WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

REPORT OF THE NINETEENTH SESSION OF THE

WMO-IOC-UNEP-ICSU STEERING COMMITTEE FOR GCOS

(READING, 20-23 September 2011)

GCOS – 152

UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL FOR SCIENCE

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REPORT OF THE NINETEETH SESSION OF THE GCOS STEERING COMMITTEE

TABLE OF CONTENTS

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REPORT OF THE NINETEENTH SESSION OF THE GCOS STEERING COMMITTEE

1. Opening of the Session

The Nineteenth session (SC-XIX) of the Global Climate Observing System (GCOS) Steering Committee (SC) was held at the headquarters of the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, United Kingdom from 20-23 September 2011. This report provides an overview of the presentations and discussion at the session and identifies specific action items flowing from the deliberations of the SC. The list of participants is provided in Appendix 1, the final agenda for the session is given in Appendix 2, the list of the available documents is included as Appendix 3, a consolidated list of actions is given in Appendix 4, and the two approved GCOS-GAW agreements are included in appendices 5 and 6.

1.1 Welcome by ECMWF Director-General

The Director-General of the ECMWF, Prof. Alan Thorpe, welcomed SC Members and other participants, including the Executive Secretary of the Intergovernmental Oceanographic Commission, Dr Wendy Watson-Wright, and the Deputy Secretary-General of WMO, Mr Jerry Lengoasa, to ECMWF. Prof. Thorpe stressed that ECMWF could not make the weather forecasts that it does, day-in day-out, for time scales from days to seasons ahead, without access to high quality observations of the atmosphere, ocean, and land. He noted that the weather and climate communities have a shared interest in ensuring that measurements are made regularly to high standards, transmitted fully and quickly, sustained into the future, and improved where needed. As such ECMWF is committed to support GCOS and related international programmes, such as WCRP, and their sponsoring organisations—the World Meteorological Organization (WMO), the International Oceanographic Commission (IOC), the United Nations Environment Programme (UNEP), and the International Council for Science (ICSU).

1.2 Opening Remarks

The Chairman of the GCOS Steering Committee, Dr Adrian Simmons, welcomed SC Members and other participants to his home institution. He then warmly welcomed the three new Members of the SC this year, Dr Juliet Hermes, Dr Roger Pulwarty, and Dr Ed Harrision. Following his welcome all session participants introduced themselves in a “tour de table.”

1.3 Approval of Agenda

The Chairman asked the SC members if they had any questions about the final draft agenda or wished to propose modifications to it. The Committee agreed that the agenda could be adjusted, as necessary, as the session proceeded, and, on this basis, it was approved.

1.4 Arrangements for the Session

The Chairman briefly described ECMWF facilities and noted times for coffee breaks and lunch. Dr William Westermeyer, the GCOS Secretariat officer responsible for the organization of the session, outlined the process of producing the report of the session, noting that the draft session report would be developed from oral comments, PowerPoint slides, and the written documents participants had submitted. He also noted that the complete list of actions would be included in the report, that the draft report would be circulated to SC members and other participants for comment prior to its finalization, and that the final SC-XIX Report would be approved by the Chairman in the light of comments received on the draft.

2. Reports of the Director and Chairman

2.1 Report of the Chairman, GCOS Steering Committee

The Chairman reviewed his activities since SC-XIII. These included his participation in April 2010 in a session of the Joint Scientific Committee of the World Climate Research Programme (WCRP), his attendance at two segments of the XVIth WMO Congress (Cg XVI) in May and June 2010, his participation in the Group on Earth Observations (GEO) Plenary and Ministerial in Beijing in November 2010, and his presentation of the 2010 update of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (IP-10) at COP 16/SBSTA 33 in Cancún in November 2010. He drew special attention to the fact that his presentation on GCOS to the WMO Congress was well received as indicated by the fact that the 29 interventions during discussion of GCOS were overwhelmingly positive in tone. He also noted, however, that Congress expressed concerns over the availability of funding, the need for network improvements, including data transmission, and, more generally, the lack of implementation of the Regional Action Plans. Congress recommended that consideration be given to inviting the UN Food and Agricultural Organization (FAO) to co-sponsor GCOS. It also requested the Secretary-General of WMO to liaise with the other Sponsors of GCOS and revise the GCOS Memorandum of Understanding (MoU) as necessary.

Following the review of his GCOS-related activities leading up to SC-XIX, the Chairman introduced some of the important issues on which he would be seeking advice from the SC Members and Sponsors of GCOS. These included views on revision of the GCOS MoU. The Chairman expressed his view that the basic concept set out in the current version of the MoU remains sound but that in a revised MoU he would like to see a baseline funding commitment, reference to technical development activities and the GCOS Cooperation Mechanism (GCM), clarification of the role of GCOS in a changing institutional environment, and clear nomenclature distinguishing between GCOS the programme and GCOS the composite system of climate observing systems. In response to a question from a Member concerning the revision of the GCOS MoU, the Chairman noted that he wanted this session of the SC to provide a clear sense of the advice it would like to offer to the Sponsors, but he noted that ultimately the revision of the MoU was up to the Sponsors. Other important issues to be discussed at the session included the expectations of the Sponsors of GCOS, particularly in relation to the new Global Framework for Climate Services (GFCS); the role of GCOS in supporting the UN Framework Convention on Climate Change (UNFCCC); the role of GCOS in regional activities; observational needs for adaptation; handling of cross-domain issues; interactions with WCRP, GEO, and other organizations; and general strategic planning and the overall work programme for the coming five years.

2.2 Report of the Director, GCOS Secretariat

The Director of the GCOS Secretariat, Dr Carolin Richter, highlighted ten strategic issues in her report on which the work of the GCOS Secretariat has been based since SC-XIII. Thus, her goals as Director have been to:

1. Strengthen GCOS Panels and engage with Sponsors;
2. Implement a mechanism to establish networks;
3. Improve visualisation of GCOS networks and Essential Climate Variable (ECV) products;
4. Engage closer with the Intergovernmental Panel on Climate Change (IPCC);
5. Engage closer with the research community;
6. Promote national implementation of GCOS;
7. Continue to engage with the UNFCCC;
8. Continue to engage with the space/satellite community;
9. Strengthen existing, and initiate new, partnerships for GCOS implementation; and
10. Strengthen outreach and communication activities.

In seeking to strengthen GCOS Panels, she noted that there has been an agreement on cost sharing with other observing system secretariats. She also highlighted her wish to organize an annual coordination meeting of the directors, chairpersons, or representatives of GCOS, GOOS, GTOS, WIGOS, and WCRP (the first was held in May 2010). The establishment of the GCOS Reference Upper Air Network (GRUAN) was cited as a success story and a good example to follow for other networks that are being considered. The Director noted that the Global Observing Systems

Information Center (GOSIC), which is kindly hosted and maintained by the US National Climatic Data Center (NCDC), has more potential than is currently being exploited to showcase GCOS networks and ECV products. Further interaction with the IPCC is expected following a suggestion of the Technical Support Unit (TSU) of Working Group I to organize a follow-up meeting to the 2007 GCOS-WCRP-IPCC Workshop in Sydney, Australia once the WG I Report of the Fifth Assessment Report (AR5) has been published in September 2013. The Director highlighted her participation in the research dialogue at the 34th session of the Subsidiary Body for Scientific and Technological Advice (SBSTA 34) and underscored the need to improve interaction with the research community.

The GCOS Secretariat, she noted, continues to try to promote greater coordination among those responsible for climate observations at the national level. However, she also indicated that its proposal to organize a National Coordinators meeting has not yet secured the resources to hold such a meeting. In stressing the Secretariat's strong desire to continue to engage with the UNFCCC, the Director noted the wish expressed by SBSTA in Cancun for further assessments, with timelines yet to be discussed, which would take into account the "assessment cycle" proposed by GCOS. Also, GCOS is now receiving attention by the UNFCCC's Subsidiary Body for Implementation (SBI). Developments under the Ad Hoc Working Group on Long-term Cooperative Action (AWG-LCA) also indicate a number of emerging areas requiring increased attention to observations where GCOS could eventually play an important role. The new interest by these bodies in GCOS will need careful attention by the Secretariat. GCOS has also interacted strongly with space agencies. The Director stressed that the Secretariat will continue to engage with these agencies, for example, by attending important satellite meetings. She noted that the Satellite Supplement of IP-10 will be published before the end of 2011. The Climate for Development in Africa Programme (ClimDev Africa) continues to be a focus of Secretariat regional activities. Also in Africa, the Director noted recent cooperation with the West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) project, which is being led by the German Federal Ministry of Research (BMBF). Finally, the Director reviewed the various publications produced and outreach activities undertaken since the last SC session.

In discussion following the Director's report, the issue of communicating the benefits of improving observations to society at large was raised. Dr Sue Barrell introduced her idea for the Secretariat to produce a promotional brochure describing the socio-economic benefits of improving climate observations. Another Member noted that in such a brochure the GCOS Secretariat needs to articulate how improving observations for science leads to outcomes that society wants. The SC agreed that producing a brochure would be useful.

The Steering Committee affirmed the view that the primary strength and purpose of GCOS lay in its assessment of the adequacy of the overall global observing system for climate, its implementation planning, and its reporting on progress. This was particularly evident in the support GCOS gave the UNFCCC and the response of the space agencies to GCOS requirements and recommendations. The Committee nevertheless recognized the importance of communicating the benefits of, as well as the requirements for, climate observation, and it encouraged the Secretariat to develop material to this end.

Action 1. Brochure on the Socio-economic Benefits of Observations. The GCOS Secretariat is asked to produce a brochure on the socio-economic benefits of improving climate observations, using as a starting point the case studies prepared at the Australian Bureau of Meteorology for this purpose. Committee members were invited to assist the Secretariat by identifying further such case studies.

3. UNFCCC: From Cancún to Durban

Ms. Rocio Lichte discussed the importance of climate observations from the perspective of the UNFCCC Secretariat in a presentation titled "From Cancún to Durban--Matters of Relevance to Climate Observations." She reminded SC Members that systematic observation of the climate is embedded in Articles 4 and 5 of the Convention and outlined the long-standing collaboration with GCOS on matters related to observations in the UNFCCC process. She reviewed the outcomes of SBSTA 33 (Cancún, December 2010), at which SBSTA welcomed the 2010 update of the GCOS Implementation Plan; noted that this plan provides a sound assessment of requirements for climate-related observations and its enhanced focus on adaptation; urged Parties to work towards implementation of this plan; encouraged Parties to increase consideration of GCOS-related

implementation in relevant national and regional activities (e.g., by regional climate centres and National Meteorological and Hydrological Services--NMHSs); and encouraged increased data rescue and digitization of historical data.

Significantly, Ms. Lichte observed that SBSTA is aware of the information concerning additional funding requirements identified in IP-10 and has emphasized the urgent need to secure funding to meet the essential climate observing needs of the Convention on a long-term basis. She noted that SBI considered these funding needs at SBI 34 in June 2011 at the invitation of SBSTA and that it will consider the issue further with the expectation that additional guidance will be provided to the Global Environment Facility (GEF) at SBI 35/COP 17 in Durban, South Africa in November-December 2011. Ms. Lichte indicated that the UNFCCC Secretariat is considering organizing a Side Event with the aim of helping Parties obtain a better understanding of the funding needs for observations, which in turn may help deliberations on this matter in the SBI. She invited the Chairman of the GCOS Steering Committee to participate in this Side Event to review the funding requirements discussed in IP-10 and outline current funding approaches for observations in the context of GCOS. Experts from the GEF would also be invited. It is not yet clear how funding for observations may be considered in the future, but it will be important to keep an eye on developments so as to try to ensure that structural funding needs are embedded into relevant mechanisms under the UNFCCC and the UN System at large.

Among other items mentioned were matters relating to adaptation. The Cancún Adaptation Framework, adopted by the Cancún Agreements (Decision 1/CP.16), calls for enhanced action on adaptation, *inter alia*, by improving climate-related research and systematic observation for climate data collection, archiving, analysis and modelling in order to provide decision makers at national and regional levels with improved climate-related data and information. Therefore, identifying observational needs for adaptation would be an important emerging issue for GCOS to consider. This topic is addressed in more detail in section 11 of this Report.

The Steering Committee welcomed the provisional invitation extended to GCOS to participate in a possible UNFCCC side event related to SBI's consideration of the funding needs for climate observation.

***Action 2. SBI Side Event and Other COP-17 Activities*.** The Steering Committee requested the Chair and Secretariat to respond positively to a formal invitation, which would provide an opportunity to explain how observations are currently funded and the needs for and benefits of increased funding. The Committee further encouraged the Chair and Secretariat to consider submitting a short paper to SBI for information on this topic.

4. Regional Activities

4.1 An Overview of GCOS Regional Activities

The GCOS Secretariat officer responsible for regional activities, Dr William Westermeyer, reviewed regional activities in which the Secretariat has been involved or is planning. He noted that GCOS has defined a strategy for facilitating the updating and implementation of the GCOS Regional Action Plans and that this strategy is being followed in South America. Thus, the Secretariat is currently working with the Centro Internacional para la Investigación del Fenómeno de El Niño (CIIFEN) in the organization of a meeting on improving observations in South America for better climate services. The purpose of the meeting is to facilitate the integration of atmospheric, terrestrial, and oceanic observations into existing and future risk management and adaptation initiatives so that the countries of South America can derive more benefit from the current and planned national and international funds being expended to address development concerns. It is being jointly funded by Spain and Switzerland and will take place at CIIFEN Headquarters, Guayaquil, Ecuador in March 2012.

Dr Westermeyer updated the SC on developments in the Climate for Development in Africa Programme (ClimDev Africa), noting in particular that the GCOS Secretariat participated in the first ClimDev Africa Steering Committee (CDSC) meeting in Addis Ababa, Ethiopia, in May 2011 and that it will present a paper in October 2011 at the First Climate Change and Development for Africa Conference (CCDA-I), which is being organized under the auspices of the ClimDev Africa Programme. A number of international donors are now contributing funds to ClimDev Africa, and the Programme will soon enter its operational phase. More detail on ClimDev Africa is given in section

4.3. Dr Westermeyer also noted the intention of the Secretariat to organize a first GCOS National Coordinators meeting. Funds for this meeting have not yet been secured, however.

The Steering Committee welcomed the engagement of the GCOS Secretariat in the regional activities set out in Dr Westermeyer's presentation. It noted the benefits that could accrue from regional collaboration to produce reviews, such as those published in the comprehensive annual Bulletin of the American Meteorological Society (*BAMS) State-of-the-Climate article, and urged the Secretariat to promote this type of collaboration, which could foster regional data exchange, and for which the regional Lead Centres had a role to play. The establishment of WIGOS also provided for a more pro-active fostering of regional observation of climate.*

4.2 The GCOS Cooperation Mechanism (GCM) and System Improvement Activities

The GCOS Implementation Project Manager, Mr Richard Thigpen, provided a summary of his activities since the last SC session to promote system improvements. Most of these activities have focused on improvements of the GCOS Surface Network (GSN) and GCOS Upper Air Network (GUAN) and include coordination among the nine Commission for Basic Systems (CBS) Lead Centres for GCOS, the administration and management of the GCOS Cooperation Mechanism, and the management of direct station renovation activities. GUAN revitalization activities included generator repairs at stations in the Maldives, Mauritius, and Zimbabwe and radiosondes and new ground systems for Dar es Salaam, Tanzania; Mauritius; Khartoum, Sudan; and Rarotonga, Cook Islands. GSN revitalization included installation of a high-performance wind system at Bjelasnica, Bosnia and Herzegovina; replacement of instruments and refurbishment of the building at the Aragats high mountain station in Armenia. A project to renovate the GSN stations in Madagascar has been started, but renovation of eight GSN stations in Angola has had to be postponed.

Mr Thigpen said that significant progress was made in the last year in the area of improving telecommunications over the Global Telecommunication System (GTS). Also, the GCOS Cooperation Mechanism continued to function well with direct contributions from Switzerland, Germany, Japan, Spain, and the Netherlands. The United States continued its support of the contract for the Implementation Project Manager, but future support is not guaranteed.

Members pointed out that the shopping list for the GCM mainly includes projects in the atmospheric domain and that in the future the list, as it was planned already from the onset, should try to include projects in the ocean and terrestrial domains as well. Although this might not be as easy for these domains, the SC agreed that ocean and land projects should be included where possible. Recently listed projects in support of ocean observing networks have not been picked up by GCM donors as the projects were considered being too big.

Another issue introduced under this agenda item was the difficulty some countries have in keeping revitalized GUAN stations operational after the initial supply of radiosondes funded through the GCM is depleted. This issue was also discussed at the GCM meeting on September 19, and it was agreed in that meeting to send a letter to the Permanent Representatives (PRs) of countries that have received such support, indicating that it is the responsibility of those countries to fund the continuing operation of GUAN stations and that the GCM is not a mechanism for long-term support.

Mr Wim Monna reviewed the key issues discussed at the 19 September GCOS Cooperation Mechanism (GCM) meeting. He stressed the fact that financial support for the Implementation Project Manager is needed. He also noted that the shopping list needs to be improved and distributed before the annual GCM meeting and that countries that receive support through the GCM need to be encouraged to continue the supported activity after the initial help. He pointed out that the interest of the UNFCCC's Subsidiary Body for Implementation (SBI) in considering funding for observing system improvements is important, and thus that the GCOS National Coordinators and NMHSs should try to inform and educate the financial experts of national delegations that attend SBI sessions about climate observing needs.

The Steering Committee thanked Mr Thigpen for his presentation and continuing work in support of implementation. It also welcomed the presentation by Mr Monna and thanked him for his Chairmanship of the GCM Donor Board. It stressed the importance of consideration of ocean and

land projects as well as atmospheric projects under the GCM, taking account of related support activities, such as the capacity building programme run under IOC auspices. It was important that station reactivation under the GCM be backed up by continuity of subsequent operation by the countries who had been supported. There remained a need to make the connection between observation and end-use in promoting the case for recurrent expenditure by the countries concerned. The Committee also endorsed the suggestion of the GCM Meeting that WMO consider bringing the attention of NMHSs to the consideration of funding for observations by the SBI, with a view to their engaging with national financial experts who participate in the SBI.

Action 3. Funding the GCM. Recognising the value of the GCM and concerns over the current economic situation, the Committee further asked the Director to write a letter to donor countries encouraging the continued provision of funds.

4.3 The Climate for Development in Africa Programme

Dr Seleshi Bekele Awulachew, a special guest at this year's SC session, was invited to review developments in, and future plans for, the ClimDev Africa Programme. After reviewing the background to the creation of ClimDev Africa, in which the GCOS Secretariat played an important role, Dr Bekele discussed the goals and Result Areas of the Programme, its governance structure, the work plan of the Africa Climate Policy Centre (ACPC) (which will implement ClimDev Africa and serve as its Secretariat), opportunities for partnership, and forthcoming events.

Of special interest to the GCOS Programme is Result Area 1, which addresses needs for climate observations and is intended to make high-quality climate information widely available in Africa. SC Members were pleased with the progress that has been made in launching the ClimDev Africa Programme and hoped that the implementation of Result Area 1 would lead to substantial improvements in climate observing networks in Africa. Dr Bekele noted that a demand-led ClimDev Special Fund will finance activities consistent with the Programme's overall objectives. This fund will be managed by the African Development Bank.

Dr Bekele also discussed planning for the first Climate Change and Development for Africa Conference, which is being organized by the ACPC as part of ClimDev Africa. Both the GCOS Secretariat and WMO will participate in this Conference. The Conference results will feed into Africa's contribution to the UNFCCC's COP-17, which will be held in Durban, South Africa beginning in late November, in particular through the African Pavilion, which is being set up to showcase Africa's climate change and development agenda.

The Steering Committee expressed its appreciation for the presentation on ClimDev Africa, and welcomed in particular the objectives of Result Area 1, which seeks wide availability and dissemination of high-quality climate information and analysis for decision making and management practice and should be supported by improvement in underlying measurement networks. The Committee strongly endorsed continuation of the advisory role played by GCOS.

4.4 Update on National GCOS Activities in Switzerland

Dr Gabriela Seiz of the Swiss GCOS Office gave a short presentation that focused on ECV data in International Data Centers. She cited the IP-10 conclusion that the flow of data to the user community and to International Data Centres (IDCs) is inadequate for many ECVs, especially those in the terrestrial domain, and she noted, therefore, that IP-10 urged Parties to the UNFCCC to ensure regular and timely submission of climate data to International Data Centres for all ECVs. In order to better understand what Swiss data is being held at IDCs, the Swiss GCOS office compiled a report on the status of Swiss GCOS data in IDCs. The report will be published online in November 2011 but concludes that discovery of, and access to, data is uneven and can be difficult. Also, there is no dedicated IDC for certain ECVs, such as clouds; others, for example, for snow, are not used much; and certain others (e.g., for lakes and groundwater) are still under construction. While online performance monitoring works well for GSN and GUAN, it is largely non-existent for most other ECVs, and use statistics are normally not available to the public. Dr Seiz pointed out that submission of national data to International Data Centres is essential for the success of GCOS and that there is no doubt a role to play here for GCOS National Focal Points and National Coordinators to help ensure that this is done.

The Steering Committee welcomed the report on national GCOS activities in Switzerland. It noted the interest in the quality statistics for two Swiss-supported stations in Africa that had been supplied by ECMWF in addition to its routine reporting of data availability. It further noted the finding that navigating the data-centre landscape was not straightforward and that centres for all ECVs did not exist. It encouraged monitoring and archive centres to report more on data quality.

Action 4. Consideration of ECV data in International Data Centres. The Atmospheric Observation Panel for Climate (AOPC) and Terrestrial Observation Panel for Climate (TOPC) are asked to consider how to facilitate the regular and timely submission ECV data to International Data Centres at their next Panel meetings, with a view to further discussion at the next session of the Committee. The Committee also requested that these monitoring and data-centre issues be considered at the forthcoming meeting of CBS Lead Centres for GCOS and related climatological data.

5. Climate Observing-System Status, Initiatives, Concerns, and Views on the Role of GCOS

5.1 World Meteorological Organization

SC-XIX was pleased to welcome the Deputy Secretary-General of WMO, Mr Jeremiah Lengoasa, to the session. Mr Lengoasa was accompanied by Dr Wenjian Zhang, the Director of the WMO Observing and Information Systems Department (within which the GCOS Secretariat sits), Dr Thomas Peterson, the President of the WMO Commission for Climatology, and Dr Sue Barrell, the Vice-President of the WMO Commission for Basic Systems, to discuss the views of WMO on GCOS and GCOS-related issues.

5.1.1 GFCS. Mr Lengoasa provided an overview of the Global Framework for Climate Services (GFCS), perhaps the most important new initiative of WMO and one that is currently being developed. He highlighted why a GFCS was needed, that is, because present capabilities for providing climate services do not exploit all that is known about climate and fall far short of meeting current and future needs and in delivering their full and potential benefits, especially in developing countries. At present, many countries lack the infrastructural, technical, human, and institutional capacities to provide high-quality climate services.

Several options for the governance of the GFCS were discussed by the WMO Congress. A final decision on the governance of the GFCS, as well as consideration of its Implementation Plan, is to be made at an extraordinary session of Congress in October 2012. This Implementation Plan is currently being developed, and various stakeholder consultations, including with the climate observing community, are currently being organized as part of the development process. Mr Lengoasa observed that because GCOS (the Programme) has "experience in coordinating observing systems of a wide variety of organizations," including WIGOS, GOOS, and GTOS, and because *the* GCOS is an "ensemble of atmospheric, oceanic, and terrestrial observing systems addressing climate observations from the global to regional level" it is well positioned to contribute strongly to the GFCS. He suggested, however, that GCOS could be refined or modified to better support GFCS requirements. He also noted that other organizations not yet integrated into the GCOS also have things to offer.

