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Global Terrestrial Network – Hydrology (GTN-H)

Report of the 3rd GTN-H Coordination Panel Meeting

Koblenz, Germany, 17-19 September 2007

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Executive Summary

Germany hosted the 3rd Coordination Panel Meeting of the GTN-H (Global Terrestrial Network - Hydrology) from 17 to19 September 2007 at the Federal Institute of Hydrology in Koblenz. The main objectives were to review key GTN-H projects that were defined at the first and reviewed at the second session of the Panel in November 2002 and July 2005 (WMO/TD-No. 1155; GCOS-83, GTOS-33, and WMO/TD-No. 1298; GCOS-101, GTOS-37) and to identify additional networks, products and plans relevant to global aspects of hydrology. Furthermore, the meeting discussed new projects within the GTN-H framework, and agreed on measures to improve public visibility of the GTN-H in the international context, especially within the WMO CHy, GCOS and GEOSS communities.

This report provides a record of the meeting as well as information on all activities within GTN-H in an incremental fashion, using the report from the 2nd meeting as a reference [1]. Therefore, no full account of all activities is given here.

The GTN-H consists of a "network of networks" to support the need for global hydrological datasets and (sometimes blended) products for a range of applications in the climate and water domains. GTN-H builds on existing research and operational activities, networks and data centres, and, through its projects, promotes the generation of value-added products through shared development among network partners.

Participants at this meeting learned of the progress made over the past two years by their colleagues, especially with respect to eight demonstration projects aimed at developing basic products unique to the GTN-H. They learned of the roles and contributions of the original GTN-H sponsors, namely, the Hydrology and Water Resources Programme of WMO, GCOS and GTOS, and the relationships between the GTN-H, the Integrated Global Water Cycle Observations Theme (IGWCO), and the Global Earth Observation System of Systems (GEOSS).

In the course of the session, existing and new networks and sources of data were confirmed as well as added to the GTN-H inventory of networks, data products and organizations: networks related to water use, evapotranspiration, lake area and storage, soil moisture, water vapour, isotopes, precipitation, snow and ice, river discharge, water quality and groundwater.

Finally, based on its discussions, the meeting revised the existing action items and agreed on a new list of actions, which are contained in section 6 and 8 of this report.

Acknowledgements

The GTN-H Coordination Panel is most grateful to the German Federal Institute of Hydrology (BfG) for hosting this meeting in Koblenz. Funding for this meeting was also provided by the Hydrology and Water Resources Programme of WMO and the GCOS Secretariat.

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1. Introduction

The Global Terrestrial Network for Hydrology (GTN-H) Coordination Panel met on 17-19 September 2007 at Federal Institute of Hydrology in Koblenz, Germany, to review progress in eight demonstration projects for global hydrological datasets and products, as well as to discuss the future of GTN-H in the international framework.

The concept of a GTN-H is the result of the joint efforts of the WMO 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; GCOS-63; GTOS-26). The second meeting of the GTN-H Coordination Panel in July 2005 reviewed progress and discussed next steps in the shared development of global hydrological datasets and products among all network partners and institutions, in particular in relation to emerging technology, e.g. for the measurement of soil moisture, and in connection with the Global Earth Observation System of Systems (GEOSS) (WMO/TD-No. 1298; GCOS-101; GTOS-37).

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. Figure 1 shows composition of the GTN-H in terms of geophysical variables, network partner institutions and data centres.

Objectives of the 2007 GTN-H Coordination Panel Meeting

The objectives of this meeting were to review key GTN-H projects that were reviewed at the second session of the Panel in July 2005 (WMO/TD-No. 1298; GCOS-101; GTOS-37), as well as the identification of additional networks, products and plans relevant to global aspects of hydrology. The meeting was intended to revitalise joint activities between GTN-H partners (see List of Participants in Annex II) along the lines of defined GTN-H projects.

In addition, the session was expected to provide suggestions to improve its coordination mechanisms and its visibility in the international context.

Opening of the GTN-H Coordination Panel Meeting

The meeting was opened at 9.30 a.m. on 17 September 2007, by Ulrich Looser, Director of the Global Runoff Data Centre at German Federal Institute of Hydrology (BfG).

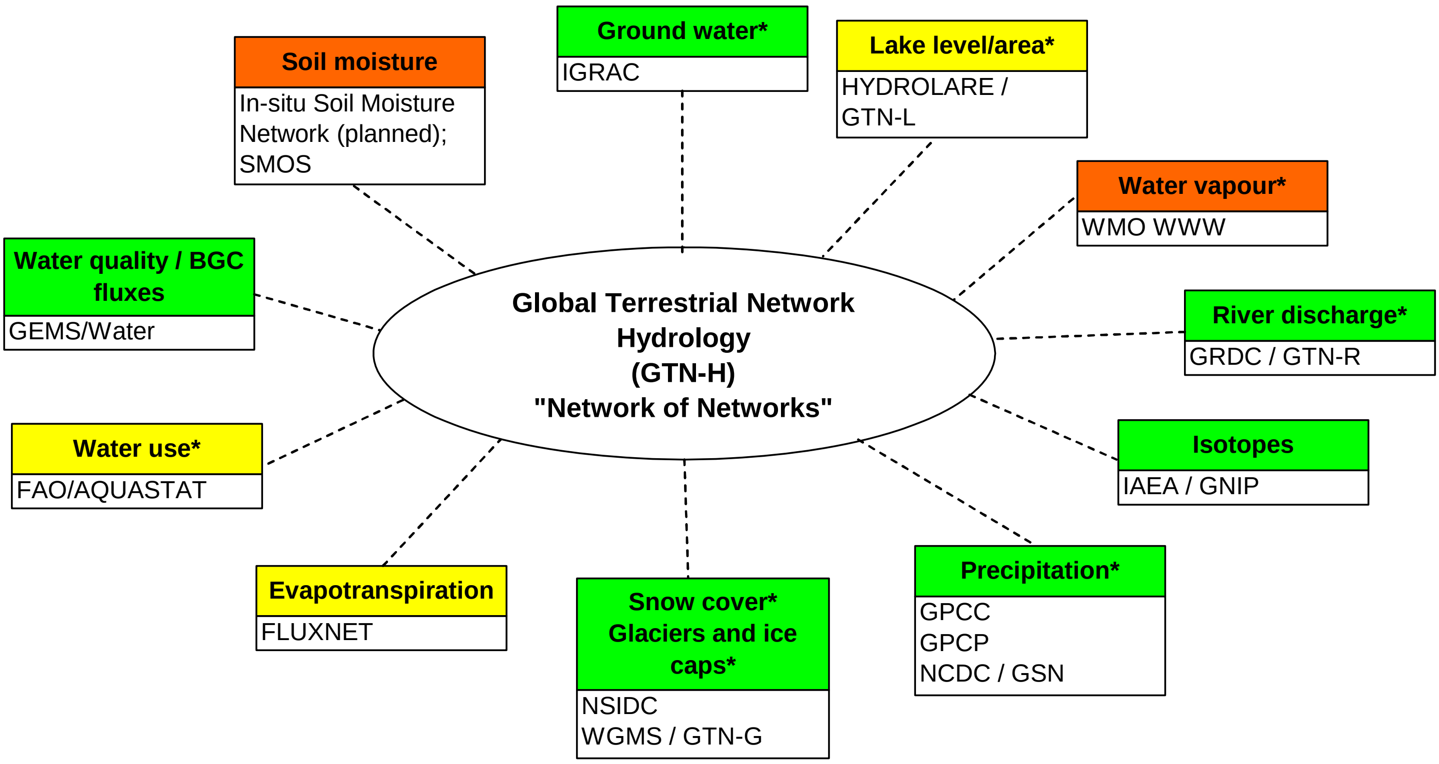

Fig. 1: GTN-H Configuration (September 2007)

Global network/coverage defined and contact established

Global network/coverage partly existing/identified and/or contact to be improved

No global network/coverage identified

* GCOS Essential Climate Variable

2. Report of GTN-H development

Wolfgang Grabs opened the meeting as WMO representative. After a general introduction, he briefly reviewed the development of GTN-H in the past two years. Progress was mainly achieved in the refinement of a number of products generated for different hydrological variables (e.g. precipitation, water quality, see section 5). Further, the establishment of HYDROLARE at the State Hydrological Institute St. Petersburg (Russian Federation) serving as the International Data Centre on the Hydrology of Lakes and Reservoirs has taken great strides in 2007. Overall, GTN-H progress and coordination has been ailing in the past two years due to difficulties in finding a replacement for David Harvey (Environment Canada), who had to resign as GTN-H Coordinator in late 2005. In August 2007, the Water Systems Analysis Group at CSRC of University of New Hampshire (USA), with Balázs Fekete as principal point of contact, expressed interest in taking over this function. The meeting unanimously accepted this proposal and thanked Mr Fekete and his collaborators for accepting this task.

David Goodrich welcomed all participants on behalf of the Global Climate Observing System (GCOS) programme. He highlighted the need for a global perspective on hydrological issues and stressed the need for long-term hydrological datasets and products for climatological analyses, for example in the case of continental runoff. GTN-H should take an active role in countering the widespread decline of in-situ observations by providing showcase products that demonstrate the need for in-situ networks. He expressed his appreciation for the diversity of GTN-H partners within the field of hydrology, giving great potential for enhancing the collaboration among all partners.

Julius Wellens-Mensah, who acted as the representative for the WMO Commission for Hydrology (CHy), expressed his gratitude for being invited to the GTN-H panel and was looking forward to report back into the CHy Advisory Working Group (AWG) on the activities performed by GTN-H partners. He stressed the need for not only posting all relevant GTN-H material on the GTN-H website (see project 1.1), but also producing a CD with the most relevant reports and maps to ensure wide dissemination in developing countries.

In the past, continued support and engagement by GTN-H sponsors (WMO HWR, GCOS) have helped raise awareness for the objectives of GTN-H, as evidenced by the visibility of the GTN-H in the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (WMO/TD-No. 1219; GCOS-92) ("GCOS Implementation Plan") and, the GEOSS 10-year Implementation Plan and its Reference Document.

3. Reports by GTN-H Sponsors

WMO

Wolfgang Grabs provided a brief overview of relevant WMO programmes and specifically of WMO HWR activities. He reminded the group of the linkages relevant to GTN-H within WMO Programmes as well as other international activities. In particular:

- Close collaboration between WMO HWR and GCOS secretariat in terms of data requirements, observations, and adequacy for climate and water resources management purposes;
- Close linkage between GTN-H and WMO/UNESCO World Climate Programme – Water (WCP-Water);
- Linkages between GTN-H and World Climate Research Programme (WCRP) (GEWEX, WRAP);
- Linkage between GTN-H and the GCOS/GTOS Terrestrial Observation Panel for Climate (TOPC)
- GTN-H as the operational arm within the Integrated Global Water Cycle Observations Theme (IGWCO), which is currently being merged into the GEOSS working structure

Mr Grabs showed the links between WMO and national hydrological services. He stressed the fragmented nature of responsibilities in many countries for hydrological observations, rendering it difficult for WMO HWR to effectively communicate with the appropriate bodies and persons on a national level.

Regarding the role of the World Hydrological Cycle Observing System (WHYCOS), Mr Grabs informed the session that for each individual regionally-confined project, regional data centres had the responsibility for managing the data. These data were as a general rule, not shared globally. Furthermore, their quality was mixed and the length of observation time series was strongly correlated with the duration of the projects. It was presumed that they might have some value for regional climate modelling.

In terms of data acquisition, participants suggested a more aggressive approach in country requests for data, using data and product demonstration on the Web, as well as some form of comparative approach. If there was reluctance by countries to make raw data widely accessible, the dissemination of aggregated or derived products was considered a viable second-best solution. An equivalent of the WCASP/CLIPS Regional Climate Outlook Forum (see http://www.wmo.int/pages/prog/wcp/wcasp/clips/outlooks/climate_forecasts.html) in the field of hydrology was considered a very good idea, which should be promoted in the framework of CHy.

GCOS

Dave Goodrich, Director of the GCOS Secretariat, provided a briefing on GCOS and the GCOS Implementation Plan pertinent to global observations for hydrology. He recalled the strong connection of GCOS to the UNFCCC, explained the concept of GCOS Essential Climate Variables (ECV) and their pertinence to atmospheric, oceanic and terrestrial observation domains. He noted that the majority of GTN-H variables (cf Fig 1) was recognized as ECVs, for which the TOPC shall provide further guidance in terms of overall observing strategy at its 10th session in November 2007.

Mr Goodrich informed the group of the development of the GCOS ‘Satellite Supplement’ report [1] in September 2006, which recommended to space agencies the generation of satellite-based products (see Annex IV), some of which with direct relevance to hydrological applications. He noted that space agencies and their coordinating bodies have since been very active in incorporating the GCOS satellite requirements into their planning.

Finally, he reminded the group of a major reassessment of the progress in the implementation of GCOS scheduled for 2009, requested by the UNFCCC. Partners in GTN-H shall contribute to this assessment in due course. However, any advice on priorities in the observation of hydrological variables would be welcome, e.g. a shift of focus toward better observation of ice sheets.

GTOS

On behalf of Reuben Sessa (GTOS Secretariat), Wolfgang Grabs provided a brief overview of mandate and scope of the Global Terrestrial Observing System (GTOS) that relate to the implementation of GTN-H.

The GTOS programme structure is composed of panels, regional projects and technical programmes. Implementation of the observing programs is accomplished using satellite missions, technical programs, and existing and expanded terrestrial networks. One of the priority areas of GTOS has been monitoring of the world's ecosystems through the Global Terrestrial Observing Network (GT NET), since

- Approximately 60% (15 out of 24) of ecosystem services evaluated being degraded or used unsustainably
- More land converted to cropland since 1945 than in 18th, 19th centuries combined
- Coral reefs reduced by 20% and a further 20% degraded in last decades
- Mangrove area reduced by 35% in last decades
- Water in reservoirs quadrupled since1960
- Withdrawals from rivers and lakes doubled since 1960
- Biological nitrogen flows in terrestrial ecosystems doubled since 1960; phosphorus flows tripled

Participants expressed their gratitude for Dr Sessa's briefing. They were also looking forward to a more active role of GTOS within GTN-H in the future.

