WCRP REPORT

World Climate Research Programme

**A WCRP Core Project on Global Energy and Water Exchanges**

Report of the

# Twenty-Sixth Session of the GEWEX Scientific Steering Group

SSG-26: Boulder, Colorado, USA 28-31 October 2013

October 2013

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# Table of Contents

# 1. RECOMMENDATIONS AND ACTION ITEMS

From the 26th Session of the GEWEX Scientific Steering Group (SSG)
28-31 October 2013, Boulder, Colorado, USA

## 1.1 General Overview

**R.1 African Climate Conference (ACC) Executive Committee**

SSG recommends that the outcome of the ACC be a means for advancing work in the region, specifically related to the development of a hydroclimate study of the Lake Victoria Basin (HyVic) to evolve in the framework of a GEWEX Regional Hydroclimate Project (RHP). In this context, the African Climate Panel (ACP), following its disbanding at the end of the ACC, should be reconstituted with more focused land and monsoonal aspects, in the context of the new Monsoon Panel, that can promote effective cross-cutting scientific and technical initiatives between both GEWEX and CLIVAR.

*Action Item GHP D4*: The SSG has asked Dr. R. Anyah to draft a set of Terms of Reference (TORs) for this new Panel with nominations for members. Drs. van Oevelen, Detemmerman, and Semazzi to assist in following up on this recommendation.

**R.2 Latin American and Caribbean Conference (LAC) (ALL, IGPO)**

It is recommended that the SSG nominate a GEWEX representative to attend the Latin American and Caribbean (LAC) Conference with the possibility of interacting on the development of regional studies that might evolve in South America that could eventually meet the criteria for status as GEWEX Regional Hydroclimate Projects (RHP). Subsequently, IGPO submitted an abstract on behalf of GEWEX/GHP that will be presented at the Conference.

**R.3 Science Conference Promotion (ALL, IGPO)**

There will be opportunities for cross Panel interactions over the next year, especially through the GEWEX Science Conference and the following joint pan-GEWEX and pan-CLIVAR meetings. The SSG recommends that the GEWEX Panel Chair(s) promote not only the conference sessions they are leading or which are relevant to their areas of expertise, but also the entire conference, and that they should circulate the call for abstracts throughout their community. The state of the conference planning will likely form the main basis for the next JSC report. [Action: At several appropriate times (every 2 months or so), IGPO to send out reminders to all conveners to send out emails and promote their sessions.]

## 1.2 Recommendation to the Panels

**R.4 Science Conference Session Management and Follow-up (All Panels)**

The SSG recommends that all Panels manage their contributions to the Science Conference carefully. In this context, the significant number of potential areas of contribution to the GCs and

GSQs that can be developed through the Science Conference, was noted for all the Panels, however, the fact that much will remain to be done to develop these as defined projects with specified implementation steps with identified leadership, was also noted.

**R.5 CMIP-6 Participation (All Panels)**

Drs. Blyth and Seneviratne recommended that the SSG ask the GEWEX Panel chairs to participate in the process of development of metrics for CMIP-6. (Action: IGPO to raise this with panel chairs when opportunity related to CMIP-6 arises.)

**R.6 Young Career Scientist Development (IGPO, All Panels)**

The SSG recommends that, in the future, all Panels report on their efforts related to career development of young scientists (IGPO to update Panel Report Template to include these changes).

**R.7 GASS**

The SSG recommends that GASS investigate the willingness of Prof. Huang-Hsiung Hsu at Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan, to help organize a potential new monsoon project.

**R.8 GLASS**

With respect to the Science Conference Session dedicated to "New Observations for Water Cycle Research and their utility in Land Surface Model development especially covering satellite missions (SWAT, SMOS, SMAP, others)," the SSG recommends that GLASS identify an appropriate representative to become involved in WDAC to address matters related to provision/maintenance of surface fluxes data base(s), and that additionally they invite other projects dealing with global water resources such as EU FP7 Earth2Observe, etc.

**R.9 Cross-Panel Initiative (GLASS/GDAP/GHP)**

**(R.9a)** The SSG recommends a stronger interaction between GLASS and GDAP for ET products and also that a targeted working group be constituted, which combines GLASS, GDAP and other relevant groups and scientists, who can address the entire water and energy budget, beyond the land fluxes, to isolate issues responsible for discrepancies between existing satellite and ground-based products for variables of the surface energy and water balances over land and oceans (precipitation, radiation fluxes, turbulent fluxes).
**(R.9b)** The SSG recommends that GLASS work with GHP to identify new observational needs to be explored with ESA, WMAC and others such as JPL with regard to improving/implementing representation of reservoirs, sub-surface hydrology and groundwater in LSMs.

**R.10 Next Meeting**

It was recommended that the SSG study the invitation by SSG Member Dr. Chia Chou to host the next meeting in Taiwan. If it is not possible under WMO guidelines to meet in Taiwan, the SSG may wish to consider the invitation of Dr. R. Garreaud, to hold the next (27$^{th}$) GEWEX SSG meeting in Chile the week of 26 January 2015. (Action: Valery Detemmerman and IGPO, by mid-2014)

## 1.3 Action Items

**A. General**

A.1 Update the Plan/Timeline of 7th International GEWEX Conference, and present this to the SSG for final approval. (Action: IGPO, by 15 December 2013)

A.2 Draft an open announcement for nominations for 2 new SSG members whose terms end at the end of 2014. Send to SSG for comment and update as required, post and track replies. In this context it was noted that the ECMWF representative, Peter Bauer, wishes to step down and it is desirable to retain a person from ECMWF as a replacement. (Action: IGPO by mid-2014)

A.3 The Panel Rapporteur reports are due one week after the SSG Meeting. They should be sent to the IGPO with a copy to the SSG chair. These reports will be distributed to the Panel co-chairs and SSG members for comments (due the week after they are received). IGPO and the SSG will incorporate the comments and return them to the rapporteurs. The rapporteurs then will have a week to incorporate the SSG comments and send the final reports to IGPO to post on the website. (Action: GDAP: Peter Bauer, Graeme Stephens, Remko Uijlenhoet; GASS: Minghua Zhang, Chia Chou; GLASS: Paolo Ruti, Eleanor Blyth (iLEAPS), Sonia I. Seneviratne; GHP: Howard Wheater, Richard Anyah, Rene Garreaud; Extremes: Ron Stewart, Olga Zolina). Subsequently, this action was completed as requested.

A.4 Respond to the WCRP 34th Session Joint Scientific Committee action items in accordance with the list and deadlines noted in the JSC report. Specifically, actions 21, 22, 26, 32, 37, 43, and 48 apply to GEWEX. (Action: IGPO to coordinate with Panels and SSG Members as required.)

A.5 Complete all aspects of the SSG Member nomination forms and submit all candidates to the JSC at least 8 weeks (5 May 2014) in advance of JSC-35 Session (30 June-4 July 2014). (Action: IGPO)

A.6 Determine the need for GEWEX action, by way of a letter or other formal contact with agencies such as JAXA, acknowledging the need to continue to place their highest priority on science quality missions versus missions of commercial significance. (Action: G. Stephens to contact agency representatives)

A.7 **SPARC** is planning a workshop on the Grand Challenge on Clouds, Circulation & Climate Sensitivity in 2014 that GEWEX may jointly organize. (Action: IGPO to contact T. Shepherd and A. Sobel to discuss plans for this workshop in 2014 details to be ready by mid-2014 for a meeting in the second half of 2014)

A.8 GEWEX should connect with **CliC** to discuss mutually beneficial initiatives. (Action: G. Stephens to contact CliC Representatives). Subsequently this action was completed and a plan of action will be finalized by the time of the next GEWEX SSG meeting in January 2015.

A.9 GEWEX must consider activation of an isotope study as a necessary element of its contribution to the WCRP GCs and GSQs. (Action: G. Stephens and S. Seneviratne to Contact D. Noone and report, by mid-2014, if activating a GEWEX Isotope initiative is appropriate at this time.)

A.10 Compile a list of potential candidates to contribute to the water availability/storage activities related to the Water Availability GC to expand involvement from the broader community in work

being initiated in this area by GEWEX. Consider a cross-panel meeting or Workshop. (Action: IGPO, S. Seneviratne)

A.11 GEWEX must refine the draft plan for its Pan-GEWEX meeting (July 2014) and send it to the GEWEX SSG for review/comment by the end of December. Following review, the plan should be finalized and coordinated with CLIVAR for maximum mutual interaction at the Pan-GEWEX/Pan-CLIVAR meetings. (Action: IGPO, by mid-January 2014)

A.12 GEWEX should identify a representative to participate on behalf of GEWEX at the WWRP Open Science Conference Planned for August 2014. The representative should report to the SSG with regard to commonalities between the GEWEX and aspects of WWRP including monsoon studies, model development/application, etc. (Action: IGPO with R. Rosen)

**B. GASS**

B.1 Determine the need for GEWEX action with regard to a letter or other formal contact in support of in-situ supersites such as Cabauw, which may be in threat of shut down or limited operations. (Action: R. Uijlenhoet)

B.2 In the face of a perceived gap in the WCRP structure in the domain of research on atmospheric dynamics as expressed by the JSC (JSC-34 Action item 43) GEWEX should evaluate its work in this field. (Action: G. Stephens to assess the relevance of GASS initiatives in this context and develop a strategy for advancing GEWEX work in this field that recognizes relevant elements of a whitepaper being prepared by CLIVAR on this topic. Assessment and response to CLIVAR ready by mid-2014)

B.3 GASS leadership can play an important role in promoting not only the GEWEX 7$^{th}$ Science Conference sessions they are leading but also the entire conference, and is strongly encouraged to circulate the call for abstracts throughout their community.

B.4 GASS must begin to consider ways to archive its project data for long-term use. In this context, GASS leadership should contact the DOE Atmospheric Radiation Program (ARM) to make a request of asking ARM to house a reasonable volume of data. The SSG will provide a support letter if needed.

B.5 The GASS SSC should organize the GASS projects to more directly address the GEWEX Grand Science Questions (GSQs) and the WCRP Grand Challenges (GCs) and to facilitate as many collaborative activities as possible with other programs, as a way to improve their science return, publicity, funding, and societal significance. The Rapporteur reports provide more information.

**C. GLASS**

C.1 Expand other GEWEX Panels in ALMIP and GSWP-3. In the case of GSWP3, there should be contact with Trendy (S. Sitch, P. Friedlingstein), LUCID (N. de Noblet, A. Pitman), and LUMIP (G. Hurtt, D. Lawrence) groups for interactions on the topics of carbon-water relationships and the prescribing of land use changes. (Action: A. Boone to contact GHP co-chairs and reps of relevant external activities.)

C.2 A 2-D benchmark should be envisaged for future PALS activities and there should be a focus in improving the model representation of the surface fluxes. In addition, there should be stronger

interactions between PALS and Obs4MIP, so that the PALS framework can be used in the evaluation of the CMIP6 simulations. (Action: A. Boone, M. Ek)

C.3 In the case of support to CMIP-6, GLASS should ensure that coordination is established between the LUCID and LUMIP communities (Action: A. Boone)

C4. Connect with the Cloud-Dynamics CLIVAR effort and to organize a workshop concerning low-frequency atmospheric dynamics and link with land-surface processes (up-scaling topic) for detecting and attributing extreme events and connect with CLIVAR in the area of drought modeling (Action: A. Boone)

**D. GHP**

D.1 Expand framework for High-elevation Hydrology Cross-cut (CC). (Action: J. Evans, J. Polcher contact J. Renwick on precipitation issues and J. Pomeroy on hydrology related facets to entrain both aspects in the GHP CC, and ensure that they are coupled).

D.2 The table presenting GEWEX Questions, RHP and cross-cutting themes was noted to be a very commendable means representing the overall contributions to the GCs and GSQs. It was suggested that the table could be modified to replace the static "yes" or "no" by a dynamical percentage of advances in addressing the questions.

D.3 GHP is the primary location for hydrological modeling in WCRP and should recognize the need to foster and champion this area of activity, which was mentioned to only a limited degree in the GHP presentation. This is also a major deficiency in WMAC that GHP should seek to rectify.

D.4 *(From R1)* The SSG has asked Dr. R. Anyah to draft a set of Terms of Reference (TORs) for this new Panel with nominations for members. Drs, van Oevelen, Detemmerman, and Semazzi will assist in following up on this recommendation.

**E. GDAP**

E.1 Devise a strategy to ensure continuity of support/resources to maintain necessary in-situ Observational networks (e.g. soil moisture, flux data, solid precipitation, etc.), which are in threat of being diminished or shut down do to other priorities. (Action: G. Stephens, S. Seneviratne to contact a person to assist with the proper approach to this action, e.g., J. McClusky, H. Diamond, or other.)

E.2 Deliver whitepaper on Assessments. (Action: Joerg Schultz, by mid-2014)

E.3 Investigate parameter covariance statistics in order to evaluate flux and budget statistics as close as possible to the native processes, as an extremely valuable near-term objective. (Action: GDAP Chair, report progress by mid-2014)

E.4 More attention should be given land surface aspects, as discussed earlier, including best practice guidance for implementation of new networks, definition of standards in methods, metrics, and benchmark data for validation, provision of information scaling and representativeness issues, and aiming for an enhanced consistency with other products (indirect validation).

**F. Grand Challenge on Extremes**

F.1 Panels/SSG to provide inventory of Extremes Activities underway or known of that may fit the GEWEX contribution to the Extremes CG. (Action: IGPO to assist with this and include the CLIVAR IPO to ask them to participate – 15 November Deadline for response to request for inventory, by all).

F.2 Drs. Stewart and Zolina will synthesize the SSG Extremes Session(s) discussion points and provide the outcome(s) to the SSG and Dr Zheng through a letter/message supportive of his efforts to move this CG ahead and specifying the direction the SSG is taking. (Action: Stewart, Zolina; Deadline: 1 December)

F.3 Final draft of Whitepaper ready by 15 December to be distributed for comment to Panels and SSG. Revise by 31 December 2013. (Action: Zheng, Hegerl, with SSG POCs of Stewart, Uijlenhoet, and Seneviratne)

F.4 Add the WP and related background material to the GEWEX web page and distribute final version of WP to broader community by 15 January 2014. (Action: IGPO)

F.5 Further GSQ3/WP implementation progress should be made before and during the GEWEX 7$^{th}$ Science Conference and related Pan-GEWEX, -CLIVAR meetings ending in a viable implementation strategy/plan. (Action: Zheng, Hegerl, with SSG POCs of Stewart, Uijlenhoet, and Seneviratne, and inputs from the broader science community).

**G. Monsoons and CLIVAR Collaboration**

G.1 The Terms of Reference for the Monsoon Panel need to be reviewed, with further comment from the GEWEX SSG. (Action: D. Gochis to provide IGPO with a copy of the Monsoon Panel TORs.)

G.2 GEWEX must follow-up on actions related to the further development of the Monsoon Panel by (i) commenting on the draft TORs/Whitepaper; (ii) provide suggested focus areas and potential Leads to increase the role of land in the Monsoon Panel initiatives and (iii) set up a meeting on the matter of Monsoon initiatives joint with CLIVAR at the 7$^{th}$ GEWEX Science Conference and Pan GEWEX/Pan CLIVAR meetings (July 2014). (Action: IGPO send a message to GEWEX SSG/Panels to move this forward.)

# 2. INTRODUCTION AND OVERVIEW

This report summarizes the main developments in GEWEX during the year 2012 and includes the major items and recommendations from the 26th Session of the GEWEX Scientific Steering Group (SSG), which was hosted by Kevin Trenberth at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado on 28-31 October 2013. This session of the SSG addressed both responses to advice resulting from the latest WCRP Joint Scientific Committee (JSC) meeting and developments in WCRP and the global programs. Key activities included reviewing results from recent workshops on the GEWEX Science Questions (GSQs) and developing an implementation strategy for advancing these topics. A review was undertaken of the planning related to the International GEWEX Science Conference scheduled for July 2014 in the Netherlands and the follow-on Pan-GEWEX Meeting, which will launch the next phase of GEWEX. The SSG meeting was held at NCAR, in the Damon Room at the Mesa Lab, located at 1850 Table Mesa Drive, Boulder, Colorado.

## 2.1 Major Activities and Achievements in 2013

The SSG meeting marked the advancement of changes to the structure and scientific priorities of GEWEX. These changes have been taking place incrementally under the guidance of the JSC and were motivated by a recent series of consultations with WCRP sponsors, stakeholders and affiliate network of scientists. The result has been the documenting of the WCRP Grand Science Challenges (http://www.wcrp-climate.org/index.php/grand-challenges), which identify high priority and relevant research and prompted GEWEX to define a complementary set Grand Science Questions (http://gewex.org/pdfs/GEWEX_Science_Questions_final.pdf). The changes have also been framed in the context of the GEWEX Imperatives: http://gewex.org/pdfs/GEWEX_IMPERATIVES_final.pdf.

A major effort by IGPO in 2012 was its central role in the overall coordination and planning of a workshop on GEWEX Science Question (GSQ) 1 (precipitation), which was held in Fort Collins in late June 2013 and a Workshop GSQ 2 (water resources), which was held in Saskatoon in early June 2013. The format of both meetings was 4 half-day sessions with one or two presentations and a discussion with a moderator and rapporteur and a final summary session. Full reports from both workshops have been prepared and published online:

- Report from the Workshop on GEWEX Science Question-1 (GSQ-1): Developing a Water Strategy for the World Climate Research Programme (held 27-28 June 2013, CIRA, Fort Collins, Colorado)
- Report from the Workshop on Water Strategy for the World Climate Research Programme (WCRP) (held 5-7 June 2013, Saskatoon, Canada)

Among the IGPO activities related to these meetings were drafting the workshop proposals, developing and maintaining the workshop materials through the GEWEX Web Page, preparing the invitation and proposed list of attendees, distributing the invitation and tracking responses. IGPO assisted in finalizing and distributing the agendas, as well as participating in the GSQ2 workshop and ensuring that the meeting reports were drafted and distributed for comment, finalized and posted on line. IGPO has, also advanced plans for the 7th International GEWEX Science Conference (http://gewex.org/2014conf/home.html) that will take place 14-17 July 2014 at the World Forum in The Hague, The Netherlands. A Pan-GEWEX meeting is being organized in conjunction with the

Conference. More details on the exact form and content of the Conference were advanced through the efforts of IGPO in conjunction with WCRP and Dr. Bert Holtslag of Wageningen University, who is the local host/organizer. The basic format of the conference will be similar to that of the WCRP Open Science Conference with a plenary in the morning and parallel sessions and posters in afternoon. The conference theme will be focused on the WCRP Grand Challenges on water resources, extremes, and climate sensitivity, which include the GEWEX Science Questions.

Major activities related to the GEWEX Panels are given below.

Under the **GEWEX Data and Assessments Panel (GDAP)**, GDAP and GHP met jointly during the time of the annual business meetings for each Panel. The joint part of the meeting(s) was held to (a) develop strategies to jointly address some of the overarching GEWEX Science Questions in support of the WCRP goals, and (b) to find workable synergies between the two panels that could move GEWEX forward. Discussions generally focused on tackling some of the broad issues related to snow and orographic precipitation that is challenging for both panels but where combined approaches seem viable. Plans are now in place to work on these new challenges in the coming year.

