

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



**WORLD METEOROLOGICAL  
ORGANIZATION**

**INTERGOVERNMENTAL  
OCEANOGRAPHIC COMMISSION**

**SUMMARY REPORT OF THE NINTH SESSION OF THE  
  
GCOS/GTOS TERRESTRIAL OBSERVATION  
PANEL FOR CLIMATE**

**(Ispra, Italy, 28-29 March 2006)**

**March 2007**

**GCOS - 111**

**GTOS - 43**

**(WMO/TD No. 1371)**

**UNITED NATIONS  
ENVIRONMENT PROGRAMME**

**INTERNATIONAL COUNCIL FOR  
SCIENCE**

© 2007, World Meteorological Organization

NOTE

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

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

## TABLE OF CONTENTS

1.	Report from GCOS Steering Committee .....	1
2.	Report from GTOS Steering Committee .....	1
3.	Review of the draft report on Systematic Observation Requirements for Satellite-based Products for Climate .....	1
4.	Long-term strategy .....	2
5.	Terrestrial Commission development; roles, responsibilities and strategy .....	5
6.	Membership and Panel structure review .....	6
7.	Calendar and future meetings.....	6
	Appendix 1 Agenda .....	8
	Appendix 2 List of Participants .....	9
	Appendix 3 TOPC Terms of Reference .....	10
	Appendix 4 TOPC Membership (30 March 2006).....	11

*(Intentionally blank)*

# **Ninth session of the GCOS/GTOS Terrestrial Observation Panel for Climate**

European Commission JRC Ispra, 28<sup>th</sup> and 29<sup>th</sup> March 2006

The ninth session of the Terrestrial Observation Panel for Climate of the Global Climate Observing System and Global Terrestrial Observing System was held at the European Commission's Joint Research Centre in Ispra, 28<sup>th</sup> and 29<sup>th</sup> March 2006. The agenda and list of participants are given in Appendix 1 and 2. Apologies were received from Dr. Thomas Maurer, Dr. Steve Running and Dr. Allen Solomon.

## **1. Report from GCOS Steering Committee**

The thirteenth session of the GCOS Steering Committee was held in St Petersburg in October 2005. The GCOS-SC tasked TOPC to provide support for the preparation of the report on Systematic Observation Requirements for Satellite-based Products for Climate (see section 3). This document will form a supplement to the GCOS Implementation Plan and is also being sent to the space agencies, which, through their Committee on Earth Observing Satellites now have to report to COP 12, stating how they plan to respond to the GCOS Implementation Plan. The report being prepared by GCOS will go for open review on 15<sup>th</sup> April.

The GCOS Secretariat also drew TOPC's attention to the GCOS Africa workshop which will concentrate on building a climate observation strategy with the African Nations.

The Secretariat also pointed out that the GTOS report on the development of standards for Essential Climate Variables in the Terrestrial Domain should be submitted to the UNFCCC in May 2007 (see section 5, below) and that GCOS will have to submit a report on progress within the GCOS Implementation Plan by June 2009. This latter will probably take the form of a third adequacy report.

## **2. Report from GTOS Steering Committee**

GTOS has recently appointed new members to its steering committee, which met in Rome, 25<sup>th</sup> to 27<sup>th</sup> January 2006. The GTOS – SC confirmed that TOPC should remain focused on climate issues and the new Chair should reflect this (see section 6 membership). The GTOS – SC recommended that TOPC concentrate on implementing the GCOS implementation plan. TOPC and the other GTOS Panels also need to ensure adequate collaboration especially in regards to crosscutting issues. For example GOFD-GOLD needs to provide support to TOPC in regards to the land cover and fire components of the GCOS implementation plan.

## **3. Review of the draft report on Systematic Observation Requirements for Satellite-based Products for Climate**

Version 1.0.1 (including the comments) of the draft report on Systematic Observation Requirements for Satellite-based Products for Climate was distributed to attendees with the request that this version not be circulated

outside the meeting. Version 1.0.1 was used because dealing with some of the comments in the document demanded specialist technical knowledge, which the Panel members had.

The Panel reviewed all product specification sheets and provided extensive editorial revisions. These were given to the Chair at the close of the meeting, who will assemble them into a new revision and submit the revised version to the GCOS Secretariat.

