

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



WMO



of UNESCO



UNEP



ICSU

WORLD METEOROLOGICAL  
ORGANIZATION

INTERGOVERNMENTAL  
OCEANOGRAPHIC COMMISSION



GEF

Global  
Environment  
Facility



## REPORT OF THE GCOS REGIONAL WORKSHOP FOR THE MEDITERRANEAN BASIN

Marrakech, Morocco  
22-24 November 2005

July 2006  
GCOS - 106  
(WMO/TD No. 1337)

UNITED NATIONS  
ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL  
FOR SCIENCE

© 2006, World Meteorological Organization

NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

*Editorial Note:* This report has been produced without, editorial revision by the WMO Secretariat. It is not an official WMO publication and its distribution in this form does not imply endorsement by the organization of the ideas expressed.

## **FOREWORD**

The GCOS Regional Workshop for the Mediterranean Basin, 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 Mediterranean Basin in the development of a Regional GCOS Action Plan.

During the workshop, we made progress in identifying regional and national needs for climate information as they relate to climate policies, national activities, and sustainable development. We also identified deficiencies in current observing systems for climate and agreed on a number of key regional priorities. We began discussion on a Regional Action Plan that can serve as a vehicle to articulate the needs and priorities of the region and bring these to the attention of the Parties to the United Nations Framework Convention on Climate Change and 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 the Mediterranean Basin and looks forward to working with you as we seek to improve systematic climate observations in the Mediterranean Basin.

I wish to express my appreciation to the Government of Morocco for its hospitality and the fine reception that we all enjoyed in Marrakech. I also wish to thank Mr. Mustapha Geanah, Director of the National Meteorological Service of Morocco, for his efforts and for those of his staff, which were major factors in the success of the workshop.

David Goodrich  
Director, GCOS



## TABLE OF CONTENTS

Forward .....	i
Executive Summary.....	v
Introduction .....	1
Opening Ceremonies.....	1
Summary of Workshop Presentations and Discussions.....	2
Theme 1: Setting the Context.....	2
Theme 2: User Needs for Climate Observations.....	5
Theme 3: Atmosphere: Status, Deficiencies, and Needs.....	8
Theme 4: Oceans: Status, Deficiencies, and Needs.....	11
Theme 5: Terrestrial Observations: Status, Deficiencies, and Needs.....	14
Theme 6: Cross Cutting Topics .....	16
Theme 7: Resource Mobilization.....	20
Theme 8: First Steps in Developing a Regional Action Plan.....	23
Next Steps.....	25
Conclusion of the Workshop.....	26
<b>Appendices</b>	
1. Agenda .....	27
2. Participants.....	29
3. Draft Resolution.....	35
4. The Global Climate Observing System and the GCOS Regional Workshop Programme .....	37
5. The UNFCCC and Systematic Observation .....	39
6. Implementation Plan for the Global Observing System for Climate in Support of The UNFCCC.....	43
7. Observational Needs for Extreme Events and for Adaptation to Climate Change .....	55
8. Climate Information Needs for the Agricultural Sector.....	59
9. Climate Observing Needs for Locust Control.....	63
10. GCOS Surface and Upper-Air Networks and Regional Basic Climatological Network.....	65
11. GCOS Surface and Upper Air Networks Implementation Project Manager’s Report.....	67
12. Needed Upgrading of Climate Data Rescue Activities over the Mediterranean Countries.....	69
13. Global Atmosphere Watch: Aerosols, Ozone, and Greenhouse Gases.....	73
14. Operational Oceanography in the Mediterranean: A Step Towards Understanding Ocean Climate Variability in the Region .....	77
15. The Gloss Network and Sea Level Rise .....	79
16. Long-Term Monitoring of the Mediterranean Sea: The Operational Oceanography Approach in Support of Climate Research and Applications .....	81
17. An Additional Contribution for the Oceans Theme .....	89
18. Status, Deficiencies, and Needs for Hydrological Observations for Climate in North Africa and the Eastern Mediterranean .....	95
19. Satellite Application Facilities on Land Surface Analysis (SAF LSA): Overview of the Programme and Presentation of First Operational Results .....	99

<b>20. Generating Detailed Scenarios of Climate Change .....</b>	<b>101</b>
<b>21. Space Observation and Its Applications: An Essential Contribution to Climate Monitoring .....</b>	<b>105</b>
<b>22. Climate Indices.....</b>	<b>109</b>
<b>23. Contribution of the WMO Sub-regional Office .....</b>	<b>113</b>
<b>24. Resource Mobilization Matters: A Summary.....</b>	<b>117</b>
<b>25. List Of Acronyms .....</b>	<b>119</b>

## EXECUTIVE SUMMARY

The Global Climate Observing System (GCOS) held the Regional GCOS Workshop for the Mediterranean Basin at the Hotel Atlas Marrakech, Marrakech, Morocco during the three-day period 22-24 November 2005. GCOS organized this tenth workshop in its Regional Workshop Programme in collaboration with the National Meteorological Service of Morocco. The workshop was made possible through financial assistance provided by the Global Environment Facility/United Nations Development Programme (GEF/UNDP), Spain, and the United States. Their contributions are gratefully acknowledged.

The goals of the workshop were to identify gaps and deficiencies in systematic climate observing networks and systems in the Mediterranean Basin and to initiate discussions on the development of a Regional GCOS Action Plan. The proposed Action Plan would be aimed at improving regional capabilities in atmospheric, oceanic, and terrestrial data collection and the production and delivery of climate products and services. This Regional Action Plan for the Mediterranean Basin will contribute to global and regional efforts to monitor and detect climate variability, climate change, and extremes of climate and to the development policies that can mitigate and adapt to climate impacts. At the same time, it will enhance the abilities of the nations of the Mediterranean Basin to address their domestic requirements for climate data and services to support domestic and regional priorities, such as poverty reduction, water resources management, and sustainable development.

In his brief opening remarks, Dr. David Goodrich, Director of the GCOS Secretariat, emphasized the importance of systematic observation of the climate system in the Mediterranean Basin. Dr. Paul Mason, Chair of the GCOS Steering Committee, stressed the urgent need to enhance systematic climate observations in the region. He encouraged participants to contribute actively to the identification of key regional deficiencies in these programmes and to propose related, high priority, projects and initiatives for inclusion in the proposed Regional GCOS Action Plan. He also emphasized that the Action Plan would assist resource mobilization efforts aimed at improving the climate-related infrastructure, systems, and capacities in the Mediterranean Basin.

Subsequent workshop presentations and discussions focused on the status, deficiencies, and needs of atmospheric, terrestrial, and marine observational networks and related data exchange and data management systems in the region. User needs for climate observations were also addressed, with particular emphasis on important socio-economic applications in sustainable development, water resources management, and control of locusts. The vital issues of adaptation to climate and resource mobilization received substantial attention. During their deliberations, workshop participants identified a considerable number of topics and themes as possible priorities that might be addressed in formulating Regional Action Plan projects. Among others, these included:

- Strengthening atmospheric observation networks, e.g., GSN, GUAN, BSRN, RBCN, and GAW;
- Enhancing hydrological observation networks;
- Enhancing oceanographic programmes in the Mediterranean Sea, particularly the Global Sea Level Observing System (GLOSS) network;
- Data rescue;
- Drought monitoring and prediction;
- Risk management for extreme events (e.g., floods);

- Enhancing capacity in the application of satellite remote sensing data; and
- Improving capacity in regional climate modeling and its application to impact assessments and adaptation studies and policies.

Participants also highlighted the need to improve national, regional, and international coordination in order to pursue resource mobilization, achieve increased efficiency in observational activities and implement Regional Action Plan projects.

Workshop participants agreed on a process for the selection of 10 to 15 high priority projects, drawn from a lengthier list of potential topics. The selected projects would, in so far as possible, reflect broad regional concerns, seeking to add value for people across the Mediterranean region. A follow-up meeting of a representative writing team would be held in early 2006 to compile a draft Regional GCOS Action Plan that included these projects. It was emphasized that project descriptions will need to be prepared well in advance of the writing group meeting.

WMO Permanent Representatives and other national representatives were requested to identify individuals who could take the lead in preparing project descriptions and participate in the writing team. It was noted that the writing team should have a balanced composition, ideally including WMO Permanent Representatives, National Climate Change Coordinators, and representative experts from the various sectors. The GCOS Secretariat undertook to facilitate the identification of writing team members and to assist the team in drafting the Action Plan document. The draft Regional GCOS Action Plan prepared by the writing team would be circulated to workshop participants for their review and approval prior to being finalized.

## **INTRODUCTION**

The GCOS Regional Workshop for the Mediterranean Basin was held at the Hotel Atlas Marrakech, Marrakech, Morocco on 22–24 November, 2005. The workshop was made possible through financial assistance provided by the Global Environment Facility/United Nations Development Programme (GEF/UNDP), Spain, and the United States. Participants included National Climate Change Coordinators and WMO Permanent Representatives from nations in the Mediterranean Basin, the Chair of the GCOS Steering Committee, the Director of the GCOS Secretariat, and invited experts from various disciplines. A copy of the workshop agenda and a list of attendees are attached to this report as Appendices 1 and 2.

## **OPENING CEREMONIES**

**Master of Ceremonies: William Westermeyer**

In opening the Global Climate Observing System Regional Workshop for the Mediterranean Basin, Mustapha Geanah, Director of the Moroccan National Meteorological Service and Permanent Representative of Morocco to the World Meteorological Organization, conveyed the regrets of Mr. Abdelkebir Zahoud, Morocco's Minister for Water, for his absence due to other pressing engagements. Extending a warm welcome to Morocco and to Marrakech, Mr. Geanah drew attention to the importance of the Workshop in addressing regional issues related to global warming. Climatic variations and extremes can exert negative impacts on agriculture and food security in the region, with drought being a particular concern, as illustrated during the severe 1980 to 1983 droughts in Morocco. In view of the region's vulnerability to the impacts of climate, efforts to improve understanding of the climate system were, he indicated, becoming an increasing political priority. The Regional GCOS Workshop represented a unique opportunity to assess and improve systematic observation of the climate system across the Mediterranean Basin. The wide variations in the level of development across the region left considerable room for technology transfer and capacity building in areas such as the application of satellite remote sensing. Mr. Geanah also stressed the need for cooperation and coordination between governments, agencies, and other institutions in pursuing effective actions to address the climate challenge in the Mediterranean Basin. He concluded his address by extending his best wishes for a successful workshop and expressing the hope that participants would find their time in Marrakech to be both productive and enjoyable.

In subsequent welcoming remarks, David Goodrich, Director of the GCOS Secretariat, indicated that systematic observation of the climate system is of special importance to the Mediterranean region as well as globally. This provided the rationale for participants' presence in Marrakech. Noting the participation of a number of WMO Permanent Representatives and National Climate Change Coordinators in the workshop, he extended a particular welcome to them. He concluded his brief opening comments by expressing his thanks to Mr. Geanah and the National Meteorological Service of Morocco for hosting the workshop and indicating that he looked forward to a most productive meeting.

Following the speeches of welcome, workshop participants then identified themselves and their individual interests to the other attendees. The Master of Ceremonies adjourned the Opening Session of the workshop at the conclusion of this round-table.

## **SUMMARY OF WORKSHOP PRESENTATIONS AND DISCUSSIONS**

### **THEME 1: Setting the Context**

**Chair: Abdalah Mokssit**

Following a short break, the workshop reconvened to hear and discuss a series of context-setting presentations.

In an address entitled “The Global Climate Observing System and the GCOS Regional Workshop Programme,” David Goodrich, Director, GCOS Secretariat, summarized the mission, goals, and strategy of GCOS. He then reviewed the major GCOS observing networks. Discussing the relationship between GCOS and the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC), he stated that COP decisions provide a mandate for Global Observing Systems for Climate. He also pointed to the linkage between GCOS and the Group on Earth Observations (GEO) initiative to establish a Global Earth Observing System of Systems (GEOS), highlighting that climate is one of nine GEO “Societal Benefit Areas.” Reporting on the establishment of a GCOS Cooperation Mechanism, consisting of a Cooperation Board and Cooperation Fund, he indicated that the goal was to achieve a coordinated multi-governmental approach to address the critical need for stable long-term funding for systematic climate observation programmes. Turning to the GCOS Regional Workshop Programme, he reminded participants that, in 1999, the COP, by Decision 5/CP.5, had invited the GCOS Secretariat, in consultation with relevant regional and international bodies, to organize regional workshops to facilitate improvements in observing systems for climate. During the present workshop, he stated, GCOS was looking for a clear expression of regional needs for enhancements of GCOS networks. He hoped that an agreement could be reached on a process for completing a Regional GCOS Action Plan, on its priorities, and on a strategy for addressing these priorities. He concluded his presentation by re-emphasizing that the purpose of a Regional Action Plan was to address needs for climate information, ensure efficient actions to respond to these needs, and engage donors in supporting its initiatives. The content of the Regional Action Plan for the Mediterranean Basin, therefore, represented a very important output of the present workshop, reflecting a regional consensus on priorities and an agreement by regional stakeholders.

Addressing the second topic, “The UNFCCC and Systematic Observations,” Olga Pilifosova, UNFCCC Secretariat, reminded participants that the ultimate objective of the UNFCCC was the stabilization of greenhouse gases. She then pointed out that the Conference of the Parties (COP) to the UNFCCC and its Subsidiary Bodies have repeatedly considered issues related to systematic observations of the climate system. This emphasis was stimulated by the perception that the number and quality of atmospheric data were declining and that action must be taken to reverse this trend, particularly in developing countries. Subsequently, COP and its Subsidiary Body for Scientific and Technological Advice (SBSTA) endorsed several major activities to address this problem, including a regional workshop programme to identify priority needs, develop specific proposals for corrective actions, and identify related capacity building and funding requirements. Furthermore, SBSTA has invited the Subsidiary Body on Implementation (SBI) to consider funding requirements related to project proposals emanating from the GCOS Regional Workshops, invited Parties to submit systematic observation reports as part of their National Communications, and asked for the preparation of an “Adequacy Report” and follow-up “Implementation Plan.” Highlighting that issues relating to impacts, vulnerability and adaptation to climate change have been steadily gaining prominence, especially since COP 7 (2001), Ms. Pilifosova drew attention to the COP 10 request to SBSTA to develop a Five Year Plan to address scientific and technical aspects of vulnerability and adaptation. She concluded her talk by reiterating the need for GCOS Regional Action Plans to include specific high priority projects

reflecting increased emphasis on adaptation to climate change and on regional needs and concerns.

Paul Mason, Chair, GCOS Steering Committee, followed with a talk on “Developing a Regional Action Plan for the Mediterranean Basin.” In his introductory remarks, he stressed that requirements for systematic observations were tied to the need to sustain socio-economic systems, noting also that donor funding for observational initiatives will be tied to socio-economic needs. Briefly reviewing the *Second Report on the Adequacy of the Global Observing Systems for Climate in support of the UNFCCC* (the 2<sup>nd</sup> Adequacy Report), he drew attention to the development of a list of Essential Climate Variables (ECVs) as reflecting the essential observational requirements of the UNFCCC. The GCOS Implementation Plan, developed in response to a specific request from the Convention, he noted, contains an observational strategy aimed at achieving an optimum balance between satellite and in-situ observations, long-term stability of observations, and the use of all available data in the interests of cost effectiveness. The Plan implies a 15–20 percent increase in annual expenditures on systematic climate observations. It incorporates global observational coverage by satellites, strengthening of infrastructure, and emphasis on sustained generation of integrated, global climate analysis products. Addressing the needs of Least Developed Countries (LDCs), Small Island Developing States (SIDS), and countries in transition, are also given special attention.

Addressing GCOS Regional Action Plans against the preceding backdrop, he drew attention to the need to ensure that systematic observation programmes address key societal needs for data. In particular, relatively few climate impact studies have been undertaken for developing countries and observations from many GSN stations are not readily accessible. He suggested that observational requirements that should be addressed in a Regional Action Plan include those related to key socio-economic priorities, such as water availability, land use and land cover, and planning for low lying coastal areas, as well as more scientific needs related to modeling, prediction, and mitigation of future regional and global climate change.

In overview, a Regional Action Plan for the Mediterranean Basin should aim to strengthen GCOS networks; improve telecommunications, where necessary; build capacity for data management, analysis, and applications; and improve the recovery of historical data. The linkage to adaptation should be highlighted in project proposals in order to increase their appeal to donors. A Regional Action Plan should focus on regional priorities for enhancing global networks and also incorporate regional projects linked to vulnerability and adaptation to climate. He repeated that the goals of the present workshop were to reach consensus on feasible, high priority projects linked to societal needs and to begin the process of drafting an Action Plan. These goals could be achieved through discussion and agreement on key elements to be included in the Plan, its format and content, and the process for drafting the document. In concluding, he emphasized the importance of regional ownership, pointing out that some person or group must take responsibility for pursuing the development and implementation of the Regional Action Plan. He also suggested endorsement of the Plan by SBSTA and COP could assist in raising its profile, a helpful measure in seeking donor funding for projects.

Substantive plenary discussion followed the above presentations. The following summarizes the key points raised during these discussions.

- The need to ensure reliable, free, and open data exchange from all GCOS stations and networks was emphasized. The reluctance of some countries to exchange data and the high percentage of missing reports from existing stations hindered efforts to engage donors in supporting network enhancement projects.

- In some instances, there was a lack of awareness of the importance of data exchange while, in other cases, countries may not wish to exchange data for various reasons, such as the need to gain commercial benefits from their observations. GCOS has tried to accommodate these realities by establishing a global commons of data that is generally recognized as being useful to all Parties and has sought a reasonable balance in defining, for example, the GSN and GUAN station networks.

- UNFCCC Annex 1 countries (developed countries and economies in transition) have been requested to submit separate GCOS reports as part of their National Communications. However, not all Annex 1 countries knew how to report on some aspects of their programmes, and some reluctance to report on deficiencies in networks was evident in reports received. Non-Annex 1 countries have also been invited to report on a voluntary basis, and COP 8 has adopted guidelines for these voluntary reports that are less formalized than those for Annex 1 nations.

- The requirement for national reporting to the UNFCCC on GCOS activities exerts positive pressure on Parties to improve data exchange. Good national reports are also needed to identify problems and deficiencies in systematic observation programmes so that the latter can be remedied. Consequently, all countries are encouraged to submit national GCOS reports in accordance with the relevant guidelines. Ms Pilifisova offered to provide information and advice to assist in improving future reports.

- The linkage between individual Action Plan projects and socio-economic needs should be highlighted in a Regional Action Plan. The need to include sustainable development was particularly stressed, with all sectors that are affected by climate being considered.

- The socio-economic importance of adaptation to the impacts of climate in the Mediterranean region was underscored. GCOS networks alone, however, are insufficiently dense to address adaptation requirements. Supplementary observational data from national networks were needed to provide the higher density data needed to address the critical issue of adaptation.

- Most observation networks in the Mediterranean Basin are supported by national governments. It is vital to ensure that sustained funding support is provided to sustain these national and regional networks over the long term. Workshop participants should press for sustained, preferably increased, national support for systematic observation networks and programmes across the region, as well as for external donor support for implementation of specific projects.

- For some socio-economic applications, the limiting factor may be the organization and availability of sectoral socio-economic data, rather than inability to access adequate climate system observational data.

- Regional ownership of the Regional Action Plan is essential to success in implementing it. This highlights the need for improved coordination across the region in pursuing GCOS initiatives and priorities. Regional, national, and even international coordination may be required. The coordination issue should be addressed in the Regional Action Plan

- The GCOS Upper Air Network (GUAN) is a subset of the WMO global upper air network. GUAN stations were chosen on the basis of uniform geographic coverage of the globe, their long station history and their long-term sustainability. Individual countries have been requested

to identify a GCOS focal point who can be contacted to resolve operational problems related to the operation of GUAN and other GCOS stations.

- The GCOS Regional Workshop for the Mediterranean Basin and the Regional Action Plan should build on experiences from earlier workshops.

In winding up the session, the Chair stressed that a successful workshop must have specific goals and lead to concrete actions. Strengthening the observational system must have a positive impact on society, particularly in developing countries. We must build on and seek to improve the existing system to make it work better and produce and exchange the maximum possible data. New means of observation such as satellites and remote sensing by radar and other devices should be pursued in a coherent effort consistent with the GEOSS concept and in line with UNFCCC requirements. Regional initiatives that meet global needs should be encouraged. Adaptation to climate should be an important theme of the Regional Action Plan. Particular emphasis should be laid on capacity building, stressing human resources development to build an expanded cadre of well-trained staff in the region. Regional collaboration must also be pursued in the interests of efficiency and effectiveness. Projects should be selected that involve all countries in the region, both developed and developing, with priority given to projects that address poverty reduction or reduce vulnerability to the impacts of climate and climate change across the region. Furthermore, every opportunity should be pursued to obtain funds to purchase needed equipment and implement projects. The Chair concluded his remarks by suggesting that initiatives and projects that involve everyone will have the greatest impact and chance of success and by reiterating the need for the region to take ownership of the Action Plan.

## **THEME 2: User Needs for Climate Observations**

**Chair: (Mrs) Awatef Messai Larbi**

In the opening presentation on user needs, Taoufiq Bennouna (Tunisia) discussed "Environmental Information for Sustainable Development." Pointing to the diversity of the African continent, he also cited its strong dependence on aid. The principal issues relating to sustainable development in Africa included land degradation, its causes and consequences, and the increasing problem of access to water. Following a brief review of relevant institutions, he noted the availability of considerable information relevant to sustainable development. There were, however, significant difficulties in access, minimal utilization of satellite remote sensing data, inadequate spatial information (maps), and little if any use of such data by decision makers. Many information initiatives were underway to improve data access and utilization, but these were not well coordinated. The linkage of climate information to development planning was poor, with planning efforts reflecting sectoral division and a short-term focus. He advocated that climate considerations must be integrated into economic sectors and institutions, with climate change being placed at the heart of development. Environmental impacts must be considered in planning projects, coordination must be improved, and the private sector and local groups must be engaged in planning.

Important challenges included the need to revisit development paradigms, broaden decision-making, and establish clear links between environment and development. At the same time, important opportunities were presented by the New Partnership for Africa's Development (NEPAD), the Millennium Development Goals, the Plan of Action of the World Summit on Sustainable Development, and other initiatives focused on poverty reduction. He stressed the need to reinforce scientific and technical capacity, noting the focus of his parent organization, the Observatory of the Sahara and Sahel (OSS), on capacity building and on the production and dissemination of useful environmental information. He drew particular attention to the Réseau d'Observatoires et de Suivi Écologique à Long Terme (ROSELT) network in the Sahara-

Sahelian region, to the applications of satellite remote sensing and *in situ* observational data in tracking desertification, and illustrated data, maps, and other relevant products available through the OSS server. He concluded his presentation by briefly outlining a strategy for the pursuit of sustainable development to 2010.

In the second presentation of this session, Abdalah Mokssit (Morocco) discussed “Extreme Events and Climate Change Adaptation – Observational Needs.” Drawing attention to the contrast between northern and southern areas of the Mediterranean Basin, he summarized by saying that the north was “green,” while the south suffers from a shortage of water and from periodic invasions by locusts. He underlined the importance of regional data in defining precipitation patterns, illustrating the spatial and temporal variations that occur across the Basin. He noted a need to differentiate between climate variations and climate change. Drawing attention to the political implications of climate and climate change, he stressed the vital importance of mitigation and adaptation to their impacts. Following a brief review of projections of future climate to the year 2100, he emphasized the need to pursue adaptation pathways and suggested that scope for adaptation exists on all space and time scales. Decision tools for adapting to an uncertain climate included a monitoring system, planning that recognizes the variability in climate, and the development of appropriate strategies for longer term changes in climate. Some characteristics of an effective adaptation system were outlined, the basic elements of a global climate watch were described, and applications of climate information in several economic sectors were illustrated.

Pointing out that most sectoral clients require derived climatic information rather than simply observations of standard variables, he stressed the importance of communication of information, expanding on the concept of end-to-end service systems. He noted that sources of uncertainty include incomplete data, incomplete conceptual frameworks, inaccurate prescriptions of known processes, and lack of predictability. Climate-induced perturbations can cause major disruptions to developing economies, while similar perturbations can be absorbed relatively easily by developed nations. Consequently, model projections that indicate significant increases in the frequency of hot days and in the number of consecutive dry days gave cause for serious concern in the Mediterranean Basin. In concluding his presentation, Dr. Mokssit identified a series of outstanding research issues under the twin themes of systematic observations and modeling and process studies. He ended his talk by emphasizing GCOS principles and guidelines for the conduct of systematic climate observation programmes.

The final presentation by Driss Fakhour (Morocco) addressed “Needs for Climate Observations in the Fight Against Locusts.” Morocco has experienced 5 great invasions by locusts in the 20<sup>th</sup> century, each lasting from 2 to 10 years. The economic impact of such invasions can be very large, with 1 km<sup>2</sup> of locusts able to consume about 100 tonnes of vegetation. In 1953-54, for example, losses due to locusts in Morocco alone represented sufficient food for about 1 million people. Meteorological conditions exert a major influence on the population dynamics and behaviour of locusts as illustrated in the summer of 2003 when unusual rainfall in the Sahel made conditions favourable for rapid growth in locust population. Subsequently, strong winds in February 2004 transported locusts from the southern interior to the Atlantic coast of Morocco. Following a review of the specific climatic conditions affecting locusts and their migration patterns, Mr. Fakhour described the meteorological services provided in support of the fight against invasions by locusts. These include special bulletins for locust-infested zones, forecasts of wind velocity, heavy precipitation, relative humidity, temperature, and other parameters, climate data, and studies and observations from neighbouring countries. He drew attention to recommendations from a workshop held in Niamey, Niger in 2005 that aimed to enhance regional and national capacity and capability in fighting invasions of locusts. In his concluding remarks, he reiterated the value of meteorological information and the vital role of National

Meteorological Services in fighting invasions of locusts, and he advocated constant efforts to improve the flow of such information to the operational agencies.

Plenary discussion following the presentations highlighted the following:

- To form a basis for an Action Plan, priorities and projects must be identified that will have broad appeal. This requires that projects be tuned to end-users' needs at the national level across the Mediterranean Basin. Projects that address drought and locusts are examples of projects with widespread appeal.

- International exchange of raw observational data can sometimes present difficulties. However, the exchange of processed information such as indices does not usually pose a problem, and a recommendation should be formulated that stresses the free and open exchange of processed information.

- Resolutions adopted by the 12<sup>th</sup> WMO Congress advocate free and unrestricted exchange of meteorological and hydrological data. It was suggested that a workshop recommendation might encourage countries to implement these WMO resolutions.

- Finer scale observational data from national networks are needed to support model validation and to address adaptation to the impacts of climate. However, the quality and reliability of data from national networks is sometimes less than desirable for such applications and needs to be addressed.

- The synergy between in-situ and space based systematic observation programmes should be exploited, and the importance of metadata must also be emphasized.

- A Regional Action Plan must first inventory what is already being done, assess these programmes, identify gaps and deficiencies, and develop recommendations to address these gaps.

- The ROSELT network should be optimized to address the various problems that affect the region. Efforts are being made to move ROSELT from a regional to a nationally supported network, with the countries in the region taking over ownership of the network and contributing to its upkeep to increase its sustainability.

- It would be desirable to standardize vulnerability indices across the region. The OSS representative indicated that they have been working to address that issue in the context of drought and wish to extend this work to other sectors.

- Politicians sometimes debate whether climatic events reflect climate variability or a changing climate. However, climatic variations are always embedded in the climate record. The changes in climate have been very rapid during the past century and are attributable to human impacts on the climate system.

- The Regional GCOS Action Plan should include proposals to install stations to fill observational gaps in the Mediterranean Basin. It should highlight training and capacity building needs.

- A participant drew attention to the vulnerability of Algeria to droughts, floods, and locusts, citing the November 2001 floods that caused over 800 casualties in that country.

Following the plenary discussions, the Chair expressed her thanks to the speakers for their excellent presentations and to workshop participants in general for their active participation in the discussions. Their interventions had drawn attention to a number of important issues that should be considered in developing a Regional Action Plan.

**THEME 3: Atmosphere: Status, Deficiencies, and Needs      Chair: R. Juvanon du Vachat**

In a joint opening presentation, Hans Teunissen and Richard Thigpen (GCOS Secretariat) addressed the topic "GSN, GUAN and RBCN." Mr. Teunissen described the various GCOS global networks, and briefly discussed the considerably larger Regional Basic Climatological Network (RBCN) that includes all GSN and GUAN stations. The RBCN provides supplementary data that add value to the observations from the GCOS networks. Addressing the current status of these networks in the Mediterranean Basin, he commented on the data flows from the stations, the roles of the GSN and GUAN Monitoring Centers, and the archival responsibilities of the World Data Centre. Pointing to the set of GCOS observational "Best Practices," he noted the current emphasis on obtaining daily data to support assessment of extreme events. He highlighted the important roles of the WMO's Commission for Basic Systems (CBS) Lead Centers and national GCOS Focal Points in resolving observational problems in relation to GCOS station operations. Monitoring Centre statistics were used to illustrate the need for improvements in timeliness, quality, and reliability of reporting for CLIMAT and CLIMAT TEMP messages from some regional GCOS stations. The availability of World Weather Watch (WWW) monitoring products for CLIMAT reports from other RBCN stations was also identified as assisting in improving the latter's performance. Mr. Teunissen concluded his part of the joint presentation by drawing attention to the Certificates of Recognition awarded by the WMO Secretary General to GCOS station operators, citing these as a motivator for observing staff to achieve high levels of quality in their observational activities.

Richard Thigpen followed with the Implementation Manager's Report. He noted that the GUAN revitalization programme has resulted in the activation of 4 new GUAN stations; provided assistance in the form of balloons, sondes, or hydrogen generators to 18 others; and, overall, reduced the number of silent GUAN stations by 5 during the past year. The first performance review of the GSN indicated that a significant number (about 10 percent) of stations that are operating are not delivering CLIMAT messages, while around 6 percent of stations are silent. In addition, a substantial number of stations have not as yet supplied their historical data to the World Data Centre. He reported that a World Weather Watch (WWW) handbook on CLIMAT/CLIMAT TEMP messages and a GCOS/World Climate Programme (WCP) CliRep software package are now available to assist in the preparation and transmission of these vital climatological reports. He also cited the scheduling of workshops on the CliRep software, efforts underway to improve the distribution of stations in the GCOS networks and major network changes being implemented in Canada and Russia.

A series of technical support projects has been undertaken in various locations. These were aimed at enhancing station operations and data quality and timeliness. The roles of the CBS Lead Centers for GCOS data were outlined, and performance reports from the Monitoring Centers were illustrated, with particular emphasis on the Mediterranean Basin. "Things to do" at the national level included verifying the performance of stations, ensuring station information was correct, adhering to observing guidelines, forwarding historical data to the archives, using the monitoring reports to improve station performance, and making use of the respective national focal points. Mr. Thigpen ended his talk with some suggestions for possible Action Plan projects. These included a project to increase awareness in the region, a regional network enhancement project, conduct of a network distribution analysis, establishment of a GCOS lead center in the region, and creation of a regional technical support project.

The following issues and topics were raised during subsequent plenary discussion:

- Action should be taken to fill apparent gaps in GCOS networks, and at least one GUAN or GSN station should be activated in each country in the Mediterranean Basin to link the networks more closely to the political system. The WMO Regional Associations might assist in identifying suitable candidate stations.
- Only stations with a long history and stable funding support for the foreseeable future are suitable candidates for inclusion in the GCOS global networks. National Meteorological Services in the region are in the best position to identify the most appropriate stations for designation as GSN and GUAN sites. GCOS is anxious to work with National Meteorological and Hydrological Services (NMHSs) to improve the global networks and encourages them to identify the best stations for inclusion in these networks.
- Sustaining, the operation of the GSN and GUAN networks as being essential was reinforced by several speakers. Assistance from GCOS and other sources was, however, needed to support the sustained operation of upper air stations with needs being identified for training, equipment and consumables such as balloons and sondes.
- While the GCOS Cooperation Mechanism might provide an umbrella for provision of support to station operations, donor funding will be necessary to make the Mechanism a viable one. In the past, GCOS and WMO purchased a large supply of sondes for use in the GUAN network, but when this supply was depleted no resources were available to replenish it.
- Very attractive volume discounts are available for large purchases of sondes. This provides an incentive for NMSs in the region to collaborate in making bulk purchases.
- Richer countries gain the greatest benefits from investments in global networks. Consequently, upgrading GCOS networks and station operations in poorer countries could be considered to be a development issue where richer nations support poorer ones, and the status quo approach may need to be re-evaluated.
- Further to the preceding observation, the WMO system requires the free distribution of forecasts and other products from global centres to all nations who supply the observational data needed to generate these products. This represents a return for the observations supplied by individual countries.
- Enhancement is required of the capacities of less developed countries to conduct observational programmes and to utilize globally produced products more effectively. Practical approaches to capacity building might include accessing expertise from neighbouring countries on a bilateral basis or even the operation of observational programmes by external bodies, acting with the permission of the relevant national authorities.

