

# WCRP REPORT

World Climate Research Programme



ICSU  
International Council for Science

*Global Energy and Water Cycle Experiment*

**GEWEX**  
WCRP

Report of the

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GEWEX Scientific Steering Group

SSG-22: New Delhi, India, 25-29 January 2010

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# RECOMMENDATIONS AND ACTION ITEMS

From the 22<sup>nd</sup> Session of the GEWEX Scientific Steering Group (SSG)  
25-29 January 2010, New Delhi, India

## Recommendations to GEWEX Panels

1. The Group on Earth Observations (GEO) is developing a registry of all data sets, systems, and services. The Coordinated Energy and Water Cycle Observations Project (CEOP) has registered its data sets with GEO. It is recommended that the GEWEX Radiation Panel (GRP) look into registering its data sets with GEO.
2. It is recommended that the GEWEX Cloud System Study (GCSS) and GEWEX Atmospheric Boundary Layer Study (GABLS) co-chairs review their project structure and discuss this with their project members at the 2<sup>nd</sup> Pan-GEWEX Meeting in August 2010. Their recommendations for reorganizing their projects should then be provided before the next SSG meeting.
3. Based upon the recommendation of CEOP, the GEWEX SSG provisionally accepts the HYdrological cycle in the Mediterranean EXperiment (HyMeX) as a Regional Hydroclimate Project (RHP). HyMeX is asked to give a presentation at the next SSG (to be held in conjunction with the 2<sup>nd</sup> Pan-GEWEX Meeting) and request approval as an RHP.
4. The following scientists are approved as GRP members: Hirohiko Masunaga (Japan), Carlos Jimenez (Paris), Mark Ringer (Met Office, UK) and Enio Pereira (Brazil).
5. Dennis Lettenmaier is approved as co-chair of CEOP.
6. Chris Bretherton is approved as co-chair of GCSS.

## Recommendations to the WCRP Joint Scientific Committee (JSC)

1. It is recommended GEWEX be represented on the WCRP Task Force on Regional Downscaling by Burkhardt Rockel. He is already a member of the COordinated Regional climate Downscaling Experiment (CORDEX), which is a part of this task force. The International GEWEX Project Office (IGPO) and CEOP will contact B. Rockel regarding this.
2. The Scientific Steering Group (SSG) recommends Jan Polcher as the GEWEX representative for the Terrestrial Observation Panel for Climate (TOPC).
3. The SSG recommends Chris Kummerow as the GEWEX representative for the WCRP Observation and Assimilation Panel (WOAP).
4. The SSG recommends Kevin Trenberth as the new chair of the GEWEX SSG.

## Action Items

### A. General

- A.1 Prepare an inventory of GEWEX interactions with the International Geosphere-Biosphere Programme (IGBP) (Action: IGPO and Panel Chairs)
- A.2 Inventory current and potential GEWEX/Climate and Cryosphere (CliC) interactions and explore holding a joint workshop (Action: D. Lettenmaier, IGPO, P. Groisman, GRP, and GMPP reps)

- A.3 Define the role of GEWEX in analyzing the Coupled Model Intercomparison Project-(CMIP)5 and determine whether there should be an organized GEWEX activity in this area. GCSS is already involved and Asian Monsoon Year (AMY) will contribute. It was suggested that GEWEX should start a dialogue with the JSC/CLIVAR Working Group on Coupled Modeling (WGCM). GRP was asked to provide advice on the use of its data sets, for example (Action: C. Kummerow, C. Jakob, J. Matsumoto, SSG Chair, and IGPO)
- A.4 Develop Terms of Reference for Working Groups and Panels under GEWEX and provide to SSG for discussion (Action: IGPO and Panel Chairs)
- A.5 Each panel chair is to provide:
- a. A short description of where his panel will be in a three to five year timeframe.
  - b. A brief report (one to three paragraphs) of research problems that they would like to collaborate on with the other panels
- A.6 Investigate a diagnostic activity for model development (Action: C. Jakob, C. Kummerow, T. Koike)
- A.7 Send the Aerosols, Clouds, Precipitation and Climate Initiative (ACPC) document to the chairs of Stratospheric Processes And their Role in Climate (SPARC) before the JSC meeting and ascertain their interest in a joint GEWEX/SPARC ACPC activity (Action: C. Jakob)
- A.8 Prepare a statement on climate services (Action: H. Wheeler, R. Stewart, GRP, GMPP, CEOP)
- A.9 Design a survey for the numerical weather prediction (NWP) centers to find out which GEWEX products they are using. Invite a representative/representatives from the NWP center(s) to attend the next SSG meeting to give a presentation/presentation (Action: IGPO, SSG Chair; GMPP Chair)
- A.10 Investigate an activity on diagnostics in support of model development (Action: CEOP, GRP, GMPP)
- A.11 Provide an inventory of current Panel interactions with the European Space Agency (ESA) to Valery Detemmerman (Action: CEOP, GRP, GMPP)

## **B. CEOP**

- B.1 Explore potential GEWEX/Global Water System Project (GWSP)/International Human Dimensions Programme on Global Environmental Change (IHDP) collaboration (Action: R. Lawford, E. Wood)
- B.2 Investigate coordination with the Year of Tropical Convection (YOTC) program for AMY (Action: J. Matsumoto)
- B.3 Recommend a new co-chair to replace Toshio Koike (Action: IGPO, T. Koike, SSG Chair)
- B.4 CEOP to clarify the relationship between CEOP activities and African and Asian water studies in terms of management, roles, and responsibilities. This will help clarify the role of GEWEX in the oversight of these activities (Action: T. Koike)

- B.5 Given that the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Program for the Americas (CPPA)'s financial support for CEOP data collection activities at the University Corporation for Atmospheric Research (UCAR) has decreased by 50 percent, letters will be sent to the National Aeronautics and Space Administration (NASA), the NOAA National Climatic Data Center (NCDC), the National Science Foundation (NSF), and the U.S. Department of Energy (DoE) to endorse this activity by designating additional support. Note: UCAR has been doing the data quality control for CPPA and all other CEOP data (Action: IGPO, T. Koike, S. Williams, V. Detemmerman)
- B.6 CEOP will prioritize its objectives to ensure that the needs of the hydrological community are being met by CEOP (Action: T. Koike)
- B.7 In response to concerns expressed at the SSG that the Hydrologic Applications Project (HAP) has insufficient membership to carry out its responsibilities, the membership of HAP will be increased and appropriate action will be taken to make HAP more accessible to the hydrologic community. Specifically, HAP is requested to collaborate with the GEWEX Radiation Panel, the World Meteorological Organization (WMO) Hydrology Department, The Observing System Research and Predictability Experiment (ThorpeX), and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) International Hydrology Programme (IHP) and Water and Development Information for Arid Lands — A Global Network (G-WADI) (Action: E. Wood, T. Koike, IGPO, S. Sorooshian)
- B.8 CEOP is encouraged to actively pursue collaboration with the African Monsoon Multidisciplinary Analysis Project (AMMA), including having representation at the 3<sup>rd</sup> International AMMA Conference in Ouagadougou, Burkina Faso (July 2009). AMMA is also encouraged to participate in the next CEOP meeting being held in Melbourne, Australia in August 2009
- B.9 GEWEX data collected under CEOP activities should be interactively linked with GWSP data on water availability and reservoir storage to allow for a more effective use of GEWEX data in a wide spectrum of applications. (Action: T. Koike)
- B.10 GEWEX data collected under CEOP activities should be interactively linked with GWSP data on water availability and reservoir storage to allow for a more effective use of GEWEX data in a wide spectrum of applications. (Action: T. Koike)
- B.11 CEOP and GLASS to coordinate with CliC on cold region studies

## **C. GMPP**

- C.1 Review the Climate-system Historical Forecast Project (CHFP) implementation plan and determine if GEWEX concerns are being addressed. CHFP is a multi-model and multi-institutional experimental framework for sub-seasonal to decadal complete physical climate system prediction that was launched at the WCRP Workshop on Seasonal Prediction in June 2007 (Action: C. Jakob)
- C.2 Identify a replacement for Randy Koster (Global Land Atmospheric Coupling Experiment-2, GLACE-2) in the CLIVAR Working Group on Seasonal-interannual Prediction (WGSIP) (Action: C. Jakob)

C.3 Recommend a co-chair for GMPP (Action: C. Jakob, IGPO)

C.4 GLASS will extend its panel membership to include the National Centers for Environmental Prediction (NCEP)/the National Oceanic and Atmospheric Administration (NOAA) and others. SSG will need to approve the restructure. It is recommended that Mike Ek (replacement for Ken Mitchell) be involved in this group (Action: M. Best)

#### **D. GRP**

D.1 Investigate the feasibility of having a Baseline Surface Radiation Network (BSRN) site in China (Action: C. Kummerow and E. Dutton)

D.2 Send a letter to Instituto Nacional de Pesquisas Espaciais (INPE)'s Director General requesting permission for Enio Pereira to become a member of GRP (Action: IGPO, C Kummerow)

D.3 Send thank you letters (from WCRP) to outgoing GRP members with copies to their Department Chairs (or other) (Action: IGPO, C. Kummerow, V. Detemmerman)

D.4 Send new GRP members invitation letters (Action: IGPO)

D.5 In an effort to revive the GEWEX Water Vapor Project, GRP will investigate holding a joint workshop with the International Television and Infrared Observation Satellite (TIROS) Operational Vertical Sounder Working Group (ITWG), CLIVAR, and SPARC to assess existing water vapor products (Action: J Schultz, C. Kummerow)

D.6 The SSG agreed with the GRP request to find a new name for this panel that more accurately represents its activities. GRP will suggest alternatives for its name at the next SSG meeting (Action: C. Kummerow)

D.7 Draft a letter to the Director of WCRP requesting support for travel for Baseline Surface Radiation Network (BSRN) activities within the GRP context (Action: C. Kummerow, IGPO)

D.8 Coordination is to be improved between GRP and CLiC for hydrologic studies in northern latitudes

D.9 Increase the visibility of Continuous Intercomparison of Radiation Codes (CIRC) in the climate modeling community by encouraging presentations at climate modeling meetings and at the Working Group on Numerical Experimentation (WGNE) meeting

# 1. INTRODUCTION AND OVERVIEW

This report summarizes the main developments in GEWEX during the year 2009 and includes the main items and recommendations from the 22<sup>nd</sup> Session of the GEWEX Scientific Steering Group (SSG), held in New Delhi, India on 25–29 January 2010. The meeting was hosted by Dr. Kapil Dev Sharma of the National Rainfed Area Authority (NRAA), Government of India. Dr. J. S. Samra, the Chief Executive Officer of NRAA and Dr. Ghassem Asrar, Director of the World Climate Research Programme (WCRP), provided opening remarks. Special presentations included “Cold waves, heat waves and droughts” (J. Samra); “Integrated information base—savior of water sector” (A. Gosain); “Plan of Indian satellites in understanding the science of tropical weather and climate” (P. Pal); and “Formulation of a global model as a tool for forecasting, geo-engineering and climate change” (O. Sharma).

At the meeting Tom Ackerman resigned as Chair of the SSG due to obligations at his home institution and the SSG members unanimously endorsed Kevin Trenberth to replace him. The WCRP Joint Scientific Committee approved Dr. Trenberth as Chair in February.

## 1.1 Major Activities and Achievements in 2009

One of the year’s larger focuses was the Sixth International GEWEX Science Conference, held in conjunction with the Second Integrated Land Ecosystem-Atmosphere Study (iLEAPS) Science Conference in Melbourne, Australia, on 24-28 August 2009. Almost 400 scientists from 32 countries attended. Both conferences were organized together and around a central theme, *Water in a Changing Climate—Progress in Land-Atmosphere Interactions and Energy/Water Cycle Research*, to emphasize the unique aspects of the GEWEX and iLEAPS programs, while highlighting the overlap in their scientific communities. Joint oral and poster sessions were held that combined the mutual scientific interests and subject matter of both programs. The 150 oral and 250 poster presentations given during the Conferences showed that the mutual science from both international frameworks has already led to new collaborations and insights, and the Early Career Scientist Workshop engaged students and young researchers involved in the field. The weeklong event also featured keynote speeches highlighting the important role that GEWEX and WCRP as a whole have played in the progress of climate research.

The **GEWEX Radiation Panel (GRP)** showed excellent progress in many of its activities. The final report of the Cloud Assessment Project is scheduled for completion in 2010. It reviews existing long-term climatologies and compares these to data from the improved complement of satellite-flown instruments. Climatological averages, as well as their regional, seasonal, and diurnal variations are presented, and differences between results from the various data sets are discussed. Routine International Satellite Cloud Climatology Project (ISCCP) data set production is being transferred to NOAA/NCDC, which will ensure its long-term archival.

The GRP/SeaFlux Version 1.0 data set has been completed for the period of 1998–2005. LandFlux produced an inventory of available global surface latent and sensible heat flux products. First results from global, monthly (1993–1995) comparisons indicate that overall geographical patterns are consistent among data sets (dry vs. wet regions), but there exists a large range between data sets in some regions, in particular in tropical rainforest areas. GRP is planning a “state-of-the-art” suite of global energy and water cycle products with error bars for closing the global water and energy budgets for the period 1980 to 2010.

GRP projects are making headway for the first-ever integrated data set that combines the different projects to produce an integrated product for water and energy variables. This product will contain water variables in the form of water vapor, clouds and precipitation, short and long wave radiation at the top of the

atmosphere as well as the surface, and surface turbulent (latent and sensible) fluxes. The integrated data, planned for 50 km and three to six hour intervals, will be the first data set that tries to close budgets at regional scales and should be useful for process studies.

The **GEWEX Modelling and Prediction Panel (GMPP)** and the Working Group on Numerical Experimentation (WGNE) initiated and conducted a WCRP-wide survey on model development across all application areas. The survey went out to the community in August 2009 and response has been good. The main areas for future model development that were highlighted in an early analysis of the responses to the survey included: (i) tropical biases and errors in tropical variability often associated with the representation of tropical deep convection; (ii) cloud-climate feedbacks; (iii) the carbon cycle; and (iv) the representation of physical processes in high-resolution models. The analysis of the responses is ongoing and a second distribution of the survey that includes the World Weather Research Programme's THE Observing System Research and Predictability Experiment (THORPEX) community went out in early December. The results of the survey will serve as the foundation for a workshop on "physical processes in Earth-system models" planned for early 2011.

The GMPP/Global Land/Atmosphere System Study (GLASS) has reorganized into three focus areas: (1) benchmarking, (2) data assimilation, and (3) land-atmosphere coupling. For details about the three focus areas, see the GLASS meeting report in the November 2009 issue of *GEWEX News*. First results from the Global Land-Atmospheric Coupling Experiment (GLACE-2) have been published in the American Geophysical Union Geophysical Research Letters and show that there is a significant impact of land-surface initialization for large anomalies. The GEWEX Clouds System Study (GCSS) continues its strong research activity with more than 300 researchers involved. One of the successes this year is the approval of a new European Union Seventh Framework Project called EUCLIPS that concerns cloud intercomparisons, process studies, and evaluation. In 2009 the GEWEX Atmospheric Boundary Layer Study (GABLS-3) presented results of the experiment at a successful workshop (see related article in November 2009 issue of *GEWEX News*). In the future, GABLS will focus more on regional models/modelling as well and there are plans to include some tagged-on experiments in conjunction with the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5).

GMPP remains at the heart of the implementation of the model development activities in WCRP, and GMPP study groups form the core of a new expert group on parameterization within the World Meteorological Organization (WMO) under the auspices of WGNE. The role of this group is to advise all WMO activities in the area of parameterization and to set the agenda for parameterization development activities.

