GCOS

GLOBAL CLIMATE OBSERVING SYSTEM

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AOPC Atmospheric Observation Panel for Climate

GCOS • WCRP

21st Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-21)

Asheville, NC, United States
5-8 April 2016

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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=AOPC-21.
Summaries of the presentation can be found in appendix 1 of this report.

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21st Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-21) 5-8 April 2016

1. Opening of the Meeting

1.1 Welcome and introductions

The meeting opened with a welcome to all participants from the AOPC Chairman, Ken Holmlund, who added that the most important task for the week is to work on the draft Implementation Plan (IP). Updates of normal activities are also going to be presented and discussed.
Mike Tanner, *Director of NOAA's National Centers for Environmental Information (NCEI) Center for Weather and Climate (CWC)* welcomed the participants, telling the story of the building where the meeting is held, and explained that we are the first users of this facility.

Carolin Richter, Director of the GCOS Secretariat, introduced the panel and participating secretariat staff, Tim Oakley and Caterina Tassone.

The list of participants can be found in Annex 1.

1.2 Adoption of the Agenda

The agenda (Annex 2) was adopted.

1.3 Introduction of participants

Ken Holmlund welcomed the new panel members: Olga Kalashnikova (Jet Propulsion Laboratory (JPL)-USA), Peter Thorne (University of Maynooth, Ireland), Zhanqing Li (University of Maryland, USA), and Peng Zhang (NCMC, China).

All other participants introduced themselves, and explained their role in the AOPC.

1.4 Conduct of the Meeting

Matt Menne from NCEI explained logistics and organization of evening's activities.

1.5 Aims and expectations

K. Holmlund re-iterated that the main objective of this meeting is to write the atmospheric component of the new GCOS IP.

He also mentioned the need to further advance the set of Essential Climate Variable (ECVs) that are available, promoting an analysis on what kind of new ECVs are needed. This requires an understanding of what the final goal of AOPC is. Finally, he talked about the importance of ensuring that data sets are consistent with each other.

2. Review and Actions from AOPC-20

Actions from 2015 were reviewed. The following actions were closed but will be discussed within the break out groups to assess whether they should be included in the new Implementation Plan (IP) as recommendation or actions:

- **Action 20/5**: Recommend that a surface based component is an integral part of global observing system using satellites. Contribute to vision papers (GOS for 2025, WIGOS for 2040);
- **Action 20/8:** Promote access to raw data, rather than just processed data from observations: It was recognized that this is a more broad issue, that deals with traceability for observations, one of the principles of GCOS. It will be taken up as an explicit action in the IP;
- **Action 20/23** Clarify the formal process for a network to become a GCOS network.

The following list contains actions from AOPC-20 that are now reformulated as new actions:

- **Action 20/9**: Opening archives is a good contribution but countries should be encouraged to allow full open access to data.
  The need to have open access to data is always reiterated and written in every document.
  The action will be left open for one more year as a reminder for the GCOS Secretariat to continue to promote open access to data. (**Action 21/2**);
- **Action 20/15**: Formally ask India to designate 4 radiosonde sites as part of GUAN.
  This action resulted in a new action (**Action 21/3**) and it will be approached on two sides: at the informal level, Roger Saunders will find the right person in India to talk to, and at the more formal level, the WMO SG will officially ask collaboration from India in this matter;
- **Action 20/18**: Support ICOADS (International Comprehensive Ocean-Atmosphere Data Set) Land Archive integrating existing separate archives and NCDC:
  Peter Thorne asked for GCOS support for the meeting on data rescue and aiming towards the integrated (temporally and geophysically) set of holdings. The meeting will be held in June in Maynooth, Ireland**.** A new action (**Action 21/5**) calls for Peter Thorne to represent GCOS in the meeting and report back on progress;
- **Action 20/23**: Clarify the formal process for a network to become a GCOS network. This action requires the involvement of all three panels and was reformulated as: Set up a task team to develop a formal mechanism for a network to achieve GCOS recognition (**Action 21/9**). The task team will put together a list of documents to formalize the process, and will prepare a proposal for 2017 GCOS Panel meetings (**Action 21/10**);
- **Action 20/26**: Encourage the rescued data being entered into global/regional data centres. Consider storing images of rescued data rather than just digitised data- was reformulated in **action 21/12**. It was noted that this is also an issue of transparency and traceability and therefore it is part of the main question on how to build an integrated data holding.

Summary of revised ACTIONS from AOPC:

#	Action	Deadline	Responsibility
21/1 (20/7)	Consider and agree on any new definitions of ECVs, in particular: 1.Definitions of aerosols 2.Other long-lived greenhouse gases 3.Agree on need for observations in tropopause/mesosphere and define upper limit of ECVs	September 2016	All
21/2 (20/9)	GCOS Director to use letters and other means to encourage countries to allow full open access to data	April 2017	GCOS Secretariat
21/3 20/15	Letter from WMO SG to PR of India with regard to Action 20/15 (Designated GUAN 4 sites for India); Roger Saunders to explore a contact on working level	May 2016	GCOS Sec/R. Saunders
21/4	Invite Victor Venema as a subject matter expert to AOPC 22 to present the parallel measurements collection and analysis effort.	April 2017 (next AOPC)	GCOS Sec (TBC,AOPC panel members to express interest)
21/5 (20/18)	In order to give recognition by GCOS of ICOADS Land Archive, ensure GCOS representation at upcoming ICOADS meeting at Maynooth University, Ireland.	June 2016	GCOS Sec/Peter Thorne
21/6 (20/18)	AOPC to approve GRUAN ICM report	End April 2016	AOPC/GCOS Secretariat
21/7	GRUAN to provide future reports well in advance of the AOPC meetings to AOPC in order to have AOPC review and approve the report.	February 2017	GRUAN
21/8 (20/22)	Encourage implementation of web services for data and product dissemination (in cooperation with GOSIC)	2017	All (GCOS letter)
21/9 (20/23	Set up a task team to develop a formal mechanism for a network to achieve GCOS recognition.	Before AOPC22 in 2017	GCOS Sec to raise issue with all panels
21/10	Task team on 'formal mechanism to become a GCOS network' to prepare a proposal for 2017 GCOS panels meeting	January 2017	Task group
21/11 (20/25)	Support WMO CCl and their promotion of GCOS ECVs as part of GCOS outreach. In particular continue to support WMO CCl data rescue i-DARE international data rescue portal. Also encourage USAID to support data rescue from ACMAD microfiches by IEDRO (supported by GCOS/CCl).	September 2016	GCOS Sec/DMA (O. Baddour) (P. Hechler)
21/12 (20/26)	Prepare GCOS letter to encourage entering rescued data into global/regional data centers and storing images of rescued data rather than just digitized data (NCEI will do this for land). GCOS will write memo to various stakeholders.	June 2016	GCOS Sec
21/13 (20/28)	Produce a position paper on AOPC way forward from which a draft work plan (2017-2019) can be produced and agreed.	December 2017	AOPC and GCOS Sec

3. Update on Programme activities

3.1 GCOS Update

Presentation	
Update for AOPC-21	C. Richter

C. Richter, Director of the GCOS Secretariat, presented the structure of the GCOS program, its component expert panels AOPC, OOPC and TOPC, the roadmap for the Implementation Plan and the main outcome of the GCOS open science conference.

Given the success of this first conference, a second conference should be planned in 4 years.

The following was decided:
Decision: the GCOS SC-25 (in 2017) will draft a time plan for a second GCOS Science Conference to take into account the next update of the GCOS Status report.

3.2 GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN) & GCOS Cooperation Mechanism (GCM)

Presentation	
GSN, GUAN and GCM	T. Oakley

Tim Oakley, as the GCOS Network Manager, presented the main points from his 2016 report on the GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN) and the GCOS Cooperation Mechanism (GCM).

The key items for the consideration of the meeting were:

- The 2016 update to the GSN and GUAN station list;
- The status of the GCM project in Madagascar: delivered system is too complex and there is the need of a system that relies on the technical capability and knowledge of the local staff not only on automatized system.
- The long-term 'silent' GUAN silent stations and the GCOS National Focal points: some stations have not been working for 2-3 years. The National Focus points should be approached and asked to consider future operations for the stations.

During the discussion, the requirements, benefits and governance of these 'baseline' networks was raised, given that they were set-up many years ago, along with the improving concept of tiered networks. It was agreed that it was important that these key points need to be captured within the new GCOS Implementation plan, including having a better definition of a GSN.

The outcomes were as follows:
Decision – The 2016 update to the GSN and GUAN station list was approved by AOPC.

#	Action	Deadline	Responsibility
21/14	It was agreed that the GCOS Secretariat would contact the countries with the long-term 'silent' GUAN stations, reminding them of their commitment to this baseline network and asking for their considerations on the future	30 April 2016	GCOS Secretariat/T. Oakley

	operations. Technical support would be offered along with the possibility of financial help, subject to finding a sponsor, but an alternative suggestion should be to remove the station from the GUAN.		
21/15	Review and update as appropriate the GCOS National Focal Point The GCOS Secretariat will arrange for a letter to be sent to all WMO Members requesting that they confirm/update their GCOS National Focal Point	30 April 2106	GCOS Secretariat

As part of the discussion about GCOS networks, it was decided that the outcome of the network workshop on the review of the GSN, GUAN and related networks held in Ispra, Italy, in 2014 (GCOS 182), should be taken up in the IP. The IP should rationalise the GCOS network.

The panel was also informed that GSN-MC web site operated by Deutscher Wetterdienst (DWD) will be updated.

3.3 Status Report

Presentation	
Relevant part of the status report for AOPC Implementation Plan	A. Klein-Tank

Points from the Status report relevant to the work of AOPC 21 were outlined by Albert Klein-Tank, AOPC Vice-Chairman. These are:

- The need of defining GCOS users: It was clarified that GCOS is the middle facilitator, it only provides the middle platform so that then user's defined needs can be taken care of.
- The need of defining standards and procedure for metadata and its storage and exchange: include this as an action in the IP.
- Clarify GCOS relationship with WIGOS (and OSCAR) as the framework for the functioning of all WMO observing systems.
- Clarify the role of reanalysis: consider the possibility of including a re-analysis expert in the AOPC.

