GEWEX WCRP

Global Energy and Water Cycle Experiment

NEWS

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GEWEX Celebrates 20 Years and Begins Planning Its Future at the 2nd Pan-GEWEX Science Meeting

For the outcomes and prospects from the 2nd Pan-GEWEX Science Meeting, see page 10.

Looking Back

- GEWEX: How it All Got Started (page 2)
- Reflections on GEWEX: Moustafa Chahine and Soroosh Sorroshian (page 5)
- 20 Years of GEWEX Regional Hydroclimate Projects (page 7)

Moving Forward

- Process for Planning the Future of GEWEX Begins at the 2nd Pan-GEWEX Science Meeting (page 10)

By virture of its breadth, GEWEX is not an "experiment" in the traditional sense; rather, it is an integrated "program" of research, observations, and science activities ultimately leading to prediction of variations in the global and regional hydrological regimes.

Moustafa T. Chahine, 1991

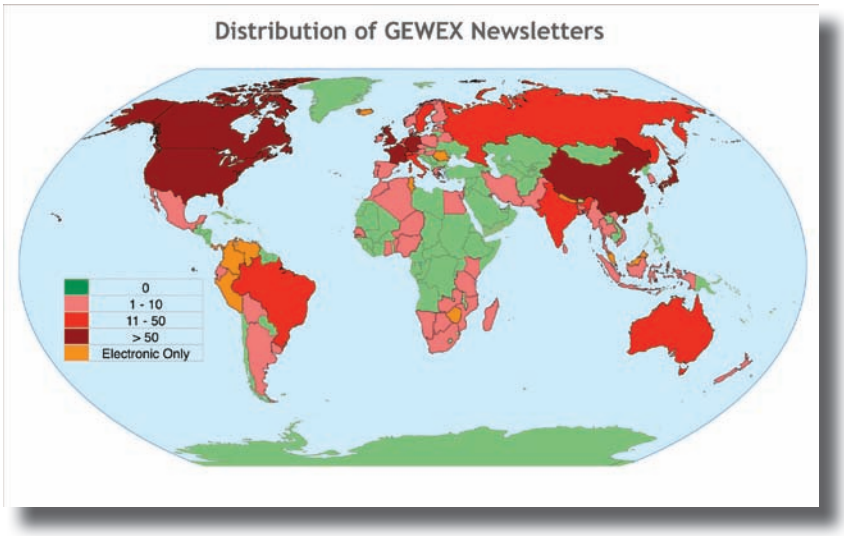
Contents

Commentary

GEWEX: How It All Got Started

Peter J. van Oevelen
Director, International GEWEX Project Office

Sometime in the 1980s, a proposal by the World Climate Research Programme (WCRP) for a project called the Global Energy and Water Cycle Experiment (GEWEX) was born out of the realization that Earth observational systems at that time were not adequate to facilitate the necessary progress in meteorological and global climate research. Consequently, in 1986, the WCRP Committee on Climatic Changes and the Ocean Working Group on Satellite Observing Systems organized a workshop to investigate the feasibility of the GEWEX proposal. On the basis of this workshop, the WCRP Joint Scientific Committee concluded that an in-depth review was necessary, as GEWEX would interact with many, if not all, activities of the WCRP. Two workshops were held in 1987 and 1988 to assess whether GEWEX should be a major component of WCRP for studying the Earth's global energy fluxes and the hydrological cycle, to determine where it would be best placed organizationally, and if the proposed observing and data management systems were adequate to address the GEWEX objectives. In the mid-1990s a scientific plan was written and in December 1990 GEWEX was officially approved as a project of WCRP, with the concurrence of both WCRP parent organizations, the World Meteorological Organization and the International Council for Science. The rest, as they say, is history.



Number of subscribers to GEWEX News.

The International GEWEX Project Office (IGPO) was established in 1990 to support the planning of the GEWEX program, coordinate international implementation activities, and to facilitate collaboration between the components of GEWEX and other related scientific efforts. Since the beginning, the National Aeronautics and Space Administration has been the primary sponsor of IGPO, and for that we are extremely grateful. We also thank organizations, such as the National Oceanic and Atmospheric Administration and the European Space Agency, which have also supported the office in varying capacities. The contributions by these agencies are indispensable to our ability carry out GEWEX activities.

In its 20 years of existence, GEWEX has, and continues to prove, its worth for global water cycle and energy studies. The Project's many accomplishments can be found in the scientific literature—for example, typing "GEWEX" into *Google Scholar*, an online search of scholarly literature, yielded more than 14000 hits! The achievements of GEWEX can also be measured by the existence of a broad and active science community, the large number of workshops and conferences organized, and through its many data sets. In particular, I wish to highlight the popularity of the GEWEX newsletter, *GEWEX News*, which is evident in its wide and global distribution (see the figure below). Many thanks to the staff at the IGPO as well as the support from the Science and Technology Corporation in making the publication of the newsletter possible. In particular, I thank Paul F. Twitchell, the Editor from 1991 until his retirement in August 2002, and Dawn Erlich, who has been the driving force behind the newsletter since then. All current and past editions can be found online at *http://www.gewex.org*.

In this anniversary edition of *GEWEX News*, we look both back to the past and foward to the future. In particular, I would like to highlight the interview on page 5 with the former chairs of the GEWEX Scientific Steering Group (SSG), Moustafa Chahine and Soroosh Sorooshian, who give their perspectives on various aspects of their chairmanship of GEWEX and what it meant to them to be a part of this Project. On page 7, Rick Lawford presents the history of the first Regional GEWEX Experiments and the GEWEX Hydrometeorology Panel. On page 10, the Chair of the SSG, Kevin Trenberth, reports on the 2nd Pan-GEWEX Meeting held in August, and how the results from the meeting are being used in laying the foundation for the next phase of GEWEX.

We are always looking for new material for the newsletter, so please feel free to contact us if you have something you think might be of interest to the GEWEX community. We would be happy to publish it.

Being a part of GEWEX, and in particular the IGPO, has been a deeply rewarding experience for me, and no doubt my predecessors, Paul Try, Robert Schiffer, and Rick Lawford, would agree that it is a challenging, but above all a very gratifying job, especially for having the privilege of working with such a fine scientific community. Thank you for being a part of what GEWEX stands for and we look forward to working with and for you for another 20 years!

Changes in GEWEX Leadership

New Scientific Steering Group Members

The following new members of the GEWEX SSG will begin their terms in January 2011.

Dr. Peter Bauer is the Head of the Satellite Section in the Research Department of the European Centre for Medium-Range Weather Forecasts in Reading, UK. His areas of interest are satellite data assimiliation in numerical weather prediction models, moist atmospheric processes, and radiative transfer modeling.

Dr. Eleanor Blyth is the Head of the Land Surface Processes Group at the Centre for Ecology and Hydrology in Wallingford, UK. Her scientific interests are in land-surface modeling, using data for benchmarking land-surface model performance, linking hydrological and meteorological models, land-atmosphere interactions, and arctic land-surface processes.

Dr. Stephen Klein is a research scientist in the Program for Climate Model Diagnosis and Intercomparison at the Department of Energy's Lawrence Livermore National Laboratory in Livermore, California. His research interests include clouds, their role in climate change, and the fidelity with which climate models simulate clouds.

GEWEX Cloud System Study (GCSS)

Dr. Jon Petch is the new Co-Chair of GCSS. He leads the group that develops improved parameterizations of clouds and radiation at the UK Met Office in Exeter. He is also the Manager of Academic Partnerships, overseeing science collaboration between the Met Office and its UK and international research partners. Dr. Petch has been an active member of GCSS since 1996 and has chaired the Precipitating Cloud Systems Working Group for the past 5 years.

Dr. Petch succeeds Dr. Pier Siebesma of the Royal Netherlands Meteorological Institute, who served as chair of GCSS from January 2007–January 2010 and then as co-chair until November. Dr. Petch co-chairs GCSS with Dr. Chris Bretherton of the University of Washington in Seattle.

GEWEX Hydroclimatology Panel (formerly CEOP) Looks for a Co-Chair to Fill Big Shoes

Professor Toshio Koike of the University of Tokyo's Department of Civil Engineering stepped down in August as Co-Chair of the Coordinated Energy and Water Cycle Observations Project (CEOP), which has since been renamed the GEWEX Hydroclimatology Panel (GHP).

Prof. Koike has been a driving force in GEWEX hydroclimate activities for almost 10 years. In 2001 he initiated and began chairing the successful Coordinated Enhanced Observing Period (referred to now as old CEOP), and a number of initiatives that he promoted within CEOP have resulted in important contributions to the objectives of GEWEX, including: (a) development of fully integrated, internationally administered data management scheme populated with quality-controlled, unified-format satellite, in situ, and model data that are co-registered in time and space over a number of reference sites and monsoonal regions around the globe, associated with CEOP Regional Hydroclimate Projects (RHPs; for more information about these regional projects, see article on page 7); (b) development of a unified strategy for connecting the RHPs' needs and applications with CEOP global observation and prediction activities; (c) institution of a global high elevation observing period and a joint CEOP/China semi-arid regional study; (d) creation of CEOP studies on extreme weather events focused on drought, heavy precipitation, floods, and low flows; and (f) expansion of water and energy budget studies to understand average conditions during the entire CEOP period, including the influence of aerosols and a study of water isotopes.

Prof. Koike also oversaw the completion of Phase 1 of the CEOP Inter-Continental Transferability Study. In this Study, which was led by Dr. Burkhardt Rockel, six regional climate models from different institutions performed continuous simulations using CEOP data for the time period 2000–2004 for seven worldwide regions that coincided with RHP domains.

In 2007 Prof. Koike and his Co-Chair, the late Dr. John Roads, oversaw the merger of CEOP into a GEWEX Panel under the CEOP acronym. Prof. Koike's leadership and standing in the international community and his commitment of both intellectual and fiscal support toward achievement of the goals and objectives of CEOP and GEWEX has been unparalleled within the framework of the World Climate Research Programme.

We at GEWEX thank Prof. Koike for his hard work in establishing and fostering these important activities and are grateful that he will continue to be involved in GEWEX research in other capacities.

Recent News of Interest

GEWEX Panel Chair Selected as New Director of CIRA

Christian Kummerow, Professor of Atmospheric Science at Colorado State University, was selected as the Director of the Cooperative Institute for Research in the Atmosphere. Prof. Kummerow has served as the Chair of the GEWEX Radiation Panel since 2008, and will continue to chair the Panel until, in his own words, "I accomplish what I set out to do for GRP."

2011 Advanced Study Summer Colloquium on Statistical Assessment of Extreme Weather Phenomena under Climate Change

The 3-week colloquium (6–24 June 2011) will be held at the National Center of Atmospheric Research in Boulder, Colorado to provide training in use of extreme value analysis to assess how frequency, duration, and intensity of extreme weather events could shift as part of global climate change. A Researcher Colloquium organized by US CLIVAR will be held June 13–17 to provide focus for a research agenda on extremes. Travel funding is available for students. For more information, see: *http://www.asp.ucar.edu/colloquium/summer_colloquiua.php.*

New Website Explains Climate Change

Dr. Alan Betts, a Fellow of the American Geophysical Union, the American Meteorological Society, the Royal Meteorological Society, the American Association for the Advancement of Science, GEWEX scientist, and author or co-author of more than 140 reviewed papers in the scientific literature, has created a website (*http://alanbetts.com)* to archive his research and make available to the public his writings and commentaries explaining climate change issues.

In Memoriam – Igor A. Shiklomanov

Professor Igor A. Shiklomanov, the Director of the State Hydrological Institute, died on 22 August 2010 in St. Petersburg. He had served as the head of the State Hydrological Institute, one of the oldest scientific hydrological institutions in Russia and the world, since 1981.