**Action: TOPC Chair to provide revised version of “GCOS Sat Req for Climate v1.0.1.doc” to GCOS Secretariat.**

#### **4. Long-term strategy**

TOPC's terms of reference clearly reflect a concentration on climate issues. Discussion at TOPC 9 reconfirmed this focus. The Panel discussed its long-term strategy in this context. Forthcoming scientific challenges; new or strengthened observation requirements; interactions with other GCOS / GTOS science Panels; interactions with other scientific bodies, with the Rio Conventions and with international initiatives provided the framework for this debate, culminating in recommendations on membership and panel structure.

##### *4.1 Scientific Challenges*

Prof. Bernard Pinty from JRC made an invited presentation relating remote sensing products to radiation transfer schemes used in climate models. The presentation concentrated on two key questions; Are the radiative fluxes and state variables retrieved from remote sensing useful for GCMs? And how GCMs can (must) adapt themselves to this new situation where accurate global land products are available, i.e. adjusting (improving) their radiation transfer surface schemes. The conclusions were that remotely sensed products are useful where these products are “validated” (meaning inter-compared and checked against ground-based estimations) and if assimilation procedures are developed to ensure consistency between observed/modeled fluxes and state variables. The presentation and the debate it stimulated confirmed that improving the handling of (land surface) radiation transfer routines in GCMs is clearly an issue TOPC must address, which in turn implies strengthening the Panel's membership in this domain.

**Action: TOPC Panel to identify, and recruit, new panel members with expertise in land surface process modeling, in consultation with the GCOS and GTOS Secretariats –see also section 6.**

Discussion also highlighted the need for the TOPC strategy to take into account the high spatial heterogeneity of land surfaces, which creates specific issues when relating localized -often point - in situ measurements with the larger area space observations. This is further complicated by the fact that space measurements are exclusively electromagnetic measurements instead of the desired ECV. This implies the development of the scientific understanding and the formalization of the past and current expertise in data acquisition in the form of mathematical models of the relevant processes and of the associated up-scaling procedures.

#### *4.2 Emerging ECVs*

The Panel recognized that the emerging ECV “global soil moisture” deserves increased attention. The Panel took note of the Global Soil Moisture Data Bank at Rutgers University, as well as the growing number of space based observations. The recommendation in the short term is to ensure appropriate representation from this Community on the Panel. Jurate Landwehr volunteered to contact GEWEX with a view to securing appropriate support.

**Action: Jurate Landwehr to contact GEWEX. See section 6.**

The Panel also recommended renewed attention to “ground water”. This variable is highlighted in the second adequacy report where technical limitations to global monitoring are discussed. New initiatives such as the Gravity Recovery and Climate Experiment (GRACE) are beginning to address these technical limitations.

**Action: TOPC to review ground water as recorded in the Products and Variables documentation under preparation (e.g. the annex to the 2<sup>nd</sup> adequacy report).**

Initially discussed in the context of limitations in mapping spatial extent of seasonally frozen ground (GIP Action T17) the Panel revisited the issue of land surface temperature measurements. The debate quickly expanded beyond the frozen ground discussion as arguments concerning the importance of Land surface temperature (LST) as a key variable in its own right were made, especially in terms of accurate modeling of energy fluxes between the surface and the atmosphere and for other (non climate) land process applications such as drought monitoring. Satellite remote sensing offers well established LST products (analogous to the sea surface temperature measurements) and the Panel recommends additional input to the GIP supplement (see section 3 above) which reflects this.

**Action: Massimo Menenti to draft an LST Product sheet.**

#### *4.3 Liaisons with other GCOS and GTOS Panels*

As dictated by the Panel’s terms of reference TOPC reports to both GTOS and GCOS Steering Committees. TOPC recognizes that more formal links need to be established with the other GCOS and GTOS science Panels. On the GTOS side links with the Panel dealing with Terrestrial Observations from Carbon (TCO) and Global Observations of Forest Cover – Global Observations of Land Cover Dynamics (GOFC-GOLD) are needed to avoid duplication of effort, as well as to ensure that correct lines of communication are maintained with the Parent organizations. This is not the case for TCO and GOFC-GOLD. However, the two are leading definition of variables such as land cover and fire disturbance, as well as benchmarking and validation of land cover and fire products (tasks which are fully recognized in the GCOS Implementation Plan).

TOPC needs to maintain dialogue with TCO and GOFC-GOLD and also provide a mechanism for TCO and GOFC-GOLD to communicate their concerns and

developments to GCOS. To this end TOPC 9 recommends that both TCO and GOF-C-GOLD be formally represented as full Members of TOPC.