The **Coordinated Energy and Water Cycle Observations Project (CEOP)** Satellite Gateway was established at the following Internet page: <http://monsoon.t.u-tokyo.ac.jp/ceop2/satellite/>. A contribution by JAXA in coordination with the University of Tokyo has been established that applies to an ongoing effort to provide CEOP satellite data sets for integration with CEOP in situ and model output data. CEOP satellite data were geo-coded (i.e., re-sampled to a regular lat/long grid) and provided at three scales: 250 km rectangular, monsoon regional, and global scales. These data were also made of an image element and a metadata component that is compliant with the ISO-19115 standard.

The CEOP Water and Energy Budget Studies (WEBS) have been expanded to understand average conditions during the entire CEOP period, including the influence of aerosols and a study of water isotopes. CEOP modelling studies now include explicit global, regional, land surface, and Hydrologic Applications Project (HAP) efforts and have begun researching international models related to the CEOP reference sites. "Multimodel Analysis for CEOP" was published by M. Bosilovich, et al., in the August 2009 issue (Vol. 10) of the *Journal of Hydrology*.

In order to better utilize available CEOP data sets for bridging the gap between the global and regional aspects of CEOP research, opportunities are being explored to integrate these efforts with other planned or ongoing initiatives in the broader climate research community, such as the WCRP-initiated Coordinated Regional climate Downscaling Experiment (CORDEX) effort.

## 1.2 GEWEX Planning for Post-2013

A significant part of the SSG Meeting was devoted to discussions and planning surround the future of GEWEX in accordance with WCRP plans to redefine its long-term functions and structure for the post-2013 era. The SSG agreed that the three GEWEX panels [the GEWEX Radiation Panel (GRP), the GEWEX Modeling and Prediction Panel (GMPP), and the Coordinated Energy and Water Cycle Observations Project (CEOP)] were relevant to the organization of GEWEX and similar components were strongly recommended in future plans for GEWEX. After a discussion of how the GEWEX Phase II objectives and activities could best evolve into the new post-2013 WCRP organizational structure, the SSG developed a draft mission statement (see below) for GEWEX post 2013 with a list of draft Imperatives (things that must be done). The Imperatives will be further refined at the 2<sup>nd</sup> Pan-GEWEX Science Meeting to be held 23–27 August 2010 in Seattle, Washington, which will include all of the GEWEX panels, projects, and working groups, and will be followed with an abbreviated session of the SSG. The anticipated outcome of the 2<sup>nd</sup> Pan-GEWEX Meeting is a document that states where GEWEX is headed and how it will be accomplished, which will feed directly into WCRP plans.

### **GEWEX Mission Statement:**

*To measure and predict global and regional energy and water variations, trends, and extremes (such as heat waves, floods, and droughts), through improved observations and modeling of land, atmosphere, and their interactions, thereby providing the scientific underpinnings of climate services.*

The SSG members also discussed how GEWEX will contribute to the World Meteorological Organization global framework for climate services and developed a draft statement of GEWEX contributions (see Appendix).

## 1.3 Goals and Plans for Major Activities for 2010

As stated in the previous section, a significant amount of time in 2010 will be spent in defining the GEWEX Imperatives for the post-2013 period and how the Project will transition there.

The GEWEX and CLIVAR Task Force on Climate Extremes will develop the scope, focus, and deliverables for this crosscut. IGPO will coordinate an assessment of GEWEX accomplishments for Phase II.

All GRP products are preparing for the reprocessing cycle to begin in late 2010. This reprocessing cycle will not only improve each of the products separately, but will use common ancillary data so that products can be merged into the integrated GEWEX water and energy product. NCDC has tentatively agreed to put together the product and host it. Key activities within the GRP projects relate to improving their own product to accommodate this integrated water and energy cycle product.

The Cloud Assessment Project report should be finished mid-2010. It discusses existing long-term climatologies and also compares these to improved instruments aboard the NASA Earth Observing

Satellites (EOS) and A-Train. Climatological averages as well as their regional, seasonal, and diurnal variations will be presented, and differences between results from the various data sets will be discussed.

BSRN expressed a strong desire to add measurements and reporting of aerosol optical depth as the highest priority from BSRN sites. The second priority for these sites is spectral measurements, which can be used for independent validation of models as they do not assimilate down welling radiances.

The Global Precipitation Climatology Project (GPCP)'s plans, aside from continuing to process data on a timely manner, is to focus on the version three (V3) plans for the algorithm that will have significantly higher time and space resolutions (approximately three hour, 25 km) for part of the period.

One focus of GMPP for 2010 will be to investigate linkages to the new emerging direction in the community, which is the generation of so-called parameterization test-beds, such as the one currently running at the Royal Netherlands Meteorological Institute (KNMI) for the European community and the one under development by the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) community. Those test-beds are essentially automatic systems that run single-column models routinely every day in real time and compare their results to observations taken at the highly instrumented ARM and Cloudnet sites. As these activities involve the entire single column model, they essentially integrate the research interests of all GMPP projects. They therefore constitute a great opportunity for a GMPP-wide activity in model evaluation.

CEOP Land Modeling activities will be emphasized during 2010. Moving this work up in priority will allow the HAP Task Team to advance the common goal of generating physically coherent fields of land surface states and fluxes through the integration of disparate data products. The Land Modeling effort will avail itself of available data sets such as those at NASA/the Goddard Space Flight Center (GSFC) (<http://disc.gsfc.nasa.gov/hydrology/>) and Princeton (<http://hydrology.princeton.edu/data.pgf.php>) that have been identified as relevant and will seek opportunities to integrate its work with that being undertaken as part of the planning for the third Global Soil Wetness Project (GSWP-3) and with work underway as part of the GEWEX Global Land Atmosphere System Study (GLASS) and the LandFlux activity that has been launched recently by the GEWEX Radiation Panel (GRP), in collaboration with GLASS. LandFlux wants to develop the needed capabilities and to produce a global, multi-decadal surface turbulent flux data product, which is consistent with the goals proposed for the CEOP Land Modelling Task Group.

CEOP will advance existing collaboration between CEOP Cold Regions and High Elevation Studies in 2010. Existing collaboration between the CEOP Cold Regions Study (CRS) and the CEOP High Elevations Study (HE) will be better organized and more formally established. International conference calls designed to further the existing dialog between these groups related to work on these specific topics will continue in 2010.

CEOP will also ensure that Global to Regional Scale Analysis will be given priority in 2010 in order to better utilize available CEOP data sets for the purpose of addressing the matter of bridging the gap between the global and regional aspects of CEOP research. The Baltic Sea Experiment (BALTEX RHP), the Tibet region of the Monsoon Asian Hydro-Atmospheric Science Research and prediction Initiative (MAHASRI) and parts of the AMMA RHP are the initial candidate regions to be included in this work. Key individuals from the CEOP Cross Cutting Study area and the CEOP Model Output Working Group who are doing work at both the Global and Regional scales will make use of data sets that have already been produced under CEOP-initiated studies in each case.

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

Dr. Einar-Arne Herland presented European Space Agency (ESA) plans to establish long-term alliances with major international Earth system science programs. The Water Cycle Multi-Mission Observation Strategy (WACMOS), funded by ESA and supported by GEWEX, is the first of many such planned. Initial results of this project were presented during a Water Cycle Science Conference held in November 2009. The Project, funded under ESA's Support To Science Element Programme, has two primary objectives: (1) developing and validating a product portfolio of novel geo-information products that respond to GEWEX scientific priorities and that exploit the synergic capabilities between data from ESA and other Earth observing missions; and (2) exploring and assessing different methodologies towards the development of long-term consistent data sets of key variables describing the water cycle. WACMOS is focused on four components of the water cycle: evapotranspiration, soil moisture, clouds, and water vapor.

The Cold Regions Study and several Regional Hydroclimate Projects (RHPs) of the Coordinated Energy and Water-Cycle Observations Project (CEOP) are coordinating activities with the WCRP Climate and Cryosphere (CliC) Project to produce a solid precipitation data set. This process includes integrating satellite, model, and in situ data from CEOP cold region sites in different RHPs. The characteristics of the CliC cold regions data archive and in situ data set have been defined to include snow cover and frozen ground from Asian regions that can and are now being compared with CEOP sites. In addition, information, data, and analyses taking place within the activities of the Glacier Group of Asia-CliC and CliC are being gathered and formatted for application toward meeting the goals of the CEOP Cold Regions Study. The Baltic Sea Experiment (BALTEX) is contributing to this effort through a national activity to calculate radar-based daily precipitation accumulation maps in a limited area at the CEOP Sodankylä site.

The CEOP High Elevations (HE) Regional Study requires globally integrated analyses of CEOP reference sites' data, remote sensing observations, and models' analysis and application. For this reason HE enlisted the support of a number of groups, including members of the CEOP RHPs and representatives from other GEWEX Panels, as well as from CliC, to provide input and review of the CEOP HE Science Plan. A special HE poster session was also organized at the GEWEX/iLEAPS Joint Conferences held in August 2009 in Melbourne, Australia. A number of posters highlighted collaborative initiatives related to water and energy budget studies, aerosols, and extreme events in high elevation regions, as well as multidisciplinary topics related to climate change in mountain areas that support ecosystems sensitive to global change. CEOP HE is also cooperating with the Coordinated Asia-European long-term Observing system of Qinghai-Tibet Plateau hydrometeorological processes and the Asian-monsoon system with Ground satellite Image data and numerical Simulations (CEOP-AEGIS) in the planning of the 2<sup>nd</sup> International Workshop on Energy and Water Cycle over the Tibetan Plateau and High-Elevations, to be held in Lhasa, China, 19–21 July 2010.

## 1.5 Publications and Other Projects

IGPO publishes a quarterly GEWEX Newsletter. Representation of GEWEX at numerous national and international conferences, meetings, and workshops has resulted in various publications, including proceedings, peer-reviewed literature, and more. This year the IGPO prepared four newsletters and the Report of the 21<sup>st</sup> Meeting of GEWEX SSG, Irvine, California,

Publications:

- (1) Bosilovich et al., 2009. A Multi-model Analysis for CEOP. *J. Hydrometeorol.* 10, 912-934.

- (2) MacDonald, A., L. Bowling, B. Fekete, R. Lammers, and R. Lawford, 2009. US River Discharge for 2008 [In "State of the Climate in 2008"]. *Bull. Amer. Meteor. Soc.* 90 (8), S129.
- (3) Z. Li et al., 2009. Uncertainties in Satellite Remote Sensing of Aerosols and Impact on Monitoring their Long-Term Trend: A Review and Perspective. *Ann. Geophys.* 2755-2770.
- (4) Chen et al., 2009. Improving Noah Land Surface Model in Arid Regions with an Appropriate Parameterization of the Thermal Roughness Length. *J. Hydrometeorol.*, submitted.
- (5) Ferguson, C. R. and E. F. Wood, 2009. An evaluation of satellite remote-sensing data products for land surface hydrology. *J. Hydrometeorol.*, submitted.
- (6) Ferguson, C. R., J. Sheffield, E. F. Wood, H. Gao, and D. P. Lettenmaier, 2009. Quantifying uncertainty in remote sensing based estimates of evapotranspiration due to data inputs over the continental United States. *Int. J. Rem. Sens.*, in review.
- (7) Qin, J., S. Liang, K. Yang, I. Kaihotsu, R. Liu, and T. Koike 2009. Simultaneous estimation of both soil moisture and model parameters using the particle filtering method through the assimilation of microwave signal. *J. Geophys. Res.*, 114, D15103, doi:10.1029/2008JD011358.
- (8) Sheffield, J., C. R. Ferguson, T. J. Troy, E. F. Wood, and M. F. McCabe, 2009. Closing the terrestrial water budget from satellite remote sensing. *Geophys. Res. Lett.*, 36, L07403, doi:10.1029/2009GL037338.
- (9) Yang et al., 2009a. Validation of a Dual-pass Microwave Land Data Assimilation System for Estimating Surface Soil Moisture in Semi-arid Regions, *Journal of Hydrometeorol.*, 10, 780-793.
- (10) Yang et al., 2009b. Some practical notes on the land surface modeling in the Tibetan Plateau. *Hydrol. Earth Syst. Sci.*, 13, 687-701.
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- (12) Yang, K., H. Lu, T. Koike, 2009e. Microwave LDAS improves soil moisture and land flux estimates. *GEWEX News* 19(3), 2-3.
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## 1.6 Outreach and Capacity-Building Activities

Peter van Oevelen organized scientific sessions at the European Geophysical Union on remote sensing of land-surface/atmosphere interaction processes and a session on Remote Sensing and Hydrology. For the Hydrology-Satellite Application Facilities (SAF) Workshop at the Vienna University of Technology, he arranged a session and invited lecture on Microwave Remote Sensing.

During 2009, Dr. Oevelen provided inputs on GEWEX and the energy and water cycle to a number of documents and questionnaires from organizations including GEO, ESA, and the European Science Foundation (ESF). He made presentations to agencies such as the NOAA Climate Prediction Office, the U.S. Global Change Climate Program, and NASA. He also serves on the Expert User Advisory Committee in support of the Water Cycle Multi-Mission Observation Strategy (WACMOS) of ESA. Dr. van Oevelen continued to strengthen the links between GEWEX and the other WCRP core-projects in particular with CLIVAR, and contributed to two major WCRP reports, the WCRP Implementation Plan 2010-2015 and the WCRP Achievements Report.

The IGPO sponsored two conferences during the year. The Milankovitch Symposium, *Climate Change at the Eve of the Second Decade of the Century*, was organized by the Serbian Academy of Sciences and Arts

(SASA) in Belgrade on 22-25 September 2009. GEWEX sponsored this symposium and helped with advertising and the selection of speakers. The symposium was also supported by UNESCO and the International Association of Hydrological Sciences (IAHS). The second meeting, *Earth Observation and Water Cycle Science: Towards a Water Cycle Multi-mission Observation Strategy*, was an ESA conference planned in collaboration with GEWEX, EGU, and ISPRS and held at ESA/ESRIN in Frascati, Italy on 20-21 November 2009. Nearly 200 remote-sensing experts from more than 30 countries gathered to assess the state-of-the-art instruments and scientific developments used in characterizing global water cycle variability and to identify the main needs in modelling and data assimilation.

IGPO continues to serve on the Executive Board of the IGWCO and support the IGWCO Science Committee that currently takes responsibility for input to the water task under GEO. IGPO also continues to serve as a link to GEO activities through representation on various GEO committees, including Capacity Building (Dr. van Oevelen) and the User Interface Committee (Dr. Lawford).

## 2. GEWEX PANEL STATUS REPORTS

### 2.1 Coordinated Energy and Water-Cycle Observations Project (CEOP)

**Full Name (Acronym):** Coordinated Energy and Water-Cycle Observations Project (CEOP)

**Reporting Period:** 2009

**URL:** <http://www.ceop.net>

**Chair(s) and term dates:** Co-Chairs Drs. Toshio Koike and Ron Stewart. Two-year terms beginning in 2007 renewable for additional two years and set to coincide with the endorsement of the GEWEX SSG at its annual meeting.

*Objectives:*

CEOP's goal is to understand and predict continental to local-scale hydroclimates for hydrologic applications. CEOP's strategic objectives, which are parallel with GEWEX objectives, include:

1. Producing consistent research-quality data sets complete with error descriptions of the Earth's energy budget and water cycle and their variability and trends on interannual to decadal time scales, for use in climate system analysis and model development and evaluation
2. Enhancing the understanding of and quantification of how energy and water cycle processes contribute to climate feedbacks
3. Improving the predictive capability for key water and energy cycle variables and feedbacks through improved parameterizations to better represent hydrometeorological processes, and determine the geographical and seasonal characteristics of their predictability over land areas
4. Undertaking joint activities with operational hydrometeorological services' hydrological research programs to demonstrate the value of GEWEX research, data sets, and tools for assessing the consequences of climate predictions and global change for water resources

Some technical issues that are being addressed as part of the CEOP objectives are:

- Applying an integrated hydroclimate data set to address a variety of scientific topics, which must be advanced in order for the Project to meet its objectives
- Developing the capability to handle and disseminate a large amount of data from diverse sources
- Analyzing and comparing this diverse data with model simulations to understand the underlying mechanisms and model deficiencies

- Assimilating and integrating the data with newly developed models
- Transferring CEOP methodologies to other regions, sectors, and applications

*Past Year Activities (Status, Significant Changes, Accomplishments):*

A “Multimodel Analysis for CEOP” was published by M. Bosilovich, et al. in the August 2009 issue (Vol. 10) of the *Journal of Hydrology*.

