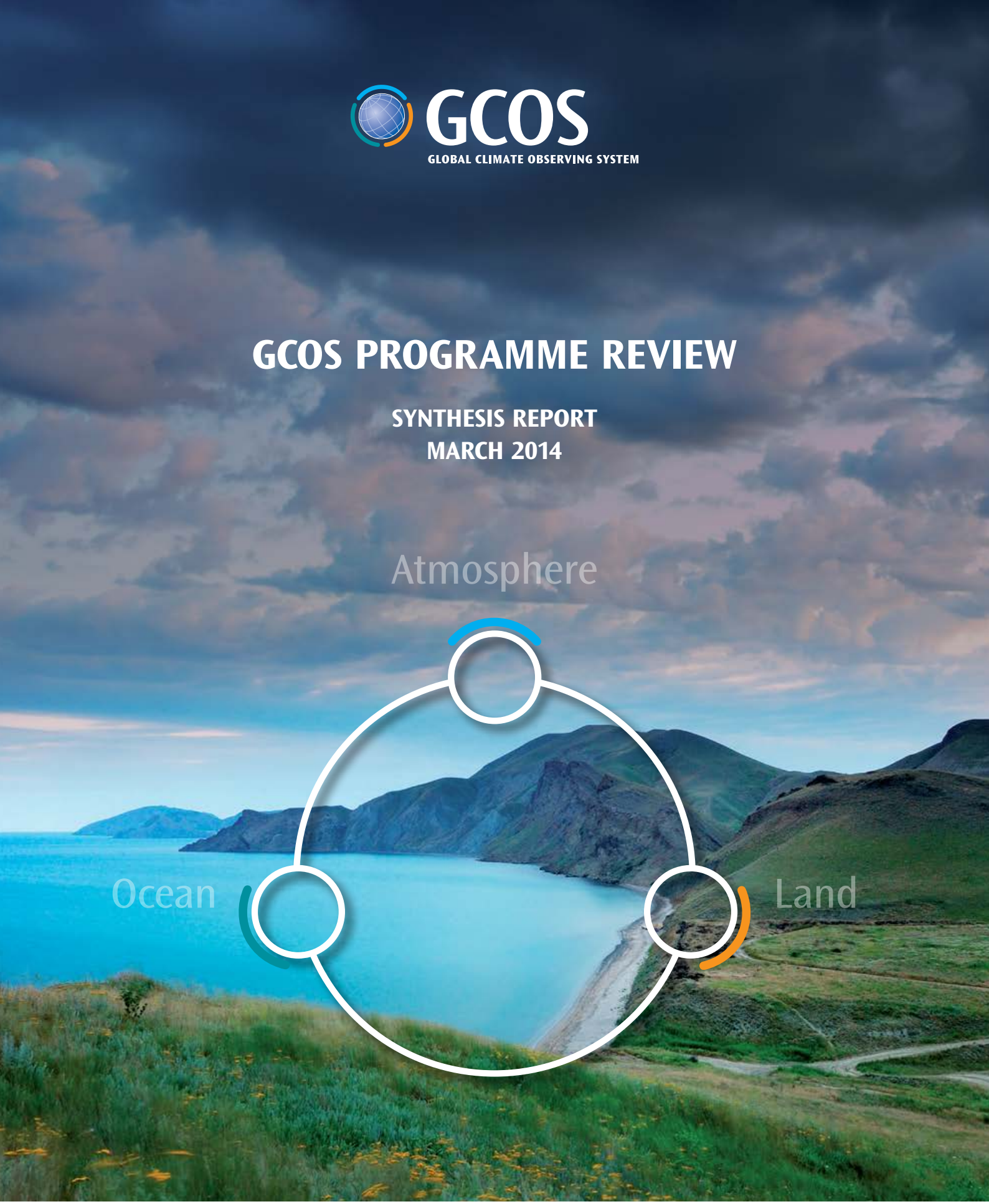
GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

GCOS PROGRAMME REVIEW

SYNTHESIS REPORT
MARCH 2014



WMO UNESCO IOC ICSU International Council for Science UNEP

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ICSU

Founded in 1931, the International Council for Science (ICSU) is a non-governmental organization representing a global membership that includes both national scientific bodies and international scientific unions. The ICSU 'family' also includes more than 20 interdisciplinary bodies - international scientific networks established to address specific areas of investigation. Through these networks, ICSU coordinates interdisciplinary research to address major issues of relevance to both science and society. In addition, the Council actively advocates freedom in the conduct of science, promotes equitable access to scientific data and information and facilitates science education and capacity building. [http://www.icsu.org]

IOC

The Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) was created in 1960. On behalf of its Member States, IOC promotes international cooperation and coordinates programmes in research, sustainable development, protection of the marine environment and capacity building for improved management and decision-making. It facilitates interagency coordination in the UN system through the UN-Oceans mechanism and collaborates on global reporting and assessment of the state of the marine environment. Through the Global Ocean Observing System (GOOS), the IOC helps improve operational oceanography, weather and climate forecasts, and monitoring. [http://ioc-unesco.org]