**Action: Michael Brady – Director of GOF-C-GOLD, and Antonio Bombelli – TCO liaison with FAO, be confirmed as TOPC Members by the GCOS and GTOS Secretariats followed by letters of invitation to be sent by the new Chair of TOPC.**

Michel Verstraete has been invited to join AOPC. In a presentation to TOPC he outlined a possible strategy for strengthening links between the two Panels. This strategy hinges on AOPC and TOPC identifying common ECVs (either those common to both Panels, such as albedo, or where a related approach is needed, such as aerosol retrievals over land), making joint recommendations (e.g. on reprocessing), and for joint activities through science teams drawing from both Panels. TOPC 9 welcomed the development and asked Michel to represent the interests of the TOPC at AOPC. The next AOPC meeting will determine the value of reciprocal representation from AOPC at TOPC meetings.

**Action: Michel Verstraete to attend AOPC as the formal TOPC representative.**

#### *4.4 Links with WCRP*

TOPC is very aware of new research concerning assimilation of land surface albedo observations from satellite into GCMs. As noted in section 4.1 the Panel sees strengthening interaction with land surface process modelers as an important part of its long-term strategy. Improved links with the World Climate Research Program are sought. TOPC, in common with the other GCOS Panels, is represented on the WCRP Observation and Assimilation Panel (WOAP). In the short-term the GCOS Secretariat will contact the WCRP asking for advice on possible new TOPC Panel members. In the longer term the new TOPC Panel Chair should meet with WCRP to discuss possible ways of strengthening collaboration.

**Action: GCOS Secretariat to ask WCRP for nominations.**

#### *4.5 Links with International Polar Year*

The international Polar Year will run from March 2007 to March 2009. This major international science effort has already resulted in commitments to reinforce glacier and permafrost observations. In particular proposals have been made to fill the gaps in the GTN-P, highlighted in both the second adequacy report and in the GCOS Implementation Plan – but the commitment is only for the period of the IPY. Clearly this represents a major opportunity for long-term monitoring of these sites. IPY would already cover the infrastructure and set up costs. This should be acknowledged in any short-term reports on the status of the global climate observing system (e.g. in the annual progress reports made to COP). The report must highlight the importance of continuing the observations beyond the IPY period as a sustained part of the GTN-P network.

**Action: TOPC to supply GCOS secretariat with information on where gaps have been filled (and ideally who funded the gap filling) as the GTN-P proposals to IPY mature (N.B.: information will probably only become available in fall 2006), GCOS Secretariat to bring this to the attention of**

**COP with suggestions that funding continue to ensure sustained observation of the new sites.**

#### *4.6 Links with GEO GEOSS*

The Group on Earth Observations has now established a Secretariat, hosted at WMO, to oversee the planning and implementation of the Global Earth Observing System of Systems (GEOSS). The GEOSS 10 year implementation plan includes many work packages where GTOS and GCOS are taking the lead. Indeed, the GCOS Implementation Plan has been adopted as the Climate Change societal benefit component of the GEOSS 10 year plan. TOPC will continue to support the GCOS and GTOS secretariats in their work with GEOSS, though will still rely on these two secretariats to provide the formal interface with the GEO process.

#### *4.7 Links with the Integrated Global Observing Strategy's Land Theme*

TOPC 9 noted the progress made on the Integrated Global Observing of Land (IGOL) - one of the IGOS themes. The Panel agreed that it would review the Proposal at the next Panel meeting, - or the final IGOL plan, should this already be approved before TOPC 10. The review is needed to ensure that TOPC does not a) duplicate scientific review work carried out by IGOL and that b) coordination mechanisms and terrestrial climate variables as proposed in the GIP don't conflict with the IGOL proposal.

**Action: TOPC to review the IGOL proposal for discussion at TOPC 10.**

#### *4.8 Support to the Convention to Combat Desertification and Convention on Biological Diversity*

Some of the terrestrial climate variables, e.g. fAPAR and Albedo also offer great potential as indicators/measures of desertification with potential value to the UN Convention to Combat Desertification. Likewise, variables related to land cover and cover change, lakes etc, offer potential for biodiversity monitoring. The GTOS Secretariat is making progress on interaction with both CCD and CBD. However, there is no formal reporting mechanism to the UNCCD's CST (Committee for Science and Technology) nor has the UNCCD generated any legally binding reporting/monitoring requirements which such observations could support. TOPC will continue to highlight non climate use of terrestrial ECVs and will support GTOS in its work in this domain, but will remain focused on climate applications.