The CEOP Cold Regions Study and several Regional Hydroclimate Projects (RHPs) are now coordinating activities with the WCRP Climate and Cryosphere (CliC) Project. The process of integrating data from CEOP cold region sites has begun. The characteristics of the cold regions data archive and data set have been defined to include snow cover/frozen ground from Asian regions that can be compared with CEOP sites.

The CEOP Water and Energy Budget Studies (WEBS) have been expanded to understand average conditions during the entire CEOP period, including the influence of aerosols and a study of water isotopes.

The CEOP Reference Site Data Management Internet page at <http://www.joss.ucar.edu/ghp/ceopdm/> was newly re-organized. The reference site characteristics have been catalogued on that page along with all of the information about the entire CEOP in situ database. The data collection has been an on-going process and it is the role of the NCAR EOL as the CEOP Central Data Archive (CDA) to maintain the status of the contributions from the CEOP reference sites.

CEOP modeling studies now include explicit global, regional, land surface, and Hydrologic Applications Project (HAP) efforts and have begun researching international models related to the CEOP reference sites.

A CEOP Model Output Management Document was drafted as a guide for the participating centers to use in setting up their processes for meeting their commitments to CEOP.

In order to better utilize available CEOP data sets for bridging the gap between the global and regional aspects of CEOP research, opportunities are being explored to integrate these efforts with other planned or ongoing initiatives in the broader climate research community, such as the WCRP-initiated COordinated Regional climate Downscaling EXperiment (CORDEX) effort.

A CEOP satellite data set has been populated with data from instruments flown on Japan Aerospace Exploration Agency, European Space Agency, and National Aeronautics and Space Administration spacecraft. Tools for handling historical data were provided by the National Oceanic and Atmospheric Administration.

CEOP Satellite data were geo-coded (i.e., re-sampled to a regular lat/long grid) and provided at three scales, 250 km rectangular, monsoon regional, and global scales. These data were also made of an image element and a metadata component that is compliant with the ISO-19115 standard.

The CEOP Satellite Gateway was established at the following Internet page: <http://monsoon.t.u-tokyo.ac.jp/ceop2/satellite/>. A contribution by JAXA in coordination with the University of Tokyo has been established that applies to an ongoing effort to provide CEOP satellite data sets for integration with the CEOP in situ and model output data.

*New Directions – Longer Term Vision:*

Many of the former GEWEX Continental Experiments (CSEs) have evolved to more complete Regional Hydroclimate Projects and even beyond in that more than GEWEX efforts are now needed to solve regional problems involving a climate prediction focus (CLIVAR) and a biological/environmental focus. Many now have an anthropogenic climate focus that CEOP will continue to encourage.

This development has prompted CEOP to begin investigating how to best enhance integration of data from in situ, satellite, and model sources. In the same way, but on the broader international scale, CEOP is committed to investigating outreach initiatives with other Earth System Science Partnership elements such as the Group on Earth Observations (GEO).

In addition to the RHPs, CEOP now includes groups focused on regional studies in cold regions, high elevation, monsoon, and semi-arid regions. These groups are associated with the CEOP Monsoons Regional Study, which is working in concert with the Pan-WCRP Monsoon crosscut. CEOP will exploit this range of topics in unique ways that match the strengths and weakness of each community.

The science of CEOP will continue to provide a traditional focus on Water and Energy budgets, which will extend the efforts to understand average conditions to conditions during the time period of 2002 to present. This extension will have a special focus on extremes during the same period, which will be another connection to WCRP crosscut activities. New crosscutting CEOP science efforts include a study of the influence of aerosols and the study of water isotopes, which is also connected to efforts in other international research communities.

CEOP has added explicit global, regional, land surface, and hydrologic applications as part of its group activities, including a specific Hydrologic Applications Project (HAP) that is cooperating with other similar efforts such as the Hydrologic Ensemble Prediction Experiment (HEPEX).

All of the CEOP modeling groups are looking at an ensemble of international models in many different regions focused on the new CEOP reference sites. Some of these modelling projects expect to show not only their capability to simulate the present climate but also to predict at seasonal (HAP) scales and also be useful for global change assessments in some of the RHPs.

By 2012, a functioning CEOP data center will be in use by all of the CEOP science groups. It should be noted that this CEOP data is already open to outside groups. CEOP data management is also in the process of developing links to a number of associated groups, such as the Global Runoff Data Centre and Global Precipitation Climatology Centre.

#### *2010 Activities:*

The main actions/recommendations for 2010 that were formulated at the CEOP Third Annual Meeting at Melbourne, Australia, during the period 19-21 August 2009, included:

The Data Management Working Group will submit a proposal with an implementation scheme and schedule for defining and organizing a CEOP ten-year data set. This action is to take the data periods associated with the Coordinated Enhanced Observing Period and to meld them with the expanded data requirements of the “new” CEOP as a means of integrating the overall CEOP data requirements with the available CEOP data resources.

Develop a concise summary of CEOP activities, especially covering the work that has taken place since the successful integration of the RHPs to be submitted to the Bulletin of the American Meteorological Society (BAMS). A draft of the initial CEOP Synthesis Document will be ready by the end of March 2010, with submission set for later in 2010.

Ensure further integration of the CEOP Hydrological Applications Project (HAP) with other synergistic parts of the CEOP science community. This activity has been selected as a high priority effort for 2010. A number of action items are currently being worked on, including ways to ensure this effort will address both seasonal forecasting, mainly drought, in cooperation with Hydrological-Atmospheric Pilot Experiment (HAPEX) and flood prediction and climate change impact analyses in cooperation with the Global Earth Observation System of Systems (GEOSS)/Asian Water Cycle Initiative (AWCI).

CEOP Land Modeling activities will be given “Fast Track” status during 2010. Moving this work up in priority will allow the HAP Task Team to advance the common goal of generating physically coherent fields of land surface states and fluxes through the integration of disparate data products. The Land Modeling effort will avail itself of available data sets such as those at NASA/GSFC (<http://disc.gsfc.nasa.gov/hydrology/>) and Princeton (<http://hydrology.princeton.edu/data.pgf.php>) that have been identified as relevant and will seek opportunities to integrate its work with that being undertaken as part of the planning for the third Global Soil Wetness Project (GSWP-3) and with work underway as part of the GEWEX Global Land Atmosphere System Study (GLASS) and the LandFlux activity that has been launched recently by the GEWEX Radiation Panel (GRP), in collaboration with GLASS. LandFlux wants to develop the needed capabilities and to produce a global, multi-decadal surface turbulent flux data product, which is consistent with the goals proposed for the CEOP Land Modeling Task Group.

CEOP will advance existing collaboration between CEOP Cold Regions and High Elevation Studies in 2010. Existing collaboration between the CEOP Cold Regions Study (CRS) and the CEOP High Elevations Study (HE) will be better organized and more formally established. International conference calls designed to further the existing dialog between these groups that is related to work on these specific topics will continue in 2010. The CEOP International Coordination function has the action to work with the CRS and HE Lead persons (O’Hata and Tartari) to initiate more regular interactions and communications between these existing groups to improve their collaboration and show additional results in a number of areas where there are already existing interactions, including:

- The convergence of observations and data integration from CEOP Cold Regions and HE reference sites,
- Long-term variation of snow distribution in northern regions and its impact on atmospheric circulation,
- Water and energy budgets (WEBs) in cold regions, and
- High mountain hydrology, including glaciers.

CEOP will ensure that Global to Regional Scale Analysis will be given priority in 2010 in order to better utilize available CEOP data sets for the purpose of addressing the matter of bridging the gap between the global and regional aspects of CEOP research. The BALTEX RHP, the Tibet region of MAHASRI, and parts of the AMMA RHP are the initial candidate regions to be included in this work. Key individuals from the CEOP Cross Cutting Study area and the CEOP Model Output Working Group who are doing work at both the Global and Regional scales will make use of data sets that have already been produced under CEOP-initiated studies in each case. These would include:

- Model Analyses for CEOP (MAC) subset products for CEOP RHPs,
- CEOP Inter-Continental Transferability Study (ICTS) co-analysis products, and
- CEOP Stable Water Isotope Intercomparison Group (SWING) subset products for RHPs.

CEOP will take on the formulation of “adaptation” as a main theme. Although it is agreed that the broadest aspects of Anthropogenic Climate Change (ACC) are not consistent with the current CEOP Strategic Implementation Plan, they are not wholly outside the scope of the work CEOP has been involved in on a day-to-day basis. It has, therefore, been agreed that CEOP would embrace some of the main tenets

of ACC and would look into ways of contributing to those in direct fashion. Some ideas related to this consensus were:

- Identifying regional to local Impacts of ACC on the hydroclimates in RHP basins,
- Quantifying uncertainty by using CEOP data infrastructure,
- Testing models and ACC scenarios by applying WEBS analysis techniques, and
- Exploiting CEOP/RHP connections to local/basin scale model Centers to assist in ACC work.

CEOP expects to make progress toward its first objective to produce consistent research quality data sets. To provide the framework in which this progress can be made, CEOP has identified the following three specific technical issues:

- Development of an integrated hydroclimate data set that can be used to answer the CEOP main scientific questions
- Development of the capability to handle and disseminate a large amount of data from diverse sources
- Analysis and comparison of a diverse but “standardized” dataset with model simulations to understand the underlying mechanisms and model deficiencies

These technical issues will drive work in the coming year in the context of the CEOP interoperability scheme for achieving its scientific objectives through organization, handling, and analysis of its specialized research data sets.

One of the key activities of CEOP going forward is to establish an integrated observation system by combining different types of observations, in situ and satellite. In addition, the numerical weather prediction model outputs are merged with the observed data to provide spatially and temporally continuous coverage in a complementary way.

Key agreements will be pursued to obtain in situ data from 52 selected globally-distributed "reference" stations. These Reference Sites provide enhanced observations of sub-surface (soil profiles), surface (standard meteorological and radiation), near surface (flux tower), atmospheric profiles (rawinsonde and profiler), and ancillary data sets (radar, special observations).

Almost all components of the water cycle among the atmosphere, land, and ocean can be observed by currently available satellite sensors. The CEOP satellite data set, which consists of the main water cycle parameters, will be exploited to accomplish CEOP's own scientific goals.

The nine operational and one experimental NWP centers and two data assimilation centers that archive specific model output data for CEOP will continue to be coordinated and the data archived for application in the follow-on to both the Multimodel Analysis for CEOP and the CEOP Inter-Continental Transferability Study (ICTS).

Other Global Data Centers have sought collaboration with CEOP. The Global Runoff Data Center (GRDC) and the GPCC have had long-term affiliation with GEWEX and this synergistic affiliation will be continued through CEOP in the future. At the core of the collaboration between CEOP and these Centers is their potential contribution to CEOP studies through provision of quality controlled data sets that the CEOP database would not otherwise have available.

To make maximum use of the multi-temporal, spatial scale, and multi-source data sets covering global climate diversity, CEOP has established a global interoperability arrangement. This agreement, which covers the in situ, satellite, and model output from all contributing groups, will be made more efficient in the coming year to ensure that there will be a consistent long term source of quality data products required by CEOP's expanded science agenda.

The work associated with satellite data set development, integration, and dissemination will continue to evolve as planned.

*Key Results:*

**Cold Region Study:** The process of integrating data from CEOP cold region sites has begun. The characteristics of the cold regions data archive and data set have been defined to include snow cover/frozen ground from Asian regions that can be compared with CEOP sites. Information, data, and analysis within the activities of the glacier group of Asia-CliC and CliC are being gathered and formatted for application toward meeting the goals of the CEOP Cold Regions study.

Work is progressing with good success for CEOP to produce a well-calibrated solid precipitation dataset in cooperation with CliC. The effort will continue using CEOP northern latitude reference site data with data from CliC sites. BALTEX is playing an important role in this effort by contributing relevant data and improved understanding of how to more accurately determine snow amount and type from radar data.

**High Elevation Study (HE):** CEOP-CRS, CEOP-WEBS, CEOP-Extremes, CEOP-Model, MAHASRI, the Northern Eurasian Earth Science Partnership Initiative (NEESPI) and GMPP-GLASS, CliC, and GWSP have begun cooperating to contribute to the understanding of water and energy cycles in high elevation regions and study their role within the climate system by means of globally integrated analysis of CEOP reference sites data, remote sensing observations, and models analysis and application.

**Monsoons:** CEOP has evolved components to integrate observations based on coordination among field science groups, space agencies, and Numerical Weather Prediction (NWP) centers in the local, regional, and global scales to assist in advancing the CEOP Monsoon Study (MONS) effort. This initiative now includes multiple observation and science activities within the fields of hydrometeorology and hydroclimatology. Elements of GEWEX, WCRP, and Earth System Science Partnership (ESSP) initiatives including CEOP-Aerosols, CEOP-WEBS, CEOP-Extremes, CEOP-Model, MAHASRI, the Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA), the La Plata Basin (LPB), AMMA, GMPP, and GRP; CLIVAR; and the Global Water System Project (GWSP) and the Monsoon Asia Integrated Regional Study (MAIRS) are being urged to contribute to the Monsoon Studies in CEOP.

**Semi-Arid Region Study:** As a result of a CEOP-inspired International Workshop on Semi-arid Land Surface-Atmosphere, four task groups have been formed and are working on the following issues in the context of the CEOP Southern Research Station (SRS) study framework:

- Observation standards and data quality control,
- Application of remote sensing information,
- Intercomparison of land surface models, and
- Feedback mechanism between aerosol-cloud-precipitation.

**Water and Energy Budget Study:** The microwave land data assimilation system developed by the University of Tokyo was evaluated with the Mongolian soil moisture network. Soil moisture and soil porosity estimated by this system were comparable with observations. With respect to the application of CEOP satellite data, a satellite data algorithm was developed to utilize high-resolution Landsat-7 Enhanced Thematic Mapper (ETM) and Atmosphere Surface Turbulent Exchange Research (ASTER) to estimate surface energy budget on Tibet for clear-sky conditions. The estimates agree with in situ observations, and all their absolute percent difference is less than ten percent.

The diurnal cycle of water and energy (both surface and integrated column) was compared over the continental United States from three analyses, showing consistent phases despite varying amplitude. Two

evaluations are conducted, respectively, for dominant balances and exchanges of the atmospheric water cycle in the NCEP/DOE Reanalysis-2 and the temporal variability of the water cycle's sensitivity to pairings of land-surface schemes and convective parameterizations.

A recent key result in the CEOP WEBS crosscutting science foci was that the University of Maryland developed a high-resolution shortwave radiation product. This product is proved superior to GEWEX-Surface Radiation Budget (SRB) and International Satellite Cloud Climatology Project (ISCCP)-Flux Data (FD) for the Tibet region.

**Extremes Working Group:** Since this effort officially began in 2007, significant steps have been taken. These include maintaining a listing of extremes-related activities within CEOP, arranging a workshop to address common and unique issues, organizing special sessions at annual CEOP meetings to address these issues, and developing specific activities to move the effort ahead. In this regard a number of specific steps are currently underway, including:

- Assessing existing extreme event catalogues and incorporate this into the Extremes information base,
- Producing a high resolution dataset on global precipitation,
- Pulling together at least one comprehensive, continental-scale dataset on multi-year drought, and
- Preparing a review article on extremes.