SC Members asked about the size and scope of the Implementation Plan and were told that this will depend on the extent and depth of the individual pillars. It will be easier to answer this question after the consultation process. When asked how the approximately USD 75 million/year that has been suggested will be needed to implement the GFCS would be raised, Mr Lengoasa noted that the case for funding needs to be built together with all the stakeholders and interested parties. Dr Wendy Watson-Wright, the Executive Secretary of the Intergovernmental Oceanographic Commission (IOC), noted that the GFCS is supposed to be a UN initiative and observed that many feel that it is becoming more of a WMO-focused initiative. Mr Lengoasa assured her that for the GFCS to be truly global, it must go beyond the NMHSs and that the intent is to involve other UN agencies.

The Steering Committee thanked the Deputy Secretary-General of WMO for his presentation and invitation to the Committee to submit its views on the ways GCOS, modified as necessary, could support the GFCS. Among other things, this could be through participation of the Chair (or, if not him,

a representative of the SC) in the work of the Executive Committee Task Team on the GFCS. The Chairman noted that the SC would emphasize IP-10 as a major building block for the observation component of the GFCS. The Committee repeated its support for the development of the GFCS and the willingness of the GCOS programme to contribute to its implementation and operation. Further consideration of the role of GCOS and its input to the implementation planning process would be formulated later in the session.

Action 5. Contributing to the Development of the GFCS Implementation Plan. The SC Chairman, assisted by SC members as needed, and the Secretariat are asked to support fully the development of the component of the GFCS Implementation Plan that relates to observations.

5.1.2 The Commission for Climatology (CCl) and the World Climate Programme. After briefly summarizing the structure of the CCl, Dr Thomas Peterson raised the issue of the meaning of the GFCS for the CCl and the World Climate Programme (WCP). He stated that at the moment there is a great deal of uncertainty as to how the CCl and the WCP will be affected. He expressed concern that the GFCS may have difficulty meeting its goals without changes to Resolution 40, which is the WMO policy and practice for the exchange of meteorological and related data and products. He noted that while Resolution 40, in particular its Annex I, urges Members to provide free and unrestricted data and products, it is heavily weather oriented and does not require the provision of historical time series. Temperature and precipitation data are perhaps the most important data that need to be exchanged; however, all ECV data should be shared in his opinion. Therefore, Dr Peterson advocated that a specific and scientifically sound request for edits to WMO Resolution 40 should be made in light of the GFCS, noting that ultimately the decision to share data or not will be up to individual WMO Member States.

Mr Lengoasa observed that the WMO experience in negotiating Resolution 40 (and also Resolution 25 concerning hydrological data) was difficult. However, he also noted that the world has changed and that in developing the GFCS it is clear that the issue of data exchange and access will come up again. He noted that much of the developing world believes there is value in restricting access to data but that the case needs to be made that there is greater value in exchanging data.

The Steering Committee restated its endorsement of free and open exchange of data to the greatest extent possible. It recognized the need to consider the revision of Resolution 40 and also Resolution 25, notwithstanding potential difficulties, in particular due to the needs for observations to support climate services provided under the GFCS. Opportunities to promote the arguments for freely releasing data should be exploited whenever they occur, in particular at Rio+20.

Action 6. Free and Unrestricted Exchange of Climate Data. The SC Chairman and Secretariat are asked to promote free and open exchange of climate data to the greatest extent possible.

5.1.3 CBS and the WMO Integrated Global Observing System (WIGOS). Dr Sue Barrell began her presentation on WIGOS by asking "Why is WIGOS important to GCOS?" She answered this question by saying that WIGOS will provide a mechanism to integrate all types of observing systems. These include more than just those of WMO. They include those of the IOC, FAO, and other organizations, and this is where GCOS comes into the picture. These other partners are needed at the table, and GCOS can help. A challenge in implementing WIGOS, she noted, will be in gaining the commitment of WMO Members and other organizations to WIGOS. These entities need to know what benefits they are going to receive from it. The biggest challenges, however, are at the national level where national coordination will be very important. Alignment at the national level will be needed with GCOS, GEOSS, and the GFCS, and this coordination needs to be reflected at the international level. Another challenge will be to build up the WIGOS Secretariat, which at present is very small. Although a focus of WIGOS is on integration and sustainability, WIGOS cannot be expected to fix every problem of an NMHS. She notes that the concepts of standardization and best practices are key and that it is important to recognize where WIGOS needs to be "fit for purpose." WIS is probably the single most important element of WIGOS.

In concluding Dr Barrell noted that WIGOS will not work without commitment to implementation, sustained operations, and relationships at all levels. Also, a communication strategy is essential to understand and address challenges faced by all constituents and to facilitate links to national,

regional, and global WIGOS plans. Finally, at its simplest, WIGOS is about implementing best practice in making and sharing observations, coordination and collaboration for efficiency and effectiveness, sustainably delivering the "Vision for the GOS/WIGOS in 2025," and in delivering observations that meet user needs in a way they can use them.

Following Dr Barrell's presentation Dr Zhang also addressed WIGOS issues. Dr Zhang drew attention to the benefits of WIGOS, noting that WIGOS will enhance the ability of Members to meet expanding national mandates and achieve higher national visibility of NMHSs with other environment related agencies. WIGOS will also provide a framework for improved collaboration and coordination between NMHSs and relevant national and regional organizations. He saw the GFCS as both a great challenge and an opportunity for GCOS and WIGOS, and he noted that GCOS can play an important role in the GFCS by defining new requirements at global, regional and national levels, and that this will guide future WIGOS implementation.

The Steering Committee was pleased to be informed of the progress towards establishment of the WIGOS. It recognized the challenge of integrating the component observing systems, in particular those for which WMO was not the lead sponsor, but also those that fell under WMO leadership. Balancing the requirements of weather forecasting, environmental monitoring, and climate would require care in planning and implementation and in coordination at national level. The Committee envisaged a significant facilitating role for GCOS in these matters. It endorsed the involvement of GCOS in the Inter-Commission Coordination Group on WIGOS.

5.1.4 The Role of GCOS. Discussion under this agenda item centered on the proposed review of the GCOS Programme. It was initiated by Mr Lengoasa, the WMO Deputy Secretary-General, who pointed out that the GCOS Programme has had substantial success in the past but that several new developments and some emerging issues have given rise to the need to re-examine the mandate and terms of reference of GCOS. The new developments include the establishment of the Global Earth Observing System of Systems (GEOSS) and the increased attention countries are now giving to adaptation. On the horizon are the development and implementation of the GFCS and WIGOS and the findings of the IPCC's Fifth Assessment Report, all of which will affect the GCOS Programme. Mr Lengoasa therefore informed the SC that, as the 20th anniversary of the establishment of the GCOS is approaching, it is now timely to undertake a thorough and independent review of GCOS. WMO, as the principal Sponsor of GCOS, would lead this effort. Mr Lengoasa suggested that WMO could make a financial contribution to the conduct of the review and that it should be completed before the June 2012 session of SBSTA, at which time the observations component of the Research and Systematic Observations agenda item would again be considered. He also noted that the review can provide the basis for revising the GCOS MoU. WMO and the other Sponsors would consult with the Chairman of the GCOS SC in putting together a review team. One issue that should be addressed is the future funding of the GCOS Programme and Secretariat.

In response to a question by the Chairman concerning contributions by the SC, Mr Lengoasa indicated that the SC can propose people to be included on the review team, that it can assist in setting the frame for doing the review, and that it can suggest questions that should be addressed. One SC Member wondered if the review should be broadened to include other observing systems. However, another cautioned against equating GCOS with GTOS and GOOS, as that would be a misrepresentation of what GCOS is. GCOS functions, he noted, as a cross-cutting observing system for climate, integrating across GTOS, GOOS, WIGOS, and other systems.

The Steering Committee welcomed an independent review of GCOS and appreciated the willingness of WMO to take the lead in seeking to carry this out quickly, in particular, in the light of development of WIGOS and the GFCS and the UNFCCC/SBSTA's forthcoming consideration of the timing of future contributions of GCOS to SBSTA, which will cover assessment of adequacy and progress and updated implementation planning. The Committee also appreciated the invitation extended to it to provide input to the review.

(See Section 14 for the Committee's further discussion on the relation between the GCOS review, the update of the GCOS MoU and GCOS Plan, and the role of GCOS in the GFCS).

Action 7. Proposing People for the GCOS Review Team. The SC Chairman is asked to consult with SC Members to identify candidates for the GCOS Review Team to be established by the Sponsors.

5.2 Intergovernmental Oceanographic Commission

SC-XIX was pleased to welcome the Executive Secretary of the IOC, Dr Wendy Watson-Wright, to speak about the status of the Global Ocean Observing System (GOOS) and to address the questions posed by the GCOS Secretariat to the Sponsors. She was accompanied by the Acting Director of the GOOS Project Office, Dr Albert Fischer.

5.2.1 Status of GOOS and the Framework for Ocean Observations. Dr Watson-Wright introduced the Framework for Ocean Observations, which was conceived at the OceanObs'09 conference in Venice, Italy. She noted that the development of the Framework is seen as a common systems view and blueprint for expanding the capabilities of GOOS. Its governance structure would consist of three levels. At the top level would be a Framework Steering Group that would have as its major goal a negotiation amongst Sponsors and the GOOS bodies about how to evolve in a stepwise, stable fashion to align existing bodies with the Framework and to deliver an observing system that is fit-for-purpose. In the middle would sit bodies like the Ocean Observations Panel for Climate (OOPC), which have the technical expertise to define requirements for scientific and societal benefit, coordinate observing networks, ensure data management arrangements are in place, and promote the generation of useful variable-based data products. And at the third level would be various Technical Advisory Groups, whose mandate would encompass observing technologies, data and data products, etc.

Dr Watson-Wright then addressed the restructuring of the GOOS. She noted that the 2011 session of the IOC Assembly streamlined and strengthened GOOS governance. The resolution addressing GOOS defined it as a holistic system encompassing global, regional, and coastal observations and products. It noted that GOOS is to be aligned with the Framework for Ocean Observing and oriented around Essential Ocean Variables. It will set requirements based on the needs of global conventions and agreements in climate, natural hazards, biodiversity, safety of life at sea, marine assessment, and regional conventions. And it will work to reinforce global participation through capacity development. A new interim GOOS Steering Committee will be made up of five Member State-appointed expert members and up to 10 other expert members, representatives of relevant implementing and coordinating bodies, and Sponsors. Significantly, Dr Watson-Wright noted that the GOOS sponsorship of the OOPC will cease at the end of 2011. However, she expects the new GOOS Steering Committee to recommit to co-sponsoring the OOPC. Dr Eric Linstrom, who is the current Chairman of the OOPC, has been nominated by both GCOS and the WCRP to represent them on the interim GOOS Steering Committee.

5.2.2 The Role of GCOS. The second part of Dr Watson-Wright's presentation addressed the questions that the GCOS Secretariat had posed to all the Sponsors. In answering the question, "How has IOC benefited from sponsorship of GCOS?" Dr Watson-Wright said that GCOS has provided a clear framework for thinking about ECVs, defining adequacy, requirements, implementation, and reporting progress; it has facilitated integration among atmospheric, oceanic, and terrestrial observations for climate; and it has been a strong voice at the UNFCCC. As to what IOC has done to assist the development of GCOS, she noted that the climate component of GOOS is the ocean component of GCOS, that IOC has played a leading role in coordinating the growth of ocean observations over the past decade with support to the OOPC, GOOS, and JCOMM and building on strong national efforts by IOC's Member States. And that, in the GCOS cycle of defining and reporting, the OOPC and GOOS Project Office have taken the lead on the oceanic elements of GCOS.

The Steering Committee thanked the Executive Secretary of the IOC for her presentation and appreciated her identification of the benefits of GCOS to the IOC. Several SC Members raised the issue of user needs, especially in relation to the question of observational requirements for adaptation. One noted that everyone talks about the importance of developing links to users but that very little is done to address this issue. Another noted that it comes down to perception among users about where they can extract value, so the highest priority products should be those from which users can extract the most value. Another noted that we must ask users what the want and also help clarify

for them what they really need. There is a special role for "boundary organizations" that utilize observation in their provision of information and services to end users. In working with partners dealing with ecosystems, desertification, forecasting, and modelling, these organizations need to make the case that observations are critical to what they provide to their user communities.

The Committee noted and discussed Dr Watson-Wright's views that GCOS must continue to be relevant in a changing political environment that focused more on adaptation to climate change in the wider context of vulnerability, resilience, and sustainable development, and that GCOS must address the observations required to support adaptation and develop climate services, link observations to economic valuation of ecosystem services and to human exposure and vulnerability to climate change and extremes, and re-assess the ECVs for the needed knowledge, while at the same time sustaining its current important activities.

Further consideration of these matters is given later in the report when discussing the future programme of work for GCOS.

5.3 United Nations Environment Programme (UNEP)

UNEP was represented by Mr Ashbindu Singh, who introduced the new UNEP-UNESCO-WMO Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA). PROVIA's objectives are to advance research on vulnerability, impacts, and adaptation related to climate change and to coordinate and facilitate the dissemination and practical application of this research for the benefit and value of society.

Mr Singh introduced a number of UNEP needs for climate observations. These included observations for ecosystem-based climate adaptation, for the Nile Basin climate adaptation project, for issues related to permafrost melting, for the impact of climate change on water level in Lake Turkana and other lakes, for better estimates of water balance in Africa, for monitoring melting glaciers in the Himalayas, for tracking sea level rise, and for producing value added products and services. He pointed out that there is a lack of data for these and other issues on which UNEP is planning to report at next year's United Nations Conference on Sustainable Development in Rio de Janeiro (Rio+20).

The Steering Committee was grateful for the presentation made on behalf of UNEP. As a user of climate data, UNEP could benefit from a closer engagement with GCOS in the establishment of requirements for data and products, and specific issues related to data could be taken up with the appropriate GCOS panel. The Committee also noted the potential benefit to UNEP of the capabilities of the WMO Information System.

The Committee urged UNEP that when assessing environmental change not to ignore variables for which it could not make a statement due to lack of data, but rather that it highlight the implied need either for additional observations or for greater exchange of data, and thus the importance of having an adequate and sustained GCOS. Rio+20 and the UNEP Council were fora where such messages could be put across to potential good effect. It was important that environment ministers did not take the availability of observations for granted and that they understood that the required data are often not available. The Committee noted that what is needed is often local rather than global data.

Action 8. Advancing GCOS-UNEP Links. The SC Chairman and Director should investigate improving linkages with UNEP. Thus UNEP and GCOS could work together to identify what data are needed to address societal needs, and then assess the adequacy of the data sets available.

5.4 International Council for Science (ICSU)

Although ICSU staff were making final preparations for the ICSU General Assembly, beginning on 26 September in Rome, and were unable to send a representative to the GCOS SC this year, the Steering Committee appreciated the paper submitted by ICSU. The paper made several important points, not least of which was that ICSU attaches great importance to the work of the GCOS Steering Committee, Panels, and Secretariat. Another key point was that ICSU is planning a strategic review of its role in observing systems. This could become part of ICSU's Second Strategic Plan 2012-2017 and would be determined at the upcoming General Assembly. The questions GCOS posed to

Sponsors for SC-XIX would be addressed in the strategic review. One SC Member noted that the issue of a strategic review raises the issue of the possible need for GCOS to address socio-economic data, or at least of the need to understand where the boundary lies between climate data and socio-economic data. He noted that perhaps we should be thinking about this in terms of interfacing with an organization such as the Organization for Economic Cooperation and Development (OECD). The SC Chairman noted that while pre-existing arrangements for weather and climate meant that there was a limited role for GEO to play for these Societal Benefit Areas (SBAs) alone, there is a clear role for GEO in improving the interfaces between weather and climate and the other SBAs . A participant responded that GEO hasn't really addressed the dialogue between the SBAs, and that GCOS could carry to GEO the message that there is a need for a capability for dialogue.

The ICSU document noted that ICSU is participating actively in the preparatory process for the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012 (Rio+20), both in its own right and as a coordinator of input from the ICSU-sponsored global environmental change research programmes. ICSU will use this opportunity to bring to the attention of the intergovernmental Preparatory Committee and the Rio+20 Summit in 2012 the need for governments to step up significantly their support for the development of GCOS and the other global observing systems in the context of GEOSS.

The ICSU report also mentions that developing the ICSU World Data System (WDS) as an ICSU Interdisciplinary Body is making good progress. The WDS is to be a global federated system of long-term data archives and data-related services covering a wide spectrum of natural sciences and encouraging interdisciplinary science approaches. In ICSU's view, the WDS and GCOS should develop close cooperation.

The Steering Committee welcomed the indication that ICSU would have a proposal for GCOS participation in the ICSU Forum on Science and Technology for Sustainable Development, to be held in Rio de Janeiro, in conjunction with UNCSD Rio+20 and stated that it would respond positively if invited to the conference.

The Committee supported ICSU's recommendation for closer cooperation over ICSU's world data system. The Committee emphasized the importance of adequate resourcing on the individual data centres within the system. The interdisciplinary nature of ICSU meant that the data system should contain socio-economic data valuable for linking with climate data in development of adaptation and climate services. The Committee noted that there was an as yet unfulfilled role for GEO to improve the interface between the SBAs in this regard. The Committee further noted a potential role for GCOS as well as the research programmes in ICSU's Earth System Sustainability Initiative.

Action 9. GCOS representation at Rio+20. The Chairman and Secretariat should engage with ICSU to ensure effective GCOS representation at Rio+20.

6. GCOS and Space-Based Observations

6.1 The Satellite Supplement

The Chairman described the process of drafting the 2011 Satellite Supplement to the 2010 Update of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC. The draft document had been open for public review from 9 May to 1 July 2011. The comments received were currently being examined by the SC Chairman and GCOS Secretariat in consultation with the respective panel experts. He noted that the time pressure for completing the report had abated somewhat because consideration of systematic observation by SBSTA has been deferred until its June 2012 session. The Steering Committee thanked all concerned for their contributions to the revision of the Satellite Supplement.

Action 10. Completion of the Satellite Supplement. The Steering Committee encouraged those involved in finalizing the Satellite Supplement to complete their work by the end of October.

6.2 Space Architecture

The CEOS Working Group on Climate is the first working group that CEOS has created in 30 years. The mission of the Working Group is to facilitate the implementation and exploitation of Essential Climate Variable (ECV) time-series through coordination of the existing and substantial activities that CEOS member agencies are undertaking. This includes the numerous iterative steps involved in the creation of ECVs and ensuring ECV life cycle information is gathered, organized, and preserved for future generations. In the CEOS presentation a Wordle "word cloud" was shown. This provides an indication of the references to "GCOS" in selected satellite-related observation documents, and is a way to show the success that GCOS has had in promoting satellite observations of climate. The UNFCCC representative at the meeting considered this a very encouraging indication.

The Steering Committee welcomed the reports of climate-related activities of the WMO Space Programme and CEOS Working Group on Climate. The Committee, in particular, congratulated the joint writing group (led by Dr Mark Dowell and including representatives of CGMS) that had prepared the first draft of the "Strategy Towards an Architecture for Climate Monitoring from Space." The document was well written and well linked with the work of GCOS. The Committee supported and encouraged the implementation of the architecture, noting and endorsing the comment from WCRP that the value and need for independent evaluation of products could be emphasized more in the document. It is expected that the final report will be available by the next WMO Executive Committee meeting. A meeting to review the draft will be attended by the GCOS Director in October 2011. The Committee looked forward to ensuing commitments by agencies to future operation of the required missions through the upstream planning process that was not represented in the architecture.

6.3 Importance of Past Observational Data for Climate

The Steering Committee expressed its appreciation of Dr Kazutoshi Onogi's presentation illustrating the importance of reprocessing of past satellite data in the context of improving the quality of the integrated data products provided by reanalysis. In particular, it noted the demonstrated improvement due to use of reprocessed wind data from Japanese and European geostationary satellites. The Committee urged that global coverage be provided by the reprocessing of other major holdings of geostationary data, which would be consistent with the aims of the Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring Programme (SCOPE-CM) and the response of CEOS to the 2004 GCOS Implementation Plan.

***Action 11. Reprocessing of geostationary satellite data*.** The Steering Committee requested the Secretariat to draw the SC's conclusion on this topic to the attention of CEOS.

7. GCOS Panel Reports

7.1 Atmospheric Observation Panel for Climate

The AOPC Chair reported on a number of topics considered at the session of AOPC held earlier in the year. He drew particular attention to two proposals of the AOPC to the SC concerning recognition of greenhouse-gas networks and the procedure for the re-appointment of the Lead Centre for the GRUAN. He also reported back on actions placed on AOPC at earlier sessions of the SC, noting that Bamako and Pointe Noire could not be recommended for designation as GUAN stations, that persistently silent stations in GCOS-designated networks should have their designation removed in the absence of a satisfactory explanation, and that steps had been taken towards encouraging prompt submission of World Weather Records and alignment of GCOS and CBS planning. Some examples of observing-system monitoring were presented. Finally, the AOPC Chair drew the attention of the SC to several concerns regarding future observation. Concerning satellite data, in addition to the likely gap in limb-sounding provision identified earlier, the past year had seen an increased likelihood of a gap between NPP and JPSS-1 in coverage of the afternoon orbit, the placement of the CLARREO mission into an "extended pre-formulation phase" and budget uncertainty over the GMES Sentinels and associated services. There were also reports from informed sources of an impending serious degradation of Canadian ozone and surface flux networks, as well as the World Ozone and UV Data Centre in Toronto.

The Steering Committee agreed that the WMO/GAW N2O network be recognised as a comprehensive observing network of GCOS, and that subsets of the CO2, CH4, and N2O networks be recognised as baseline observing networks of GCOS, as set out in SC-XIX documents 7.1a and 7.1. This was subject to rewording by the Secretariat of the first paragraph of Annex 1 of each of the agreements to remove or explain the uncertainties in the very precise figures quoted for radiative forcing.[1]

The Steering Committee agreed that AOPC should review the appointment of the Lead Centre for the GRUAN, based on reports from the current Lead Centre and the Chair of AOPC's Working Group on Atmospheric Reference Observations. Should AOPC agree to recommend renewal of the appointment of the current Lead Centre, it should make this recommendation directly to the Secretary-General of WMO.

The Steering Committee welcomed the steps taken by CBS in establishing an expert-team meeting to agree on inclusion of operational practices for the GRUAN within WMO regulatory material, and to consider governance and management issues related to long-term operation of the GRUAN. The Committee noted the sensitivities that arose from the inclusion in the GRUAN of sites run by organisations that do not normally fall under the WMO umbrella. It further noted that the outcomes of the expert-team meeting will be considered at the subsequent fourth GRUAN Implementation and Coordination Meeting and at the next session of AOPC, and looked forward to further consideration of these matters next year at SC-XX, which would precede their consideration by CBS-XV.

The Steering Committee was pleased to be informed of the efforts that had been made for more prompt submission of World Weather Records and thanked the President of CCl and the National Climatic Data Center (NCDC) for their role in this.

The Steering Committee was concerned by recent reports of forthcoming closures of Canadian measurement sites and formulated Action 14 below. The Committee also expressed concern over funding uncertainties and gaps for several satellite-observing systems.

Action 12. Reviewing the Performance of New Networks. The Committee requested AOPC to keep the performance of new GAW networks in the GCOS under review, as it does for other atmospheric networks designated by GCOS.

Action 13. Meeting with Earth Networks, Inc. Noting an increasing involvement of the private sector in greenhouse-gas observation, the Committee asked D/GCOS and the SC Chairman to meet Earth Networks Inc., prior to a possible discussion of private sector greenhouse gas observation at the next session of the Committee. The Committee also invited input from AOPC and TOPC on this topic.

