

# Summary Report of the Thirteenth Session of the Terrestrial Observation Panel for Climate (TOPC) of the Global Climate Observing System and the Global Terrestrial Observing System

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## 1. Welcome and Introduction

The Terrestrial Observation Panel for Climate (TOPC) was set up to develop a balanced and integrated system of *in-situ* and satellite observations of the terrestrial ecosystem. The Panel focuses on the identification of terrestrial observation requirements, assisting the establishment of observing networks for climate, providing guidance on observation standards and norms, facilitating access to climate data and information and its assimilation, and promoting climate studies and assessments. TOPC is jointly sponsored by the Global Climate Observing System (GCOS), the Global Terrestrial Observing System (GTOS) of the United Nations Food and Agricultural Organization (FAO) and the World Climate Research Programme (WCRP).

The thirteenth Session of the TOPC was held 10-11 March 2011 at WMO Headquarters in Geneva, Switzerland. This report summarizes key discussions and outcomes rather than being a full record of the meeting.

### 1.1 Opening Remarks

Prof. Han Dolman, Chairman of the TOPC, opened the meeting and Dr Wenjian Zhang, Director of the WMO Observing and Information Systems Department, welcomed panel members and invited experts to the session on behalf of WMO. Dr Zhang noted that it was already the second GCOS panel meeting taking place in 2011 and that he was glad WMO hosted for the first time a TOPC meeting. As an important event, he mentioned the upcoming 16<sup>th</sup> Session of the WMO Congress (16 May to 3 June, Geneva), which is expected to agree on key priorities, among them the future Global Framework for Climate Services (GFCS) and the WMO Integrated Observing System (WIGOS). Taking into account the need for improved climate observations as the fundamental basis on which a new global framework for climate services will be built, GCOS is expected to play an important role. He also stressed the critical contribution of the panels' work to these priorities and to the overall implementation of GCOS. Pointing out the importance of capacity building for climate observations in enabling Members to provide climate services and the fundamental role of WIGOS and the WMO Information System (WIS), Dr Zhang ensured the full and continuous support from WMO to its cross cutting observing systems and highlighted the need for joint activities

### 1.2 Approval of Agenda

The panel adopted the agenda on the basis that it could be adjusted during the session as necessary. The final meeting agenda is given in Annex I and the list of participants is included in Annex II.

## 2. Update on GCOS

Dr Carolin Richter, Director of the GCOS Secretariat, outlined upcoming GCOS-related meetings and activities.

The week after TOPC-XIII, a meeting of the Global Terrestrial Network for Hydrology (GTN-H) was planned in Tokyo, Japan, but had to be postponed as consequence of the major earthquake on 11 March.

Dr Richter in particular mentioned the upcoming 15<sup>th</sup> Session of the Ocean Observation Panel for Climate (OOPC, 1–2 April 2011, Paris, France), being combined with the Deep Ocean Observing Strategy Workshop (30 March to 1 April 2011, Paris, France); the upcoming GCOS Steering Committee (SC) meeting (20–23 September at ECMWF, Reading, UK); and the WCRP Open Science Conference (24–28 October, Denver, USA), where SC Chairman Prof. Adrian Simmons will be chairing the agenda theme 'Observation and Analysis of the Climate System'.

Finally, in 2012 GCOS will be celebrating the 20<sup>th</sup> anniversary of the programme.

## 2.1 GCOS Activities

Under the leadership of GCOS, and with the involvement of experts from the climate and satellite communities, high-level requirements on the accuracy, stability and resolution of satellite-based datasets and derived products in support of the GCOS Essential Climate Variables (ECVs) were defined in 2006 and documented in the supplement to the satellite-based component of the 2004 published GCOS implementation plan (GCOS-107). A supplement to the satellite-based component of the 2010 published GCOS implementation plan is currently underway, to be presented as an information document at COP 17, the 17<sup>th</sup> Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) in December 2011 in Durban, South Africa. The draft document will be available for public review from 9 May to 1 July 2011.

COP 17 is further supposed to set the timeframe for the preparation of a new version of the 'Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC', to be followed by a second progress report for the 2009–2013 period. The work on this will have to start by mid 2012.

GCOS is also cooperating with the Committee on Earth Observation Satellites (CEOS) concerning activities of the CEOS Working Group on Climate, as well as with the Coordination Group for Meteorological Satellites (CGMS).

Dr Richter finally reported on the GCOS Cooperation Mechanism (GCM) and explained the plan to provide a so-called 'shopping list' of improvement and implementation projects covering all three domains, land, ocean and atmosphere. She invited meeting participants to propose such projects, which then should be suggested to potential donors at the annual GCM board meetings. In this regards, she also made the invitation to suggest themes for outreach activities, e.g. additional GCOS brochures. Dr Richter further mentioned the need for TOPC experts to be more involved in domain-crossing activities such as the Baseline Surface Radiation Network (BSRN).

### 3. GFCS Update

Dr Carolin Richter spoke on behalf of Geoff Love on the establishment of a Global Framework for Climate Services (GFCS) that is envisaged to develop and provide data, information products and advice relating to climate to assist in decision-making, and has been the major outcome of the World Climate Conference–3 (WCC-3) in 2009. Taking into account the need for improved climate observations as the fundamental basis on which a new global framework for climate services will be built, GCOS is expected to form an essential part of it.

Following the consultation of the GFCS' High-level Task Force, its report<sup>1</sup> was published which outlines several options for a governance structure comprising a small secretariat and five technical committees. GCOS is expected to play a role in the observation committee. The report of the High-level Task Force also formulates general principles to guide the implementation of the framework and it identified three levels of countries regarding existing capacities.

Participants noted the critical lack of scientific knowledge and the absence of a critical mass of scientists in most developing countries that likely bring capacity building in danger. Others stressed the need to ensure the effort is seen coherently in its planned structure, in particular when speaking to governments.

### 4. GTOS Strategy Update

Prof. Riccardo Valentini, Chairman of the GTOS Steering Committee, reported on the new five-year GTOS Strategy and Implementation Plan (IP) and their implications for TOPC.

GTOS is grounded on the scientific community, but with an operational mandate. Whereas GTOS can not and should not undertake activities in every field of the terrestrial domain, its role is to provide a coordinating structure, particularly by:

- I. Formulating, leading, monitoring and revising as appropriate the overall approach to global terrestrial observations;
- II. Identifying systematic observations/variables that are required and define their characteristics (e.g., standardization in observations and reporting);
- III. Advocating in the relevant international policy arena (linking between science and policy) the adoption of the proposed variables, approaches and methods and take the steps necessary to ensure their ongoing provision, availability and use.

The new strategy included the revision of GTOS' priority areas as:

- Development of guidelines and standards for improved terrestrial observation systems.

<sup>1</sup> The report of the High-level Task Force is available under:  
[http://www.wmo.int/hlt-gfcs/downloads/HLT\\_book\\_full.pdf](http://www.wmo.int/hlt-gfcs/downloads/HLT_book_full.pdf)

- Synthesis products, position papers, databases, geo-referenced analysis of global/regional/national terrestrial ecosystems services and their changes

Focus will be given to climate change, land degradation and terrestrial carbon (stocks and fluxes) and loss of biodiversity with attention to the impact of these issues on the vulnerability of ecosystems.

Furthermore, the GTOS structure has been simplified from previous four to now three panels:

- **TOPC**  
dealing with climate changes issues, mitigation and adaptation options and the impacts of climate changes on biodiversity, carbon cycle and land degradation (in close connection with TCO);
- **Terrestrial Carbon and Land Degradation Panel (TCD)**  
coordinating international initiatives for understanding the terrestrial carbon budget and providing impact indicators on desertification, land degradation and drought (DLDD);
- **Panel on Global Observation of Forest and Land Cover Dynamics (GOF-C-GOLD)**  
cross cutting among the other GTOS panels, activities and themes; GOF-C-GOLD will provide continuous space-based and *in-situ* observations of land cover and land use in order to feed all the themes relevant to GTOS, such as land degradation, terrestrial carbon, biodiversity and climate.

These panels carry out the scientific and technical implementation of the GTOS activities on a voluntary basis following the guidelines given by the GTOS strategy and IP. The specific role of TOPC as a shared panel between GTOS and GCOS has not been changed in the restructuring process.

Target beneficiaries of GTOS include the related programmes of its five sponsors (FAO, ICSU, UNEP UNESCO and WMO), the multi-lateral environmental agreements (Rio Conventions), national governments, policy makers, international and inter-governmental science programmes, environmental managers, and non-governmental organizations (NGOs). Besides the collaboration with GCOS and the Group on Earth Observation (GEO), GTOS directly contributes to the three conventions: The UNFCCC, the UN Convention to Combat Desertification (UNCCD) and the Convention on Biological Diversity (CBD). As conventions lack the support of operational systematic observations in many areas, GTOS aims to support international conventions and their partners in obtaining access to timely, reliable and comprehensive observations and information on which to base environmental assessments, policies and plans. As an example, Prof. Valentini highlighted the Integrated Carbon Observation System (ICOS) research infrastructure built in the context of the EU Framework Programme GEO CARBON project.

Prof. Valentini further outlined his view that GTOS could modify its panel responsibilities to establish a wider role by working with the multilateral conventions with which it already has strong linkages with UNFCCC, these could include, inter alia, the GEO Biodiversity Observation Network (GEO BON) and the

UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA)/CBD, and by linking with DIVERSITAS for the observation component with a focus on protected areas and national parks/reference sites.

Despite the Earth's biological resources being vital to economic and social development, survival of species and ecosystems are under increasing pressure and species extinction continues at an alarming rate. Consequently, COP/CBD expressed the need for integrated regional and sub-global ecosystem assessments and for improvements in the availability and interoperability of biodiversity data. In Prof. Valentini's view, space observations on habitat fragmentation, land cover, and species recognition were considered a unique niche for GTOS

Consequently, participants discussed whether the role of the GTNs in GTOS should be clarified and whether linkages to the panels should be formalized. Panel members agreed that there was no need for the distribution of responsibility with respect to individual ECVs between the panels, e.g. by establishing additional focal points, since the general coordination can be managed by TOPC. Other comments stressed the importance to clearly communicate what GTOS/GCOS understand by setting 'standards' and how the underlying process works. Panel members reiterated that TOPC should base its work plan and programme always on the GCOS IP, which has been widely accepted, e.g. by space agencies. It was agreed that the GTOS work plan for the establishment of a terrestrial framework and the development of standards for terrestrial ECVs (GTOS-77) should undergo a wider review by the relevant scientific communities, in particular involving data centres.

