GLOBAL CLIMATE OBSERVING SYSTEM

WMO of UNESCO UNEP ICSU

Global Terrestrial Network – Hydrology (GTN-H)

Report of the GTN-H Coordination Panel Meeting

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Executive Summary

Canada hosted a WMO Expert Meeting on Hydrological Data for Global Studies in Toronto on 18-20 November 2002. Environmental monitoring experts from eight countries met to address key issues related to accessing and sharing hydrological data around the world. Immediately following the Expert Meeting, the GTN-H Coordinating Group met (21-22 November) in Toronto to discuss the recommendations of the Expert Meeting and to define a set of projects to advance the GTN-H. This report summarizes the results of the Coordination Group meeting.

This work is the result of the recent initiation by WMO, GCOS and GTOS, of a project to develop a global observing system for hydrological data, formally named the Global Terrestrial Network for Hydrology, or GTN-H. The GTN-H is intended to support a range of climate and water resource objectives, building on existing networks and data centres, and producing value-added products through enhanced communications and shared development.

The objectives of this Coordination Group meeting were to review progress on implementing the GTN-H; to complete the Terms of Reference for the GTN-H Coordination Group; and to develop a work plan that will advance the GTN-H in the short-term consistent with the strategies recommended at the Expert Meetings in Toronto (18-20 November 2002) and in Koblenz (21-22 June 2001).

Some progress had been made in developing components of the GTN-H, particularly by the GRDC, GEMS/Water and UNH members. The Expert Meeting in Toronto re-affirmed some earlier recommendations on GTN-H product development and led to the proposal of additional demonstration projects that have been classified in each of the four general areas listed below:

1. **Products that improve our understanding of what is available and how to access it (e.g., metadata, maps)**

   Project 1.1 – Development of GTN-H Website
   Objective: To develop a public website to help GTN-H users to discover and access GTN-H data and information products, and to provide linkages to GTN-H partners.

   Project 1.2 – Inventory of Existing Data Products, Databases, and Organizations
   Objective: To compile a general inventory of existing data products and databases, data sources, organizations, and other information of relevance to the GTN-H and its users; to integrate this inventory into the GTN-H website.

Project 1.3 – Demonstration of Metadata

Objective: To propose standardized detailed metadata formats for selected GTN-H data types and demonstrate their use in enabling the user to discover and access data and related information (e.g., data quality).

2. Products that enhance baseline or core hydrological data and improve our knowledge of hydrology (e.g., gridded runoff datasets, mapped statistics)

Project 2.1 – Development of Gridded Runoff Dataset

Objective: To develop an on-line mapping application that presents gridded runoff resulting from water balance analysis.

Project 2.2 – Map Product on Real-time Hydrological Conditions

Objective: To develop a pilot web application that demonstrates the retrieval, integration and presentation of real-time hydrometric data for selected large rivers from several countries.

3. Products that result from the integration of existing datasets (e.g., biogeochemical fluxes)

Project 3.1 – Mapping of Biogeochemical Fluxes

Objective: To develop a pilot web mapping application that presents global characteristics of biogeochemical (BGC) fluxes for selected large rivers from several countries.

4. Products that are designed to address specific science questions (e.g., reference hydrological datasets for use in detecting climate change)

Project 4.1 – Reference Hydrologic Dataset

Objective: To prepare a feasibility report and recommended path forward to develop a global reference hydrometric dataset for use in detecting climate change.

Project 4.2 – GTN-H Networks

Objective: To initiate the setting of criteria for defining each of the GTN-H variables and networks.

Acknowledgements

Funding to offset this meeting was provided by the Hydrology and Water Resources Programme of WMO. The sponsoring agency for this meeting was the Atmospheric Monitoring and Water Survey Directorate of the Meteorological Service of Canada. The contributions of the following GTN-H participants are gratefully acknowledged: Andrew Fraser, Wolfgang Grabs, Thomas Maurer, Richard Lammers, Harry Lins and Alan Thomas.

1. Introduction

A 2-day meeting of the GTN-H Coordination Panel was held in Toronto on 21-22 November 2003, immediately following the Expert Meeting on Hydrological Data for Global Studies. A major objective of the Coordination Panel meeting was to discuss and implement the recommendations of the Expert Meeting, as appropriate, and to refine a set of projects to advance the development of the GTN-H.

The meetings in Toronto marked the third time since June 2000 that a group of experts had assembled to address the need for improved availability and access to global hydrological data, information and products to support a wide range of climatic and hydrological objectives.

The concept of a Global Terrestrial Network for Hydrology, or GTN-H, is the result of the joint efforts of WMO's Hydrology and Water Resources (HWR) Department, the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS). The concept is fully described in the report of the Expert Meeting in Geisenheim, Germany, in June 2000 on the Establishment of a Global Hydrological Observation Network for Climate (WMO/TD-No. 1047).

The GTN-H is a global hydrological "network of networks" for climate that is building on existing networks and data centres and producing value-added products through enhanced communications and shared development. The goal of the GTN-H is to meet the needs of the international science community for hydrological data and information to address global and regional climate, water resources and environmental issues, including improved climate and weather prediction; detection and quantification of climate change; assessment of impacts of climate change; assessment of freshwater sustainability; and understanding the global water cycle.

The GTN-H was established at a second Expert Meeting in Koblenz, Germany in June, 2001(WMO/TD-No. 1099). The major objective of that meeting was to define specific actions for the initial implementation of GTN-H. Figure 1 presents an initial configuration of the GTN-H.

