GEWEX WCRP

Global Energy and Water Cycle Experiment

# NEWS

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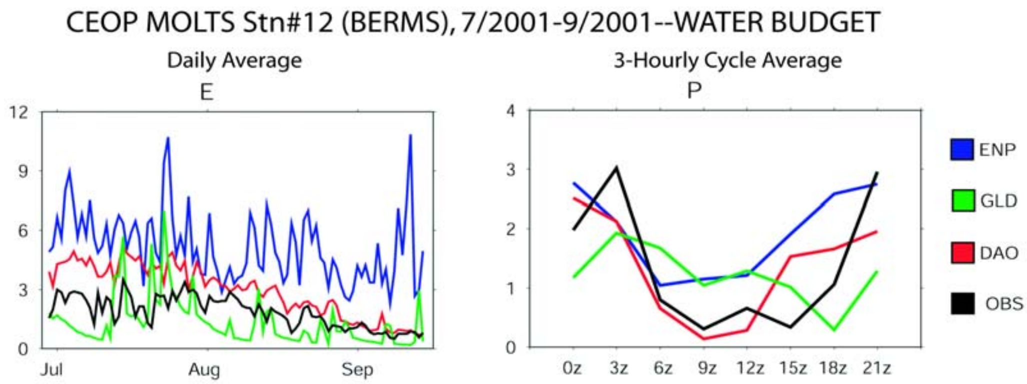
World Climate Research Programme–WCRP

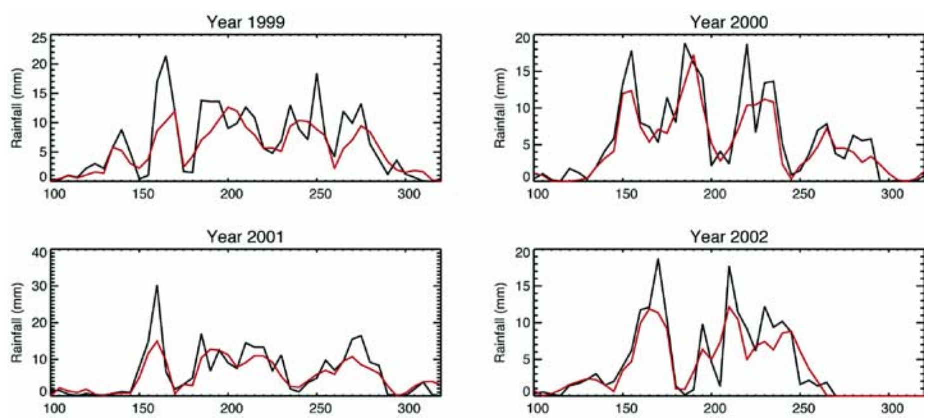
## FIRST RESULTS FROM COORDINATED ENHANCED OBSERVING PERIOD (CEOP)




*Reference site data from Canadian BERMS and model output (MOLTS) from Scripps/NCEP (ENP) and NASA/DAO (DAO) and NASA/GLDAS (GLD).*

Early comparisons indicate model difficulties in depicting seasonal and diurnal cycle precipitation (P) and evaporation (E) that additional CEOP Reference Site data and Model (MOLTS) output may help resolve. *(See CEOP Newsletter No. 3, March 2003)*

## NEW RAINFALL PREDICTION METHOD BENEFITS AGRICULTURAL AND FLOOD FORECASTING IN SOUTH ASIA




*Forecast for 1999–2002: Forecasts of 5-day average precipitation for the Ganges Valley in India made 20 days in advance. The black curve is the satellite rainfall observations or verifications and the forecast is the red curve. Note that the scheme very accurately predicts the mid-summer drought over northern and central India from mid-June through July 2002. Thus, 20 days in advance the prolonged drought would have been forecast. With advancing time, the duration and cessation of the drought would have been forecast, all with lead times of about 3 weeks. Abscissa is in pentads.* *(See article on page 10)*

### What's New

- **SSG-15 members provide mid-course assessment and added direction for more global analyses (see Commentary)**
- **Joint GRP-JSC/CLIVAR Climate Feedback Workshop questions appropriateness of current linear feedback analyses**
- **First attempt to model atmospheric impact of irrigation on a large scale (India) – page 7**
- **Announcement out for permanent IGPO Director – page 14**
- **Soroosh Sorooshian named to NAE and John Roads heads GHP**

## PACS-GAPP FILLS THE GAP IN NAME PRECIPITATION DATA

The North American Monsoon Experiment (NAME), the first international project to be jointly undertaken by GEWEX and CLIVAR to investigate monsoon systems, has recognized that filling this gap in precipitation observations is "job one" in the buildup towards the upcoming NAME Intensive Observing Period (IOP) in 2004. Acting together, CLIVAR's Pan-American Climate Study (PACS) and the GEWEX Americas Prediction Project (GAPP) have taken on the task of providing the required measurements. *(See article on page 6)*

*COMMENTARY*

## SSG-15 MEMBERS PROVIDE PHASE I ASSESSMENT AND PHASE II DIRECTION

**Soroosh Sorooshian, Chairman**
**GEWEX Scientific Steering Group**

At the recent GEWEX SSG-15 meeting in Bangkok, Thailand, January 20–24, 2003, the SSG members were asked to provide a snapshot assessment based on background summaries and presentations provided during the week-long meeting. While not a comprehensive, in-depth review, the broad background and senior level experience of the members were clearly sufficient to provide the guidance needed to develop appropriate mid-course corrections to our GEWEX Phase II implementation planning.

There was agreement that the overall objectives remain appropriate and necessary for guiding GEWEX, along with the science questions and implementing objectives modified by the WCRP Joint Scientific Committee (JSC) for Phase II; however, the members believed there was a need for some mid-course changes in the focus of our implementation planning. There was an initial assessment from Dr. Paul Try, outgoing Director of the IGPO, on how far along we have come in achieving the basic GEWEX objectives. A significant and lively discussion followed and direction was provided on how we continue to implement Phase II.

The initial subjective assessment indicated that we have made significant progress in Phase I in attaining nearly 20 years in global 1x1 daily degree data sets for the major variables; however, the lack of global analyses and perspective on the energy and water cycles and the need for improved accuracy in some parameter descriptions leaves us with an estimate of 60% for meeting our first objective of determining the global hydrological cycle and energy fluxes. The second objective of modelling the global hydrological cycle may be estimated to be only 40% achieved based on the good progress in achieving major upgrades to all regional and global model land surface parameterizations, but slow progress in providing adequate cloud and precipitation. It then follows that achieving the third objective for prediction of the hydrological cycles necessary for water resources use trails further at about 30% since precipitation prediction remains a major problem for both weather and climate models. We see a higher accomplishment estimate of 50% in the last objective of fostering new observational capabilities and assimilation techniques with the development of the new series of global satellite observations in clouds, aerosols, water vapor and precipitation, but still having difficulties with the assimilation of the full set of data streams as they become available. This means that we have a strong need for continued focus on the GEWEX objectives and on the WCRP/JSC philosophy and direction that established and continues the GEWEX concept for achieving these overall objectives.

The SSG members followed up their assessments with recommendations for Phase II implementation planning. Central to these was the need to focus on global and combined analyses of the water and energy budgets and their coupling and representation in the global models. Also, while keeping our attention on the acquisition of the two types of data sets—(a) global, long-term sets for relationships and trends, and (b) detailed sets of measurements that can be used to diagnose and compare to model processes—we must increasingly focus on the water cycle, particularly precipitation, which is probably our largest uncertainty in the feedback process. The connection between large-scale forcing, cloud microphysics, aerosols, and resulting precipitation is not specified well enough and is critically needed. The development of a more structured "road map" to achieve our objectives was also recommended to assist in the implementation process for Phase II. See page 3 for further results from SSG meeting.

The participation and contributions of the GEWEX SSG members has been extremely helpful in guiding our planning and we are looking forward to continued assistance from all of our dedicated SSG members.

