
PROJECT REPORT

# Report of the third session of the WCRP Data Advisory Council (WDAC)

National University of Ireland, Galway, Ireland
6-7 May 2014

July 2014

WCRP Report No. 13/2014


**WCRP Data Advisory Council 3rd Session**

**6-7 May 2014**

**AULA MAXIMA, National University of Ireland, Galway, IRELAND**

*WDAC3 attendees: From left to right and bottom to top: Michael Bosilovich, Otis Brown, Toshio Koike, John Mitchell, Paul Poli, Pierre-Philippe Mathieu, Jörg Schulz, Peter Gleckler, João Luis de Almeida, Kaoru Sato, Christina Lief, Michel Rixen, Robert Husband, Brian Ward*

**Present**: Otis Brown (Co-Chair), Toshio Koike (Co-Chair), John Bates (remotely), Michael Bosilovich, Peter Gleckler, Pierre-Philippe Mathieu, Walt Meier (remotely), David Schimel (remotely), Mark Bourassa (remotely), Kaoru Sato, Joerg Schulz, Brian Ward

**Invitees**: Robert Husband, Christina Lief, John Mitchell, Paul Poli, João Luis de Almeida (technical support)

**Apologies**: Katy Hill

**WCRP JPS**: Michel Rixen

## 1. Introduction

### a. Introduction

Otis Brown welcomed all participants and thanked them for attending the third WDAC meeting in Galway. He provided a brief overview of the WDAC's mission and role with in the WCRP. He noted that WDAC3 is planned to address a number of core topics at the heart of WDAC's business: progress on *in situ* inventories, initial outcomes from the Obs4MIPs Task Team activities, "best practices" quality assessment approaches from GEWEX, a broad discussion of surface flux observations, and Council business. He expressed his gratitude to the National University of Ireland – Galway, President Browne and Professor Brian Ward for hosting the meeting and for providing all the necessary facilities and support. A quick round table allowed everyone to introduce themselves to one another. He commented that the agenda was quite busy and welcomed the assistance of everyone to stay within the allocated briefing and discussion times.

### b. Welcome address

James Browne, President of the National University of Ireland, Galway welcomed all participants and presented a short overview of the University created back in 1845 during the major famine, which affected Galway significantly, and which holds nowadays approximately 17,000 students and offers a range of full programmes covering sciences, law, engineering, business. The University has pioneered several areas in the last decades, including marine environmental engineering and a center for climate studies. He further highlighted the importance of this meeting in the context of climate change to be mitigated and note the focus of this session on fluxes to better understand the earth system.

### c. Meeting arrangements

Brian Ward provided details on meeting arrangements and local logistics.

### d. Adoption of agenda

The agenda was adopted without any further changes.

### e. Review of WDAC2 actions

WDAC2 actions were briefly reviewed, most of them being complete, the remaining once being addressed during WDAC3.

### f. WCRP Update

M. Rixen presented the new WCRP structure aimed at better tackling climate science in service to society under the Global Framework for Climate Services (GFCS) as well as multidisciplinary science under the new Future Earth initiative. The Research, Modeling and Prediction pillar of the GFCS represents an important initiative in the context of WDAC, especially regarding the seamless provision of data sets in support of climate research.

The WCRP community has identified 6 Grand Challenges (GC) representing the major science foci of the WCRP for the 3-5 years ahead. The importance of fluxes to tackle the GCs was highlighted.

WMAC2 and the JSC34 endorsed the Earth System Grid Federation (ESGF) as the future pan-WCRP model-data dissemination mechanism within the program. Initially adopted by the CMIP community, this archiving system is now being also used by CORDEX. WGSIP is planning to migrate to this infrastructure soon. The sister initiative on observations aka obs4MIPs brings satellite data to the same archive and aims at expanding to many observational products. A kick-off meeting was held on 29 April – 1 May 2014 at NASA HQ, Washington, USA with data providers to expand holdings.

Some important upcoming meetings were briefly reviewed, such as the pan-GEWEX meeting in The Hague, Netherlands, 14-17 July 2014, the WWRP Open Science Conference in Montreal, 16-21 August 2014, the WCRP-IPCC workshop at ISSI in Bern, Switzerland 8-10 Sept and the Climate Symposium in Darmstadt, Germany, 13-17 October 2014.

*The discussion emphasized the need to have all WDAC members liaising effectively between the Council and the entities they represent.*

## 2. Flux observations and analysis

### a. Flux measurements: introduction

Carol Anne Clayson began her presentation with an overview of the SeaFlux project, which is under the GEWEX Data and Assessments Panel. The SeaFlux project's main objective is to improve our understanding and determination of ocean surface turbulent fluxes. SeaFlux has sponsored a

number of workshops that have included in situ observers, modelers, and remote sensing experts. SeaFlux has also sponsored workshops jointly with CLIVAR groups on specific topics, such as high latitude fluxes. A focus of this presentation was Version 1.0 of the SeaFlux satellite-based surface flux dataset. This dataset is currently available at seaflux.org, and is a 0.25°, 3 hourly turbulent flux dataset. Data in both swath level and a gridded interpolated product is available. The presentation touched on the methodologies used to create the dataset. Also available with this dataset are uncertainty estimations, and the manner of calculation of these by propagation of errors using comparisons with IVAD *in situ* data was described. Other satellite-based datasets were discussed as well, particularly the HOAPS 3.2 dataset. All of the producers of these datasets meet during the SeaFlux workshops and exchange ideas and methodologies for improvement.

Some comparisons were shown between the satellite data sets and various model datasets. In comparison with a variety of reanalysis products, nearly all of the satellite products (with the exception of the older weekly version of the IFREMER3 product) evidenced much smaller latent heat flux biases than any of the reanalysis products with the exception of MERRA. Further comparisons of the satellite flux products with the CMIP5 models demonstrated that the uncertainty between the satellite flux datasets is much smaller than the differences between the satellite flux datasets and the models, both for the individual components making up the bulk fluxes such as the wind speed and near surface humidity, but also the turbulent fluxes themselves. Thus the satellite datasets provide a useful target for the models, even with the uncertainties still remaining in the flux datasets. In addition, in large-scale correlations between latent heat flux and winds in the extratropics, all of the CMIP5 products demonstrated either no correlation or large negative correlations, while all of the satellite flux datasets demonstrated high positive correlations, indicating that some aspects of the dynamics within the models must be lacking.

Finally a discussion of strategies for improving fluxes was provided. One aspect is that more routine observations are needed, both of the bulk parameters such as surface wind speed, but also direct eddy correlation measurements of the fluxes themselves. Certain regimes are very under-sampled with respect to the needed inputs and fluxes, including high wind speeds and high latitudes. These are needed for improvements of the bulk flux parameterizations, which now have high uncertainties under specific wind and wave regimes. Satellite observations of the surface parameters under extreme conditions also evidence higher errors, in part due to the limited number of comparison data available. The community also needs to agree on clearly defined and common measures of accuracy, and once these are agreed upon more flux intercomparisons of the different products are necessary. One of the issues affecting the satellite datasets is also the issue of the effect of the calibration of the input brightness temperatures, as multiple calibrations exist, and it is unclear to what extent these differing calibrations of the cause of some of the differences. More global coverage of the fluxes is needed as well, as important extreme events can be missed by either the in

situ observations or the limited number of satellite data available. Lastly, the availability of both the datasets and their uncertainties need to be improved. Additional funding is needed in order to make significant progress on these fronts; compared to other aspects of the earth system such as precipitation there are relatively fewer researchers working on air-sea fluxes.