GEOSS

Wolfgang Grabs provided a brief overview of the Global Earth Observation System of Systems (GEOSS), the Group on Earth Observations (GEO) that completed the GEOSS 10-year Implementation Plan in February 2005 (for more information see http://earthobservations.org), the current work plan structure of GEOSS and current activities of GEO and GEOSS.

The primary current activity of GEOSS is the creation of a progress report for the GEO Ministerial Summit in November 2007 that will be based on the achievements of GEO against its 10-year implementation plan.

Note that Annex IV of this report lists the 'Water' Tasks in the GEO 2007-2009 work plan that are most relevant for the workings of GTN-H.

Transitioning the IGWCO into GEO and follow-up

Wolfgang Grabs provided an overview about the planned transition of Integrated Global Observing Strategy Partnership (IGOS-P) and its programme launched in 2003 the Integrated Global Water Cycle Observations (IGWCO) into GEO.

A proposal initiated at the time of the Third Plenary of the GEO (Bonn, November 2006) called for the individual Themes under IGOS-P to be transitioned into GEO. At the 3rd Annual Planning Meeting of the IGWCO (Washington DC, March 2007) and the 14th Session of the IGOS-P (Paris, May 2007), this proposal was discussed and ultimately accepted. Thus, it is anticipated that all IGOS-P Themes will be transitioned into GEO and the IGOS-P itself dissolved by the time of the GEO Ministerial Summit in Cape Town, November 2007. Negotiations of each IGOS-P Theme regarding the terms of integration into GEO are currently under way, including the IGWCO.

The transition is expected to be a smooth one, given that the objectives of the IGWCO are largely similar to those of GEO with respect to global observations of the hydrologic cycle, and especially since the IGWCO already contributes to each of GEO's Water Tasks to varying degrees.

4. Reports on GTN-H Projects

The projects planned at the 1st GTN-H Coordination Panel Meeting have evolved during the last two years. Divided in four general areas of interests, the following pilot projects are developed:

1. Products that improve our understanding of what's 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 catalog and standardization procedures

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 data acquisition

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 – pristine basins
    - Project 4.2 GTN-H Networks

The following is a summary of the progress on each of these projects, based on the status at the 2nd GTN-H Coordination Panel Session. Action items in each of the projects are listed in the agreed List of Actions in section 9.

Project 1.1 Development of GTN-H Website (B. Fekete)

Objective:

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

Status/Progress since 2005:

The GTN-H website (see http://gtn-h.unh.edu) was last updated in November 2006. The site provides an overview about the GTN-H network, its partners and links to sources of data, related initiatives and contact persons. The website has been structured for presenting additional content, especially data products that are identified or developed under the GTN-H initiative.

Participants of the meeting agreed on the need for a rejuvenation of the website. Available datasets should be included, either as a list of links of the network partners or by providing a global map (Google Earth) with an overview about the available data.

Access to databases could be made easier for users, if a standardized interface for automated queries would be included. Any efforts in this regard should make best use of existing infrastructure, such as the Global Change Master Directory (http://gcmd.nasa.gov). This would also highlight the added value of GTN-H network and provide the means to offer combined products from network partners. The development of such a standardized interface is dependent upon its feasibility and resources.

Next Steps:

- Update information about the meeting in Koblenz, report, new coordination, members of coordination panel etc. on the website
- Make the website more attractive, by including more information and some data products
- Include a map for a global overview about the available data
- Make a list of links to the network partners available (beside the existing clickable graphic of the GTN-H partners)
- UNH provides a concept (1-2 pages) for the development of a global overview of databases on the website based on the existing resources
- NSIDC assists in the process and contributes with its web people

The contact person for adding to or modifying the GTN-H website is Balaz Fekete.

Project 1.2 Inventory of Existing Data Products, Databases, and Organizations (S. Bojinski)

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 be integrated into the GTN-H website.

Status/Progress:
The latest status of the GTN-H inventory of global hydrological networks is given in Table 1.

A first attempt to capture the diversity of GTN-H network partners consists of the collection of global maps for all the available datasets and products.

Next Steps:

This point is considered terminated as a 'project', but will be perpetuated as a database on the website, with regular updates.

Project 1.3 Management of Metadata (I. Dornblut)

Objective:

To propose a standardized detailed metadata format 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).

Status:

On the 2^{nd} GTN-H panel meeting 2005 the development of a web-based, multilingual software product for the exploration of metadata was announced, provided that a metadata standard, a standardised detailed metadata format, an adequate software product (off-the-shelf or internally re-usable) and funds to buy and adapt a software product by an external company are available.
The "management of metadata" in the sense of the description of hydrologic/hydrometric data by an appropriate set of metadata consists of two fundamental parts:

1. The standardised description of river discharge data using an ISO conform metadata profile
2. The collection, processing and management of metadata by standard rules offered in a web-based environment that enables the user to discover and access data.

GRDC has defined the version 3.0 of its Near Real-Time Data Format in 2006. It is already in use. In 2006, GRDC prepared a proposal for a hierarchically structured description of hydrologic/hydrometric data intended to integrate it in the WMO 19115 metadata profile. This (still internal) proposal combines the metadata requirements of current GRDC projects. It joins elements of the WMO 19115 profile with the corresponding ISO-standards, the metadata definitions, proposed by CUAHSI (Consortium of Universities for the Advancement of the Hydrologic Sciences, Inc.) and the Hydrologic Markup Language (HydroML) of USGS, and integrates some additional elements which GRDC considers as important, e.g. for the more detailed description of the providing institution or the results of observations (measurements / analysis procedure / model simulation). This draft proposal of a description of the river discharge component is currently under review and needs to be discussed with expert groups and transferred to XML (currently only available in XLS files).

Table 1: Inventory of global hydrological networks and data centres (September 2007, based on 3rd GTN-H Meeting and GCOS-101)

Variable	Contributing Networks	Status (data availability etc)	Data Centres and Archives	Network Coordination	Contributing remote sensing data	Comments / Points of Contact (POC) / Needs of data centres
River discharge	GTN-Rivers (proposed)	380 stations selected; WMO support letter sent to countries; no formal status yet	GRDC	WMO CHy, GCOS	Research on laser/radar altimetry	GTN-R can deliver: long-term freshwater flux into the oceans; long-term mean river discharge; global composite runoff fields POC: Ulrich Looser
Lake levels and area (merged with surface storage flux)	GTN-Lakes (proposed)	156 priority lakes defined by GCOS/TOPC	HYDROLARE	WMO CHy, GCOS	Research on altimetry, optical and radar sensors	GTN-L list of lakes available HYDROLARE data archive at SHI St. Petersburg POC: Valery Vuglinsky
Ground water (levels and use)	None; many national archives of ground-water level; Observation wells	n/a	IGRAC	n/a	GRACE, GOCE SAR	IGRAC: global groundwater information products online; Models: coupled groundwater surface models POC: Neno Kukuric, Sophie Vermooten
Water use (area of irrigated land)	No network, but single geo-reference database exists	n/a	FAO AQUASTAT	FAO	n/a	5' raster map of irrigated land based on *in situ* and RS data (University of Kassel, Germany) POC: Karen Frenken (tbc), GTOS/FAO (tbc)
Water quality / BGC fluxes	Global Network of Biogeochemical Fluxes (tbd)	106 countries and 2991 stations contributing	GEMS/Water	UNEP	n/a	GEMS/Water freshwater assessments available POC: Richard Robarts
Isotopes	Global Network for Isotopes in Precipitation; ISOHIS	196 met. stations in 59 countries; ISOHIS information system	IAEA	IAEA and WMO		POC: Luis Araguas, Pradeep Aggarwal
Evapotranspiration	FLUXNET sites Flux aircraft	AmeriFlux CarboEurope AsiaFlux Fluxnet Canada	FLUXNET DAAC at Oak Ridge National Lab	US Agencies, EU, Japan, others	Derived estimates from satellites	Models: values inferred through models or water balance estimates POC: GTOS, Ricardo Valentini (tbc)
Soil Moisture	National/regional networks	Major geographical gaps	Rutgers University (USA); National archives e.g. in Russian Federation, China, USA	n/a	Research missions (SMOS, Hydros)	Reference network for satellite validation tbd; GSWP? LDAS? POC: Peter van Oevelen
Permafrost	GTN-Permafrost	Coordination of national networks; Major gaps	NSIDC Geological Survey of Canada	Int. Permafrost Association	Derived near-surface temperature and moisture	POC: Richard Armstrong, Jerry Brown

Variable	Contributing Networks	Status (data availability etc)	Data Centres and Archives	Network Coordination	Contributing remote sensing data	Comments / Points of Contact (POC) / Needs of data centres
Precipitation	Baseline GCOS Surface Network (GSN)	90% of data collected, only 70% as CLIMAT	GSN Monitoring Centres (DWD, JMA); GSN Analysis Centres (NCDC, Hadley); GSN Archive (WDC Asheville); WMO CBS Lead Centres for GCOS in each WMO RA	AOPC with WMO CBS	Surface-based radar networks; National radar networks; Precipitation radar; Passive microwave and IR high-resolution sounders	GPCC products: Monthly surface precipitation monitoring; monthly 1st guess precipitation anomaly; full precipitation reanalysis; 50-year climatological dataset GPCP products: Hourly, daily, monthly precipitation monitoring, using GPCC products and satellite retrievals Model products: corrected NWP-derived fields based on model re-analyses POC: WMO WWW, Tom Peterson, Tobias Fuchs, Robert Adler
	Full WWW/GOS Synoptic Network	Operational, data quality variable	Integrated Surface Hourly (WDC Asheville) GPCC (DWD)	WMO CBS		
	National surface networks	Most countries operate high-resolution net-works, but data are often hardly available	National responsibility; submission to WDC and GPCC (DWD)	WMO CCI, WMO CBS and WMO Regional Associations		
Water vapour	Full WWW/GOS Synoptic / Radio-sonde Network	Operational	WDC Asheville	WMO CBS, AOPC, WMO CIMO	Passive microwave; Infrared sounders; GPS radio occultation; IR and microwave limb sounders; Solar occultation	Data not widely used for climate studies; however, land surface schemes of models for seasonal prediction, such as at ECMWF, use water vapour datasets; check out NASA GLDAS dataset/project POC: Pedro Viterbo (Portugal Met Service, formerly ECMWF) (tbc); NASA GLDAS (tbc)
	VOS, VOSClim	Under implementation; Poor observational practices frequent	VOSClim Data Centre	JCOMM SOT		
	Tropical Mooring Network		IODE Data Centres	JCOMM TIP		
	Reference Buoy Network			JCOMM DBCP		
	GPS receiver network	Int. cooperation needed	n/a	n/a		
	Commercial aircraft	Potentially useful, but limited geographic coverage	n/a	n/a		
Snow cover	WWW/GOS Synoptic Network (snow depth); National networks (snow depth, SWE)	Significant gaps and contracting networks; issues with data consistency; Southern hemisphere not monitored operationally	NCDC NSIDC Fragmented responsibilities and archives within countries; Network funding mostly research-based	n/a	Moderate resolution optical sensors for snow extent/duration; Passive microwave for SWE	Daily/weekly Northern hemisphere snow extent maps by NOAA/NESDIS, NASA; Daily global snow depth analyses by Canadian Met Centre Models: NWP, global climate models POC: Richard Armstrong
Glaciers and Ice Caps	GTN-Glaciers	Network of national contacts; Major geographical gaps, especially in Southern Hemisphere	World Glacier Monitoring Service NSIDC	Int. Commission on Snow and Ice, FAGS and others	Visible and IR high-resolution; Along-track stereo optical imagery; SAR; Satellite Altimetry	GLIMS Radarsat Antarctic Mapping Project Digital elevation maps of ice sheet surfaces? POC: Wilfried Haeberli, Richard Armstrong
	Research projects such as ACIA	One-off	NSIDC	n/a		

In 2005, it was intended to engage in the German NOKIS++, a project which investigates the implementation of information infrastructures as part of the Integrated Coastal Zone Management. In the framework of NOKIS++ a web-based environment was developed by a German software company allowing the standardised metadata collection, processing and management. Nowadays this software is commercially distributed as a stand-alone product and is as such of high interest for future metadata management of the project. Currently, GRDC has no active part in the development and design of NOKIS++. Alternatively, it was intended by GRDC to re-use the metadata management structures developed internally within the envisaged European Terrestrial Network for River Discharge (ETN-R). Unfortunately, over the course of the ETN-R project, the development of the metadata management system was cancelled. Consequently, as of today, the ETN-R project does not provide a software product for the collection and management of hydrological metadata for GRDC purposes.

A web-based environment for the collection, processing and management of metadata portable to other platforms is still the most suitable solution. It would facilitate the metadata collection and processing on both the providers (NHS) and the processors (GRDC) side. With the web-based environment, which was originally developed for the German NOKIS++, now a software product is available which meets the essential requirements of the GTN-R project. The customisation for the special needs of the GTN-R/GTN-H and the adjustment to the WMO 19115 core profile including the river discharge data component seems the most favourable solution at present.

Next Steps:

- Development of a hierachical structure to describe hydrologic/hydrometric data, data transfer and exchange parameters by an appropriate set of metadata
- Identification and application of a software to implement metadata profile and search for data and products (GRDC to contact the contractor to , find out license and adjustment needs)
- Action by mid-2008

Project lead: Irina Dornblut

Project 2.1 Development of Gridded Runoff and Discharge Datasets (B. Fekete)

Objective:

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

Status:

The development of spatially distributed runoff and discharge products requires

- the establishing of core gridded river networks at various resolutions,
- the co-registration of auxiliary data discharge gauges, lakes/reservoirs, etc. to the river networks, and
- streamlining the access to climate forcing information.

The UNH team made significant progress on each front and is ready to operationally distribute gridded runoff and discharge products.