The discussion following the presentation of these points, made evident the need to have a plan for 2017 that includes defining the important issues to be discussed and how to proceed with the selected issues, possible task teams, working groups and timelines. The draft of a work plan for 2017 should be included as an action in the IP.

#	Action	Deadline	Responsibility
21/16	AOPC Chairs to explore and propose to the GCOS SC the inclusion of a re-analysis expert on the AOPC.	September 30 2016	AOPC Chairs
21/17	Develop a work plan for 2017	December 2016	GCOS Sec and AOPC, TOPC, OOPC
21/18	Define standards and procedure for metadata and its storage and exchange	December 2017	GCOS Sec and AOPC, TOPC,

			OOPC
21/19	Work on the in-situ supplement	December 2017	GCOS Sec and AOPC, TOPC, OOPC

3.4 Space based Architecture for Climate Monitoring

Presentation	
Report of the GCOS Space Rapporteur to AOPCXXI	J. Shulz

J. Schulz, Climate Product manager at EUMETSAT, explained the structure of the CEOS/CGMS Joint Working Group on Climate. In doing so, he outlined the importance of the ECV inventory and of the ECV numerical requirements. It was noted that ECV requirements for space based climate observations, will be an Annex to the new GCOS IP. The approach of having the requirements for satellites as an Annex should facilitate the response of the satellite community to the new GCOS IP.

The panel was asked to revise the numerical portion of the requirements from the GCOS satellite supplement to the 2010 Implementation Plan.

#	Action	Deadline	Responsibility
21/20	ECVs requirements of the satellite supplement to be revised	September 2016	AOPC
21/21	Review of the Space-based supplement: Identify potential initiatives that can be built upon in order to update the satellite supplement and propose revised requirements within 3 months.	CEOS SIT by April 2016 CGMS by May 2016	GCOS Secretariat

3.5 Vision for WIGOS in 2040

Presentation	
Update from WIGOS space 2040 workshop	K. Holmlund

K. Holmlund presented an update from WIGOS space 2040 workshop, explaining that the role of a vision on space base observations for WMO is to provide high-level goals to guide the evolution of the WMO Global Observing Systems in the coming decades and it is based on the Rolling Review of Requirements (RRR). The climate view of the vision should match the Architecture for Climate Monitoring from Space, as suggested by CEOS, CGMS and WMO.

3.6 Commission for Climatology (CCl)

Presentation	
3.6a Bahamas volunteer Rain Gauge network	T. Peterson
3.6b CCl reporting on Climate Monitoring and assessment	M. Brunet

T. Peterson, president of the WMO Technical Commission on Climatology (CCl), presented the Bahamas volunteer Rain Gauge Network. As more station for monitoring precipitation are needed in areas of convective precipitation, like the Bahamas, the plan is to extend the US volunteer

Community Collaborative Rain Hail and Snow (CoCoRaHS) observing network in the Bahamas. Initial funding is by NOAA and GCOS and the official launch will be in late May 2016.

#	Action	Deadline	Responsibility
21/22	GCOS to support the launch of CoCoRahs in Bahamas emphasizing the value of voluntary networks	May 2016	GCOS Secretariat

M. Brunet, Director of Centre of Climate Change in Terragona-Spain, presented a report of the CCl activities to the panel. Attention was given to the two resolutions approved by the 17th session of WMO Congress (Cg-17) and relevant for GCOS ECVs, Resolution 60, on international exchange of climate data and products, and Resolution 35, on a recognition mechanism for centennial observing sites.

The discussion following the presentation outlined that the most relevant CCl activity is the one on National Climate Monitoring Products and that it is important to strengthen and develop a working mechanism between GCOS panels and Open Panel of CCI Experts (OPACEs)

4. New GCOS Implementation Plan

4.1 GCOS Implementation Plan

Presentation	
New GCOS Implementation Plan	C. Richter

The New GCOS IP was introduced to the AOPC by C. Richter, focusing on the reason why such a plan is needed and what will be achieved through the new IP.

4.2 Atmospheric ECVs

Presentation	
Issues arising from the Atmosphere Domain in the Implementation Plan	R. Saunders

Actions from the in 2010 published IP were presented and participants were asked to comment on them. The general suggestion from R. Saunders, UK Met Office, was to convert some of those actions into recommendations. This discussion serves as a brainstorming of all participants before the break out groups, where participants will work on the draft of the IP.

The following were identified as possible discussion in the break out groups:

- Have a section in the IP explaining the quality standard of GCOS.
- Implement guidelines and procedures for the transition from TAC to BUFR. Some NMS will require assistance to make the transition (NEW ACTION)
- Incorporate pressure sensors as a matter of routine in drifting Buoy pressure and precipitation (ENHANCE ACTION)
- Exchange of radar reflectivities: Should there be an upper air ECV for precipitation profiles? (NEW ACTION)

#	Action	Deadline	Responsibility
21/23	Review the requirements for Radiosondes launches and to what height they should be recorded.	AOPC 22	AOPC

5. Presentations by new panel members

5.1 Clouds/precipitation/aerosols

Presentation	
Cloud, Aerosol, Radiation and Precipitation (CARP): Key components of the Earth's Climate System and Powerful Forces Driving the Energy and Water Cycles. Observations, Processes and Understanding	Z. Li

Zhanqing Li of University of Maryland gave an overview talk concerning aerosol, cloud, radiation and precipitation and their interactions. These variables play critical roles in driving the Earth's climate system by altering the earth's energy and water cycles. As aerosols effect cloud geometry and induce changes on cloud radiative forcing, observing aerosols is of crucial importance and the known discrepancy in satellite retrieval of aerosol optical depth is therefore to be addressed.

5.2 Contribute of the Chinese Meteorological satellite program to GCOS

Presentation	
Contribution of the Chinese meteorological Satellite Program to GCOS	P. Zhang

P. Zhang, Deputy Director-General of the National Satellite Meteorological Center in China, gave an overview of the history, current status and future program of the Chinese Meteorological Satellite, i.e. Fengyun satellite (FY).
Chinese meteorological satellites are an important component of the WIGOS WMO, and in the future the FY can be important for GCOS with improved instrument performance, and with enhanced and traceable calibration procedures.
The contribution of Chinese satellite has increased a lot in the last years and data are made open.
However, reprocessing of historical data is just in the beginning and it may take up to 5 years to have it in place. Ken Holmlund and Roger Saunders offered help in terms of recommendation as there is a lot of experience in Europe that can be shared.

5.3 Aerosols

Presentation	
Aerosol properties and climate effect: outstanding questions	O. Kalashnikova

O. Kalashnikova, research scientist at JPL in USA, gave a presentation on aerosols properties and climate effects. She explained that in order to observe aerosols, NASA launched Terra with aerosol instruments MODIS and MISR. NASA has also aerosol ground-based monitoring, AERONET, that provides sparse global coverage of aerosols optical depth. However, in spite of the progress in observing, the current assessment of climate forcing is that aerosols contribute the largest uncertainty to the total radiative forcing estimate.
The connection between climate and air quality was also explained. More details on that can be found in Appendix 4.

5.4 GRUAN and GAIA-CLIM

Presentation	
Network of networks: the what, the why, the how.	P. Thorne

P. Thorne, co-Chair of GRUAN, presented the EU H2020 GAIA-CLIM project, including the concept of network of networks and of capabilities assessment.
During the discussion following the presentation, there was the concern that there are other quality assessments around, for example, WMO has requirements, and the connection between the two systems is not clear. This could result in a problem of duplication, with yet another independent tool of assessment.
There was also consent among the participants that GCOS should discuss about how to treat uncertainty as this is of extreme importance for a correct understanding of data.

#	Action	Deadline	Responsibility
21/24	Consider inviting an expert of the BIPM, International Bureau of Weights and Measures, to talk about metrology and to be involved in 21/26	January 2017	AOPC
21/25	Agree a formal tiered networks framework and assessment criteria, apply this to global observational capabilities, and produce a (series of) resulting (domain specific) reports that highlight strengths, weaknesses, opportunities and threats to the observing system capabilities.	Framework by 2018,assessments in 2019 and final report by 2020	GCOS SC, GCOS Secretariat, AOPC, TOPC and OOPC (Not required as a specific action as covered by IP. For AOPC panels to comm.

6. Coordination of ECVs

6.1 Monitoring of ECVs

Presentation	
Monitoring ECVs in BAMS State of the Climate	J. Blunden

J. Blunden, scientist at NCEI, explained about the ECV monitoring in BAMS State of Climate, with 14 out of the16 atmospheric ECV fully monitored and cloud properties and aerosols and their precursors only partially monitored. Observations include in-situ, satellite and reanalysis data and products. ECVs are analysed by comparing year anomalies with past years, spatially, with previous years for historical perspective and datasets are compare with one another.

This is important for the outreach, for showing the value of what GCOS is doing and has a lot of value as it is a continuous report at reasonable time spacing.

6.2 Carbon, water and energy cycle

Presentation	
Carbon: Carbon dioxide, Methane and GHG	J. Butler
Water: New ECV for monitoring the water cycle?	A. Becker
Energy: Energy Cycle	N. Ohkawara

6.2.a:
J. Butler, from NOAA Global Monitoring Division in Boulder, presented the concept for an Integrated Global Greenhouse Gas Information System, IG3IS. GHG are the primary driver of climate change and one of the goals of COP21 is GHG reduction. The main objective of IG3IS is to provide observations based information on policy relevant scales. It was commented that on global

scale there has been a lot of experience by inverse tracing nuclear products, and it has been shown that the models are extremely good. This experience could be used for GHG.

The main concern is that, in spite the European Community is setting two task forces, one on the satellite and one on the global system, for monitoring the emission of CO2, to get this in place it will take 15 years, and predictions show that this is going to be too late, at a point of no return.
It was also re-iterate that there is a need of observations from the Planetary Boundary Layer (PBL), but no conclusion was reached as of which ECVs needed for monitoring the PBL.