*The discussion stressed the importance of collaboration between ocean and atmospheric experts. The ocean turbulent flux community is small and its profile should be raised from individual activities to institutional level so as to reach a critical mass. The significant impact of waves/sea state on the quality of products was discussed. Seaflux and ISCCP data sets are entirely different products and much would be learned from a common framework. Similarly, some strategy to propagate uncertainties on turbulent fluxes could be developed. It was noted that flux data represent an important resource for climate research that could be published on obs4MIPs.*

### b. GCOS update

Mark Bourassa provided an update on GCOS activities. He described the structure of the Global Climate Observing System (GCOS) in the context of defining requirements for surface fluxes. The fluxes (radiation and precipitation) and the variables needed to calculate fluxes (sea surface temperature, surface wind speed, near surface air temperature, near surface humidity, pressure, sea surface temperature, and sea state) are split among the atmospheric (Atmospheric Observation Panel for Climate, AOPC) and oceanic (Ocean Observation Panel for Climate, OOPC) panels. GCOS recognizes the importance of surface flux in a coupled climate systems and the importance of flux observations for a broad range of research and model evaluation. GCOS has only provided observational requirements for precipitation at this time. AOPC and OOPC are in the process of developing requirements for fluxes, and recognize that CLIVAR has already provided requirements for various regions and applications. Historically, OOPC has worked with the CLIVAR basin panels to develop useful goals for the observing system, and worked with observing networks to insure requirements are practical.

Examples of requirements are provided for high latitudes and the tropical Pacific Ocean. These requirements are a function of the spatial and temporal scales for the process being investigated, rather than valid for all applications and scales. Fluxes are rarely observed directly (from eddy covariance measurements) and are usually calculated from bulk variables (listed above). For accurate fluxes these variables should be very closely coincident in space and time. They must also be on daily or finer scales to limit sampling related errors in many locations. Such requirements have not yet been officially addressed by GCOS, however, some published research can guide the development of such requirements. Issues associated with small scale variability that is missing in reanalyses will be shown to be substantial, particularly in areas with large currents and large gradients in sea surface temperature. This variability in space and time indicates that satellite

observations must be a key part of the observing system. Recent results in retrievals of near surface (10m) temperature and humidity will be shown to demonstrate that such capability is feasible. This capability might also account for sea state related variability in surface stress, which is a relatively controversial issue.

*Wave measurements are missing to calibrate flux measurements and models sometimes present a better alternative. Depending on the wavelength, winds can be assimilated as well but ideally, wave measurements should be added to in-situ systems. The WDAC very much welcomed the attendance of the GCOS Space Rapporteur and the remote participation of Mark Bourassa (OOPC) in the meeting, and looked forward to the participation of other GCOS Panels in future WDAC meetings.* WDAC expressed a willingness to enter a dialogue with GCOS during any ECV update process to provide the needs of the modeling community. In this respect it was noted that surface fluxes could be expected to form part of such a process. The GCOS Space Rapporteur noted that, following the TOPC discussions, the extension of the ECV Inventory to *in situ* data will be subject to further discussion and confirmations by the GCOS SC.

### c. SOLAS

Brian Ward provided an update on SOLAS activities. The current term for SOLAS will expire in December 2015. At the most recent SOLAS SSC (May 2013, Tsukuba, Japan), the committee decided that SOLAS will not end and that SOLAS will prepare a whitepaper for its extension. A transition team composed of the SSC members and others scientists were appointed to define the scope of future SOLAS and write a transition document for our sponsors. SOLAS also carried out a bottom-up visioning exercises with the community (in particular with young scientists) and defined both capacity building strategies as well as contributions to and modes of interaction with Future Earth. The Team identified 8 research themes:

- Greenhouse gases and the oceans
- The air-sea interface and fluxes of mass, energy
- Atmospheric nutrient and particles supply to the surface ocean
- Interconnections between aerosols, clouds and ecosystems
- Ocean emissions and tropospheric oxidizing capacity
- Interconnections between ocean biogeochemistry and stratospheric chemistry
- Multiple stressors and ocean ecosystems
- High Sensitivity Systems

There was a scientific focus on the SOLAS Theme 2 (Air-sea interface and fluxes of mass, energy) and the influence of the mixed layer depths on producing reliable estimates of sea surface temperature from models. These parameters are critical for accurate determination of air-sea fluxes. Also discussed was the expanding database of global partial pressure measurements of $CO_2$ from the Surface Ocean Carbon Atlas (SOCAT), and

how these will contribute to the Integrated Carbon Observing System (ICOS). Finally there were some results from eddy covariance estimates of air-sea CO2 fluxes. The WDAC delegates were also informed of the SOLAS Open Science Conference due to take place in Kiel in September 2015, as well as the ESA-SOLAS-EGU conference in Frascati in October 2014.

*It was pointed out that people working on turbulent fluxes are also often involved in $CO_2$ flux measurements. Water vapor severely affects $CO_2$ fluxes, requiring hence specific corrections. It was noted that ECMWF is working on coupling between wave and ocean models and that the Chinese-French Oceanic SATellite (CFOSAT) is planned to carry two scatterometers, to observe ocean winds and ocean waves. The issue of several bulk formulae to deal with extremes was also highlighted.*

### d. CGMS

Jörg Schulz provided a presentation on flux observation needs from the CGMS perspective. He stated that fluxes at top of atmosphere and in particular the surface are not directly measured with satellite instruments but are parameterized or derived using complex models. Many parameterizations and models need basic meteorological, oceanographic and terrestrial basic state variables that describe atmospheric and surface characteristics. Long-term measurements from CGMS satellites including several data products can contribute in this area very well. The example surface radiation fluxes showed that beside very good broadband (or converted narrow band) radiometer measurements many additional measurements characterizing water vapor, cloud properties, aerosol and surface properties such as albedo are needed. For most of the needed parameters CGMS long-term operational missions provide essential data which are used in today surface radiation flux data sets, e.g., all geostationary data to characterize cloud properties. Also the example of the SCOPE-CM surface albedo project producing an all geostationary satellite albedo product contributes to this through international coordination within CGMS.

The second part of the presentation was addressing the sustained activity of the EUMETSAT Climate Monitoring Satellite Application Facility (CM SAF, www.cmsaf.eu) producing an ocean surface turbulent heat flux data record (**H**amburg **O**cean **A**tmosphere **P**arameters and Fluxes from **S**atellite Data - **HOAPS**) together with a precipitation record. The data record is produced using a Fundamental Climate Data Record (FCDR) of SSM/I measurements that was recently published by the CM SAF. The strategy to produce flux data followed was to use as little as needed ancillary data such as NWP model-based reanalyses to keep issues such as temporal stability under better control.

The SSM/I FCDR has been evaluated in comparison exercises initiated by the GEWEX SEAFLUX project where results shown in Carol Anne Clayson's presentation are clearly indicating that it is fully competitive with other data records. Its value for climate model evaluation was demonstrated in

collaboration with the Max-Planck Institute for Meteorology, Germany in a comparison of fluxes with AMIP and fully coupled historic model runs performed for the CMIP5. In particular the capability of a consistent E-P estimate seems very valuable. Comparisons of model E-P with the HOAPS satellite estimate resemble similar results as comparison to surface salinity from the World Ocean Atlas but with much greater spatial detail.