Action 14. Letter addressing closures of Canadian measurement sites. The Committee asked the Secretariat to prepare a joint letter with WCRP to Canadian authorities expressing concern over the forthcoming closures of Canadian ozone, BSRN, and Fluxnet measurement sites, as well as the World Ozone and UV Data Centre in Toronto. The Secretariat should check with WMO to determine to whom to send the letter.

7.2 Ocean Observations Panel for Climate

The OOPC Chair reviewed the state of ocean observing systems, highlighting that the continuity of Jason-3 altimetry is worrisome and that the *in situ* observing system has been stuck at 62 percent for the last several years. He noted also that the deep ocean constituted a large gap in the ocean observing system. The objective of a Deep Ocean Observing Strategy (DOOS) Workshop in Paris in March/April 2011 was to develop a common statement of requirements and a first strategy for sustained global deep ocean observations for climate that would consider all ECVs, regions, and technologies and propose high priority and feasible actions for the next 5-10 years. It is hoped that a DOOS strategy can be established in the next two years and that it will be incorporated in GCOS. By Ocean Obs 2019, it is hoped that global sustained coverage of the deep ocean will be in sight.

[1] The revised agreement on CO_2 and CH_4 monitoring networks is given in Annex 5; the new agreement on N_2O monitoring networks is given in Annex 6.

The proposed Framework for Ocean Observing was also introduced. OOPC hopes to complete this framework in the coming year and move on to its implementation through the interim GOOS Steering Committee.

The Steering Committee thanked the OOPC Chair for an interesting set of recent observational results related to oceans. It shared his concerns over continuity of high-quality altimetry due to delay in the planned launch date for Jason-3 and over the stalling of improvement of in situ ocean observations. Developing a strategy for deep ocean observation was strongly endorsed, and the Committee was pleased to see the report on the Framework for Ocean Observing approaching completion. The Steering Committee noted that change in the governance of GOOS would result in the ending of GOOS sponsorship of OOPC at the end of 2011. It was nevertheless expected that the new GOOS Steering Committee would re-commit to sponsorship, and the Committee looked forward to full establishment of OOPC under the new arrangements. The Steering Committee welcomed initiatives aimed at the interpretation of extreme events, but recognized that this needed to be handled carefully, making clear what one can and cannot say, and allowing an openness of debate when issues are not clear cut.

***Action 15. Co-Sponsoring OOPC*.** The Chairman is asked to encourage the IOC to continue to be a co-sponsor of the OOPC.

7.3 Terrestrial Observation Panel for Climate and Global Terrestrial Observing System

The TOPC Chair summarised the activities of the Panel. He drew particular attention to issues with the ISO process for terrestrial ECVs, the need for GTOS/GCOS to stay closely aligned with the GEO Carbon Strategy, the increased visibility of terrestrial ECV products, and issues concerning the identification of ECVs. His presentation was supplemented by that of the GTOS representative, who provided further information and comment on the framework for climate-related terrestrial observations and the work being carried out on the developments of ECV standards within this framework.

The Steering Committee was concerned at the amount of work and expense required to establish standards for the terrestrial ECVs through a formal International Organization for Standardization (ISO) process and at the risk that emphasis on standardisation would divert effort from other tasks. It noted that in some areas best practices need to be established and documented before considering routing through an ISO process. It further noted that WMO as a standard-setting organization had developed regulatory material for some terrestrial ECVs and could be consulted. Furthermore, for glaciers there is long-established monitoring, but the proposed ISO process seems to be decoupled from the people who are actually doing this monitoring. There was also concern over implications for the atmospheric and oceanic ECVs of establishing ISO standards for the terrestrial ECVs.

The Steering Committee welcomed the emergence of a GEO Carbon Strategy, which, through its alignment with GCOS planning, could be viewed as part of the global observing system for climate on which GCOS assessed adequacy, reported progress, and reviewed implementation needs. Links were currently largely on an informal basis, although as a participating organization in GEO, GCOS also had a formal overview of GEO activities as set out in the GEO Work Plan and other documents.

The Steering Committee was pleased to see increased coverage of terrestrial ECVs in the latest Bulletin of the American Meteorological Society (BAMS) State-of-the-Climate publication. It took note of the TOPC Chair's remarks on several matters concerning the choice of ECVs. These are considered in more detail under later agenda items on cross-cutting issues and the designation of ECVs.

Action 16. Lessons Learned from GTOS Work on Standardisation. The Committee decided to invite GTOS to report in depth to SC-XX on lessons learned from its work on standardisation, including providing a cost-benefit analysis of establishing and implementing ISO standards.

Action 17. Linking the GEO Carbon Strategy to GCOS. The Committee requested its Chairman to liaise with the Chair of TOPC as to whether and how a more specific formal link between GCOS and the GEO Carbon Strategy might be established.

8. World Climate Research Programme

8.1 Proposed Data Council

The WCRP representative provided information on the proposed WCRP Data Council that had been conceived in connection with the restructuring of WCRP. The new structure will have four overarching themes—observations, modelling, processes, and applications. The Data Council addresses the first theme and will replace the WCRP Observations and Assimilation Panel (WOAP). Its terms of reference are to:

- Promote research using sustained observations and data from process studies across the WCRP;
- Promote assessment of the adequacy of sustained observations and derived products to support climate research;
- Promote assessment of gaps in the global observing system;
- Promote coordinated assessment and comparison of climate-data products, including those from reanalyses;
- Promote research for continuing improvement in the processing and reprocessing of fundamental climate data records;
- Promote development of mechanisms for archival of, access to and analysis of data, and associated metadata, across the research community;
- Promote standards for product generation, including global and regional reanalyses;
- Promote a coordinated approach to reanalysis across all domains;
- Promote scientific development of coupled assimilation; and
- Work with the Modelling Council to promote effective use of observations with models.

GCOS will have less of a formal role than it has in WOAP, which it sponsors jointly with WCRP, but it will still be well represented, as representatives from each of its three Panels will be members of the Council.

The Steering Committee thanked the WCRP representative for his presentation. It suggested that the JSC consider using the name Observations Council rather than Data Council. It noted that potential duplications between the GCOS SC or Panel activities and the work of the Data Council needed to be avoided; this could be achieved through continued liaison with WCRP at secretariat level and by the engagement of the SC and Panel Chairs in the work of the JSC and Data Council. The Committee also proposed that the Data Council report to the GCOS SC at its annual meeting and that consideration be given to the GCOS SC and Data Council meeting back-to-back.

8.2 Open Science and Reanalysis Conferences

The WCRP representative gave brief overviews of the upcoming WCRP Open Science Conference, which will be held in Denver, Colorado from 24-28 October 2011, and of the Fourth WCRP International Conference on Reanalysis, to be held in Silver Spring, USA from 7-11 May 2012. Observing needs will be considered at a dedicated session of the Open Science Conference chaired by the SC Chairman. The objectives of the Reanalysis Conference are to share understanding of the major challenges facing reanalysis (the changing observing system and integrated earth system); to assess the state of the disciplinary atmospheric, ocean, and land reanalyses, including the needs of the research community for weather, ocean, hydrology, and climate reanalyses; and to review new developments in reanalyses, models, and observations.

The Steering Committee thanked the WCRP representative for this information and looked forward to being briefed on the conclusions of these important meetings at its next session.

8.3 Workshop on Evaluation of Satellite-Related Global Climate Datasets

A summary of the WOAP workshop on the Evaluation of Satellite-Related Global Climate Datasets was given by Dr Michael Manton. Dr Manton was both the principal organizer of the workshop, which was hosted by the European Space Agency (ESA) in Frascati, Italy from 18-20 April 2011, and the lead author of the report of the workshop.

The objectives of the workshop were to evaluate some ECV datasets against the GCOS Guidelines, to provide a framework for the future evaluation of global climate datasets, and to assess the value of establishing an inventory of the status of ECV datasets. As a basis for detailed consideration of global climate datasets, the utility of these datasets was first summarised, and it was concluded that global climate datasets are vital components of climate science, supporting activities such as monitoring of climate variability and change on a range of time scales, monitoring of forcing of the climate system, prediction of climate variability and change, attribution of causes of climate change, and characterisation of extreme climate events. Some general issues addressed by workshop participants included observing strategies for ECVs, reprocessing of Fundamental Climate Data Records (FCDRs), atmospheric adjustment for satellite retrievals, independent expert-group assessment of datasets (considered very important), indices of maturity and uncertainty, interdependence of variables, the need for long-term homogeneity of datasets, and international cooperation.

To provide a consistent framework for the workshop evaluations, the status of each dataset considered at the workshop was entered in an inventory that includes a description of the extent to which the GCOS Guidelines have been followed. The establishment and maintenance of such an inventory at a site, such as the NOAA Global Observing Systems Information Centre (GOSIC), would provide a consistent and accessible source of information on global climate datasets. The admission of new datasets into the inventory is expected to be managed by the GCOS Panels.

The Steering Committee thanked Dr Manton for his work on the meeting and in drafting the report, and was grateful to ESA for its hosting of the meeting. The Committee considered dataset evaluation to be an important activity on which GCOS should continue to collaborate with WCRP and other partners. It agreed that GOSIC would be a good place to host the inventory, and negotiations should be carried out with GOSIC to ensure that a robust process can be established and maintained.

8.4 WOAP Reanalysis Task Group

For some years AOPC and WOAP have had a joint Working Group on Observational Datasets for Reanalysis. While some progress has been made, it is believed that a group with a broader charter could further develop the international cooperation needed to ensure that reanalysis activities, including dataset development, are undertaken efficiently and effectively. A WOAP Reanalysis Task Group would aim to assure the value to the research community of global reanalyses. The Terms of Reference for such a group proposed by WOAP include reviewing data holdings, promoting standards, ensuring maintenance of a dataset catalogue, promoting dataset production and maintenance, promoting common global dataset for reanalysis, promoting cooperation on scheduling, and promoting consistent output and access.

The Steering Committee supported the establishment of a Task Group under the Terms of References proposed by WOAP. The Committee noted that the Task Group is envisaged at present to be an atmospheric reanalysis group. It supported including the oceans in the future, as coupling of atmospheric and ocean reanalysis becomes more fully established.

9. Opportunities for GEO and GCOS

9.1 Review of the New GEO Work Plan

The representative of the Group on Earth Observations (GEO) reviewed the elements that are being considered in its draft (i.e., Version 1) GEO Work Plan for the 2012-2015 period. The new Work Plan is to have a target-oriented approach wherein Tasks will correspond to outcomes identified as necessary to meet Strategic Targets. It will have a three-part structure, consisting of Infrastructure

(architecture and data management), Institutions and Development (data sharing, capacity building, science and technology, user engagement), and Information for Societal Benefits (the 9 GEOSS Societal Benefit Areas). The number of tasks will be streamlined, and there will be improved Work Plan management.

Several of the proposed tasks in the draft Work Plan were cited as being especially relevant to GCOS. These included Earth Observing Systems (IN-01), Oceans and Society (Blue Planet)(SB-01), Global Land Cover (SB-02), Climate Information for Adaptation (CL-01), and Global Carbon Observation and Analysis (CL-02).

A lively discussion among Steering Committee Members and other session participants followed this presentation. It is widely recognized that cooperation and coordination between the GEO and GCOS Secretariats can potentially be more effective than it has been. Although on paper the GCOS has been accepted by GEO as the climate-observing component of the GEOSS, it is not clear in practice how this recognition has worked to the benefit of the GCOS Programme. One view, fairly widespread, is that GEO has done little to help groups aligned with it to prosper. The Director of the GCOS Secretariat indicated that, at the moment, the Secretariat is in "standby mode" and is uncertain as to how it can contribute to, and benefit from, greater cooperation with GEO.

Dr Sue Barrell, speaking from the viewpoint of membership of the GEO Executive Committee, pointed out that much good had been achieved in the name of GEO, notwithstanding the recognised problems. She informed the Committee that a discussion paper is being drafted at the moment concerning the future of GEO and GEOSS after 2015. She indicated that there is an opportunity for GCOS to be involved in the process by submitting its views to the working group drafting the paper. She advocated that the group look at the Societal Benefit Areas (SBAs) and how they are structured, noting that six of the current nine are user areas but that three—weather, climate, and water—cut across these other six SBAs.

Another issue that arose concerned the need to deliver a coordinated message on climate to GEO. The Chairman observed that at GEO Plenary sessions he speaks for GCOS, but that the Sponsors of GCOS may also speak on climate issues, as might the representative of ECMWF, the current home institution of the Chairman. This carries the risk of failure to deliver a coherent, consistent message.

The Steering Committee thanked the representative of GEO for his presentation. The Committee agreed that GCOS has a potential role to play in helping to frame the future GEO and GEOSS. The contribution that GCOS can make to the GEOSS was tied to the resources that GCOS has at its disposal. Its potential future role should be clearer after the GCOS review is completed by the Sponsors. The Chairman indicated that in his report to the Sponsors at the end of the year he would ask for advice concerning the input GCOS might make to the post-2015 future of GEO, as the Sponsors themselves may wish to provide input directly; he would express his personal willingness to contribute if requested.

9.2 Requirements of SBAs Other Than Climate for Climate Observations

The GEO representative was also asked to address the requirements of SBAs other than the Climate SBA for climate observations. It was reported that a cross-SBA analysis had been undertaken showing that the 20 highest-ranked observations are common to at least four SBAs and that the three highest-ranked observations were precipitation, soil moisture, and surface air temperature. ECVs for climate clearly are important for many of the GEO SBAs, as GCOS had itself determined.

The Steering Committee thanked the GEO representative for this information. Whilst noting the ranked list of variables for which observations were needed to meet the requirements of other SBAs, the Committee also noted that providing forecast and interpretative information on these variables required observations of many other variables.

10. Issues in the Designation of Essential Climate Variables

The SC Chairman introduced this topic by giving a brief history of the development of the concept of Essential Climate Variables (ECVs). Since their introduction, the ECVs have achieved increasing recognition, and the general concept is now beginning to be seen in other contexts. One example is

the proposal to assign Essential Ocean Variables as the organizational basis for processes of the Framework for Ocean Observing. Some changes to the original ECV list were made in the 2010 update to the GCOS Implementation Plan, i.e., in IP-10. However, in part because of the success of their use, some have questioned how the initial list of ECVs was established and how it is revised over time. After IP-10 was published, a specific request was received to add land surface temperature as an ECV. The SC Chairman responded that it was his opinion that it was neither practical nor desirable to change the list more frequently than the roughly five-year cycle that GCOS has for assessment and implementation planning, but that he would raise the issue at this session of the Committee.

The Steering Committee agreed that the list of ECVs be updated only when the IP is updated, a process that involves community consultation and guarantees a stable list for the purposes of applications, such as for the purposes of national reporting on systematic observation by Parties to the UNFCCC, the organization of the ESA Climate Change Initiative, and for calls for proposals under the European Union's 7th Framework Programme. In the meantime potential or proposed ECVs could be identified in the ECV Wiki pages under development by the Secretariat. The Committee encouraged continued efforts towards describing the provenance of the ECVs, for example, through a peer-reviewed article in a publication such as the Bulletin of the American Meteorological Society. Also, an annex that was supposed to provide additional information on the ECVs in the Second Adequacy Report (but that was never attached to that report) might now be brought up to date and more widely distributed.

Action 18. Communicating the Provenance of ECVs. The SC Chairman is requested to support the preparation of an article for peer review describing the provenance of the ECVs and the process of revising the ECV list. The Secretariat is asked to liaise with Panel Chairs to identify potential or proposed ECVs, and to consider whether the unpublished annex linked to the Second Adequacy Report might be updated and made available, e.g., in the ECV Wiki pages under development.

11. Adaptation and Climate Services: GCOS Role in Adaptation

For several years the GCOS Steering Committee and Secretariat have been following the increasing interest of Parties to the UNFCCC and others in adaptation to climate change. It is clear that the GCOS SC needs to consider the role of observations in addressing adaptation requirements and to develop a strategy for ensuring that the observations required for decisions related to adaptation are made. Moreover, the Secretariat has recently received funding from the U.S. State Department to allow it to undertake an assessment of this role. To stimulate discussion on this topic, the Secretariat asked three session participants to provide their views.

11.1 Three Presentations

SC session special invitee Dr Roger Street, Technical Director of the UK Climate Impacts Programme, Oxford University Centre for the Environment gave the first presentation. Dr Street highlighted several potential roles for GCOS in addressing adaptation. He suggested there were roles for GCOS 1) in helping to improve understanding and communication of users' needs for comprehensive information on the total climate system that can support adaptation; 2) in supporting the integration of information on the total climate system (*in situ* and space-based components) to support adaptation; 3) in enhancing both the quality and quantity of observed climate system data and information through data rescue, filling gaps in observational coverage, improving quality assurance (QA) and quality control (QC) processes, and improving information from remote sensing components; and 4) in improving the accessibility of observational data for the intended benefits. He highlighted the importance of sustained engagement of providers and users of information so that, on the one hand, providers can better understand users' needs and, on the other, users can better appreciate science capabilities and developments.

Dr Roger Pulwarty, a new Member of the Steering Committee this year, talked about confronting models with data and the need for local information. He emphasized that it was important to maintain multi-way communication among the observation and research communities and policymakers. Scenario planning must address problem-definition and characterize both technical and institutional capacity uncertainties. Some important questions to bear in mind are: Does the present data collection cover current data requirements and potential requirements under a changing climate?

Does the current data provide for adequate monitoring of climate impacts? And does current monitoring provide adequate information for assessing the effectiveness of adaptation measures? He noted that adaptation was a continuous process and that more observations would lead to better knowledge that could in turn lead to reconsideration of adaptation decisions. Like Dr Street, he stressed that information must be authoritative, accessible, and usable.

Dr Ed Harrison, another new Member of the GCOS SC, posed a challenge for GCOS. He noted that the GCOS ECVs provide essential information for a variety of climate assessment, research, and forecasting activities and that, in the years ahead, they will also provide critical information for the evaluation of climate projections. The UNFCCC and developers of the GFCS have requested extra effort on activities in support of the delivery of climate services and adaptation. Does the GCOS Programme have opportunities to meet this challenge and, if so, what steps could the SC and Secretariat try to take?

Dr Harrison suggested that weather and climate variability, rather than climate change, are going to be the main drivers for the next couple of decades. Thus, the *historical* range of variability is critical information for near-term adaptation/resilience planning and action, and climate projections are not essential to this. People don't understand just how variable our climate really is, and this means that it is difficult to derive useful trends for the near term. Shorter-term variability often will dominate trend estimates even over multi-decadal periods. Hence, it may be smarter to think about adaptation in terms of variability. Further, historical data sets are the critical source of information needed for climate variability on regional scales.

Dr Harrison also noted that our present skill at seasonal prediction is demonstrated by the way forecasting systems capture the evolution of climate indices. The more one focuses on particular regions, the more likely it is that skill will become more evident if additional indices relevant to that region are introduced. Research is needed to enhance regional skill. He argued that the limits of regional forecast skill will be pushed forward only with continuing research and data availability. These thoughts led Dr Harrison to conclude that a robust set of adaptation activities is possible and appropriate, given only historical observations and impact analysis frameworks. Assessment of climate variability impacts and planning for adaptation actions fall usefully within this existing framework. The GCOS Programme, he suggested, might benefit from creation of a new Panel with this focus.

11.2 Discussion, with Focus on Possible Projects in the 2012-2013 Timeframe

The Steering Committee thanked the presenters for their thoughts on observation for adaptation and discussed what the Programme might do. It was noted that there has been much discussion on the need to adapt to climate change but that it is seldom recognized that we are not ideally adapted to the current climate. Nevertheless, it is also important to ask what observations are needed to support longer time scales. A suggestion was to pick a few past events around the world and try to demonstrate how the availability of more and better observations would have helped the response to those events.

The central questions for GCOS are "what is our role in adaptation and what can we add?" The Steering Committee agreed that making historical data available is important. Providers and users of climate data need to know if the data are adequate in vulnerable places or, stated another way, if observational requirements are being met for adaptation needs. An SC Member suggested that GCOS probably needs to look at all ECVs to determine if they are adequate for adaptation. The adequacy of the density of networks should also be considered. There may exist an opportunity to work with CCl on the adaptation issue, and, in that context, it was proposed that it could be useful to organize a joint workshop on environmental risk assessment. The Chairman suggested that, at a minimum, a workshop should be organized that would bring together representatives of the GCOS community with others to determine the observation requirements for adaptation. Relevant in this context were the questions of the observational needs for the GFCS and the preparation of a new Adequacy Report.

Action 19. Organizing a Workshop on Observation Needs for Adaptation. The GCOS Secretariat, in consultation with the Chairman and Members of the Steering Committee, was asked to design one or more workshops to consider the observation requirements for adaptation, linking these

with potential workshops on observational needs for the GFCS and on preparing for the next Adequacy Report.

12. Progress of the Surface Temperature Initiative

The International Surface Temperature Initiative (ISTI) was described by Dr Kate Willett of the UK Met Office Hadley Centre. The ISTI concept, endorsed by the WMO Commission for Climatology at its 15th session, was launched at a meeting at the UK Met Office, Exeter in September 2010. It was formally recognized by the WMO Congress in 2011 and, for WMO purposes, reports to the Commission for Climatology. The purpose of ISTI is to provide a complete land-surface temperature data resource for 21st Century climate science, which requires high-quality and high-resolution dataproducts with openness, transparency, verification, and user tools. It will provide the foundation for creation of a range of estimates within a common framework. This will aid decision-making at national and international scales and inform adaptation strategies. It encompasses data rescue and digitisation; an open, transparent, and comprehensive land surface temperature databank with version control and provenance tracking; a programme of benchmarking and assessment for homogenisation algorithms; and a data-portal for multiple products estimating local-, regional-, and global-scale changes with platforms for data download, intercomparison and visualisation solutions.

Dr Willett had several recommendations for GCOS. She suggested that GCOS review the prototype databank archive and provide feedback on adequacy for GCOS purposes; recognise the ISTI databank as a GCOS data archive for land-surface temperatures and other data; provide feedback on any aspects of ISTI (especially on its implementation plan and timelines) to the ISTI Steering Committee; consider appropriate ongoing reporting mechanisms to GCOS, if desired, recognising that the Initiative is a voluntary effort; and consider instigation of a global surface reference network, modelled upon the US Climate Reference Network (USCRN) and GRUAN.

The Steering Committee expressed its support for this initiative, noting that it had been well thought through. It is potentially a major effort that will bring rigour to the process of surface temperature analysis, but it will also require people and resources. While GCOS has no formal mechanism or precedent for recognizing data banks, the Steering Committee saw a role for the GCOS programme in monitoring and advising on the progress of the Initiative.

Action 20. Support for the ISTI. The Steering Committee requested that AOPC monitor and formulate views on the progress of the ISTI at its annual meetings, either through direct reports from the ISTI or through the regular reporting it receives from NCDC and from the CCl representative. It further requested that AOPC discuss and report back to the SC on the rationale and potential for establishing a global surface reference network.

