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GCOS-GTOS-WCRP TOPC Terrestrial Observation Panel for Climate

18th Session of the GCOS /WCRP Terrestrial Observation Panel for Climate

(TOPC-18)

CIRES, Boulder, USA

25-27 April, 2016

GCOS-202

WCRP World Climate Research Programme

Chair, Publications Board

World Meteorological Organization (WMO)

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Note this report does not describe all the presentations but summarises the discussions and actions agreed. Presentations are made available at:

http://www.wmo.int/pages/prog/gcos/index.php?name=TOPC-XVIII

A summary of all the actions from the TOPC meeting and the joint session are included in Appendix 2

This report also includes tables of ECV requirements (Appendix 3). These will be reviewed and updated in the new Implementation Plan which, when it is published, will be the definitive source of this information.

Contents

18th Session of the GCOS /WCRP Terrestrial Observation Panel for Climate

Boulder Colorado, USA, 24-26 April 2006

NOTE: This report refers to presentations which are available on the web at xxx. The contents of the presentations are not included here, this is a report of the main points and agreements and decisions made at the meeting.

This report also includes tables of ECV requirements. These will be reviewed and updated in the new Implementation Plan which, when it is published, will be the definitive source of this information.

1. Introduction and Welcome

Stephen Briggs, Chairman of the GCOS Steering Committee, welcomed the participants to the Cooperative Institute for Research in Environmental Sciences (CIRES) in Boulder, United States of America. This would be an important year for GCOS. The Status Report was an important milestone and GCOS was now working on the new Implementation Plan which will be submitted to the United Nations Framework Convention on Climate Change *(*UNFCCC*)* at 22nd Session of the Conference of the Parties (COP 22) in Marrakech in November 2016. The aim of the meeting is to prepare the TOPC inputs into the new GCOS implementation Plan. This is an opportunity for TOPC to consider, if changes to the list of Essential Climate Variables (ECVs), or their definitions, are needed to prepare the ECVs for the future.

2. Aims and Expected Outcomes

Presentation	
Konrad Steffen (TOPC Chair)	The Terrestrial Panel for Climate 18

Konrad Steffen (TOPC, Chairman) also welcomed the participants to CIRES in Boulder.

The new Implementation Plan will address climate observation needs and actions over the next 5-10 years and so TOPC needed to consider actions for this timeframe. The new Implementation Plan will have an increased focus on meeting needs beyond climate science: e.g. adaptation to climate change and variability and climate indicators. Other issues for TOPC included taking a more proactive role in monitoring ECV observations and the coordination of terrestrial observations given the demise of the Global Terrestrial Observing System (GTOS).

TOPC also needed to consider detailed requirements for each ECV. GCOS needs to be able to say exactly what it is that we are asking to be observed in terms of frequency, resolution and uncertainties. It is against these requirements that the success of observations can be judged – this is currently being done for satellite observations. The GCOS satellite supplement gives requirements for satellite observations and these should be reviewed.

Requirements also need to be specified to in situ observations. There are some numbers available but their provenance is not known. There are also standards and best practises for some ECVs. The question of how to bring this together and specify requirements needs to be addressed. It may not be possible to complete this for the new Implementation Plan but a start should be made and this could also be a task for 2017.

Time was provided for small break-out groups which drafted individual sections for the terrestrial chapter of the new Implementation Plan. Additional inputs needed to be provided before 16 May 2016, so they could be integrated into the full document before the final Implementation Plan Writing Team meeting held 24-26 May 2016.

3. Updates from Selected Organisations

3.1 GCOS and GCOS Cooperation Mechanism

Presentation	
Carolin Richter (Director, GCOS Secretariat)	**GCOS/WCRP Terrestrial Observation Panel for Climate (TOPC) 18th session**

GCOS has adopted a three-phase approach: identifying ECV and their requirements, review the performance of the observing systems and planning ways to improve the situation.

GCOS works with existing systems, organisations, for example, Global Ocean Observation System (GOOS), United Nations Convention to Combat Desertification (UNCCD), Convention on Biodiversity (CBD), United National Convention on Climate Change (UNCCC), and the Intergovernmental Panel on Climate Change (IPCC.) GCOS has a 20-year history and is not starting from scratch in developing these plans. The three science panels provide the technical input. The GCOS Science Conference held from 2 to 4 March 2016, in Amsterdam, provided a wide range of views and ideas for the new Implementation Plan, but GCOS also needs to take account of policy aims and needs, globally and where appropriate, locally.

The ECV Inventory continues to be developed and may provide a valuable access to users. The panels need to define the ECV requirements and for the new Implementation Plan, as a minimum, update the numerical values contained in the satellite supplement.

Finally, the GCOS Cooperation Mechanism (GCM) assisted by TOPC needs to identify terrestrial opportunities, but funding is a significant problem and constraint.

3.2 CEOS WGCV Land Product Validation (LPV)

Presentation	
Miguel Roman	CEOS/WGCV Land Product Validation Update

An update on the working group on calibration and validation (WGCV) and the land product validation (LPV) sub-group were provided.

They are producing a Land Validation Framework: an operational

product for validation. This will provide best practice for in situ standards and how to use this information to assess satellite data. This will provide accepted reference data for comparison. NASA supporting a full-time editor to produce frameworks for each ECV, with the timings in line with missions.

Action	Who	When
1) Encourage the use of air-borne observations with space and in situ observations to fill gaps.	TOPC	ongoing

3.3 Copernicus Climate Change Service - European Union's flagship for operational ECV monitoring

Presentation	
Michael Zemp	Copernicus Climate Change Service - European Union's flagship for operational ECV monitoring

The European Union is providing operational funding with hard-to-get in situ observations being funded. Copernicus is changing the situation and is building web access to data stores for some ECVs. Copernicus is providing funding for operational monitoring.

3.4 WIGOS

Presentation	
Lars-Peter Riishojgaard	WIGOS - What is it and how might it relate to TOPC?

WIGOS, WMO Integrated Global Observing System, includes the OSCAR database of observational requirements which could hold the TOPC (and GCOS) requirements as they are finalised. Requirements depend on application – without context requirements are meaningless. The current requirements feed into IPCC WG1 (i.e. climate science needs) and adaptation has not been addressed yet (though discussions started with recent GCOS workshops).