Gridded river networks

UNH released its first gridded network at 30-minute spatial resolution (STN-30, Vörösmarty et al., 2000) as part of the UNH-GRDC Composite runoff fields (Fekete et al., 1999; 2002) which is still widely used in the research community. Since then, UNH developed 6-minute resolution network derived from HYDRO1k (1km resolution gridded networks) using a network regridding algorithm [2] and complementary manual editing. Unfortunately, the quality of HYDRO1k as a gridded network was insufficient and as a consequence, the 6-minute network (STN-06) needed much more manual correction than anticipated. While the manual correction was feasible at the 30-minute resolution, it turned out to be a daunting task at 6-minute and the STN-06 never reached the production quality that the UNH team was comfortable to release to the public. Therefore, the STN-06 remained an experimental network, that served several pilot projects (e.g. UNESCO's Ecohydrology http://www.global-rims.unh.edu). The UNH team abandoned the further development of STN-06 after learning about the ongoing development of HydroSHEDS, a high resolution (at 500 m) gridded river network derived from the Shuttle Radar Terrain Mission (SRTM) elevation data (http://www.worldwildlife.org/ freshwater/hydrosheds.cfm). HydroSHEDS is already complete for South America, Africa and expected to be finished by the first quarter of 2008 (Bernhard Lehner personal communication). Preliminary versions of HydroSHEDS are currently tested at UNH and the first results indicated that HydroSHEDS lives up to the expectations. HydroSHEDS clearly has the potential to provide the basis for wide range of hydrological studies. The UNH team intends to apply the aforementioned re-gridding algorithm to produce coarser resolution networks (3, 6 and 30 minutes) that suits better continental and global applications.

Another important gridded runoff dataset and applications thereto has been developed by T. Oki et al. called TRIP (Total Runoff Integrating Pathways), on the basis of a 0.5° grid. TRIP is operated since 2006 as part of the “Today’s Earth” numerical monitoring series (http://hydro.iis.u-tokyo.ac.jp/LIVE) by The Institute of Industrial Science of the University of Tokyo. “Today’s Earth” estimates and visualizes the situations of the global water cycle from current to a-few-days ahead. The core system consists of four global models, iso-MATSIRO land surface model (Yoshimura et al.,2006), TRIP river routing model (Oki et al., 1999), the isotope circulation model (ICM; Yoshimura et al., 2003), and colored moisture analysis (CMA; Yoshimura et al., 2004) model. All models are directly or indirectly driven by the JMA’s global model forecast data, namely GSM-GPV (Global Spectral Model, Grid Point Values, data archived at http://gpv.tkl.iis.utokyo.ac.jp/GPV/), in 1-degree horizontal resolution.

Selected discharge gauges

The discharge gauge density varies significantly regionally. Considering all available discharge gauges for the production of gridded runoff fields is not feasible for several reasons. Discharge gauges close to each other along the mainstream of river networks often increase the uncertainties of the spatial distribution of the runoff when the discharge increment is below the discharge measurement accuracy at the discharge gauges. Furthermore, the inclusion of discharge gauges with short time series record has limited value especially for time series analysis. The UNH and GRDC established selection criteria for discharge gauges in the development of the successful UNH-GRDC Composite runoff fields [3, 4] which were based on 663 discharge gauges selected from ~1300 previously identified candidate sites from the GRDC data archive. The selection criteria (minimum 12 years of record, >25 000 km^2 catchment area, >10 000 km^2 inter-station area, etc.) were

documented in the accompanied report [3]. The catchment area requirements were motivated by the use of our 30-minute network, which was found to have a minimum of 10 000 km^2 catchment area threshold to accurately represent real conditions.
UNH revisited the selection criteria for STN-06 network for North America and identified 1196 stations from USGS and Environment Canada's real-time reporting stations that can give spatially consistent information on the runoff distribution over the North American continent. A 192 station subset was identified for 30-minute analysis. This subset was demonstrated at the last GTN-H meeting, and was used in the production prototype of high resolution composite and discharge fields.
Establishing a global selection of key hydrological stations hinges on the availability of suitable gridded networks. It is expect that shortly after the release of HydroSHEDS, UNH will be in the position to produce a new production quality 3- and 6-minute networks that can serve both GRDC and UNH as a baseline for representative gauge selection.

Streamlined data processing
UNH already developed data mining tools to continuously retrieve discharge data from USGS, Environment Canada and various National Hydrometeorological Services throughout the Pan-Arctic region, precipitation data from NASA (Global Precipitation Climatology Project, GPCP and Tropical Rainfall Measuring Mission, TRMM and Moderate Resolution Imaging Spectrometer, MODIS products), data from the Global Precipitation Climate Center, Offenbach, Germany and from weather station records from the National Climatic Data Center (NCDC) of NOAA.
Data mining in simple cases requires automated data download from publicly available ftp or web-sites to retrieve the latest updates (e.g. GPCC, GPCP products) and reformatting of the downloaded data. In other cases, a special arrangement is made with the data providers to send regularly updates for example transferring discharge data from Norwegian Hydrological Service). In the most complicated scenario, automated retrieving tools are developed that access data provider's web-site by mimicking the queries that ordinary user would make by navigating through the web interface (e.g. discharge downloads from USGS and Environment Canada). Developing data mining tools to web-interfaces is clearly a tedious task since it involves the “reverse engineering” of the web-site services and writing the necessary tools that walk through the web interface and retrieve the recent updates.
The downloaded data are incorporated into a comprehensive data archive that is part of the UNH Data Collaborative which is aimed to act as clearing house services integrating data products from different data providers into a coherent data management and analysis system. The UNH Data Collaborative is UNH's contribution to NOAA's Whitewater-to-bluewater initiative.

One of the key applications that operates on top of the data services from the UNH Data Collaborative is the redesigned water balance and transport modelling system. Recent developments yielded a model framework infrastructure which is highly configurable and can directly tap into the data services of the UNH Data Collaborative. The UNH fully-coupled water balance and transport modelling system is unique in several aspects. Coupled water balance and transport models that operate at continental and global scales are currently rare, but proper incorporation of human activities requires the two-directional linkage between the land-surface model component and the river routing. This modeling framework is open to further extension, therefore, coupling out existing water balance/transport with groundwater model is feasible in the near future. The modelling framework also allows data assimilation for the generation of merged products like the UNH-GRDC composite discharge fields. Currently, the framework offers data assimilation in two ways: The first one is the application

of runoff correction “on the fly” to create composite runoff fields; the second is the injection of discharge records that can take over the simulated discharge at gauging stations. The latter can be viewed as running the river transport model individually for inter-station regions between gauges using the discharge records at the gauges as boundary condition.
The integrated water balance/transport and data assimilation system on top of the data services from the UNH Data Collaborative were tested in applications at different scales ranging from basin scale (operating on a 120 m resolution gridded network), through regional scale (at 2 km resolution) up to continental and global scale (at 10 - 50 km resolutions which is the equivalent of operating on 6' and 30' grids).

Web interfaces
The UNH team developed several prototype systems on top of the aforementioned modelling framework. The two relevant systems for GTN-H are Global-RIMS and the hydrological forecast system developed as part of the Joint Center for Ocean Observing Technology. Global-Rapid Indicator Mapping Systems (Global-RIMS) has the unique ability to provide additional processing capabilities beyond the visual presentation of the runoff and discharge data. The processing capabilities make Global-RIMS and ideal tool for water managers who can perform simple GIS-like calculations on their own without the need for exporting the relevant data to a local analysis system.
The JCOOT system developed for New England (US) offers forecasting capabilities beyond representing the current hydrography. The hydrological component is primary driven by the North American Reanalysis as data forcing and the simulated runoff and river flows are corrected by assimilating USGS discharge data. Forecasting is performed using the forecast products of AER (privately own atmospheric research company).

Next Steps:

The future development of GTN-H will require the improvement of current baseline datasets like gridded networks, co-registered discharge gauges, reservoirs, etc. The resulting static data products would benefit a wide research community and provide the basis for an integrated data processing and analysis system, such as the combined Global-RIMS/JCOOT system that UNH intends to develop for GTN-H.
Explore commonalities between the tools developed by UNH (under “streamlined data processing” and GRDC within project 2.2

Static database development
The expected availability of HydroSHEDS globally early next year will open new opportunities for wide range of hydrological applications. Since HydroSHEDS will be scalable from 500 m to 30-minute resolutions, applications can be tested in similarly wide scales offering unique capabilities to assess the impact of scales on hydrological analysis. The key to this scalability is to use HydoSHEDS as the core baseline data preferably at its highest resolution as a basis for georeferencing hydrologically-relevant data. The Global Water Systems Project of UNESCO (with UNH as participating member) is already working on the consolidation of various reservoir data products within the HydroSHEDS framework. UNH is planning to identify the key stations from GRDC discharge gauge archive that are suitable for global scale data assimilation and co-register those stations to HydroSHEDS. Furthermore, UNH will apply its river geometry estimation methodology to HydroSHEDS to provide river channel characterization in the form of parameterized exponential functions as idealized cross-sections. Furthermore, UNH will consolidate other relevant data like land use and irrigated lands within HydroSHEDS.

Operational state-of-the-water cycle
UNH will work with GWSP to develop an operational “state-of-the-water cycle” product that will integrate all the relevant information in our water balance/transport data-assimilation infrastructure to provide a near-real-time representation of the key water cycle components. This effort will build on recently completed NASA projects and utilize new advancement in NASA's WaterNet effort.

Project lead: Balázs Fekete, Richard Lammers

Project participants: Bernhard Lehner

Product(s) to be maintained by:
University of New Hampshire (USA), McGill University (Canada) and USGS EROS Data Center.

Project 2.2 Map Product on Real-Time Hydrological Conditions (I. Dornblut)

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 (Global Terrestrial Network for River Discharge, GTN-R, http://gtn-r.bafg.de)

Status:

GRDC is currently developing a service capable to automatically "harvest" real-time river discharge data, using FTP and HTTP servers via Internet protocols. In 2004 GRDC developed a prototype of an operative engine that continuously monitors online active data sources according to their download frequency attributes, visits them, downloads the relevant data files and stores them in an interim database for harmonisation. Based on the experiences gained with this prototype, GRDC started in 2006 within the ETN-R project to develop a software system that draws together the near real-time river water level and discharge data, with time steps of at least 1 hour, provided by individual NHS via Internet protocols.

Output/ deliverable:

This software system will be able:
- to process and store the data in a database,
- to check the plausibility of the data,
- to transform water level data into discharge data where required,
- to classify the data on the background of historic data, and
- to re-distribute all required data in a harmonised way via the Internet.

Within the ETN-R, the development of a customised mapping application is planned to display the current and forecasted hydrologic situation on a European map.
Since 2005, a prototype of a scaleable and interactive map is provided by the GRDC. Using the ArcReader software the maps display the stations of the initially proposed GTN-R

network. Apart from this prototype no further activities regarding a web mapping application were made in 2006.

Schedule (resource-dependent):

GRDC intends to apply the ETN-R software system and corresponding mapping application to the GTN-R as soon as it is in regular operation, latest by the end of the ETN-R project in December 2008. Designed primarily for the ETN-R, the system must be adapted for the requirements of the GTN-R, considering the experiences of the ETN-R. This relates in particular with regard to changes in the spatial and temporal discretization of polled gauge data and a more generalized data plausibility analysis.

Project lead: Irina Dornblut

Project participants:
GRDC internal staff and externally funded staff, depending on funding

Product(s) to be maintained by:
GRDC

Project 3.1 Mapping of Biogeochemical Fluxes (R. Robarts)

Objective:

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

Status:

The United Nations GEMS/Water Programme, established in 1978, provides scientifically-sound data and information on the state and trends of global inland water quality required as a basis for the sustainable management of the world's freshwater to support global environmental assessments and decision-making processes. To this end, GEMS/Water develops and maintains a global freshwater quality information system with a series of national and international partners and is unique in that it is the only source for global water quality monitoring data. Its other major activities are assessment, research and capacity building, including monitoring network and analytical laboratory evaluations for national governments. GEMS/Water has just completed the development of a drinking water quality index that evaluates surface water with regards to its suitability as a source of drinking water. Indicators that quantify water quality with respect to biodiversity and overall indices of pollution are currently in development. The programme is in the unique position to evaluate impacts of changes in water quality to society and the environment, as it relies upon real water quality data and compares these data to established benchmarks for good water quality.

While the GEMS/Water programme belongs to the whole UN system, it functionally fits into the Division of Early Warning and Assessment (DEWA) of the United Nations Environment Programme.

The twin goals of the programme are to improve water quality monitoring and assessment capabilities in participating countries, and to determine the status and trends of regional and global water quality. These goals are implemented through the GEMS/Water data bank, GEMStat at www.gemstat.org, including water quality data and information from about 3,000 stations in 100 countries, with almost four million entries for lakes, reservoirs, rivers, wetlands and groundwater systems. By compiling a global database, GEMS/Water adds value to country-level data by contributing to global and regional water quality assessments.

All GEMStat monitoring can be geospatially referenced using Google Earth. The database is interoperable and has been expanded to include open web services.

The programme also carries out evaluations on a range of water quality issues and methodologies. GEMS/Water data have been used by other organizations, including the UN system and universities around the world.

Next Steps:

GEMS/Water wants to include more flux stations in collaboration with GRDC. More water quality stations need to be identified within acceptable distance from river discharge gauge location.

Project Lead: Richard Robarts

Project(s) be maintained by:
GEMS/Water

Project 4.1 Reference Hydrological Dataset – pristine basins (Harry Lins, Ulrich Looser, Wolfgang Grabs)

Objective:

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

Status:

In June 2006 the WMO sent out a request to its member Hydrological Advisors to supply the WMO with a list of river discharge stations, which comply with 7 selection criteria provided in the requesting letter.
23 countries have replied positively and 22 countries have provided the WMO with a list of river discharge stations representing pristine conditions in their respective countries. Information for three more countries is pending and one country indicated that it does not dispose of suitable stations as defined by the 7 selection criteria.
The majority of the responding countries are situated in Eastern Europe and Asia, whereas Northern America is covered by the densest network with the majority of the stations. Southern America, Africa, and Australasia are still underrepresented.
So far one country has provided river discharge data for the selected stations and for the North American countries the historical data is available from their websites.

The metadata provided for the stations is of varying quality and a follow-up action is necessary to obtain additional metadata, historical discharge data and more participating countries.

Next Steps:

Workshop on use of pristine basins for climate analyses is planned for the first quarter in 2008. After this workshop another letter should be written to countries, to ask for their data.

Project Lead:
Harry Lins, Ulrich Looser, Wolfgang Grabs

Project 4.2 GTN-H Networks (W. Grabs, A. Thomas, S. Bojinski)

Objective:

Initiating the setting of criteria for defining each of the GTN-H variables and networks.

Status:

This project is terminated, since it was successfully completed.

5. Reports by GTN-H Partners

Under this item, network partners provided progress reports on their specific activities related to the GTN-H.