Following the preceding discussion, Manola Brunet (Spain) delivered a presentation entitled "Needed Upgrading of Data Rescue Missions in the Mediterranean Basin," with the objective of raising awareness of the need for data rescue in the region. She pointed out that the long history of atmospheric observations in the region offered great potential for the rescue of important data time series. Such long period data have many important applications including detection of changes in climate, satellite calibration, reanalysis and model validation, as well as for adaptation studies, policy development, and other socio-economic applications. Much of the

available historical data in the Mediterranean is, however, widely dispersed, difficult to access, and in paper format, often residing in books or manuscripts. Digital records of climate generally exist only for the second half of the 20<sup>th</sup> century and there are significant variations between countries, particularly between northern and southern nations. She then discussed observed changes in climate that have occurred in recent decades. Some examples of significant regional variations in climate changes were illustrated but, she indicated, limited spatial and temporal definition of such changes was possible at present. This reinforced the need for data and metadata rescue initiatives in order to add spatial and temporal detail to the climate record. Pointing to WMO Data Rescue (DARE) project and its achievements, she described GCOS data rescue priorities as emphasizing the Essential Climate Variables (ECVs) and incorporating observational data on various scales, metadata, non-instrumental observations, and phenological data. In view of the dispersion of historical records, she advocated a national approach to data rescue, one that was, however, internationally coordinated. She underlined that metadata were vitally important in addressing data quality and homogeneity. In concluding her presentation, Ms. Brunet encouraged cooperative data rescue efforts to build an accessible, high-quality historical database for the Mediterranean Basin, with emphasis on the ECVs, and offered recommendations as to the approach and method. She also stressed the need for capacity building and for the provision of supporting infrastructure and equipment (e.g., cameras, digitization equipment, and software) to countries in the region in order to provide a foundation for continuing data rescue activities.

Following the talk on data rescue, plenary discussion centered on recent variations and trends in Mediterranean climate.

- It was observed that warming in recent decades is unprecedented and that only climate change can explain this reality.
- Historical data are needed to provide a basis for defining the magnitude and spatial variation of observed changes in climate. Data rescue is essential to capture and preserve such historical data records.

At the end of the discussion, the Chair summarized by noting that a clear consensus existed that data rescue must be a priority reflected in the Regional Action Plan.

“The WMO Global Atmosphere Watch” was the theme of the next presentation, delivered by Emilio Cuevas (Spain). He outlined the history of the Global Atmosphere Watch (GAW) programme, summarized its three-fold mission--systematic monitoring of the atmosphere's chemical composition and related variables; analysis and assessment; and development of predictive capacity for future atmospheric states--described the motivation underlying the programme, and pointed out that GAW is the atmospheric chemistry component of GCOS. Noting GAW's additional objective of coordination of regional air quality measurements around the globe, he summarized its global and regional observation networks, the parameters measured, and its infrastructure of Quality Assurance/Science Activity Centres, World Calibration Centres, and World Data Centres. He also described the roles of the GAW Training and Education Centre and Scientific Advisory Groups. In support of GCOS, the GAW system must not only continue to promote quality ground-based measurements, but also incorporate efforts to integrate ground and satellite-based measurements. Reviewing the status of monitoring of greenhouse gases in the Mediterranean Basin and North Africa, he advocated significant expansion of this programme. Where ozone monitoring was concerned, the network in the Basin was significantly less dense than that in Central and Northern Europe. Consequently, he offered several recommendations for improvements (i.e., installation of a surplus Dobson instrument at Ankara, Umkehr observations at all Dobson/Brewer stations,

provision of calibration assistance from European Union (EU) GAW facilities, additional Brewer installations). Finally, he reviewed the status of aerosol observations in the region, illustrating the station network, the observed parameters and the need for measurements of additional parameters. He stressed that GAW aerosol monitoring is generally very poor in the Mediterranean Basin, with the exception of optical depth, and pointed out that this is an important deficiency in a region where polluted continental particles and Saharan dust are frequently present. He concluded his talk with a recommendation that GAW stations should measure aerosol optical depth, mass concentration, major chemical components in two size fractions, and aerosol light scattering and absorption coefficients.

Plenary discussion following Mr. Cuevas's presentation centered on:

- The need to protect the vital GAW observatories over the long-term as a resource for all of humanity. (It was reported that GCOS is making continuing efforts to ensure the sustained operation of these stations.)
- It was proposed that the GAW observatories might be developed as educational centres. This would add a tourism and education dimension that could assist in solidifying support for the sustained, long-term, operation of these critically important observation programmes.

Following the preceding discussion, the Chair adjourned the session, thanking the speakers for their stimulating talks and the workshop participants for their active involvement.

## **DAY 2**

### **THEME 4: Oceans: Status, Deficiencies, and Needs**

**Chair: Aldo Drago**

The Chair opened the second day of the workshop by setting the stage for subsequent discussions on the oceans theme with a comprehensive overview of "Operational Oceanography in the Mediterranean." He defined operational oceanography as the "study of the sea with a purpose," involving routine, long-term observation on synoptic, basin and coastal scales and the delivery of data and products in near real-time. The ocean observing system combined in-situ and remote sensing and addressed ecosystem as well as physical aspects, using both traditional approaches and new technologies. A modern ocean prediction system, he indicated, melds the observations from these systems into numerical models that yield a 3 dimensional description of the ocean and provides forecasts of the future state of the sea. Various observing technologies and some examples of outputs from them were then illustrated. Following a brief overview of the Global Ocean Observing System (GOOS) and its structures, objectives, and linkage to GEOSS, he summarized the reasons for establishing a marine observing and forecasting system. He stressed that more than science was involved in the establishment of an operational system. Other relevant factors included institutional frameworks, collaboration, awareness building, linkages to end users, and responsiveness to the priorities of coastal states. He noted that a Mediterranean GOOS (MedGOOS, the GOOS Regional Alliance for the Mediterranean) had been established to provide a concerted regional approach to the planning and implementation of an operational ocean monitoring system in the Mediterranean. In addition, the MAMA (Mediterranean network to Assess and upgrade Monitoring and forecasting Activity) project had been directed towards building the regional network, upgrading capacities, increasing awareness and designing an initial observing system. The MedDir-OP (Mediterranean Directory for Operational Oceanography) with its database access was introduced as a valuable tool for oceanographic interests in the region. Mr. Drago emphasized that MedGOOS builds upon national efforts in the Mediterranean and detailed a number of national programmes that contribute to it. He then briefly drew attention to the

Mediterranean GLOSS (MedGLOSS) and outlined the phased approach being implemented for a Mediterranean Forecasting System (MFS), including the Mediterranean Operational Oceanographic Network (MOON), Mediterranean Ocean Forecasting System Towards Environmental Prediction (MFSTEP), and Marine Environment and Security for the European Area (MERSEA). He also highlighted the mission and tasks of GRAND (GOOS Regional Alliances Network Development) in defining a common regional strategy for GOOS, coordinating the Regional Alliances, and providing training and other support to them. Mr. Drago concluded by noting that the challenge in the Mediterranean Sea is to implement an operational system that embraces an ecosystem approach; integrates and links global, regional, and coastal domains; builds and maintains consensus, cooperation, synergies, and sharing of resources to optimize cost effectiveness; and provides useful services.

In the second presentation, Enrique Alvarez (Spain) addressed the “GLOSS Network and Sea Level Rise.” In a brief overview of the history and role of the Permanent Service for Mean Sea Level (PSMSL), he drew attention to its data holdings, their uneven data standards and historical bias towards the northern hemisphere, and the absence of long term commitments by participants. He then described the Global Sea Level Observing System (GLOSS) programme, established by the Intergovernmental Oceanographic Commission (IOC) in the 1980’s to improve the quantity and quality of sea level data supplied to the PSMSL and other data centers. The GLOSS Core Network (GCN) of about 300 stations, he reported, incorporates a balanced geographic distribution, open ocean locations, common technical requirements (including defined data standards), and represents a high quality and long-term data set. Some results from GLOSS were presented. It was pointed out that GLOSS offers national authorities access to data and quality control standards, archiving facilities, training courses, expert visits, manuals and workshops, and also provides gauges and assistance with upgrading stations.

MedGLOSS, a GLOSS regional network sponsored by the Mediterranean Science Commission (CIESM) and the Intergovernmental Oceanographic Commission (IOC), adds station density to the GLOSS network in the Mediterranean and Black Seas. Here, Mr. Alvarez highlighted the need for additional sea level stations in North Africa. He also raised the future application of GLOSS data in operational oceanography, citing the Spanish NIVMAR operational storm surge system as an illustration of the integrated use of circulation models and sea level gauge data. Mr. Alvarez noted that MedGLOSS is collaborating fully with the European Sea Level Service (ESEAS) and drew attention to the ESEAS data portal that has been established to provide easy access to European sea level data and related metadata. In concluding his presentation, he underlined the desirability of integrating North African tide gauge stations and responsible institutions in North Africa and the Eastern Mediterranean into the MedGLOSS system and, through it, into ESEAS. He also reiterated that MedGLOSS would sponsor technical visits to countries to support upgrading of national tide gauges. He stressed that CIESM, assisted by GLOSS, is willing to support the purchase and installation of modern sea level stations in North African CIESM countries and to provide training.

In the concluding marine presentation, Giovanni Coppini (Italy) spoke on “Long-Term Monitoring in the Mediterranean Sea—the Operational Oceanography Approach in Support of Research and Applications.” His introductory remarks highlighted applications of a Mediterranean Forecasting system to hazards such as algal blooms, oil spills and contaminants, ecosystem changes, invasive species and coastal erosion. He then summarized the components of such a system and described the various phases of the related EuroGOOS Mediterranean Task Team project. This project started with the Mediterranean Forecasting System Pilot Project (MFSP) in 1998, moving to a second phase involving the Adriatic Sea Integrated Coastal Areas and River Basin Management System (ADRICOSM) and MFSTEP from 2001-2005, and culminating in a third phase scheduled for the period 2004–2010, focused on MERSEA and MOON. Following a

description of the MFSTEP system, he detailed the various technologies used in basin scale observing systems and coastal observational networks, drawing attention to the contributions of new technologies such as Argo floats and gliders. He also summarized the components of a real time Mediterranean data dissemination network connected to the Global Telecommunications System (GTS) through the Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER). Various products and capabilities of the MFS were illustrated, including sub-regional and ecosystem modeling capabilities. The final part of his presentation focused on the proposed action plan for MOON. MOON contributions to GCOS were highlighted, and its deficiencies in climate-oriented monitoring and modeling were noted. Mr. Coppini concluded his talk by stressing the need to sustain the existing operational oceanography network, ensure wide accessibility to archived data, enlarge the observing system to include monitoring in deep water and straits, increase reanalysis activities, and pursue coupled ocean-atmosphere marine ecosystem modeling.

Plenary discussion following the presentations highlighted the following topics:

- The need to geo-reference tide gauges in order to address climate-related sea level changes. A working group is addressing this requirement in the Mediterranean.
- An important opportunity exists to build up the MedGLOSS network with strong support existing for a new station on the African coast. Funds are available for such an initiative through CIESM.
- Initiatives to establish MedGLOSS stations in Egypt and Morocco should continue to be pursued. The fact that many North African countries are already partners in the European Community's Sixth Framework Plan (EC FP-6) provides potential access to EC support for initiatives related to sea level monitoring.
- MedGOOS partnerships are largely between institutions. However, efforts are now being made to increase governmental involvement in the programme. In particular, MedGOOS is pursuing partnerships with African nations and programmes and already embraces North African countries such as Algeria and Egypt along with others such as Lebanon.
- Support was expressed for an integrated approach to monitoring and prediction. It was suggested that climate could provide the link in an integrated approach combining physical and biological data with socio-economic elements. It was also pointed out, however, that although physical variables are well identified, oceanographic ecosystem variables are not, as yet, well specified.
- Within the MOON community, agreements are being developed to facilitate the exchange of data sets.
- Downscaling from the basin scale is needed to address coastal variability, since deep ocean currents influence coastal variability. While MFSTEP is already producing coastal products and forecasts, much remains to be done.
- Three buoy stations are now operational off the coast of Lebanon that observe sea temperature and wave height.

## **THEME 5: Terrestrial Observations: Status, Deficiencies, and Needs Chair: Paul Mason**

In the opening terrestrial presentation, Omar Elbadawy (Egypt) discussed the “Status, Deficiencies, and Needs for Hydrological Observations for Climate.” He began by outlining the mission and roles of the Center for Environment and Development for the Arab Region (CEDARE) in capacity building and technology transfer and as an enabling agent for sustainable development initiatives. Pointing out that it was a collaborative centre with the United Nations Environment Programme (UNEP) for North Africa, he also indicated that it was a founding agency in the Global Water Partnership. Since water scarcity was a concern for most countries in the southern half of the Mediterranean Basin, the need existed for an effective and reliable hydrological observation system. Important variables for observation included surface discharge and storage flux, precipitation, evapotranspiration, and groundwater storage and flux.

While climatological data collection in some countries in the region began in the 19<sup>th</sup> century, hydrological data collection is more recent and long hydrological data series are rare. He emphasized the value of integrating hydrological data into a Geographic Information System (GIS), particularly for identifying inconsistencies. Mr. Elbadawy then discussed applications to watershed management. He explained that inputs, including precipitation, topographic contours, and soil characteristics, fed to a processing component that incorporated a runoff model or routing scheme can produce useful outputs, such as risk matrices, vulnerability maps and runoff hydrographs. The importance of a groundwater observation system was highlighted. Geological and other factors that must be considered in the design of a regional monitoring network were illustrated by reference to a large aquifer that is shared between Egypt, Libya, and Chad. The potential impacts of human-induced changes in land cover and land use on precipitation and runoff patterns were cited, and inhomogeneities in time series of water levels of the Blue Nile and the Atbara River were discussed. Improvements in hydrological observation systems in the region were needed, he indicated. These included increased investment in monitoring, addition of stations (particularly in key areas in North Africa and the Eastern Mediterranean), network optimization, improved instruments, method of observations, enhanced processing, quality assurance, and archiving and interpretation systems. In addition, climate change must be incorporated into planning and the establishment of national priorities for networks. Emphasis must also be increased on capacity building, exchanges of expertise and research. Mr. Elbadawy concluded by recommending the establishment of an Environmental Information System to facilitate regional efforts and information exchange between the countries of the Mediterranean.

The second talk, by Jean-Louis Roujean (France), addressed satellite-derived terrestrial products from Meteosat Second Generation (MSG) observations in a talk entitled “SAF for Land Surface Analysis—Concepts, Products and Services.” He began by describing and illustrating enhanced capabilities for observation of land surface processes and land-atmosphere interactions that are associated with the latest generation of meteorological satellites, particularly MSG and the European Polar Orbiting Meteorological Satellite (Metop). Drawing attention to the Satellite Application Facilities (SAFs), he indicated that five of these centers of excellence in processing satellite data are now in the initial operations phase, with an additional three under development. The Land Surface Analysis SAF, operated by the Portuguese National Meteorological Service with support from the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), has as its main purpose to increase the benefits from MSG and EUMETSAT Polar System (EPS) data related to land, land-atmosphere interactions, and biophysical applications. The goal of Land SAF activities is operational production of biophysical parameters that yield key inputs to a wide variety of modelling tools for energy, heat, and momentum exchanges in the atmospheric boundary layer. SAF products, he indicated, encompass solar radiation parameters, (long wave) thermal radiation parameters,

and biophysical parameters related to soil moisture, evapotranspiration, snow cover, and vegetation. Various products and their characteristics, processing algorithms and validation results were illustrated, and applications were identified in crop and forest monitoring, drought monitoring, land cover change, and wildfire monitoring and burnt area discrimination. Land SAF product distribution is presently in the pre-operational phase (see <http://landsaf.meteo.pt>), with full operational status being targeted for 2007, including distribution to users via the Global Telecommunication System (GTS) and on the Internet. Mr. Roujean pointed out that since, 6 October 2005 some operational products are already being disseminated by the EUMETSAT Broadcast System for Environmental Data (EUMETCAST). Drawing participants' attention to the 2<sup>d</sup> Land Surface Analysis SAF Workshop, scheduled for 8-10 March 2006 in Lisbon, Portugal, he underlined urgent SAF requirements to identify high quality long-term *in-situ* radiation measurements from North Africa to support calibration and validation of satellite measurements. He also made a plea for the establishment of pilot projects aimed at evaluating SAF Land Surface Analysis products in North Africa. In concluding, he noted that a proposal was currently being prepared for EUMETSAT aimed at developing new products that addressed land cover, land use change, fire disturbance, burnt areas, and productivity.

Speaking on behalf of Alan Belward (EC Joint Research Centre, Ispra, Italy), who was unable to participate in the workshop, Paul Mason addressed the topic of "Satellite Derived Terrestrial Essential Climate Variables: Status, Limitations and Potential" in the final presentation on the terrestrial theme. Emphasizing the great potential of satellite remote sensing for systematic observation of important terrestrial variables, he reviewed how terrestrial ECVs connect to atmospheric boundary layer processes and to the climate system. He highlighted that instrument calibration is a major concern in using satellite data, both in relation to pre-launch calibration and post-launch sensor degradation. The climate community's requirements for long time series of observations presents a significant challenge in view of inhomogeneities between observations from different satellites. Dr. Mason also stressed the importance of atmospheric, geometric, and directional corrections in combining data from different satellites to produce high quality global imagery. He drew attention to the potential of satellite remote sensing in detecting anomalous vegetation growth patterns by tracking the amount of energy accumulated in plants (Fraction of Absorbed Photosynthetically Active Radiation or FAPAR). A 1-km resolution satellite-derived global land cover distribution was illustrated, as were applications to monitoring the global distribution of active fires, and mapping of snow cover, glacier extent, and lake area. Scientific and technical challenges that remain in terrestrial applications include improving the ability to measure key variables, such as soil moisture, above ground biomass and canopy structure, development of appropriate observation techniques and algorithms, deployment of appropriate instruments, and combining data to create integrated products (e.g., greenhouse gas emissions from biomass burning and terrestrial carbon sink estimates from FAPAR), and new assimilation techniques. Dr. Mason noted that an important advocacy role could be undertaken by workshop participants to keep climate high on the Global Monitoring for Environment and Security (GMES) and GEOSS agendas, support the continuity of key missions, and stress the importance of calibration and validation. In concluding, he re-emphasized that regional support was needed in relation to land cover and land cover change and in calibration/validation campaigns, through provision of in-situ observations and related expertise. He noted that opportunities existed for partnership projects with EUMETSAT.

Extended plenary discussion following the above presentations centered on the following issues and topics.

- The availability of satellite data was of significant concern, especially data from MSG that covers much of Africa. North African countries must have access to the complete suite of derived satellite products. The workshop should make a recommendation in favor of ensuring

the continuing operation of satellites that were important for climate, stressing the importance of ensuring the accuracy and continuity of their measurements and of ensuring that all satellite products were accessible to all potential users.

- Every effort should be made to ensure the long-term operation of in-situ observation networks needed for calibration of satellite measurements. Furthermore, there are always observations that cannot be obtained by satellites, due to cloud cover, for example. The ROSELT network might provide a stable long-term *in-situ* observational network for such applications.

- Partnerships should be established with the SAF for Land Surface Analysis in the context of building capacity in the countries south and east of the Mediterranean. It was indicated that joint projects would be very useful to the SAF and that the SAF was anxious to collaborate in such projects. It encourages both partnerships with people on the ground and pilot projects that give visibility to requirements.

- Significant gaps exist in the observational data needed for accurate hydrological modeling at watershed scales in the region. Accurate observations of precipitation, soil characteristics, and other variables to calibrate and feed hydrological models can be used to estimate the discharge from these watersheds.

- In response to a question, it was indicated that precipitation maps displayed during the opening presentation were based on all available data from different sources. The GCOS networks alone were too coarse in spatial resolution to respond to finer scale requirements such as the preceding mapping requirement.

In closing remarks following this discussion, the Chair emphasized that the terrestrial domain is of key societal importance but is less well developed observationally than other components of the climate system. In particular, he underlined the critical importance of water resources and hydrological networks to the countries of the Mediterranean Basin.

## **THEME 6: Cross Cutting Topics**

**Chair: Abdelhak Trache**

Abdelhak Trache of the Centre Régional Africain des Sciences et Technologies de l'Espace en Langue Française (CRASTE-LF) delivered the opening presentation on cross cutting topics with a talk on "Observation from Space and its Applications—an Essential Input to Climate Monitoring." Noting that continuous monitoring of the climate system was essential for a variety of reasons, he cited the particular need for observations on a global scale. He indicated that the combination of in-situ and space based observations provided the means to respond to this requirement. Describing satellite techniques as fundamental tools in addressing sustainable development, he drew attention to the importance of meteorological satellites (e.g., TIROS, GOES, and METEOSAT) and briefly summarized plans for enhancement of these operational satellite programmes during the coming decade. Where climate monitoring was concerned, he detailed atmospheric, oceanic, and terrestrial climate variables whose effective observation is largely dependent on satellite techniques and illustrated present and planned satellite remote sensing capabilities related to these variables. He briefly discussed the Global Observation Strategy, the Integrated Global Observing Strategy (IGOS) partnership, and the linkage between these and GCOS, and drew attention to the GEOSS and GMES initiatives. Focusing on Africa, he stressed the importance of the PUMA and AMESD projects (respectively, Preparation for the Use of Meteosat Second Generation and African Monitoring of the Environment for Sustainable Development) and pointed out that a central preoccupation was pursuit of capacity building, cooperation, and synergy to ensure optimal utilization of satellite information. The concluding part of his presentation focussed on CRASTE-LF as an institution

that existed to provide training, research, and scientific competence. Noting that the CRASTE-LF was established in 1998, under UN auspices, he reviewed its mission, member countries, and programmes and pointed out that, to date, more than 80 students have undergone training there. He then illustrated the breadth of subjects studied by these students and outlined the institute's activities in organizing and participating in workshops, seminars, and planning activities. He concluded by underlining the valuable resource for capacity building represented by CRASTE-LF and by encouraging expanded application of satellite techniques in the region.

Deborah Hemming (Hadley Centre, UK Met Office) followed with a talk on "The Use of the PRECIS Climate Model System for Regional Climate Predictions." Her talk addressed why Regional Climate Models (RCMs) are necessary, provided examples of applications of RCMs, and introduced the PRECIS--Providing Regional Climates for Impacts Studies--system. She noted that the United Nations Framework Convention on Climate Change requires the assessment of national vulnerability to climate variability and change, the preparation of plans for adaptation, and the submission of National Communications. These commitments necessitate that estimates are made of regional and national climate change impacts. Studies of impacts must, however, be based on detailed scenarios of the future climate. Such scenarios, she indicated, are best produced locally, using regional information and expert knowledge of the area being studied. This approach increases local ownership and improves the linkage between the observing and modeling communities. Noting that Regional Climate Models (RCMs) are tools for downscaling Global Climate Model (GCM) results to higher spatial resolutions, she illustrated the enhanced spatial detail that can be obtained from RCMs. Highlighting the uncertainties at every step in predicting climate change impacts, she identified the potential for errors in emission scenarios, carbon cycle and chemistry models, global and regional climate models, and impact models. She then described the components and capabilities of the PRECIS model, drawing particular attention to its modest requirements for PC-based computing power and its portability. The PRECIS team at the Hadley Centre, she indicated, aims to assist in capacity building and technology transfer by supplying PRECIS freely to developing countries, training national experts in its operation, and providing subsequent follow-up support. Ms. Hemming identified the regions where the PRECIS model is currently being used to develop climate scenarios and the locations where training workshops have been held. The next training workshop will be held in Ghana in April 2006. In passing, she reported that, in April 2005, the UK Met Office activated an operational 20km resolution African Limited Area Model (LAM) that is currently producing 48-hour forecasts. This reflects an increased focus by the Met Office on assisting developing countries and on disaster mitigation. Further information on this model can be obtained by email at:

Africa-LAM@metoffice.gov.uk or at: <http://www.metoffice.com/weather/africa/lam/>  
*Password protected:* Username: AFR\_NMS Password: UK\_ALAM

In concluding her presentation, Ms. Hemming encouraged the utilization of both the PRECIS system and the outputs from the African LAM by countries in the region, stressing that feedback was welcomed.

The presentations on the satellite and PRECIS topics generated several questions and considerable plenary discussion. The major points discussed were as follows:

- Satellite data are often restricted to those participating in partnerships with space agencies, but much more open access is highly desirable. It was observed that while present programmes and institutions (other than those that are strictly commercial) are actively seeking to expand partnerships and improve access, cost is always a limiting factor.

- There is a need for training in order to enable countries in the region to take full advantage of space based remotely sensed observations.
- The synergy between satellite and *in situ* observations was stressed.
- PRECIS is a fully dynamic, scaled-down, version of the GCM used by the Hadley Centre. It must be coupled to the GCM. Full details regarding the products and outputs from the African LAM can be found on the web site identified earlier.
- The data used in PRECIS runs is primarily scenario data that can be requested from the Hadley Centre.
- While PRECIS is the most portable and easily used Regional Climate Model, it is very useful to apply other RCMs to permit inter-model comparisons.
- It would be worthwhile to set up PRECIS runs over the Mediterranean since previous runs centered over the European domain have left the Mediterranean region at the edges of the domain.
- The PRECIS workshop schedule is full for the next year and contact should be made with the PRECIS team to organize a subsequent workshop. An alternative could be to attend the workshop in Ghana.

Following the preceding discussion, Serhat Sensoy (Turkey) presented a talk on “Internationally Coordinated Climate Indices.” He explained that in 1999, the WMO Commission for Climatology (CCI)/World Climate Research Programme (WCRP) Climate Variability and Predictability (CLIVAR) Working Group on Climate Change Detection concluded that developing an internationally coordinated suite of indices, mainly highlighting changes in extremes, along with sponsorship of regional climate change workshops would be a useful contribution to climate change detection. Global analyses of changes in extremes used in the Intergovernmental Panel on Climate Change Third Assessment Report (IPCC TAR) represented less than half of the world. Consequently, six regional workshops were held to address the gaps in global extreme analyses. A software package (RClimDex) was provided to assist workshop participants. These workshops have resulted in a number of peer-reviewed papers that will provide useful input for the IPCC’s Fourth Assessment Report. Mr. Sensoy summarized the advantages of indices relative to unprocessed data as follows:

- Indices are information derived from data
- Represent the data
- Are more readily released than data
- Are not reproducible without the data
- Are useful in a wide variety of climate change analyses
- Are useful for model–observation comparisons
- Are useful for analyses of extremes

After highlighting the importance of data series length, homogeneity, and quality, he illustrated the process of applying the RClimDex software to compute 27 Core Climate Indices. Noting that climate changes are usually characterized by a shift in the mean value, he emphasized that small changes in the mean can result in more extreme events. He then presented results of various analyses of global indices, including trends in cold and warm days and nights and several precipitation indices. The final part of his talk was devoted to a review of Turkey’s atmospheric observation networks, weather and sea state prediction models and capabilities,

climatological analyses, and related infrastructure components. He concluded with a series of recommendations focussed on the need for sustained operation of historically uninterrupted observing stations, routine assessment of the quality and homogeneity of data in the archive system, retention of station metadata, and the calculation of additional climate indices for more stations.

Dusan Hrcek (the WMO Regional Representative for Europe) delivered the concluding presentation on the topic "An Overview of Linkages Between WMO RAVI and WMO RAI." Drawing attention to instruments and methods of observation, he underlined the need for regular calibration and inter-comparison of instruments to achieve homogeneity and comparability of data through adherence to regional and international standards. To that end, he advocated progressive adoption by national meteorological and hydrological services (NMHSs) of the ISO 9001 Quality Management System that includes the ISO 17025 standard applying to calibration laboratories. He further encouraged pursuit of training opportunities, through WMO and other bodies, to improve the quality of atmospheric observation and measurement. Switching to the new WMO Regional and Technical Cooperation Activities for Development (RCD) Department, with its focus on regional and technical cooperation programmes, he described its organizational structure and system of field offices. Shifting focus to WMO RA 6 (Europe), he reviewed the driving forces that have led Members of that Region to undertake development of a Strategic Plan and an Action Plan. Pointing to the Network of European Meteorological Services (EUMETNET), he described its core and optional programmes and raised the possibility of the future establishment of a joint WMO-EUMETNET office. He then briefly discussed the future of European cooperation in numerical weather prediction, drew attention to the achievements of the Mediterranean Hydrological Cycle Observing System Programme (MED-HYCOS), cited the PUMA and the AMESD projects in Africa, and summarized the memorandum of understanding between the European Community and WMO signed in December 2003. He also briefly outlined WMO's Climate Information and Prediction Services (CLIPS) Mediterranean Showcase project. All of these initiatives and programmes, he considered, provided opportunities for collaboration between the two WMO Regional Associations, with potential advantages for the nations of the Mediterranean Basin.

The preceding two presentations generated several questions and comments that can be summarized as follows:

- Mr. Sensoy indicated that a method developed in Europe was used to identify inhomogeneities in data time series but this method does not correct the problem. He underlined the importance of carefully examining metadata in assessing homogeneity.
- Regarding an index for heat waves, Mr. Sensoy stated that a heat wave had been defined in the RclimDex software package as 6 consecutive days with maximum temperature greater than the 90th percentile value. He suggested that not all countries might agree with this definition.
- Establishing an effective partnership with Europe was considered to be highly desirable. This could include the possibility of expanding EUMETNET to include North African countries.
- Networking and collaboration is the way of the future and could result in substantial savings. The two Regional Associations wish to work much more closely together, and it is possible that the Regional GCOS Action Plan could provide a mechanism to further that objective.

- The possibility was raised of establishing an African equivalent of EUMETNET, building on experience gained with the European body. This was seen as a situation where the opportunity existed to take an initiative that could benefit the region as a whole.

At the end of the plenary discussions, the Chair gave the floor to William Westermeyer (GCOS Secretariat) who proceeded to set the stage for the final day of the workshop. He briefly reviewed the programme for the following day, noting that it would commence with presentations on resource mobilization then shift to discussions on the approach that should be taken to drafting a Regional GCOS Action Plan for the Mediterranean Basin. In preparation for these discussions, he requested participants to review the Framework Document that had been included in their information package and to give thought to the priorities that should be addressed in a Regional Action Plan. He concluded by underlining that it was important that the workshop end on a positive note, that is, with a broad consensus on the highest GCOS priorities from a regional perspective, and with a list of potential projects that might be included in the Action Plan.

Following Mr. Westermeyer's comments, the Chair thanked the speakers for their presentations and called for adjournment of the workshop session.

### **DAY 3**

#### **THEME 7: Resource Mobilization**

**Chair: Mustapha Geanah**

The final day of the workshop began with a presentation on "Resource Mobilization Matters" by Jim Williams (Consultant to GCOS). He stated that his purpose was to inform collective efforts towards obtaining financing to meet priority GCOS needs in the Mediterranean Basin and to outline a logical process for seeking funds. Success in obtaining funding support, however, required making one's institution attractive to those organizations with funds, be they governments, research councils, or donors. His presentation centred on four themes – globalization, institutional change and the international development agenda; sources of development assistance; how to make an institution (weather service) more attractive for financial support; and the significance of the GCOS Regional Action Plan and how best to present it. He emphasized that institutions must continually adapt to change in a globalized world if they are to avoid becoming irrelevant. The Organization for Economic Cooperation and Development's (OECD) establishment of Millennium Development Goals (MDGs) has meant that most governments now work to a common development agenda aimed at sustainable development and poverty reduction. Against this backdrop, considerable opportunity exists for adaptable institutions and, in particular, there are increasing incentives for regional collaboration.

Pointing to the large amount of development assistance flowing to the Mediterranean Basin, he provided detailed information on potential sources of funding for Action Plan projects and reviewed how governments and donors decide on the priorities for investment. He stated that National Hydrometeorological Services and other institutions involved with climate must become a vital part of the national development agenda. They must be seen to deliver useful services in areas that are priority targets (e.g., water resources, climate change, pollution monitoring, and disaster warning) if they are to attract funding from national governments and be eligible for support from donors and other funding bodies.

In view of the preceding realities, the Regional GCOS Action Plan for the Mediterranean Basin, in his view, needed to emphasize strengths, address weaknesses and seize opportunities for the region. It must be written in such a way that busy, decision makers can read it quickly and

'agree' with proposals. It must have clear goals and objectives with the details, including activities and outputs, provided as supporting material, and not the other way round. What we want to achieve needs to be packaged in a form that is a high priority on the national and regional development agenda. Mr. Williams thus proposed a structure for the Regional Action Plan, incorporating a vision and problem statement, a goal or wider objectives statement, a purpose or specific objectives, outputs, and activities. In summarizing his remarks, he reiterated that significant financing is available for development in the Mediterranean Basin. He believed that some of these funds could be "attracted" by a good Regional Action Plan that targets funding agencies' priorities. Promising thematic approaches for the Regional Action Plan, he suggested, included adaptation to climate change, integrated water resources management, good environmental governance, and multi-hazard early warning and response systems. These should all be seen as opportunities for institutional development, with effective public services being an important over-arching theme mentioned in many development and reform programmes. Reinforcing his earlier recommendations, he concluded his talk by emphasizing the value of regional collaboration in attracting funding and by encouraging climate-related institutions to address the priorities in their respective countries' National Development Agendas.

Mohammed Sadek Boulahya (Climate and Environment for Society (CLENSO-Africa)) delivered the second resource mobilization presentation in addressing "The Africa Development Agenda--Problems and Opportunities in Programme Implementation." Pointing to the paradigm shift in development brought about by the MDGs, the creation of the African Union and the New Partnership for Africa's Development (NEPAD), he considered that this presents exciting opportunities for hydrometeorological institutions in partnering for wealth creation. NEPAD, launched by the African Union with the support of the G8 countries, aims to place Africa on a path towards sustainable growth and social development. He identified weather, climate, water and environmental information as being the new resources for development. In this context, he noted that, in Feb 2005, the MDG implementation proposal made detailed reference to management of climate variability and to climate change impact and adaptation studies. He advocated that the climate community should engage immediately in partnering for the implementation of the MDGs. It should make the best possible use of the capacities and capabilities of science and technology to address the expressed needs of society. He then provided many recent African examples of demand-driven climate services provided by national and regional specialized institutions. Among others, these included applications to desert locust control, forest fire prevention and control, urban flood prediction, seasonal rainfall prediction in the Sahel, and early warning systems for health, particularly for outbreaks of malaria. The common thread in all of these examples of "best practices" was climate and development. They also incorporated the following elements:

- Management and leadership for change--actively seeking opportunities to be part of the development agenda;
- Partnership;
- Providing demand- or user-driven services;
- Public service mandate targeting application of knowledge to socio-economic needs;
- Taking best advantage of emergencies by learning from them; and
- Mobilizing to be part of adaptation and mitigation.