The context of data is important but linking TOPC requirements is not obvious and will require some thought.

The WIGOS Data Quality Monitoring System (WDQMS) aims to provide on-line near real time monitoring of data quality though the relevance of this to TOPC ECV is unclear for many ECV where they are either based on satellite products or data collected with high latency. However, Data Quality Monitoring is important.

Action	Who	When
2) Look for areas of cooperation between TOPC and WIGOS	GCOS Sec	Next TOPC meeting

3) Improve description and specification of uncertainty	TOPC	Sept 2016 (new IP)

3.5 Global Cryosphere Watch (GCW)

Presentation	
Jeff Key	The Global Cryosphere Watch

Activities under the WMO's Global Cryosphere Watch (GCW) include measurement guidelines/best practices, observations requirements and inter-comparisons. This is an opportunity to work together. Cooperation can bring benefits to all. One topic is identifying minimum in situ observations to validate satellite products – this is being done by WGCV but will have broader benefits.

Action	**Who**	**When**
4) Discuss possible attendance of TOPC at GCW Steering Committee	GCOS Sec & TOPC Chair & WMO GCW	June 2016 (WMO EC)

3.6 GTH-H Wolfgang Grabs

Presentation	
Wolfgang Grabs	GTN-H : Network of Federated Global Data Centres in Support of GCOS

Essential Water Cycle Variables (EWV) are being defined and overlap with ECV. A significant issue is with data sharing – there is a reluctance to share. A greater understanding of use of data is needed to help overcome this issue. It may be possible to improve data sharing through the African Union.

There are Inconsistencies between GEO and WIGOS infrastructures and metadata that need to be addressed.

The ESA funding of the International Soil Moisture Monitoring Network (ISMN) will end at end of June. *[Update from June 2016: ESA has kindly agreed to support a continuation of the ISMN]*

Action	**Who**	**When**
5) Send a letter about continued support for ISMN	GCOS Sec	ASAP

3.7 GOFC-GOLD

Presentation	
Brice Mora	GOFC-GOLD Activities in Support of Global Land Cover and Land Use Observations

There are some datasets being produced and released without peer-

review literature to document the data, without reference datasets or without accuracy assessment.

The need for land use in addition to land cover for climate modelling, mitigation and adaption activities was highlighted. Land use needs local bottom-up data in addition to satellite information.

There is a need to develop a hub for local expert communities to sustain validation efforts.

A proposal to change the ECV from "Land Cover" to "Land Cover and Land Use" was rejected.

Action	Who	When
6) Proposal to change "Land Cover" to "Land Cover & Use" was rejected but text in new Implementation Plan to discuss derivation of land use for land cover.	GOFC-GOLD & TOPC	New Implementation Plan

4. Review of Actions from TOPC XVII

Presentation	
Simon Eggleston	TOPC XVII Actions

Apart from a few actions that will be addressed in the new Implementation Plan all the actions were completed.

5. News about ECVs.

5.1 GTN-P

Presentation	
Elchin Jafarov	Global Terrestrial Network for Permafrost GTN-P

TOPC noted the continued uncertainty around the sustainability and funding of GTN-P.

Action	Who	When
7) Send letter of concern about continued funding GTN-P signed by TOPC Chair	GCOS Sec TOPC Chair	ASAP

5.2 New Land Surface Temperature ECV

Presentation	
Miguel Roman	Land surface temperature: an Essential Climate Variable

The climate community is already using LST - the clear sky radiative temperature.

Action	Who	When
8) LST was agreed and actions and requirements should be included in the new Implementation Plan	TOPC CEOS/CGMS WG Climate	ASAP

5.3 Revision of Fire Disturbance

Presentation	
Kevin Tansey	A review of Fire ECV Requirements

The revised specifications presented were agreed and should be included in the new Implementation Plan.

Action	**Who**	**When**
9) Adopt the proposed description of the Fire disturbance ECV in future and in the new Implementation Plan	TOPC	New Implementation Plan

5.4 Anthropogenic Water Use

Presentation	
Simon Eggleston	Anthropogenic Water Use

It was agreed that anthropogenic water use was an important ECV given that the IPCC has identified water scarcity as an important and increasing consequence of climate change. It was noted that current efforts to collect data are insufficient: there are both temporal and spatial gaps. One way forward would be to focus on pilot projects in specific areas that could then be used as templates for wider use.

Action	**Who**	**When**
10) ECV: Water Use. Agree to refocus on all uses. Support pilot projects	TOPC	New Implementation Plan

5.5 Anthropogenic Greenhouse Gas Emissions

Presentation	
Simon Eggleston	Anthropogenic Greenhouse Gas Emissions

It was agreed that these will be important and that they should be an ECV. They are important to close the carbon cycle and because they are needed by the UNFCCC to track mitigation efforts.

Action	**Who**	**When**
11) ECV: Anthropogenic GHG Emissions, ask working group to produce justification and specification before next SC for potential inclusion in new Implementation Plan	Shaun/ Sassan/ Simon/ Stephen	Now -Sept 2016

5.6 Latent and Sensible Heat Fluxes

Presentation	
Simon Eggleston	Anthropogenic Greenhouse Gas Emissions: A proposed ECV

Following a discussion, it was agreed that it was premature to make Latent and Sensible Heat Fluxes over land and ECV until concerns over how well they can be measured on a global scale given their heterogeneity.

Action	**Who**	**When**
12) Technical workshop on consistency between ECVs (e.g. Fire and Albedo)	GCOS Sec	2017
13) ECV: Heat Fluxes. ask working group led by Han to produce justification and specification before next TOPC meeting for consideration at next TOPC meeting	Han Dolman	Next TOPC meeting

5.7 CCI soil moisture project, the ISMN and C3S

Presentation	
Wolfgang Wagner	Soil Moisture ECV: Status 2016

5.8 Snow cover data sets available at NSIDC

Presentation	
Lisa Booker	Snow Cover Data Sets at NSIDC

There was a discussion of the continuity of passive microwave satellite measurements – US satellites are coming to the end of their lives. However, Metop will continue to deliver relevant data.