5.1 GTOS

GTOS had informed earlier that their staff could not attend this time. However, a report was provided that is documented below. The Panel positively commented on the progress made in GTOS and reiterated its view that GTOS needed to be more actively participating in the GTN-H as a natural partner of the network. Participants further expressed their expectation that this could be achieved in the near future.

The GTOS TEMS database has been expanded by including additional ecosystem types, global change monitoring data and metadata services. To date the database comprises

- 2040 monitoring sites, 40 networks, 1200 contact persons
- 120 environmental variables and 60 socio-economic indicators (with description sheets)
- Interactive Maps
- Thematic modules related to biodiversity, coastal zones (Coastal GTOS), forest, hydrology and mountain.
- Local Climate Estimates, Geology, Pedology and Hydrology data.

The TEMS Activities during the last two years were concentrated upon:

- New digital Terrain Model available for each T-site (100km2) (3D image will include Landsat ETM+) Landsat TM, MSS and Land Cover will also be extracted
- GOSIC data matrix, MAB cooperation, network links

The objective of IGOS land is to provide a comprehensive framework to harmonize the common interests of the major space-based and in-situ systems for global observation of the Earth. Land theme of IGOS will provide a comprehensive picture of the present state of terrestrial ecosystems, and build capacity for long-term monitoring of those ecosystems.

5.2 Water Use

Participants regretted that FAO was not in a position to send a representative to inform the Panel on progress in FAO's Water Data base AQUASTAT. Subsequently, no report had been available for the session. The Panel discussed this issue and concluded that on behalf of WMO, GCOS and GTN-H coordination a solution needs to be found to obtain regular updates on water use data and patterns from reliable organizations including FAO and other regional institutions where available.

5.3 Evapotranspiration

Evapotranspiration (ET) data are a derived quantity rather than being measured directly. ET estimates may be derived from satellite data, through ET models or through water balance analyses.

Energy-based ET models can be applied if suitable data are available, for example, at FLUXNET sites. FLUXNET is a global network of tower sites that use eddy covariance methods to measure the exchanges of carbon dioxide, water vapour and energy between terrestrial ecosystem and atmosphere. At present, approximately 300 tower sites are operating on a long-term and continuous basis. Researchers also collect data on site vegetation, soil, and hydrological and meteorological characteristics at the tower sites.

FLUXNET data are available from the Distributed Active Archive Center (DAAC) of the Oak Ridge National Laboratory, and include monthly and annual heat, water vapour, and carbon dioxide flux, gap-filled flux products, ecological site data, and remote-sensing products (see http://daac.ornl.gov/FLUXNET). At present the data products available on the FluxNet website represent around 30% of the total of the FluxNet sites, and the most recent data presented is at least 5 years old.

FluxNet Component	Website
FluxNet	http://www.fluxnet.ornl.gov/fluxnet/index.cfm
AmeriFlux	http://public.ornl.gov/ameriflux/
CarboEurope	http://www.carboeurope.org/
AsiaFlux	http://www-cger2.nies.go.jp/asiaflux/main.html
KoFlux	http://koflux.org/koflux/home/index.html
OzFlux	http://www.dar.csiro.au/lai/ozflux/
Fluxnet-Canada	http://www.fluxnet-canada.ca/
ChinaFlux	http://www.chinaflux.org/Observation/index.html.

Table 2 Summary of FluxNet components and links to their websites.

No further update on the status of FLUXNET in the GTN-H context was available at this session.

5.4 Lake levels and Lake Surface Area

Real activity on the establishment of the International Data Centre on the Hydrology of Lakes and Reservoirs (HYDROLARE) began after the letter from the Head of Russian Hydrometeorological Service Dr. A. Bedritsky to WMO in June 2006 reiterating the firm intent to create the Centre at the State Hydrological Institute (SHI) in St.Petersburg, the consultation meeting between representatives of SHI and ROSHYDROMET in Moscow in July 2006 and the Planning meeting on the established of HYDROLARE at the SHI on 1 November 2006. During the last meeting the steps leading to the formal establishment of the Centre and its operation were discussed and agreed. It was agreed that the Centre would operate under the auspices of WMO based on a Memorandum of Understanding (MoU) between ROSHYDROMET and WMO.

In February 2007 the SHI received the financial resources from ROSHYDROMET and the initial 2 years pilot phase period of HYDROLARE activity was began. During the first part of 2007 the block rooms of HYDROLARE at the SHI was repaired and a necessary equipment and technical facilities were bought. The draft of MoU and suggestions on metadata, database structure and data holdings were also prepared.

During 14-15 June 2007 the first meeting of the Steering Committee of HYDROLARE took place at the State Hydrological Institute in St. Petersburg. The Committee discussed all relevant issues related to the technical establishment of the Centre including its funding and staff resources. Likewise, all issues related to the governance of the Centre were discussed including its legal status and administrative mode of operation. In addition, the policy for the acquisition and exchange of data and information was discussed. The Committee agreed also on a final version of Terms of Reference for the HYDROLARE Steering Committee.

Based on the discussions on deliverables of the Centre priority activities, the Committee agreed on a set of milestones for HYDROLARE until December 2008. Mains of them are:

- Development of encoding system for database – September 2007.
- Preparation of metadata for lakes and reservoirs of Russia and other former USSR countries and historical observational data for lakes and reservoirs of Russia; loading these data into the prototype data base – until February 2008.
- First test operation of HYDROLARE – March 2008
- First review of HYDROLARE functions and activities – June 2008.
- Preparation of metadata for lakes and reservoirs of foreign countries and historical observational data for lakes and reservoirs of former USSR countries and foreign countries; loading these data into the data base – until October 2008.
- Second meeting of HYDROLARE Steering Committee – November 2008

5.5 Soil Moisture

Wolfgang Grabs provided an overview about the development of the Soil Moisture Network on behalf of Peter van Oevelen.
The Portuguese Meteorological Institute will host the Soil Moisture Network database. The data hosting contract is funded through ESA within the framework of SMOS Calibration-Validation activities. This is seen as an opportunity to:

- Prototype for global network hosting
- Following and setting international standards (ISO, as well as based upon CEOP activities)
- Cooperation with CEOP (Coordinated Energy and Water Cycle Observations Project of GEWEX)
- Kick-Off within next 2 months, SMOS Launch 2nd half 2008
- Aim for two types of products a quick release product as pre-cursor for NRT observations and a consolidated quality checked product
- Open access

The 2nd International Soil Moisture Working Group meeting is held in Beijing from 14 to 15 November 2007. The aims for the meeting are:

- Establish Protocols for Soil Moisture Measurements (sensors, networks)
- Establish quality assurance
- Strengthen coordination between contributors
- Ensure good participation, in particular from Asian counterparts

The Network will eventually be distributed with more than one centre collecting and hosting the data, in order to stimulate cooperation within different global regions.

The following three points are seen as long term plans for the network:

- Strengthen the acceptance of ‘soil moisture’ as a GCOS ‘essential climate variable’
- Ultimately, make soil moisture network a part of WMO World Weather Watch, e.g. by encouraging synoptic networks to include soil moisture measurements

5.6 Surface Runoff

Ulrich Looser presented the functions and projects of the Global Runoff Data Centre (GRDC), which is operated from within the German Federal Institute of Hydrology (BfG). The GRDC provides river-discharge data in support of the predominantly water and climate related programmes and projects of the United Nations (UN), their specialised agencies and the scientific research community.
The major functions of the GRDC include:

- Acquisition of global runoff data
- Harmonisation of the diverse runoff datasets
- Maintenance and the management of the runoff database
- Distribution of the data.

In August 2007 the GRDC database held world-wide discharge data of 7,317 stations in 156 countries featuring around 275,000 station-years of monthly and daily values with an average time-series length of 37.7 years. Over the past 18 months data of 3233 stations from 22 countries have been updated.

The GRDC is involved in a number of projects such as the Global Terrestrial Network for River Discharge (GTN-R) which is aimed at improving access to near real-time river discharge data for about 400 selected gauging stations around the world that capture the majority of the freshwater flux into the oceans. GTN-R is also a GRDC contribution to the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* and the GTN-H.

Following the severe Elbe and Danube floods in 2002, the European Commission initiated the development of an European Flood Alert System (EFAS) to increase flood warning times for trans-national river basins. This project is conducted at the EC Joint Research Centre (JRC) and the GRDC has been tasked to supply the required hydrological data for Europe. Therefore the three year project European Terrestrial Network for River Discharge (ETN-R) was launched in 2006. The ETN-R project aims to access near real-time discharge and water level data from 30 trans-national river basins in 36 European countries. Most of the data are already collected by the various National Hydrological Services, but currently no uniform system exists through which this data can be accessed. To achieve its objectives, the ETN-R project follows a two-pronged approach. On the one hand all affected National Hydrological Services must be contacted and their cooperation to provide near real-time (NRT) data must be secured. On the other hand computer programmes and data formats must be developed for the automated collection, quality control and distribution of NRT data. The ETN-R project serves as a pilot study for GRDC plans to collect NRT data on a global scale as part of the GTN-R.

The GRDC maintains the European Water Archive (EWA). This is a direct contribution to the UNESCO NE-FRIEND community. Plans exit to apply the same database model to the EWA database in order to utilise standardised database tools.

The GRDC is currently in the process of developing a metadata profile for hydrology for inclusion into the WMO metadata profile based on ISO19115. A prototype has been developed and needs further refinement before it can be presented to the WMO for inclusion into the WMO metadata profile.

Apart from the project and data tasks the GRDC is also involved in updating some GIS products, like the WMO sub regions and an improved global drainage basin and river network.
Currently the main objectives of the GRDC are the consolidation of existing projects and an intensified drive on data acquisition to better meet the data needs of GRDC clients.

5.7 River Discharge

The GTN-R has been defined by GRDC as the key hydrological network describing continental fluxes into the oceans (GRDC Rep. No.5, 1996). Since, the network definition has been updated as more stations became available to GRDC. TOPC has accepted the GTN-R as the GCOS Baseline River Discharge Network and is formally supported by action item T4 of the Implementation Plan for the Global Observing System for Climate in support of the United Nations Framework Convention on Climate Change (UNFCCC) (GCOS-IP).

In April 2005 the GCOS secretariat of WMO sent out a data request and support letter signed by the WMO Secretary General to The Permanent Representatives with WMO and their Hydrologic Adviser of 82 countries which feature tentative 380 GTN-R stations. The national data providers were invited to evaluate the initial station selection regarding its suitability to capture the freshwater fluxes to the oceans in terms of continuity, length and quality of the historic records. They were requested to confirm the location of the stations, define their operational status including the measurement, data recording and transmission technologies used, and provide GRDC with the updated station metadata.

In responses by the NHSs, a total of 185 stations have been confirmed so far as GTN-R stations – these include 97 stations from the initial proposal of 380 stations, as well as 88 alternative suggestions by the National Hydrological Services NHSs.
However, no feedback was received for 265 stations. The status of these stations still has to be clarified.
21 countries have replied positively on the request for collaboration and GRDC already received a number of datasets of both historic or NRT-data. Most of the countries replied within the first six months after sending out the support letter. The last reply dates back to September 2006.
In summary, 75% of the contacted national authorities made no reply. Only 10 of the invited NHS provided GRDC with historic records of discharge data. Currently the NHS of only three countries, INHGA of Romania, NVE of Norway and ORKUSTOFNUN of Iceland provide the GRDC with daily discharge data in near real-time.
Because of the low percentage of replies (25%), the GTN-R baseline network of river runoff reference stations on a global scale has not yet been finalised.

5.8 Water vapour

Stephan Bojinski provided an overview about the progress of the measurement of water vapour. Water vapour is measured as relative/absolute humidity on an operational basis by a number of networks and by satellite. However, there is no designated world data centre identified yet for coordinated analysis of water vapour data. Quality control is not standardized, and there are issues with non-standard operational practices.

Water vapour data are not widely used for climate studies; however, land surface schemes of models for seasonal prediction, such as developed by ECMWF, use water vapour datasets. The NASA Global Land Data Assimilation System (GLDAS) also makes use of water vapour data.

WMO World Weather Watch should assume responsibility for this variable and work with CBS, CIMO and the GCOS Atmospheric Observation Panel for Climate (AOPC) to harmonize the monitoring of water vapour on a global scale. It is also necessary to explore with users of water vapour data, such as modelling centres (e.g., ECMWF), if the lack of centralized quality control, standard operating practices is detrimental to the utility of the data as input to land surface schemes of forecast models.

5.9 Global Network of Isotopes in Precipitation (GNIP)

Stephan Bojinski presented slides on behalf of Luis Araguas, representing the Isotope Hydrology Section of the International Atomic Energy Agency (IAEA), and recalled the role of the global GNIP program in hydrology and climatology by observing stable isotopes of oxygen and hydrogen in the water cycle.

The stable isotopes ^{18}O and ^{2}H are fractionated during the evaporation, condensation and vapour transport processes of the water cycle, leaving “fingerprints” that provide excellent tracers of the origin of water. The GNIP program collects basic monthly data on isotopic content in precipitation from 183 active stations around the world. The GNIP database contains data collected at about 700 stations operated at some time during the last 50 years. An initial emphasis on tritium (an unstable radioactive isotope) later shifted to stable isotopes (see more information on GNIP in GCOS-101, and on the GNIP website: http://isohis.iaea.org)

Balázs Fekete noted that the Global Network Isotopes in Rivers (GNIR), recently declared operational by IAEA, had great potential to estimate total continental runoff [5]. Further investigations to this regard were underway, and publications in peer-reviewed literature are in preparation.

5.10 Global Precipitation Climatology Centre (GPCC)

Since the end of 1988 the GPCC is operated by Deutscher Wetterdienst (DWD, German Weather Service) under the auspices of the WMO as a German contribution to the World Climate Research Programme (WCRP) and to the Global Climate Observing System (GCOS).

The main objective of GPCC is the analysis of the spatial and temporal distribution of global land-surface precipitation on a monthly time-scale based on *in situ* observation data.

The rain gauge data base used for the GPCC analyses comprises:

- near real-time weather and climate observation data (SYNOP and CLIMAT) regularly exchanged via the WMO Global Telecommunication System (GTS);
- non real-time precipitation observation data provided by WMO Member States' National Meteorological and Hydrological Services (NMHSs). Up to now data of ca. 180 countries have been provided to GPCC. Additionally all major monthly precipitation station data bases, such as CRU, FAO and GHCN, have been integrated into GPCC's data base.