Professor Shiklomanov was recognized as one of the world's foremost authorities on hydrology and water resources, human impact on river runoff, and the dynamics of water use and availability on regional and global scales. For more than 30 years, he actively contributed to international cooperation in the field of hydrology and water resources within UNESCO, the World Meteorological Organization, the International Association of Hydrological Sciences, and the United Nations Development Programme. In the mid-1990s, he was a member of the GEWEX Scientific Steering Group and Chairman of the Intergovernmental Council for the International Hydrology Programme of UNESCO.

GEWEX Receives Praise in Report on Achieving and Sustaining Earth Observations

The US Office of Science and Technology Policy recently released a report addressing US Earth observation capabilities. In the report GEWEX received recognition as a program that coordinates Earth observations successfully.

The myriad of observations taken today vary widely in purpose and scope and are appropriately distributed among hundreds of programs .... To a large degree, these observations have been only loosely coupled, coordinated, and integrated, although there are notable exceptions, such as the Global Energy and Water Cycle Experiment (GEWEX). GEWEX successfully integrates activities both nationally and internationally to better observe, understand, and model the hydrological cycle and energy fluxes in the Earth's atmosphere and at the surface, providing a great example of what can be done.

GEWEX is proud to receive this recognition and will continue to incorporate those observations into products describing the global energy and water cycle. The report is available at: *http://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp-usgeo-report-earth-obs.pdf.*

International Water Prize Awarded to Soroosh Sorooshian

Professor Soroosh Sorooshian, former Chair of the GEWEX Scientific Steering Group, was honored with one of the most prestigious water prizes in the world, the Prince Sultan Bin Abdulaziz Award given out by Prince Khalid bin Sultan bin Abdulaziz of Saudi Arabia. Prof. Sorooshian received the prize for Management and Protection of Water Resources for his work in developing user friendly, low cost and hydrologically relevant information, such as real-time rainfall estimates for use by the international community.

In Memoriam – Joël Noilhan

Dr. Joël Noilhan, former head of the Mesoscale Meteorology Division of the National Meteorological Research Center of Météo-France, died on 31 October 2010. Dr. Noilhan was an outstanding researcher in the field of soil-vegetation-atmosphere transfer (SVAT) modeling and renowned for his ISBA Land-Surface Model, which is widely used by the climate, numerical weather prediction, and hydrology communities. In addition to his involvement in GEWEX as a member of the Scientific Steering Group in the late 1990s, Dr. Noilhan actively participated in several intercomparison exercises for two GEWEX projects—the Project for Intercomparison of Land-Surface Schemes, and the Rhône-AGGregation SVAT Model Intercomparison Project of the Global Land/Atmosphere System Study (GLASS).

Reflections on GEWEX: Moustafa Chahine and Soroosh Sorooshian

Moustafa T. Chahine, AIRS/AMSU-A/HSB Science Team Leader, National Aeronautics and Space Administration Jet Propulsion Laboratory

Soroosh Sorooshian, Director, Center for Hydrometeorology and Remote Sensing, University of California, Irvine

In commemorating the 20th Anniversary of GEWEX, we thought it would be insightful to interview the two former Chairs of the GEWEX Scientific Steering Group (SSG) who guided GEWEX activities for the majority of those years, Drs. Moustafa Chanine (1989–1999) and Soroosh Sorooshian (1999–2008). Below are their answers to questions related to their experiences in chairing the GEWEX SSG.

(1) Why did you become the Chair of the GEWEX SSG?

M. Chahine: Following my participation as a member of NASA's Earth System Science Committee which defined the NASA Earth Observing System (EOS), I was interested in extending the use of the existing and future EOS data to be obtained from NASA's Terra, Aqua, and Aura satellites, as well as data from the European and Japanese Space agencies, to climate studies. In parallel with the EOS activities in the US, Pierre Morel, the Director of WCRP, and Vern Suomi of the University of Wisconsin were considering a concept to study the Earth's fast component of the hydrology cycle, prior to the study being named GEWEX. When I was asked by Pierre Morel to chair the newly named GEWEX, I accepted the challenge. That was around the end of 1989.

S. Sorooshian: I had played a number of roles in various capacities within the GEWEX program, last of which was membership in the SSG. After a few years on the SSG and as Mous was ending his role as Chair, I was approached and asked if I would consider being a candidate for Chair. My response was positive because of my interest in bringing more "land-surface hydrology" into the GEWEX program, and I guess after that the WCRP Joint Scientific Committee (JSC) in consultation with the GEWEX leadership at the time selected me for the position.

(2) What was the hardest thing you had to do as Chair?

M. Chahine: The most arduous task was launching GEWEX, organizing its structure, and defining its mission. We had to define the scientific goals and objectives of GEWEX and establish connections to the broader science community and the various international space organizations in the US, Europe, and Japan. We began by building on an existing WCRP activity, "The Radiation Committee," chaired by Tom Vonder Haar. He agreed to collaborate with GEWEX and ultimately became Chair of the GEWEX Radiation Panel (GRP). Subsequently, GEWEX added two more panels, the Hydrometeorology Panel (GHP) for continental scale studies and the Modeling and Prediction Panel (GMPP).

S. Sorooshian: To maintain a balance between the multifaceted elements of the program with the realization that satisfying all the elements (panels, working groups, stakeholders, etc.) with their scientific agendas would be a daunting task.

(3) What was your most rewarding experience as Chair?

M. Chahine: It was the positive reception and cooperation we received from the various space agencies, in particular from NASA under Dr. Shelby Tilford and from the weather and climate research community, as well as from the late Tony Hollingsworth at the European Centre for Medium-Range Weather Forecasts. We all wanted GEWEX to bring together the global satellite data and climate modeling to study and understand the water cycle, clouds, and radiation as a coupled system.

S. Sorooshian: Engagement in an international program and working with a diverse group of outstanding scientists and promoting a truly interdisciplinary project with broad implications was the greatest reward.

(4) In your opinion, what has been the greatest accomplishment of GEWEX?

M. Chahine: Comprehensive "data-based climate modeling" became the signature of GEWEX and remains so today. The assimilation of global data sets into weather prediction models was already established, but GEWEX extended this to climate modeling as well as process studies. GEWEX supported the development of validated data sets such as the International Satellite Cloud Climatology Project (ISCCP), the NASA Water Vapor Project (NVAP) for total column water vapor, and the International Satellite Land-Surface Climatology Project (ISLSCP), among others. These data sets continue to be updated and utilized by a wide range of scientists worldwide. A notable accomplishment of GEWEX during that time was the advocacy it provided for the CloudSat Project, leading to a successful operational program. CloudSat is now in Earth orbit as part of the NASA A-Train constellation.

S. Sorooshian: Interestingly enough, when my term was over, a close colleague asked me if I felt that during my tenure, GEWEX had accomplished its intended objectives. My reply was that "some hydrologists alleged that the Project had placed too much emphasis on the atmospheric component of the hydrologic cycle, while some atmospheric scientists claimed that perhaps GEWEX had become too land-surface hydrology oriented." This gave me the satisfaction that I achieved my goal of maintaining a balance. Thanks to the SSG and the Panels and Working Groups, we maintained the focus on the scientific and observational issues that had challenged the community and, therefore, we "stayed the course" rather than being influenced by a number of "fashionable trends" that would pop up in the WCRP community.

(5) Do you have any regrets?

M. Chahine: There was the expectation that the "climate quality" space observations initiated by the various space agencies in the US and abroad would continue for two or more decades to establish a long-term global data record. Disappointingly, this did not happen for a variety of political reasons, in spite of continued advocacy by GEWEX and its scientific constituents.

S. Sorooshian: Those who know me will attest to the fact that, in general, I am a very positive individual and as such, I consider myself lucky to have served GEWEX in various capacities and to have learned so much from my colleagues.

(6) Any pointers or words of wisdom based on your experience for scientists currently involved in GEWEX?

M. Chahine: Progress has been made in several process studies on many fronts. Scientists continue to make improvements in the studies of feedback and interactions between clouds and water, aerosols and radiation, cloud classification and parameterization into climate models, and the role of the land-surface and vegetation in the hydrological cycle. Without a doubt, the range of new problems to tackle is expanding and will continue to do so. I would like to urge GEWEX scientists to keep in close touch with the user community, funding agencies, and space agencies to anticipate their needs and to plan ahead.

S. Sorooshian: Fortunately, GEWEX attracts bright and highly committed scientists who volunteer their time and effort. Needless to say that due to the international nature of the program, one must be highly sensitive to not only the scientific opinion of all who serve GEWEX, but also to the cultural diversity of the members.

(7) What would you like most to see GEWEX accomplish that has not yet been done?

M. Chahine: Toward the end of the first decade of GEWEX (1990–2000) a vision emerged of future challenges for the Project. At their meeting in Rio de Janeiro, Brazil (1998), the SSG approved a statement that saw the future of GEWEX in three parallel phases: the first was data acquisition and exploitation for the study of climate/hydrology processes. Building upon this is the second phase to enable the application of GEWEX to global modeling and predictions. The third phase focuses on regional (i.e., continental scales) modeling and prediction. The ultimate test of success is how well we can predict precipitation on seasonal time scales. This is, unquestionably, a higher-order goal that has remained outside GEWEX's reach, and cannot be accomplished by GEWEX alone but must be done in collaboration with the larger Earth System Science community. Therefore, I see outreach to other research and modeling programs, such as CLIVAR, to be imperative.

S. Sorooshian: The study of the "global energy and water cycle" is a complex and challenging problem that will require much effort and time with a great deal of patience and persistence to address. It is my hope that GEWEX will continue to pursue the many remaining questions as we attempt to close the water and energy cycles at all scales (time and space).

(8) In what area do you think GEWEX should provide more focus and effort?

M. Chahine: I believe that a focus on process studies in the "boundary layer" would add greatly to the current need to assess the interactions between clouds, water vapor, and the surface. As we know, satellite observations within the boundary layer are very challenging for today's remote sensing instruments. New capabilities using both passive and active measurements should be evaluated. In addition, at the start of GEWEX in the 1990s, model grid sizes were about 100 km x 100 km and hyperspectral sounders like the Atmospheric Infrared Sounder (AIRS) and the Infrared Atmospheric Sounding Interferometer (IASI) proved to be very useful. But the grid size of both regional and global models is currently approaching 5 km x 5 km. The development of a new generation of hyperspectral sounders with footprints of approximately 1 km x 1 km would anticipate the evolving needs of the user community and prove essential, not only in modeling research, but also in studying cloud-water vapor interactions and feedback inside and above the boundary layer. Observation and modeling go together, step by step, with each one relying upon and challenging the other as we move toward expanding our understanding of the climate system.

S. Sorooshian: Validation and testing of models at scales relevant to the stakeholders, which in the case of GEWEX, have been identified as hydrologic services and water resources communities. In my opinion, it is GEWEX's responsibility to ensure that the efficacy of various climate model predictions at different temporal scales is appropriately examined and an accurate assessment of their potential for application be presented to stakeholders.

(9) Any suggestions on how to attract and entrain young scientists into GEWEX's areas of interest?

M. Chahine: There are several programs in the US under the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the National Science Foundation, and other agencies aimed at encouraging and introducing Earth science to students in various fields. What GEWEX could do is focus on water and hydrology. At the K-12 level GEWEX could, for example, participate in workshops for teachers with a focus on measurements of in situ hydrological parameters with the possibility of using such data to show trends in comparison with GEWEX and satellite data sets. At the university level, the GEWEX data set should become one of the ingredients of graduate research and modeling studies. The basic approach of GEWEX, data-based modeling and acquainting graduate students with GEWEX data sets, is a good beginning.

