Global Energy and Water Cycle Experiment

GEWEX NEWS

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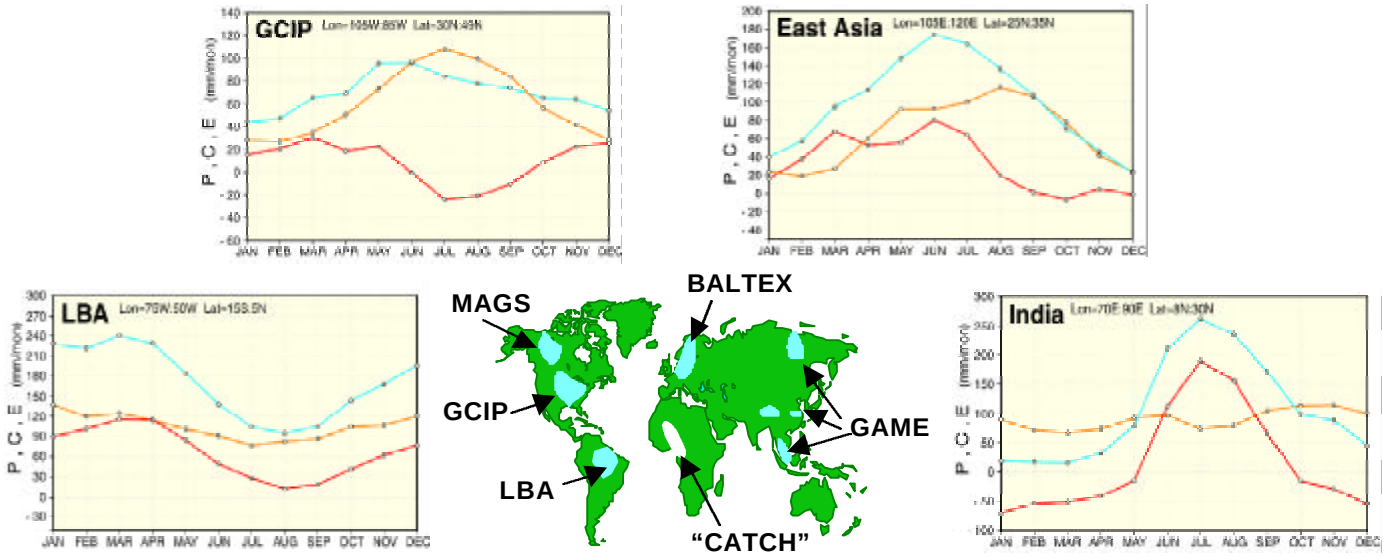
World Climate Research Programme–WCRP

GEWEX Regions: Focus of Water Balance Feedback Studies



Seasonal cycles of monthly mean precipitation – P (blue), convergence – C (red), and evapotranspiration – E (green) for GEWEX regions help illustrate water balance and feedback processes. *See Yasunari et al. on page 7.*

NOTICE

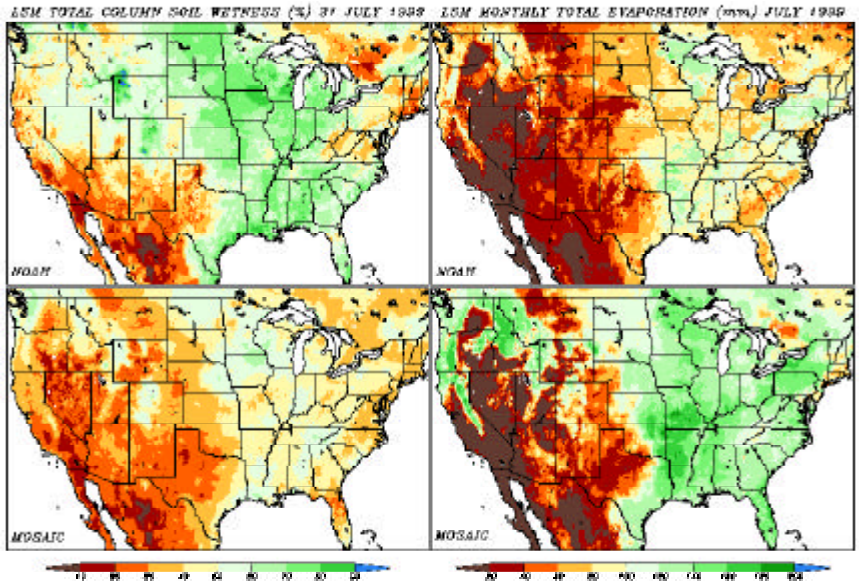
New Web site location:

www.gewex.com

WHAT'S NEW

- ***CATCH to have important role within GHP***
- ***GHP working group to link with water resources agencies***
- ***AGU Conference highlights GVaP***