He considered management of climate variability and adaptation to climate change to represent not only a scientific and technological challenge but also a golden opportunity to contribute to socio-economic development. The Regional GCOS Action Plan provided a means to access resources to support the development and delivery of such contributions. Repeating the call to "accelerate the doing part of NEPAD" delivered by its chief executive, Professor Firmino

Mucavele, he pointed out that a capacity development programme is in preparation within the University of Pretoria and FSU, using distance education. This could integrate all aspects of water and environmental resources management, climate variability and change and disaster risk reduction. He also highlighted the collaborative implementation of a modeling facility for weather and climate forecasts that involves the University of Pretoria, the Ugandan National Meteorological Service, and Environmental Development Africa (ENDEV), with support from the United Kingdom, as a tool for integrated water resources management. He concluded his presentation by expressing that his wish was to further the GCOS-Africa process by networking all stakeholders in a Partnership of Land-Space-Ocean Information for Development, with the objective of applying this information in order to provide a chance for people to enjoy a better life.

In initiating plenary discussions on the topic of resource mobilization, the Chair observed that National Meteorological Services must re-orient themselves, make themselves known to public institutions, and strive to ensure the sustainability of essential observation programmes. They must, furthermore, make people aware of their existence and of the value of their services, developing indicators of the benefits that accrue to society from their forecasts and other products. In order to attract resources, they must listen to users to understand their requirements and become relevant to the goals of funding bodies, such as the elimination of poverty, protection of human health and sustainable development. Following these remarks, interveners made the following observations:

- Regional leadership is needed to pursue implementation of the projects in the Regional GCOS Action Plan, since it will be regionally and nationally oriented. The workshop must recommend how to address this requirement for regional leadership.
- The climate system involves oceanic and terrestrial sectors as well as the atmosphere. Development and enhancement of partnerships between all of these sectors should be pursued at the national level.
- Service providers in all components of the climate system simply must service users' requirements and their governments' agenda and priorities. If they can't add value in these priority areas, they don't deserve to exist.
- National Climate Change Coordinators and members of the broader climate community must become more active in influencing decision makers, since current development plans for some countries make no reference to the climate issue. A strategic or long-term view could be useful and should focus on ensuring that climate change is reflected in national policy papers related to development.
- NMHSs have not clearly demonstrated the socio-economic value of their services to decision-makers and have not always been very responsive to user needs. In recognition of the former deficiency, WMO is organizing an International Conference on the Benefits of NMHSs in 2007. Mediterranean countries should participate in this WMO conference and in related pilot projects.
- Countries' national science councils and science agencies represent a potential funding option that should be pursued in seeking resources to advance national projects related to GCOS. The fact that the G8 countries have endorsed the implementation of a GEOSS should assist in setting the stage for such approaches.

- Since climate researchers are more aware of the importance of climate and climate change than the public at large, they should exert pressure on their nation's science councils and science departments to give high priority to the climate issue.
- A recommendation from the Beijing Climate Summit advocated the development of application products for the various economic sectors, with the underlying concept being to use "information as a resource." NMHSs must, therefore, work as partners in the producer–consumer relationship with information being the link.
- The need was underlined to formulate the proposed Regional GCOS Action Plan so that it meets the requirements of donors and reflects an integrated approach.

At the conclusion of the plenary session, Mr. Geanah thanked the participants for their presentations and contributions to the discussion.

**THEME 8: First Steps in Developing a Regional Action Plan    Chair: Abdellah Mokssit**

William Westermeyer outlined GCOS experience with Regional Action Plans in a short presentation. He indicated that the present workshop was the 10<sup>th</sup> and final one in the workshop programme and that, to date, 9 Regional GCOS Action Plans have been completed. Emphasizing the need for regional participants and organizations to take responsibility for identification and preparation of projects in the Regional Action Plan, he stated that the GCOS Secretariat would facilitate this process. Regional Action Plans, he considered, have particular value in increasing the visibility of regional needs related to observations of the climate system, as they were highlighted at meetings of the Parties to the UNFCCC and at WMO Regional Associations. A key goal was to use the Regional Action Plan as a vehicle to obtain resources to address identified deficiencies in GCOS programmes in the region. He pointed to some progress that has been made in other regions, but admitted that resource mobilization was not easy. The chances of success were, however, improved if broadly based regional involvement and agreement on needs was reflected in the Action Plan. He reiterated that interested and motivated people were needed to develop projects and assist in drafting the Action Plan. Based on previous experience, a regional body was also needed to assume overall responsibility for the Action Plan, including identifying partners and donors, pursuing resource mobilization, and overseeing the Plan's implementation.

Mr. Westermeyer indicated that a follow-up meeting was planned in early 2006, at which time a writing team would prepare a draft Regional GCOS Action Plan for the Mediterranean Basin that reflected the priorities identified during the present workshop. This writing team should, for practical reasons, be of modest size and should be chaired by an individual from the Mediterranean Basin. The GCOS Secretariat would assist the team with the writing process through his own involvement and the participation of their consultant, Desmond O'Neill. The composition of the writing team should be a balanced one and, ideally, should include WMO Permanent Representatives, National Climate Change Coordinators, and regional experts from disciplines related to the major components of the climate system. Reflecting the advice from participants in the present workshop, the Action Plan itself should be written as a strategic, attention getting document that would appeal to decision makers and donors. It should, moreover, contain practical, fundable projects that would significantly improve systematic climate observation programmes in the region.

In the second presentation under Theme 8, Desmond O'Neill, a consultant to GCOS, drew participants' attention to the "Framework Document" that had previously been distributed. He pointed out that this Framework Document was intended to assist in formulating a Regional

GCOS Action Plan by proposing a structure for consideration and offering some initial suggestions regarding content. In a brief review of the document, he pointed to the many questions included in its various sections and stressed that these questions were intended to stimulate input on the most appropriate structure for the Plan and what should be included in it. He then challenged workshop participants to take ownership of the development of the Action Plan, reach consensus on its key thrusts, and propose specific projects and recommendations to address priorities. He also requested suggestions for improvements to its proposed structure and corrections or improvements to the background material contained in the Framework Document.

Under the guidance of the Chair, workshop participants then engaged in extended discussion on the priority issues that should be reflected in a Regional Action Plan for the Mediterranean Basin. This debate resulted in the identification of a number of themes and considerations, detailed in the form of a resolution that is attached as Appendix 3 to this report. Against the backdrop of this resolution and its themes, the participants then conducted a brainstorming session to identify potential project areas for further consideration. A limited number of the highest priority projects would then be selected for inclusion in the Regional GCOS Action Plan for the Mediterranean Basin. The results of this brainstorming session are summarized in the Table 1.

**Table 1. Proposals for Action Plan Projects and their Proponents**

Risk management – extreme events in large cities	(Boucherf Meteo Algeria)
Impact of climate change on water resources	(Boucherf Meteo Algeria)
Climate and the struggle against locusts	(Boucherf Meteo Algeria)
Reinforcing GAW stations in the central Mediterranean and Northern Africa; emphasis on ship emissions	(Cuevas and Sammut)
Drought alert system, extended from Algeria, Tunisia, Morocco	(Bennouna/OSS)
Ecological (ROSELT) observation network in North Africa	(Bennouna/OSS)
AMESD extension for North Africa	(Bennouna/OSS)
Data/metadata rescue for longest records, ECVs	(Brunet Spain)
Consolidation of MOON operational oceanography services (model, analysis, and observations) in support of climate change detection	(Coppini, Italy)
Enlarge observing system to consider deep water and straits	(Coppini, Italy)
Extension of MEDGLOSS to North African countries	(Alvarez Fanjul)
Climate impacts on locusts	(Fatima Driouech)
Climate change impacts on health	(Fatima Driouech)
Extend drought alert to all Mediterranean countries	(Pashiardis)
Extension of PRECIS modeling to Southwest Asia	(Sensoy, Turkey)
Update of monthly GCOS data	(Pelino)
Capacity building for an integrated multidisciplinary approach to climate assessments	(Drago)
Apply long-range forecast projections to drought monitoring, health, etc.	(Coelho)
Improvement of traceability of meteorological and hydrological instruments to regional and international standards	(Hrcek)
Mediterranean showcase on CLIPS	(Hrcek)
Future climate impact on dust	(Cuevas)
Capacity building, resource mobilization	(Boulahya)
Establishment of guideline for best practices	(Boulahya)
GCOS construction, new equipment, consumables	(Boulahya)
Reanalysis of Mediterranean ocean-atmosphere coupled system based on numerical modeling	(Copini & Alvares)
Improvement of terrestrial observations using satellite measurements	

(SAF) (Juvanon du Vachat & Roujean)  
Economic benefits (Simango)  
Identification of data requirements and tools for the assessment of impacts  
and vulnerabilities of climate change on key socioeconomic sectors and  
ecosystems in the Mediterranean (J R Picatoste)

Having developed the preliminary list of suggestions shown in Table 1, further discussion took place regarding the number and characteristics of projects that should be included in the Regional Action Plan. Speaking from the perspective of the GCOS Secretariat, Mr. Westermeyer indicated that a way must be found to reduce the number of projects in the Action Plan to about 10 or 12 for practical and tactical reasons. He suggested that projects should relate primarily to GCOS programmes and concerns, though projects with very high regional priority could also be considered. Subsequent comments by participants reinforced the desirability of packaging projects in a regional dimension while ensuring that they addressed GCOS programme priorities. An integrated approach in the formulation of projects was also advocated, one that incorporated resourcing, training, observation, and applications linked to end-users.

## **NEXT STEPS**

At the conclusion of the preceding discussion, the Chair summarized that the following the approach would be pursued in selecting the final projects to be included in the Regional GCOS Action Plan for the Mediterranean Basin:

- The objective would be to identify a manageable number of about 10 to 12 projects that could be fleshed out by their authors and included in the Regional GCOS Action Plan.
- Working with the GCOS Secretariat, he would assume the challenge of reducing the list of suggestions in Table 1 to 10 or 12 projects.
- His goal would be to complete the identification of a final list of 10 to 12 projects within about 15 days from the end of the workshop.
- The final list of Action Plan projects would be determined by first consolidating repetitions in Table 1 and then identifying those projects that best addressed high priority region-wide concerns, from the perspective of GCOS goals and priorities.
- The final projects selected for inclusion in the Regional Action Plan would, in so far as possible, reflect broad regional interests and concerns of the Mediterranean Basin countries, seeking to add value for people across the region.

In order to facilitate the selection process, the individual proponents of proposed projects in Table 1 were asked to forward short summaries of their respective proposals to the GCOS Secretariat and to Mr. Mokssit within 15 days. These project files should be concise (a few paragraphs) but provide sufficient information to assist in assessing their appropriateness and priority for inclusion in the Regional GCOS Action Plan.

The Chair further explained that the proponents of those projects that were finally chosen for inclusion in the Regional Action Plan would subsequently be asked to prepare more detailed project descriptions that followed the structural framework outlined in the presentation by Mr. O'Neill. As noted earlier, these final project descriptions would then be incorporated into the

draft Regional Action Plan that would be compiled by the writing team at their meeting in March or April 2006.

Having completed discussion of the main business of the session, the Chair then requested the Director of the GCOS Secretariat, David Goodrich, to take the floor and deliver his concluding remarks.

## **CONCLUSION OF THE WORKSHOP**

Dr. Goodrich began by expressing his thanks to Dr. Mokssit for his leadership in chairing the current session of the workshop, in guiding the project identification process, and for agreeing to chair the upcoming meeting of the writing team. He then emphasized the need for realism and consideration of costs in the development of projects for inclusion in the Regional Action Plan, reinforcing points made earlier regarding practicality and viability of projects and the need to ensure that they would be attractive to donors. He also underscored the importance of leadership and sustained effort in pursuing the implementation of projects in the Regional Action Plan, stating that, in his experience, persistence can make a genuine difference. He conveyed his thanks to workshop participants for their contributions, to the translators who had worked so hard during the various sessions, and to the staff of the GCOS Secretariat for their efforts in organizing the workshop. Finally, he expressed his deep gratitude and warm thanks to the hosts of the workshop, Mr. Geanah and the staff of the Moroccan Meteorological Service and the government of Morocco, for the excellent arrangements that had been provided for the workshop sessions and for the hospitality that had been shown to all participants.

Mr. Geanah, the Permanent Representative of Morocco to WMO, congratulated all participants for their efforts, which had resulted in a very stimulating and successful workshop. He added his thanks to the workshop organizers, the interpreters, and to all those who had made the workshop possible. He then conveyed the thanks of the Minister for Water, Mr. Abdelkebir Zahoud, who expressed his hopes for successful completion and implementation of a Regional GCOS Action Plan for the Mediterranean Basin. Speaking on behalf of the government of Morocco and King Mohammed 6, the Minister had pointed out that the significant changes affecting climate were of great concern, raising the specter of serious and irreversible impacts on Morocco and on the resources of the North African region. The establishment of an efficient and effective observational system for climate was, therefore, a domestic and international priority. The Minister encouraged the National Meteorological Services to improve their observational networks and their services and expressed the hope that the needs identified during the Marrakech GCOS workshop will be addressed through successful projects. He indicated that Morocco was always willing to host scientific meetings, such as the present workshop, and conveyed his wishes for a safe journey home to all workshop participants. Following the delivery of the Minister's remarks, Mr. Geanah then declared a formal end to the workshop, adding his best wishes to all for homeward travel.

**GCOS Regional Workshop for the Mediterranean Basin  
Marrakech, Morocco 22-24 November 2005**

**Agenda**

**DAY 1**

- 0800-0845 **Registration of Participants**
- 0845-0915 **Opening Ceremonies**
1. D. Goodrich, Director GCOS
  2. M. Geanah, Directeur de la Météorologie Nationale
- 0915-0930 **Break**
- 0930-1100 **Theme 1      Setting the context      Chair: Abdalah Mokssit**
1. Overview of GCOS—D. Goodrich, Director, GCOS (20)
  2. The UNFCCC and Systematic Observations—O. Pilifosova, UNFCCC (20)
  3. A Review of the GCOS Implementation Plan *and* Developing a Regional Action Plan for the Mediterranean, P. Mason—Chair, GCOS Steering Committee (20)
  4. Discussion (10)
- 1100-1130 **Break**
- 1130-1330 **Theme 2      User Needs for Climate Observations      Chair: Awatef Larbi**
1. User Needs for Climate Observations, T. Bennouna (25)
  2. Observational Needs for Extreme Events and for Adaptation to Climate Change—A. Mokssit (25)
  3. Observational Needs for Agriculture—F.Y. Abdo (25)
  4. Climate observing needs for locust control—D. Fakhour (25)
  5. Discussion and Workshop Recommendations (20)
- 1330-1500 **Lunch**
- 1500-1730 **Theme 3      Atmosphere: Status, Deficiencies, and Needs      Chair: Regis Juvanon du Vachat**
1. GSN, GUAN, RBCN—D. Thigpen and H. Teunissen (GCOS) (30)
  2. Data Rescue Issues—M. Brunet India (30)
  3. Global Atmosphere Watch— E. Cuevas (30)
  4. Discussion and Workshop Recommendations (30)
- 1900 **Reception**

**DAY 2**

- 0900-1100 **Theme 4      Oceans: Status, Deficiencies, and Needs      Chair: Aldo Drago**
1. Med GOOS—A. Drago (30)

2. GLOSS network and sea level rise—E. Alvarez Fanjul (30)
3. Monitoring the Mediterranean—G. Coppini (30)
4. Discussion and Workshop Recommendations (30)

1100-1130 **Break**

1130-1330 **Theme 5 Terrestrial Observations: Status, Deficiencies, and Needs**  
Chair: Paul Mason

1. Status, Deficiencies, and Needs for Hydrological Observations for Climate O. Elbadawy (30)
2. Products Over Land as Derived from MSG Observations—J-L. Roujean (30)
3. Essential Climate Variables in the Terrestrial Domain—P. Mason (30)
4. Discussion and Workshop Recommendations (30)

1330-1500 **Lunch**

1500-1700 **Theme 6 Cross Cutting Topics** Chair: Abdelhak Trache

1. The Use of the PRECIS Climate Model to Undertake Regional Climate Predictions—D. Hemming (25)
2. Satellite Observations and Application Products—A. Trache (25)
3. Climate Indices presentation—S. Sensoy (25)
4. An Overview of linkages between WMO RAVI and RAI—D. Hrcek (25)
5. Discussion and Workshop Recommendations (20)

### DAY 3

0900-1030 **Theme 7 Resource Mobilization** Chair: Mustapha Geanah

1. Resource Mobilization Issues—J. Williams (30)
2. Implementation Issues Facing Africa—M. Boulahya (20)
3. Discussion (45)

1030-1100 **Break**

1100-1300 **Theme 8 First Steps in Developing a Regional Action Plan**  
Chair: Abdalah Mokssit

1. GCOS experience with Regional Action Plans, W. Westermeyer (10)
2. An Introduction and Initial Discussion of the Framework Action Plan—D. O'Neill (30)
3. Review of priorities as determined during first two days and discussion of potential project proposals (90)

1300-1430 **Lunch**

- 1430-1630
1. Discussion of potential projects—continued (120)
  2. Next steps—Abdalah Mokssit (10)
  3. Conclusion of workshop—D. Goodrich and A. Mokssit (10)

## PARTICIPANTS - GCOS REGIONAL WORKSHOP FOR THE MEDITERRANEAN BASIN

**Fayez S. Y. Abdo**

Jordan Meteorological Department  
 P.O. Box 341011 Amman 11134  
 Amman Civil Air Port Marka  
 Amman, JORDAN  
 Tel. : +962 6 4892408  
 Fax: +962 6 4894409  
 Email: [fzabdo@yahoo.com](mailto:fzabdo@yahoo.com)

**Ibraheem Alallan**

General Commission for Environmental Affairs  
 Mazraa SQ  
 P.O. Box 3773  
 Damascus  
 SYRIAN ARAB REPUBLIC  
 Tel.: +963 11 446 59 05 / 331 43 93  
 Fax: +963 11 446 10 79  
 Email: [env-min@net.sy](mailto:env-min@net.sy)

**Carlos Almarza**

Instituto Nacional de Meteorología  
 20071 Madrid  
 SPAIN

**Eglantina Bruçi**

Hydrometeorological Institute  
 Rrugë e Durrësit 219  
 Tirana – ALBANIA  
 Tel.: +355 42 235 18 / 224 39  
 Fax: +355 42 235 18  
 Telex: HIDMET TIRANA

**Taoufiq Bennouna**

Observatory of the Sahara and Sahel  
 Boulevard du Leader Yacer Arafat  
 BP31  
 Postal code 1080  
 Tunis, TUNISIA  
 Tel. : +216 98 46 42 41  
 Fax : +216 71 20 66 36  
 Email: [taoufiq.bennouna@oss.org.tn](mailto:taoufiq.bennouna@oss.org.tn)

**Djamel Boucherf**

Chef de la Division Veille Climatique  
 Office National de la Météorologie  
 BP 153 Dar El Beida  
 16200 Alger, ALGERIA  
 Tel.: +213 21 50 73 93  
 Fax: +213 21 50 88 49  
 Email: [d.boucherf@meteo.dz](mailto:d.boucherf@meteo.dz)

**Mohammed Sadeck Boulahya**

Senior Expert/Advisor  
 Climate & Environment for Development  
 Tel.: +216 71 20 66 33, ext 122  
 Tel.: +33 5 61 25 97 10  
 Email 1: [msboulahya@yahoo.fr](mailto:msboulahya@yahoo.fr)  
 Email 2: [msb@oss.org.tn](mailto:msb@oss.org.tn)

**Manola Brunet**

Climate Change Research Group  
 University Rovira I Virgili  
 Pza. Tarraco, 1  
 Tarragona 43071  
 SPAIN  
 Tel.: + 34 977 55 9580  
 Fax: +34 977 55 9597  
 Email: [manola.brunet@urv.net](mailto:manola.brunet@urv.net)

**Espirito Santo Fatima Coelho**

Instituto de Meteorologia (IM - Portugal)  
 Divis?o de Rela?es Externas (External  
 Relations Division)  
 Rua C, Aeroporto de Lisboa  
 1749-077 Lisboa - PORTUGAL  
 Tel.: +351 21 844 70 00 (IM)  
 Fax: +351 21 847 43 33  
 Email: [im@meteo.pt](mailto:im@meteo.pt)

**Giovanni Coppini**

Istituto Nazionale di Geofisica e Vulcanologia  
 Via Donato Creti 12  
 40128 Bologna, ITALY  
 Tel: +39 051 4151442  
 Fax: +39 051 4151499  
 Email: [coppini@bo.ingv.it](mailto:coppini@bo.ingv.it)

**Emilio Cuevas**

Observatorio Atmosférico de Izaña, Director  
INSTITUTO NACIONAL DE  
METEOROLOGIA (INM)  
C/ La Marina, 20, Planta 6  
38001 Santa Cruz de Tenerife  
SPAIN  
Tel: +34-922-151718  
Mobile: +34-626022781  
Fax: +34-922-574475  
Email : [ecuevas@inm.es](mailto:ecuevas@inm.es)  
[ECUEVAS@telefonica.net](mailto:ECUEVAS@telefonica.net)

**Aldo Drago**

MedGOOS Secretariat  
University of Malta  
c/o 43/1 Valley Road  
Birkirkara BKR 10  
MALTA  
Tel/Fax: +356 2144 0972  
Email: [aldo.drago@um.edu.mt](mailto:aldo.drago@um.edu.mt)

**Ibrahim Barakat Diab**

Directeur  
Service météorologique  
Direction de l'aviation civile  
Aéroport international de Beyrouth  
Beyrouth – LEBANON

**Ibrahim Dib**

Syrian Meteorological Service  
P.O. Box 4211  
Damascus  
SYRIAN ARAB REPUBLIC  
Tel.: +96 311 66 24 984  
Fax: +96 311 66 20 553  
Email: [dib\\_damas@mail2world.com](mailto:dib_damas@mail2world.com)

**Omar Elbadawy**

Water Resources & GIS Expert  
Center for Environment & Development  
of the Arab Region & Europe (CEDARE)  
2 El Hegaz Street  
Cairo, EGYPT  
Tel.: +202 451 39 21 / 22/23/24 Ext: 664  
Fax: +202 451 3918  
Email: [elbadawy@cedare.org.eg](mailto:elbadawy@cedare.org.eg)

**Faiçal Elleuch**

Meteo Tunisia  
B.P. 107  
3028 Sfax  
TUNISIA  
Tel.: +216 74 221 510  
Fax: +216 74 22 84 10  
Email: [elleuch@meteo.tn](mailto:elleuch@meteo.tn)

**Driss Fakhour**

Centre Météorologique de Rabat-Salé  
Direction Régionale Météorologique du Nord  
(DMN)  
B.P. 8088  
10102 Rabat -MOROCCO  
Tel: +212 72 26 43 30 / 37 781 37 63  
Fax:: +212 37 83 43 10 / 83 34 10  
Email: [driss.fakhour@caramail.com](mailto:driss.fakhour@caramail.com)

**Enrique Alvarez Fanjul**

Puerto del Estado  
Avda. Del Partenon, 10  
Campo de las Naciones  
28042 Madrid  
SPAIN  
Fax: +34 91 524 55 04  
Email: [enrique@puertos.es](mailto:enrique@puertos.es)

**Mustapha Geanah**

Director  
Direction de la météorology nationale  
B.P. 8106  
Casa-Oasis  
20103 Casablanca  
MOROCCO  
Tel.: +212 22 913 803 / 05  
Fax: +212 22 913 797  
Email: [dmn@mtpnet.gov.ma](mailto:dmn@mtpnet.gov.ma)

**David Goodrich**

Director  
Global Climate Observing System  
c/o World Meteorological Organization  
7bis, Avenue de la Paix  
1211 Genève 2  
SWITZERLAND  
Tel.: +41 22 730 82 75  
Fax: +41 22 730 82 52  
Email: [Dgoodrich@wmo.int](mailto:Dgoodrich@wmo.int)

**Deborah Hemming**

Met Office  
Hadley Centre for Climate Prediction and  
Research  
Fitzroy Road  
Exeter Devon EX1 3PB  
UNITED KINGDOM  
Tel.: +44 (0)1392 886279  
Fax: +44 (0)1392 885681  
Email: [debbie.hemming@metoffice.gov.uk](mailto:debbie.hemming@metoffice.gov.uk)

**Dusan Hrcek**

World Meteorological Organization  
7bis, Avenue de la Paix  
1211 Genève 2  
SWITZERLAND  
Tel: + 41 22 730 8143  
Email: [Dhrcek@wmo.int](mailto:Dhrcek@wmo.int)

**Régis Juvanon du Vachat**

D21/ENV, 1 Quai Branly  
75007 Paris – FRANCE  
Tel.: +33 1 45 56 57 51  
Fax: +33 1 45 56 57 43  
Email: [Regis.Juvanon-du-Vachat@meteo.fr](mailto:Regis.Juvanon-du-Vachat@meteo.fr)

**Meltem Kukul**

Climate Change Coordinator  
Ministry of Environment and Forestry  
Air Management Department  
Ankara – TURKEY  
Tel.: +90 312 287 99 63 /43 18  
Fax: +90 312 285 34 63  
Email: [meldurukan@yahoo.com](mailto:meldurukan@yahoo.com)

**Paul Mason**

Director NCAS/Universities Weather  
Research Network  
Dept of Meteorology, University of Reading  
PO Box 243, Reading RG6 6BB  
UNITED KINGDOM  
Tel: 44 (0) 118-378 8957/6311  
Fax: 44 (0) 118-378 8791  
[p.j.mason@reading.ac.uk](mailto:p.j.mason@reading.ac.uk)

**Awatef Messai Larbi**

Tunisian Ministry of Environmental and  
Sustainable Development  
Centre Urbain Nord Immeuble ICF  
1080 Tunis  
TUNISIA  
Tel. : +216 71 703 394  
Fax : +216 71 703 340  
Email: [larbi\\_awatef@yahoo.fr](mailto:larbi_awatef@yahoo.fr)

**Abdellah Mokssit**

Direction de la météorologie nationale  
Face Préfecture Hay Hassani  
B.P. 8106  
Casa-Oasis – Casablanca  
MOROCCO  
Tel.: +212 22 913 682  
Fax: +212 22 913 797  
Email: [mokssit@marocmeteo.ma](mailto:mokssit@marocmeteo.ma)

**Desmond O'Neill**

Donmec Consulting Inc.  
110 Johnson Crescent  
Lower Sackville, Nova Scotia  
CANADA B4C 3A5  
Tel.: +1 902 865-7208  
Fax: +1 902 865-7208  
Email: [desoneill@eastlink.ca](mailto:desoneill@eastlink.ca)

**Athanasios Nianios**

National Meteorological Service  
14 Venizelou Street  
Helliniko  
16777 Athens – GREECE  
Tel.: +30 210 969 90 35  
Fax: +30 210 962 89 52

**Stelios Pashiardis**

Meteorological Service  
Ministry of Agriculture, Natural Resources  
and Environment  
CY-1418 Nicosia  
CYPRUS  
Tel.: +357 22 802911  
Fax: +357 22 305500  
Email 1: [metservice@ms.moa.gov.cy](mailto:metservice@ms.moa.gov.cy)  
Email 2: [spashiardis@ms.moa.gov.cy](mailto:spashiardis@ms.moa.gov.cy)

**José Ramón Picatoste Ruggeroni**  
Área de Asesoría Científica  
Oficina Española de Cambio Climático  
Ministerio de Medio Ambiente  
Plaza de San Juan de la Cruz s/n(Pabellón)  
28071 Madrid  
Tel.: +34 91 597 64 96  
Fax: +34 91 597 59 82  
Email: [JRPicatoste@mma.es](mailto:JRPicatoste@mma.es)

**Vinicio Pelino**  
CNMCA  
Aeroporto De Bernardi  
Via Di Pratica Di Mare  
1-00040 Rome – ITALY  
Tel.: +39 069 129 34 94  
Fax: +39 069 129 32 54  
[pelino@meteoam.it](mailto:pelino@meteoam.it)

**Olga Pilifosova**  
UNFCCC Secretariat  
Tel: +49 228 815 14 28  
Fax: +49 228 815 14 49  
Email: [OlgaPilifosova@unfccc.int](mailto:OlgaPilifosova@unfccc.int)

**Jean-Louis Roujean**  
CNRM/GMME/MATIS  
Meteo-France  
42, avenue G. Coriolis  
31057 Toulouse Cedex, FRANCE  
Phone : +33 (0)5 61 07 93 43  
Fax : +33 (0)5 61 07 96 26  
Email : [roujean@meteo.fr](mailto:roujean@meteo.fr)  
URL : <http://www.meteo.fr>

**Osman Saber**  
Environment Resercher – Climate Change  
Egyptian Envrironmental Affairs Agency  
30 Misr Helwan El-Zyrae Rd.  
Maadi 1178  
Cario – EGYPT  
Tel.: +202 525 64 81  
Fax: +202 525 64 54 / 81  
Email: [saber\\_cc@hotmail.com](mailto:saber_cc@hotmail.com)

**Mitat Sanxhaku**  
Director  
Hydrometeorological Institute  
Dr. Durrës, Z.P. 219  
Tirana - ALBANIA  
Tel. : +355 4223518  
Fax: +355 4223518  
EEmail: [mitats@yahoo.com](mailto:mitats@yahoo.com)

**Charles Sammut**  
Project Manager  
University of Malta  
Faculty of Science  
Msida MSD 06  
MALTA  
Tel.: +356 21 371 280  
Fax: +356 21 332 728  
EEmail: [charles.v.sammut@um.edu.mt](mailto:charles.v.sammut@um.edu.mt)

**Serhat Sensoy**  
Engineer, Climatology Division  
Turkish State Meteorological Service  
P.O. Box 401  
06120 Ankara, TURKEY  
Tel.: +90-312-3022457  
Fax: +90-312-3612371  
Mobile: +90-535-9723305  
Email: [ssensoy@meteor.gov.tr](mailto:ssensoy@meteor.gov.tr)

**Victor Simango**  
World Meteorological Organization  
7bis, Avenue de la Paix  
1211 Genève 2  
SWITZERLAND  
Tel.: +41 22 730 83 03  
Fax:: +41 22 730 80 47  
Email: [Vsimango@wmo.int](mailto:Vsimango@wmo.int)

**Hans Teunissen**  
Global Climate Observing System  
c/o World Meteorological Organization  
7bis, Avenue de la Paix  
1211 Genève 2  
SWITZERLAND  
Tel.: +41 22 730 80 86  
Fax: +41 22 730 82 52  
Email: [Hteunissen@wmo.int](mailto:Hteunissen@wmo.int)

**Richard Thigpen**

15205 Baughman Drive  
20906 Silver Spring  
UNITED STATES OF AMERICA  
Tel. – Fax: +1 301 598 56 83  
E.Mail: [thigpenr@erols.com](mailto:thigpenr@erols.com)

**Abdelhak TRACHE**

CRASTE-LF  
BP. 765, Avenue Ibn Sina  
Rabat-Agdal  
MOROCCO  
Tel.: +212 37 68 18 26  
Fax: +212 37 68 18 24  
Email: [trache@emi.ac.ma](mailto:trache@emi.ac.ma) or  
[trache\\_a@yahoo.fr](mailto:trache_a@yahoo.fr)

**Adnan UNAL**

Director General  
Turkish State Meteorological Service (SMS)  
P.O. Box 401  
Ankara – TURKEY  
Tel.: +90 3123612350  
Fax: +90 3123612351  
Email 1: [aunal@meteo.gov.tr](mailto:aunal@meteo.gov.tr)  
Email 2: [bilgi@meteor.gov.tr](mailto:bilgi@meteor.gov.tr)

**Jim Williams**

Mount Ararat  
Cave Hill  
Maidstone, ME15 6DX  
UNITED KINGDOM  
Tel.: +44 1622 755022  
Fax: +44 1622 755022  
Email: [mountararat@btinternet.com](mailto:mountararat@btinternet.com)

**William Westermeyer**

Global Climate Observing System  
C/o World Meteorological Organization  
7bis, Avenue de la Paix  
1211 Genève 2  
SWITZERLAND  
Tel.: +41 22 730 80 83  
Fax: +41 22 730 82 52  
Email: [WWestermeyer@wmo.int](mailto:WWestermeyer@wmo.int)

*(Intentionally Blank)*

## GCOS REGIONAL WORKSHOP DRAFT RESOLUTION

The participants to the GCOS Regional workshop,

**Noting** the importance of continuous sustained terrestrial, atmospheric, and oceanic observation for the purpose of climate variability and change monitoring and adaptation;

**Recognizing** the benefit of cooperative regional initiatives that mobilize all parties (partners) in a project framework to meet well-being needs;

**Taking benefit from** technical (including special and remote measurement) and financial opportunities offered at international level; and

**Considering** the local characteristics and preoccupations, define as priorities:

- Coordination/Collaboration, nomination of GCOS focal points; an updated list of national coordinators for GCOS;
- Adaptation - Impact Studies/Applications/vulnerability sectoral approach;
- GSN/GUAN/RBCN - Performance and Network Enhancements/Calibration multipurpose observing platforms;
- Identify gaps in global networks, see how the Action Plan would address;
- DataManagement/Tools/Exchange/QC/normalization/harmonization/Access; homogeneity assessment for long-term records; development of climate indicators;
- Regional Centres;
- Sustained Resources for Observing Stations and Networks;
- Satellites/Remote Sensing (Partnership opportunity);
- Capacity Building/Training; integrated, multidisciplinary scientific approach to climate assessments;
- Data and Metadata Rescue;
- GAW Network Enhancement (Partnership opportunity);
- Background Air Quality Network;
- Drought Project, Flood Forecasting, Extreme Events;
- Ground Water Monitoring Networks;
- Hydrological projects and exchange of expertise;
- GLOSS Project (N. Africa) (Partnership opportunity)
- Use of existing MOON observing systems;
- Monitoring of straits and deep ocean;
- Hydrology Project/Capacity Building (Partnership opportunity)

- Collaborative Project with WMO RA – 6;
- Regional climate modeling - scenario approach;
- Risk Management - Locusts/Other Hazards;
- Impact of projects on MDGs;
- Assessment of resource mobilization.