5.9 Lakes

Presentation	
Simon Eggleston	Lakes ECV

It was agreed that new satellite based products (Lake Surface Temperature, ice extent and lake colour) should be included in the Lake ECV.

Action	**Who**	**When**
14) It was agreed to include Lake Surface Temperature, ice extent and lake colour as part of the Lakes ECV in the new Implementation Plan.	TOPC	New Implementation Plan

5.10 Discussion and agreement on new/redefined ECVs

Summary of agreements on new/refined ECVs:

- ***Land Surface Temperature (new ECV)***: TOPC 17 set up a small working group which had discussed with the community came back with a community report. It was **Agreed** this should be a new ECV. This is a radiative temperature. Temperature product can be made consistent over time, sensors etc. Distribute CEOS CV paper;
- **Land Heat Flux Sensible and Radiant Heat fluxes and radiant fluxes (potential future ECV).** This should not be an ECV now but TOPC will follow the approach used for LST and ask group to report before the next TOPC meeting;
- **Land Use (refined ECV)** GOFC-GOLD to continue to lead. They will redefine for the new Implementation Plan;
- **Anthropogenic Greenhouse Gas Fluxes (new ECV)** a working group will work on text and definitions for the new Implementation Plan;
- **Anthropogenic Water Use. (refined ECV)** this should be redefined in the new Implementation Plan to make its usefulness and importance clearer;
- **Lakes (refined ECV).** Additional parameters have been agreed: Lake Surface Temperature, ice extent and lake colour

TOPC discussed the need to be clear about what the ECV requirements are and how well they are being monitored. It was agreed that detailed specification sheets for each ECV should be published, similar to the unpublished technical supplement to 2004 plan, GTOS brochures. It was also agreed that, in order to make the TOPC meetings more efficient, that expert should report on each ECV, in writing, to the Panel before the meeting so the meeting itself can concentrate on more substantive issues.

Action	Who	When
15) Specification of all Terrestrial ECV, based on existing material (e.g. unpublished technical supplement to 2004 plan, GTOS brochures) to be published.	GCOS Sec & TOPC	2017/8
16) Experts to report to TOPC before meeting on status of ECV observations. Experts to be allocated to each ECV.		Next TOPC meeting

6. Recent work at National Snow and Ice Data Center (NSIDC)

Two presentations were given about the work of NSIDC. TOPC thanked the presenters for their informative presentations.

Presentation	
Mary Jo Brodzik, D. G. Long, M. A. Hardman, A. Paget, R. L. Armstrong	Using image reconstruction to enhance spatial resolution of the satellite passive microwave historical record

Presentation	
Karl Rittger, Mary J. Brodzik, Thomas H. Painter, Richard Armstrong, Jeff Dozier	Development and application of improved snow cover algorithms

7. GCOS Status Report - Key Issues for TOPC

Simon Eggleston introduced main points of interest and of concern to the panel which are addressed in the GCOS Status Report and which will need to be incorporated into the terrestrial section of the new GCOS Implementation Plan if the findings require an action.

Presentation	
Simon Eggleston	GCOS 2015 Status Report

8. Discussions on General TOPC Issues including

A general discussion was held on the approach to be followed by TOPC in the future. This included:

- TOPC needs to better monitor the performance of ECV observational networks and systems;
- Reports for some ECVs are already made, for example BAMS publishes a annual report that covers several ECV. However, tracking of network issues is more of an problem;
- The current ECVs need improvement to better monitor the carbon and energy cycles. The addition of anthropogenic greenhouse gas fluxes will help with the carbon cycle. While latent and sensible heat fluxes are needed there are still questions about monitoring at a global scale;
- The coastal zone overlaps with ocean observations. Examples include carbon fluxes and stores such as mangroves, sea grasses and salt-marshes; riverine carbon fluxes to air and ocean that are poorly understood; and sea ice and ice shelves. In the new Implementation Plan TOPC, will consider joint meetings with OOPC to address these issues;
- In the absence of GTOS the coordination of terrestrial observations should be improved. The is some coordination in the hydrological area (GTN-H, WMO) and cryosphere (WMO's GCW) but nothing for the biosphere;
- Consider how to improve the geographic coverage and gender balance of the TOPC membership;
- Improve the referencing and discoverability of data including the use of digital object identifiers (DOI).

Action	**Who**	**When**
17) Need to agree on a rotation cycle for TOPC membership and balanced composition	GCOS Sec & SC	Oct 2016 (SC)
18) Include action on use of DOI in new Implementation Plan	GCOS Sec	NOW

Action	Who	When
19) Find about use of DOI on GCOS Reports	GCOS Sec	June 2016
20) Discuss joint meeting of TOPC and OOPC at GOOS SC June 1st	GCOS SC Chair	June 1st

9. New demands on ECVs arising from adaption and mitigation

Presentation	
Daniel Ochieng Olago	Climate Observation Needs for Adaptation (in the context of EBA projects)

In assessing adaptation needs and climate risks both climate change and variability are needed. However, both are changing over time are combined with significant uncertainties. Climate data are needed for several purposes:

- Increased knowledge and understanding of climate variability and change- induced threat at various scales and in vulnerable areas;
- Improved climate change risk information relevant to a broad range of end users;
- Building resilient ecosystems;
- Sustaining ecosystem services;
- Disaster Risk Reduction;
- Enabling effective adaptation;
- Supporting livelihoods and development planning.

Observational needs include:

- Precipitation – changing onset and cessation of seasons; increased magnitude and frequency of short-duration storms; rainfall spread within seasons changing;
- Temperature – changes observed in Tmax/Tmin related to changes in crop production, disease & pests spread;
- Lake level changes – recent rise in East Africa lakes (2011-2013) destroyed infrastructure, property and livelihoods;
- Ecosystems – invasive species spread; fragmentation;
- Land Use Change – rapid increase in urbanisation and use of rural lands; erosion and land degradation with strong poverty links;
- Groundwater – high dependence on both shallow and deep.