13. Crosscutting Issues

13.1 Cryosphere—On Integrating Cryospheric Observations into the GCOS Domain-Based Structure

Dr Barry Goodison provided an overview of the Global Cryosphere Watch (GCW), the development of which has now been approved by the WMO Congress. The mission of the GCW is to provide authoritative, understandable and useable data, information, and analyses on the past, current and future state of the cryosphere to meet the needs of WMO Members and partners in delivering services to users, the media, the public and to decision- and policy-makers. The GCW will implement the IGOS Cryosphere Theme (CryOS); support reliable and comprehensive observations through an integrated observing approach in collaboration with relevant national and international programmes and agencies; provide the scientific community with the means to predict the future state of the cryosphere; facilitate the assessment of changes in the cryosphere and their impact; support decision making and environmental policy development; and provide authoritative information on the current state and projected fate of the cryosphere. It will contribute to WMO's integrated global observing and information systems (WIGOS and WIS) and to GCOS networks and will strengthen the WMO contribution to the GFCS. GCW will work with, and build on, existing GCOS networks (including the Global Terrestrial Network for Glaciers (GTN-G), the Global Terrestrial Network for Permafrost (GTN-

P), and the Global Terrestrial Network for Hydrology (GTN-H)). It is intended to be a one-stop portal for authoritative up-to-date cryospheric data and products.

Dr Goodison introduced the Executive Council Panel of Experts on Polar Observations, Research, and Services (EC-PORS) and indicated that this Panel would like the support and guidance of the GCOS SC in the Implementation of the GCW. It seeks direction from the SC on developing improved integration of the cryosphere across the GCOS domain. He also asked if the GCOS SC and its Panels could identify the appropriate contacts within the GCOS Programme to develop effective coordination. In addition, he invited the SC, the GCOS Panels, and the Sponsors of GCOS to provide the EC-PORS GCW Task Team with comments or suggestions on the GCW implementation strategy, especially on the proposed next steps that could benefit the GCOS Panels, networks, and wider GCOS Programme. Discussions on this strategy will be held in November 2011. Some near-term tasks for the GCW include establishing cryospheric reference sites and co-ordinating development of guidelines, best practices, and standards; developing an inventory of satellite products for the GCW; and identifying GCW partnerships.

The Steering Committee thanked Dr Goodison for his presentation. Its subsequent discussions included the specific question of the future of the joint AOPC/OOPC Working Group on Sea Surface Temperature and Sea Ice, and more general needs to ensure adequacy of cryospheric observations and data products. Two actions were formulated.

Action 21. Sea Ice. The Steering Committee encouraged the AOPC and OOPC Chairs to conclude their consideration of the future of the joint working group on SST and Sea Ice, and to ensure that adequate arrangements are in place for ongoing review of observations and data products for these two ECVs.

Action 22. Other Cryospheric Issues. The Steering Committee requested AOPC, OOPC and TOPC each to consider their coverage of cryospheric issues in general and to report back to the Committee on any organisational changes that might be considered to ensure better handling of cryospheric and other cross-cutting issues. The Committee also requested the Panels to provide feedback on the GCW implementation strategy appropriate to their domains.

13.2 Fluxes

The WOAP Chair presented an Action Plan for WCRP research on surface fluxes and a timetable for the full development of this Plan. Across WCRP and GCOS programmes, surface flux observations are obtained both directly and indirectly. Surface flux datasets are generated from both *in situ* and satellite-based data, and model-based fluxes are generated. Fluxes are considered over land, ice and ocean, and the fluxes of both physical and chemical variables are considered. A number of groups have been carrying our inter-comparison studies of specific datasets, which often identify some inconsistencies. Many of these issues will be resolved by the individual groups, but a number of problems may extend across domains. Moreover, some issues remain on the basic measurement of fluxes. Associated with the observation of fluxes has been the establishment of reference sites or super-sites at which comprehensive measurements are taken. A number of different networks of super-sites have been established around the world, and the relationships between these networks could also be considered.

It is recognised that surface fluxes are of interest because they represent exchanges across interfaces, and so should not be considered in isolation from the state variables on both sides of the interface. For example, to properly understand the relationship between heat flux and SST it is necessary to know the character of the mixed layers in the ocean and atmosphere. The spatial and temporal variability of surface fluxes further highlights the need for careful consideration of their measurement and representation in models. The need to link fluxes with their associated state variables means that, when developing and evaluating global datasets, these inter-dependencies must be considered.

Six issues that will be considered in the Action Plan are: common issues over land, ice, and sea; distribution of reference sites; flux measurement and data processing; global datasets of fluxes; evaluation of model fluxes; and communication across the international research community. Specific information was sought from TOPC. Land-ocean (i.e., coastal) fluxes are not a focus at this time.

The Steering Committee thanked WOAP for this initiative, to which it gave its full support. The initiative would be followed by the Panel Chairs through their (or their nominee's) membership of WOAP and the WCRP Data Council, and feedback into the work of the Panels was expected to flow from this. The Committee noted that specific consideration of coastal fluxes was given in the implementation plan prepared by the GOOS Panel for Integrated Coastal Observations (PICO).

Action 23. Land-based networks for flux measurement. The Steering Committee requested TOPC to summarize characteristics of land-based networks and recommend actions to optimize the spatial distribution of reference sites, the consistency of measurements and data handling, and the promotion of sites measuring a broad range of variables.

14. GCOS Strategic Issues

14.1 Discussion on the GCOS Contribution to the GFCS

The SC Chairman introduced this item by recalling that the WMO Deputy Secretary-General had invited the Steering Committee to offer its views on the role of GCOS in the GFCS. A number of SC Members put forward ideas. The Chairman suggested that the SC and Secretariat should produce a short document that would both clarify how what the GCOS Programme does now is important for climate services and indicate what new contributions can be made to the GFCS. An SC Member proposed that the GCOS Programme might benefit from establishing a fourth panel, an interface panel bringing together people looking after climate observations with those who deal with socio-economic issues. This panel would, in a sense, address interface issues that GEO was not currently addressing. Before establishing a new panel, it could be helpful to organize a small workshop that would consider its terms of reference. However, as an alternative to a panel, one or more *ad hoc* special meetings might be organized to consider interface issues.

Another suggestion for the GCOS SC and Secretariat was to engage with the relevant Open Panels of CCl Experts (OPACEs), which will have to support the GFCS, and use these panels as the interface mechanisms. The Chairman emphasized that some sort of mechanism will need to be established to engage with information providers from communities with which GCOS has not yet begun to work, and that this mechanism would involve a meeting or meetings that should include representatives of the Steering Committee or Panels. The Director of the WMO Observing and Information Systems Department (D/OBS) noted that WIGOS will support the GFCS, that the GFCS Office could play a coordinating role in developing the observations section of the GFCS Implementation Plan, and that any workshop to address the observation component of the GFCS could be organized jointly with the CCl, CBS, and other groups. A key question is where the pieces of the global climate observing system that are outside WMO can be brought into the GFCS.

Another comment was that the GFCS needs to ensure that it can deliver the outcomes, that is, the required services that will be needed by the user communities. Therefore, the user interface platform will be an important component of the GFCS, and it is equally important that GCOS be part of the associated conversation with users. The challenge of engaging with other communities will be a sizable one, both for GCOS and for the WMO. One such community with which it could be especially productive to interact could be the reinsurance industry. As one SC Member asked, what stops the SC from asking the reinsurance companies what they need from observing systems? Feedback from this industry could be obtained through attending some of the upcoming industry meetings and/or by organizing a joint workshop to discuss the observational needs of the reinsurance industry.

The Steering Committee noted that a WMO Executive Committee Task Team (ECTT) had been established to develop a draft Implementation Plan for the GFCS and to draft Terms of Reference and Rules of Procedure for an Intergovernmental Board and its substructures based on the Implementation Plan. The ECTT was requested to ensure the close involvement of, *inter alia*, the Chair of the GCOS SC in the conduct of its work.

Action 24. GCOS and the GFCS. The Steering Committee requested the Chairman and Secretariat to engage to the fullest extent possible with the work of the Executive Committee Task Team developing the draft implementation plan for the GFCS, taking note of the points raised during the Committee's discussion of the contribution of GCOS to the GFCS. Planning of any workshops on

observational aspects of the GFCS to be held in the initial implementation phase should take into account the workshops envisaged by GCOS on observational needs for adaptation and in preparation of a new Adequacy Report.

14.2 Updating the GCOS Memorandum of Understanding.

It was noted that there had been periodic discussion among the Sponsors in the last four years or so about the desirability of updating the GCOS Memorandum of Understanding (MoU), last updated in 1998. Moreover, earlier in this session the Deputy Secretary-General of WMO had indicated that he would like the four GCOS Sponsors to complete a review of the GCOS Programme before the June 2012 session of SBSTA (see section 5.1.4). This review would then form the basis for revising the 1998 MoU. In discussion on this topic, which continued under the following agenda item, the SC concluded that it should be proactive, in particular by providing Sponsors with its assessment of what GCOS has achieved, including discussion of how closely GCOS works with CEOS and the UNFCCC Secretariat. This, plus a statement on future directions (see below), would provide input for the review and subsequent MoU revision. D/OBS agreed that WMO would be happy to receive the views of the GCOS SC.

14.3 Updating the GCOS Plan.

It was recalled that updating the GCOS strategic plan, initially published in 1995 as the *Plan for the Global Climate Observing System, Version 1.0*, had been discussed at least since SC-XVI in 2008. It was now widely recognized that the Plan is in need of updating. However, it had been considered appropriate to wait to update the Plan until after the GCOS MoU has been revised, which will not now be until after the Sponsor review of the GCOS Programme. Now, also, it may be appropriate to postpone updating the Plan until after the role that GCOS will play in the GFCS becomes clearer. However, some SC Members and other Session participants expressed different views on the timing for updating the Plan. Following discussion, the Steering Committee agreed that a clear view of the future GCOS should be developed in a document of about six pages to be submitted to the Sponsors' review team. Once the review had been completed, this document, if accepted in essence by the review, might be reduced to four pages for outreach material, and expanded to perhaps 15 to 20 pages to form the full Plan. Members highlighted the need to address national activities, adaptation, and the socio-economic benefits of observations.

Action 25. SC Input to the Sponsors Review. The SC Chairman and GCOS Secretariat were asked to draft a summary of the achievements of GCOS and a view of the future GCOS based on the discussions at this session. These drafts should be circulated to the SC Members for comment. Final versions should be prepared and submitted to the Sponsors' review team. The Secretariat was asked to determine with the Sponsors when the documents would be needed in final form, taking note of other commitments in the coming months.

14.4 The Assessment Cycle

SBSTA 33 in Cancún, Mexico in 2010 invited the GCOS Secretariat to report regularly on progress made in implementing IP-10. It also noted the usefulness of updating the implementation plan on a regular basis and agreed to consider the timing of GCOS contributions to the SBSTA at SBSTA 35 at the end of 2011. In this context, it would be useful if the Secretariat consider suitable timeframes for reporting to the SBSTA and to provide this information to the SBSTA when it considers this matter. Although the consideration of GCOS contributions to the SBSTA has been deferred until the May 2012 session of SBSTA, the Secretariat has given some consideration to the "assessment cycle."

The Director observed that GCOS reporting must be tied in with other efforts, in particular with the planned release of the Working Group I report of IPCC's Fifth Assessment Report (AR5) in 2013, and that we must ensure that the GCOS Implementation Plan is aligned with the implementation plans of others. In this regard, she suggested that Progress and Adequacy reports should be released in the 2014-2015 timeframe, while an update of the Implementation Plan could be done in the 2015-2016 timeframe. In the 2012-2013 period, special reports on adaptation and/or on the GCOS contribution to the GFCS could be undertaken.

The Steering Committee noted that it would be important also to take into account the forthcoming report of IPCC Working Group II to be finalised in the first quarter of 2014. It considered several variations to the basic assessment cycle proposal: that the Progress and Adequacy reports be done in one document, that the Adequacy Report and Implementation Plan be combined, that the Progress Report be skipped completely, or that the Progress and Adequacy Reports and the Implementation Plan all be combined in one document. Some considered that streamlining the cycle of reporting would be helpful, as it requires much time and resources to do properly. It was, however, advocated and agreed that the Adequacy Report needs to appeal to a broader audience than the Implementation Plan. A proposal to hold a preparatory "brainstorming" workshop on the structure and likely main themes of the Adequacy Report, and implications for implementation reporting and planning, before starting the cycle again met with broad support. The UNFCCC representative suggested that it might be possible for the UNFCCC to organize a small (i.e., about 30-40 people) expert meeting to prepare for SBSTA. This suggestion was appreciated by the Steering Committee, but would be difficult to accommodate given other commitments in the period up to May, not least the review of GCOS. D/OBS noted that new requirements, such as for the GFCS, need to be considered in the next Adequacy Report.

The Steering Committee concluded that it could foresee the preparation of a new Adequacy Report to be finalised following completion of the contributions of Working Groups I and II to the Fifth IPCC Assessment Report and subsequent liaison between GCOS and Working Group members. This would be followed by a new version of the Implementation Plan. How reporting of progress in the context of IP-10 could be incorporated in one or both documents could not yet be foreseen, but it was considered unlikely that resources would permit production of a separate Progress Report within the time frame under consideration.

Action 26. The Assessment Cycle. The Steering Committee asked the Chairman to report to the May 2012 session of SBSTA that the Steering Committee envisaged that a new Adequacy Report would be prepared by late 2014 or early 2015, to be followed by a new Implementation Plan in 2016. Reporting on recent progress in implementation would most likely be incorporated in one or both documents. The Secretariat was asked to work towards setting up the first preparatory workshop for the Adequacy Report in late 2012 or early 2013, to be followed by a workshop or workshops with representatives of Working Groups I and II of the IPCC. Consideration should be given to combining the preparatory workshop with a workshop on observational needs for adaptation (called for in Action 19) or holding the two workshops back-to-back.

14.5 Celebrating 20 years of the Global Climate Observing System

The year 2012 is the 20th anniversary of the establishment of the Global Climate Observing System. The Director reviewed ideas for celebrating this milestone. She indicated that she has set aside some funds for creating a brochure on the chronology of the development of GCOS. Dr David Goodrich, a former Director of the GCOS Secretariat, will take the lead in drafting this brochure. The plan is also to bring together for a day former Steering Committee Chairmen and Members, Panel Chairs, Secretariat directors and staff, and others who have been involved in the establishment, development, and/or operation of the GCOS to celebrate the occasion. The one day event could look forward as well as backward and combine a symposium or brainstorming session with a social gathering. The WMO Deputy Secretary-General suggested that the event could be held in June 2012 in before, during, or after the Executive Council session, by which time the outcome of the review of GCOS should be known.

The Steering Committee enthusiastically approved the organization of this event.

Action 27. 20th Anniversary Celebration of the GCOS. The Steering Committee asked the Secretariat to continue its planning for the 20th Anniversary celebration of GCOS along the lines indicated.

15. GCOS Budget and Fundraising

The Director briefly reviewed the budget of the GCOS Secretariat. The Secretariat requires about one million Swiss francs per year to cover its core activities, additional programme activities, and the

salaries of staff (other than that of herself and her administrative assistant, who are covered directly by WMO). She emphasized that the Secretariat had only about half of the resources that it needs to continue operating at its current level as of mid September 2011. This situation, however, should improve somewhat as additional expected resources are received. She credited, in particular, the extrabudgetary contributions of the United States and Germany, which have been used in part to support the Senior Scientific Officer and Junior Professional Officer. Nevertheless, the long-term situation of the Secretariat budget is not healthy. She noted that donors who contribute resources for observing system improvements in developing countries cannot so easily provide resources to cover the salaries of Secretariat staff.

The Chairman also expressed his view that it would be useful to see figures for the total cost of GCOS, including, for example, for the cost for office space. A tabulation of *in kind* contributions that other organizations provide would be equally helpful, as would some indication of what others (e.g., NCDC) spend for on GCOS-related activities. D/OBS noted that some WMO Members do not see the direct contribution of GCOS to their activities. He suggested that the GFCS could give a new opportunity for GCOS to be more visible and that this may help resource mobilization.

The Director showed a slide of voluntary contributions from sponsoring organisations from 1996 to 2010. The trend has clearly been downward, even for WMO, the Sponsor providing the bulk of support to the Secretariat. Sponsor support of GCOS is clearly an issue that needs to be addressed when the Sponsors consider revising the GCOS MoU. If GCOS is to function effectively, however, the Secretariat must also mobilize resources from sources other than the Sponsors. It was noted that the U.S. Department of State had been a stable source of funding for GCOS in the last few years. It was important that contacts be developed with a view to ensuring continuation of such funding, and that more be done to seek support from individual European governments and the European Union as a whole.

The Steering Committee agreed that a long-term solution to the problem of adequate funding for the Secretariat needed to be found, and looked to this being addressed as part of the review of GCOS. In this regard it was important that members of the sponsoring organisations be aware of the benefits that GCOS provides, and that opportunities to promote the visibility of GCOS be exploited. Additional fundraising for specific activities was also important and required both continued contact with those that had traditionally supported GCOS and the exploration of new sources of funding.

16. Communication Strategy: Annual Report, Brochures, WIKI

Following on from the discussions under the previous agenda item, a number of ideas were considered as to how to improve knowledge about GCOS and the benefits of GCOS to members of its sponsoring organisations as well as to funders and users of climate observations in general. The Steering Committee's support of the production of a brochure on the socio-economic benefits of observations (see section 2.2, Action 1) was reiterated. It was also suggested that the communication strategy of the IPCC could be useful to study, and, to that end, it asked the Secretariat to liaise with the IPCC Secretariat to see what it could learn. The Chairman mentioned that he will likely have the opportunity to inform the SBI about the cost of observing systems (see section 3, Action 2). Finally, an update on developing a Wiki with supplementary information on ECVs was provided. The initial version, developed by GCOS Secretariat and presented at the previous Steering Committee meeting, has not yet become available for the public for both technical and security reasons, as the Wiki software is not supported by WMO's IT department.

The Steering Committee repeated its wish that duplication between the GCOS ECV Wiki and the information provided by the GOSIC web site be avoided. It encouraged the GCOS Secretariat to continue its liaison with NCDC on this matter and to find a practical solution for hosting the ECV Wiki in a sustainable way outside the WMO infrastructure.

17. GCOS Work Programme to SC-XX

17.1 Planning for Panel Sessions in 2012

The Steering Committee reviewed dates for the 2012 session of the GCOS Panels. The Ocean Observations Panel for Climate meeting is expected to be held in January 2012 in Paris, although it could be scheduled any time during the first quarter of 2012. The Terrestrial Observations Panel for Climate meeting will be held in Geneva 1-2 March 2012 and the Atmospheric Observations Panel for Climate meeting will take place in Geneva from 30 April to 3 May 2012.

17.2 Arrangements for SC-XX

The Steering Committee Session for 2012 could not yet be scheduled as the timing of the next session of CBS had still to be determined. As usual, however, the Secretariat would try to schedule the Session in either September or October 2012. SC Members would be polled concerning preferred dates.

18. Other Business

18.1 General Steering Committee Membership and Related Issues (*In Camera*)

Although the Steering Committee met *in camera* for this agenda item, there was no membership issue to discuss at this SC Session. It was noted that after next year's Session a substantial number of SC Members would be rotating off the Committee, and that SC members may wish to identify potential new candidates for membership to the Secretariat.

18.2 Other

The Steering Committee had several suggestions for making future SC Sessions more effective and/or relevant. One was to send a note to Members before planning begins for the next Session asking for Member advice on what they would like to see in the agenda. A second was for the Panel Chairs to provide summary information on the state of observing systems and the state of the climate at the start of each session of the SC. In this regard, the Chairman noted that the annual state of the climate publications of WMO and BAMS would provide valuable sources of information. The Chairman also indicated that he would circulate his year-end report to the Sponsors to all SC Members. A further idea was to include in the agenda talks on science and/or on other new developments. The Chairman stated that it was his desire to have one or more science talks at this SC Session, but that the agenda did not allow time for such talks. A more streamlined agenda for next year's Session may allow for such talks.

19. Close of the Session

The Chairman closed the session at approximately 12.30 on 23 September 2011 with thanks to the Sponsors, the Steering Committee members, invitees, and other participants. He also thanked Dr Richter, Dr Westermeyer, and the other members of the GCOS Secretariat for their work in organizing the session. He wished members of the Steering Committee and other attendees a safe journey home.

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Appendix 1

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Appendix 2

FINAL AGENDA FOR SC-XIX

1. Opening of the Session

   1.1 Welcome (Director-General, ECMWF)
   1.2 Opening Remarks
   1.3 Approval of Agenda
   1.4 Arrangements for the Session

2. Reports of the Director and Chairman: Activities since SC-XVIII

   2.1 Chairman, GCOS Steering Committee
   2.2 Director, GCOS Secretariat

3. UNFCCC: From Cancún to Durban

4. Regional Activities

   4.1 An Overview of GCOS Regional Activities
   4.2 The GCOS Cooperation Mechanism (GCM) and System Improvement Activities
   4.3 The Climate for Development in Africa Programme
   4.4 Update on National Activities in Switzerland

5. Climate observing-system status, initiatives, concerns, and views on the role of GCOS

   5.1 WMO

      5.1.1 GFCS
      5.1.2 CCl and the World Climate Programme
      5.1.3 CBS and WIGOS
      5.1.4 The role of GCOS

   5.2 IOC
      5.2.1 Status of GOOS and the framework for ocean observations
      5.2.2 The role of GCOS (Watson-Wright)

   5.3 UNEP

   5.4 ICSU

6. GCOS and Space-Based Observations

   6.1 The Satellite Supplement
   6.2 Space Architecture
   6.3 Importance of Past Observational Data for Climate

7. GCOS Panel Reports

   7.1 Atmospheric Observation Panel for Climate
   7.2 Ocean Observations Panel for Climate
   7.3 Terrestrial Observation Panel for Climate

8. World Climate Research Programme (WCRP)

   8.1 Proposed Data Council
   8.2 Open Science Conference
   8.3 Workshop on Evaluation of Satellite-Related Global Climate Datasets
   8.4 WOAP Reanalysis Task Group

9. Opportunities for GEO and GCOS

   9.1 Review of the new GEO Work Plan
   9.2 Requirements of SBAs other than climate for climate observations

10. Issues in the designation of Essential Climate Variables

11. Adaptation and climate services: The GCOS role in adaptation

    11.1 Three presentations
    11.2 Discussion, with focus on potential projects in the 2012-2013 timeframe

12. Progress of the Surface Temperature Initiative (Willett)

13. Crosscutting Issues

    13.1 Cryosphere—on integrating cryospheric observations into the GCOS domain-based structure
    13.2 Fluxes

14. GCOS Strategic Plan and Work Programme, 2012-2015

    14.1 Updating the GCOS Contribution to the GFCS
    14.2 Updating the GCOS Memorandum of Understanding
    14.3 Updating the GCOS Plan
    14.4 The Assessment Cycle
    14.5 Celebrating 20 years of GCOS

15. GCOS Budget and Fundraising

    15.1 Budget
    15.2 Fundraising Issues

16. Communication Strategy: Annual Report, Brochures, WIKI

17. GCOS Work Programme to SC-XX

    17.1 Planning for Panel Sessions for 2012
    17.2 Arrangements for SC-XX

18. Other Business

    18.1 General Steering Committee Membership and Related Issues (*In Camera*)
    18.2 Other

19. Close of the Session

Appendix 3

AVAILABLE DOCUMENTS (D) AND/OR PRESENTATIONS (P)

Doc. No.	Description	D/P
	Agenda	D
1.4	Arrangements for the Session	D,P
2.1	Report of the Chairman	D,P
2.2	Report of the Director	D,P
3	UNFCCC: From Cancún to Durban	D,P
4.1	An Overview of GCOS Regional Activities	D,P
4.2	The GCOS Cooperation Mechanism and System Improvement Activities	D,P
4.3	The Climate for Development in Africa Programme	D,P
4.4	Update on National Activities in Switzelrand	P
5.1.1	GFCS	P
5.1.2	The Commission for Climatology and the World Climate Programme	P
5.1.3	The Commission for Basic Systems and WIGOS	D,P
5.2	IOC	P
5.3	UNEP	P
5.4	ICSU	P
6.3	Importance of Past Observational Data for Climate	P
7.1	Atmospheric Observation Panel for Climate (AOPC)	D,P
7.1a	GCOS-GAW Agreement CO_2 and CH_4 Networks	D
7.1b	GCOS-GAW Agreement N_2O Network	D
7.2	Ocean Observation Panel for Climate (OOPC)	P
7.3	Terrestrial Observation Panel for Climate (TOPC)	D,P
8.1	Proposed Data Council	D,P
8.2	WCRP Conferences	D,P
8.3	Workshop on Evaluation of Satellite-Related Global Climate Datasets	D,P
8.4	WOAP Reanalysis Task Group	D,P
9.1	Review of the New GEO Work Plan	P
9.2	Requirements of SBAs Other Than Climate for Climate Observations	P
10	Issues in the Designation of Essential Climate Variables	D
11.1.1	The GCOS Role in Adaptation	P
11.1.2	Adaptation in a Changing Climate	P
11.1.3	Some Thoughts on GCOS and Adaptation	P
12	Progress of the Surface Temperature Initiative	D,P
13.1	Cryosphere—On Integrating Cryospheric Observations into GCOS	D,P
13.2	Fluxes	D,P

The available documents may be found here:

http://www.wmo.int/pages/prog/gcos/index.php?name=SC-XIX

and the presentations may be found here:

address: ftp.wmo.int
folder: /Xchange/gcos/
user: wmo_temp
password: temp_08

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Appendix 4

CONSOLIDATED LIST OF ACTIONS

Action 1. Brochure on the Socio-economic Benefits of Observations. The GCOS Secretariat is asked to produce a brochure on the socio-economic benefits of improving climate observations, using as a starting point the case studies prepared at the Australian Bureau of Meteorology for this purpose. Committee members were invited to assist the Secretariat by identifying further such case studies.