6.2b:
Andreas Becker, head of the Global Precipitation Climatology Centre (GPCC) at the Deutscher Wetterdienst, examined the question of the introduction of new ECV's with regard to the water cycle suggesting that this is not a priority, and it would be better to improve requirements and specifications of existing ECV rather than introducing new ones. The new 3 cycle concept of the IP asks for cross-cycle consistency for observations across the energy, water and energy cycle, which is already a big challenge.
In summarizing the actual situation for the ECVs for the water cycle in AOPC, A. Becker noted that uncertainty is the main aspect and difficulty when taking measurements that are important for the water cycle. The main challenges remain that for in situ there are problems with data sharing, and a drop in available in situ data in recent decades; observations in key place are sparse; Arctic precipitation remains a particular challenge and for studying of extremes, sub-daily and hourly information is crucial. Further recommendations encompass the importance of ocean salinity observations (OOPC requirement), the higher integration of existing (in-situ, radar, sat) and new (micro link, internet of things) observational regimes for precipitation and for P-E diagnostics.

6.2c: N. Ohkawara, from the Atmospheric Environment Division Global Environment and Marine Department Japan Meteorological Agency talked about the variables to be monitored to understand the energy cycle.

Few comments followed this section:

- Profilers are useful: sites and location where it has sense to have profile should be identified. This should be included in the IP as a recommendation in the IP.
- Is there a need of an action on how to merge different ECVs so that there is consistency across different domains?
- Is there a need to create a network of supersites, where several ECVs are observed, rather than spreading out sited each with a single or few ECVs?

No final decision was made about the last two questions.

6.3 Coordination of ground-based observation

Presentation	
Toward a GCOS Reference Surface Network	A. Klein-Tank

A. Klein-Tank presented pros and cons of having a GCOS Reference Surface Network, noticing as well that in the US such a network already exists, USCRN stations (US reference network). It was suggested to instigate a task team to report in two years' time with a firm plan on a GCOS Surface Reference Network for consideration.
The Task team should include CCl and CBS and it should include a term of reference.

The questions that need an answer and are interconnected are:

- What is a reference station? What is the infrastructure to run a station that will be able to give data that are reference data?
- What is a reference network?

It was also noted that GCOS surface reference network should be interoperable with the USCRN, and it was also suggested that the reference of the surface could be a subset of the GSN and to respect GCOS objective it has to be global.

#	Action	Deadline	Responsibility
21/26	Consider instigating a task team to report in two years time with a firm plan on a GCOS Surface Reference Network for consideration	September 2016	GCOS secretariat
21/27	Request CCl for their definition of a reference station for a possible adaption by GCOS	September 2016	GCOS Secretariat

6.4 Precipitation

Presentation	
Role of radar technology in GCOS IP	A. Becker

A presentation suggesting an extended role of radar technology for GCOS given its potential to substantially increase the geo-temporal resolution of the observation of land-surface precipitation and upper air precipitating water was given by Andreas Becker. The motivation for this lies in the possibility to detect heavy events and extreme precipitation that are otherwise difficult to capture with in-situ measurements and are the ones that matter for adaptation. Radar data is important for climate and it has the advantage of a great area coverage, high spatial resolution and near-real-time data availability for the radar sites.

It has however also short comings, like short time series yet not exceeding 15 years, no ocean coverage, in-situ validation not available everywhere, The original reflectivity data need to be exchanged internationally (and it is property of countries so far) and no international standards in data storage and documentation is yet in place.

The main recommendation was to start storing the data as there is a potential value for the climate application in radar, and the radar communities could be interested. It would be best for GCOS to start interaction with the radar community and inform them that their data can be used not only for real time but also for climatological applications.

#	Action	Deadline	Responsibility
21/28	Establish a task team to consider the way forward for using precipitation radar data for climate monitoring and introduce relevant activities for the AOPC work plan	September 2016	GCOS Secretariat
21/29	AOPC precipitation radar task team to propose a way forward for precipitation radar data and AOPC involvement	AOPC22	Task Team

The session was closed by a discussion about emerging observations technologies which we need to anticipate will become climate relevant in the coming decade, introduced by A. Klein-Tank.

It was decided that GCOS needs to look into emerging technology, and initially, until these things become more robust, explored, analysed, take an observing role.

Discussion on new IP:
The participants split into 3 groups: surface air, upper air and composition.
In the upper air group there were: P. Thorne, Z. Li, J. Shulz, R. Saunders;
In the surface group: A. Klein-Tank, P. Jones, A. Becker, T. Peterson, M. Brunet, M. Menne;
and in the atmospheric composition: D. Hurst, P. Zhang, J. Butler, O. Kalashnikova.
As first priority, groups were assigned to revise the actions.

7. Joint Session with WRCP Data Advisory Council 5th session

Reference is made to Annex 3.

8. Providing ECVs datasets

8.1 ECVs datasets

Presentation	
GCOS ECV Data Access Matrix	C. Lief

C. Lief, NCEI, Physical Scientist and Program Manager, gave an update on the GOSIC Portal which provides a clearinghouse that facilitates discovery of and access to authoritative space and in-situ based GCOS data and products. One of the data access tools available on the GOSIC is an ECV data access matrix. This matrix will be updated per the newly published 'Status of the Global Observing System for Climate) October 2015 (GCOS-195). Other information, such as Digital Objective Identifiers (DOIs), Maturity Matrices, BAMS State of the Climate ECV data links, etc., will be added as well.

C. Lief suggested adding the information of which dataset should be used for a specific are, like for example for agriculture etc.

8.2 Satellite climate data records

Presentation	
NCEI's Climate Data Records: Approaches, Products, Current Focus	J. Privette

J. Privette, Deputy Director of CWC at NCEI, gave a presentation on NCEI's Climate Data Records (CDRs). In CDRs Provide, satellite data are reprocessed to become a long term homogenous record. Requirements come from expert guidance, which included GCOS.

There are now 16 operational atmospheric CDR bundles (AOD over ocean). Data is accessible and free. CDRs are evolving in different way. For example to serve a larger community beyond the climate one, they transitioned to a reference environmental data record (REDR), which is shorter than the CDR and answer the need of people wanting an idea of what is going to happen in 1-5 years (CDRs are a subset of REDRs). Users want also mobile access and most salient points, like snow impact, obtained by combining snow and population. There is also a project to do data set integration by extending data in the past when satellite were not yet in use. This can be achieved by adding the in-situ records to the satellite ones.

8.3 Creating a land station historical database

Presentation	
Global in situ datasets at NCEI	M. Menne
Creating a land historical database	

M. Menne, from NCEI, presented a brief update on the status of NCEI's main in situ datasets: the Integrated Global Radiosonde Archive (IGRA); the International Comprehensive Ocean-Atmosphere Dataset (ICOADs); and the land surface datasets (monthly, daily and sub-daily). NCEI is planning to vertically integrate all of their land data holdings into an integrated database to manage both data and metadata (station histories). The development of an integrated land station database at NCEI is consistent with the emerging concept of a comprehensive land surface database similar to ICOADs.

Having measurements of temperature and precipitation at the same place is of high value.

#	Action	Deadline	Responsibility
21/30	Ensure that ICOADs action is included in IP	September 2016	AOPC

Discussion on new IP:

Break out group came together to present the outcome of their discussion on progress on the IP. Results of these discussions will be included in the IP draft by Roger and distributed for further comments to the panel.

9. Closure

During the final discussion on the IP, it was suggested to take away the cost item from the actions on the IP, (to be discussed with the other GCOS panels). The panel members were also asked to think about how to use the term “action” vs. the term “recommendation”.

Last discussion was dedicated to the OSCAR requirements. First, it was noticed that the application areas in the OSCAR requirements database need to be updated by AOPC. It was also decided to ask experts to complete an initial review of OSCAR climate related requirements, while they are already revising satellite requirements for the Satellite Supplement for the IP. A table, including the requirements for the last satellite supplement as well as the requirements for the OSCAR table, will be prepared and circulated among experts (see Annex 6).

#	Action	Deadline	Responsibility
21/31	Propose update to OSCAR application areas	April 2016	GCOS Secretariat
21/32	Establish and complete initial review of OSCAR climate related requirements.	December 2016	GCOS Secretariat

Actions were reviewed and approved.

The GCOS Secretariat and the panel participants expressed their sincere gratitude to the host of the meeting, Matthew Menne. The AOPC benefited greatly from the provision of excellent meeting facilities and enjoyed thoroughly the generous hospitality of NCEI.

The meeting closed on 8 April 16:15 hrs.

ANNEX 1: List of Participants

GCOS/WCRP
ATMOSPHERIC OBSERVATION PANEL FOR CLIMATE
TWENTY-FIRST SESSION (AOPC-XXI)
5-8 April 2016

NOAA's National Center for Environmental Information (NCEI), Asheville, North Carolina, USA

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ANNEX 2: Agenda

21th Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-21), 5-8 April 2016

Item	Item. No.	Presenter(s) (including discussion)	Supporting documents/ additional information
Tuesday, 5th April 2016			
9:00 – 10:30			
1. Opening of the Meeting			
Welcome and introductions	1.1	Tanner/Holmlund/Richter	
Adoption of Agenda	1.2	Holmlund/Klein-Tank	
Introduction of participants	1.3	All	
Conduct of the Meeting	1.4	Menne	
Aims and expectations	1.5	Holmlund/Klein-Tank	
2. Review and Actions from AOPCXX	2	Holmlund	
10:30-10:45 Coffee Break			
10:45-12:00			
3. Update on programme activities			
GCOS Update	3.1	Richter (15')	*General updates on GCOS activities and Conference outcome.*
GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN) & GCOS Cooperation Mechanism (GCM)	3.2	Oakley (30')	*2016 Status report-Update on GCM;GSN and GUAN. Potential input from/benefit for AOPC.*
Status report	3.3	Klein-Tank (20')	*Relevant part of the status report for AOPC Implementation Plan*
12:00-13:30 Lunch			
13:30-15:00			
3. Update on programme activities-continued			
Space based Architecture for Climate Monitoring	3.4	Schulz	*Update on CEOS-CGMS working group*
Vision for WIGOS in 2040	3.5	Holmlund	*Update from WIGOS Space 2040 workshop*
CCL	3.6a	Peterson	*Bahamas volunteer Rain gauge network*