**Action 1: Invite to comment on the draft GTOS work plan for establishment of a terrestrial framework and the development of standards for terrestrial ECVs (GTOS-77), also addressing feasibility of some of the steps; Give coordinated response from TOPC to GTOS Secretariat by end of April 2011; Submit response to the GCOS SC. (TOPC panel members)**

## 5. GTNs and ECVs overview

### 5.1 Global Terrestrial Network for Glaciers (GTN-G) / World Glacier Monitoring Service

Dr Michael Zemp from University of Zurich and Director of the World Glacier Monitoring Service (WGMS) updated meeting participants on ongoing GTN-G activities, as well as on specific challenges and needs. The Global Terrestrial Network for Glaciers (GTN-G) is jointly run by three operational bodies: the World Glacier Monitoring Service (WGMS), the U.S. National Snow and Ice Data Center (NSIDC), and the Global Land Ice Measurements from Space (GLIMS) initiative. GTN-G is largely based on the scientific monitoring community; this creates special needs - sometimes different from those of WMO. To serve the needs of the glacier community, a 'One-stop data-portal'<sup>2</sup> that will allow joint exploration of data products from all three operational services (WGMS, GLIMS, and NSIDC), including

<sup>2</sup> GTN-G website: [www.gtn-g.org](http://www.gtn-g.org)

a metadata browser, is currently under construction. Summary descriptions of the datasets available were also published in WGMS reports. Those three operational services, which are equally part of the International Council of Science (ICSU) World Data System (WDS), collect public and scientific data, perform quality checks and redistribute the data to international organizations, the science community, and the public. They take efforts to actively go out to collect the data, complementary, national correspondents help coordinate within their countries. The glacier inventory holds detailed information for about 100 glaciers worldwide, from photographs dating back from the 1970s to length, area, and mass changes, obtained from satellite observations. The 2010 WGMS General Assembly of National Correspondents (1-4 September 2010, Zermatt, Switzerland) took into account the following recommendations by GCOS for an improved understanding of glacier processes, distribution and changes:

- I. Maintain current glacier observing sites;
- II. Add sites and infrastructure in data-sparse regions;
- III. Attribute quality levels to long-term mass balance observations;
- IV. Complete satellite-based inventories in key areas;
- V. Improve understanding of glacier contribution to sea-level rise and runoff, and of the climate system in polar regions.

A particular challenge remains to increase the visibility of long-term monitoring and to secure funding for long-term monitoring sites. The activities of GCOS Switzerland, which achieved highest political recognition for the value of long-term observation series and in parallel involved the UNFCCC process, can serve as a role-model on how this can be solved at the national level.

Initiatives, such as GlobGlacier, Sentinel4Science and the Glacier project under the ESA Climate Change Initiative (CCI) foster active involvement in the discussion about scientific priorities and the potential of new satellite generations. In course of updating the systematic observation requirements for satellite-based products for climate, Dr Zemp suggested to replace 'Ice-sheets' by 'Glaciers'. Aiming at the attribution of quality levels (point 2 above), an expert workshop on the quality of mass-balance measurements is foreseen in 2012 as a contribution to the fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). To complete satellite-based inventories in key areas is a major target; *in-situ* measurements will nevertheless stay crucial for process understanding. Another major goal is to improve the understanding of glacier contribution to sea-level rise and river run-off. Regardless of the increased visibility of polar science, Dr Zemp stressed that besides sea level rise, the major impacts of glacier changes on human activities originate from non-polar regions. He further reminded panel members that any action from international organizations, such as the ISO-standardization process for ECVs, needs to be coordinated with the operational services as ISO standardization might risk destroying existing standards with a consequent loss of data. Whereas the GTOS Secretariat feels that international standards, developed in an open forum such as ISO, add value and do not detract from the quality of the process. In the view of GTOS, the current efforts in ISO to address Land Cover have been very careful to ensure that the standards describe the data in a uniform manner, as it is defined by GTOS or by nations, and do not

affect the data itself. This approach needs to be used for all ECV standards. From the view of the WGMS and the GTN-G, the demands on international bodies, such as GCOS and GTOS, are to:

- better coordinate initiatives among the existing organizations under the framework of ICSU, UNEP, UNESCO and WMO in order to use the limited resources available in a more focused manner;
- better interact with operational services, such as the WGMS, GLIMS and NSIDC for improved understanding of the potential and limitations of the monitoring reality;
- make the case for a better funding situation for long-term (glacier) monitoring sites, e.g. to postulate that an over-head budget for monitoring should be included in each scientific proposal, and that data should be made available, to strengthen national support for long-term monitoring (like GCOS Switzerland);
- improve the visibility of (glacier) monitoring by promoting dedicated chapters in IPCC ARs on observations and related uncertainties and to enforce strict citation rules for datasets (e.g. using a digital object identifier);
- support the implementation of super-sites, e.g., with long-time glacier series and automatic weather stations

In the following discussion, participants stressed the need to involve and name national data centres, as funding is mostly raised on the national level, in particular to run *in-situ* networks. It was further highlighted that a future GFCS should promote the joint collaboration between science and climate services.

Meeting participants agreed that proposals in support of long-term monitoring for individual glaciers or the implementation of supersites at some glacier could be submitted to the GCM, e.g., a short-list of priority glaciers could be developed by the WGMS.

**Action 2: Seek better coordination between sponsoring agencies (WMO, UNEP, FAO, ICSU,...) on specific terrestrial ECVs. (GCOS, GTOS, WGMS)**

**Action 3: Liaise with the IPCC regarding the contribution of fresh water outflow from glaciers to sea level rise. (WGMS (Michael Zemp))**

## 5.2 Update from the WMO-EC Expert Panel on Polar Observations, Research and Services; Global Cryosphere Watch

The WMO-Executive Council Expert Panel on Polar Observations, Research and Services (EC-PORS) is a service driven approach with focus on the polar region. Joint programmes are the WMO Global Atmosphere Watch (GAW), WCRP, the Arctic Hydrological Cycle Observing System (HYCOS), and GCOS, involved in particular through GOOS, the Global Terrestrial Networks for Permafrost (GTN-P), for Glaciers (GTN-G), and for Hydrology (GTN-H). PORS' role is to facilitate integration and coordination between legacy initiatives of the International Polar Year (IPY) and WMO observing systems and programmes, since polar prediction is a decadal

undertaking, requiring active involvement of WMO programmes, co-sponsored programmes and technical commissions. Furthermore, PORS is supposed to contribute to the GFCS with its 'Polar Regional Climate Centres'. The 'Polar Prediction System' will need to be an end-to-end operational prediction system, from the timescale of hours to centuries. The EC-PORS research task team conducted an initial gap analysis concerning perceived service and observational or modelling deficiencies of the current polar prediction systems to be expanded through services white papers. Observational gaps were found significant, though geographic and parameter specific. Challenges lie in sustaining and funding networks in remote, harsh environments, as well as new networks established during the IPY. Further challenges are associated with automation of observations. One of the objectives is also to strengthen the interface with users, including the research community, northern peoples and economic sectors, e.g., by providing services for transportation, search and rescue, as well as polar climate outlook forums. EC-PORS agreed to the concept of developing a major decadal initiative entitled the Global Integrated Polar Prediction System (GIPPS) which, for polar areas, would become a foundation of delivering WMO's substantial contribution to 'the protection of life and property against natural disasters, to safeguarding the environment and to enhancing the economic and social well-being of all sectors of society in areas such as food security, water resources and transport.' GIPPS shall build the framework for the operation of a Global Cryosphere Watch (GCW). The implementation of the GCW also reaches beyond activities of National Meteorological and Hydrological Services (NMHSs) and cuts across all three GCOS panels. Most stations in the Antarctic, for example, are run by the University of Wisconsin. These are real-time operational stations. Therefore, it has been proposed by the EC-PORS Antarctic task team to integrate all Antarctic stations into one Antarctic Observing Network (AntON), which should produce CLIMAT messages. GCW will encompass requirements, integration, standardization, access, coordination and will build upon and serve as an international mechanism for implementing the recommendations of the Integrated Global Observing Strategy (IGOS) - Cryosphere Theme (CryOS). Currently, 33 members have nominated focal points to be involved in the development of GCW on global and national level. Countries are most interested in sea-level rise and in teleconnections between cryospheric processes and their climate. A polar space task group has been set up to coordinate polar observational requirements to work with space agencies and the WMO Space Programme. Of particular importance were observations in the Himalaya region, the so-called 'third pole' and the establishment of supersites for multidisciplinary, integrated environmental monitoring. Here China provides an example of already running supersites. There is a strong community desire to establish a network of reference stations or supersites, called CryoNET, working on a coherent agreed programme to monitor changes in all components of the cryosphere, and to produce valuable long-term records. The Arctic Atmosphere Observing Network might form a basis for CryoNET. A standardized global cryospheric programme needs to:

- consider user requirements, new technologies, updated standards for sustainability of observing systems;
- identify and close observation gaps (e.g. oceans and land); and to
- promote interoperability with other polar observing networks.

During the following discussion, questions about data quality and quality assurance were raised and how this could be established within GCW, e.g. with the help of the WGMS, which has a scientific advisory board. It was felt that this was an area where progress has been made despite access and exchange of data remaining a continuing issue. Snow depth data for example does not have to be shared and is regarded by many countries as strategic value for their snow water equivalent, even in Europe; e.g., the European Centre for Medium-Range Weather Forecast (ECMWF) would need this data.

### 5.3 Global Terrestrial Network for Lakes (GTN-H/Lakes)

Dr Valery Vuglinskiy briefed meeting participants on activities of the International Data Centre on Hydrology of Lakes and Reservoirs (HYDROLARE). HYDROLARE is operated by the Russian State Hydrological Institute (SHI) since 2009, following an agreement between WMO and The Russian NMHS 'Roshydromet'. The objectives of the centre are to:

- foster the exchange of information on the hydrologic regime of lakes and reservoirs;
- contribute to the improvement in collecting, handling, analysing and monitoring of data;
- provide information on inland waters on regional and global scales for decision-makers;
- contribute to the development of international standards;
- assist WMO Member-countries in realization of international projects using data of lakes and reservoirs around the world.