***Action 2. SBI Side Event and Other COP-17 Activities*.** The Steering Committee requested the Chair and Secretariat to respond positively to a formal invitation, which would provide an opportunity to explain how observations are currently funded and the needs for and benefits of increased funding. The Committee further encouraged the Chair and Secretariat to consider submitting a short paper to SBI for information on this topic.

Action 3. Funding the GCM. Recognising the value of the GCM and concerns over the current economic situation, the Committee further asked the Director to write a letter to donor countries encouraging the continued provision of funds.

Action 4. Consideration of ECV data in International Data Centres. The Atmospheric Observation Panel for Climate (AOPC) and Terrestrial Observation Panel for Climate (TOPC) are asked to consider how to facilitate the regular and timely submission ECV data to International Data Centres at their next Panel meetings, with a view to further discussion at the next session of the Committee. The Committee also requested that these monitoring and data-centre issues be considered at the forthcoming meeting of CBS Lead Centres for GCOS and related climatological data.

Action 5. Contributing to the Development of the GFCS Implementation Plan. The SC Chairman, assisted by SC members as needed, and the Secretariat are asked to support fully the development of the component of the GFCS Implementation Plan that relates to observations.

Action 6. Free and Unrestricted Exchange of Climate Data. The SC Chairman and Secretariat are asked to take steps to promote free and open exchange of climate data to the greatest extent possible.

Action 7. Proposing People for the GCOS Review Team. The SC Chairman is asked to consult with SC Members to identify candidates for the GCOS Review Team to be established by the Sponsors.

Action 8. Advancing GCOS-UNEP Links. The SC Chairman and Director should investigate improving linkages with UNEP. Thus UNEP and GCOS could work together to identify what data are needed to address societal needs, and then assess the adequacy of the data sets available.

Action 9. GCOS representation at Rio+20. The Chairman and Secretariat should engage with ICSU to ensure effective GCOS representation at Rio+20.

Action 10. Completion of the Satellite Supplement. The Steering Committee encouraged those involved in finalizing the Satellite Supplement to complete their work by the end of October.

Action 11. Reprocessing of geostationary satellite data. The Steering Committee requested the Secretariat to draw the SC's conclusion on this topic to the attention of CEOS.

Action 12. Reviewing the Performance of New Networks. The Committee requested AOPC to keep the performance of new GAW networks in the GCOS under review, as it does for other atmospheric networks designated by GCOS.

Action 13. Meeting with Earth Networks, Inc. Noting an increasing involvement of the private sector in greenhouse-gas observation, the Committee asked D/GCOS and the SC Chairman to meet

Earth Networks Inc., prior to a possible discussion of private sector greenhouse gas observation at the next session of the Committee. The Committee also invited input from AOPC and TOPC on this topic.

Action 14. Letter addressing closures of Canadian measurement sites. The Committee asked the Secretariat to prepare a joint letter with WCRP to Canadian authorities expressing concern over the forthcoming closures of Canadian ozone, BSRN, and Fluxnet measurement sites, as well as the World Ozone and UV Data Centre in Toronto.. The Secretariat should check with WMO to determine to whom to send the letter.

Action 15. Co-Sponsoring OOPC. The Chairman is asked to encourage the IOC to continue to be a co-sponsor of the OOPC.

Action 16. Lessons Learned from GTOS Work on Standardisation. The Committee decided to invite GTOS to report in depth to SC-XX on lessons learned from its work on standardisation, including providing a cost-benefit analysis of establishing and implementing ISO standards.

Action 17. Linking the GEO Carbon Strategy to GCOS. The Committee requested its Chairman to liaise with the Chair of TOPC as to whether and how a more specific formal link between GCOS and the GEO Carbon Strategy might be established.

Action 18. Communicating the Provenance of ECVs. The SC Chairman is requested to support the preparation of an article for peer review describing the provenance of the ECVs and the process of revising the ECV list. The Secretariat is asked to liaise with Panel Chairs to identify potential or proposed ECVs, and to consider whether the unpublished annex linked to the Second Adequacy Report might be updated and made available, e.g. in the ECV Wiki pages under development.

Action 19. Organizing a Workshop on Observation Needs for Adaptation. The GCOS Secretariat, in consultation with the Chairman and Members of the Steering Committee, was asked to design one or more workshops to consider the observation requirements for adaptation, linking these with potential workshops on observational needs for the GFCS and on preparing for the next Adequacy Report.

Action 20. Support for the ISTI. The Steering Committee requested that AOPC monitor and formulate views on the progress of the ISTI at its annual meetings, either through direct reports from the ISTI or through the regular reporting it receives from NCDC and from the CCl representative. It further requested that AOPC discuss and report back to the SC on the rationale and potential for establishing a global surface reference network.

Action 21. Sea Ice. The Steering Committee encouraged the AOPC and OOPC Chairs to conclude their consideration of the future of the joint working group on SST and Sea Ice, and to ensure that adequate arrangements are in place for ongoing review of observations and data products for these two ECVs.

Action 22. Other Cryospheric Issues. The Steering Committee requested AOPC, OOPC and TOPC each to consider their coverage of cryospheric issues in general and to report back to the Committee on any organisational changes that might be considered to ensure better handling of cryospheric and other cross-cutting issues. The Committee also requested the Panels to provide feedback on the GCW implementation strategy appropriate to their domains.

Action 23. Land-based networks for flux measurement. The Steering Committee requested TOPC to summarize characteristics of land-based networks and recommend actions to optimize the spatial distribution of reference sites, the consistency of measurements and data handling, and the promotion of sites measuring a broad range of variables.

Action 24. GCOS and the GFCS. The Steering Committee requested the Chairman and Secretariat to engage to the fullest extent possible with the work of the Executive Committee Task Team developing the draft implementation plan for the GFCS, taking note of the points raised during the Committee's discussion of the contribution of GCOS to the GFCS. Planning of any workshops on observational aspects of the GFCS to be held in the initial implementation phase should take into

account the workshops envisaged by GCOS on observational needs for adaptation and in preparation of a new Adequacy Report.

Action 25. SC Input to the Sponsors Review. The SC Chairman and GCOS Secretariat were asked to draft a summary of the achievements of GCOS and a view of the future GCOS based on the discussions at this session. These drafts should be circulated to the SC Members for comment. Final versions should be prepared and submitted to the Sponsors' review team. The Secretariat was asked to determine with the Sponsors when the documents would be needed in final form, taking note of other commitments in the coming months.

Action 26. The Assessment Cycle. The Steering Committee asked the Chairman to report to the May 2012 session of SBSTA that the Steering Committee envisaged that a new Adequacy Report would be prepared by late 2014 or early 2015, to be followed by a new Implementation Plan in 2016. Reporting on recent progress in implementation would most likely be incorporated in one or both documents. The Secretariat was asked to work towards setting up the first preparatory workshop for the Adequacy Report in late 2012 or early 2013, to be followed by a workshop or workshops with representatives of Working Groups 1 and 2 of the IPCC. Consideration should be given to combining the preparatory workshop with a workshop on observational needs for adaptation (called for in Action 19) or holding the two workshops back-to-back.

Action 27. 20th Anniversary Celebration of the GCOS. The Steering Committee asked the Secretariat to continue its planning for the 20th Anniversary celebration of GCOS along the lines indicated.

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Appendix 5

The following text presents an amendment of the 2005 agreement between GCOS and the World Meteorological Organization's Global Atmosphere Watch (WMO/GAW) Programme of the Research Department, operating under the auspices of the Commission for Atmospheric Science (CAS). The agreement specifies the terms under which the WMO/GAW Global Atmospheric CO2 & CH4 Monitoring Networks are recognized as Global Baseline Observing Networks of GCOS. Prepared by a joint GAW/GCOS group, the amendment of the original agreement has been approved by the Scientific Advisory Group for Greenhouse Gases of WMO/GAW and by the Chair of the CAS Working Group on Environmental Pollution and Atmospheric Chemistry. It is presented to the GCOS Steering Committee for approval at its 19th Session, following the recommendation of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) at its 16th Session.

Amendment of the GCOS-GAW Agreement Concerning the WMO/GAW Global Atmospheric CO_2 & CH_4 Monitoring Networks

1. Greenhouse gases are an important class of variables with regard to radiative forcing of the atmosphere, in which CO_2 and CH_4 are the main greenhouse gases of anthropogenic origin. Their observation in the atmosphere and scientific analysis are needed to improve understanding of the factors impacting climate variability and change. Atmospheric contents of these gases were considered as GCOS Essential Climate Variables (ECVs) in the Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UN Framework Convention on Climate Change (UNFCCC).

2. In 1989, in view of the need for globally coordinated observations of the chemical composition of the atmosphere and its physical properties, the World Meteorological Organization established the Global Atmosphere Watch (GAW) Programme. The GAW Programme coordinates global greenhouse gas observations performed by WMO Members in support of climate studies. In 2005, an agreement was signed between WMO/GAW and the GCOS Programme designating the WMO/GAW Global Atmospheric CO_2 & CH_4 Monitoring Networks as comprehensive observing networks of GCOS. These comprehensive networks have further developed within the past six years. They follow stringent quality assurance and quality control (QA/QC) schemes, overseen by designated calibration centres. The current status of the CO_2 & CH_4 comprehensive networks is described in Annex I of this document. According to the 2010 GCOS Implementation Plan, which specifies the different purpose and structure of the 'global comprehensive observing networks' and the 'global baseline observing networks', a core subset of observations with the highest reliability and importance within the CO_2 & CH_4 Monitoring Networks can be regarded mature enough to serve as global baseline observing networks as outlined in Annex I. Such designation might also serve the need to support continuous funding and national support on the long-term base for these key observations.

3. The WMO/GAW Networks have demonstrated the quality and maturity to fulfil the requirements of a global baseline observing network of GCOS, which consists of a limited number of stations at selected locations, which are globally distributed and provide long-term high-quality data records of key global climate variables, as well as calibration for the broader comprehensive and designated networks. WMO/GAW supports consistent, long-term, globally-distributed measurements of CO_2 & CH_4. The most stringent quality control measures and highest constancy of measurements can be implemented at the subset of ground-based continuous and flask-sampling observations via its well established QA/QC system.

4. In view of these facts, it was recommended by AOPC that the subsets of WMO/GAW Global Atmospheric CO_2 & CH_4 Monitoring Networks, which have already been designated as GCOS global comprehensive observing networks, should be formally recognized as GCOS global baseline observing networks for these ECVs.

ANNEX I

Status of WMO/GAW Global Atmospheric CO2 & CH4 Monitoring Network in 2011

1. INTRODUCTION

Greenhouse gases are an important class of variables with regard to climate. CO_2 shows strong absorption bands in the infrared and is the largest contributor of anthropogenic origin to the greenhouse effect, accounting for almost 2/3 of the radiative forcing caused by the increase in the long-lived greenhouse gases from 1750 to 2009. CH_4 is the second most important anthropogenic greenhouse gas, with an estimated global warming potential per molecule of 25 times greater over a 100 year horizon, and 72 times greater over a 20 years horizon, than the global warming potential of CO_2. Between 1750 and 2009, increase in atmospheric CH_4 led to about 18 % of the increase in radiative forcing caused by well-mixed greenhouse gases. Acknowledging the importance of greenhouse gases in the atmosphere, and in particular the role of CO_2 and CH_4, their atmospheric contents were considered as GCOS Essential Climate Variables (ECVs) in the Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC.

The WMO/GAW Programme, with support of its Scientific Advisory Group for Greenhouse Gases (SAG-GHG), coordinates activities on greenhouse gas observations including quality assurance, calibration, validation, and archiving of data for climate research purposes. Consisting of a global partnership of managers, scientists, and technical experts in 80 countries, the GAW Programme is coordinated by the Research Division of the WMO Secretariat in Geneva under the auspices of the WMO Commission for Atmospheric Science (CAS). The US National Oceanographic and Atmospheric Administration (NOAA) and other major greenhouse gas monitoring agencies are contributing to the GAW Programme and have strong representation in its advisory groups.

The thirteenth Session of the GCOS Steering Committee in 2005 designated the World Meteorological Organization/Global Atmosphere Watch (WMO/GAW) Global Atmospheric CO2 & CH4 network as a global comprehensive observing network of GCOS.

The current status of the CO_2 & CH_4 global comprehensive networks is described below. According to the 2010 GCOS Implementation Plan specifying the different purpose and structure of the 'global comprehensive observing networks' and the 'global baseline observing networks', a core subset of observations with the highest reliability and importance within the CO_2 & CH_4 Monitoring Networks can be regarded mature enough to serve as global baseline observing networks. Such designation might also serve the need to support continuous funding and national support on the long-term base for these key observations.

2. STRUCTURE AND DEVELOPMENT OF THE CO_2 & CH_4 GLOBAL COMPREHENSIVE NETWORKS

The WMO/GAW Programme supports the atmospheric component of the Integrated Global Carbon Observing System. Observations from different platforms are integrated by linking them to a single standard scale for all contributors and implementing a stringent quality control and assurance scheme. This integrated system, which represents the GCOS global comprehensive observing network, consists of *in-situ* and remote-sensing, ground-based observations, observations from mobile platforms (e.g., ships and airplanes), and, though still emerging, satellite remote sensing.

According to the GCOS definition (cf. 2010 GCOS Implementation Plan, p.22), a global comprehensive network includes "regional and national networks and, where appropriate/possible, satellite data. The comprehensive networks provide observations at the detailed space and time scales required to fully describe the nature, variability and change of a specific climate variable…".
Below, the elements of the GCOS-affiliated WMO/GAW Global Atmospheric CO_2 & CH_4 Monitoring Networks which are GCOS comprehensive observing networks are described.

2.1. Global, in-situ, ground-based observations of CO_2 & CH_4 mixing ratios

As of January 2011, the WMO/GAW global atmospheric CO_2 & CH_4 monitoring networks consist of some 133 / 118 (i.e., CO_2 / CH_4) fixed stations on the ground and two permanent ocean transects. About 14 % / 13 % of stations perform both flask sampling and continuous measurements of CO_2 / CH_4. The network has been extended by four reporting stations for CO_2 and two reporting stations for CH_4 since 2009. More details on this part of observational network are given in Section 4.

2.2. Global in-situ aircraft-based observations of CO_2 & CH_4 mixing ratios

Routine aircraft-based observations are performed by commercial aircraft in the framework of the CONTRAIL project, in commercial flights on a monthly basis within the CARIBIC project, and by weekly or bi-weekly sampling from light aircraft, mostly over North America. These observations constitute the current airborne component of the global comprehensive network. The measurements from aircraft are used to validate model reanalyses and support validation of satellite retrievals of greenhouse gases. Greenhouse gas measurements are planned to be extended within the IAGOS-ERI project.

2.3. Global surface-based remote sensing of CO_2 & CH_4 total column

The need for validation of satellite data and data representation on the WMO calibration scale drove the development of a network of upward-looking Fourier Transform System (FTS) instruments measuring total column CO_2 and CH_4. The Total Carbon Column Observing Network (TCCON, www.tccon.caltech.edu) was founded in 2004 in view of the OCO mission proposed at that time and currently consists of 13 operational sites. It is a ground-based network of high resolution FTS instruments, which record the near-infrared, solar absorption spectrum and retrieve column-averaged mixing ratios of CO_2, CH_4, N_2O, and several other gases. Total column measurements of CO_2 are associated with measurements made on the WMO calibration scale through comparisons of FTS measurements with aircraft profiles measured over or near TCCON stations. In turn, TCCON measurements, once vetted, will assist in validating satellite measurements from GOSAT, SCIAMACHY and, in the future, OCO-2. TCCON became a GAW contributing network in 2009.

2.4. Satellite Observations.

The GAW Greenhouse Gas SAG recognizes the potential for greenhouse gas satellite observations to fill gaps in the global observing system and to aid in creating integrated data products, hence collaborates with GOSAT, SCIAMACHY and OCO-2 teams on this issue.

3. IMPLEMENTATION OF THE QUALITY ASSURANCE SYSTEM

QA/QC principles concern all elements of the comprehensive network. WMO/GAW QA procedures address the quality of an observation through maintenance of components of the entire measurement process, from operational procedures at stations and personnel training to submission of properly quality controlled data to a World Data Centre. The key principles are summarized the WMO/GAW Strategic plan: 2008-2015 and include, in particular, network-wide use of a single reference standard or scale (primary standard); stringent guidelines in terms of measurement quality (data quality objectives (DQOs)) and measurement methods (Measurement Guidelines and Standard Operating Procedures); regular independent assessments (system and performance audits) and timely data submission, including associated metadata to the responsible World Data Centre. The QA system involves Quality Assurance/Science Activity Centres, Central Calibration Laboratories and World/Regional Calibration Centres.

Long-term education, training, workshops, calibrations, station audits/visits and twinning are also provided to build capacities in atmospheric sciences in the WMO/GAW network. These capacity building activities are of increased importance, as many WMO/GAW stations in developing countries have become operational. These activities are further promoted by recognition of the network by GCOS.

NOAA/ESRL serves as the Central Calibration Laboratory (CCL) for both CO_2 and CH_4 and as a World Calibration Center (WCC) for CO_2. The WCC started the 5th greenhouse gas round robin campaign in 2009. 28 Laboratories have finished the analysis of the test cylinders and 12 Laboratories are still to finish. In 2010 NOAA/ESRL made over 1100 calibrations. More than 400 new standards were made for the ESRL Carbon Cycle Greenhouse Gases group and 37 other universities and laboratories world-wide.

The Japan Meteorological Agency (JMA) serves as the WCC for methane and as Quality Assurance/Science Activity Centres (QA/SAC) in Asia and the South-West Pacific. Reference gas comparison is one of the important activities towards verification to which extent the current practice of calibration is accurate. In 2008-2009, the sixth comparison has been carried out to compare CH_4 measurements at GAW stations, as well as other stations monitoring atmospheric CH_4 mixing ratios, particularly in Asia. In the sixth comparison, the methane reference gases (Cylinder numbers: CPB13002, CPB13003), prepared in Japan in 2008, were circulated from May 2008 through July 2009 among JMA, the Korea Research Institute of Standards and Science (KRISS), the Korea Meteorological Administration (KMA), and the China Meteorological Administration (CMA). The results of this comparison are summarized at: http://gaw.kishou.go.jp/wcc/ch4/com_annex2.html.

WMO signed the Mutual Recognition Arrangement (MRA) with the Comité International des Poids et Mesures (CIPM), with approval of the Bureau International des Poids et Mesures (BIPM) in April 2010, making the World Meteorological Organization the second intergovernmental organization to join the CIPM MRA. The CIPM MRA serves as the framework for the mutual acceptance of measurements and, in this instance, concerns measurements of greenhouse gases. The 26th meeting of the CCQM Gas Analysis Working group (GAWG) is planned at NIST and NOAA in Boulder, CO, USA, from 26 to 28 September 2011, and will involve active participation by WMO representatives.
The Swiss Federal Laboratories for Materials Science and Technology, Empa, serve as a WCC for methane and in this role performs regular system and performance audits of the GAW Global stations. In 2009, the GAW stations Izaña, Mt. Waliguan and Mace Head and calibration laboratory CAWAS (Beijing) and in 2010 the GAW stations Baring Head, Lauder, Mt. Kenya and Cape Grim and calibration laboratories NIWA (Wellington) and CSIRO (Aspendale) were audited by the Empa WCC.

4. THE GLOBAL, IN-SITU, GROUND-BASED OBSERVATIONS OF CO_2 AND CH_4 MIXING RATIOS

According to the GCOS networks description, Global baseline observing networks “involve a limited number of selected locations that are globally distributed and provide long-term high-quality data records of key global climate variables, as well as calibration for the comprehensive and designated networks…”.

The comprehensive network component of surface sites described in 2.1 satisfies these requirements. Below are more details on this subset of the comprehensive network with regards to the GCOS requirements for global baseline observing networks are presented.

The GAW CO_2 and CH_4 stations are well distributed over about 50 countries worldwide. As of January 2011, the WMO/GAW global atmospheric CO_2 and CH_4 monitoring networks consisted of some 133 (118) fixed stations on the ground and two permanent ocean transects. About 14 % / 13 % of the stations perform both flask sampling and continuous measurements of CO_2 / CH_4.

Figure 1 shows the locations of the sites. Sample collection at all WMO/GAW sites is performed routinely and regularly to provide a consistent, evenly distributed subset of data from each site (cf. Figure 2). Simultaneous observations by continuous instruments and flask sampling with subsequent analysis in the laboratory are necessary to ensure the consistency of the different measurement techniques. As shown in Fig.2, some observational data sets have a length of several decades and provide a reliable picture of the CO_2 content in the atmosphere. CH_4 observations are similar.

Some of the advantages of flask sampling are the provision of a centralized site for analyses, which assures consistency in the calibration of measurements from several (or many) sites, which provides opportunities for re-analysis or comparative analyses between laboratories, and which allows to sample from many locations without requiring highly trained personnel or expensive instrumentation at every site. The disadvantage of using flasks is that time resolution is only of the order of a week. While this shortcoming is not critical for long-lived gases, such as CO_2 and CH_4, especially in connection with climate research, the low time resolution makes it difficult to analyse the impact of small scale processes on the CO_2 and CH_4 content in the atmosphere. This task is partly addressed

by continuous observations, and by the other components of the WMO/GAW global CO_2 and CH_4 observational network which constitute the broader GCOS comprehensive network.

Continuous CO_2 and CH_4 measurements are performed using either non-dispersive infrared spectroscopy or gas chromatography. New instruments based on cavity-ring-down spectroscopy become widely used within GAW. Continuous observations offer an opportunity to obtain high-frequency measurements useful for understanding the influence of regional transport as well as local air-surface (air-biosphere) exchange effects. A constraint in taking this approach is the need for carefully controlled and documented intercalibration of the field instrument with a central laboratory. Continuous measurement instruments are presently deployed at about 46 / 43 observational stations for CO_2 / CH_4.