The SSM/I FCDR will be further developed by replacing individual retrieval schemes for state variables with a 1D-Var retrieval that produces a simultaneous retrieval for all state variables derived from SSM/I also allowing a better representation of retrieval uncertainty in the end products. The funding for the CM SAF contributions is secured by EUMETSAT programs until 2022 with a likely extension of another 10 years. Thus, this could be a major long-term asset to a WCRP activity of surface turbulent heat fluxes over oceans.

*The discussion highlighted the need to have at least one broadband radiometer to validate extrapolation of narrow band options. It was noted that changes in optimal interpolation in HOAPS3.2 have improved some records derived from SSM/I and SSMIS.*

### e. Reanalyses

Michael Bosilovich and Paul Poli provided an update on reanalysis activities. At the atmospheric reanalyses centers, major efforts are making progress. The JMA JRA55 has been released, and the validation effort has demonstrated improvement over JRA25. This is the result of updated and improved input observations, improved model physics, higher spatial resolution and the 4DVAR data assimilation with bias correction. The European project ERA-CLIM (led by ECMWF) has produced several new data products aimed at climate scale reanalyses. ERA-20C is a 20$^{th}$ century reanalysis of surface pressure (similar to NOAA 20CR), while the ERA-20CM is a 20$^{th}$ century ensemble model simulation. An offline land surface product was also developed using the ERA-20C forcing. All reanalysis data, the input observations and feedback information will be available online. NCEP's new system will include a *Hybrid EnKF* data assimilation approach, and a new reanalysis is running. NCEP is looking to a coarse 3DVAR version of their current system to replace their 50-year reanalysis. The GMAO's MERRA will be replaced with a new reanalysis, MERRA2. The new system includes several new features including observationally based precipitation forcing for the land surface processes, latest observations for assimilation (e.g. GPSRO and IASI), revised boundary layer physics and tropical cyclone relocation. In addition, aerosol assimilation is enabled and interactive with the radiation physics, a fundamental step toward a more fully coupled Earth system reanalysis. Also, a new mass constraint on the water cycle limits unrealistic global biases in the analysis of water vapor. The result is that the new system will have some improvement in the balance of global water. MERRA2 production began in mid-2014.

Community Efforts

NCEP is building a community effort called Climate Reanalysis Task Force (CRTF). The CRTF consists of members of NCEP's reanalysis development group and also PI's recently funded by NOAA's Climate Program Office specifically to contribute to the development of the next generation of climate reanalyses and overcoming past issues in reanalyses.

User contributions to *reanalysis.org* are continuing and the site is growing well. New products and evaluation methods are being posted regularly. There is an issue with NOAA policy, in that they will no longer support the domain cost ($500). External support for the web domain name is being sought by the management team.

There are many efforts regarding reanalyses, primarily on their use, across WCRP activities. These include land reanalyses, ocean reanalyses and investigation and intercomparison of different products. Since reanalyses are applicable to many different research issues, it would be good to have some definition of the scope that reanalyses reporting to WDAC. If the scope includes development beyond the weather prediction centers, into land and ocean reanalyses, and the broad user community, then some organization of these additional inputs is needed.

Meetings

An invitation-only workshop on best practices for observing systems in reanalyses is being planned by the ERA-CLIM project for mid-2015 in Reading UK. The purpose would be for reanalyses developers and observation curators to discuss the latest information on observations and share best practices.

The Fifth International Conference on Reanalyses planning was discussed briefly. Timing would be in the 2016-17 timeframe, and Europe is next in line for hosting the conference. A conference chairperson needs to be identified, and would likely be a representative from the ERA-CLIM project.

*The discussions noted the reanalysis efforts in the other components of the earth system, namely within GEWEX under GLASS and the International Ocean Reanalyses Intercomparison Project (ORA-IP) within the CLIVAR/GSOP and GODAE communities. A paper is being submitted to the Journal of Physical Oceanography, and a preliminary overview is available in the Feb 2014 issue of CLIVAR EXCHANGES (issue 64): http://www.clivar.org/publications/exchanges.*

## f. CEOS

John Bates updated the WDAC on CEOS activities. He noted that since the last WDAC meeting, the Committee on Earth Observation Satellites (CEOS) Working Group on Climate has been joined by the Coordination Group for

Meteorological Satellites (CGMS). Only minor changes were needed in the Working Group's terms of reference to accommodate this change. A new overarching objectives statement was added stating the Joint Working Group will focus on:

- Provision of a structured, comprehensive and accessible view as to what Climate Data Records are currently available from satellite missions of CEOS and CGMS members or their combination;
- Creation of the conditions for delivering further Climate Data Records, including multi-mission Climate Date Records, through best use of available data to fulfill GCOS requirements (e.g. by identifying and targeting cross-calibration or re-processing gaps/shortfalls);
- Optimization of the planning of future satellite missions and constellations to expand existing and planned Climate Data Records, both in terms of coverage and record length, and to address possible gaps with respect to GCOS requirements.

The first meeting of the Joint Working Group on Climate took place in March and concentrated on: 1) building an inventory of data on space agency production of GCOS essential climate variables (ECVs), 2) defining an architecture for climate monitoring, 3) conducting an assessment of ECVs existing and planned, and 4) stewardship and scientific assessments of ECVs. Details on the Working Group and meeting presentations can be found on the CEOS web site www.ceos.org selecting 'climate' in the left column.

For this WDAC meeting, approaches to how the GCOS ECV approach may be used to study WCRP science themes, such as ocean-atmosphere-land fluxes were explored. It was proposed to construct a matrix of the flux individual variables against the ECVs. The required ECVs should be prioritized and any gaps in variables needed for flux computations should be identified. This input should be conveyed to the GCOS as GCOS is currently conducting their update of the observing system and will be issuing the next implementation plan within one year.

## 3. Flux analysis and modeling

### a. Fluxes and modeling: an introduction

John Mitchell, co-chair of the WMAC, introduced this session. Coupled ocean atmosphere models are used climate prediction, seasonal prediction and increasingly for shorter range weather prediction. There are persistent sea surface temperature errors in climate simulations, which have been documented in the last four IPCC Working Group I Assessments, include a warm bias in the subtropical stratocumulus regions (including off California, Peru, Namibia and West Africa) and over much of the Southern Oceans. The errors in the former regions are mainly associated with too little low cloud. Over the Southern Ocean, the error appears after a few days in weather and seasonal predictions, and appears only to be partly associated with too little cloud. There is evidence that there are other sources of errors in this region,

including an underestimate of evaporative cooling. This evidence relies on reanalyses, and on estimates of the radiation absorbed between the top of the atmosphere and the surface, and thus is still to some degree model dependant. There is an urgent ongoing need for independent *in situ* measurements of turbulent surface fluxes, particularly over the Southern Ocean, to validate coupled ocean-atmosphere models.

*The discussion noted the challenge dealing with fluxes over the ocean because of the lack of observations and the need to manage radiative and turbulent fluxes in a single framework to address net fluxes which are of prime interest to the community. The community also welcomes guidance about the quality of products being updated on a regular basis.*

### b. CLIVAR Ocean-atmosphere interactions

Pierre-Philippe Mathieu noted that CLIVAR has recently established a new research opportunity on "*Consistency between Planetary Heat Balance and Ocean Heat Storage*". The main objective of the CLIVAR cross-cutting activity is to better understand the "*role of the ocean energy uptake*" by analyzing consistency of heat budget components as seen by *independent* global observing systems, including (i) Earth Observation (EO) satellite data, (ii) *in-situ* measurements of ocean heat content storage changes, and (iii) Ocean reanalysis for heat transports and exchanges. Each of these independent approaches has its own advantages and drawbacks in terms of sampling capability and accuracy, leading to different estimates, and associated uncertainties of budget imbalance. *Reconciling* these different estimates to close the energy budget is a key emerging research topic.