**Aerosols Working Group:** Major recent activities for the CEOP Aerosol Study included AMY/Japan-Mexico Joint Meeting (JAMEX). Through this work the CEOP Aerosol Element has been able to provide an opportunity to attract other resources to conduct joint aerosol-monsoon research. The 6<sup>th</sup> Workshop of Asian Monsoon Years, which was held 30 November to 1 December 2009 in Kunming, China, was supported by CEOP. The data collected in earlier field observations initiatives is now part of the AMY 2007-2012 and CEOP data archive. Collaborations have been developed with groups that will allow assessment of the direct and indirect radiative forcing and water cycle feedback processes.

**Isotopes Working Group:** The Isotope Cross Cut Study (ICCS) contributes to CEOP by facilitating isotope studies, which augment and enhance the predominant non-isotope studies within GEWEX/CEOP. The ICCS includes a modeling research group called the Stable Water Isotope Working Group (SWING; <http://atoc.colorado.edu/~dcn/SWING>). The SWING has been using water isotope information to understand water cycle processes and to quantify their role in climate and climate feedbacks. Since the first SWING, several new isotope implementations in climate models have emerged (currently nine or more operational models). Nudging techniques (*c.f.* Yoshimura et al., 2008) have been introduced that allow direct comparisons between the simulations and the Global Network of Isotopes in Precipitation (GNIP) database.

**Global Model Working Group:** The global modeling effort within CEOP has been providing global analyses and forecasts supporting CEOP science goals, including Model Output Location Time Series (MOLTS) for local process studies. It has also been evaluating the uncertainty of models and analyses with the intent of having the science activities provide feedback into understanding the global NWP systems. Most recently this effort has achieved a number of accomplishments, not the least of which has been achieved through the Multimodel Analysis for CEOP (MAC) initiative, including the finding that MAC Ensemble data compare well to Global P (GPCP), Global outgoing longwave radiation (OLR), and Basin scale precipitation.

**Regional Model Working Group:** CEOP Inter-Continental Transferability Study (ICTS) Phase 1 finished in 2009. Six regional climate models (RCMs) from different institutions participated in the ICTS Phase 1 experiment. Continuous simulations for the time period 2000-2004 were performed for seven domains on the globe. These domains were chosen to reflect the CEOP RHPs. The time period covers the

CEOP coordinated enhanced observation period of 2002-2004, which gives the opportunity to compare model results with observations collected within CEOP. Model results from ICTS can be used within the CEOP regional and crosscutting studies. This work has provided a basic data set that can be used in studies on extreme events like floods and droughts that are of great importance.

**Regional Hydroclimate Projects:** The regional studies associated with GEWEX/CEOP are major regional studies that have already been tasked by the GEWEX SSG with satisfying a number of scientific and technical criteria that can only be established by large projects involving a multitude of investigators. The CEOP focus on regional basins and climatically sensitive regions of the world encourages researchers to study these areas, understand their regional hydrological and radiation budgets, and ensure that these are well represented in global climate system models.

**AMMA** (<http://amma-international.org/>): The AMMA Third International Conference was held in Ouagadougou, Burkina Faso, on 20-24 July 2009. The AMMA data page is on the Internet at: <http://database.amma-international.org/home.jsf>. A new point of contact has been provided to CEOP for discussions on data sharing and research priorities. Dr. Thierry Lebel is now the main contact point for AMMA.

The AMMA policy to communicate and report to the various international programs and bodies was revised in October 2009. AMMA is currently preparing the science plan for its second phase (2010-2020). The plan is to forward that document to CEOP for comments, in the hope that fruitful collaborations with AMMA will continue to contribute to CEOP.

**BALTEX** (<http://www.baltex-research.eu/>): Recent technical findings from BALTEX reported at the CEOP Third Annual meeting include:

- Kjellström and Lind, 2009: Changes in the water budget in the BALTEX area in future warmer climates as simulated in a regional climate model, BER 14 (1)
- The third release of the Rossby Centre Regional Climate model (RCA3) has been used to downscale results from two general circulation models, with three different emissions scenarios, for the years 1961–2100
- The future climate change signal shows a gradually warmer and wetter climate during the 21<sup>st</sup> century with increased moisture transport into the region via the atmosphere. This leads to an intensification of the hydrological cycle with more precipitation and evaporation, except for the summer
- The net precipitation increases in all scenarios in the entire region. The changes are of the order 15%–20% for annual and areal mean fluxes
- The control climate in the late 20<sup>th</sup> century is too wet as compared with observations. This wet bias in the simulations is partly attributable to biases in the global forcing models but is also amplified in the regional climate model

**CPPA** ([http://www.climate.noaa.gov/cpo\\_pa/cppa/](http://www.climate.noaa.gov/cpo_pa/cppa/)): CPPA moved ahead on a number of initiatives, one of which was a core modelling project undertaken in concert with NCEP, outlined below.

#### **CPPA NCEP Core Project: 2009**

##### *Coupled Climate Modeling*

- Completed summer and winter seasonal forecasts (25 different years during 1979-2006) using the NCEP Climate Forecast System (CFS)
- Upgrading from previous generation *Oregon State University (OSU)* to advanced *Noah* land-model physics necessary in both Global Land Data Assimilation System (GLDAS) and in CFS for consistent and proper spin-up of land-state initial conditions

- Modest gain in CFS precipitation skill during summertime over U.S. for El Nino Southern Oscillation (ENSO)-neutral (vs. ENSO-active) years

#### *Uncoupled Land Modeling*

- Completed 30-year (1979-2008) retrospective for North American Land Data Assimilation System (NLDAS) land models [Noah, Variable Infiltration Capacity (VIC), Mosaic, and Sacramento Soil Moisture Accounting (SAC)]
- Quasi-real time monitoring of model hydrological land-states (soil moisture, evaporation, runoff, streamflow, etc)
- Routine execution of Princeton University CFS-forecast-based national (U.S.) seasonal hydrological forecasts
- Monitoring and seasonal forecasts used in drought support (National Integrated Drought Information System, NIDIS)

**LBA** (<http://daac.ornl.gov/LBA/lba.html>): LBA focused a great deal of time and resources in 2009 on improving on its commitment to provide CEOP with specialized data sets. The main accomplishments in this respect include:

- Manaus Surface Meteorology and Radiation submitted on July 2009
- Manaus Soil Temperature and Moisture submitted on August 2009
- Manaus Flux data submitted on August 2009
- Processes and procedures now in place allow us to start delivering data at a much faster pace than before!

**LPB** (<http://www.eol.ucar.edu/projects/lpb>): Progress in 2009 was focused on three specific activities underway within the LPB framework:

- A Europe-South America Network for Climate Change Assessment and Impact (CLARIS)
- Inter-American Institute for Global Change Research (IAI)/LPB Ecosystems, Biodiversity, Land Use and Cover, and Water Resources
- NASA/LPB Remote Sensing/Data assimilation–Capacity Building

**MAHASRI** (<http://mahasri.cr.chiba-u.ac.jp/>; <http://www.wcrp-amy.org/>): An important part of MAHASRI's progress in 2009 was further cooperation with the Asia Monsoon Years (AMY) initiative:

- Coordination with AMY has been going well. New coordination with YOTC has started
- AMY-Intensive Operation Period (IOP) (2008-2009) has been successfully conducted
- MAHASRI has come into a new epoch, starting two new projects in Thailand and Indonesia through Japan International Cooperation Agency (JICA)/Japan Science and Technology Agency (JST) funds
- Interactions among diurnal variations, International Organization for Standardization (ISO), monsoon
- Warming processes, data assimilation over the Tibetan Plateau
- Long-term data rescue in South East Asia

**MDB**: Progress in 2009 was summarized at a workshop that was held in Sydney on 6-7 April 2009 that involved research groups working on the hydrology, meteorology, and climate of the Murray-Darling Basin (MDB). The workshop web page is online at:

[http://web.maths.unsw.edu.au/~jasone/mdb\\_rhp/workshop09/aims.html](http://web.maths.unsw.edu.au/~jasone/mdb_rhp/workshop09/aims.html). Many of the action items from the workshop were activities for the newly forming Bureau of Meteorology Water Division to perform. The division is up and running, and progress is being made. It is actively developing the Australian Water Resources Information System (AWRIS), which is expected to be operational by the end of 2009. This system addresses a number of the action items focused on data collection, quality control, and

dissemination. Another development has been the formation of the Water Information Research and Development Alliance (WIRADA), which in collaboration with the Centre for Australian Weather and Climate Research (CAWCR), is addressing a few more action items including a comparison of evapotranspiration estimation methods and the potential for real-time rainfall predictions. The Terrestrial Ecosystem Research Network (TERN), which recently gained funding, will address other action items including supporting the monitoring of fluxes through the Australian flux network and observational super-sites within the MDB.

**NEESPI** (<http://neespi.org>): More than 560 scientists from over 200 institutions of 30 countries are working on more than 130 individually-funded projects under the Initiative umbrella (with annual budget of ~\$15M), and several more projects are in the process of joining NEESPI. Additionally, NEESPI receives in-kind assistance from E.U., U.S., Russian, Chinese, Japanese, Ukrainian, and International Agencies and Institutions. Two studies that were reported on at the CEOP Third Annual meeting in August 2009 were:

- Observed sea ice retreat associated with more atmospheric moisture in early winter over usually dry continent leading to deeper snow cover over Eurasia (Bulygina et al., 2009) and
- Dramatic warming in Siberia associated with projected land cover change (*c.f.* Vygodskaya et al., 2007) that begins more quickly/earlier following forest fire and permafrost thaw leading to the forest being replaced by steppe.

**HyMeX** (<http://www.hymex.org/>): The Hydrological cycle in the Mediterranean Experiment (HyMeX) is the newest RHP. It is an international project that aims to

- Improve our understanding of the water cycle, with emphases on extreme events by monitoring and modeling the Mediterranean coupled system (atmosphere-land-ocean), its variability (from the event scale, to the seasonal and interannual scales) and characteristics over one decade in the context of global change and
- Evaluate societal and economical vulnerability and adaptation capacity to extreme meteorological and climate events.

Series of coordinated observation periods are foreseen during the 2010-2020 time period. They will be based on measurement campaigns, the deployment of dedicated instrumentation, and the enhancement of existing operational systems. A comprehensive description of HyMeX's underlying science is provided by the project white-book, available through its web page. First versions of the International Science and Implementation Plans are expected for the end of 2009. Outcomes of the multi-disciplinary research conducted in HyMeX should be beneficial to the improvement of:

1. Observational and modeling systems, especially of coupled (ocean-atmosphere-land) systems,
2. The prediction capabilities of high-impact events,
3. The accurate simulation of the long-term water-cycle, and
4. The definition of adaptation measures, especially in the context of global change.

*Recommendations/Issues for the SSG:*

1. CEOP recommends that the SSG endorse the nomination of Dr. Dennis Lettenmaier to become the CEOP Co-Chair replacing Dr. Ronald Stewart, effective at the end of the 2010 SSG meeting.
2. The SSG may wish to revisit the matter of the selection and integration of new Regional Hydroclimate Projects (RHPs) into the GEWEX/CEOP International Framework. It should be reconfirmed that all the current RHPs will remain designated as full partners in GEWEX/CEOP. Limitations exist in some aspects of all of the RHPs' abilities to meet their commitments to address every aspect of the criteria established by GEWEX for them to be fully recognized as a GEWEX/CEOP Regional Hydroclimate Project. When do such limitations constitute a large

enough breach to prevent recognition of a new project or to change the designation of an existing project?

*Contributions to WCRP Strategic Framework:*

As noted in **1. Overview** above, the CEOP Objectives parallel those of GEWEX and CEOP believes that by fulfilling its commitment to provide deliverables that meet its objectives, it will make significant contributions to the WCRP/GEWEX strategic framework.

**Objective 1:** Produce consistent research quality data sets complete with error descriptions of the Earth's energy budget and water cycle and their variability and trends on interannual to decadal time scales, for use in climate system analysis and model development and evaluation.

Specific Technical Issues:

- Developing an integrated hydroclimate data set that can be used to answer the main CEOP scientific questions
- Developing the capability to handle and disseminate a large amount of data from diverse sources
- Analyzing and comparing with model simulations this diverse data to understand the underlying mechanisms and model deficiencies

Specific Deliverable (2011-2012): A “state-of-the-art” suite of global energy and water cycle products complete with error bars for closing the global water and energy budgets for the period 1980 to 2010.

**Objective 2:** Enhance the understanding of and quantification of how energy and water cycle processes contribute to climate feedbacks.

Associated Science Questions:

- What are the average hydroclimate conditions over various regions and seasons?
- How do water and energy flow into and through individual regions as well as being redistributed within these regions by local mechanisms?
- How do extremes occur and what is their role in the hydroclimate?
- How do aerosols affect the hydroclimate?
- Does knowledge of water isotopes help us to understand the water cycle?

Specific Deliverable (on-going): By making work on these questions its highest priority, the CEOP community is advancing in a step-wise manner the understanding of the contributions of water and its highly coupled non-linear interactions in regulating feedbacks to the climate system.

**Objective 3:** Improve the predictive capability for key water and energy cycle variables and feedbacks through improved parameterizations to better represent hydrometeorological processes, and determine the geographical and seasonal characteristics of their predictability over land areas.

Associated Science Question:

- Can we simulate and predict the hydroclimate cycle?

Specific Technical Issues:

- Assimilating and integrating the data with newly developed models

Specific Deliverable (TBD): CEOP expects to assist in providing a final review of the success of GEWEX in improving parameterization at operational NWP and climate modeling centers and its impact on the predictive capabilities for key energy and water cycle variables, including hydrological prediction.

**Objective 4:** Undertake joint activities with operational hydrometeorological services' hydrological research programs to demonstrate the value of GEWEX research, data sets, and tools for assessing the consequences of climate predictions and global change for water resources.

Associated Science Question:

- What is society's benefit from this increased knowledge about the hydroclimate?

Specific Technical Issues:

- Transferring CEOP methodologies to other regions, sectors, and applications

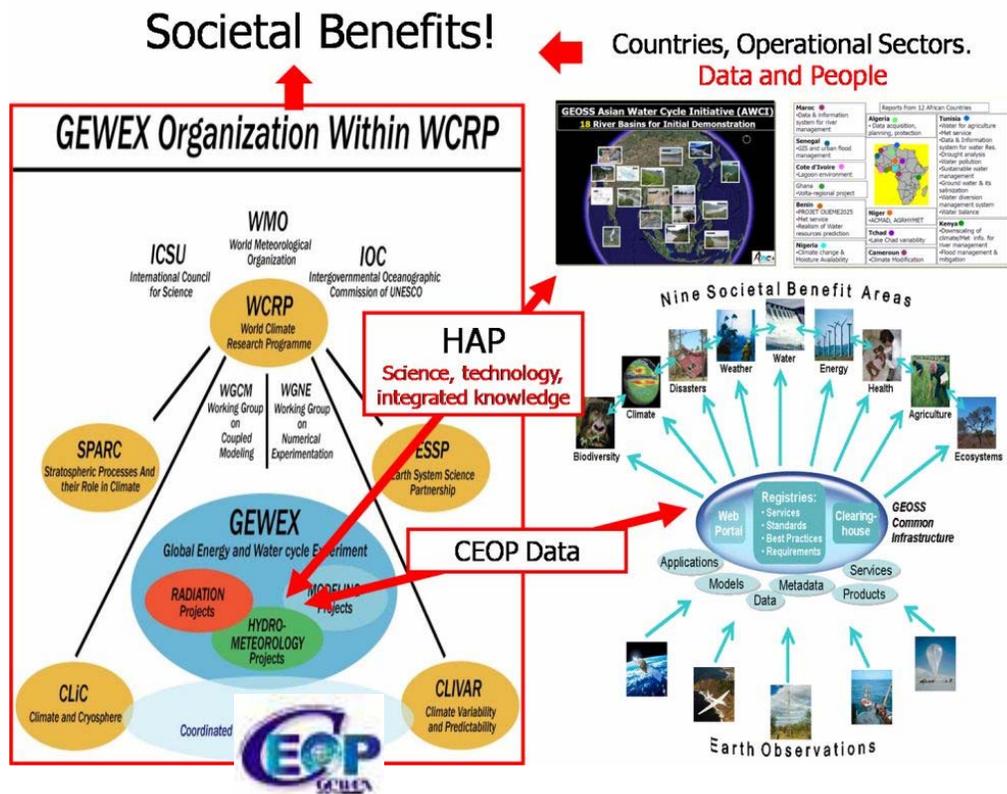
Specific Deliverable (TBD): CEOP expects to assist with providing metrics that will clearly demonstrate the benefits of improved hydrometeorological predictions for water resources.