The main functions of HYDROLARE are:

- the development and regular update of the international database; including support in data rescue if requested;
- periodic preparation of information products on the world's hydrological regime of lakes and reservoirs;
- development of computer technologies to support these activities.

HYDROLARE started from a prototype database of metadata and historical *in-situ* data from the largest lakes and reservoirs of former USSR countries collected until 1991. The data were compiled into unified electronic forms and sent back to these countries for correction and completion. A special questionnaire on the hydrology of lakes and reservoirs was distributed across WMO Member states. Answers from 45 countries had been received by 2009 and 32 countries agreed to exchange their data using HYDROLARE.

Core activities in 2010 and for the upcoming year were the preparation of top-priority information products and the development of a data-retrieval technology to

make regularly updated information accessible via the HYDROLARE website<sup>3</sup>. The database holds, in particular, names and coordinates of sites categorized by WMO regions and sub-regions, WMO Members, water bodies, and gauging sites, as well as information about the availability of data from gauges and posts. The hierarchically based data retrieval system provides a way to search database entries by name, display information on the website and to visualize observing sites on Google Maps. HYDROLARE will continue computing results for various applications. Particularly important tasks are to analyze the independence of ECVs and to assess volume changes from satellite observations.

Dr Valery Vuglinskiy presented the GTOS ECV publication, titled 'Water Level–Water level in lakes and reservoirs, water storage' issued in 2009. The report concluded among others, that: 'For lakes and reservoirs without storage and area curves, it is rather promising to develop a method of assessing volume change within drawdown storage using satellite images for estimation of lake and reservoirs surface area for a particular date'. It also highlights the necessity to continue the comparative analysis of results from *in-situ* and satellite observations in order to assess the accuracy of water-level measurements from satellites.

The GTN-L list of lakes has been revised in 2010 with now 79 lakes remaining. Excluded were duplications, lakes lacking of observations, lakes with water regimes disrupted by anthropogenic activity, and small lakes with surface area less than 100 km<sup>2</sup>. In a next step, some lakes for which data can be obtained from satellites shall be added. The criteria for lakes to be included in the GTN-L list are to:

- be representative of the natural region (i.e., they should have a typical natural water regime, water balance and water exchange regime) and covered with hydrological observations in order to record long-term water regime fluctuations;
- be indicative of climate changes (first of all closed lakes and large open lakes with large basin area);
- cover all continents and natural zones as uniformly as possible.
- have water level observations.

Furthermore, a visit of the HYDROLARE staff to the Global Runoff Data Centre (GRDC) in Koblenz, Germany, took place in June 2010. The workshop resulted in the publication of two documents describing the database and its guidelines for data policy<sup>4</sup>.

With regard to international standards, it has been discussed that despite the existence of different ISO standards from different mother organizations (WMO, UNESCO, ...) a single standard document was needed, for example when calculating the means of water level measurements. For liquid flow measurement in open channels, there are ten different ISO standards exist. The WMO Guide to Hydrological Practices (WMO-No. 168) might be used as a principle document when combining existing guidance.

<sup>3</sup> HYDROLARE website: <http://www.hydrolare.ru/>

<sup>4</sup> Available at: [http://www.hydrolare.ru/other\\_files/Data\\_policy.doc](http://www.hydrolare.ru/other_files/Data_policy.doc)

**Action 4: Continue updating the GTN-L list of lakes, including additional lakes with satellite observations of lake level. (Lake experts (Valery Vuglinskiy & Jean-Francois Crétaux))**

Dr Jean-François Crétaux presented activities within the Hydroweb<sup>5</sup> project as a contribution to HYDROLARE. While a letter of agreement with SHI is still in process, official support from the Centre National d'Etudes Spaciales (CNES) is also provided through a project within its TOSCA programme.

Products from CNES/LEGOS to HYDROLARE:

- Water height variation (monthly) from radar altimetry
- Surface variations (monthly) from satellite imagery (optic and radar)
- Ice phenology (formation of ice, break up and duration) of lakes in boreal regions (Canada, Russia) from satellite altimetry
- Regular reporting on the calibration/validation of products by comparison with *in-situ* data in coordination with SHI

Hydroweb activities in 2010 comprised the estimation of surface variation of 41 lakes from satellite imagery and the comparison of satellite altimetry data with *in-situ* observations. Recent studies have been published in the Journal of Advance Space Research<sup>6</sup>. In 2011, two engineers will be employed for six month each to establish lake surface variations from satellite imagery for all GTN-L lakes and for the automatisisation of satellite data processing from Jason-2. The creation of web pages showing surface and height variations for all lakes in GTN-L is foreseen and a cooperation with a private company having expertise in space data analysis is being investigated for the generation of improved waveform re-tracking for lakes and rivers as new input for Hydroweb. The reprocessing would be necessary for small lakes in particular due to surrounding land cover. Finally, a link to Hydroweb products for lakes has to be built into HYDROLARE.

Dr Crétaux further noted the importance of ice phenology for lakes in boreal regions, e.g. Canada and Russia. First results from studies on two Russian reservoirs in the Volga region and eastern Siberia showed that internal trends could be reproduced within 40-50 cm accuracy. A comparison on bigger lakes is expected to achieve better results with an estimated accuracy going down to 3-5 cm for some big lakes, depending on the period of comparison.

During the following discussion, the question was raised whether new altimetry instruments will enhance the quality. Dr Crétaux mentioned though Cryostat; Sentinel-3 and Altika were promising, it was still too early to confirm a higher quality. On future missions for satellite altimetry, a French – Indian mission is supposed to be launched this year, as well as the Jason-3 satellite. Climate time

<sup>5</sup> HYDROWEB database: [http://www.legos.obs-mip.fr/en/equipes/gohs/resultats/i\\_hydroweb](http://www.legos.obs-mip.fr/en/equipes/gohs/resultats/i_hydroweb)

<sup>6</sup> J.-F. Crétaux et al. (2010), SOLS: A lake database to monitor in the Near Real Time water level and storage from remote sensing data, Journal of Advance Space Research.

serials are built from satellite revisits on intervals of about ten days. For some lakes several visits on one track are possible.

Participants further mentioned that NASA is developing a database on water surface temperature and that the Journal Geophysical Research Letters will include a section on the state of the climate. It was therefore considered important for TOPC to get into contact with the CEOS Cal/Val group or the CEOS Working Group on Climate.

**Action 5: Get closer interaction and/or invite a representative from the CEOS Cal/Val group (J. Nightingale) or from the CEOS Working Group on Climate to next TOPC meeting. (TOPC Chairman)**

## 5.4 Soil Moisture

In the course of the 2010 updated GCOS IP, soil moisture has become an ECV. The updated IP lists two tasks (T13 & T14) related to soil moisture, calling for the establishment of a 'Global Terrestrial Network for Soil Moisture' (GTN-SM) and for the development of a globally-gridded near-surface record of soil moisture from satellite observations.

Since 2006, the International Soil-Moisture Working Group (ISMWG) has met several times under the leadership of Peter van Oevelen from the WCRP Global Energy and Water Cycle Experiment (GEWEX) and Tom Jackson from the U.S. Department of Agriculture (USDA). The proposal to establish an International Soil-Moisture Network (ISMN) as an international cooperation to establish and maintain a global *in-situ* soil-moisture database has been supported by ESA, whereas the Vienna University of Technology is in charge of the initial implementation within 2009-2012. Project coordinator is Wouter Dorigo. This database would provide an essential tool for the geo-scientific community for validating and improving global satellite observations and land-surface models.

Prof. Wolfgang Wagner from the Vienna University of Technology reported on the progress in establishing the global *in-situ* soil-moisture database. ISMN was successfully implemented with low costs by using open source software and a large amount of the work carried out by students. ISMN seems to evolve as the main integrated distribution platform for *in-situ* soil-moisture measurements. The 'Robock's Global Soil-Moisture Data Base' was integrated into ISMN and data of several networks (e.g., REMEDHUS, SMOSMANIA, GSMDB, CNR-IRPI) are distributed only through ISMN. Network and station information is accessible via the web portal<sup>7</sup>, which also provides a data viewer. The database currently holds data of 16 networks in the USA, Europe, Asia (only historical), and Australia, with more than 400 stations in total, for the period 1952-2010. Nevertheless, it still remains an open question who will be responsible for the long-term operations.

<sup>7</sup> Soil Moisture Database: <http://www.ipf.tuwien.ac.at/insitu/>

The development of a globally-gridded record from satellite observations has seen significant advances within the last few years in terms of progress in sensor technology and improvements of the physical understanding and retrieval capacity. Several global soil-moisture datasets derived from different sensors (multi-frequency radiometers, scatterometer, Synthetic Aperture Radar (SAR)) and algorithms have been released in recent years. The first near real time operational product of 120 min-delayed data from ASCAT was made available<sup>8</sup>. There has also been progress in form of new validation methods (triple collocation, data assimilation, ...) and an increasing number of independent assessments and inter-comparisons took place. The development of new applications in meteorology, hydrology, agronomy, and other areas, has a very positive impact in demonstrating the value of observational data. A first merged active-passive microwave soil-moisture dataset will become available in 2011, covering the period 1978-2009. In general, the quality of data improves over time in terms of spatial resolution, temporal sampling and accuracy. By using new assimilation approaches and error estimation techniques, such as triple collocation, e.g., between *in-situ*, model and satellite data, the spatio-temporal error can be estimated. Prof. Wagner showed examples from the Water Cycle Multi-mission Observation Strategy (WACMOS) project, funded by ESA's Support to Science Element programme, which aims to produce global products for the whole water cycle and focuses on evapotranspiration, soil moisture, clouds, and water vapour. A WACMOS soil-moisture product will be released within 2011.

The very active soil-moisture community is triggered by the upcoming satellite missions. The ESA Soil Moisture and Ocean Salinity (SMOS) mission was successfully in November 2009 and is now under intense investigation by the Cal/Val teams. The NASA Soil Moisture Active/Passive (SMAP) mission is foreseen for launch in the 2014/15 time frame.