Thus GPCC holds the largest monthly *in situ* precipitation database of the world comprising more than 1.5 million station years (since 1951) of rain gauge based precipitation data of ca. 78,000 stations.

The GPCC data processing steps include quality-control and quality assurance of the station meta data, as well as of the precipitation data, interpolation of the station-related data to regular grids, and calculation of the spatial means on the 2.5° respectively 1.0° and 0.5° latitude/longitude grid areas.

In order to fulfill the different user requirements the GPCC has implemented a set of various gridded monthly precipitation products, which have been optimized for the purpose of their application.

Products maintained by GPCC:

A) First Guess Analysis (Oct. 2003-present)

- Designed for global precipitation anomaly analysis, useful e.g. for early drought monitoring;
- Based on weather observation data received near real-time via the GTS from ca. 6,500 stations; automatic-only quality-control.

B) Monitoring Product (Jan. 1986-present)

- Designed for global near real-time precipitation monitoring in context of GCOS and used as in-situ reference by GEWEX/GPCP for global satellite-gauge combined products;
- Based on weather and climate observation data from approximately 7,500 stations; automatic pre-control plus visual QC.

C) Full Data Reanalysis (1951-2004, Version 3)

- Optimized for high spatial density and accuracy as needed for model verification and water cycle studies;
- Based on near real-time data (as Monitoring Product) plus all additional monthly precipitation data in the GPCC data base; data coverage per month varies from 10,000 to more than 43,000 stations.

D) 50-Year Analysis of monthly precipitation (1951-2000, Version 1.1)

- Optimized for time-series homogeneity and quality needed for climate variability/trend analyses;
- Based on more than 9.300 stations in the GPCC data base providing almost complete time-series.

Next Steps:

The significantly enlarged data base enables GPCC to prepare a new global monthly precipitation climatology, which will be based upon more than 50,000 stations with at least 10 years of data and will be released by the end of this year. On the basis of this new background climatology new and extended versions of the Full Data Reanalysis (Version 4; period 1901-2006) and of the 50-Year Analysis (Version 2; period 1951-2005) will be prepared.

Corresponding to international agreement, station data provided by Third Parties to GPCC are protected. However, all gridded GPCC analysis products are disseminated free of charge via Internet (http://gpcc.dwd.de). More than 2000 users per month visualise and download GPCC products.

Project lead: B. Rudolf (until May 2006), T. Fuchs (since May 2006)

Project Participants:

U. Schneider, A. Meyer-Christoffer, additional GPCC-internal staff

5.11 International Groundwater Resources Assessment Centre (IGRAC)

Sophie Vermooten, of the Netherlands Institute of Applied Geoscience TNO at Utrecht, presented an overview of the International Groundwater Resources Assessment Centre (IGRAC) and its activities, and discussed the contribution of IGRAC to the GTN-H.

Assessment of the global groundwater resources is the core activity of International Groundwater Resources Assessment Centre (IGRAC). The change of groundwater in time makes the groundwater assessment a dynamical process and the groundwater monitoring a necessary precondition for the assessment.

Groundwater is monitored in many parts of the world, mainly by measuring groundwater levels, groundwater abstraction, spring discharge and water quality. The results of these point measurements are often interpolated and combined with other information pieces to produce various groundwater thematic maps covering aquifers, regions or even countries. There is, however, no systematic monitoring and assessment of groundwater change on global scales.

IGRAC intends to establish a sustainable Global Groundwater Monitoring System (GGMS) and to use monitored data for a periodic assessment of the global groundwater resources. The term ‘system’, is used to avoid the impression that a new, separate global ‘network’ of monitoring wells will be created. Likewise, no redesign of existing groundwater monitoring networks should be expected. The global monitoring system will use aggregated information from existing networks in order to represent a regional change of groundwater resources at the scale relevant for the global assessment.

A sound regional aggregation of the point groundwater measurements is usually more than a numerical interpolation and averaging procedure. It needs to be carried out by regional experts, making use of their knowledge of hydrogeological conditions, measurement practice, historical records, socio-economical setup, and other factors relevant for derivation of reliable figures. Therefore, establishment of a sustainable people network composed of skilled regional and/or country representatives is the main challenge of this initiative.

IGRAC is developing a web-based application to assist the aggregation procedure, as well as the gathering and dissemination of information. The GGMS application enables the user to periodically produce periodic on-line maps showing a regional change of groundwater variables in time. Representative groundwater point measurements and proxy information (such as precipitation and demography) can be uploaded in the application to assist the aggregation procedure. Moreover, the uploaded point measurements can be automatically interpolated, creating the basis for the subsequent aggregation. Once the aggregation is completed, the information is stored in the IGRAC database to be combined with information from other monitoring regions and eventually disseminated via the IGRAC portal.

The use of the GGMS application requires only a browser and the access to the Internet. Further on, the user has a direct access to the database and a full control over own data. The simplicity of the application and the clear information ownership are provided to ensure the commitment of the groundwater community in supporting and joining the network.

As complementary to the above described terrestrial measurements, IGRAC is exploring possibilities to use remote sensing observations for monitoring the change of global groundwater resources. The most promising method is GRACE (Gravity Recovery and Climate Experiment), dealing with gravity field change and the change in terrestrial water storage. The scale of the implementation and a specification of the groundwater storage component are the main GRACE challenges at this moment.

Next steps:

From 18 to 19 October 2007 the IGWCO/GARS/UNESCO Groundwater group will meet in Utrecht for a Workshop on global monitoring of groundwater resources. The workshop will bring together specialists from various fields to discuss the aspects of global monitoring and to design a plan of action. The main objectives of the workshop are as follows:

- To assess the state of relevant information resources including: terrestrial monitoring networks, remote sensing for the purpose of groundwater and large scale numerical models
- To set up a global groundwater monitoring system, including: monitoring networks and aggregation procedures, people network, technological framework
- To recommend research directions and promote international collaboration towards the goal of global groundwater resources monitoring.

The workshop will foster coordination among the following programmes and projects: GEO (Group on Earth Observations), GTN-H (Global Terrestrial Network for Hydrology), and GRAPHIC (Groundwater Resources Assessment under the Pressures of Humanity and Climate). Further, this workshop will constitute a second (open) meeting of IGWCO/GARS/ UNESCO Groundwater Working Group. Workshops participants will contribute to the completion of Terms of Reference and development of an Action Plan for the Working Group.

5.12 Snow Cover and Glacier Data

Richard Armstrong presented an overview of the National Snow and Ice Data Center (NSIDC) and the World Data Centre for Glaciology in Boulder, Colorado, USA, describing the data and products available from NSIDC and its relationship with GCOS, GTN-G, GTN-P and GTN-H.

The National Snow and Ice Data Center (NSIDC), University of Colorado, archives and distributes, free of charge, global data representing all components of the cryosphere, which include snow cover, glaciers, permafrost and seasonally frozen ground, river and lake ice, ice sheets, ice shelves, and sea ice.

Of particular interest to GTN-H are the components of the cryosphere which contribute most directly to the storage and flow of fresh water resources and thus a primary focus is on seasonal snow cover and glaciers.

Snow cover and glacier data sets are available through the NSIDC data catalogue and can be accessed through http://nsidc.org with direct user assistance available through nsidc@nsidc.org Data sets summarized below represent updates from the Report of the 2nd GTN-H Coordination Panel Meeting.

Snow Cover

In situ Snow Cover Data: There is no globally complete archive for in situ data. However, NSIDC continues in the attempt to fill this need, although financial and political considerations often prevent complete success. The archive of in situ snow measurements at NSIDC is one which is restricted to data that are discontinuous in space and time but nevertheless represent the single most comprehensive archive for in situ data. For example, the NSIDC directly receives data from the former Soviet Union for 1345 snow survey transects for 1966 to 1996, following digitization of these data through support by NSIDC and NOAA and from 284 WMO snow measurement sites for 1881 to 1995. A current project at NSIDC is to compile and grid all currently available station snow depth data from all possible sources in the Northern Hemisphere.

Satellite Snow Cover Data: NSIDC provides two long-term satellite records of hemispheric to global scale snow cover: 1) Weekly snow extent for the Northern Hemisphere, nominal resolution of 100 x 100 km, derived from visible wavelength satellite data for the period 1966 to the present; 2) Daily and monthly global snow extent and snow water equivalent (SWE), resolution of 25 x 25 km, derived from both visible and passive microwave satellite data for the period 1978 to the present.

Glaciers

Satellite Glacier Data: The completion of a global database of glacier outlines (vector shape files) is an important goal for both climate change analysis as well as for the successful prediction of future water resources. The Global Land Ice Measurements from Space (GLIMS) project at NSIDC is creating such a glacier inventory (http://glims.org). GLIMS relies on collaboration among over sixty institutions world-wide that provide the analysis corresponding to their particular region of expertise. Data received by the GLIMS team at NSIDC are ingested into a spatially-enabled database and made available via a website featuring an interactive map, and a Web-Mapping Service (WMS) (http://glims.colorado.edu/glacierdata). The GLIMS Glacier database currently contains outlines of over 58,000 glaciers representing all continents on which glacier ice is found. In addition, historical map-derived outlines are included in the archive to provide the context for comparison with current satellite-based assessments. Finally, this work is being undertaken in direct collaboration with the World Glacier Monitoring Service (WGMS), Zurich Switzerland, and is a logical extension of the WGMS World Glacier Inventory (WGI).

In situ (surface) Glacier Data: These data primarily include the historical time series of glacier terminus locations and mass balance. The global archive for these data is the WGMS. Similar to the contributor network described above for GLIMS, these data are available through an internationally coordinated global network. Activities at the WGMS are being undertaken in direct collaboration with NSIDC and GLIMS.

Prof. Wilfried Haeberli, Univ. of Zurich, is the Director of WGMS and chair of the GTN-G. GTN-G represents the coordinating body through which GTOS reports to GCOS on the topic of glaciers. Coordination between GTN-H and GTN-G is important to avoid duplication as well as to facilitate efficient and timely delivery of data to researchers worldwide. This coordination currently exists through the ongoing working association, and the current development of a formal MoU, between WGMS-Zurich and NSIDC/WDC-Boulder

GTN-G covers only glaciers while GTN-H should encompass all additional water in solid form – seasonal snow, semi-permanent snow, ground ice and river ice where it affects flow and storage. A possible approach for direct coordination between these two groups would be for GTN-H to mirror activity and products of GTN-G, assisted through the close collaboration between NSIDC and WGMS. GTN-H would then take sole responsibility for additional cryospheric variables considered essential to a comprehensive global hydrology network.

5.13 Development of a global hydrological monitoring system – Presentation of the project document

Wolfgang Grabs provided an overview of the project proposal “Hydrological Applications Runoff Network” (HARON). Main Objective of the project is to integrate, in a phased approach, dedicated river gauging networks of existing hydrological stations into a global runoff observation network with the principal goals to support water resources management while contributing in a cross-cutting fashion to all societal benefit areas of GEO. HARON is also designed to improve and support the closure of the global water budget, in line with requirements of GCOS and the Global Water Cycle Experiment (GEWEX).

The phases of the project are described as follows:

PHASE I – Upgrade & sustained maintenance of major global run-off stations, monitoring continental freshwater fluxes into the world’s oceans (link to GTN-R);

PHASE II – *Integration* of hydro-meteorological and related *in-situ* components *with satellite observations;*

PHASE III – Consolidation of integrated hydrological observation network development and application of user-oriented information products made available by HARON

HARON in its final implementation will form a platform for a broad global water cycle data integration system, combining water cycle in-situ, satellite, and model output data

At present, a full project proposal has been developed and is being promoted for funding. The project is being facilitated by GEO in collaboration with WMO and IGWCO.

6. Review of 2005 Action Items

Wolfgang Grabs and Stephan Bojinski reviewed with the meeting participants the status of action items that were agreed at the second GTN-H session in 2005 [5]. The following list contains the revised list of actions (completed actions have been deleted and numbering adjusted).

No	Action	Who	Progress to date	Next steps
1	Database of "pristine" basins available at GRDC	W. Grabs, H. Lins, U. Looser	Network under development	Ongoing; proposals coming in from various countries.
2	Clarify role of AQUASTAT as water use database with FAO	W. Grabs, S. Bojinski	None	Re-establish contact K. Frenken (FAO) (WG, SB)
3	Cross-check content of TEMS database with GTN-H inventory and FLUXNET	A. Letourneau	None	Refresh contact and set deadline March 2008 (WG, SB)
4	Clarify status of proposed international data centre for lakes in Russian Federation, including *in situ* and satellite-based data; take TOPC priority list into account	V. Vuglinsky, W. Grabs, S. Bojinski	Establishment of International Data Centre on the Hydrology of Lakes and Reservoirs at SHI St. Petersburg (HYDROLARE), June 2007	See milestones of HYDROLARE 1st Steering Committee report
5	Update GTN-H configuration diagram and inventory	S. Bojinski, W. Grabs	Done	Ongoing; Update
6	Update and amend GTN-H website, based on user feedback (see also 'Next steps' in section 1.1)	B. Fekete (D. Harvey)	Modest	Ongoing; Update urgently needed
7	Identify soil moisture network activities and relevant points of contact; organize meeting at ESA ESTEC	P. van Oevelen	Meeting of soil moisture community in July 2007; report pending	Establish institutional data collection (proposal by Portugal)
8	Document feedback to GTN-R support letter on GTN-R website	U. Looser (T. Maurer)	Done	Ongoing ; report by Looser
8a	Send new request letter on GTN-R to non-responding countries, and inform responding countries on progress	W. Grabs		By 1 January 08
9	Provide web-based	U. Looser, I.		Use of software

	demonstration of near real-time monitoring from a subset of GTN-R stations	Dornblut		developed in ETN-R framework for GTN-R by end of 2008
10	Inform GTN-G and GTN-P of GTN-H activities, and explore possible areas of coordination	S. Bojinski, W. Grabs	None	Establish contact at TOPC-10 in November 2007 (DG, SB)
11	Follow-up actions and recommendations of 2nd GTN-H panel meeting	B. Fekete (D. Harvey)	Modest	Regular reporting to Panel; meeting report

7. Position of GTN-H in the international context

Participants of the meeting agreed on a position paper presented by Wolfgang Grabs on the GTN-H and its contribution to the IGWCO and GEO (see Annex V).