UNEP

The United Nations Environment Programme (UNEP) is an international programme that coordinates United Nations environmental activities, assisting developing countries in implementing environmentally sound policies and practices. It was founded at the United Nations Conference on the Human Environment in June 1972. Its activities cover a wide range of issues concerning the atmosphere, marine and terrestrial ecosystems, environmental governance and green economy. UNEP has helped formulate guidelines and treaties on issues such as the international trade in potentially harmful chemicals, trans-boundary air pollution and the contamination of international waterways. UNEP and WMO jointly established the Intergovernmental Panel on Climate Change (IPCC) in 1988. [http://www.unep.org]

WMO

The World Meteorological Organization (WMO) is a specialized agency of the United Nations. It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources. WMO has a current membership of 191 States and six Territories. It emerged from the International Meteorological Organization (IMO), which was founded in 1873. Established in 1950, the next year WMO became the agency of the United Nations specializing in meteorology (weather and climate), operational hydrology and related geophysical sciences. [http://www.wmo.int]

EXECUTIVE SUMMARY

After 20 years of operations, a review of the Global Climate Observing System (GCOS) programme was long overdue. The GCOS programme sponsors accepted the proposal for a review, and in December 2012 the WMO Secretary General appointed a Chair and invited the sponsors to nominate a Review Board for this purpose.

This document is based on the GCOS Programme Review Full Report. Its purpose is to give the GCOS community and the decision-makers an overview of the review process and the findings and recommendations. The GCOS Review formally began with the First Meeting of the GCOS Review Board in Geneva, 26-27th March 2013 and continued throughout the year; to be completed in April 2014. The review was conducted by a Review Board appointed by the programme's sponsors: the International Council for Science (ICSU), the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the United Nations Environment Programme (UNEP).

The Review Board gathered evidence in four ways: 1) a self-assessment by current and former GCOS Steering Committee Chairs and former GCOS Secretariat Directors; 2) a survey questionnaire distributed to the broader GCOS community; 3) a number of targeted personal interviews with senior representatives of the GCOS programme sponsors; and 4) active and considered appraisal and interpretation of results by the Review Board members.

The outcome of the review is a range of critical reflections on GCOS—these are the Review Board's findings. The findings were summarized thus:

> There is no doubt that the GCOS Programme should be continued. It is indispensable. If it ceased to exist it would need to be re-created. To make GCOS fit for the future, the GCOS Memorandum of Understanding (MoU) should be redrafted on the basis of careful consideration of all its chapters and annexes. A revised MoU should reflect all items that were previously included, along with new understandings and commitments by sponsors, such as a better cooperation mechanism and an optimized structure for the Secretariat, Steering Committee and its Panels. This should be supported by a more stable financial foundation as a prerequisite for everything else.

The Review Board has prepared 18 recommendations based on the findings. It is hoped that these recommendations will assist the sponsors in their consideration of further action to support the GCOS programme.

1 RATIONALE FOR THE REVIEW

The GCOS Programme formally celebrated the 20th anniversary of the Global Climate Observing System on Friday, 29 June 2012, during the 64th WMO Executive Council meeting in Geneva. This important milestone provided an opportunity to review the origins of GCOS, to take stock of its accomplishments during its first twenty years and to think ahead about the programme's upcoming opportunities and challenges.

This set of tasks was tabled at the 19th Session of the GCOS Steering Committee, held from 20-23 September 2011 at the European Centre for Medium-Range Weather Forecasting (ECMWF) in Reading, UK, where discussions under agenda item "The Role of GCOS" focused on the proposed review of the GCOS Programme.

The GCOS Programme has had substantial success in the past, but several important new developments have resulted in the need to re-examine the GCOS Memorandum of Understanding (MoU). These new developments include the establishment of the Global Earth Observation System of Systems (GEOSS) of the Group on Earth Observations (GEO), as well as the increased attention countries are now giving to adaptation to climate variability and change. In addition, the development and implementation of the Global Framework for Climate Services (GFCS), the WMO Integrated Global Observing System (WIGOS) and the recent findings of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, all have a bearing on the GCOS Programme. Moreover, GCOS assesses the adequacy of global observations for climate to the Subsidiary Body on Scientific and Technological Advice (SBSTA) of the United Nations Framework Convention on Climate Change (UNFCCC), and this assessment is considered in the programme review.

Lastly, a GCOS programme review can be the basis for revising and updating both the GCOS Memorandum of Understanding and the GCOS Strategic Plan. It is also of course good practice to subject programmes to periodic review.

1.1 HISTORICAL BACKGROUND

The Global Climate Observing System (GCOS), sponsored by the World Meteorological Organization, the Intergovernmental Oceanographic Commission of UNESCO, the United Nations Environment Programme and the International Council for Science, formally came into being at the first meeting of the GCOS Joint Scientific and Technical Committee in Geneva in April 1992. This occurred in response to a growing demand for information on the global climate system.

The basic concept of GCOS was set forth in the 1992 MoU, which specified its goal, objectives and design philosophy, all of which have been refined and elaborated over the years. The original MoU listed the objectives of GCOS as support for all aspects of the World Climate Programme (WCP) and for the relevant aspects of other climate-related global programmes, including eventually the International Geosphere-Biosphere Programme (IGBP) and other Earth System Science Partnership (ESSP) programmes. GCOS also supports the assessment role of the IPCC and the policy development role of the UNFCCC, specifically in meeting the needs for climate system monitoring and climate change detection. GCOS helps these programmes monitor the impacts of climate change and helps monitor the response to these impacts as well, especially as they concern terrestrial ecosystems and mean sea level. It does this by providing data that can be applied to national economic development, and by undertaking research designed to improve understanding, modeling and prediction of the evolution of the climate system.