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## SUMMARY OF GEWEX SSG-15

**Dawn Erlich**
**International GEWEX Project Office**

The 15th Session of the GEWEX SSG was held on January 20–24 at the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) in Bangkok, Thailand. During the opening remarks, the economic and social value of the accurate prediction and modeling of the hydrological cycle was emphasized as well as the importance of GEWEX research towards accomplishing this task.

In his opening statement, Mr. Kim Hak-Su, Executive Secretary of UNESCAP, noted that by 2025 about 60% of the world population is expected to be living in water stressed countries. As the largest regional economic and social commission of the United Nations, with members extending from Europe to the Pacific, UNESCAP serves a region that represents some 60% of the world's population (3.8 billion) and 75% of the poor in the world. Mr. Hak-Su stressed the importance for policy makers of knowing how climate change scenarios will impact the regional hydrological cycle for the next 20, 50 and 100 years. For example, millions of Asians are displaced by monsoon flooding each year. Operational flood forecasting could alleviate this problem.

The following activities of the GEWEX Hydrometeorology, Radiation and Modelling and Prediction Panels were reviewed during the meeting.

In 2001 the Coordinated Enhanced Observing Period (CEOP) was confirmed as the first element of the Integrated Global Water Cycle Observations theme at the 8th session of the Integrated Global Observing System Partners (IGOS-P). This year, a series of workshops are being held to draft the report on this theme, to which GEWEX is a key contributor. It is hoped that this involvement by GEWEX will facilitate the development of new initiatives that could assist us in achieving our goals and provide GEWEX with an opportunity to "broadcast" its need for observational data, services and infrastructure.

The GEWEX Asian Monsoon Experiment (GAME) and the Mackenzie GEWEX Study (MAGS), both in their intensive analysis phases after earlier observational efforts, are producing results.

At a joint GEWEX-International Association of Hydrological Sciences (IAHS) Workshop on the Application of GEWEX Scientific Research to Water Resources Management, the participants noted that GEWEX goals are not well understood in the water resource community. Water managers see the intregration of hydrological and climate models by GEWEX as most applicable to their needs. The SSG agreed that the guidance and objectives of Water Resources Application Project (WRAP) should be revised to provide broader interactions with the hydrology community. These interactions would include: further development of a joint project with IAHS such as the Decade of Prediction in Ungaged Basins (PUB); a "catalog" of applications type projects that are related to the Continental Scale Experiments (CSE), and re-emphasizing mountain area activities that may cross-cut with the precipitation activities throughout GEWEX.

Couplage de l'Atmosphère Tropicale et du Cycle Hydrologique (CATCH) activities have been folded into the African Monsoon Multidisciplinary Analysis (AMMA), which is becoming a major international effort focusing on the African monsoon. The SSG agreed that AMMA may assume the status from CATCH as a GEWEX Hydrometeorology Panel (GHP) "affiliated" project and is encouraged to continue along its path to develop into a more complete CSE type experiment.

The SSG recognized the growing importance of isotope studies to better characterize continental scale water balance and encouraged the GHP to consider forming a new working group on the use of isotopic data to assist in determining the water cycle variability.

The comparison of the Tropical Rainfall Measuring Mission (TRMM) precipitation estimates with the Global Precipitation Climatology Project (GPCP) data is becoming the baseline for both incorpo-

*Participants at the 15th Meeting of the GEWEX Scientific Steering Group.*

rating TRMM data into the GPCP product and extending the understanding provided by TRMM back for 20 plus years (GEWEX News, November 2002).

The International Satellite Cloud Climatology Project (ISCCP) has produced an 18-year global radiative flux data product, which provides consistent surface and top-of-atmosphere (TOA) radiative fluxes by showing the global monthly mean net shortwave and net longwave anomalies at the surface, in the atmosphere and at the TOA over the whole time period (GEWEX News, November 2002). In 2003 the review of Global Circulation Model (GCM) radiative transfer code features and metrics for testing clouds and radiation in GCMs will be completed and a workshop on polar clouds and precipitation will be organized jointly with the Climate and Cryosphere (CliC) Study.

Scientific advances by the GEWEX Cloud System Study (GCSS) working groups that are expected during the next several years include rapid progress on the representation of sub-grid scale cloud overlap and inhomogeniety due to the combination of Cloud Resolving Models (CRM), cloud radar observations, and faster methods of calculating radiative fluxes for arbitary cloud configurations; and progress in the understanding and representation of cloud microphysical, formation, and dissipation processes due to integrated use of Large-Eddy Simulations (LES) models, CRMs, Single Column Models (SCM), GCMs, and cloud-scale observations, plus insights from recent and upcoming field experiments.

Under the Global Land-Atmosphere System Study (GLASS), the Rhone-AGGregation experiment was successfully completed this year. This experiment was an intermediate step leading up to the next phase of the Global Soil Wetness Project Phase (GSWP) II for which there will be a broader investigation of the aggregation between global scales (GSWP-1) and the river scales.

In March 2002, the GEWEX Atmospheric Boundary Layer (GABLS) held a very successful workshop at the European Centre for Medium-Range Forecasting. An additional meeting was held at Wageningen University in July 2002. The outcome of these meetings is that the initial focus of GABLS is the stable boundary layer over land.

The SSG acknowledged the importance of cross-cutting activities and encouraged the establishment of the following two activities across the GEWEX Radiation Panel (GRP), the GEWEX Modeling and Prediction Panel (GCSS and GSWP) and GHP:

(1) Precipitation – address critical issues in reducing errors in retrievals and representations of global precipitation (including solid precipitation), and improve model precipitation process representations to improve climate and weather model predictions of precipitation.

(2) Global Water Cycle and Energy Budget (G-WEBS) Estimations – provide a structured process for determining the variations and changes in the global energy and water cycles (to estimate our ability to meet this first objective for GEWEX) and to determine our ability to close the energy and water budgets on various scales.

## CHANGES IN GEWEX

At the 15th Session of the GEWEX SSG, Dr. John Roads, Director of the Experimental Climate Prediction Center, Climate Research Division, Scripps Institution of Oceanography at the University of California at San Diego, was appointed as the chair of the GEWEX Hydrometeorology Panel. He replaces Dr. Ronald Stewart, who held this position twice in two nonconsecutive terms. Dr. Roads also serves as the lead for the Water and Energy Budget Study (WEBS) under GHP.

## WCRP SATELLITE WORKING GROUP REPORT PRESENTED TO CEOS

The WCRP Satellite Working Group Report, "Update of Space Mission Requirements for WCRP," prepared by Guy Duchossois and Gilles Sommeria, was presented by Gilles Sommeria to the Committee on Earth Observation Satellites (CEOS) Consultative Group meeting on High Level Policy on Satellite Matters, 3–4 February 2003 in Geneva, Switzerland.

A review of past accomplishments and research progress was conducted by an informal Working Group set up by WCRP over the period September–December 2002. The findings and recommendations of the Group were given in terms of priorities for future space missions, requirements regarding data management and enhanced interaction with space agencies.

In order to get the full benefit of the large space investments, the Working Group made a number of specific recommendations emphasizing the importance of ensuring continuity of existing and planned missions or measurements (e.g., precise altimeter missions, Earth radiation measurements), the identification of priorities for next space missions and measurements (precipitation/GPM, salinity and soil moisture/SMOS), and the need to explore further scientific processes crucial for climate understanding (e.g., troposphere/stratosphere interaction processes, cloud radiative processes). The importance of protecting appropriate radio-frequencies for the next generation of microwave sensors was also highly stressed by the Working Group.