Following the presentation, the panel discussed the lack of standards for soil moisture observations. It was mentioned that the WMO Commission for Instruments and Methods of Observation (CIMO) guide includes a chapter on soil moisture, which should be checked if it seems appropriate from ISMN perspective. Furthermore, a guideline brochure on soil moisture, similar to existing GTOS reports should be developed.

**Action 6: Start preparing an outline and plan for a soil moisture guideline brochure similar to existing GTOS reports and with involvement of the International Soil Moisture Working Group. (TOPC Chairman, GTOS Secretariat & soil moisture experts (Wolfgang Wagner))**

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<sup>8</sup> ASCAT data: <http://www.ipf.tuwien.ac.at/radar/dv/ascats/>

## 5.5 GTN-H / Global Terrestrial Network for River Discharge (GTN-R) and Climate Sensitive Stations (Pristine Basins)

Ulrich Looser from the Global Runoff Data Centre (GRDC) reported on the status of the GTN-R and on pristine basins, as well as on the GTN-H on behalf Wolfgang Grabs.

The GTN-H links existing networks and systems for integrated observations of the global water cycle. The network was established in 2001 as a joint project of the GCOS, GTOS, and the WMO Climate and Water Department to support a range of climate and water resource objectives, while building on existing networks and data centres, and producing value-added products through enhanced communications and shared development. The GTN-H website<sup>9</sup> is supposed to be a gateway to a large number of global observing systems for hydrological data, providing descriptions and links to all network partners of GTN-H and the hydrological data products developed under the cooperation.

The following hydrological variables have been identified as essential for the GTN-H network; most of them are also ECVs (\*):

- Ground Water\*
- River discharge\*
- Water vapour\*
- Lakes\*
- Isotopic Composition
- Precipitation\*
- Soil Moisture\*
- Water Use\*
- Snow Cover, Glaciers and Ice Caps\*
- Evapotranspiration
- Water quality / Biogeochemical Fluxes

For most, but not yet for all of these variables a global observation and monitoring network is defined and a point of contact established. Among the missing variables was soil moisture, this is now undertaken through Wolfgang Wagner. The observation and data centre networks for the three variables lake level/area, water use and evapotranspiration are under development and shall be fully implemented in the next few years.

Recent GRDC activities with respect to climate sensitive stations include:

- The request for the identification of climate sensitive stations according to the WMO selection criteria and the provision of station metadata and discharge data was included in GRDC's standard data acquisition activities.
- Climate sensitive stations from countries with a large number of identified 'reference stations', e.g. Canada and the USA, are gradually included into the GRDC database.

<sup>9</sup> GTN-H website: <http://gtn-h.net>

- Stations for which no data have been provided to GRDC were identified to facilitate acquisition efforts of 'missing' station metadata and discharge data.

28 countries responded to the request for data from pristine basins, only Brunei replied that it had no climate relevant stations; 27 countries expressed their willingness to support, but not all stations were included in the database yet. Since June 2010, a part time staff became available to assist GTN-R implementation. Nevertheless, the funding situation remains critical for GRDC activities. If additional funding became available, GTN-R would like to assess near real-time river run-off data for fresh water entering the ocean. Apart from climate scientists, ocean modellers have a keen interest in this data.

To date, 15 countries were submitting runoff data; 67 countries need to be approached again. A proposal within the seventh EU framework programme (FP 7) to support the standardization of hydrological data transfer in support of GTN-R, GTN-H, WIS and GEO is in negotiation phase. It is further planned to adopt near real-time data collection software for utilisation of GTN-R data collection, which is already in operational use for the European Terrestrial Network for River Discharge (ETN-R) project. The timeframe, however, is uncertain due to resource constraints.

TOPC-XIII participants mentioned that daily river information would be desirable. Dr Valery Vuglinskiy clarified that this was not feasible for every region. Siberian rivers for example are measured only 15-20 times a year. The daily data are being reconstructed from the discharge curve; it is not a direct measurement, but rather a result of calculation.

## 5.6 Global Terrestrial Network for Groundwater (GTN-GW) / Activities of the International Groundwater Resources Assessment Centre (IGRAC)

Dr Jay Famiglietti joined the meeting over telephone to report on the GTN-GW. Taking into account the important role of groundwater for the environment and human uses, global monitoring is needed to assess the current state and anticipate changes, as well as to provide information for improved management strategies. This requires continuous, methodologically and technically standardized measurements of groundwater level, whereas recharge and discharge is calculated by groundwater models. Other crucial information is 'wellhead level' and water quality.

The IGRAC provides an inventory on groundwater monitoring and available guidelines, which reveal minimal or non-existent monitoring in many countries. A variety of variables are collected by a variety of institutions, resulting in numerous standards and protocols for groundwater, e.g. the Environmental Protection Agency (EPA) Standard Operating Procedure (SOP) gives guidelines for constructing water table surface maps using a variety of borehole/well techniques, and the UK Technical Advisory Group on the Water Framework Directive (UKTAG) is currently developing a classification system for chemical and quantitative status of

groundwater. Expansion of existing monitoring programmes (including IGRAC) is strongly encouraged; however, progress is expected to be rather on the long term.

Current efforts include the following initiatives:

- GTN-H
- Global Groundwater Monitoring System (GGMS)
- Global Groundwater Information System (GGIS)
- Hydrology and Water Resources Programme (HWRP)
- Hydrologic Information Referral Service (INFOHYDRO)
- Internationally Shared Aquifer Resource Management (ISARME) Programme

For *in-situ* observations, the GGMS plans to assign 1°-global-grids for which local experts shall be responsible. Measurement techniques would include:

- Piezometer for direct measurement;
- Estimations using groundwater balance equation and supplementary data;
- Lab analysis of water quality (based on the 'Groundwater rule Source Water Monitoring Guidance Manual' of the U.S. EPA)

Remote-sensing and satellite observations, but also the Global Positioning System (GPS) provide huge observational capacities. Combined Interferometric Synthetic Aperture Radar (InSAR) and GPS techniques relate to groundwater storage changes and aquifer system response. The Gravity Recovery and Climate Experiment (GRACE) measures large-scale total column-integrated terrestrial water storage changes, while supplementary data can be used to isolate the groundwater component. The GRACE mission is coming towards its end of lifetime and a replacement is supposed to be launched by 2016. However, the budget is still not confirmed. A key unknown remains the depth of soil; 3-D info on sub-soil is actually needed to estimate how much water is in the ground. Groundwater models are used to analyse present conditions, as well as evolutions of groundwater systems. Model applications are for example sensitivity or pollution risk analyses. Interpolated groundwater resource maps, integrating existing measurements with other information, are available from the AQUASAT database by FAO and from the UNEP 'Ground on Earth Observations' data portal. General overview maps of global groundwater regions are provided by the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP).

Dr Neno Kukuric briefed the panel on IGRAC activities, which is hosted by the UNESCO Institute for Water Education in Delft, and also supported by The Netherlands. Its objectives are to facilitate and promote global sharing of information and knowledge required for sustainable groundwater resources development and management, with a focus on information and knowledge management, trans-boundary aquifer assessment and groundwater monitoring. IGRAC maintains a world-wide inventory of networks and programmes performing groundwater monitoring (including the users), as well as an inventory of existing guidelines and protocols for groundwater assessment and monitoring. An IGRAC-led working group is also undertaking the development of guidelines on groundwater

monitoring for general reference purposes. This contributes to a WMO/UNESCO manual on water resources assessment.

To date, no systematic monitoring and assessment of groundwater change is in place on a global scale. Therefore, IGRAC is setting up a sustainable Global Groundwater Monitoring Network (GGMN) for a periodic assessment of the global change of groundwater resources. As a 'network of networks', IGRAC will collect aggregated information, involving point measurements and proxy values. Because point measurements are not always representative for regional and global assessment, averaged products which have been assessed by regional experts seem preferable. Dr Kukuric briefly demonstrated the first version of a web-based system for collection, analysis and dissemination of information. The goal is to develop GGMN as a long-term programme, a 'people network' of skilled country representatives. This 'people network' should guarantee involvement, ownership, and recognition of regional experts, as well as the accessibility of data. The approach would be to set up regional communities workshops and supplying them with monitoring kits and applications, e.g. for mobile phones. Those activities might be supported through the EU FP 7 call for 'Developing community-based environmental monitoring and information systems using innovative and novel Earth observation applications' (ENV.2012.6.5-1) and a proposal for ground water monitoring in Africa has been submitted. Suggestions from the audience were collected on where to do case studies, in order to determine what the added value is from an observational perspective.

Ongoing activities are the further development of the GGMN software and the processing of accessible data, mainly from the U.S. Geological Survey (USGS) and the European Environment Agency (EEA), to fill the GGMN database. The GGMN programme will be embedded in the 2011-2015 IGRAC strategy and in its operational planning. It is also planned to enclose the GGMN in the World Water Assessment Programme (WWAP) of UNESCO and to provide linkages to WHYMAP's groundwater resources maps and output from the Global Precipitation Climatology Centre (GPCC), such as gridded precipitation maps.

**Action 7: Write a support letter for IGRAC and the African Water Initiative. (GTOS Secretariat)**

## 5.7 Fire Disturbance

Dr Kevin Tansey reviewed progress concerning the fire ECV and distributed an accompanying document. Active fire and burned area data continue to be made available. On-going activities are the processing of fire disturbance data (burned area) from the Moderate Resolution Imaging Spectrometer (MODIS) and SPOT satellites (Geoland2 product) at the global scale. There continues to be strong user interest in active fire and burned area data, e.g. FAO is using the data operationally. Communication between interested parties including the CEOS Working Group on Climate, the CEOS Working Group on Land Product Validation

(LPV), GOF-C-GOLD, and product developers (e.g. ESA CCI fire ECV<sup>10</sup>) remains strong. It is important that standards are adhered to, and effort is being directed to communicate this to all groups involved. ESA is supporting validation efforts and the establishment of long-term datasets through its CCI programme. User requirements have been further defined within this project and this will be reflected in the 2011 updated supplement to the satellite-based component of the GCOS IP<sup>11</sup>. Sections on active fire and fire radiative power have been updated based on requests from GCOS.