In order to address the EO component of the new CLIVAR initiative, ESA and the CLIVAR Project Office held a workshop on 3-4 July 2013 at the University of Reading in the UK. The meeting, supported by the World Meteorological Organization (WMO), the National Centre for Earth Observation (NCEO), and ESA attracted more than 27 participants from Europe and the US, with additional presentations delivered from the US by videoconference. The workshop aimed to define the EO requirements for a potential ESA activity in support of CLIVAR. In particular, the objectives of the workshop were to *Review* the status of current EO-based observations and methods used to derive air-sea fluxes, and *consolidate* the scientific requirements of the CLIVAR community in terms of data sets, and new methodology (using heat budget constraints) needed to improve ocean surface fluxes. The workshop led to a series of recommendations by the community regarding the EO component of the new CLIVAR research opportunity and also the wider planetary heat budget closure. In particular, regarding the EO component, the workshop has identified the need to:

- (R1) Quantify the different types of *uncertainties* of EO-based surface fluxes (see above), their *correlation* structure, and *sensitivity* to uncertain parameters (e.g. input data, transfer coefficients) and algorithms (e.g. retrieval schemes) in order to improve the usefulness of global flux products, and

make them more suitable to support scientific studies of climate variability, trends, and the global ocean heat budget closure problem that remains unresolved.

• (R2) Develop an innovative *ensemble* approach to generate a new global EO-based data set, combining the individual strengths of existing data sets, the latest knowledge in bulk formulations and associated input data, and the most recent efforts in re-processing EO data sets of climate quality (e.g. CCI). The idea is that a well-designed ensemble of multiple realizations of fluxes would sample some of the uncertainties related to the flux product, in a similar way as is done for SST within the HadSST3 data set.

• (R3) Exploit *integral constraints* as suggested by GSOP to check consistency of the Net Heat Flux product components, and in particular by use of Argo data on a series of Cages or "super-regions" of interest, such as enclosed seas (e.g. Mediterranean Sea, Pacific Warm Pool).

• (R4) Develop a community-led *Flux Platform* to share, *access* and inter-compare easily different sets of flux climatologies, and their input data (e.g. different SSM/I data streams), thereby fostering close collaboration between different communities (e.g. meteorologists, oceanographers, climatologists, observationalists and modelers), as well as new ways of combining *in situ* measurements and EO data. Such a platform was regarded as a vital tool to achieve R1, R2 and R3, and organize a global effort to coordinate the evaluation of flux products, improve their inter-operability and encourage their use.

• (R5) Complement the GSOP inventory with "assessment" information regarding the strengths and weaknesses of the various flux products, in an effort analogous to the "Climate Data Guide" [URL-8], to guide the users (in particular non-experts) in selecting the best product for their application across the multitude of flux products available on the web (Schneider et al, 2013).

*The hiatus has illustrated the need to better understand the deep ocean and the hence the strong requirements for surface observations, especially over extreme events. The use of obs4MIPs as a platform to exchange data in this context was recommended.*

### c. GEWEX Land-atmosphere interactions

Jörg Schulz provided a comprehensive presentation on the GEWEX LandFlux initiative focusing on evapotranspiration estimates. The goal of the GEWEX Data and Assessments Panel (GDAP) LandFLux initiative is the development of a global observations based product of land surface turbulent heat flux covering 1984-2007. The LandFLux product is part of GDAPs integrated product that combines products for all parts of the energy and water cycle to allow an independent assessment.

The challenge for LandFlux is that heat fluxes do not have a unique signature that can be remotely detected. Thus, satellite observations need to be combined by a model (process-based, empirical, *etc.*) to infer them. The presentation provided details on model selection, the impact of forcing parameters needed for each model on the inferred fluxes. The different evaluation activities in LandFlux allowed for the examination of global scale response, the assessment of region-to-catchment scales and also to evaluate validation conceptual issues such as the mismatch of model grid variability to tower based observations.

The global scale comparisons showed that a large number of ET datasets (GCM, LSM, reanalysis) from different sources exist and that the observations-based products are largely consistent with others but differences can be very pronounced in some regions. Overall it can be stated that evapotranspiration is a difficult product to derive, as it merges products with their own uncertainties and models with their own assumptions. Global products require multiple metric and multiple evaluation scales (incl. spatial and temporal) with the model performance linked to metric, scale and zone/type model sensitivity to forcing vs. forcing uncertainty. Outstanding challenges are the production of sensible heat and ground heat fluxes, to address frozen/snow-covered areas and some ongoing algorithm developments considering a soil moisture stress term and better surface resistance/vegetation parameters.

Finally it needs to be kept in mind that satellite products respond to different user needs. LandFlux is targeting climatological applications and consistency with other GDAP products to enable water and energy budget studies. Further product developments need continuous community involvement to be successful. The LandFlux Version 0 products shall be released to the public in July 2014 via the GDAP web pages.

*The discussion noted that in many instances, flux data are collected by the research community and raises the issue of adopting common standards and protocols and quality control procedures. Landflux data are currently in Netcdf format but it is unsure whether they are CF compliant. Adherence to obs4MIPs would require funding lines and specific resourcing. Land surface models are part of the GEWEX GLASS effort. FluxNET data from eddy covariance tower measurements provide reference data.*

### d. SPARC Stratosphere-troposphere interactions

Kaoru Sato updated the Council on SPARC activities. Efforts related to “flux”, CCMI (IGAC/SPARC Chemistry-Climate Model Initiative), SPARC Gravity wave and SPARC Data Initiative as well as other WDAC-related topics were introduced.

CCMI is a project aiming at the process-oriented evaluation of chemistry-climate models to improve model processes and to gain confidence in their predictions of air pollution, the ozone layer and their interactions with climate

in the troposphere and stratosphere. About 150 scientists including modelers, experimentalists, and data analysts are participated. As an example of outputs from this activity, tropospheric increase in ozone compensates partially the stratospheric ozone depletion resulting in no negative trend in the tropical region. It is emphasized that the evaluation of observational data is crucial to give better diagnostics of the key physical and chemical processes, and WDAC can help to create support for and facilitate future observational and model data assessments including surface fluxes of chemical species from the historical period to the future.

The circulation in the stratosphere and mesosphere is important to understand the troposphere-stratosphere exchange and the distribution of mass (i.e., surface pressure) and minor constituents. This circulation is mainly wave-driven, but there are significant uncertainties in the relative contributions of planetary wave, synoptic-scale waves and gravity waves to the momentum and energy budget regarding the three dimensional distribution and time variation. One of the most uncertainties is the momentum flux associated with gravity waves that are usually sub-grid scale phenomena in the climate models. Recent SPARC gravity wave research activities including the ISSI activity to make an attempt to give observational and model constraints to the gravity wave parameterization in the climate models and the working group on numerical experimentation (WGNE) treating the surface momentum fluxes were introduced.

The SPARC Data Initiative is the first comprehensive inter-comparison of 18 different limb satellites instruments evaluating 25 different chemical species and aerosols. Assessments of available data sets and data quality have been made. This activity is crucial for better tracer scenario validation, model validation projects, trend analysis and empirical studies of stratospheric climate and variability. Looming gap in vertically-resolved stratospheric observation beyond 2020 was also indicated.