**Recommend the following:**

Initiation of a regional integrated project with clear deliverables, fundable, and with added value for the socio-economic sector mainly in areas of:

- water resources management and reduction of scarcity;
- improvement of agricultural practices to reduce poverty;
- implementation of risk management strategies against hazards and adverse impacts of extreme events (drought, flood, locusts, tsunamis, sea level rise, desertification, and fires) to reduce vulnerability;
- building capacity to monitor the climate change and variability; and
- impact of climate on marine ecosystem and health of the ocean

Processed Data - Exchange

Support of the WMO Resolution on Free Exchange of Data, is to include other sectors such as agriculture.

Regional workshops for indices of climate change and on prediction application, including end users;

Free exchange of data through PR or GCOS focal points;

Urge WMO to implement projects similar to PUMA for Syria, Lebanon, and the Palestinian Authority;

More GCOS Stations -- All Countries -- or expansion of GCOS comprehensive networks, e.g., RBCN;

Importance of Metadata; and the

Importance of prediction, especially long-range forecasts and their interpretation, sent to the end user.

## THE GLOBAL CLIMATE OBSERVING SYSTEM AND THE GCOS REGIONAL WORKSHOP PROGRAMME

David Goodrich  
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 and coordinate the taking of 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 impacts 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 the Mediterranean Basin 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, a substantial opportunity now exists to obtain the support to make much needed improvements in observing networks that will benefit not only the global concerns of the UNFCCC 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 June 2006. With resources limited both nationally and internationally, a regional plan for improving observing systems is practical, achievable, and fundable.

## THE UNFCCC AND SYSTEMATIC OBSERVATION

Olga Pilifosova  
UNFCCC secretariat

Several Articles of the United Nations Convention on Climate Change (UNFCCC) have made references to systematic observations, including Article 5, which states that Parties shall support international efforts to strengthen systematic observation, taking into account the needs of developing countries for improving their capacities to participate in systematic observation.

The Conference of Parties (COP) to the UNFCCC and its subsidiary bodies have repeatedly considered the issue relevant to systematic observation at their sessions. The UNFCCC meetings adopted a number of important decisions aimed at strengthening the global observing systems for climate.

The major milestones are the following:

- COP became seriously interested in the global observing system in 1998. This was stimulated by a perception that the number and quality of 'atmospheric' data were declining, and that something had to be done to reverse the trend, particularly in developing countries.
- Then COP5 and SBSTA, in various decisions, have endorsed several major activities to address the problem, namely:
  - organizing a regional workshop programme which would help to develop specific proposals for the purpose to address deficiencies in the climate observing networks and to identify the capacity-building needs and funding required in developing countries to enable them to collect, exchange and utilize data on a continuing basis in pursuance of the Convention;
  - inviting parties to develop and submit separate GCOS reports as part of national communications;
  - preparation of an 'adequacy report' by the GCOS agencies. This report should help guide the efficient expenditure of scarce resources, and
  - preparation of the Implementation Plan based on the "adequacy report". This plan is to be coordinated by GCOS in collaboration with the ad hoc Group on Earth Observations (GEO). COP10 (Buenos Aires, December 2004) endorsed the implementation plan. It also requested the GCOS secretariat to provide information to the SBSTA at its twenty-third session (November–December 2005) and, as required, at subsequent sessions, on how the actions identified in the implementation plan are being implemented.

These activities are obviously linked and should lead to defined priorities for actions, with a **practical outcome** that should result in formulating concrete project proposals for different donors, including GEF.

## **Workshops**

SBSTA, on a number of occasions has repeated the call for the practical outcome of the regional workshop programme and urged Parties to work in collaboration with the GCOS secretariat in formulating project proposals for developing countries to address deficiencies in observational network. More specifically, SBSTA made a direct link between the workshops and specific project proposals. It also invited the Subsidiary Body for Implementation (SBI) to take note of the need to fund those aspects of the proposals relating to the global system and to consider at future sessions possible financial implications of such needs, including in its guidance to the financial mechanism of the Climate Convention.

## **National Reports on GCOS**

To guide national reporting on GCOS, *UNFCCC REPORTING GUIDELINES ON GLOBAL CLIMATE CHANGE OBSERVING SYSTEMS* have been developed with the help of GCOS secretariat. COP of the UNFCCC requested Annex I Parties (developed and EIT countries) and *invited* all Parties to provide detailed reports on systematic observation in accordance with these guidelines, and on a voluntary basis for Parties not included in Annex I (i.e., developing countries, and some others including countries of the region).

The guidelines are a set of general instructions that outline the preferred approach for reporting to the COP of the UNFCCC on the national status of meteorological and atmospheric, oceanographic, and terrestrial observing systems.

Standard guidelines provide a format that will help the Convention secretariat and GCOS easily understand and assess the status of key observing system attributes. Standard guidelines also enable the information submitted by individual countries in national reports to be easily amalgamated or synthesized so that an overall picture of the status of global observing systems can be constructed. COP invited the Convention secretariat, in conjunction with GCOS, to develop a process for synthesizing and analyzing the material submitted in national reports. Information provided using a standard format makes this task easier. Two synthesis reports have been produced: one from GCOS secretariat, summarizing findings from both available information from developing and reporting in accordance with new guidelines - developed countries; and another - synthesis of the UNFCCC secretariat - summarizing information provided in separate reports of 43 developed countries.

The COP of the UNFCCC strongly endorses the request that as many countries as possible undertake national reports on the status of their observing systems. Individually and collectively, these reports will provide essential information that can be used in making the case for upgrading climate observing systems. Moreover, the final synthesis report(s) will only be as good as the amount and quality of the information on which it is based. It is especially important that countries experiencing problems in maintaining or upgrading observing systems prepare and submit reports. The availability of a quality synthesis report will also help to raise the level of awareness among the delegates to UNFCCC meetings of the importance to them of systematic observation and the remaining deficiencies and the ways to eliminate them.

## **Linkage to the Work on Adaptation to Climate Change**

In recent years (and in particular since COP7 in 2001), interest in issues related to impacts, vulnerability and adaptation to climate change under the UNFCCC has grown considerably. One of the major outcomes of COP 10 in December 2004 was the adoption of the Buenos Aires programme of work on adaptation and response measures (decision 1/CP.10). This decision, inter alia:

- Decides to further implementation of actions on data and modeling, assessment and implementation.
- Requests GEF to report on support of the above.
- Requests the secretariat to organize before end 2007 four regional workshops to facilitate information exchange and integrated assessments reflecting regional priorities
- Requests SBSTA to develop a 5-year programme of work on scientific and technical aspects of V&A and address the following issues: methodologies, data and modeling; vulnerability assessments; adaptation planning, measures and actions; and integration into sustainable development.

In all of these activities one of the most important areas is improving access to high quality data and information on current climatic variability, extreme weather events, as well as data on likely future climate variability and climate change. In this regard, using complementarities with the above activities on systematic observation and working with close cooperation with relevant international, regional and national organizations and initiatives on GCOS is essential.

*(Intentionally Blank)*

**IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE  
IN SUPPORT OF THE UNITED NATIONS  
FRAMEWORK CONVENTION ON CLIMATE CHANGE**

**EXECUTIVE SUMMARY**

**Paul Mason  
Chairman, GCOS Steering Committee**

**Introduction**

The Global Climate Observing System (GCOS), in consultation with its partners, has prepared an implementation plan that addresses the requirements identified in the Second Report<sup>1</sup> on the Adequacy of Global Observing Systems for Climate in Support of the United Nations Framework Convention on Climate Change (UNFCCC) (hereafter called the 'Second Adequacy Report'). This plan specifically responds to the request of the Conference of Parties (COP) to the UNFCCC in its decision 11/CP.9 to develop a 5- to 10-year implementation plan. As requested, the plan:

- Builds on the Second Adequacy Report and draws on the expressed views of Parties with respect to that report;
- Takes into consideration existing global, regional and national plans, programmes and initiatives, including those of the Global Monitoring for Environment and Security programme of the Economic Union and the Integrated Global Observing Strategy Partnership as well as the plans of the Group on Earth Observations;
- Is based on extensive consultations with a broad and representative range of scientists and data users, which included an open review of the implementation plan before its completion;
- Includes indicators for measuring its implementation;
- Identifies implementation priorities and resource requirements.

**Meeting the Needs of the UNFCCC for Climate Information**

This plan, if fully implemented by the Parties both individually and collectively, will provide those global observations of the ECVs and their associated products required to meet key societal needs of the Parties including support to Articles 4 and 5 of the UNFCCC. In addition, it will provide many of the essential observations required by the World Climate Research Programme (WCRP) and Intergovernmental Panel on Climate Change (IPCC). Specifically the proposed system would provide information to:

1. Characterize the state of the global climate system and its variability;
2. Monitor the forcing of the climate system, including both natural and anthropogenic contributions;
3. Support the attribution of the causes of climate change;
4. Support the prediction of global climate change;
5. Enable projection of global climate change information down to regional and local scales;
6. Enable characterization of extreme events important in impact assessment and adaptation, and to the assessment of risk and vulnerability.

---

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

As noted in the Second Adequacy Report, “Without urgent action and clear commitment of additional resources by the Parties, the UNFCCC and intergovernmental and international agencies, the Parties will lack the information necessary to effectively plan for and manage their response to climate change.”

**Essential Climate Variables.** The Second Adequacy Report established a list of the Essential Climate Variables (ECVs) (see Table 1) that are both currently feasible for global implementation and have a high impact on the requirements of the UNFCCC. Clearly there are additional climate variables that are important to a full understanding of the climate system and many of these are the subjects of important on-going research; however, they are not currently appropriate for global implementation on a systematic basis. As our knowledge and capabilities develop, it is expected that some of these additional variables will be added to the list of ECVs.

**Table 1. Essential Climate Variables that are both currently feasible for global implementation and have a high impact on UNFCCC requirements.**

Domain	Essential Climate Variables
<b>Atmospheric</b> (over land, sea and ice)	<p><b>Surface:</b> Air temperature, Precipitation, Air pressure, Surface radiation budget, Wind speed and direction, Water vapour.</p> <p><b>Upper-air:</b> Earth radiation budget (including solar irradiance), Upper-air temperature (including MSU radiances), Wind speed and direction, Water vapour, Cloud properties.</p> <p><b>Composition:</b> Carbon dioxide, Methane, Ozone, Other long-lived greenhouse gases<sup>2</sup>, Aerosol properties.</p>
<b>Oceanic</b>	<p><b>Surface:</b> Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Current, Ocean colour (for biological activity), Carbon dioxide partial pressure.</p> <p><b>Sub-surface:</b> Temperature, Salinity, Current, Nutrients, Carbon, Ocean tracers, Phytoplankton.</p>
<b>Terrestrial</b>	<p>River discharge, Water use, Ground water, Lake levels, Snow cover, Glaciers and ice caps, Permafrost and seasonally-frozen ground, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI), Biomass, Fire disturbance<sup>3</sup>.</p>

<sup>2</sup> Including nitrous oxide (N<sub>2</sub>O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF<sub>6</sub>), and perfluorocarbons (PFCs).

<sup>3</sup> Includes run off (m<sup>3</sup> s<sup>-1</sup>) ground water extraction rates (m<sup>3</sup> yr<sup>-1</sup>) and location, snow cover extent (km<sup>2</sup>) and duration, snow depth (cm), glacier / ice cap inventory and mass balance (kg m<sup>-2</sup> yr<sup>-1</sup>), glacier length (m), Ice sheet mass balance (kg m<sup>-2</sup> yr<sup>-1</sup>) and extent, permafrost extent (km<sup>2</sup>), temperature profiles and active layer thickness, above ground biomass (T/ha), burnt area (ha), date and location of active fire, burn efficiency (%vegetation burned/unit area)

**Implementation Actions and Associated Cost Implications.** The implementation plan includes over a hundred specific actions to be undertaken over the next 10 years, across the three domains. Many of the proposed actions are already underway, at least as part of research activities, and most of the required coordination mechanisms have been identified. The costs of undertaking these actions are summarized in Table 2 by cost and type of action. Priority should be given over the first 5 years to those actions that will address the critical issues identified within the Second Adequacy Report, specifically access to high quality global climate data; integrated global analysis products; key satellite and in-situ network improvements; and strengthening national and international infrastructure including the full participation of least developed countries and small island developing states.

The plan is both technically feasible and cost-effective in light of the societal and economic importance of climate observations to the considerations of the UNFCCC. It involves global extension and improved operating practices for observing systems that are currently supported and functioning for other purposes. While its implementation is dependent on national efforts, success will be achieved only with international cooperation, coordination and, in some particular cases, such as the key global reference observation sites in least developed countries, sustained technical and financial support. While the plan focuses on meeting global requirements, such global data and products are also relevant to regional and local needs. In the case of extreme events, which are usually of a small scale and/or short lived, the plan provides for global estimates of many such phenomena. Finally, the plan will be updated over time as networks and systems become operational and as new knowledge and techniques become available.

**Table 2. Summary of New Annual Recurring Costs.**

<b>Cost Category</b>	<b>No. of Actions Common</b>	<b>No. of Actions Atmospheric</b>	<b>No. of Actions Oceanic</b>	<b>No. of Actions Terrestrial</b>	<b>Total</b>
I / <\$100K	4	8	5	8	25
II / \$100K<\$1M	11	4	9	10	34
III / \$1M-\$10M	5	11	18	6	40
IV / \$10M-\$100M	0	7	9	12	28
V / >\$100M	0	2	0	2	4
Total No.	20 <sup>4</sup>	32	41	38	131 <sup>5</sup>

The cost estimates include both the costs of transition of current systems from research to operations as well as those wholly associated with new systems. The new observations and infrastructure for climate will serve many applications other than just the climate needs of the Parties. In addition, as the climate component of the proposed Global Earth Observing System of Systems (GEOSS) they would meet many of the needs of the other GEOSS applications. Satellites, though a major cost item in category V, uniquely provide global coverage.

**Key Action 1: Parties need, both individually and collectively, to commit to the full implementation of the global observing system for climate, sustained on the basis of a mix of high-quality satellite measurements, as well as ground based and airborne *in situ* and remote-sensing measurements, dedicated analysis infrastructure, and targeted capacity-building.**

<sup>4</sup> There are 20 costed and 2 uncosted common actions.

<sup>5</sup> There are 131 costed and 2 uncosted actions in total.

### **Agents for Implementation**

The global observing system for climate requires observations from all domains: terrestrial, oceanic, and atmospheric, which are then transformed into products and information through analysis and integration in both time and space. Since no single technology or source can provide all the needed observations, the ECVs will be provided by a composite system of *in situ* instruments on the ground, on ships, buoys, floats, ocean profilers, balloons, samplers, and aircraft, as well as from all forms of remote sensing including satellites. Meta-data (i.e. information on where and how the observations are taken) are absolutely essential, as are historical and palaeo-climatic records that set the context for the interpretation of current trends and variability. Although these individual activities are to be coordinated internationally through a variety of programmes, organizations and agencies, success will depend mainly on national and regional entities that will translate the plan into reality. Collectively all of these entities are referred to in the plan as the "Agents for Implementation".

The implementation plan outlines a comprehensive program that marshals contributions from virtually all countries and organizations dealing with Earth observations that will require continuing and strengthened coordination and performance monitoring. In addition, the GCOS Cooperation Mechanism is being developed to mobilize resources to ensure the effective operation of the overall global system. An International Project Office is needed to help coordinate the activities of the component elements of the system, to monitor the performance of the system, to identify deficiencies in the system, and to coordinate measures to correct such deficiencies.

**Key Action 2: Parties need to provide support for an International Project Office to provide overall coordination, to monitor performance, to report regularly on implementation, to initiate corrective actions, and to oversee the GCOS Cooperation Mechanism.**

**International Agents.** The networks, systems, data centres and analysis centres identified within this plan are almost all funded, managed or coordinated by the individual Agents for Implementation and operate within their own requirements, plans, procedures, standards and regulations. This implementation plan calls on all contributing networks and systems to respond to the actions contained in this plan and, where appropriate, to adjust their plans, procedures and operations to address the specified climate observing requirements. GCOS will continue to emphasize with all relevant international and intergovernmental organizations the need for their Members to a) undertake coordination and planning for systematic climate observations where this is not currently being undertaken, and b) produce and update on a regular basis plans for their contributions to the global observing system for climate, taking into account the actions included in this implementation plan. For this to be effective it will also be essential for the Parties to ensure that their requirements for climate observations are communicated to these international and intergovernmental organizations.

**Key Action 3: The international and intergovernmental organizations need to incorporate the relevant actions in this implementation plan within their own plans and actions.**

**Regional Agents.** For some observations, regional planning and implementation of climate observing system components is particularly effective as a means of sharing workloads and addressing common issues. The GCOS Regional Workshop Programme has established a framework for interested nations to work together to optimize their networks and to identify both national and GCOS network needs in each region. Regional action plans, one of the outputs of

these workshops, are being developed and some elements of them are finding support from member nations and/or donors for implementation.

**Key Action 4: Parties need to complete development and alignment of regional action plans for observations in the context of this implementation plan.**

**National Agents.** The needs of the UNFCCC and other users for global climate observations and products can be addressed only if plans are developed and implemented in a coordinated manner by national organizations. As noted in the Second Adequacy Report, with the exception of the main meteorological networks and the planning for individual activities, most climate-observing system activities are poorly coordinated, planned and integrated at the national level. All Parties need national coordination mechanisms and national plans for the provision of systematic observation of the climate system. Such mechanisms are usually best sustained when national coordinators or focal points<sup>6</sup> are designated and assigned responsibility to coordinate planning and implementation of systematic climate observing systems across the many departments and agencies involved with their provision.

**Key Action 5: Parties are requested to undertake national coordination and planning and produce national plans on their climate observing, archiving and analysis activities that address this implementation plan.**

Reporting on systematic climate observation activities by the Parties<sup>7</sup> as part of their National Communications under the UNFCCC is essential for planning and monitoring the implementation of the global observing system for climate. The response by Parties to the Second Adequacy Report emphasized that accurate and credible information relative to all aspects of climate observations must be exchanged, according to the relevant guidelines (Decision 4/CP.5).

**Key Action 6: Parties are requested to submit information on their activities with respect to systematic observations of all ECVs as part of their national communications to the UNFCCC utilizing an updated Supplementary Reporting Format.**

**Participation by all Parties.** Recognizing the common requirement for information on climate variability and change, the need for all Parties to improve global observing systems for climate in developing countries has been a consistent theme in the considerations by COP on systematic observation. There are many ways that systems can be improved, including through developed-country agencies working with organizations and personnel from developing countries, and the donation of equipment and the training of personnel, for example. The GCOS Cooperation Mechanism has been established by a core set of countries to provide a coordinated multi-governmental approach to address the high-priority needs for stable long-term funding for key elements of global observing system for climate, especially in least developed countries, small island developing states and some countries with economies in transition.

The GCOS Cooperation Mechanism can address priority improvements in atmospheric, oceanic, and terrestrial observing systems for climate, including addressing data rescue, analysis and archiving activities. It is intended to complement and work in cooperation with existing funding and implementation mechanisms (e.g. Voluntary Cooperation Programme of World Meteorological Organization (WMO), United Nations Development Programme, and the

---

<sup>6</sup> The GCOS Steering Committee has developed guidelines for such functions.

<sup>7</sup> Available through the UNFCCC Secretariat.

many national aid agencies), many of which deal with climate-related activities and support capacity building in particular.

**Key Action 7: Parties are requested to address the needs of least-developed countries, small island developing states and some countries with economies in transition for taking systematic climate observations by encouraging multi-lateral and bilateral technical cooperation programs to support global observing systems for climate and by participating in the GCOS Cooperation Mechanism.**

### **Access to Climate Data**

**High-Quality Climate Data.** Ensuring that high-quality climate data records are collected, retained and made accessible for use by current and future generations of scientists and decision makers is a key objective of this implementation plan. As a result, investment in the data management and analysis components of the system is as important as in the acquisition of the data. The plan calls for strengthening the current International Data Centres<sup>8</sup> and seeking commitments for new International Data Centres so that all ECV have an appropriate infrastructure.

**Key Action 8: Parties need to ensure that International Data Centres will be established and/or strengthened for all ECVs.**

The flow of data to the user community and to the International Data Centres is not adequate for many ECVs, especially for those of the terrestrial-observing networks. Lack of national engagement and/or resources, restrictive data policies, and inadequate national and international data-system infrastructure are the main causes of the inadequacy.

In Decision 14/CP.4, the COP urged Parties to undertake free and unrestricted exchange of data to meet the needs of the Convention, recognizing the various policies on data exchange of relevant intergovernmental and international organizations. Yet, as the Second Adequacy Report points out repeatedly with respect to almost all of the variables, the record of many Parties in providing full access to their data is poor. This implementation plan is based on the free and unrestricted exchange of all data and products and incorporates actions to: develop standards and procedures for meta-data and its storage and exchange; to ensure timely, efficient and quality-controlled flow of all ECV data to climate monitoring and analysis centres and international archives and to ensure that data policies facilitate the exchange and archiving of all ECV data.

### **- International Standards and Guidance**

The international programmes and Technical Commissions of WMO and International Oceanographic Commission (IOC) exist to provide the standards, regulatory material and guidelines for the collection of climate data in the atmospheric and oceanic domains. There is at present no equivalent international body or technical commission for climate observations for the terrestrial domain. A key requirement for successful implementation of this plan is the urgent establishment of such an international body by the relevant international organizations, including

---

<sup>8</sup> International data centres are responsible for monitoring, product preparation and dissemination as well as archiving.

WMO, Food and Agriculture Organization (FAO), United Nations Environment Programme (UNEP), and International Council for Science (ICSU).

**Key Action 9: The relevant intergovernmental organizations including the WMO, FAO, UNEP, and ICSU need to create a mechanism for establishing standards, regulatory material and guidelines for terrestrial observing systems.**

- **GCOS Climate Monitoring Principles**

The GCOS Climate Monitoring Principles (GCMP) provide basic guidance regarding the planning, operation and management of observing networks and systems, including satellites, to ensure high quality climate data that contributes to effective climate information. The GCMP address issues such as the effective incorporation of new systems and networks; the importance of calibration, validation and data homogeneity; the uninterrupted operation of individual stations and systems; the importance of additional observations in data-poor regions and regions sensitive to change; and the crucial importance of data-management systems that facilitate access, use and interpretation of the data. These principles have been adopted or agreed by the UNFCCC, WMO, Committee on Earth Observation Satellites (CEOS) and other bodies. The implementation actions now call on all data providers to adhere to the GCMP and to initiate effective programs of data quality control.

**Key Action 10: Parties need to ensure that their climate observing activities contributing to GCOS adhere to the GCMP.**

- **Data Stewardship and Management**

Climate observations that are well documented and have good metadata about the systems and networks used to make them become more valuable with time. The creation of climate quality data records is a fundamental objective of the global observing system for climate. International standards and procedures for the storage and exchange of metadata need to be developed and implemented for many climate observing system components, including those of the operational satellite community. It is essential that all such data be properly archived and managed with the full expectation that they will be reused many times over in the future, often as a part of reprocessing or reanalysis activities. Good stewardship of the data also requires that data be migrated to new media as technology changes, be accessible to users, and be made available with minimal incremental costs.

**Key Action 11: International standards for metadata for all ECVs need to be established and adopted by the Parties in creation and archiving of climate data records.**

**Domain-Specific Observing Networks and Systems.** The proposed global observing system for climate is an integrated system in which the various satellite and *in situ* components complement each other. Whilst some ECVs will remain dependent on *in situ* observations, satellites can ultimately provide the most important means of obtaining observations of a large part of the climate system from a near-global perspective and for comparing the behaviour of different parts of the globe. Therefore, a system of satellite sensors implemented and operated in a manner that ensures the long-term accuracy and homogeneity of the data through the adoption of the GCMP, is a high priority within the plan. At the same time, the requirements for long-term trend information means that a substantial effort must be made to ensure the continued operation and refinement of *in situ* networks.

Some of the key domain specific components merit highlighting.

- **Atmospheric Domain**

Many atmospheric networks and systems, including some satellite components, are relatively mature, having been in existence for several decades, albeit generally for non-climate purposes. As a result, a key action in this domain is to ensure the full global implementation of these networks and systems for climate purposes. Other key actions respond to the need for additional baseline observations to enable full use of existing measurements, improvements relating to a few important but poorly observed variables, and for the use of reanalysis techniques to generate needed climate information products.

The GCOS Surface Network, (GSN), together with the other surface atmospheric networks, provide the basic observations of the surface climate in which we live, while the GCOS Upper Air Network (GUAN) together with related satellite observations provides a baseline for the upper atmosphere. Network and system improvements are proposed in many areas, including the extension of the GSN to include all relevant surface ECVs. Indeed, the advantages of co-located measurements imply that greater efforts should be made to establish sites where many of the ECVs for both the atmospheric and terrestrial domains are observed. In the upper atmosphere water vapour plays a critical role in climate feedback and supplements to the current baseline observations are needed from reference networks and GPS based techniques.

**Key Action 12: Parties need to a) ensure the implementation and full operation of the baseline networks and systems contained in Table 3 in accordance with the GCMP, to specifically resolve reported problems, to ensure the exchange of these data with the international community, and to recover and exchange historical records, b) establish a high-quality reference network of about 30 precision radiosonde stations and other collocated observations, and c) exploit emerging new technology including the use of radio-occultation techniques and ground-based Global Positioning System sensing of the total water column.**

**Table 3. Existing Atmospheric Baseline Networks and Systems.**

- |  |
|--|
| <ul style="list-style-type: none"><li>• GCOS Surface Network (GSN)</li><li>• The atmospheric component of the composite surface ocean observation system including sea level pressure (see Key Actions 17 and 18)</li><li>• GCOS Upper-Air Network (GUAN).</li><li>• MSU-like radiance satellite observations.</li><li>• Total solar irradiance and Earth radiation budget satellite observations.</li></ul> |
|--|

With the societal importance of precipitation there is further urgent need for improved global analyses including unbiased estimation of rainfall over the oceans and snow at high latitudes.

**Key Action 13: Parties are urged to a) establish a reference network of ocean-surface precipitation stations on key islands and moored buoys around the globe, b) to submit national precipitation data (preferably hourly data) to the International Data Centres, and c) to support the further refinement of satellite precipitation measurement techniques.**

The total solar irradiance and Earth radiation budget measurements provide overall monitoring of the solar radiation and the net greenhouse effect within the atmosphere. Clouds as well as water vapour strongly affect this Earth radiation budget and provide the most uncertain feedbacks in the climate system. It is vital to maintain long-term records concerning the overall radiation of the Earth. Cloud properties are of particular importance and research, some of which is in progress, is needed to improve the monitoring of clouds. Surface radiation measurements over land are an important complementary observations and the baseline surface radiation network need extension to achieve global coverage.

**Key Action 14: Parties need to a) ensure the continued operation of satellite measurements of the Earth radiation budget and solar irradiance (e.g. ERBE), and b) research to extend and improve current capabilities for monitoring clouds is a high research priority.**

Greenhouse gases and aerosols are the primary agents in forcing climate change; continuous observations that are spatially and temporally homogeneous are therefore required. For the greenhouse gases elements of the needed networks are in place but extension and improved attention to calibration are needed. Aerosols are, however, a complex variable and the plan proposes a key action in the establishment of an improved reference network and a global network for the aerosol related variable optical depth.

**Key Action 15: Parties need to a) fully establish a baseline network for key greenhouse gases, b) improve selected satellite observations of atmospheric constituents, and c) extend existing networks to establish a global baseline network for atmospheric optical depth.**

#### - **Oceanic Domain**

New technology, developed and proven by the ocean climate research programmes of the 1990's, has allowed the ocean community to design, and commence implementation of, an initial ocean climate observing system. The first action of the initial system is the global implementation of the surface and subsurface networks and the establishment of data analysis systems. This will allow for a composite system of satellite and *in situ* observations collected by operational and research groups to be synthesized into information products. Sustaining this system will require national designation of and support for Agents for Implementation, and the establishment of effective collaboration between research and operational groups. It will also involve continuity of existing and predominantly research-based *in situ* and satellite activities.

**Key Action 16: Parties need to a) complete and sustain the initial ocean observing system for climate, b) designate and support national Agents for Implementation for the implementation of this system, c) establish effective partnerships between their ocean research and operational communities for implementation, and d) engage in timely, free and unrestricted data exchange.**

The surface ocean network will provide information about the patterns of ocean surface temperature, pressure, winds, salinity, sea level, waves and sea ice that are important both to the global climate and its regional distribution and to marine resources and coastal societies. In particular, sea ice, which plays a key role in climate feed back, is a complex variable needing continued research into improved *in situ* and satellite measurements.

The surface observing network depends critically on the continuity of some satellite observations, most of which are in research rather than operational status (Table 4), and on the full implementation of a number of *in situ* activities.

**Key Action 17: Parties need to ensure climate quality and continuity for essential ocean satellite observations. (Table 4)**

**Table 4. Essential Ocean Satellite Systems.**

- |  |
|--|
| <ul style="list-style-type: none"><li>• Sustained support for vector-wind (scatterometer), sea-ice, sea-surface temperature (microwave and infra-red) and ocean-colour measurements.</li><li>• Continuous coverage from altimeters to provide high-precision and high-resolution sea-level measurements (1 high-precision and 2 lower-precision altimeters).</li></ul> |
|--|

**Key Action 18: Parties need to provide global coverage of the surface network by implementing and sustaining: a) the GCOS baseline network of tide gauges, b) an enhanced drifting buoy array c) an enhanced Tropical Moored Buoy network, d) an enhanced Voluntary Observing Ships Climate (VOSCLIM) network, and e) a globally-distributed reference mooring network.**

The subsurface ocean network will provide critical information on ocean climate variability and change. The network will provide a capacity for monitoring the regional oceanic uptake of heat, freshwater and carbon, and identification of abrupt climate change arising from changes in the planetary hydrological cycle processes. In association with the surface observations, they also provide the basis for seasonal-to-interannual predictions that can be critical in giving forecasts of the likelihood of extreme climatic events.

**Key Action 19: Parties need to provide global coverage of the subsurface network by implementing and sustaining: a) the Argo profiling float array b) the systematic sampling of the global ocean full-depth water column, c) the Ship-of-Opportunity Expendable Bathythermograph (XBT) trans-oceanic sections, and d) the Tropical Moored Buoy and reference mooring networks referred to in Key Action 18 above as well as the satellite altimetry system described in Table 4.**

In recognition of the importance of potential changes to the ocean carbon cycle and marine ecosystems, the implementation plan contains a number of important research and implementation actions dealing with the establishment of an observing network for the partial pressure of carbon dioxide ( $p\text{CO}_2$ ) and the measurement of the state and change of carbon sources and sinks in the oceans.

Finally, continuing climate research and technology programmes for the oceans are needed to enhance the efficiency and effectiveness of observing efforts, and to develop capabilities for important climate variables that cannot currently be observed globally. This need for enhanced capability is particularly acute for remote locations, for improved understanding of the ocean ecosystems, for improving the estimates of uncertainty, and for understanding the mechanisms of climate change.

## - Terrestrial Domain

The climate observing system in the terrestrial domain remains the least well-developed component of the global system, whilst at the same time there is increasing significance being placed on terrestrial data for climate forcing and understanding as well as for impact and mitigation assessment.

The plan proposes actions designed to achieve an initial coordinated and comprehensive observational program for all terrestrial ECVs. The nature of the terrestrial domain is such that priority is being placed on obtaining global products for all ECVs from a range of research-level satellite sensors supported by an increasing number of reference and baseline *in situ* networks.

**Key Action 20: Parties are urged to support the operational continuation of the satellite-based products given in Table 5.**

**Table 5. Priority Terrestrial Satellite Products.**

- |   |
|---|
| <ul style="list-style-type: none"><li>• Daily global albedo from geostationary and polar orbiting satellites.</li><li>• FAPAR and LAI products to be made available as gridded products.</li><li>• Gridded fire and burnt area products through a single international data centre.</li><li>• Snow cover of both hemispheres.</li><li>• Digital elevation maps of the ice sheet surfaces and full glacier inventory from current space borne cryosphere missions.</li><li>• Specification and production of land cover characterization datasets.</li></ul> |
|---|

A coordinated reference network is needed for *in situ* observations of the fullest possible range of terrestrial ECVs and associated details relevant to their application in model validation; process studies; validation of observations derived from Earth observation satellites; and to address intrinsic limitations in some of these, such as the saturation of LAI measurements.