	36.b	Brunet	*CCI reporting on Climate Monitoring and Assessment*
4. New GCOS Implementation Plan			
GCOS IP	4.1	Richter	Draft 2016 GCOS IP
15:00-15:15 Coffee Break			
15:15-17:30			
Atmospheric ECVs	4.3	Saunders	*Issues arising from the atmospheric domain in the IP*
DISCUSSION – Identify break out groups topics and composition – Saunders (15')			
Break out groups on new IP			
17:30 End of day 1			
Wednesday, 6th April 2016			
9.00 – 10.15			
5. Presentations by new panel members			
Clouds/precip/aerosols	5.1	Li (20')	
Contribute of the Chinese meteorological satellite program to GCOS	5.2	Zhang(20')	
Aerosols	5.3	Kalashnikova(20')	aerosols including direct forcing, climate effects, outstanding questions and current measurement approaches
GRUAN and GAIA-CLIM	5.4	Thorne (20')	*Short GRUAN update and a GAIA-CLIM update*
10:15 – 10:30 Coffee			
10:30-12:00			
6. Coordination of ECVs			
Monitoring of ECVs	6.1	Blunden(20')	*How well the ECV's are covered in the atmospheric?*
Carbon, water and energy cycle	6.2	Carbon: Butler (15') Water: Becker (15')	*New ECVs for monitoring the cycle*

		Energy: Ohkawara (15')	
12:00-13:30 Lunch			
13:30-15:00			
6. Continued			
Coordination of ground-based observation	6.3	Klein-Tank (20')	*Toward a GCOS reference Surface Network*
Precipitation	6.4	Becker (20')	*Role of radar technology in GCOS IP*
Discussion: emerging observations technologies which we need to anticipate will become climate relevant in the coming decade			
15:00-15:15 Coffe Break			
15:15-17:30			
DISCUSSION – Break out groups on new IP			
17:30 End of day 2			
19:00 Dinner at "The Market Place"			
Thursday, 7th April 2016			
8:30-13:00			
7. Joint session with WCRP Data Advisory Council 5th Session			
13:00-14:00 Lunch			
8. Providing ECVs datasets			
14:00-15:30			
ECV datasets	8.1	Lief	GCOS Essential Climate Variable (ECV) Data Access Matrix
Satellite climate data records	8.2	Privette	Satellite Climate data records
Creating a land station historical database	8.3	Menne	Main in situ datasets Creating a land historical database
15:00 Break out groups on new IP			

15:30-15:45 Coffee Break			
15:45-17:30			
DISCUSSION – Break out groups on new IP			
17:30 End of day 3			
20:00 TRAPEZE CLASS			
Friday, 8th April 2016			
9:00-10:15			
DISCUSSION – Break out groups continued			
10:15-10:30 Coffee Break			
10:30-11:30			
Presentation of outcomes of break out groups to plenary			
11:30:00-13:30 Tour of NCEI Building and Lunch			
13:30-14:00			
Discussion _ Finalizing the input for the IP			
14:00:15:30			
9. Closure			
Agree on actions	9.1	Holmlund	
AOB	9.2		
Next session	9.3		

ANNEX 3: Summary of Joint session with WCRP Data Advisory Council 5th Session

7-8 April 2016
The Collider
Asheville, USA

Joint WDAC-AOPC session

1.a . Opening of the Meeting

O. Brown opened the meeting.

1.b. Welcome address:

Mike Tanner welcomed the participants and presented the NCEI strategic Framework.

1.c . WCRP update (**M. Rixen**)

M. Rixen gave an update for WRCP. The stated mission and objectives for WCRP is to support climate-related decision making and adaptation planning by coordinating research required to improve climate predictions and understanding of human influence on climate. Among the traditional fields, there is an expected new UN Urban Agenda, which is a stretch as climate is global, but it is recognized important for adaptation purposes. WRCP works with observations (GCOS) but mostly with models and reanalysis, applied to atmosphere, land, ocean and ice. The importance of uncertainties when working with climate research was noted and it was asked the problem of uncertainty to be addressed together with GCOS. Next challenges for WRCP were presented and include uncertainty, fluxes, in order to couple the components of the earth system, reanalysis, open data policy and the polar challenge.

1.d. GCOS Update including status report and Implementation Plan (C. Richter)

C. Richter presented GCOS, the status report and the IP as well as the outcome of the GCOS open science conference.

It was suggested that a possible ground of cooperation between GCOS an WDAC could be on reanalysis, as WDAC is strong on reanalysis and this was identified as an AOPC weakness.

A discussion on uncertainty followed the presentation, and it was recognized that without taking into account uncertainty it will be impossible to create data that are consistent. The problem on uncertainty will be included in the GCOS IP.

It was also commented that while GCOS has always been a global system, now GCOS is asked from UNFCCC to be more a regional system, a decision that will imply a significant increase of work and needs therefore to be taken to the SC.

1.h. Impact of observations (J.-N. Thépaut)

J.-N. Thépaut presented the current status of assimilation, in terms of studying the impact of observations on assimilation. As climate models are less driven by initial fields and more by boundary conditions, data assimilation is not useful.

The real help of data assimilation for the climate community is the experience that data assimilation has in treating uncertainties, as the system assimilates different variables and put them in a multivariable context.

1.i Reanalyses (M. Bosilovich)

M. Bosilovich gave an overview of several reanalysis system for the atmosphere, pointing out strength and weakness of each of them.

1.k. Development of a WRCP-GCOS Data Prize (M. Rixen)

M. Rixen presented the WRCP-GCOS Data prize. The prize proposed will focus on:

- Young scientist
- Climate data
- Science impact (potential)
- Community engagement (outreach)

WRCP is looking for answer from GCOS in terms of wanting to endorse such a price and asked whether we will have to extend it to the other GCOS panels.

C. Richter confirmed that while this effort is led by WRCP, GCOS strongly supports it.

Finally, GCOS was asked to approve of WCRP Data Policy to consolidate/harmonize data policy

ANNEX 4: Agenda of Joint Session

WCRP Data Advisory Council 5th Session

7-8 April 2016
The Collider
Asheville, USA

Draft Agenda

NB All briefers are kindly asked to allow time for discussion in their allocated slots, and to raise any specific issues to be addressed by WDAC

Time	*Agenda Item*	*Docs*
	Thursday 7 April 2016	
1. Joint WDAC-AOPC session – Chairs O. Brown, K. Holmlund and A. Klein-Tank		
08h30	a. Introduction – WDAC and AOPC Co-chairs	
08h40	b. Welcome address – NOAA / NCEI - T. Karl	
08h50	c. WCRP update – M. Rixen	
09h10	d. GCOS update including Status Report and Implementation Plan – C. Richter	
09h30	e. GCOS panel reports – A. Klein-Tank/K. Holmlund, C. Richter	
10h00	f. Discussion - all	
10h30	*Coffee break*	
11h00	g. Fluxes – C.A. Clayson	
11h30	h. Impact of observations – J.-N. Thépaut	
12h00	i. Reanalyses – M. Bosilovich	
12h30	k. Development of a WCRP-GCOS Data Prize - M. Rixen	1
12h45	l. Discussion - all	
13h00	*Lunch*	
2. Data set products and requirements - Chair O. Brown *Briefers are invited to focus their presentation specifically on climate data set requirements, assessments and dissemination, including fluxes, reanalyses and interfaces with other efforts such as obs4MIPs and ana4MIPs*		
14h30	a. Review of WDAC4 actions – O. Brown	

15h00	b. CLIVAR – GSOP etc – P.-P. Matthieu (remotely)	
15h30	c. GEWEX – GDAP etc – J. Schulz	
16h00	*Coffee break*	
16h30	d. SPARC – S-RIP etc – S. Tegtmeier	
17h00	e. CliC – W. Meier	
17h30	f. SOLAS – C. A. Clayson o.b.o B. Ward (TBC)	
18h30	*Reception/ice-breaker hosted by CICS-NC*	
	Friday 8 April 2016	
3. Data partnerships – Chair O. Brown		
08h30	a. ESA CCI and uncertainties - P.-P- Matthieu o.b.o P. Lecomte (remotely)	
09h00	b. WG Climate and uncertainties – Joerg Schulz o.b.o. P. Lecomte	
09h30	c. obs4MIPs and ana4MIPs – P. Gleckler	
10h00	d. In-situ data – obs4MIPs – J. Biard (TBC)	
10h15	e. Discussion: uncertainties nomenclature and standards, the way forward - all	2
10h30	*Coffee break*	
11h00	f. GEO update, GCI and ESGF – G. Rutledge	
11h15	g. ECV inventory – C. Lief	
11h30	h. Copernicus Climate Change Services – J.-N. Thépaut	
12h00	i. International Conference on Reanalyses – J.-N. Thépaut	
12h30	*Lunch*	
4. WDAC Business – Chair O. Brown		
14h00	a. Inputs to WCRP Strategic Plan	
14h30	b. Memberships	
14h45	c. Next WDAC Meeting – Date/Venue	
15h00	d. AOB	
15h30	e. Review of Draft actions list	
16h00	*Meeting ends*	

