Seventh session of the Terrestrial Observation Panel for Climate of the Global Climate Observing System and Global Terrestrial Observing System

Rome, 16th to 18th December 2003

The seventh session of the Terrestrial Observation Panel for Climate of the Global Climate Observing System and Global Terrestrial Observing System was held at the UN Food and Agriculture Organisation in Rome, 16th to 18th December 2003. The agenda and list of participants are given in appendix 1 and 2.

1. The second adequacy report

The Panel was thanked for the work that went into the second report on the adequacy of the global observing systems for climate in support of the UNFCCC. The final report is available at http://www.wmo.ch/web/gcos.

The main conclusions from the report are that full implementation of integrated global observing systems for climate, sustained on the basis of a mix of high-quality satellite and in situ measurements, dedicated infrastructure and targeted capacity-building will require commitment of all Nations. Achieving global coverage and climate-quality observations for the essential climate variables is essential to meet the needs of the UNFCCC and IPCC. Adherence to the principles of free and unrestricted exchange of data, particularly for the Essential Climate Variables is vital. Adherence to the GCOS Climate Monitoring Principles for global climate observations from both in situ networks and satellites is required. Observations and associated metadata, including historical observations must be available at international data centres.

The report was presented to the 18th session of the UNFCCC's Subsidiary Body on Scientific and Technological Advice (SBSTA-18) in June 2003 and to the 9th Conference of the Parties to the UNFCCC in Milan, 1st -12th December 2003.

1.1 SBSTA-18

SBSTA-18 concluded that the report "provides an opportunity to build momentum among governments to improve the global observing systems for climate" and they agreed to consider four overarching recommendations from the GCOS Steering Committee in its further work, namely the need for free and unrestricted exchange of data for essential climate variables; the necessity of generating integrated global climate products to meet user needs; the importance of capacity building and system improvements in developing countries if we are to implement a truly global observing system; and the need for observing standards - especially for the terrestrial domain. Furthermore SBSTA considered that Parties would submit views on the priorities for actions arising from the report to assist in developing a GCOS Implementation Plan. Comment was received from around 23 countries. The countries agreed with the priorities set in the second adequacy report.

1.2 COP-9

The COP-9 Decision concerning the work of GCOS and the second adequacy report recommends that Parties review the report within the context of their national capabilities and consider what actions they can take. It also asks GCOS to coordinate development of a five to ten year implementation plan for the integrated global observing systems for climate, using a mix of high-quality satellite and in-situ measurements, dedicated infrastructure and targeted capacity-building. The COP also invites the GCOS Secretariat and the Ad Hoc Group on Earth Observations (GEO) to collaborate closely in developing their respective implementation plans, and the Ad Hoc Group on Earth Observations to treat global climate monitoring as a priority and to adopt a balanced approach to the application of in situ and remote-sensing systems for climate monitoring.

On the issue of standards the COP9 Decision asks sponsoring agencies of GCOS and in particular those of the GTOS to develop a framework for the preparation of guidance materials, standards and reporting guidelines for terrestrial observing systems for climate, and associated data and products and report to COP-11 (November 2005).

The Subsidiary Body for Implementation Decision invited the Global Environment Facility to consider funding for priority actions in developing countries. TOPC could therefore recommend specific actions to the GCOS secretariat, who would work with their regional partnerships to build GEF proposals for funding in situ observations to support specific global ECVs.

1.3 Resource mobilisation (and COP-9)

In a separate resource mobilisation action a GCOS Cooperation Mechanism has been established. This consists of a Board and a Fund established by a core group of 6 countries. It aims to identify and make the most effective use of resources available for improving global observing systems for climate in developing countries. The board is ready to examine specific proposals for action in developing countries and TOPC should consider this for targeting specific shortcomings. Although separate from the UNFCCC and the Global Environment Fund (GEF) COP-9 did urged Annex 1 Parties to support, through contributions to the GCOS Cooperation Mechanism and other relevant funding mechanisms, the priority needs, identified in the second adequacy report and in the regional action plans developed by GCOS, in developing countries, especially the least developed countries and small island States. **Action TOPC to provide detail of networks operating in the developing world and state where the key gaps are, this would then form the basis of a proposal for funding under the terms of the co-operation mechanism.**