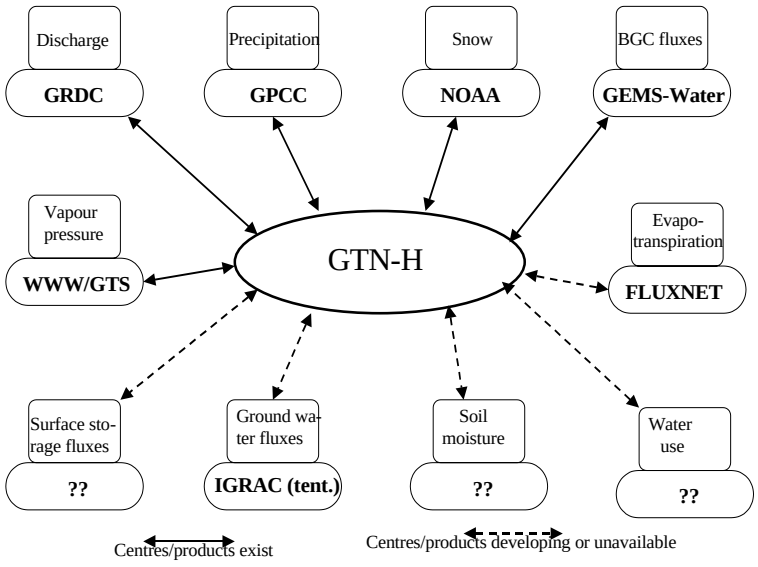
A GTN-H Coordination Group was formed around four key partners:

Global Runoff Data Centre;
Global Precipitation Climatology Centre;
Global Environmental Monitoring System – Water; and the
Complex Systems Research Centre, University of New Hampshire.

The core functions of the GTN-H are to address the following:

- Provision of timely access to global hydrological data to and metadata for users;
- Generation of relevant products and related documentation, satisfying timeliness and quality requirements of users;
- Promotion of standardization in observations and the use of 'best practices';
- Promotion and facilitation of free and unrestricted exchange of data and products within existing frameworks, e.g., WMO resolutions 40 (Cg-XII) and 25 (Cg-XIII);
- Soliciting of user feedback and measures to ensure responsiveness to changing needs;
- Monitoring and evaluation of GTN-H performance;
- Identification of key observational requirements of GTN-H, including requirements for satellite observations; and
- Provision for capacity-building.

Figure 1: Initial Configuration for GTN-H



Additional information is available in the report of the Expert Meeting in Koblenz, Germany, in June 2001 on the Implementation of a Global Terrestrial Network - Hydrology (GTN-H) (WMO/TD-No. 1099).

2. Objectives of GTN-H Coordination Panel Meeting

The objectives of this meeting were to review progress on implementing the GTN-H; to complete the Terms of Reference for the GTN-H Coordination Group; and to develop a work plan that will advance the GTN-H in the short-term consistent with the strategies recommended at the Expert Meetings in Toronto (18-20 November 2002) and in Koblenz (21-22 June 2001).

The agenda is presented as Appendix A.

3. Review of Membership and Organizations

The Coordination Panel reviewed the membership of the GTN-H Coordination Panel and clarified the roles of each member organization. In addition to the expertise that each member brings to the GTN-H Panel, each also brings a unique network of affiliations and linkages to other international organizations that could play a role in the development of the GTN-H. Table 1 summarizes these characteristics of the GTN-H Coordination Panel membership.

With respect to user representation, the GTN-H initiative has been capturing user perspectives through its Expert Meetings. The GTN-H will continue to interact with users working at both regional and global scale through *ad hoc* outreach to regional centres once GTN-H products have been developed, focussing on regions that seem ready to participate (e.g., South America); and through meetings of the IPCC and regional representatives to solicit input.

On the question of funding for the GTN-H, no base funding for the initiative is foreseen, and the initiative will continue to build on other existing initiatives and take advantage of opportunities to work with other global projects and programmes.

The following action items resulted from the discussions on representation and governance:

Action: Dave Harvey – Amendment of Figure 1 (Initial Configuration of GTN-H) to reflect the governance aspect (i.e., GCOS-GTOS-HWRP and AOPC-TOPC).

Action: Dave Harvey – Contact Richard Armstrong about NSIDC representation on the GTN-H Panel.

Action: Dave Harvey – Contact Ron Stewart or Rick Lawford to discuss adding someone with satellite expertise to the GTN-H Panel.

Action: Alan Thomas and Wolfgang Grabs to identify contacts in regional centres and IPCC.

Action: Andrew Fraser to discuss the GTN-H with UNEP RONA colleagues and report on their interest.

Action: Dave Harvey – Clarify and encourage WHYCOS involvement in GTN-H.

Action: Dave Harvey – Amendment of Figure 3 (Geisenheim Report):

1. Link to revised GTN-H management description (diagram);
2. Replace issues with GTN-H objectives; and
3. Identify real-time, historical, synoptic/discontinuous data types.

Table 1: GTN-H Coordination Panel			
GTN-H Role	**Organization**	**Name of Representative**	**Affiliations and/or Linkages**
Sponsor	WMO	Wolfgang Grabs	HWRP, GEWEX, IGOS, CHy, WCP-Water, WHYCOS, IAHS
Sponsor	UNESCO	Alan Thomas	GCOS, GOOS, CBS, CCL, TOPC, AOPC, OOPC, IGOS
Sponsor	GTOS	Jeff Tschirley	GTOS TOPC, FAO
Sponsor	GCOS	Mike Bonell	UNESCO, IHP, HELP, IAHS, WCP-Water, FRIEND
Member	GRDC	Thomas Maurer	WMO, TOPC, FRIEND, WCRP (GEWEX-CliC)
Member	GPCC	Bruno Rudolf	NESDIS, GPCP (GEWEX) AOPC
Member	GWPO	Andrew Fraser	UNEP, WHO, GIWA, GEO, GPA
Member	UNH	Balazs Fekete Richard Lammers	IAHS, WWAP, UNESCO, IGBP, IAEA
Member	NSIDC	To be determined	(GEWEX-CliC)
Technical / Scientific	USGS	Harry Lins	WCP-Water, Joint Water Project (JWP), IPCC, Dialogue on Water and Climate (DWC)
Technical / Scientific	MSC	Dave Harvey	WMO RA-IV, HOMS
Technical / Scientific	WCRP	Rick Lawford	GEWEX, IGOS
Technical / Scientific	GEWEX	To be determined	GEWEX
Users (*ad hoc*)	Regional Centres	To be determined	
Users (*ad hoc*)	IPCC	To be determined	

4. Review of Terms of Reference

The Panel did not have time to discuss the Draft Terms of Reference (see Appendix D) during the meeting. Panel members were asked to review and submit comments to Dave Harvey prior to the next meeting.