With independent products now available for the radiative energy, turbulent fluxes and condensation heating, GDAP is also focused on creating an "integrated" product. This integrated product uses a common grid, ancillary data, procedures and assumptions in order to ensure that relationships among water and energy variables are due to the data and products themselves rather than inconsistencies in the assumptions. The separate GDAP meeting reviewed the readiness of GEWEX reference products, and set firm deadlines for individual activities resulting in a release of the Integrated Product by June 30, 2014. This release date is intended to precede the GEWEX Science Conference in The Hague on 14-17 July, 2014 so the product can be properly advertised and initial results can be discussed.

The GDAP panel will then focus on an assessment of the state of the Water and Energy Budgets based upon these new Integrated GEWEX products. This assessment, which is intended to document the state of our observing system, is meant to be the first in a periodic reevaluation of the state of the Water and Energy Observing System. The assessment will consist of closure tests on the global scale; temporal variability in the fluxes and states; attribution of changes to observed forcings; and a maturity index of various components based upon ongoing assessments of individual components of the budget.

A summary of recent accomplishments includes:

- GDAP has finished and published assessment of Precipitation (GPCP), Clouds (ISCCP) and Radiation budgets (SRB) as WCRP reports. Clouds article is published in BAMS articles. The Radiation Assessment is still in review
- GDAP water vapor assessment (total column, vertical distribution) is well underway
- GDAP finalizing SeaFlux, LandFlux, and "Integrated Product"
- GDAP adding focus on water storage components. Wouter Dorigo & Felix Landerer have agreed to join Panel
- Very high level of individual GEWEX data usage by the community.

A list of near term goals consists of:

- GDAP's goal is to promote observations that will help close budget but not to force observations to achieve closure

- Variability, and more importantly, co-covariance of parameters at various time/space scales is key to understanding the water and energy budgets and therefore GDAP's chief priority. Processes need focus and GDAP should lead this effort
- Assessments are intended to verify the fidelity of variability and trends in the products to provide guidance both to GDAP, GEWEX, WCRP and the broader science community

As a way to address SSG concerns about the lack of attention to land surface features, GDAP has entrained an individual who is dealing directly with issues that must be dealt with from the validation perspective, including:

- Best Practice Guidance for implementation of new networks
- Define standards in methods, metrics, and benchmark data for validation
- Seek a long-term solution to keep the ISMN operational and expanding
- Information on scaling and representativeness issues
- Consistency with other products (indirect validation), such as precipitation

The **GEWEX Global Atmospheric System Studies (GASS) Panel** activities have continued to be primarily directed to the organization and coordination of projects to improve understanding of atmospheric processes and their modeling. The GASS Scientific Steering Committee (SSC) provides guidance and coordination, and, often, direct leadership to these projects. The Panel now has 14 activities underway five of which that have been undertaken recently including:

1. GABLS4: Stable Boundary Layer on the Antarctic Plateau*
2. Weak Temperature Gradient*
3. Grey-Zone study*
4. Land-Atmosphere Interactions (DICE)*
5. Cloud Radiation Errors and Surface Temperature Biases (CAUSES)*

The **GEWEX Global Atmospheric System Studies (GASS)** has been an active participant under the WGCM-led Clouds and Climate Sensitivity Grand Challenge project. GASS projects will be an active part of this Grand Challenge including an anticipated project to study the accuracy of the radiative forcings simulated by climate models. Other projects that will contribute to this Grand Challenge include the current project on Low-Cloud Feedbacks and the new project on the Weak Temperature Gradient. The cold air outbreak and Microphysics projects are also expected to play a role in the Clouds and Climate Sensitivity Grand Challenge.

With respect to the GEWEX-led Grand Challenge on Precipitation and the related GEWEX Science Questions, GASS has contributed indirectly through projects which are designed to improve the understanding and representation of physical processes in the atmosphere, such as precipitation, and have been shown to improve weather and climate prediction systems. Showing that GASS studies improve model simulations of these key processes provides more evidence that they are making a significant contribution to the advancement of knowledge associated with the GSQs. GASS is also developing strong interactions with GLASS through the Land-Atmosphere Interactions (DICE) project. GASS is also pursuing other opportunities for cross Panel interactions over the next year, especially through the GEWEX Science Conference and the following joint pan-GEWEX and pan-CLIVAR meetings.

The **GEWEX Global Land/Atmosphere System Study (GLASS) Panel** aims to improve the best estimates and the model representation of state variables (e.g., soil moisture) and fluxes (e.g., evaporation), or to improve our understanding of land/atmosphere feedbacks and the role of land surface in predictability. By restructuring into three themes associated with Benchmarking, Model

Data Fusion (MDF) and Land-Atmosphere Coupling (LAC) GLASS has made progress in achieving its goals.

The concept of model benchmarking (rather than validation) has begun to enable the modeling community to identify the current strengths and weaknesses of our models in relation to their required applications. This is a complete shift of focus for the modeling community and will require careful definitions of the a priori metrics that a model needs to achieve. The PLUMBER project launched this year directly addresses this theme with the goals of demonstrating this approach to benchmarking for the community.

The PILDAS project will directly address the MDF theme of GLASS, and should enable GLASS to make connections with GHP/GDAP with regards to the GSWP3 and ALMIP2 projects. The launch of PILDAS has been delayed to 2014. The experimental design is nearly complete, and a pilot study by the project lead to use 2 LSMs with 1 DA algorithm in NASA's LIS is to be carried out in late 2013/early 2014. Phase-1 is focused on operational centers (rather than niche research projects), synthetic observations, and different DA algorithms w/different LSMs for a 1/8 degree domain over the SGP. Later phases are expected to build off of actual satellite observations from SMOS and SMAP.

The LAC theme aims at understanding the physical interactions between the land and the atmosphere and how feedbacks can change the subsequent evolution. GLASS will help to facilitate two aspects of land/atmosphere coupling, the first being to understand the physical processes whilst the second will strive to understand how both land and atmospheric parameterizations interact. The focus is at both the process/local level (LoCo) and the global behavior of the coupling (GLACE). This understanding will help to maximize the inherent predictability of the coupled land/atmosphere system.

Adoption of new TORs and changes in membership have allowed the broader GEWEX community better access to and understanding of the Panel operations. GLASS currently has a good mix of established and new projects that map into the Panel's main themes (MDF, Benchmarking, LAC). GLASS has reached out to GHP on a number of projects, is launching projects with GABLS (e.g., DICE), and continues to engage WGNE on benchmarking and data assimilation activities.

The **GEWEX Hydroclimatology Panel (GHP)** activities are based on integrated research projects, observations, and scientific activities that aim to improve the knowledge about global climate change and its impacts on a regional scale. The leadership role of GHP in the hydrologic sciences and modeling activities within WCRP has been established as well has the progress of the GEWEX Regional Hydroclimate Projects (RHPs) in seasonal forecasting, the detection and attribution of change, and the development and analysis of climate projections. In this way, GHP has continued to organize its activities to keep with the recent strategic planning process in WCRP and GEWEX, to support development and implementation of the WCRP Grand Challenges (http://www.wcrp-climate.org/grandcha.shtml) specifically, the WCRP Grand Challenge related to changes in water availability, which is led by GEWEX.

Similarly, GHP has continued to develop its current activities and encourage new efforts that address the GEWEX Science Questions (GSQs) (http://www.gewex.org/pdfs/GEWEX_Science_Questions_final.pdf) in support of the WCRP

challenges. In this context, GHP has aligned all of its activities, to make progress on the matter of "Water availability" as addressed in the GSQs, especially associated with "Observations and Predictions of Precipitation" and "Global Water Resource Systems" (GSQs 1, 2), but also to a smaller extent with "Changes in Extremes" and "Water and energy cycles and processes" (GSQs 3, 4).

Application of the new criteria also allowed the Panel to validate the continuation of three studies and confirm their end dates for future planning purposes (NEESPI-2014/15, MAHASRI-2015, and HyMeX-2016). The completion of BALTEX was marked in June.

Five other regional studies evolving in the context of GEWEX Regional Hydroclimate Projects (RHPs) are under development and should be formally initiated as part of GHP within the next 3-5 years: (i) The Hydrology of the Lake Victoria Basin (HyVic) study, which is developing under the auspices of GHP, held a planning meeting in July 2013 and elected an International Planning Committee (IPC) which has a term of responsibility that will run from 2013-2016 or until HyVic is approved as an RHP; (ii) The North American Water Project (NAWP), planning is still evolving, a session at the 2013 AGU meeting will explore more aspects of a possible Water resources regional study in North America; (iii) The Third Pole Environment (TPE) initiative, has been discussed in international meetings but little progress has been made recently, GHP will, none-the-less continue to monitor activity related to TPE, especially its potential to evolve into an RHP; (iv) Baltic Earth is the name of the program which is to succeed BALTEX. A smooth transition from BALTEX to BALTIC-Earth is expected in 2014 and be active for 3-5 years; The OzEWEX Science and Implementation plan, is evolving toward a set of integrating themes that the GHP feels will meet the criteria of an Initiating RHP by the end of 2014.

All of the GHP Cross-Cutting projects (CCs) have been constrained to be projects carried out for 2-3 years but which can be renewed. The currently active CCs (see list below) were addressed in short proposals in 2012-2013, that followed a prescribed template with specifics related to the science objectives, the relationship to the RHPs and the GEWEX Science Questions, and their implementation process. This requires that they provide results or be renewed in the 2014-2016 time period. The **GHP Currently active Cross-Cut Projects list includes:**

- Drought (Ron Stewart)
- Sub-daily precipitation (Hayley Fowler), and
- LSM validation & Benchmarking (Mike Ek, GLASS)

## 2.2 GEWEX Planning for Post-2013

The comprehensive conclusion of the SSG is that the implementation of the WCRP Grand Challenges and science questions also depend heavily upon the GEWEX Imperatives: observations and data sets, their analyses, process studies, model development and exploitation, applications, technology transfer to operational results, and research capacity development and training of the next generation of scientists.

These discussions with regard to consideration of science initiatives that are responsive to the imperatives as well as the GCs and the GSQs, led to further direction to the Panels for more cross-Panel proposals in the future (post 2013). In this context, GHP and GDAP will work toward

improved application of the products they have produced including Energy/Water, TOA and Surface Fluxes, Land Fluxes, Sea Fluxes, Clouds and Aerosols. Specifically, GHP will look at water budgets with the gross runoff over the world's largest basins. The effort would look at twenty major basins, where runoff is available, to determine if the water budget is closed in the products. As a corollary, a check of potential evaporation (if/where it exists) would enable a conclusion to be made about whether or not evaporation is the reason the budget is not balanced. A proposal will be made to engage GDAP in an effort to examine a number of large river basins (up to 20) using observed runoff to determine the extent to which their water budgets can or cannot be closed. GHP, through its RHPs would contribute to this effort by providing data (including masks) relevant to the exercise, from their regions (SaskRB/CCRN, MAHASRI, HyMeX, BALTEX, etc.). The first results from the analysis of the basin study, should be available at the GEWEX Science Conference and pan GEWEX meeting (July 2014). GLASS will also be engaged in this effort

Similarly, other GEWEX science initiatives will begin in the next period that fit into the imperatives by having the GEWEX Panels cooperate on other high priority science issues. Therefore, an effort that could contribute to a better understanding of the hydrology over orographic terrain (i.e., high mountain precipitation) is being initiated as part of GEWEX plans for the next 3-5 year period.

## 2.3 Goals and Plans for Major Activities for 2014

In keeping with the requests from the JSC, GEWEX has also undertaken efforts to support/activate regional activities, in Latin America and the Caribbean as well as in Africa. Starting with stakeholder needs in the region, GEWEX, in coordination with the other Projects, will develop research initiatives that are in line with the new WCRP research priorities. In particular, GEWEX is in contact with Scientists in South America to expand the scope of plans for an existing regional study to meet criteria for a GEWEX RHP. GEWEX will contribute to the Latin American and Caribbean Conference in 2014. GEWEX will take advantage of the 7$^{th}$ GEWEX Scientific Conference (July 2014) to advance development of a number of new initiatives and will also coordinate with CLIVAR on a number of joint topics during the pan-GEWEX and pan-CLIVAR meetings to be held in conjunction with the Conference.

## 2.4 Interactions (Especially with WCRP Sponsors and Partners)

Planning for the 7th International Scientific Conference on the Global Water and Energy Cycle with the theme of Trending Now: Water, has provided the basis for interactions with a number of WCRP sponsors and partners. The scientific committee for the conference is a broadly international and interdisciplinary group of noted scientists representing more than eight different countries and a dozen affiliated Agencies, Institutes, and Centers that are interested in and supportive of WCRP and GEWEX. The Conference will celebrate 25 years of GEWEX research and set the stage for the next phase of research addressing the WCRP Grand Challenges on water resources, extremes, and climate sensitivity.

A number of sponsoring groups are interested in addressing the issues related to the demand for fresh water and the impacts of climate change on water availability and extreme events. These matters highlight why water, which is a current major global concern is "Trending Now."

NASA continues to strongly support the IGPO and the plans for the upcoming 7th International Scientific Conference on the Global Water and Energy Cycle.

Continued collaboration with the Group on Earth Observations (GEO) is provided through the Director of IGPO who has been activity in the Integrated Global Water Cycle Observations (IGWCO). In addition, GEWEX was invited to give a presentation at the GEOSS Joint Asia – Africa Water Cycle Symposium held in Tokyo, Japan, 25-27 November 2013. A brief talk was presented on the background for the current phase of GEWEX and the status and plans for regional hydroclimate studies, including one in Africa.

IGPO has made contact with the Future Earth team working on developing communications and outreach strategy. Through this interaction, GEWEX has been able to have the 7th International Scientific Conference on the Global Water and Energy Cycle registered on the ICSU website: http://www.icsu.org/events/2018trending-now-water2019-7th-international-scientific-conference-on-the-global-water-and-energy-cycle.

## 2.5 Outreach and Capacity-Building Activities

GEWEX is benefiting greatly from strong interactions with other WMO and WCRP initiatives. The Global Data Centers for precipitation, river runoff, and lakes/reservoirs (GRDC, GPCC and Hydrolare, respectively) are affiliated activities under GEWEX and are activities that are connected through a number of outside bodies to obtain meaningful data for application to research of interest to the broader climate research community.

GEWEX has agreed to encourage the development of an international, multi-agency, field program to study multi-scale aspects of intense, organized convective systems that produce severe weather in subtropical South America. The "Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations" (RELAMPAGO-working acronym) study has already met a number of criteria for becoming an RHP, but GHP involvement will require further expansion of its science priorities and will mean working with a number of international groups outside of WCRP including several with links to applications.

By participating in the Latin American and Caribbean Conference on Climate and Society GEWEX will be working to identify links to new regional groups that may require further support to broaden current activities into international studies that fit within the WCRP structure. The conference is being promoted by the WCRP Joint Scientific Committee (JSC) through the Variability of the American Monsoon Systems (VAMOS) Panel of CLIVAR.

The IGPO has been involved in the planning and has participated in scientific sessions at the European Geophysical Union as well as the American Geophysical Union and the Director of IGPO has been involved in defining sessions on the climate system, land and the atmosphere that are now part of the program for the 7th International Scientific Conference on the Global Water and Energy Cycle, which expects to draw over 400 international participants.

A GEWEX Summer Session for Early Career Scientists will take place the week before the 7th International Scientific Conference from 6-12 July 2014 at the Delft University of Technology, and will focus on the GEWEX Science Questions.

# 3. GEWEX PANEL STATUS REPORTS

## 3.1 GASS Global Atmospheric System Studies Report

**Reporting Period:** November 2012 – October 2013

**Starting date**: GCSS and GABLS combined at the end of 2010 to form GASS. It also took joint ownership of the CIRC activity along with GDAP.

**URL:** http://www.gewex.org/gass_panel.html

**Chair(s) and term dates**: Jon Petch (end March 2014) and Steve Klein (end March 2015)

**Panel Activities:** GASS facilitate and support the community who carry out and use observations, process studies and numerical model experiments with a focused goal of developing and improving the representation of the atmosphere in weather and climate models. It aims to address this primarily through the coordination of scientific projects which bring together experts from around the world who can contribute to the development of atmospheric models. GASS primarily oversees intercomparison projects based around observational field campaigns or more idealised studies which typically take from two to five year from initiation to completion with publication of the results.

The past meeting was very quiet, following the very time-consuming planning and execution of the 1st pan-GASS meeting that occurred in Boulder, Colorado in September 2012.

**Projects Status including new projects:** GASS has 13 current and planned projects; one project was completed in the past year. Newer projects of note include:

- a collaboration with GLASS on land-atmosphere interactions (DICE project)
- the examination of interactions of moist processes parameterizations with the large-scale circulation under the Weak-Temperature Gradient approximation. This effort will be joint with WGCM/EUCLIPSE
- a cold air outbreak intercomparison project which will examine how model parameterize convective processes when the model horizontal resolution only partially permits convective clouds to be simulated (2-10 km range) – the so called "grey-zone".
- The examination of the ability of models to simulate the very stable boundary layers seen over Antarctica
- The examination of cloud radiation errors and associated surface temperature biases occurring in model over the central United States in summertime.

For more detail on these and all of the GASS projects see the supplemental material to this report.

**Contributions to GEWEX Grand Science Questions and WCRP Grand Challenges:** GASS has been an active participant under the WGCM-led Clouds and Climate Sensitivity Grand Challenge project. GASS co-chairs have helped to write the white paper for the project and GASS SSC members Robert Pincus and Pier Siebesma are co-leaders of initiatives under this Grand Challenge. GASS projects will be an active part of this Grand Challenge including an anticipated project to study the accuracy of the radiative forcings simulated by climate models. Other projects that will contribute to this Grand Challenge include the current project on Low-Cloud Feedbacks and the new

project on the Weak Temperature Gradient. The cold air outbreak and Microphysics projects are also expected to play a role in this Grand Challenge.

While GASS has not been a strongly active participant on the GEWEX-led Grand Challenge on Precipitation and related GEWEX Grand Science Questions, we did contribute to the organisation of the Fort Collins workshop. Also, GASS projects are designed to improve the understanding and representation of physical processes in the atmosphere, such as precipitation, and have been shown to improve weather and climate prediction systems. We are confident that if models improve their simulations of the key processes that GASS studies then the specific phenomena listed in the Grand Science Questions will markedly improve.

**Meetings:** GASS held a very successful 1st Pan-GASS science conference 10-14 September 2012 in Boulder, CO. In the reporting period though, no pan-GASS meetings were held. Smaller project-level meetings did occur such as a meeting in Singapore for the MJO project, a meeting in Exeter for the stable boundary layer and land-atmosphere interactions projects, and discussion of the low-cloud feedbacks project at the CFMIP/EUCLIPSE meeting.

In the coming year, GASS participants will take part in the pan-GEWEX conference planned for July 2014 in the Hague. There may be small breakout meetings during the conference for individual projects of GASS and the WGCM Grand Challenge on Clouds, Circulation, and Climate Sensitivity. It is likely that the next pan-GASS meeting will occur in 2015.

**Co-operation with other WCRP projects**: GASS maintains various interactions with other bodies. These include: (a) The vertical structure and diabatic heating of the MJO project is conducted jointly between GASS and the WCRP-WWRP MJO task force, (b) GASS is supervised in part by WGNE and presents reports to the annual WGNE meetings, (c) the Low-Cloud Feedbacks project (CGILS) has been conducted jointly with the CFMIP project of WGCM, (d) A GASS SSC member, Gunilla Svensson, has been attending the meetings associated with the new Polar project initiatives of WWRP and WCRP. (e) GASS is represented by Steve Woolnough on the joint WWRP/WCRP seasonal prediction project.