The current MoU dates back to 1998. It notes in particular that the sponsors agree to regard the Steering Committee "as the main scientific and technical body for formulating the overall concept and scope of GCOS, and advising on the further development of GCOS". The GCOS Secretariat is charged under the

MoU with assisting the Steering Committee and, by implication, the panels and working groups established by the Committee. It is further responsible for scientific and technical liaison with relevant bodies of the sponsors and other organizations, for document and information preparation and services, and for organizing, planning and coordination in accord with financial arrangements set out in the MoU and Steering Committee guidance.

The GCOS Secretariat is based at WMO Headquarters in Geneva and comprises a Director and an Administrative Assistant funded directly by WMO, plus two or three staff funded through various means, usually on a short-term basis. The Steering Committee Chair submits annual reports to sponsors. In an accompanying letter, the Chair may highlight specific topics and identify other important matters.

Over the years, GCOS has supported many of the programmes and initiatives of its sponsoring organizations. The need and demand for information on global climate has never been greater. Many regions in the world are affected by changes in climate, and those changes need to be managed now. It has taken years of work by the IPCC, assessing the climate science literature, and by the World Climate Research Programme (WCRP), advancing the state of climate science, to raise the awareness that observations of climate must be available on a global scale to underpin decision-making. Recent changes in the climate-observation-programme landscape have led to an evolving framework for climate services, not just for the IPCC and WCRP, but also for the programmes of GCOS sponsors, including Future Earth, Blue Planet, Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA), GFCS, and many others.

1.2 STRUCTURE OF THE REVIEW

As mentioned above, the review was carried out by a Review Board appointed by the programme's sponsors, the International Council for Science (ICSU), the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and the United Nations Environment Programme (UNEP). The Review Board consists of experts nominated by the four sponsoring organizations. Each organization agreed on the Terms of Reference for the review and contributed its suggestions for Review Board membership.

The Full Report has six parts:

- the first, outlining the rationale for the review;
- the second, describing the process of the review;
- the third, presenting the evidence gathered by the elements of the review process;
- the fourth, exploring what was learned by the review board as a result of the review;
- the fifth, providing a list of observations and recommendations arising from the review; and
- the sixth, a final statement by the review board.

Finally, a set of Annexes provides background documentation and further detail.

This synthesis report is based on the full report. It is being disseminated according to the instructions of the programme's sponsors.

2 PROCESS OF THE REVIEW

The Review Board gathered evidence in four ways. These are discussed in detail below.

2.1 SELF-ASSESSMENT

The self-assessment focused on how the GCOS Steering Committee perceives its past achievements and its understanding of future challenges and opportunities. Materials used for the self-assessment included:

(a) A presentation by the current Chair of the GCOS Steering Committee, Prof. Adrian Simmons, along with questions and answers following the presentation. This presentation was given during the first GCOS Review Board meeting in March 2013.

(b) A 'Think Tank' document presented for the 20th Anniversary of GCOS. The 'Think Tank' was organized as part of the GCOS 20th anniversary celebration. The preparation of this document took advantage of the fact that many people who have given much thought to GCOS over the years were in Geneva to participate in the celebration. These included former GCOS Steering Committee Chairmen and former GCOS Secretariat Directors. Also on hand were some current GCOS Steering Committee members, some WMO Commission presidents, and several members of the WMO Executive Committee.

(c) A journal article (Houghton, et al. 2012) describing GCOS over its 20-year history. This article was prepared by current and past Chairs of GCOS Steering Committees and Joint Scientific and Technical Committees in recognition of GCOS accomplishments.

2.2 SURVEY OF THE BROADER GCOS COMMUNITY

Review Board Members designed the survey questionnaire during the 1st Review Board meeting in March 2013. The Review Board agreed on the survey's targeted distribution and the questionnaire was implemented via the proprietary online survey utility 'Survey Monkey' (www.SurveyMonkey.com). The questionnaire consisted of 33 multiple-choice questions broadly covering five component sections of the survey:

Section 1 – Balance and relevance of GCOS MoU (questions 1-6)
Section 2 – GCOS programme achievements (questions 7-12)
Section 3 – The relation of GCOS to international and national organizations (questions 13-17)
Section 4 – GCOS programme functions and mechanisms (questions 18-26)
Section 5 – Vision and future plans (questions 27-33)

The survey questionnaire was sent to experts in each sponsor's community as well as to data providers. In total, 150 questionnaires were sent out, and the Board received 54 responses. The Review Board considered the return of more than one-third of the questionnaires to be a very satisfactory result.

Reference copies of the following are included in the Full Report:

- The survey questionnaire is included as Annex 5.
- The survey statistics are included as Annex 6.
- The survey comments are included as Annex 7.

2.3 PERSONAL INTERVIEWS

Certain individuals were selected for personal interviews based on their senior standing within partner agencies and their familiarity with the programme. The interviews, which were conducted by the Chair of the Review Board, were intended to provide in-depth consideration of specific points and to augment the statistical results and comments of the survey questionnaire.

While the interviews were broadly based on the structure of the questionnaire, the interviews did not necessarily include all of its questions; they provided instead the opportunity for more open discussion and comment. The interviewees provided a clear picture of the needed changes and offered advice for future engagement of GCOS with its sponsors. The input of these interviewees has helped in formulating the findings and recommendations in this report. More details can be found in the Full Report (section 3.3 – Interviews).