It was noted that the main policy focus is on food security. However, TOPC needs to identify exactly what can TOPC do in this area. (Some of the biosphere and hydrological ECVs are clearly important). More general needs include:

- Standardised datasets;
- Information at higher scales;
- Wider temporal scales;
- Tmax/Tmin rather than average temps;
- Improved Climate predictions in Africa – currently they are only

seasonal.

Countries in Africa face many challenges including:

- Few ground observation stations, unevenly dispersed, infrequent monitoring;
- Lack of appropriate equipment, maintenance, archiving – related to financing and human resource capacities;
- Information does not reach intended users, or is not translated into an easily understandable form;
- Lack of adequate structures for early warning systems;
- Few databases, duplicate databases not harmonized;
- In a single country it is common to see a variety of indicators and methods of data collection used to measure the same parameter, which renders comparative analysis impossible;
- Insufficient capacity to extract and analyse spatial data from global or regional databases;
- Inappropriate data: metrics or scale (resolution);
- lack of demand for information by decision makers;
- Overlapping/conflicting institutional mandates – nothing happens.

Presentation	
Michael Zemp	The new GCOS Implementation Plan Update or Review? Some thoughts from the glacier example

While the new Implementation Plan is a new plan not an update of the 2010 Implementation Plan, it is also an evolutional develop of earlier plans. Most of the ECV remain, others have their definitions refined. Most actions in the new Implementation Plan will be to continue and improve existing monitoring.

10. Draft 2016 GCOS Implementation Plan

Presentation	
Simon Eggleston	2016 GCOS Implementation Plan

This meeting will work on draft text for the terrestrial chapter of the new Implementation Plan and on the ECV requirements. The draft text should be sent to the GCOS Secretariat before 16 May in advance of the new Implementation Plan Writing Team Meeting at the end of May. The draft document will be reviewed internally starting on 13 June to 8 July and go out for public review on 25 July. All participants were encouraged to consider the draft before the review to ensure a high quality public review draft.

The new draft plan introduces targets for each of the main climate-relevant cycles, carbon, water and energy, as well as for biodiversity monitoring. These over-arching targets may not be currently met but the observing system should work towards meeting them.

11. Break-out groups working checking/re-drafting text from the draft 2016 GCOS Implementation Plan

The meeting split into 3 breakout groups that revised the ECV requirements table and produced draft text for the new Implementation Plan. Each group agreed to send final text to the GCOS Secretariat by 16 May.

The breakout groups all reviewed the ECV requirements from the satellite supplement, updated the data and added information for ECV primarily observed through in situ observations. The outcomes[1] are presented in Appendix 3.

Biosphere: The text still needs additional work after the meeting. In particular on anthropogenic greenhouse gas emissions (Simon), an action item on heat fluxes, the Land Surface Temperature text.

Water: Introductions to each ECV need to be completed. The link in freeze thaw between soil moisture, permafrost and biomass should be included.

Cryosphere: Text for permafrost on the way, (Michel Zemp has contacted GTN-P). Snow also needs to be finalise. There should be a be cross linked to between snow albedo and the albedo ECV.

12. Closure

The meeting closed with thanks to Konrad Steffen and Shaun Quegan who are both retiring for their efforts for GCOS and TOPC over the past years.

TOPC also expressed its thanks to CIRES and NSIDC for hosting and supporting the meeting.

[1] This list will be revised as part of the reviews of the implementation plan. After it is published, consult the published Implementation Plan for a up-to-date list of ECV requirements.

Appendix 1 Agenda

TOPC XVIII - Agenda

Boulder Colorado, USA, 24-26 April 2006

Final

1. The aim of the meeting is to prepare the TOPC inputs into the new GCOS implementation Plan that is currently being drafted for submission to the UNFCCC at COP 22 in November 2016.
2. The new Implementation Plan discusses climate observation needs and actions over the next 5-10 years and so TOPC needs consider actions for this timeframe. The new Implementation Plan will have an increased focus on meeting needs beyond climate science: e.g. adaptation to climate change and variability and climate indicators. Other issues for TOPC include taking a more proactive role in monitoring ECV observations and the coordination of terrestrial observations given the demise of GTOS.
3. TOPC will also need to consider detailed requirements for each ECV. GCOS needs to be able to say exactly what it is that we are asking to be observed in terms of frequency, resolution and uncertainties. It is against these requirements that the success of observations can be judged – this is currently being done for satellite observations. The GCOS satellite supplement gives requirements for satellite observations and these should be reviewed. Requirements also need to be specified to in situ observations. There are some numbers available but their provenance is not known. There are also standards and best practises for some ECVs. The question of how to bring this together and specify requirements needs to be addressed. It may not be possible to complete this for the new Implementation Plan but a start should be made and this could also be a task for 2017.
4. Time will be provided for small break-out groups which will draft individual sections for the terrestrial chapter of the new Implementation Plan. If this cannot be all completed at the meeting clear actions and deadlines will need to be agreed as all TOPC inputs will need to be provided before 16 May so they can be integrated into the full document before the final Implementation Plan Writing Team meeting will be held 24-26 May.

DAY 1 - Monday 25 April 2006 Start at 09:00					
		Item			
Day 1 - Monday, 25 April	am	1	Introduction & Welcome		*Konrad Steffen & Carolin Richter*
		2	Aims and expected Outcomes		*Konrad Steffen*
		3	Updates from Selected organisation (10 minutes each)		
			3.1	GCOS & GCOS Cooperation Mechanism	*Carolin Richter*
			3.2	CEOS WGCV	*Miguel Roman*
			3.3	Copernicus Climate Change Service - European Union's flagship for operational ECV monitoring	*Michael Zemp*
			3.4	WIGOS	*Lars-Peter Riishojgaard*
			3.5	Global Cryosphere Watch (GCW)	*Jeff Key*
				Coffee	
			3.6	GTH-H	*Wolfgang Grabs*
			3.7	GOFC-GOLD	*Brice Mora*
			3.8	UNEP Climate Dashboard: UNEPLive	*Carolin Richter (tbc)*
		4	Review of Actions from TOPC XVII.		*Simon Eggleston*
		5	News about ECVs. (20 minutes each inc. discussion) *Short Presentations on significant new information to inform the new Implementation Plan and proposals for new ECVs. More general issues will be considered on the second day.*		
			5.1	GTN-P	*Hugues Lantuit*
				LUNCH (12:30-14:00)	
	pm		5.2	New Land Surface Temperature ECV	*Miguel Roman*
			5.3	Revision of Fire Disturbance	*Kevin Tansey*
			5.4	Anthropogenic Water Use	*Simon Eggleston*
			5.5	Anthropogenic Greenhouse Gas Emissions	*Simon Eggleston*
				Coffee	
			5.6	Latent and Sensible Heat Fluxes	*Simon Eggleston*
			5.7	CCI soil moisture project, the ISMN and C3S	*Wolfgang Wagner*
			5.8	Snow cover data sets available at NSIDC	*Lisa Booker*
			5.9	The new Implementation Plan: Update or Rewrite? Some thoughts from the glacier example	*Michael Zemp*
			5.10	Discussion and agreement on new/redefined ECVs	*Konrad Steffen*