**Key Publications:** Please see the list of publications provided in the progress reports of the individual projects below.

**GASS Science Steering Committee (SSC):** GASS is managed by it SSC which holds a telecon usually every 4-8 weeks. Each project will have a GASS SSC member as a sponsor and typically at least one project lead who may not be part of the SSC. Current members of the SSC include: Chris Bretherton, Ann Fridlind, Christian Jakob, Adrian Lock, Hugh Morrison, Robert Pincus, Pier Siebesma, Ben Shipway, Gunilla Svensson, and Steve Woolnough. There is not a formal term length for the membership of SSC although it is felt that 4 years is a good length to review member's contributions.

**Archiving needs:** Although no progress has been made on this subject in the past year, GASS continues to have a requirement for a resource to archive their project data. This will need IT equipment to deliver data over the internet and human resource to do the work in gathering and documenting the cases. This has in the past been done at an ad-hoc level for the working groups (to a mixed level) but as we have moved away from having WGs then there is now no system to ensure our valuable case studies are easily available to the community.

**SUPPLEMENTAL MATERIAL: Progress reports of GASS projects**

The following pages present progress reports for activities in the reporting period involving planned, current, and recently completed projects. The projects reported on include:

- GABLS3: Stable Boundary Layer at Cabauw
- GABLS4: Stable Boundary Layer on the Antarctic Plateau
- Weak Temperature Gradient
- Grey-Zone (NOTE THAT THIS PROJECT REPORT IS MISSING)
- Microphysics
- Low Cloud Feedbacks (CGILS)
- Land-Atmosphere Interactions (DICE)
- Radiative Processes in Observations and Models
- Cloud Radiation Errors and Surface Temperature Biases (CAUSES)
- Mid-latitude Cirrus
- Polar Clouds
- Stratocumulus-to-Cumulus Transition
- Vertical Structure and Diabatic Processes of the MJO
- Convective Systems: TWP-ICE

**GABLS3: STABLE BOUNDARY LAYER AT CABAUW**

**SSC sponsor:** Gunilla Svensson
**Project leads:** Gunilla Svensson and Bert Holtslag
**Case leads:** Fred Bosveld and Sukanta Basu
**Project status:** Finished, publications in progress

***a. Accomplishments***

The third GABLS intercomparison, based on a case selected Cabauw, the Netherlands, with the aim to study the model's performance for the LLJ development, morning and evening transitions and surface-atmosphere coupling. The intercomparison consists of a SCM and a LES case coordinated by Fred Bosveld and Sukanta Basu, respectively. The latter is focusing on a shorter time span than the SCM. Two papers on the SCM case are in the final publication state in Boundary-Layer Meteorology. The LES case focused on the nighttime conditions and the morning transition. Main findings from these studies are that the LES is able to capture the transition fairly well after considerable effort was put on the case setup. The SCM results show large variability and strong sensitivity to the forcing provided and the results are analyzed using a method which allows the interpretation of differences among models in terms of the dominating physical processes in the stable boundary layer, i.e. coupling to the soil, turbulent mixing and long wave radiation. Substantial differences among models are found in the representation of these three processes.

***b. Activities for next 1-2 years***

None planned.

***c. List of key publications***

Basu, S., et al., 2012, GABLS Intercomparison of Large-Eddy Simulation models with Cabauw observations. In preparation for Boundary Layer Meteorology.

Bosveld F.C., P. Baas, E. van Meijgaard, E.I.F. De Bruijn, G.-J. Steeneveld and A.A.M. Holtslag (2012). The third GABLS intercomparison case for model evaluation, part A: Case Selection and Set-up. Submitted to Boundary Layer Meteorology.

Bosveld F.C., P. Baas, G.-J. Steeneveld and A.A.M. Holtslag et al. (2012). The third GABLS intercomparison case for model evaluation, part B: Single Column Model results and Process Understanding. Submitted to Boundary Layer Meteorology.

Holtslag, A.A.M., G. Svensson, P. Baas, S. Basu, B. Beare, A.C.M. Beljaars, F.C. Bosveld, J. Cuxart, J. Lindvall, G.J. Steeneveld, M. Tjernström, and B.J.H. Van De Wiel , 2013: Diurnal cycles of temperature and wind – A challenge for weather and climate models. Bulletin of the American Meteorological Society. doi: 10.1175/BAMS-D-11-00187.1

***d. List of Meetings***

Nothing to report.

***e. Planned meetings, workshops***

No further meetings for this completed project.

## GABLS4: STABLE BOUNDARY LAYER ON THE ANTARCTIC PLATEAU

**SSC sponsor:** Gunilla Svensson
**Project leads:** Eric Bazile, Timo Vihma, Bert Holtslag, and Gunilla Svensson
**Project status:** Formation

### *a. Accomplishments*

Since the ECMWF/GABLS workshop in Reading November 2011, discussions on how to setup a SCM intercomparison case for a very stably stratified boundary layer has been ongoing between the project leads. Two different observational datasets from Antarctica (Halley and Dome C) are explored and some modeling has been performed in individual groups at FMI, Wageningen University, and MeteoFrance. After a workshop hosted by Timo Vihma at FMI, February 14-15, 2013, it became clear that different approaches would be needed for the two very different observational sites. They are both interesting to pursue but not at the same time and later in the spring, it became clear that GABLS4 will focus on a case selected from observations on the Antarctic Plateau at Dome C and is a "typical diurnal cycle for summer" with an amplitude of about 18K, with a very shallow boundary layer during night. Two 1D experiments are proposed: the first one with a full coupling with the surface (snow) scheme and the second one with a prescribed surface temperature. Possibilities for a LES inter-comparison are discussed.

### *b. Activities for next 1-2 years*

The final specifications for the case are about to be finalized and will be released late 2013 with data delivery in time for a first analysis and presentation at the pan-GEWEX meeting in July 2014.

### *c. List of key publications*

Bazile E., O. Traullé, H. Barral, T. Vihma, A.A.M. Holtslag, and G. Svensson, 2013: GABLS4: An intercomparison case for 1D models to study the stable boundary layer at Dome-C on the Antarctic plateau. EMS Annual Meeting Abstracts Vol. 10, EMS2013-578, 2013

### *d. List of Meetings*

13th EMS Annual Meeting & 11th European Conference on Applications of Meteorology (ECAM) | 09 – 13 September 2013 | Reading, United Kingdom

DICE workshop in Exeter, October

### *e. Planned meetings, workshops*

The following meetings have been proposed:

- Presentation at the DICE workshop in Exeter, October, 2013.
- Discuss initial analysis at the pan-GEWEX meeting, July 2014.

**WEAK TEMPERATURE GRADIENT**

**SSC sponsor:** Steve Woolnough
**Project leads:** Steve Woolnough, Adam Sobel, Sharon Sessions, Gilles Bellon, Shuguang Wang, Chimene Daleu
**Project status:** Formation

***a. Accomplishments***

This project arose out discussions preceding the Pan-GASS meeting in Boulder, with the objective of comparing two methods of parameterizing the feedbacks from the large-scale tropical circulation in process models of convection. A comprehensive project specification has been developed and is ready for release this autumn. Following some funding issues a scientist to lead the analysis has been identified.

***b. Activities for next 1-2 years***

The project specification will be released this autumn with an invitation to participate. We expect to be collecting data in spring 2014 with analysis extending through the summer 2014.

***c. List of key publications***

***d. List of Meetings***

***e. Planned meetings, workshops***

The following meetings have been proposed:

- Likely meeting in Autumn 2014 to discuss initial analysis

**GREY ZONE**

(NOTE THAT PROJECT UPDATE FOR 2013 IS STILL NOT AVAILABLE. THE TEXT BELOW IS THE 2012 REPORT)

**SSC sponsor:** Pier Siebesma
**Project Committee:** Pier Siebesma, Andy Brown, Christian Jakob, Jeanette Onvlee.
**Case Leaders:** Paul Field, Adrian Hill, Stephan de Roode, Pier Siebesma, Verena Grutzun, Axel Seifert
**Project Status:** Early

***a. Accomplishments***

WGNE recently expressed the need to organize a systematic evaluation project of atmospheric models that operate in the so-called Grey Zone Resolution range of 1~10km. As a response, a Grey Zone Project was established and the project committee performed a survey concluding that there was a strong preference, especially from the mesoscale model community, to select a cold air outbreak as a first intercomparison study for the Grey Zone Project.

The case leaders have worked over the last 12 months to set up a cases for a full hierarchy of models (global, LAM, and LES) based on observations from the CONSTRAIN experiment during which a classic cold air outbreak over the North Sea north of Great Britain was observed. Realistic high resolution simulations with the correct, classic spatial mesoscale features with two independent LES models have been produced.

As a result the case will be released early October after the MPI Hamburg group has come up with a output list for the Global model experiments

***b. Activities for next 1-2 years***

The following activities are planned for this project:

- October 2012: Release of the Cold Air Outbreak as a first part of the Grey Zone
- Early 2013: Deadline for submission of model results
- Late 2013: Workshop on intercomparison results

***c. List of key publications***

***d. List of Meetings***

***e. Planned meetings, workshops***

A meeting is envisioned to occur in late 2013 to discuss the results of the first cold air outbreak intercomparison, possibly in conjunction with another GASS meeting.

## MICROPHYSICS

**SSC sponsor:** Ben Shipway
**Project leads:** Adrian Hill, Zach Lebo
**Project status:** Mature

### *a. Accomplishments*

An initial intercomparison of bin microphysics codes was carried out to assess the importance of bin resolution and complexity (number of moments). This was carried out in the Kinematic Driver (KiD) model and results were presented at the ECMWF Workshop on Parametrization of Clouds and Precipitation (see publications below). This also included an assessment of the precipitation susceptibility of a range of bulk microphysics codes.

Other publications using KiD are listed at
http://appconv.metoffice.com/microphysics/publications.shtml.

### *b. Activities for next 1-2 years*

A note on the intercomparison of warm rain bin microphysics codes will be prepared for submission and a more comprehensive intercomparison project case will be outlined in the next 6 months. A paper comparing precipitation susceptibility of microphysics codes is in preparation and will be submitted soon.

### *c. List of key publications*

Hill, A., B. Shipway, I. Boutle, and R. Onishi, "Kinematic modelling: How sensitive are aerosol-cloud interactions to microphysical representation," ECMWF Workshop on Parametrization of Clouds and Precipitation, 5 - 8 November 2012, http://www.ecmwf.int/publications/library/do/references/show?id=90783.

Shipway, B.J. and Hill, A.A., 2012, "Diagnosis of systematic differences between multiple parametrizations of warm rain microphysics using a kinematic framework." Q.J.R. Meteorol. Soc. doi: 10.1002/qj.1913.

Bretherton, C., A. Fridlind, H. Morrison, and B. Shipway, 2010, "GCSS workshop on microphysics and polar/precipitating clouds." GEWEX News, 20, no. 4, 17-19.

Shipway, B.J. and Hill, A.A., 2011, "The Kinematic Driver model (KiD)," Met Office Technical Report No. 549.

### *d. List of Meetings*

A session on this project was held at the Pan-GASS meeting in Boulder, CO, 2012.

### *e. Planned meetings, workshops*

No meetings are currently planned.

**CFMIP-GASS INTERCOMPARISON OF LES AND SCMS (CGILS): LOW CLOUD FEEDBACKS**

**SSC sponsor:** Chris Bretherton and Adrian Lock
**Project leads:** Minghua Zhang, Peter Blossey, Chris Bretherton
**Project status:** Mature

***a. Accomplishments***

CGILS was formulated in 2008 to help understand physical mechanisms of low cloud feedback in climate models, and why these feedbacks differ substantially across models. The strategy has been to use a column modeling framework to intercompare subtropical marine boundary layer cloud response to idealized climate changes between different LES and SCMs, using cases grounded at least loosely in observations. Three locations along the GPCI were selected corresponding to different summer cloud regimes: S12 (well-mixed Sc), S11 (Cu under Sc) and S6 (trade cumulus).

*Summary of Phase 1 results (finished)*

The climate perturbation ('P2S') studied in Phase 1 of CGILS, completed in 2012, was a 2 K SST increase, a corresponding moist-adiabatic increase of free tropospheric temperature, and an 11% decrease in mean subsidence. Zhang et al. (2012) document the detailed case specification. After some iterations of the case specification, 15 SCMs (representing single-column versions of many of the world's leading climate models) and 6 LESs submitted final results, described in a set of three papers submitted in 2012, all but one of which is now published. For the S12 case, the LES models also considered a variation 'P2' on the climate perturbation with no subsidence change, and one LES also considered other climate perturbations that CMIP models suggest will accompany global warming in the subtropics, such as $CO_2$ increase, wind speed and free-tropospheric relative humidity changes, and increased inversion strength.

The cloud response of the SCMs scattered widely between each other and away from their parent GCMs. Because of the smallness of the climate perturbation and the use of steady forcings, the SCMs responses were distorted by locking of cloud features to discrete grid levels. In general, models and cases with active shallow cumulus parameterizations tended to show positive cloud feedbacks (Zhang et al., 2013). After harmonization of the radiation and surface flux schemes, the LES models produced more similar responses. Without subsidence, all LESs showed cloud thinning in the warmer climate, but reduced subsidence counteracted this to varying degrees in the different models (Blossey et al., 2013). Thus LES suggested that there are multiple compensating cloud responses whose net result dictates the overall cloud feedback (Bretherton et al., 2013). In the S6 (shallow cumulus) case the equilibrium cloud-layer depth in each LES was also sensitive to its microphysical parameterizations (Blossey et al., 2013; Bretherton et al., 2013).

*CGILS Phase 2 (ongoing)*

At the Sept. 2012 Pan-GASS meeting, CGILS Phase 2 of was formulated. Based on sensitivity studies with a single LES (Bretherton et al., 2013) and recent results on the fast adjustment of clouds in GCMs, two further forcing perturbations were added to the original case, for all three locations. The first (4CO2) was a quadrupling of CO2 with no change in surface or free-tropospheric temperature. The second (dCMIP3) uses composite forcing perturbations taken from the CMIP3 multimodel mean for a CO2-doubled climate (Bretherton et al., 2013). So far, several LES have run the perturbed case, and SCMs have been asked to run this case; results were presented at the Hamburg CFMIP meeting in June 2013 that corroborate the original single-LES results (Bretherton et al., 2013) that showed both perturbations led to reduced cloudiness in almost all LESs at both Sc locations, consistent with most GCMs.

The other prong of CGILS Phase 2 was to test whether more consistency between SCMs and GCMs, as well as between LES and observed climatology, could be obtained using transient (synoptically-varying) forcing at each location, derived from a summer of ECMWF analyses provided to us by Martin Koehler. The forcing perturbations are still added as steady increments to the transient control forcing.

It was decided that one LES would test out the feasibility of this approach on the least computationally intense case, S6. Peter Blossey volunteered to do this, and presented results at the Hamburg CFMIP meeting. They showed that the transient forcing did create a range of cloud depths over the course of a simulated month, but that it did not have a large effect on the time-mean cloud response to the forcing perturbations, with only small changes in cloud radiative effect in a warmed climate case, just like for the steady simulation. This case needs further refinement before it is intercomparison-ready.

***b. Activities for next 1-2 years***

The steady-forcing results from CGILS Phase 2 will be finalized and readied for publication next year, ideally by the GEWEX meeting in July 2014. By that time, Blossey and Bretherton will also have tried a transient-forcing S11 case for which we expect a larger cloud response to a warm-climate forcing perturbation that could show significant differences between a steadily-forced and an transient forcing case. They will then lead a discussion about whether to proceed with an LES and SCM intercomparison based on such a transient-forcing case. At that time, we will also discuss whether or not CGILS should be continued as a GASS activity.

***c. List of key publications***

M. Zhang and 39 co-authors (including myself), 2013: CGILS: First Results from an International Project to Understand the Physical Mechanisms of Low Cloud Feedbacks in General Circulation Models. J. Adv. Model. Earth Syst., in review. – Overview of CGILS SCM and LES results

M. Zhang, C. S. Bretherton, P. N. Blossey, Sandrine Bony, Florent Brient and Jean-Christophe Golaz, 2012: The CGILS Experimental Design to Investigate Low Cloud Feedbacks in General Circulation Models by Using Single-Column and Large-Eddy Simulation Models. J. Adv. Model. Earth Syst., 4, doi:10.1029/2012MS000182. – CGILS Phase 1 case specifications

P. N. Blossey, C. S. Bretherton, M. Zhang, A. Cheng, S. Endo, T. Heus, Y. Liu, A. Lock, S. R. de Roode and K.-M. Xu, Marine low cloud sensitivity to an idealized climate change: The CGILS LES Intercomparison. J. Adv. Model. Earth Syst., 5, doi:10.1002/jame.20025 --Phase 1 LES results

C. S. Bretherton, P. N. Blossey and C. R. Jones, Mechanisms of marine low cloud sensitivity to idealized climate perturbations: A single-LES exploration extending the CGILS cases. J. Adv. Model. Earth Syst., 5, doi:10.1002/jame.20019 – Phase 1 Single-LES sensitivity study

***d. List of Meetings***

Sept. 2012: Afternoon breakout at the 1st pan-GASS meeting (Boulder, CO, USA)
June 2013: Session at CFMIP workshop, Hamburg

***e. Planned meetings, workshops***

June 2013: Joint EUCLIPSE/CFMIP meeting to be held at MPI (Hamburg, Germany)
July 2014: CFMIP workshop, Netherlands, and contributions to GEWEX summit, The Hague.

## LAND-ATMOSPHERE INTERACTIONS (DICE) (JOINT WITH GLASS)

**SSC sponsor:** Adrian Lock
**Project leads:** Martin Best and Adrian Lock
**Project status:** Early

### *a. Accomplishments*

This project grew out of the GABLS/ECMWF workshop in November 2011 where there was a consensus that the atmospheric boundary layer and land surface communities needed to work more closely together. At the pan-GASS meeting in Sept 2012, it was proposed to initiate a project, joint between GASS and GLASS, on a clear-sky diurnal cycle case study, from the same observational campaign as was used for GABLS2. The period chosen consists of 3 full diurnal cycles covering a range of different stable boundary layer regimes. The intercomparison, initially, has three components. In stage 1, land surface and single column (atmosphere only) models are run separately (uncoupled) for the 3 day period forced entirely by observed quantities (noting that the soils in the LSM must be spun up by running, forced by observations, for several years of data previous to the campaign to ensure these are in balance for each model). In stage 2, the two models are run coupled. These two stages allow the impact of coupling to be evaluated. In stage 3, the submitted results from the models in stage 1 are used to derive multiple forcings (i.e., the surface fluxes are extracted from the LSM and the near-surface atmospheric variables from the SCM) so that each participant can run an ensemble of LSM and SCM simulations. This then allows the sensitivity of each model to differences in forcing to be quantified. Overall this project should both promote greater understanding of each model's strengths and weaknesses, help quantify the importance of coupling the two systems together and give insight into what aspects are important for surface coupling sensitivity.

The case was released in Spring 2013 and so far 10 LSM and 12 SCM are participating so far.

The project website is http://appconv.metoffice.com/dice/dice.html.

### *b. Activities for next 1-2 years*

The following activities are envisioned for this project:

- Conduct intercomparison of simulations.

### *c. List of key publications*

Best, M., A. Lock, J. Santanello, G. Svensson, and B. Holtslag (2013). A New Community Experiment to Understand Land-Atmosphere Coupling Processes. *GEWEX News*, May 2013.