S. Sorooshian: At the 2nd Pan-GEWEX Meeting held in Seattle, Washington, GEWEX created an outstanding opportunity for supporting young scientists to participate. In my view, this is the right direction, and in every occasion possible, the same support should be made available to bring in more junior scientists to the GEWEX camp.

GEWEX Thanks a Long-Time Advocate

Sam Benedict, the International Coordinator for the Coordinated Energy and Water Cycle Observations Project (CEOP) has played a key role in GEWEX for almost 20 years. In 1992 he joined the WCRP Joint Planning Staff in Geneva, Switzerland as the Senior Scientific Officer for GEWEX, where he was dedicated to aiding GEWEX activities for the next 10 years. Upon his retirement from WCRP in 2002, he became the International Coordinator for the Coordinated Enhanced Observing Period (the original CEOP).

Beginning with his time at WCRP during the conception of GEWEX as an organized project, through the development of the GEWEX Hydrometeorology Panel, the Global Land/Atmosphere System Study, CEOP, most of the components of GEWEX, and now continuing as a key player as GEWEX moves into Phase III, Sam has been at the core of the development and facilitation process. Always a passionate supporter of GEWEX objectives and the projects designed to meet these objectives, Sam works both behind the scenes and at the helm, contributing new ideas and plans. GEWEX owes much to Sam for his dedication to its past and continuing contributions to Earth Science.

Reflections on GEWEX

(Continued from page 6)

(10) Are there any other thoughts you would like to add?

M. Chahine: Current Sounders like AIRS and IASI provide additional information such as CO_2 and other trace gases, which can be used as tracers to test and validate the transport capabilities of various models, especially in vertical transport. As I have personally found out, the use of such trace gases in modeling studies reveals the need to significantly improve such models. This is a new capability that can be added to the data sets that are among the GEWEX data "treasures."

Finally, I would like to add my personal thanks and those from Pierre Morel to all those who worked diligently to facilitate the evolution GEWEX to what it became. Those include Paul Try and the International GEWEX Project Office and many more individuals around the world. In particular, I would like to thank Deborah Vane, Sam Benedict, and Tetsuzo Yasunari. For a while the three, separated by about 8 hours from each other, kept a watchful eye 24 hours a day on events that could have affected the path of GEWEX. That path was not always smooth!

S. Sorooshian: Whether the program is called GEWEX or becomes known under a different acronym, many exciting scientific questions that have been the focus for a number of years should not be abandoned because they will remain crucial to gain increasing understanding of the hydrologic cycle in the climate system.

20 Years of GEWEX Regional Hydroclimate Experiments

Richard (Rick) Lawford
International GEWEX Project Office, Silver Spring, Maryland

Twenty years have sped by since GEWEX held its first open workshop in October 1990 in Reston, Virginia to plan a regional hydroclimate experiment. It was a focused workshop: no one rushed out to answer their cell phones, no one was reading e-mails on their laptops, and everyone paid attention to the viewgraph slides as they were presented. In addition to introducing the concept of GEWEX to a large international community of scientists, this meeting focused on plans for a sustainable macroscale hydrological project in a basin that would cover a size equivalent to a continent, leading to the name "Continental-Scale Experiment (CSE)." It was clear from the presentations (mainly by U.S. scientists) that the preferred basin was the Mississippi River Basin. There were many excellent reasons for this, including: (1) at that time the Mississippi River Basin was the only basin of this scale in the world that had such extensive plans for instrumentation, including Doppler radars and Light Detection And Ranging systems (LIDARs); (2) no other basin could mobilize the domestic expertise then available in the U.S.; and (3) the Mississippi River Basin was the only basin supported by government agencies, indicating that if their interests were met they would provide support.

While there was a consensus at the first workshop that a study in the Mississippi River Basin was highly desirable, the non-U.S. participants raised concerns, most notably that countries that had funds and expertise to contribute could participate more extensively in a project in their country. And although the Mississippi River Basin had a range of hydrometeorological processes, it was missing processes associated with deforestation, rice patties, permafrost, tropical storms, and large seas, all important for global climate models. As a result of this seminal workshop, a framework was accepted that supported the launch of the GEWEX Continental-scale International Project (GCIP) in the Mississippi River Basin, with guidance from an international science committee. Other countries were invited to come forward with plans for their own continental-scale initiatives to complement those of GCIP.

Over the next few years, GCIP plans took shape under the guidance of Michael Coughlin of the National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs (OGP), together with a science committee and John Leese, NOAA/OGP, who developed the data plans. GCIP was strengthened by having a "core project" that enabled the NOAA Office of Hydrology and the National Centers for Environmental Prediction (NCEP) to jointly implement GCIP results in their operational environments. GCIP sequentially addressed science issues in different parts of the Mississippi River Basin, going from the southwest (soil moisture), to the northwest (cryosphere), to the east (runoff generation), to the entire basin. At the same time, GCIP funding was support-

ing other efforts, such as the Project for the Intercomparison of Land-Surface Parameterization Schemes (PILPS) and Water Vapor measurements from commercial aircraft. In 1997, GCIP became truly multi-agency as the National Aeronautics and Space Administration (NASA) issued calls that made important contributions to GCIP in the areas of land data assimilation and regional water budget studies.

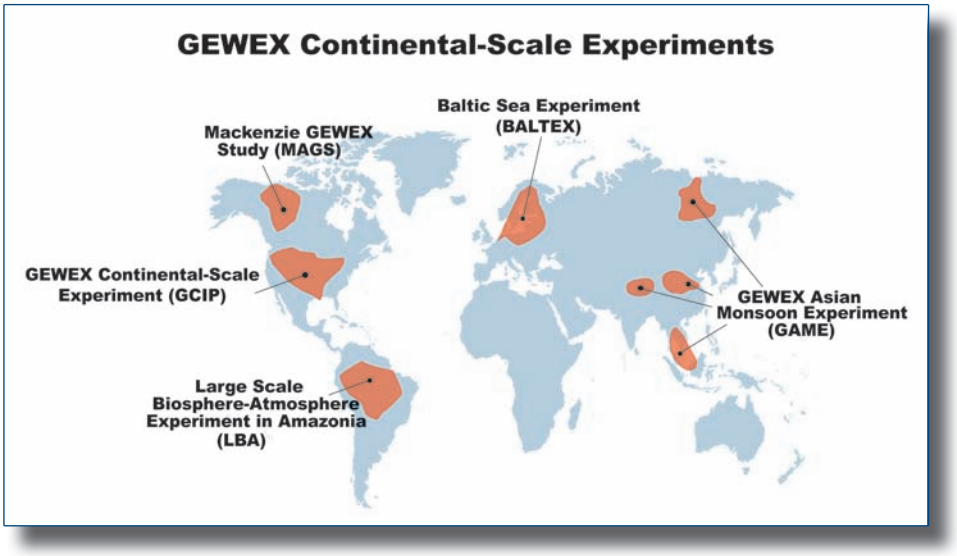
At the same time other countries were responding to the GEWEX invitation to start their own CSE. The Mackenzie GEWEX Study (MAGS) in the Mackenzie River Basin began in the early 1990s, initially with very modest funding, mainly for government scientists, from Environment Canada. MAGS, which focused upon the assessment of the role of freshwater fluxes to the Arctic Ocean, blossomed under the scientific leadership of Ronald Stewart and secured substantial university involvement in the project. Specific study periods were launched and included the Canadian GEWEX Enhanced Study (CAGES) from September 1998 to July 1999, and a comprehensive study of a low flow year on the Mackenzie River in 1994. These successes are fully documented in a two book set entitled *Cold Region Atmospheric and Hydrologic Studies–The Mackenzie GEWEX Experience*, published by Springer.

The Baltic Sea Experiment (BALTEX) was also developed during the same period and its first phase was implemented with funding from the German and Scandinavian governments. It investigated the physical processes and water and energy budgets in the drainage basin of the Baltic Sea, including studies of their impact on the Sea itself. BALTEX involved 14 countries, and through the coordination efforts of Erhard Raschke provided excellent opportunities for capacity building with smaller countries that had recently separated from the former Soviet Union. BALTEX was successful in integrating meteorology, hydrology, and oceanography in ways that had not occurred before in Europe. Although BALTEX has reinvented itself several times since its started in the early 1990s, it is arguably the longest lasting GEWEX CSE.

Through the efforts of Tetsuzo Yasunari and his colleagues in Japan, the GEWEX Asian Monsoon Experiment (GAME) was planned, funded, and implemented. GAME assessed the effects of land on the Asian monsoon. Four distinct areas were identified for field studies to assess the land-monsoon interactions, including Thailand, the Tibetan Plateau, the Huai basin in China, and sites in the Lena Basin in eastern Siberia. Some unique data sets and process studies were developed through these studies that have contributed to substantial improvements in models (e.g., the albedo of larch forests was documented and used to improve the representation of winter high latitude land albedo in climate models).

Another CSE emerged in the Amazon basin as a result of a major interdisciplinary study that was funded to examine climate change and deforestation impacts on regional water cycles. The Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA) Project was tied to an even larger NASA-funded ecological study of the Amazon forest. Carlos Nobre led the hydrometeorological GEWEX component that took advantage of the extensive infrastructure provided through the larger ecological study, as well as additional European support for land-atmosphere studies. The study provided assessments of the consequences of deforestation on the Amazon forest in terms of regional climate and hydrologic impacts, leading to substantial improvements in our understanding of complex, multi-scale forest-climate interactions.

The figure below shows the distribution of the original five CSEs. As these experiments expanded along with other components of GEWEX, their coordination through the GEWEX Scientific Steering Group became very unwieldy.



The original five Continental-Scale Experiments.

In order to accommodate the need for more oversight, the concept for a GEWEX Hydrometeorology Panel (GHP) was adopted in 1994 and implemented in 1995. This Panel was largely self-organized, drawing its Chair on an annual basis from the leads of the CSEs with nearly all of them cycling through the position between 1995 and 2001. It developed criteria for the CSEs so that they could measure their progress towards good project management practices, integration, and support for GEWEX goals. These criteria were also applied to new projects that wished to be recognized as CSEs. During this period considerable effort was given to the development of "cross-cutting activities," such as the Water and Energy Budget Study (WEBS), which was first initiated in GCIP and then on a GHP-wide basis under the leadership of the late John Roads. Other cross-cutting activities included monsoons, and two that proved more difficult to implement, namely precipitation and the Water Resources Application

Project (WRAP). Also, within the framework of GHP, leadership was provided for WCRP cross-cutting activities related to monsoons (led by Tetsuzo Yasunari) and extreme climate events (led by Ronald Stewart), such as drought, heavy precipitation, and flooding.

During the 1990s, GHP also included CSE-affiliates and collaborative projects, such as the International Satellite Land-Surface Climatology Project (ISLSCP). One of the CSE affiliates, Couplage de l'Atmosphère Tropicale et du Cycle Hydrologique (CATCH), contributed to the development of the African Monsoon Multidisciplinary Analysis Project (AMMA), which became a CSE in 1999 under the leadership of Jan Polcher. AMMA was the first of several collaborative efforts with the Climate Variability and Predictability Project (CLIVAR), combining large-scale and local process studies as it developed an integrated understanding of studies of the development and impacts of the West Africa monsoon. Under the leadership of Piers Sellers and Pavel Kabat, ISLSCP developed global data sets to facilitate climate modeling and undertook intensive process studies with high temporal resolution and a domain size of a climate grid. The First ISLSCP Field Experiment (FIFE, conducted in Kansas) and the Boreal Ecosystems-Atmosphere Study (BOREAS, conducted in Northern Manitoba and Saskatchewan), were two intensive ISLSCP field campaigns that provided valuable data sets that were used in model calibration in numerous GHP studies.