### **5. Terrestrial Commission development; roles, responsibilities and strategy**

In response to the Decision made at COP-9 the sponsoring agencies of the Global Climate Observing System, and in particular those of the Global Terrestrial Observing System, in consultation with other international or intergovernmental agencies, as appropriate, are developing a framework for the preparation of guidance materials, standards and reporting guidelines for terrestrial observing systems for climate, and associated data and products.

This process is being managed by a new body, the Interagency Coordination and Planning Committee for GEO/GEOSS (ICPC).

TOPC will continue to support ICPC as it makes progress towards the establishment of a joint mechanism for terrestrial observations. The strategy adopted by ICPC is exploring ways of using existing processes to establish draft standards, regulatory material and guidelines – both within the UN system, and external to it (e.g. technical sub committees of ISO). In this framework TOPC suggested that the process explore links with the WMO Commission for Hydrology (CHy) and Commission for Agricultural Meteorology (CAgM), both of which could help in setting and implementing standardized observations of some of the ECVs from the terrestrial domain. The TOPC's work on hydrological climate variables, coordinated through the GTN-H already has good links with CHy and has indeed received concrete support in terms of strengthening the network of river discharge observations. The GCOS and GTOS Secretariats are best placed to make this suggestion to the ICPC.

**Action: GCOS and GTOS Secretariats.**

## **6. Membership and Panel structure review**

Professor David Norse and Dr Harold Kibby both stood down from the Panel before the meeting. The Panel acknowledged their valuable contributions and the GTOS Secretariat is preparing letters of thanks.

**Action: GTOS Secretariat.**

Alan Belward has completed his four year term as Chair of the Panel and will stand down as soon as a new Chair has been nominated. The TOPC Chair is nominated by the GCOS and GTOS Secretariats (Steering Committee Chairs and Office Directors) in agreement with the Observing Systems sponsoring organizations. Nominations / recommendations are currently with the sponsors and a new Chair will be put in place as soon as possible.

**Action: GCOS / GTOS Secretariats.**

TOPC Panel Members are invited by the Panel Chair following nomination by GCOS and GTOS Secretariats. The Secretariats act on advice from the Panel itself. The Panel's long-term strategic orientation, as discussed at TOPC 9 (see section 4) suggests that the Panel would benefit from new membership concerning land surface process modeling and observations of soil moisture. The GCOS Secretariat will approach the Director of WCRP, whilst Jurate Landweher will contact GEWEX for advice on possible new members with suitable expertise.

**Action: GCOS Secretariat.**

Current TOPC membership is listed in Appendix 4.

## **7. Calendar and future meetings**

The Institute for Environment and Sustainability was thanked for hosting TOPC 9. TOPC 10 is planned for the last week of March 2007. If TOPC 10 is going to

include writing sessions (as was the case at this meeting) then participants would like the Panel to meet for three days, rather than two. The exact location and dates TBD by the incoming Chair of TOPC and circulated to the Panel.

**Action: New Chair.**

## **Ninth session of the GCOS/GTOS Terrestrial Observation Panel for Climate**

European Commission JRC Ispra, 28<sup>th</sup> and 29<sup>th</sup> March 2006

### Agenda

#### **28<sup>th</sup> March convene 09.00**

1. Welcome and introductions
2. Review of Agenda
3. Report from GCOS and GTOS Steering Committees
4. TOPC Plans for implementing the GCOS Implementation Plan
  - 4.1. IP Annex - Review of variable list, specifications, institutional responsibilities and timelines
  - 4.2. Long-term strategy - liaison with other GCOS and GTOS Panels, pilot projects (CGMS actions, links with CEOS WGCV, assimilation, benchmarking activities), panel structure (working groups) – liaison with International Polar Year – liaison with GEO GEOSS – interaction with IGOL IGOS – interaction with WCRP – interaction / support to the Convention to Combat Desertification and Convention on Biological Diversity - International Year for Planet Earth
5. Terrestrial Commission development; roles, responsibilities and strategy
6. Membership review
7. Calendar and future meetings
8. AOB

#### **29<sup>th</sup> March close of meeting 17.00**

A working dinner will be hosted by the Institute for Environment and Sustainability on 28<sup>th</sup> March 2005

