the GCOS Surface Network (De Bilt, The Netherlands, June 25-27, 1997)
GCOS-36 (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)
GCOS-37 (WMO/TD-No. 845) (GOOS-10) & (GTOS-9)	Report of the Global Observing Systems Space Panel, third session (Paris, France, May 27-30, 1997)
GCOS-38 (WMO/TD-846) (GTOS-10)	Report of the Meeting of Experts on Ecological Networks (Guernica, Spain, June 17-20, 1997)
GCOS-39 (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)
GCOS-40 (WMO/TD-No. 848)	Report of the GCOS/WCRP Atmospheric Observation Panel for Climate, third session (Reading, UK, August 19-22, 1997)
GCOS-41 (WMO/TD-No. 849) (Baltimore, (GOOS-33)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC) Ocean Climate Time-Series Workshop, MD, USA, March 18-20, 1997)
GCOS-42 (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)
GCOS-43a (GOOS-36)	TAO Implementation Panel, sixth session (Reading, U.K., November 4-6, 1997)
GCOS-43b (GOOS-55)	International Sea Level Workshop (Honolulu, Hawaii, USA, June 10-11,1997)
GCOS-44 (GOOS-61)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC), third session (Grasse, France, April 6-8, 1998)
GCOS-45 (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)

GCOS-46 (GTOS-15)	Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, fourth session (Corvallis, USA, May 26-29, 1998)
GCOS-47 (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)
GCOS-48	Report on the Adequacy of the Global Climate Observing Systems (United Nations Framework Convention on Climate Change, November 2-13 1998, Buenos Aires, Argentina)
GCOS-49 (GOOS-64)	Implementation of Global Ocean Observations for GOOS/GCOS, first session (Sydney, Australia, March 4-7, 1998)
GCOS-50 (GOOS-65)	Implementation of Global Ocean Observations for GOOS/GCOS, second session (Paris, France, November 30, 1998)
GCOS-51 (GOOS-66)	Global Ocean Observations for GOOS/GCOS: An Action Plan for Existing Bodies and Mechanisms
GCOS-52 (GOOS-68)	TAO Implementation Panel, 7th Session (Abidjan, Ivory Coast, November 11-13, 1998)
GCOS-53 (WMO/TD-No. 958)	GCOS Surface Network (GSN) Monitoring Centre Implementation Meeting (Offenbach, Germany, January 19-20, 1999)
GCOS-54 (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)
GCOS-55	Report of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), fifth session (Silver Spring, MD, USA, April 20-23, 1999)
GCOS-56 (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)
GCOS-57 (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)
GCOS-58 (GOOS-71**)**	Report of the 6th Session of the IOC Group of Experts on the Global Sea Level Climate Observing System (GLOSS)
GCOS-59 (GTOS-22)	Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, fifth session (Birmingham, UK, July 27-30, 1999)
GCOS-60 (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 30-3 May, 2001)
GCOS-69 (GOOS-98)	Report of the fifth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Bergen, Norway, June 20-23, 2000.
GCOS-70 (GOOS-113)	Report of the sixth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Melbourne, Australia, May 2-5, 2001
GCOS-71 (GTOS-29)	Report of the GCOS/GTOS/HWRP Expert Meeting on the Implementation (WMO/TD-No. 1099) of a Global Terrestrial Network - Hydrology (GTN-H), Koblenz, Germany,June 21-22, 2001
GCOS-72 (GOOS-95)	Report of the 7th Session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, April 26-27, 2001
GCOS-73 (WMO/TD-No. 1106)	Manual on the GCOS Surface and Upper-Air Networks: GSN and GUAN, April 2002
GCOS-74 (WMO/TD-No. 1109)	Report of the GCOS Regional Workshop for Eastern and Southern Africa on Improving Observing Systems for Climate, Kisumu, Kenya, October 3-5, 2001
GCOS-75 (WMO/TD-No. 1124)	Summary Report of the tenth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Farnham, UK, April 15-19, 2002
GCOS-76 (WMO/TD-No. 1125)	Report of the eighth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Wokingham, UK, May 20-24, 2002

GCOS-77 (GOOS-122)	International Workshop for Review of the Tropical Moored Buoy Network, September 10-12, 2001, Seattle, Washington, USA. Workshop Report
GCOS-78 (WMO/TD-No. 1126)	Report of the GCOS Regional Workshop for Central America and the Caribbean. "Observing Climate from Weather Extremes to Coral Reefs", San José, Costa Rica, March 19-21, 2002 (disponible también en español)
GCOS-79 (WMO/TD-No. 1133)	Interim Report to the Sixteenth Session of the Subsidiary Body for Scientific and Technological Advice of the UNFCCC by the Global Climate Observing System, Bonn, Germany, June 5-14, 2002
GCOS-80 (WMO/TD-No.1140)	Report of the GCOS Regional Workshop for East and Southeast Asia on Improving Observing Systems for Climate, Singapore, September 16-18, 2002
GCOS-81 (GOOS-124)	Seventh Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Kiel, Germany, June 5-8, 2002
GCOS-82 (WMO/TD-No.1143)	The Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC
GCOS-83 (WMO/TD-No.1155) (GTOS-33)	Report of the Global Terrestrial Network - Hydrology (GTN-H) Coordination Panel Meeting, Toronto, Canada, November 21-22, 2002
GCOS-84 (WMO/TD-No.1156) (GTOS-32)	Report of the GCOS/GTOS/HWRP Expert Meeting on Hydrological Data for Global Studies, Toronto, Canada, November 18-20, 2002
GCOS-85 (WMO/TD-No.1167)	Report of the GCOS Regional Workshop for Western and Central Africa on Improving Observing Systems for Climate, Niamey, Niger, March 27-29, 2003 (also available in French)

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