In the 2000–2001 time frame, the Coordinated Enhanced Observing Period (CEOP) was created. Initially, CEOP collected data from each of the CSE reference sites and archived them at the University Corporation for Atmospheric Research (UCAR) for use in water budget studies. Plans also emerged for storage of satellite data and products and modeling data in a distributed data archive at the University of Tokyo. The early intent was to develop a global data set for the period of 2001 to 2004. Under the ambitious leadership of Toshio Koike, assisted by Sam Benedict and Petra Koudelova, CEOP became recognized as a prototype for aspects of the Global Earth Observation System of Systems (GEOSS) and subsequently extended its data collection activity to a decadal data set (2001 to 2010).

During this period, GHP implemented a more permanent Chair when John Roads stepped forward to undertake the challenge. The Murray Darling Basin (MDB) Project in Australia (led by Michael Manton) and the GEWEX Americas Prediction Project (GAPP), the follow-on to GCIP (led by Rick Lawford and Jin Huang), were accepted as new CSEs. The MDB basin examined the water budget in a semi-arid region while GAPP focused on the contiguous 48 states of the US with an emphasis on hydrometeorological and seasonal prediction issues in the western US. In addition, Soroosh Sorooshian, the Chair of the GEWEX SSG beginning in 1999, gave more attention to hydrology in these projects and encouraged more interpanel collaboration. During this time, WRAP morphed into the Hydrological Applications Project (HAP) under Eric Wood. Subsequently, from 2004 to 2007, three new CSEs came into GHP, including the La Plata Basin (LPB) Project, focused mainly in the Argentinean part of the La Plata Basin (led by Hugo Berbery), the Monsoon Asian Hydro-Atmospheric Science research and Prediction Initiative (MAHASRI) in Eastern Asia (led by Jun Matsumoto), and the Northern Eurasia Earth Science Partnership Initiative (NEESPI) in Northern Eurasia (led by Pasha Groisman). In this same period, due to programmatic changes within NOAA, GAPP was combined with the Pan America Climate Studies (PACS) to form the Climate Prediction Program for the Americas (CPPA).

In an effort to improve efficiency, increase interactions between CEOP and the CSEs, and streamline the organizational structure, a decision was made to merge CEOP and GHP into the Coordinated Energy and Water Cycle Observations Project (CEOP) in late 2007. Recognizing the increasing role of the CSEs in addressing regional hydroclimate issues, they were renamed Regional Hydroclimate Projects (RHPs) with modified terms of reference. While the concept of unified effort under CEOP was desirable, the coordination challenge proved to be very difficult for a volunteer organization. At the 2nd Pan-GEWEX Science Meeting in August 2010, a proposal to change the name of CEOP to the GEWEX Hydroclimatology Panel (GHP) and modify its terms of reference accordingly was accepted. Admittedly, some may respond to this name change with the comment "plus les choses changent, plus elles restent les mêmes" (the more things change, the more they remain the same), but it is my view that with the talented pool of people within GHP, it will continue to make substantial progress through the RHPs and its data activities during the coming years. An important contribution to this talent pool are the scientists from the Hydrological cycle in the Mediterranean Experiment (HyMeX) study (led by Philippe Drobinski), which was accepted as a RHP in August 2010.

Please allow me to close with a personal note. During the 20-year period since the Reston workshop, I have had the pleasure of maintaining a continuous involvement with aspects of GHP, ranging from project definition in the early days of MAGS as a Canadian government research manager, to program management and project selection and oversight for GCIP and GAPP while a NOAA program manager, to dealing with organizational issues while serving as the Director of the International GEWEX Project Office from November 2003–November 2007. In addition to my exposure to the many personalities, scientific ideas, new technologies, meeting venues, and organizations, this experience has provided me with a number of lessons about effective ways to implement international and interdisciplinary research. For example, the development of a vibrant international collaborative "best efforts" activity requires patient nurturing and preferably a "champion" or dedicated leader who at times may be willing to sacrifice some efficiency for inclusiveness. The new GHP Co-Chair, Dennis Lettenmaier, and his colleagues are now beginning to write a new chapter in this unfolding story, so that book of lessons will need to wait for a few more years before being written.

Moving Forward: Process for Planning the Future of GEWEX Begins at 2nd Pan-GEWEX Meeting

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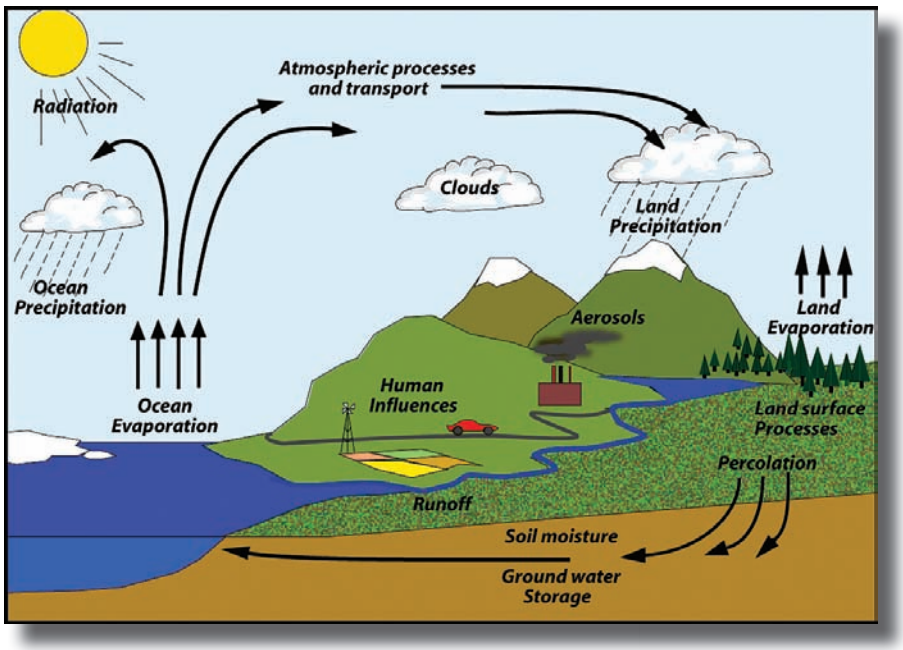
The 2nd Pan-GEWEX Science Meeting was held on 23–27 August 2010 at the University of Washington in Seattle to develop a strategy for GEWEX activities in the post 2013 era that fits within the new framework of the World Climate Research Programme (WCRP). To foster planning, the meeting brought together the project and working group members of the three GEWEX Panels and members of the GEWEX Scientific Steering Group (SSG), as well as a number of agency program managers and young scientists (see page 14) from different nations. After the meeting, a special session of the GEWEX SSG was held to review the results.

Background for Reorganization

In its planning for the post 2013 timeframe, the WCRP Joint Scientific Committee (JSC) recommended that the four core projects of WCRP should have revised responsibilities to better facilitate climate system research at the interface of the physical Earth system components. These include: (1) Ocean-atmosphere (cf. the current Climate Variability and Predictability Project, CLIVAR); (2) Land-atmosphere (cf. GEWEX); (3) Cryosphere (cf. Climate and Cryosphere Project, CliC); and (4) Stratosphere-troposphere (cf. Stratospheric Processes And their Role in Climate Project, SPARC). Each core project will have a common set of basic "themes" including: (1) observations and analysis; (2) model development, evaluation, and experiments; (3) processes and understanding; (4) applications and services; and (5) capacity building. Coordination of these themes across the projects is to be facilitated by the new WCRP Modeling and Observations Councils.

In preparation for the forthcoming changes, the GEWEX SSG met in January 2010 in New Delhi and began formulating plans for a revised mission statement, a set of imperatives (things that must be done), and a set of long-term frontiers or challenges for the future. The draft of these was published in the May 2010 issue of *GEWEX News* as a basis for discussions at the August Pan-GEWEX Meeting. The SSG agreed that the three GEWEX panels, GEWEX Radiation Panel (GRP), GEWEX Modeling and Prediction Panel (GMPP), and 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. The figure on this page illustrates the rational for retaining the panels from the standpoint of the hydrological cycle, featuring radiation, atmospheric processes, and land-surface hydrology and processes. The original motivation for these being together is that they correspond to the "fast" processes in the climate system, and this still applies.

Following the JSC meeting, which was held in February 2010, key questions arose, such as "how much science falls under the category of land-atmosphere?" and "what about the science that does not?" Accordingly, the approach taken at the 2nd Pan-GEWEX Meeting was that while the future GEWEX should be the place where land-atmosphere interactions are featured, it should also retain the global energy and water cycle as a core focus while highlighting regional aspects. In addition, GEWEX should also include hydrological and land-surface processes and modeling, and interactions with the atmosphere. Further, GEWEX should retain a strong atmospheric component related to the water and energy cycles, and hence scientific issues related to radiation, clouds, convection, precipitation, boundary layers, surface fluxes, runoff, and human influences, which should also be included in terms of observations, process understanding, and modeling.



A schematic of the water and energy cycle illustrating how radiation and energy are driven, including the atmospheric dynamics that produce clouds which block the sun, the complex land-surface interactions with the atmosphere, and the surface and below surface processes that complete the water cycle (adapted from Trenberth et al., 2007).

Results from the 2nd Pan-GEWEX Meeting

While the GEWEX name (Global Energy and Water Cycle Experiment) is liked by many for its uniqueness (e.g., in a Google search) and has good name recognition, the "EX" (experiment) is clearly obsolete. Accordingly, a new name for post-2013 was suggested, "Global and Regional Energy and Water" (GREW). However, there were strong sentiments expressed for keeping the old acronym and suggestions have been made for alternative words defining GEWEX, including "Global and re-

gional Energy and Water Exchanges." Please feel free to give me your opinion on this variation or make another suggestion.

The Pan-GEWEX Meeting provided a venue for vigorous discussions about future directions for GEWEX, and after consideration, the SSG has agreed upon the Mission Statement and Imperatives shown below. The header in each imperative highlights the link between the imperative and the themes outlined by the JSC. There is still much left to be done to flesh out these imperatives with more details regarding what they mean in terms of actions to be taken, what lead groups in GEWEX will be involved, and how interactions with other parts of WCRP and the other organizations will be involved.

Modeling

Prior to the Pan-GEWEX Meeting, discussions via e-mail set the stage for the modeling discussions in Seattle, in particular, the desire of the Chair of the GEWEX Modeling and Prediction Panel (GMPP) to step down and his proposal to remove the reporting layer of GMPP, as well as the need to address the future structure of GEWEX modeling. The proposal to replace GMPP with two panels, (1) the Global Land/Atmosphere System Study (GLASS) Panel and (2) the GEWEX Cloud System Study (GCSS)/GEWEX Atmospheric Boundary Layer Study (GABLS) Panel, which both report directly to the SSG, was positively received during the Pan-GEWEX Meeting and this new structure was later approved by the SSG.

As a part of the organizational changes, GCSS will abandon its current working group structure and will instead operate through projects, which can be initiated by any member of the community. Members of a GCSS/GABLS Science Steering Committee (SSC) will provide oversight of the program, including the approval of proposals for new activities. GABLS activities will be fully integrated into this structure through specific projects as well as GABLS membership on the SSC.

There was much discussion at the meeting regarding the proposal for a new post 2013 activity called the Framework for Atmospheric Model Enhancement (FAME), which would improve the representation of physical and dynamical processes in the troposphere in models for all purposes, and especially weather and climate services. Its main focus would be the improvement of the representation of clouds and precipitation in atmospheric models, which can only be achieved by improving our understanding of the intricate coupling of physical and dynamical processes associated with clouds and precipitation at various scales.