DAY 2 - Tuesday 26 April 2006 Start at 09:00				
Day 2 - Tuesday, 26 April	am	6	Recent work at NSIDC (20 minutes each)	
			6.1 Gridded passive microwave ESDR for monitoring cryospheric & hydrologic time series	*Mary Jo Brodzik*
			6.2 Development and application of improved snow algorithms	*Karl Rittger*
		7	GCOS Status Report - Key Issues for TOPC	*Simon Eggleston*
		8	Discussions on General TOPC Issues including	
			How well does TOPC monitor ECV observations and what more can be done? *How well do the current ECV monitor changes: fluxes v stocks?* *What are the missing gaps in the three cycles: carbon water and energy? Can we detect anthropogenic influences on the carbon cycle?* *Coastal overlaps with ocean observations. E.g. carbon fluxes – mangroves? Marshes? Riverine carbon fluxes to air and ocean? Sea Ice and Ice shelves?* *In the absence of GTOS how should coordination of Terrestrial Observations be improved?* *Can Global and regional in-situ networks be better coordinated e.g. a database of networks/sites?*	
			Coffee	
			Discussions (Continued)	
	LUNCH (12:30-14:00)			
	pm	9	New demands on ECVs arising from adaption and mitigation (20 minutes)	*Daniel Ochieng Olago*
		10	Draft 2016 GCOS Implementation Plan (20 minutes)	*Konrad Steffen, Shaun Quegan, Simon Eggleston*
			Discussion	
			e.g. Are the general GCOS actions appropriate for TOPC Are the specific terrestrial ECV actions practical and well costed?	
		11	Break-out groups working checking/re-drafting text from the draft 2016 GCOS Implementation Plan	
			Composition and number of BOG tbd. The aim is to have as much compete text as possible for the Terrestrial chapter and a through review of the remainder of the document. Any work that cannot be completed should have responsibilities assigned and a clear time line for completion, in line with the overall schedule of the new Implementation Plan.	
			Coffee	
			Break-out Groups (Continued)	

DAY 3 - Wednesday 27 April 2006 Start at 09:00			
Day 3 - Wednesday 27 April	am	12	Break-out Groups (continued)
	LUNCH (12:30-14:00)		
	pm	12	Presentation of outcomes of Breakout Groups to Plenary
		13	Agree Actions
		14	AOB
		15	Closure (15:00 approx)

Appendix 2 Agreed Actions

Action	Who	When
1) Encourage the use of air-borne observations with space and in situ observations to fill gaps.	TOPC	ongoing
2) Look for areas of cooperation between TOPC and WIGOS	GCOS Sec	Next TOPC meeting
3) Improve description and specification of uncertainty	TOPC	Sept 2016 (new IP)
4) Discuss possible attendance of TOPC at GCW Steering Committee	GCOS Sec & TOPC Chair & WMO GCW	June 2016 (WMO EC)
5) Letter about continued support for ISMN	GCOS Sec	ASAP
6) Proposal to change “Land Cover” to ”Land Cover & Use” was rejected but text in new Implementation Plan to discuss derivation of land use for land cover.	GOFC_GOLD & TOPC	New Implementation Plan
7) Send letter of concern about continued funding GTN-P signed by TOPC Chair	GCOS Sec TOPC Chair	ASAP
8) LST was agreed and actions and requirements should be included in the new Implementation Plan	TOPC CEOS/CGMS WG Climate	New Implementation Plan
9) Adopt the proposed description of the Fire disturbance ECV in future and in the new Implementation Plan	TOPC	New Implementation Plan
10) ECV: Water Use. Agree to refocus on all uses. Support pilot projects	TOPC	New Implementation Plan
11) ECV: Anthropogenic GHG Emissions, ask working group to produce justification and specification before next SC for potential inclusion in new Implementation Plan	Shaun/ Sassan/ Simon/ Stephen	Now -Sept 2016
12) Technical workshop on consistency between ECVs (e.g. Fire and Albedo)	GCOS Sec	2017
13) ECV: Heat Fluxes. ask working group led by Han to produce justification and specification before next TOPC meeting for consideration at next TOPC meeting	Han …	Next TOPC meeting
14) It was agreed to include Lake Surface Temperature, ice extent and lake colour as part of the Lakes ECV in the new Implementation Plan.		New Implementation Plan
15) Specification of all Terrestrial ECV, based on existing material (e.g. unpublished technical supplement to 2004 plan, GTOS brochures) to be published.	GCOS sec & TOPC	2017/8
16) Experts to report to TOPC before meeting on status of ECV observations. Experts to be allocated to each ECV.		Next TOPC meeting

Action	Who	When
17) Need to agree on a rotation cycle for TOPC membership and balanced composition	GCOS Sec & SC	Oct 2016 (SC)
18) Include action on use of DOI in new Implementation Plan	GCOS Sec	NOW
19) Find about use of DOI on GCOS Reports	GCOS Sec	June 2016
20) Discuss joint meeting of TOPC and OOPC at GOOS SC June 1st	GCOS SC Chair	June 1st

Appendix 3 ECV Requirements

This appendix include 2 tables. The first, Table 1 outlines the current monitoring of each ECV, the second, Table 2, present the requirements of the ECV products for each ECV.