**Key Action 21: Parties are urged to develop a global network of at least 30 reference sites to monitor key biomes and to provide the observations required in the calibration and validation of satellite data.**

The hydrological variables are of critical societal importance. Many are observed but not well exchanged for the purposes of assessing global climate change. The proposed international body (Key Action 9 above) is intended to establish standards for and to facilitate the exchange of terrestrial data for climate and other purposes. The plan proposes specific actions to continue with the implementation of the Global Terrestrial Networks (GTNs) for hydrology, including specific lakes and rivers components, for glaciers and for permafrost.

**Key Action 22: Parties are urged to: a) fill the identified gaps in the permafrost, glaciers, rivers and lakes networks, b) provide support for the designated International Data Centres, and c) submit current and historical data to the International Data Centres.**

### **Availability of Climate Products**

Use of observations for policy and planning purposes depends on access to information beyond the basic observations. To meet the needs of all nations for climate information, the global observing system for climate must generate useful climate products. The preparation of climate products almost invariably involves the integration of data in time and space, as well as the blending of data from different sources. Some activities, such as reanalysis, involve extensive data-set preparation and significant computing and data-management resources. Estimation of uncertainties in products through careful studies also requires considerable data set preparation and access to all relevant information. Providing access to climate information for all Parties will involve significant information technology infrastructure. The best use of available resources will come via international coordination of these activities. Therefore, a sustained and coordinated application of reanalysis is one of the key actions of this plan for all domains.

**Key Action 23: Parties are urged to adopt an internationally-coordinated approach to the development of integrated global climate products and to make them accessible to all Parties. As far as possible these products should incorporate past data covering at least the last 30 years in order to serve as a reference for climate variability and change studies.**

**Key Action 24: Parties are urged to give high priority to establishing a sustained capacity for global climate reanalysis, to develop improved methods for such reanalysis, and to ensure coordination and collaboration among centres conducting reanalyses.**

### **Improving the System**

Our ability to measure some key and emerging ECVs from *in situ* and remote sensing (both surface and satellite based) is limited by the lack of suitable instruments and techniques. The limitation can vary all the way from difficulties with the fundamental observing technique to those associated with instrumentation, algorithms, suitable calibration/validation techniques, spatial and/or temporal resolution, ease of operation, and cost.

The development, demonstration, and validation of new techniques are vital to the future success of the global observing system for climate. It is critically important that as new global satellite-based observations of environmental variables are made, the validation of both the measurements themselves (e.g. radiances) and the retrieval algorithms be carried out under a sufficiently broad range of conditions that they can be confidently applied in the creation of a global data sets.

Research is needed to improve the ability to blend different data sets and/or data sources into integrated products. As new types of data are assimilated into models, it will also be important to understand the error characteristics of the new data and the models used. The techniques of climate data assimilation are still in an early stage of development and require continued research support. As these developments occur, reprocessing of data to take advantage of the new knowledge will be vital to sustained long-term records.

**OBSERVATIONAL NEEDS FOR EXTREME EVENTS  
AND FOR ADAPTATION TO CLIMATE CHANGE**

**Abdalah Mokssit  
Deputy Director  
Direction de la Météorologie Nationale, Morocco**

In recent decades, considerable effort has been invested in analyzing long-term monthly-average data. The assessments of the Intergovernmental Panel on Climate Change (IPCC) (e.g., Folland, et al., 2001b) clearly demonstrate that at the surface, the globe has been warming during the last century and also that during the last few decades mean monthly-average minimum temperatures have generally been rising faster than mean monthly-average maximum temperatures. Long-term trends in patterns of annual and seasonal precipitation are also reviewed in the IPCC assessments. Climatic variations, however, make their impacts felt more through extreme events than through mean values (WMO, 2002). Therefore, to provide more insights into changes in extremes, a comprehensive list of indices based on daily data was developed and regional analyses were undertaken in North America, Russia, Asia, South Africa, Australia, and Europe. (Frich, et al., 2002). In other areas, regional workshops were organized under the auspices of the WMO Commission for Climatology (CCL) and the WCRP's CLIVAR programme. The analyses undertaken in the January 2001 Jamaica workshop for the Caribbean region (Peterson, et al., 2002) indicate that the percentage of days having high maximum or minimum temperatures in the Caribbean has increased significantly since the late 1950s. Also, the percentage of total rainfall contributed by heavy rainfall events above the 1961-90 95<sup>th</sup> percentile has increased. These changes are similar to those reported by Frich, et al, 2002.

For Africa, the results from the February 2001 Casablanca workshop show that there has been a decreasing trend in the frequency of days with minimum temperatures below the 1961-1990 10<sup>th</sup> percentile threshold over most of the continent between 1961 and 1990.

Other experiments regarding climate change detection, adaptation, and extreme events characterization raise the need for more data, free access, and homogenization and standardization. They also demonstrate the necessity to transform the traditional data to performed indices (see attached table), products, and model skills with relevant information for both extreme event measures and adaptation studies by sectors. These experiments support the ten climate monitoring principles listed below, which were adopted in paraphrased form by the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) through Decision 5/CP.5 of COP5, November 1999. If Members follow these principles when designing and operating observing networks, and when controlling quality, distributing and archiving data, the benefits to Members and to climate research will be fully realized. The *Global Climate System Reviews* depend strongly on the timely provision of reliable data by all Members. In order to assess changes in extremes that have major socio-economic and environmental impacts, it is crucial that daily data for the GCOS Surface Network (GSN) (described at <http://www.wmo.ch/web/gcos/gcoshome.html>) be included in data exchanges as soon as possible. Effective monitoring systems for climate should adhere to the following principles:

1. The impact of new systems or changes to existing systems should be assessed prior to implementation;
2. A suitable period of overlap for new and old observing systems is required;
3. The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata) should be documented and treated with the same care as the data themselves;
4. The quality and homogeneity of data should be regularly assessed as a part of routine operation;
5. Consideration of the needs for environmental and climate-monitoring products and assessments, such as IPCC assessments should be integrated into national, regional, and global observing priorities;
6. Operation of historically-uninterrupted stations and observing systems should be maintained;
7. High priority for additional observations should be focused on data-poor regions, poorly-observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution;
8. Long-term requirements should be specified to network designers, operators, and instrument designers at the outset of system design and implementation;
9. The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted; and
10. Data management systems that facilitate access, use, and interpretation of data and products should be included as essential elements of climate monitoring systems.

## **References**

Folland, C.K., T.R. Karl and Co-authors, 2001: Observed climate variability and change. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, J.T. Houghton et al., eds, Cambridge University Press, 99-181 pp.

Frich, P., L.V. Alexander, P. Della-Marta, B. Gleason, M. Haylock, A.M.G. Klein Tank, and T. Peterson, 2002: Observed coherent changes in climatic extremes during the 2<sup>nd</sup> half of the 20<sup>th</sup> century, Climate Res., 19, 193-212.

Peterson, T.C., C. Folland, G. Gruza, W. Hogg, A. Mokssit, and N. Plummer, 2001: Report of the Activities of the Working Group on Climate Change Detection and Related Rapporteurs, World Meteorological Organization Technical Document No. 1071, World Meteorological Organization, Geneva, 146 pp.

Sensoy, S., T.C. Peterson, L.V. Alexander, 2005: Submitted to the Bulletin of the American Meteorological Society on March 9, 2005 with the number of 2037 and published at <http://www.clivar.org/organization/etccd/docs/SWAsiaWorkshopRep.pdf>

Zwiers, F., H. Cattle, T.C. Peterson, and A. Mokssit, 2003: Detecting climate change, WMO Bulletin, 52, 37-42.

### List of the 27 Core Climate Indices

ID	Indicator Name	Definitions	UNITS
FD0	Frost days	Annual count when TN (daily minimum) $<0^{\circ}\text{C}$	Days
SU25	Summer days	Annual count when TX (daily maximum) $>25^{\circ}\text{C}$	Days
ID0	Ice days	Annual count when TX (daily maximum) $<^{\circ}\text{C}$	Days
TR20	Tropical nights	Annual count when TN (daily maximum) $>20^{\circ}\text{C}$	Days
GSL	Growing season length	Annual (1 <sup>st</sup> Jan to 31 <sup>st</sup> Dec in NH, 1 <sup>st</sup> July to 30 <sup>th</sup> June in SH) count between first span of at least 6 days with TG $>5^{\circ}\text{C}$ and first span after July 1 (Jan 1 in SH) of 6 days with TG $<5^{\circ}\text{C}$	Days
TXx	Max Tmax	Monthly maximum value of daily maximum temp	$^{\circ}\text{C}$
TNx	Max Tmin	Monthly maximum value of daily minimum temp	$^{\circ}\text{C}$
TXn	Min Tmax	Monthly minimum value of daily maximum temp	$^{\circ}\text{C}$
TNn	Min Tmin	Monthly minimum value of daily minimum temp	$^{\circ}\text{C}$
TN10p	Cool nights	Percentage of days when TN $<10^{\text{th}}$ percentile	Days
TX10p	Cool days	Percentage of days when TX $<10^{\text{th}}$ percentile	Days
TN90p	Warm nights	Percentage of days when TN $>90^{\text{th}}$ percentile	Days
TX90p	Warm days	Percentage of days when TX $>90^{\text{th}}$ percentile	Days
WSDI	Warm spell duration Indicator	Annual count of days with at least 6 consecutive days when TX $>90^{\text{th}}$ percentile	Days
CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN $<10^{\text{th}}$ percentile	Days
DTR	Diurnal temperature range	Monthly mean difference between TX and TN	$^{\circ}\text{C}$
RX1day	Max 1-day precipitation	Monthly maximum 1-day precipitation	mm
Rx5day	Max 5-day precipitation	Monthly maximum consecutive 5-day precipitation	mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PR $\geq 1.0\text{mm}$ ) in the year	mm/day
R10	Number of heavy precipitation days	Annual count of days when PR $\geq 10\text{mm}$	Days
R20	Number of very heavy precipitation days	Annual count of days when PR $\geq 20\text{mm}$	Days
Rnn	Number of days above nn mm	Annual count of days when PR $\geq$ nn mm, nn is user defined threshold	Days
CDD	Consecutive dry days	Maximum number of consecutive days with RR $<1\text{mm}$	Days
CWD	Consecutive wet days	Maximum number of consecutive days with RR $>1\text{mm}$	Days
R95p	Very wet days	Annual total PRCP when PR $>95^{\text{th}}$ percentile	mm
R99p	Extremely wet days	Annual total PRCP when PR $>99^{\text{th}}$ percentile	mm
PRCPTOT	Annual total wet-dry precipitation	Annual total PRCP in wet days (PR $\geq 1\text{mm}$ )	mm

*(Intentionally Blank)*

## APPENDIX 8

### CLIMATE INFORMATION NEEDS FOR THE AGRICULTURAL SECTOR

**Fayez S. Y. Abdo**  
**Director, Agro meteorology Directorate**  
**Jordan Meteorological Department**

#### **Introduction**

Weather is one of the key components that controls agricultural production. In some cases it has been stated that as much as 80% of the variability of agricultural production is due to the variability in weather conditions. Climate data, information, and products are widely used in agriculture, animal husbandry, forestry and fisheries.

#### **The Possible Users of Climate Data in the Agriculture Sector**

User may be a farmer or group of farmers or a farmers organization, or by Planners and decision-makers in various areas, Including agriculture and irrigation; Climate change research; Drought mitigation; Emergency management; Natural hazard mitigation; Natural resource management; Planning and development, and Water resource management.

#### **Data needed**

**Basic Climate Data** Users need **real time data** for daily inquiries in operational agriculture. The critical meteorological variables associated with agricultural production are air temperature, solar radiation and Precipitation. Air temperature is the main weather variable that regulates the rate of vegetative and reproductive development. Solar radiation provides the energy for the processes that drive photosynthesis and the rate of biomass growth. Precipitation is considered to be a modifier that affects many of the plant growth and development processes. Precipitation can be expressed as drought, when soil moisture is inadequate, or as water logging, when too much water is available. Secondary weather variables associated with agricultural production are wind speed, relative humidity, evaporation and soil temperature.

**Historical and Past Climate Records** All relationships between climate and Agriculture systems are derived from historical and records of both climate and agriculture. Such records are also used in deriving the basic statistics and risks that may be associated with any climate based planning and operational decisions. Quantitative description of climate can help provide the historical data needed for the description of climate characteristics over a region. Accordingly, it can provide the opportunity to determine the type of crops that can be grown in a region and the needed information for planning operational activities. Historical data should be long enough to capture the temporal variability of climate and also, with good geographical coverage, to explore the spatial variability of climate. Basic data can be obtained from the CLICOM climate database or from any other database in use.

**Derived Data** In addition to the previous basic data, some other parameters need to be derived from basic meteorological elements such as net radiation, potential evapotranspiration, and accumulated temperatures above given thresholds (which used in irrigation and crop growth models). The INSTAT (INteractive STATistics) package is more commonly used in agro meteorology to obtain derived data and for climate data analyses, such as summary statistics (e.g., average 10-day, monthly yearly, etc.), water balance from rainfall and evaporation, start

and end of rains, probability of the beginning and end of rains, probability of receipt a of quantified rainfall amount in a specified period, start of growing season, dry spell lengths, wind direction frequencies, potential evapotranspiration according to Penman, and crop performance index according to FAO methodology.

**Agronomic Data** In addition to meteorological observations, agro meteorological stations carry out other types agricultural observations on crops, soil, pests and diseases, and pastures. The most used observations are of plant development (phenology), soil moisture, and the occurrence of pests and diseases.

### **Forecasts and Warnings**

In addition to purely meteorological forecasts of expected weather, agro meteorological services issue weather forecasts of agriculture aspects (daily, weekly, monthly, and seasonal), including advisory guidance. They can also provide the following predictions and warnings:

- Forecast for occurrence of frost and heat waves;
- Prediction of onset of pest and disease on crops and animals;
- Forecast of crop sowing and yield maturing dates;
- Forecasts of rainy season ahead;
- Forecasts regarding pest and disease management operation;
- Prediction of periods of probable forest fire;
- Forecasting of crop and grassland products;
- Crop yield forecasts and assessment of crop condition;
- Warnings from hazardous weather phenomena for crops; and
- Early warning on sea states, strong winds, and storms for fisheries.

The awareness of the importance of agrometeorology among agricultural communities has grown and their level of usefulness of agrometeorology has also risen. The demand of more specific and specialized agrometeorological services is increasing. Presently, the agricultural community is asking more questions which are also technically demanding. Activities in general Agrometeorology include:

- Measuring and providing weather characteristics.
- Issue of Agrometeorological bulletins and reports;
- Providing central and local government organizations with Agrometeorological information;
- Issue of special Agrometeorological information at request;
- Advices on Agrometeorological observation practices;
- Issue of weather forecasts in agriculture aspect (daily, weekly, monthly and seasonal), including advisory guidance;
- Issue of statistical Agro climatic (raw and analytical) data;
- Supporting the cooperative technical programmes and projects;
- Drought-incidence and persistence;
- Issue of Agrometeorological information for agriculture sector management and planning, and
- Advices on programmes and projects to combat with desertification.

Activities in Agrometeorology (cropping) include:

- Recommendation on weather condition of crop sowing and harvesting period;
- Recommendation on spraying pesticides on crops;

- Field to market transportation of agriculture commodities;
- Analysis of crop water requirement and rainfall data;
- Research activities in Agrometeorology;
- Assessment of Agro climatic resources;
- Utilization of Agrometeorological data in assessing irrigation requirements;
- Utilization of Agrometeorological data in hydrological studies;
- Utilization of Agrometeorological in all agricultural activities;
- Estimation and mapping of soil droughts and moisture provision of crops;
- Estimation of evapotranspiration;
- Estimation of global radiation, terrestrial radiation and net radiation;
- Application of GIS in Agro meteorology;
- Application of remote sensing methods in Agrometeorology;
- Impact and adaptation assessment of climate change on agriculture sector;
- Crop water requirement;
- Soil-crop-weather systems interrelationship;
- Simulation of crop growth and development.
- Pest and disease warning system;
- Crop harvest for various varieties.

### **Agrometeorology and sustainable development**

In the last ten years, the world community has negotiated and ratified three important International Conventions, all of which have a significant bearing on sustainable agriculture. These include:

- United Nations Framework Convention on Climate Change (UNFCCC),
- Convention on Biological Diversity (CBD),
- United Nations Convention to Combat Desertification (UNCCD)

Accordingly, the Commission for Agriculture Meteorology (CAgM) has proposed some of the priorities for agrometeorologists to address to promote sustainable agriculture:

- Improvement and strengthening of agrometeorological networks;
- Development of new sources of data for operational agrometeorology;
- Improved understanding of natural climate variability;
- Promotion and use of seasonal to inter-annual climate forecast;
- Establishment or strengthening of early warning and monitoring systems;
- Promotion of geographical information system and remote sensing applications;
- Use of improve methods, procedures and techniques for the dissemination of agrometeorological information;
- Development of agrometeorological adaptation strategies to climate variability and climate change;
- Mitigation of climate change; and
- Active applications of models for phenology, yield forecasting, and crop growth,

These present important challenges and great opportunities for agrometeorologists to play a proactive role in promoting sustainable development.

*(Intentionally Blank)*

**CLIMATE OBSERVING NEEDS FOR LOCUST CONTROL**

**Driss Fakhour  
Centre Meteorologique  
Salé, Morocco**

During the 20<sup>th</sup> century, Morocco has experienced 5 great invasions by locusts with each one lasting from 2 to 10 years. Locusts can have disastrous economic impacts with a locust swarm of one square kilometer in extent consuming up to 100 tonnes of vegetation in one day. During 1953-54, for example, the damage due to locusts in Morocco represented the equivalent of the annual food supply for one million people. Correspondingly, the two most recent invasions, in 1987-89 and 2003-2005, each necessitated the treatment of about 5 million hectares.

Meteorological conditions exert substantial control on the development and behaviour of locust populations with rainfall, temperature, relative humidity, wind velocity, environmental conditions and vegetation all influencing the locust threat. The development of eggs depends on soil temperature, with larval development being more rapid when temperatures are higher. Mortality of eggs can be caused by many factors such as flooding, drought, exposure to wind, and soil temperature higher than 35°C. Prior to 2003, for example, environmental conditions in the Sahelian countries were unfavorable, and locusts survived as small widely dispersed populations. Exceptional rainfall during the summer of 2003, however, created very favorable conditions for growth in population and large swarms of locusts developed and migrated northward. On 17 February 2004, southern Morocco experienced strong winds that transported locust swarms from the interior of the kingdom towards the South Atlantic coast. On 18 February, even stronger winds transported some of these locusts along the coastline so that some locusts were found at El-Jadida and Essaouira on the morning of 19 February.

In view of the influence of climate and weather on locust behaviour, Meteorological Services in affected regions can provide very useful advice to operational agencies engaged in the battle against locusts. Meteorological assistance for these operations includes observations, special bulletins for infested regions, warnings of strong winds and heavy precipitation, and forecasts of wind velocity, relative humidity, maximum and minimum temperatures and other relevant variables. In addition, research studies provide useful insights into the relationships between climatic conditions and locust behaviour. Wide-ranging recommendations from a workshop held in Niamey in 2005 reinforce the importance of meteorological and climatological support in the battle against locusts. Consequently, they identify needs for meteorological training and capacity building, publication of relevant meteorological information, conduct of locust-related research, enhancement of observation station networks in locust zones, improved telecommunications and, during periods of infestation, deployment of meteorologists to national centres for fighting locusts.

In summary, a close correlation exists between meteorological conditions and the reproduction and migration of locusts. Enhanced meteorological knowledge and improved access to relevant meteorological information will significantly assist agencies responsible for fighting locusts. National Meteorological Services have a key role to play in contributing to monitoring the evolution of the locust situation and predicting its future development.

*(Intentionally Blank)*

## GCOS SURFACE AND UPPER-AIR NETWORKS AND REGIONAL BASIC CLIMATOLOGICAL NETWORK

Hans W. Teunissen  
GCOS Secretariat

The GCOS Surface and Upper-Air Networks (GSN and GUAN) were established in 1998 and 1997 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 group of CCI/CBS experts used lists of existing synoptic and climatological stations around the world and then developed a ranking process (based on certain criteria) that rated each station on its geographic location, historical record, quality of observations, and sustainability for the future. 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. The identification process for GSN stations, was described by T. Peterson, H. Daan, and P. Jones (Bulletin of the American Meteorological Society, Vol. 78, No. 10, October 1997).

The identified stations are by definition an integral part of the WMO World Weather Watch / Global Observing System. They are listed in WMO Pub. 9, Volume A and are by definition part of the Regional Basic Climatological Network (RBCN) established by Resolutions of Regional Associations during the period from year 2000 (RA II) to 2003 (RA VI), although some stations are still to be formally approved in this process. As of 1 January 2005, the GSN consisted of a total of 998 stations and the GUAN a total of 161 stations. The current lists of stations are available through the GCOS Web site (<http://www.wmo.ch/web/gcoshome.htm>). The full RBCN consists of 2,586 stations over the globe, including GSN, GUAN, and additional CLIMAT and CLIMAT TEMP reporting stations.

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 is 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. The Guide may also be found on the GCOS Web site.

In order to monitor network performance and to assist in identifying and eliminating problems, GCOS and CBS have established a network of Centres for monitoring, analysis and archiving of the data. This includes CBS Lead Centres for GCOS Data in Australia (BOM), Iran (IRIMO), Japan (JMA) and the US (NCDC), as well as Monitoring Centres in Germany (DWD), Japan (JMA) and the UK (ECMWF and Hadley Centre). A number of very useful performance reports are produced by these centres, and most are accessed through the GCOS Web site.

In order to appropriately recognize the efforts of the operators of the GSN and GUAN stations, the GCOS Secretariat, at the suggestion of the GCOS Atmospheric Observation Panel for Climate, recently distributed Certificates of Recognition to the Permanent Representatives with WMO of all relevant Members. This initiative has provided not only additional visibility for the networks, but has also assisted in identifying problems and effecting the needed remedial actions at a number of stations.

These data show that the performance of GSN, GUAN and RBCN in this particular region as well as in others has not yet achieved the level that is needed. There are a variety of reasons

for this. First, observing stations in synoptic networks in some cases do not forever remain in operation. The NMSs may make changes in the operation or locations of their stations. Errors have existed in the identification of stations and their altitudes. Equipment has become obsolete, and supplies have become prohibitively expensive for some operators. Synoptic 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 as synoptic stations. It has been reported for some time that roughly 40% of the stations in GSN and GUAN are "silent," although more recent analysis indicates that the networks are actually working somewhat better. 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.

An important point is to establish a network of focal points for validation of GSN and GUAN stations in individual countries. 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 the GSN and GUAN stations lists is correct. At the WMO, the WWW maintains and publishes the RBSN and RBCN lists, which include the GSN and GUAN stations. After this validation process, the same focal points would become the points of contact for the operation of these stations in their host countries.

Another serious deficiency in the implementation of these networks so far is the lack of historical data from many of the stations. The National Climatic Data Centre (NCDC) in Asheville, North Carolina is responsible for building a permanent data base of GSN daily and monthly data submissions, along with the appropriate station metadata history, and for providing free and open user access to this information via their web site at <http://wf.ncdc.noaa.gov/servlets/gsn>. This site contains an inventory of all of the historical daily and monthly CLIMAT-formatted GSN data received from stations. There are sometimes technical reasons, such as that the historical data are either lost or not in a suitable form. In any case, historical data from many of the stations are not in the NCDC archives 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. These historical data are important to any country, to countries within the region, and to the global climate community.

Progress in improving of both networks, although slow, is being made through a variety of means, such as through discussions in regional workshops (like this one) conducted by the GCOS Secretariat; through efforts of the World Weather Watch and GCOS to correctly identify network stations; by the analysis of operational problems; and by improvements to the monitoring functions. Regional Action Plans have been developed for other regions, and one should be prepared for this region as well. It should contain a project addressing the problems and operational issues associated with the GSN and GUAN. Working together, we can insure that these globally important networks operate well.

Recommendations 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;
2. Develop a Regional Network Improvement Plan/Proposal;
3. Develop a Regional Plan for Rescuing and Sharing RBSN and RBCN Historical data with Emphasis on GSN and GUAN Stations.

## **GCOS SURFACE AND UPPER AIR NETWORKS IMPLEMENTATION PROJECT MANAGER'S REPORT**

**Richard K. Thigpen  
GCOS Secretariat**

The Implementation Projects fall into a few general categories. First there is the analysis of the performance of the networks, which includes the analysis of the specific causes of performance problems. Then there are the actual revitalization projects, which are aimed at reestablishing the operation at some stations and at improving network coverage. Three regional technical support projects have already been established to provide hands-on technical support for the operation of network stations. And finally, the number of CBS Lead and Monitoring Centers has been expanded to improve the overall monitoring of the networks. The Implementation Manager's report will provide a status report on these activities.

As noted in the various performance reports distributed at the workshop and that will be described, the networks in this region, in general, are working very well. Participants are reminded that, as members of WMO, they have agreed through their Permanent Representative, to maintain various levels of performance and make data available. This includes historical data and accurate meta-data. Numerous errors have been found in the various catalogs and lists maintained by WMO. Some examples are: the WMO Pub 9 Vol A contains the specifics such as location and operating schedules for stations; the RBCN and RBSN lists form the basis for the GTS monitoring activities of the WWW; WMO Pub 9 Vol C1 contains the GTS headings that are used to exchange the data on the GTS; and, of course, the lists of focal points and specific GCOS stations. Members should coordinate within their services to ensure that all of these lists and catalogs are correct. The various lead and monitoring centers depend on this information as do the GTS telecommunications hubs and the WWW data monitoring activities. Also, the historical data from many stations are not yet available.

GCOS has managed the revitalization of several important observing stations. Most of the specific revitalization activity thus far has been directed towards the GUAN. The major reasons found for problems in the GUAN are associated with the high cost of operation. Several stations have been completely replaced (hydrogen generator and upper air equipment) and many others have received generators, radiosondes and balloons, or equipment upgrades. So far 18 GUAN stations have received some benefit and now almost all of the "silent" GUAN stations have been addressed. Attention is shifting towards revitalization of surface stations. Classic surface instruments are being purchased, and an AWS based project has been drafted for the revitalization of the GSN stations in Madagascar.

GCOS Technical Support Projects (TSP) have been established in the Pacific Islands, operated by the New Zealand Met Service; in the Caribbean operated by a private contractor; and in the SADC region of Africa, operated by the Botswana Met Service. The implementation of these projects and the terms of reference for their operation will be discussed. These are one year projects that require mandatory visits to all GUAN station in the region and as many GSN site visits as possible. Commonly used spare parts are provided, as well as some common consumables. Inspection kits are included, and the TSPs are required to validate the station metadata with each visit, including GSP position verification and photographs of the station. Quarterly performance reports are required and are available on-line.

The functions of the GCOS/CBS Lead and Monitoring Centers will be presented. Recently additional CBS lead Centers for GCOS data have been established to augment the original centers in JMA and NCDC. Iran and Australia have been added. This provides a much better distribution of effort among the centers and also adds a “regional” perspective. Hopefully additional lead centers will be recruited.

Recommendations for inclusion into the Regional Action Plan:

1. Conduct an analysis of the performance of the GUAN and GSN stations in the region with a focus on specific remedial actions that are needed to strengthen the operation. This analysis should include the identification of additional stations whose data would improve the overall network coverage and result in specific projects that have a better chance of success.
2. A project or series of smaller projects could be defined that are aimed at rescuing critical historical data from some stations and ensuring that the historical data from all stations is in the GCOS Archive.
3. Establish additional GCOS Technical Support Projects in the region. The success of the current 3 TSPs indicates that additional projects would directly benefit the developing countries in the region.
4. Establish a CBS Lead Center for GCOS within the Region. This would bring additional focus to the activities of the GCOS and result in improved data.
5. Continue regional GCOS workshop coordination activities by establishing periodic workshops hosted by members of the region themselves. More developed members should help the less developed.

## NEEDED UPGRADING OF CLIMATE DATA RESCUE ACTIVITIES OVER THE MEDITERRANEAN COUNTRIES

**Dr. Manola Brunet**  
**University Rovira i Virgili, Tarragona, Spain**

### **Introduction**

It is widely recognised that long-term and reliable climate records (both instrumental and proxy data) are key pieces of information needed for better understanding, detection, prediction and response to global climate variability and change. The development of environmental and societal climate change adaptation and mitigation strategies also requires high quality climate data. In this regard, scientists, decision makers and application communities require the best data for their particular needs. High quality and high-resolution climate data is also essential for regional detection/attribution studies of climate change (integrating observational and modelling activities), the calibration of satellite data or the generation of climate quality reanalyses.

### **Status and deficiencies**

The Mediterranean countries have a very long and rich monitoring history in the atmospheric domain, going back in time several centuries in some countries (i.e. Italy, France, Spain) and at least to the 19<sup>th</sup> century across much of the region. At the same time, this area not only offers a high quantity and quality of long instrumental station records but also a wide range of natural proxies (tree-rings, speleothems, corals, boreholes, etc.) and documentary information (i.e. reports from chronicles, ship logbooks, daily weather reports, etc.). This potential wealth of climate information makes the Mediterranean Basin ideal for undertaking a wide range of climate reconstructions at different temporal and spatial scales (both for the instrumental period and prior to the period of instrumental data) and assessments (both analysing long-term climate variability and change and assessing changes in climate extremes and their socio-economic impacts). An improved knowledge of these aspects over a region that will, as has been stressed in the last IPCC (2001) report, likely suffer a significant decrease of precipitation also requires upgrading of basic high-quality climate data.

The glaring lack of readily available and accessible datasets from global to local scales is still, however, hampering our knowledge of long-term climate variability and change, its forcing factors, and the environmental and socio-economic impacts associated with current, likely man-made, climate change. The lack of available historical climate data is a common feature of many meteorological regional and national networks around the world due to different situations and circumstances. In this regard, the Mediterranean area is not an exception, although, as stated before, a long and rich observational history has been the common denominator across most of the countries in the region. Different types of situations prevail with respect to the accessibility and availability of climate data among the Mediterranean NMSs.

Easily accessible digital climate data is mostly restricted to the second half of the 20<sup>th</sup> century, although this varies on a country-by-country basis. Most of the Mediterranean NMSs have recently dedicated efforts to building up high-quality datasets containing digital data going back to the 1940s/1950s (mostly in western, northern and some of eastern Mediterranean countries). In southern Mediterranean countries, climate data availability and accessibility in digital format is more limited (from 1960s/1970s onwards, according to the different countries).

The availability of historical instrumental data is even more restricted across much of the Mediterranean region. Historical climate data have been recorded in different places at different time scales ranging from a few observations sub-daily and daily to multiple hourly observations. Numerous data have been recorded since the earliest days of the instrumental period in the different Mediterranean countries, being collected by NMSs, private organizations and individuals or by the scientific community. From this rich observational history and for a few Mediterranean countries, mostly located in the northern half of the Basin, some station records for some Essential Climate Variables (ECVs) (i.e. air pressure, air temperature and precipitation) have been recovered, digitised, quality controlled and homogenised. However, this has mainly been done on a monthly basis. Even though some progress has been made at this scale, there still remain huge amounts of key monthly, daily and hourly observations to be located, recovered, preserved, digitised, quality controlled, adjusted and analysed. This historical information is retained in fragile media (paper forms) in a wide range of sources and locations, ranging from the NMSs historical central and local archives to local, national and international libraries and archives in the different Mediterranean countries and former colonial powers. Moreover, over most of the southern and some eastern Mediterranean countries, historical data recorded during the colonial period were collected by foreign institutions of the former colonial powers, while later the current meteorological data are held by the corresponding NMSs.

Although some NMSs have already undertaken data rescue activities aimed at transferring historical climate records from fragile media (paper forms) to new media (imaging), fewer long-term records than are needed are readily available in digital form. In this regard, and for few Mediterranean countries, close cooperation between scholars and scientists working at the Climatological Branches of NMSs has proven to be a worthwhile exercise, enabling recovery and digitization of a few long stations records going back to the earliest instrumental period (i.e. Spain, Italy). Unfortunately, despite the rich meteorological legacy of most of the Mediterranean countries, few efforts have been made either by NMSs or scholars to recover and digitise the longest, key and reliable records from their respective historical national networks. This reality is preventing the region from developing a more accurate assessment of regional climate variability and trends. Also the requirement for high-quality integrated climate products is impeding the development of the best strategies to mitigate and/or adapt to the negative impacts of global climate change over the Mediterranean Basin.

Lack of funding, both at the local/national level and at the regional/international scale, and not the lack of climate data, can partially explain this unsustainable current situation within the group of western, northern and eastern Mediterranean countries. In southern Mediterranean countries, an even more severe lack of human, economic and technical resources, together with the isolation of some of them due to historical and political circumstances, explains why present and past observational data remain dispersed and in fragile media. On the other hand, and from a scholarly perspective, it is perceived that NMSs do not redirect enough resources to their own Climatological Branches to develop convenient programs to make their recent recorded data available in digital form and to extend their climate datasets back in time. Locating/recovering/digitising the most valuable stations records for the ECVs is recommended in the GCOS Implementation Plan.

This situation should and could be solved by encouraging international bodies, NMSs and scholars to make common efforts to locate/recover/digitise the instrumental data currently held in hard-copy and fragile media in different kinds of national and international archives and libraries. This effort should be undertaken for the people that in the past dedicated huge and

heroic efforts to consciously and regularly monitor our atmosphere with the scarce resources that were then available. This can be done by undertaking data rescue missions in each one of the Mediterranean countries, placing special emphasis on southern Mediterranean countries, where the legacy of historical data remains important and current meteorological data are not still completely digitised nor easily available.