FAME was proposed in recognition of the need expressed by the Intergovernmental Panel on Climate Change (IPCC) in several reports, which highlighted the significant shortcomings in models of the simulation of clouds and precipitation with consequences for the simulation of important climate feedbacks and climate sensitivity. Other important factors included the recent revolution in the ability to observe clouds and precipitation, especially from space, and improvements in ability to model the processes involved at the process-scale. The experience of more than 15 years of the GCSS project and almost 10 years of the GABLS project makes the time right for a more concerted effort in atmospheric model improvement that builds on the existing strengths and adds to them the important new research area of physics-dynamics coupling.

The envisaged components of FAME would be programs on the planetary boundary layer (GABLS), clouds, convection and precipitation (GCSS), radiation (currently residing in GRP and SPARC), coupling to dynamical processes (new), and potentially also coupling to numerics (new). FAME will be built around the core approaches identified by the WCRP JSC (e.g., observations, modeling, data analysis and model diagnosis, and process studies). Through the direct involvement of operational modeling centers in FAME, as well as through the engagement of scientists throughout the world, the activities in FAME could make major contributions to capacity building and services.

GEWEX Mission Statement and Imperatives for Post 2013

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.

Imperatives:

Data Sets: Foster development of climate data records of atmosphere, water, land, and energy-related quantities, including metadata and uncertainty estimates.

Analysis: Describe and analyze observed variations, trends, and extremes (such as heat waves, floods, and droughts) in water and energy-related quantities.

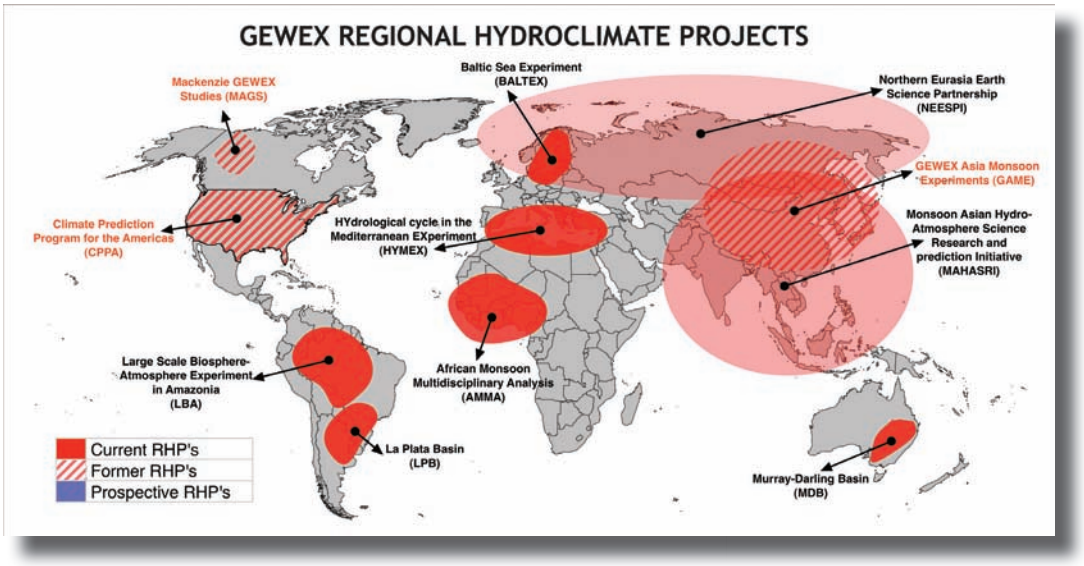
Processes: Develop approaches to improve process-level understanding of energy and water cycles in support of improved land and atmosphere models.

Modeling: Improve global and regional simulations and predictions of precipitation, clouds, and land hydrology, and thus the entire climate system, through accelerated development of models of the land and atmosphere.

Applications: Attribute causes of variability, trends, and extremes, and determine the predictability of energy and water cycles on global and regional bases in collaboration with the wider WCRP community.

Technology Transfer: Develop diagnostic tools and methods, new observations, models, data management, and other research products for multiple uses and transition to operational applications in partnership with climate and hydro-meteorological service providers.

Capacity Building: Promote and foster capacity building through training of scientists and outreach to the user community.



GEWEX regional projects, past and present.

As FAME is tightly focused on providing a means for the improvement of the representation of core physical processes in atmospheric models, it would partner with many other programs to contribute to the research on phenomena that go beyond the physics-dynamics coupling in the atmosphere. Those include partnerships with GLASS and the GEWEX Hydroclimatology Panel (GHP) (land); CLIVAR (oceans); the Aerosols, Clouds, Precipitation and Climate Initiative (ACPC); the Integrated Land Ecosystem-Atmospheric Processes Study (iLEAPS) (aerosols); SPARC and International Global Atmospheric Chemistry (IGAC) (atmospheric chemistry); SPARC (stratosphere); and CliC (cryosphere). Necessarily, these go well beyond GEWEX alone.

FAME could be seen as a natural extension to the existing GCSS/GABLS panel described above. This would maintain continuity, provide close links to the land and limited area modeling communities, and ensure FAME's natural focus on the energy and water cycles. These activities were originally grouped together to provide a focus on relatively "fast processes" as compared with those involving the ocean or cryosphere. FAME could also make a major contribution to a potential cross-WCRP effort on atmospheric model development.

This proposal was discussed by the SSG, which strongly recommend keeping FAME within the post 2013 GEWEX structure. Questions include how FAME will be organized, whether as a panel or working group. Many of the other modeling activities within WCRP are under working groups (WG). The CLIVAR WG on Seasonal to Interannual Prediction (WGSIP) is an example of where the WG reports to the CLIVAR SSG but acts on behalf of WCRP to deal with seasonal to interannual prediction. A new group, integrating FAME and possibly called WGAP, short for WG on Atmospheric Processes and modeling for climate, could operate similarly within the new post 2013 GEWEX. However, as the activities relate to the established WGs, especially the WMO (CAS)/JSC Working Group on Numerical Experimentation (WGNE), this aspect has yet to be decided after broad consultation with the community.

Hydrometeorology

Major changes were also underway in the realm of the regional hydrological projects at the Pan-GEWEX Meeting. In part these came about naturally from the evolution of the program, and were given an extra nudge by the change in leadership. Under the leadership of Toshio Koike, the original CEOP (Coordinated Enhanced Observing Period) developed an impressive and extensive program, including the Regional Hydrometeorological Programs (RHPs), associated modeling and data base development, and the Hydrologic Applications Project (HAP). CEOP remains at the core of the GEWEX mission, including more than a thousand researchers, and providing important regional and modeling data and a valuable end-user interface.

Regional Projects

The concept for the RHPs was developed in the 1990s for the development, diagnosis, and testing of coupled land-atmosphere models with a focus on water and energy budget closure at near-continental scales. The first CSE, the GEWEX Continental-Scale International Project (GCIP), was located in the Mississippi River Basin, which featured extensive observing instrumentation. CSEs in other regions were developed later [the Mackenzie GEWEX Study (MAGS), the Baltic Sea Experiment (BALTEX), the GEWEX Asian Monsoon Experiment (GAME), the Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA), and the African Monsoon Multidisciplinary Analysis Project (AMMA)]. GEWEX established the GEWEX Hydrometeorology Panel (GHP) in 1994, primarily to coordinate the wide range of regional interests and activities involved in these CSEs. The overall GHP mission was to "demonstrate the capability to predict changes in water resources and soil moisture at time scales up to seasonal and interannual as a component of the WCRP's prediction goals for the climate system." For a more detailed history of GHP and the RHPs, see the article on page 7.

To take advantage of the observations becoming available via new satellites and other resources, the Coordinated Enhanced Observing Period (CEOP) was initiated in 2001. This activity, which also developed extensive data management activities, led to the development of new projects that overlapped ex-

isting projects within GHP and resulted in some duplication of effort. Accordingly, the first CEOP activity was combined with GHP and evolved to become the Coordinated Energy and Water Cycle Observations Project with the same acronym, CEOP, in 2007. The initial observing period grew to become an effort to produce a 10-year data set and archive especially set up for the regional projects. However, other developments had already occurred in observations and data management, which suggested that the activity should be wrapped up and refocused, even as it is utilized and hopefully becomes part of the heritage of GEWEX. In particular, the development of the many flux towers around the globe provides alternatives to the CEOP reference sites for local studies of energy, water, and biogeochemistry.

Accordingly, the GEWEX community began what might be called a "back to basics" movement, with recognition of the need to reinvigorate the regional hydrological projects. In particular, there was a call by the new co-chair, Dennis Lettenmaier, for stronger hydrological activities that would foster the next generation of hydrologically realistic land-surface schemes and provide a home for activities like the Project for the Intercomparison of Land-Surface Parameterization Schemes. This was discussed at the Pan-GEWEX Meeting and the recommendation made to the GEWEX SSG was along these lines. Thus, a new GEWEX Hydroclimatology Panel (GHP: note the change in the name from the first version) was created to replace CEOP, effective immediately. The SSG also followed up on the recommendation from CEOP to approve a new RHP, the Hydrological cycle in the Mediterranean Experiment (HyMeX), which is focused on the 20 countries around the Mediterranean Sea and the fresh water and salinity of the Sea itself.

GHP is thus the home for hydrologic science and modeling within WCRP and there is considerable scope for developments in this area (e.g., in seasonal forecasting, the detection and attribution of change) and the development and analysis of climate projections. Challenges remain in dealing with monsoons and to help coordinate the multitude of national initiatives in this area. There are also opportunities for linkage with GLASS in bringing disciplines together in the development of next generation Land-Surface Models as well as increasing interactions with the Coordinated Regional Downscaling Experiment (CORDEX). Changes in the management structure are likely to accompany the new consolidation of efforts as GHP realizes its considerable potential.

Radiation

Changes in atmospheric water vapor, precipitation, clouds, and aerosols affect the energy balance of the Earth, and since these processes are intertwined, complex, and simultaneous, considerable uncertainty remains concerning their feedbacks. Addressing these issues requires coordinated global observations, and satellite observations must be employed. The GEWEX Radiation Panel (GRP) was organized in the 1990s to bring together theoretical and experimental insights into these aspects. However, it is looking for a name change as it encompasses a lot more than radiation.

The original GEWEX data sets were developed under the auspices of GRP and their production continues today. These data sets deal with all of the global satellite data related to energy and water and their synthesis into products. GRP is also leading and promoting the reprocessing of the data sets with a goal of creating climate data records of sufficient quality to be useful for examining trends. Some of the data sets, such as the Global Precipitation Climatology Project (GPCP) and the International Satellite Cloud Climatology Project (ISCCP) are well known and already used extensively. However, scientists are confident that the data sets can be improved and made more consistent with each other, and with better estimates of uncertainties. In general GRP is working well toward these goals and has produced simulators that take into account the sampling and characteristics (such as thresholds) of the observations to enable intercomparison of satellite products with model data. Interactions between GRP and the other GEWEX panels were fostered by the Pan-GEWEX Meeting. GRP data sets have great potential for use in the evaluation and improvement of models on issues such as clouds and the indirect effects of aerosols; precipitation frequency, intensity, and amount; and in providing context for the RHPs.

Extremes

The recent summer record breaking flooding in Pakistan, India, and China, and heat-waves and wildfires in Russia highlight the extremes of the hydrological cycle of drought and floods that are changing from human activities. Dealing with extremes in WCRP is a cross-cutting activity that involves all projects although GEWEX plays a leading role. Olga Zolina, who is a member of the GEWEX SSG, led the WCRP extremes workshop involving some 150 people at UNESCO in late September. The full workshop report will be available in the February 2011 newsletter issue. Breakout groups were held on issues of (1) data requirements and availability (such as the need for hourly precipitation data to properly characterize extremes); (2) representation of extremes in models, including scaling and spatial issues (how station data relate to grid squares, comparing apples to apples); and (3) methodologies for estimating extremes across areas and disciplines, including statistical methods. Continuing issues are sorting out the extremes that are to human activities and how to best communicate with the general public on such technical attribution issues.