### *d. List of Meetings*

A workshop to discuss the results and plan future work was held at the Met Office, Exeter from 14-16 October 2013.

## RADIATIVE PROCESSES IN OBSERVATIONS AND MODELS

**SSC sponsors:** Lazaros Oreopoulos and Robert Pincus
**Project leads:** Lazaros Oreopoulos and Eli Mlawer
**Project status:** Early

### a. Accomplishments

The project is new in GASS. It is envisioned as an outgrowth/extension/expansion of the Continual Intercomparison of Radiation Codes (CIRC) project, which also resides in GDAP (ex-GRP). During the reporting period, CIRC was highlighted as a major ARM accomplishment in the draft of a monograph about the first 20 years of ARM, and was used as the validation source for the various radiative codes within the University of Maryland Cloud-Aerosol-Radiation (CAR) ensemble modeling system.

### b. Activities for next 1-2 years

- Develop the next suite of cases for CIRC Phase II with possibly greater emphasis on heating rates.
- Collaborate with the "Stable Boundary Layer Project" to investigate discrepancies between measured and modeled downwelling thermal infrared fluxes.
- Collaborate with the "Cirrus Project" to evaluate cirrus-modulated surface radiation fluxes in the modeling intercomparison built around SPARTICUS ARM SGP flights.
- Assess current ability of radiative transfer codes and required future steps to incorporate the radiative effects of precipitating particles at solar and thermal IR wavelengths.
- Participate in a structured comparison of radiation codes in CMIP/CFMIP GCMs as part of CMIP6 that will use offline radiation calculations to understand the degree to which radiative forcing discrepancies are due to parameterizations as opposed to diversity in model base states.

### c. List of key publications

Oreopoulos, L., and E. Mlawer (2010). The Continual Intercomparison of Radiation Codes (CIRC): Assessing anew the quality of GCM radiation algorithms Bull. Am. Met. Soc., 91, 305-310doi:10.1175/2009BAMS2732.1

Oreopoulos, L., et al. (2012), The Continual Intercomparison of Radiation Codes: Results from Phase I, J. Geophys. Res., 117, D06118, doi:10.1029/2011JD016821.

Liang, X.-Z. and Zhang, F. (2013), The cloud–aerosol–radiation (CAR) ensemble modeling system, Atmos. Chem. Phys., 13, 8335-8364, doi:10.5194/acp-13-8335-2013.

### d. List of meetings, workshops held

None

### e. Planned meetings and workshops

None at this time

## CLOUD RADIATION ERRORS AND SURFACE TEMPERATURE BIASES (CAUSES)

**SSC sponsors:** Jon Petch and Stephen Klein
**Project leads:** Cyril Morcrette, Hsi-Yen Ma, Jon Petch, Stephen Klein, and Shaocheng Xie
**Project status:** Formation

### a. Accomplishments

This proposed project is new with an observationally-based focus, which evaluates the role of cloud, radiation, and precipitation processes in contributing to the surface temperature biases in the region of the central United States and which are seen in several weather and climate models. The project title is "Clouds Above the United States and Errors at the Surface" (CAUSES).

The warm bias over the US in summer is common to many GCMs and it is seen in the long-term climate mean and it shows up as a bias within a few days when running the climate models from analyses in NWP mode. We hypothesize that the US warm bias is due to a combination of errors involving the land and atmosphere. Potential issues include: the diurnal cycle of convection, timing of precipitation and how much evaporates, soil moisture, surface fluxes, organization and propagation of convection, shallow convection, radiative impact of convective cores, detrained cloud, and anvils.

In this project, we aim to understand the role of errors in the atmosphere model in contributing to the warm bias seen in climate models. Specifically, we are proposing study of two areas of investigation:

1. What is the contribution of radiation errors to the temperature errors? How much of the errors in radiation result from errors in clouds and their properties? Which cloud regimes contribute most the radiation errors?
2. What is the relative contribution of precipitation errors to the temperature errors? Does this atmosphere provide the correct amount of precipitation for the soil? Which type of precipitating convection systems dominates the errors in the surface precipitation? Does the surface energy balance reveal signs that evaporation is underestimated due to the lack of soil moisture?

Part I of this study will focus on the errors in clouds and radiation and will be based largely upon Morcrette et al. (2012). This effort will be led by Cyril Morcrette. Part II of this study will focus on the simulated precipitation and surface energy balance and will be based largely upon Klein et al. (2006). This effort will be led by Hsi-Yen Ma.

### b. Activities for next 1-2 years

- Formulate intercomparison, draft participants, conduct intercomparison and analysis.

### c. List of key publications

None yet.

### d. List of meetings, workshops held

None yet

### e. Planned meetings and workshops

A breakout session to discuss this project may occur at the Pan-GEWEX meeting in The Hague, July 2014.

**MID-LATITUDE CIRRUS**

**SSC sponsors:** Hugh Morrison
**Project leads:** Andreas Muhlbauer and Thomas Ackerman
**Project status:** Early

**a. Accomplishments**

Initiation of the cirrus model intercomparison project based on a case study from the U. S. DOE Small Particles in Cirrus (SPartICus) field campaign. The objective of this case study is to investigate the microphysical and macrophysical evolution and life cycle of a deep-wave cirrus observed over the ARM Southern Great Plains (SGP) site in Oklahoma and to compare simulated cirrus cloud properties and radiative effects among models and with observations. Special emphasis is on the contribution of small ice crystals in cirrus and the role of homogeneous and heterogeneous ice nucleation. Simulations are compared and evaluated with in situ aircraft observations and with various ground-based and space-borne remote sensors. This project specifically targets cloud-system resolving (CSRM) models, cloud-resolving (CRM) models, large eddy simulation (LES) models and single column models (SCM) with advanced cloud microphysics schemes such as multi-moment bulk microphysics parameterizations or bin microphysics schemes. A detailed description of the project can be found at http://www.atmos.washington.edu/~andreasm/case3_midlatitude_cirrus/case3_midlatitude_cirrus.html.

**b. Activities for next 1-2 years**

The following activities are envisioned:

- Finalize case setup and logistics for participating models
- Analyse model results, focusing on cirrus macrophysical and microphysical properties through detailed intercomparison of models and comparison of models with in-situ and remotely sensed observations
- Draft a paper detailing results from the model intercomparison

**c. List of key publications**

Muhlbauer, A., W. W. Grabowski, S. P. Malinowski, T. P. Ackerman, G. H. Bryan, Z. J. Lebo, J. A. Milbrandt, H. Morrison, M. Ovchinnikov, S. Tessendorf, J. M. Thériault, G. Thompson, 2013: Reexamination of the State of the Art of Cloud Modeling Shows Real Improvements, Bulletin of the Amer. Meteor. Soc., 94, 45-48, doi: http://dx.doi.org/10.1175/BAMS-D-12-00188.1

Muhlbauer, A., T. P. Ackerman, J. M. Comstock, M. Deng, G. Diskin, and P. Lawson, 2012: An observationally-based case of mid-latitude cirrus for cloud-permitting and cloud-resolving models. Geosci. Model Develop., in prep.

**d. List of Meetings**

The following meetings have been held for this project:

- January 2012, Introduction of the project during the MACPEX/SPartICus Science Team Meeting (Salt Lake City, UT, USA)
- March 2012, Discussion of the project during the U. S. DOE ASR Science Team Meeting (Arlington, VA, USA) at a breakout meeting on cirrus, where the case was introduced

- July 2012, International Cloud Modeling Workshop (Warsaw, Poland); a breakout session devoted to the cirrus intercomparison project
- September 2012, 1st pan-GASS conference (Boulder, CO, USA); a breakout session on cirrus clouds centered around the intercomparison project including detailed presentations of the case and preliminary results

**e. Planned meetings, workshops**

No meetings are currently planned.

**POLAR CLOUD**

**SSC sponsors:** Ann Fridlind
**Project leads:** Mikhail Ovtchinnikov
**Project status:** Mature/Nearly complete

**a. Accomplishments**

The ISDAC intercomparison project for Arctic mixed-phase boundary layer clouds has been nearly completed:

- Results were obtained based on the case description as released (https://engineering.arm.gov/~mikhail/ISDAC_F31.html)
- This case is a follow up to previous MPACE and SHEBA intercomparisons, but under different conditions and using a more constrained model setup with respect to ice particle properties, model's spatial resolution, and parameterization of radiative effects
- The case has been conducted jointly with the US DOE Atmospheric System Research Program (ASR) and 2012 International Cloud Modeling Workshop (CMW)
- Manuscript prepared and distributed for co-author comments as of September 2013

**b. Activities for next 1-2 years**

The final activities:

- See manuscript through peer-review process

**c. List of key publications**

Ovchinnikov, M., A. S. Ackerman, A. Avramov, A. Cheng, J. Fan, A. M. Fridlind, J. Harrington, S. Ghan, A. Korolev, G. McFarquhar, H. Morrison, M. Paukert, J. Savre, B. Shipway, M. Shupe, A. Solomon, and K. Sulia, 2013: Intercomparison of large-eddy simulations of Arctic mixed-phase clouds, in preparation.

**d. List of Meetings**

The final meeting held for this project:

- 1st pan-GASS conference (September 2012, Boulder, CO, USA); a breakout session on Polar Clouds included presentations on and discussion of the ISDAC intercomparison

**e. Planned meetings, workshops**

No further meetings are currently required.

## STRATOCUMULUS-TO-CUMULUS TRANSITION

**SSC sponsor:** Adrian Lock
**Project leads:** Stephan de Roode, Irina Sandu, Roel Neggers
**Project status:** Mature

### a. Accomplishments

This project studies the stratocumulus to trade cumulus transition, one that is of climatological importance for understanding low cloud cover variations in the marine subtropics. There are two parallel LES intercomparisons as well as SCM intercomparisons. These intercomparisons are being run in collaboration with a European project, EUCLIPSE. In combination these cases challenge models to produce both a realistic transition compared to detailed in situ data and also a realistic sensitivity of the speed of transition to changes in environmental forcing. Results suggest the LES do a good job of capturing these details, although requiring very high (5m) vertical resolution. One of the motivations for this intercomparison was that these transitions would present a particular challenge for SCMs, many of which would need to make the transition between different parameterizations of vertical mixing. Over 20 SCMs have participated and, although many do indeed struggle to generate realistic transitions, it is encouraging that those organizations that have worked hard to develop these aspects of physical parameterizations (invariably using previous GCSS intercomparison cases) can do a much better job.

### b. Activities for next 1-2 years

The following activities to complete this project are:

- Spin-off work investigating the difference between forcing the SCM with mean forcing as compared to running an ensemble of SCM and taking the mean
- While the LES paper has appeared, a SCM paper is in preparation describing these studies in much more detail

### c. List of key publications

van der Dussen, J. J., S. R. de Roode, A. S. Ackerman, P. N. Blossey, C. S. Bretherton, M. J. Kurowski, A. P. Lock, R. A. J. Neggers, I. Sandu, and A. P. Siebesma (2013), The GASS/EUCLIPSE model intercomparison of the stratocumulus transition as observed during ASTEX: LES results, J. Adv. Model. Earth Syst., 5, doi:10.1002/jame.20033.

De Roode, S.R. et al (2012) LES Results of the GASS-EUCLIPSE Lagrangian Stratocumulus to Shallow Cumulus Transition Cases, AMS-BLT Conference, https://ams.confex.com/ams/20BLT18AirSea/webprogram/Manuscript/Paper208663/intercomparison_lags.pdf

Lock, A.P. (2011) GCSS/CFMIP/EUCLIPSE Meeting on Cloud Processes and Climate Feedbacks. GEWEX News, August 2011

### d. List of Meetings

The following meetings have been held for this project:

- September 2010, Joint workshop with EUCLIPSE on the Transition and CGILS cases held at KNMI (deBilt, Netherlands)

- June 2011, joint meeting with CFMIP and EUCLIPSE including further discussions on the Transition and CGILS cases held at the Met Office (Exeter, Devon, UK)
- April 2012, some discussion of progress alongside an otherwise EUCLIPSE-only meeting at MeteoFrance (Toulouse, France)
- September 2012, Discussion of project at the 1st pan-GASS meeting (Boulder, CO, USA)

**e. Planned meetings, workshops**

No meetings are currently planned, although work will continue.

## VERTICAL STRUCTURE AND DIABATIC PROCESSES OF THE MJO

**SSC sponsors:** Jon Petch and Steve Woolnough
**Project leads:** Jon Petch, Duane Waliser, Prince Xavier, Nick Klingaman, Xianan Jiang & Steve Woolnough
**Project status:** Mature

### a. Accomplishments

This project is studying the vertical structure of diabatic process in the MJO in global models and its relationship to MJO simulation fidelity using 3 sets of model integrations: 20 year climate simulations, 2-day hindcasts from 2 YOTC MJO cases (E&F), and 20-day hindcasts of the same events. Over the spring/summer of 2012 data submissions for one or more components of the project were received from 23 modelling centres. The initial analysis of the 3 components has been carried out and papers on each component are being drafted for submission this autumn, with a further summary paper to be developed. The preliminary analysis was discussed at a project meeting in Singapore in June 2013. At that meeting a further set of 20-day hindcasts for the Nov 2011 MJO observed during the CINDY/DYNAMO campaign was defined with analysis to be performed by scientists from the CINDY/DYANMO group.

This project is conducted jointly between GASS and the WCRP-WWRP MJO task force.

### b. Activities for next 1-2 years

Continued analysis of the three components of the experiment focusing on the diabatic tendencies and their relationship to MJO simulation, including the relationships between forecast skill, climate simulations and details of physical processes and representation. The following activities are envisioned for this project:

- Draft papers on each component & model output made publicly available by December 2013
- Synthesis paper and recommendations for future process study March 2013

### c. List of key publications

Petch, Jon, Duane Waliser, Xianan Jiang, Prince Xavier, and Steve Woolnough: A Global Model Intercomparison of the Physical Processes Associated with the Madden-Julian Oscillation, 2011, GEWEX News, 21, 3-5.

### d. List of Meetings

The following meetings have been held for this project:

- 1st pan-GASS meeting in Boulder September 2012 where preliminary results were discussed
- GASS/MJO-TF meeting on Diabatic Processes in the MJO, Singapore Met Office, 3-5 June 2013 – discussion of model analysis and plans for future work on CINDY/DYNAMO case

### e. Planned meetings, workshops

No meetings are currently planned.

## CONVECTIVE SYSTEMS: TWP-ICE

**SSC sponsors:** Ann Fridlind & Jon Petch
**Project leads:** Ann Fridlind, Yanluan Lin, Ping Zhu and Laura Davies
**Project status:** Finished

### a. Accomplishments

This completed project examined simulations of convective clouds in the environment of Darwin, Australia in early 2006. This was the first model intercomparison project to:

- Involve four model types (CRM, LAM, SCM, GAM) with multiple international modelling groups participating
- Use ensemble forcing data in the SCM component

### b. Activities for next 1-2 years

All journal articles have been published.

### c. List of key publications

Bretherton, C., A. Fridlind, H. Morrison, and B. Shipway, 2010: GCSS workshop on microphysics and polar/precipitating clouds. GEWEX News, 20, no. 4, 17-19.

Varble, A., et al. (2011): Evaluation of cloud-resolving model intercomparison simulations using TWP-ICE observations. Precipitation and cloud structure. J. Geophys. Res., 116, D12206, doi:10.1029/2010JD015180.

Fridlind, A. M., et al. (2012), A comparison of TWP-ICE observational data with cloud-resolving model results, J. Geophys. Res., 117, D05204, doi:10.1029/2011JD016595.

Lin, Y., et al. (2012), TWP-ICE global atmospheric model intercomparison: Convection responsiveness and resolution impact, J. Geophys. Res., 117, D09111, doi:10.1029/2011JD017018.

Zhu, P., et al. (2012), A limited area model (LAM) intercomparison study of a TWP-ICE active monsoon mesoscale convective event, J. Geophys. Res., 117, D11208, doi:10.1029/2011JD016447

Petch, J., Hill, A., Davies, L., Fridlind, A., Jakob, C., Lin, Y., Xie, S. and Zhu, P. (2013), Evaluation of intercomparisons of four different types of model simulating TWP-ICE. Q.J.R. Meteorol. Soc.. doi: 10.1002/qj.2192

Davies, L., et al. (2013), A single-column model ensemble approach applied to the TWP-ICE experiment, J. Geophys. Res. Atmos., 118, 6544–6563, doi:10.1002/jgrd.50450.

### d. List of Meetings

No meeting took place during the reporting period.

### e. Planned meetings, workshops

No further meetings are scheduled for this completed project.

## 3.2 GDAP GEWEX Data And Assessments Panel Report

**Full Panel, Project or Working Group Name:** *GEWEX Data and Assessments Panel (GDAP)*
**Reporting Period:** September 2012 – September 2013
**URL:** http://gewex.org/GDAP.html; http://rain.atmos.colostate.edu/GDAP/index.html
**Chair(s) and term dates:** Christian Kummerow (2008-2011); Vice Chair: Joerg Schulz (2010 – 2013)

**1. Panel activities**

Activities of the GDAP can be divided simply into Data Products, Product Assessments, and Radiative Transfer Code Assessments. The individual products for Clouds (ISCCP), Aerosols (GACP, MAC), Radiation (SRB), Turbulent Fluxes (SeaFlux and LandFlux), as well as Precipitation (GPCP) continue with reasonable support from agencies except for GACP which is currently unfunded. The Max Planck Institute für Meteorologie has begun producing an Aerosol Climatology that is being adopted by GDAP instead. Each of the GEWEX reference products is currently preparing for a reprocessing cycle that will result in common space and time grids as well as ancillary data and assumptions. These will be merged into a single product called the GEWEX Integrated Water and Energy Product.

The Integrated GEWEX product is designed to ensure that geophysical signals and their covariances are tied to the data and products themselves rather than inconsistencies in their assumptions. Reviewing the readiness of GEWEX reference products for this reprocessing with common assumptions and setting realistic goals for product deliveries was the primary objective of the GDAP team meeting held in Rio De Janeiro, Brazil, on 3-5 September, 2013. The panel has encountered significant issues, of the scientific rather programmatic nature, as it has forged ahead to create this product. Details are found in the Rio de Janeiro meeting minutes. The first year of the integrated product is now scheduled for delivery by June 30, 2014.

With respect to Assessments, the panel has now finished the Precipitation, Clouds and Radiation products which have been published in their entirety was recently published in BAMS whiel the Radiative Flux Assessment is still in the review process. GDAP is currently still actively involved in the Aerosol assessment as well as the Water Vapor Assessment, which just held its most recent meeting in Fort Collins, CO in late September of 2013. LandFlux and SeaFlux have proceeded along the lines of combining initial assessment with product recommendations so those two are still on-going but with a different character as they are recommending the GEWEX standard product rather than assessing an existing one.

Given the maturity of the ongoing activities, GDAP has begun to expand to encompass the terrestrial water budget – including soil moisture, storage, and runoff. The panel plans to slowly add these parameters in order to further constrain the Water and Energy budgets on a scale that is relevant for climate processes.

**2. New projects in place**

GDAP has not formally initiated any new projects in the last year.

**3. New projects and activities being planned, including timeline**

GDAP is exploring the expansion of GEWEX standard products to include terrestrial water budget terms. It has begun the process by inviting Wouter Dorigo (Soil Moisture) and Felix Landerer (GRACE Observations of water storage) to join the team to advise on best ways to incorporate potential data sets. Formal decisions will be made in the following two years based upon the feasibility of creating standard products that would be recognized by the community.