ANNEX 5: List of actions from AOPC-20

#	Action	Deadline	Responsibility	Status
20/1	Nomination people for new implementation Plan writing team	September 2015	AOPC Chair	Completed
20/2	Make proposal for new panel members (try to extend membership diversity).Cloud expert.	July 2015	All	Completed
20/3	AOPC to take note of the schedule for the status report and contribute to the review, especially precipitation, water vapour and clouds	March-April 2015	All	Completed
20/4	Consider current grouping of atmospheric ECV with a view to a new arrangement for the new Implementation Plan	Discuss and agree before September	All	In Progress
20/5	Recommend that a surface based component is an integral part of global observing system using satellites. Contribute to vision papers (GOS for 2025,WIGOS for 2040)		WMO	Open
20/6	Support the BIPM/WMO Mutual Recognition Arrangement on coordinating calibration of GHG concentrations, traceability etc. to avoid bias among observing systems. Represent AOPC/GCOS at a meeting of BIPM in Paris 1st July.	1st July meeting	AOPC/ GCOS Secretariat	Completed
20/7	Consider and agree any on new definitions of ECVs, in particular: 1.Definitions of aerosols 2.Other long-lived greenhouse gases 3.Agree on need for observations in tropopause/mesosphere and define upper limit of ECVs	Discuss and agree before September	All	Open
20/8	Promote access to raw data, rather than just processed data from observations		All	Open
20/9	Opening archives is a good contribution but countries should be encouraged to allow full open access to data		GCOS Sec	Open
20/10	Produce improved plots for hourly temperature/wind measurements received by NCDC and ECWMF to better show changes and regional	Summer 2015	Adrian Simmons	Completed for ECMWF. Open for NCEI
20/11	Provide extra paragraph on data archives, digitization and data recovery for the status report to Adrian. Also provide a summary of what is new for the ECV	April 2015	Albert Klein-Tank	Completed
20/12	Provide more interpretation in the GSN	August	Adrian	Completed

	figures; show the number of data against area in GSN map, so that it can be demonstrated that, for example, 50% of the land only holds 5% of the data. Could be supplementary information in an annex. Ask for better figures by the end of August 2015	2015	Simmons	
20/13	Redraw the figures in a way which shows again the data voids or concentrations; update precipitation plot on historic observations	April	Andreas Becker to discuss with Phil Jones how the figures can be improved	Completed
20/14	Consider if GCOS observation requirements should be included into the WIGOS OSCAR requirements database. Consider • If GCOS requirements should be included • How to translate GCOS requirements to WIGOS • Should all ECV be included or a subset? • Timescale for updating existing information • Inclusion of new requirements from new IP Trial with some easy items		GCOS Secretariat to produce proposals on these items and circulate to panel chairs.	Open
20/15	Formally ask India to designate 4 radiosonde sites as part of GUAN. Need to build relationship with India to get commitment.		Tim Oakley	In Progress
20/16	GSN. Where stations have been replaced and operation of new stations overlap with old stations ask for data from both stations for overlap period. Ensure this data is shared with the emerging parallel measurements database effort under the International Surface Temperature Initiative		Tim Oakley, Peter Thorne	Completed
20/17	Produce report cards on receipts by DWD/JMA, ECMWF, NCEI for each country to track what is received		Menne	Completed
20/18	Support ICOADS Land Archive integrating existing separate archives and NCDC.		GCOS Secretariat	Open
20/17	Check on GRUAN paper for “Our Common Future” conference		GCOS Secretariat	Completed
20/18	Approve ICM-7 report when it is available		GCOS Secretariat and AOPC Chairs	Open
20/19	Cooperate on updated data request letter		GPCC & GCOS Secretariat	Completed
20/20	Support alternative ways for joint daily data acquisition, in particular OGC compliant XML & cooperation with GEO		GPCC & GCOS Sec.	In Progress
20/21	Review meta information		GPCC &	In

			GCOS Secretariat	Progress
20/22	Consider web services for data and product dissemination		GPCC & GCOS Secretariat	In Progress
20/23	Clarify the formal process for a network to become a GCOS network		Oakely and GCOS Secr.	Open
20/24	Produce some text on what are GCOS, reference and baseline networks. There is a parallel effort ongoing in GAIA-CLIM to deliver in November led by Peter Thorne with Tim Oakley involved.	Inclusion in status report and discussion at next AOPC	Adrian Simmons and Peter Thorne and GCOS Secretariat	Text: completed Follow up with Peter and Tim
20/25	Support WMO CCl and their promotion of GCOS ECVs as part of GCOS outreach. In particular continue to support WMO CCl data rescue i-DARE international data rescue portal. Also encourage USAID to support data rescue from ACMAD microfiches by IEDRO (supported by GCOS/CCl).		GCOS Secretariat	Open
20/26	Encourage that rescued data being entered into global/regional data centres. Consider storing images of rescued data rather than just digitized data. NCEI will do this for land data		GCOS Secretariat	Open
20/27	Consider and make suggestions for the AOPC Terms of Reference		AOPC Chairs	Completed
20/28	Produce a position paper on AOPC way forward from which a draft work plan can be produced and agreed	Try to agree this year	C.Richter	Open

ANNEX 6: List of Actions from AOPC-21

#	Action	Deadline	Responsibility
21/1	Consider and agree on any new definitions of ECVs, in particular: 1.Definitions of aerosols 2.Other long-lived greenhouse gases 3.Agree on need for observations in tropopause/mesosphere and define upper limit of ECVs	September 2016	All
21/2	GCOS Director to use letters and other means to encourage countries to allow full open access to data	April 2017	GCOS Secretariat
21/3	Letter from WMO SG to PR of India with regard to Action 20/15 (Designated GUAN 4 sites for India); Roger Saunders to explore a contact on working level	May 2016	GCOS Sec/Saunders
21/4	Invite Victor Venema as a subject matter expert to AOPC 22 to present the parallel measurements collection and analysis effort.	April 2017 (next AOPC)	GCOS Sec (TBC,AOPC panel members to express interest)
21/5	In order to give recognition by GCOS of ICOADS Land Archive, ensure GCOS representation at upcoming ICOADS meeting at Maynooth University, Ireland.	June 2016	GCOS Sec/Peter Thorne
21/6	AOPC to approve GRUAN ICM report	End April 2016	AOPC/GCOS Secretariat
21/7	GRUAN to provide future reports well in advance of the AOPC meetings to AOPC in order to have AOPC review and approve the report.	February 2017	GRUAN
21/8	Encourage implementation of web services for data and product dissemination (in cooperation with GOSIC)	2017	All (GCOS letter)
21/9	Set up a task team to develop a formal mechanism for a network to achieve GCOS recognition.	Before AOPC22 in 2017	GCOS Sec to raise issue with all panels
21/10	Task team on 'formal mechanism to become a GCOS network' to prepare a proposal for 2017 GCOS panels meeting	January 2017	Task group
21/11	Support WMO CCl and their promotion of GCOS ECVs as part of GCOS outreach. In particular continue to support WMO CCl data rescue i-DARE international data rescue portal. Also	September 2016	GCOS Sec/DMA (Omar Baddour) (Peer Hechler)

	encourage USAID to support data rescue from ACMAD microfiches by IEDRO (supported by GCOS/CCl).		
21/12	Prepare GCOS letter to encourage entering rescued data into global/regional data centers and storing images of rescued data rather than just digitized data (NCEI will do this for land). GCOS will write memo to various stakeholders.	June 2016	GCOS Sec
21/13	Produce a position paper on AOPC way forward from which a draft work plan (2017-2019) can be produced and agreed.	December 2017	AOPC and GCOS Sec
21/14	It was agreed that the GCOS Secretariat would contact the countries with the long-term 'silent' GUAN stations, reminding them of their commitment to this baseline network and asking for their considerations on the future operations. Technical support would be offered along with the possibility of financial help, subject to finding a sponsor, but an alternative suggestion should be to remove the station from the GUAN.	30 April 2016	GCOS Secretariat and Tim Oakley
21/15	Review and update as appropriate the GCOS National Focal Point The GCOS Secretariat will arrange for a letter to be sent to all WMO Members requesting that they confirm/update their GCOS National Focal Point	30 April 2016	GCOS Secretariat
21/16	AOPC Chairs to explore and propose to the GCOS SC the inclusion of a re-analysis expert on the AOPC	September 30 2016	AOPC Chairs
21/17	Develop a work plan for 2017	December 2016	GCOS Sec and AOPC,TOPC and OOPC
21/18	Define standards and procedure for metadata and its storage and exchange	December 2017	
21/19	Work on the in-situ supplement	December 2017	
21/20	ECVs requirements of the satellite supplement to be revised	September 2016	AOPC
21/21	Review of the Space-based supplement: Identify potential initiatives that can be built upon in order to update the satellite supplement and propose revised requirements within 3 months	CEOS SIT by April 2016 CGMS by May 2016	GCOS Secretariat
21/22	GCOS to support the launch of CoCoRahs in Bahamas enphasizing the value of voluntary networks	May 2016	GCOS Secretariat

21/23	Review the requirements for Radiosondes launches	AOPC-22	AOPC
21/24	Consider inviting an expert of the BIPM, International Bureau of Weights and Measures, to talk about metrology and to be involved in 21/26	January 2017	AOPC
21/25	Agree a formal tiered networks framework and assessment criteria, apply this to global observational capabilities, and produce a (series of) resulting (domain specific) reports that highlight strengths, weaknesses, opportunities and threats to the observing system capabilities	Framework by 2018,assessments in 2019 and final report by 2020	GCOS SC, GCOS Secretariat, AOPC, TOPC and OOPC (Not required as a specific action as covered by IP. For AOPC panels to comment
21/26	Consider instigating a task team to report in two year time with a firm plan on a GCOS Surface Reference Network for consideration	September 2016	GCOS Secretariat
21/27	Request CCl for their definition of a reference station for a possible adaption by GCOS	September 2016	GCOS Secretariat
21/28	Establish a task team to consider the way forward for using precipitation radar data for climate monitoring and introduce relevant activities for the AOPC workplan	September 2016	GCOS Secretariat
21/29	AOPC precipitation radar task team to propose a way forward for precipitation radar data and AOPC involvement	AOPC22	Task Team
21/30	Ensure that ICOADs action is included in IP	September 2016	AOPC
21/31	Propose update to OSCAR application areas	April 2016	GCOS Secretariat
21/32	Establish and complete initial review of OSCAR climate related requirements	December 2016	GCOS Secretariat