2.4 REVIEW BOARD

The GCOS Review Board members were chosen by nominations from the sponsors on the basis of their in-depth knowledge of the programme and their ability to represent the perspectives of the sponsors, the Steering Committee and the Secretariat. The Review Board members guided the formulation of the review's structure, process and survey design. The Board members analysed and interpreted the results. Finally, they gave additional insight and commentary to help fill gaps in the knowledge and to guide the drafting of this report. A list of the Review Board members can be found in the Full Report, Annex 1.

The Review Board met formally at WMO Headquarters in Geneva in March and October 2013. The report was finalized in March 2014, following its review by the programme's sponsors.

3 REVIEW BOARD CONSIDERATIONS OF THE EVIDENCE AND FINDINGS

3.1 RELEVANCE OF THE GCOS MEMORANDUM OF UNDERSTANDING

GCOS was established in 1992 as an outcome of the Second World Climate Conference. The concept and mandate of the programme was set forth in an MoU. The programme has four major sponsors: WMO, IOC, UNEP, and ICSU. As part of its original concept and mandate, the programme was not intended for providing observational services, but for representing the aggregated climate-observing elements of observing systems. Therefore, GCOS is a programme that coordinates a set of activities with common attributes. The survey shows, however, that there is a need to clarify and communicate more clearly the role and functions

of GCOS. The survey revealed many diverse views and concepts of what GCOS is. A general answer may be: "The Global Climate Observing System (GCOS) is an internationally coordinated network of observing systems and a programme of activities that support and improve the network. It is designed to meet evolving national and international requirements for climate observations."

Respondents of the survey largely agreed that the GCOS MoU and its five major points are still valid. Respondents also agreed that the MoU should be revised to become "fit for the future". Respondents indicated that future roles and responsibilities should be clarified, and relations with other programmes and activities should be discussed in more detail. For example, respondents agree that activities by the GFCS programme address significant future needs and those should be focused on, with GEOSS as a secondary link. GCOS could use GFCS as the scope-setting mechanism, at scales ranging from global to regional.

GCOS remains broadly supported by its four major sponsors. Wider sponsorship of GCOS has a positive aspect—it demonstrates a core value of the programme, namely "independence". Less positively, wider sponsorship can dilute the sponsors' commitment and sense of ownership. But, as a multi-sponsored programme representing a broad range of users and stakeholders, GCOS is able to serve different needs and values. The survey showed support consistently above 80 per cent for the GCOS concept.

For the major sponsors, the programme meets many needs:

> **For WMO:** GCOS supports the work of WMO in climate-related matters throughout the UN system. GCOS is an essential element of GFCS. GCOS gives technical guidance to the National Meteorological and Hydrological Services (NMHSs) on climate observations. And GCOS is building the platform to coordinate with partner programmes, supporting WIGOS activities in the area of climate and serving the sustained observational needs of WCRP.
>
> **For IOC:** GCOS provides IOC with guidance and the coordination mechanism for the climate-element of the Global Ocean Observing System (GOOS). GCOS is the overarching mechanism for Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) activities, setting the requirements.
>
> **For UNEP:** GCOS provides the observational backbone of UNEP regional and sector focused activities, in particular for vulnerability and impact studies.
>
> **For ICSU:** GCOS provides the scientific community with climate observations requirements and with access to climate information, and it provides access to climate observations from research networks. GCOS shares with ICSU the goal of free data sharing and access of information.

3.2 PROGRAMME ACHIEVEMENTS

The normative work of GCOS is well recognized. It is recognized globally as an authority. Respondents of the survey overwhelmingly consider GCOS an indispensible program, one that is performing a very important role representing climate-observing networks and enabling enhancement and applications of the global climate observation on a long-term basis. While GCOS does not itself produce observational data products, it coordinates with organizations that produce climate data, and it enables public access to those data products. GCOS also works with the community to define and enhance standards and the usability of data products, responding to needs from a broad range of users (such as the science community and global policy

applications), and contributing to the goal of more integrated monitoring in multiple domains (atmosphere, lands, and oceans).

Its major achievements over the last twenty years include development of the concept and standards of essential climate variables (ECV), advocacy of climate-monitoring principles and activities, and efforts to strengthen global and national observation capabilities. The concept and technical specifications of ECV have been accepted globally as an effective climate-monitoring tool for atmosphere, ocean and land ecosystems. In addition, the normative work of GCOS for other observational efforts is well recognized. It is recognized globally as an authoritative programme of climate observations. As a result of these achievements, GCOS is able to coordinate and represent key climate observations at the global scale in aggregate.

GCOS is valuable not just for WMO and its other sponsors. Many stakeholders rely on GCOS for their mission-critical information needs, and they strongly support the work of GCOS. These stakeholders include, for example, several WMO programs or initiatives (GFCS, WIGOS, etc.), IOC, UNEP, ICSU, UNFCCC, IPCC working groups, GEO, WCRP, and the scientific community working on climate-change research or on earth-science research that uses climate data. WCRP relies on GCOS for sustained climate observations. GCOS has mature relationships with many of its partners, and it has earned their trust.

Space observation groups (i.e., the Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS)) are major data providers where synergy is gained by integrating in-situ observations. GCOS is a valuable resource for developing the architecture of space-based climate monitoring. As a result, CEOS agencies are actively testing, researching and developing satellite-based ECV products with close coordination provided by GCOS.