### List of Participants

Prof. Roger BARRY  
Distinguished Professor of Geography and  
Director, National Snow and Ice Data  
Center (NSIDC) and World Data Center  
(WDC) for Glaciology,  
University of Colorado  
UCB 449, Boulder, CO 80309  
[rbarry@kryos.colorado.edu](mailto:rbarry@kryos.colorado.edu)

Dr. Alan BELWARD  
Chair TOPC  
European Commission  
Joint Research Centre  
21020 Ispra, VA, Italy  
[alan.belward@jrc.it](mailto:alan.belward@jrc.it)

Dr. Antonio BOMBELLI  
GTOS TCO Panel  
FAO (United Nations)  
Rome, Italy  
[Antonio.Bombelli@fao.org](mailto:Antonio.Bombelli@fao.org)

Dr. Michael BRADY  
GOFC-GOLD Director  
Canadian Forest Service  
5320-122 St. Edmonton  
Alberta, Canada T6H 3S5  
[MBrady@NRCan.gc.ca](mailto:MBrady@NRCan.gc.ca)

Dr. Jerry BROWN  
President  
International Permafrost Association  
P.O. Box 7  
Woods Hole MA 02543  
[jerrybrown@igc.org](mailto:jerrybrown@igc.org)

Dr. David GOODRICH  
Director, GCOS Secretariat  
World Meteorological Organization  
Case postale 2300  
7bis, Avenue de la Paix  
CH-1211 Geneva 2  
[DGoodrich@wmo.int](mailto:DGoodrich@wmo.int)

Prof. Wilfried HAEBERLI  
Geography Department  
University of Zurich  
Winterthurerstrasse 190  
CH-8057 Zürich  
Switzerland  
[haeberli@geo.unizh.ch](mailto:haeberli@geo.unizh.ch)

Prof. Sandy HARRISON  
School of Geographical Science  
University of Bristol  
University Road  
Bristol BS8 1SS  
[sandy.harrison@bristol.ac.uk](mailto:sandy.harrison@bristol.ac.uk)

Dr. Jurate LANDWEHER  
Research Hydrologist, BRR/ER National  
Research Program, U.S. Geological Survey  
National Center Mail Stop 431  
12201 Sunrise Valley Drive  
Reston, VA 20192 USA  
[jmlandwe@usgs.gov](mailto:jmlandwe@usgs.gov)

Prof. Shaun QUEGAN  
Centre for Terrestrial Carbon Dynamics  
Sheffield Centre for Earth Observation  
Science (SCEOS), University of Sheffield  
Hicks Building, Hounsfield Road  
Sheffield S3 7RH, UK  
[S.Quegan@sheffield.ac.uk](mailto:S.Quegan@sheffield.ac.uk)

Prof.. Massimo MENENTI  
Director  
Istituto per i sistemi agricoli e forestali del  
Mediterraneo – ISAFoM  
Via Patacca 85  
80056 Ercolano (NA), Italy  
[m.menenti@isafom.cnr.it](mailto:m.menenti@isafom.cnr.it)

Dr. Reuben SESSA  
Programme Officer (GLCN/GTOS)  
FAO (United Nations)  
Rome, Italy  
[Reuben.Sessa@fao.org](mailto:Reuben.Sessa@fao.org)

Dr. Michel VERSTRAETE  
European Commission  
Joint Research Centre  
21020 Ispra, VA, Italy  
[Michel.verstraete@jrc.it](mailto:Michel.verstraete@jrc.it)

Dr. John ZILLMAN  
Chair GCOS Steering Committee  
Bureau of Meteorology  
GPO Box 1289  
Melbourne Victoria 3000  
Australia  
[J.Zillman@bom.gov.au](mailto:J.Zillman@bom.gov.au)

### **TOPC Terms of Reference** **(as revised with representatives from the GCOS and GTOS Secretariats, and endorsed by the 9<sup>th</sup> TOPC session)**

Recognizing the need for specific and technical input concerning terrestrial observations for climate purposes, the steering committees of GTOS and the GCOS have jointly established TOPC with the following terms of reference.