# THE ROLE OF GEWEX STUDIES IN ENVIRONMENTAL POLICY DECISIONS

**Kim Hak-Su**

**Executive Secretary, United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)**

*The following text was excerpted from the opening statement given by Mr. Kim Hak-Su at the Fifteenth Session of the GEWEX Scientific Steering Group.*

Climate change is very much on the top of the global political agenda these days, as reflected by the intensive on-going international negotiations of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. Science is the basis for the political agreements of the UNFCCC and the Kyoto Protocol. Based on the Third Assessment Report (2001) of the Intergovernmental Panel on Climate Change (IPCC) we know that: the Earth's surface temperature is projected to increase 1.4 to 5.8 $^{o}$C by the end of this century and sea level is projected to rise by 9 to 88 cm; precipitation patterns have changed and are projected to change further spatially and temporally; extreme weather events are projected to increase; and the frequency, persistence and magnitude of El Niño events, which have increased in the last 20 years, are projected to continue.

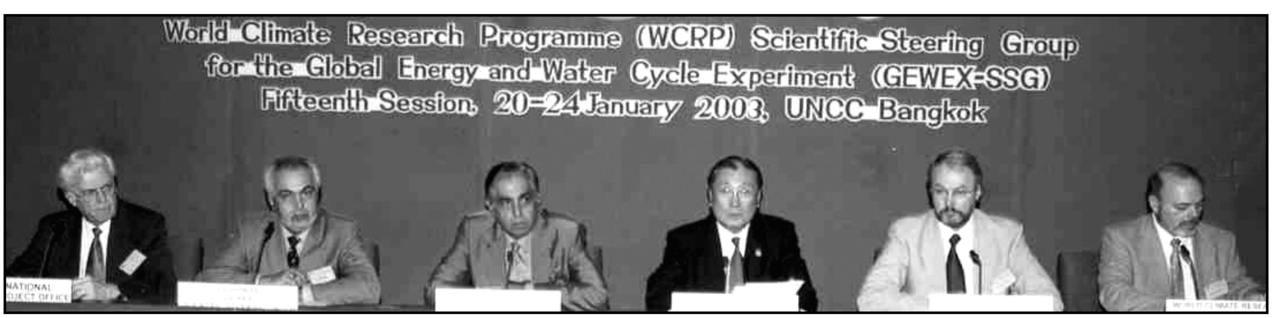
I am sure that there are many scientific uncertainties in the IPCC Assessment that need to be further reduced. Nevertheless, it seems that climate change will bring more adverse than beneficial impacts on our ecological and socio-economic systems. Developing and least-developed countries are expected to suffer the most because of their limited capability to adapt to climate change.

The research of the World Climate Research Programme (WCRP), including GEWEX, has been most valuable for the IPCC Assessment. Your studies of atmospheric and thermodynamic processes that determine the global hydrological cycle and water budget, and their response to global changes, such as the increase in greenhouse gases, are very important to our scientific understanding in climate variability and climate change. Of particular interest to UNESCAP are the results of the GEWEX Asian Monsoon Experiment (GAME).

As the largest regional economic and social commission of the United Nations, we are particularly interested in finding the socio-economic impacts of climate variability and climate change for our region and subregions. For example, it is noted that by 2025 about 60% of the world population is expected to be living in water-stressed countries. What will be the implications for the availability of water resources in the Asia-Pacific region and its associated impacts on other socio-economic sectors, such as agriculture, forestry, industry, human health and biodiversity? This means that we would need the further refinement of General Circulation Models and the development of Regional Circulation Models that are capable of simulating weather events that give rise to floods and hydrological droughts, as well as the future improvement of regional integrated assessment models. Clearly, more reliable predictions of extreme climatic events would have enormous socio-economic benefits.

The above-mentioned activities fall within the mandates of GEWEX, which within the framework of WCRP, are to observe and model the hydrologic cycle and energy fluxes in the atmosphere and at the land and ocean surface. GEWEX is an integrated program of research, observations, and science activities ultimately leading to the prediction of global and regional climate change.

I hope that WCRP, including GEWEX, together with other international research programs will provide us with a comprehensive regional assessment. I believe that UNESCAP will be in a better position to assist our member states in formulating relevant socio-economic policies in response to climate variability and climate change based on the results of your scientific research.




*Left to right: Paul Try, IGPO; Soroosh Sorooshian, Chair, GEWEX Scientific Steering Group; Ravi Sawhney, Director, Environment and Sustainable Development Division, UNESCAP; Kim Hak-Su, UNESCAP; David Carson, WCRP; and Gilles Sommeria, WCRP.*

## PACS-GAPP FILLS THE GAP IN NAME PRECIPITATION DATA

**David J. Gochis[1], Juan-Carlos Leal[2], W. James Shuttleworth[3], Christopher J. Watts[2], and Jaime Garatuza-Payan[4]**

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Ask a meteorologist to specify three of the most important influences on convective processes during the North American Monsoon (NAM) and you may get the reply, "Topography, topography, and topography." The problem is that observations that document the daily cycle of convective precipitation and its variation with topography in the region affected by the NAM are in short supply, and this has inhibited the understanding of processes and development of predictive models.

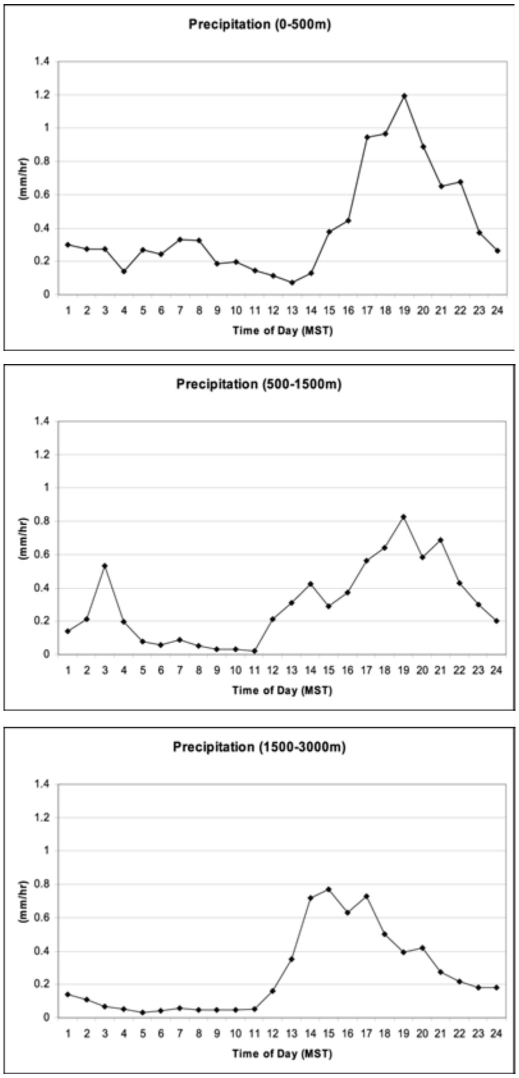
A new network of tipping bucket rain gauges coupled to event recording data loggers is being installed in the core region of the NAM, i.e., in the "Tier 1" region of North American Monsoon Experiment (NAME) that lies around the Gulf of California. The new gauges can resolve the timing of rain during individual storms and lie along transects, each accessible by road, to sample the intensity of and topographic influence on precipitation in the Sierra Madre Occidental Mountain range. The information these gauges provide will aid in the evaluation of different parameterizations of the convective precipitation process in regional and global models which are known to simulate dramatically different precipitation and atmospheric flow fields (Gochis et al., 2002). They will also aid in understanding the hydrologic flows associated with precipitation which, when generated by the infiltration excess mechanism, are likely to be strongly dependent on the relative timing and intensity of individual rain storms (Gochis and Shuttleworth, 2002).