5. Review of Progress

The Coordination Panel reviewed action items and recommendations that had arisen from the June, 2001 GTN-H meeting in Koblenz. Annex 9 of the Koblenz report summarizes these items, and is re-presented below, with annotations.

Actions/Recommendations

Establish a Web page for GTN-H

- Partners to comment on contents of Web page
- MSC to host the server during development
- Initial page for partner review

This action has not been completed; it is to be done as soon as possible.

For each product (initially 5), appropriate partner will prepare a short write-up in a common format (copy available)

- Gridded discharge/runoff field
- Map product on data availability
- Map product on hydrological conditions
- Tools
- BGC Fluxes
- Snow - National Snow and Ice Data Center (NSIDC)

This action has not been completed; it is to be done as soon as possible. Note that work has been initiated in most of these areas (refer to section 7 of this report).

Obtain endorsement of GTN-H by sponsoring agencies and other appropriate entities

Some progress to date, including presentations to the SBSTA and Executive Council; further action is awaiting the development of GTN-H website and products.

Complete membership of the Coordination Group, including furthering the ownership of GTN-H, e.g., NSIDC, IAEA, Kassel

Good progress – see Table 1 of this report.

Ensure documentation of QC procedures. Data QC will be governed by procedures of existing Data Centres

This action has not been completed; it is to be done as soon as possible.

Contact CEOP concerning interest of GTN-H in data from CEOP
A presentation on the GTN-H was made to the GEWEX Steering Committee by Alan Thomas.

Develop an initial communication strategy
This action has not been completed; it is to be done as soon as possible.

Contact WHYCOS re: involvement in GTN-H
WHYCOS has been informed and is waiting for additional information.

Prepare a short summary of GTN-H for report to UNFCCC
Completed by Alan Thomas.

Revisit the data functions chart (Fig. 3 in Geisenheim Report)
This action has not been completed; it is to be done as soon as possible.

Complete a mission/vision statement, Terms of Reference, and framework for implementation by the Coordination Group
This work is in progress. Draft Terms of Reference are presented in Appendix D. The initial framework for implementing the GTN-H is presented in Chapter 7 of this report.

6. Review of Observations and Recommendations of WMO Expert Meeting on Hydrological Data for Global Studies (November, 2002, Toronto)

The Coordination Panel reviewed each of the rapporteur's reports from the WMO Expert Meeting on Hydrological Data for Global Studies, held in Toronto on 18-20 November 2002. Where appropriate, the Panel formulated a response or action to ensure that the observations and recommendations of the experts are integrated into the development of the GTN-H.

6.1 Review of Theme I: Requirements and adequacy of "Current Systems"

Reference to result I: A strategic approach has been outlined to identify and monitor observational requirements.

Reference to result II: (in part) State-of-the-art challenges and opportunities in hydrological observations, data management and access to data and information have been documented.

1. Key problems cited were *inter alia*:

a) Adequacy of networks;
b) Access to data and information;
c) Harmonization including policies, quality control, data formats, coding and transmission;

d) Data integration including both multiple platform observations as well as data from different networks; and
e) Generation of research and applications-oriented products.

2. It was observed that most of the information generated from global observation networks is used by developed countries and hardly by research and user communities in the developing world. Sharing information across regions becomes valuable especially for smaller countries to complement their spatially and/or technologically restricted national observation networks. This is especially important for hydrometeorological variables and hydrological data and information from shared river basins used for forecasting purposes.

RESPONSE: The GTN-H must foster the sharing of information across regions. As part of its communication strategy, the Coordination Panel will extend invitations to regional representatives, on an ad hoc basis, to solicit input and otherwise promote awareness of the GTN-H as it is developed.

3. Research requirements for data and information cover a wide range such as climate change, water resources variability and availability, extreme events and "vulnerable areas" (the latter including the notion of risk and adaptation capacity by the concerned population).

RESPONSE: The GTN-H is aware of and will link to research centres and organizations (e.g., Centre for Research on the Epidemiology of Disasters (CRED), Dartmouth Flood Observatory, IPCC) and ensure their requirements are considered.

4. The heterogeneity of research fields makes it difficult to prioritize requirements for data and information in terms of variables to be included as well as the required resolution in time and space.

5. As a consequence, network requirements also vary largely depending on requirements from the research and application communities.

6. It is therefore desirable to conceptualize a flexible network architecture that allows the definition of networks as subsets of a larger composite network.

RESPONSE: The challenges to meet a broad range of needs are recognized. To address this, the GTN-H must define core reference networks.

7. The GTN-H should comprise minimum operational baseline networks of routine observations (ground- and satellite-based) augmented by research networks.

RESPONSE: This concept has been discussed and is key to implementing the GTN-H.

8. GTN-H should promote the harmonization, standardization of global datasets.

RESPONSE: Yes, this is a goal of the GTN-H. The standardization of metadata should also be promoted.