- To define the requirements for long-term monitoring of terrestrial properties for climate and climate change;
- To liaise with relevant research and operational communities to identify measurable terrestrial (biosphere, cryosphere, and hydrosphere) properties and attributes which
  - control the physical, biological and chemical processes affecting climate,
  - are themselves affected by climate change, are indicators of climate change and provide information on impacts of climate change;
- To assess and monitor the adequacy of terrestrial observing networks (in-situ, EO) and promote the development of their capacity to measure terrestrial properties and exchange climate data and information;
- To identify gaps in present systems and design, promote and periodically revise plans for a long-term systematic observing system that fills these gaps, makes the data available and so better serves the needs of the research and operational communities;
- To coordinate activities with other global observing system panels and task groups to ensure consistency of requirements with the overall programmes;
- Publish and update GCOS/GTOS studies and planning documents;
- Carry out agreed assignments from the GCOS and GTOS Steering Committees;
- Report regularly to the GCOS and GTOS Steering Committees.

**TOPC Membership  
(as of 30<sup>th</sup> March 2006)**

One representative from GOF-C-GOLD and one representative from TCO (both GTOS Panels) have full TOPC Membership in addition to the persons listed below.

Chair : TBD

**Prof. Roger BARRY**

WDC-A for Glaciology  
National Snow and Ice Data Center  
CIRES/WDC  
University of Colorado, Campus Box 449  
BOULDER, CO 80309-0449  
USA  
Email: [rbarry@kryos.colorado.edu](mailto:rbarry@kryos.colorado.edu)

**Prof. Wilfried HAEBERLI**

Department of Geography  
University of Zurich  
Winterthurerstrasse 190  
CH-8057 ZURICH  
Switzerland  
Email: [haeberli@geo.unizh.ch](mailto:haeberli@geo.unizh.ch)

**Prof. Sandy HARRISON**

School of Geographical Sciences  
University of Bristol  
University Road  
BRISTOL BS8 1SS  
United Kingdom  
Email: [Sandy.Harrison@bristol.ac.uk](mailto:Sandy.Harrison@bristol.ac.uk)

**Dr Jurate M. LANDWEHR**

U.S. Geological Survey  
National Center - MS431  
12201 Sunrise Valley Drive  
RESTON, VA 20192  
USA  
Email: [jmlandwe@usgs.gov](mailto:jmlandwe@usgs.gov)

**Dr Thomas MAURER**

Global Runoff Data Centre (GRDC)  
Federal Institute of Hydrology  
P.O. Box 200253  
56002 KOBLENZ  
Germany  
Email: [thomas.maurer@bafg.de](mailto:thomas.maurer@bafg.de)

**Prof. Massimo MENENTI**

Université Louis Pasteur  
Boulevard Sebastien Brant  
F-67400 Illkirch-Graffenstaden  
France  
E-mail: [menenti@sepia.u-strasbg.fr](mailto:menenti@sepia.u-strasbg.fr)

**Prof. Shaun QUEGAN**

Centre for Terrestrial Carbon Dynamics  
Sheffield Centre for Earth Observation  
Science  
University of Sheffield, Hicks Building  
Hounsfield Road  
SHEFFIELD S3 7RH  
UK  
Email: [s.quegan@sheffield.ac.uk](mailto:s.quegan@sheffield.ac.uk)

**Dr Steve RUNNING**

School of Forestry, NTSG  
University of Montana  
MISSOULA, MT 59812  
USA  
Email: [swr@ntsg.umt.edu](mailto:swr@ntsg.umt.edu)

**Dr Allen M. SOLOMON**

U.S. Environmental Protection Agency  
Western Ecology Division  
200 SW 35th Street  
CORVALLIS, OR 97333  
USA  
Email: [solomon@mail.cor.epa.gov](mailto:solomon@mail.cor.epa.gov)

**Dr Michel VERSTRAETE**

Institute for Environment and Sustainability  
European Commission, Joint Research  
Centre  
Via Enrico Fermi 1  
21020 ISPRA, (Varese)  
Italy  
Email: [michel.verstraete@jrc.it](mailto:michel.verstraete@jrc.it)

*(Intentionally blank)*

## **LIST OF GCOS PUBLICATIONS\***

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

\*GCOS publications may be accessed through the GCOS website at:  
<http://www.wmo.int/web/gcos/gcoshome.html>