*Contributions to Society and to WCRP/GEWEX Visibility*

CEOP has continually maintained a vision within its community of making specific contributions to those aspects of the WCRP/GEWEX International framework that will have the greatest impact on improving societal conditions. Through a series of organizing workshops and meetings starting in November of 2005, CEOP has initiated the Asian Water Cycle Initiative (AWCI) as a CEOP/GEWEX contribution to GEOSS.

The data shared through this initiative will not only benefit researchers and populations in their own region, but will also populate the CEOP Data Integration and Analysis System (DIAS), making it available to a broader group of researchers and thereby extending its visibility and value to the entire WCRP/GEWEX community. More directly, CEOP's Hydrological Applications Project (HAP) will utilize the data to advance the common goal of generating physically coherent fields of land surface states and fluxes through the integration of disparate data products.

A similar process was begun in 2009 to begin the African Water Cycle Initiative (AfWCI), raising the visibility of GEWEX and CEOP in another climatically important region of the globe. This paradigm is illustrated in the figure below.



*Summary:*

CEOP has gone through the process of the merger of the Coordinated Enhanced Observing Period with the GEWEX Hydrometeorology Panel (GHP) and the development and thorough review of the initial draft of the CEOP Strategic Implementation Plan (SIP) by the GEWEX SSG in 2008. In addition, CEOP addressed all of the SSG’s comments and concerns in a final draft of the SIP, which is now available on the Internet at <http://www.ceop.net>. As a result of this vetting, CEOP has now reconciled its implementation plans with all of the other elements of GEWEX and WCRP. This process has provided the basis for CEOP to make its unique and separate but equal contributions to the success of the overall objectives of the broader international climate research community represented by GEWEX and WCRP. CEOP, therefore, feels it is now the international focal point for WCRP/GEWEX Global Hydrometeorological Research. CEOP welcomes all interested researchers to participate and contribute to the development of current hydrometeorological observations, simulations, and predictions, and to those endeavors that will be undertaken in the CEOP framework in the future, including those that may be part of the longer term legacy of WCRP/GEWEX and prototypes of elements of GEOSS.

*List of Key Publications:*

- (1) Chen et al., 2009. Improving Noah Land Surface Model in Arid Regions with an Appropriate Parameterization of the Thermal Roughness Length. *J. Hydrometeorol.*, submitted.
- (2) Ferguson, C.R., and E.F. Wood, 2009. An evaluation of satellite remote-sensing data products for land surface hydrology. *J. Hydrometeorol.*, submitted.
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- (8) Yang, K., 2009d. Diurnal variations of thermal roughness length and its importance for land surface modeling in dry regions. *AsiaFlux Newsletter*, No. 30, 10-14.
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- (14) Grant, R.F., L.R. Hutyrá, R.C. de Oliveira, J.W. Munger, S.R. Saleska, and S.C. Wofsy, 2009. Modeling the carbon balance of Amazonian rain forests: resolving ecological controls on net ecosystem productivity. *Ecological Monographs*, 79(3): 445-463.
- (15) Malhi, Y., L. Aragao, D.B. Metcalfe, R. Paiva, C.A. Quesada, S. Almeida, L. Anderson, P. Brando, J.O. Chambers, A.C.L. da Costa, L.R. Hutyrá, P. Oliveira, S. Patino, E.H. Pyle, A.L. Robertson, and L.M. Teixeira, 2009. Comprehensive assessment of carbon productivity, allocation and storage in three Amazonian forests. *Global Change Biology*, 15(5): 1255-1274.
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- (23) Yoshimura, K., M. Kanamitsu, and M. Dettinger. Regional downscaling for stable water isotopes: A case study of an Atmospheric River event. *JGR*, submitted.
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#### Planned Meetings, Workshops

TBA

#### List of Members and Their Term Dates

The list below is current and all leaders are in place for one more year of their three-year terms that will be reviewed at the fourth CEOP Annual Meeting in August/September 2010. Renewals or changes at that time will be valid up to the time of the CEOP Annual Meeting in August/September 2013.

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CEOP co-chair	<a href="http://www.drinetwork.ca/xtremes/">http://www.drinetwork.ca/xtremes/</a>	Ron Stewart*	ronald.e.stewart@gmail.com
International Coordinator	<a href="http://www.gewex.org/">http://www.gewex.org/</a>	Sam Benedict*	sam.benedict@gewex.org, gewex@gewex.org
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Monsoon co-chair		Hugo Berbery	Berbery@atmos.umd.edu
Monsoon co-chair		William Lau	lau@climate.gsfc.nasa.gov
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Extremes	<a href="http://www.drinetwork.ca/extremes/">http://www.drinetwork.ca/extremes/</a>	Ron Stewart*	ronald.e.stewart@gmail.com
Aerosols		Bill Lau	
Isotope co-chair		David Noone	dcn@Colorado.EDU
Isotope co-chair		Kei Yoshimura	kyoshimura@ucsd.edu
Models			
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HAP		Eric Wood*	efwood@princeton.edu
Data Management	<a href="http://www.eol.ucar.edu/projects/ceop/dm/">http://www.eol.ucar.edu/projects/ceop/dm/</a>		
Reference Sites/Basins	<a href="http://www.eol.ucar.edu/projects/ceop/dm/">http://www.eol.ucar.edu/projects/ceop/dm/</a>	Steve Williams*	sfw@ucar.edu

Model Output	<a href="http://www.eol.ucar.edu/projects/ceop/dm/model/">http://www.eol.ucar.edu/projects/ceop/dm/model/</a>	Michael Lautenschlager	Michael.Lautenschlager@zmaw.de
Satellite Data	<a href="http://monsoon.t.u-tokyo.ac.jp/camp-i/doc/sat_info/index.htm">http://monsoon.t.u-tokyo.ac.jp/camp-i/doc/sat_info/index.htm</a>	Toshio Koike	tkoike@hydra.t.u-tokyo.ac.jp
Data Integration & Dissemination	<a href="http://jaxa.ceos.org/wtf_ceop/">http://jaxa.ceos.org/wtf_ceop/</a>	TBD	
Central Data Integration	<a href="http://monsoon.t.u-tokyo.ac.jp/ceop-dc/ceop-dc_top.htm">http://monsoon.t.u-tokyo.ac.jp/ceop-dc/ceop-dc_top.htm</a>	Kenji Taniguchi	taniguti@hydra.t.u-tokyo.ac.jp
Associated Global Data Centres	<a href="http://www.ngdc.noaa.gov/wdc/">http://www.ngdc.noaa.gov/wdc/</a>		
GRDC	<a href="http://grdc.bafg.de/">http://grdc.bafg.de/</a>	Ulrich Looser	Looser@bafg.de
GPCC	<a href="http://gpcc.dwd.de">http://gpcc.dwd.de</a>	Tobias Fuchs*	Tobias.Fuchs@dwd.de

## 2.2 GEWEX Radiation Panel (GRP)

**Full Name (Acronym):** GEWEX Radiation Panel (GRP)

**Reporting Period:** 2009

**URL:** <http://www.gewex.org/projects-GRP.htm> and <http://rain.atmos.colostate.edu/GRP/index.html>

**Chair:** Christian Kummerow (2007–2010)

*Overview:*

Within the World Climate Research Program (WCRP) and its Global Energy and Water Cycle Experiment (GEWEX), the GEWEX Radiation Panel was organized to review theoretical and experimental knowledge of radiative processes in and for the study of the climate system. These processes are central to the climate's energy cycle: climate is determined by the imbalances of solar radiative heating and longwave radiative cooling. The circulation of the atmosphere and ocean, the environment on land, and the biosphere are all driven by local radiative imbalances. Changes in climate can be caused by alterations of the radiation budget at the top of the atmosphere or at the surface, such as those induced by changing amounts of greenhouse gases or aerosols in the atmosphere or by changing land surface properties. The sensitivity of the climate response to a change in radiative forcing is determined by many feedback processes that alter the radiation budget, especially those involving clouds and water vapor.

The main source of global information about the climate system comes from the analysis of satellite remote sensing data which requires detailed models of the interaction of radiation with the atmosphere and the ocean-land-ice surfaces (including the effects of vegetation) as a function of wavelength, polarization state and observing geometry. Water is unique in its role on Earth. Not only does it provide the necessary sustenance to support life, but it also acts as an energy storage and transport mechanism as it changes phase from solid to liquid and vapor. Together with water vapor in the atmosphere, the reservoirs of water are continually exchanging mass. Water evaporates from the ocean and land surfaces, is transported by the atmosphere, forms clouds, and returns to the surface as precipitation. Rainfall on land can return to the sea via rivers or be stored in lakes and aquifers. Snowfall on land can melt into rivers or build up into ice sheets, which can melt into rivers later. The cycle of water is thus inextricably linked with the cycle of

energy by clouds, water vapor, and precipitation, so it makes sense to study these water processes together with radiation processes. □ □

The GPR thus focuses on answering the following specific questions:

1. How can we better measure and characterize the state and the variations of the climate using global observations?
2. What are the changes in radiative forcing that cause climate change?
3. How do the interactions of radiation with changes of the internal state of the climate (a.k.a. radiative feedbacks) affect the climate's sensitivity?
4. How do the internal water exchange and transport processes in the climate (a.k.a. water feedbacks) affect the climate's sensitivity?

*Status:*

**ISCCP:** The International Satellite Cloud Climatology Project (ISCCP) continues to process cloud data from geostationary and polar orbiting satellites. Production is currently completed through June 2008. The primary set of cloud data products (+DX, D1, and D2) and the two ancillary data products (atmospheric temperature and humidity, snow/ice cover) have been delivered for the period July 1983 through June 2008. The radiative flux product produced by ISCCP (called FD) is available and has been compared to the Surface Radiative Budget (SRB) values. Other specialized products (mesoscale convective tracking, CT, tropical, low latitude and midlatitude weather states analysis, WS, cyclone tracking, CY) are currently being extended through 2008 also. A new cloud particle size climatology has been completed and is awaiting publication of its review article for release. □ ISCCP (based on various assessments) suffers from inconsistencies in the TIROS Operational Vertical Sounder (TOVS) products—specifically that Advanced Microwave Sounding Unit (AMSU) instrument and AMSU retrieval methods impact ISCCP but are not controlled by ISCCP or GRP. This makes a strong case for coordinated global activity. GRP strongly endorsed GEWEX Continental-scale International Project (GCIP) Central Information Source (GCICS) activity to bring infrared and microwave instrument calibration under one umbrella. The GEWEX SSG can help promote the consolidation of these activities.

ISCCP is getting close to handing off routine production to the National Oceanic and Atmospheric Administration (NOAA) and National Climatic Data Center (NCDC). This ensures long-term production and frees scientists up for product improvement. GRP had a productive joint meeting with the Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) to discuss ways of continuing this transition from research to operations for additional products. □ □

**Cloud Assessment:** The GEWEX Cloud Assessment was initiated by the GEWEX Radiation Panel (GRP) in 2005 to evaluate the reliability of available, global, long-term cloud data products. An article was written for GEWEX News in Feb. 2009 summarizing results to that date. Key results include:

1. 70% ( $\pm 5\%$ ) clouds: ~ 40% high clouds and ~40% single-layer low clouds
2. Geographical cloud structures and seasonal cycles agree quite well
3. Absolute values depend on instrument sensitivity (and retrieval method)
4. Detection thresholds also affect average cloud optimum depth and temperature, e.g., CALIPSO highest cloud amount (sensitive to subvisible cirrus)
5. Infrared sounders are approximately 10% more sensitive to cirrus than ISCCP (20% in tropics)

**SRB:** The Surface Radiation Budget (SRB) project completed Version 3 (V3) of its product in October of 2008. V3 (July 1983–June 2007) includes:

- New fixed background aerosols climatology (from the Model of Atmospheric Transport and Chemistry, MATCH)
- Angular Distribution Model interpolation
- Added special desert surface treatment

- Added new output products: upper troposphere daily average
- Cloud Filling v3.0 (Completed all 23 years)
- Corrected issues with inconsistent high/middle/low clouds
- Corrected issues with terminator and sun glint

New radiation budgets are available. Differences with ISCCP are slight and probably due to differences in surface temperature. There are significant differences (15 W/m<sup>2</sup>) against other analyses. Science activity is focusing against the Baseline Surface Radiation Network (BSRN), concentrating on understanding what causes the differences. Clear sky and completely cloudy sky will be investigated first to see what causes biases.

Surface observations from BSRN now total over 5,000 station months in the archive. Global Models are converging towards BSRN numbers. Data submission has improved dramatically since moving the archive to the Alfred Wegener Institute (AWI).

**GPCP:** The Global Precipitation Climatology Project (GPCP) continues to process data smoothly with research products coming out about three months after observation time. The project produced an interim version (V2.1) to take advantage of the latest GPCC reprocessing. V2.1 shows significant improvement in regions of orographic precipitation. The focus has moved recently to uncertainties, although methods are still crude.

The Version 2.1 dataset averages 2.68 mm per day over the whole globe. Confidence in the results varies by region, with developed land areas leading in certainty and high-latitude ocean areas trailing. The new average is about two percent higher than for the previous Version 2 GPCP dataset, with essentially all of the change occurring over land due to the new gauge analysis. Notably higher values are now analyzed in tropical mountain regions (northwestern South America, Papua New Guinea, the Himalayas, and along the east coast of the Bay of Bengal), along the mountainous Pacific coasts of northwestern North America and southern Chile, in New Zealand, and in central Africa. These are all high-precipitation areas that benefited from the improved quantity of input data and the revised analysis approach in the new GPCC dataset. □ □

**SeaFlux:** Version 1.0 of climatological flux data has been completed for years 1998-2005. Version 2 will include diurnal Sea Surface Temperature (SST) variability from the Clayson and Curry algorithm. The diurnal cycle computations use Surface Radiation Budget (SRB) solar radiation and NOAA blended winds. Collaboration with Global High-Resolution Sea Surface Temperature (SST) (GHRSSST) is ongoing but the SST product is primarily meant for oceanographers, who will remove the skin temperature and diurnal cycle to produce a value close to the upper ocean heat content. SeaFlux data retains the skin temperature and diurnal cycle. □ □

**LandFlux:** LandFlux activities continued during the past year with a meeting at the Joint GEWEX-ILEAPS Scientific Conferences in August 2009. An inventory of available global surface latent and sensible heat flux products was produced. Available products include:

- Satellite measurements consisting of radiance-based evapotranspiration estimates
- Diagnostic estimates using atmospheric water balance to estimate evapotranspiration
- Empirically-based estimates are flux-net driven estimates extrapolated via satellite observables
- Models consist of Land Surface Models forced by observations

The first results from global, monthly (1993-1995) comparisons indicated that overall geographical patterns are consistent among data sets (dry vs. wet regions), but there exist a large range between data sets in some regions, especially in tropical/rainforest areas.