9. From a pragmatic viewpoint, the network design for a global observing system should start up with variables which combine the following criteria (non-exclusive):

a) Already routinely observed by national agencies or global research programmes;
b) Adequate lengths of record;
c) Adequate geographical coverage;
d) Adequate parameters;
e) High quality of data with comparable observation methods → compatible datasets; and
f) Long-term commitment for continued observations.

10. With regard to c) above, methods of observation need to be standardized in accordance with WMO's standard observational procedures (e.g., WMO Guide to Meteorological Instruments and Methods of Observation; and WMO Guide to Hydrological Practices).

RESPONSE: This should be promoted through GTN-H activities (e.g., demonstration projects).

11. To obtain a global picture of the availability and accessibility of selected variables, data providers (here primarily global data centres, global research programmes, global observing systems) should compile a comprehensive geo-referenced meta-database that includes descriptions of the observations in accordance with an agreed criteria for selected metadata.

RESPONSE: The GTN-H will demonstrate the use of standardized metadata formats with selected GTN-H data types to enable users to discover and access data and related information (e.g., data quality).

12. The compilation of a meta-database necessitates the standardization of metadata information to allow comparability and to maintain homogeneity and consistency of a comprehensive meta-database for a global observing system.

13. In its pragmatic implementation, a global observation network should start from a "minimum requirement" approach with regard to the number and complexity of observed variables (or derivatives such as fluxes of evaporation or soil moisture) and minimum temporal and spatial resolution: as an example, daily data on a 2.5 degree global grid or over a river basin.

RESPONSE: This is the approach being taken to implement the GTN-H.

14. This approach allows a multiple layer compilation of a virtual integrated meta-database for each grid-cell or river basin on a global basis. Likewise, this approach allows for the identification of observation gaps with respect to each

variable in each grid-cell and for an assessment of the “adequacy” (based on minimum requirement standards) of all information available in each grid-cell both historically as well as on a continued basis.

RESPONSE: This is a very desirable goal for the GTN-H.

15. For climate-sensitive hydrological observations, and discharge information in particular, a hydrological reference network needs to be defined that reflects a minimum of human influence on and/or stable conditions of the hydrological regime in the concerned basin. A scoping exercise is proposed prior to undertaking this as a major project.

RESPONSE: Such reference networks are being studied as potential GTN-H products.

16. As a principle, global observing systems need to be designed to meet a practical set of priorities and requirements.

17. It needs to be understood that basic data for a global observing system are largely based on observations that are funded through national agencies. This is largely valid for terrestrial observations and for many satellite-based observations even though the latter are carried out increasingly in the framework of multinational agreements. (Question: Is it “thinkable” that selected terrestrial observations in the context of global observing systems could likewise be carried out on the basis of multinational agreements? Examples are HYCOS projects.)

RESPONSE: This relates to the principles of ownership. The GTN-H will identify this as an issue to be addressed elsewhere.

18. Given the resource inputs into global observing systems by national agencies, product development and other derived services need to be responsive to national requirements to encourage continued national participation and funding of observation programmes. A close feed-back loop needs to be established between national data providers and the users of the global observing system.

RESPONSE: This is a significant challenge. The GTN-H needs to ensure that such feedback is given to the data providers, including satellite data providers.

19. In the case of developing countries this (item 18) means also an enhancement of country participation in global projects.

RESPONSE: The GTN-H will endeavour to promote greater participation of developing countries in regional projects and regional and global data centres.

6.2 Review of Theme II: Approaches and Tools for Data Collection, Management and Access

6.2.1 Discussion of Regional Issues

Actions are typically undertaken at national level: there is a need for implementing systems and actions at regional levels.

Rationale: Small countries need to supplement information needs from regional sources (neighbouring countries).

Regional projects need to be driven by region-specific requirements and therefore region-specific needs for data and information.

Question: In each region, is there a regional infrastructure (regional centre, river basin organization etc) to do the business?

Reminder: Thinking in regional and global context: River basins need to be considered as the appropriate geographical unit to implement planning and implementation of activities.

Major problems:

Poor status of networks and support infrastructure, especially in Africa;
Support infrastructure is often lacking;
Both political and technical challenges differ from region to region; and
Data quality problems.

Strategy:

Interact with programmes such as IGOS – Water, WHYCOS and bilateral projects;
Start-up from data-rich regions;
Engage regional data centres;
Involve more countries and regions in global projects;
Promote regional monitoring approaches (such as WHYCOS, but also as spin-off from global projects);
Improve communications facilities and communications culture; and
Prepare common inventories (such R-HydroNet).

RESPONSE: This validates the general approach taken to the initial development of the GTN-H.

6.2.2 Discussion of Generic Data Issues

1. Problems have been identified as follows:

   (a) Inadequate monitoring (spatially and temporally);
   (b) Gaps in observations;
   (c) General decline of number of stations;
   (d) Chronic under-funding; and
   (e) Differences in processing and quality control.

   It was noted that such problems are common to both developing and so-called "developed" countries.

2. Various levels of data policies: both political and technical challenges to setting policy.

3. Global versus regional networks: the challenge for a network to meet a wide range of needs.

4. Various levels of quality control (QC):

   Researchers are reluctant to carry out quality control as they consider it is not their domain.
   QC and archiving must be included in research proposals.

5. Data management issues and opportunities:

   (a) Setting GTN-H priorities;
   (b) Coordination of data sources (e.g., satellite, data flow);
   (c) Encourage cooperation among data providers (e.g., network inventories);
   (d) Transition from research to operational data collection;
   (e) Standardization of monitoring and formats;
   (f) Data and product access - redistribution restrictions;
   (g) Reduce duplication of effort;
   (h) Human dimensions feedback (e.g., socio-economic);
   (i) Use of higher resolution data (spatial/temporal);
   (j) Data archaeology and data rescue;
   (k) Simplify data/metadata collection procedures;
   (l) Encourage regional initiatives for data standards and exchange; and
   (m) Pilot projects as a tool for developing measurements capabilities

RESPONSE: All of these issues are duly noted. Many have been discussed in previous GTN-H reports.