Box 1 - Terrestrial Standards: References.

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Table 1 Monitoring of ECVs

	Name	Quantities Measured	Measurements	Standards	Data
HYDROLOGICAL	River discharge	Mean daily discharge data from all major river basins draining into the world's oceans are required. Measured parameters are: River Discharge (m3/day) Water Level (m) Flow Velocity (m/s) Cross-section (m^2)	Satellite microwave altimeters National In situ observations according to WMO standards. GTN-R	ISO/TC 113: WMO (2010) WMO (2008a) WMO (2009)	GTN-R data centre: Global Runoff Data Centre Satellite data centre: Hydroweb at LEGOS/CNES
	Groundwater	Groundwater volume change (m^3/month) Groundwater level (m): Groundwater recharge (m^3/s): Groundwater discharge (m^3/s): Wellhead level (m): Water quality.	Gravity measurements have been used to estimate changes of groundwater at very coarse scale globally. Satellite gravity missions need to be operationalised National In situ observations	ISO/TC 147/SC 6 N 120, ISO 5667-18:2001 part 18	Data centre: International Ground Water Resources Assessment Centre (IGRAC)
	Lakes	Lake water level (cm) Water Extent (m^2) Lake surface water temperature (C^o) Lake ice cover (m^2) Lake ice thickness (m) Lake Colour (Lake Water Leaving Reflectance)	Satellite microwave altimeters for lake level Multi-spectral optical and thermal sensors for water extent, water temperature, water colour, and ice cover SAR for water extent and ice cover National In situ observations according to WMO standards. Global Terrestrial Network- Lakes (GTN-L)	WMO (2006) WMO (2008a)	Data Centre: HYDROLARE Satellite data centre: Hydroweb Copernicus Global Land Service / CEOS, ESA CCI, GloboLakes
	Soil moisture	Surface soil moisture content (m^3/m^3) Freeze/thaw status Surface inundation Vegetation optical depth Root-zone soil moisture content (m3/m3)	Microwave radiometers, scatterometers and synthetic aperture radars (SAR) inin 1-10 GHz range (L, C, and X-band) complemented by medium resolution optical and thermal sensors. nternational Soil Moisture Network (ISMN) ; as part of GTN-H	WMO (2008b)	ESA CCI Soil Moisture Copernicus Climate Change Service

	Name	Quantities Measured	Measurements	Standards	Data
CRYOSPHERE	Snow cover	Spatial and temporal variation in the following: Spatial Extent of Snow (m^2) Fractional Snow Cover (viewable and canopy-adjusted) Snow Depth (m) Snow Water Equivalent (kg/m^3)t Grain Size (m) Radiative Forcing by Impurities In addition to spatial extent of snow cover: snow depth, snow water equivalent, and the presence of water in the liquid phase - including spatial and temporal trends in the above variables.	Optical and microwave satellite data for snow cover extent and duration. Lidar and microwave for depth and water equivalent. National In situ measurements according to WMO guidelines. WWW/GOS surface synoptic networks (depth). National and regional networks (depth and water equivalent), manual and automated. GCW	WMO (2008b) IGOS (2007)	Data Centre: NSIDC NRCS SNOTEL NASA JPL
	Glaciers	Area (m^2) Elevation change (m/decade) Mass balance.(kg/year)	Optical data for glacier area; stereo image, radar topography missions and laser altimetry and scanner for elevation change; in-situ measurements for mass balance (current gravity missions too coarse for resolving individual glaciers) National in situ data. GTN-G coordinates national monitoring networks, mainly research-based In-situ, Airborne sensors (e.g., IceBridge; national **photogrammetry** & LiDAR surveys), Spaceborne sensors (e.g., LandsatTM, ASTER, Spot)	IGOS (2007) Paul, F., Barry, et al. (2009): Zemp et al. (2013)	Data Centre: WGMS, Univ. Zurich, CH and NSIDC, CIRES, USA
	Ice sheets and ice shelves	Surface elevation change (m/(30 days)) Ice velocity (m/(30 days)) Mass balance (kg/(30 days)) groundling line location Ice shelf thickness (m) Also required is the Topography	Gravity mission, Synthetic Aperture Radar and laser altimetry Aircraft observations such as IceBridge In situ data from specific missions and projects. Program for Arctic Regional Climate Assessment. Antarctic Climate Change in the 21st Century (AntClim21)	IGOS (2007)	Data Centre: NSIDC

	Name	Quantities Measured	Measurements	Standards	Data
	Permafrost	Depth of active layer, (m) permafrost temperature (K)	Derived near-surface temperature and moisture (e.g., from ERS/Radarsat, MODIS, AMSR-E) but no sensors able to directly detect permafrost. National networks of in situ observations being developed by GTN-P	A glossary of terms has been developed	GTN-P coordinates National Monitoring Networks. Data Centre: GTN-P
BIOSPHERE	Albedo	Bidirectional reflectance factors (BRFs) BHR and DHR ("white-sky" and "black-sky") for modelling and adaptation	Daily to 10-days measurements of both black-sky and white-sky albedo in spectral bands, visible, near-infrared and shortwave broadbands with Use of operational geostationary satellites (SCOPE-CM Pilot Project) and moderate-resolution optical polar orbiters In situ data for calibration/validation. No designated reference network. CEOS WGCV;MODLAND. Atmospheric Radiation Measurement sites.		Copernicus Climate Change Service
	FAPAR	Fraction of incoming solar radiation at the top of the vegetation canopy that contributes to photosynthesis	In situ data for calibration/validation. No designated baseline network exists. CEOS WGCV;FLUXNET; TERN,EnviroNet NEON,ICOS		Copernicus
	LAI	One half the total leaf area per unit ground area.	Optical, multi-spectral and multi-angular observations. No designated baseline network exists. CEOS WGCV;FLUXNET; Long term infrastructural networks e.g. TERN, NEON, ICOS;		
	Land-surface temperature to support generation of land ECVs	Land Surface skin temperature	Optical, multi-spectral and multi-angular observations.		