The first 50 tipping rain gauges were installed in July and early August 2002, and the installation of an additional 50 rain gauges is planned for April/May 2003. A global positioning system and barometric altimeter are being used to specify the location and elevation of the gauges, and extensive metadata are being gathered on the gauge sites, including site and soils descriptions, contact information, and a photographic archive of the detailed mounting of each gauge. The figure on the bottom of page 16 shows the location of the gauges installed so far in relation to the topography in the NAME Tier 1 region and the (still preliminary) proposed sites for the remainder of the network. Of the rain gauges installed so far, 21 are collocated with existing daily-observation climate stations operated by the Comission Nacional del Agua (CNA) to facilitate error checking and quality control in the processing of precipitation data. Bulk rainfall collectors were also deployed at 12 selected sites (shown as white dots in the figure on page 16) to sample the longitudinal and elevational gradients of stable isotope (especially $\delta O^{18}$) content in monsoon rainwater.

Already, the overall range of elevation sampled by the enhanced network (71-2979 m) is significantly larger than the range of the existing daily-observation climate network (71-2347 m), and the mean elevation of the newly installed gauges is 1226 m compared with 886 m for the climate network. There are now 13 gauges above 2000 m in elevation; before, there were only two. The gauges that will be installed in 2003 will no doubt further mitigate the low-elevation bias in the original observational network relative regional topography.

The data gathered to date only sample one (the 2002) monsoon season, but already show intriguing trends. Above 1500 m, for example, there were approximately 50% more "wet" days (i.e., days with measurable precipitation greater then 0.25 mm) than at lower elevations. The three figures on the next page show the time-average diurnal cycle of hourly-total precipitation for wet days for gauges in three elevation bands, less than 500 m, 500-1500 m, and over 1500 m. In each case, there is a distinct precipitation maximum in the early afternoon, beginning around 1300 MST and continuing until around 1800 MST, but the average timing and peak rain-rates clearly vary with elevation. When only wet days are included in the average, the highest average peak rain-rate (>1.1 mm/hr) occurs in the lowest elevation band. (Note: this is not the case when all days are included in the average because more days without rain are then brought in to the low-altitude average.) Consequently, while precipitation may be less frequent at lower elevations, when storms do occur, there is a tendency for them to be somewhat later in the day and to have a higher rain-rate. Such differences in the duration and intensity of precipitation may have a significant impact on hydrological responses and the generation of surface runoff (Gochis and Shuttleworth, 2002). The data gathered so far tend to suggest behavior similar to that seen in eastern Rocky Mountains and western Great Plains (e.g., Carbone et al., 2002; Dai et al., 1999), where high-elevation thunderstorms originating over large topographic features often organize and propagate to lower elevations.

In summary, the first phase of the Pan-American Climate Study (PACS)-GEWEX Americas Prediction Project's (GAPP) new rain-gauge network has now been successfully deployed in the core region of the North American Monsoon in northwestern Mexico to increase understanding of the diurnal cycle of convection and its topographic dependency and to provide ground-truth data for remote-sensing estimates of precipitation during the upcoming NAME-IOP in 2004. The second phase of installations planned for the spring of 2003 will bring the




*The figures above show the time-average diurnal cycle of hourly-total precipitation for wet days for gauges in three elevation bands, less than 500 m, 500–1500 m, and over 1500 m.*

total number of event gauges in the network to 100. So far, preliminary results seem to confirm the original motivation for the study, the belief that three of the most important influences on convective processes during the NAM are topography, topography, and topography!

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## ESTIMATING THE ATMOSPHERIC IMPACT OF IRRIGATION IN INDIA USING A MODIFIED LAND-SURFACE MODEL

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Irrigation is the main water user in the world, with 61% of the water withdrawal and 87% of the water consumption (withdrawal minus return-flow) (Shiklomanov, 1997). The Indian Peninsula is a relevant region to make a first assessment of the irrigation impact on the surface energy budget because it is the most important irrigating region of the world (Shiklomanov, 1997), and the land surface processes are important for the climate and monsoon variability, as well as for water resources management and sustainable development. In addition, this regional case allows the development of an irrigation modeling and validation structure in a continental scale land-surface scheme.

Because this approach is innovative, an important part of the work presented here is devoted to: (1) collecting data sets of irrigation water use or requirements which are suitable for continental scale modeling studies, (2) developing a modeling infrastructure of irrigation relevant for the purpose of the continental scale land-surface modeling with respect to irrigation time and space scale constraints, and (3) assessing the feasibility and suitability of the implementation of an irrigation scheme in a continental land-surface scheme.

The developed methodology is applied to a simple analysis of the numerical sensitivity of the land surface fluxes to the intensive irrigation over the Indian Peninsula. It is conducted in the framework of the Predictability and Variability of Monsoons and the Agricultural and Hydrological Impacts of Climate Change (PROMISE, 2002) European project. Modeling experiments are conducted with the land surface scheme ORCHIDEE (ORganizing Carbon and Hydrology In Dynamic EcosystEms) of the Laboratoire de Météorologie Dynamique (LMD) (Ducoudré et al., 1993; Polcher, 2002), at a 1-degree

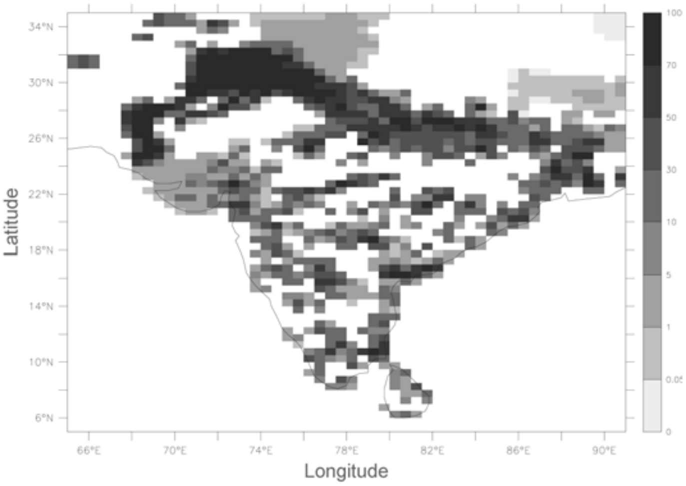


*Figure 1. Irrigated fraction of the area in percent of each 0.5°x0.5° pixel on the Indian Peninsula (from Döll and Siebert, 2002).*

spatial resolution for a region covering the whole Indian Peninsula. Two-year simulations forced by the International Satellite Land-Surface Climatology Project (ISLSCP) Initiative I (1987–99) data set (Meeson et al., 1995) atmospheric data sets, are conducted, and two experiments are compared, with and without land irrigation.

Appropriate irrigation data sets for use in climate and land surface processes study require global coverage of the amount of irrigation water consumption or requirement, and the irrigated areas. The UN Food and Agricultural Organization (FAO), as well as the World Resources Institute and the International Water Management Institute provide information about irrigation by year for each country (FAOSTAT, 2001; World Resources, 1998; Seckler et al., 1997). Based on a modeling approach, the Center for Environmental Systems Research, in Germany, is the only one today to provide a global scale data set on irrigation at the daily time step with a fine enough resolution (0.5°x 0.5°) (Döll and Siebert, 2002).

Based on the FAO guideline for computing irrigation requirement (Brouwer and Heibloem, 1986; Smith 1992; Raes and Smith, 1998), and the digital global map of irrigated areas (Figure 1), an irrigation scheme is developed in ORCHIDEE for the purpose of this study. Two cases may be encountered: (1) when water demand is lower than water availability (then the actual irrigation satisfies the irrigation requirement), and (2) when water demand is larger than water supply (as this is typically the case in dry years), the irrigation amount is lower than the irrigation requirement. The resulting actual irrigation is added to the near surface soil moisture.