6. No international commission exists for developing metadata standards for environmental data, especially in terrestrial domain for geophysical data. Recommendations should be made to WCRP, IGOS, satellite agencies, etc.

RESPONSE: The GTN-H will demonstrate the use of standardized metadata formats with selected GTN-H data types to enable users to discover and access data and related information (e.g., data quality).

7. Standards.
   ”The nice thing about standards is that there are so many to choose from“.
   Formats will probably not be unified.
   “Community data portal” role of GTN-H will require standards-based metadata production by all data providers.
   Separate data archiving and QA/QC but do it in a coordinated fashion.

8. What kind of data (quality) is allowed to come into GTN-H?

RESPONSE: The GTN-H will develop a framework for a high-level Quality Management System (QMS), covering both terrestrial and satellite-based data.

9. Keep data management processes to lowest possible technical level – to maximize interoperability and data exchange.

10. Adopt pragmatic approaches to data management – to minimize problems.

11. Good metadata is a prerequisite for data quality assessment, and for developing an inventory of existing data sources.

RESPONSE: The GTN-H will demonstrate the use of standardized metadata to assist with building an inventory of existing data sources, that would include information on data quality.

12. Near real-time data collection: impacts on data quality because of challenges to undertaking QA/QC procedures in near real-time.

13. GTS transmission system, CREX-coding, free-of-charge.
    Today: multi-platform.
    Transmission protocol: to be clear and simple.
    Overview of common standards.
    RTH Regional Communication Hub.

RESPONSE: The GTN-H will advocate the use of GTS wherever possible for data transmission, otherwise alternatives such as the Internet.

6.3 Review of Theme III: Development of Global-Scale Data Products

1. GTN-H needs to ensure the availability of metadata to provide the user with an understanding of the data and essential attributes, otherwise all data could erroneously be treated as equal.

RESPONSE: The GTN-H will demonstrate the use of standardized metadata formats with selected GTN-H data types to enable users to discover and access data and related information (e.g., data quality).

2. GTN-H needs to include additional cryospheric variables, not just snow water equivalent. Snow products (e.g., snow cover) have improved immensely. Relationship between GTN-H and CliC needs to be further explored.

RESPONSE: The GTN-H will do so.

3. Web-based cryospheric products are being developed such as graphs for minima and maxima and maps depicting “departures from normal values”, as requested by users.

4. A process was presented for identifying/developing reference hydrological data sets that can be used to address specific climate objectives (e.g., climate change detection, impacts, prediction, etc). Canadian and American examples were discussed.

5. Two ways of looking at the climate change question: river basin approach and flux approach. Two recommendations for reference networks were put forth: pristine/stable basin network and the “flow-to-oceans” network concepts.

RESPONSE: Such reference networks are being studied as potential GTN-H products.

6. Such specialized networks could also be useful in planning new or expanded observing networks in data-scarce regions.

7. Integration of the data from reference networks (e.g., precipitation and streamflow) can lead to additional value-added products (e.g., trend analyses to understand cause and effect).

RESPONSE: It may be more appropriate for other organizations, such as WCP-Water, to develop such products.

8. An initial set of data products has been proposed by the GTN-H Coordination Group (reference: the Koblenz Rport of June 2001) that represents a first attempt at developing products using available core "baseline" datasets. These include:

    - Gridded discharge/runoff field (University of New Hampshire has developed a first version);
    - Map product on data availability;
    - Map product on hydrological conditions, anomalies; and
    - Biogeochemical fluxes based on assessment of water quality data (GEMS-Water) and streamflow data (GRDC).

9. It was suggested that a global database on hydrological extremes, both floods and droughts, is needed in support of the climate work. Apparently, this has been done to a certain extent by the Dartmouth Institute. The Centre for Research on the Epidemiology of Disasters (CRED) and The Global Disaster Information Network (GDIN) identify disasters in their databases.

RESPONSE: The GTN-H will establish links to these centres.

10. The initial 10 GTN-H hydrological variables include fluxes in the Koblenz Report. Caution was urged over the approaches to deriving these fluxes: In many cases, this is a fairly complex undertaking, requiring additional datasets not identified by the GTN-H. The GTN-H needs to work with the appropriate scientists and coordinate. Other parameters needed to determine flux values to be added to the list. The FLUXNet initiative is trying to standardize approaches. Primarily, fluxes to oceans are being computed.

RESPONSE: The GTN-H will proceed cautiously and in coordination with experts.

11. The initial GTN-H list does not include the development of specialized or "reference" networks as products – this needs to be discussed further.

RESPONSE: Such reference networks are being studied as potential GTN-H products.

12. It was noted that certain variables essential to hydrology (e.g., temperature, snow cover) are not part of the GTN-H. These may be addressed under other GCOS or GTOS initiatives.

RESPONSE: The GTN-H will establish links to appropriate sources.

13. There was a (repeated) suggestion for the GTN-H to undertake an inventory of available global datasets and related products as an initial step.

RESPONSE: The GTN-H will undertake an inventory as an initial GTN-H product.

14. NOAA/NCDC has much experience and offers many insights into data management, assimilation and global product generation, and should be studied further (e.g., 10 principles, statistics, maps).

RESPONSE: The GTN-H will endeavour to profit from NOAA/NCDC expertise and experience.

15. NCDC is a major player in developing proposed map-based North American drought index.

RESPONSE: OTHER PLAYERS INCLUDE NOAA, USGS, USDA, Environment Canada and the Mexican government.

16. GEWEX experiences have resulted in a good understanding of needs for hydrological data to answer many climate questions.