### **Recommendations**

There is an urgent and critical need to undertake data rescue (DARE) missions in each of the Mediterranean countries, in order to avoid the risk of losing highly valuable climate data and their related metadata as well as to preserve and digitise the historical instrumental data and make them available in a useful format for end users. To complement those initiatives already undertaken by former DARE projects, a major effort should be devoted to recovering and making available in digital form both current and past climate data for those southern Mediterranean countries that, up to now, have not been able to document the climate evolution over their respective territories and over a key sub-region of the Mediterranean Basin, with their high-quality time series.

As a best practice, the data to be rescued should incorporate those key, long and high quality records, which will likely continue to be observed for the foreseeable future. The data sets should be defined on a country-by-country basis. As a minimum requirement, it would be worthwhile for every NMS, together with scholars and other voluntary individuals, to undertake the recovery/preservation/digitalisation of, at least, their respective GCOS surface network (GSN) stations. These DARE missions should not forget the valuable and essential metadata.

In this regard I strongly recommend, for the Action Plan, the development of a DARE project for the entire region aiming to fulfil the following objectives:

- To define the key needs, deficiencies and gaps of the essential climatic stations and ECVs for long-term monitoring of trends over the Mediterranean region and for which DARE missions are urgently needed.
- To raise awareness among NMSs, scholars and individual scientists regarding the importance of undertaking the recovery, preservation and availability of long climate records and their related metadata.
- To assist the countries to undertake DARE missions and ensure their continuity in the future.
- To preserve and make available all essential climate records in digital format and create reliable historical datasets and associated metadata bases.
- To ensure digitization capacity in each country.
- To upgrade, where needed, hardware, software and photography equipment and provide training in the use of this equipment.

*(Intentionally Blank)*

## APPENDIX 13

### GLOBAL ATMOSPHERE WATCH: AEROSOLS, OZONE, AND GREENHOUSE GASES

**Emilio Cuevas**  
**Instituto Nacional de Meteorología (Spain)**  
**Izaña Atmospheric Observatory**

The Global Atmosphere Watch (GAW) Programme of the World Meteorological Organization (WMO) was established in 1989, merging the Background Air Pollution Monitoring Network (BAPMoN) and the Global Ozone Observing System with increased emphasis on quality assurance and global partnership. GAW focuses on six measurement groups: greenhouse gases, UV radiation, ozone, aerosols, major reactive gases and precipitation chemistry.

The WMO/GAW office and its Scientific Advisory Group (SAG) for Greenhouse Gases have been actively involved in supporting the United Nations Framework Convention on Climate Change (UNFCCC) through contributions to the Strategic Implementation Plan of the Second Report on the Adequacy of the Global Observing Systems for Climate by the Global Climate Observing System (GCOS). Essential Climate Variables (ECVs) that need to be systematically measured globally in order to address major issues are officially recognized by the UNFCCC. Greenhouse gases are amongst those ECVs and WMO/GAW is designated by GCOS and WMO as the lead international programme in furthering the observational requirements. World Data Centers, the GAW Station

Information System (GAWSIS), and Scientific Advisory Groups (SAGs) are essential part of the GAW program.

The current status, deficiencies and needs of the GAW monitoring system in the Mediterranean Basin and Northern Africa region is briefly summarized as follows.

#### **1. Aerosols**

##### ***Status***

##### ***Aerosol optical depth (AOD)***

AOD is a quantitative measure of the extinction of solar radiation by aerosol scattering and absorption between the point of observation and the top of the atmosphere. It is a measure of the integrated columnar aerosol load and the single most important parameter for evaluating direct radiative forcing.

The AOD network is relatively well spatial-distributed in the Mediterranean basin and Northern Africa considering the GAW-cooperative AERONET/PHOTONS network: present stations at El Arenosillo, Granada and Izaña (Spain), Blida (Algeria), Thala (Tunisia), Lampewdusa, Etna, Oristano-Sardinia, Rome, Lecce (Italy), Crete (Greece), Metu-Erdemli (Turkey), Nes-Ziona and Sede-Boker (Israel), Toulouse, Clermont Ferrand, Tarbes, Villefranche (France), Ispra (EU), and Moldova (Moldova) provide near-real time AOD for satellite data validation and aerosol characterization in this region. The AOD network is also very helpful for monitoring the frequent Saharan dust intrusion into the Mediterranean basin. Izaña Station (Spain) operates a GAW precision filter radiometer. This Observatory is also an absolute sun calibration center of Aeronet/PHOTONS network.

### *Aerosol chemistry*

The primary goals of aerosol chemical measurements at GAW stations are: (i) to determine long-term trends locally and, taken collectively, in global distribution (ii) assess the impact of aerosols on regional and global climate and (iii) monitor regional air quality. In addition, long-term measurements of aerosol chemical size distribution can be used to evaluate and improve aerosol chemical transport models used in air quality forecast and climate models. GAW aerosol chemical measurements draw upon the activities of several contributing regional networks, mainly EMEP.

### *Light absorption coefficient*

Aerosol radiative properties are needed for evaluation of aerosol effects on climate and visibility. One of the most important radiative parameter is the aerosol cross-section for light extinction per unit volume of air, commonly called the aerosol light extinction coefficient. No data from the Mediterranean basin and Northern Africa region has been deposited into the GAW World Data Center for Aerosols.

### *Light scattering coefficient*

The aerosol cross-section for light extinction per unit volume of air, commonly called the aerosol light extinction coefficient, is another important parameter to characterize the radiative properties of aerosols. No data from the Mediterranean basin and Northern Africa region has been deposited into the GAW World Data Center for Aerosols.

### *Aerosol size distribution*

Measurement of the size distribution is helpful for inferring relative contributions to aerosols from different sources. Size distribution measurements are needed to evaluate regional and global chemical transport and climate models that attempt to include size distributed aerosols as active constituents. No data from the Mediterranean basin and Northern Africa region has been deposited into the GAW World Data Center for Aerosols.

### *Condensation Nuclei*

Particle number or condensation nuclei (CN) concentration represents a single integral measurement of particle number across a wide size range, encompassing several modes in the number size distribution. CN is used for long-term change and to know the health effects of particles. No data from the Mediterranean basin and Northern Africa region has been deposited into the GAW World Data Center for Aerosols.

### **Deficiencies**

The GAW aerosol program in this region is really poor. Except for aerosol optical depth that is relatively well covered, thanks to the AERONET/PHOTONS contribution, and some contributions to the Aerosol chemistry program from the EMEP-Regional GAW stations, the rest of the aerosol programs show important lacks. These deficiencies are especially important in a region where polluted continental particles and Saharan dust are frequently present.

### **Needs, suggestions**

GAW stations should measure aerosol optical depth, mass concentration and major chemical components in two size fractions, aerosol light scattering and absorption coefficients.

## 2. Atmospheric Ozone

### **Status**

#### *Total ozone*

Long-term regular measurements of total ozone are performed at about 11 stations in the Mediterranean basin. Most of the operating stations perform high quality Dobson and/or Brewer measurements. Tamanrasset (Algeria), El Cairo, Assuan, Mrsa Matrouh, and Hurghada (Egypt), Thessaloniki (Greece), Rome (Italy), Buchares (Romania), and El Arenosillo, Murcia and Izaña (Spain) regularly deposit their observations into the WMO World Ozone and UV Database, Toronto (WOUDC).

Two Brewers from Morocco have recently reinitiated operations. No data have been submitted yet to WOUDC. There are a number of Brewer stations in Spain (A Coruna, Zaragoza, and Madrid) fully operative that do not deposit evaluated data in WOUDC. The GAW Regional Brewer Calibration Center for Europe (RBCC-E) has been set up in Izana Observatory in November 2003. The first RBCC-E Brewer intercomparison was held in September 2005 with the participation of seven instruments currently operating in the Mediterranean basin and Northern Africa (5 from Spain and 2 from Morocco).

#### *Vertical profiles of ozone*

Only one station in the Mediterranean basin – Northern Africa region (Izana, Spain) performs a regular Electrochemical Concentration Cell (ECC) ozonesonde program submitting data to the World Ozone and Ultraviolet Radiation Data Centre (WOUDC). Sporadic ozone soundings have been performed at El Arenosillo station (Spain) for research purposes. Ozonesondes are launched, on a weekly basis, since 1992 at Madrid station. However no data have been deposited at WOUDC.

Ozone vertical profiles derived from Umkehr inversion technique are routinely performed at only four stations (El Cairo, Assuan, and Hurghada in Egypt and Izaña-Spain). However, only the Egyptian stations deposit regularly Umkehr profiles in WOUDC). France has numerous total column ozone stations using a UV-VIS (DOAS) SAOZ instrument network. However no enough intercomparison studies against Brewer or Dobson spectrophotometers have been performed to demonstrate inter-comparability of the networks. Regular lidar ozonesonde profiles are performed at Haute-Provence Observatory.

### **Deficiencies**

The network in southern Europe and northern Africa is significantly less dense in comparison to Central and Northern Europe. Eastern Mediterranean basin is poorer covered than Western part. The present network is not adequate for operational mapping of total ozone. However some stations can be used for estimation of long-term changes of the ozone layer (El Cairo, Aswan, Thessaloniki, Bucharest and El Arenosillo). Regular ozone vertical profile program is very poor in the Mediterranean basin. This lack of observations does not allow the scientific community to investigate properly the relationship between vertical ozone profiles and stratospheric dynamics in this region.

### **Needs, suggestions**

The ozone sounding programme at the Ankara station (Turkey) should be supported by installation of some unused Dobson spectrophotometer from some EU countries (there are several instruments available now). North-African ozone monitoring network (four stations in Egypt, one-two stations in Morocco, one station in Algeria) should be assisted by EU GAW facilities: Regional Brewer Calibration Center for Europe (RBCC-E) and Regional Dobson

calibration Center for Europe (RDCC-E), mainly in instrument maintenance and calibration and in data quality evaluation, as well as for quality assurance activities.

Umkehr observations should be run at all the above Dobson/Brewer stations. The SAOZ network could contribute to real time ozone mapping. Further comparison studies against Dobson and/or Brewer instruments should be performed.

The Brewers from Morocco must submit data as soon as possible to WOUDC. Monochromator Brewer (#051) should be re-located in a new station after one-year intercomparison at Casablanca against the double Brewer (#165).

### **3. Greenhouse Gases**

#### ***Status***

The Laboratoire des Sciences du Climat et de l'Environnement (LSCE; France), The National Agency for New Technology, Energy, and Environment (ENEA; Monte Cimone ; Italy), the Italian Meteorological Service (IMS) and the Instituto Nacional de Meteorologia (Izana Observatory; Spain) perform continuous measurement and research programs of the main Greenhouse Gases (GHGs) CO<sub>2</sub> and CH<sub>4</sub>. Monte Cimone and Izana observatories report GHGs data to the WMO World Data Centre for Greenhouse Gases (WDCGG) and to the Cooperative Atmospheric Data Integration Project (Globalview project). LSCE contributes to Globalview project only.

Some stations, participating in the flask-sampling network established by NOAA-GMD report data to WDCGG. Within this program CO<sub>2</sub>, CH<sub>4</sub>, CO, H<sub>2</sub>, <sup>13</sup>CO<sub>2</sub>, <sup>18</sup>O<sub>2</sub> are determined on a weekly basis. Sede-Boker (Israel), Dwejra-Point (Malta) and Tamanrasset (Algeria) are the stations in the Mediterranean basin-Northern Africa with NOAA-GMD flask sampling program.

More than twenty stations of this region report data from reactive gases (NO<sub>2</sub>, SO<sub>2</sub>) and surface ozone to WDCGG, most of them produced within the respective national air-quality programs.

#### ***Deficiencies***

The network of observations is clearly very poor in Southern Europe and Eastern Europe, and almost non-existent in Northern Africa.

As it had been reported in the previous GAW-GCOS report from K. Vanicek, attempts were made by NOAA/GMD to extend measurements of Greenhouse Gases (GHGs). However most of them failed due to problems with shipping of flask samples to NOAA-GMD.

#### ***Needs, suggestions***

In general, the GAW contributing institutions should either solve logistic problems with shipping samples to international analytic centres or renew/establish national analysis and calibration equipments. The GHGs observation program should be significantly expanded in the region.

**OPERATIONAL OCEANOGRAPHY IN THE MEDITERRANEAN  
A STEP TOWARDS UNDERSTANDING OCEAN CLIMATE VARIABILITY IN THE REGION**

**Aldo Drago  
MedGOOS Executive Secretary  
Physical Oceanography Unit  
IOI-Malta Operational Centre  
University of Malta**

**Abstract**

The prospect of substantial changes in the climate of the Mediterranean basin, as a consequence of enhanced greenhouse gas emissions and other human induced environmental alterations, presents a major threat that can critically undermine efforts to achieve sustainable development in the region. Climate change can seriously undermine efforts to re-orient societies towards sustainable development in the region since it has far-reaching consequences affecting a whole range of conditions and activities. These include people's health, the integrity of ecosystems and the services they support, industry, the risk of social disruption and the course of national economies. Sustainable development needs, therefore, to be tackled from a broader perspective that includes provisions for improved management in all climate ranges, especially in relation to climate extremes, which bring the greatest risk of environmental degradation.

Improving climate understanding and constructing reliable future scenarios are essential steps in assessing impacts and devising adequate mitigation measures. Such assessments rely on systematic observations of the climate system. While countries are urged to take the necessary precautions to keep climate change within tolerable limits, there is also a great need for a concerted basin-wide effort to establish an integrated and sustained ocean monitoring system to complement atmospheric observations.

An improved evaluation of human-induced changes in Mediterranean climate will necessarily involve both atmospheric and oceanic components and require an accompanying assessment of the natural variability, through the integrated use of observations and models including the relationships between the global and regional climate tele-connections. Meteorologists already make extensive atmospheric observations from a network of land and ocean surface measurement stations. Reliable, longer term, climate predictions covering the broader patterns of the weather over seasons and years, require additional and improved observations, including measurements within the oceans. An improved understanding of climate variability and its processes depends, therefore, on systematic observations of both the ocean and atmosphere along with improved predictions of both components.

The thematic networking activity on operational oceanography in the Mediterranean, undertaken in MAMA (Mediterranean network to Assess and upgrade Monitoring and Forecasting Activity in the region), the various international RTD projects (such as MFSTEP, MERSEA, MFSP, MEDAR/MEDATLAS, MATER, etc), and the establishment of national marine observing networks (such as POSEIDON in Greece and RAYO in Spain) have generated momentum towards a sustained framework for the routine observation of water properties and circulation in the region.

*(Intentionally Blank)*

## THE GLOSS NETWORK AND SEA LEVEL RISE

**Enrique Alvarez (Puertos del Estado)**  
**Begoña Pérez, Chair, GLOSS Technical Subgroup**  
**Dov Rosen, Chair, MedGLOSS**  
**Thorkild Aarup, GLOSS Secretary, IOC**

In the middle of 1980s, the International Oceanographic Commission (IOC) established the **GLOSS** Programme (Global Sea Level Observing System), the main objective of which was to improve the quantity and quality of sea level data available around the world. Until then monthly means of data were routinely provided by the tide gauges operators to the Permanent Service for Mean Sea Level (PSMSL), with a number of stations larger in the Northern Hemisphere.

A GLOSS Core Network of more than 300 sea level stations was developed with the following characteristics: geographically balanced, open ocean locations, long-term and higher frequency data (hourly values). The data set constitute the basis for global ocean dynamics studies and climate change, apart from other practical and local applications. The Intergovernmental Panel for Climate Change (IPCC) has based on GLOSS stations for global sea level rise studies.

However, due to the global characteristic of GLOSS, the need of denser regional networks soon became dear. In 1996, MedGLOSS was established sponsored by CIESM (Mediterranean Science Commission) and IOC, with the particular objective of improving the sea level monitoring in the Mediterranean and Black seas, a local densification of GLOSS in the area. At this moment MedGLOSS is composed of 42 stations, 15 of which transmit data in near real time and are displayed in its web page: <http://medgloss.ocean.org.il/eseas/new>.



Figure 1: MedGLOSS network. Red (near-real time transmission), blue (delayed mode), green (proposed stations).

In parallel with this, since 2001 a densification of GLOSS in Europe has become the European Sea Level Service (ESEAS), with which MedGLOSS has collaborated closely since the very beginning. As ESEAS does not include countries outside Europe, MedGLOSS is the best link to bring the North-African Mediterranean bordering countries to the sea level community, which up

to now are not yet included in the network. In the figure above, it is evident the lack of information from these countries.

Although the main concern of GLOSS was originally scientific applications and climate change related studies, the tsunami in Indonesia in December 2004 has brought real time data transmission as a new objective, in order to have multipurpose sea level stations that can be included in hazard- and particularly tsunami-warning systems. The advantage of this upgrade of existing stations is that real time access to data will always facilitate the control and maintenance of the sensors, making possible quick reaction when malfunctioning and consequently more continuous and higher quality sea level data series for long-term studies.

From the introduction above, it is obvious that one of the main problems and objectives of sea level monitoring in the Mediterranean is the inclusion of tide gauges from the countries of North Africa. Many attempts have been made in recent years. Last October 5<sup>th</sup>, during a meeting of the Mediterranean and Black Sea Hydrographic Committee, a talk about MedGLOSS status was given and the conclusion was that Hydrographic Offices encourage North African countries to participate in MedGLOSS. This is also the focus of this presentation.

As a conclusion the following main points should be considered:

- 1) There is a fairly dense sea level observation network in the Mediterranean/Black Seas
- 2) There is regional organization of sea level in place through MedGLOSS and ESEAS
- 3) Institutions (particularly in North Africa) and the Eastern Mediterranean are encouraged to participate in MedGLOSS and ESEAS
- 4) Virtually all countries around the Mediterranean and the Black Sea have some kind of national sea level network in place- the only exception being Libya and perhaps Syria and Lebanon.
- 5) Some upgrading of the observation network may be needed (i.e. replacing analog gauges, real-time communications, and co-locating gauges with continuous GPS stations).
- 6) Data sharing and data exchange is facilitated with this already existing organizations

Proposed concrete actions for the near future:

- 1) Technical visits to selected countries to provide advice on upgrading national tide gauge networks from MedGLOSS experts
- 2) Offer equipment and training, assisted by GLOSS

**LONG TERM MONITORING OF THE MEDITERRANEAN SEA: THE OPERATIONAL  
OCEANOGRAPHY APPROACH IN SUPPORT OF CLIMATE RESEARCH AND  
APPLICATIONS**

**Nadia Pinardi and Giovanni Coppini  
Istituto Nazionale di Geofisica e Vulcanologia - INGV  
Sede di Bologna, Italy**

**Introduction**

The long-term ocean variability of the Mediterranean Sea has been studied intensively in the past thirty years. Results illustrate the correlation between atmospheric forcing variability and ocean response at seasonal, interannual and interdecadal time scales. Major climate variability events have occurred in the 1980s and 1990s driven by long-term interannual variability of atmospheric forcing over the basin. The changes involve inversion of current direction in deep regions of the basin, strengthening and weakening of sub-basin scale circulation structures, deep and intermediate water formation events variability (Roether et al., 1995, Pinardi et al., 1997, Pinardi and Masetti, 2000, Brankart and Pinardi, 2001, Demirov and Pinardi, 2002, Gertman et al., 2005). Moreover, shorter-term ocean variability, connected with the time scales from the seasonal to the mesoscale, has been thoroughly investigated (Robinson et al., 2004).

From this understanding we may derive the conclusion that any climate change problem should be dealt with a coupled monitoring and modeling system for the entire Mediterranean Sea with intensifications in coastal regions. From here the need of a concerted action to build a large scale monitoring and modeling system that is modern, efficient and adapted to the region. The EuroGOOS Mediterranean Task Team has decided to implement a Mediterranean ocean Forecasting System (MFS) to predict ocean variability in the Mediterranean Sea from the global scale to the shelf areas since 1996. The MFS started operational activities in January 2000. Presently it produces daily analyses and daily 10-day forecasts of currents and temperature and salinity fields for the entire Mediterranean at approximately 10 km resolution.

The main elements of the Mediterranean Forecasting System (Pinardi et al., 2003) are now upgraded and developed by the EU project, "Mediterranean Forecasting System: Toward Environmental Predictions" (MFSTEP, V-FP contract number: EVK3-CT-2002-00075) that started March 1, 2003 and will end in February 2006.

The Mediterranean Forecasting System that has been developed, demonstrated and made operational is composed of: a) the Near Real Time Observing system; b) a numerical forecasting system at basin scale and with downscaling in sub-regional and shelf areas (core service); and c) a product dissemination/exploitation system (downstream service).

The MFSTEP Targeted Operational Period (TOP) started in September 2004 and ended in March 2005, collecting a large amount of data for assimilation and model verification. Part of the deployed observing platforms are still active and observations will continue to be collected for the next years to come. During TOP, eight forecasting centres have started to produce in real time forecasts at the basin scale (6.5 km of resolution) (Fig. 1), at four sub-regional areas with resolution up to 3 km and in four shelf areas with resolution of 1.5 km. Forecasts are produced once a week at the basin scale for 10 days and at the sub-regional scale for 5 days, using Limited Area Model-LAM high resolution weather forecasts. MFSTEP has also developed a new

biochemical model (so-called BFM) that is constructed, to be easily interfaced with operational hydrodynamic models for future predictions of algal blooms in different shelf areas.

MFSTEP has organized also a downloading and viewing service of the analyses and forecasts (following the INSPIRE directive nomenclature), i.e., data are displayed operationally through a Web service and products are also downloadable by the interested community by ftp with password. This service is a 'core service facility' that supplies the Essential Climate Variables, as stated by the GCOS Plan, at the highest temporal, spatial resolution and accuracy. The end-user community is connected to this service either directly or indirectly via a 'downstream service interface' that in MFSTEP is developed for several end-users, particularly governmental environmental agencies responsible for management of emergencies at sea and the management of marine resources.

End-users applications involve oil spill forecasting, contaminant dispersion in coastal areas, real time observing and modelling system for fish management coupled to ocean forecasting, search and rescue forecasts and Rapid Environmental Assessment modeling. Finally the study of the forecast economic value and impact is being carried out. The operational functioning of the MFS is demonstrated through the MFSTEP web site: <http://www.bo.ingv.it/mfstep>.

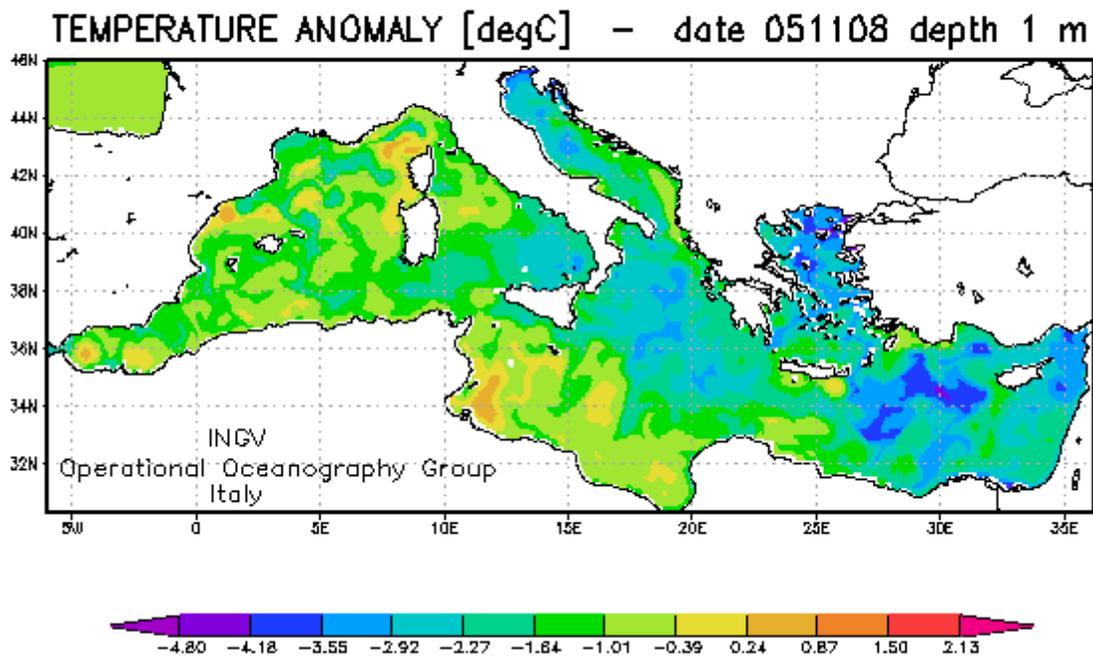


Figure 1: Temperature anomaly forecasted for November 8, 2005 at 1 meter depth by the large scale model upgraded in MFSTEP.

## **Current status of the Mediterranean Forecasting System**

**The Real Time Observing system** The Observing system components running operationally progressively since summer 2004 are:

1. a Ship Of Opportunity Program-SOOP composed of 9 tracks with 12 nautical miles resolution and full profile transmission. As part of the technological improvements, a multiple launcher for XBT has been constructed and will be tried operationally. Furthermore a new prototype expandable instrument (T-FLAP) has been constructed that can collect temperature and fluorescence data from SOOP as well as a new tethered instrument for multidisciplinary upper thermocline monitoring (SAVE) always from SOOP. During winter-spring of 2006 a Voluntary Observing Ship (VOS) upgrade of SOOP will occur in the southern Adriatic Sea that will enhance the surface meteorological observing capability of the system.
2. a network of Mediterranean Multidisciplinary Moored Array (M3A) stations with Real Time collection and dissemination of data (E1-M3A in the Cretan Sea, E2-M3A in the Southern Adriatic Sea, W1-M3A in the Ligurian Sea).
3. 23 MEDARGO floats deployed from VOS, with 350 meters parking depth, 700 meters profiles and 5 days cycle (every 5 cycles a 2000 m. profile is also collected);
4. an altimeter near real time data analysis system using four available altimeter sensors for sea surface elevation anomalies.
5. a real time analysis of satellite radiometric measurements (AVHRR) that produce daily SST fields from night time passes.
6. a near real time analysis of scatterometer winds producing daily optimal estimates of surface winds;
7. a glider autonomous vehicle experiment in the Ionian Sea (a coastal glider sampling down to 200 m depth and a deep glider sampling down to 950 m depth).

The real time data dissemination network works properly on a weekly time scale. Figure 2 shows the overall data collection performed from Summer 2004 up to October 2005.

The sampling strategy in the Mediterranean is assessed by the Observing System Simulation Experiment (OSSE) activities. The OSSE experiments have shown the complementarities of the first three elements of the observing system listed above and the final results will show the optimal sampling scheme for the Mediterranean basin scale circulation. Innovative assimilation of float trajectories from MEDARGO is being completed.

## Data Selection

31/10/2005

Latitude 49,44N  
Longitude 15W      Longitude 37E  
Latitude 24,16N

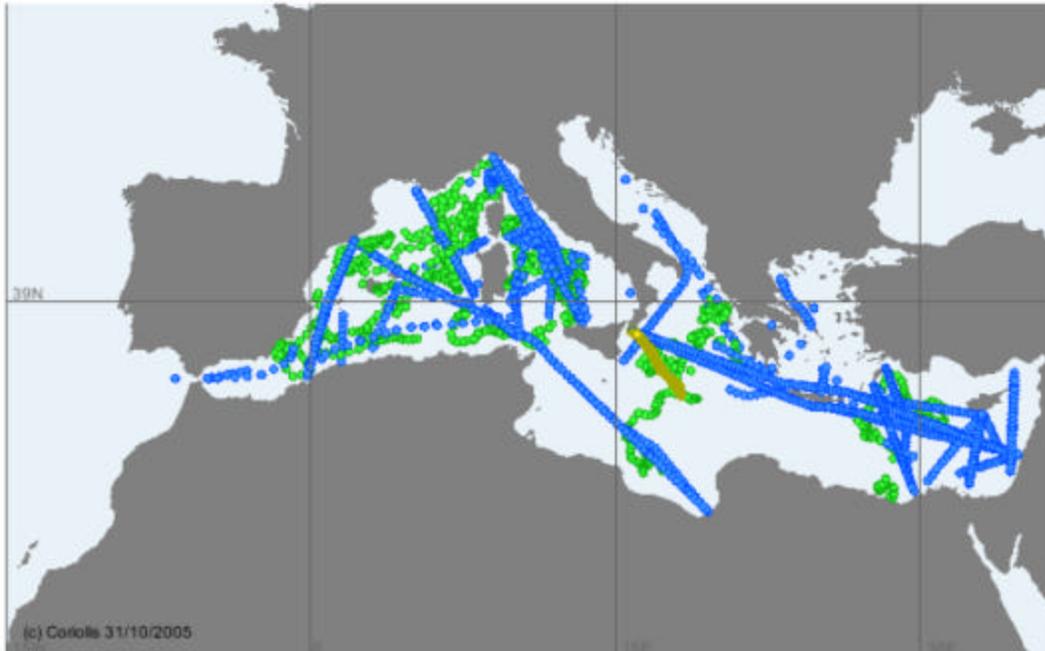


Figure 2: Overall data collection performed by MFSTEP from Summer 2004 up to October 2005. The blue dots indicate XBT drops along SOOP lines, the green dots indicate profiles from ARGO floats and the yellow the glider experiment data.

**The numerical forecasting system sub-component** The operational numerical forecasting system component is now composed of:

1. 10 days basin scale forecasting model at 6.5 km resolution and 71 levels. The forecast have been available in real time for all the Targeted Operational Period-TOP and is continuing now producing daily forecasts.
2. Four regional forecasting models at 3 km resolution in four regions nested in the basin scale model. The regions are the North-Western Mediterranean, the Sicily Strait, the Adriatic Sea and the Aegean-Levantine Sea. Forecasts are produced weekly and for five days in the future.
3. Four shelf forecasting models at 1,5 km resolution in four regions nested in the regional scale models. The shelf area systems are: CYCOFOS, for the Eastern Levantine and Cyprus shelf, the GULF OF LION shelf area, the MALTA shelf area, the South-Eastern Levantine shelf area. Other shelf models have been implemented but they are not operational.
4. Operational weather forecasts at 10 km resolution are produced to force the regional and shelf nested models with the SKYRON-Athens and the Météo France-Czech Republic LAM systems;
5. Several new schemes for data assimilation at the basin scale and for the nested models have been developed. An upgraded Reduced Order Optimal Interpolation Scheme for the basin scale model is now assimilating with a daily cycle sea level anomalies, XBT profiles, ARGO profiles and satellite composites of sea surface temperature. Data assimilation tools developed for shelf models are: **a)** a variational initialization scheme

for nested models; and **b)** a multivariate variational initialization and assimilation scheme that allows to consider at the same time the coarser scale model outputs and the local observations.

**The Ecosystem Modelling Sub-Component.** In MFSTEP one new numerical model for the marine food web has been developed and disseminated. It is called Biochemical Flux Model-BFM and it is the evolution of the previous ERSEM code, developed in the third EU-FP under the MAST theme. The BFM is still based upon a biomass and functional group representation of the marine food web but it now considers more processes in the bacterial compartment, it consider variable Carbon to chlorophyll ratio, allowing for phytoplankton adaptation to light in the open ocean areas. The code has been constructed to be easily coupled to any hydrodynamic model, via a coupling interface that is now left free to the user to be specified. The code is written in F90 and it is implemented in the Adriatic Sea and the Levantine and Aegean Seas.

In addition to the BFM, the Singular Evolutive Extended Kalman filter (SEEK) has been coupled to the biochemical flux model and disseminated in order to start experiments on the assimilation of surface chlorophyll data from satellites.

**The CORE Service: Viewing and Downloading.** MFSTEP has developed a CORE service for ocean currents in the Mediterranean Sea. This CORE service consists mainly of making available several gridded model data sets integrating the observations and the model output via data assimilation.

The products disseminated by this CORE service are essentially the basic hydrodynamic state variables, such as sea level, tri-dimensional currents, tri-dimensional temperature, salinity, and density fields. In addition some ancillary fields are also considered such as the heat fluxes, the surface stresses and the water flux.

Two different CORE services are implemented:

- 1) A VIEWING SERVICE that provides a Web-based access to images that represent graphically the products. This service is useful for the general public, for far-reaching discovery purposes, and for educational purposes.
- 2) A DOWNLOADING SERVICE that provides an ftp-based data transmission system between the basin scale models and the sub-regional/shelf scale forecasting centres, between the different forecasting models and some of the end-users applications.

This part of MFSTEP developed in a rapid way before the TOP and it has been the basic means to access both image and numerical information from the forecasting centres by commercial users and other end-users such as fisherman.

**The Downstream Services.** The end-users component that exploit the nowcasting/forecasting products made available from the CORE service is composed of:

- oil spill forecasting models;
- floating objects forecasting models;
- contaminants fate prediction models;
- relocatable models for fast emergency intervention at sea;
- combination of hydrodynamic field state variables and pelagic fish data sets for stock assessment and management in the open sea and Adriatic shelf areas;

### **Proposed Action Plan 2005-2012: Mediterranean Operational Oceanography Network**

In 2003, the EuroGOOS Mediterranean Task Team started to develop the follow-up strategy to MFS. It developed the so-called Mediterranean Operational Oceanography Network-MOON that has devised a scientific and operational strategy for the next eight years. This strategy is meant to show the benefit of the operational oceanography system implemented in the past ten years for management of environmental hazards in the climate change perspective.