The first intercomparison also noted that differences among observationally-based estimates of Fluxes are of the same order of magnitude as differences between existing model-based estimates.

**GACP:** The Global Aerosol Climatology Project (GACP) has been relatively inactive; aerosol product generation has some funding for current NASA missions, but GACP is not specifically funded at the moment. There is little progress except to compare existing product with newer ones. An assessment activity led by Sundar Christopher is being organized.

□ Since GACP is ocean only, discussions focused on the possibility of using aerosol source with dynamics type models such as Spectral Radiation-Transport Model for Aerosol Species (SPRINTARS) to complete the global aerosol picture. □ □

**CIRC:** Continuous Intercomparison of Radiation Codes (CIRC) activities focused on four outcomes. These included:

- Maintaining an improved website
- Reached 20 registered participants (nine from U.S., two from Brazil, two from France, two from Russia, one from Australia, one from Canada, one from UK, one from Finland, one from China)
- Results from 23 radiative transfer codes (short wave and long wave, including non-GCM) available for evaluation
- Bulletin of the American Meteorological Society article (in press), GEWEX newsletter article, and IRS proceedings article published; Journal of Geophysical Research article in preparation

*Key Results:*

GRP products continue to set the standard for quality products and independent assessment activities. GPCP alone, for instance, has over 1000 references in journal publications to date. A citation list can be found at: [ftp://precip.gsfc.nasa.gov/pub/gpcp-v2/doc/gpcp\\_citation\\_list.pdf](ftp://precip.gsfc.nasa.gov/pub/gpcp-v2/doc/gpcp_citation_list.pdf). □ LandFlux activity is moving ahead with broad interest from the research community to produce a global product.

□ New radiation budgets are produced using the latest satellite products produced by SRB. Preliminary information shows that long wave down welling may increase even more once active sensors are fully incorporated into flux calculations. □ The earnest shift from research to operations is beginning with ISCCP transitioning to NOAA/NCDC, with the Scientific Committee on Problems of the Environment (SCOPE)-CM welcoming such partnerships.

*Plans for 2010:*

All GRP products are preparing for the reprocessing cycle to begin in the fall of 2010. This reprocessing cycle not only improves each of the products separately, but also uses common ancillary data so that products can be merged into the Integrated GEWEX water and energy product. NCDC has tentatively agreed to put together the product and host it. Key activities within the GRP projects relate to improving their own product to accommodate this integrated water and energy cycle product. □ □

**ISCCP** will focus primarily on ancillary data issues. Assessment reports have highlighted TOVS problems. In particular, the use of the newly-reprocessed HIRS will be investigated to assess if the AMSU-related artifacts are eliminated from the data. □ □

It is expected that ISCCP will spend significant effort in the coming year to prepare for the transition to operations at NCDC. □ □

The **Cloud Assessment** project is working on the final WCRP report that should be finished mid-2010. It discusses the existing long-term climatologies and also compares these to improved instruments aboard the NASA Earth Observing Satellites (EOS) and the A-Train. Climatological averages as well as their

regional, seasonal, and diurnal variations will be presented, and differences between results from the various data sets will be discussed. Specific next steps include:

- Distribute all data sets to assessment groups
- Analyze data sets and sort into mature, less mature, and complementary data sets [Pathfinder-Atmosphere-X (PATMOSX), Along Track Scanning Radiometer-Global Retrieval of ATSR Cloud Parameters and Evaluation (ATSR-GRAPE)] and complementary Multi-angle Imaging SpectroRadiometer, POLarization and Directionality of the Earth's Reflectances (POLDER)]
- Actualize sections about cloud amounts (global, maps, season cycles, interannual variations, long term anomalies, regions, diurnal cycle)
- Write section on new variables (ct, cod, crei, crew, ciwp, clwp: averages standard variations and histograms)
- Make database public
- Berlin meeting (22-25 June 2010)

**SRB** plans involve preparing for homogenized GRP reprocessing. This includes:

- Evaluate and implement homogenization of SRB inputs/ancillary data sets. Potential data parameters include:
  - Standardized surface topography » w/ISCCP
  - Surface and atmospheric temperature and water vapor profiles [alternative to GEOS-4, Modern Era Retrospective-analysis for Research and Applications (MERRA) (GEOS-5)] » new HIRS, corrected TOVS, or reanalysis?
  - Ozone and other trace gas concentrations » use ISCCP
  - Total solar irradiance and variability » new Kopp time series
  - Surface spectral emissivity annual variability » review w/ISCCP
  - Surface spectral albedo treatments » update spectral models w/University of Maryland; temporal change
  - Aerosol properties in climatological and historical sense » assess various data sets, i.e., Global Ozone Chemistry Aerosol Radiation Transport (GOCART), AeroCom median, MATCH, etc.
  - Implement/assess codes to process new ISCCP “NX” products for production of 1x1o and/or 0.5o x 0.5o

**BSRN** expressed a strong desire to add measurements and reporting of Aerosol optical depth as highest priority from BSRN sites. Second priority for these sites is spectral measurements. These can be used for independent validation of models as they do not assimilate downwelling radiances.

**GPCP**'s plans, aside from continuing to process data on a timely manner, is to focus on the V3 plans for the algorithm that will have significantly higher time and space resolutions (approximately 3 hr. 25 km) for part of the period. V3 requires major revisions through the issue of:

- New passive microwave algorithm (GProf), new passive microwave data [Advanced Microwave Scanning Radiometer-E (AMSR-E), Tropical Rainfall Measuring Mission (TRMM), Advanced Microwave Sounding Unit (AMSU)]
- Integration of high time space resolution period with longer period with coarser time space resolution
- Rain/snow discrimination (by temperature)

**SeaFlux:** The intercalibrated data set from Special Sensor Microwave Imager (SSM/I) is an issue. Level 1C from Colorado State University (CSU) is introducing a trend in wind speed that does not appear to be real. CSU group will look at using Data Stewardship support from NOAA. Specific algorithm work includes:

- Finishing Version 1 back through 1987

- Full analysis of Version 1
- Improved SST diurnal cycle (Version 2)
- Better aerosol effect characterization
- Higher resolution/more satellites–non climatological data set Version 1.
- Continued comparisons with MERRA, Intergovernmental Panel on Climate Change (IPCC)

**LandFlux:** The integrated water and energy product requires latent and sensible heat flux over land. Because this is still immature, the goal is to continue with the assessment activity and then select one or more of the mature data sets for use in the GEWEX LandFlux product. This decision will be made in mid-2010 to allow for the product(s) to be processed or integrated if a combination of products is selected.

CIRC plans for 2010 include:

- Addition of “pristine” and “cloudless” Phase I sub-cases soon to be calculated and released
- A few more submissions expected (no GCM Radiative Transfer codes)
- Complete analysis of Phase I and submit paper
- Phase II preparation [Atmospheric Radiation Measurement (ARM) Broadband Heating Rate Profile (BBHRP) 1.5 + CLAMS]
- Evaluate response so far and redefine our strategic goals?

There is some concern from CIRC’s perspective that the GCM community believes that radiative transfer is solved within its models and that the CIRC activity, despite immediately highlighting errors with most submitted codes, is not a high priority.

#### *Science Highlights:*

The Landflux activities made significant progress in 2009 with the first intercomparison of global products. This intercomparison of the submitted global products, based on analyses of the Observatoire de Paris (1993-1994) and ETH Zurich (1989-1995/2006), proved to be an extremely interesting and valuable exercise, particularly in identifying consistencies and disparities between remote sensing and other model based estimation approaches. While there seemed to be generally good agreement between spatial patterns among the various approaches, there was also a large range in values across many regions of the world (Fig. 1). Identifying the causes and mechanisms producing these differences, model dependencies, and sensitivities and the complicated issue of how to actually evaluate global products remains a major challenge. The LandFlux-EVAL intercomparison effort will shed more light on addressing these important issues. GPCP found 2008 to have record low precipitation. The ocean decreased because of La Niña but land did not compensate as it usually does. □ □

Yearly averaged latent heat fluxes for 1993 from a suite of different products. The following products are displayed: (a) four remote sensing products from Oxford University (OXUNI, provided by Joshua Fisher), the University of Maryland (MAUNI, provided by Kaikun Wang), Paris Observatory (OBSPM, by Carlos Jimenez), and Princeton University (PRUNI, by Justin Sheffield and Eric Wood); (b) Land surface model estimate from the GSWP-2 multi-model ensemble; (c) three reanalysis estimates (MERRA, NCEP-DOE and ERA-INTERIM). Note that these data represent a subset of products considered as part of LandFlux-EVAL.

#### □ *New Directions:* □ □

GRP is best known for its global long-term products and this focus will be maintained. The new objective for 2010 is to produce an Integrated Water and Energy (W&E) cycle product that combines the existing data products into a unified data set. Two key objectives of this product are to allow closure studies on regional scales and process studies involving the exchange between energy and water. The data will thus be generated on a 50 km, 3-6 hour time scale. This composite product is envisioned to usher in a new era of interaction between GRP and the modeling community as well as other satellite providers vis-à-vis closure of the water and energy budgets at both global and regional scales. □ □

Aside from the broad push for the integrated product, GRP continues to work through a series of white papers to define its future directions. These include “Assessments” where GRP notes the need to make assessments a more important activity of space agencies as the number of data products related to water and energy cycles increases. A paper on water vapor, in the meantime, points clearly at the need to begin a water vapor assessment activity before launching into the creation of the new product. This will be initiated in 2010. □ A validation white paper is being formulated that thus far hints at the need for GRP to lead the way in developing W&E validation strategies that not only test a climate model’s fidelity at reproducing individual fields (e.g., clouds or surface fluxes) but the interaction between these. GRP would help find robust data sets for these interactions and better connect the observations to the model physics that each of these possible validation studies might help elucidate. □ □

Also related to the unification of the water and energy variables, GRP continues to foster the Cloud/Aerosol/Precipitation Initiative. While not independent of the modeling activity, GRP sees potential in collecting simultaneous global scale data on aerosols, clouds, and precipitation in order to broaden what otherwise tend to be a very case-oriented analysis. □ □

Finally, GRP feels that although perhaps not central to its initial charter, it must get involved in the data stewardship activities springing up. A consistent, high quality data set is critical for the long-term products being produced by GRP. Unfortunately, each calibration/intercalibration and stewardship activity has its own objectives that only sometimes fit GRP’s needs. As a panel, we want to encourage communities to use GRP algorithms to assess the stability of their long-term data products.

#### *Recommendations and Issues for Attention of the SSG:*

GRP in general, but GPCP in particular, needs a closer working relation with Climate and Cryosphere (CliC) for joint evaluation of products in high latitudes.

GRP strongly endorsed GCICS activity to bring infrared and microwave instrument calibration under one umbrella. SCOPE-CM can likewise bring climate product generation under a single umbrella. The GEWEX SSG can help consolidate these activities. □ □

GRP hopes the SSG can help convince space agencies of the importance of properly undertaken assessment activities in addition to the development of new products and sensors. GRP has had good experiences with the cloud and radiation budget assessments that can be used to provide guidance to the agencies. These assessments are necessary to place historical data in the context of newer products as we construct long-term climate series.

#### *Contributions to WCRP Strategic Themes:*

The production of global data sets is a strategic theme that GRP addresses directly.

#### *Summary:*

GRP projects are making headway for the first-ever integrated data set that combines the different projects to produce an integrated product for water and energy variables. This product will contain water variables in the form of water vapor, clouds and precipitation, and short and long wave radiation at the top of the atmosphere as well as the surface will be provided, as will surface turbulent (latent and sensible) fluxes. The integrated data, planned for 50 km and 3-6 hr intervals, will be the first data sets that tries to close budgets at regional scales and should be useful for process studies. □ The radiation code intercomparison activity is up and accessible through the web. Unlike previous efforts, the current CIRC activity uses actual observations from the ARM site and Lawrence Berkeley National Laboratory (LBL) calculations as

a reference. It is available to all participants—including the IPCC models, if they wish to avail themselves of this opportunity.

*Planned Meetings:*

- LandFlux workshop together with Global Soil Wetness Project 3 (GSWP3) in Tokyo
- Potential Water Vapor Workshop with International TIROS Operational Vertical Sounder Working Group (ITWG)
- Sea Flux Workshop with CLIVAR high latitude Surface Flux Working Group (Boulder, 17-19 March 2010)
- Cloud Assessment Workshop Berlin (22-25 June 2010)
- GRP meeting with Pan-GEWEX (23-27 August 2010)

## 2.3 GEWEX Modeling and Prediction Panel (GMPP)

**Full Name (Acronym):** GEWEX Modeling and Prediction Panel (GMPP)

**Reporting Period:** 2009

**Chair(s) and Term Dates:** Christian Jakob (extended to Northern Hemisphere Fall 2010)

*Overview:*

GMPP's role is to coordinate the activities within GEWEX that aim at improving the representation of the global water and energy cycle within Earth system models. Furthermore, it coordinates collaboration with modeling and related observational activities within and beyond GEWEX. Particular focus areas of the work of GMPP are cloud systems, land-surface processes, and the atmospheric boundary layer (ABL). To address these difficult areas of parameterization adequately, GMPP is organized into three activities:

1. The GEWEX Cloud System Study: GCSS
2. The Global Land/Atmosphere System Studies: GLASS
3. The GEWEX Atmospheric Boundary Layer Study: GABLS

*Progress Report:*

The main activities of GMPP take place in the three study groups mentioned above and are summarized in the progress reports of those groups.

The activities at the GMPP level are now synonymous with the activities of the WGNE sub-group on physical parameterization, as the latter essentially consists of the project chairs of GCSS, GLASS, and GABLS. They largely relate to activities in support of model development that are organized through WGNE/GMPP. The annual joint meeting of WGNE and GMPP took place in November 2009 and this progress report as well as the plans below largely relate to activities discussed at that meeting.

WGNE/GMPP have initiated a WCRP-wide survey on model development across all application areas (see Appendix 1). A first call for responses went to the community in August and yielded about 75 responses. The main areas for future model development that were highlighted in an early analysis of the responses to the survey were:

- Tropical biases and errors in tropical variability often associated with the representation of tropical deep convection;
- Cloud-climate feedbacks;
- The carbon cycle; and
- The representation of physical processes in high-resolution (O(5 km)) models.

The analysis of the responses is ongoing and the above should be seen as emerging themes rather than final conclusions. At the last WGNE/GMPP meeting, the Numerical Weather Prediction (NWP) community expressed interest in becoming more actively involved in the survey and it was decided to carry out a second call for responses, this time including the WWPR/THORPEX community as well. The call was sent in early December with a 15 January 2010 deadline. It is anticipated that the results of the survey will be published in a BAMS-like article. They will also serve as the foundation for a workshop on “Physical Processes in Earth-System Models” planned for early 2011. See the plans section of this report for more detail.

Other projects that are ongoing and involve GMPP through the WGNE connection are:

- Transpose the Atmospheric Model Intercomparison Project (AMIP): This project tests climate models in NWP mode. The project has completed its first phase and is headed into a second phase with the support of the European Framework 7 [European Union Cloud Intercomparison, Process Study & Evaluation Project \(EUCLIPSE\)](#) on cloud climate feedbacks.
- Aqua-Planet Experiment (APE): This project is now finished and has yielded very interesting results. Climate models are run on an aquaplanet with a sequence of different prescribed distributions of sea-surface temperature (SST). Remarkably there is very little agreement between the models’ response to changes in the SST pattern. Currently there is no simple explanation for this behavior. The project will be phased into CMIP5 and hence the model output will be widely available for analysis.
- Metrics for climate models: A climate model metrics panel has been formed and is in the process of defining a standard set of climate model metrics for application to the CMIP5 models. Robert Pincus is the GCSS and hence GMPP representative on the panel.
- Year of Tropical Convection (YOTC): YOTC is working very closely with the model development community and with the strong response on tropical model errors in the survey is likely to become central to some of the GMPP activities in the years to come. The transpose AMIP project already uses YOTC as its core period of investigation.