17. GEWEX has experience in producing several global datasets, such as soil wetness, radiation, precipitation, and aerosols, going back to the early 1980s.

18. GEWEX and CliC have good ideas about data needed to validate climate models, including streamflow, soil moisture, albedo, and snow water equivalent.

RESPONSE: It is proposed that the GTN-H Coordination Panel include a representative from CliC.

19. Challenges to the GTN-H: What are the best variables for detecting climate change? How do we integrate models and data to produce the best quality products?

RESPONSE: The GTN-H approach is to identify and solicit advice from expert organizations that address such issues.

7. Work Planning Session: Development of Global-Scale Data Products

Previous Expert Meetings had identified a number of products that should be undertaken as part of the GTN-H development. The Expert Meeting held in Toronto (November, 2002) served to reinforce the earlier recommendations and further classified the types of data products desired. The Coordination Panel proceeded to discuss and plan specific demonstration projects leading to the development of products in each of the four general areas listed below. Most of these projects are more fully described in the following pages.

1. **Products that improve our understanding of what is available and how to access it (e.g., metadata, maps)**

   Project 1.1 Development of GTN-H website.
   Project 1.2 Inventory of existing data products, databases, and organizations.
   Project 1.3 Demonstration of metadata.

2. **Products that enhance baseline or core hydrological data and improve our knowledge of hydrology (e.g., gridded runoff datasets, mapped statistics)**

   Project 2.1 Development of gridded runoff datasets.
   Project 2.2 Map product on real-time hydrological conditions.

3. **Products that result from the integration of existing datasets (e.g., biogeochemical fluxes)**

   Project 3.1 Mapping of biogeochemical fluxes.

4. **Products that are designed to address specific science questions (e.g., reference hydrological datasets for use in detecting climate change)**

   Project 4.1 Reference hydrologic dataset.
   The GTN-H has requested that WCP-Water (lead: Harry Lins) prepare a feasibility report and recommended path forward, by February 28, 2003.

   Project 4.2 GTN-H Networks.
   Alan Thomas and Wolfgang Grabs to initiate the setting of criteria for each of the GTN-H variables/networks and to complete a project definition for this effort.

Project 1.1 – Development of GTN-H Website

Objective:
To develop a public website to help GTN-H users to discover and access GTN-H data and information products, and to provide linkages to GTN-H partners.

Output/deliverable:
Version 1 of GTN-H Home Page, with minimal content and links, but ready for expected products.

Methodology:
A simple GTN-H website will be created based on recent GRDC and GWPO models.

Schedule:
Layout of home page distributed to GTN-H Coordinating Group,
by January 2003 (Dave Harvey).

Launch of GTN-H website by February 2003 (Dave Harvey).

Resources required:
Web developer (2 weeks).

Project lead:
Dave Harvey.

Project participants:
All GTN-H Coordinating Group members.

Product(s) to be maintained by:
Environment Canada.

Notes / Issues:
Confirmation is required that website can be hosted by Environment Canada or by University of New Hampshire.

Project 1.2 – Inventory of Existing Data Products, Databases, and Organizations

Objective:
To compile a general inventory of existing data products and databases, data sources, organizations, and other information of relevance to the GTN-H and its users.

To integrate this inventory into the GTN-H website.

Output/deliverable:
"Discovery-level" meta-database (Dublin Core format) that describes GTN-H products, databases, and organizations, and provides links (e.g., URL).

Both text and geo-referenced map web interfaces to the inventory.

Clickable graphic of GTN-H diagram (Figure 1 of this report) added to the website, linking to responsible organizations.

Methodology:
All members identify products, databases, organizations in their areas of expertise and create metadata records and forward to Dave Harvey who will integrate; design text and map-based web interfaces to metadata; integrate with GTN-H site.

Sources/references:
Handbook of international Organizations
GIS map layers provided by GRID
Open-Source "MapServer" (U of Minnesota)
MySQL database (Bob Duffield).

Schedule:
Layout of inventory presentation by 31 January 2003 – produce as web pages, consistent with GTN-H home page (Dave Harvey).

Metadata template (Dublin Core) by 31January 2003 (Dave Harvey).

Identify organizations and data sources, URLs, descriptions of organizations, submit to Dave Harvey by 31January 2003 (All).

Create metadata by 31January 2003 (Dave Harvey).

Develop text interface to inventory by April 2003.

Develop map interface by August 2003 (Dave Harvey).

Resources required:
Web developer with on-line GIS expertise (2-3 months**).**

Project lead:
Dave Harvey.

Project participants:
All GTN-H Coordinating Group members, Bob Duffield (Environment Canada).

Product(s) to be maintained by: Environment Canada.

Project 1.3 – Demonstration of Metadata

Objective:
To propose standardized detailed metadata formats for selected GTN-H data types and demonstrate their use in enabling the user to discover and access data and related information (e.g., data quality).

Output/deliverable:
Mapping application that presents the user with a selected number of points representing a range of hydrological variables; for each point, the metadata record can be displayed, including a link to the website of the data provider.

Methodology:
Using the process proposed by Thomas Maurer and the FGDC standard metadata format, propose a standardized metadata format for selected data types:

Hydrometric:Thomas Maurer
Water quality: Andrew Fraser
GSN – Asheville: Jeff Arnfield
Precipitation – GPCC: Bruno Rudolf
Gridded dataset: Richard Lammers, UNH + GPCC products
A satellite-derived snow product: Barry Goodison.

Choose a few stations or products to demonstrate. Develop the demonstration mapping application using the mapping interface developed for the inventory in Project 1.2.

Schedule:
Metadata formats ready by May 2003 (Thomas Maurer)
Mapping application by August 2003 (Dave Harvey).

Resources required:
Web developer with on-line GIS expertise (1 month).