### e. CliC and Cryosphere interactions

Walt Meier noted that the cryosphere plays an important role in energy and mass fluxes between the land, ocean, and atmosphere. For example, sea ice decreases the absorption of solar energy because of its high albedo; and sea ice also acts as a physical barrier to inhibit the flux of heat and moisture between the ocean and atmosphere. The WCRP Climate and Cryosphere project is involved with several activities relating to fluxes in the snow and ice covered regions of the earth. With a new chair, Greg Flato, and several new members, the CliC Science Steering Group (SSG) in its recent meetings has begun refocusing priorities and is developing new “targeted activities”. One of these targeted activities is the Polar CORDEX to compare regional climate model simulations, both historical and future projections, for the Arctic and Antarctic. Another new activity is a SnowMIP (Model Intercomparison Project) to better understand snow processes, feedbacks, and its role in the global climate system. A third activity is a model intercomparison project for the West Antarctic Ice Sheet, particularly focusing on ice shelf-ocean interations. CliC is

also continuing to support several ongoing activities, such as the CliC Sea Ice Working Group, the planned MOSAiC field campaign, a Southern Ocean data needs survey, an Arctic Freshwater Synthesis, the Ice-Sheet Mass Balance and Sea Level (ISMASS) project. Finally, CliC is collaborating with partners on a U.S.-funded Sea Ice Prediction Network and the ICARPIII meeting in Toyama, Japan next year.

*The discussion noted the recent publication in EOS of the article on the Grand Challenge on Cryosphere in a Changing Climate.*

### f. IGBP and biogeosphere interactions

David Schimel presented a perspective from the IGBP Merton Initiative addressing observational constraints on terrestrial carbon feedbacks with a particular focus on data sources, gaps and opportunities.

Modeled terrestrial ecosystem and carbon cycle feedbacks contribute substantial uncertainty to projections of future climate. Feedbacks from the global carbon cycle contribute substantially to uncertainty about future climates. Lack of knowledge about positive and negative feedbacks from the biosphere is a major limiting factor to credible simulations of future atmospheric CO2 concentrations. Currently, ecosystems take up a significant fraction of carbon released to the atmosphere from fossil fuel burning and deforestation, but if this subsidy declines, the rate of increase in atmospheric CO2 accumulation will increase sharply for any given emission scenario. The importance and complexity of the world's terrestrial ecosystems have come into sharp focus over the past few decades.

The limitations of current observing networks contribute to this uncertainty and were recently analyzed by an IGBP-led initiative (the Merton Initiative: see www.geo-tasks.org/.../The%20Merton%20Initiative-Aug2012-1.docx). Carbon cycle tipping points occur in terrestrial regions where fluxes or stocks are largest, and where biological variability is highest, the tropics and Arctic/Boreal zones. Global observations are predominately in the mid-latitudes and are sparse in high and low latitude ecosystems. Observing and forecasting ecosystem change requires sustained observations of sufficient density in time and space in critical regions. Using data and theory available now, we can develop a strategy to detect and forecast terrestrial carbon cycle-climate interactions, by combining in situ and remote techniques.

Models of the climate system show large feedbacks from terrestrial ecosystems, including simulated negative feedbacks resulting from increased uptake as northern ecosystems become less temperature limited, and positive feedbacks from tropical dieback. Simulated net positive feedbacks from terrestrial ecosystems can cause atmospheric CO2 concentrations to be a as much as 100 ppmv higher than simulations with no feedbacks for a specified fossil emission level, with accompanying climate effects. These feedbacks are focused in the least-observed parts of the biosphere, the Arctic-Boreal Zone (ABZ) and the tropics. The ABZ is a region where changes to climate could trigger rapid changes to ecosystem carbon storage, and where, if

respiration or combustion were to increasingly dominate over GPP, the massive reserves of carbon stored there could cause rapid increases in CO2 and temperature. The tropics are a region where either reductions in GPP or increases in forest dieback as a result of warmer, drier climates could lead to release of biomass carbon. This release could be rapid, since wood, the main storage component, can be rapidly oxidized to CO2 if fires increase. If the ABZ and the tropics are indeed the location of climate tipping points, then theory suggests that early detection of the system response requires dense observations in time and space.

Understanding fluxes and their covariance with climate is central to understanding carbon-climate coupling. FLUXNET, a network of eddy covariance sites coordinated internationally, is one of the key networks for carbon science. FLUXNET's coverage extends throughout the world and spans terrestrial climates, but the sampling is biased relative to carbon fluxes. About 85% of FLUXNET sites are between 30 and 55°N, in a region of low GPP and intermediate-to-low carbon storage. Most global GPP (carbon uptake) is in the tropics, and carbon storage is dominated by the tropics, in wood, and the ABZ, largely in soil. The well-observed mid-latitudes may be a sink for carbon today, but are unlikely to play a major role in future feedbacks.

Observations of carbon storage, and changes in storage over time, are also crucial. Total and soil carbon storage is sparsely observed on the ground. Tropical regions are grossly undersampled, with <1 plot 1000 km-2 or about 1000 tropical plots globally. By contrast, the mid-latitudes typically have 10-20 plots per 1000 km-2 or hundreds of thousands globally. Brazil is now developing a new forest inventory which will bring coverage there up to about 2 plots 1000 km-2. Because of the sparse plot coverage in the tropics, where much of the world's forest biomass is concentrated, spaceborne measurements are critical for extrapolation of local data and in situ sampling bias detection. Repeat space coverage may be the best means for assessing longterm changes to forest carbon stocks, if sufficient accuracy and length of record can be achieved to enable quantification of losses and increases over time. Aboveground carbon storage (wood) can be estimated using active remote sensing techniques from a combination of Radar and LiDAR sensors, and it is unlikely any probably expansion of the in situ network will be as successful in reducing uncertainty, however this requires both the right sensors, and their continuity to allow change detection over decadal time scales.

While lack of data on stocks and fluxes limits the ability to develop and benchmark models, uncertainty about key model parameters is also serious. Terrestrial carbon models require parameterizations of ecosystem-specific vegetation properties. These parameterizations group vegetation into a small number of Plant Functional Types (PFTs) and assign parameter values to each PFT. Parameters represent a number of key plant traits controlling growth, competition, environmental sensitivity and carbon storage. Today, models use extremely reduced descriptions of biological diversity to simulate processes. The roughly 250,000 vascular plant species worldwide are represented in models by 7-22 PFTs: recent experiments show this is a

significant limitation to model skill. While the total number of observations is quite large (millions), the observations are most limited in the diverse tropics. Again the distribution of observations is severely biased to the northern hemisphere mid-latitudes, from regions of intermediate to low diversity, while regions of high diversity are undersampled.

In order to improve models of the terrestrial carbon cycle, and monitor the emergent effects of predicted carbon-climate feedbacks, a major redirection of effort to undersampled regions is required. The logistics, cost, environmental challenges and issues of political stability make using on-the-ground approaches for long term observation challenging, though field campaigns and process studies are urgently required as well, and many are underway, meaning that the long-term, spatially extensive component may need to be largely space-based. A combination of well-established and continually improved products (eg, GPP), newer and emerging products (biomass from Radar and LiDAR), and frontier products (plant parameters from spectroscopy) focused on carbon cycle feedbacks are essential. These measurements, integrated with column CO2 from space (GOSAT, OCO-2) will provide an entirely new observational framework for carbon in the climate system.