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

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

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

- GCOS-61**  
(WMO/TD-No. 1031) Report of the ninth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS (Beijing, China, September 12-14, 2000)
- GCOS-62**  
(WMO/TD-No. 1038) Report of the Pacific Islands Regional Implementation Workshop on Improving Global Climate Observing Systems (Apia, Samoa, August 14-15, 2000)
- GCOS-63**  
(WMO/TD-No. 1047)  
(GTOS-26) Establishment of a Global Hydrological Observation Network for Climate. Report of the GCOS/GTOS/HWRP Expert Meeting (Geisenheim, Germany, June 26-30, 2000)
- GCOS-64**  
(GOOS-107) Report of the eighth session of the TAO Implementation Panel (TIP-8) (St. Raphael, France, October 15, 1999)
- GCOS-65**  
(WMO/TD-No. 1055) Report of the sixth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 10-13, 2000)
- GCOS-66**  
(GOOS-108) Report of the ninth session of the TAO Implementation Panel (TIP-9) (Perth, Australia, November 16-17, 2000)
- GCOS-67**  
(WMO/TD-No. 1072) GCOS Implementation Strategy: Implementing GCOS in the New Millennium
- GCOS-68**  
(WMO/TD-No. 1093) Report of the seventh session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 30-3 May, 2001)
- GCOS-69**  
(GOOS-98) Report of the fifth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Bergen, Norway, June 20-23, 2000.
- GCOS-70**  
(GOOS-113) Report of the sixth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Melbourne, Australia, May 2-5, 2001
- GCOS-71**  
(WMO/TD-No. 1099)  
(GTOS-29) Report of the GCOS/GTOS/HWRP Expert Meeting on the Implementation of a Global Terrestrial Network - Hydrology (GTN-H), Koblenz, Germany, June 21-22, 2001
- GCOS-72**  
(GOOS-116) Report of the seventh session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, April 26-27, 2001
- GCOS-73**  
(WMO/TD-No. 1106) Manual on the GCOS Surface and Upper-Air Networks: GSN and GUAN, April 2002
- GCOS-74**  
(WMO/TD-No. 1109) Report of the GCOS Regional Workshop for Eastern and Southern Africa on Improving Observing Systems for Climate, Kisumu, Kenya, October 3-5, 2001
- GCOS-75**  
(WMO/TD-No. 1124) Summary Report of the tenth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Farnham, UK, April 15-19, 2002
- GCOS-76**  
(WMO/TD-No. 1125) Report of the eighth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Wokingham, UK, May 20-24, 2002

- GCOS-77**  
(GOOS-122) International Workshop for Review of the Tropical Moored Buoy Network, September 10-12, 2001, Seattle, Washington, USA. Workshop Report
- GCOS-78**  
(WMO/TD-No. 1126) Report of the GCOS Regional Workshop for Central America and the Caribbean. "Observing Climate from Weather Extremes to Coral Reefs", San José, Costa Rica, March 19-21, 2002 (disponible también en español)
- GCOS-79**  
(WMO/TD-No. 1133) Interim Report to the sixteenth session of the Subsidiary Body for Scientific and Technological Advice of the UNFCCC by the Global Climate Observing System, Bonn, Germany, June 5-14, 2002
- GCOS-80**  
(WMO/TD-No.1140) Report of the GCOS Regional Workshop for East and Southeast Asia on Improving Observing Systems for Climate, Singapore, September 16-18, 2002
- GCOS-81**  
(GOOS-124) Seventh session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Kiel, Germany, June 5-8, 2002
- GCOS-82**  
(WMO/TD-No.1143) Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC
- GCOS-82 (ES)**  
(WMO/TD-No.1176) Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC – Executive Summary
- GCOS-83**  
(WMO/TD-No.1155)  
(GTOS-33) Report of the Global Terrestrial Network - Hydrology (GTN-H) Coordination Panel Meeting, Toronto, Canada, November 21-22, 2002
- GCOS-84**  
(WMO/TD-No.1156)  
(GTOS-32) Report of the GCOS/GTOS/HWRP Expert Meeting on Hydrological Data for Global Studies, Toronto, Canada, November 18-20, 2002
- GCOS-85**  
(WMO/TD-No.1167) Report of the GCOS Regional Workshop for Western and Central Africa on Improving Observing Systems for Climate, Niamey, Niger, March 27-29, 2003 (disponible en français)
- GCOS-86**  
(WMO/TD-No.1183) Report of the GCOS Regional Workshop for South America on Improving Observing Systems for Climate, Santiago, Chile, October 14-16, 2003 (disponible también en español)
- GCOS-87**  
(WMO/TD-No.1189) Summary Report of the eleventh session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Melbourne, Australia, April 7-10, 2003
- GCOS-88**  
(WMO/TD-No. 1190) Conclusions from the ninth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Asheville, NC, USA, June 23-27, 2003
- GCOS-89**  
(GOOS-140) Report of the Eighth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Ottawa, Canada, September 3-6, 2003
- GCOS-90**  
(GOOS-141) IOC Group of Experts on the Global Sea Level Observing System (GLOSS), eighth session, Paris, France, October 13 and 16-17, 2003