Closing Remarks

The above is but a sample of the goings-on and developments from the 2nd Pan-GEWEX Science Meeting. What I have tried to do is provide a sense that we are looking forward to the future with considerable excitement at the science we can achieve through collaboration and friendly competition, with the help of coordination through GEWEX. I thank all those who attended and participated.

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Young Scientists Attend 2nd Pan-GEWEX Meeting and Exchange Ideas at Lunch

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The National Science Foundation and the World Climate Research Programme (WCRP) joined together to bring a dozen students and early career scientists from the US, Iran, Australia, China, Senegal, and the Ukraine to the 2nd Pan-GEWEX Science Meeting in Seattle. For most of these young scientists, it was the first time they had participated in such a meeting and all agreed that it was a very interesting and worthwhile experience, even if the number of acronyms tossed out during the presentations was bewildering to them.

The International GEWEX Project Office hosted a luncheon for the students to meet with some of the more senior scientists attending the meeting. Both Kevin Trenberth, the Chair of the GEWEX Scientific Steering Group, and Antonio Busalacchi, the Chair of the WCRP Joint Scientific Committee, attended and provided words of encouragement to the future GEWEX scientists. However, it was the younger generation that provided the most revealing (and entertaining) insights. One young woman remarked that prior to coming to this meeting she had been very disappointed in her research results, but now felt much better, because she realized that aiming for the least error was acceptable and in her case, the best achievable. Another commented on the many different opinions and directions being voiced at the meeting and was glad that there were meetings like this for scientists to come together and work towards agreement. On a cautionary note, one of the participants observed that if you were not careful, someone might volunteer you to be a rapporteur. More serious reflections were voiced on the need for data sharing, capacity building, and putting together the pieces of the scientific puzzle. Senior scientists also shared some anecdotes about their careers, and a good time was had by all.

Participants at the Young Scientists Luncheon.

More Work to Do: Multiple Analyses of RHP Water and Energy Budgets

Michael Bosilovich and David Mocko

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The GEWEX Regional Hydroclimate Projects (RHPs, formerly the Continental-Scale Experiments, CSEs) have served the overall GEWEX goal of obtaining a better understanding of the global water and energy cycle by providing a regional focus on observations, models, analyses, and the unique regional physical processes. (For a brief history of GEWEX regional experiments, see article on page 7.) Roads et al. (2002, henceforth RKS02) used the National Centers for Environmental Prediction (NCEP) Reanalysis-2 (NCEP R2) data and GEWEX observation data sets over RHP domains to evaluate the interrelationships among the water and energy budget terms for all RHPs, identifying the impact of the data assimilation on the budgets, and characterizing the climatology of key regional atmospheric circulations. While NCEP R2 has been an important tool for weather and climate research for more than a decade, we know that individual analyses retain model uncertainty in the resulting analyses, especially in the physical fields (those not directly related to the assimilated states). While the RKS02 work was being developed, one effort within the Coordinated Enhanced Observing Period (CEOP Phase I) was designed to provide a number of analysis data sets in order to quantify the model uncertainty in operational analyses and reanalyses (Bosilovich et al., 2009).

During CEOP Phase I, data from eight global analysis systems (research and operational Numerical Weather Prediction systems, NWP) were collected for the period of October 2002–December 2004. The Multi-model Analysis for CEOP (MAC) homogenized the disparate nature of each of the data sets, provided uniform spatial and temporal structure, and produced mean and variance of the data at 6-hourly, daily, and monthly time scales (Bosilovich et al., 2009). Since the original release of the MAC data, both the European Centre for Medium-Range Weather Forecasts (ECMWF) Re-analysis (ERA) Interim and Modern Era Retrospective-analysis for Research and Applications (MERRA) have been included in the data set, to bring the number of analysis systems to ten. While Bosilovich et al. (2009) evaluated the variance of precipitation and outgoing longwave radiation among the analyses, here the regional analysis performed by RKS02 on NCEP R2 is considered. The MAC analyses and mean have been area averaged to the regions shown in RKS02, and the evaluation areas have also been updated to include recent additions to the GEWEX RHPs of the Hydrological Cycle in the Mediterranean Experiment (HyMeX), the La Plata Basin (LPB), and the Murray Darling Basin (MDB).

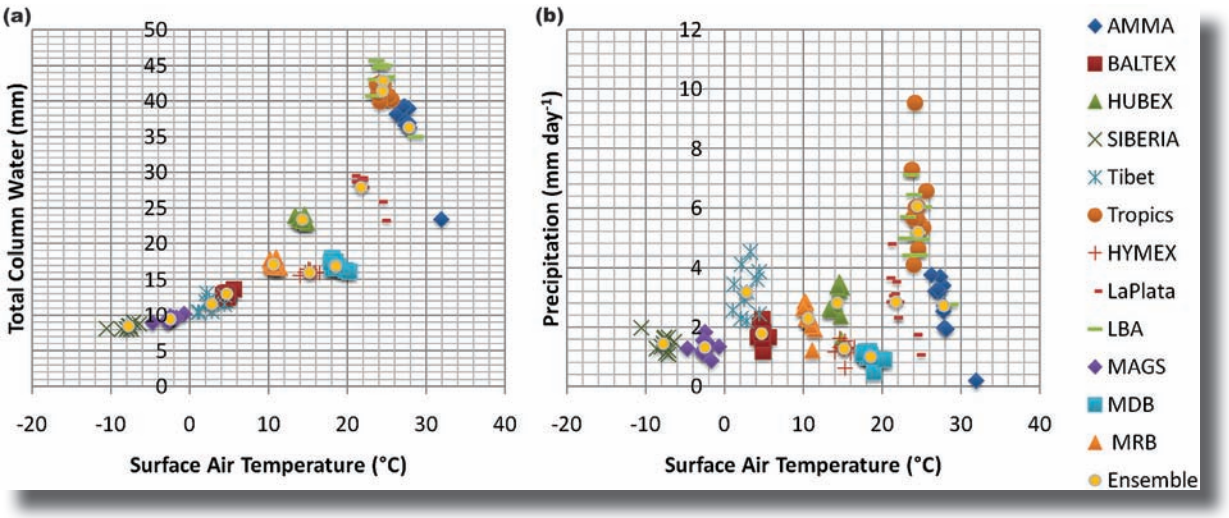

Figure 1. As in RKS02 Figure 2, annual average (except for October 2002–December 2004) surface temperature compared to (a) total column water and (b) precipitation for each of the RHPs currently participating in GEWEX. However, instead of only one reanalysis, each analysis system contributing to the Multi-model Analysis for CEOP (MAC) is given a marker, so that the range of analyses is evident in the evaluation. The ensemble of analyses is also included (yellow circles).

RKS02 compares the complete energy and water budget annual means to temperature in order to characterize the climate regimes of each of the GEWEX RHPs. The authors also suggest that the functional relationship shown in the comparison may provide insight into how regional water and energy budgets may change in warmer climates. Figure 1a above reproduces the RKS02 comparison of total column water with surface temperature, except that the time period is only for 27 months, and for each RHP there are multiple analysis data sets, as well as the mean of the analyses. Total column water compares to temperature much the same as shown in RKS02's NCEP R2 study, owing to the adherence of the modeling systems to the Claussius-Clapyeron relationship. Still noteworthy in this figure is that despite each system doing different data analysis and modeling over a limited period of time, there are small variations about the ensemble relative to each climate regime for each RHP. The distribution of points for the ensemble of the analyses is remarkably close to that shown in RKS02.

Likewise, the ensemble precipitation (Figure 1b) distribution as a function of RHP is also quite comparable to that of Figure 2c in RKS02. However, the range of variability among the different analyses' precipitation is much more noticeable, and some RHPs also indicate a temperature variation associated with the precipitation (Figure 1b). Variations tend to be greater in the warmer RHPs, but relative to the ensemble mean there is some variability in precipitation even in the cold regions. Apparent outliers are also easily identified in the precipitation comparison. As opposed to many other budget variables, gauge or merged satellite measurements could also be added here to better define the uncertainty of the analysis data [RKS02 added a Global Precipitation Climatology Project (GPCP) curve based on all temperature regimes, not just the RHP areas]. **The main point is that significant variations in precipitation exist among analysis-derived precipitation.** While application purposes, such as land-surface model forcing, can always revert to an observation data set, the analyses provide a complete set of water and energy budget terms, and the uncertainty of the precipitation will be reflected in both energy and water budgets.

RKS02 also considered the mean annual cycle of the RHP water and energy budget terms and this is shown in the article's Figures 9–11. The consideration of multiple analyses adds an extra dimension to such an evaluation. Specifically, the uncertainty of each system also adds more information, and by using several systems we can provide the variance of the data. Figure 2 on page 16 provides the mean annual cycle of ensemble mean precipitation and evaporation for the Mississippi and Amazon River Basins, including one standard deviation of the ensemble and the range of values in individual member mean annual cycles. While there is reduction in the variations during respective cold or dry seasons, the analyses produce a wide range of variations in precipitation during the wet seasons. The result is not surprising in and of itself, as the data allow the quantification of this variation, but also raise the question of what the RKS02 RHP study would have concluded considering that the NCEP R2 water and energy budgets include some uncertainty in key physical terms. It is important to note that the MAC data used here are for a limited period in time and also do not include all the variables used in the RKS02 evaluation.

Despite the work of RKS02 and many others, the primary objectives set out at the start of GEWEX have not reached a sufficient closure. GEWEX is in the process of revising the efforts needed to make progress in our understanding and application of the Earth's water and energy cycles, and certainly analysis and reanalysis data will play a considerable role in that, simply because we cannot directly observe all the important components. **It is also apparent that, at this time, no one single analysis or reanalysis system can be relied upon to**

provide the benchmark water and energy budget globally, regionally, and at all times. One aspect of GEWEX's mission is making improvements to the modeling systems that we must rely on, and to do that, global and regional model data are needed, along with sufficient observations to constrain the model results. The RHPs, then, will continue to play a significant role in the GEWEX science plan. Additionally, collecting and homogenizing the analysis data was not a straightforward task, and was only completed with support of a funding agency.

To continue to improve models and data analysis systems, the availability of model data to a wide range of researchers is required. There are possibilities and opportunities for ongoing sources of model data to support GEWEX. Atmospheric reanalyses have become a key science utility, and there are many more options and available systems now than at the time the RKS02 study was performed. However, the number of centers providing reanalysis is relatively low, with new data only coming in 5 year cycles, at best. On the other hand, THe Observing System Research and Predictability Experiment (THORPEX) Interactive Grand Global Ensemble (TIGGE) is providing the analysis and forecast from a larger number of operational NWP centers for a few years and continuing on in time (Bougeault et al., 2010). The main disadvantage of the TIGGE data set is that not all the water and energy budget terms considered by RKS02 are included in its data streams, and even more important, not all the data providers include all the requested variables, making comparisons more difficult. However, data access and tools for dealing with the multitude of disparities between model data products are being implemented and should make the data much more accessible for research purposes. Regional modeling experiments have also provided useful insight into the variation of water and energy budgets, and the transferability of models among the different RHPs (Takle et al., 2007). Regardless of the source(s) of the model and analysis data, the reduction of uncertainty of the analyses and their based-on-GEWEX research will provide one fundamental metric to determine GEWEX's success.

The 27-month MAC data set, including all ten members and the ensemble mean and standard deviation, at 6-hourly, daily, and monthly averages in grid point values expressed in binary form (GRIB) and Network Common Data (NetCDF) formats with documentation, is available at: *http://gmao.gsfc.nasa.gov/research/modeling/validation/ceop.php*. This website also has a document and spreadsheet detailing how the MAC data set was developed from the generous data contributions of participating NWP and research centers.