A significant challenge exists in the disciplinary “ownership” of these different data sets, with fluxes and concentrations mainly “belonging” and being understood in the geophysical community and stocks and parameters being largely the province of the ecological and biodiversity community. A key role for WDAC and its partner international organizations will be to ensure that these areas are coordinated and brought synergistically together. GEOSS has an excellent framework for this, but communication still needs to be improved. A demonstration project, using these different data types (fluxes, stocks, parameters) together in model evaluation could be of great value for CMIP6.

*The discussion highlighted the need to include bio-geochemistry (nutrients, phytoplankton, etc) to critically address Earth System Model developments. It was pointed out that a small number of ARGO floats now include CO2 sensors, and some underwater gliders are equipped with optical sensors. The Council also noted that Earth Observations observed carbon emissions from forest fires.*

### g. Data assimilation, uncertainties

Paul Poli, on behalf of Jean-Noël Thépaut recalled that data assimilation estimates numerically the state of a physical system with the help of observations and models, explicitly taking into account uncertainties in all these sources of information. Advances over the past decade have enabled great progress in this respect, with the now widespread use of multi-member ensembles. Poli suggested that data assimilation offers an excellent framework to represent sources of uncertainties, combine them to obtain the

overall total uncertainty, and also to identify deficiencies and discrepancies in the representation of these uncertainties.

For example, the first ECMWF pilot reanalysis of the 20th century assimilating only surface observations of pressure and marine winds (ERA-20C) uses a 10-member ensemble which combines three sources of uncertainties: forcing uncertainties (an ensemble of SST and sea-ice realizations), model uncertainties (stochastic physics within the atmospheric model), and observation uncertainties. As shown in the slides, the resulting reanalysis ensemble contains a spread on short time-scales that, once added to the assumed observation errors, matches the broad patterns of the root-mean-square of the differences between observations and background. Also, as the number of observations assimilated in the ERA-20C reanalysis is multiplied by a factor of about 50 between year 1900 and year 2010, the data assimilation system is able to pick-up the improvement seen in the quality of the analyses to lower subsequent background errors and sharpen its structure functions.

As illustrated with a comparison with observed downwelling longwave and shortwave radiation measurements from a buoy over the New England shelf, and also with snow depths over Siberia, the fluxes produced by ERA-20C at the surface contain realism on diurnal and seasonal time-scales. The results also point to an underestimation of the systematic uncertainties.

However, we find, for example with an animation of wave energy fluxes into the ocean, that the ensemble spread on monthly time-scales is lacking realism: it is too small, owing to the absence of specification of uncertainties on such time-scales (except for the sea-surface).

A posteriori diagnostics suggest that the quality of observations assimilated in ERA-20C has improved significantly between 1900 and 2010. Also we find that the quality of surface pressure observations from now defunct meteorological vessels is similar to that of land stations. We also find that the quality of buoy observations of surface pressure in recent years stands out. These results could be applied in future analyses of such observations by adopting time-varying observation error estimates, but it would be important beforehand to know the causes of these many observing network improvements. Reconstructing now this history of observation uncertainty from the metadata for each observing station and ship is a daunting task; yet we can suspect that many changes to the observing system happened in fairly short steps, over wide networks, and were perfectly known by the network operators at the time.

It is hence proposed to consider a new, high-level, synthetic publication, to be named possibly « Annual State of the Observing System ». It would serve future generations to understand changes in observation quality. That publication could also find its place in the Future Earth framework to federate efforts on all environmental observations.

*The discussion noted that the impact of observing networks on forecast skill is very useful to get the attention of sponsors.*

### h. Discussion and way forward

Otis Brown summarized the main issues pertaining to fluxes raised during the session, including the impact of waves on the quality of flux observations, the historical and on-going contribution of GEWEX and CLIVAR on fluxes, the ESA initiative, the potential role of obs4MIPs in hosting flux data, past efforts with WGNE, and a number of other efforts (e.g. SOLAS), which WCRP could leverage more proactively. Recognizing the importance of fluxes across WCRP, the Council recommended establishing a Flux Task Team to promote a stronger dialogue and profile of flux efforts across WCRP and with sister programmes. This would also be a timely opportunity to put forward ECV flux data requirements as part of the new GCOS Implementation Plan due 2016.

## 4. Data dissemination, inventories, obs4MIPs

### a. osb4MIPs

Peter Gleckler briefed the WDAC on the progress and challenges associated with obs4MIPs, although it should be noted that the subject had already came up on numerous occasions during the discussions of surface fluxes. Three main topics were addressed during the obs4MIPs briefing: 1) a status update on obs4MIPs, 2) infrastructural challenges and opportunities, and 3) a summary of the obs4MIPs-CMIP6 meeting that was held one week before WDAC3 at NASA HQ in Washington D.C.

As a result of discussions at WDAC2 and in consultation with the JSC, the WDAC has formed a task team to provide guidance and oversight of obs4MIPs (Observations for Model Evaluation Task Team or OMETT). Obs4MIPs was initiated with support from NASA and the U.S. DOE, and initially led by a small team from PCMDI and JPL along with a NASA working group to help identify appropriate data products. The intent of the WDAC task team is to broaden obs4MIPs to include observational data from a diversity of data sources that are useful for the evaluation and diagnosis of climate models. The current focus of obs4MIPs remains on satellite products, in large part because technically aligning these data with CMIP model output is already fairly well defined. However, WDAC members expressed interest in other classes of data being included into obs4MIPs, although it was understood that this would likely require additional infrastructural support (see below). Several members of the task team provide expertise with atmospheric reanalysis as it is envisioned there will need to be close linkages between obs4MIPs and the related ana4MIPs project.

Much of the discussion of obs4MIPs was focused on the infrastructure required to make the project viable, and in particular the leveraging of data/metadata conventions and technologies that have been developed in support of the Coupled Model Intercomparison Project (CMIP). It was noted that some of these capabilities do not require the dedication of substantial

resources (e.g., the ongoing support of the CF conventions) where as others do (e.g., the Earth System Grid Federation, ESGF). A concern expressed by the WDAC members is that the underlying data management capability appears somewhat fragile because it is unclear how well essential components are supported or can be expected to be sustained. These concerns are not unique to obs4MIPs but in fact reflect some of the challenges experienced in the much larger task of managing CMIP. A new capability that the WDAC was encouraged by is the Earth System CoG, a multi-institutional effort that has created software infrastructure to support the efficient governance and operation of community projects. The latest information regarding obs4MIPs, including access to all available obs4MIPs data (via the ESGF) is available at:

https://www.earthsystemcog.org/projects/obs4mips

The week before WDAC3 approximately sixty data experts, modelers and agency program mangers attended an obs4MIPs-CMIP6 planning meeting at NASA HQ. The meeting was dedicated to ensuring that relevant satellite data sets currently (or potentially) available can be fully utilized for CMIP6 research was to evaluate the mismatch between CMIP model output and satellite-based products, and to recommend changes and additions to output and datasets to achieve more effective alignment. A series of presentations were giving at the meeting, striving to set the stage for discussion with both modeling and observational perspectives involving atmospheric composition and radiation, terrestrial water and energy, the ocean and cryosphere, and the carbon cycle. The meeting was organized around extended discussion sessions that stimulated a variety of ideas on how obs4MIPs should advance. One example was a reoccurring plea to see inclusion of higher (temporal) frequency data products that could help advance more process level model evaluation. This led to a proposal for a “golden era” of more extensive high frequency sampling of model output sampling for a recent decade that corresponds to a period of extensive measurements. To date, NASA has provided most obs4MIPs datasets, but at the meeting several agencies (ESA, EUMETSAT, JAXA and NOAA) expressed their intent to contribute datasets to obs4MIPs. A meeting report is under preparation and will be made publically available via the obs4MIPs website. This report will be used to help inform the newly formed WDAC task team.