Dr Tansey mentioned that there is still uncertainty within the fire community over the procedure to comment and update GCOS documents and the respective roles of GOF-C-GOLD and the various arms of CEOS (WGCV-LPV, Climate). He stated that he was working to break these barriers down and address the uncertainty of the review process.

An ESA 'Carbon from Space' Workshop<sup>12</sup> took place in September 2010 in Oxford, UK. Upcoming planned events are a GOF-C-GOLD Fire IT meeting, to be held 18-19 October 2011 followed later in the week by an EARSel workshop on fire.

## 6. Items for Discussion

### 6.1 Review of Actions from the 12<sup>th</sup> Session

The panel reviewed the status of actions from the last TOPC Session as outlined in the respective meeting document. It was noted that all Actions from 2009 and 2010 were completed, became ongoing activities or were superseded by new action items as given in Annex III.

### 6.2 Activities within the ESA Climate Change Initiative (CCI)

Dr Olivier Arino reported on the ESA CCI and running Data User Element (DUE) GlobProjects, which formed a series of precursor projects for CCI, in particular GlobSnow, GlobGlacier, DUE Permafrost, GlobCarbon, GlobCover and GlobAlbedo. The CCI aims at securing comprehensive long-term climate observations from space. Foreseen is the establishment of feedback mechanisms between, reprocessing (e.g. calibration), ECV generation, assimilation and assessment. Its international partners are UNFCCC, GCOS, International Research Programmes (WCRP, IGBP, DIVERSITAS and others), space agencies, as well as the European Commission and national research programmes.

21 ECVs are in scope of the CCI and a subset of 11 ECVs are to be covered by the first initiative phase (2011-2016) with a budget of 20-25 Million Euro over 3 years. Soil moisture and ice sheets are next to being covered in 2011. Not supported within the CCI are operational meteorology and *in-situ* based observations, as well

<sup>10</sup> ESA CCI fire project website: <http://www.esa-fire-cci.org/>

<sup>11</sup> The 2011 Update of GCOS-107: 'Systematic Observation Requirements for the Satellite-based Products for Climate'.

<sup>12</sup> Workshop website: [http://earth.eo.esa.int/workshops/Carbon\\_from\\_Space/](http://earth.eo.esa.int/workshops/Carbon_from_Space/)

as areas where leading contributions by other CEOS agencies are in place, e.g. the Sustained Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) initiative. The terrestrial ECVs not addressed by CCI projects are water use, ground water, river discharge, permafrost and seasonally-frozen ground. Permafrost and seasonally-frozen ground are not directly observable, but modelled on the base of existing remote-sensing observations of other parameters, such as land surface temperature, land cover, snow properties, soil moisture and terrain properties. It is hoped that the EU FP 7 could support permafrost activities.

GlobCover2009, an activity covering multiple variables in space, sensor and time to provide land cover products, has been released in 2010 and now counts more than 8000 project users. GlobCover2009 products are for example the ATSR World Fire Atlas and GlobGlacier products. The CCI concept comprises mapping of land cover state and land cover condition through the use of land surface features, whereas, land cover change corresponds to a permanent modification of the land cover state and thus is currently not addressed by CCI. Detection of land cover change would likely increase the error bars, too, and relates to the problem of validation.

Panel members commented that from the users' perspective, going down to (at least) level 2 processing would be essential, as level 1b products are still beyond of what most scientists are able to use. In addition, ESA should not only look for remote sensing users.

### 6.3 Forest Carbon: GEO Forest Carbon Tracking & UN REDD Activities

Dr Giovanni Rum from the GEO Secretariat briefed participants on the GEO forest carbon tracking task. Comprehensive information is needed for forest policy, planning and management. Information on forest cover and forest carbon stocks is crucial for monitoring reduction of emissions from deforestation and forest degradation. Comprehensive, continuous and systematic information on forests is needed in particular to underpin national Measurement, Monitoring, Reporting and Verification (MRV) Systems for implementation of the UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD).

The GEO forest carbon tracking task has been established in 2008 to address this need and to provide support to countries in implementing their national MRV's by:

- providing access to (remote and *in-situ*) information;
- building a pre-coordinated set of national system;
- creating a framework and technical interoperability of standards for the establishment of comparable national MRV systems; and
- developing and validating methodologies, tools and products that follow UNFCCC guidelines.

GEO forest carbon tracking is supposed to start from the national level and so far national demonstrators have been established in ten countries, mainly in the tropics. Interfaces with UN REDD and the World Bank should be strengthened and

new national demonstrator countries progressively included. Organizations from more than 30 countries are contributing to the GEO task. Its objective is to demonstrate that coordinated Earth observations, validated by *in-situ* measurements and properly linked to forest models can provide the basis for reliable, accurate, consistent and continuous information services to support forest monitoring and carbon tracking by means of national MRV. A yearly monitoring approach with 25-30 meter resolution has been identified as best suited to cover a wide range of potential outcomes of the REDD+ policy-framework negotiations. Guidance documents on forest carbon tracking, as well as work on methods and protocols, have been identified or are being produced to become accessible via the data portal<sup>13</sup>.

Despite significant progress being made in 2009 and 2010, forest carbon tracking needs to move from preliminary activities to more comprehensive, consistent and continuous observations, setting up permanent solutions for data policies, availability of satellite observations, and the transition from demonstration to operations. The GEO Plenary meeting approved the planning for the Global Forest Observations Initiative (GFOI). The GFOI is envisaged to support long-term observation needs of the UNFCCC and engage with other key users, notably FAO and IPCC. Key components of the GFOI are to provide support to national governments in:

- development of consistent and comparable methods for national systems;
- provision of systematic (regular and routine) observations;
- development of methods and protocols for data collection and processing;
- promotion of coordinated research and development;
- national capacity building.

Antonio Bombelli presented current UN REDD efforts. 17% of greenhouse gas emissions are attributed to deforestation and degradation of forest resources, primarily through tropical deforestation. This is the second leading cause of carbon emissions after fossil fuels. The REDD+ programme aims to mitigate effects of deforestation and forest degradation on global atmospheric carbon levels and is addressing not only carbon emissions, but also other benefits related to the conservation of forests, such as food security, biodiversity, water regulation, forest products, etc. At COP 16 in December 2010 in Cancún, REDD+ was agreed by the parties leading towards major financial transactions. Estimates vary between 30 and over 100 billion US \$ annually transferred to developing countries in exchange for reduced emissions from deforestation and forest degradation, and increased storage of carbon in forests. It is governed by a policy board of representatives from partner countries, donors, civil society, indigenous peoples and UN agencies, and supported by a small interagency Secretariat in Geneva. The REDD+ strategy foresees MRV based on national governance. The principle of country ownership implies issues like the need for data sharing policies and more coordination would be needed, e.g. with respect to the GEO data sharing policy. Currently, UN REDD pilot countries and GEO forest carbon tracking national demonstrators have only three countries in common (Indonesia, United Republic of Tanzania, and the

<sup>13</sup> GEO forest carbon tracking data portal: [www.geo-fct.org](http://www.geo-fct.org)

Democratic Republic of the Congo). One reason for this lack of coordination is that validating is difficult and there is no authority deciding which method is better. There has been increased demand for assistance from FAO and UN REDD is collaborating with the GEO forest carbon tracking activities to improve access to data and expertise on remote sensing.

**Action 8: Discuss the need for standardization of forest carbon observations in the context of UN REDD and GEO forest carbon tracking. (GCOS Steering Committee)**

## 6.4 Reference Network for Ecosystem Sites

The 2010 updated GCOS IP with action T3 calls for the establishment of a set of reference sites. These are meant to:

- ensure that a representative set of biomes are properly and consistently documented over long periods of time (decades or more). This will allow the details of natural vegetation changes and carbon stocks, including fluxes, to be carefully monitored at key locations;
- measure key meteorological ECVs to support interpretation of changes recorded at such sites;
- optimize the joint use of these terrestrial reference sites with a set of sites delivering essential ground data for the validation of satellite-derived products that provide extensive geographical coverage for these variables (dealing specifically with calibration/validation of fraction of absorbed photosynthetic active radiation (FAPAR) and Leaf Area Index (LAI), action T29 IP 2010) and with key ecosystem sites (Action T4: Monitoring of terrestrial biodiversity and habitats at key ecosystem sites).

Prof. Han Dolman presented his supporting paper where he had summarized thoughts towards the establishment of a reference network for ecosystem sites. This should consist of so-called 'supersites' that measure a whole suite of ECVs and would be linked to biodiversity observations by optimizing the joint use of existing sites, e.g. from the Flux and Energy Exchange Network (FLUXNET) and the U.S. National Ecological Observatory Network (NEON). A crucial point is certainly the needed long-term funding mechanism, as generally research does not provide money for the coordination of monitoring. Current movements exist in China to establish a set of supersites. In the USA, NEON, which is funded through the national science foundation, in concert with Ameriflux, funded by the Department of Energy, are setting up long-term sustained ecological observatories. Similar efforts are being undertaken in Europe through the ICOS infrastructure and a number of national, often complimentary, programmes. However, the different continental programmes often run their own suite of observations and operate different QA/QC procedures. Strongly related to the previous issue is the lack of a global, long-term funded data centre that also holds the database. Such centres have operated regionally, and sometimes on the basis of short-term and limited funding, but there is no sustained institutional arrangement in place that can keep the data for longer term (>10 years) and not all data is publicly available. While considerable progress in harmonization of a subset of data was achieved through the 'la Thuile process',

access to this harmonized dataset is blocked by complicated procedures that severely limit the outside community from the use of the data.

Participants considered that GAW might be the right model to follow. Dr Ed Harrison recalled that ocean programmes went through similar approaches. To be successful, internal discipline is necessary and there is always a coordination person needed. As a way forward the panel recommended to bring this issue to the attention of ESA's CCI scientific advisory committee.