OSCAR: 1st value: goal – 2nd value: breakthrough – 3rd value: Threshold

ANNEX 7: ECV Requirements Table

ECV	Satellite requirements			In Situ requirements		standards	OSCAR Requirements					
	Observations	Resolution (H/V/Time)	Accuracy/ stability	Resolution	Accuracy		Variables	H Res	V Res	Obs Cycle	Time liness	uncertainty
Surface Wind Speed and direction	Surface wind retrieval	10km/NA 3hr	0.5m/s and mean quadratic statistics to 10% of the locally prevailing mean wind speed, for speed >20m/s/ 0.1m/s				Wind Vector over the surface	10 km 50 km 500 km		60 min 3 h 6 h	3 h 6 h 12 h	0.5 m/s 1 m/s 5 m/s
Precipitation	Estimates of liquid and solid precipitation	25km/NA Monthly (resolving diurnal cycles and with statistics of 3 hr values)	Max(10% of daily totals;0.1mm)/ 5% of daily totals (regional scale)				Accumulated precip (over 24hr)	100 km 200 km 500 km		12 h 16 h 24 h	24 h 3 d 12 d	1 mm 1.3 mm 2 mm
Temperature (Surface)							Air temp At surface	25 km 50 km 100 km		3 h 6 h 12 h	24 h 36 h 2 d	0.1 K 0.15 K 0.3 K
Pressure (surface)							Air Press At surface(land) "(Ocean)	200 km 300 km 500 km		3 h 6 h 24 h	3 h 6 h 12 h	0.5 hPa 0.65 hPa 1 hPa
Water Vapour (surface)							Air Spec Hum at surface	25 km 50 km 100 km		3 h 4 h 6 h	24 h 2 d 3 d	1 % 1.3 % 2 %
Earth Radiation Budget	Top-of-atmosphere ERB longwave	100km/NA/ Monthly(resolving diurnal cycle)	1W/m2/ 0.3W/m2				Upward longwave irradiance TOA	100 km 200 km 500 km		3 hr 4 hr 6 hr	3 hr 6 hr 24 hr	5 W/m^2 6.5 W/m^2 10 W/m^2
	Top-of-atmosphere ERB shortwave	100km/NA/ Monthly(resolving diurnal cycle)	1W/m2/ 0.3W/m2				Upward shortwave irradiance TOA Downward shortwave irradiance TOA	100 km 200 km 500 km		3 d 4 d 6 d	3 d 7 d 24 d	1 $W.m^{-2}$ 1.3 2 $W.m^{-2}$
	Surface ERB longwave	100km/NA/ Monthly(resolving diurnal cycle)	1W/m2/ 0.3W/m2				Downward longwave irradiance at earth surface	25 km 50 km 100 km		3 hr 4 hr 6 hr	24 h 2 d 5 d	5 $W.m^{-2}$ 6.5 $W.m^{-2}$ 10 $W.m^{-2}$

Energy Radiation Budget	Surface ERB shortwave	100km/NA/ Monthly(resolving diurnal cycle)	1W/m2/ 0.3W/m2	Upward longwave irradiance at earth surface (sea surface) Downward shortwave irradiance at earth surface	25 km 50 km 100 km		24 hr 2 d 5 d	24 h 3 d 30 d	5 $W.m^{-2}$ 6.5 $W.m^{-2}$ 10 $W.m^{-2}$
	Total solar irradiance	NA/NA/ Monthly(resolving diurnal cycle)	1W/m2/ 0.3W/m2						
	Solar spectral irradiance	NA/NA/ Monthly(resolving diurnal cycle)	0.3%(200-2400nm);/ 0.1%(200-2400nm)						
Temperature (upper-air)	Tropospheric Temperature profile	25km/1km/ 4hr	0.5K; 0.05K	Atmos Temp Low Troposphere High Tropos	100 km 200 km 500 km	0.1 0.2 0.5km	3 h 4 h 6 h	3 h 6 h 12 h	0.5 K 1 K 2 K
	Stratospheric Temperature profile	100km/2km/ 4hr	0.5K; 0.05K	Atmos Temp Low Stratosphere	100 km 200 km 500 km	2 km 2.5 3 km	3 h 4 h 6 h	3 h 6 h 12 h	0.5 K 1 K 2 K
	Temperature of deep atmospheric layers	100km/5km/ Monthly averages	0.2K; 0.02K	Atmos Temp High Stratos. And meso	100 km 200 km 500 km	2 km 2.5 3 km	3 h 4 h 6 h	3 h 6 h 12 h	0.5 K 1 K 3 K
Wind speed and direction (upper-air)	Upper-air wind retrievals	10km/0.5km/ 1hr	2m/s,20deg; 0.5m/s,5deg	Wind horiz (for 4 levels: High and Low Tropos;low stratos+high strato&meso)	100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	2 $m.s^{-1}$ 3 $m.s^{-1}$ 5 $m.s^{-1}$
Water Vapour	Total column-water vapour	25km/NA/ 4hr	2%, 0.3%	Integrated water vapour(total) Integrated water vapour(tropo)	50 km 100 km 200 km 10 km 25 km 200 km		3 h 4 h 6 h	7 d 14 d 60 d	1 $kg.m^{-2}$ 1.4 3 $kg.m^{-2}$

	Tropospheric and lower-stratospheric profiles of water v.	25km/2km/ 4hr (troposphere) 100-200km/2km/ daily (stratosphere)	5%, 0.3%	Specific Humidity(Low Tropos.)	10 km 15 km 25 km		3 h 4 h 6 h	7 d 14 d 60 d	2 % 4 % 15 %
				Specific Humidity(Low Stratosphere)	50 km 100 km 200 km	2 2.5 3 km	3 h 4 h 6 h	7 d 14 d 60 d	2 % 5 % 20 %
				High strato & meso		2 km 3 -5			
	Upper tropospheric humidity	25km/NA/ 1hr	5%, 0.3%	Specific Hum(High Tropos.)	20 km 50 km 100 km	0.1 0.5 2 km	3 h 4 h 6 h	7 d 14 d 60 d	2 % 5 % 20 %
Cloud Properties	Cloud amount	50km/NA 3hr	0.01-0.05; 0.003-0.03	Cloud cover	99 km 100 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	10 % 15 % 20 %
	Cloud Top Pressure	50km/NA 3hr	15-50hPa, 3-15hPa	Cloud Top Height	100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	0.5 km 1 km 2 km
	Cloud Top Temperature	50km/NA 3hr	1-5K; 0.2-1K	Cloud Top Temperature	100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	0.3 K 0.4 K 0.6 K
	Cloud Optical Depth	50km/NA 3hr	10%, 2%						
	Cloud Water Path(liquid an ice)	50km/NA 3hr	25%; 5%	Cloud liquid water total column	100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	5g/m2 10g/m2 20g/m2
	C, effective particle radius (liquid + ice)	50km/NA 3hr	5-10%; 1-2%	Cloud ice (total column)	100 km 200 km 500 km		3 h 4 h 6 h	3 h 6 h 12 h	10g/m2 15g/m2 20g/m2
Carbon Dioxide, Methane and other Greenhouse Gases	Tropospheric CO2 column	5-10km/NA 4hr	1ppm; 0.2ppm	Tropospheric CO2 Column	10 km 50 km 500 km		3 h 4 h 6 h	7 d 14 d 60 d	1 % * 1.3 % * 2 %
				Total CO2 column	50 km 100 km 500 km		3 h 4 h 6 h	30 d 60 d 180 d	1 % * 1.3 % * 2 %
	Tropospheric CO2	5-10km/5km 4hr	1ppm; 0.2ppm	Low Troposp CO2	10 km 50 km 500 km	0.5 1 2 km	3 h 6 h 12 h	7 d 14 d 60 d	1 % * 1.3 % * 2 %
				High Troposp CO2	50 km 100 km 250 km	1 1.5 2 km	3 h 4 h 6 h	7 d 14 d 60 d	1 % * 1.5 % * 2 %
	Tropospheric CH4 column	5-10km/NA 4hr	10ppm; 2ppm	Tropospheric CH4 column	10 km 20 km 50 km		3 h 4 h 6 h	30 d 60 d 180 d	2% 4 % 10%

	Tropospheric CH4	5-10km/5km 4hr hr	10ppm; 2ppm	Total CH4 column	10 km 50 km 250 km				
				Low-Tropo. CH4	10 km 20 km 50 km	2 km 2.5 3 km	3 h 4 h 6 h	30 d 60 d 180 d	2% 4 % 10%
				High-Tropo CH4	50 km 100 km 250 km				
	Stratospheric CH4	100-200km/2km daily	5%; 0.3%	Low Stratosphe CH4 High Stratos CH4 (+meso)	50 km 100 km 250 km	2 km 2.5 4 km	3 h 4 h 6 h	30 d 60 d 180 d	2% 4 % 10%
Ozone	Total column ozone	20-50km/NA/ 4hr	Max(2%;5DU); <1%	O3 Total column O3 Tropos column	5 km 10 km 50 km		3 h 9 h 3 d	30 d 60 d 180 d	5 DU 8 DU 15 DU
	Troposphere Ozone	20-50km/5km/ 4hr	10-15%; 1%	O3 (Low Troposphere)	5 km 10 km 50 km	0.5 1 km 2 km	3 h 9 h 3 d	30 d 60 d 180 d	10 % 13 % 20 %
				O3 (High troposphere)	5 km 20 km 100 km				10 % 15 % 30 %
	Ozone profile in upper and lower stratosphere	100-200km/1-2km/ 4hr	10%; 1%	O3 (Low Stratosphere)	50 km 75 km 100 km	0.5 1 km 3 km	3 h 9 h 3 d	30 d 60 d 180 d	5 % 8 % 20 %
	Ozone profile in upper strato-and mesosphere	100-200km/3km/ daily	5-20%; 1%	O3 (High Stratosphere and meso)	50 km 100 km 500 km	0.5 1 km 2 km	3 h 9 h 2 d	30 d 60 d 180 d	5 % 8 % 20 %
Precursors(supporting the Aerosol and Ozone ECVs	NO2 tropospheric column	5-10km/NA 4hr	Max(20%,0.03DU) 2%						
	SO2,HCHO tropospheric columns	5-10km/NA 4hr	Max(30%,0.04DU) 5%						
	CO tropospheric column	5-10km/NA 4hr	Max(20%,20DU); 2%						
	CO tropospheric	10km/5km 4hr	20%; 2%						

Aerosols properties	profile		
	Aerosol optical depth	5-10km/NA/ 4hr	Max(0.03;10%); 0.01
	Single-scattering albedo	5-10km/NA/ 4hr	0.03; 0.01
	Aerosol-layer height	5-10km/NA/ 4hr	1km; 0.5km
	Aerosol-extinction coeff. profile	200-500km/1km(near tropopause),2km(mid stratosphere)/weekly	10%, 20%

Aerosol optical depth	1 km 2 km 10 km		24 h 2 d 7 d	7 d 14 d 60 d	0.01 0.015 0.02 Dimless
Aerosol-extinction coefficient profile	10 km 20 km 100 km	0.5 0.65 1 km	24 h 2 d 7 d	7 d 14 d 60 d	1e-05 1.5e-05 2e-05 m^{-1}

Appendix 1: Presentation summaries from the participants

3.1 GCOS Update

Presentation	
Update for AOPC-21	C. Richter

Carolin Richter, Director, GCOS Secretariat, presented the GCOS program, the different components of GCOS (AOPC, OOPC, TOPC), and explained that GCOS is also engaged reaching out with other UN organization.