Name	Quantities Measured	Measurements	Standards	Data
Land cover (including vegetation type)	Land cover classes	300m resolution satellite imagery 10-30m resolution satellite imagery European Copernicus program and Landsat Continuity mission National maps. No designated reference network.	No agreed standards but see GLCN (2014), GOFC-GOLD (2015a), and LCCS/LCML	ESA LC-CCI, NGCC.
Above-ground biomass	Above-ground living biomass (excludes roots, litter and dead wood) Forest above-ground biomass (AGB) is sometimes derived using the subsidiary variable forest height	Optical and SAR are observations at 30m horizontal resolution Demonstration LIDAR missions (ESA Biomass, NASA Global Environmental Dynamics Investigation on the ISS) are planned and possible use of IceSAT-2. No designated baseline network exists. The FAO's Forest Resource Assessments provide national statistics but not spatially explicit map-type data on forest biomass	GOFC-GOLD (2015a) GOFC-GOLD (2015b) GFOI (2013) IPCC (2006)	No global data centre for either forest or non-forest biomass.
Soil carbon	Fraction of carbon in soil.	No satellite sensors. National in situ data. No designated global network major geographical gaps; Harmonized World Soil Database (HWSD) National soil carbon surveys	GFOI (2013) IPCC (2006)	

	Name	Quantities Measured	Measurements	Standards	Data
	Fire disturbance	Burnt area (m2), fire radiative power (FRP, Watts)Burnt area, fire radiative power (FRP)	Optical, middle infrared and thermal infrared Geostationary and moderate to high-resolution optical systems continuity required. Daily detection of burnt area with horizontal resolution of 250 m and accuracy of 15% FRP horizontal resolutions of 1km to 0.25km, time resolution of 1-6 hrs, with accuracy of 25% Optical and thermal Geostationary and moderate to high-resolution optical systems continuity required. Daily detection of burnt area with horizontal resolution of 250 m and accuracy of 15% FRP horizontal resolutions of 1km or 0.1km, time resolution of 1 hour with accuracy of 25%		GOFC Regional Networks, GFMC ESA CCI GFED Copernicus LPDAAC GOFC Regional Networks, GFMC Data Centre: GFMC

	Name	Quantities Measured	Measurements	Standards	Data
HUMAN DIMENSION	Anthropogenic Water use	Water used by humans for drinking water, reservoir storage and agriculture or industrial purposes	None Areas of irrigated land can be estimated from land use information. Other information from census data No network, but a single geo-referenced database (AQUASTAT) for irrigation exists based on national data reported to FAO. Several data sets are available to be merged to one single data set indication water use and availability		AQUASTAT
	Anthropogenic Greenhouse Gas Fluxes	Emissions from fossil fuel use, industry, agriculture and waste sectors.	Estimated from fuel and activity statistics CDIAC, BP, IEA for global estimates, National reporting to UNFCCC	IPCC (2006) IPCC (2013) GFOI (2014)	National reporting to UNFCCC CDIAC Global Carbon Project
		Emissions/removals by land use sectors	Estimated by IPCC methods using statistics and satellite observations of changes in land cover. (see ECV land cover and above ground biomass) National reporting to UNFCCC		
		Emissions/removals by “land sink”	Improved knowledge on reforestation and forest growth rates		Global Carbon Project
		Estimated fluxes by inversions of observed atmospheric composition	Observations of atmospheric composition, in situ and satellite. Modelling of atmospheric transport and processes in a data assimilation scheme GAW, IG3IS, GEOCarbon, ICOS, CEOS Carbon Observations Strategy , Copernicus C3S/CAS, Global Carbon Project		Global Carbon Project

Table 2 ECV Requirements

Terrestrial Requirements							
ECV	Notes	Products	Frequency	Resolution	Accuracy	Stability	Standards/ References
River Discharge	Volume of water flowing through a given cross-section of a waterway	River discharge	Daily	Per river	10 % (relative)		ISO/TC 113: WMO (2010) WMO (2008a) WMO (2009)
		Water Level	Daily	100m	10 cm	1 cm/yr	
		Flow Velocity	Few times per year for station calibration	Per river	1 cm/s		
		Cross-section	Few times per year for station calibration	Per river	10 % (relative)		
Groundwater	Changes in groundwater resources	Groundwater volume change	Monthly	100 km	10cm	tbd	ISO/TC 147 ISO 5667-18:2001 part 18
		Groundwater level	Weekly	Per well	1 cm		
		Groundwater recharge	Weekly	Per well	10 % (relative)		
		Groundwater discharge	Weekly	Per well	10 % (relative)		
		Wellhead level	Weekly	Per well	1 cm		
		Water quality	Weekly	Per well	tbd		
Lakes	Changes and variability in lakes	Lake water level	Daily.	100 m	3 cm for large lakes, 10 cm for the remainder	1 cm/yr	WMO (2006, 2008a)
		Water Extent	Daily	20 m	10 % (relative) 5% (for 70 largest lakes)	5%/%/yr	
		Lake surface water temperature	Weekly	300 m	1 K	1 K/yr	
		Lake ice thickness	Monthly	100m	1-2 cm		
		Lake Ice Cover	Daily	300 m	10 %	10 % /yr	
		Lake Colour (Lake Water Leaving Reflectance)	Weekly	300 m	30 %	5 %/yr	
Soil Moisture	Changes and variability in soil moisture	Surface soil moisture	Daily	1-25 km	0.04 m^3/m^3	0.01 m^3/m^3/year	WMO (2008b)
		Freeze/thaw	Daily	1-25 km	90 %	tbd	
		Surface inundation	Daily	1-25 km	90 %	tbd	
		Root-zone soil moisture	Daily	1-25 km	0.04 m^3/m^3	0.01 m^3/m^3/year	