**Action 9: Get comment on establishment of a reference network into review to ESAC scientific advisory committee by 23rd March for ESA-EOP3. (TOPC Chairman to liaise with Riccardo Valentini, Olivier Arino & Jan Polcher)**

## 6.5 The GEO Biodiversity Observation Network (GEO BON)

Already in 2002, the Parties to the Convention on Biological Diversity (CBD) committed themselves to achieve by 2010 a significant reduction of the rate of biodiversity loss at the global, regional and national level. This target was subsequently endorsed by the World Summit on Sustainable Development and the UN General Assembly, and was incorporated as a new target under the Millennium Development Goals. Nevertheless, the loss of biodiversity persists with nearly all status measures showing negative trends. Although the number of existing biodiversity observations is large, these observations are very uneven in spatial, temporal, and topical coverage. They range from genetics to species to ecosystem levels with observations being made in the laboratory, in the field, and from satellite imagery. The observations exist in a variety of different formats and are scattered among independent systems, making it difficult or impossible to access the data and limiting the ability to conduct global or regional assessments. The vision is to build a coordinated, global network that gathers and shares information on biodiversity, provides tools for data integration and analysis, and thus contributes to improving environmental management and human well-being. Controversy about standards is also a big issue in the observation of biodiversity and in achieving the goal to harmonize the mapping and monitoring of ecosystems world wide, including terrestrial, freshwater and marine ecosystems.

GEO BON is organized around eight working groups at the genetic, species, and ecosystem levels, which are:

- Genetics
- Terrestrial species monitoring
- Terrestrial species change
- Freshwater ecosystem change
- Marine ecosystem change
- Ecosystem services
- *In-situ*/remote sensing integration: integration and modelling across scales
- Data integration and inter-operability; informatics and portals

The programme focuses on three main groups of species:

- Rapidly declining species, e.g., the International Union for Conservation of Nature (IUCN) 'red list' species and Evolutionarily Distinct Globally Endangered (EDGE) species - those with few close relatives on the tree of life;
- Rapidly increasing species, such as invasive alien species and novel pests and diseases; and
- Species selected for largely scientific reasons, as reference groups ('controls').

Species observations priorities are:

- mobilisation and accessibility of online primary biodiversity data,
- consensus on data collection protocols,
- rescue of historical datasets and making them accessible,
- coordination of the biodiversity observation efforts of independent institutes and countries to help ensure more systematic coverage.

The key metrics of ecosystem change are: extent, condition, and change in functional parameters. Monitoring changes in ecosystem extent (and related measures, such as fragmentation and connectivity) are based on the combination of *in-situ* observations and remote-sensing techniques. The hierarchical stratification and classification of ecosystems is a first step, followed by their spatial mapping.

In 2010 the Parties to the CBD in Nagoya, Japan, adopted the 'Strategic Plan for Biodiversity 2011-2020' with the purpose of inspiring action in support of biodiversity over the next decade by all countries and stakeholders. The strategic plan is, among others, comprised of 20 targets, collectively known as the 'Aichi Targets', which fall under five strategic goals:

- I. Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.
- II. Reduce the direct pressures on biodiversity and promote sustainable use.
- III. Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.
- IV. Enhance the benefits to all from biodiversity and ecosystem services.
- V. Enhance implementation through participatory planning, knowledge management and capacity-building.

The COP established an Ad-hoc Technical Expert Group (AHTEG) to develop a monitoring framework to measure progress in achieving the strategic plan for biodiversity. GEO BON was invited to prepare an evaluation of existing observation capabilities relevant to meeting the 20 targets contained in the strategic plan and report to the AHTEG by May/June 2011. A group of about 50 experts assembled from 1-3 March 2011 in Wangeningen, The Netherlands, for the 'assessment of the adequacy of existing observation capabilities for the CBD 2020 targets'.

## 6.6 Invitation by WMO to review the draft Implementation Plan for the Evolution of the Global Observing System (EGOS)

Dr Carolin Richter informed the panel that experts of the GCOS community are invited to review the draft Implementation Plan for the Evolution of the Global Observing System (EGOS)<sup>14</sup>. The review has been requested by the WMO Commission for Basic Systems (CBS) in its extra-ordinary session, held in Namibia in November 2010, and is led by the WMO Expert Team on the EGOS, chaired by Dr John Eyre. The draft EGOS Implementation Plan is supposed to take note of and also respond to the 2010 updated GCOS IP. The panel was invited to comment in particular on sections 5 and 6 of the EGOS Plan, and to answer the following questions: Is the emphasis in the subsections correct? Are the proposed actions appropriate and are they the most important ones?

## 7. Activities of the WCRP/GCOS Observation and Assimilation Panel (WOAP)

### 7.1 Workshop on Evaluation of Satellite-Related Global Climate Datasets

WOAP recognizes the need to enhance international activity supporting the evaluation of global climate datasets. Guidelines have been prepared on the generation of datasets and products to meet the GCOS requirements, and in 2010 WCRP and GCOS jointly wrote to agencies to promote improved data stewardship through systematic actions to assess climate data records and derived products. In order to move this process forward, WOAP will convene workshops to promote the inter-comparison and evaluation of satellite and *in-situ* datasets suitable for climate studies with the goal to develop an inventory. ESA kindly offered to host the first WOAP workshop on 'Evaluation of Satellite-Related Global Climate Datasets' in Frascati, Italy, from 18-20 April 2011 to assess a number of key satellite-related global climate datasets against the GCOS guidelines. The primary aim of the workshop was to produce a technical report on detailed assessments of existing datasets for a subset of ECVs, three of them from the terrestrial domain: snow cover, soil moisture, and FAPAR. A further aim of the workshop was to develop a framework for an inventory of all ECV datasets that includes indices of the maturity and uncertainties of each product, and therefore the workshop provided an opportunity for consideration of appropriate indices for different ECVs. The assessments will be structured consistently in order to provide a framework for the development of an inventory of ECVs that contains a description of the products and information on their availability, strengths and weaknesses, maturity, and conformity to the GCOS guidelines. Recommendations emerging from this workshop will go a step further than current GCOS guidelines and monitoring principles, but should be general and also applicable to other ECVs. The workshop participants were invited on the basis of their expertise in the generation of specified ECV products and their ability to contribute to the preparation of the workshop report. A further group of experts representing the modelling, analysis and diagnostic

<sup>14</sup> The draft document is available at: <ftp://ftp.wmo.int/Documents/PublicWeb/www/gos/egos-ip/>

community and also a representative from CIMO have been involved in this process.

## 8. Satellite Observations of Terrestrial ECVs

### 8.1 Update of the GCOS Satellite Supplement

The panel discussed the draft update of the 'Systematic Observation Requirements for Satellite-based Products for Climate' (GCOS-107), known as the 'Satellite Supplement' to the GCOS IP. The 2006 requirements need to be updated, given advances in science, technology and emerging user needs and in light of the 2010 update of the ECV list to now 50 variables. An expert meeting was held in January 2011, where several panel members provided input, and the draft document is opened for public review from 9 May to 1 July 2011.

In the course of the following discussion, with respect to inadequacy of existing systems, Wolfgang Wagner pointed out that the current system for processing Sentinel missions is inadequate and that the expected amount of data will overflow existing capacities.

**Action 10: Ensure compatibility between the updated of the Satellite Supplement and GTOS ECV reports. (GTOS Secretariat, GCOS Secretariat)**

### 8.2 Analysis of satellite missions supporting terrestrial ECVs

Jérôme Lafeuille from the WMO Space Programme office delivered a presentation on satellite missions supporting terrestrial ECVs, in the context of the WMO Global Observing System (GOS).

The evolution of the GOS (both surface-based and space-based) is supported by a Rolling Review of Requirements (RRR) process. The RRR process is conducted by the Expert Team on Evolution of the Global Observing System (ET-EGOS) and its designated focal points for each of the application areas; in particular, the GCOS Secretariat is the focal point for GCOS (AOPC, OOPC and TOPC) application areas. The RRR database of observing requirements, i.e. the WMO repository of observing requirements<sup>15</sup>, gives information on elementary physical variables (not derived products), in terms of five criteria: horizontal resolution, vertical resolution, observing cycle, timeliness and accuracy. For each of these criteria the table indicates three values:

- The 'threshold' is the minimum requirement to be met to ensure that the data is useful.
- The 'goal' is an ideal requirement above which further improvements are not necessary.
- The 'breakthrough' is an intermediate level between 'threshold' and 'goal' which, if achieved, would result in a significant improvement for the targeted application. The breakthrough level may be considered as an optimum, from a cost-benefit point of view, when planning or designing observing systems.

<sup>15</sup> The RRR database is available at: <http://www.wmo-sat.info/db/>

In contrast to this the 'Satellite Supplement' only describes the 'goal' value.

The list and definitions of variables have been reviewed with input from meteorological, oceanic and atmospheric chemistry communities, and the requirements are being updated. Jérôme Lafeuille invited the panel members to also review the list and definitions of terrestrial variables and the corresponding TOPC user observation requirements when updating the Satellite Supplement. Participants noted that "lake extent" is missing among the variables of the current RRR database.

Jérôme Lafeuille further presented results from a gap analysis of satellite missions with respect to GCOS requirements based on a study by Dr Bizzarro Bizzarri and the 'Dossier on the space-based GOS'<sup>16</sup>. The 80-page study reviews instrument performance and availability of satellite missions relevant to each ECV for the 50-year period 1975-2025. It does not consider the processing of climate records nor data stewardship issues. Terrestrial ECVs with good continuity prospect are: permafrost, land surface temperature, albedo, land cover, FAPAR, fire disturbances, and LAI. After the recent failure of the Glory Satellite, a high risk of a gap in observing solar irradiance exists in the coming years. On the other hand, the existence of satellite datasets does not automatically imply that the product has been or will be effectively retrieved and archived. The gap analysis of satellite missions with respect to GCOS requirements is meant to support more detailed studies and feeds into plans for a new GCOS report on the adequacy of observing systems, which is envisaged for 2012/2013.

**Action 11: Review the list and definitions of variables and user observation requirements (in <http://www.wmo-sat.info/db/>) in the progress of updating the Satellite Supplement (TOPC panel members)**

## 9. UNFCCC/ SBSTA related activities

A decision on systematic climate observations (Decision 9/CP.15) adopted by the 15<sup>th</sup> Session of the Conference of the Parties held in Copenhagen, Denmark, in December 2009, contains provisions to further enhance climate observations, including observations from space, coordinated through CEOS, and activities to be undertaken by GCOS and GTOS.