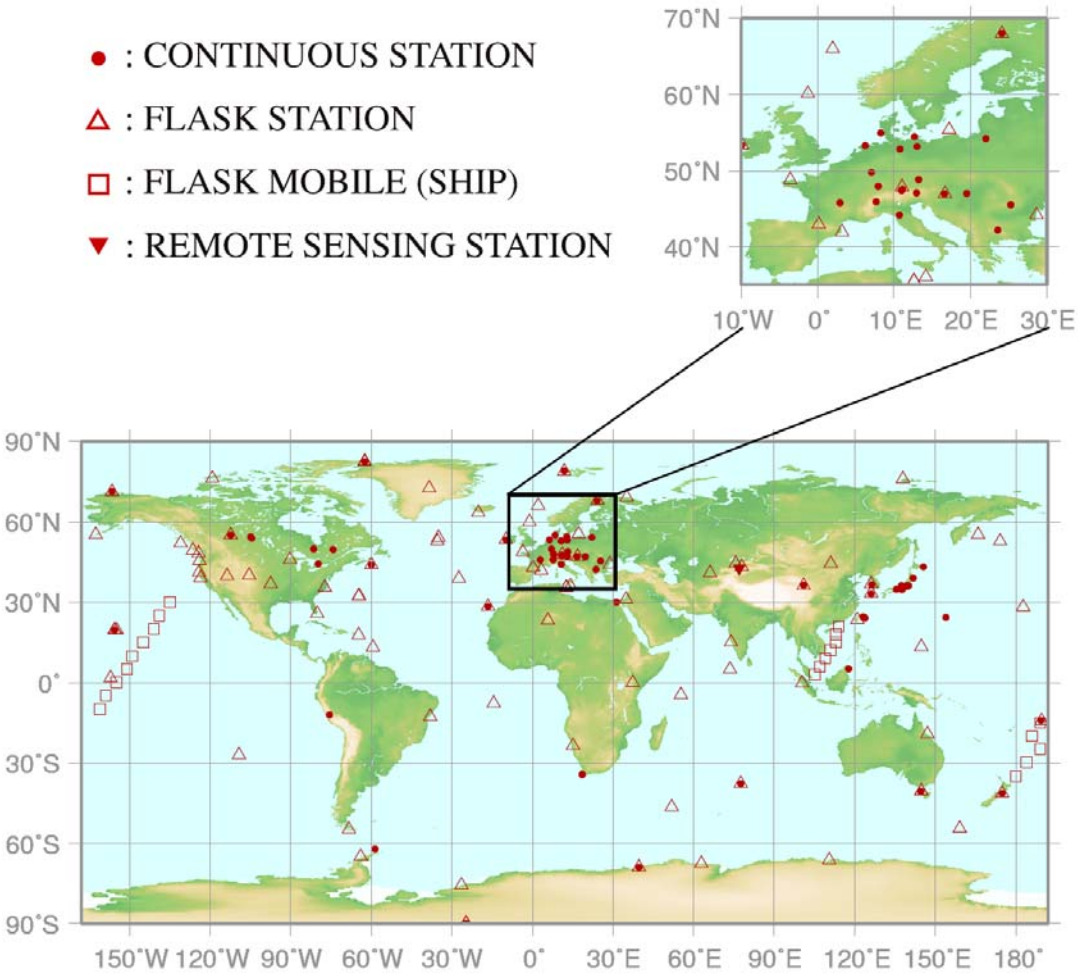

Figure 1: CO_2 ground-based observations in GAW. The stations with remote sensing observations are also indicated on the map. Remote sensing sites are suited for validating satellite observations, especially when properly compared to vertical profiles. The map is adopted from the WDCGG Data Summary No. 35 available at: http://gaw.kishou.go.jp/wdcgg/products/summary/sum35/sum35contents.html

Detailed information about GAW stations and their measurement programme is available from the WMO/GAW Station Information System (GAWSIS) http://www.empa.ch/gaw/gawsis/, which is an on-line query and mapping facility supported by MeteoSuisse.

The procedures for station activation and deactivation, data management and data products have been summarized in the original agreement between WMO/GAW and GCOS. The key principles of the QA/QC implemented at the ground-based stations are described in sections 3.

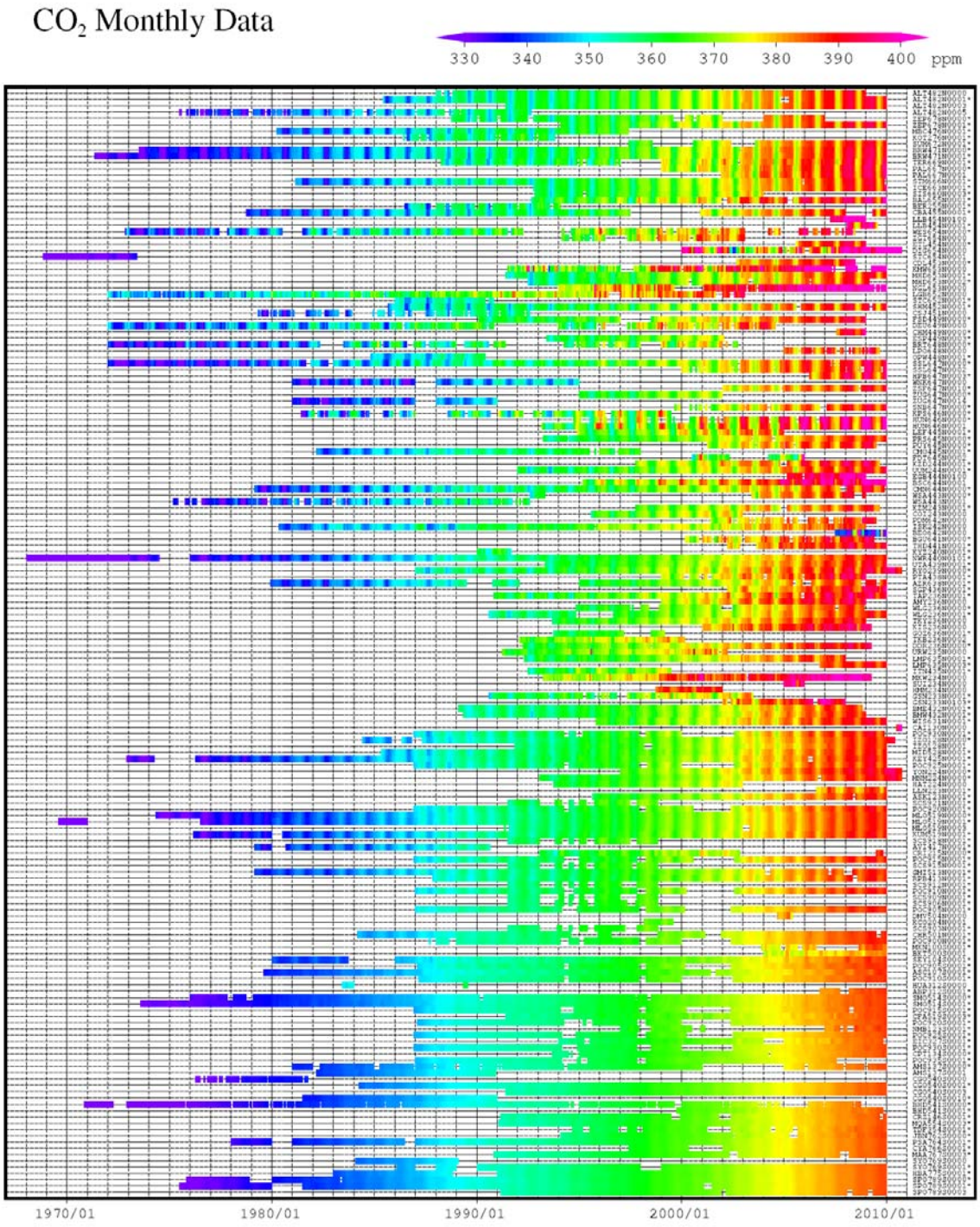

Figure 2: Monthly mean CO_2 mole fractions which have been reported to the World Data Center for Greenhouse Gases (from the Data Summary N. 35).

Forty-eight WMO member countries currently contribute CO_2 data to the GAW WDCGG. Approximately 49 % of the measurement records submitted to WDCGG are obtained at sites in the NOAA ESRL cooperative air-sampling network. The rest of the network is maintained by Australia, Canada, China, Japan and many European countries (see the national reports in GAW Report No.

186, available at http://www.wmo.int/gaw). The Advanced Global Atmospheric Gases Experiment (AGAGE) is also a GAW-affiliated network contributing observations to the GAW Programme. The GAW monitoring stations contributing data to the WDCGG are included in the List of Contributors on the WDCGG Web page (http://gaw.kishou.go.jp/wdcgg/).

5. Relevant WMO/GAW Reports since the original agreement was signed in 2005 (available at: www.wmo.int/gaw)

- GAW-168. 13th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracers Measurement Techniques (Boulder, Colorado, USA, 19-22 September 2005) (edited by J.B. Miller) (WMO TD No. 1359), 40 pp, December 2006.
- GAW-170. WMO/GAW Expert Workshop on the Quality and Applications of European GAW Measurements (Tutzing, Germany, 2-5 November 2004) (WMO TD No. 1367).
- GAW-172. WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008 – 2015 (WMO TD No. 1384), 108 pp, August 2008.
- GAW-174. World Data Centre for Greenhouse Gases Data Submission and Dissemination Guide (WMO TD No. 1416), 50 pp, January 2008.
- GAW-184. Technical Report of Global Analysis Method for Major Greenhouse Gases by the World Data Center for Greenhouse Gases (WMO TD No. 1473), 29 pp, June 2009.
- GAW-185. Guidelines for the Measurement of Methane and Nitrous Oxide and their Quality Assurance (WMO TD No. 1478), 49 pp, September 2009.
- GAW-186. 14th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (Helsinki, Finland, 10-13 September 2007) (WMO TD No. 1487), 31 pp, April 2009.
- GAW-188. Revision of the World Data Centre for Greenhouse Gases Data Submission and Dissemination Guide (WMO TD No.1507), 55 pp, November 2009.
- GAW-194. 15th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (Jena, Germany, 7-10 September 2009) (WMO TD No. 1553). 332 pp, April 2011.
- GAW-197. Addendum for the Period 2012 – 2015 to the WMO Global Atmosphere Watch (GAW) Strategic Plan 2008 – 2015.

6. ADHERENCE TO GCOS MONITORING PRINCIPLES

The ten basic GCOS Climate Monitoring Principles[2] are as follows:

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 should be required.
3. The results of calibration, validation and data homogeneity assessments, and assessments of algorithm changes, should be treated with the same care as data.
4. A capacity to routinely assess the quality and homogeneity of data on extreme events, including high-resolution data and related descriptive information, should be ensured.
5. Consideration of environmental climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.
6. Uninterrupted station operations and observing systems should be maintained.
7. A high priority should be given to additional observations in data-poor regions and regions sensitive to change.
8. Long-term requirements should be specified to network designers, operators and instrument engineers at the outset of new system design and implementation.
9. The carefully-planned conversion of research observing systems to long-term operations should be promoted.

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

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

Principles 1,2, and 6: Given the maturity of the global carbon gas measurement community and the networks operated in the framework of the WMO/GAW Programme, the GCOS Monitoring Principles are met and often exceeded throughout the WMO/GAW network. Principles 1, 2, and 6 form an essential part of the WMO/GAW community.

Principle 3: Regarding the importance of archiving and utilizing calibration, validation and other data quality assurance mechanisms this principle is recognized by the WMO/GAW community and documented by its respective bodies (stations hold data logs; WCCs perform intercalibration and stations audits; CCLs maintain scale and standards; and WDCs hold data and metadata records).

Principle 4: Measurements at the continuous monitoring sites are especially well suited for capturing extremes in greenhouse gas concentrations on short time scales. Analyses of the longer term records from the GAW sites also are able to capture extremes. The recent increase in CH_4 concentrations in the atmosphere, for example was readily identified as emanating from both the tropics and the arctic.

Principle 5: The link of the GCOS network to outstanding questions identified by IPCC is totally relevant and indeed shapes the WMO/GAW Programme in particular through the biennial consultation with research experts (at the CO_2 expert meetings) and smaller thematic workshops.

Principle 7: The priority of filling gaps in data-sparse areas is directly addressed in the WMO/GAW strategic plan and its addendum.

Principle 8: Optimal design of the WMO/GAW baseline network is addressed through biennial meetings of Experts and through the SAG for greenhouse gases and via collaboration with a modelling community utilising the results of inverse models and numerical experiments on the observational network optimization.

Principle 9: The need to stabilize observations that initially were conducted as project research has long ago been addressed by the WMO/GAW community who favour routine observations to be conducted within the framework of a group that is also conducting research and able to adapt to changes in long-term measurement strategy dictated by observation needs, data evaluations, and IPCC scientific assessments.
Principle 10 is implemented by the WMO/GAW Data Centres open access policy and by GAW partners organizations via numerous data products and cervices.

Appendix 6

The following text presents an agreement between GCOS and the World Meteorological Organization's Global Atmosphere Watch (WMO/GAW) Programme of the Research Department, operating under the auspices of the Commission for Atmospheric Science (CAS). The agreement specifies the terms under which the WMO/GAW Global Atmospheric N2O Monitoring Network shall be recognized as a comprehensive observing networks of GCOS and a subset thereof as a Global Baseline Observing Network of GCOS. Prepared by a joint GAW/GCOS group, the agreement has been approved by the Scientific Advisory Group for Greenhouse Gases of WMO/GAW and by the Chair of the CAS Working Group on Environmental Pollution and Atmospheric Chemistry. It is presented to the GCOS Steering Committee for approval at its 19th Session, following the recommendation of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) at its 16th Session.

GCOS-GAW Agreement Concerning the WMO/GAW Global Atmospheric N_2O Monitoring Network

1. Greenhouse gases are important for the radiation balance of the atmosphere. N_2O is the third most influential anthropogenic greenhouse gas. According to the 4th IPCC Report, its Global Warming Potential over 20 year and 100 year time horizons is about 300 times higher than that of CO_2. N_2O observations are important for obtaining a better understanding of the factors impacting climate and its variability. The atmospheric abundance of N_2O was considered as a GCOS Essential Climate Variable (ECV) in the Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UN Framework Convention on Climate Change (UNFCCC).

2. In 1989, in view of the need for globally coordinated observations of the chemical composition of the atmosphere and some of its physical properties, the World Meteorological Organization established the Global Atmosphere Watch (GAW) Programme. The GAW Programme coordinates global greenhouse gas observations performed by WMO Members in support of climate studies. The WMO/GAW Global Atmospheric N_2O monitoring network was developed in line with the other greenhouse gas observational networks (e.g. global atmospheric CO_2 & CH_4 monitoring network which is a GCOS comprehensive network) following similar principles. A detailed description of the status of the N_2O global atmospheric monitoring network is given in Annex I of this document. This network is continually developing. It follows stringent quality assurance and quality control (QA/QC) schemes, overseen by designated calibration centres. Designation of the N_2O global atmospheric monitoring network as a GCOS observational network will help secure continuous funding and national support over the long-term for these key observations.

3. The WMO/GAW Network for N_2O has demonstrated the quality and maturity to fulfil the requirements of both a global baseline and a global comprehensive observing network of GCOS. Compliance with the GCOS monitoring principles is reflected in the text of the agreement (Annex II). WMO/GAW supports long-term, globally-distributed measurements of N_2O. The most stringent quality control measures and and testing for consistency of measurements are implemented at a subset of ground-based continuous and flask-sampling observations, which are designated to make up the GCOS global baseline observing network.

4. In view of these facts, it was recommended by AOPC that the WMO/GAW Global Atmospheric N_2O Monitoring Network is recognized as a global comprehensive observing network of GCOS and that a subset of the WMO/GAW Global Atmospheric N_2O Monitoring Network is recognized as a global baseline observing network of GCOS for this ECV.

ANNEX I

Status of WMO/GAW Global Atmospheric N2O Monitoring Network in 2011

1. INTRODUCTION

Greenhouse gases are an important class of the variables related with climate. N_2O is the third most influential, anthropogenic greenhouse gas in the atmosphere, constituting about 6 % of radiative forcing from long-lived greenhouse gases, behind CO_2 (about 63 %) and CH_4 (about 18 %) and responsible for about 7 % of the annual increase in radiative forcing from all long-lived greenhouse gases over at least the past three decades. N_2O is associated strongly with the nitrogen and carbon cycles and is increasing in the atmosphere mainly because of fertilizer applications. Its actual release occurs worldwide, as nitrogen is swept from agricultural systems into rivers, oceans, and sediments where, under low-oxic conditions, is converted in part to N_2O, which ultimately escapes to the atmosphere. The N_2O lifetime in the atmosphere is 120 years, owing mainly to slow, stratospheric removal processes. At 323 ppb, its mixing ratio in the atmosphere is about 1000 times less than that of CO_2 (~390 ppm), but its global warming potential, per mass, is 298 times greater than that of CO_2 over a 100 year time horizon, making it a powerful, long-lived, greenhouse gas. N_2O's rate of increase in the atmosphere is about 0.2 % per year, whereas CO_2 is increasing at about 0.5 % per year.

N_2O is emitted into the atmosphere from natural and anthropogenic sources, including the oceans, soil, combustion of fuels, biomass burning, use of fertiliser and various industrial processes. Human activities account for about 40 % of N_2O emissions today. Most of the anthropogenic N_2O entering the atmosphere comes from the transformation of fertilizer nitrogen into N_2O and its subsequent emission from agricultural soils. N_2O is removed from the atmosphere mainly by photo-dissociation in the stratosphere. However, uncertainties on estimates for emissions from specific source sectors are still large.

Atmospheric N_2O was designated together with the other key greenhouse gases as an Essential Climate Variable (ECV) in the Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC.

The WMO/GAW Programme through its Scientific Advisory Group for Greenhouse Gases (SAG-GHG) coordinates the activity of observational components and the quality assurance, calibration, validation, and archiving of data for climate research purposes. Consisting today of a global partnership of managers, scientists, and technical experts in 80 countries, WMO/GAW is coordinated by the Research Division of the WMO Secretariat in Geneva under the auspice of the WMO Commission for Atmospheric Science (CAS). NOAA and many other major greenhouse gas monitoring agencies are members of WMO and have strong representation in its advisory groups.

The status of the N_2O global monitoring network in 2011 is described below. According to the GCOS Implementation plan specifying, different elements of the global N_2O observational network presented below can constitute both baseline (for the aim of the climate studies on longer term) and comprehensive (for the process oriented studies) networks. Designation of the WMO/GAW Global Atmospheric N_2O monitoring network as both a GCOS baseline and a comprehensive network will help to ensure national funding and support for these climate important observations.

2. STRUCTURE AND DEVELOPMENT OF THE N_2O GLOBAL MONITORING NETWORK

The WMO/GAW Programme implements the IGACO strategy for the variables addressed in the programme, including greenhouse gases. Observations from different platforms are integrated by linking them to one standard scale for all contributors and implementing a strong quality control and assurance system. This integrated system satisfies the requirements of the GCOS comprehensive observing network and consists of in-situ and remotely-sensed ground-based observations, in situ observations from mobile platforms (e.g., ships and airplanes), and satellite remote sensing.

According to the GCOS definition (GCOS implementation plan, p.22), a comprehensive network "includes regional and national networks and, where appropriate/possible, satellite data. The comprehensive networks provide observations at the detailed space and time scales required to fully describe the nature, variability and change of a specific climate variable". Below, the elements of the WMO/GAW Global Atmospheric N_2O monitoring network, which is proposed for designation as a GCOS comprehensive observing network, are described.

2.1. Global, in-situ, ground-based observations of N_2O mixing ratios

Currently (as of January 2011) the ground based part of WMO/GAW global atmospheric N_2O monitoring network consists of some 42 fixed stations which have data records in the World Data Center for Greenhouse Gases. 28 of these stations perform flask sampling and 24 run continuous measurements of N_2O. Data from the ground-based observations are highly reliable, go through a rigorous system of quality control, and are used for calculation of the global average mole fraction for assessment of the N_2O global trend. More details on this part of observational network and its future development are given in chapter 3.

2.2. Regional tall tower observations

Resolving regional-scale fluxes requires a different approach than that used for assessing the global scale N_2O budget. NOAA and other partners in WMO/GAW continue to explore new sampling approaches, ranging from sample collection aboard aircraft to continuous measurement from multiple locations on very tall (>300 m) towers. These approaches also require novel analytical techniques to support the increasing volume of samples and require measurement of additional compounds as tracers of different atmospheric processes.

NOAA/ESRL Carbon Cycle group operates a network of 8 in situ tall towers as part of the North American Carbon Program. Samples are collected approximately daily from one level of each tall tower (normally the upper-most level), and the data are used to estimate N_2O fluxes. Tower measurements are also made by other WMO/GAW members.

2.3 Light Aircraft Vertical Profiles

In addition to observations at the tall towers, NOAA currently obtains twice-monthly vertical profiles of several greenhouse gases including N_2O at 17 sites (Fig. 1). This provides regional information on the N_2O budget in North America. The system has required development of automated samplers for hands-off sampling by pilots and automated analysis in the laboratory. This approach is being explored by other WMO/GAW members, as well.

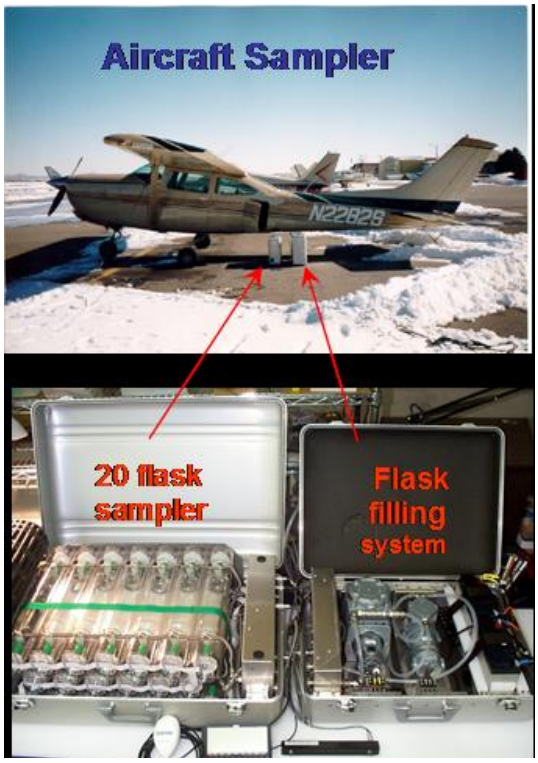

Figure 1: NOAA installation for sampling vertical profiles.

2.4. Global in-situ aircraft-based observations of N_2O mixing ratios

Regular commercial aircraft observations on a monthly basis (e.g., the CARIBIC project – see Figure 2 for the aircraft routes; also the regional observations described in 2.3) constitute the current elements of the airborne component of the N_2O global monitoring network. These measurements are used to validate model reanalyses and support validation of satellite retrievals of greenhouse gases.