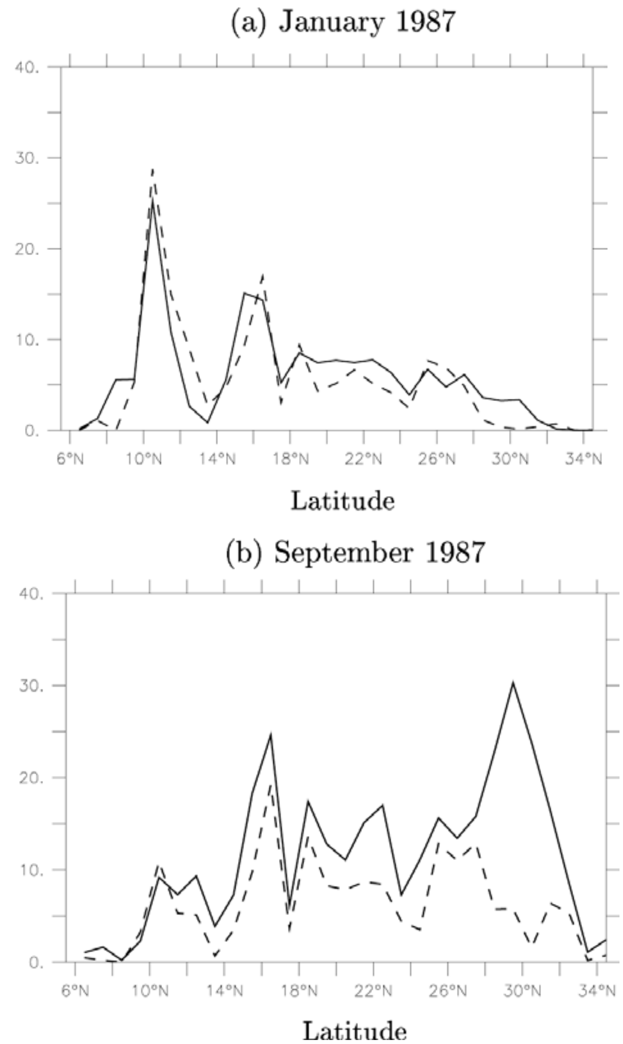


*Figure 2. Zonal mean distribution (averaged between 65° and 90° east) of the irrigation over the Indian Peninsula, for January (a) and September (b) 1987 (in mm by month). The black line refers to the estimates of Döll and Siebert (2002); the dashed line depicts the simulation of the irrigation by the model ORCHIDEE. The Döll and Siebert estimates refer to the irrigation requirement while the model simulates the actual irrigation. Strong seasonal and geographical variations in irrigation amount between January and September are represented in ORCHIDEE, for the actual irrigation, and the requirement estimates. Low moonson intensity in 1987 is associated with strong water scarcity which leads to reduced water supply (model) compared to the water demand (estimates).*

Figure 2 shows that the model captures the main features of the time and space variations of the irrigation over India. In January the geographical distribution and variations of the actual irrigation simulated by ORCHIDEE (dashed line) is in good

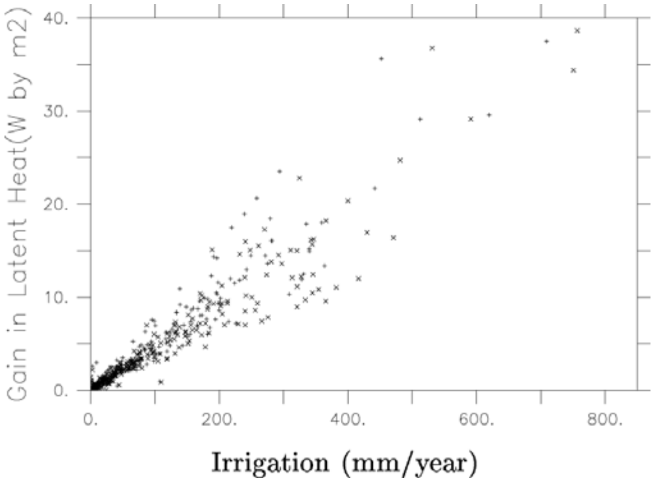


*Figure 3. Annual mean values of the increase of latent heat flux versus input of irrigation for the whole Indian Peninsula in 1987 and 1988. Large values of irrigation over the Indian Peninsula leads to strong increases in the annual mean latent heat flux.*

accordance with the Döll and Siebert estimates of the irrigation water demand (black line). In September the net radiation is larger than in January, particularly in the northern part of the Peninsula. This contributes to higher values of the potential evaporation than in winter and spring. Maximum values of irrigation correspond to the Indus and Ganges basins, which are the largest irrigating regions. The model ORCHIDEE (dashed line) underestimates the amount of actual irrigation in September compared to the estimates of the irrigation requirement. The extreme water scarcity in 1987, due to a dramatically weak monsoon, explains that the estimates of irrigation requirement are larger than the simulated actual irrigation. In contrast to 1987, the wet monsoon of 1988 is associated with larger water availability in the streams and aquifer. In this case (not shown), simulated actual and estimated requirement of irrigation are in better agreement than in 1987.

As expected the intensive irrigation over the Indian Peninsula leads to an increase in the annual mean value of the latent heat fluxes (Figure 3). The increased values of the latent heat fluxes influence the surface energy budget which in turn affects the plant water demand through a positive feedback. But this feedback results from an off-line experiment where the irrigation does not influence the precipitation rates, nor the air humidity and the incoming solar radiation, or the surface wind, as it should be in the real world.

Based on the feasibility and relevance of this preliminary approach, further numerical experiments with the land surface scheme ORCHIDEE and coupled to the LMD General Circulation Model will be devoted to study the interactions and feedbacks between irrigation and climate, from regional to global scales.

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## NEW RAINFALL PREDICTION METHOD DIRECTLY BENEFITS AGRICULTURAL AND FLOOD FORECASTING IN SOUTH ASIA

**Peter Webster and Carlos Hoyos**
**Georgia Institute of Technology**

Research shows that precipitation can be forecast 20 days in advance over central India by using a Baysean wavelet regression statistical scheme. The regression variables are derived from current understanding of the physics of intraseasonal variability.

Accurate intraseasonal forecasts (20–30 days) are perhaps the most important from an agricultural and water resources perspective. An accurate forecast three weeks in advance can provide a distinct reduction in agricultural vulnerability to climate variations and the ability to take advantage of favorable future conditions. Forecasting on 20–30 day time scales is much more important than forecasting interannual variation (e.g., El Niño time scales). Hitherto, 20–30 day forecasts have been difficult or impossible to make because of the inability of models to simulate intraseasonal variability and the lack in understanding of the basic physics. New insights on the physical nature of monsoon variability, coupled with new statistical techniques, has allowed us to move forward.

How important are the forecasts shown in the figure on the cover? A. Subbiah of the Asian Disaster Preparedness Centre (ADPC) in Thailand, an agricultural expert, feels that use of these forecasts could increase agricultural yield by 20–30 percent. In that sense, the increase in yield may be equivalent to that achieved during the "Green Revolution" that accompanied the introduction of new grain species in the 1960s. Another very exciting by-product of this prediction method, is that the same technique can be used for river discharge into Bangladesh, thus providing a 20–25 day lead time for floods.

This technique does not require sophisticated weather and climate modeling infrastructures. Once data links are made available the techniques can be used locally. Thus, capacity building is relatively minimal. More development has to be done as we would like these forecasts to be probabilistic. However, technical transfer to Bangladesh and Indian user communities is relatively simple and can easily be accomplished within the next 18 months to 2 years.

This research was made possible through grants from the National Science Foundation and the US Agency for International Development.