The relevance and importance of the GTN-H as the observational arm of the IGWCO within GEO has been outlined. In addition, both the WMO/HWR and GCOS provide guidance to the GTN-H. Therefore, in view of the transition of the IGWCO into GEO, it would be appropriate to regularly report progress in GTN-H to the specific GEO Water Tasks mentioned in Annex IV. Additionally, consideration should be given to the ways in which the GTN-H might strengthen its position within GEO, and have a bearing on current and/or future Tasks of the GEO Work Plan. Figure 1 below outlines the relationship of the WMO/HWR and GCOS in the water domain with respect to GEO, and illustrates how they can to contribute to GEO Water Tasks through the IGWCO with inputs to the GTN-H. It may also be appropriate for the GTN-H to be represented in the GEO committee structure , such as the User Interface (UIC), Science and Technology (STC), Architecture and Data (ADC), or Capacity Building (CBC) Committees.

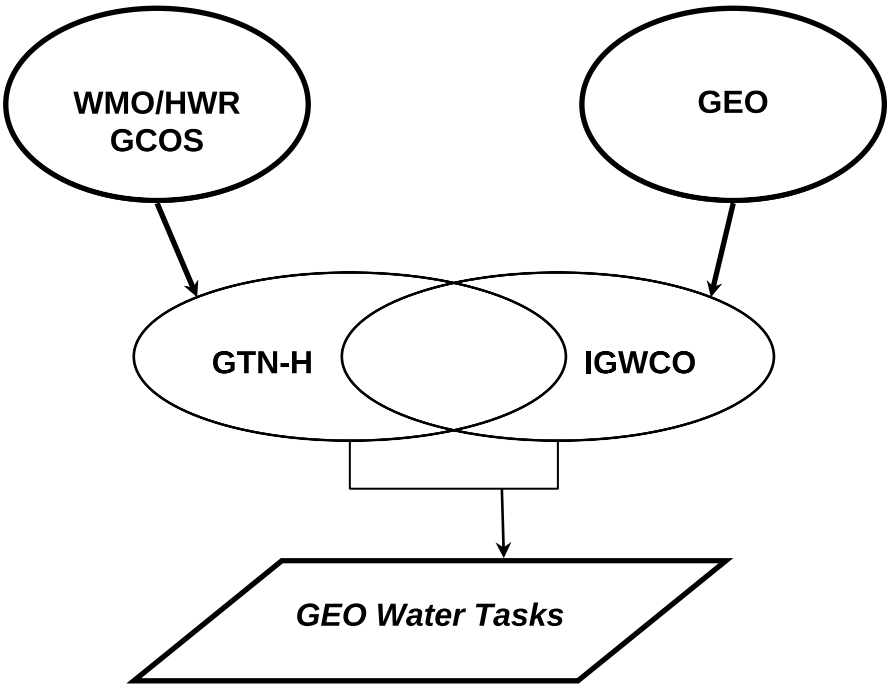

Fig. 3: With inputs to the GTN-H, the WMO/HWR and GCOS contribute to GEO Water Tasks, in coordination with the IGWCO.

8. Future Projects and Action Items

8.1 Proposals for new Projects

The current project structure was reviewed among the participants and a number of new projects under the umbrella of GTN-H were identified.

A. Trends in inorganic nitrogen (NO_2+NO_3, NH_3) concentrations at river monitoring stations

Although inorganic nitrogen concentrations are not climate-related, they deserve global attention and require therefore global exchange of datasets on the basis of river basins.

A project proposal for a monitoring of nitrogen concentrations at GEMS/Water was provided by Genevieve Carr (who will lead the project) and Richard Robarts:

Inorganic nitrogen released into the atmosphere has increased by several orders of magnitude over much of the globe since pre-industrial times. The deposition of inorganic nitrogen to inland aquatic environments contributes to the eutrophication of lakes and rivers, leading to increased productivity, shifts in community composition toward species more tolerant of high nutrient environments and, often, a loss of biodiversity. Similar impacts can be detected in near shore marine environments, where nutrients carried by rivers discharging into oceans can lead to changes in the ecology of these environments.

Nutrient loading to aquatic environments is an important issue globally and many efforts have been made at local, national, and international levels to limit loadings and slow rates of eutrophication. To this end, the implementation of best management practices (BMPs) in agricultural areas, advanced wastewater treatment facilities in urban areas, and emissions targets for industries and automobiles in many parts of the world should have detectable effects on nitrogen concentrations in rivers and lakes.

The goal of this study is to document global trends in inorganic nitrogen (nitrates and ammonia) concentrations at river water quality monitoring stations over space and time.

Water quality monitoring data from the global inland water quality monitoring database, GEMStat (www.gemstat.org), will be used to assess trends in inorganic nitrogen over time and space. River water quality monitoring stations in GEMStat are separated according to 'baseline' or minimally disturbed stations, 'trend' or impacted stations, and 'global river flux' stations that represent water quality at the mouths of large rivers discharging into the ocean.

As of 1 August 2007, GEMStat housed N data for 741 river stations from 61 countries. At the national level, median NO_2+NO_3 concentrations ranged from 0.03 mg L^{-1} to 20 mg L^{-1}, and median NH_3 concentrations ranged from 0.01 mg L^{-1} to 2 mg L^{-1} (with one country reporting median NH_3 concentrations of > 100 mg L-1).

When the data were constrained to only those stations that have been monitored for at least 10 years and the most recent observation was recorded within the last 5 years (i.e., since 13 August 2002), 305 stations from 16 countries remained in the data set. These stations will be evaluated in terms of long term trends in inorganic N.

Results will be examined at the scale of freshwater ecoregion, and collaborations with The Nature Conservancy (Carmen Revenga, Jennifer Molnar) will focus on quantifying effects of changes in nitrogen concentrations to habitat and biodiversity by ecoregion.

Next Steps:

Activity	Estimated time frame
Nonlinear and nonparametric trend analysis of NO2+NO3 and NH3 concentrations in rivers	31 October 2007
Study of spatial patterns in DIN in rivers	15 November 2007
Draft report of analysis of trends in rivers	1 January 2008
Final manuscript of global N trends submitted for publication	1 February 2008
Ecoregion analysis of nitrogen trends and effects on habitat and biodiversity	30 May 2008
Draft report of ecoregion analysis	30 June 2008

B. Estimation of Groundwater recharge

The objective of this joint project between GPCC, NSIDC/ GTN-G and IGRAC will be, to use observed trends in precipitation and snow equivalents to help estimate groundwater recharge. Meeting participants saw a good opportunity to integrate the three datasets, thereby producing a more valuable product.

C. Joint product(s)

Meeting participants agreed on a combined product between GPCC and GRDC. The essence of the project would be to establish region-wide correlations between monthly precipitation and runoff with a view to quantify streamflow sensitivity to precipitation. The project idea will be further developed by GPCC and GRDC

In the context of collaboration between GTN-H partners and the Global Water Systems Project (GWSP) mention was made by Balázs Fekete to develop a project concept incorporating GRDC's runoff time series, water use information and population dynamics. This project idea would need to be further developed through UNH.

D. NSIDC

In the meeting, participants discussed the role of NSIDC as the leading data centre for snow and ice. These datasets and products are essential indicators to detect climate variability and change. Participants concluded that NSIDC products would need to be adapted for use in hydrological forecasting and prediction. A small team would be formed on the basis of electronic communication to further develop this concept.

8.2 Action Items

Meeting participants agreed on the following new list of actions arising from the meeting.

No	Action	Who	Time-frame
12	Improve GTN-H website (News, Links, Maps, reports, other), provide concept asap	B. Fekete, S. Lorenz	By 31 October 07; commence updates ASAP
13	GTN-H letter to GEO Sec	W. Grabs, S. Bojinski, D. Goodrich	By 30 October 07
14	GTN-H G.P. presentation	Grabs/Bojinski/Lorenz	By 30 October 07
14a	GTN-H G.P. flyer, CD (with dissemination to all NHSs)	Grabs/Bojinski/Lorenz	By February 2008
14b	GTN-H –related publication in EOS;	Grabs/Bojinski/Fekete	By December 2007
14c	Publication in Nature/Science on dwindling networks; rationale for GTN-H etc	Grabs/Bojinski/Fekete	By March 2008
15	Formalize GTN-H coordination; WMO letter to UNH	W. Grabs	By 15 October 07
16	Liaise GRDC with WMO ET on Metadata Standards (for 1.3)	S. Bojinski	By 30 October 07
16a	Review title of project 1.3 (“Demonstration of metadata…”)	U. Looser, I. Dornblut	By 15 October 07
16b	Develop and use software to implement metadata profile, and to search for data and products (project 1.3)	U. Looser, I. Dornblut	By June 2008
17	Liaise UNH with WMO core metadata standard: where on the web	S. Bojinski	By 30 October 07
18	Ask GEWEX on status of water vapour observations, standards, data management	W. Grabs, S. Bojinski	Next GEWEX Steering Committee (Jan 08)
19	Explore with AOPC if perceived deficiency related to water vapour observations, e.g. standard observational practices	S. Bojinski	AOPC-XIV (April 2008)
20	Ask GTOS, ask Oak Ridge DAAC on status, products, level of guidance; ask users such as ECMWF	W. Grabs, S. Bojinski	30 Nov 07
21	Re-name ‘isotopes’ to ‘isotopic composition’ in GTN-H framework	S. Bojinski	15 Oct 07
22	Further steps in project 3.1 (mapping of BGC fluxes)	R. Robarts	By mid 2008
23	Write letter to countries that proposed data on pristine basins on the use of this data	U. Looser, W. Grabs	After workshop on use of pristine basins for climate analyses (first quarter 2008)

24	Send proposal for new project at GEMS/Water	R. Robarts	30 Sep 07
25	Promote idea of equivalent of 'Climate Outlook Fora' in the area of hydrology	J. Wellens-Mensah	To be discussed during next session of the Advisory Working group of CHy, in 2/2008
26	Formal agreement of GTN-H coordination, exchange of letters	W. Grabs, S. Bojinski, Ch. Vörösmarty	30 Nov 2007

9. Administrative matters and coordination of GTN-H

Recognizing that GTN-H has lacked support from a dedicated coordinator outside the Secretariats of both WMO and GCOS, participants welcomed the offer of the Charles Vörösmarty to take the lead in the coordination of GTN-H. Participants agreed that a coordination group will be established in the Water Systems Analysis Group at UNH under the leadership of Charles Vörösmarty. A dedicated GTN-H email address will be established and the website of GTN-H will be further hosted at UNH. The tasks of coordination are described in annex VI to this report. Formally, the GTN-H coordination will be agreed on by an exchange of letters between the secretariats of WMO and GCOS and UNH.

10. References

1. Global Terrestrial Network – Hydrology (GTN-H), Second Report of the GTN-H Coordination Panel Meeting, Koblenz, Germany, 4-5 July 2005 (GCOS-101, GTOS-37, WMO/TD No. 1298)

2. GCOS Secretariat (2006): Systematic Observation Requirements for Satellite-based Products for Climate. Supplemental details to the satellite-based component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC, GCOS-107/WMO-TD/No. 1338.

2. Fekete, B. M.; C. J. Vörösmarty and R. B. Lammers (2001): Scaling gridded river networks for macro-scale hydrology: Development and analysis and control of error, *Water Resources Research* 37(7), 1955-1968.

3. Fekete, B.M., Vörösmarty, C.J., Grabs, W. (1999): Global Composite Runoff Fields on Observed River Discharge and Simulated Water Balances. GRDC resports, 22. Global Runoff Data Centre, Koblenz.

4. Fekete, B. M., C. J. Vörösmarty and W. Grabs (2002): High resolution fields of global runoff combining observed river discharge and simulated water balances, *Global Biogeochem. Cycles*, *6*(3).

5. Fekete, B.M., Gibson, J.J., Aggarwal, P.,Vörösmarty, Ch. (2006):Application of isotope tracers in continental scale hydrological modeling, Journal of Hydrology, 330, 444-456.

These and other GCOS publications may be accessed through the GCOS World Wide Web site at http://www.wmo.int/pages/prog/gcos/.

Other publications can be accessed from the WMO webpage (www.wmo.int) and the webpage of GRDC (http://grdc.bafg.de/servlet/is/Entry.987.Display/). Publications from other network partners can be downloaded from their respective homepages.

Homepages of Network Partners (status October 2007)

GTN- R	http://gtn-r.bafg.de
GEMS/water	www.gemswater.org and www.gemstat.org
IGRAC	www.igrac.nl
IAEA	www.iaea.org/water
GPCC	http://www.dwd.de/en/FundE/Klima/KLIS/int/GPCC/GPCC.htm
NSIDC	http://nsidc.org/
Fluxnet	http://daac.ornl.gov/FLUXNET/
AQUASTAT/ FAO	http://www.fao.org/nr/water/aquastat/main/index.stm

11. Presentations and Other Material

The presentations and additional material from this meeting are available on the GTN-H website for download: http://gtn-h.unh.edu.