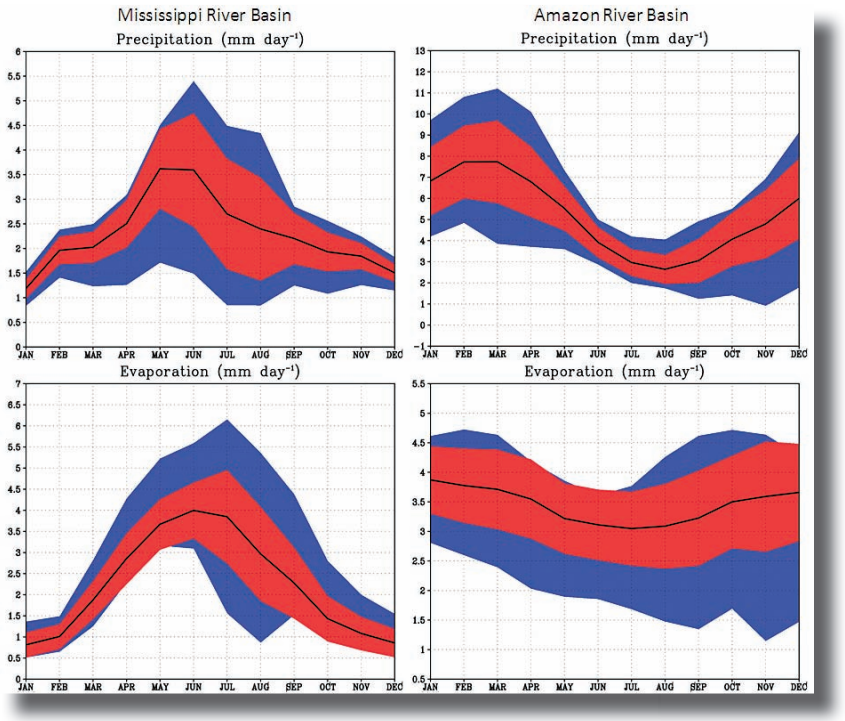

Figure 2. Mean annual cycle (October 2002–December 2004) of precipitation (top) and evaporation (bottom) for the Mississippi River Basin (left) and Amazon River Basin (right) area averages. The black line is the ensemble of 10 analyses' data, while the red area shows 1 standard deviation of the ensemble mean. The blue area shows the range of analyses' mean annual cycles.

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GEWEX NEWS

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Meeting/Workshop Reports

HESSS-2 International Conference

22–25 June 2010
University of Tokyo, Japan

Peter J. van Oevelen[1], Hyungjun Kim[2], Taikan Oki[2], and Sam Benedict[1]

[1]International GEWEX Project Office, Silver Spring; Maryland, USA, [2]University of Tokyo, Japan

During the First International Conference on Hydrology delivers Earth System Science to Society (HESSS-1) in 2007, an attempt was made to ascertain the gaps between the needs of society and the services of the hydrology community. In particular, the estimation and reduction of uncertainty in simulations were identified as key leverage points along with an appropriate use of observational data sets in validation and data assimilation. The success of the first conference laid out the basis for the 2nd HESSS International Conference, which was hosted at the University of Tokyo in June 2010. The meeting brought together four unique communities—the Global Soil Wetness Project (GSWP)/Global Land/Atmosphere System Study (GLASS); the AsiaFlux/Flux Tower Network (FluxNet); LandFlux-Eval; and the GEWEX Hydroclimatology Panel (formerly CEOP)—to bridge the aforementioned gaps and address the key leverage points with a shared vision of a sustainable and desirable world.

The meeting brought together more than 140 researchers and students from 12 countries and included a great mix of oral (82) and poster (33) presentations in 24 sessions. The main objective of the conference was to establish practical protocols and frameworks to promote more effective collaboration among the research communities of hydrological modeling, field observations, and remote sensing in the context of sustainability science. As a true test bed for community level collaboration, new frameworks similar to the Global Soil Wetness Project-3 (GSWP-3) and HydroEastAsia will be launched as the outcome of the Conference. In particular, a follow-up to the GSWP-3 initiative was proposed for further development called the Coupled Hydro-Energy-Eco System Experiment (CHEESE). Furthermore, a special issue of the *Journal of Hydrometeorology* (Guest editors: S. I. Seneviratne, T. Oki, J. Kim, and H. Kim) is in preparation and will include a selection of papers from HESSS-2.

Participants at the HESSS-2 International Conference.

GCSS Workshop on Microphysics and Polar/Precipitating Clouds

24–25 June 2010
University of Washington, Seattle, WA, USA

Chris Bretherton[1], Ann Fridlind[2], Hugh Morrison[3], and Ben Shipway[4]

[1]University of Washington, Seattle, Washington, USA; [2]NASA/Goddard Institute of Space Studies, New York, NY, USA; [3]National Center for Atmospheric Research, Boulder, Colorado, USA; [4]UK Met Office, Exeter, Devon, United Kingdom

Thirty-five scientists from three GEWEX Cloud System Study (GCSS) Working Groups (WGs) attended the Workshop to discuss their current studies and plans for improving understanding of the coupled cloud microphysical and dynamical processes based on their relevance to improving the parameterizations in large-scale weather/climate models.

The Polar Cloud WG (*http://www.ral.ucar.edu/projects/GCSS/WG5/*) has been focusing on Arctic mixed phase clouds and presented results from a recent intercomparison case that used Surface Heat Budget of the Arctic Ocean (SHEBA) Project data for a shallow radiation-driven, cloud-topped mixed layer cloud (temperatures around –20°C) with a mix of super cooled droplets and crystals (growing mostly by water vapor deposition with very light precipitation). Due to the poor understanding of the different modes of ice nucleation, the ice crystal concentration was specified in the models. The six participating large eddy simulation (LES) and cloud-resolving models (CRMs) showed sensitivity to changes in the specified crystal concentration (within the range of observational plausibility). They also exhibited sudden transition from sustained mixed-phase clouds at low crystal concentration, to rapid glaciation, to all-ice clouds within the first hour at slightly higher crystal concentrations (see Figure 1 on page 18). These sudden transitions present parameterization challenges and need to be further investigated. Even in the presence of relatively large concentrations of ice nuclei above the cloud layer, the rapid depletion of ice crystals within the layer can lead to much lower concentrations, which may help to sustain the mixed-phase cloud layer.

Overall, the results presented reinforced the need to improve the understanding of the factors controlling ice nucleation and crystal concentration. The next Polar Cloud WG intercomparison (to be led by Mikhail Ovchinnikov, Pacific Northwest National Laboratory) will be based on a similar case using data from the Indirect and Semi-Direct Aerosol Campaign (IDAC), where crystal aggregation and precipitation is more important.

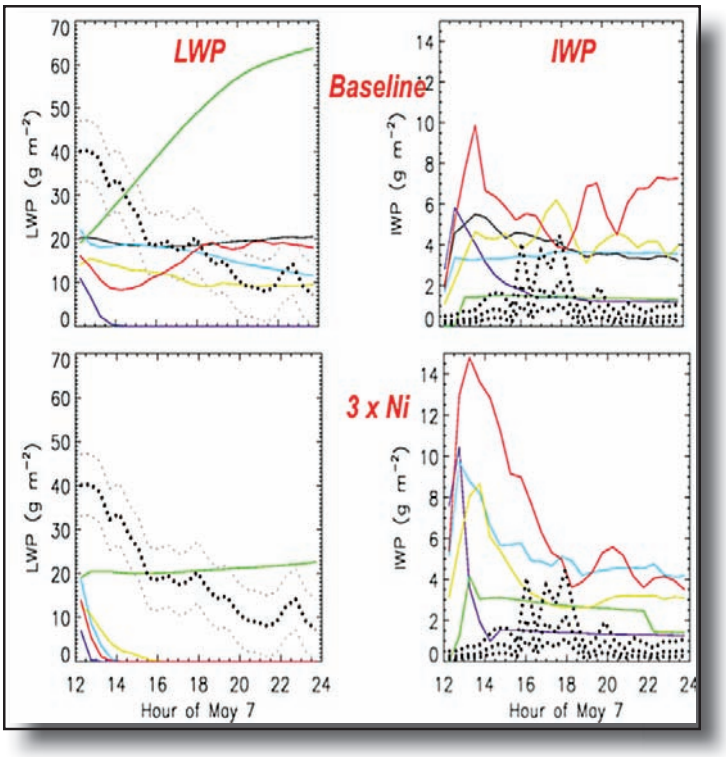
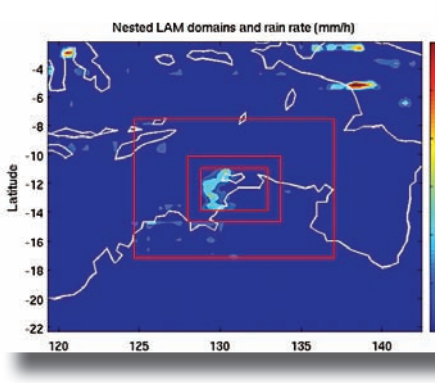


Figure 1 (left). Model runs for liquid water path (LWP; left panels) and ice water path (IWP; right panels) for the baseline (top panels), and three times the ice number concentration (bottom panels). Color lines show results from the different models and dashed lines show observations from ground-based remote sensors. With best-guess baseline ice crystal concentrations, three out of four models maintain a super cooled liquid cloud layer comparable to that observed. With the ice crystal concentration tripled (3xNi), all but one model quickly glaciates away the cloud layer, highlighting a strong sensitivity of cloud microphysics to ice crystal concentration.



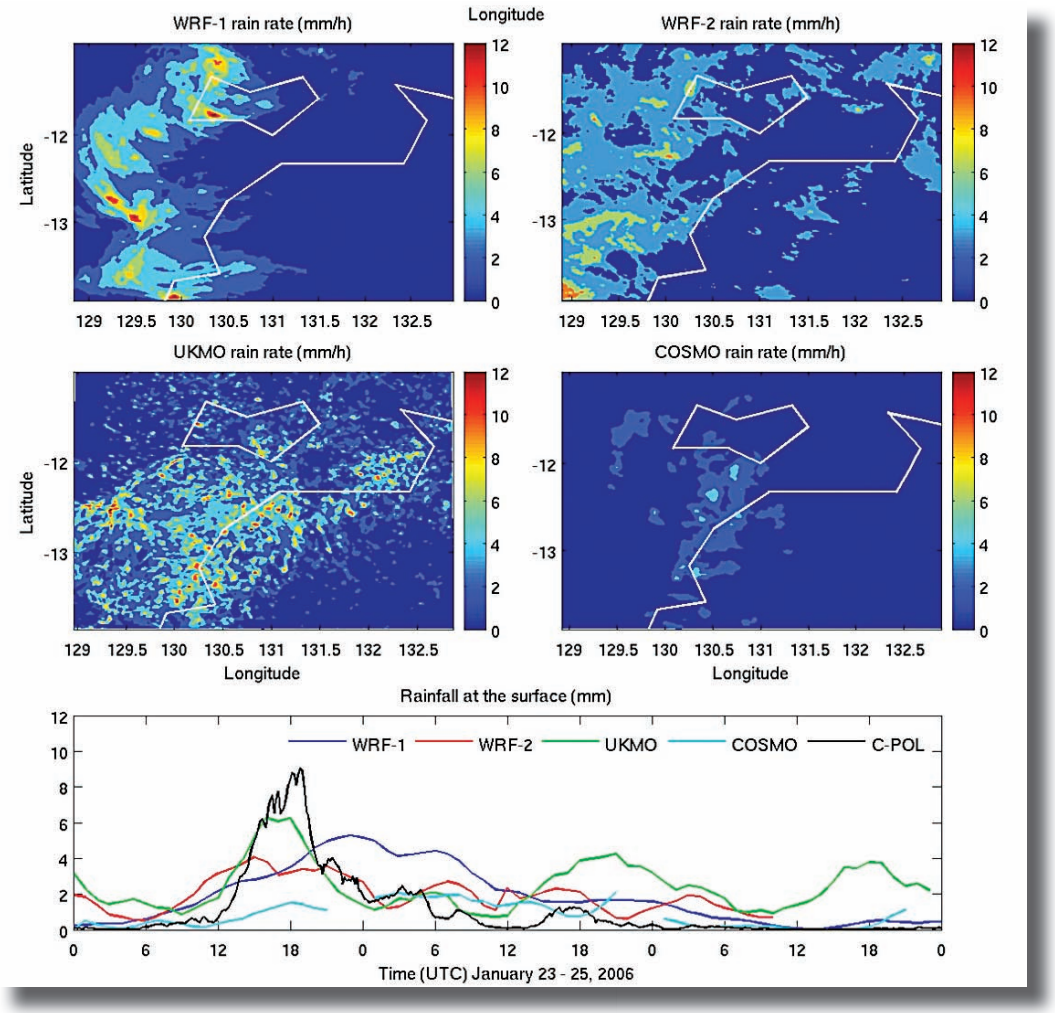


Figure 2. Limited-area model simulations of rainfall over the TWP-ICE analysis domain using four models and estimated from the C-band polarimetric (CPOL) radar at Darwin, Australia. Over this domain, all models have either 1 km or (for COSMO) 2.2 km horizontal resolution and are run without a cumulus parameterization.