At the 33<sup>rd</sup> Session of the SBSTA (COP 16/SBSTA 33) in Cancún, Mexico, in December 2010, the updated GCOS IP and the coordinated response by CEOS was welcomed. For the first time all three sister-observing systems, GCOS, GOSS and GTOS delivered a statement and GCOS was invited to continue reporting on progress made in the implementation of the 2010 updated GCOS IP on a regular basis and to provide a new adequacy report.

<sup>16</sup> The Dossier on the space-based GOS is available at:  
<http://www.wmo.int/pages/prog/sat/Refdocuments.html#spacebasedgos>

The related discussion raised the question if the future adequacy report should be again accompanied by a technical supplement a means for providing linkage to underlying sources. The panel supported the development of a mechanism to foster more peer reviewed papers on ECVs and ECV standards was supported by the panel.

The SBSTA agreed to consider issues related to the timing of GCOS contributions at its 35<sup>th</sup> Session, taking place together with COP 17 in Durban, South Africa, in December 2011.

Furthermore, a new GCOS brochure explains the UNFCCC engagement process<sup>17</sup>, which is titled: 'Opportunities to Improve Climate Observing Networks through Engagement with the UN Framework Convention on Climate Change'.

**Action 11: Come up with a mechanism to get more peer reviewed papers on ECVs & ECV standards (Riccardo Valentini, Han Dolman & Shaun Quegan)**

## 10. Status of Standards and Guidelines for Terrestrial ECVs

Dr Antonio Bombelli from the GTOS Secretariat reported on the development of standards and guidelines for terrestrial ECVs and the attempt to establish a standard-setting process with the International Organization for Standardization (ISO). The proposed ISO process foresees three ways:

- the 'normal route', through a Technical Committee, which is the most effective in building consensus but also the lengthiest (can take several years);
- the 'fast-track route', which is relatively rapid and produces full international standards, and
- the 'workshop root', which is the fastest but the weakest with respect to the resulting product.

Dr Antonio Bombelli explained that in his view option two was possible for most of ECVs thanks to the collective preliminary work done by preparing the GTOS ECV reports. The joint UN-ISO mechanism for the standardization of key terrestrial ECVs proposed by the GTOS also foresees the set-up of a Joint Steering Group (JSG) as an inter-agency group external to the ISO's technical structure, reporting to the sponsoring UN organizations, as well as to the ISO Technical Management Board.

The envisaged timeline is as follows:

### 2011

- Signing UN-ISO MOU (near-final draft available)
- JSG establishment
- Preparation of ECV proposals for priority ECVs
- JSG decision on initial standards to be developed, establishment of JWG, JWG work begins

<sup>17</sup> The brochure is available at:

[http://www.wmo.int/pages/prog/gcos/Publications/GCOS\\_UNFCCC\\_2011.pdf](http://www.wmo.int/pages/prog/gcos/Publications/GCOS_UNFCCC_2011.pdf)

**2012-2015**

- Development, approval and publication of ECV standards for priority ECVs
- Preparation of proposals for other ECVs
- JSG decisions on other standards to be developed, establishment of appropriate JWG, JWG work underway.

Panel members noted that such an ISO process has little to do with accuracy, as it is rather based on methodology – provided that all documentation is in place. Prof Vuglinskiy highlighted the need to differentiate between standards for measurements/methodology and standards on data processing. Standardization was regarded as very useful in order to distinguish claims from real capabilities. Equally important are data availability, version control, and quality control. Furthermore, many observations are scale dependent implying that results look very different, depending on what scale is used. Criteria of GCOS datasets will be addressed by the WOAP workshop in Frascati, for example.

General concerns were raised about the proposed fast-track route and participants expressed the view that in some areas best practices need to be established first instead of routing this through an ISO process. While the community should be encouraged to collect guidelines of best practices in GTOS ECV reports, participants questioned if the relevant communities are sufficiently aware of these publications. Great concerns were expressed about starting with the most difficult and complex field as here is no such process in place for oceans or the atmosphere. Dr Miroslav Ondras from the WMO Observing and Information Systems Department and in charge of observational standards reported that, from his experiences to get WMO standards internationally recognized, it is a lengthy process. Since a lot of variables are in common, WMO can offer collaboration regarding terrestrial ECVs. WMO has been accredited as standard setting organization and therefore can go for fast-track recognition. Nevertheless, governing bodies are requested to make cost estimates for implications and explain this to their members before releasing standards.

Dr Bombelli stressed that has GTOS always followed an open and transparent process working on a request basis for UNFCCC to raise the profile of GTOS and its sponsors for standard setting. All the developments related to the ECV framework and workplan have been shared with sponsors, as well as presented and discussed at TOPC meetings, as well as GTOS and GCOS Steering Committees meetings. UNFCCC called on GTOS for developing internationally agreed standards and not for the application of best practices. The proposed UN-ISO framework is considered by GTOS to be the best approach to develop internationally consistent and agreed standards. This has been extensively discussed and agreed upon also in previous UNFCCC meetings.

TOPC members stressed that they or GTN specialists need to be part of the technical advisory body for the standardization of ECV's. It was further agreed that TOPC members provide additional input on this issue to the GTOS Secretariat. The GTOS Secretariat will take into account the comments received, however, radical changes would not be viable at this stage as the process is agreed by SBSTA and GTOS Secretariat has been requested to proceed with the standardisation process.

## 11. Calendar and Future Meetings

It was agreed to hold the upcoming TOPC-XIV meeting in March 2012 at WMO Headquarters in Geneva or at one of the global data centres.

The next COP session will take place in December 2012 in Durban, South Africa.

## Annex I: Meeting Agenda

Item	Doc. No.	Presenter(s) (time slots include discussion)
<b>Thursday 10 March</b>		
<b>9.00 – 10.30</b>		
<b>1. Opening of the Meeting (30')</b>		
1.1 Welcome and introductions		Dolman, WMO
1.2 Adoption of Agenda	1	Dolman
1.3 Conduct of the Meeting		Secretariat
<b>2. Update on programme activities (60')</b>		
2.1 GCOS Update	2.1	Richter (10')
2.3 GFCS Update	2.3	Richter (10')
<b>3. GTNs-overview</b>		
3.1 GTN-G / WGMS	3.1	Zemp (20')
3.2 Update from the WMO-EC Expert Panel on Polar Observations, Research and Services; Global Cryosphere Watch	3.2	Goodison (20')
<b>10.30 – 11.00 Coffee Break</b>		
<b>11.00 – 12.30</b>		
3.3 GTN-H	3.3	Looser for Grabs (20')
3.4 GTN-H/lakes	3.4	Vuglinskiy / Crétau (20')
3.5 Soil Moisture ECV	3.5	Wagner (30')
3.6 GTN-R	3.6	Looser (20')
<b>12.30 – 14.00 Lunch</b>		
<b>14.00 – 15.30</b>		
2.2 GTOS Update	2.2	Valentini (20')
3.7 IGRAC activities	3.7	Kukuric (20')
3.9 Fire Disturbance ECV	3.9	Tansey (20')
3.8 GTN-GW	3.8	Famiglietti (from remote) (30')
<b>15.30 – 16.00 Coffee Break</b>		
<b>16.00 – 17.30</b>		
<b>4. Items of discussion</b>		

4.1 Review of Action Items from last year	4.1	Dolman /all (20')
4.2 Activities within the ESA Climate Change Initiative	4.2	Arino (20')
4.3 Forest Carbon: GEO Forest Carbon Tracking & UN REDD activities	4.3	Rum / Bombelli (20')
4.4 Reference Network for Ecosystem Sites	4.4	Dolman / Valentini (20')
4.5 Invitation by WMO to review the draft Implementation Plan for the Evolution of the Global Observing System (EGOS)	4.5	Richter (10')
<b>17.30 - 18.00 Plenary Discussion - Wrap-Up of Day 1</b>		
<b>18.30 – 20.00 Reception – WMO Attique</b>		
<b>Friday 11 March</b>		
<b>9.00 – 10.30</b>		
<b>5. Establishment of a Terrestrial Framework</b>		
5.1 Status of GCOS/GTOS Standards and Guidelines for Terrestrial ECVs	5.1	Bombelli (30')
5.2 Establishment of Terrestrial Framework: Status, plans and roles of TOPC / GTOS	5.2	Bombelli (30')
<b>6. GEO Activities</b>		
6.1 GEO Bon	6.1	Reed (30')
<b>10.30 – 11.00 Coffee Break</b>		
<b>11.00 – 12.30</b>		
<b>7. WCRP/GEWEX/WOAP Activities</b>		
7.1 WOAP Frascati Workshop	7.1	Westermeyer / Dolman (30')
<b>8. Satellite Observations of Terrestrial ECVs</b>		
8.1 Update of the GCOS Satellite Supplement	8.1	Dolman (60')
<b>12.30 – 14.00 LUNCH</b>		
<b>14.00 – 15.00</b>		
8.2 Analysis of satellite missions supporting terrestrial ECVs	8.2	Lafeuille (20')
<b>9. UNFCCC/ SBSTA related activities</b>		
9.1 UNFCCC/ SBSTA related activities	9.1	Richter (30')

<b>15.00 – 15.30 Wrap-Up</b>		
<b>15.30 – 16.00 Coffee Break</b>		
<b>10 Closure (10')</b>		
10.1 AOB, Next session		
10.2 Adjourn		

## Annex II: Meeting Participants

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## Annex III: List of Actions