She stressed that the goals of these meeting are:

- Identify and review ECVs and their specifications;
- Review adequacy of networks to measure and exchange data;
- Give recommendations for the new Implementation Plan;
- The last task is particular important as GCOS received a mandate from COP21 to report back to the UNFCCC through work of the IP.

The roadmap for the GCOS IP, which culminates in the review and approval of the IP by the GCOS steering committee in October and the presentation of the IP at the COP22, was presented, as well as the main outcome of the GCOS open conference. A written outcome of the conference is currently being completed, conference proceedings will be available on the web and there will be a reviewed article on a paper like Nature Climate change.

Given the success of this first conference, a second conference should be planned in 4 years.

3.2 GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN) & GCOS Cooperation Mechanism (GCM)

Presentation	
GSN, GUAN and GCM	T. Oakley

Tim Oakley, as the GCOS Network Manager, presented the main points from his 2016 report on the GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN) and the GCOS Cooperation Mechanism (GCM). As there were several new members of AOPC he started with an overview of his work for GCOS, the broad range of activities and the reasoning for the GCM.

The 2016 statistics show a similar status of the networks as in previous years, although there are signs across all the WMO regions of a slight degradation in performance both for the GSN and GUAN. Region 1 (Africa) continues to be the worst performing region by some margin and hence is the priority area for most of the projects undertaken by the GCM.

The key items for the consideration of the meeting were; the 2016 update to the GSN and GUAN station list; the status of the GCM project in Madagascar; the long-term ‘silent’ GUAN silent stations and the GCOS National Focal points. There followed some discussions on the underlying issues of the networks, particularly in Africa, with the feeling being that this was not always just about the resources available to purchase the equipment but also the local infrastructure and the technical capability and knowledge of the staff. Once again the requirements, benefits and governance of these ‘baseline’ networks was raised, given that they were set-up many years ago, along with the improving concept of tiered networks. It was agreed that it was important that these key points need to be captured within the new GCOS Implementation plan.

3.6 Commission for Climatology (CCl)

Presentation	
3.6a Bahamas volunteer Rain Gauge network	T. Peterson
3.6b CCl reporting on Climate Monitoring and assessment	M. Brunet

3.6a

The CCl-GCOS-NOAA project of creating a volunteer rain observing network in the Bahamas is moving along nicely. The official launch is planned for late May 2016. The Bahamas Meteorological Department is engaged in exemplary outreach to stakeholders. This network leverages off an existing volunteer rain gauge network in the US (CoCoRaHS) which handles the IT part of the network and new communication technology such as mobile phone apps that allow volunteers to easily report their data.

Two actions for consideration:

1. Having GCOS (Tim) participate in person in the launch of this network to (a) better understand how similar stakeholder outreach can be translated to other NMHSs and their observing systems and (b) help impress on the Bahamas Meteorological Department the importance of success of this volunteer network as it can serve as an alternate cost effective observing paradigm for other countries.

2. Support the purchase of some additional gauges. Even a box (12 gauges per box costing $30 per gauge) or two would be helpful as only 60 gauges were in the current budget and it is likely that this network could, resources permitting, easily expand into well over 100 stations. Indeed, another 100 gauges would be better.

3.6b

Among the climate monitoring and analysis activities carried out by the WMO/Commission for Climatology (CCl) in between the 20th and 21st Sessions of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) being reported at the last AOPC-21 session it might be highlighted the recommendation and resolution approved by the 17th Congress of WMO (WMO/Cg-17). First, the adoption of dual system to calculate climatological normals (WMO/Cg-17 Recommendation 2 (CCl-16); second, the WMO policy for the international exchange of climate data and products to support the implementation of the Global Framework for Climate Services (WMO/Cg-17 Resolution 60); and third, the implementation of a recognition mechanism for centennial observing sites (WMO/cg-17 Resolution 35).

In addition, it might be noted the progress achieved by the Expert Team on National Climate Monitoring Products (ET-NCMP) in the identification of national focal points and the National Meteorological and Hydrological Services (NMHS) capabilities and feasibility for calculating and timely delivering the six NCMPs to ensure a harmonised climate monitoring activities among NMHSs worldwide. It includes, as well, the finalisation of the NCMPs specification and software to support their operational calculation. The CCl task team on Definitions of Extreme Weather and Climate Events has also produced a draft guidance on extreme definitions and it is now under external review. It is expected this guidance will promote a common approach among NMHSs to issue warnings and watches of extreme events. Finally, the team on Homogenisation is elaborating a guidance on the need for and application to climate time-series of the state-of-the-art in homogenisation methods.

4.1 GCOS Implementation Plan

Presentation

New GCOS Implementation Plan C. Richter

The New GCOS IP was introduced to the AOPC by C. Richter, focusing on the reason why such a plan is needed. In particular:

There have been many changes since 1992 (when GCOS was established) and there are now good reasons to look at a new observational system to monitor climate.
It is extremely important to effectively work on climate-change issues, as for example failure of climate-change mitigation and adaptation is flagged as the #1 risk for humanity.
Looking at actions from 2010 IP, 50% of them have not been achieved, so there is a real need for improvement.
GCOS is also looking at other UN Convection, like for ex. CBD, UNCCD and SDG.

The new IP will:

- Broadening its scope to global Earth`s environmental cycles, i.e., energy, carbon and water, and inter alia taking into account Sustainable Development Goals, climate services, climate indicators and relevant outcomes of discussions during COP21;
- Advise on new requirements for measures needed for adaptation to a changing climate, and measures to mitigate climate changes;
- Llay out a new strategic approach to further implement the Global Climate Observing System and introduce a section on cross-cutting disciplines and on scientific and technological challenges.

5.1 Clouds precipitation and aerosols

Zhanqing Li of University of Maryland gave an overview talk concerning aerosol, cloud, radiation & precipitation and their interactions. These variables play critical roles in driving the Earth's climate system by altering the earth's energy and water cycles. He demonstrated how various observations made from the ground observation networks, satellite missions and aircraft campaigns can be jointly used to advance our understanding of the key physical processes dictating climate changes. A few important points he made are
Earth's energy balance and its disposition between the atmosphere and surface and between various fluxes have improved drastically in the last two decades or so, but the uncertainties are still larger or compatible to the greenhouse effect.
A major source of uncertainties stem from aerosol radiation interactions ARI) and aerosol-cloud interactions (ACI). Observations are still insufficient to quantify these effects to within a few Wm-2 due largely to inadequate observation of aerosol absorption, and to poor understanding of ACI processes.
More efforts are warranted to regional studies where the signals of anthropogenic effects may be large enough to offset the uncertainties, especially in the world major emission source regions.

5.2 Contribute of the Chinese Meteorological satellite program to GCOS

Presentation	
Contribution of the Chinese meteorological Satellite Program to GCOS	P. Zhang

The history, current status and future program of the Chinese Meteorological Satellite, i.e. Fengyun satellite (FY) is introduced in this presentation. The type of the instruments amounted on FY satellites includes the optical imager, the atmospheric sounder, the microwave imager, the

atmospheric composition detector, and the radiation budget mapper. Current FY-2 constitute the Geo constellation with 3 premier satellites to provide the full disk regular scanning image in every 60 minutes and the regional rapid scanning image in every 6 minutes. Current FY-3 constitute the Leo constellation with 2 premier satellites to provide the global observation of the Earth 5 times per day in AM orbit and PM orbit. Future FY-3 successors and FY-4 will provide some particular observations, such as early-morning orbital observations from LEO, hyperspectral sounding observation from GEO, etc. At the same time, the atmospheric composition monitoring will be enhanced in the future FY program. FY series will improve the capacity of the global observation and be one important component of GCOS with the stable instrument performance (NEΔT), the traceable and comparable calibrated accuracy.

5.3 Aerosols

Presentation	
Aerosol properties and climate effect: outstanding questions	O. Kalashnikova

The connection from climate and air quality was explained:

Although there is a scientific consensus that exposure to airborne particulate matter (PM) increases the risks of death and disease, the relative toxicity of specific PM types—components having different size and chemical composition—is poorly understood. Identifying the toxic constituents of PM has far-reaching implications for safeguarding public health and prioritizing intervention and control strategies. Surface PM monitors alone cannot meet the challenge of understanding of the associations between specific particle types and health impacts because they are too sparsely distributed, expensive to install and maintain, and non-existent in many parts of the world where air pollution health impacts are greatest. Space-based observations offer the only practical and cost-effective approach to measuring total and speciated PM concentrations with sufficient density and coverage to determine PM composition variability at spatial-scales relevant for human health worldwide. To assure a high-quality of PM speciation data the linkages between aerosol optical properties retrieved by remote sensing techniques and aerosol chemical composition measured in situ must be well established with an integrated satellite/surface-level data and modelling strategy. In summary, the high-resolution space-based aerosol property retrievals informed by a first guess from chemical transport model (CTM) predictions constrained by in-situ atmospheric aerosol particle sampling and ground-based PM observations would yield immense societal benefit by offering unprecedented information on PM composition.

5.4 GRUAN and GAIA-CLIM

Presentation	
Network of networks: the what, the why, the how.	P. Thorne

Following the networks meeting held before AOPC-XIX, the EU H2020 GAIA-CLIM project has taken the discussion around the network of networks concept and further formalized the concept and how to perform a capabilities assessment. While the details may not be exactly applicable 'as are', the panel saw some value in exploring this approach, potentially with work of others, to: i) formalize how GCOS defines network tiers and then ii) assess across all domains where different observational networks sit. Several potential benefits were foreseen:

- This may then directly inform priorities of future observational capability improvements;
- This may help to inform the certification of new GCOS networks;
- The assessment may provide useful feedback to networks regarding where they could improve their performance.