Major achievements are described in more detail in Houghton, et al. 2012.

3.3 CHALLENGES AND OPPORTUNITIES FACING GCOS

Challenges facing GCOS are real and urgent. Recent years have seen the emergence of new global programs with overlapping climate-observation responsibilities. To remain effective, GCOS must remain relevant and unique. It must clarify its relationships with other international and national organizations. Relationships between GCOS and other international and national organizations are ambiguous regarding many of its roles and functions. For example, what are the distinctions between GCOS and GOOS and between GCOS and Global Terrestrial Observing System (GTOS) as regards climate observations? The challenge for GCOS is to maintain its unique roles and responsibilities, and thus to be both relevant and cost effective. Clarifying those relationships will help GCOS to continue its contributions to its stakeholders. Perhaps GCOS can operate as a requirement-setting element for climate observations, whereas GOOS, GTOS, and WIGOS can function as implementing elements. In this regard, the original MoU may require updating and clarification.

GCOS is the natural group to be the observation and monitoring pillar for the global scope of GFCS, which addresses requirements and applications at all scales. In regions having organized regional implementation plans, GCOS has had a positive impact. GFCS will have significant needs in the future, and GCOS should focus

on those. GCOS may be able to use GFCS as the scope-setting mechanism, at scales ranging from global to regional. Similarly, GEO GEOSS and UNEP also require regional focuses with respect to their monitoring and assessment programs for natural disasters, land degradation, deforestation, climate change mitigation and adaptation, and other needs. Monitoring and assessment by UNEP, for example, tend to be regionally focused because of regional forces that exert significant pressure on the environment. GCOS should be prepared to add regional focus to its program of work.

GCOS is weak in communication and outreach. Some potential users are not aware of GCOS activities and the service it provides. Communication between GCOS and other international programs remains sporadic and inconsistent. Strengthening communication will require additional resources and support by GCOS sponsors and stakeholders.

GCOS has done well with assessments of climate observations and monitoring at the global scale, particularly in the atmosphere and ocean domains. But the need for assessing regional and national requirements has not been met adequately. There is a continuing need for GCOS in regional assessment of vulnerability and adaptation (for example, food security and community health), anthropogenic effects, and monitoring of mitigation.

In recognizing these challenges and opportunities, the sponsors must help GCOS maintain its unique roles, as it also adapts to new needs and the changing operating environment. Unfortunately, the sponsors are not currently engaged in a way that is optimal to the future of GCOS. For example, the recommendation in the current MoU for 'regular review' of the programme by its sponsors has never been executed. Regular reviews could help GCOS assess the effectiveness of its work and promptly identify problems.

3.4 VISION AND FUTURE PLANS

The environment in which GCOS operates has changed significantly in the last twenty years.

GCOS and its partners must ensure that the programme is an enabling and guiding mechanism for agencies charged with understanding and responding to climate change. GCOS is not alone in the arena of climate and climate change observations, which has many consequences. There are positive developments with regard to satellite data, numerical models, radar data, and new observational technologies. But there are also many deficiencies: lack of resources (staff and finance), alienation of sponsors, communication problems, gaps in observation networks and insufficient support by some regions.

Undoubtedly, GCOS must be continued. It is indispensable. If it ceased to exist it would need to be re-created. But to make GCOS fit for the future, the MoU should be revised. A revised MoU should include all items that were previously included, along with new understandings and commitments among sponsors, such as a better cooperation mechanism, as well as an optimized structure for the Secretariat, Steering Committee and its Panels. Moreover, a more stable financial basis is a pre-requisite for all these.

Over the last twenty years, there has been significant technical progress, largely according to the mandate defined in the GCOS concept and the MoU. An updated MoU will define the modern principles that will enable GCOS to maintain its leadership in global climate observations.

4 RECOMMENDATIONS

GCOS is an active and successful programme serving a broad range of user needs for globally coordinated climate observations. Its goal is to provide comprehensive observations of the total climate system, including a range of physical, chemical and biological properties, along with atmospheric, oceanic, hydrological, cryospheric and terrestrial processes.

GCOS is working with existing or planned operational and research programmes for observing the global climate system. It enables the development of these programmes to ensure continuity of climate observations. It has chosen to organize observations around the concept of essential climate variables (ECVs). Currently 50 ECVs are defined, spanning the atmospheric, oceanic and terrestrial domain.

Recommendation 1 - GCOS and its sponsors should develop a more succinct mission statement. Different documents contain different versions, and there are some conflicting statements.

In the following pages several specific recommendations are made. The MoU has five main points of agreement that provide the structure against which the recommendations are proposed.

4.1 BALANCE AND RELEVANCE OF THE GCOS MEMORANDUM OF UNDERSTANDING

> *(MoU point 1) To cooperate in organizing and supporting a Global Climate Observing System (GCOS) based on the coordination of existing or planned operational and research programmes for observing the global climate system, and the further development of these programmes as required to ensure continuity of observations.*

GCOS is encouraged to keep up its good work in networking with a large and diverse range of observing networks. GCOS is recognized as a mechanism to ensure high quality global observations by providing clear targets and guiding principles for a large range of essential climate variables.

Recommendation 2 - The sponsors should review all elements of the existing MoU and update them to reflect the environment in which GCOS operates today.