The MOON strategy starts from the recognition that the overall Mediterranean Sea environmental hazards are:

- changes in the basin hydrological cycle (also due to man-induced changes in the river basins and their runoff), in underground waters and in precipitation events;
- fate and dispersal of oil and contaminants in the open sea;
- fate and dispersal of land derived nutrients and contaminants;
- fishery activities and aquaculture;
- algal blooms and adverse effects in coastal areas (anoxia, turbidity, etc.);
- coastal erosion;
- ecosystem changes, invasive species and long term adverse marine trends.

These problems are all embedded in the climate change and variability issues of the Mediterranean Sea: in particular the changes in the hydrological cycle and the ecosystem changes are the basic problems that are connected to climate variability and that can be dealt with an operational oceanography approach.

MOON aims will focus on two main operational goals:

- i) consolidate the operational observational/modeling system in the Mediterranean developed during the MFS phase, and
- ii) demonstrate the usage of the marine environmental prediction system for integrated management of open ocean and coastal marine areas

and on two overall scientific goals:

- i) explore model and quantify the potential predictability of the marine ecosystem from the overall basin to the coastal areas, also integrating the river basin systems and for the time scale of days to months (seasonal), and
- ii) connect the predicted system variability to anthropogenic forcing that may cause pollution and ecosystem degradation

The MOON aims require a scientific basis of understanding, monitoring and modelling of the marine environment from the basin scale to the coastal areas. After a ten years development, MFSTEP has implemented and demonstrated the first part of the marine integrated information system intended for the marine hydrodynamics from monitoring to forecasting. The continuation of this effort will be a strong coupling of the hydrodynamic forecasting activities with ecosystem, atmospheric, contaminant, sedimentary observations and models that can give environmental scientific information to policy makers.

In other words, MFS CORE service is the backbone for environmental and climate oriented applications that will be developed by MOON and that will produce downstream services directly related to the above-mentioned environmental problems. Hydrodynamic forecasting from the basin scales to the shelf areas is practical with present day technology and MOON will use this as a basis to develop the follow-up environmental prediction system that could in the future issue warnings for environmental hazards, assess the health of the marine ecosystem, serve the planning of investments in the region. All this should be viewed in the framework of climate

change and variability studies with the long time series collected by the operational oceanographic network implemented by MFS and continued by MOON.

MOON will also provide the means to connect operational services to research and to improved understanding by supporting, with its products and models, several research and development projects that will start in future years. The MOON community has developed a MOON MoU signed by 23 operational and research Institutions in the Mediterranean Sea.

### **Key issues for the sustainability of the system, needs and deficiencies**

The MOON Science and Strategy Plan recognizes that the backbone of the regional forecasting system, MFS, and the sub-regional and coastal systems has been developed and that the overall observing and forecasting components are operational on a best effort agency basis. The basin scale forecasting system is maintained operational in Italy by national support (INGV) while the sub-regional and coastal forecasting components are sustained by other national agencies.

MOON recognizes also the developments of other national systems, such as ESEOO, POSEIDON, MERCATOR, CYCOFOS, etc. With the exception of MERCATOR, they are all sub-regional scale systems that already depend on the availability of the basin scale forecasting service.

The MFS system is being integrated into the MERSEA system, becoming the regional sub-system of the global ocean component. MOON will add to MERSEA activities:

- continuation of the Mediterranean observing system at basin scale in a coordinated way;
- consolidation of the MFS CORE service in support to the coastal systems and climate;
- development of end-users applications (downstream services) at each single nation level;
- connection with the research and development local community to upgrade and train on operational forecasting also the non EU countries bordering the Mediterranean Sea.

MOON coordinates the community for continuing the R&D strategy toward a fully integrated environmental hazards system in the Mediterranean area and will make available products for training and education in operational oceanography for the area..

Last but not least, the MOON system provides the meaning to improve our understanding, and our capability to accurately predict the system evolution with an incremental approach and the optimal usage of all information. In the future it will be necessary to couple such a system with monitoring and modelling of biochemical fluxes. This will give rise to a complete, predictive system of marine ecosystem variability and change.

The major deficiencies of such system for climate oriented monitoring and modelling are:

- i) missing monitoring of the deep water masses of the basin by deep ocean sensors and/or multi-hazards deep ocean observatories;
- ii) missing monitoring of the Gibraltar and Sicily Straits as well as other Straits important for water mass exchanges such as Otranto and the Cretan Arc Straits;
- iii) validation/calibration of fully coupled ocean-atmosphere models capable to make credible scenarios for the next hundred years, starting from analyses produced by MFS models;
- iv) re-analysis activity for satellite and in situ data of the past 50 years.

The needs are:

- i) sustain the existing operational oceanography network and the real time/delayed mode management of the archived data to be accessible as widely as possible;
- ii) enlarge the observing system to consider deep water and Strait monitoring;
- iii) increase the activities of re-analysis for the past 50 years data sets with the basin scale and sub-regional model components developed by MFS;
- iv) advance the coupled ocean-atmosphere capabilities and the coupled marine ecosystem modeling activities.

### **Acknowledgements**

This work has been funded by MFSTEP, a project supported by the European Community, V Framework Programme – Energy, Environment and Sustainable Development; Contract n° EVK3-CT-2002-00075. All the partners of the project are thanked for their contribution to the material of this document.

## AN ADDITIONAL CONTRIBUTION FOR THE OCEANS THEME

**Aldo Drago, Giovanni Coppini, and Enrique Alvarez Fanjul**

### **Framework**

Data necessary for climate studies can be obtained both by means of existing operational oceanography systems offering access to measurements in real time, as well as through the use of existing baseline data sets. This section will review the actual situation for these two sources of data on the Mediterranean Sea.

Achievements in operational oceanography in the Mediterranean provide a framework for climate change and variability studies with the provision of long time series collected by the ocean observing networks and through numerical model outputs. Most of the existing structure in operational oceanography in the region has been coordinated by means of the MFS (Mediterranean Forecasting System) program, which is part of EuroGOOS. Its continuation, MOON (Mediterranean Operational Oceanography Network), has established an even larger consortium and will be the focal point for the development and maintenance of the existing systems. The actual observing system is composed of a specific implementation of SOOP, ARGO, meteo-oceanographic buoys and analyzed satellite data that are both archived and real time.

MedGOOS established as an informal association of 19 marine institutions from 16 countries under the auspices of UNESCO-IOC provides a regional framework for partnerships, synergies and capacity building for operational oceanography to the benefit of all coastal states in the region.

The MAMA (Mediterranean network to Assess and upgrade Monitoring and forecasting Activity) thematic network has brought together key marine institutes from each of the riparian countries and conducted a concerted effort focusing on the assessment of current capacities in the region in terms of infrastructures, human resources, and funding for ocean observations and forecasting, bringing awareness to national stakeholders of the benefits of operational oceanography and investing in capacity building and a number of demonstration products. Additionally, the Global Sea Level Observing System (GLOSS) and its regional densifications MedGLOSS and ESEAS are of particular relevance for GCOS. These initiatives coordinate the collection and dissemination of sea level data.

### **Contributions**

1) MOON has been developed by the EuroGOOS Mediterranean Task Team and now, the Memorandum of Understanding, based on the MOON Science Plan, has been signed by 24 operational agencies and Institutes in the Mediterranean region. MOON members are running the Mediterranean Forecasting System components in terms of observing system (Ship Of Opportunity Program-SOOP, network of oceanographic buoy stations, MEDARGO floats, altimeter real time data analysis system, real time analysis of satellite radiometric measurements (AVHRR) that produce daily SST fields, near real time analysis of scatterometer winds, glider autonomous vehicle experiment) and modeling (10 days basin scale daily forecasting and analysis, sub-regional forecasting models at higher resolution, shelf forecasting models at 1,5 km resolution, Operational weather forecasts at 10 km resolution, numerical

model for the marine food web). MOON can contribute to GCOS objectives by providing most of the ECVs for the Ocean (sea level, sea-surface temperature, sea-surface salinity, ocean colour, surface current, and the corresponding sub-surface ECVs, including phytoplankton). MOON will promote the following activities:

- continuation of the Mediterranean observing system at basin scale in a coordinated way;
- consolidation of the MFS CORE service in support to the coastal systems and climate;
- development of end-users applications (downstream services) at each single nation level;
- connection with the research and development local community to upgrade and train on operational forecasting also the non EU countries bordering the Mediterranean Sea.

MOON coordinates the community for continuing the R&D strategy toward a fully integrated environmental hazards system in the Mediterranean area and will make available products for training and education in operational oceanography for the area.

Last but not least, the MOON system provides the means to improve our understanding, and our capability to accurately predict the system evolution with an incremental approach and the optimal usage of all information. In the future it will be necessary to couple such a system with monitoring and modeling of biochemical fluxes. This will give rise to a complete, predictive system of marine ecosystem variability and change.

2) MedGOOS can contribute to GCOS through the experience of its thematic partnership that involves all the Mediterranean countries. The MAMA activities served to identify the needs and assets on ocean observations in the region, strengthened the network with capacity building activities, and can now be used as a platform for promoting regional co-development of operational systems, sharing of expertise, technologies and capacity building targeting the needs of coastal states, especially in view of sustainable development issues and mitigation of climatic change impacts. In particular, MedGOOS can offer to GCOS the experience to achieve the objective of an integrated and multi-disciplinary scientific approach to climate assessments through dedicated capacity building activities,

One of the key roles that GRAs are called to exercise consists in the pooling of information on operational marine monitoring activities in the regions. Such inventories of existing operational observation programmes constitute a pre-requisite to the harmonious planning and optimal design of regional ocean observing, modeling and forecasting systems composed of integrated national components, and targeting the exploitation of results by a wide range of end-users. Within this framework MedGOOS can also contribute to GCOS with assessments and compilation of information relevant to the ocean component of the climate observing system. The target would be to increasingly favour an approach that integrates the scientific and social dimension, and address the scope of multipurpose observing and information systems that deal with scientific, technological, social and economic factors in a holistic manner. In this sense, MedGOOS can provide support through two of its main MAMA deliverables, namely:

a) MedDir-OP the Mediterranean directory for operational oceanography that consists of a web-based regional directory of key Mediterranean institutions/agencies supporting operational oceanography, and of their routine monitoring programmes and activities. It contains detailed descriptions on observing platforms, instrumentation, measured variables, as well as on users of marine data, key national administrative structures responsible for marine affairs, and on the economic relevance of the marine sector in the Mediterranean countries. The information is presented in user-friendly clickable maps and in the form of searchable mini-databases. MedDir-OP can provide the backbone and experience for a comprehensive online directory of climate-

relevant information at regional and national levels, pointing to sources and descriptors of observing platforms, programmes and activities, and additionally linking to snapshot information on socio-economic scenarios and trends, policy frameworks and targets, management practices, as well as essential resources and assets especially those that are at risk from climatic changes.

b) MAMA-Net, which was developed as a portal to real-time data and derived products from a number of sources in the Mediterranean. MAMA-Net was mainly intended to serve as a demonstrator in MAMA to raise awareness on the potential benefits that can be derived from ocean observations and forecasting. Within GCOS, MAMA-Net can be further developed to reach a wider community including the climate community, as well as enhanced with products that are of more direct relevance to management, policy and decision-making.

3) MedGLOSS can contribute to the GCOS objective by the delivery of Sea Level ECV. Long-term observation of sea level is essential in order to detect and monitor sea level trends and to assess their impacts. Such measurements also enhance the safety of navigation, provide input to early warning systems, underpin studies of coastal erosion and saltwater intrusion and are needed for the calibration of satellite observations. The Global Sea Level Observing System (GLOSS) was established to promote the installation and operation of high-quality, long duration, global and regional sea level monitoring networks. Its main component is the 'Global Core Network' (GCN), consisting of about 290 sea level stations around the world. MSL data from these stations are supplied to the global archive operated by the Permanent Service for Mean Sea Level (PSMSL). GLOSS requirements include the free exchange of the original (typically hourly) sea level data in delayed-mode to an International Sea Level Centre. Four GCN monitoring stations are located in the Mediterranean, along with one (Port Tuapse) in the Black Sea.

In addition, GLOSS and the International Oceanographic Data and Information Exchange (IODE) have initiated a Date Archaeology Project aimed at the rescue of sea level records that exist only in vulnerable paper form (charts, paper tape etc.) and their conversion into computer-accessible format. Organizations that need assistance in converting their paper records into computer form are encouraged to contact either the GLOSS Technical Secretary or the PSMSL. Regional changes in sea level may differ significantly from the globally average. Therefore, the IOC and the CIESM (Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée) have undertaken the establishment of a long-term sea-level monitoring system in the Mediterranean and Black Seas. This is the origin of MedGLOSS, the Mediterranean regional subsystem of the Global Sea Level Observing System. The pilot MedGLOSS network will provide hourly sea level and atmospheric pressure data through a near real-time monitoring, telecommunication and presentation system. In this context, mention should be also made of the developing European Sea Level Service (ESEAS) that aims to provide quality-assured sea level information for European waters, co-ordinate and where necessary initiate, sea level observations, and set standards for the operation of gauges and for the quality control of data. Moreover it is recommendable the GCOS community takes advantage of the existing baseline data sets such as HIPOCAS and MEDAR/MEDATLAS.

The **HIPOCAS** Project (Hindcast of dynamic processes of the ocean and coastal areas of Europe), funded by the EU's Environment Program, was established to produce environmental (atmospheric and oceanographic) long-term data useful to assess the climate. Within the frame of the HIPOCAS Project, OPPE has developed, set, and run atmospheric and oceanographic hindcast for the Mediterranean Basin. High-resolution long-term (1958-2001) databases were produced using the atmospheric parameters (10-m wind field, mean sea level pressure, and

2-m temperature among others), together with oceanographic ones such as significant wave height, peak period and sea level residuals produced through these hindcasts.

The overall objective of the **MEDAR/MEDATLAS** database was generated in order to make available a comprehensive data product of multi-disciplinary in-situ data and information in the Mediterranean and Black Sea, through a wide co-operation of the Mediterranean countries.

**Operational systems:**

MOON (MFS, MERCATOR, ADRICOSM, POSEIDON, ESEOO), MEDGLOSS,

**Directories and portals:**

MEDGOOS (MAMA, MeDIR-OP, MAMA-Net)

EUROGOOS (EDIOS)

**Baseline Databases:**

HIPOCAS, MEDAR/MEDATLAS

**Ocean Observing system present status:**

Accessing the data and core services

Focal points for climate data observing system

ECV – Sea Level:

- GLOSS and its regional densification MEDGLOSS and ESEAS,
- MOON: SLA satellite, model analysis
- Hipocas climatic data base of sea level residuals

ECV– Sea-surface Temperature (MOON: XBT-SOOP, MEDARGO, Oceanographic buoys, glider, SST satellite, model analysis)

ECV – Sea-surface Salinity (MOON: ARGO, Oceanographic buoys, glider, , model analysis)

ECV – Ocean Colour (MOON: Ocean colour from satellite actually only in the Adriatic sea)

ECV – Sea State:

- National components, TAG of E-SURFMAR
- Hipocas climatic data base of sea level residuals

ECV – Surface Current (MOON: Oceanographic buoys, model analysis)

**Oceanic Domain – Sub-surface**

ECV – Sub-surface Temperature (MOON: XBT-SOOP, MEDARGO, Oceanographic buoys, glider, SST satellite, model analysis)

ECV – Sub-surface Salinity (MOON: ARGO, Oceanographic buoys, glider, model analysis)

ECV – Sub-surface Nutrients (oxygen, phosphorus, nitrates, silicates)

ECV – Sub-surface Currents (MOON: Oceanographic buoys, model analysis)

ECV – Phytoplankton (MOON: Oceanographic buoys, model analysis)

**Oceanic Domain – Data Management:**

MedGLOSS data management system, MOON thematic data centres

## **Oceanic Domain – Integrated Global Analysis Products**

## **Oceanic Domain – Scientific and Technological Challenges**

MOON technological advancements (TFLAP, Multiple launcher, antifouling techniques)  
Multipurpose data exchange and network integration (via MEDGLOSS and MOON)

## **Oceanic Domain – Synthesis and Consolidation of Actions**

MOON MoU, MedGOOS, MedGLOSS

### **Deficiencies:**

The major deficiencies of such system for climate oriented monitoring and modeling are the:

- i) missing monitoring of the deep water masses of the basin by deep ocean sensors and/or multi-hazards deep ocean observatories;
- ii) missing monitoring of the Gibraltar and Sicily Straits as well as other Straits important for water mass exchanges such as Otranto and the Cretan Arc Straits;
- iii) validation/calibration of fully coupled ocean-atmosphere models capable to make credible scenarios for the next hundred years, starting from analyses produced by MOON models;
- iv) re-analysis activity for satellite and in situ data of the past 50 years.
- v) lack of MedGLOSS stations in the Northern African countries

Moreover there is a need to translate observations into relevant information and knowledge for sound assessments, policy formulation and decision-making.

### **Needs:**

The needs are:

- i) sustain the existing operational oceanography network and the real time/delayed mode management of the archived data to be accessible as widely as possible;
- ii) enlarge the observing system to consider deep water and Strait monitoring;
- iii) increase the activities of re-analysis for the past 50 years data sets with the basin scale and sub-regional model components developed by MOON;
- iv) advance the coupled ocean-atmosphere capabilities and the coupled marine ecosystem modeling activities.
- v) extension of MedGLOSS stations in the Northern African countries
- vi) reference directories that integrate at national and regional scales all the climate-relevant information, by linking and incorporating various dimensions including S&T infrastructures and basis, socio-economic drivers and forcing, environmental management practices and policy frameworks, as well as the key resources and assets especially those that are at risk from climatic changes.

### **Proposed Projects:**

- Consolidate the MOON operational oceanography core services (model analysis and observations) in support of climate change detection;
- Enlarge the observing system to consider deep waters and straits
- Extension of MedGLOSS to Northern African Countries
- Capacity building for an integrated and multi-disciplinary approach to climate assessments
- Reanalysis of Mediterranean ocean-atmosphere coupled system based on numerical modeling

*(Intentionally Blank)*

## STATUS, DEFICIENCIES, & NEEDS FOR HYDROLOGICAL OBSERVATIONS FOR CLIMATE IN NORTH AFRICA & EASTERN MEDITERRANEAN

KHALED ABUZEID,<sup>9</sup> PH.D., PE, PMP & OMAR ELBADAWY,<sup>10</sup> PH.D.

### **Abstract**

This paper presents some of the important global observing systems parameters necessary to study climate change in the south and east Mediterranean region, and most importantly those parameters related to water resources assessment. It presents some of the gaps and deficiencies in observing systems for climate. It also recommends some of the actions needed to initiate development of a Regional Action Plan to address these deficiencies.

### **Introduction**

The quality of knowledge in hydrology is dependent on the availability of historical data sets of hydrological observations and measurements and therefore on the continuity of data collection. Hence, current efforts at observation and investigation are not of immediate use. The collecting of climate data started in the nineteenth century in some countries. However, hydrological and hydrogeological measurements are more recent, and sensitive to political change. Therefore, long historical data sets are rare. However, the longest ones concern arid countries where water development has long been important. An indication of the current efforts to produce basic data is evidenced by the statistics on the measurement networks (precipitation and runoff) gathered by the WMO on the Mediterranean countries.

### **Required Hydrological Observations**

Climate is the average state of the atmosphere during a period of time. Climatic conditions are one of the master factors in hydrological response since they affect most components of the hydrologic cycle and supply energy and water to the watersheds. Solar radiation is the primary external energy source driving the climate system. There are some other factors that can affect the earth's climate such as volcanic eruptions and human-induced changes, e.g., land surface change. Climatic conditions affect the type of vegetation and land use in watersheds. These in turn have great effects on interception, evaporation, and evapotranspiration. Climatic data such as temperature, humidity, solar radiation, and precipitation are also necessary for defining hydrologic response. Temperature, humidity, and solar radiation are all necessary for estimating water loss through the processes of evaporation and evapotranspiration.

The Terrestrial Observation Panel for Climate (TOPC) identified the following 9 variables as important. Each variable was then analyzed to ascertain the present status of the observations and data products, their adequacy, and key actions required improving the status of these observations.

**Surface Water-Discharge.** Discharge is typically calculated at a particular location in a river from measured water levels (the 'stage' or water level) by means of a transformation or rating curves developed for the particular channel cross-section at which the stage is measured. At many stations the water level is measured automatically in time-steps of several minutes to one hour. Because of the dynamics of the river-bed, this rating curve has to be recalibrated with appropriate frequency. Other factors can also influence the transformation stage at discharge,

---

<sup>9</sup> Regional Water Resources Program Manager, Centre for Environment & Development for the Arab Region & Europe (CEDARE)

<sup>10</sup> Regional Senior Water Resources Specialist, CEDARE

including the presence of ice or vegetation or debris in the channel. Flow in a channel can be influenced by factors such as changes in land use, withdrawal for water use, or contributions from artificial water storage reservoirs, and thus discharge does not necessarily represent a response to climatic conditions.

**Surface Water Storage Fluxes.** This variable is directly related to the retention of surface fluxes in lakes, reservoirs and wetlands, and also the issue of water storage in river channels, flood plains and large estuaries. At present, most climate circulation models do not realistically model lateral water fluxes, in part because of inadequate information on flow times; flow retention in dams, reservoirs, lakes and wetlands; and the evaporative loss of water from storage surfaces. Improved data are therefore required to increase the realism of the model results.

**Groundwater Fluxes.** Groundwater fluxes have a major influence on the dynamics of the global hydrological cycle. Because groundwater tends to respond more slowly to short term climatic variations than do surface water resources, this variable is often not considered to be of first-order importance from climate change perspective. Groundwater data considered to be of low importance for the detection of groundwater change, but highly important to climate questions because of its high potential impact. It is also noted that climate can be a key consideration in the sustainability of ground water resources.

**Precipitation.** Precipitation is the primary source of water supply. Rainfall characteristics such as intensity, duration, and frequency are important in determining the hydrologic response of watersheds.

**Evapotranspiration.** Direct measurements of actual ET estimates from formulae or from pan evaporimeters. Strictly speaking, even the direct measurements are estimates because of the observation methods used.

### **Integration of Hydrological Information in a GIS**

The assembly of hydrological data sets is the first step in applying these in hydrological analysis. Due to the spatial nature of hydrological processes it is useful to incorporate the data into a Geographic Information System (GIS). Special attention must be given to the co-registration of point data (discharge gauging stations or the location of reservoirs, water uptake, pollution sources, etc.). One advantage of linking different data sets within GIS is the ability to identify inconsistencies in the different data layers.

### **Framework Convention for Climatic Change in North Africa & East Mediterranean**

**Algeria** signed this Convention in June 1992, and ratified it in June 1993. Therefore, a National Committee was formed for the study of climatic changes, and is actually organizing the work for a national screening of gas production according to their different sources, and of their absorption according to the gas types that influence the warm cultivation zones.

In **Syria**, the Convention was accepted and confirmed on January 2/1996. The Minister of Environment in **Syria** has formed a Consulting Committee for the climatic changes that include members representing the various ministries and organizations operating in this field.

**Lebanon** has signed this Convention, and accordingly the Ministry of Environment issued a protocol that set the pollutant concentration of air, water and land according to the international standards. This protocol was approved in September 1996.

**Egypt** signed this Convention in 1992. There are a number of activities that reflect the effective participation in the international efforts aiming to face the environment problem.

In **Morocco**, the Convention was approved in 1996.

### **Status of Hydrological Observations in NA and East Med. Countries**

Rainfall networks: their density is relatively high in the small countries of the Near East (Palestine, Lebanon), considerably lower in the Maghreb (fewer than 1 per 1 000 km<sup>2</sup> in Algeria and Morocco), and very low in Egypt and Libyan Arab Jamahiriya (very arid anyway).

Hydrography networks: widely varying density in the Near East (1-10 stations per 1 000 km<sup>2</sup>), and lower in Africa. However, these densities are not comparable as the level of knowledge and the hydrography structures differ greatly. Figure (1) shows the spatial distribution of the GCOS Surface Network (GSN) stations accepted by WMO members.



Figure (1) Spatial distribution of the GCOS Surface Network (GSN) stations accepted by WMO members.

### **Deficiencies & Needs for Hydrological Observation Systems in the Region**

- Need for rationalization and optimization of the basic hydrological and hydrogeological networks;
- Need for improvement of instruments and methods for observation, processing and interpretation of hydrological and hydrogeological data;
- Need for development of software for data processing and quality control, data storage and creation of database;
- Lack and need for intensifying climate observation points
- Lack and need for increasing investment in monitoring efforts.

## **Recommendations for an Action Plan**

- There is an essential need for data from surface and groundwater observations in many key areas in the region of North Africa and East Mediterranean countries.
- There is a need to prepare continuous monitoring of a national work plan with respect to the climate change.
- Increase of the research and the technical programs and demanding from the donors to be up to their commitments they declared in the Earth Summit.
- Building capacities and technical assistance and training at the national level
- Include climatic change issues among national priorities in the principal sectors.
- Exchange and complement expertise with the other projects in other countries having the same objective
- Establish an Environmental Information system within a potential regional center or organization that covers the Mediterranean Region to facilitate regional efforts & exchange information between the countries in the region.

## **References**

- The Regional Consultation for North Africa and the Middle East, Five years after the Earth Summit Final Report, 18 -23 November 1996 - Beirut – Lebanon.
- GCOS-53 (WMO/TD-No. 958), 1999: GCOS Surface Network (GSN) Monitoring Centre Implementation Meeting (Offenbach, Germany, 19-20 January, 1999).
- United Nations Framework Convention on Climate Change, FCCC/SBSTA/1999/10, 1999: RESEARCH AND SYSTEMATIC OBSERVATION. Issues related to the Global Climate Observing System.
- WMO Pub. 9, Volume A - Master File of Observing Stations: <http://www.wmo.ch/web/ddbs/publicat.html>.
- World Meteorological Organization, WMO-No 306, 1993: Manual on Codes, International Codes, Volume I.1, (1993 edition), WMO, Genf, 1993.
- World Meteorological Organization, WMO-No. 870, 1997a: Commission for Climatology, Twelfth Session, Geneva, 4-14 August 1997. Abridged Final Report with Resolutions and Recommendations.
- World Meteorological Organization, WMO-No 306, 1997b: Manual on Codes, International Codes, Volume I.1, 1995 edition, Suppl. No. 1 (VI, 1997), Rec.7 (CBS-XI), WMO, Genf, 1997.

**SATELLITE APPLICATION FACILITIES ON LAND SURFACE ANALYSIS (SAF LSA):  
OVERVIEW OF THE PROGRAMME AND PRESENTATION OF FIRST OPERATIONAL  
RESULTS**

**Jean-Louis Roujean,  
Météo-France / Centre National de Recherches Météorologiques**

The new generation of satellite sensors, namely Meteosat Second Generation (MSG) and EPS (EUMETSAT Polar System), will bring an upgraded level of remotely-sensed information to the user community thanks to a much better spatial, temporal, spectral, and angular sampling of the radiation fields emerging from the surface of the Globe. The time resolution and the global coverage provided by SEVIRI on MSG and AVHRR-3 on EPS, together with the extensive sampling in both the spectral and angular domains, will pave the way for a broad range of novel applications, namely within the scope of land surface processes and land-atmosphere interactions. SEVIRI will provide multi-illumination angles of the surface whereas AVHRR-3 will allow multi-angular viewing of a given ground target. A better determination of anisotropic properties of the land surface is to be expected thanks to the synergy between MSG and EPS. The diurnal and sub-diurnal sampling of thermal signatures by MSG, together with the access to imagery and soundings from EPS, will afford solving the land surface temperature cycles. Further, the high temporal resolution of MSG will offer new opportunities to detect short-term evolution of land resources. This is especially relevant over areas of high cloud occurrence as well as for semi-arid ecosystems with short vegetation cycles. The spatial characteristics of SEVIRI and AVHRR-3 mainly relate to events at regional to continental scales, with emphasis on parameters that change rapidly in time.

The LSA SAF is hosted by the Institute of Meteorology of Portugal in partnership with the other National Meteorological Services of Météo-France, the Finish Meteorological Institute and The Royal Meteorological Institute in Belgium. The project entered the Initial Operational Phase at the beginning of the year 2005. The broad scope of this Consortium is to increase the benefits from MSG and EPS data related to land and atmosphere interactions and biosphere applications by developing techniques that will allow an operational effective use of data from the two EUMETSAT satellites. Products to be derived are extracted from Levels 1.0/1.5 for MSG and 1.a/1.b for EPS. Data will be completed with information from other satellite programmes like NOAA and other sources such as routine meteorological information.

The project encompasses five classes of products: operational products, internal operational products, internal products potential operational candidates, demonstration products, and experimental products. For the time being, five operational products (down-welling shortwave and long-wave radiation, albedo, temperature, snow cover) are being produced and freely accessible since august 2005 over the whole MSG disk at appropriate fine temporal and spatial resolutions (<http://landsaf.meteo.pt>). The product quality takes benefits from large effort in data pre-processing, particularly using the cloud mask and classification information provided by the Now-Casting SAF. In parallel, an important effort of validation of the products has started which relies in three steps: inter-comparison with similar products from other satellite projects, validation with ground measurements, testing with meteorological models. In this contribution, the methodology is briefly described, product examples are shown, and first validation results are discussed. The LSA SAF system is planned to be fully operational in the year 2007.

*(Intentionally Blank)*

## GENERATING DETAILED SCENARIOS OF CLIMATE CHANGE

**Debbie Hemming, Richard Jones, Geoff Jenkins  
Hadley Centre for Climate Prediction and Research  
Met Office, EXETER, UK**

### **Introduction**

In order to investigate the impacts of climate change, and plan adaptation to it, all countries need to have estimates of how their climate will change in the future, in the form of scenarios. The only tool we have for predicting change, representing all components of the climate systems, atmosphere, ocean, cryosphere, land surface etc., and the relevant interactions and feedbacks between them, is the global climate model (GCM). In order to run global models even on the largest of supercomputers, the models generally have a resolution of some 300km square, and the predictions from them are not detailed enough to use directly to study impacts and adaptation. For example, over a distance of 300km there can be great changes in the terrain, such as mountains and coastlines, the effect of which is not adequately captured by global models. Hence we need to be able to downscale the global predictions to give a greater detail over individual countries in order for them to be useable.

### **Regional Climate Models**

The most robust form of downscaling GCM predictions is the use of a regional climate model (RCM). This is a full physical climate model very similar to a GCM, containing the same representations of the climate system, but at a much higher resolution – typically 50km or 25km. Because of computer limitations it can only be run over a limited area (“domain”), typically 5000km x 5000km (about the size of Australia). It is “nested in” (or “driven by”) predictions from a global model, and therefore carries any uncertainty in the GCM predictions. Predictions from RCMs have substantial advantages for impacts studies, viz, and:

- show greater geographic detail
- take account of smaller-scale terrain features such as mountains and coasts
- resolve smaller-scale weather features such as cyclones
- representation of current climate is much better than in GCMs
- climate extremes simulated in RCMs are much closer to those observed than simulations in GCMs, and hence changes in extremes will be better predicted.

### **The Hadley Centre PRECIS Regional Climate Modelling System**

In the past, RCMs have required supercomputers or large workstations to run on, and this has generally limited their availability to developed countries. Over the last few years the Hadley Centre RCM group has ported its current regional climate model to work efficiently on a PC, and made it possible for the user to set up the RCM area over anywhere in the world. A straightforward User Interface has been provided, together with analyses and graphical software. The whole system is known as PRECIS; Providing Regional Climate for Impacts Studies. With funding from UK ministries (Defra, Dfid and FCO) and from UNDP, the model is being made freely available to government and related institutes in developing countries.

To run PRECIS, users require a fast PC (the faster the better) with adequate memory and hard disk capacities, a digital tape drive with which to input global data and to store RCM output data.

On a 3GHz PC, with a typical setup (50km resolution; 5000km x 5000km domain), PRECIS will run for 10 model years in about 1 month. PRECIS can also incorporate a full sulphur cycle, allowing prediction of aerosol cooling from sulphur dioxide emissions, with an increase of about 50% in run times.

### **Using PRECIS**

To generate climate change scenarios using PRECIS involves ideally running the regional climate model to make a simulation of climate over the period 1961-1990 (the current WMO reference period) and then running to make a climate prediction over a future period (generally 2071-2100) under a particular scenario of future emissions (most commonly the IPCC SRES A2); the basic climate change scenario is the difference between these two. Running the model for as long as 30 years in each case is not essential; 10 years may be sufficient to make an initial estimate of changes in average climate although uncertainty in these estimates due to the effect of natural variability will be larger and little information on changes in climate extremes will be available.

Climate change scenarios for other emissions (for example, SRES A1F1 or SRES B1) or other time periods (for example 2041-2070) can be generated from a single climate change scenario (typically the 2071-2100 SRES A2) by scaling changes by the global temperature predicted by the GCM for the other time periods and emissions. It is normal practice for the climate change scenario to be added to a baseline observational data set (for example, 1961-90) to give the scenario of future climate, rather than using the model predictions directly.

### **The Need for Observational Data**

It is important to validate the model over the area of interest, which can be done in two ways:

- i) by comparing the 1961-90 model climatology with observational data for the same period (both seasonal means and distributions/extremes) and
- ii) by carrying out a run of the model driven by a re-analysis of global observations, such as that compiled by the European Centre for Medium Range Weather Forecasting (ECMWF) and known as ERA15 (and recently updated and extended to ERA40), and comparing the RCM output with day-to-day or month-to-month observations.

Validation allows users to assess the reliability of the model, for specific outputs (eg precipitation) and in different regions; it is therefore important in estimating confidence in the predictions. In order to be able to carry out the validation, it is critical that countries maintain and extend national climatological observations, to GCOS standards. A good observational database is also required to provide the baseline climate of the country (for example, over 1961-90), to which the PRECIS prediction of climate change can be added to form a climate scenario for a future period.