- GCOS-90bis** Report of the GCOS/GTOS Terrestrial Observation Panel for Climate (TOPC), seventh session, Rome, Italy, December 16-18, 2003.
- GCOS-91**  
(WMO/TD-No.1221) Summary Report of the twelfth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Geneva, Switzerland, March 15-19, 2004
- GCOS-91bis** Conclusions from the tenth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Geneva, Switzerland, April 19-23, 2004
- GCOS-92**  
(WMO/TD-No.1219) Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC
- GCOS-92 (ES)**  
(WMO/TD-No.1244) Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC – Executive Summary
- GCOS-93**  
(WMO/TD-No.1238)  
GTOS-35 Summary Report of the eighth session of the GTOS/GCOS Terrestrial Observation Panel for Climate, Ispra, Italy, April 6-7, 2004
- GCOS-94**  
(WMO/TD-No.1248) Report of the GCOS Regional Workshop for Central Asia on Improving Observing Systems for Climate, Almaty, Kazakhstan, May 24-26, 2004 (имеется также на русском языке)
- GCOS-95**  
(GOOS-143) Report of the ninth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Southampton, UK, June 7-10, 2004
- GCOS-96**  
(WMO/TD-No. 1255) Analysis of Data Exchange Problems in Global Atmospheric and Hydrological Networks
- GCOS-97**  
(WMO/TD-No. 1259) Report of the GCOS Regional Workshop for South and Southwest Asia on Improving Observing Systems for Climate, New Delhi, India, October 11-13, 2004
- GCOS-98**  
(GOOS-146) Progress with the Initial Ocean Climate Observing System: A Report to the UNFCCC – April 2005
- GCOS-99**  
(GOOS-149) IOC Group of Experts on the Global Sea Level Observing System (GLOSS), ninth session, Paris, France, February 24-25, 2005
- GCOS-100**  
(WMO/TD-No. 1283) Report of the GCOS Regional Workshop for Eastern and Central Europe on Improving Observing Systems for Climate, Leipzig, Germany, April 26-28, 2005
- GCOS-101**  
(WMO/TD-No. 1298)  
(GTOS-37) Report of the 2nd Meeting of the GTN-H Coordination Panel, Koblenz, Germany, July 4-5, 2005
- GCOS-102** Conclusions from the eleventh session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Geneva, Switzerland, April 11-15, 2005
- GCOS-103**  
(WMO/TDN-No 1341) Summary report of the thirteenth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, St Petersburg, Russian Federation, 5-8 October 2005

- GCOS-104** Report of the tenth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate Tenth, Geneva, Switzerland, May 9-12, 2005  
(GOOS-150) Session Final Report
- GCOS-105** Conclusions from the twelfth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Geneva, Switzerland, April 3-7, 2006
- GCOS-106** Report of the GCOS Regional Workshop for the Mediterranean Basin, Marrakech, Morocco, November 22-24, 2005  
(WMO/TD-No. 1337)
- GCOS-107** Systematic Observation Requirements for Satellite-Based Products for Climate  
(WMO/TD-No. 1338)
- GCOS-108** Climate Information for Development Needs an Action Plan for Africa, Report and Implementation Strategy, Addis Ababa, Ethiopia, 18-21 April 2006  
(WMO/TD-No. 1358)
- GCOS-109** Summary report of the fourteenth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Geneva, Switzerland 10-12 October 2006  
(WMO/TD-No 1363)
- GCOS-110** Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Eleventh Session, Tokyo, Japan 16-20 May 2006  
(WMO/TD-No. 1370)  
(GOOS No. 154)  
(WCRP No. )
- GCOS-111** Summary Report of the ninth session of the GTOS/GCOS Terrestrial Observation Panel for Climate, Ispra, Italy 28-29 March 2006  
(WMO/TD-No. 1371)  
(GTOS No. 43)

*(Intentionally blank)*

**GCOS Secretariat**  
Global Climate Observing System  
c/o World Meteorological Organization  
7 *bis*, Avenue de la Paix  
P.O. Box No. 2300  
CH-1211 Geneva 2, Switzerland  
Tel: +41 22 730 8275/8067  
Fax: +41 22 730 8052  
Email: [gcosjpo@wmo.int](mailto:gcosjpo@wmo.int)