#### *Plans for 2010:*

The GMPP study groups will continue their efforts as outlined in their individual reports. At the GMPP coordination level much of the work will focus on the collaboration with the WGNE effort, as GMPP is the core of that effort.

Some of the core activities that involve GMPP at the coordination level are:

- Plans for a workshop on physical processes in Earth-System Models are now firmly in place. An organizing committee will be formed within the next few months with its core consisting of Joao Teixeira (JPL), Pier Siebesma (KNMI, GCSS chair) and Christian Jakob (Monash University, GMPP chair and WGNE co-chair). The aim of the meeting will be to formulate strategies for accelerating progress in the model development areas that are highlighted by the responses to the community survey currently underway (see above).
- Contribute to the organization of the WCRP Conference in 2011 with a particular aim to ensure that model development is well represented at the meeting. Christian Jakob is on the organizing committee.
- At the WGNE meeting, it came to our attention that many model projects are saving high-time resolution output at carefully chosen grid-points that coincide with major measurement sites, for instance, those of the ARM or CLOUDNET programs. Examples for modeling projects doing so are CFMIP and transpose AMIP. This, taken together with the fact the operational centers already store this information routinely, opens the possibility for a joint GMPP-CEOP project on model evaluation. Our plan is to explore this possibility at the GEWEX SSG meeting.

- Reanalyses are used by the entire community and yet, at almost every occasion it becomes clear that financial support for generating them is increasingly difficult to find by all centers engaged in producing them. WGNE/GMPP propose to organize a high-level support letter from the entire World Meteorological Organization (WMO) community in support of reanalyses.

*New Directions:*

GMPP in its coordinating role will continue to work with WGNE as its core partner.

A new emerging direction in the community is the generation of so-called parameterization test-beds, such as the one currently running at KNMI for the European community and the one under development by the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) community. Those test-beds are essentially automatic systems that run single column models routinely every day in real time and compare their results to observations taken at the highly instrumented ARM and CLOUDNET sites. As these activities involve the entire single column model, they essentially integrate the research interests of all GMPP projects. They therefore constitute a great opportunity for a GMPP-wide activity in model evaluation. It will be a focus of 2010 to investigate how GMPP can link better with the existing activities.

*Recommendations and Issues for Attention of the SSG:*

- Congratulate the GMPP study groups on their continued success in supporting the community's efforts in parameterization development and endorse their plans for 2009.
- Approve GMPP's further involvement in the activities discussed above.
- Discuss approaches to a community-wide support for reanalyses.

*Summary:*

GMPP remains at the heart of the implementation of the model development activities in WCRP that resulted in a new expert group on parameterization within WMO under the auspices of WGNE. The role of this group is to advise all WMO activities in the area of parameterization and to set the agenda for parameterization development activities. The existing GMPP study groups form the core of this activity. Through the GMPP groups, GEWEX continues to drive progress in this very important area of research.

*List of Meetings and Workshops:*

WGNE-25/GMPP-11, November 2009, Frankfurt, Germany

*Planned Meetings and Workshops:*

2<sup>nd</sup> Pan-GEWEX Meeting, Fall 2010

WGNE-26/GMPP-12, 18-22 October 2010, Tokyo, Japan

## **2.3.1 Global Land Atmosphere System Study (GLASS)**

**Full Name (Acronym):** Global Land Atmosphere System Study (GLASS)

**Reporting period:** 2009

**Chair(s):** Bart van den Hurk and Martin Best, co-chairs

*Overview:*

Coordinate the development of improved land-surface schemes for coupled land-atmosphere models at all scales.

*Progress Report:*

The new structure of GLASS, focusing on the areas of Land Model Benchmarking, Model Data Fusion, and Land-Atmosphere Coupling, can be considered to be successful. It has attracted new membership (see list below), and enables the grouping of existing and newly planned projects and activities with great flexibility. Some major activities are in an exploratory/preparation stage [like the benchmarking activities, land data assimilation intercomparison, and the invocation of a third phase of the Global Soil Wetness Project (GSWP) – see below], and the role of the GLASS panel is to make inventories of existing activities and create connections between these. Some other activities (isolated projects) are well underway, such as the Global Land-Atmosphere Coupling Experiment (GLACE-2) and the Land-Use and Climate Identification of robust impacts (LUCID) Project (see below). GLASS chairs will contribute actively to the inventory of “outstanding research issues” endorsed by the Working Group on Numerical Experimentation (WGNE) and the World Weather Research Programme (WWRP), and to ongoing discussions on the need for benchmarking and engaging research activities in the field.

*Progress Per Activity:*

GLACE-2: A draft paper on first results has been submitted to *Geophysical Research Letters* (GRL), focusing on additional prediction skill related to realistic soil moisture initializations in the U.S. Results show that for lead times of up to more than a month, temperature skill increases considerably, and precipitation skill somewhat when focusing on extreme initial soil moisture conditions.

LUCID: The GRL paper with first results appeared this year, demonstrating that the way different climate models interpret land use change information varies widely, giving rise to fairly different responses to imposed (radiative) forcing.

Benchmarking: The Exeter workshop in June brought together developers of various benchmarking systems around the world (mainly focusing on carbon models), and an inventory of possible benchmarking standards was made. Later discussions focused on a discrimination between (a) providing standard infrastructure to collect observations and model results and performing standard statistical tests (like the Protocol for Atmosphere-Land Studies, PALS), and (b) a conceptual model where the potential predictability of any modeling system is to be used as the ultimate benchmark. In that case, benchmarking comes down to assessing the potential predictability, and determining the degree to which a particular modeling system is skilful in this respect.

Data assimilation: During the European Centre for Medium-range Weather Forecasts (ECMWF)/GLASS workshop, a clear recommendation was issued to organize a Project for Intercomparison of Land Data Assimilation Systems (PILDAS), which was embraced by NASA, ECMWF, MeteoFrance, and CanadaEnv. Collaboration with the University of Tokyo is sought. A work plan will be drafted before summer 2010.

GSWP-3: Various groups are interested in creating an offline land surface forcing dataset, covering a longer period than GSWP-2. The University of Princeton and the European project WATCH have prepared data sets based on different input data and covering different periods. ECMWF was recommended to contribute actively to such a data set. University of Tokyo has announced a workshop (July 2010) to initiate a third GSWP activity, and the GEWEX Radiation Panel LandFlux Project has expressed interest in this. We are seeking ways to combine these activities into a coordinated effort.

*Panel Membership:*

Bart van den Hurk and Martin Best will continue to co-chair GLASS until well into 2010. Many new members have joined with active participation in each of the working groups, with representatives from the U.S., Europe, Australia, and Japan. Membership will continue to change during 2010, as new activities mature. For instance, Gianpaolo Balsamo and Patricia de Rosnay will be co-member to represent ECMWF. Extension of the panel with a groundwater hydrologist (Ger de Rooij) is initiated.

*Main Meetings in 2009:*

- GLASS/QUEST Benchmarking Meeting, Exeter, June 2009
- GLASS/WATCH Land-Atmosphere Feedback Meeting, Wallingford, June 2009
- GLASS Panel Meeting, Melbourne, 22 Aug 2009
- WGNE Meeting, Offenbach, 2-4 Nov 2009
- GLASS Sub-panel Meeting, ECMWF, Reading, 11 Nov 2009
- ECMWF/GLASS Workshop on Land Modelling, Data Assimilation and Predictability, Reading, 9-12 Nov 2009

*Upcoming Meetings:*

- GLASS Panel Meeting, attached to the Pan-GEWEX Meeting (N. Hemisphere Fall 2010)
- A WGNE/WWRP meeting on parameterization requirements
- Planning meeting of GSWP3, Tokyo (July 2010)

## 2.3.2 GEWEX Cloud Systems Study (GCSS)

**Reporting Period:** 2009

**URL:** [www.gewex.org/gcss.html](http://www.gewex.org/gcss.html)

**Chair:** A. Pier Siebesma, Royal Netherlands Meteorological Institute (KNMI), NL/Technical University, Delft, NL

**Related Documents:** (1) ACPC Science Plan and Implementation Strategy; (2) Description of Work of EUCLIPSE FP7 Project

*Overview:*

A number of the cross-cutting themes initiated over the last two years have come into full swing and are attracting new research communities in addition to the activities of the traditional thematic working groups on the various cloud types. This holds especially true for the Cloud Feedback Model Intercomparison Project-2 (CFMIP2)-GCSS collaboration on understanding and reducing the uncertainty in the cloud climate feedback of climate models.

*Activities and Plans of Existing Working Groups:*

### **Working Groups on Boundary Layer Clouds (WGBLC)**

Chair: Adrian Lock (UK Met Office)

From June 8-12, 2009, 100 scientists attended a joint WGBLC-CFMIP2-GCSS/WGNE Pacific Cross-section Intercomparison (GPCI) meeting at the University of British Columbia, Vancouver, Canada, which was sponsored by the Canadian Foundation for Climate and Atmospheric Science. The presentations and discussions can be found on the GCSS website.

Key outcomes of particular relevance to the GCSS Boundary Layer Clouds Working Group are:

- GCSS-CFMIP2 Case Study: This project will focus on low clouds over the eastern oceans since these clouds have the largest impact on radiative forcing and recent studies suggest that low clouds are the main cause of model differences of cloud feedbacks (Bony and Dufresne, 2005). To this purpose three grid points from the GPCI were selected as representatives for stratus, stratocumulus, and shallow cumulus clouds and Large Eddy Simulations and Single Column

Model (SCM) runs were analyzed for present and future climate. Minghua Zhang presented results from many (~10) SCMs and three LES models. The SCMs appeared more consistent than the Large Eddy Simulation (LES) models, at least in terms of equilibrium profiles. As it is the general GCSS philosophy that LES results should constrain the SCM results, it is the plan to better constrain the case, in particular through the use of a common radiation scheme to be used by all LES codes. A dedicated follow-up workshop is planned in early 2010. An overview of the case description and the preliminary results can be found at [http://atmgcm.msrc.sunysb.edu/cfmip\\_figs/Case\\_specification.html](http://atmgcm.msrc.sunysb.edu/cfmip_figs/Case_specification.html).

- RICO LES: Pier Siebesma and Louise Nuijens presented work on a revised draft version of the LES paper, which will be circulated to co-authors by the end of 2009.
- RICO SCM: Ideas for the content of a paper were discussed. Pier Siebesma and Roel Neggers agreed to develop a skeleton draft over the next few months.
- Stratocumulus to Shallow Cumulus Lagrangians:
  - Irina Sandu has examined thousands of transitions in satellite data. Combined with reanalysis, there seems to be a pretty consistent picture that should lend itself to a composite case, perhaps also sampling the probability distribution functions using an ensemble approach.
  - Stephan de Roode has been revisiting the Atlantic Stratocumulus to Cumulus Transition Experiment (ASTEX) Lagrangian intercomparison case and plans an updated intercomparison under the EUCLIPSE proposal in which it is hoped GCSS will participate.
  - The general view at the meeting was that these two approaches are complementary and can proceed in parallel.
- VOCALS and POST: There were interesting discussions around both the VAMOS (Variability of the American Monsoon System) Ocean-Cloud-Atmosphere-Land Study (VOCALS) and Physics of Stratocumulus Top (POST) stratocumulus observational campaigns. These look like they will provide valuable data for a future GCSS intercomparison case.

A final development worth mentioning is more long-term evaluation of cloud and convection parameterizations of SCM versions of climate models using data of atmospheric profiling stations such as the ARM sites and the Cloudnet sites. An example of this is the KNMI parameterization test-bed (KPT) ([www.knmi.nl/~neggers/KPT](http://www.knmi.nl/~neggers/KPT)), which provides drivers, evaluation, and graphical tools to confront models with observations. One main advantage of this approach and difference with the standard GCSS case studies is that it moves away from single golden day studies and therefore offers a more comprehensive evaluation of parameterization packages.

### **Working Group on Cirrus**

Chair: Steve Dobbie (University of Manchester UK)

- A paper based on an intercomparison case of cirrus such as observed on March 9, 2000 at the SGP ARM site has been submitted.
- Steve Dobbie and Bernd Kaercher have developed a case study over the summer on thin cirrus and glassy aerosols in the tropopause transitional layer (TTL) in order to explain the high supersaturations in that environment both within and outside of clouds. The work has been accepted for review to *Nature*. Interest from the Working Group on Cirrus will be solicited to determine if they would like to run this case as an intercomparison.
- A meeting of GCM and cloud modelers is planned to get to the root of what is going to benefit the GCM modelers and their climate simulations. The March 9, 2000 intercomparison illustrated that there is reasonable agreement between the models and observations, but that GCMs are far less reliable for thin cirrus clouds. There is a need to separate out cirrus types (anvil origin, large scale

forced, frontal, etc.) and come to grips with the issues for each, not from a cloud scale, but more from what the first order problems are in the GCMs.

### **Working Group on Precipitating Cloud Systems**

Chair: Jon Petch (Met Office UK)

The Working Group on Precipitating Cloud Systems has had joint meetings with ARM and SPARC on various studies related to the Tropical Warm Pool-International Cloud Experiment (TWP-ICE) in which tropical convection during the Monsoon around Darwin, Australia was observed from January 20 through February 13, 2006.

The two principal goals of this intercomparison were to answer the following three science questions:

1. What physical processes control the amount of moisture transported to the tropical upper troposphere?
2. What physical processes control anvil cirrus clouds' longevity?
3. How well are these processes parameterized?

A novel point in this study is that for the first time, the four different model types are: Cloud Resolving Models (CRMs), Single Column Models (SCMs), 3-D limited area models, and Global Circulation models (GCMs).

A fundamental difference of the SCM intercomparison study from previous ones is that an ensemble of forcing data sets is provided instead of just a single "best guess" forcing data set. This way it is possible to compare inter-model differences due to different parameterizations with differences purely due to uncertainty in the forcing data sets, such as expressed through the ensemble spread. In the CRMs and LAMs, tracers have been included to inform TTL convection issues for SPARC. Several different examples of all four different model types have been submitted, but it is too early to draw any definite conclusions. The case is still open for new submissions.

### **Working Group on Polar Clouds**

Chairs: Hugh Morrison and James Pinto (NCAR, USA)

The Working Group on Polar Clouds aims to improve the understanding and model parameterization of cloud, radiative, and boundary layer processes in the polar regions. The overall methodology is to conduct intercomparisons between models and observational case studies.

The primary working group activities focus on a wide range of modeling activities, although data analysis, integration, and field studies play an integral role in the working group activities. Of central interest to the GCSS modeling effort are Cloud Resolving Models (CRMs) and Single Column Models (SCMs). General Circulation Models (GCMs) and process models (e.g., radiative transfer models) are also important to the GCSS modeling activities.

Two papers have been published this year on a comprehensive intercomparison study based on the ARM Mixed-Phase Arctic Cloud Experiment (MPACE) that took place at the ARM's Barrow site in October 2004. In short, models tend to underestimate liquid water path and overestimate ice water path, but there is a lot of scatter (no consistent difference between LES/CRM and SCMs). Despite the scatter among models it appears that models with a more detailed treatment of microphysics produce better results. Causes of differences among models were difficult to isolate, suggesting the need for more constrained testing frameworks (such as kinematic tests proposed as part of GCSS Microphysics WG).

A follow-up case was based on long-lived low-level mixed-phase stratus observed during early May 1998, such as observed during the Surface Heat and Energy Budget of the Arctic (SHEBA) Program. There are several key differences from the previous MPACE cases:

- Colder temperatures ( ~ -22° C vs. -15° C)
- Much smaller surface turbulent heat fluxes (ice-covered vs. open ocean)
- More polluted aerosols
- Much smaller amounts of cloud liquid water

The SHEBA case builds upon the MPACE intercomparison but uses a more constrained framework to better isolate model differences. This new intercomparison case is also being coordinated with 1-D kinematic tests as part of GCSS Microphysics WG (Ben Shipway) to isolate tests of microphysics (see below).