### **Uncertainties in Climate Scenarios**

The PRECIS system will provide users with a detailed climate change scenario, which can be used to investigate impacts. However, it is important the uncertainties in the scenarios are fully understood, so that adaptation can be properly designed to reflect these. The first major uncertainty arises from our lack of knowledge of future emissions; this can be taken into account by developing scenarios for a wide range of SRES emissions profiles (for example, A1FI to B1). The second is associated with our incomplete understanding of the climate system and our inability to model it perfectly – so called “science” or “modelling” uncertainty. This can be quite large in some regions of the world, as shown in the IPCC Third Assessment report. We can scope the modelling uncertainty by using global fields from a number of GCMs to drive the

PRECIS RCM; currently PRECIS can be run using data from Hadley Centre GCMs and from the German ECHAM4 model. Soon PRECIS will be able to be used with probabilistic GCM predictions from the Hadley Centre and work will soon start to interface PRECIS with various North American GCMs.

The remaining uncertainty in scenarios is that due to natural variability of the climate system; we do not know if natural variability will act in the same direction as human-made climate change in a particular future period and location and hence accentuate it, or act in the opposite direction and hence reduce its effects. This uncertainty can be quantified by running the global model a number of times with different initial conditions, and driving the PRECIS RCM with each of these global predictions. It is clear from the above that, several experiments with PRECIS will be required in order to take account of these uncertainties, and it is more efficient for the work to be done in collaboration between several countries, and the model domain chosen to include these countries.

It is worth noting that for many European countries a significant database of regional climate projections already exists from the PRUDENCE project (<http://prudence.dmi.dk/index.html>), although the domain for RCMs usually only covers European Mediterranean countries. In this project several GCMs and eight RCMs were used to provide a wide range of climate projections for most or all of Europe. Though this still will not give a comprehensive picture of future climate change over the whole region it could form the basis of an initial assessment, which may then be enlarged upon with additional PRECIS experiments. (PRECIS results for the European region chosen by the Hadley Centre are available from the PRUDENCE data archive). Another potential future source of regional climate projections for the European and adjacent regions (in some cases the domain will include the entire Mediterranean coastal region) is the EU project ENSEMBLES (<http://www.ensembles-eu.org>).

### **Training for PRECIS Users**

In order to ensure that PRECIS is used in the most efficient way, but also to ensure that all the uncertainties in scenario generation are properly understood and appreciated, the model will be made available together with a week's training course, ideally involving users from several neighbouring countries. This has already been done for users in south Asia, China, West Africa (through ACMAD – African Centre for Meteorological Applications to Development, Niamey, Niger) and Southern Africa, Central America and the Caribbean and South America. In 2005, courses were run in Kazakhstan (including representation from several neighbouring countries), Turkey (again for countries in the region) and in Reading (for users from any region). A follow-up workshop was held in India for existing and new users from the south Asian region and a similar workshop has just been completed (Nov 2005) for South American users in Argentina.

With specific relevance to the North African region, PRECIS training for ACMAD-nominated scientists was organized following participation in the Niger GCOS meeting in March 2003. Scientists from ACMAD and the Algerian Meteorological Service, spent two weeks at the Hadley Centre in May 2003 learning about and working with PRECIS, with the aim of becoming contact points and eventually a local training/coordination centre for PRECIS work in the region. A future PRECIS workshop focused on Africa will be held in Ghana in April 2006.

### **Using PRECIS Predictions**

We believe that regional climate models such as PRECIS can provide useful information on future climate change, with clear advantages of corresponding GCM predictions, whilst always bearing in mind the uncertainties inherent in GCMs. The use of PRECIS by local centres of expertise will give national ownership of the scenarios. The scenarios can then be used in:

- i) publications, to effectively raise national awareness of climate change as an issue
- ii) National Communications to the UNFCCC and
- iii) to feed into models which estimate the impacts of change on agriculture, water resources, in a structure, etc.

Hence PRECIS, used in conjunction with impacts models, will aid choice of efficient adaptation, through the process of mainstreaming climate change in planning by governments and businesses.

**SPACE OBSERVATION AND ITS APPLICATIONS  
AN ESSENTIAL CONTRIBUTION TO CLIMATE MONITORING**

**Abdelhak Trache  
Deputy – Director, CRASTE-LF  
African Regional Center for Sciences and Space Technologies  
Agdal-Rabat, Morocco**

**Summary**

Continuous monitoring of climate system through systematic observation is an essential activity to understand its variability, its causes and its interactions with natural and human systems, to validate models, enhance climatic predictions services, anticipate extreme events associated with climate changes, mitigate climatic disaster effects and plan a sustainable development. In fact, a prime significance must be given to the availability of observation means capable of providing reliable overall data feeding prediction models of atmosphere behavior. Whether it's operational meteorology or climate monitoring, spatial observation combined with in situ observation points hence brings a determined contribution to the process of accurate auscultation of our environment. Through their overall, synoptic, continuous, repetitive and objective character, the measurement carried out from space enabled to refine the understanding of climate mechanisms. The contribution of spatial tool became essential to set up reliable diagnoses of ongoing changes, to understand and predict evolutions of earth dynamics.

Thus, in operational meteorology and in the context of Global Meteorological Watch, the overall observation system makes a large room for satellite techniques by implementing a belt of geostationary satellites and almost polar satellites in orbit. Here, we will underline essential contributions of MSG whose imager SEVIRI becomes a privileged tool of immediate prediction and meteorological risk management of short duration, thanks to its capacity to characterize active meteorological systems, their quick evolution and their development probability.

With regard to climate monitoring, the approach hence lies on a unified vision of climatic system components, whereby the Earth is analyzed as an overall system through a pluridisciplinary approach using measurements made from space and in situ analyzing the components of the earth system (atmosphere, hydrosphere, geosphere, and biosphere). In this context, spatial techniques are the genuine tool for overall, permanent and reliable monitoring of the environment, as well as the atmosphere, oceans and emerged lands. The collected data may cover all the required scale of space (from the continent to the individual), time and spectrum. Thus, at the level of the atmosphere numerous tools were dedicated to the study of radiation assessment of the Earth (tool ScaRab, or GERB on MSG, POLDER on ADEOS). Other projects are scheduled such as CALIPSO satellite (2005), which must localize clouds and aerosols and measure their radiation impact on climate by setting up vertical profiles of the atmosphere. With CLOUDSAT satellite (observations of clouds and climate) and CALIPSO, AQUA, AURA (NASA) and PARASOL (CNES) satellites, they will constitute the constellation A-TRAIN, original mechanism of 6 satellites devoted to the observation of the atmosphere.

The earth component of climate system includes multiple angles for which knowledge is far from being complete. The contribution of spatial technologies may then be determining for the description of variables related to the coverage of snow, glaciers, pergelisol and frozen

seasonal soils, the measurement of albedo, soils occupation, the determination of active absorbed photosynthetic radiation or the impact of fires. Thus, the measurements of albedo and reflectance are acquired by multi spectral sensors (HRV and HRVIR on SPOT) and by multidirectional and polar metric radiometers (POLDER, GERB on MSG, ERBE on NOAA). A large number of multi-spectral imagers with various spatial and temporal resolutions (LANDSAT, SPOT, IRS, NOAA-AVHRR, POLDER and VEGETATION) provide data used to restore vegetation indices such as NDVI. The measurement of lands' temperature such as provided by MODIS on TERRA may be used in the study of water assessments or detection of forest fires.

Due to the essential role that the ocean plays in climate regulation, its monitoring and the prediction of its behavior will enable to predict a climate variability one day at the scale of months, seasons, years. The rising of sea level is also an indicator particularly meaningful of overall climate changes. The major observation systems analyze observable relevant parameters related to the physical aspect (SST, wispy cloud, circulation, winds) or the biological aspect (color of the ocean). This is particularly CZCS, then POLDER and OCTS on ADEOS, now SeaWiFS/SEASTAR, MODIS/TERRA, MERIS/ENVISAT, POLDER-2 and GLI on ADEOS-2 (Japan). The European Space Agency (with ERS-2, then ENVISAT) and CNES (with TOPEX-POSEIDON, then JASON and POLDER-2) may undertake an overall oceanic monitoring of concerned parameters. ERS and Topex-Poseidon missions constituted the spatial component of the system of observation and WOCE experience, which enabled to characterize oceanic circulation at various space and time scales and forcing to the interface ocean-atmosphere. An example of the remarkable sensitivity of Topex-Poseidon was the early detection of the El Niño event. It's a contribution to the establishment of the Global observation of oceans' system (GOOS).

On basing on the fact that the earth, the atmosphere and the oceans were integral part of a single planetary system, and that research programs would only reach their full effectiveness if gateways were launched among the different global initiatives, the decision was made to launch the Integrated Global Observation Strategy (IGOS) which provides a general framework for harmonizing major observation systems of the Earth from space in situ. The second report on the appropriateness of global observation systems of climate underlined that those observations provided limited advantages as long as satellite missions were not designed to meet climatic monitoring needs over long periods. Being aware that there cannot be developed a new overall observation mechanism, the community adopted the concept of "system of systems" GEOSS, intended to optimize the synergies of interpretation and use of data that they produce. At the European level, GAMES initiative is the contribution material of European to GEOSS and aims at establishing an overall operational capacity of information services in environment and security monitoring. This is about a European observation system of the Earth, which will enable to better understand environmental phenomena (floods, evolution of soil occupation, atmospheric chemistry), and to contribute to civilian security in Europe. At the African level, the initiative of "African Environment Monitoring for a sustainable Development "(AMES) must ensure the continuity of PUMA project and constitute the African response to the proposal of opening GMES to developing countries. It aims at developing new applications using satellite technologies and other accessory data to sustain development in Africa.

The appropriate use of environment spatial observations and their transformation into useful information requires a consistent level of information and expertise, involving an increase effort of training, acquisition of skills, research and development. Capacity building in the use of those technologies, in particular through training constitutes a response to the requirement but it's a process that must be conducted with a long-term perspective. This underlines the

implementation of an overall strategy on the use of space Technologies for Africa and development countries.

CEOS and IGOS, following the recommendations of the Global Summit on Sustainable Development, launched two partnerships called Type 2 one of which concerns education and training in the area of Earth observation. The latest G8 held in Gleneagles called for "To sustain efforts to help developing countries and regions to benefit fully from GEOSS.... by strengthening the capacity of analyzing and interpreting data drawn from observation and design of systems and support tools in decision making meeting the needs of local population".

Regional training Centers in Sciences and Space Technologies such as CRASTE-LF in Rabat (Morocco) constitute the adequate solutions for the implementation of training programs (short or medium duration), information, enhancement of experiences and skills supporting the implementation of the strategy to which training, education and information will bring effectiveness and sustainability guarantee. It will remain to fulfill the execution conditions of the strategy, through the consolidation of indispensable partnerships and mobilization of funding opportunities.

*(Intentionally Blank)*

## CLIMATE INDICES

**Serhat Sensoy**  
**Turkish State Meteorological Service**  
**Ankara, Turkey**

### **Summary**

It is difficult to pick up a newspaper nowadays without reading something about global warming. It's also hard to pick up a professional climate journal without realizing that some of the best scientific minds in the world are working on climate change detection and attribution. Climate change is brought about by the complicated interactions among the atmosphere, the oceans, the cryosphere, the surface lithosphere and the biosphere, which comprise the climate system. Since climate change is extremely complex and totally global in its nature, cooperative activities with international and interdisciplinary programs are indispensable for monitoring and predicting climate change and disseminating reliable information on it. (JMA, 2003)

A small change in the mean can have a big effect on the extremes, but extremes consist of only a small number of data. Extreme climate events, however, have a significant impact and affect both the natural and human systems much more than the normal condition. Therefore, it is important to know if and how climate extremes are changing. Analysis of extremes requires long-term daily station data and, unfortunately, there are many regions in the world where these data are not internationally exchanged. The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (Folland et al., 2001) relied heavily on the multi-national analysis of Frich et al. (2002). However, Frich et al. (2002) had no results for nearly half of the global land surface. To remedy this situation for the IPCC Fourth Assessment Report, the joint World Meteorological Organization (WMO) Commission for Climatology (CCI)/World Climate Research Programme (WCRP) project on Climate Variability and Predictability (CLIVAR) Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI) coordinated an internationally-agreed set of indices for analyses of extremes and sponsored a series of regional climate change workshops. (See Zwiers et al. (2003) and <http://www.ncdc.noaa.gov/oa/wmo/ccl/> for more information on the Expert Team).

Combining the overlapping interests of CLIVAR and CCI, ETCCDMI sits at the intersection of observational data and models. Together with many collaborators around the world, they are trying to address questions such as: "What observational data are needed for climate change detection and attribution?" "What analyses of these data can provide information useful for climate change detection and monitoring?". They have placed particular emphasis on indices derived from daily data for analyses of extremes. Daily data are being used because monthly means filter out important information. Long-term daily data allows for analyses of a wide variety of extreme events, such as heat waves and flood-producing rains, that are of great interest to the general public as well as derived parameters that would be of interest to modelers (Peterson et al., 2001). A main objective in constructing extremes indices is to use them for climate change monitoring and detection studies. The information provided by the indices not only includes how mean values have changed over time but how the statistical distribution of the data has changed.

The preceding initiative started in 1999 and, to date, the ETCCDMI has implemented five regional workshops. Two workshops covered the Americas, one in Brazil and one in Guatemala.

One workshop addressed southern Africa. A workshop in India involved south and central Asia, while the workshop for the Middle East sought to address the region from Turkey to Iran and from Georgia to the southern tip of the Arabian Peninsula. By establishing an exact formula for 27 climate indices, analyses done in different countries or different regions can fit together seamlessly. Xuebin Zhang of Environment Canada wrote the workshop software called RCLimDex to perform quality control (QC) on the data, test the time series for homogeneity, and calculate the indices. (The complete list of the 27 climate indices (Appendix-A), software and users guide of RCLimDex are available from <http://cccma.seos.uvic.ca/ETCCDMI>). It calculates trends and shows the magnitude of increases or decreases over 100 years. Also it gives information about the trends, indicating whether or not these are statistically significant. Turkey workshop results have already been submitted to WMO, CLIVAR and BAMS (Sensoy et al., 2005)

RCLimDex loads the data and has several Quality Control checks:

- If daily precipitation amount is less than zero, it is assumed as a missing value (-99.9)
- If daily maximum temperature is less than daily minimum temperature, both of them are assumed as missing values (-99.9)
- If the data lie outside of the user-defined threshold (mean  $\pm 4 \times \text{STD}$ ), QC identifies these as outliers. At this point, the user may check the data to determine it is really an outlier or not.

After the QC, RCLimDex creates 27 core indices. Indices have some advantages versus data:

- Indices are information derived from data
- Indices represent the data
- Indices are more readily obtained than data
- Indices are useful in a wide variety of climate change analyses
- Indices are useful in Model – observations comparisons
- Indices are useful especially for analyses of extremes

Tools and techniques that were used to calculate climate indices also provided capacity building on extreme analyses, QC and homogeneity issues. Although GCOS Surface Network data are mainly being used in the regional workshops, participants are encouraged to apply the related software to their remaining stations. In this context, we have run RCLimDex for 225 climate stations in Turkey that have at least 30 years of records. Most of the outputs show that maximum and minimum temperatures are increasing. The number of frost days, ice days and cool nights are decreasing while the number of summer days and warm nights are increasing. The results show that, in general, there are large coherent patterns of warming over the region. On the other hand, however, some stations that have very local climatic conditions show opposite trends. The maximum one-day precipitation amounts increase even where mean annual precipitation declines. However, there is a much more mixed pattern of change in precipitation.

## **Recommendations**

1. Operation of historically uninterrupted stations and observing systems should be maintained because long-duration time series are essential to build a more detailed

global picture of climate trends. Relocation of stations must be avoided. A suitable period of overlap is required for new and old observing systems.

2. The quality and homogeneity of data should be regularly assessed as part of routine operations in the archive system, rather requiring individual researchers to do this.
3. The details and history of local conditions, instruments, operating procedures, data processing algorithms and information on relocations should be documented in metadata.
4. Addition of more parameters and calculation of more climate indices for more stations would provided a more detailed picture in climate change detection studies.

## **References**

- Folland, C. K., T. R. Karl and Coauthors, 2001: Observed climate variability and change. *Climate Change 2001: The scientific Basis. Contribution of working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, J.T. Houghton et al., Eds., Cambridge University Press, 99-181 pp.
- Frich, P., L. V. Alexander, P. Della-Marta, B. Gleason, M. Haylock, A. M. G. Klein Tank and T. Peterson, 2002: Observed coherent changes in climatic extremes during the 2<sup>nd</sup> half of the 20<sup>th</sup> century, *Climate Res.*, 19, 193-212.
- Peterson, T. C., C. Folland, G. Gruba, W. Hogg, A. Mokssit, and N. Plummer, 2001: *Report of the Activities of the Working Group on Climate Change Detection and Related Rapporteurs*, World Meteorological Organization Technical Document No. 1071, World Meteorological Organization, Geneva, 146 pp.
- Sensoy, S., T. C. Peterson, L. V. Alexander, 2005: Submitted to the *Bulletin of the American Meteorological Society* on March 9, 2005 with the number of 2037 and published at <http://www.clivar.org/organization/etccd/docs/SWAsiaWorkshopRep.pdf>
- Zwiers, F., H. Cattle, T. C. Peterson, and A. Mokssit, 2003: Detecting climate change, *WMO Bulletin*, 52, 37-42.

## **APPENDIX A - List of the 27 Core Climate Indices**

<b>ID</b>	<b>Indicator name</b>	<b>Definitions</b>	<b>UNITS</b>
FD0	Frost days	Annual count when TN(daily minimum)<0°C	Days
SU25	Summer days	Annual count when TX(daily maximum)>25°C	Days
ID0	Ice days	Annual count when TX(daily maximum)<0°C	Days
TR20	Tropical nights	Annual count when TN(daily minimum)>20°C	Days
GSL	Growing season Length	Annual (1st Jan to 31 <sup>st</sup> Dec in NH, 1 <sup>st</sup> July to 30 <sup>th</sup> June in SH) count between first span of	Days

		at least 6 days with TG>5°C and first span after July 1 (January 1 in SH) of 6 days with TG<5°C	
TXx	Max Tmax	Monthly maximum value of daily maximum temp	°C
TNx	Max Tmin	Monthly maximum value of daily minimum temp	°C
TXn	Min Tmax	Monthly minimum value of daily maximum temp	°C
TNn	Min Tmin	Monthly minimum value of daily minimum temp	°C
TN10p	Cool nights	Percentage of days when TN<10th percentile	Days
TX10p	Cool days	Percentage of days when TX<10th percentile	Days
TN90p	Warm nights	Percentage of days when TN>90th percentile	Days
TX90p	Warm days	Percentage of days when TX>90th percentile	Days
WSDI	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TX>90th percentile	Days
CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN<10th percentile	Days
DTR	Diurnal temperature range	Monthly mean difference between TX and TN	°C
RX1day	Max 1-day precipitation	Monthly maximum 1-day precipitation	mm
Rx5day	Max 5-day precipitation	Monthly maximum consecutive 5-day precipitation	mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PR >=1.0mm) in the year	mm/day
R10	Number of heavy precipitation days	Annual count of days when PR >= 10mm	Days
R20	Number of very heavy precipitation days	Annual count of days when PR >= 20mm	Days
Rnn	Number of days above nn mm	Annual count of days when PR >= nn mm, nn is user defined threshold	Days
CDD	Consecutive dry days	Maximum number of consecutive days with RR<1mm	Days
CWD	Consecutive wet days	Maximum number of consecutive days with RR>=1mm	Days
R95p	Very wet days	Annual total PRCP when PR>95 <sup>th</sup> percentile	mm
R99p	Extremely wet days	Annual total PRCP when PR>99 <sup>th</sup> percentile	mm
PRCPTOT	Annual total wet-day precipitation	Annual total PRCP in wet days (PR>=1mm)	mm

## CONTRIBUTION OF THE WMO SUBREGIONAL OFFICE

**Dušan Hrcek**  
**WMO Representative for Europe**

### **Subregional Office for Europe**

The Subregional Office for Europe was established in 2003. The Office supports the relevant Departments of the Secretariat, including GCOS, in discharging of their responsibilities related to RA VI activities. The Office maintains close liaison with Members in Region VI in their efforts to strengthen their National Meteorological and Hydrological Services (NMHSs) by organizing visits to countries, assisting in follow-up of their requests and provides advice through visits to Members, study tours of the new Permanent Representatives to WMO headquarters, and provision of relevant information. An important tool for enhanced collaboration between the Secretariat and NMHSs, as well as amongst NMHSs is WMO Country Profile.

#### **1 Recommendation**

The expert missions of the WMO Subregional Office and other visits to Member countries, including high level visits of the Secretary-General, should be used to address the needs of the Members in order to fully implement the Global Observing System for Climate.

#### **2 Recommendation**

The WMO Country Profiles should be used to indicate the status of the Global Observing System for Climate in the Member country and point out eventual problems with its implementation.

### **XIV-RA VI session in Heidelberg**

The 14<sup>th</sup> RA VI Session was held from 7 to 15 September 2005 in Heidelberg, Germany. The Regional Association VI (RA VI - Europe) Member states agreed to develop the Regional Strategic Plan for the Enhancement of National Meteorological and Hydrological Services (NMHSs). They adopted an Action Plan while the Strategic Plan is being developed. It builds on the strategies contained in the Sixth WMO Long-Term Plan (2004-2011). The goal of the plan is to strengthen the capabilities of all NMHSs throughout the Region by providing appropriate meteorological, hydrological and related services; highlighting the important role of WMO and its Members in the prevention and mitigation of natural disasters; protection of life and property; safeguarding of the environment and contributing to sustainable development.

The RA VI Action Plan has a concrete set of actions for the intercessional period over the next four years. It is attached to the XIV-RA VI as Annex I to Resolution 16/1 (XIV-RA VI) for implementation until such time as the RA VI Strategic Plan is adopted. The Association established its Task Team on the RA VI Strategic Plan and Action Plan in order to oversee and monitor the implementation of the action plan and to develop the Strategic Plan. The RA VI document 16.1 is available on WMO Web site under: <http://www.wmo.int/web-en/ftpdocuments.html>

### **3 Recommendation**

The regional GCOS Action Plan for the Mediterranean Basin should be linked to the RA VI Action Plan.

#### **Instruments and Methods of Observation**

The Regional Instrument Centres (RICs) play a very important role in capacity building, such as the active support towards the organization of training workshops and preparation of training materials. The RICs should also play an important role in organizing instrument evaluations and comparisons, and in providing assistance and advice in calibration of national standards/reference instruments within the Region.

The 14<sup>th</sup> RA VI Session designated the Calibration Laboratory of the Slovak Hydrometeorological Institute and the Calibration Laboratory of the Environmental Agency of the Republic of Slovenia as new Regional Instrument Centres (RICs) for RA VI, in addition to the already existing Regional Instrument Centre in Trappes, France. Countries from the eastern Mediterranean would therefore have a possibility to use the newly established RICs in order to regularly calibrate the meteorological and hydrological instruments.

The 14<sup>th</sup> RA VI Session underscored the importance of capacity building and training in the field of instruments and methods of observation as a prerequisite for the uninterrupted operation of instruments and the generation of high quality of data. It encouraged Members to arrange for required training through national and regional training programmes and urged Members as well as the private industry to sponsor regional instrument training events.

A successful determination of the radiation budget, which is fundamental to understanding the Earth's climatic system, climate variability and climate change, is only possible with very homogeneous solar radiation data measured all over the world. The way to guarantee a desired level of quality of radiation data is to assure the traceability of solar radiation measurements to World Radiation Reference (WRR). At present this is achieved through International and Regional Pyrheliometer Comparisons done in 5-years cycles. And WMO does it for more than 40 years already. The Tenth International Pyrheliometer Comparison was held in September/October 2005. The Regional Pyrheliometer Comparisons (RPCs) should be organized in all WMO Regions in the period from six months to 4 years following the completion of IPC. This mostly neglected due to financial constraints.

Quality Management appears to be of growing relevance for Members in RA VI, partly because of the development of the Single European Sky. Some NMSs had reported that they were implementing their own QMS and audit mechanisms. Furthermore, it had been reported that several Members had gained positive experience with the Quality Management System (QMS) based on the ISO 9001 standard, which had resulted in a continuous process of improvements in the management and operation of NMSs and in the delivery of services through an enhanced focus on the customer and user community.

### **4 Recommendation**

Regular calibration of meteorological and hydrological instruments should be introduced where it is not in place already. Broader international cooperation in this respect is needed, especially with institutions able to issue internationally valid certificates. In RA VI three Regional Instrument Centres are available.

## **5 Recommendation**

NMHSs should use the possibilities through WMO Secretariat and other international organizations and bilateral arrangements to enhance the education and training opportunities for its staff. Special attention should be given to training of observers and technicians in order to contribute to a higher quality of observations and measurements in the Service.

## **6 Recommendation**

It is suggested that GCOS support holding the RPCs in the regions, in which case national pyrheliometers would be traceable through the standards of RRCs to WRR.

## **7 Recommendation**

Quality management system (QMS) is a business tool used by organizations to achieve efficiency and effectiveness, and improve relationship with customers. It is recommended that NMHS not having QMS in place would gradually start implementing or seeking to implement ISO 9001 quality management systems to improve its overall visibility and performance.

*(Intentionally Blank)*

## RESOURCE MOBILIZATION MATTERS: A SUMMARY

Jim Williams

Independent Consultant supported by the UK Met Office/GCOS

**The Purpose** of this presentation is to help inform efforts towards obtaining finance to meet priority GCOS needs in parts of the Mediterranean Basin. It explores the logic of obtaining 'development' money, to do what needs doing. It is oriented particularly towards countries in North Africa and the Eastern Mediterranean.

The presentation is structured around **four themes** pertinent to securing finance:

1. Globalisation, Change and the International Development Agenda
2. Sources of Development Assistance Pertinent to countries in the region
3. How to make a weather service more attractive for financial support
4. The significance of the GCOS Regional Action Plan and how best to present it

### 1. Globalisation, Institutional Change and the International Development Agenda

There is an overriding imperative for institutions (such as weather services, which are *de facto* time-sensitive, information service providers) to continually 'adapt to change' in a globalised world where 'everything is always changing.'

- Global economy: World Trade Organization
- Global environment: Climate change
- Meteorology/GCOS: Global technical partnership
- Poverty elimination: Global social goal
- Global Government: UN +

In this rapidly changing world, institutions must evolve or they become irrelevant.

Today, there is increasing coordination in national objectives, policies, strategies and practices. Nearly all governments now work to a **common development agenda for sustainable development and reducing poverty worldwide**. See the Millennium Development Goals for an example of global development coordination, reconfirmed at the September UN Summit in New York (also PRSPs, CSAs and NAPAs).

There is much opportunity for individuals and institutions capable of evolving in accordance with their economic, social, technical, and institutional environment. There are also increasing incentives to form partnerships within regions (e.g., Magreb, Mediterranean, Africa).

### 2. Sources of Development Assistance pertinent to the Mediterranean Basin

In principle, it is the responsibility of the national government to maintain a national weather service that is 'fit for purpose.' In practice, 'meteorology' is often a low priority when competing for funding from a restricted national budget. Possible sources of additional finance include:

#### A. Global/UN System

- *Role of Poverty Reduction Strategy Papers and National Action Plans for Adaptation*
- *World Bank Group: see <http://www.worldbank.org/>, under countries and regions, select a country then country assistance strategy (CSA) or overview*
- *GEF (UNDP): AIACC and ALM, et al*

- *ISDR: Development of Early Warning and Response Systems*
- *African Development Bank/Islamic Development Bank/EBRD*

## **B. European Union/Commission**

- *Action Plan for assisting with Adaptation to Climate Change*
- *Development assistance for countries in region: MEDA*
- *Research funds*

## **C. Donors in OECD countries**

- *Examples from Canada, Denmark, Germany, UK*

Examples will be shown where significant finance is allocated for different development purposes, some of it for multi-country (regional) funds. Perhaps the most important assets for accessing these funds are initiative and determination.

### **3. How to make a weather service more attractive for finance and support**

In order to attract funding, a weather service must

- be seen to be a vital part of the national development agenda
- be sure to be delivering services in well financed areas
- take responsibility for its own future (leadership) through appropriate institutional development

If a weather service is perceived as effective in contributing to the national development agenda, then it will receive more finance from government **and** be eligible for support from donors and development banks.

### **4. The significance of the GCOS Regional Action Plan for North Africa and the Eastern Mediterranean, and how to present it**

We need to ask ourselves:

- What is the objective of the Action Plan and who is it written for?
- How best could it be designed to facilitate funding?

The RAP needs

- to emphasise strengths, address weaknesses and seize opportunities
- to be set out clearly so busy (e.g.) economists can read it quickly and agree
- to present a package that is high priority on development agendas.

Possible Thematic Approaches towards funding of the RAP include:

- a) Climate Change
- b) Integrated Water Resource Management
- c) Good Environmental Governance
- d) Multi-hazard Early Warning and Response Systems

## **Conclusion**

Significant finance is available for development in the Mediterranean Basin. Some of these funds might be considered for support to GCOS objectives if we develop a good GCOS regional action plan based on delivering objectives attractive to the funding sources, and then approach the appropriate agencies accordingly.

## LIST OF ACRONYMS

ADRICOSM	Adriatic Sea Integrated Coastal Areas and River Basin Management System Pilot Project
AMESD	African Monitoring of the Environment for Sustainable Development
BSRN	Baseline Surface Radiation Network
CBS	(WMO) Commission for Basic Systems
CCI	(WMO) Commission for Climatology
CEDARE	Center for Environment and Development for the Arab Region and Europe
CLENZO-Africa	Climate and Environment for Society
CIESM	Commission Internationale pour L'Exploration Scientifique de la Mer Méditerranée
CLIMAT	WMO Message Format for Surface Climatological Data
CLIMAT TEMP	WMO Message Format for Upper Air Climatological Data
CLIPS	Climate Information and Prediction Services
CliRep	CLIMAT and CLIMAT TEMP Software
CLIVAR	(WCRP) Climate Variability and Predictability Programme
COP	Conference of the Parties to the UNFCCC
CRASTE-LF	Centre Régional Africain des Sciences & Technologies de l'Espace en Langue Française
DARE	WMO Data Rescue Project
EC	European Community
ECC	Electrochemical Concentration Cell
ECVs	Essential Climatic Variables
EIT	Economy in Transition
ENDEV Africa	Environmental Development Africa
EPS	EUMETSAT Polar System
ESEAS	European Sea Level Service
EU	European Union
EUMETCAST	EUMETSAT Broadcast System for Environmental Data
EUMETNET	Network of European Meteorological Services
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAPAR	Fraction of Absorbed Photo-synthetically Active Radiation
FP-6	EC 6 <sup>th</sup> Framework Programme
GAW	Global Atmosphere Watch
GCM	General Circulation Model
GCN	Global Core Network (of GLOSS)
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse Gas
GIS	Geographic Information System
GLOSS	Global Sea Level Observing System
GMES	Global Monitoring for Environment and Security
GCN	GLOSS Global Core Network

GOOS	Global Ocean Observing System
GOS	(WWW) Global Observing System
GRAND	GOOS Regional Alliances Network Development
GSN	GCOS Surface Network
GTOS	Global Terrestrial Observing System
GTS	WMO Global Telecommunication System
GUAN	GCOS Upper Air Network
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer
IGOS	Integrated Global Observing Strategy
IOC	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
LAM	Limited Area Model
LDC	Least Developed Country
MAMA	Mediterranean Network to Assess and Upgrade Monitoring and Forecasting Activity
MDG(s)	Millennium Development Goal(s)
MedGLOSS	Mediterranean GLOSS Sub-system
MedGOOS	Mediterranean GOOS Sub-system
MEDHYCOS	Mediterranean Hydrologic Cycle Observing System
MeDir-OP	Mediterranean Directory for Operational Oceanography
MERSEA	Marine Environment and Security for the European Area
METEOSAT	Geosynchronous Meteorology Satellite
MetOp	European Polar Orbiting Meteorological Satellite
MFS	Mediterranean Ocean Forecasting System
MFSP	Mediterranean Forecasting System Pilot Programme
MFSTEP	Mediterranean Ocean Forecasting System Towards Environmental Prediction
MOON	Mediterranean Operational Oceanographic Network
MSG	METEOSAT Second Generation
NEPAD	New Partnership for Africa's Development
NHS	National Hydrological Service
NIVMAR	Spanish Storm Surge Forecasting System
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological Service
OECD	Organization for Economic Cooperation and Development
OSS	Sahara and Sahel Observatory
PC	Personal Computer
PRECIS	Providing Regional Climates for Impacts Studies
PSMSL	Permanent Service for Mean Sea Level
PUMA	Preparation for the Use of MSG in Africa
QA	Quality Assurance
QC	Quality Control
RBCN	Regional Basic Climatological Network
RCD	WMO Regional and Technical Cooperation Activities for Development Department
RCM	Regional Climate Model
ROSELT	Long-Term Ecological Observations Monitoring Network
RTH	Regional Telecommunications Hub
SAF	Satellite Application Facility
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice

SIDS	Small Island Developing States
TAR	IPCC Third Assessment Report
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Economic, Social and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WCRP	World Climate Research Programme
WCP	World Climate Programme
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WOUDC	World Ozone and Ultraviolet Radiation Data Centre
WWW	World Weather Watch