2. GCOS Implementation plan

In the light of the COP9 Decision TOPC is contributing to the Implementation Plan and providing revised input to the CEOS / WMO database for all essential climate variables. The latter is important because the GEO considers this database one of two sources of information for its own implementation plan (the other being the GCOS Implementation Plan). **Action TOPC to comment before TOPC-8 (March/April '04). Action SH to send first draft of revised table to TOPC.**

The GCOS Secretariat has prepared a draft structure for the implementation plan. This is based on the following seven chapters. 1. Background and Introduction; 2. Approach to plan; 3. Ensure Global Coverage and Implementation of Key Global Networks, Systems and Facilities; 4. Satellite Operations in Support of Climate; 5. Establish/Improve Global Integrated Climate Products; 6. Improved Operations of Networks and Systems and Stewardship of Data; 7. Emerging Science and Technologies. A more complete outline is given in annex 3. The first draft will be completed at the GCOS secretariat between 19th and 22nd January 2004. **Deadline for all actions below is therefore 16th January 2004**.

TOPC accepted the overall structure, though recognised that this may still change. Care should be taken that the separate chapter on satellite observations should not lead to emphasis on Observations from Earth Observing satellites data *at the expense of* in-situ.

The value of the detailed annex to the second adequacy report as a complement to any implantation plan was stressed by the Panel members. The completeness of the version currently available from the GCOS web site will be checked and revisions made as appropriate. The revised set should form the core of a new document setting out the broader role of the terrestrial domain. GTOS will sponsor production of this document by providing a technical editor and manage its publication. **Action AB to review status and ask TOPC to revise content where needed by TOPC-8.**

The annex to the second adequacy report sets out in detail the philosophy behind and current status of each Essential Climate Variable. A new set of documents is required to support the preparation of the implementation plan. A one-page sheet setting out the actions needed to address the findings drawn from the second adequacy report and lead to sustained availability of each ECV. Each sheet will follow a common structure and will include illustrations. For each finding (usually subdivided by variable) the following 8 points will be addressed:

1. Why: emphasises the ECVs' roles as drivers, feedbacks, indicators, and for aqimpact assessments
2. Aim: how will the variable be used in the next five to ten years, e.g. an assimilation scheme is there, waiting for the variable, and it will be used immediately…or the availability of the variable provides a valuable indicator of change …this will condition the ECV's specifications.
3. What: will provide very specific information on the resolution of the measurements (spatial, temporal etc.), will present the technology used to make

the measurements and will highlight what needs to be done to ensure current, historic and future records. Stress the integrated nature of the observations (In-situ and EO)

4. Outcome: what will be produced in information/knowledge terms…not just the variables, but also analysis.

5. Who: where do the responsibilities for measurement, processing and maintenance (archival, standards, benchmarking) lie. What mandate do data centres have to have to be part of the IP (if they exist…and if they don't what should they look like/do?) Who determines fitness for purpose(s), consults with the users, establishes the common language and determines minimum acceptable standards?

6. How: an extension of the who, where suitable institutional structures are identified, e.g. x is responsible for taking observation y, according to standards set by GTN-a, and z will turn them into information. Identifying what is in place already…who is doing what.

7. Indicators: specific measurable factors used to judge progress over the 5 – 10 year period.

8. Timeframe and costs.

The detail from these will be distilled into the Implementation Plan and will help TOPC to establish priorities within the ECV list. It will also provide a framework for TOPC's own work plan.

2.1 The Findings

Each of the findings was examined with respect to the 8 questions outlined above and to the ECV table as proposed in the draft Implementation plan. The findings are given in annex 4. The table is in annex 5. For the table contributing networks is taken to mean in-situ. Contributing satellite observations currently identifies the generic nature of the observations, but the final version should contain detailed information concerning the past, current and future sensors (e.g. JERS, MODIS, SPECTRA).