The panel above shows domain nesting for the weather research and forecasting (WRF) models. The maps in the panels (right) show geographical distributions of rainfall averaged over the period 00UTC 23 Jan–00 UTC 26 Jan 2006. The time series show domain-mean rainfall (courtesy of Ping Zhu). The models show some qualitative agreement on timing of rainfall, but less agreement about its geographic structure.

Presentations by the Microphysics WG (*http://www.iac.ethz.ch/groups/lohmann/ext_projects/GCSS*) focused on using the Kinematic Driver for microphysics intercomparison (KiD), a freely available software developed by Ben Shipway and his coworkers at the UK Met Office (UKMO). The KiD is used for comparing and testing bulk and bin microphysics representations in a column setting with prescribed initial conditions and time-dependent vertical motion profiles. It was shown how a test case idealized from diverse cloud regimes could be effectively used to improve warm-rain auto conversion and collection parameterizations in bulk microphysical schemes to better agree with nominally more accurate bin-resolved schemes.

The Microphysics WG, led by Ben Shipway, plans to use the KiD as a platform for a GCSS microphysics intercomparison using a wave-cloud case from the Ice in Clouds Experiment-Layer (ICE-L) clouds experiment. The KiD is also suitable for developing new test cases that might complement complete dynamically coupled intercomparison cases by other GCSS groups. Adrian Hill, UKMO, volunteered to lead an intercomparison of the sensitivity of warm-rain production to microphysical representation, cloud depth, droplet concentration, and vertical velocity using an "eddy-pair" approach.

The current focus of the Precipitating Cloud Systems WG (*http://www.convection.info/*) is the Tropical Warm Pool-International Cloud Experiment (TWP-ICE). Key case objectives include a quantitative understanding of the development and maintenance of tropical anvil cirrus and the role of land-ocean contrast in the observed convection during active and less active phases of the Australian monsoon. Cloud-resolving and single-column models have been run on a master case that uses large-scale advective forcings averaged over a region including both land and ocean centered on Darwin, Australia. Case leader Ann Fridlind, Goddard Institute of Space Studies, reported that the domain averaged ice water path (a metric for upper-tropospheric clouds) ranged widely between models, with only two-dimensional models being within observational estimates. Three-dimensional models consistently overestimated ice water path by roughly a factor of two when compared with two independent retrievals, which may be related to a factor of two to three overestimates of convective area coverage when compared with scanning precipitation radar data.

Limited area models (LAMs) with a cloud-resolving inner grid nested inside a coarser model forced at its boundaries by global analyses (case leader: Ping Zhu, Florida International University) showed some skill in capturing the evolution of monsoonal convection over this region, as well as land-ocean contrast in convective development. The case highlights the challenges for simulation of individual tropical rainfall events using these models (see Figure 2 on page 18). The outer model in which the LAM is embedded is a critical factor in rainfall simulation. Case leaders are planning to publish results within the next year in coordination with related single-column model and general circulation model numerical weather prediction studies led by Laura Davies, Monash University, and Yanluan Lin, Geophysical Fluid Dynamics Laboratory.

GEWEX/WCRP Calendar

For the complete listing, see the GEWEX web site: http://www.gewex.org

23 January 2011—WCRP Chairs and Directors Meeting—Seattle, Washington, USA.

23–27 January 2011—AMS Annual Meeting—Seattle, Washington, USA.

2–5 February 2011—SPARC Scientific Steering Group Meeting—Pune, India.

2–4 March 2011—WCRP Workshop on Drought Predictability and Prediction in a Changing Climate—Barcelona, Spain.

8–10 March 2011—GEWEX/ESA DUE GlobVapour Workshop on Long Term Water Vapour Data Sets and Their Quality Assessment—ESRIN, Frascati, Italy.

22–25 March 2011—Sentinel Scientific Products for Land, Ocean and Cryosphere: Assessment and Consolidation Workshop—ESRIN, Frascati, Italy.

4–8 April 2011—WCRP Joint Scientific Committee Session—UK Met Office/Hadley Centre, UK.

11–13 April 2011—EUMETSAT/ESA Scatterometer Science Conference 2011—Darmstadt, Germany.

16–18 May 2011—YOTC International Science Symposium, Beijing, China.

16 May–3 June 2011—WMO Congress XVI—Geneva, Switzerland.

28 June–7 July 2011—IUGG XXV General Assembly—Earth on the Edge: Science for a Sustainable Planet—Melbourne, Australia.

1–5 August 2011—IGARSS 2011—Sendai, Japan.

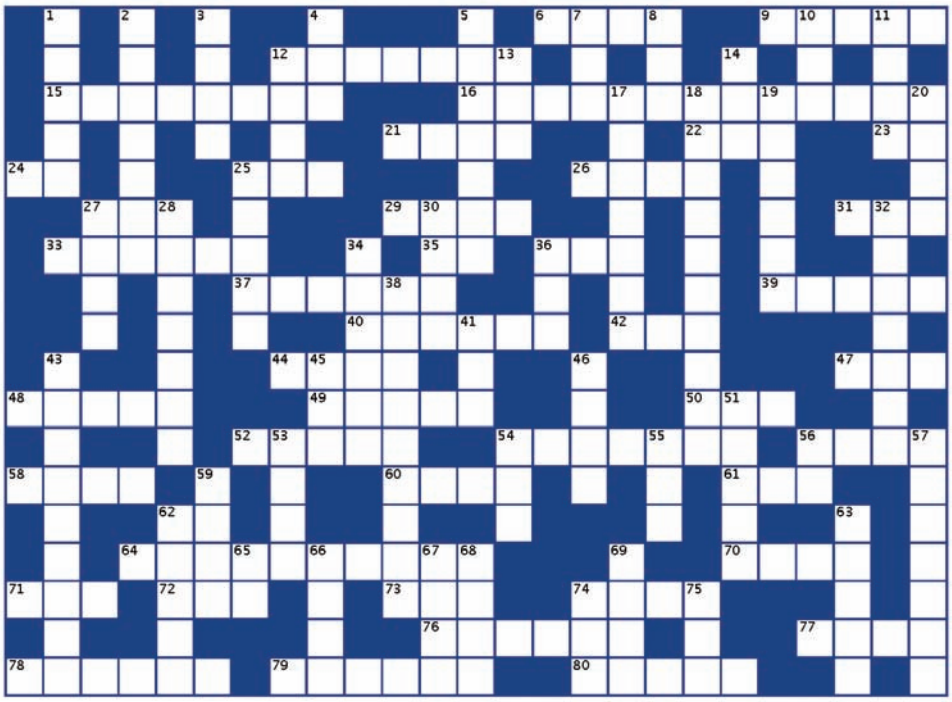
30 August–10 September 2011—5th SOLAS Summer School—Corsica, France.

30 August–2 September 2011—GEWEX Radiation Panel (GRP) Meeting—Tokyo, Japan.

18–23 September 2011—3rd iLEAPS International Science Conference—Garmisch-Partenkirchen, Germany.

25–29 September 2011—International Water Resources Association's World Water Congress—Porto de Galinhas/PE, Brazil.

GEWEX 20TH ANNIVERSARY CROSSWORD



ACROSS

6. Literally the Earth is moist everywhere in this organized endeavour
9. G that number '6' must be spelled wrong
12. The first Chair of the GEWEX SSG
15. They sell labor in this place
16. Sweating of plants
21. This orbiter really moves
22. Near Infra Red
23. River in Italy
24. Former
25. City in Northern Morocco
26. Mountains
27. Incomplete explosive device in Australia
29. This laborious bunch does mathematical R&D
31. This South American dance is shortened
33. Location of WCRP Planning Staff
35. Are these unknown drinkers a river in the Netherlands?
36. Solid water
37. River
39. Circle
40. Vigor
42. This uncle coordinates CEOP
44. This visitor is missing U
47. Cloud
48. Fresh color
49. This project sounds like it would light up
50. No strings attached to this acronym
52. Leader to sit on
54. This is what 30 years is all about on average; weatherwise, that is
56. Dry measure of capacity
58. Flaky cold substance
60. This type of coke you do not drink
61. US Science concensus building is not all 'Nasty'
62. European City or Credit or Commission, take your pick
64. Well known hydrologist with similar first and last name
70. Space Operations Centre in Darmstadt
71. A limb of the Department of Energy
72. A Spanish dish in an earthly tub
73. Canadian goes rapping
74. This former Canadian experiment is short for Margaret
76. Well known movie pattern
77. The framework for this atmospheric model enhancement hopes to become well known
78. This projects makes you smile
79. Seems to refer to a changing ambiance
80. "The Big Blue Marble"

DOWN

1. Greek Goddess of Mother Earth and this project have the same first letters
2. Skyline
3. What do you get when you mix Administrators, Astronauts, N' Scientists?
4. Formerly known as CEOP, although it was there before already
5. Feeler
7. Source of radiation
8. Liquid music
10. An Earth orbiter sitting in the past
11. It used to be the Coordinated Enhanced Observations Period
12. Center
13. First European Earth Observational Satellite?
14. Arid project in Canada
17. Astronaut salesmen
18. Music tool
19. Extreme cold region
20. Weather and Climate under one roof; sounds fishy! Like a biblical figure who misses a few...
25. Brief moment of illumination
27. Radiate
28. Gathering
30. Monsoons in a playful project
32. Airship
34. A misspelled spy born French
36. International Polar Year
38. The opposite of an extreme cold region
41. A bird of enormous size and power (Arabic legend)
43. Sounds like it gave birth to a tendency
45. SEA messed up
46. A beauty contest for airy models?
51. Feel
53. Xbox game around the Sun?
54. Both the Chinese and WMO are in climate control
55. Atmosphere
56. Post Scriptum
57. A Nordic god with thunderous powers connects with what sounds like a chest muscle
59. A World Class Reseach Programme
62. Daughter of the European Space Agencies wind mission?
63. Sea
65. River in Siberia
66. Earthly matrix
67. A West African experiment that is also palindrome
68. National climate vehicle
69. A large cutting tool in Japanese hands
74. Scattering pasta
75. Sea Surface Temperature