*The discussion emphasized the challenge of comparing different observational data sets, which requires a specific approach different from typical model intercomparison efforts. One approach to gate keeping somewhat the publication on obs4MIPs is to assign maturity indices to data sets. The panel congratulated the obs4MIPs Task Team for their contribution. Some suggestion was made to revisit the name of obs4MIPs to highlight its infrastructure role but the initial branding has already been widely recognized.*

### b. ana4MIPs

Michael Bosilovich provided an update on ana4MIPs. Following the obs4MIPS project, bringing satellite observations to the CMIP community, ana4MIPS

was originally initiated with a similar goal. These exercises are putting reanalysis and observations in the common format of CMIP, facilitating comparison and evaluation. Along the way, it has been recognized that while reanalyses can provide similar variables as the CMIP models, all variables are not necessarily useful in evaluating the present day CMIP simulations, for example, precipitation, clouds and radiation. As such, the reanalyses can also benefit from the common format and evaluations of the reanalysis parameters.

During Apr 29- May 1, the obs4MIPS project held an international workshop to discuss the future of the project (see above). Several important questions were raised about reanalyses. There was a suggestion that the reanalyses provide a quality index or rating, similar to that presented by Kalnay et al. for the first NCEP reanalysis, updated for the current reanalyses. Such a grading system, if derived should be done with input of each reanalysis center based on their understanding of the system. Though, some consistency or uniformity of definitions among centers in this criterion would provide a standard for users doing assessment and comparison.

Reanalysis assessment and intercomparison projects are currently ongoing (e.g. S-RIP). In parallel, the European project CORE-CLIMAX is drafting a procedure for intercomparison. Ana4MIPS is providing common formatted data for reanalyses intercomparions, but not conducting the assessment itself. So while there are many possibilities for reanalysis assessment, a remaining question is: should there be some more formal organization of reanalysis intercomparison? A community effort including the reanalysis developers and science community could be a significant undertaking.

*The discussion highlighted the rather easier process to publish reanalyses on ESGF as compared to observational data sets, because of the intrinsic gridded nature of these model products. It was recommended to gradually invite all reanalysis to publish their products on ana4MIPs to make them discoverable, and to flag those suitable for model intercomparison efforts. The question about the international governance of such effort was also raised.*

### c. S-RIP

Kaoru Sato presented S-RIP which stands for SPARC Reanalysis Intercomparison Project. Middle atmosphere/climate community has used reanalysis (RA) and analysis data sets to understand the atmospheric processes and variability, to analyze trends and to validate chemistry-climate models. Currently about nine global reanalysis data sets are available. Different results of diagnostics can be expected from different data sets because they were made by using different models in which different observational data were assimilated with different schemes. Thus, it is needed to examine diagnostics to evaluate respective RAs. The goals of S-RIP are to create a communication platform between SPARC community and the reanalysis centers, to understand the current reanalysis products and contribute to future reanalysis improvements. An important activity is

publication of S-RIP report organized with basic chapters and advanced chapters. A rough schedule of this activity and facilities of the S-RIP were also introduced.

*It was noted that S-RIP data would be collected at BADC. The Council welcomed further details on progress and formats and strongly recommended this effort to liaise very closely with ana4MIPs to avoid parallel developments.*

### d. CORE-CLIMAX

Paul Poli presented the Coordinating Earth Observation Data Validation for RE-analysis for Climate Services (CORE-CLIMAX) effort, which is a coordination activity funded by the European Union FP7 framework and coordinated by ITC at the University of Twente in The Netherlands and involving nine partners. Not a research and development activity, it offers opportunity to conduct coordination work, which is otherwise too often left to best intentions. The results of the project already suggest that such coordination activities are very valuable and could be followed upon and repeated in the future, especially if we want to meet the challenges ahead of us in connecting better with a user community which is growing in size and diversity.

The following is a non-exhaustive list of CORE-CLIMAX outcomes since the WDAC-2 meeting. The CORE-CLIMAX project has conducted under the responsibility of the Finnish Meteorological Institute (FMI) a survey of reanalysis users and applications. The response to the survey was significant, attracting about 2600 respondents from 94 countries, though most users were ECMWF reanalysis product users. A brief analysis of a few of the questions was shown during the meeting, and choice was made to concentrate on one point in the discussion. Less than half the users admitted to mild or serious problems in coping with the large data sizes of reanalysis products. Yet, also more than half the users asked for increased spatio-temporal resolution in reanalysis products. In parallel, if we corroborate these two responses with the extrapolation from past trends that storage capacity does not double as fast as computing capacity, then we realize that the problem of storing reanalysis data for users will only become more acute; consequently, the answer from reanalysis products to these users cannot be to provide them with higher resolution datasets of ever-increasing sizes which must be downloaded before users can work with the data. One solution could rather be pursue exploring cloud or remote computing solutions so users can apply, where the data are stored, their own (sometimes complex) algorithms but also simple operations (e.g., sub-setting, extracting time-series, plotting).

Another project outcome is, under ECMWF responsibility, an analysis of a series of consultations of stakeholders involved in the process of realization of Climate Data Records (CDRs) and which use reanalysis as ancillary data. For this process to be improved: reanalysis datasets should all be tagged with Digital Object Identifiers (DOIs) to improve traceability, standard data format converters should be made available by the community to avoid duplication of

efforts in converting data at each user institution, data access needs to be improved (especially for large users – echoing the comment above about cloud or remote computing), and all reanalysis centers should make efforts to come up with metrics to characterize the uncertainties (something that ECMWF has started to tackle with an ensemble approach – see brief on "data assimilation, uncertainties" in this report).

Capacity building activities are also being conducted by CORE-CLIMAX, with the next training to be given at the EMS 2014 in Prague. Lastly, the project aims to organize coordination meetings on dedicated topics including reanalysis feedback and comparison, to be reported at the next WDAC meeting.

*It was suggested to organize a dedicated session on reanalysis at the WDAC4 session next year.*

### e. ECV inventory

Christina Lief noted that the Essential Climate Variables (ECV) Inventory project was initiated in January 2011 at a workshop on the "Continuity and Architecture Requirements for Climate Monitoring – First Workshop on Space-based Architecture for Climate." The workshop produced a strategy document that focuses on satellite observations for climate monitoring from space, and the need for an international architecture that ensures delivery of these observations over the timeframes required for analysis of the Earth's climate system. This project has been endorsed by the CEOS Working Group on Climate, the Global Climate Observing System (GCOS) and the WMO Space Program to evaluate the current data capability through a systematic and granular assessment of the production of the Thematic Climate Data Records at the level of the individual agencies using questionnaires. The CEOS Systems Engineering Office (SEO) at the NASA Langley Research Center in Hampton, VA helped develop an on-line questionnaire to gather information on these data sets. Data information from Data Centers is being captured in a spreadsheet and is available online at http://ecv-inventory.com. In 2013, a joint effort between the National Climatic Data Center (NCDC), the Cooperative Institute for Climate and Satellites – North Carolina (CICS-NC) and the Global Observing Systems Information Center (GOSIC) adapted the questionnaire for *in situ* data. An on-line beta version has been completed by the CEOS SEO and is going through final quality control. Once this phase is completed, the *in situ* questionnaire will be made available for evaluation and comments to the International Panels. The *in situ* part of the project is waiting for approval by the GCOS Steering Committee (SC).