Finding 1: Many organizations make terrestrial observations for a range of purposes. Different measurement protocols are used, even for the same variable. There is a need to improve co-ordination for terrestrial climate observations especially among the UN agencies and to provide assistance to countries for reporting associated with multilateral environmental agreements. The proposed solution is to establish an intergovernmental technical commission to prepare and issue regulatory and guidance material establishing common standards for terrestrial observations, data management and services. This must take into account existing standards and initiatives. This will result in harmonised terrestrial measurements to agreed standards held in agreed standardised formats with metadata and distributed according to agreed standardised protocols and distributed from recognised global data centres supported with sustained funding. GTOS and GCOS should work with their sponsors, especially ICSU, FAO, UNEP, UNESCO and WMO and the convention secretariats to create an inter-agency working group linking

with relevant international science programmes with a view to establishing an inter-governmental technical commission such as the JCOMM model or other suitable mechanism. **Action AB to prepare first draft implementation sheet for discussion by GTOS and GCOS secretariats.**

Finding 2: River discharge, lakes, wetlands and water use will be treated separately. Water use will be treated as irrigation area and volume. Wetlands will be covered in land cover. Two lists of rivers for a GCOS baseline network have been identified, one from NCAR and a more comprehensive list adding some of the smaller rivers needed for regional studies. **Action TM to prepare text for Implementation sheet.**

Monthly measurements of lake level and area will be made for the c.a. 145 lakes that are climatically important. This will include the largest and key ephemeral water bodies. **Action SH to revise list and to give to TM. Action TM to co-ordinate preparation of text for Implementation sheet with GTN-H.**

Other comments for the Implementation sheets: Groups with potential to become a Global Lake Level and Area Data Centre need to be identified **Action SH and TM to identify possible data centres**.

Space agencies flying radars should be approached concerning the wetlands…e.g. JAXA may consider building a wetlands data base. The Dartmouth flood monitoring activity could be approached for lake area. In any case we should ask Parties with space agencies to establish analysis centres producing monthly measurements of lake level and area to within 30 m horizontal and 10 cm vertical using optical, altimetry and historical record reconstructed. These should be provided to the Lake data centre once established. Agencies should also back-process archived high resolution optical and microwave to extend the historical record on lake area. **Action TM to consult GTN-H on horizontal and vertical specifications for lake level/area Action SH to draft implementation sheet**

Water use will be monitored in terms of ground water extraction rates (cubic km / year) and irrigation. For impact studies monitoring some of the aquifers in terms of age, recharge, extent etc. would be valuable. The International Ground Water Assessment Center in the Netherlands could provide guidance on this. **Action TM to contact IGRAC for advice, and possibly preparation of an implementation sheet. Action. AT to provide AB to provide TM with one page explanation of the COP GCOS Implementation Plan process.**

We need to monitor the area under irrigation, the volumes of water brought to the sites and the efficiency with which it is used. Monitoring irrigated area in arid and semi-arid environments is feasible. In temperate regions and the tropics it is less so. FAO have in-house studies and are also in contact with CGIAR's International Water Management Institute. Together they may provide a framework for irrigation area and volume monitoring. **Action JL to contact FAO's land and water service and IWMI and prepare implementation sheet.**

Finding 3: Who currently generates snow cover/duration maps and are these adequate? How compatible are the different snow cover products and what process is there for

intercomparison? Can the snow cover/duration maps be easily combined with other spatial terrestrial data such as land cover? i.e. are common gridding systems used? What is the historical snow cover record like? Where are the in situ measurements of snow cover made, how many of them are there, and where are the critical gaps?

Finding 4: Confirm data flow from existing records (e.g. Himalaya) and confirm key gaps.

Finding 5: Confirm number and location of additional bore holes. Confirm adequacy of geographic distribution of existing boreholes. Is current monitoring of the change in latitudinal altitudinal limits of the permafrost extent acceptable, and can they be crossed with other spatial data such as snow cover and land cover.

Action WH to prepare implementation sheets in consultation with GTN-G and GTN-P

Findings 6 and 7: The Implementation plan will stress measurement of spectrally integrated hemispherical reflectance…sometimes referred to as Albedo. Production mechanisms are largely in place through CGMS, but benchmarking isn't. This is essential, especially as this is a "space only" product. In situ validation will be very limited (non existent?). Compatibility with other gridded products is needed. e.g use of albedo for monitoring daily changes in wetland extent. The CEOS WGCV could co-ordinate the benchmarking. A standard set of protocols could be developed for this and other space based products e.g. LAI, FAPAR. **Action MV to prepare implementation sheet. Action MM and MV to prepare general validation/benchmarking approach.**

Findings 8 and 9: The implementation plan must stress common standards, e.g. the LCCS system for harmonisation and translation. The database linked to land cover must include the spectral/temporal classifiers e.g. seasonality. Without adherence to standards and benchmarking the products won't be useful for climate. The GLC-N could play a key role in the validation and would play a key role in capacity building.