Project lead:
Thomas Maurer.

Project participants:
All GTN-H Coordinating Group members, Steve Williams, Barry Goodison, Phil Jones.

Product(s) to be maintained by: Environment Canada.

Project 2.1 – Development of Gridded Runoff Datasets

Objective:
To develop an on-line mapping application that presents gridded runoff resulting from water balance analysis.

Output/deliverable:
Monthly total runoff.

Methodology:
Not applicable.

Schedule:
Initial product ready for website by February 2003 (to coincide with launch of website).

Resources required:
Not applicable.

Project lead:
Richard Lammers or Balazs Fekete.

Project participants:
Thomas Maurer.

Product(s) to be maintained by:
University of New Hampshire.

Notes / Issues:
Suggest adding a new animation map that shows on the grid when the resultant is from “observed” or “estimated”.

Project 2.2 – Map Product on Real-time Hydrological Conditions

Objective:
To develop a pilot web application that demonstrates the retrieval, integration and presentation of real-time hydrometric data for selected large rivers from several countries.

Output/deliverable:
Web-mapping application.

Methodology:

Develop a “flow-to-oceans” list of hydrometric stations (Thomas Maurer, Richard Lammers, Andy Fraser, Harry Lins).

Choose stations from list of 50 largest rivers (reference J. of Hydrometeorology paper) from countries that already are making R-T data available in real-time.

Schedule:

Resources required:

Project lead:
Thomas Maurer.

Project participants:
All GTN-H Coordinating Group members.

Product(s) to be maintained by:
GRDC.

Notes/Issues:
Once the first version of the application is ready, letter can be sent to NHMS to request participation of those countries who do not currently provide data in R-T.

Programme linkage: BGC flux project (GEMS-Water).

Project 3.1 – Mapping of Biogeochemical Fluxes

Objective:
To develop a pilot web-mapping application that presents global characteristics of biogeochemical (BGC) fluxes for selected large rivers from several countries.

Output/deliverable:
On-line mapping application.

Methodology:
Selected rivers – watershed-based maybe 20-25 rivers
(Based on historical data).

Unbiased estimator technique to link WQ parameters with discharge provided by GRDC.

Schedule:
Fall 2003.

Resources required:
GWPO putting $10 K towards project.

Project lead:
Andrew Fraser.

Project participants:
Thomas Maurer, Dave Harvey.

Product(s) to be maintained by:
Environment Canada.

Notes/Issues:
Work to date includes: comparing GRDC and GEMS/Water metadata and data, reconciling differences, work on structured routine for linking metadata has been completed; progress on deriving flux information; increasing data holdings; tasks necessary to the application development.

Programme linkage: R-T Hydrological Conditions project (2.2 above).

8. Next Meeting

The next meeting is proposed for mid-January, 2004, in Geneva.

9. References

1. Establishment of a Global Hydrological Observation Network for Climate. Report of the GCOS/GTOS/HWRP Expert Meeting, Geisenheim, Germany, June 26-30, 2000 (GCOS-63) (GTOS-26) (WMO/TD-No. 1047).

2. 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-71) (GTOS-29) (WMO/TD-No. 1099).

These and other GCOS publications may be accessed through the GCOS World Wide Web site at: http://www.wmo.ch/web/gcos/gcoshome.html

10. Expert Meeting Presentations

The presentations made at the Expert Meeting on Hydrological Data for Global Studies are available for viewing on the CD accompanying the report.

Alternatively, these presentations may be accessed via the following website: http://www.msc.ec.gc.ca/wsc/gtnh

11. APPENDICES

Appendix A – Agenda
Appendix B – List of Participants
Appendix C – GRDC Project Plan
Appendix D – GTN-H Coordinating Panel – Draft Terms of Reference.

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APPENDIX A

GLOBAL TERRESTRIAL NETWORK – HYDROLOGY

Meeting of the Coordination Group

21-22 November 2002

Meteorological Service of Canada
1st floor boardroom
4905 Dufferin Street
Toronto

Agenda

The objectives of this meeting are: to review progress on implementing the GTN-H; to complete the Terms of Reference for the GTN-H Coordination Group; and to develop a work plan that will advance the GTN-H in the short-term consistent with the strategies recommended at the Expert Meetings in Toronto (November 18-20, 2002) and in Koblenz (June 21-22, 2001)

Thursday, November 21, 2002

08:30 Opening of the meeting (Dave Harvey)

08:35 Adoption of Agenda

08:45 Review of membership of GTN-H Coordination Group
(*reference: Annex 8 of GTN-H report, Koblenz, June 2001)*

09:00 Review progress on recommendations developed at GTN-H meeting in Koblenz (June 2001)
(*reference: Annex 9 of GTN-H report, Koblenz, June 2001)*

10:00 Coffee break

10:15 Discussion: Impact on the GTN-H of the Expert Meeting on Hydrological Data for Global Studies

11:00 Review of draft Terms of Reference of GTN-H Coordination Group
(to be distributed by November 14)

12:00 Lunch

13:15 Framework for Workplanning (Dave Harvey)

13:30 Planning 1: User Requirements and Adequacy of GTN-H **
To ensure that the GTN-H is evolving to meet user and stakeholder needs – an on-going process.

*** With references to progress to date and to recommendations of Expert Meetings, what are the tasks and projects to be undertaken by the GTN-H Coordination Group in the coming year? Each task/project to be sufficiently defined as to deliverables, general methodology, group member responsible, group members involved, other organizations involved, estimated resource requirements, milestone and completion dates, priority and assessment of risk.*

14:45 Coffee

15:00 Planning 2: Approaches and Tools for Data Collection, Management and Access **
To ensure that the GTN-H is efficiently developed using appropriate technology and standards, best practices and available infrastructure

17:00 Adjourn

Friday, November 22, 2002

08:30 Brief summary of planning sessions 1 and 2

08:45 Planning 3: Development of global-scale data products **
To foster the development and maintenance of credible and essential global-scale GTN-H data products

10:00 Coffee break

10:15 Planning 3: (continued)

10:45 Planning 4: Stakeholder collaboration **
To ensure the support and participation of all stakeholders.