## COUPLED MODEL INTERCOMPARISON PROJECT

**Gerald A. Meehl[1], Curtis Covey[2], Mojib Latif[3], Bryant McAvaney[4], and Ronald J. Stouffer[5]**

**[1]National Center for Atmospheric Research, USA; [2]Program for Climate Model Diagnostics and Intercomparison, USA; [3]Institut fuer Meereskunde, Germany; [4]Bureau of Meteorology Research Centre, Australia; [5]Geophysical Fluid Dynamics Laboratory, USA**

The Coupled Model Intercomparison Project (CMIP) is an activity of the WCRP Working Group on Coupled Models (WGCM). CMIP was initiated in 1995 with the general goal of collecting and intercomparing simulations from global coupled climate models. These models are high end state-of-the-art comprehensive climate simulation tools with components typically consisting of atmosphere, ocean, sea ice and land surface. The resolution of the components generally ranges from roughly 5 degrees to about 2 degrees latitude-longitude in the atmosphere, and from about 5 degrees down to ½ degree in the ocean. Vertical levels are typically about 15 to 25 levels in the atmosphere, and roughly 20 to 45 in the ocean. Any type of spin-up and/or flux adjustment is allowable to find initial conditions for the control integrations of these models since it is virtually impossible to specify these techniques across all coupled models. Thus, CMIP is a "level 1" intercomparison (Gates, 1992) where available simulation results are compiled, analyzed and intercompared. The transition to a true "level 2" intercomparison (where coupled model experiments are done under exactly the same standard conditions) has proved challenging; the very rapid development efforts in coupled models, their great computational expense, and their ever increasing complexity mitigates against a consensus view as to what constitutes "standard conditions."

The first CMIP workshop was held in 1998 in Melbourne, Australia, and a summary of that workshop and some preliminary results from CMIP intercomparisons were described by Meehl et al. (2000). A number of results related to contributions provided by CMIP appeared in the IPCC Third Assessment Report (e.g., McAvaney et al., 2001;

Cubasch et al., 2001). A further compilation of intercomparison results from CMIP is given by Covey et al. (2000), and an example of CMIP results is shown in the figure on page 16, taken from Covey et al. (2003).

Part of the motivation of CMIP arose from the IPCC process in that many of the global coupled models are relied on for high visibility climate change simulations. Thus, it is important for the global coupled climate modeling community to undertake a comprehensive evaluation of current global coupled models. Additionally, experience with other model intercomparisons such as the Atmospheric Model Intercomparison Project (AMIP) has shown that such an exercise provides valuable information to the participants to point the way toward subsequent model improvement.

Further information on CMIP can be found on the web page http://www-pcmdi.llnl.gov/cmip/.

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***WORKSHOP/MEETING SUMMARIES***

## 7TH GAME INTERNATIONAL SCIENCE PANEL MEETING

**6–7 November 2002**
**Tokyo, Japan**


**Kenji Nakamura**
**Hydrospheric Atmospheric Research Center**
**Nagoya University, Japan**


The 7th GEWEX Asian Monsoon Experiment (GAME) International Science Panel meeting (GISP) was held at the Earth Observation Research Center of the National Space Development Agency of Japan (EORC/NASDA) under the auspices of Ministry of Education, Culture, Sports, Science and Technology and NASDA. A total of 35 participants including observers and experts from 10 countries attended.

After the opening speeches by Prof. Yasunari, Chairperson of GISP and Mr. Otsuki, Director of EORC/NASDA, reports were given on GAME related international programs and projects, such as the GEWEX Hydrometeorology Panel and Coordinated Enhanced Observing Period (CEOP).

GAME is in Phase II, where the emphasis is on analysis of GAME data sets and the modeling of the Asian monsoon climate and hydrological cycles. Many working group reports were presented on Phase II activities and results, including the following:

- New scientific results on the hydrometeorological processes in the Asian monsoon region from the Tropics to the Siberian Arctic region. Particularly, the land-atmosphere interaction process in some typical climate and vegetation condition in monsoonal Asia have been revealed in diurnal through seasonal time scales. Cloud and precipitation processes have also been scrutinized in the tropical region, the Meiyu-Baiu frontal zone in the subtropical China, and on the Tibetan plateau area.

- The role of regional-scale water-fed rice paddy field (which is a typical land surface condition in monsoonal Asia) has been studied in the development and modifying of the precipitation systems, using the cloud-resolving atmospheric model forced by surface energy fluxes observed through HUBEX and GAME-AAN(Asian AWS Network). The result strongly suggested that the water-fed rice paddy field plays an important role in forming the mesoscale systems embedded in the Meiyu front in China.

- The observational as well as modeling studies in the tropics (GAME-Tropics) and in the Tibetan Plateau (GAME-Tibet) have presented some interesting processes in the diurnal as well as in the synoptic-scale of cloud/precipitation system. The regional model studies are essential for these problems, including improvement of land-surface schemes and the atmospheric boundary layer processes based on GAME data sets.
- Regional and continental-scale vegetation, such as tropical monsoon forest in Southeast Asia, and the boreal forest in east Siberia, have been suggested to play an important role in controlling seasonal surface energy and water balance. This role of vegetation, in turn, modifies the seasonal cycle of the climate and atmospheric circulation. Some model experiments also have strongly suggested these processes.

GAME has provided a tremendous amount of unique data. GAME reanalysis data are one of the important fundamental products of GAME and Version 1.5 has been validated by the GEWEX Global Precipitation Climatology Project and the Tropical Rainfall Measuring Mission. The archival and distribution of GAME data are going well, thanks to the significant effort of Mr. Takahashi of MRI/JMA. An extended multi-year GAME database (1997–2002) was proposed and the concept was agreed upon by the GISP. Regional climate models and cloud resolving models were presented and expectations of short-time forecasts and seasonal forecasts were expressed. Project activities and observations related to GAME and to the future of GAME were reported from China, Russia, Thailand, Myanmar, Vietnam, Malaysia and Mongolia. It was recognized that the monsoon onset in Indochina is not part of GAME-Tropics but an important part of GAME.

Considering the importance of regional/basin-scale modeling for understanding the hydro-meteorological processes and predictions in monsoon Asia, the GISP agreed to hold the 2nd International Workshop on Regional Climate Modeling for Monsoon Systems on March 4–6, 2003 in Yokohama, Japan, which is co-sponsored by the Frontier Research System for Global Change (FRSGC). The next GISP meeting would be held in Thailand in November 2003. The final GISP would be held in 2004, in conjunction with the 6th International Study Conference on GEWEX in Asia and GAME.

## WORKSHOP ON CLIMATE SYSTEM FEEDBACKS

**18–20 November 2002**
**Atlanta, Georgia, USA**

**William B. Rossow**
**NASA Goddard Institute for Space Studies**

The Workshop on Climate System Feedbacks was organized by the GEWEX Radiation Panel and the JSC/CLIVAR Working Group on Coupled Models. The term “feedback” looms important in many WCRP (and Intergovernmental Panel on Climate Change [IPCC]) documents and is used to motivate many WCRP programs and projects. We all have some sense of what the feedback concept means in the climate system in that a perturbation of the climate system is either amplified or diminished by a feedback process. Linear control theory (from engineering) has been used since the late 1970s to assess radiation-climate feedbacks in terms of simple energy balance models using the top-of-atmosphere (TOA) radiative fluxes as the dependent variable and global mean surface temperature as the independent variable. This type of analysis has led to discussion of a whole host of feedbacks on surface temperature: water vapor feedback, ice/snow albedo feedback, and many different cloud feedbacks, including those associated with changes in total cloud cover, cloud top temperature (and/or infrared emissivity) or height, cloud optical thickness (or solar albedo), cloud droplet size, and boundary layer or cirrus cloud cover. Many other feedbacks that do not involve radiation directly have also been described, notably ones that alter water exchanges. **The continuation of attempts to isolate and describe more climate feedbacks and to quantify those already mentioned in this same way has become very confusing and misleading because application of this simple linear control theory to the complex, non-linear climate system composed of many coupled sub-systems is simply not appropriate.** In particular, in observations of the variations of the real climate, many feedback processes act simultaneously so that their intrinsic magnitude cannot be estimated. The most obvious demonstration of the flaw in such an analysis approach comes from studies that show that the magnitude of “feedback factors” determined from climate model experiments depends on the order in which they are evaluated — this expresses the fact that most feedbacks are coupled to others. In particular, most feedbacks are coupled to cloud feedbacks because the climate can only be altered by changing its energy and water cycles, which are really one cycle involving clouds. Considering the derivation of the mathmatical expressions commonly used to determine feedback factors shows that several very strong assumptions are required, none of which is true of the real climate or even of climate Global Circulation Models (GCM). **Moreover, even if the feedback concept is useful in summarizing the overall sensitivity of a climate model to changes of forcing, the way in which these quantities are evaluated in practice cannot be reproduced with observations: in other words, this way of describing a climate model's sensitivity can never be verified.**