The land cover data base should help with wetlands monitoring. It needs to identify forest peatlands (boreal), mangroves, sedge grasslands, rush grasslands and seasonally flooded forests. The maps must also serve the plant functional types needed by IGBP. Responsibility for looking after the basic data and the products must be defined **Action AB and JL to develop implementation sheet. Action SH to take this and get input from IGBP. Action AB to take this and get input from GOFC-GOLD and TCO.**

Finding 10: Main sources of historical land use to be identified. **Action SH to prepare implementation sheet.**

Findings 11 and 12: Space agency involvement is good here. But there is a need for benchmarking and for clarification of terminology used. Is it FAPAR, APAR, FPAR? WGCV may have a role in cal/val. The benchmarking process should cross reference with Albedo (findings 5 and 6). FAPAR and LAI should be treated in separate sheets. **Action MV to prepare implementation sheets. Action MM and MV to prepare general validation/benchmarking approach.**

Finding 13: There are substantial problems in monitoring global biomass. This should receive priority for research missions. A best estimate of global biomass should be produced e.g. for biomass burning emission estimates. Forest inventory information could possibly be used for this. **Action SQ to prepare implementation sheet.**

Findings 14 and 15: The GOFC regional networks should be engaged for cal/val activities. GOFC-GOLD is also best placed for benchmarking and the WFMC is an excellent candidate for the data centre. **Action AB to approach GOFC-GOLD for preparation of implementation sheet.**

Finding 16: The long-term operation of a representative set of terrestrial flux measurement sites is required. Highlight the reference site role and look to FLUXNET and partners as an implementing mechanism. **Action SR and WC to prepare draft implementation sheet**

Although not in the original list of ECV's the meeting discussed the production of Land Surface Temperatures as measured by Earth observing satellites. The wider uses of this variable : An implementation sheet should be prepared. **Action MM to prepare implementation sheet**

3. TOPC strategic direction

Panel's terms of reference as approved by the 10th meeting of the GCOS Steering Committee in 2002 ensure that TOPC complements the other GCOS and GTOS science panels. The main strategic direction provided by the GCOS and GTOS secretariats was to extend the terrestrial climate networks (e.g. support the evolution of the FAO's Global Land Cover – Network), to provide guidance on the location, composition and function of reference sites network (e.g. based on FLUXNET and similar) and to drive the evolution of research networks into operation.

4. Meetings and membership

The importance of an annual meeting was stressed by the GCOS and GTOS secretariats. The next meeting is planned for 6th and 7th April 2004 in Ispra. All current Panel Members are asked to reaffirm their interest in membership and to agree to attend the annual meeting. New nominations may be needed in some key domains. NB the date for TOPC-8 isn't unmoveable…if unsuitable for most panel members we will reschedule. Also funding rules / mechanisms supporting T&S will be clarified well in advance.

5. Close

FAO were thanked for hosting the 7th session of the TOPC, attendees for their direct input, the Panel Members for all the help and support over the last 24 months.

Appendix 1: List of participants

TOPC Terrestrial Observation Panel for Climate

Rome, Italy, 16-18 December 2003

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Appendix 2: Agenda

Agenda

16th December convene at 14.00

1. Welcome and introductions
2. Review of Agenda
3. Review of process and outcome of 2nd Adequacy Report including statement on TOPC input into the actions arising from the recommendations from the 2AR (Alan Thomas, GCOS Director)
4. Introduction to the GCOS Implementation Plan process
5. Review all 15 "terrestrial specific" findings and the relevant cross-cutting findings
6. Report from TOPC 6th Session
7. Status of the TOPC contribution to the GCOS Essential Climate Variables annex (The detailed Parameter Status sheets)
8. Review TOPC strategic direction (especially with respect to the other GCOS and GTOS Science Panels)
9. Draft outline TOPC report to GCOS and GTOS Steering Committees
10. Calendar and future meetings
11. AOB