*Activities and Plans of Cross-Cutting Themes:*

### **Working Group of the GCSS Pacific Cross Section Intercomparisons (GPCI)**

Chair: Joao Teixeira (JPL, USA)

The objective of the Working Group of the GCSS Pacific Cross Section Intercomparisons (GPCI) is the analysis of models with observations along a transect in the Pacific Ocean from stratocumulus, across shallow cumulus, to deep convection for June, July, August (JJA) period of 2006. This is a follow-up of an earlier intercomparison based on a JJA 1998 period. The advantage of the JJA 2006 period is that the full benefit of the A-train products such as Cloudsat, Calipso, Multi-angle Imaging SpectroRadiometer (MISR), and Atmospheric Infrared Sounder (AIRS) was available. A paper with a critical evaluation of 23 climate and numerical weather prediction models with satellite observations has been submitted. Most model results are assembled and organized at the Data Integration for Model Evaluation (DIME) website at [http://gcss-dime.giss.nasa.gov/gpci/modsim\\_gpci.html](http://gcss-dime.giss.nasa.gov/gpci/modsim_gpci.html), where a browser has been developed to produce plots that merge model and observational data.

The future of the GPCI-framework will be embedded in the GCSS-CFMIP2 and EUCLIPSE projects. The objective of these projects is to gain understanding of the physical processes of Scu, shallow Cu, and deep Cu for present and future climates. This will be done through the use of Large Eddy Simulations that will be run until equilibrium in an Eulerian manner for a limited number of grid points along the GPCI transect and (see also WGBLC) the set up of a Lagrangian case from the Scu to the shallow Cu along the transect. The Eulerian cases will be repeated for future climate conditions where the SST is changed by 2K and the subsidence rate is weakened. Provided that an ensemble of LES models give a comprehensive signal, it can be used to critically evaluate and improve SCM versions of climate models and gain understanding of the response of low clouds in a changing climate.

### **Working Group on Metrics**

Chair: Robert Pincus (NOAA-CDC, USA)

At the last WGNE meeting, Peter Gleckner gave an update of the WGNE Climate Model Metrics panel. Despite the problems of defining widely-accepted metrics for climate models, there has been a proposal to:

- Identify overall “standard” metrics including atmosphere, ocean, land, and ice consisting of 10 to 20 large- to global-scale statistical or “broad-brush” metrics
- Define more targeted metrics, quantifying skill in simulating important processes, defined in consultation with other WCRP metrics groups:
  - Ocean (CLIVAR basin panels)
  - Stratospheric processes (SPARC, CCMVal)

- ENSO (CLIVAR Pacific Panel)
- MJO (U.S. CLIVAR)
- Clouds and Radiation (GCSS/CFMIP)

The plans of the WGNE Climate Model Metrics panel are to identify its “standard set” of observations to be used and to coordinate with the other WCRP activities to identify “extended metrics” in early 2010. For as far as GCSS/CFMIP is concerned, Robert Pincus proposed “extended metrics” for clouds and radiation that has been published (Pincus et al., 2008) and will serve as a starting point.

### **GCSS Working Group on Microphysics**

Chairs: Ulrike Lohmann (ETH Switzerland) and Ben Shipway (Met Office UK)

A simple 1-D kinematic model has been developed as a tool to assess and evaluate inherent differences between the different microphysical schemes that are commonly used in process and large-scale models. Due to the complex behavior of microphysics and its interaction with dynamics, it is desirable to have a constrained environment in which to make such an assessment. It may then be possible to associate particular features, as seen in fully-coupled 3-D intercomparison cases, with particular microphysical processes. The broad range of cloud characteristics produced by different models (e.g., surface precipitation, cloud phase, spatial and temporal development) has recently been demonstrated within the Rain In Cumulus over the Ocean (RICO) and Mixed-Phase Arctic Cloud Experiment (MPACE) intercomparison cases.

This so called Kinematic Driver for Microphysics intercomparison (KiD) (see <http://appconv.metoffice.com/microphysics/contact.shtml>) has been written in such a way as to make the interface as accessible as possible to different flavors of microphysics, such as bulk, bin, and multiple ice categories. A number of test cases were supplied that are designed to test the microphysical processes expected within a number of different cloud regimes. Although the 1-D nature of the model removes it to a certain extent from reality and thus observations, it allows a very quick comparison between numerous schemes and over a much wider parameter space than could be accommodated with 3-D fully-coupled runs. The link to observations can then be restored in the 3-D runs.

This framework is currently being used alongside the SHEBA intercomparison case, which falls into the work of the Polar working group. A joint meeting with the Polar group is planned to take place in June 2010, at which the future uses for this framework will be discussed (e.g., as a stand-alone intercomparison or as a tool to run alongside dynamically-coupled intercomparisons). There is also a plan to write a short note on this framework for publication.

### **Cloud Climate Feedback Intercomparison Project (GCSS/CFMIP2)**

Chairs: Sandrine Bony (Institut Pierre Simon Laplace, IPSL), Mark Webb (Met Office), Chris Bretherton (University of Washington), and George Tselioudis (NASA Goddard Institute for Space Studies, GISS)

CFMIP2 is a response to the observation that “cloud effects remain the largest source of uncertainty in model based estimates of climate sensitivity.” Since the physical mechanisms that cause this widespread uncertainty remain obscured, a working plan has been formulated by CFMIP and GCSS, which is available on the web (<http://cfmip.metoffice.com/CFMIP2.html>). The document contains plans to do process studies of the physical mechanisms that can be linked to the uncertainty of the cloud climate feedback. These plans have been further solidified in a European FP7 project, EU Cloud Intercomparison, Process Study and Evaluation Project (EUCLIPSE). This 3.5 million euro EU-sponsored project should be viewed as further capacity building around the CFMIP/GCSS plans and will run for the period 2010-2014. The full Description of Work can be found at <http://www.euclipse.eu/> and as a supplement to this

overview. The first kick-off meeting is planned in May 2010 and the first General Assembly is planned at the end of 2010 or early 2011, along with CFMIP and CBLWG.

It consists of five Working Groups:

1. Evaluation Techniques and Earth System Model (ESM) Experiments (chair: G. Tselioudis)
2. Climate Evaluation and Analysis (chair: S. Bony)
3. Process Evaluation and Analysis (chair: S.R. de Roode)
4. Metrics and Diagnostics for Narrowing Uncertainty in Cloud Feedbacks (chair: B. Stevens)
5. Aerosols, Clouds, Precipitation, and Climate (ACPC) (chairs: M.O. Andrea and B. Stevens)

ACPC is a joint initiative of the International Geosphere-Biosphere Programme (IGBP) and WCRP in cooperation with the Integrated Land Ecosystem-Atmospheric Processes Study (iLEAPS), International Global Atmospheric Chemistry (IGAC) project, and GEWEX. The goal of ACPC is to obtain a quantitative understanding of the interactions between aerosols, clouds, and precipitation and their role in the climate system. A Science Plan and Implementation Strategy plan were finalized in 2009 and can be found at the iLEAPS website and as a supplement of this overview. The central questions formulated in this plan are:

1. How do aerosols affect the cloud microstructure?
2. In what way do aerosol particles influence precipitation efficiency?
3. How do the direct radiative effects of the aerosol alone affect the distribution of clouds and precipitation?
4. (How) do the aerosol-driven changes affect the dynamics on the regional and global scale?

In order to address these questions, the following (partly GCSS-inspired) strategic elements will be utilized:

- Isolation of and focus on systems where there are strong indications of aerosol-cloud-precipitation interactions (follow here GCSS philosophy)
- Emphasis on statistical characterization of aerosol-cloud-precipitation interactions
- Development of approaches that leverage past and ongoing activities [the Second Dynamics and Chemistry of Marine Stratocumulus experiment (DYCOMS-II), RICO, AMMA]
- Thorough integration of modeling and observational approaches
- Hierarchical approach to both modeling and data collection/analysis
- Continued development of measurement techniques

In practice, two complementary routes will be followed to answer the above stated central questions:

1. Through local closure studies: prerequisites for such observational studies are a strong separation between diabatic and adiabatic processes and large variations of the aerosol occurring for the same meteorological conditions. A possible example could be the Amazon area with and without smoke from vegetation fires.
2. Through statistical closure studies: this method requires long term measurements that trade comprehensiveness and intensity from the previous method for more realizations and larger statistical significance.

*Concluding Thoughts:*

- GCSS is fast growing community (300+ scientists). This is a positive development but it also poses practical problems from a management point of view.
- A shift can be observed from the traditional working groups centered around isolated cloud types towards working groups grouped around research themes (cloud climate feedback, for instance).
- There is an increasingly larger role for 3-D GCMs within GCSS.

- There is an observable transition of moving away from single “golden day” case studies towards longer observational periods and composites.

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*Recommendations/Issues for the SSG:*

- Appointment of Chris Bretherton as co-chair of GCSS

22<sup>ND</sup> SESSION OF THE GEWEX SCIENTIFIC STEERING GROUP  
NEW DELHI, INDIA • 25-29 JANUARY 2010

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# AGENDA for SSG-22

## 22<sup>nd</sup> Session of the Scientific Steering Group (SSG) of the Global Energy and Water Cycle Experiment (GEWEX)

**National Rainfed Area Authority, Government of India, New Delhi, India  
25–29 January 2010**

**Monday, January 25, 2010**

08.00	08.30	General Registration	
08.30	08.45	Welcoming Remarks	J.S. Samra, T. Ackerman, G. Asrar, K.D. Sharma
08.45	10.15	<b>Overview of Activities and Plans</b> Chairman's Report Update on WCRP Activities Update and Outlook on Int'l GEWEX Project Office	T. Ackerman V. Detemmerman P. van Oevelen
10.15	10.30	BREAK	
10.30	11.30	<b>Overview of Activities and Plans (continued)</b> Review of Outstanding Action Items from the Last Joint Scientific Committee (JSC) and the 21 <sup>st</sup> GEWEX SSG Meeting	T. Ackerman
11.30	12.00	Executive Session 1 (GEWEX SSG Members Only)	
12.00	13.00	LUNCH	
13.00	15.00	<b>Presentations from Host and Sponsor</b> • Cold Waves, Hot Waves and Droughts • Integrated Information Base – The Savior of the Water Sector • Plan of Indian Satellites in Understanding the Science of Tropical Weather and Climate • On a Formulation of a Global Model as a Tool for Forecasting, Geo-engineering and Climate Change Discussion	J.S. Samra, NRAA AK Gosain, IITD  P Pal, SAC  OP Sharma, IITD
15.00	15.15	BREAK	
15.15	16.15	<b>Agency and Other Organizational Updates</b> • ESA • JAXA • WGNE	E.-A. Herland K. Umezawa C. Jakob
16.15	17.30	Future of WCRP and Its Structure	A. Busalacchi, G. Asrar
18.00		WELCOME RECEPTION	

## Tuesday, 26 January 2010

08.30	10.30	<b>Coordinated Energy and Water Cycle Observations Project (CEOP)</b> <ul style="list-style-type: none"> <li>• Actions and Recommendations for the SSG Introduction and Overview of Milestones in 2009 CEOP Response to 2009 SSG Rapporteurs' Report and SSG Actions</li> <li>• CEOP Science and Data Organization with Progress and Plans Science and Data Overview with Selected Results and Perspectives (Toshio Koike) RHP Perspectives and Extremes Cross Cuts</li> <li>• Perspectives on CEOP Strategy and Framework from Co-Chair Elect</li> </ul>	S. Benedict T. Koike  T. Koike, R. Stewart, D. Lettenmaier T. Koike  R. Stewart D. Lettenmaier
10.30	11.00	BREAK	
11.00	11.45	<b>CEOP (continued)</b> <ul style="list-style-type: none"> <li>• Review of CEOP Science and Data Priorities for 2010</li> <li>• Wrap-Up and Discussion, Including Actions for SSG</li> </ul>	T. Koike, R. Stewart  D. Lettenmaier, T. Koike, R. Stewart, S. Benedict
11.45	12.30	<b>WCRP, GEWEX, and International Coordination Programs</b> <ul style="list-style-type: none"> <li>• CLIVAR</li> <li>• GWSP and GEO Water Activities</li> </ul>	H. Cattle R. Lawford
12.30	14.00	LUNCH	
14.00	15.00	Future of GEWEX within WCRP	
15.00	15.45	Rapporteur's Report on GMPP	A. Beljaars, J. Polcher, R. Yu
15.45	16.30	WCRP Cross Cuts: Extremes	R. Stewart
16.30	16.45	BREAK	
16.45	17.30	Monsoon Cross Cut and VAMOS	J. Matsumoto
17.30	18.00	Monsoons and Extremes Discussion	

## Wednesday, 27 January 2010:

08.15	10.30	<b>GEWEX Radiation Panel (GRP)</b> <ul style="list-style-type: none"> <li>• GRP Actions and Recommendations for the SSG</li> <li>• Status of GRP Projects and Assessments</li> <li>• Addressing Legacy Documents and Future Ideas</li> </ul>	C. Kummerow C. Kummerow
10.30	11.00	BREAK	
11.00	11.45	<b>GRP (continued)</b> <ul style="list-style-type: none"> <li>• LandFlux</li> <li>• SCOPE-CM</li> <li>• WOAP Representatives</li> </ul>	M. McCabe L. Schueller C. Kummerow, K. Trenberth
11.45	12.30	Rapporteurs' Report on CEOP	A. Gaye, J. Matsumoto

12.30	13.30	LUNCH	
13.30	18.00	FIELD TRIP	

**Thursday, 28 January 2010:**

08.15	09.15	Executive Session 2	
09.15	10.30	<b>GEWEX Modelling and Prediction Panel (GMPP)</b> <ul style="list-style-type: none"> <li>• GMPP Actions and Recommendations for the SSG</li> <li>• GMPP Progress and Plans</li> <li>• Accelerating Progress in Model Development: Key Science and Programmatic Needs</li> </ul>	C. Jakob C. Jakob C. Jakob
10.30	10.45	BREAK	
10.45	11.30	<b>GMPP (continued)</b> <ul style="list-style-type: none"> <li>• Accelerating Progress in Model Development: Key Science and Programmatic Needs</li> </ul>	C. Jakob
11.30	12.15	Rapporteurs' Report on HAP and Extremes	R. Stewart, H. Wheeler, K.D. Sharma
12.15	13.15	LUNCH	
13.15	14.00	Rapporteurs' Report on GRP	K. Trenberth, O. Zolina
14.00	14.30	Rapporteurs' Report on GMPP	A. Beljaars, J. Polcher
14.30	15.00	BREAK	
15.00	16.30	Synthesis Discussion on the Future Direction of GEWEX	
16.30	17.00	Executive Session 3	

**Friday, 29 January 2010**

08.30	09.30	<b>2<sup>nd</sup> Pan-GEWEX Meeting</b> <ul style="list-style-type: none"> <li>• Venue</li> <li>• Theme and Program Structure</li> <li>• Decisions</li> </ul>	P. van Oevelen, T. Ackerman
09.30	10.00	Review of SSG Recommendations and Actions	
10.00	10.30	Discussion of Inputs to WCRP Priorities for the Next JSC Meeting	
10.30	10.45	BREAK	
10.45	12.00	<b>Other Issues of Relevance to GEWEX (All)</b> <ul style="list-style-type: none"> <li>• The Role of GEWEX in the New WCRP Order</li> <li>• Other Issues</li> <li>• Chairman's Summary Remarks</li> </ul>	All All T. Ackerman
12.00		FAREWELLS	