New GCIP Land Data Assimilation System (LDAS) Results From Collaborative Effort



Driven by observed precipitation and insolation, the new LDAS column soil wetness and evaporation data highlight the drought signature in the northeast United States using NOAH and MOSAIC land surface models. *See page 3.*

COMMENTARY

NEW COMPLEMENTARY HYDROLOGY INITIATIVES

Soroosh Sorooshian, Chairman
GEWEX Scientific Steering Group

During the September 1999 meeting of the GEWEX Hydrometeorology Panel (GHP) in Hamburg, Germany, several new initiatives were discussed. First, a Water and Energy Balance Study (WEBS) is to be undertaken to focus on the process of closing the water and energy balance budgets over the Continental-Scale Experiments (CSE). This is particularly important as we move towards the implementation of Phase II, an exploitation of new satellites and models, and Phase III, the application of GEWEX results to climate prediction. It was the consensus of the GHP that such an important study be carried out in order to determine, after many years of observations, modeling, and analysis, if significant gaps in our ability to close the cycles still exist. This evaluation will, in turn, be helpful in deciding to what extent our observational gaps will or should be satisfied by remote-sensing observations, to what extent new in situ observations should be initiated, and to what extent the gaps would be filled satisfactorily by models.

Furthermore, the Hamburg meeting proposed the establishment, within GHP, of a subworking group to develop some concrete strategies towards linking with the water resources management communities. This aspect is essential with respect to GEWEX satisfying its primary objective, namely "to develop the ability to predict the variations of global and regional hydrologic processes and water resources and their response to environmental change." It is my personal opinion that this is an extremely important role for WCRP to fulfill, particularly the GEWEX program. The rationale for this is based on the fact that, irrespective of which continent and which country is used as an example, the relevance of our science to critical water management issues is always a major concern to the decision-making process. Perhaps this is the main reason for recent calls by scientists and organizations for some future initiatives. For example, Entekhabi et al. (in the October issue of the *Bulletin of the American Meteorological Society*) presented an agenda for land-surface hydrology research and a call for the 2nd International Hydrologic Decade. By the time this newsletter goes to print, the workshop on HELP (Hydrology, Environment, Life, and Policy) will have taken place in Tucson, Arizona. HELP's primary objective is "providing the scientific basis for improved land and water management through a global network of experimental basins." This initiative is intended to complement and build upon the activities of other hydrology and water-related programs of UNESCO, WMO, and IGBP. Thus, it is important that GEWEX's future activities and objectives be clarified as early as possible in order to avoid potential duplications and/or major gaps, as we embark on discussions and the coordination with both international and national agencies.

I was asked not too long ago by a colleague about my personal feelings with regard to the recent calls for these new initiatives, particularly the two mentioned above. My honest answer is that I have mixed feelings. On the one hand, it is great to see so much interest from several directions being channeled towards these hydrologic and water resources issues. On the other hand, however, we may run the risk, if we're not careful, of causing some unnecessary confusion, particularly in the view of funding agencies, of the program to which they should be directing their limited resources. It is clear that some of the key scientific questions posed in the article by Entekhabi et al., for example, are already among the specific objectives of such ongoing programs as GEWEX and IGBP-BAHC. Hence, it is critical that, as a relatively small community, we work together to ensure that the future of our observational, research, and implementation activities be well coordinated.

The upcoming GEWEX Science Steering Group (SSG) Meeting in late January/early February in Hawaii will place needed emphasis on these issues, and I welcome your comments and input towards this end.