ANNEX I
Agenda

Monday, 17 September

09:00 Registration

09:30 Welcome and opening of the session (*BfG, Looser*)

09:40 Adoption of the agenda

09:45 Report of GTN-H development (*Grabs*)

10:15 Review of action items arising from the second session of the Panel (*Grabs*)

10:30 Coffee Break

10:45 Briefing on GCOS and the GCOS Implementation Plan (*Goodrich*)

11:00 Briefing on relevant activities of WMO; linkage to other relevant programmes and activities (*Grabs*)

11:15 Update on GTOS (*Grabs [for Sessa]*)

11:30 Review of projects - update from the second GTN-H panel session

Project 1.1 - Development of GTN-H website (*Fekete*)
Project 1.2 - Inventory of existing data products, databases, and organizations (*Bojinski*)
Project 1.3 - Demonstration of metadata catalog and standardization procedures (*Dornblut*)
Project 2.2 - Map product on real-time hydrological data acquisition (*Dornblut)*

12:30 Lunch

14:00 Review of projects (*continued*):

Project 2.1 - Development of gridded runoff datasets (*Fekete*)
Project 3.1 - Mapping of biogeochemical fluxes (*Robarts*)

15:00 Coffee Break

15:15 Review of projects (*continued*):

Project 4.1 - Reference hydrological dataset – Pristine basins (*Grabs, Looser*)

15:45 Reports from network partners:

Network of isotopes in precipitation (*Bojinski [for Araguas]*)
Review of activities of the GPCC (*Rudolf*)
Snow cover, glaciers and icecaps (*Armstrong*)

17:00 Session adjourns

Tuesday, 18 September

09:00 Reports from network partners (*continued*)

Lakes and reservoirs (*Vuglinsky*)
Soil moisture (*Grabs [for Van Oevelen]*)
Surface Runoff (*Looser*)
Groundwater *(Vermooten*)

10:30 Coffee break

10:45 Reports from network partners (*continued*)

Water quality (*Robarts*)
Water vapour (*Bojinski*)
Evapotranspiration (*Bojinski*)
Water use (*Grabs*)

11:15 Development of a global hydrological monitoring system – Presentation of the project document (*Grabs*)

11:30 Position of GTN-H in the international context (*open discussion*)

- Views of GCOS
- Views of GTOS
- Development and operation of the Integrated Global Water Cycle Observations (IGWCO) theme of the IGOS partnership
- The GEO 10-year Implementation Plan, water and related societal benefit areas, IGWCO and GEOSS

12:30 Lunch

13:30 Position and role of GTN-H in the international context (*continued*)

15:00 Coffee Break

15:15 Review of project structure; future projects

16:30 Decision on implementation of old projects, and identification of new projects

17:00 Session adjourns

Wednesday, 19 September

09:00 Administrative matters and coordination of GTN-H

09:45 Future work plan and milestones for the next 18 months

10:30 Coffee break

10:45 Any other business

11:00 Meeting adjourns

<u>Note</u>*: After lunch break, the meeting of the Steering Committee of the Global Runoff Data Centre (GRDC) is expected to open in the same location*

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ANNEX II
List of Participants

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Annex III
GCOS Recommendation to Space Agencies

GCOS Recommendation to Space Agencies to generate satellite base products

Systematic Observation Requirements for Satellite-Based Products for Climate (GCOS – 107, WMO/TD No. 1338)

Table 1: Overview of Products – Terrestrial

ECVs / Global Products requiring Satellite Observations	Fundamental Climate Data Records required for Product Generation (from past, current and future missions)
Lakes For lakes in the Global Terrestrial Network for Lakes: Maps of lakes; Lake levels; Surface temperatures of lakes	VIS/NIR imagery, and radar imagery; Altimetry; High-resolution IR imagery
Glaciers and Ice Caps Maps of the areas covered by glaciers other than ice sheets; Ice-sheet elevation changes for mass-balance determination	High-resolution VIS/NIR/SWIR optical imagery; Altimetry
Snow Cover Snow areal extent	Moderate-resolution VIS/NIR/IR and passive microwave imagery
Albedo Directional-hemispherical (black sky) albedo	Multispectral and broadband imagery
Land Cover Moderate-resolution maps of land-cover type; High-resolution maps of land-cover type, for the detection of land-cover change	Moderate-resolution multispectral VIS/NIR imagery; High-resolution multispectral VIS/NIR imagery
fAPAR Maps of fAPAR	VIS/NIR imagery
LAI Maps of LAI	VIS/NIR imagery
Biomass Research towards global, above-ground forest biomass and forest-biomass change	L band / P band SAR; Laser altimetry
Fire Disturbance Burnt area, supplemented by active-fire maps and fire-radiated power	VIS/NIR/SWIR/TIR moderate-resolution multispectral imagery
Soil Moisture[4] Research towards global near-surface soil-moisture map (up to 10cm soil depth)	Active and passive microwave

Table 2: Overview of Products - Ocean

ECVs / Global Products requiring Satellite Observations	Fundamental Climate Data Records required for Product Generation (from past, current and future missions)
Sea Ice Sea-ice concentration	Microwave and visible imagery
Sea Level Sea level and variability of its global mean	Altimetry
Sea Surface Temperature Sea-surface temperature	Single and multi-view IR and microwave imagery
Ocean Colour Ocean colour and oceanic chlorophyll-a concentration derived from ocean colour	Multispectral VIS imagery
Sea State Wave height and other measures of sea state (wave direction, wavelength, time period)	Altimetry
Ocean Salinity Research towards the measurement of changes in sea-surface salinity	Microwave radiances
Ocean Reanalyses utilizing altimeter and ocean surface satellite measurements	Key FCDRs and products identified in this report, and other data of value to the analyses

Table 3: Overview of Products – Atmosphere

ECVs / Global Products requiring Satellite Observations	Fundamental Climate Data Records required for Product Generation (from past, current and future missions)
Surface Wind Speed and Direction Surface vector winds analyses, particularly from reanalysis	Passive microwave radiances and scatterometry
Upper-air Temperature Homogenized upper-air temperature analyses: Extended MSU-equivalent temperature record; New record for upper-troposphere and lower-stratosphere temperature using data from radio occultation; Temperature analyses obtained from reanalyses	Passive microwave radiances; GPS radio occultation; High-spectral resolution IR radiances for use in reanalysis
Water Vapour Total column water vapour over the ocean and over land; Troposphere and lower- stratosphere profiles of water vapour	Passive microwave radiances; UV/VIS radiances; IR imagery and soundings in the 6.7 µm band; Microwave soundings in the 183 GHz band
Cloud Properties Cloud radiative properties (initially key ISCCP products)	VIS/IR imagery; IR and microwave soundings
Precipitation Improved estimates of precipitation, both as derived from specific satellite instruments and as provided by composite products	Passive microwave radiances; High-frequency geostationary IR measurements; Active radar (for calibration)
Earth Radiation Budget Top-of-atmosphere Earth radiation budget on a continuous basis	Broadband radiances; Spectrally-resolved solar irradiances; Geostationary multispectral imagery
Ozone Profiles and total column of ozone	UV/VIS and IR/microwave radiances
Aerosol Properties Aerosol optical depth and other aerosol properties	VIS/NIR/SWIR radiances
Carbon Dioxide, Methane and other GHGs Distribution of greenhouse gases, such as CO_2 and CH_4, of sufficient quality to estimate regional sources and sinks	NIR/IR radiances
Upper-air Wind Upper-air wind analyses, particularly from reanalysis	VIS/IR imagery; Doppler wind lidar
Atmospheric Reanalyses	Key FCDRs and products identified in this report, and other data of value to the analyses

ANNEX IV
Water Tasks of GEO

Water Tasks in the Geo 2007-2009 work plan (status 19th October 2007)

WA-06-02: Forecast Models for Drought and Water Resource Management
This Task is led by Tunisia, WCRP and IGOS-P.
Enhanced prediction of the global water cycle variation is a key contribution to mitigation of water-related disasters, drought and sustainable human development. Forecasting methods are to be improved for use by hydrological services throughout the world. The hydrological data and information system infrastructure should be determined, the data from hydrological and meteorological services should be pulled together first on a global level including moisture flux from the air-sea interface, on a national level including terrestrial systems and then on river basin level. The systems should also be made interoperable to facilitate global exchange of data and information. An international symposium is proposed to be held on approaches to Earth observations, drought predictive capabilities and management responses.

WA-06-07: Capacity Building Program for Water Resource Management
This Task is led by IGOS-P and Tunisia.

Initiate capacity building programs to develop tools for using Earth Observation data in support of water management, and to show the value of Earth observations generally in water resource management. The program will be initiated in Latin America and will then be extended to Asia and Africa. Linkages with existing efforts of GEO Members and Participating Organisations will be made.

WA-07-01: Global Water Quality Monitoring
This Task is led by IGWCO.

Many aspects of water quality monitoring and assessment, both in-situ and remotely sensed are severely deficient. Many countries lack the technical, institutional, and financial resources to conduct proper assessments using in-situ water quality monitoring methods for terrestrial sources and in the coastal ocean. Remote-sensed operational systems of global-scale freshwater quality are non-existent. Operational observation systems need to be developed, and the resulting information systems should be made compatible and interoperable as part of the system of systems. This Task is built on the outcomes of the water quality workshop in 2006 (1st Inland and Coastal Water Quality workshop)and first pilot projects are being planned to begin in Asia as a result of the Asia Water Resource Management Capacity Building Workshop. This Task has relevant synergies with HE-07-02.

WA-08-P1: Integration of In-situ and Satellite Data for Water Cycle Monitoring
This Task represents the merger of WA-06-05 and WA-07-02. Lead is not defined yet.

Current capabilities of water cycle observations are inadequate for monitoring long-term changes in the global water system and their feedback into the climate system. In addition, the lack and inaccessibility of crucial data is a major constraint on decision-making for sustainable development of water resources and improvement of water management practices. To address this gap, an integrative initiative is needed, involving different types of scientific- as well as applications-oriented efforts and initiatives (e.g. WCRP/GEWEX/CEOP). It would combine different types of satellite and in-situ observations related to key variables of the water cycle (e.g. precipitation, soil moisture, snow water equivalent, surface water, ground water, streamflow, etc.), eventually with model outputs, for improved accuracy and global coverage. In addition to filling gaps in measurement capability, the initiative should advocate the interoperability of observing systems and standardization of metadata in order to promote the sharing of data and telecommunication infrastructures. The Hydrological Applications and Run-Off Network (HARON) Project is proposed as one of the means to accomplish the operational aspect of these goals, and ultimately provide the most comprehensive water cycle information possible to the science community, water resource managers, and other decision-makers. Other ongoing initiatives related to integrated precipitation products, soil moisture and groundwater will also provide essential contributions.

ANNEX V
GTN-H Linkage to IGWCO and GEO

The GTN-H and its Contributions to the IGWCO and GEO

1. Introduction

The GTN-H
In the year 2000, water experts from the Hydrology and Water Resources (HWR) Department of the World Meteorological Organization (WMO), along with the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS), recognized the need for better global observations of the water cycle. This recognition gave rise to the concept of a global hydrological observation network, one that would provide timely information, data, and products in support of climate research and improved water resource management. A year later, at the conclusion of a second expert meeting, the Global Terrestrial Network – Hydrology (GTN-H) was formed. As a “network of networks,” the main objective of the GTN-H is to enhance the value of data from existing hydrological observational networks through synergistic integration to produce datasets suitable for research in the areas of global and regional climate change, environmental concerns, and water quality and resource management.

The IGWCO
The Integrated Global Observing Strategy Partnership (IGOS-P) launched the Integrated Global Water Cycle Observation (IGWCO) Theme in 2004 to address critical environmental and social issues pertaining to the hydrologic cycle. These issues include the long-term sustainability of safe water provision for human activities globally, and the need to detect and understand climate change through the observation and analysis of trends in atmospheric water vapor, precipitation, stream flow, and other water cycle variables. Thus, the primary objective of the IGWCO is to provide a framework for guiding decisions regarding priorities and strategies for the maintenance, scope, and enhancement of water cycle observations. From this perspective of providing guidance strategy, the IGWCO is presently active in the following areas:

- precipitation and runoff
- soil moisture and groundwater
- water quality
- capacity building

A second main objective of the IGWCO is to promote strategies that facilitate the acquisition, processing, and distribution of data products needed for effective management of the worlds water resources. To achieve these goals, the initial activities will rely on space-based systems and *in-situ* networks that are currently in place or planned. Furthermore, it will engage the global community through multiple linkages to global programs and internationally coordinated activities.

The IGWCO may be characterized as a “best efforts” enterprise in that it sets up strategies, identifies partners, and then attempts to foster collaboration between them. As such, it relies on the good will and cooperation of the agencies it is involved with to accomplish agreed-upon goals.

GEO
In response to the World Summit on Sustainable Development (WSSD) held in Johannesburg (2000) which called for strengthened cooperation and coordination among global observing systems and research programs to produce integrated global observations, confirmed by the G-8 Summit held in Evian (2003), the Group on Earth Observations (GEO) was established at the time of the Earth Observation Summit in Washington DC (2003). GEO is charged with the development of a Global Earth Observation System of Systems (GEOSS) over the next decade, whose purpose will be to achieve comprehensive, coordinated, and sustained observations of the Earth system. This integrative approach should improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the Earth system. Among the 9 Societal Benefit Areas (SBAs) providing focus for GEO's activities, the Water SBA aims to improve water resource management through better understanding of the water cycle.

2. Transitioning the IGWCO into GEO

A proposal initiated at the time of the Third Plenary of the GEO (Bonn, November 2006) called for the individual Themes under IGOS-P to be transitioned into GEO. At the 3rd Annual Planning Meeting of the IGWCO (Washington DC, March 2007) and the 14th Session of the IGOS-P (Paris, May 2007), this proposal was discussed and ultimately accepted. Thus, it is anticipated that all IGOS-P Themes will be transitioned into GEO and the IGOS-P itself dissolved by the time of the GEO Ministerial Summit in Capetown, November 2007. Negotiations of each IGOS-P Theme regarding the terms of integration into GEO are currently under way, including the IGWCO.

The transition is expected to be a smooth one, given that the objectives of the IGWCO are largely similar to those of GEO with respect to global observations of the hydrologic cycle, and especially since the IGWCO already contributes to each of GEO's Water Tasks to varying degrees.

3. The GTN-H as Observational Arm of the IGWCO in GEO

Given that the GTN-H is concerned with the establishment of a global hydrological observation network, the GTN-H has been an integral part of fulfilling the observational objectives of the IGWCO. Indeed, the IGWCO regards the GTN-H as a leading initiative to improve access to data through the identification of relevant observational networks and promotion of common standards. It will therefore continue to have an important role to play as the IGWCO transitions into GEO. This is especially true where the GTN-H is involved in products that:

- enhance baseline or core hydrological data and thus improve our knowledge of hydrology;
- are designed to address specific science questions and ultimately provide reference hydrological datasets for use in detecting climate change.

Specific areas in which the GTN-H could influence GEO through the IGWCO include:

- Water Task WA-05-06: "Initiate the creation of a coordination mechanism within GEO for global in-situ water observations, including ocean observations, and advocate synergy and sharing of infrastructure among observing systems. In addition to filling gaps in measurement capability, interoperability of observing systems, and standardization of metadata for data sharing, progress in product development of the global near real-time river runoff network, advocate sharing of telecommunication infrastructure and joint know-how are important goals that need to be reached within the next few years."
- Water Task WA-02-07: "Develop an operational mechanism to provide water level observations in rivers, lakes/reservoirs and estuaries from satellite observations to

support the upgrade of deficient run-off water gauge networks. Combine different types of satellite data that are relevant for water quantity measurements (snow water equivalent, stream flow) with in-situ observations for better accuracy and global coverage."