18th December close meeting at 13.00

Appendix 3: Implementation plan structure

GCOS IMPLEMENTATION PLAN (OUTLINE)

I. Background and Introduction

II. Approach to plan

A. Based on Second Adequacy Report

B. Criteria Used to Assign Priority

C. Recognize Integrated Approach

D. Capacity Building

III. Ensure Global Coverage and Implementation of Key Global Networks, Systems and Facilities

A. Atmospheric Domain Surface

1. **General**
2. **Specific issues by ECV**
    a. **Surface Temperature**
    b. **Air Pressure**
    c. **Precipitation**
    d. **Near Surface Wind Speed and Direction**
    e. **Water Vapor**
    f. **Surface Radiation Budget**

B. Atmospheric Domain Upper-air

1. **General**
2. **Specific issues by ECV**
    a. **Upper-air Temperature**
    b. **Upper-air Wind Speed and Direction**
    c. **Upper-air Water Vapor**
    d. **Cloud Properties**
    e. **Earth Radiation Budget**

C. Atmospheric Domain Composition

1. **General**
2. **Specific issues by ECV**
    a. **Carbon Dioxide**
    b. **Methane**
    c. **Other Greenhouse Gasses**
    d. **Ozone**
    e. **Aerosol Properties**

D. Oceanic Domain Surface

1. **General**
2. **Specific issues by ECV**
    a. **Sea Surface Temperature**
    b. **Sea Surface Salinity**
    c. **Current**
    d. **Sea Level**

e. Sea State
f. Sea Ice
g. Ocean Color

E. Oceanic Domain Sub-surface

1. General
2. Specific issues by ECV
   a. Sub-surface Temperature
   b. Sub-surface Salinity
   c. Sub-surface Currents
   d. Nutrients
   e. Carbon
   f. Ocean Tracers
   g. Phytoplankton

F. Terrestrial Domain

1. General
2. Specific issues by ECV
   a. River discharge
   b. Lake Levels
   c. Ground Water
   d. Water Use
   e. Snow Cover
   f. Glaciers and Ice Caps
   g. Permafrost and Seasonably Frozen Ground
   h. Albedo
   i. Land Cover
   j. Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)
   k. Leaf Area Index (LAI)
   l. Biomass
   m. Fire Disturbance

IV. Satellite Operations in Support of Climate

A. Routine Operation of Key Satellite Measurements

B. Satellite Operations and Data Management Programs

1. Continuity and Homogeneity
2. Orbit Control
3. Calibration
4. Data Interpretation and Validation
5. Institutional Issues

C. Research/Experimental Satellite Contributions

D. Satellite Data Archives, Access and Preservation Issues

V. Establish/Improve Global Integrated Climate Products

A. Robust Institutional Arrangements

1. Data Centers
2. Analysis Centers

Appendix 4: Findings

T. 1) FINDING: There is a requirement for the establishment of an international mechanism that would prepare and issue regulatory and guidance material relating to terrestrial observing systems and management of their data and associated products.

T. 2) FINDING: The Parties need to provide the observations identified by the GTN–H, in particular those on river discharge, lakes, reservoirs and wetlands, and groundwater, to the associated international data centres. In spite of repeated calls by the international community for free and unrestricted exchange of hydrological data, this still does not happen.

T. 3) FINDING: The contraction of *in situ* observations should be halted and there is an urgent need to develop optimal procedures to blend surface observations of snow with visible and microwave satellite data and related airborne measurements.

T. 4) FINDING: Mass-balance measurements of glaciers and ice caps need to be re-initiated in Patagonia, New Zealand and Africa so that changing patterns can be monitored globally. Archived Earth observation data should be analyzed to determine trends over the last two decades. Observations should be provided to the World Glacier Monitoring Service.

T. 5) FINDING: New temperature boreholes and *in situ* observations of active layer thickness need to be established in both hemispheres by the Parties at sites identified by the Permafrost Network with the observations provided to the Network's international data centre.

T. 6) FINDING: There is a need to: (1) establish a benchmark for assessing land-surface albedo products, and (2) implement a system to retrieve land-surface albedo from existing geostationary platforms on a daily and global basis.

T. 7) FINDING: Archived data from geostationary platforms should be reprocessed to form a global climatology of albedo for the entire period of available measurements.