Although the notion of climate feedback is useful for evaluating sensitivity of a climate model to forced changes and the roles of different physical processes in determining the model sensitivity when they are isolated in special experiments, we need a more appropriate, yet still practical way of analyzing climate model feedbacks that can be verified from a similar analysis of observations. To explore useful ways of addressing the feedback problem and to evaluate alternate analysis approaches, the GEWEX Radiation Panel and the Joint Steering Committee (JSC)/CLIVAR Working Group on Coupled Models (WGCM) sponsored a workshop in Atlanta, Georgia, USA on 18–20 November 2002 to discuss:

(1) Advanced analysis methods for complex, nonlinear dynamical systems; and
(2) Better applications of the concept of feedbacks for understanding, evaluating and improving climate models.

The desired outcome of the meeting was suggestions for new lines of research to develop better analysis approaches to be applied to both climate observations and climate model outputs and assessments of possible metrics for evaluating climate model feedbacks and sensitivities.

About 30 scientists attended the 3-day workshop. Papers and discussion sessions during the first two days of the meeting were arranged around consideration of two topics:

(1) Analysis of Multi-Variate, Non-Linear Dynamical Systems Like Climate, Their Behavior and Their Predictability,
(2) Advanced Methods of Model-Data Comparison and Parameterization Testing

The last day of the meeting was composed of two parallel break-out meetings and a final plenary session to formulate some suggestions and recommendations in response to three questions:

(1) How do we evaluate the usefulness of new analysis methods?
(2) How do we diagnose climate and climate model behavior more effectively?
(3) How do we better compare observations and models?

A number of interesting proposals for different ways to analyze non-linear dynamical systems, like climate and climate models, were presented; but very few of the talks actually concerned climate feedbacks directly. Some of these methods have been applied to climate models in informative ways but they could not be applied to observations of the real climate in practice. In particular, it was noted that the common modeling practice of evaluating climate model feedbacks by finite differences between the state variables of two "equilibrium runs" of the model could not be verified against observations. A number of other aspects of model sensitivity testing were also discussed and some specific suggestions for the design of such activities were made and incorporated into the WGCM plan for a "cloud feedback" experiment. Also, several aspects of model-data comparisons were discussed, leading to a specific decision to employ the "International Satellite Cloud Climatology Project (ISCCP) simulator" (http://gcss-dime.nasa.gov/simulator.html), which converts model cloud output into a form that allows for direct comparison of the space-time distributions of cloud top pressure and optical thicknesses as seen by satellites in the ISCCP data set, in the WGCM cloud feedback exercise.

Very interesting discussions occurred, covering a wide range of topics, and some useful suggestions for improved analysis were made; but the **basic questions of how to make progress on quantifying climate feedbacks and verifying models of them remained unanswered.** The participants believe that this fact indicates the depth of the feedback problem, that there is a general lack of understanding by the climate research community of the issues involved in the feedback problem, and that what the climate research community is mostly working on is not what really needs to be worked on. A tentative conclusion was that the whole feedback approach may not be viable, when applied to such a complicated system as the climate, but that a focus on a more general diagnosis of the dynamic relationships among variables in the system, using methods capable of handling non-linear, multi-variate relationships, would be useful. Another conclusion was that, whatever advanced analysis techniques were to be developed, they would have to determine quantities from models that can also be determined from observations.

**Although not well defined, the next steps would seem to include the formulation of a small set of analysis tasks that all of the proposed analysis methods could be applied to, using the same data sets and the outputs from a hierarchy of climate models of varying complexity.** The purpose would be to compare and evaluate the results obtained by the different analysis methods to learn what aspects of the dynamical system they are describing and to examine how the results depend on the complexity of the system being considered. Also, this comparison of different diagnostics when applied to different kinds of climate models could help determine what information about the model's feedback processes can be extracted in practice. The participants agreed to continue discussions towards more definite plans for such coordinated studies, possibly leading to another workshop in about 18 months.

## TWO GEWEX SCIENTISTS NAMED TO NATIONAL ACADEMY OF ENGINEERING

**Soroosh Sorooshian**, Chair of the GEWEX SSG, Regents Professor and Director, SAHRA Hydrology and Water Resources, The University of Arizona; and **Thomas H. Vonder Haar,** Professor of Atmospheric Science and Director of the Cooperative Institute for Research in the Atmosphere, Colorado State University have been elected to the National Academy of Engineering (NAE).

Prof. Sorooshian directs the NSF-STC program for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA) and was elected to NAE for his work on developing flood-forecasting models that are used worldwide. Prof. Vonder Haar was elected for his fundamental analysis of the Earth's radiation balance and its impact on climate.

Profs. Sorooshian and Vonder Haar are two of 77 new members and nine foreign associates who were elected to NAE on February 14, 2003. This brings the total U.S. membership to 2,138 and the number of foreign associates to 165.

Election to NAE is among the highest professional distinctions accorded an engineer. Academy membership honors those who have made important contributions to engineering theory and practice, including significant contributions to the literature of engineering theory and practice and those who have demonstrated accomplishment in the pioneering of developing/implementing innovative approaches to engineering education.

## POSITION ANNOUNCEMENT: DIRECTOR, IGPO

The World Climate Research Programme (WCRP) and the University of Maryland, Baltimore County (UMBC) invite applications for the position of Director of the International GEWEX Project Office (IGPO) located in the Washington-Baltimore area. The Director of the Project Office leads development and implementation of the GEWEX Project, and its international coordination.

**Background:**

The GEWEX project was initiated in 1988 by the WCRP to observe and model the hydrologic cycle and energy fluxes in the atmosphere, and at the land and ocean surface. GEWEX is an integrated programme of research observations and science activities ultimately leading to the prediction of global and regional climate change. The IGPO is the focal point for the planning and implementation of all GEWEX projects and activities. For more information on GEWEX or IGPO, visit www.gewex.org or contact Dr. Robert Curran at: 001-410-455-8813.

**Duties and responsibilities:**

The Director's primary function is to provide an effective executive arm of the GEWEX Scientific Steering Group and its panels and working groups. The Director will be required to:

- Oversee the development of plans for each of the GEWEX project elements and their international coordination and implementation;
- Ensure that GEWEX develops as an effective component of the WCRP and as a contributor in the wider field of global change research;
- Maintain effective links between GEWEX as an international project and the countries that contribute to, and benefit from, GEWEX research;
- Ensure the timely flow of pertinent information to GEWEX participants and relevant international scientific bodies; publish a regular newsletter; maintain a web site and produce communications material as appropriate;
- Represent GEWEX in international fora and undertake appropriate negotiations with the sponsors of national or regional programmes, as well as promote GEWEX objectives and projects in the broader science community; and

- Be responsible for the management of the Project Office staff, budget and operations and for maintaining adequate funding for the IGPO, in accordance with the procedures established by the hosting institution and those of the contributing agencies or organizations.

*Qualifications:*

Candidates should have demonstrated ability to conceive, organize and manage interdisciplinary and international science activities. Excellent written and oral communication skills in English and knowledge of national and international organizational structures in the climate sciences are essential. Candidates should have a Ph.D. or equivalent, and experience with global space observing systems and climate-related science.