There was discussion at the last meeting in Rio de Janeiro, held jointly with GHP, to join efforts of the two panels to tackle orographic precipitation as well as high altitude (snow) precipitation. GDAP is currently awaiting input from GHP about candidate regions.
GDAP is still evaluating the feasibility of formalizing the Satellite Simulator Assessment. Decisions should be made at the next GDAP meeting in the summer of 2014.

**4. Science highlights**

All GEWEX reference products agreed to deliver the first year of the Integrated Product parameters by no later than March 2014 for a June 2014 release of the Integrated Product. This includes uncertainties.

The discrepancy in Water and Energy budgets seen in observations continues with both the radiative flux and the precipitation communities finding additional validation data to support their values. The discrepancies, while not impossible based upon estimated uncertainties, would nonetheless imply significantly more precipitation globally (15-20%).

Water budget closure studies over five Tropical Pacific basins suggests that precipitation, evaporation and water vapor divergence from Reanalyses such as ERA-I or MERRA close the budgets quite well but that the Models have higher evaporation because of a dry bias in the near surface layers. The observations also show a significant trend of P-E drifting away from the water vapor divergence over the last decade in the West Pacific that is not seen in any of the other basins. This suggests that changes in geophsyisical parameters, rather than sensors drift or Model problems are the likely cause.

**5. Science issues**

The Panel views in situ reference measurements of radiation (BSRN), precipitation (GPCC), water vapour (through well calibrated radiosondes) and latent heat flux from ships and towers around the world as an important reference for Climate Data Records. The SSG and WCRP might consider a concerted effort to foster small but highly characterized networks (similar to BSRN) that can be used to assess satellite stability over very long periods. The maintenance of these activities is central to satellite derived products and GDAP cannot emphasize their importance enough.

**6. List contributions to the GEWEX Science Questions and plans to include these.**

GDAP provides global products designed to test model processes related to the water and energy budgets.

- **Observations and Predictions of Precipitation**

GPCP directly addresses issues related to the observation of precipitation. With the advent of GPM in 2014, these products will be improved significantly. Ongoing improvements and homogenization with other Water and Energy parameters is intended to ensure consistency with other GEWEX products.

- **Global Water Resource Systems**
  GDAP does not work much in this area.
- **Changes in Extremes**
  GPCC has begun producing daily products of precipitation where available. This was done specifically at the request of GEWEX to allow better understanding of changes in precipitation extremes.
- **Water and energy cycles**
  The GEWEX Integrated product is designed specifically for Water and Energy cycle studies.

**7. Other key science questions that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project (1-3 suggestions)**

Terrestrial water and energy budget closure at scales important to climate processes is a key area that GDAP will focus its energy on in the next 5-10 years. This includes questions about precipitation cycling and feedbacks between soil moisture and precipitation.

**8. Briefly list any specific areas of your panel's activities that you think would contribute to the WCRP Grand Challenges as identified by the JSC**

- **Provision of skillful future climate information on regional scales (includes decadal and polar predictability)**
- While the panel is not in a position to predict future climate, the panel can focus on process studies at regional scales that would be essential to verify that the regional climate models are indeed capturing the key elements of each region's unique physics.
- **Regional Sea-Level Rise**
- **Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)**
- **Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity**
- The GDAP Integrated Product and science articles it plans to publish go directly to answering questions about the interactions of clouds precipitation and the radiation balance. The data sets are made specifically to test co-variance and climate sensitivity.
- **Past and future changes in water availability (with connections to water security and hydrological cycle)**
- While GDAP can certainty help with past precipitation amounts and the distribution of rain rates that might be viewed as important for water availability, the panel has no particular information on water availability or changes therein
- **Science underpinning the prediction and attribution of extreme events**
- GDAP global products have been re-engineered to 1 degree, 3 hourly time steps so that extremes and processes related to extremes may be seen in the data.

**9. Cooperation with other WCRP projects (CLIVAR, CliC, SPARC), outside bodies (e.g. IGBP) and links to applications**

The SeaFlux product is being developed with input from the CLIVAR community and joint Workshops are being held. The SPARC community is being consulted about their evaluation of upper tropospheric humidity products to be integrated with the GDAP water vapor Assessment. Coordination with CLiC on high altitude W&E budgets is clearly desirable. The LandFlux activity, while not coordinated with IGBP at the project level, is well coordinated at the working level as there is tremendous overlap in the researchers involved. Further coordination is not seen as helpful.

**10. Workshops/meetings held**

- 22-26 April 2013 – ISCCP at 30 Workshop, New York, New York, USA
- 19-20 Sept., 2013. Joint SeaFlux/LandFlux WG meeting, Vienna, Austria
- 30 Sept. – 02 Oct., 2013. Water Vapor Assessment meeting, Ft. Collins, Colorado, USA
- 02-05 Sept., 2013. Joint GDAP/GHP meeting, Rio de Janeiro, Brazil.

**11. Workshops/meetings planned. Include travel support needs anticipated.**

* Support for 1-2 people may be needed for each meeting except BSRN meeting that requires support for travel from developing countries.

06-07 February 2014: Potential Integrated Product Meeting. Rayleigh, NC.
Spring 2014. Potential LandFlux meeting, Location TBD
Summer 2014. BSRN Semi-annual meeting. Location TBD (Beijing; Bologna; St. Petersburg or Princeton).
13-18 July 2014. GEWEX Data and Assessments Panel meeting, The Hague, NL
Fall 2014. GEWEX Water Vapor Assessment meeting. Location TBD (likely in Europe)
Fall 2014. Precipitation Assessment meeting. Location likely in US

**12. Other meetings that were attended on behalf of GEWEX or your Panel**

01-03 July, 2013. ESA Soil Moisture Workshop. Frascati, Italy

**13. Issues for the SSG**

In-situ datasets of precipitation, radiation, soil moisture and turbulent fluxes all are under funding pressure with little international visibility or status. As anchors to many of the global products, it would be good to see WCRP and possibly WMO elevate these measurements to a level where we can get national commitments to their maintenance as well as capacity building that is desperately needed in underdeveloped regions of the world.

**14. List of key publications**

Both the Cloud and Radiation Assessments have been submitted as WCRP reports. The Cloud Assessment has been published as a BAMS article while the Radiative Flux assessment is still under review. The GDAP products publish their papers independently but ISCCP maintains a database indicating over 2,000 publications citing its data; GPCP is well over 1,500 and BSRN recently reported over 1,000 citations.

**15. List of members and their term dates (* indicates new member):**

| | |
|---|---|
| Christian Kummerow | 2008 – present |
| Joerg Schulz | 2010 – present |
| Wouter Dorigo* | 2013 – Present |
| Carlos Jimenez | 2010 – present |
| Felix Landerer* | 2013 – present |
| Norman G. Loeb | 2005 – present |
| Hirohiko Masunaga | 2010 – present |
| Matthew McCabe | 2008 – present |
| Axel Schweiger | 2008 – present |
| Sonia Seneviratne | 2008 – present |
| B.J. Sohn | 2007 – present |
| Claudia Stubenrauch | 2007 – present |
| Susan Van den Heever | 2008 – present |
| Tianjun Zhou | 2011 – present |
| Andrew Heidinger | 2012 – present |

## 3.3 Global Land/Atmosphere System Study (GLASS) Report

**Reporting period**: 1 October 2012 – 15 October 2013

**URL**: http://www.gewex.org/glass.html

**Chair(s) and term dates**:
Martin Best 2009-2012 (ended 31 Dec)
Joseph Santanello 2011 – 2014
Aaron Boone 2013 – 2016 (began 1 Jan)

**GLASS Overview and Summary:**

"Support improved estimate and representation of (land) states and fluxes in models, the interaction with the overlying atmosphere, and maximize the utilized fraction of inherent predictability."

The aim of GLASS is to promote community activities that improve our best estimates and the model representation of state variables (e.g., soil moisture) and fluxes (e.g., evaporation), or to improve our understanding of land/atmosphere feedbacks and the role of land surface in predictability. To achieve these aims, GLASS has been re-structured into three 'themes': Benchmarking, Model Data Fusion (MDF) and Land-Atmosphere Coupling (LAC). The concept of model benchmarking (rather than validation) will enable the modeling community to identify the current strengths and weaknesses of our models in relation to their required applications. This is a complete shift of focus for the modeling community and will require careful definitions of the a priori metrics that a model needs to achieve. The PLUMBER project launched this year directly addresses this theme with the goals of demonstrating this approach to benchmarking for the community.

The second theme of MDF will bring data assimilation and parameter estimation techniques to both the initial value problem and to constrain the bounds of unknown parameters by using historical datasets. In the past, land data assimilation has been limited due to restrictions in observational data of the land components (e.g. soil moisture), but new satellite data enables an opportunity to explore more advanced data assimilation techniques. The PILDAS project will directly address this theme of GLASS, and connections look to be made between GHP/GDAP and GLASS with regards to the GSWP3 and ALMIP2 projects.

The final theme of LAC aims at understanding the physical interactions between the land and the atmosphere and how feedbacks can change the subsequent evolution. Whilst the GLACE1 and GLACE2 projects have demonstrated regions of the globe and situations where the land can have a significant impact on atmospheric evolution, they also highlighted large differences between modeling systems. Hence GLASS will help to facilitate two aspects of land/atmosphere coupling, the first being to understand the physical processes whilst the second will strive to understand how both land and atmospheric parameterizations interact. The focus is at both the process/local level (LoCo) and the global behavior of the coupling (GLACE). This understanding will help to maximize the inherent predictability of the coupled land/atmosphere system.

In summary, the adoption of new TORs (now in Year 2) for the panel has already improved the expectations of and for panel members, shed former members who were no longer contributing, brought new experienced (4 added just this year) and young scientists (3 officially and 5 more unofficially in the LoCo working group) into the fold, and allowed the outside community better access to and understanding of the panel operations. GLASS currently has a good mix of established and new projects getting off the ground and in the planning stages, each of which maps well to the themes (MDF, Benchmarking, LAC). GLASS has reached out to GHP on a number of projects, is launching projects with GABLS (e.g. DICE), and continues to engage WGNE on benchmarking and data assimilation activities.

**1. Panel activities and 4. Science highlights**

**GSWP3 (Hyungjun Kim)**
A follow-up project to the Global Soil Wetness Project 2 is in the near-launch stage, with a kick-off meeting scheduled for February 2014 in Tokyo. The new components being considered for this project are:

- Cover a longer period of the 20$^{th}$ Century (~1900 – recent), which includes some interesting global trends in hydrology, but is also long enough for carbon processes
- Include carbon models, to explore/attribute a possible carbon-related effect or changes in eco-system functioning on these trends. This could make a bridge to the terrestrial carbon cycle modeling community. GLASS will actively recruit member(s) of iLeaps to be actively involved in both the planning and analysis of the carbon component of GLASS.
- Explore uncertainties in (precipitation) forcings by using multiple data sets
  Include simulations using CMIP5 models, both present day and future conditions. In addition, include land cover change scenarios.
- Use a routing scheme (TRIP) and GRACE data for evaluation and diagnostics.
  Over the last year, a great deal of bias correction has been applied to the forcing dataset (20CR forcing), which uses global dynamical downscaling and CRU observations for 2m fields. Radiation correction is applied using the GEWEX SRB product. A "white paper" (experimental protocol) has been refined and was distributed a few days after the most recent panel meeting (Oct 16-18, in Exeter) and is currently being reviewed by the GLASS panel for final comments. Next, it will be circulated among key contacts within the carbon community (within the next month or so) to get their buy-in before the project begins. This will enable both carbon and water and energy cycle land surface models to be included, and simultaneously evaluated in them (e.g. the hydrology of carbon models and vice-versa).

**LoCo and the SGP Testbed (Joe Santanello)**
The LoCo Working Group has spent the last year producing and publishing work on diagnostics of L-A interactions and coupling across an array of scales and models. A trilogy of papers has been written based on the coupling of NASA's LIS with the WRF Mesoscale model that includes model coupling behaviour evaluation during wet and dry extreme periods over the U. S. SGP. Other diagnostics have produced global maps of coupling metrics from GCM output and reanalysis products such as NARR and MERRA. A wide net has been cast in developing coupling metrics and producing maps, but it is recognized that now is the time to reel in these efforts, and synthesize them to get at more science-driven questions of coupling. Some examples of these diagnostics are the traditional mixing diagrams, LCL-deficit, Findell-Eltahir diagnostics of triggering of convection, revised relative humidity tendency variables, McNaughton coupling coefficient, and TFS/AFS. To this end, the LoCo WG is embarking on a testbed project (see details below) that will produce a ARM-supported dataset for coupling studies over the U.S. SGP. This dataset will allow the array of

diagnostics to be applied consistently to the same location in order to understand their hierarchy and to develop a classification system based on the metrics.

**PALS and Benchmarking (Gab Abramowitz)**
The Protocol for the Analysis of Land Surface models (http://pals.unsw.edu.au) has progressed to a more advanced version that includes gap filling, empirical benchmarks, and automated metrics along with a large suite of Fluxnet data. PALS been designed to analyze in a standard way uploaded single site model simulations with site observations. Extensions to other data sets and the development of benchmarking tests are under development. For example, implementation of the Manabe bucket model and the Priestly-Taylor approach to flux estimation has been performed in order to use as standard benchmarks of the 'goodness' of current LSMs. The joint GHP-GLASS project PLUMBER has been conceived to demonstrate benchmarking through PALS and results from multiple land surface models are currently being analyzed to produce results for the AMS Annual Meeting and the GEWEX Newsletter. Discussions are now under way for including two-dimensional (ideally for specific well-instrumented and documented basins which implies developing links with GHP and GDAP) case studies within PALS potentially under the auspices of a future follow-on intercomparison project.

**LUCID (Andy Pitman)**
Four papers have been published during 2012-2013 summarizing the LUCID1 and LUCID2 results. This includes evaluation the impact of land cover change in 5 GCMs using the LUH dataset. The Effects of land cover change on temperature and rainfall extremes in multi-model ensemble simulations have been studied, along with the effect of anthropogenic land-use and land-cover changes on climate and land Carbon storage. Some of the main findings are the LULCC matters at the regional scale, the differences in the land surface model parameterizations explain 1/2 to 2/3 of the inter-model dispersion, and that differential amounts of forests removed explain approciamtely 1/3 of the inter-model dispersion. Thus, a key result supports the need to engage LSM and LCC dataset providers both, to see how to intelligently implement LCC in models. LUCID would also like to gauge interest of the LCC community in c20c/CMIP5, but it has been tough to get their attention. There may be linkages between GSWP3 and the landcover treatment in the 20c simulations and LUCID efforts that will be investigated. In terms of future actions, some plans linking LUCID and GLACE are emerging, and a new EU project is beginning near the end of 2013 and N. DeNoblet (LUCID) is coordinating the land cover change WorkPackage of this project. Finally, it is noted that improved connections with the CORDEX project could be useful.

**GLACE2-CMIP5 (Sonia Seneviratne and Bart vd Hurk)**
Exp#1A and #1B of GLACE2-CMIP5 has been completed. This involved AR5 reruns of climate change projections using a 1971-2000 soil moisture climatology versus using a seasonal transient cycle of soil moisture and evaluated during the 2070-2100 period. Five groups are participating in the simulations (GFDL, IPSL, ECHAM, CESM and EC-Earth) and the analysis and the experimental design (ETH). Papers have been submitted. Future phases of experiments involve land cover change. Highlights show that the imposed SM anomalies show similar regions as those projecting drought increase, and a larger impact of soil moisture change on daily max temperature. Precipitation changes are less clear, and additional analysis will be conducted to analyze the feedbacks and water balance (E-P). We expect this to be completed over the next 12 months. Additional groups will be contributing to GLACE-CMIP5 (HadGEM and ACCESS). Finally, a new experiment will be done in which the impact of fixed CO2 for photosynthesis in projections (2006-2100) will be studied along with the resulting radiative forcing vs. feedback from soil moisture.

**PILDAS (Rolf Reichle)**

The launch of PILDAS has been delayed to 2014. The experimental design is nearly complete, and a pilot study by the project lead to use 2 LSMs with 1 DA algorithm in NASA's LIS is to be carried out in late 2013/early 2014. Phase-1 is focused on operational centers (rather than niche research projects), synthetic observations, and different DA algorithms w/different LSMs for a 1/8 degree domain over the SGP. Later phases will focus on coupled DA systems and actual satellite observations from SMOS and SMAP. GLASS will take the experimental plan and pilot results to WGNE to put pressure on centers that are not currently listed (e.g., UK Met).

**ALMIP2 (Aaron Boone)**
The 2nd AMMA phase 2 Land MIP was launched in Spring 2012. In all, 22 LSMs, 5 hydrological models, and 1 ET model are all included in this phase. In this experiment, the focus is on a much higher spatial resolution (mesoscale: 5 km) than in ALMIP1 (regional scale: 0.5 degrees), to focus on the subtle hydrology and vegetation processes that dominate there (occasionally very large rooting depths which access water in near surface aquifers, soil crusting, lateral transfer processes, strong variability in surface runoff), and to enable use of high resolution satellite data. The period covers 4 years, where the forcing is coming from a blend of in-situ and NWP/radar/Landsat/other satellite data. ALMIP2 takes advantage of observational data along a meridional transect from the AMMA-CATCH network, which cuts across a zone with a large gradient in surface characteristics and rainfall. The project will give recommendations on the parameterization of runoff scaling and potentially missing or poorly parameterized processes, which are key to the functioning of the west African land surface. As this project has regional hydrological aspects, it is also considered to be in ideal candidate for a collaborative project between GLASS and GHP to foster close working relationships. However, efforts to connect with GHP failed despite circulating the white paper and experiment details. It is hoped that this connection can be improved in 2014. First results from the mesoscale simulations were presented at the ALMIP2 International Workshop in April, 2013 at Météo-France: analysis is ongoing and some models are finishing reruns. Local scale forcing and data have been distributed, and runs are now being done by the participating LSM groups.

**2. Projects being launched**

1) PILDAS and GSWP3 are in the 'just-launching' phases. Specifically:
   - Launch of the GSWP3 project will happen in February/March 2014 with a workshop in Tokyo. The last year has been spent refining the forcing data and current actions include fostering collaborations with the terrestrial carbon cycle modeling community.
   - Refinement of a white paper and completion of experimental design for PILDAS has taken place. A pilot study will be underway for the end of 2013-early 2014, and contributors will be finalized by early to mid 2014.

2) The GLASS/GABLS DIurnal Coupling Experiment (DICE) experiment began in 2013. The first DICE workshop was held during Oct 14-16 at the UKMO in Exeter. This project involves the GABLS and GLASS members running fully coupled SCMs at the CASES 99 experiment (which was the GABLS2 project) and controlling for surface fluxes vs. atmospheric forcing in each component to isolate the impact of land-atmosphere coupling in the models over the full diurnal cycle (stable and unstable PBLs). Stages 1 (offline land surface), 2 (fully coupled), and 3 (column models forced by surface fluxes) are complete. A protocol for additional simulations is currently being devised in order to produce an additional set of simulations with improved (i.e., closer to the observed) land surface model estimates of latent heat flux (and Bowen ratio). Members from both the GLASS and GASS GEWEX panels were also present at the workshop. A *GEWEX News* article on DICE was also published in 2013. Results from DICE will be presented at the upcoming annual AMS meeting.