List of Actions		
No.	Subject	Responsible
1	Invite to comment on draft GTOS work plan for establishment of a terrestrial framework and the development of standards for terrestrial ECVs (GTOS-77), also addressing feasibility of some of the steps; Give coordinated response from TOPC to GTOS Sec by end of April 2011; Submit response to the GCOS SC.	TOPC panel members
2	Seek better coordination between sponsoring agencies (WMO, UNEP, FAO, ICSU,...) on specific terrestrial ECVs.	GCOS, GTOS, WGMS
3	Liaise with IPCC regarding the contribution of fresh water outflow from glaciers to sea level rise.	WGMS (Michael Zemp)
4	Continue updating the GTN-H list of lakes, including additional lakes with satellite observations of lake level.	Lake experts (Valery Vuglinskiy & Jean-Francois Crétaux)
5	Get closer interaction and/or invite a representative from the CEOS Cal/Val group (J. Nightingale) or from the CEOS Working Group on Climate to next TOPC meeting.	TOPC Chairman
6	Start preparing an outline and plan for a soil moisture guideline brochure similar to existing GTOS reports and with involvement of the International Soil Moisture Working Group.	TOPC Chairman, GTOS Sec & soil moisture experts (Wolfgang Wagner)
7	Write a support letter for IGRAC and the African Water Initiative.	GTOS Sec
8	Discuss the need for standardization of forest carbon observations in the context of UN REDD and GEO forest carbon tracking.	GCOS SC
9	Get comment on establishment of a reference network into review to ESAC scientific advisory committee by 23rd March for ESA-EOP3.	TOPC Chairman to liaise with Riccardo Valentini, Olivier Arino & Jan Polcher



<b>List of Actions</b>		
<b>No.</b>	<b>Subject</b>	<b>Responsible</b>
<b>10</b>	Ensure compatibility between Updated Satellite Supplement and GTOS ECV reports.	GTOS Sec, GCOS Sec
<b>11</b>	Review definitions of variables and list of user observation requirements in the progress of updating the Satellite Supplement.	TOPC panel members
<b>12</b>	Come up with a mechanism to get more peer reviewed papers on ECVs and ECV standards	Riccardo Valentini, Han Dolman & Shaun Quegan

## Annex V: TOPC Work Plan (2007 – 2011)

- To identify key ECV's that play a role in feedbacks (amplification and impacts) within the climate system (snow, glaciers, lake level) and reassess whether current approaches to their measurement is adequate.
- Increased attention on coordination and long term maintenance of *in-situ* networks to establish both independent bottom up datasets of ECV's and datasets required for calibration and validation of Earth Observation data.
- Investigate how a number of current research networks (e.g. Fluxnet, LTER's) can be effectively adopted (or endorsed) by GCOS/GTOS terrestrial networks.
- Promote the development of data integration and assimilation techniques for the terrestrial domain.
- Ensure that the five current Global Terrestrial Networks (hydrology, glaciers, permafrost, rivers, lakes) are fully implemented.
- Through GCOS and GTOS maintain strong links with SBSTA and UNFCCC and relevant international research programmes (e.g. WCRP, IGBP) in defining key requirements for observations of the terrestrial ECV's.
- Contribute to the 2009 GCOS progress report to the UNFCCC.
- Link with international opportunities to promote the need for continued observations such as the International Polar Year 2007-2008 ([www.ipy.org](http://www.ipy.org)), the International Year of Planet Earth 2007 - 2009 ([www.esfs.org](http://www.esfs.org)) and subsequent initiatives.
- Maintain engagement of CEOS to ensure delivery of required satellite observations as stated in the GCOS 107 report.
- Maintain engagement with efforts to establish international (continental) terrestrial observation networks.
- Liaise with GTOS wherever appropriate, e.g. in the establishment of guidelines and standards for the observation of terrestrial ECVs.
- Liaise with GCOS and GTOS science Panels on issues of common interest.

## Annex VI: TOPC Terms of Reference (Status October 2010)

1. Recognizing the need for specific and technical input concerning terrestrial observations for climate purposes, the sponsoring organizations of GTOS and the GCOS have jointly established TOPC with the following terms of reference:
  - To define the requirements for long-term monitoring of terrestrial properties for climate and climate change;
  - To liaise with relevant research and operational communities to identify measurable terrestrial (biosphere, cryosphere, and hydrosphere) properties and attributes which
2. control the physical, biological and chemical processes affecting climate,
3. are themselves affected by climate change, are indicators of climate change and provide information on impacts of climate change;
4. To assess and monitor the adequacy of terrestrial observing networks (*in-situ*, satellite-based), promote their integration and promote the development of their capacity to measure terrestrial properties and exchange climate data and information;
5. To identify gaps in present systems and design, promote and periodically revise plans for a long-term systematic observing system that fills these gaps, makes the data available and so better serves the needs of the research and operational communities;
6. To coordinate activities with other global observing system panels and task groups to ensure consistency of requirements with the overall programmes;
7. Publish and update GCOS/GTOS studies and planning documents;
8. To liaise with the other GCOS panels, WCRP steering groups and other relevant entities, such as WMO Commissions and CEOS, on terrestrial climate observing system issues., and also to other GTOS panels, where relevant.
9. Carry out agreed assignments from the GCOS and GTOS Steering Committees;
10. Report regularly to the GCOS Steering Committee and GTOS Steering Committee on issues related to the terrestrial component of GCOS.

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Members of the panel participate in several working groups assigned particular tasks. These are:

- AOPC/TOPC Working Group on Land-Surface/Atmosphere Issues (WG-LSA)
- Working groups foreseen in the new GTOS Implementation Plan, cross cutting different panels and dealing with, for example, vulnerable areas (coastal, mountains, wetlands) and land degradation.

## Annex VII: TOPC Panel Members (Status April 2010)

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## Acronyms

AHTEG	Ad-hoc Technical Expert Group
BSRN	Baseline Surface Radiation Network (WMO)
CBS	Commission for Basic Systems (WMO)
CBD	Convention on Biological Diversity
CEOS	Committee on Earth Observation Satellites
CCI	Climate Change Initiative (ESA)
CGMS	Coordination Group for Meteorological Satellites
CIMO	Commission for Instruments and Methods of Observation (WMO)
CIIC	Climate and Cryosphere Programme (WCRP)
CNES	Centre National Centre National d'Etudes Spaciales (France)
CNRS	Centre National de la Recherche Scientifique
COP	Conference of the Parties
DELTA RES	Dutch independent research institute for water, soil and sub-surface issues
DIVERSITAS	International Programme of Biodiversity Science of the he Earth System Science Partnership
DLDD	Desertification, Land Degradation and Drought
DUE	Data User Element (ESA)
EEA	European Environment Agency
ECMWF	European Centre for Medium-Range Weather Forecast
ECVs	Essential Climate Variables
EGOS	Evolution of the Global Observing System
EPA	Environmental Protection Agency (USA)
ETN-R	European Terrestrial Network for River Discharge
FAO	Food and Agriculture Organization of the United Nations
FLUXNET	Flux and Energy Exchange Network
FAPAR	Fraction of Absorbed Photosynthetic Active Radiation
FRP	Fire Radiative Power
EDGE	Evolutionarily Distinct Globally Endangered
GAW	Global Atmosphere Watch (WMO)
CBD	Convention on Biological Diversity (UNFCCC)
GCM	GCOS Cooperation Mechanism
GCOS	Global Climate Observing System
GCW	Global Cryosphere Watch
GEO	Group on Earth Observations
GEOBON	GEO Biodiversity Observation Network
GFCS	Global Framework for Climate Services
GFOI	Global Forest Observations Initiative (GEO)
GEWEX	Global Energy and Water Cycle Experiment (WCRP)
GGMN	Global Groundwater Monitoring Network

GGMS	Global Groundwater Monitoring System
GIPPS	Global Integrated Polar Prediction System
GMES	Global Monitoring for Environment and Security Initiative
GOFC-GOLD	GTOS Panel on Global Observation of Forest and Land Cover Dynamics
GPPC	Global Precipitation Climatology Centre
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment (NASA)
GRDC	Global Runoff Data Centre
GTNs	Global Terrestrial Networks
GTN-G	Global Terrestrial Network for Glaciers
GTN-GW	Global Terrestrial Network for Groundwater
GTN-H	Global Terrestrial Network for Hydrology
GTN-P	Global Terrestrial Network for Permafrost
GTN-R	Global Terrestrial Network for River Discharge
GTN-SM	Global Terrestrial Network for Soil Moisture
GTOS	Global Terrestrial Observing System
HYCOS	Hydrological Cycle Observing System (WMO)
HWRP	Hydrology and Water Resources Programme
HYDROLARE	International Data Centre on the Hydrology of Lakes and Reservoirs
INFOHYDRO	Hydrologic Information Referral Service
ICOS	Integrated Carbon Observation System
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IGRAC	International Groundwater Resources Assessment Centre
IUCN	International Union for Conservation of Nature
IP	Implementation Plan
IPCC	Intergovernmental Panel on Climate Change
IPY	International Polar Year
InSAR	Interferometric Synthetic Aperture Radar
ISARME	Internationally Shared Aquifer Resource Management Programme
ISMWG	International Soil Moisture Working Group
ISO	International Organization for Standardization
LAI	Leaf Area Index
LPV	Land Product Validation
MODIS	Moderate Resolution Imaging Spectrometer
NEON	National Ecological Observatory Network (USA)
NMHS	National Meteorological and Hydrological Service
MRV	Measurement, Monitoring, Reporting and Verification
OOPC	Ocean Observation Panel for Climate (GCOS/WCRP)
REDD	UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

SAR	Synthetic Aperture Radar
SBSTA	Subsidiary Body for Scientific and Technological Advice (UNFCCC)
SCOPE	Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring
SHI	State Hydrological Institute (Russia)
SMAP	Soil Moisture Active & Passive Mission (NASA),
SMOS	Soil Moisture and Ocean Salinity Mission (ESA)
SC	Steering Committee
TCD	GTOS Panel on Terrestrial Carbon and Land Degradation
TCO	Terrestrial Carbon Observations
TOPC	Terrestrial Observation Panel for Climate
TOSCA	Terre solide, Océan, Surfaces Continentales, Atmosphère (CNES programme)
UNCCD	UN Convention to Combat Desertification
USDA	US Department of Agriculture
UNEP	UN Environment Programme
UNESCO	UN Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USGS	US Geological Survey
WACMOS	Water Cycle Multi-mission Observation Strategy
WCC-3	World Climate Conference-3
WCRP	World Climate Research Programme
WGMS	World Glacier Monitoring Service
WIGOS	WMO Integrated Observing System
WIS	WMO Information System
WHYMAP	World-wide Hydrogeological Mapping and Assessment Programme
WOAP	WCRP/GCOS Observation and Assimilation Panel
WWAP	World Water Assessment Programme