*Nature of the position:*

IGPO is hosted by the University of Maryland, Baltimore County (UMBC), as a part of the Goddard Earth Sciences and Technology (GEST) Center. The IGPO Director is presently assisted by one support scientist and one administrative assistant. The IGPO Director reports to the Director of the WCRP for overall programmatic management of the IGPO, and to the University on administrative matters. The appointment is to begin on 1 November 2003 or earlier, and extend until 10 May 2005, with possibility of extension. The position may be supported either by a national or international secondment, or via funds provided by NASA through UMBC. In the latter case, the level of remuneration will be negotiated with UMBC depending upon qualifications.

**Applications:**

Letters of application should be accompanied by a complete CV together with an explanation of the unique qualifications the applicant believes he/she would bring to the position. Submissions should include the names of at least three references and be sent no later than 30 April 2003 to:

Dr. Robert Curran, Director
Goddard Earth Sciences and Technology Center
University of Maryland, Baltimore County
South Campus, Room 3.002
1000 Hilltop Circle
Baltimore, MD 21250
USA

## GEWEX/WCRP MEETINGS CALENDAR

***For calendar updates, see the GEWEX Web site: http://www.gewex.org***

**5–7 March 2003**—IGOS-P WATER CYCLE THEME WORKSHOP, ESTEC, The Netherlands.

**11–13 March 2003**—GEWEX WORKSHOP ON OBJECTIVE ANALYSIS OF PRECIPITATION, Reading, UK.

**14 March 2003**—IGOS-P WATER CYCLE THEME WORKSHOP AT THE AWAJI SYMPOSIUM AND WORKSHOPS, Awaji Island, Japan.

**17–21 March 2003**—WCRP JOINT SCIENTIFIC COMMITTEE MEETING, Reading, UK.

**24–28 March 2003**—CONFERENCE ON MONSOON ENVIRONMENTS: AGRICULTURAL AND HYDROLOGICAL IMPACTS OF SEASONAL VARIABILITY AND CLIMATE CHANGE, Trieste, Italy.

**31 March–1 April 2003**—CEOP REFERENCE SITE MANAGERS MEETING, Berlin, Germany.

**2–4 April 2003**—CEOP SECOND FORMAL INTERNATIONAL IMPLEMENTATION PLANNING MEETING, Berlin, Germany.

**6–11 April 2003**—EGS-AGU-EUG JOINT ASSEMBLY, Nice, France.

**7–8 April 2003**—CEOP WORKSHIP ON THE ROLE OF THE HIMALAYAS AND THE TIBETAN PLATEAU WITH THE ASIAN MONSOON, Epson Meteo Centre, Milan, Italy.

**12-16 May 2003**—GRP WORKING GROUP ON DATA MANAGEMENT AND ANALYSIS, Asheville, North Carolina, USA.

**19–23 May 2003**—IAEA'S 11TH ISOTOPE HYDROLOGY SYMPOSIUM, Vienna, Austria.

**18 June 2003**—MAGS SCIENTIST USER WORKSHOP, Edmonton, Alberta, Canada.

**24–26 June 2003**—3RD GLOBAL PRECIPITATION MEASUREMENT MISSION WORKSHOP, ESA/ESTEC, The Netherlands.

**30 June – 11 July 2003**—WORKSHOP ON ISOTOPE TRACERS IN WATER CYCLE MODELS, IAHS/IUGG, Sappora, Japan.

**3–4 July 2003**—2ND WRAP WORKSHOP ON WATER RESOURCES, Sappora, Japan.

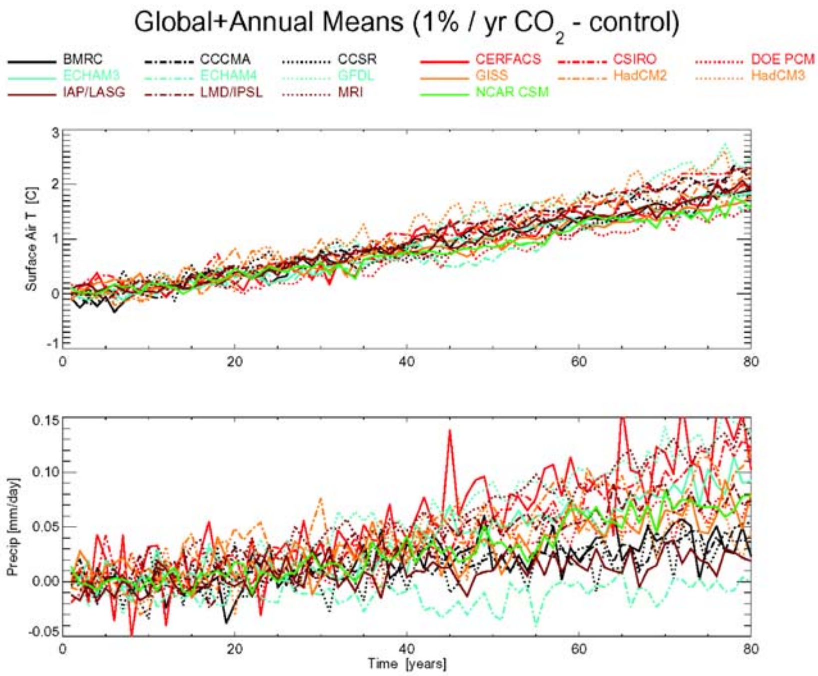
**15–19 September 2003**—INTERNATIONAL CONFERENCE ON EARTH SYSTEM MODELLING, Max Planck Institute for Meteorology, Hamburg, Germany.

**22–26 September 2003**—9TH MEETING OF THE GEWEX HYDROMETEOROLOGY PANEL, GKSS, Geesthacht, Germany.

**3–7 November 2003**—14TH SESSION OF THE GEWEX RADIATION PANEL, Toronto, Canada.

**11–14 November 2003**—ACSYS Final Science Conference, AARI, St. Petersburg, Russia.

## CLIMATE MODEL PRECIPITATION PREDICTION STILL A MAJOR PROBLEM
### *as shown by the results of the Coupled Model Intercomparison Project (CMIP)*
(see article on page 10)

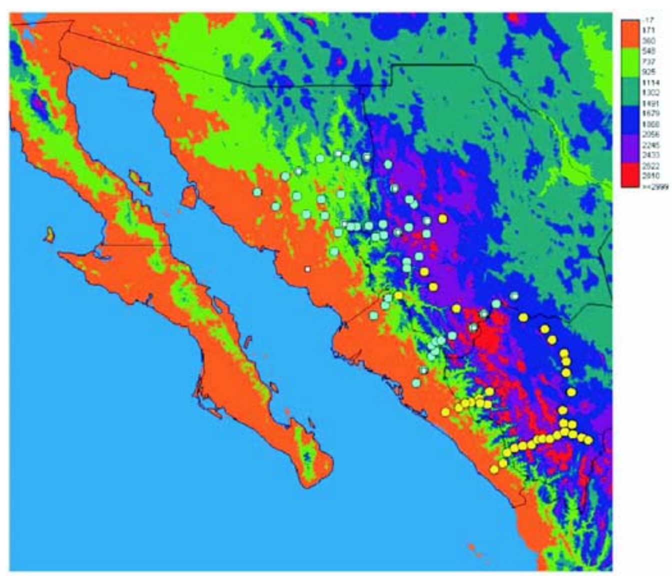



*a) Time series of surface air temperature anomalies from the various CMIP global coupled climate models for a 1% per year compound increase of $CO_2$, where $CO_2$ reaches twice its present day concentration in the atmosphere around year 70.*

*b) Same as a), except for precipitation (mm/day). After Covey et al., 2003. See article on page 8.*

## PACS-GAPP RAIN-GAUGE NETWORK WILL INCREASE UNDERSTANDING OF THE DIURNAL CYCLE OF CONVECTION
(See pages 1 and 6)

*Location of gauges installed thus far in the Tier 1 region of NAME that lies around the Gulf of California. The three subfigures show the time-average diurnal cycle of hourly-total precipitation for wet days for gauges in three elevation bands, less than 500 m, 500-1500 m, and over 1500 m.*

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