The current version of the GCOS MoU is from 1998. The general scope of that MoU is still valid and relevant. But the 1998 MoU has an agreed action that seems to have lapsed during the recent decade:

> *AGREE: that this Memorandum of Understanding shall be reviewed every four years by the sponsoring organizations, and may be called for review at any time by one of the sponsoring organizations.*

4.2 GCOS PROGRAMME ACHIEVEMENTS

> *(MoU point 2) That the GCOS shall, as its long-range objectives, support all aspects of the World Climate Programme and relevant aspects of other climate-related global programmes.*

Specifically the GCOS will ensure the data needs are met for climate system monitoring, for assessing the impacts of climate variability and change and applications to national economic development, as well as research leading to improved understanding, modelling and prediction of the climate system.

GCOS has successfully developed and implemented the concept of ECV. The ECVs are reviewed regularly and provide an organizational framework for a diverse set of on-site and remote sensing observing systems.

While in general GCOS is well known to the operators of climate observing systems and within the climate research community, some of the users of climate information are not aware of the programme and its important achievements.

Recommendation 3 - The sponsors should work with GCOS to increase the visibility of the programme, its achievements and ambitions. A more attractive website, flyers and modern media could be used to promote GCOS and its activities.

GCOS has divided the ECVs into three main domains: atmosphere, ocean and land. The atmosphere and ocean domains have shown great progress over the recent decade. The land domain, however, has not made as much progress.

Recommendation 4 - The sponsors should work with GCOS to improve terrestrial climate observations. The sponsors could hold a high level strategic workshop with the relevant bodies to develop a plan for improvement.

GCOS has engaged in several capacity-building efforts to meet some of the needs of development counties. These efforts are laudable; however, they are happening in an opportunistic rather than in a strategic manner.

Recommendation 5 - GCOS should develop a more strategic approach to capacity building, in partnership with other organizations. The GCOS cooperation mechanism should be enhanced in this context. GCOS might add the need for capacity building to its requirements documents.

GCOS has been less engaged in the development of observing systems that allow the quantification of climate impacts (e.g., health, energy and food sectors) and associated information for national economic developments.

Recommendation 6 - The sponsors should update the MoU to reflect recent developments (e.g., GFCS, PROVIA, Future Earth).

4.3 THE RELATIONSHIP OF GCOS TO INTERNATIONAL AND NATIONAL ORGANIZATIONS

(MoU point 3) To consult and call upon other relevant national and international agencies, institutions and organizations, to collaborate in the organization and participate in the implementation of the GCOS.

GCOS has developed excellent working relationships with many of the observing networks, the WMO observing efforts and the climate research community. In the last decade, there have been several important developments. In 2002 GEO was launched to coordinate efforts to build GEOSS. The relationship between GEO and GCOS has been evolving over the years.

Recommendation 7 - GCOS and its sponsors should build formal communication with GEO about the complementarities in their work. GCOS and its sponsors should develop more effective cooperation between GEO and GCOS with the goal of building a robust and sustained observing system.

In 2009, Heads of States and government ministers at World Climate Conference-3 set in motion the process for developing GFCS. This process led to the development of the Implementation Plan. One of the priority areas set out in the Plan is *Observations and Monitoring – to develop agreements and standards for generating necessary climate data*. GCOS is expected to play a central role in this endeavour.

Recommendation 8 - GCOS and the other observing entities of GFCS should devise a joint strategic plan to define the function and responsibilities of GCOS in the GFCS.

PROSPECTUS FOR A NEW GCOS ENGAGEMENT COMMITTEE

The GCOS Engagement Committee will be a strategic advisory group the primary purpose of which is to ensure that GCOS can fulfil the sponsors' and users' expectations, as articulated in a revised MoU. The Committee will focus activities and strategy at the sponsor, user and agency level. It will facilitate building a new constituency for GCOS by developing links with groups not traditionally engaged with the GCOS climate-observing community. Close stakeholder engagement will ensure that GCOS continues to provide relevant and informed guidance and solutions for an effective global climate observing system.

Its main functions are:

1. to advise and provide recommendations to the Steering Committee, the GCOS director and the sponsors on programme priorities that require new resources;

2. to agree to and oversee the GCOS engagement and communication strategy, particularly by providing strategic guidance, and by finding new ways to foster engagement and partnership with users;

3. to provide advice on fund-raising strategy and activities;

4. to initiate, propose and endorse new GCOS activities in collaboration with stakeholders, for example, new ECVs, improved capacity building and regional enhancements; and

5. to provide guidance on how to improve engagement with the private sector in matters of global climate observations.

ICSU and UNEP are developing new initiatives that address the interaction between humans and the environment. The UNEP PROVIA is a global initiative to provide direction and coherence at the international level for research on vulnerability, impacts and adaptation (VIA). Future Earth is a new 10-year international research initiative to develop the knowledge required to respond to the risks and opportunities of global environmental change and to support global sustainability in the future.

Recommendation 9 - GCOS and its sponsors should initiate communication with PROVIA and Future Earth to clarify the functions and responsibilities of GCOS in their respective activities.

The interaction between GCOS and the nations are mixed.

Recommendation 10 - Recommendation 10 - GCOS should strengthen its ties to national governments by promoting the role of national and regional coordinators. An international GCOS summit or a series of regional GCOS summits could provide the opportunity to do this.