Contents

GCIP LAND DATA ASSIMILATION SYSTEM (LDAS) PROJECT NOW UNDERWAY

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Traditional coupled land-atmosphere 4-D data assimilation systems (4DDA) often yield significant errors and drift in a) soil moisture and temperature and b) surface energy and water fluxes, owing to substantial biases in precipitation, surface radiation and air temperature in the attendant surface forcing fields. The GCIP regional PILPS-2c experiment (Lohmann et al., 1998) and the ISLSCP Global Soil Wetness Project (Dirmeyer et al., 1999) demonstrated the viability of executing physically based, distributed, uncoupled, land-surface models over large spatial domains, provided that moderately dense observations of precipitation were available. **Hence, as a land-surface alternative to coupled 4DDA, we have undertaken the development and execution of an uncoupled Land Data Assimilation System (LDAS)** — a real-time, hourly, distributed, uncoupled, land-surface simulation system for the U.S. domain at 0.125 degree resolution. **This LDAS is using three physically based, land-surface models (LSM) running in tandem on a common grid and driven by common surface forcing anchored by model-independent, observation-based precipitation and solar insolation fields**. Also, a common streamflow routing model is applied to each LSM's gridded runoff. The LSMs are (1) MOSAIC (Koster and Suarez, 1996), (2) VIC-3L (Liang et al., 1996), and (3) Eta, now called "NOAH" (Mitchell et al., 2000).

The goals of the LDAS project are to (1) improve LSM physics by sharing algorithms, methods, and insights against a backdrop of joint intercomparison and validation, (2) identify causes of and reduce extent of the spread in surface water fluxes and surface water storage typically seen in LSM intercomparisons, (3) reduce the uncertainty in land-surface water budget estimates, (4) utilize several new real-time GCIP-sponsored forcing and validation products, (5) compare uncoupled LDAS with traditional coupled 4DDA, (6) support water resource application (water supply and agriculture), and (7) provide land-surface initial conditions (e.g. soil moisture and snowpack) for both (a) predictability studies of the role of sea *vs*. land lower boundary conditions on seasonal forecasts and (b) real-time weather and climate model predictions on several time scales (days, weeks, seasons). Early on, our focus will be goals 1–4, and later in 5, we will pursue LDAS assimilation of satellite-derived land-surface fields, such as skin temperature, soil moisture, snowpack, and vegetation state.

The defining components of this LDAS project are (1) year-round realtime execution on a fully national domain, (2) use of several LSMs executing in parallel, and (3) high resolution surface forcing (hourly at 0.125 degree) on a national scale utilizing exciting new GCIP-sponsored products. The development, quality control, production and archive of the surface forcing fields in real time is a substantial undertaking by NCEP/EMC. **Clearly, the emerging archive of LDAS surface forcing in this project will become an important database in its own right, as many other LSM modeling groups are likely to apply our LDAS forcing fields for their own retrospective and real-time LSM modeling initiatives**. Therefore, we take a fair amount of space here to describe these fields and their sources.

The hourly LDAS forcing files include two types of fields, namely fundamental forcing fields (eight):

— total precipitation (gauge-only, with radar timing)
— downward solar radiation (GOES satellite based)
— downward longwave radiation (EDAS)
— 2-m air temperature (EDAS)
— 2-m specific humidity (EDAS)
— 10-m U wind component (EDAS)
— 10-m V wind component (EDAS)
— surface pressure (EDAS)

and ancillary fields (eight):

— GOES downward PAR
— GOES diffuse downward solar
— GOES skin temperature
— EDAS downward solar radiation
— EDAS total precipitation
— EDAS convective precipitation
— EDAS CAPE
— "Stage IV" WSR-88D/gauge precipitation

The three hallmark, model independent, surface forcing fields in the above are: (1) the 0.25-degree gauge-only daily precipitation analysis of Higgins (1999, private communication) using around 5–6 thousand daily reports of precipitation, (2) the GCIP-sponsored GOES satellite retrieval of hourly 0.50 degree surface solar insolation (including photosynthetically active radiation (PAR) and diffuse) by NESDIS/ORA using the retrieval algorithm of Pinker et al. (1999), and (3) the GCIP-sponsored hourly, 4-km, national "Stage IV" WSR-88D-dominated rainfall analysis of Baldwin and Mitchell (1997).

The hourly insolation and daily precipitation are interpolated to the LDAS grid. Finally, the hourly Stage IV precipitation analysis is used only to derive hourly temporal weights on the LDAS grid. These weights are used solely to partition the daily gauge precipitation into hourly amounts. LDAS forcing fields are available via anonymous ftp from ***ftp.ncep.noaa.gov at /pub/gcp/ldas/noahoutput*** or viewable at the central LDAS site of ***http://ldas.gsfc.nasa.gov***.