*The Council recalled that this effort has been endorsed by both CEOS and CGMS and also recommended linking the obs4MIPs and GOSIC efforts. The GCOS Space Rapporteur noted that the synchronization between in-situ and satellite inventories will be discussed at the upcoming GCOS Steering Committee.*

### f. GEO

Toshio Koike stated that the Group of Earth Observations (GEO) is a voluntary partnership of governments and international organizations and developing the Global Earth Observation System of Systems (GEOSS), which is an integrating public infrastructure, interconnecting a diverse, growing array of Earth observing instruments and information systems. Under its 10-year implementation plan, the GEO is now;

- bringing together data architecture experts, scientists, users, and capacity-building specialists;
- visibility as data/networks/systems contributing to society;
- developing capacity to collect and use Earth observations, and promoting regional coordination in collaboration with Member countries;
- facilitating the delivery of global datasets to improve modeling, e.g. virtual constellations
- engaging with users and decision-makers; and
- supporting research and development of integrated applications of Earth observations;
- but GEO is not a funding mechanism.

The GEO set up the Climate and Water strategic targets, which are closely related with the WCRP activities.

*The Council noted that many portals already exist and recommended to register the ESGF and obs4MIPs as resources within the GEO Common Infrastructure to avoid duplication. It would be up to GEO to implement a brokering of obs4MIPs data if this is of interest to the wider community.*

### g. Discussion

The Council noted the need to address both access to reanalysis data and science underpinning this effort. The discussion emphasized the need for a reanalysis intercomparison effort under the WDAC umbrella and maybe the establishment of a dedicated group to coordinate this effort and other activities such as reanalysis workshops and conferences.

## 5. Quality assessment and best practices

### a. Data set assessments, best practices

Jörg Schulz presented major parts of the attached document on best practices for data set assessments. Prior to the WDAC-3 meeting the draft paper was run through GEWEX with further distribution to some other individual researchers. The review of the draft pointed to some missing aspects such as the link with the obs4mips activities, ways of prioritization of assessment activities that needs to consider the needs of various user communities should be added to the draft. Also ways of a more systematic dissemination of assessment results to increase the impact on the scientific

community beyond the assessment group, the product developers and some users were encouraged. Because major data set quality assessments take their time and cannot be repeated every year a point on how to update the assessment results was raised with the proposal to employ several existing interactive tools.

In addition to the agreement of updating the document Jörg Schulz proposed to add an *Introduction and Purpose* section in the beginning to clearly state the origin of the task and who is the audience and purpose of the paper. Additions regarding obs4mips including the use of the CoG (Community of Governance) shall be worked into the draft with help from other WDAC members.

*The Council welcomed the progress on the data set assessment and recommended adding a specific section on obs4MIPs and the CoG because of the possible role these tools can play in facilitating the dialogue on these issues.*

### b. Open access publication guidelines

Kaoru Sato presented the activity of SI2N initiative regarding the open access publication guideline within WCRP. SI2N, a common activity supported by SPARC, IOC (International Ozone Commission), IGACO-O3/UV (GAW) and NDACC (Network for Detection of Atmospheric Composition Change) dealing with vertical ozone profile changes relevant in the context of the documentation of effect of the Montreal Protocol. Assessment results will be published in the reviewed literature as a special issue entitled “Changes in the vertical distribution of ozone – the SI2N report” which are jointly organized between open access journals of “Atmospheric Chemistry and Physics (ACP)”, “Atmospheric Measurement Techniques (AMT)” and “Earth System Science Data (ESSD)”. The publication has two steps: individual papers and overview papers. Open access journal publication has various merits such as transparency, accessibility, traceability, and full credit of scientists. Thus, open access journals should have a central role in publication for future reports. However, the traditional mechanism such as WMO-UNEP report will probably remain important for more technical and less publishable reports including parts that are important for agencies and material difficult to publish in the open literature.

*Following the SPARC example, the Council strongly supports the use of open access publications and DOIs within WCRP, so that data sets can be easily cited and the efforts of data producers can be more widely recognized. The Council noted that the community can be invited but cannot be forced to use these new tools.*

## 6. WDAC Business

### a. Memberships

Otis Brown explained the intention of the Council to maintain some continuity on the WDAC membership given that the Council was established less than 3 years ago. The Council thanked Kaoru Sato for her active participation on WDAC.

### b. Next WDAC Meeting

It is proposed to host the next meeting at North Carolina State University CICS, at NCDC around April-May 2015, bearing in mind the workshop on "Input observation for reanalyses" planned around the same time frame.

### c. AOB

The Council discussed potential roles that the WDAC might play in highlighting resource challenges with the TAO array, ARGO float observing networks and TPOS2020 recommendations, as well as changes in operational methologies. It was recommended to consult with OOPC Co-Chairs to that effect.

### d. Review of Draft actions list

Meeting actions were reviewed and are summarized in Appendix 1. Otis Brown thanked all attendees for their active participation and the local host Brian Ward for his great hospitality. The meeting ended at 15:00.

## APPENDIX 1 - WDAC3 ACTION LIST

### FLUXES

1. Development of ToR and membership of a Flux Task Team to address
   - flux – ECV cross walk
   - gaps in observing systems
   - web page
   - tracking of activities in the community

(Clayson - lead, Mathieu, Ward, Joerg, Gleckler)

### WEB

2. Add link to WG Climate (www.ceos.org) on WDAC page (Rixen)
3. Update ToRs to reflect WG Climate (Rixen)

### GEO

4. Register ESGF/COG as GEO resource (Rixen, Gleckler)

### REANALYSIS

5. Check hosting Reanalysis.org web page - 500 USD$/year (Rixen, Bosilovich, Compo)

6. Circulate to WDAC when ready the CORE-CLIMAX report 'procedure for inter-comparison of reanalyses and comparison with observational data records' (Thépaut/Poli)

7. Draft white/concept paper on a 'RIP', S-RIP+CORE-CLIMAX effort as a potential basis (Bosilovich, mid-summer)

8. WDAC4 to consider a focused reanalysis session (co-chairs)

9. Check BADC format of S-RIP (Sato, Gleckler, now)

10. S-RIP to liaise with ana4mips and forward WDAC3 relevant obs4MIPs and ana4MIPS briefs (Sato/SPARC, Gleckler, Bosilovich)

11. Forward any support requirement for "Input obs for reanalysis workshop (2015)" to WCRP (Thépaut)

12. Start planning 5$^{th}$ International Reanalysis Conference (Bosilovich, Thépaut/ Poli, Rixen)

**ASSESSMENTS**

13. Best practice report
    a) include obs4mips section (Gleckler, Schulz)
    b) review (WDAC)
    c) circulate to core projects and GCOS panels for final approval (Rixen)

**OPEN ACCESS AND DOI**

14. Open access and DOI (Rixen to draft text for WDAC report to JSC35)

**AOB**

15. Contact OOPC regarding rationale and need to highlight resource needs for TAO array, ARGO and TPOS2020 recommendations (Rixen, Husband)

## APPENDIX 2 – LIST OF CONTACTS

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