4.4 GCOS PROGRAMME FUNCTIONS, MECHANISMS AND GOVERNANCE

(MoU point 4) To establish a GCOS Steering Committee, to provide scientific and technical guidance for the organization and further development of the GCOS, and a GCOS Secretariat;

(MoU point 5) To support, through appropriate administrative and financial arrangements, the activities of the Steering Committee and Secretariat for GCOS.

GCOS has received administrative and financial support from its sponsors at very different levels. Survey respondents all agreed that the overall budget allocation is inadequate for the task expected from GCOS.

Recommendation 11 - The sponsors of GCOS should review the current level of support of the programme and assess its adequacy. They might consider changing the GCOS governance structure and establishing a GCOS engagement committee.

The MoU defines the task and mandate of the Steering Committee. In general its purposes are to decide the priorities for the climate observing system; guide the operation of the climate observing system, including standards, principles and architecture; and manage the overall direction of the programme. The Review Board concluded that the mandate and name of the Steering Committee are still appropriate.

The Review Board noted that there are significantly fewer members of the Steering Committee at present compared with the number set on the MoU. This appears to be a consequence of lapsing terms. The Review Board also noted that short terms present a problem. The Review Board concluded that two-year terms (with the possibility of serving three terms) should be extended to three years, with the possibility of serving two terms. This arrangement will reduce turnover.

Given the important place of the GFCS in climate matters, the Review Board suggests there should be an ex-officio Steering Committee member nominated by GFCS.

The Review Board also noted the unfortunate dual role of the current Chair, sitting as both the Chair of the Steering Committee and Chair of the constituent panel. This situation is not addressed in the MoU.

Recommendation 12 - The MoU should be updated to clarify the constitution of the Steering Committee and to ensure representation from newly formed bodies. The Review Board recommends (a) that the terms of Members be for three years, with the possibility of serving for two terms; (b) that the GFCS should have an ex-officio position on the Steering Committee, to be nominated by the GFCS Board or their designated officer; and (c) that no member of the Steering Committee, including the Chair, should have an official position on any of its subsidiary bodies.

The Review Board noted that survey respondents are positive about the Secretariat, but they also are concerned that the Secretariat is not adequately resourced to support GCOS activities.

The Review Board also noted that the level of the Director in the management hierarchy had changed over recent years and that the MoU is ambiguous about the Director's responsibilities for managing the budget. This situation is complicated by the fact that the Secretariat sits within the hierarchy of WMO. The Secretariat derives considerable benefit from this position, but the sponsors expect the Secretariat and the Director to exercise independence. The Review Board believes that the Director needs to have influence within WMO and within the sponsoring organizations at a level higher than that of the current position.

Recommendation 13 - The Duty Statement for the Director of the GCOS Secretariat (paragraph 6.5 of Annex B to the MoU) should be revised to make clear (a) that the Director is responsible for allocating budget against activities according to the priorities and direction of the Steering Committee, (b) that the Director is responsible for managing the relationship of GCOS to the sponsoring and partnering organisations, and (c) that the position should be on the same level as that of others with commensurate management and relationship responsibilities.

A general theme running through the interviews and survey results is that there has not been enough support for communicating the purpose, benefits and current activities of GCOS. Stakeholders are sometimes confused about the role of GCOS in implementation, accountability and responsibility.

The Review Board recognizes that achieving effective communication is difficult. GEO, WIGOS, GOOS, GTOS, CEOS, Partnership for Observation of the Global Observation (POGO), and JCOMM are just some of the organizations and programmes involved in climate observations, and they are all trying to highlight their own identify and purpose.

Developing a clear vision and strategy will assist in overcoming these difficulties. The unique value of GCOS should be communicated clearly and consistently. In addition, all participants should work to a single strategy, and the coordination among players must be strong.

4.5 VISION FOR THE FUTURE

The current version of the MoU states that "*GCOS is ensuring the availability of global observations for the total climate system for all users*". The Review Board heard several comments questioning whether GCOS

could ensure that the intended observations stream was available, in view of the fact that its primary functions are to create a climate observing system, analyse user needs and observational requirements, and promote standards and principles for climate observations. There were also concerns about the extent of the mandate, i.e., "all users" could imply that GCOS should respond to regional and national needs.

An additional concern was the extent to which the design of the system should be focused on the climate system in the strict sense, rather than on general earth systems and environmental information requirements.

Recommendation 14 - GCOS should develop a communication strategy (see Recommendations 15 and 16) that will provide additional clarity about the purpose of GCOS. In particular, this strategy should communicate the unique value of GCOS; it should require that all participants work in a single strategy; and it should ensure that there is strong coordination between players.

Example vision statements for GCOS:

> *To deliver the design, plans and architecture for a global climate observing system to support climate research, assessments and services through an integrated system of observing systems.*
>
> *Vision: A comprehensive climate observing system supporting climate services and improved understanding of the climate system.*

Important GCOS tasks include assimilating and interpreting standards for climate observations from its sponsoring organisations. These standards are used for research, assessments and climate services. The "one system – many uses" model is fundamental to the efficient and effective operations of the climate observing system. In some cases, the sponsors provide guidance on priorities, in others the priorities are inferred from the material and documents available to GCOS.

Therefore, the strategy should define, from the perspective of GCOS (which is leading on standards, measurement requirements, architecture and design), how the climate community should implement, maintain, and support the climate observing system. While GCOS is not itself an implementing body, it is responsible for guidance on priorities and standards and observation requirements. The strategy should guide the activities that will give such guidance.