3) The LoCo/SGP Testbed Project was presented at last year's Pan-GASS meeting where the ARM data providers attended and the community was invited to participate in a data needs survey for L-A coupling studies. The LoCo and ARM groups have since collaborated to produce a Climate Best Estimate data product (ARMBE-Land) for LoCo studies at the ARM SGP site. This new dataset includes land surface and PBL variables needed for LoCo diagnostic intercomparison, complements other ARMBE products, and is freely available now at hourly resolution from 1996-present.

4) The PLUMBER benchmarking project proposed last year has made significant strides. Using the PALS system, data acquired in conjunction with GHP for 20 sites was used to evaluate an array of land surface models and comparing metrics vs. that of simple formulations (bucket model, P-M, and simple regressions). Many GLASS member groups participated in this initial stage of PLUMBER, and results have been presented at conferences (AMS, WGNE).

**3. New Projects and Activities Planned**

1) Proposals related to the LoCo/SGP Testbed Project have been submitted by LoCo PI's (Ferguson, Santanello, Gentine) to implement new ARMBE-Land project to establish a benchmark of L-A coupling based on LoCo-derived diagnostics compiled by the working group. This includes a proposal for an extended field campaign to better monitor the PBL through augmented radiosonde launches, an integrative proposal to bring together the LoCo metrics and the ARMBE data, and investigation of additional site suitability for LoCo studies [e.g., India (monsoon), AMMA, and Cabauw] as suggested by the GEWEX SSG (2012).

2) GABLS Stable Boundary Layer project
Eric Bazile presented a proposal for a GABLS project for the Dome-C site in Antarctica. A science plan is fourthcoming. GLASS will be involved in terms of assessing the thermal coupling and momentum flux in a polar climate (to date has been lacking in terms of GLASS activities and focus). Since GLASS does not currently have members with experience cold region processes in an antarctic climate, it has been proposed that a link to CLiC needs to be established. An approach to CLiC will be made to find someone who could join the GLASS panel and form a link between GLASS, GABLS and CLiC for this project. It was also agreed at the Pan-GASS GABLS breakout session that the first step of a joint project should have both communities concentrating of their components of the system to fully understand these. A second step could then investigate the impact of land/atmosphere coupling in this environment.

**5. Science Issues**

1) The GSWP3 science details are being finalized. A 6-page document summarizing the key goals and methods of GSWP3 has been submitted to the GLASS panel (just after the recent annual meeting in Exeter, Oct 2013) before the kick-off meeting, such that it can also be distributed to entrain the carbon community up front.
2) The definition of 'local' vs. 'non-local' coupling and representation of each by the array of LoCo diagnostics is a non-trivial issue. This will be addressed directly by the SGP Testbed dataset and diagnostic intercomparison, and will include the effect on coupling metrics of spatial and temporal scales.
3) Forcing height used to force the PILDAS experiments needs to be resolved (either 2/10m or lowest model level). There is not an optimal best solution here at the moment, as some models have only one or the other available.

## 6. Contributions to GEWEX Science and Fit to Imperatives

GLASS contributes *most directly* to the following GEWEX Imperatives:

1) **Develop diagnostic approaches to improve process-level understanding of energy and water cycles in support of improved land and atmosphere models.**
   - Identify feedbacks and the interactions among different processes, and build confidence in their replication in models (GLACE2, LoCo).
   - Spin-up activities in *advanced diagnostics* through a joint pan-GEWEX effort/workshop (GRP, GLASS, GHP, and others).
   - Develop metrics to aid benchmarking activities for both un-coupled and coupled modeling activities (PLUMBER)
   - With the current and expected increasing complexity of land models in terms of various hydrologic and vegetation treatments, model optimization (i.e., parameter estimation approaches) will continue to be relevant to GLASS efforts (through Model Data Fusion).
   - Investigate alternative representations of sub-grid processes in land surface schemes (heterogeneity).
   - Develop improved understanding of climate variability and change on land surface properties, including soils, vegetation and hydrological processes, and an associated modeling capability (GSWP3).
   - Investigate the scope for development of next generation land surface models with improved representation of subsurface hydrology, including groundwater processes; identify suitable areas for their evaluation.

2) **Improve global and regional simulations and predictions of precipitation, clouds, and land hydrology, and thus the entire climate system, through accelerated development of models of the land and atmosphere.**
   - Coordinate the construction of a global land reanalysis system, building on ongoing and preparatory activities in Landflux, GSWP3, GLDAS and operational weather centers.
   - Develop a framework and infrastructure for evaluation of land-atmosphere feedbacks. This should include the development of more quantitative estimates of uncertainty in the land condition and how this uncertainty propagates through to the atmosphere (e.g., PBL, convection, water and energy). This objective will be advanced in conjunction with the Processes Imperative in developing diagnostics.
   - Organize coordinated intercomparison experiments for a range of model components in state of the art land models, especially with regard to: groundwater hydrology; surface water treatment (snow, river routing, lakes, irrigation, and dynamic wetlands); vegetation phonology and links between carbon and water; and Land Data Assimilation systems (follow-up the PILDAS initiative).
   - Evaluation of these land model components will also have to be considered in their interactive (coupled) context with the PBL, while taking into account and developing more quantitative measures of uncertainty in the land parameters and states will enable more robust evaluation of data assimilation systems.

## 7. Contributions to the GEWEX Grand Science Questions

1) **How can we better understand and predict precipitation variability and changes?**
   The GLASS activities below address the linkages of precipitation (and its accuracy) to land surface processes and LSM predictability.

Related current GLASS activities:

- GLACE – Land/SM impact on precipitation and predictability (POC: Sonia/Bart; 1 and 2 complete; CMIP in progress)
- LoCo – Regional/Local Process-Level Quantification of land-PBL interactions and impact of land surface on precipitation (POC: Joe Santanello)
- ALMIP2 – Specific precipitation event studies and heterogeneity issues in soil moisture-precipitation feedbacks (POC: Aaron Boone)
- PILDAS – Land DA of soil moisture; multi-variate coupled DA (precipitation and SM) in a future phase (POC: Rolf)
- GSWP3 – Precipitation as a key forcing for 20$^{th}$ Century simulations – this effort should quantify the error bounds on the "land reanalysis" generated due to precipitation uncertainty (POC: Hyungjun Kim)
- Benchmarking – How does precipitation uncertainty impact offline and coupled model evaluation – spread of LSM physics vs. spread due to precipitation errors (POC: Martin, Gab)

Future activities:

- Incorporation of new satellite products (GPM, SMOS, SMAP) into these efforts more explicitly.

2) **How do changes in the land surface and hydrology influence past and future changes in water availability and security?**

Water Use, Resources, and Sustainability issues are at the heart of this challenge. How can GEWEX be positioned to meet this challenge given the current structure and makeup, currently focused on modeling groups and model intercomparisons with loose ties only (at best) with water resource and planning communities? Current activities are trying to answer various aspects of the science issues here (e.g., soil moisture and drought in a changing climate), but not yet at the stage of integrating the entire terrestrial water budget. GRACE is the only current tool we have in this regard, but is very limited in space and time scales such that regional and diurnal studies and models cannot be improved or assessed using this dataset. Carbon, ecosystem, cryosphere, ground water, and distributed hydrology models are not traditionally GEWEX activities – but fully integrated Earth System and Land models are the future so we need to be forward thinking. It seems this challenge is really the overarching challenge of all land hydrology for climate studies.

As a result, this challenge also intersects directly with other entities (iLEAPS, iLAMB, CLiC, DMIP, LULCC). This challenge might boil down to coordinating model development from previously disparate disciplines and applications, and based on CMIP5 results in terms of the limitations and sensitivities to the land hydrology (e.g. LUCID recent results). The iLEAPS-GEWEX Newsletter collaboration was a good start to this.

Related current GLASS activities:

- LUCID1/2 (POC: Andy)
- ALMIP1/2 (POC: Aaron)
- PILDAS/SMAP (DA of surface>root zone will be critical to link with GRACE)
- PILPS-Urban (POC: Martin)
- LULCC w/iLEAPS (POC: Bart)

Future activities:

- TRACE (now NAWP): The first workshop (2011) ended up discussing many of these water resource and sustainability questions, as 'themes' of a potential TRACE RHP. These questions are the ones that agencies seem most willing to support in the current climate, and communication from pure science/models to stakeholders is something we need to address.

3) **How does a warming world affect climate extremes, and especially droughts, floods and heat waves, and how do land area processes, in particular, contribute?**
This seems to be the "hot topic of the year," e.g., how will the frequency and location of extremes change due to "x" amount of warming in the future? The NASA Energy and Water Cycle Study (NEWS) chose "extremes" as one of its core integration projects, and could be looked at as a model both of what and what not do, and what can be learned by a limited subset of the community (material available online). Model evaluation and benchmarking becomes critical here as well. Most models are tested offline and only for average conditions, and once into extreme realms of forcing or states tend to behave much differently. Recent LSM calibration/parameter estimation studies suggest that a vastly different set of parameters (lookup tables) is required for extremes vs. average conditions. As observational data improves (e.g., challenge #1), this is no guarantee the models will behave better as a result. DA and Calibration studies should be a focus here. Calibration is a weak component of GLASS currently and should be expanded under "Model Data Fusion." You can learn a lot about model behavior and limitations that way, especially in concert with DA.

Related current GLASS efforts:
- PILDAS - DA w/ Calibration for improved soil moisture representation during extreme conditions.
- LoCo - quantification during extremes to get at model behavior & how LSMs impact the persistence of droughts/floods and feedbacks. Seasonal drought prediction needs a lot of improvement with the emphasis on the land impact (http://www.climatecentral.org/news/lack-of-warning-on-2012-us-drought-reflects-flaws-in-forecasting-14823/)
- ALMIP2 - inherently encompasses dry extremes/feedbacks over AMMA with monsoon precipitation.
- GLACE2-CMIP is examining impact of SM on extremes in CMIP5 (IPCC report just out on the subject).
- Benchmarking - should look at model performance stratified by regime.

Future activities:
- CORDEX-GLASS collaboration possibly needs to a) exist and b) accelerate to answer these questions in the context of climate model predictions. This might be most feasible in conjunction with HyMeX over the next 5-10 years.

4) **How can understanding of the effects and uncertainties of water and energy exchanges in the current and changing climate be improved and conveyed?**
This seems to be the most traditional GEWEX-type challenge in that it promotes a lot of activities in the current Panels and relies on the strengths of the current makeup. What this challenge also shows is how much more work needs to be done in quantifying and improving water and energy cycle prediction in models of all scales and types. Results and improvements as a result are felt throughout the remaining three challenges, WCRP, and other communities as well. In order to close the land surface energy balance, we need to address all the issues and model evaluation and development listed in this challenge, and it will require SMOS/SMAP, GPM, GRACE, etc. to get right.

Related current GLASS efforts:

- GSWP3 – Land reanalysis and sensitivity of surface fluxes to forcing uncertainties including radiation.
- LoCo – Determining Processes; how are land and PBL fluxes quantified and how do they interact with each other?
- PILDAS – Constraining LSMs with observations for improved land surface energy balance
- Benchmarking – Asses land surface energy balance in models vs. empirical models, and evaluating the 'goodness' of a model prediction.

Future activities:

- GLASS-GDAP – Improve connection between SRB, Landflux and GLASS modeling and prediction and consistency between data products and models.

Overall Comment:
Having reviewed the challenge documents as a GLASS member, I was also trying to envision myself as a GABLS or GASS member. It seems their expertise lies most prominently in Challenge #1, but that is focused on precipitation only. What about all their work on other things like the stable PBL? Otherwise, they are mostly implicit amongst challenges, the majority of which are quantified at the land surface.

**8. Other key science questions that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project (1-3 suggestions)**

1. The impact of the land surface, soil moisture and vegetation (interactive phenology), and L-A coupling on Seasonal/Drought Prediction.
2. A common modular interface for LSMs (new ALMA?), such that different models and components can be more easily transferred to other's platforms, intercompared, and swapped. This would also include a common land-atmosphere coupling modularity such that different atmospheric and land models can be intercompared in order to evaluate the impact of each on the coupling results.
3. Pressing Model developments/improvements: Improved cold season processes (interactions between permafrost and greenhouse gas emissions), ground water interactions, anthropogenic processes (irrigation, aquifer uptake, crop harvest, improved LULCC), and the LSM "grey zone" (in anticipation of ever-higher resolution research and NWP applications: lateral fluxes of mass, energy...)

**9. Briefly list any specific areas of your panel's activities that you think would contribute to the WCRP Grand Challenges as identified by the JSC**

**Provision of skillful future climate information on regional scales (includes decadal and polar predictability)**

- GSWP3, ALMIP2
- Benchmarking (defining skillful), MDF (improved prediction and skill), and
- LAC (process-level improvement in L-A coupling)

**Regional Sea-Level Rise**

- None

**Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)**

- Possible links to GABLS4 experiment and stable PBL coupling.

**Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity**

- None direct, but L-A Coupling theme addressing the soil moisture-precipitation feedbacks.

**Past and future changes in water availability (with connections to water security and hydrological cycle)**

- GSWP3, GLACE (CMIP), and GPM/GRACE/SMOS/SMAP synergy
- LAC (process-level improvement in water and energy cycle feedbacks)
- Improved understanding of land-surface and hydrological processes in semi-arid zones where water resources are already limited (ALMIP2)

**Science underpinning the prediction and attribution of extreme events**

- See above with respect to GEWEX Challenge #3 (strongest contribution from GLASS is here?)
- Benchmarking (model goodness during extreme conditions), MDF (data assimilation and model calibration during extremes), and LAC (improvements in coupling leading to improved predictability of extreme events from local to global scales)

## 10. Cooperation with other WCRP projects (CLIVAR, CliC, SPARC), outside bodies (e,g. IGBP) and links to applications

1) A connection to CliC has been proposed through the GABLS Stable PBL Project over the arctic region. A suitable GLASS representative for both cold processes and stable PBLs has yet to be identified, however.

2) Better integration between GEWEX and iLEAPS was raised last year. As a result, a joint newsletter between GEWEX (GLASS) and iLEAPS was developed with Gordon Bonan and Joe Santanello as co-editors. Five solicited articles were obtained from members of each community (including four GLASS panel members), with the goal of "bridging the gaps" between modeling efforts in each, and an effort to assess common current and future directions in model development. A session will be devoted to this at both the iLEAPS science conference in China and the GEWEX Science Conference in The Hague, both in Summer 2014.

The newsletter included the following:

- Editorial (Gordon Bonan and Joe Santanello)
- NWP-perspective (Mike Ek, NOAA/NCEP)
- ESM-perspective (Nathalie de Noblet, LSCE)
- JULES joint perspective (Martin Best, Chris Jones, UK Met Office)
- CLM joint perspective (Dave Lawrence, Rosie Fisher, NCAR)
- Model benchmarking (Eleanor Blyth, Dave Lawrence)

## 11. Workshops/Meetings Held

DICE Workshop, Exeter, UK, 14-16 October 2013
ALMIP2 International Workshop 15-17 April 2013, Meteo-France, Toulouse, France

**12. Workshops/Meetings Planned**

GSWP3 Kick-off meeting: Tokyo, Feb./March 2014 (none to date)
WGNE Annual Meeting (GLASS presentation): TBD (potential travel for 1 co-chair)
AMS Annual Meeting (Benchmarking session hosted by GLASS): Atlanta, February 2014 (none)
2014 GLASS Panel Meeting, Pan-GEWEX 2014, Hague, NL (potential travel for chairs)

**13. Other meetings that were attended on behalf of GEWEX or your Panel**

**WMAC2:** Brazil, May 2013; presentation for GEWEX-GLASS, compiled input from other GEWEX Panels
**S2S:** France, February 2013; GLASS presentation, potential connections, and Bart van den Hurk as new POC
**WGNE:** France, November 2013; GLASS annual presentation, connections

**14. Issues for the SSG (*need to update these issues or raise new ones)**

The ALMIP2 leads reached out multiple times to GHP as well for feedback on the white paper/proposal before the project launched earlier this year. There was some limited response by GHP and feedback for Aaron, but were hopeful for a more tangible collaboration in this regard.

In response to an earlier SSG request, we have reached out to HyMeX, which has provided a representative (Pere) who will attend GLASS meetings in the future. Pere attended the panel meeting (teelconf.) in Exeter, and gave an update on land surface and hydrological modeling activities in HyMex. He noted that there is a need to better consolidate such efforts, and there is a possibility for a furture multi-model intercomparison project. There are many 'land activities' as part of HyMeX, and the length and design of the study make it essential that GLASS at least monitor the modelling activities therein. In addition, the HyMeX-CORDEX connection is something GLASS can look to as we attempt to strengthen the land component of CORDEX going forward (to date non-existant).

**15. List of key publications (*where appropriate*)**


GEWEX-iLEAPS

**Bonan, G.,** and **J. A. Santanello**, 2013: Bridging the gap between the iLEAPS and GEWEX land-surface modeling communities. *iLEAPS Newsletter,* **13**.

Brovkin, V., L. Boysen, V. K. Arora, J. P. Boisier, P. Cadule, L. Chini, M. Claussen, P. Friedlingstein, V. Gayler, **B. J. J. M. van den Hurk**, G. C. Hurtt, C. D. Jones, E. Kato, **N. de Noblet-Ducoudré**, F. Pacifico, J. Pongratz, M. Weiss, 2013: Effect of Anthropogenic Land-Use and Land-Cover Changes on Climate and Land Carbon Storage in CMIP5 Projections for the Twenty-First Century, *J. Climate*, 26, 6859–6881.

LAC

**Santanello, J. A., C. D. Peters-Lidard,** A. Kennedy, S. V. Kumar, 2013: Diagnosing the Nature of Land–Atmosphere Coupling: A Case Study of Dry/Wet Extremes in the U.S. Southern Great Plains. J. Hydrometeor, 14, 3–24.

MDF

**Santanello, J. A.**, S. V. Kumar, **C. D. Peters-Lidard**, K. Harrison, S. Zhou, 2013: Impact of Land Model Calibration on Coupled Land–Atmosphere Prediction. *J. Hydrometeor*, 14, 1373–1400.

**16. List of members and their term dates (including changes) where appropriate:**

See updated spreadsheet submitted to GEWEX in August 2013. No changes since last year (below).

The GLASS Terms of Reference have been presented at the panel meetings in 2011 and 2012, and have since been ratified by the GEWEX SSG. These TORs include term limits on chairs of 4 years, staggered in 2-year intervals for continuity of leadership. Two main categories of panel members have been established and without term limits: Experienced Scientists (including project leads) and Young Scientists, as well as a protocol for new members of each category that they attend the next panel meeting and establish their interest and relevance to the panel activities. Template letters signed by GEWEX/Kevin Trenberth have also been developed to welcome new Panel members and to thank departing members for their service.