T. 8) FINDING: An international body should advise on standards for the production of land-cover maps, specifically in terms of the resolution and land-type characterization to be employed. (also see 1)

T. 9) FINDING: Existing land-cover data should be analyzed and/or reprocessed, wherever possible, to ensure the compatibility of maps produced for the last decade. New land-cover maps should be produced every five years.

T. 10) FINDING: Historical land-use data sets could be significantly improved if more and better-documented inventory data sets were made available.

T. 11) FINDING: Daily global FAPAR and LAI products should continue to be generated by Space Agencies and other entities and made widely available. The validation of these products, currently being undertaken by the Space Agencies and associated research programmes, should be continued.

T. 12) FINDING: Reference sites making *in situ* observations of FAPAR and LAI are essential both for validation and to redress the intrinsic limitations in the satellite-derived measurements.

T. 13) FINDING: Satellite missions capable of measuring global vegetation biomass are required.

T. 14) FINDING: Space Agencies should continue to fly sensors capable of detecting burnt areas and active fires, and global burnt-area and active-fire products should continue to be produced. The quality of the various fire products should be established.

T. 15) FINDING: Archived Earth observation data should be reprocessed to produce a consistent data set on fire disturbances and their trends.

T. 16) FINDING: Continued support for the long-term operation of a representative set of terrestrial flux measurement towers (FLUXNET) is required. With adjustments to the distribution of sites to include under-represented ecosystems and an expansion to the range of co-located measurements, FLUXNET could form a reference network at some point in the future.

Appendix 5. Terrestrial domain table.

TERRESTRIAL DOMAIN

ECV	Contributing in situ Network(s)	International Data Center(s)	Contributing Satellite Observations	2AR FINDING
River Discharge	• Proposed GCOS Baseline River Discharge Network based on GRDC priority list • Global Terrestrial Network for Hydrology (GTN-H)	• Global Runoff Data Center (Ger.)	See research	T2
Lake Levels	• Proposed GCOS Baseline Lake Level, Area, and Volume Network • Global Terrestrial Network for Hydrology (GTN-H)	No formally recognized centre. Proposal for centre…global lake area and level data centre. In situ and the results from space agencies.	Proposed Altimetry / high res optical and reprocessing	T2
Ground Water extraction rates	• Global Terrestrial Network for Hydrology (GTN-H)	• International Ground Water Assessment Center (IGRAC) Neth. • FAO services		T2
Amount and area of Irrigation.	See research	FAO	See research	T2
Snow Cover	• WWW/GOS Synoptic Network • National Networks	NOAA ?	Visible and Infrared Passive microwave	T3
Glaciers and Ice Caps	• Global Terrestrial Network for Glaciers (GTN-G) • National Monitoring Networks	• World Glacier Monitoring Service (WGMS) Switzerland • Global Resource Information Database (GRID) UNEP	Visible and Infrared Synthetic Aperture Radar	T4
Permafrost and Seasonally Frozen Ground	• Global Terrestrial Network for Permafrost (GTN-P) • National Monitoring Networks	• National Snow and Ice Data Centre NSIDC	Thermal	T5
Spectrally integrated hemispherical	• None…but we need a reference benchmarking activity.	Held by space agencies…but the	Geostationary GCOS principles applied to	T6, T7

reflectance (Albedo)	•	benchmarking will be CEOS WGCV…global product assembly	measurements polar orbiters	
Historical Land Use		RIVM Ramankutty		
Land Cover (including vegetation type)	GLC-N	TOPC + TCO + GOLD +IGBP +IPCC UNEP GRID	MODIS, MERIS, VGT	T8, T9, T10
Fraction of absorbed Photosynthetically Active Radiation (FAPAR) terminology? **Leaf Area Index (LAI)**	Fluxnet MODLAND network (NASA) TERACC (LAND IGBP) BASIN	CEOS WGCV	Vis (BGR) Nir… Vis nir multi angular	T11, T12 T12
Land surface temperature	Fluxnet MODLAND		Thermal	
Above ground biomass	Forest inventory data	See research	Low frequency radar and lidar	T13
Fire Disturbance	GOFC Regional networks	WFMC, UNEP GRID, MODIS	Visible and Infrared + SWIR and thermal	T14, T15