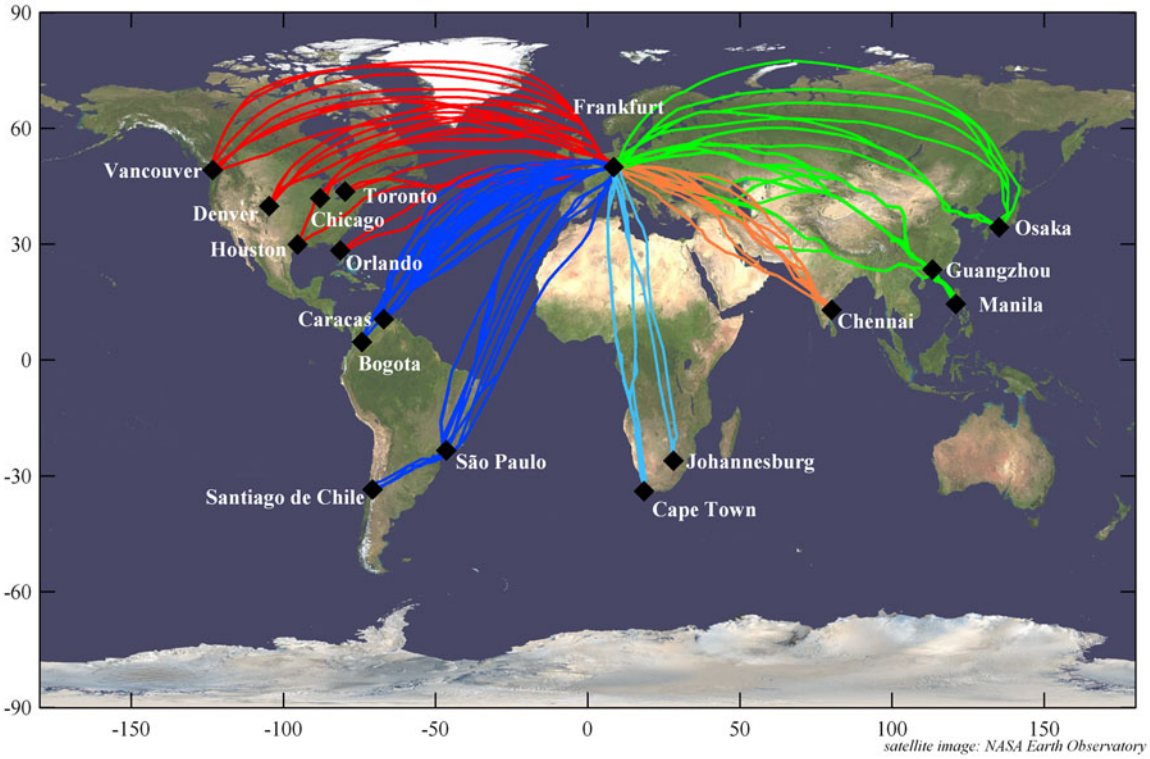

Figure 2: Routes of the regular CARIBIC flights (http://www.caribic-atmospheric.com/)

2.5. Global surface-based remote sensing of the total column of N_2O

The need for satellite data validation and data representation on the WMO scale drove the necessity of ground-based remote sensing of total column N_2O. The Infrared Working Group (IRWG) represents a network of infrared Fourier-transform spectrometers that is part of the Network for the Detection of Atmospheric Composition Change (NDACC, http://www.ndacc.org/). It is a multi-national collection of over twenty high resolution spectrometers that regularly record the atmospheric absorption spectrum from sites distributed from pole to pole. The absorption spectra are used to retrieve total column and vertical profile of mixing ratios of a number of the gaseous atmospheric components, including N_2O. Figure 3 shows positions of the observational sites. NDACC is considered as a contributing network to the GAW Programme.

2.6. Satellite Observations.

The WMO/GAW Greenhouse Gas SAG recognizes the importance of the GHG satellite observations in filling the gaps in the global observation system. Current satellite observations of N_2O are mostly covering the upper troposphere and stratosphere, and instruments are not sensitive to the lower troposphere, where sources are. GAW collaborates with the satellite community in creating integrated data products, including collaborations with scientific teams operating Odin/SMR, ILAS/ILAS-II instruments as well as a set of instruments on board of Envisat (GOMOS, MIPAS, SCIAMACHY) and EOS MLS on this issue.

3. IMPLEMENTATION OF THE QUALITY ASSURANCE SYSTEM

Quality Assurance/Quality Control principles concern all elements of the global monitoring network. WMO/GAW QA procedures address the quality of an observation through maintenance of components of the entire measurement process, from operational procedures at stations and personnel training to submission of properly quality-controlled data to a World Data Centre. The key principles are summarized the WMO/GAW Strategic plan: 2008-2015 and include in particular network-wide use of only one reference standard or scale (primary standard); stringent requirement to the measurement quality (data quality objectives (DQOs)) and measurement methods (Measurement Guidelines and Standard Operating Procedures); regular independent assessments (system and performance audits) and timely data submission with associated metadata to the responsible World

Data Centre. The QA system involves Quality Assurance/Science Activity Centres (QA/SACs), Central Calibration Laboratories and World/Regional Calibration Centres.

Long-term education, training, workshops, station audits/visits and twinning are also provided to build capacities in atmospheric sciences in the WMO/GAW network. These capacity building activities are of increased importance as many WMO/GAW stations in developing countries have become operational. These activities will be further promoted by recognition of the network by GCOS.

The data, and the system supporting them, are robust with continuous efforts to improve the precision and accuracy of observations. Objectives and requirements for N_2O measurements are evaluated every two years and, where necessary, revised, as a part of the biennial WMO/IAEA Meetings of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracer Measurement Techniques, which have taken place regularly since 1980. Following these meetings, measurement recommendations for each of the gases, including N_2O, are published in a meeting report the following year and serve as an on-going guide for measurements worldwide. GCOS monitoring principles are stringently observed within WMO/GAW. The most recent update of the measurement guidelines for N_2O measurements, describing Data Quality objectives, recommended measurement techniques, and quality assurance procedures was published as GAW Report 185 in 2009.

NOAA/ESRL Global Monitoring Division serves as the Central Calibration Laboratory (CCL) for N_2O. CCL maintains the WMO scale for N_2O and organizes round robin comparisons. The total number of calibrations performed for N_2O (not including NOAA/ESRL standards) is 242 for 2006-2010 and 72 for 2010 only. The WMO N_2O calibration scale was updated in 2006, consistent with new primary standards, and a minor correction was applied to older standards. The magnitude of the scale change is 0.19 ppb at 320 ppb N_2O. Results published on the NOAA/ESRL website (http://www.esrl.noaa.gov/gmd/dv/ccg/refgas/index.php) were updated again in 2010 after it was discovered that one secondary standard was drifting at a rate of -0.047 ppb yr^{-1}, resulting in an apparent scale drift of +0.024 ppb yr^{-1}. The secondary standards used to calibrate the N_2O analysis system were replaced in 2010. CCL continues to evaluate the reproducibility and associated scale transfer uncertainty. It is currently estimated at 0.16 ppb (2-sigma). CCL activities for N_2O are documented at http://www.esrl.noaa.gov/gmd/ccl/n2o_scale.html

Following the signing of a side letter to the Mutual Recognition Agreement established between WMO and the BIPM (Bureau of International Weights and Measures), NOAA/ESRL/GMD will participate in Key Comparisons organized by the CIPM (International Committee for Weights and Measures). NOAA will also work towards ISO 17025 compliance (an international standard for competence of testing and calibration laboratories). The CIPM MRA serves as the framework for the mutual acceptance of measurements and, in this instance, concerns measurements of greenhouse gases. The 26th meeting of the CCQM Gas Analysis Working group (GAWG) is planned at NIST and NOAA in Boulder, CO, USA, on 26 to 28 September 2011 and will involve active participation by WMO representatives.

Federal Environment Agency/Germany (Umweltbundesamt, UBA) serves as the Quality Assurance/Science Activity Centre (QA/SAC) for N_2O. By order of the German Minister of Environmental Affairs, UBA Germany, operates the QA/SAC, Germany, by giving contracts to the Karlsruhe Institute of Technology (KIT), Institute for Meteorology and Climate Research (IMK-IFU), Garmisch-Partenkirchen and to the Institute of Tropospheric Research (IfT), Leipzig. In the frame of these contracts the Karlsruhe Institute of Technology runs the World Calibration Center (WCC) for N_2O (http://imk-ifu.fzk.de/wcc-n2o/).

The WCC N_2O works of the following tasks:

- continuous operation of the laboratory
- adjustment to new technological developments and fulfillment of the data quality objectives given by WMO
- carry out round-robin comparison and audits (two per year)
- improvement of measurement guidelines if possible or necessary
- advise stations that install analytical systems for measurements of N_2O
- giving lessons at the training workshops
- report to UBA about all important activities

- cooperation with GAW-Head Quarters (especially with the Scientific Advisory Groups (SAGs)) and GAW Data Centres
- update of the homepage
- annual report of ongoing activities to UBA and WMO and final report after each financial period including a short report for laymen.

The WCC N_2O has eight gas mixtures in high-pressure aluminium cylinders in use as Laboratory Standards at the WCC-N_2O, with N_2O mole fractions ranging from 254 to 359 ppb. The Laboratory Standards of the WCC-N_2O are directly linked to the GAW scale through calibration by the Central Calibration Laboratory. For intercomparison experiments (round-robins and audits) as well as for back-up purposes, 22 N_2O gas mixtures in 10-L cylinders are available. These form the pool of Traveling and Working Standards of the WCC-N_2O. WCC-N_2O works on internal comparisons of standards (quality assurance measures). For the period 2006-2010 WCC performed system and performance audits at Jungfraujoch, Pallas-Sodankylä, Izaña, Monte Cimone, Schauinsland and the CARIBIC laboratory (Mainz, Germany). WCC participated in two international round-robin experiments: (i) CCQM-K68 N_2O International Comparison (organized by KRISS (Korea)) and (ii) WMO 2009 Intercomparison (organized by NOAA ESRL (USA)). WCC was responsible for preparation of the Measurement Guidelines for CH_4 and N_2O (GAW Report No. 185) and the GAW Glossary of QA/QC-related terminology.

4. THE GLOBAL, IN-SITU, GROUND-BASED OBSERVATIONS OF N_2O MIXING RATIOS

According to the GCOS network description, global baseline observing networks "involve a limited number of selected locations that are globally distributed and provide long-term high-quality data records of key global climate variables, as well as calibration for the comprehensive and designated networks."

Below, the details of the global ground-based N_2O monitoring network are presented in a view of its compliance with the requirements for the baseline GCOS network.

4.1. *Current network specification/type of observations*

The N_2O observation network is structured according to the same principles and procedures as the CO_2 and CH_4 networks. Measurements at the sites are well established, accurate, and well controlled.

The GAW N_2O stations are well distributed worldwide (see Fig. 4). As of January 2011, the ground based WMO/GAW global atmospheric N_2O monitoring network consisted of 42 stations with data records submitted to the World Data Center for Greenhouse gases. 28 stations implement flask sampling with subsequent analysis of the samples in the laboratory using gas chromatography. 24 stations perform continuous measurements of N_2O. (Some sites both collect flask samples and operate continuous, in situ monitoring. Of the continuous sites, 16 are GAW Global Stations. Several stations perform both flask sampling and continuous measurements of N_2O. Sample collection at all WMO/GAW sites is routine and consistent, so as to provide a consistent, evenly distributed subset of data from each site. Simultaneous observations by continuous instruments and flask sampling with subsequent analysis in the laboratory are necessary to ensure the consistency of the different measurement techniques.

Some of the advantages of collecting samples in flasks are the provision of a centralized site for analyses, which assures consistency in the calibration of measurements from several (or many) sites, opportunities for re-analysis or comparative analyses between laboratories, and opportunities to sample from many locations without requiring highly trained personnel or expensive instrumentation at every site. A disadvantage of this approach is that insufficient time resolution of the observations is obtained to capture synoptic-scale variations in the northern hemisphere. While this disadvantage is not critical for long-lived and well mixed greenhouse gases like N_2O, it makes it difficult to analyse small scale processes defining N_2O variability in the atmosphere.

A gas chromatograph equipped with electron capture detector (ECD) is used to separate and detect N_2O in ambient air at the stations performing continuous observations. The ECD signal is recorded by an integrator or computer which determines peak heights and areas. New spectroscopic-based analyzers are becoming more commercially available, and they have high potential for use at GAW

stations. Continuous observations offer an opportunity to obtain high-frequency measurements useful for understanding the influence of regional transport as well as local air-surface (air-biosphere) exchange effects. A constraint in taking this approach is the need for carefully controlled and documented calibration of the field instrument and they should have frequent comparisons with discrete samples measured in a separate central laboratory.

Detailed information about GAW stations and their measurement programme can be found in the WMO/GAW Station Information System (GAWSIS) http://www.empa.ch/gaw/gawsis/, which is an on-line query and mapping facility supported by MeteoSuisse.

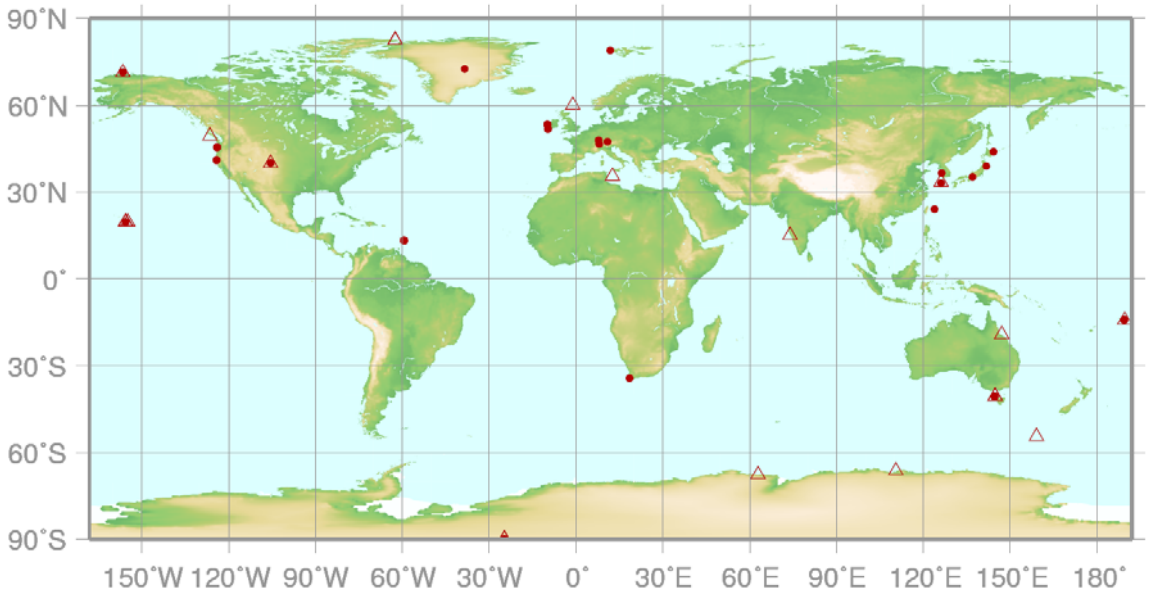

Figure 3: N_2O ground-based observation sites in GAW. Open triangular show flask sampling stations and solid circles show stations with continuous observations. The map is adopted from the WDCGG Data Summary No. 35 available at http://gaw.kishou.go.jp/wdcgg/products/summary/sum35/sum35contents.html

4.2. *Siting criteria*

All sites are long term in nature and adhere to rigorous sitting criteria that avoid strong local influences. Sites have been and continue to be selected to answer pressing scientific questions, which evolve with time, and to detect and attribute changes in climate and climate forcing.

For any time-series of measurements, it is important to ask, “what spatial and temporal scales do the data represent?” This is especially important when comparing observations with models, where “model-data mismatch” (errors introduced because the spatial and temporal resolution of the model is different from that of the data) must be assessed to properly estimate uncertainties in calculated gas fluxes. To answer this question, several related issues must be addressed:

a) Are the data traceable to the WMO/GAW standard scale (maintained by NOAA, Boulder, Colorado, USA for N_2O)?
b) Are there quality assurance rules in place to insure the measurements are free of sampling and measurement artifacts?
c) How removed is the sampling site from anthropogenic and natural trace gas fluxes?
d) What is the impact of local meteorology on the measurements? This can manifest itself in many ways including upslope/downslope flow regimes at mountain sites, diurnal land-/sea-breeze at coastal continental sites, and potential pollution sources in one wind sector, but not in others.
e) What is the frequency of sampling? To calculate time-averages (e.g., monthly means), sampling must be frequent enough.

f) For low-frequency sampling of discrete samples, is there a sampling strategy used (i.e., are samples collected only under specific meteorological conditions)?
g) Have the data been "selected" based on meteorological conditions, another species (e.g., radon-222 or CO), or trajectories after the measurements were made?

Determining the representativeness of data is necessary to insure it is used properly in scientific analyses.

4.3. *Station procedures*

New sites are added to the GAW network only if they meet quality assurance and data reporting criteria set by the SAG. GAW quality control and data reporting criteria are outlined in WMO/GAW Report No. 185, "Guidelines for the Measurement of Methane and Nitrous Oxide and their Quality Assurance". This guide specifies the site requirements, methods of measurement, sampling frequency, quality control and assurance, ancillary measurements, archiving procedures, and data treatment for N_2O.

If the sites are part of a contributing network, inclusion is straightforward in that the contributing network will already have met the GAW quality control and data reporting criteria. Any site, however, must be established with the intention of operating as a long-term site if it is to be included in the network.

Currently the procedures for joining the GAW Programme are described in the Addendum to the GAW Strategic Plan: 2008-2015, while the station requirements are given in the GAW Strategic Plan.

Presently the deactivation of sites is a topic of discussion between the SAG and the WDCGG. Stations can be indicated as inactive in GAWSIS after a long period without data submission (27 months). The timing of GAWSIS deactivation is given in the Addendum to the GAW Strategic Plan (GAW Report No. 197). Site deactivation is rare in GAW.

4.4. *Data management and data products*

The World Data Centre for Greenhouse Gases (WDCGG) was established at the Japan Meteorological Agency in October 1990 and collects and distributes data on the mixing ratios of greenhouse (CO_2, CH_4, CFCs, N_2O, etc.) and related reactive (surface O_3, CO, NOx, SO_2, VOC, etc.) gases in the atmosphere and the ocean. Simultaneously measured meteorological parameters are also recorded at WDCGG.

Metadata on station information within GAW and its contributing networks are hosted by the GAW Station Information System (GAWSIS), while the data and metadata related to GHG measurements are archived by the World Data Centre for Greenhouse Gases. WDCGG regularly updates the list of variables accepted for submission, which is reflected in a review of the "Data Submission and Dissemination Guide" (update document was published as GAW report 188 in 2009). To implement an end-to-end approach, WDCGG produces global products, which are described in the "Technical Report of Global Analysis Method for Major Greenhouse Gases by the World Data Center for Greenhouse Gases" (GAW report 184, published in 2009); most can be viewed on the website of the WDCGG. On an annual basis WDCGG prepares data summaries (the latest one is published in March 2011) and sends the data archive to the WMO Members and contributing institutes.

Forty-eight WMO member countries have contributed greenhouse gas data to the WDCGG. Approximately 49% of the measurement records submitted to WDCGG are obtained at sites in the NOAA ESRL cooperative air sampling network. The rest of the network is maintained by Australia, Canada, China, Japan, South Africa and many European countries (see the national reports in GAW Report No. 186, available at http://www.wmo.int/gaw). The Advanced Global Atmospheric Gases Experiment (AGAGE) is also a GAW-affiliated network contributing observations to the GAW Programme. The GAW monitoring stations contributing to the data to the WDCGG are included in the List of Contributors on the WDCGG Web page (http://gaw.kishou.go.jp/wdcgg/).

The data residing in the WDCs are always subject to change, for example from revisions to standard scales. For this reason, data providers at individual stations are made aware by the letter from WDCGG on the necessity to follow the calibration scale update. So that data providers are given appropriate recognition, scientists accessing the data are required to accept the following conditions:

"*On any publication using data from the individual station, the author must contact the data submitters concerning co-authorship or acknowledgments, and make proper descriptions on the data sources in their references".*

From this web site of WDCGG, anyone can obtain information including WDCGG's publications and measurement data that have been contributed by organizations and individual researchers throughout the world. Users are requested to note that they should properly reference the data should they use or publish them by citing the contributors and the source of the data. Some examples of data distribution products are as follows:

- Searchable station directory and metadata
- Downloads of all data collected by WDCGG
- Graphical Presentations of all WDCGG data and some data products
- WDCGG Data Summary
- Online Data Report (sent to all contributors monthly)

4.5. *Network development*

The WMO/GAW network continues to expand with scientific needs. Currently, the NOAA component of the system is envisioned to build out additional terrestrial, shipboard, aircraft, and tower sites to enhance the capability needed for scientific questions regarding interannual variability and regional fluxes (Figure 5).

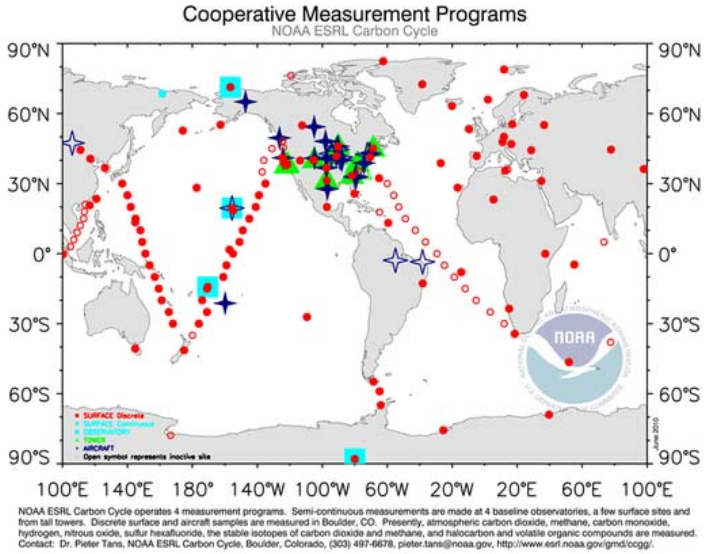

Figure 5: NOAA measurement programme contributing to the greenhouse gas observations in the GAW Programme

Development of new measurement techniques ("easy to manage" spectroscopic instruments) opens possibility for national network development. Substantial progress in the future is expected in South America (Brazil), China, India and some other countries using both well established conventional methods and new observational techniques.

In 2003, a replica of NOAA/ESRL greenhouse gas analysis system (MAGICC) was constructed at NOAA in Boulder, Colorado, USA and was sent to Brazil. In 2004 the analysis system began operation in the Atmospheric Chemistry Laboratory (LQA) at IPEN, Brazil. LQA/IPEN follows the same measurement protocol as NOAA. Since the quality of carrier gases in Brazil is limited by high levels of contaminants, much effort is made to clean the gases. Observational sites operating in Brazil are shown in Figure 6. Some of the platforms are expected to join the GAW Programme.

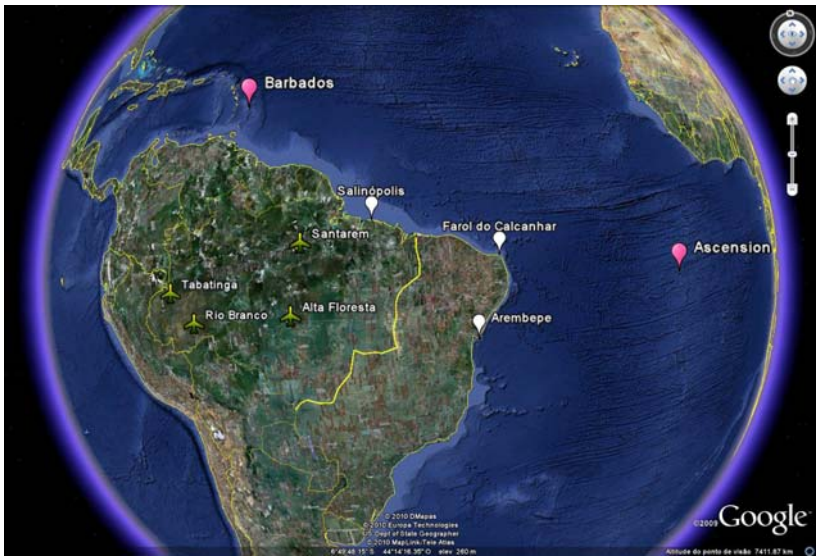

Figure 6: Actual Brazilian GHG sites monitored by LQA/IPEN. 4 Aircraft symbols indicating aircraft profiles 2 times per month and 3 blank balloons indicate coastal stations.