11:45 Coordination of Activities

11:55 Next Meeting

12:00 End of Meeting

APPENDIX B

GLOBAL TERRESTRIAL NETWORK – HYDROLOGY

Meeting of the Coordination Group

21-22 November 2002

List of Participants

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APPENDIX C

GRDC Project Plan

Title:

Creation of an internet-based Near Real Time (NRT) Monitor tool for discharge data (GRDC NRT-Monitor)
A contribution to the Global Terrestrial Network for Hydrology (GTN-H).

Background:
GTN-H is a recently started initiative of WMO and G3OS. The goal is to present world-wide near real time (NRT) data of 10 hydrological variables. (See also: (1) Workshop in Geisenheim, 26-30 June 2000: "Global Hydrological Observation Network for Climate", report available at http://www.wmo.ch/web/homs/geisenheim.pdf and (2) Expert Meeting in Koblenz, 21-22 June 2001: "Implementation of a Global Terrestrial Network for Hydrology (GTN-H)", report available at http://www.wmo.ch/web/gcos/Publications/gcos-71.pdf).

Summary description:
One of GRDC's contributions to GTN-H will be the establishment of a world-wide NRT-monitor for runoff, similar to the USGS Water Watch (http://water.usgs.gov/waterwatch), that displays the occurrence probability of the currently measured NRT-discharge values based on the long term characteristics.

Benefits:
- Easier, unified access to information on NRT discharge data
- Set a good example by providing a visible platform for international exchange of hydrological data.

Previous achievements (to be used in this project):
- A prototype of an NRT-Monitor has already been developed by GRDC in the framework of the European Flood Forecasting System (EFFS).
- An Internet Map Server (IMS) is available at the BfG and will be made available to implement the planned mapping facility.
- An overview table of existing NRT Data providers exists.

Tasks/ responsibilities/ time lines:

#	Task	name(s)	time (man-month)	end (month)
A	**COMMUNICATION**			
A1	**Project coordination**	Lüllwitz		
A2	**Networking with data providers**	Lüllwitz		
A21	*General agreement*			
A22	*Data exchange (formats, frequency etc.)*			
A3	**Networking with GTN-H project partners**	Lüllwitz		
B	**SOFTWARE DEVELOPMENT**			
B1	**Data collector**			
B11	*Generalisation of EFFS prototype for unlimited number of import channels* - configurable communication FTP-sites - configurable format filter options - automated detection of new stations (consideration of a metadata file) - improvement of robustness against false inputs	Hils		
B12	*Interface provider-collector* - GRDC format, import/export filters in various programming languages will be provided on the GRDC homepage - some additional import filters (collection of subroutines)	Hils		
B2	**Data monitor** (based on BfG-resource IMS of AutoDesk)			
B21	*Set up of a global map in the AutoDesk authoring environm.* - Zoom dependent resolution: continents, countries, rivers, lakes, catchment boundaries, cities	Dornblut		
B22	*Implementation in AutoDesk IMS* - Present in a IMS window at some URL - coordination meeting	Busskamp/ Loy		
B23	*Embedding of monitor in GRDC webpages* - coordination with departments Z2 + C	Lüllwitz/Pauler		
B24	*Interface collector-monitor* - automated production of an ESRI Shape-file (readable by AutoDesk IMS) from the current collector data set	Hils		
B25	*Develop criteria what exactly to display* (plain values, warning values, percentiles of long term mean etc.)	all		
C	**OPERATION**			
C1	**Maintenance** (requires a separate computer, running 7 x 24h)	Hils		
C2	**Backup of data**	Pauler		

GTN-H Coordinating Panel - Draft Terms of Reference

The purpose of the GTN-H Coordinating Group is to carry out the work necessary to establish and foster the development of the GTN-H observing system.

The GTN-H can be defined as a global hydrological network for climate that builds on existing networks and data centres, producing value-added products through enhanced communications and shared development.

The Terrestrial Observation Panel for Climate (TOPC), sponsored by GCOS and GTOS, proposed the concept and scope of the GTN-H at a meeting in Geisenheim, Germany in June, 2000. The report of this meeting (WMO/TD-No. 1047) is available on the WMO website.

The GTN-H Coordinating Group is accountable to TOPC.

The main responsibilities of the GTN-H Coordinating Group include:

1. The definition of the GTN-H system and its components. This will need to be refined as the system evolves.

2. The routine assessment and documentation of user requirements for GTN-H global and regional data products, and of the availability and adequacy of GTN-H products to meet these needs.

3. The use and sharing of current and emerging technology and standards, best practices and available infrastructure to foster the development of the GTN-H.

4. Participation in the development and maintenance of global-scale data products.

5. Engagement of other partners and use of existing institutional arrangements, infrastructure and policies to help build the GTN-H.

6. The use of communication and outreach methods to maximize support and collaboration for the GTN-H.

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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 World Wide Web site at:
http://www.wmo.ch/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 CCl/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 publications may be accessed through the GCOS World Wide Web site at:
http://www.wmo.ch/web/gcos/gcoshome.html

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 CCl/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) (GOOS-33)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC) Ocean Climate Time-Series Workshop, (Baltimore, 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, 7th 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 6th 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 publications may be accessed through the GCOS World Wide Web site at:
http://www.wmo.ch/web/gcos/gcoshome.html

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-95)	Report of the 7th 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

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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)	The Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC
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

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