Currently, the high-level GCOS strategy is embedded within various plans and documents; there is no standalone strategy statement. In devising strategy, it is helpful to think of GCOS as a program of activities that enable the operation of a climate observing system. Those activities should respond to a clearly articulate strategy and the priorities drawn from it. This strategy should be short—ideally on just one page—so GCOS stakeholders can easily understand it.

Recommendation 15 - GCOS should develop a short statement of strategy, based on the vision, to guide priority setting and to communicate to stakeholders the aims and intended benefits of GCOS.

GFCS is a major undertaking to bring the provision of climate services under a single framework, one that is supported across UN agencies and that responds to key sectoral, global and regional demands for climate data, products and information.

Two goals of GFCS, in particular, point to a strong relationship with GCOS:

- (Goal 3) Mainstreaming the use of climate information in decision-making. Promoting better uptake, understanding and awareness of the need for climate information and climate services; and demonstrating the value of the services in socio-economic, safety and sustainability terms;

- (Goal 5) Maximizing the utility of existing climate service infrastructure. Improving coordination, and strengthening and building this infrastructure where needed.

"Mainstreaming the use of climate information" implies that GFCS will need to draw on mainstreamed sources of data and information, and this is a role that GCOS plays for climate observations. Moreover, GCOS provides a single mechanism for coordinating the development of plans, requirements and standards for climate observation. Consequently, GFCS probably provides the most important potential way for the global climate observing system to have a major impact.

To this end, the Review Board supports GCOS being recognized as a permanent element of the GFCS architecture, providing direction and oversight for plans, architecture, standard setting and climate observation requirements in support of the GFCS. In the GFCS architecture, GCOS sits alongside operational elements, such as GOOS and WIGOS that coordinate the component observing systems. In addition, GFCS is a source of advice and support for observations that are beyond the scope of GCOS.

Recommendation 16 - The sponsors of GCOS should recommend that GCOS be recognized as a permanent element of the GFCS. That recommendations should provide:

- the policy (standards, recommendations for observations, strategy) for climate observations in support of the GFCS and, in particular, for the Climate Services Information System;

- a single point for coordination, working through bodies such as WIGOS, GOOS and CEOS for implementation; and

- a significant role for the broader observation requirements of GFCS.

At the time GCOS was created, its work on climate change focused on improving our understanding of physical climate systems and on detecting and attributing changes, as appropriate. Climate-change impacts were receiving considerable attention, but research and services concerned with adaptation, risk and mitigation were just beginning. Today, the IPCC focuses considerable attention on impacts, vulnerability and adaptation, and mitigation. The work of IPCC necessarily depends on the observational evidence, particularly evidence relating to system change. The definition of climate is being extended to variables and fields outside the physical system.

The evidence provided to the Review Board suggests a need for an increased focus on observations for climate-change mitigation (agriculture, deforestation, forest cover, land cover, etc.) and for adaptation. It is important to define the role that GCOS can play in this regard, particularly at the regional level and for regional applications. Consequently, the partnership with UNEP should be strengthened, as that organization follows a strong regional-based work approach.

The ECVs have provided an effective means for communicating the priority observational needs of the climate-observing system. There is a sound scientific rationale for the inclusion of each ECV; there is a well-developed approach for measurements to estimate the variable; and there is a clear need for the information provided through the variable. It may now be the right time for GCOS also to focus attention on the essential climate fields and products, in the context of the GFCS and other users of climate information. In other words, perhaps now is the time to emphasize deliverables instead of measurements. Such an approach may de-emphasize the individual contributions of platforms (e.g., on-site versus satellite) in favour of a focus on the fields and products derived from these sources. Such an approach has already been adopted for the Framework for Ocean Observing.

Recommendation 17 - The sponsors should consider giving GCOS a mandate that includes adapting to and mitigating climate change and its regional impact. The sponsors should consider clarifying the language in the MoU concerning "assessing the impacts of climate variability and change and applications to national economic development" and "monitoring the impacts of and the response to climate change, especially in terrestrial ecosystems and mean sea level" because, in the modern context, this implies a mandate that extends into adaptation and mitigation and regional impacts. In making this clarification the options would appear to be (a) to use the scope and mandate of the GFCS as a guide, in particular, the GFCS Information System, (b) to extend the GCOS mandate explicitly into regional impacts, adaptation and vulnerability, and mitigation, in line with the IPCC assessments and using 'climate' in the sense of IPCC or UNFCCC, or (c) to restrict explicitly the scope of GCOS by retaining an emphasis on global systems and the physical climate variables as captured by the ECVs.

Recommendation 18 - GCOS should elaborate the ECV concept to specify its key deliverable and outputs, continuing the process of emphasizing fields and products and de-emphasizing individual platforms.

5 FINAL STATEMENT OF THE REVIEW BOARD

The Review Board believes that the outcome of this review will provide a good basis for revising the GCOS Memorandum of Understanding and updating the GCOS strategic plan. Respondents all believe that "the climate community needs GCOS". Therefore, the findings and recommendations herein are intended to make GCOS "Fit for the Future".

The Review Board wishes the GCOS programme and its sponsors IOC, ICSU, UNEP and WMO great success in its work and in its development.

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Wolfgang Kusch, Chairman of the GCOS Review Board
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