The Hydrological Application and Runoff Network (HARON) project has been proposed as a means of fulfilling both water tasks. The project seeks to restore an existing network of hydrological stations, starting initially with the upgrade and sustained maintenance of major global run-off stations. In later phases, the project will be enhanced by the addition of observations from hydro-meteorological and related in-situ components, combined with remotely-sensed data from Space. This comprehensive approach will advance integration with other environmental networks, and foster interoperation with supporting synoptic weather observations, in a cross-cutting, globally coordinated effort. The main partners of HARON will be GEO Members and Participating Organizations, the WMO/HWR, GCOS, and the IGWCO. It is further proposed that HARON be built on the basis of the GTN-H, and several of the GTN-H projects would be most appropriate in this regard:

- Project 1.3: Demonstration of Metadata
- Project 2.1: Development of Gridded Runoff Datasets
- Project 2.2: Map Product on Real-Time Hydrological Conditions
- Project 4.1: Reference Hydrological Dataset
- Project 4.2: GTN-H Networks

Another issue of importance to both the IGWCO and GEO is water quality. In order to quantify the linkages between water quality and health, the IGWCO has identified a globally integrated strategy for monitoring water quality as another of its water cycle objectives. Both *in-situ* and remotely sensed monitoring are essential components of this approach. For its part, GEO has been pivotal in bringing together expert technical advice on water quality issues via remote sensing. In particular, GEO held a Nearshore Coastal Water Quality Remote Sensing Workshop (27-29 March 2007, Geneva), which dealt with an extensive list of issues including inland waters and coastal land, data reception and processing algorithms, and sensor design and calibration. This was one of the activities within the Water Task devoted to water quality:

- WA-01-07: "Many aspects of water quality monitoring and assessment, both in-situ and remotely sensed are severely deficient. Many countries lack the technical, institutional, and financial resources to conduct proper assessments using in-situ water quality monitoring methods for terrestrial sources and in the coastal ocean. Remote-sensed operational systems of global-scale freshwater quality are non-existent. Operational observation systems need to be developed, and the resulting information systems should be made compatible and interoperable as part of the system of systems."

The GTN-H with its goal of providing products that result from the integration of existing datasets, such as the mapping of biogeochemical fluxes (Project 3.1), is well suited to contribute to this particular water task.

4. Outlook

The relevance and importance of the GTN-H as the observational arm of the IGWCO within GEO has been outlined. In addition, both the WMO/HWR and GCOS provide guidance to the GTN-H. Therefore, in view of the transition of the IGWCO into GEO, it would be appropriate to revise and streamline the Workplan of the GTN-H to emphasize its contributions to the specific GEO Water Tasks mentioned. Additionally, consideration should be given to the ways in which the GTN-H might strengthen its position within GEO, and have a bearing on current and/or future Tasks of the GEO Workplan. Figure 1 below outlines the relationship of the WMO/HWR and GCOS with respect to GEO, and illustrates how they can to contribute to GEO Water Tasks through the IGWCO with inputs to the GTN-H. It may also be appropriate for the GTN-H to be represented on one of GEO's committees, such as the User Interface (UIC), Science and Technology (STC), Architecture and Data (ADC), or Capacity Building (CBC) Committees.

ANNEX VI
Tasks of Coordination

Coordination of the Global Terrestrial Network – Hydrology (GTN-H)

The Global Terrestrial Network – Hydrology (GTN-H), jointly operated by WMO, GCOS and GTOS, is looking for a volunteer coordinator of its activities. The coordinator will be actively supported in his tasks by the Secretariats of WMO, GCOS and GTOS.

Background:
The GTN-H has been established in June 2002 as 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 has been recognized by the IGOS-P Water and the GEOSS as a major building block in the development of the Integrated Global water Cycle Observation Theme (IGWCO).

The main responsibilities of the GTN-H Panel 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.

TASKS OF THE GTN-H COORDINATOR

Principal tasks

I. Provide organizational, conceptional and secretarial support to the Global Terrestrial Network – Hydrology (GTN-H);

II. Keep oversight of all activities related to GTN-H

<u>In more detail, the principal tasks include:</u>

i. Organization of meetings of the Panel of GTN-H (every approx. 15-24 months);
ii. Chair session of the GTN-H Panel;

iii. Monitor implementation of activities agreed during the panel meetings and in particular the projects agreed by the Panel;
iv. Liaise with partners of GTN-H, including WMO, GCOS (TOPC) , GTOS, ;
v. Liaise and cooperate with partners that are of interest for GTN-H, in particular IGOS-IGWCO and GEOSS;
vi. Provide conceptual inputs for the further development and implementation of GTN-H;
vii. Develop articles and promotional material for GTN-H;
viii. Maintain the website of GTN-H.

ANNEX VII
Acronyms

ACIA	Arctic Climate Impact Assessment
AOPC	Atmospheric Observation Panel for Climate
AQUASTAT	Information System on Water and Agriculture (FAO)
BfG	Bundesanstalt für Gewässerkunde (German Federal Institute of Hydrology)
BGC	Biogeochemicals
CBS	Commission for Basic Systems (WMO)
CCl	Commission for Climatology (WMO)
CEOS	Committee on Earth Observation Satellites
CHy	Commission for Hydrology (WMO)
CIMO	Commission for Instruments and Methods of Observation (WMO)
CliC	Climate and Cryosphere (WCRP)
CLIMAT	Report of monthly means and totals from a World Weather Watch land station
DAAC	Distributed Active Archive Centre
DBCP	Data Buoy Cooperation Panel
DIF	Data Interchange Format
DWD	Deutscher Wetterdienst
ECV	Essential Climate Variable
EFAS	European Flood Forecasting System
ESA	European Space Agency
ET	Evapotranspiration
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAGS	Federation of Astronomical and Geophysical Data Analysis Services
FAO	Food and Agriculture Organization of the United Nations
FLUXNET	Flux and Energy Exchange Network
FRIEND	Flow Regimes from International Experimental and Network Data Sets
FTP	File Transfer Protocol
GCOS	Global Climate Observing System
GEMS	Global Environmental Monitoring System
GEMS/Water	Global Environmental Monitoring System for Water
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GEWEX	Global Energy and Water Cycle Experiment
GGIS	Global Groundwater Information System
GHOST	Global Hierarchical Observing Strategy
GLIMS	Global Land Ice Measurements from Space
GNIP	Global Network of Isotopes in Precipitation
GOCE	Gravity Field and Steady-State Ocean Circulation Explorer
GOS	Global Observing System
GOSIC	Global Observing Systems Information Center
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GRDC	Global Runoff Data Centre

GSN	GCOS Surface Network
GSWP	Global Soil Wetness Project
GWSP	Global Water Systems Project
GT-NET	Global Terrestrial Observing Network
GTN-G	Global Terrestrial Network for Glaciers
GTN-H	Global Terrestrial Network - Hydrology
GTN-L	Global Terrestrial Network for Lakes
GTN-R	Global Terrestrial Network for Rivers
GTOS	Global Terrestrial Observing System
HELP	Hydrology for Environment, Life and Policy
HWR	Hydrology and Water Resources Department (WMO)
HYCOS	Hydrological Cycle Observing System
HYDROLARE	International Centre of Data on Hydrology of Lakes and Reservoirs
HYDROS	Hydrosphere State Mission
IAEA	International Atomic Energy Agency
ICSU	International Council for Science
IGOS	Integrated Global Observing System
IGRAC	International Groundwater Resources Assessment Centre
IGWCO	Integrated Global Water Cycle Observations
ILEC	International Lake Environment Committee Foundation
IMS	Internet Mapping Server
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IODE	International Oceanographic Data and Information Exchange
IPCC	Intergovernmental Panel on Climate Change
IR	Infrared
ISMWG	International Soil Moisture Working Group
ISO	International Organization for Standardization
ISOHIS	Isotope Hydrology Information System
JAXA	Japan Aerospace Exploration Agency
JCOMM	Joint Technical Commission for Oceanography and Marine
Meteorology	
JMA	Japan Meteorological Agency
LDAS	Land Surface Data Assimilation System
METOP	Meteorological Operational Polar Satellite
MODIS	Moderate Resolution Imaging Spectroradiometer
MSC	Meteorological Service of Canada
MSG	Meteosat Second Generation
NASA	National Aeronautics and Space Administration (USA)
NCDC	National Climatic Data Center
NESDIS	National Environmental Satellite, Data, and Information Service
(NOAA)	
NMHS	National Meteorological and Hydrological Service
NIR	Near Infrared
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration (USA)
NOKIS	North and Baltic Sea Coastal Information System
NPOESS	National Polar Orbiting Operational Environmental Satellite System
NRT	Near real time
NSIDC	National Snow and Ice Data Center
NWP	Numerical Weather Prediction

POC	Point of Contact
SAF	Satellite Application Facility
SAR	Synthetic Aperture Radar
SHI	State Hydrological Institute (Russian Federation)
SMOS	Soil Moisture and Ocean Salinity Mission
SOT	Ship Observations Team
SSM/I	Special Sensor Microwave/Imager
SWE	Snow Water Equivalent
TAO	Tropical Atmosphere Ocean Project
TEMS	Terrestrial Ecosystem Monitoring System
TIP	TAO Implementation Panel
TOPC	Terrestrial Observation Panel for Climate
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USGS	United States Geological Survey
VOS	Voluntary Observing Ship
VOSClim	Voluntary Observing Ship Climate Project
WatER	Water Elevation Recovery
WCMS	WMO Core Metadata Standard
WCP	World Climate Programme (WMO)
WCRP	World Climate Research Programme
WDC	World Data Centre
WGMS	World Glacier Monitoring Service
WMO	World Meteorological Organization
WRAP	World Resources Application Project
WWW	World Weather Watch (WMO)

LIST OF GCOS PUBLICATIONS*

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

*GCOS publications may be accessed through the GCOS website at:
http://www.wmo.int/pages/prog/gcos

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

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

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

GCOS-61 (WMO/TD-No. 1031) — Report of the ninth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS (Beijing, China, September 12-14, 2000)

GCOS-62 (WMO/TD-No. 1038) — Report of the Pacific Islands Regional Implementation Workshop on Improving Global Climate Observing Systems (Apia, Samoa, August 14-15, 2000)

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

GCOS-64 (GOOS-107) — Report of the eighth session of the TAO Implementation Panel (TIP-8) (St. Raphael, France, October 15, 1999)

GCOS-65 (WMO/TD-No. 1055) — Report of the sixth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 10-13, 2000)

GCOS-66 (GOOS-108) — Report of the ninth session of the TAO Implementation Panel (TIP-9) (Perth, Australia, November 16-17, 2000)

GCOS-67 (WMO/TD-No. 1072) — GCOS Implementation Strategy: Implementing GCOS in the New Millennium

GCOS-68 (WMO/TD-No. 1093) — Report of the seventh session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 30-3 May, 2001)

GCOS-69 (GOOS-98) — Report of the fifth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Bergen, Norway, June 20-23, 2000

GCOS-70 (GOOS-113) — Report of the sixth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Melbourne, Australia, May 2-5, 2001

GCOS-71 (WMO/TD-No. 1099) (GTOS-29) — Report of the GCOS/GTOS/HWRP Expert Meeting on the Implementation of a Global Terrestrial Network - Hydrology (GTN-H), Koblenz, Germany, June 21-22, 2001

GCOS-72 (GOOS-116) — Report of the seventh session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, April 26-27, 2001

GCOS-73 (WMO/TD-No. 1106) — Manual on the GCOS Surface and Upper-Air Networks: GSN and GUAN, April 2002

GCOS-74 (WMO/TD-No. 1109) — Report of the GCOS Regional Workshop for Eastern and Southern Africa on Improving Observing Systems for Climate, Kisumu, Kenya, October 3-5, 2001

GCOS-75 (WMO/TD-No. 1124) — Summary Report of the tenth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Farnham, UK, April 15-19, 2002

GCOS-76 (WMO/TD-No. 1125) — Report of the eighth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Wokingham, UK, May 20-24, 2002

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

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

GCOS-104	Report of the tenth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate Tenth, Geneva, Switzerland, May 9-12, 2005
(GOOS-150)	Session Final Report
GCOS-105 (WMO/TD-No. 1374)	Conclusions from the Twelfth Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Geneva, Switzerland, April 3-7, 2006
GCOS-106 (WMO/TD-No. 1337)	Report of the GCOS Regional Workshop for the Mediterranean Basin, Marrakech, Morocco, November 22-24, 2005
GCOS-107 (WMO/TD-No. 1338)	Systematic Observation Requirements for Satellite-Based Products for Climate
GCOS-108 (WMO/TD-No. 1358)	Climate Information for Development Needs an Action Plan for Africa, Report and Implementation Strategy, Addis Ababa, Ethiopia, 18-21 April 2006
GCOS-109 (WMO/TD-No 1363)	Summary report of the fourteenth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Geneva, Switzerland 10-12 October 2006
GCOS-110 (WMO/TD-No. 1370) (GOOS No. 154) (WCRP No.)	Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Eleventh Session, Tokyo, Japan 16-20 May 2006
GCOS-111 (WMO/TD-No. 1371) (GTOS No. 43)	Summary Report of the ninth session of the GTOS/GCOS Terrestrial Observation Panel for Climate, Ispra, Italy 28-29 March 2006
GCOS-112 (WMO/TD-No. 1379)	GCOS Reference Upper-Air Network (GRUAN): Justification, requirements, siting and instrumentation options
GCOS-113 (WMO/TD-No. 1396)	Report of the Third Meeting of the GCOS Cooperation Board (Geneva, Switzerland, 27 April 2007)
GCOS-114 (WMO/TD-No. 1407)	Thirteenth Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-XIII) – Consolidated List of Conclusions, Recommendations and Action Items (Geneva, Switzerland, 23-27 April 2007)
GCOS 115 (WMO/TD-No. 1408) (GTOS No. 51)	Report of the 3rd GTN-H Coordination Panel Meeting, Koblenz, Germany, 17-19 September 2007

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