**Joe Santanello (Co-chair through 31 Dec 2014)**
**Aaron Boone (Co-chair beginning 1 Jan 2013)**
Michael Ek
Hyungjun Kim
Rolf Reichle
Paul Dirmeyer
Eleanor Blyth
Andy Pitman
Bart vd Hurk
Gianpaolo Balsamo
Matt Rodell
Christa Peters-Lidard
Patricia de Rosnay
Sonia Seneviratne
Gab Abramowitz
Craig Ferguson
Nathan Brunsell
Lifeng Luo
Fei Chen
Pierre Gentine
Tomo Yamada

## 3.4 GHP GEWEX Hydroclimate Project Report

**Full Panel, Project or Working Group Name (Acronym):** The GEWEX Hydroclimate Panel (GHP)

**Reporting Period:** 18 October 2012 – 30 September 2013

**URL:** http://gewex.org/ghp-gdap/home.html

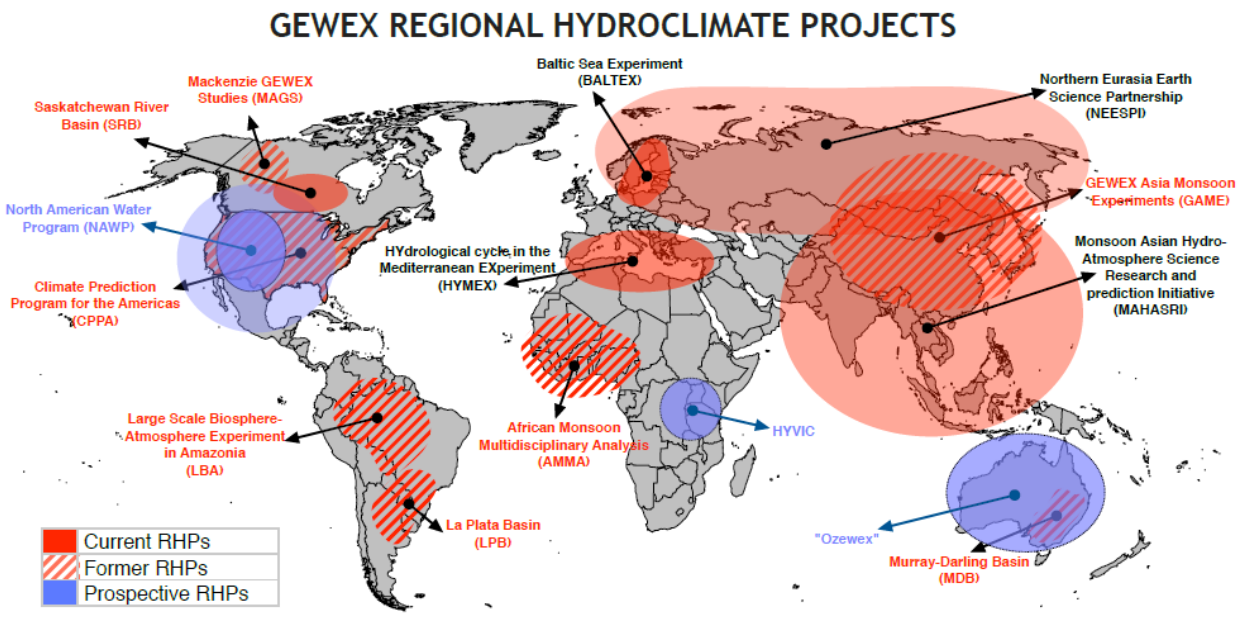
**Co-Chairs and term dates:**
Dr. Jan Polcher (appointed 1 November 2011)
Dr. Jason Evans (appointed 1 November 2012)
4 year terms (renewable one time, upon mutual agreement)

**Panel activities**

GEWEX is based on integrated research projects, observations and scientific activities that aim to improve the knowledge about global climate change and its impacts on a regional scale. The leadership role of GHP in the hydrologic sciences and modeling activities within WCRP has been established as has the progress of the GEWEX Regional Hydroclimate Projects (RHPs) in seasonal forecasting, the detection and attribution of change, and the development and analysis of climate projections. In this way, GHP has continued to organize its activities to keep with the recent strategic planning process in WCRP and GEWEX, to support development and implementation of the WCRP Grand Challenges (http://www.wcrp-climate.org/grandcha.shtml) specifically, the WCRP Grand Challenge related to changes in water availability, which is led by GEWEX and designed to respond to issues associated with how to better understand and predict precipitation variability and changes, and how changes in land surface and hydrology influence past and future changes in water availability and security. The Co-Chairs have also focused on the GEWEX Scientific Steering Group (SSG) challenge to foster collaborations with other groups with common interests in land-surface processes, including GDAP, GLASS, CLIVAR and CORDEX to deal with a number of important issues that range from monsoons, to extremes and how to help coordinate the number of national/regional initiatives in those areas.

**New projects in place**

GHP is now organized around two core activities; namely, all of the Regional Hydroclimate Projects (RHPs), including five potentially new regional studies under development that may achieve RHP status (See Figure 1) and Cross-cutting Sub-projects of which there are no less than three new initiatives since the last reporting period including: (i) Cold Regions precipitation, especially that which undergoes a phase transition (Ron Stewart, Pasha Groisman); (ii) Seasonal hydrologic prediction (Andy Wood) and (iii) GDAP integrated product regional evaluation (TBD). An additional three cross-cutting projects were discussed at the GHP 2013 business meeting, namely, High-elevation precipitation; Climate change and water resources and Regional climate model evaluation (CORDEX).




**All Regional Hydroclimate Projects (RHPs)**

| Current | | | Potential | |
|---|---|---|---|---|
| HYMEX | NEESPI | | NAWP | HyVic |
| MAHASRI | SaskRB | | Baltic-Earth | OzEWEX |
| | | | TPE | |
| **Completed** | | | | |
| LPB | LBA | BALTEX | | |
| MDB | AMMA | | | |

Figure 1 – All of the GHP Regional Hydroclimate Projects (RHPs)

**New projects and activities being planned, including timeline**

The newest RHP is the Saskatchewan River Basin Project (SaskRB), which received RHP "I-Initiating" status at the GEWEX SSG meeting in October 2012, is continuing to evolve on a timeline that should take it to full RHP status this year and continue to contribute to GEWEX through 2017. A new element has been initiated enlarging the scope of SaskRB, namely the Changing Cold Regions Network (CCRN), 2013-2018.

Application of the new criteria also allowed the Panel to validate the continuation of three studies and confirm their end dates, for future planning purposes (NEESPI-2014/15, MAHASRI-2015, and HyMeX-2016). BALTEX was completed in June.

Five other regional studies evolving in the context of GEWEX Regional Hydroclimate Projects (RHPs) are under development and should be formally initiated as part of GHP within the next 3-5 years:

1. The Hydrology of the Lake Victoria Basin (HyVic) study, which is developing under the auspices of GHP, held a planning meeting in July 2013 and elected an International Planning

Committee (IPC) which has a term of responsibility that will run from 2013-2016 or until HyVic is approved as an RHP.

2. The North American Water Project (NAWP), which is still evolving through the planning of initial steps necessary to reach eventual RHP status. A session at the 2013 AGU meeting will explore more aspects of a possible Water resources regional study in North America.
3. The Third Pole Environment (TPE) initiative, which has been discussed in international meetings but little progress has been made toward further steps necessary to reach eventual RHP status. The GHP will continue to monitor activity related to TPE, especially its potential to evolve into an RHP.
4. Baltic Earth is the name of the program that will succeed BALTEX. The continuity in basic research fields, structure (secretariat, conferences, publications) and the network (people and institutions) will be maintained. Baltic Earth stands for the vision to achieve an improved Earth system understanding of the Baltic Sea region and a smooth transition from BALTEX to BALTIC-Earth is expected in 2014 and be active for 3-5 years.
5. OzEWEX is continuing to make progress on a number of issues of importance to GEWEX including those that relate to the GSQs. The OzEWEX Science and Implementation plan, is evolving toward a set of amalgamating themes that the GHP feels will meet the criteria of an Initiating RHP by the end of 2014.

All of the GHP Cross-Cutting projects CCs have been constrained to be projects to be carried out for 2-3 years but, which can be renewed. The currently active CCs (see list below) were addressed in short proposals in 2012-2013, that followed a prescribed template with specifics related to the science objectives, the relationship to the RHP's and the GEWEX Science Questions, and their implementation process. This requires that they provide results or be renewed in the 2014-2016 time period.

Others that are listed as "Potentially" active have reached a level of maturity as to be endorsed by the Panel but have not been formally proposed as yet. Proposals are expected by the time of the GEWEX Science Conference that will take place at the World Forum, The Hague, The Netherlands, from 14-17 July 2014 (http://gewex.org/2014conf/home.html).

Those identified as "Proposed" have had an initial discussion, but require additional dialog between the Panel and those promoting the topic for CC status. Those discussions will take place in 2014.

**GHP Cross-Cutting Projects List**

**Currently active**

- Drought (Ron Stewart)
- Sub-daily precipitation (Hayley Fowler)
- LSM validation & Benchmarking (Mike Ek, GLASS)

**Potentially active**

- Cold Regions precipitation, especially that which undergoes a phase transition (Ron Stewart, Pasha Groisman)
- Seasonal hydrologic prediction (Andy Wood)
- GDAP integrated product regional evaluation (TBD)

**Proposed**

- High-elevation precipitation
- Climate change and water resources
- Regional climate model evaluation (CORDEX)

**Science highlights**

Each RHP has provided science results relevant to the GSQs. HyMeX has recently concluded an intensive observation period that has provided improved observations and predictions of precipitation in the Mediterranean region contributing directly to GSQ1. MAHASRI, using rescued data, has explored decadal and/or multi-decadal changes of ENSO, monsoon and typhoon (Chowdary et al., 2012, Kubota, 2012, Tokinaga et al., 2012). A number of GSQ related aspects of regional climate change were considered as part of the second BALTEX Assessment of Climate Change for the Baltic Sea Basin (BACC-II 2009-2013) including detailed analyses of sea level change in the Baltic Sea, a critical description of methods for describing regional climate futures, an assessment of climate change impacts on socio-economic properties, e.g. on cities and attribution of causes of regional climate change (http://www.baltex-research.eu/BACC2/tallinn2012/index.html).

GHP has initiated cross-cutting projects that involve, but are not be limited to, participation of RHPs. These projects are focused on specific science issues that will be contributions to GEWEX imperatives and grand science questions. They are two or three year initiatives, and are addressing "big" topics, such as droughts. Three of these that kicked off in 2012, have begun to return scientifically important outcomes, in a relatively short time period.

GHP undertook to map the issues that occur at the regional (RHP) scales and to produce a summary/synthesis article that considers the regional questions and brings together the many related facets for a global view. The list of topics for consideration at the regional level included:

- occurrence and known severe droughts
- ability of simple metrics to capture droughts (and limitations)
- types and features and locally appropriate metrics
- trend -- known, suspected, or needs work
- key circulations (low-level jets, storm tracks, anticyclones)
- key processes (soil moisture feedback, snowmelt, etc.)
- predictability
- impacts
- gaps in the aspects above

To put the matter in the GHP/RHP context the following Table (2) was presented, by Dr. R. Stewart.

## RHPs and Extremes-Related Phenomena

Draft summary (needs updating)

| | Heavy Precipitation | Floods | Winter Storms | Drought | Heat Waves | Fires |
|---|---|---|---|---|---|---|
| AMMA | • | | | • | | |
| BALTEX | • | • | • | • | | |
| CPPA | • | • | | • | • | |
| HyMeX | • | • | • | • | • | |
| LBA | • | • | | • | | |
| LBP | • | • | | • | | |
| MAHASRI | • | • | | • | | |
| MDB | • | • | | • | • | • |
| NEESPI | • | • | • | • | | • |
| SRB | • | • | • | • | • | • |

Table 1 – Drought and other extreme events exhibited in the GHP RHPs

The Panel was encouraged to hear that all of the Individual articles for the synthesis article had been submitted. The next milestones are submittal of the article to the Journal of Climate and plans for a follow-on workshop in 2014.

A second project, short time-scale precipitation extremes (Sub-Daily Rainfall), kicked off in 2013. This project has begun to better characterize the global distribution and temporal trends in precipitation extremes at daily and shorter time-scales. This is providing more robust knowledge of the global state of precipitation extremes, the relationship between daily and shorter time-scale extremes, and the potential changes due to global warming.

LSM validation and Benchmarking has been undertaken in GHP as a third, emerging CC. GHP is therefore involved in the GEWEX Global Land/Atmosphere System Study (GLASS) Panel land model benchmarking project: led by Martin Best (UKMO, former GLASS co-chair), Gab Abramowitz (UNSW, PALS), and other GLASS members, including Dr M. Ek, who is a member of GHP. The primary tool for the benchmarking of land models in the framework of this CC is the Protocol for the Analysis of Land Surface models (PALS). The initial project has morphed into the PALS Land sUrface Model Evaluation Benchmarking pRoject (PLUMBER), which is now a "community" experiment that has introduced the concept of land model benchmarking in land modelling development and validation processes taking place within the broader community.

**Science issues**

In keeping with the need to be responsive to the WCRP/GEWEX main challenges and scientific questions GHP has organized itself to address the GEWEX science questions from a regional and integrated perspective. Only at the regional scale can the water cycle be addressed from its physical to human and socioeconomic aspects.

The RHPs are an essential tool in this endeavor as they bring together various disciplines on the water issues. The Cross-Cutting projects allow GHP to propagate knowledge from one region to the

other and synthesis results at the global scale. They also allow development and testing of applications that use the new understanding (science with applicable outcomes).

For GHP, this approach is especially related to the challenge of developing a water strategy that addresses the issue of past and future changes in Water in general, and the GEWEX science question on global water resource systems in particular. In this context, the challenge is to provide research that is relevant to each aspect of GHP's role in GEWEX as noted by the GEWEX SSG (http://www.gewex.org/projects-ghp.html) to be:

- **Regional hydroclimate projects**
- Globally distributed extensive **regional data sets** : water and energy cycle observations (in situ and space borne and modeling data)
- **Global Data Centers**/management systems as prototypes for Water Cycle Observations
- **Regional climate and hydrological modeling and process** Descriptions
- **Hydrological Applications** and Forecasting (Drought monitoring, Hydrological Ensemble Predictions…)

**Contributions to developing GEWEX science and fit into GEWEX Imperatives**

The comprehensive conclusion of the Panel is that the implementation of the WCRP Grand Challenges and science questions depended upon the GEWEX Imperatives: observations and data sets, their analyses, process studies, model development and exploitation, applications, technology transfer to operational results, and research capacity development and training of the next generation of scientists.

These discussions with regard to consideration of science initiatives that are responsive to the imperatives as well as the GCs and the GSQs, led to a proposal for GHP to interact with GDAP to use the products they have produced including Energy/Water, TOA and Surface Fluxes, Land Fluxes, Sea Fluxes, Clouds and Aerosols. Specifically, GHP will look at water budgets with the gross runoff over the world's largest basins. The effort would look at twenty major basins, where runoff is available, to determine if the water budget is closed in the products. As a corollary, a check of potential evaporation (if/where it exists) would enable a conclusion to be made about whether or not evaporation is the reason the budget is not balanced. A proposal will be made to engage GDAP in an effort to examine a number of large river basins (up to 20) using observed runoff to determine the extent to which their water budgets can or cannot be closed. GHP, through its RHPs would contribute to this effort by providing data (including masks) relevant to the exercise, from their regions (SaskRB/CCRN, MAHASRI, HyMeX, BALTEX, etc.). The first results from the analysis of the basin study, should be available at the GEWEX Science Conference and pan GEWEX meeting (July 2014).

Similarly, GHP wants to contribute to GEWEX science that fits into the imperatives by interacting with GDAP on other high priority science issues. Therefore, GHP is going to propose to work with GDAP on an effort that might have the possibility of contributing to a better understanding of the hydrology over orographic terrain (i.e. high mountain precipitation).

**List contributions to the GEWEX Science Questions and plans to include these**

- **Observations and Predictions of Precipitation**
- **Global Water Resource Systems**
- **Changes in Extremes**

- **Water and energy cycles**

The Co-Chairs have developed an outline of plans for further study and implementation over the next 2-3 year period. Decisions have been made concerning the priority of each element in the context of the contribution GHP must make to the GEWEX Science Questions. This evaluation has allowed the Co-Chairs to make recommendations to the SSG about consolidating GHP work and redirecting priorities to be more in line with the next phase of GEWEX. Each RHP and the supporting cross-cutting science elements in GHP will continue to focus on issues that contribute to the GSQs. In specific it is felt that several of the proposed GHP cross-cuts include elements of each GSQ and, therefore, that they represent a good approach for GHP to show progress on work related to the GSQs. This framework is exhibited in Figure 3.

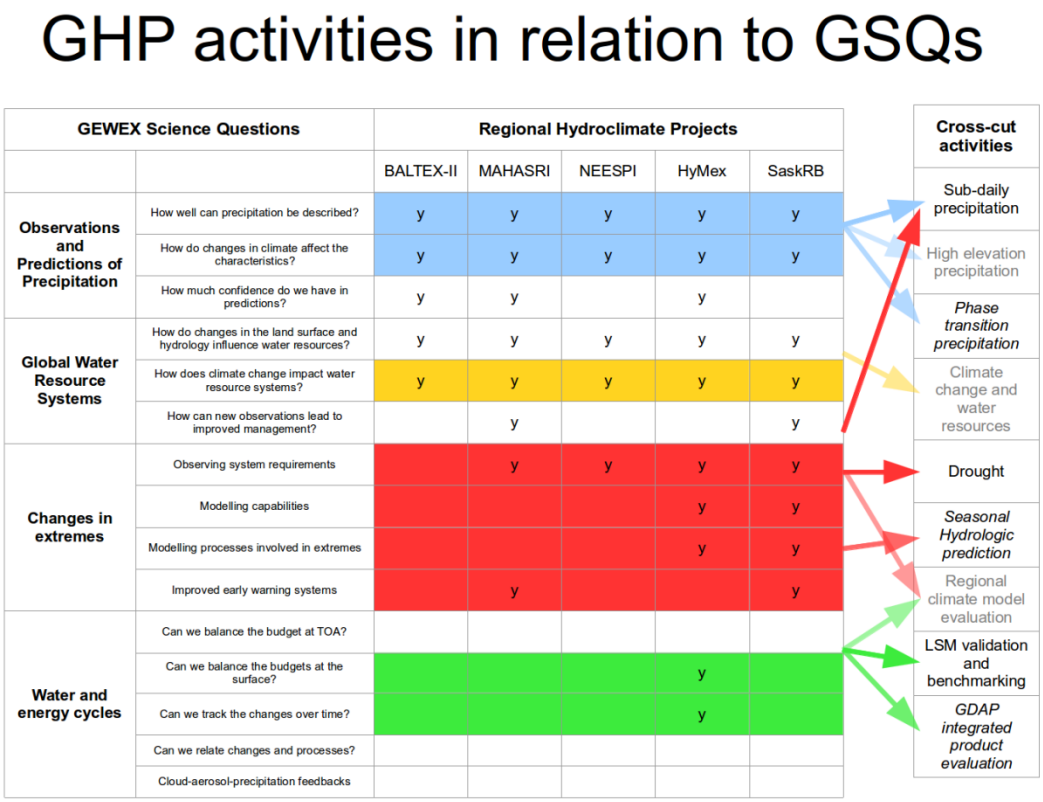



Figure 3 – GHP Contributions to the GSQs

**Other key science questions that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project (1-3 suggestions)**

As a means of hearing from the GHP constituents and the broader community of researchers with interests that parallel GHP science priorities, the Panel reviewed its input to the GEWEX Science Conference that will take place at the World Forum, The Hague, The Netherlands, from 14-17 July 2014 http://gewex.org/2014conf/home.html.