Terrestrial Requirements							
ECV	Notes	Products	Frequency	Resolution	Accuracy	Stability	Standards/ References
Snow	area, changes and variability in snow cover	Area covered by snow	Daily	1km (100m in complex terrain)	5% (maximum error of omission and commission in snow area); location accuracy better than 1/3 IFOV with target IFOV 100 m in areas of complex terrain, 1 km elsewhere	4% (maximum error of omission and commission in snow area); location accuracy better than 1/3 IFOV with target IFOV 100 m in areas of complex terrain, 1 km elsewhere	WMO (2008c) IGOS (2007)
		snow depth	Daily	1km	10mm	10mm	
		snow water equivalent	Daily	1km	10mm	10mm	
Glaciers	Changes in glaciers (Stereo optical imagery, Synthetic Aperture Radar, Satellite altimetry and Satellite gravimetry are all used.)	Glacier area	Annual (at end of ablation season)	Horizontal 15-30m	5%	15m	IGOS (2009) Paul et al. (2009) Zemp et al. (2013)
		Elevation of glacier surface	Decadal	Horizontal 30m-100m Vertical 1m	0.2m	1m	
		Glacier topography	Decadal	Horizontal 30m-100m Vertical 1m	.2m	1m	
		Glacier mass change	seasonal to annual (the latter at end of ablation period)	Vertical: 0.01m or 10kg (at point location)	better than 200kg (glacier-wide)		
Ice Sheets and ice shelves	Changes in ice sheets and ice shelves (Gravity mission, laser altimetry, Synthetic Aperture Radar)	Surface Elevation Change	30 days	Horizontal 100m	0.1m/year	0.1m/year	
		Ice velocity	30 days	Horizontal 100m	0.1m/year	0.1m/year	
		Ice mass change	30 days	Horizontal 50km	$10km^3$/year	$10km^3$/year	
		Grounding line location and thickness	yearly	Horizontal 100 m Vertical 10 m	1 m	10 m	
Permafrost	Changes and variability in Permafrost	Thermal State of Permafrost	Daily to weekly	Sufficient sites to characterise each bio-climate zone	0.1K		
		Active Layer Thickness			2cm		
FAPAR	Maps for modelling and adaptation	maps of FAPAR for modelling	Daily	200/500 m	max(10%; 0.05)	max(3%; 0.02)	
		maps of FAPAR for adaptation		50m	max(10%; 0.05)	max(3%; 0.02)	
LAI	Maps for modelling and adaptation	maps of LAI for modelling	Daily	250m	max(15%)	max(10%; 0.25)	
		maps of LAI for adaptation		50m			

Terrestrial Requirements							
ECV	Notes	Products	Frequency	Resolution	Accuracy	Stability	Standards/ References
Albedo	Maps for modelling and adaptation	Maps of DHR albedo for adaptation	Daily	50m	max(5%; 0.0025)	max(1%; 0.0001)	
		Maps of BHR albedo for adaptation		50m	max(5%; 0.0025)	max(1%; 0.0001)	
		Maps of DHR albedo for modelling	Daily	200/500m	max(5%; 0.0025)	max(1%; 0.0001)	
		Maps of BHR albedo for modelling		200/500m	max(5%; 0.0025)	max(1%; 0.0001)	
Land Surface Temperature	A measure of the skin temperature of the surface	Maps of land surface temperature	3 hour	1 km	1K		
Above-ground biomass	above-ground biomass (AGB)	maps of AGB	Annual	500m-1km (based on 100-200m observations)	< 20% error for biomass values > 50 t/ha, and 10 t/ha for biomass values ≤ 50 t/ha	10%	No agreed standards but see: GOFC-GOLD (2015b) GFOI (2013)
Land cover	Land cover type and change	maps of land cover	Annual	250m	15% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 250 m	15% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 250 m	No agreed standards but see GLCN (2014) and GOFC-GOLD (2015a)
		Maps of high resolution land cover	5 year	10 - 30m	5% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 10-30 m	5% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 10-30 m	
	Land use and land management	Maps of key IPCC land use, related changes and land management types	1-10 years (incl. historical data)	10-1000 m (depending on time period)	20% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV	20% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV	IPCC (2006)
Soil Carbon	Soil carbon stocks and changes	%Carbon in soil	5 - 10 year	20 km			
		Mineral soil bulk density to 30 cms and 1m	5 - 10 year	20 km			
		Peatlands total depth of profile, area and location	5- 10 year	2 m vertical 20 m horizontal	10%		

Terrestrial Requirements							
ECV	Notes	Products	Frequency	Resolution	Accuracy	Stability	Standards/ References
Fire	Monitoring of wildfires (both natural and anthropogenic)	Bunt Areas	24 hours	30m	15% (error of omission and commission), compared to 30 m observations		None
		Active fire maps	6 hours at all latitudes from Polar-Orbiting and 1 hour from Geostationary	0.25-1 km (Polar); 1-3 km (Geo)	5% error of commission 10% error of omission Based on per-fire comparisons for fires above target threshold of 5 MW/km² integrated FRP		
		Fire radiative power	6 hours at all latitudes from Polar-Orbiting and 1 hour from Geostationary	0.25-1 km (Polar) 1-3 km (Geo)	10% integrated over pixel. Based on target detection threshold of 5 MW/km² and with the same detection accuracy as the Active Fire Maps.		
Anthropogenic Water Use	Amounts of fresh water used by humans for all uses	volume of water per year	Annual	100 km			
Anthropogenic Greenhouse Gas Fluxes	Fluxes of greenhouse gases from anthropogenic sources including fossil fuel emissions	Emissions from fossil fuel use, industry, agriculture and waste sectors.	Annual	By country and sector	Globally 5% Nationally 10%		IPCC (2006) IPCC (2013)
		Emissions/ removals by IPCC land categories	Annual	By country/region	Globally 15% Nationally 20%		
		Estimated fluxes by inversions of observed atmospheric composition - continental	Annual	1000 - 10,000 km	1 ppm		Maps for modelling and adaptation
		Estimated fluxes by inversions of observed atmospheric composition - national	Annual	100-1000 km	1 ppm		
		Hi-res CO2 column concentrations to monitor point sources	Daily	1 km	1ppm		
Latent and Sensible Heat fluxes	Maps of latent and sensible heat fluxes	TOPC is considering the practicality of this being an ECV and what the requirements might be.					

Appendix 4 Participants

GCOS/WCRP
TERRESTRIAL OBSERVATION PANEL FOR CLIMATE
EIGHTEENTH SESSION (TOPC-18)
25 – 27 April 2016
Boulder, Colorado, USA

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