ICOS is a new European Research Infrastructure for quantifying and understanding the greenhouse balance of the European continent and of adjacent regions. ICOS aims to build a network of standardized, long-term, high precision integrated monitoring of the greenhouse gases. At the initial stage each atmospheric station of ICOS is an observatory established to measure continuously greenhouse gas (CO_2, CH_4, and in the future N_2O) mixing ratios. The ICOS network will have about 30 primary sites, considered as the backbone of the infrastructure. The GAW Programme collaborates with the ICOS project to ensure that this contribution is properly reflected in GAW. The map of different ICOS platforms is shown in Fig. 7. During the Operational Phase from 2012 until 2031, after the full scale deployment of the network, it will be run in an operational mode, and greenhouse gas concentrations and fluxes will be determined on a routine basis.

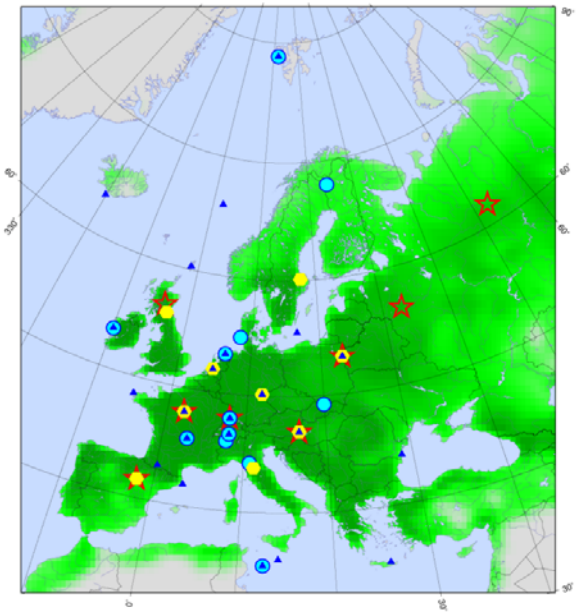

Figure 7: Map of the ICOS project stations.

5. Relevant recent WMO/GAW Reports (available at www.wmo.int/gaw)

GAW-168. 13th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracers Measurement Techniques (Boulder, Colorado, USA, 19-22 September 2005) (edited by J.B. Miller) (WMO TD No. 1359), 40 pp, December 2006.
GAW-170. WMO/GAW Expert Workshop on the Quality and Applications of European GAW Measurements (Tutzing, Germany, 2-5 November 2004) (WMO TD No. 1367).
GAW-172. WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008 – 2015 (WMO TD No. 1384), 108 pp, August 2008.
GAW-174. World Data Centre for Greenhouse Gases Data Submission and Dissemination Guide (WMO TD No. 1416), 50 pp, January 2008.
GAW-184. Technical Report of Global Analysis Method for Major Greenhouse Gases by the World Data Center for Greenhouse Gases (WMO TD No. 1473), 29 pp, June 2009.
GAW-185. Guidelines for the Measurement of Methane and Nitrous Oxide and their Quality Assurance (WMO TD No. 1478), 49 pp, September 2009.
GAW-186. 14th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (Helsinki, Finland, 10-13 September 2007) (WMO TD No. 1487), 31 pp, April 2009.
GAW-188. Revision of the World Data Centre for Greenhouse Gases Data Submission and Dissemination Guide (WMO TD No.1507), 55 pp, November 2009.
GAW-194. 15th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (Jena, Germany, 7-10 September 2009) (WMO TD No. 1553). 332 pp, April 2011.
GAW-197. Addendum for the Period 2012 – 2015 to the WMO Global Atmosphere Watch (GAW) Strategic Plan 2008 – 2015.

6. PROBLEMS AND ISSUES

The problems and issues facing the WMO/GAW Global Atmospheric N_2O Monitoring Network as proposed network of GCOS are in part generic to all networks for atmospheric ECVs and in part unique. GAW is a voluntary programme and relays on the capacity of its Members, which changes in time with a change of national priorities. Hence, the problem of maintaining existing long-term ground-based measurements of required high quality may become problematic. Expansion of the observational network coverage to fill the obvious gaps that exist also remains problematic for a number of regions. Although GCOS and WMO/GAW secretariats are already collaborating strongly in organizing regional workshops on capacity building and initiatives to identify problems related to maintenance of observations and establishment of new facilities, the solution of the problems lies in strong bilateral cooperation between developed and developing countries, in adequate commitment by host countries and, of course, resourcing.

7. ADHERENCE TO GCOS MONITORING PRINCIPLES

The ten basic GCOS Climate Monitoring Principles[3] are as follows:

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 should be required.
3. The results of calibration, validation and data homogeneity assessments, and assessments of algorithm changes, should be treated with the same care as data.
4. A capacity to routinely assess the quality and homogeneity of data on extreme events, including high-resolution data and related descriptive information, should be ensured.
5. Consideration of environmental climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.

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

6. Uninterrupted station operations and observing systems should be maintained.
7. A high priority should be given to additional observations in data-poor regions and regions sensitive to change.
8. Long-term requirements should be specified to network designers, operators and instrument engineers at the outset of new system design and implementation.
9. The carefully-planned conversion of research observing systems to long-term operations should be promoted.
10. Data management systems that facilitate access, use and interpretation should be included as essential elements of climate monitoring systems.

Given the maturity of the global greenhouse gas measurement community and the networks operated in the frame of the WMO/GAW Programme, it can be concluded that the GCOS Monitoring Principles are heeded generally for the most part, and when applied to individual stations; however, gaps arise when collective action needs to be taken on a global scale (for the network in general). Thus, principles 1, 2, and 6 form an essential part of the WMO/GAW community of practice and constitute the inherent requirements to the GAW stations.

Principle 3: Regarding the importance of archiving and utilizing calibration, validation and other data quality assurance mechanisms this principle is recognized by the WMO/GAW community and documented by its respective bodies (stations hold data logs; WCCs keeps track of comparisons and calibration; CCLs maintain standard scales and report regularly on the scale stability and possible biases; and WDCs hold data and metadata records).

Principle 4 on extreme events does not apply to greenhouse gases.

Principle 5 on the link of the GCOS network to outstanding questions identified by IPCC is totally relevant and indeed shapes the WMO/GAW Programme through the consultation with research experts every two years. Moreover, regular publication of the Greenhouse Gas Bulletin serves as a supporting document at the COP meetings.

Principle 7 on priority to filling gaps in data sparse areas is directly addressed in the WMO/GAW Strategic Plan: 2008-2015 and its Addendum.

Principle 8: Optimal design of the WMO/GAW observational network is addressed via collaboration with a modelling community utilising the results of inverse models and numerical experiments on the observational network optimization. This area is still to be developed in the case of N_2O.

Principle 9 expressing the need to stabilize observations that initially were conducted as project research has long ago been addressed by the WMO/GAW community who favour routine observations to be conducted within the framework of a group that is also conducting research and able to adapt to changes in long-term measurement strategy dictated by the IPCC scientific assessments.

Principle 10 is implemented by the WMO/GAW Data Centres open access policy and by GAW partner organizations via numerous data products and services.

More details of GAW adherence to monitoring principles are given in the agreement document (Annex II)

ANNEX II

Agreement between the Global Climate Observing System and WMO/GAW Regarding the WMO/GAW Global Atmospheric N_2O Monitoring Network as a global Comprehensive and Baseline Network of GCOS

This agreement presents the terms and conditions by which the WMO/GAW Global Atmospheric N_2O Monitoring Network proposes to satisfy the requirements for being identified as a major component of the global comprehensive and global baseline observing network of the Global Climate Observing System (GCOS) for the Essential Climate Variable (ECV) N_2O.

WMO/GAW-N_2O will remain institutionally and organizationally as it currently is within the domain of the World Meteorological Organization's Global Atmosphere Watch (WMO/GAW) Programme of the Research Department under the Commission for Atmospheric Science (CAS). It will be identified in all GCOS documentation and distributions as a GCOS comprehensive or baseline network with the title "WMO/GAW Global Atmospheric N_2O Monitoring Network" or after definition in the document, in the short form "WMO/GAW-N_2O".
Both WMO/GAW and GCOS principals will agree to the items set forth in this document.

The WMO/GAW-N_2O Monitoring Network will adhere to the GCOS Climate Monitoring Principles as presented and discussed below.

New sites will be accepted into the WMO/GAW-N_2O Monitoring Network consistent with Principle #7 and following GAW procedures laid out in the Addendum to the GAW Strategic plan: 2008-2015.

The following summarizes how WMO/GAW-N_2O relates to each of the ten basic GCOS Climate Monitoring Principles, the full set of which were adopted by the World Meteorological Organization Congress at its fourteenth session through Resolution 9 (Cg-XIV). More discussion is included in Annex I to the agreement.

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

Any change in observational methodology or instrumentation at GAW stations must conform with the standards and guidelines set by the GAW Scientific Advisory Group on Greenhouse Gases. Typically, it is part of the maturity of the network that any changes that are made are done so after careful planning and proper testing in the comparison experiments, calibration centres, individual sites or research projects.

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

It is common and accepted practice among WMO/GAW contributors to maintain significant periods of overlap when upgrading or updating on-site instrumentation. In addition, WMO/GAW considers it essential for any measurement programme to have built-in redundancy and that inconsistencies be avoided.

Principle 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.

This is already an integral part of the data reporting and data archival procedures within WMO/GAW. Metadata and ancillary data such as such as wind speed & direction, temperature, humidity, and precipitation are routinely recorded with measurements at WMO/GAW sites and, in most cases, are delivered to the WDCGG with the gas measurement data. Logging of measurement conditions is required as a part of the QA system for all stations. WCC and CCL keep track of the calibrations scale changes, comparisons, calibrations and standards provision, audits etc.

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

WMO/GAW contributors are required to assess and evaluate the quality of their data before submittal to the World Data Centre for Greenhouse Gases (WDCGG). Submission of data is required to be accompanied by appropriate meta data describing quality and links to the WMO/GAW World Reference Standard. WMO/GAW recognizes that there is no universal scheme to ensure high-quality data; each programme should develop a scheme, with guidance from other successful programmes, suitable to its own needs. WDCGG puts efforts of the checks of data homogeneity and quality and reports detected problems to data submitters.

Principle 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.

WMO/GAW's purpose is to support the UNFCCC, which is focused on climate issues. Dedication to long-term measurement is a fundamental principle in the WMO/GAW framework. Research experts are consulted biennially, working together to maintain the relevance and high quality of this network. WMO/GAW contributors prepare the publications oft-cited in the IPCC and in national assessments and are major contributors to the assessments themselves. GAW produces an annual Greenhouse Gas Bulletin which is considered as one of the supporting documents at the COP meetings.

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

Because WMO/GAW is fundamentally a long-term monitoring network, all sites are anticipated to be long-term measurement sites. The oldest of these systems are clearly the most valuable and, fortunately, often the most stable in terms of resourcing. Efforts are made to keep all sites running, but especially those that have high-quality, long-term records.

Principle 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.

The WMO/GAW observational system provides extensive global coverage for answering key questions about global trends and variations in hemispheric gradients. There are some identified gaps where sites are being sought to help improve the understanding of spatial and temporal variations. Surface sites have been added by including routine shipboard collections into the data set, for example, and some terrestrial sites are being sought in poorly represented regions. However, new scientific questions bring about new gaps and the most recent of these questions have to do with understanding the sources and sinks of the major greenhouse gases. This understanding requires knowing vertical gradients and WMO/GAW is encouraging the inclusion of carefully sited vertical profiles into the network. The WMO/IAEA global carbon gas measurements experts groups that meet biennially in conjunction with the GAW SAG for greenhouse gases is a primary source of expertise to address suggested changes in the network.

Principle 8: Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation.

This procedure is routine within WMO/GAW and forms a cornerstone of the network. Requirements and recommended procedures are documented in a long-standing series of WMO/GAW publications. Operators are provided these materials and the consultation and, sometimes, assistance necessary to ensure their implementation. GAWTEC training organized twice a year helps station operators to perform observations following quite strict GAW requirements.

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

There is no distinction between research and long-term observations in the WMO/GAW programme. The WMO/GAW community favours routine observations to be conducted within the framework of a group that is also conducting research and is able to adapt to changes in long-term measurement strategy dictated by the IPCC scientific assessment. WMO/GAW will continue to ensure that newly-developed observational systems and research infrastructures will be suitable for long-term, remote deployment before being a required measurement technique/ approach of the programme.

GCOS confirms that this principle is primarily intended to encourage establishment of strong, continuing institutional support for all aspect of the ongoing network activities.

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

With support from WMO/GAW contributors and partners, the WDCGG creates products, provides services, and makes data available freely to any interested party. Data evaluation services are also provided by WMO/GAW partners, which enhances not only the availability of data, but also the development of approaches for visualizing, evaluating, and analyzing WMO/GAW data.

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GCOS LIST OF ACRONYMS AND ABBREVIATIONS

ACMAD	African Centre for Meteorological Applications for Development
ADB	Asian Development Bank
AfDB	African Development Bank
AGG	AOPC Advisory Group on GSN and GUAN
AIACC	Assessments of Impacts and Adaptation to Climate Change initiative
AMIP	Atmospheric Model Intercomparison Project
AMMA	African Monsoon Multidisciplinary Analyses
AOML	Atlantic Oceanographic and Meteorological Laboratory
AOPC	Atmospheric Observation Panel for Climate
APN	Asia-Pacific Network
ASAP	Automated Shipboard Aerological Programme
ARM	Atmospheric Radiation Measurement Program
ASECNA	L'Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar
AVHRR	Advanced Very High Resolution Radiometer
AREP	Atmospheric Research and Environment Programme (WMO)
AU	African Union
BAPMON	Background Air Pollution Monitoring Programme
BOM	Australian Bureau of Meteorology
BSRN	Baseline Surface Radiation Network
CAS	Commission for Atmospheric Sciences
CBD	Convention on Biological Diversity
CBS	Commission for Basic Systems (WMO)
CCCCC	Caribbean Community Climate Change Centre
CCD	Convention to Combat Desertification
CCD/A	Climate Change Detection and Attribution
CCl	Commission for Climatology (WMO)
CDAS	Climate Data Assimilation System
CEOP	Coordinated Enhanced Observing Period
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CHy	Commission for Hydrology (WMO)
CLIC	Climate and Cryosphere Project (WCRP)
CLIMAT	Report of monthly means and totals from a WWW land station
ClimDev Africa	Climate for Development in Africa Programme
CLIPS	Climate Information and Prediction Services
CLIVAR	Climate Variability and Predictability (WCRP)
CLW	WMO Climate and Water Department
CMA	China Meteorological Administration
CMM	Commission for Marine Meteorology
COCOS	Coordination of Carbon Observing Systems
CONOPS	WIGOS Concept of Operations
COP	Conference of the Parties (to UNFCCC)
COPES	Coordinated Observation and Prediction of the Earth System
CSD	Commission on Sustainable Development
DAO	Data Assimilation Office
DARE	Data Rescue (WCDMP project)
DBCP	Data Buoy Cooperation Panel
DFID	Department For International Development (UK)

DIM	Data and Information Management
DWD	Deutscher Wetterdienst
EC	European Community
EC	Executive Council (WMO)
ECMWF	European Centre for Medium-Range Weather Forecasts
ECVs	Essential Climate Variables
EEZ	Exclusive Economic Zone
ENSO	El Niño/Southern Oscillation
ESA	European Space Agency
ESSP	Earth System Science Partnership
ET-ODRRGOS	Expert Team on Observational Data Requirements and Redesign of the Global Observing System
ETSI	Expert Team on Sea Ice
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organization of the United Nations
fAPAR	Fraction of Absorbed Photosynthetically Active Radiation
FCDR	Fundamental Climate Data Record
G3OS	GCOS, GOOS and GTOS
GAW	Global Atmosphere Watch
GAWSIS	GAW Station Information System
GCB	GCOS Cooperation Board
GCO	Global Carbon Observation
GCOS	Global Climate Observing System
GCM	Global Climate Model
GCMPs	GCOS Climate Monitoring Principles
GDSIDB	Global Digital Sea-Ice Data Bank
GEF	Global Environment Facility
GEMS	Global Environment Monitoring System
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GEWEX	Global Energy and Water Cycle Experiment
GFCS	Global Framework for Climate Services
GIP	GCOS Implementation Plan
GLIMS	Global Land Ice Measurements from Space
GLOSS	Global Sea Level Observing System
GMDSS	Global Maritime Distress and Safety System
GMES	Global Monitoring for Environment and Security
GODAE	Global Ocean Data Assimilation Experiment
GOFC	Global Observation of Forest Cover
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GOOS	Global Ocean Observing System
GOS	Global Observing System
GOSIC	Global Observing Systems Information Center
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning System
GRDC	Global Runoff Data Centre
GRUAN	GCOS Reference Upper Air Network
GSICS	Global Space-Based Inter-Calibration System
GSN	GCOS Surface Network
GSNMC	GSN Monitoring Centre

GSSC	GOOS Scientific Steering Committee
GTN	Global Terrestrial Network
GTN-E	GTN-Ecosystems
GTN-G	GTN-Glaciers
GTN-H	GTN-Hydrology
GTN-L	GTN-Lakes
GTN-P	GTN-Permafrost
GTN-R	GTN-Rivers
GTN-SM	Global Terrestrial Network for Soil Moisture
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System
GUAN	GCOS Upper-Air Network
HALOE	Halogen Occultation Experiment
HOPC	Hydrological Observation Panel for Climate
HWR	Hydrology and Water Resources (Department, WMO)
IAEA	International Atomic Energy Agency
IAOOS	Integrated Arctic Ocean Observing System
ICOS	Integrated Carbon Observation System
ICSU	International Council for Science
ICPAC	IGAD Climate Prediction and Application Centre
ICPC	Interagency Coordinating and Planning Committee for Earth Observations
IFAD	International Fund for Agricultural Development
IGBP	International Geosphere-Biosphere Programme
IGACO	Integrated Global Atmospheric Chemistry Observations (IGOS Theme)
IGAD	Intergovernmental Authority on Development (East Africa)
IGOS	Integrated Global Observing Strategy
I-GOOS	Intergovernmental Committee for GOOS
IGOS-P	Integrated Global Observing Strategy Partnership
IGOSS	Integrated Global Ocean Services System
IICWG	International Ice Charting Working Group
IHDP	International Human Dimensions Programme
iLEAPS	Integrated Land Ecosystem–Atmosphere Processes Study
INCOIS	Indian National Centre for Ocean Information Services
IOC	Intergovernmental Oceanographic Commission
IOD	Indian Ocean Dipole
IODE	International Oceanographic Data and Information Exchange
IOS	Initial Operational System (GCOS); Integrated Observing System (GOOS)
IRDR	Integrated Research on Disaster Risk Programme IRDR
ISO	International Organization for Standardization
IP-04	Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2004)
IP-10	Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010)
IPCC	Intergovernmental Panel on Climate Change
IPY	International Polar Year
ISCCP	International Satellite Cloud Climatology Project
ISO	International Standards Organization
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM Observing Platform Support Centre

JMA	Japan Meteorological Agency
JPO	Junior Professional Officer
JRC	Joint Research Centre (European Commission)
LAI	Leaf Area Index
LCA	Long-Term Cooperative Action
MCDW	Monthly Climatic Data of the World
MECE	Monitoring of Extreme Climate Events
MOU	Memorandum of Understanding
MPERSS	Marine Pollution Emergency Response Support System
MSC	Meteorological Service of Canada
MSU	Microwave Sounding Unit
NAPAs	National Adaptation Programmes of Action
NASA	National Aeronautics and Space Administration (USA)
NBCN	National Basic Climatological Network
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NDACC	Network for the Detection of Atmospheric Composition Change
NGDC	National Geophysical Data Center
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological Service
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	Net Primary Productivity
NPP	NPOES Preparatory Project
NWP	Numerical Weather Prediction
OBS	WMO Observing and Information Systems Department
OOPC	Ocean Observations Panel for Climate
OPAG	Open Programme Area Group
OSEs	Observing System Experiments
OSSEs	Observing System Simulation Experiments
PAntOS	Pan-Antarctic Observing System
PAGES	Past Global Changes (within IGBP)
PCOF	Polar Climate Outlook Forum
PECS	Programme on Ecosystem Change and Society
PICO	Panel for the Integration of Coastal Observations (GTOS-GOOS)
PMEL	Pacific Marine Environmental Laboratory
POGO	Partnership for Observation of the Global Oceans
PSC	Polar Satellites Constellation
QC	Quality Control
RAP	Regional Action Plan
RBCN	Regional Basin Climate Network
RCOF	Regional Climate Outlook Forum
RRR	Rolling Review of Requirements
RWP	Regional Workshop Programme
SAARC	South Asian Association for Regional Cooperation
SAFs	Satellite Application Facilities
SAG	Scientific Advisory Group (GAW)
SBI	Subsidiary Body for Implementation (UNFCCC/COP)
SBSTA	Subsidiary Body for Scientific and Technological Advice (UNFCCC/COP)
SC	Steering Committee

SHADOZ	Southern Hemisphere Additional Ozone-sondes
SIA	Seasonal-to-Inter-annual Forecasting
SIP	Seasonal-to-Interannual Climate Prediction
SIT	Strategic Implementation Team (CEOS)
SMOS	Soil Moisture Observing System
SOG	Statement of Guidance
SOOP	Ships of Opportunity Programme
SOOS	Southern Ocean Observing System
SPARC	Stratospheric Processes and their Role in Climate
SPREP	South Pacific Regional Environment Programme
SST	Sea-Surface Temperature
START	System for Analysis, Research and Training
SURFA	Surface Flux Analysis Project
TAO	Tropical Atmosphere-Ocean Array
TCDR	Thematic Climate Data Record
TCO	Terrestrial Carbon Observations
TEMS	Terrestrial Ecosystems Monitoring Sites
TOMS	Total Ozone Mapping Spectrometer
TOPC	Terrestrial Observation Panel for Climate
ToR	Terms of Reference
TOVS	TIROS Operational Vertical Sounder
TRITON	Triangle Trans-Ocean Buoy Network
TSP	Technical Support Project
UKMO	United Kingdom Meteorological Office
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UOP	Upper Ocean Panel (WCRP/CLIVAR)
UTLS	Upper Troposphere Lower Stratosphere
USGS	United States Geological Survey
VCP	Voluntary Co-operation Programme
VOS	Voluntary Observing Ship(s)
VOSClim	Voluntary Observing Ships Climatology Programme
WCC-3	Third World Climate Conference
WCDMP	World Climate Data and Monitoring Programme
WCP	World Climate Programme
WCRP	World Climate Research Programme
WDC	World Data Centre
WDCGG	World Data Centre for Greenhouse Gases
WGCCD	Working Group on Climate Change Detection
WGCV	Working Group on Calibration and Validation (CEOS)
WGNE	Working Group on Numerical Experimentation
WG-SP	Working Group on Surface Pressure
WHYCOS	World Hydrological Cycle Observing System
WIGOS	WMO Integrated Global Observation System
WIS	WMO Information System
WMO	World Meteorological Organization
WOAP	WCRP Observation and Assimilation Panel
WRAP	Worldwide Recurring ASAP Project
WWW	World Weather Watch (WMO)
XBT	Expendable BathyThermograph

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