This could constitute a cross-cutting action in the next IP. The action could be something like:

- Agree a formal tiered networks framework and assessment criteria;
- Apply this to global observational capabilities; and
- Produce a (series of) resulting (domain specific) reports that highlight strengths, weaknesses, opportunities and threats to the observing system capabilities.

6. Coordination of ECVs

6.1 Monitoring of ECVs

Presentation	
Monitoring ECVs in BAMS State of the Climate	J. Blunden

Summary for: Monitoring ECVs in AMS State of the Climate:

Essential Climate Variables (ECVs) are one of the central components of the annual State of the Climate report, published by the Bulletin of the American Meteorological Society. From 2008 to 2013, NOAA used the number of included ECVs as a metric to measure the progress and improvement of the document. During that time the number of fully or partially measured ECVs, as defined by GCOS (2010), reported grew from ~25 to ~40 and has remained fairly steady since that time. Thirteen of the 16 atmospheric ECVs are fully monitored, while two—cloud properties and aerosols and their precursors—are considered partially monitored. Surface radiation budget is expected to be introduced in the State of the Climate in 2016 edition. In situ and remotely sensed datasets are included, as are reanalyses where appropriate. Authors and editors introduce new ECV datasets into the report as available and appropriate. The datasets included are subject to the authors' and editors' discretion. All must be peer reviewed and of sufficient length for worthwhile analysis. Multiple datasets for a single ECV are welcome and encouraged. In an effort to improve data discoverability and access, an appendix in the report lists all datasets and their associated web pages to locate the data.

6.2 Carbon, water and energy cycle

Presentation	
Carbon: Carbon dioxide, Methane and GHG	J. Butler
Water: New ECV for monitoring the water cycle?	A. Becker
Energy: Energy Cycle	N. Ohkawara

6.2b

Andreas Becker examined the question for the introduction of new ECV's with regard to the water cycle. Components of the water cycle as illustrated by Trenberth et al (2007) do only partly match the current list of ECVs with relevance to the water cycle. The latter spread over the AOPC, OOPC and TOPC domains, with water vapour (surface & upper air), precipitation (surface) constituting direct matches, whereas cloud properties have an indirect but important impact on the water cycle while also being crucial for the energy cycle. Other elements of the water cycle like ocean to land water vapour transport, or evaporation across ocean or evaporation and transpiration over land are no ECV's but are rather derived from existing ECV's with the aid of budgetary approaches. As for the trade-off decision to either extend the scope of ECVs by including missing elements or to improve the observational capabilities and geo-temporal resolution of the existing AOPC ECVs precipitation, water vapour and cloud properties, Dr Becker was clearly speaking in favour of the latter. Arguments for this were presented by examination of the status quo on the existing ECVs and with reference to a core publication by Hegerl et al. (2014) on the still remaining challenges to properly quantify the global water cycle. The enhancement of the specifications of existing ECVs (geo-temporal resolution, robustness, homogeneity) in particular precipitation and water vapour are more pressing for a better understanding and quantification of the water cycle than new ECVs.

Moreover the new “three cycle” concept of the IP rather asks for “cross-cycle” consistency of the existing ECV’s and their understanding first of all.

Data availability remains a critical issue and a major cause of uncertainty in the water balance. Countries do apply conditions on the use of data so this may be a data policy issue. Moreover, daily, sub-daily and even hourly records are crucial in order to improve the detection and observation of extremes in weather and climate, which is also one of the Grand Challenges of the current WCRP work plan. Benefits of recent improvements for the land surface precipitation data products of the Global Precipitation Climatology Centre (GPCC) were presented to illustrate their potential in this context. Further recommendations encompass the importance of ocean salinity observations (OOPC requirement), the higher integration of existing (in-situ, radar, sat) and new (micro link, internet of things) observational regimes for precipitation and for P-E diagnostics. Equipment of buoys with precipitation and pressure measuring devices would substantially add to the ground truth information for calibration of satellite products across oceans. Making better use of physical mechanisms between multiple parameters observed would also improve robustness and physical consistency of recorded changes across water cycle variable. Moreover the role of aerosols and cloud properties needs to be better understood. The approach of the new GCOS IP to jointly consider the water, energy and carbon cycles will be helpful down this road. Direct measurements of turbulent water (vapour) transports and fluxes through profilers (e.g. lidar devices) are still in a premature stage, so their role for the next GCOS IP is debatable. GCOS needs to stay rigorous and conservative in adopting new ECVs or in changing the requirements of others, especially because space agencies have based their plans on the existing ECV requirements

6.2c

What element is necessary to understand the energy cycle completely?

The global mean energy balance was updated in IPCC AR5 and the magnitudes of the globally averaged energy balance components at the beginning of the 21st century were estimated. To understand the global energy flows in the climate system precisely, the components shown below are considered to be monitored quantitatively from satellite and surface observations. Most all of the components are already designated as ECVs in IP-10 with a partial exception such as evaporation in the atmosphere.

a) Top of the atmosphere earth radiation budget (incoming solar, reflected solar and thermal outgoing);
b) In the atmosphere Aerosol, Cloud, Greenhouse gases, Latent heat, Sensible heat, Evaporation
c) Surface radiation budget (downward shortwave radiation(direct and diffuse solar), downward longwave radiation, reflected shortwave radiation, upward longwave radiation), Albedo d) Sub-surface Seawater temperature (sea surface temperature, temperature).

6.3 Coordination of ground-based observation

Presentation	
Toward a GCOS Reference Surface Network	A. Klein-Tank

The GCOS Status Report notes that “the case for and practicality of establishing a global network of reference sites is being kept under review by the GCOS programme”. Klein Tank presented the pros and cons of developing such network of reference sites. It would help adhere to GCOS climate monitoring principles, build on ICOADS and GRUAN networks, address the IPCC need for authoritative statements about observed change, and serve as a benchmark for the other observation stations in a region/country. In the US a reference network already exists for several years (USCRN, Diamond et al., BAMS, 2014). However, for GCOS to establish a global reference

network, clarification is needed how such network links to the baseline GSN. Does the network consist of a subset of GSN stations? Also, the network will be too sparse for most climate applications other than global monitoring. Furthermore, close collaboration with WIGOS is needed to guarantee consistency with their standard and recommended practices, RRR, Quality Managements framework, uncertainty characterisation and metadata standard. It is suggested that a task team be instigated to report in two years time with a firm plan on a GCOS Surface Reference Network for consideration including a description of what constitutes a reference network and station. This task team should include representatives from GCOS-AOPC, CCl, CBS and possibly others.

6.4 Precipitation

Presentation	
Role of radar technology in GCOS IP	A. Becker

A presentation suggesting an extended role of radar technology for GCOS given its potential to substantially increase the geo-temporal resolution of the observation of land-surface precipitation and upper air precipitating water was given by Dr Andreas Becker. Motivation for this lies in the better understanding of the global precipitation trends in context of climate change and in the substantially improved geo-temporal resolution of weather radars compared to in-situ and satellite systems with the potential to also provide to heavy precipitation risk climatology's at a resolution that matters for customers (e.g. municipalities). Challenges associated with a global scale deployment of radar technology are substantial and encompass inter-alia harmonization of retrieval and calibration methods, data exchange, global coverage, quality control, QPE methods but are comparable to the situation of satellite based observation in the late 1980ies when the scope of usages of satellite products was extended beyond real-time applications. Therefore, Dr Becker recommended that the GCOS IP should at least set the initial steps to raise awareness with all countries on the climatological potential and value of radar data with the goal to motivate and facilitate proper and standardized storage of local radar data, so it can be re-processed even many years later when issues on international data exchange might have been solved. A survey on activities on radar processing within RA VI was presented showing that thanks to first visionary re-processing successes by groups at KNMI, Meteo France and UK Met Office and new activities in Switzerland and Germany up to 15yrs of reprocessed radar data is already available on national level, suitable in particular for extreme statistics on precipitation events. NOAA's NEXRAD archive constitute a further substantial capability and together with capabilities in Japan and China the time is right to initiate a global activity that should also finds a proper reflection in the GCOS IP.

8.1 ECVs datasets

Presentation	
GCOS ECV Data Access Matrix	C. Lief

Christina Lief, NCEI Physical Scientist and Program Manager, gave an update on the GOSIC Portal which provides a clearinghouse that facilitates discovery of and access to authoritative space and in-situ based GCOS data and products. One of the data access tools available on the GOSIC is an ECV data access matrix. This matrix will be updated per the newly published 'Status of the Global Observing System for Climate) October 2015 (GCOS-195). Other information, such as DOIs, Maturity Matrices, BAMS State of the Climate ECV data links, etc., will be added as well.

8.2 Satellite Climate Data Records

Presentation	
Satellite Climate Data Records	J. Privette

Jeffrey Privette of NOAA's National Centers for Environmental Information (NCEI) provided a summary of NCEI's multi-decadal satellite Climate Data Records (CDRs), including the engineering approaches used for CDR transition from research-to-operations and long-term sustainment. NCEI currently sustains 32 groups of CDRs with several others in development or transition. For atmospheres, NCEI provides CDRs of mean layer temperatures, aerosol optical depth, cloud properties, ocean near-surface properties, top-of-atmosphere radiation fluxes, and precipitation. Current priority CDR activities include deriving trends and other climate monitoring information, improving user access, reducing latency to better enable decision-support applications, and integrating in situ and other data sets to extend records further back in time. Privette also described NCEI's efforts to develop and sustain Reference Environmental Data Records (REDRs), a more general class of long-term homogeneous records that support both climate change work and many non-climate uses and applications. CDRs are a subset of REDRs.

8.3 Creating a land station historical database

Presentation	
Global in situ datasets at NCEI	M. Menne
Creating a land historical database	

M. Menne presented a brief update on the status of NCEI's main in situ datasets: the Integrated Global Radiosonde Archive (IGRA); the International Comprehensive Ocean-Atmosphere Dataset (ICOADs); and the land surface datasets (monthly, daily and sub-daily). NCEI is planning to vertically integrate all of their land data holdings into an integrated database to manage both data and metadata (station histories). The development of an integrated land station database at NCEI is consistent with the emerging concept of a comprehensive land surface database similar to ICOADs.

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