The Conference will set the stage for the next phase of WCRP/GEWEX research so that the GHP and the other elements of GEWEX will come to a better understanding of what key science questions their communities will want to tackle in the future. The GHP relevant sessions highlight those questions and include:

- Advancement of climate systems knowledge through new observations and field experiments (GHP RHP focus)
- Use of climate information and predictions in hydrology and water resources management (GHP/RHP Focus)
- Modeling anthropogenic impacts of land-water-management in land surface models
- Hydrology of high elevation areas
- Land precipitation and drought observations, modeling, errors and uncertainty

**Briefly list any specific areas of your panel's activities that you think would contribute to the WCRP Grand Challenges as identified by the JSC (not covered under 8).**

- Provision of skillful future climate information on regional scales (includes decadal and polar predictability):
  The science challenges associated with the Saskatchewan River Basin RHP include improved monitoring, understanding and modelling of: the region's variable climate, including its hydro-meteorological extremes; the key land surface systems, their response to climate variability and climate change, and atmospheric feedbacks; the effects, on water quantity and quality and aquatic ecosystems, of anthropogenic land use change; societal controls on water management, including policy options and economic instruments and communication of science for policy and management.
- Regional Sea-Level Rise:
  BALTIC-EARTH plans to continue work that was undertaken in BALTEX-II including detailed analyses of sea level change in the Baltic Sea, a critical description of methods for describing regional climate futures, an assessment of climate change impacts on socio-economic properties, e.g., on cities and attribution of causes of regional climate change.
- Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon):
  GHP endorsed a new project that has been initiated enlarging the scope of SaskRB, namely the Changing Cold Regions Network (CCRN), 2013-2018. This Network aims to understand, diagnose and predict interactions amongst the cryospheric, ecological, hydrological and climatic components of the changing Earth system at multiple scales with a geographical focus on Western Canada's rapidly changing cold interior. The geographic center of CCRN is the Mackenzie River Basin, where earlier RHP-type infrastructure had been built up during the Mackenzie GEWEX Study (MAGS).

**Cooperation with other WCRP projects (CLIVAR, CliC, SPARC), outside bodies (e.g. IGBP) and links to applications**

GHP is benefiting greatly from strong interactions with other WMO and WCRP initiatives. The Global Data Centers for precipitation, river runoff and lakes/reservoirs (GRDC, GPCC and Hydrolare, respectively) are affiliated activities under GHP auspices for GEWEX and are activities that are connected through a number of outside bodies to obtain meaningful data for application to research of interest to GEWEX and the broader climate research community.

CCRN as part of the SaskRB RHP will connect with the CliC community. Additionally, the Cold Regions precipitation and the High-elevation precipitation CCs will also have ties to CliC.

GHP has agreed to encourage the development of an international, multi-agency, field program to study multi-scale aspects of intense, organized convective systems that produce severe weather in subtropical South America. The "Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations" (RELAMPAGO-working acronym) study has already met a number of criteria for becoming an RHP, but GHP involvement will require further expansion of its science priorities and will mean working with a number of international groups outside of WCRP including several with links to applications.

GHP will participate in the Latin American and Caribbean Conference on Climate and Society with the objective of identifying new priorities for a new regional group within the WCRP structure. This conference is being promoted by the WCRP Joint Scientific Committee (JSC) through the Variability of the American Monsoon Systems (VAMOS) Panel of CLIVAR.

**Workshops/meetings held**

- Held a GHP side meeting at the 22-27 April 2012 EGU General Assembly 2012 Vienna, Austria.
- Involved in promotion and implementation of the 7-10 May 2012 6$^{th}$ HyMeX Workshop Primosten, Croatia.
- Involved in promotion and implementation of the 6-7 Sept 2012 BACC II Conference Tallinn, Estonia.
- Held the 11-13 Oct 2012 GHP Meeting Sydney, Australia.
- Held a side meeting at the 7-12 April 2013 European Geosciences Union General Assembly 2013 Vienna, Austria.
- Involved in promotion and implementation of the 5-7 June 2013 WCRP Strategy Workshop for Global Water Resource Systems Saskatoon, Canada.
- Involved in the promotion and implementation of the 5-17 July 2013 Workshop on using GRACE data for water cycle analysis and climate modeling Pasadena, California, USA.
- Involved in the promotion and implementation of the 18-19 July 2013 Planning Workshop for a GEWEX Regional Hydroclimate Study on the Hydrology of the Lake Victorian Basin (HyVic) University of Reading, UK.
- Held the 2-6 Sept 2013 Joint Meeting of the GEWEX Hydroclimatology (GHP) and Data and Assessments (GDAP) Panels Rio de Janeiro, Brazil.
- Involved in promotion and implementation of the 7-10 Oct 2013 7$^{th}$ HyMeX Workshop Cassis, France.

**Workshops/meetings planned**

- Will participate at the 15-18 Oct 2013 The Africa Climate Conference 2013 (ACC-2013) Arusha, Tanzania.
- Will participate at the 28-31 Oct 2013 26th Session of the GEWEX SSG Boulder, Colorado, USA.
- Will hold a side meeting at the 9-12 Dec 2013 Fall American Geophysical Union Meeting San Francisco, CA.
- Will participate at the 17-21 March 2014 WCRP Conference for Latin America and the Caribbean: Developing, linking and applying climate knowledge, Montevideo, Uruguay.

- Will participate at the 14-17 July 2014 7th International Scientific Conference on the Global Energy and Water Cycle and the 17-18 July 2014 3rd Pan-GEWEX Meeting both at The Hague, The Netherlands.
- Will hold the annual GHP Business meeting December 2014 at Pasadena, CA, USA.

**Other meetings that were attended on behalf of GEWEX or your Panel**

- Represented at the 11-13 April 2012 Global Drought Information System Workshop Frascati, Italy.
- Represented at the 7-11 May 2012 4th WCRP International Conference on Reanalyses Silver Spring, MD, USA.
- Represented at the 2-6 July 2012 4th AMMA International Conference Toulouse, France.
- Represented at the 13-14 Sept 2012 CLIVAR/Asian-Australian Monsoon Panel (AAMP12) Nanjing, China.
- Presented a poster at the 19-22 Feb 2012 Chapman Conference on Remote Sensing of the Water Cycle Kona, Hawaii, USA.
- Presented a paper at the 3-7 Dec 2012 AGU Fall Meeting San Francisco, California, USA.
- Represented at the 27-28 June 2013 WCRP Strategy Workshop on Observations and Predictions of Precipitation Ft. Collins, Colorado, USA.
- Represented at the 11-13 Sept 2013 VAMOS/CORDEX Workshop on Latin-America and Caribbean, Lima, Peru.

**Issues for the SSG**

GHP would like the SSG to endorse its efforts to advance an international, multi-agency, field program that is being planned in South America, with the possibility of it eventually becoming a GEWEX Regional Hydroclimate Project (RHP) that would study multi-scale aspects of intense, organized convective systems that produce severe weather in subtropical South America. The "Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations" (RELAMPAGO-working acronym) study has already met a number of criteria for becoming an RHP, but GHP involvement will require further expansion of its science priorities and will mean working with a number of international groups outside of WCRP including several with links to applications.

**List of key publications**

There have been a large number of publications that have resulted from work in studies that are part of GHP, especially the RHPs. As a way of indicating the scope of these publications a few have been selected here that have the key GHP representative as first or second author and only from a sample of the active RHPs, including HyMeX, MAHASRI, NEESPI and SaskRB. For further details a link is provided to the reports where more extensive publication lists are available.

HyMeX: http://gewex.org/ghp-gdap/docs/HyMeX.pdf

Drobinski P., Anav A., Lebeaupin Brossier C., Samson G., Stéfanon M., Bastin S., Baklouti M., Béranger K., Beuvier J., Bourdallé-Badie R., Coquart L., D'Andrea F., De Noblet-Ducoudré N., Diaz F., Dutay J.C., Ethe C., Foujols M.A., Khvorostyanov D., Madec G., Mancip M., Masson S., Menut L., Palmieri J., Polcher J., Turquety S., Valcke S., Viovy N., 2012: Modelling the Regional

Coupled Earth system (MORCE): Application to Process and Climate Studies in Vulnerable Regions. Env. Modelling and Software, 35, 1-18

Drobinski P., Ducrocq V., Alpert P., Anagnostou E., Béranger K., Borga M., Braud I., Chanzy A., Davolio S., Delrieu G., Estournel C., Filali Boubrahmi N., Font J., Grubisic V., Gualdi S., Homar V., Ivancan-Picek B., Kottmeier C., Kotroni V., Lagouvardos K., Lionello P., Llasat M.C., Ludwig W., Lutoff C., Mariotti A., Richard E., Romero R., Rotunno R., Roussot O., Ruin I., Somot S., Taupier-Letage I., Tintore J., Uijlenhoet R., Wernli H.: HyMeX, a 10-year multidisciplinary program on the Mediterranean water cycle. Bull. Amer. Meteorol. Soc., in revision.

MAHASRI: http://gewex.org/ghp-gdap/docs/MAHASRI.pdf

Nguyen-Thi, H.A., J. Matsumoto, T. Ngo-Duc, and N. Endo, 2012. A Climatological Study of Tropical Cyclone Rainfall in Vietnam. SOLA, 8, 041–044.

Nguyen-Thi, H.A., J. Matsumoto, T. Ngo-Duc, and N. Endo, 2013. Long-term Trends in Tropical Cyclone Rainfall in Vietnam. Jour. Agrofor. Env. Bangladesh (in press).

NEESPI: http://gewex.org/ghp-gdap/docs/NEESPI.pdf

Groisman and Gutman (eds.), 2013. Environmental Changes in Siberia: Regional Changes and their Global Consequences. Springer, 357 pp.

Groisman, P.Ya., R.W. Knight, and O.G. Zolina, 2013. Recent trends in regional and global extreme precipitation patterns. Chapter 5.03 in Pielke, R. Sr., Hossain F., et al. (eds) Water Encyclopedia (Elsevier Sciences) Climate Vulnerability: Understanding and Addressing Threats to Essential Resources. Elsevier Publishing House ISBN 9780123847034. 1440 pp.

SaskRB: http://gewex.org/ghp-gdap/docs/SaskRB.pdf

Wheater, H.S. and Gober, P. 2013. Water Security in the Canadian prairies: science and management challenges. Philosophical Transactions of the Royal Society A (in press). DOI: 10.1098/rsta.2012.0409.

Nazemi, A., Wheater, H.S., Chun, K.P. and Elshorbagy, A. 2013. A stochastic reconstruction framework for analysis of water resource system vulnerability to climate-induced changes in river flow regime. Water Resources Research. 49(1): 291-305. doi:10.1029/2012WR012755.

**List of members and their term dates (including changes) where appropriate:**

To attain an optimum balance of expertise and to achieve a staggered turn-over of membership existing "charter" members who were initially appointed for 2 years beginning in February 2011 (see list below) and who have shown special interest in continuing their current role in GHP, have been asked to extend their appointments. As a means for establishing a more consistent rotation of membership and to provide for a longer term commitment, which the Co-Chairs can rely upon, appointments for new members will be for a fixed term of 3 years with an option for one 3 year reappointment.

Hugo Berbery (Term ends 1 February 2015)
Mike Ek (Term ends 1 February 2015)
Richard Harding (Term ends 1 February 2015)

Vincenzo Levizzani (Term ends 1 February 2014)
Ana Nunes (Term ends 1 February 2014)
Jeff Walker (Term ends 1 February 2014)
Li Yaohui (3 year term began 1 September 2013; possibility for one additional 3 year term)
Kei Yoshimura (3 year term began 1 September 2013; possibility for one additional 3 year term)

# 4. LIST OF ATTENDEES

**26th GEWEX Scientific Steering Group (SSG) Meeting**
**NCAR Mesa Laboratory, Boulder, Colorado**
**28-30 October 2013**

## GEWEX SCIENTIFIC STEERING GROUP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# 5. AGENDA

## Agenda

*25 October 2013 v10*

### 26th Session of the GEWEX Scientific Steering Group (SSG-26)

Damon Room in the NCAR Mesa Laboratory, 1850 Table Mesa Drive, Boulder CO
28-31 October 2013

*SSG-26 is sponsored by NASA, NCAR, and WCRP*

**Monday, 28 October 2013**

| | |
|---|---|
| 07.30 | Shuttle pick up at Millennium to Mesa Lab |
| 08.00 – 08.30 | Registration |
| | **SESSION 1. CHAIR: H. WHEATER** |
| 08.30 – 08.35 | Opening |
| 08.35 – 08.50 | Welcomes from Local Hosts [Michael Thompson (Deputy Director), Trenberth] |
| 08.50 – 09.15 | Chairman's Report (Trenberth) |
| 09.15 – 09.30 | Introductions, new co-chairs and members |
| 09.30 – 09.50 | Update on WCRP Activities and JPS (Detemmerman) |
| 09.50 – 10.15 | IGPO Report and SSG-25 Actions and Recommendations (van Oevelen) |
| 10.15 – 10.45 | BREAK |
| 10.45 – 11.05 | JSC-34 Outcome and WCRP Grand Challenges Overview (Trenberth) |
| 11.05 – 11.50 | GEWEX Grand Science Questions: Workshops (Wheater/Kummerow) |
| 11.50 – 12.30 | 7th International GEWEX Science Conference<br>Overview on progress (van Oevelen, Wheater, Trenberth)<br>Issues for this meeting |
| 12.30 – 14.00 | LUNCH and **SSG executive session** |
| | **SESSION 2. CHAIR: P. VAN OEVELEN** |
| 14.00 – 14.15 | WGRCI (Clare Goodess) Readytalk |
| 14.15 – 14.35 | CLIVAR (Goddard) |
| 14.35 – 14.50 | JAXA (Oki) |
| 14.50 – 15.05 | SPARC (Alexander) |

| | |
|---|---|
| 14.50 – 15.05 | ESA (Rast) |
| 15.05 – 15.30 | BREAK |
| 15.30 – 15.45 | NASA (Entin) ReadyTalk |
| 15.45 – 16.00 | CliC (TBC) ReadyTalk? / Olga Zolina (5 mins) |
| 16.00 – 16.15 | YOTC (Moncrief) |
| 16.15 – 16.30 | iLEAPS (E. Blythe) |
| 16.30 – 16.45 | NOAA (Rosen) |
| 16:45 – 17.00 | DOE (Mather) |
| 17.45 – 18.00 | Discussion of Project Interactions |
| 18.00 – 20.00 | Reception: Outer Damon Room; fairly heavy Hors d'Oeuvres and drinks (should replace dinner) |
| 20.00 | Shuttle pick up at Mesa Lab to Millennium |

**Tuesday, 29 October 2013**

**SESSION 3. CHAIR: K. TRENBERTH**

| | |
|---|---|
| 08.00 | Shuttle pick up at Millennium to Mesa Lab |
| 08.30 – 09:15 | WCRP Grand Challenges + Discussion (Busalacchi) |
| 09:15 – 09:30 | WDAC (Joerg Schulz) ReadyTalk |
| 09.30 – 09.45 | WGNE (Thepaut) ReadyTalk |
| 09.45 – 10.15 | WCRP Grand Challenge: Climate Sensitivity (Meehl, Klein) ReadyTalk |
| 10.15 – 10.45 | BREAK |
| 10.45 – 12.00 | GASS (Klein) ReadyTalk |
| 12.00 – 12.15 | GASS contribution to Grand Challenges, esp water availability (Klein) ReadyTalk |
| 12:15 – 12.30 | Discussion |
| 12.15 – 13.30 | LUNCH |

**SESSION 4. CHAIR: H. WHEATER**

| | |
|---|---|
| 13.30 – 15.00 | GLASS (Aaron Boone) |
| 15.00 – 15.15 | GLASS contribution to GCs; esp. water availability (Boone) |
| 15.15 – 15.45 | GHP Part 1 (J. Evans) |
| 15.45 – 16.15 | BREAK |
| 16.00 – 17.00 | GHP Part 2 (J. Evans) |
| 17.00 – 17.50 | WCRP Grand Challenge on Extremes (X. Zheng and R. Stewart) |
| 18.00 | Shuttle pick up at Mesa Lab to Millennium |

**Wednesday, 30 October 2013**

**SESSION 5. CHAIR: P. VAN OEVELEN**

| | |
|---|---|
| 08.00 | Shuttle pick up at Millennium to Mesa Lab |
| 08.30 – 09.30 | GDAP Part I (Kummerow) |
| 09.30 – 10.15 | **Invited presentation: Progress and challenges in modeling terrestrial systems in CESM (David Lawrence)** |
| 10.15 – 10.45 | BREAK |
| 10.45 – 11.15 | GDAP Part II (Kummerow) |
| 11:15 – 11.45 | Contributions to WCRP Grand Challenges, esp. Water Availability: GDAP, GHP (15 mins each) |
| 11.45 – 12.05 | LA and C Conference (Rene Garreaud) |
| 12.05 – 12.15 | Discussion |
| 12.15 – 13.30 | LUNCH |
| 12:50 – 13.20 | Boulder flooding Sept 2013, NCAR studies (Roy Rasmussen) |

**SESSION 6. CHAIR: K. TRENBERTH**

| | |
|---|---|
| 13:30 – 13.45 | African Climate Conference (van Oevelen) |
| 13.45 – 14.00 | WMAC |
| 14.00 – 14.20 | CORDEX (Ruti) |
| 14.20 – 15.00 | Pan-GEWEX and pan-CLIVAR meetings (Stephens, Seneviratne) |
| 15:00 – 15:30 | BREAK |
| 15.30 – 16.30 | Monsoons and CLIVAR Collaboration (Goddard, Gochis) |
| 16:30 – 16:55 | The GEWEX Conference: pan-CLIVAR meeting (Goddard) |
| 17.00 | Shuttle pick up at Mesa Lab to Millennium |
| 17.45 | Shuttle pick up at Millennium to Chautauqua: excursion |
| 18.30 | Dinner at Chautauqua, 900 Baseline Rd., Boulder, CO 80302<br>Phone: (303) 440-3776 |
| 20.30 | Shuttle pick up at Chautauqua to Millennium |

**Thursday, 31 October 2013**

**SESSION 7. CHAIR: H. WHEATER**

| | |
|---|---|
| 08.00 | Shuttle pick up at Millennium to Mesa Lab |
| 08.30 – 08:50 | GDAP Rapporteur Report and Discussion (*See below agenda*) |
| 08.50 – 09:10 | GHP Rapporteur Report and Discussion (*See below agenda*) |
| 09.10 – 09:30 | GASS Rapporteur Report and Discussion (*See below agenda*) |
| 09.30 – 09:50 | GLASS Rapporteur Report and Discussion (*See below agenda*) |
| 10.15 – 10.45 | BREAK |
| 10.45 –11.05 | Extremes discussion (Ron Stewart leads) |
| 11.05 – 12.30 | GEWEX Conference |
| 12.30 – 14.00 | LUNCH |

**SESSION 8. K. TRENBERTH (CHAIR)**

| | |
|---|---|
| 14.00 – 14.45 | Actions and Recommendations/Summary and Conclusions (van Oevelen, Wheater) |
| 14.45 – 15.00 | Next Meeting and Any Other Business |
| 15.05 | Adjourn |
| 15.05 – 15.30 | BREAK |
| 15.40 | Shuttle pick up at Mesa Lab to Millennium |

**Reviewers and Rapporteurs**

GHP
Howard Wheater — Rapporteur GHP
Richard Anyah
Rene Garreaud

Extremes
Ron Stewart — Rapporteur Extremes
Olga Zolina

GDAP
Peter Bauer — Rapporteur GDAP
Graeme Stephens
Remko Uijlenhoet

GLASS
Paolo Ruti — Rapporteur GLASS
Eleanor Blyth (ileaps)
Sonia I. Seneviratne

GASS
Minghua Zhang — Rapporteur GASS
Chia Chou

This figure shows the Chautaqua Dining Hall. The odds are finite that we could have snow…