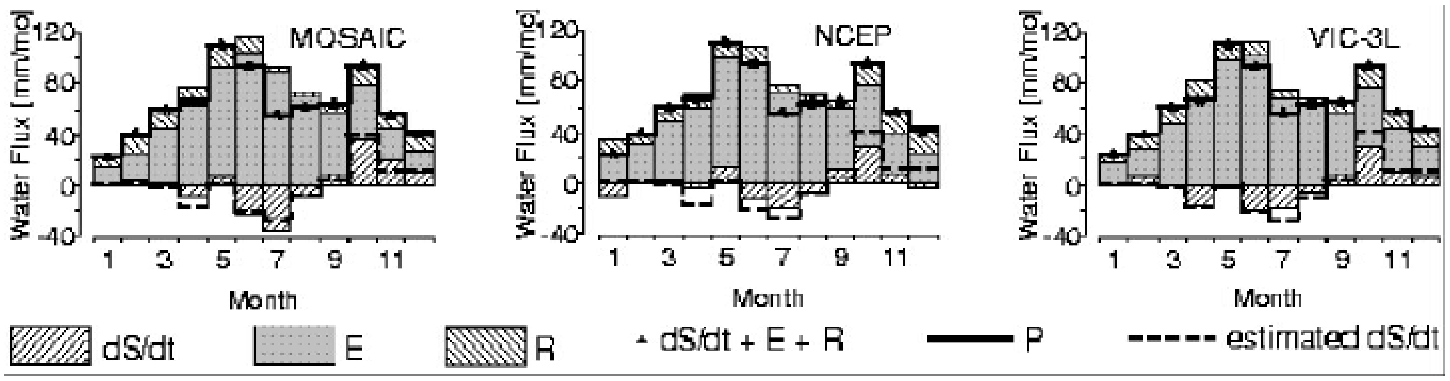
Aside from the four GOES-based products and gauge-based and Stage IV precipitation data, the remaining ten fields above are taken from the 3-hourly, 40-km, NCEP atmospheric EDAS analyses, which are temporally and spatially interpolated to hourly on the LDAS grid. EDAS denotes NCEP's Eta-based 4-D Data Assimilation System, which is NCEP's mainline regional coupled 4DDA system (Rogers et al., 1996) that has supplied extensive 4DDA output to the GCIP 4DDA archive at NCAR for over four years. (For extensive information on Eta/EDAS fields, products, and archives for GCIP, see ***http://www.emc.ncep.noaa.gov/mmb/gcip.html***.) The EDAS is a continuously cycled, Eta-model-based, regional 4DDA system, employing a series of 3-hourly forecast/analysis cycles that utilize 3-D variational analysis to depict the current state of the atmosphere using many observational data sources.

A last step in the interpolation of EDAS surface fields to the LDAS grid is a "terrain adjustment" using a standard lapse rate to adjust the 2-m air temperature to account for the terrain-height differences between the EDAS and finer resolution LDAS grid. Keeping relative humidity fixed, the specific humidity, downward longwave radiation, and surface pressure are adjusted to reflect the temperature adjustment.

The vegetation canopy submodels of some LSMs require PAR and diffuse radiation. Typically these are crudely estimated from total downward solar radiation, but in reality they are strongly dependent on cloud cover. A strong point of the GOES solar radiation retrievals is the realistic cloud cover signatures therein. Similarly, the subgrid runoff treatment in some LSMs requires an estimate of the *percentage* of precipitation that is convective. The EDAS-derived convective and total precipitation and convective available potential energy (CAPE) support estimates of these percentages. Finally, several of the ancillary fields in the LDAS forcing files were included to facilitate important forcing and LSM validation and intercomparison studies including: (1) gauge-only *vs.* Stage IV radar-dominated precipitation, (2) GOES-derived *vs*. empirical PAR estimations, and (3) GOES-derived *vs*. LSM-simulated skin temperature. The GCIP-sponsored GOES skin temperature product is retrieved hourly via the so-called "split-window" algorithm utilizing cloud-free brightness temperatures in the 11 and 12 μm window channels of the GOES imager.

Assembling and constructing a database of unified and self consistent high resolution land-surface characteristics on the common LDAS grid was a central step of this project. NASA/GSFC used high resolution source data sets (typically 1 km) to derive (1) terrain height, (2) land/water mask, (3) dominant and subdominant vegetation types, and (4) companion vegetation parameter sets. Similarly, the National Weather Service Office of Hydrology used high resolution soils databases to derive soil characteristics (such as texture) and companion soil parameters. The above vegetation and soils fields, plus more details and examples of LDAS objectives, spatial domain and configuration, surface forcing and interactive comparisons of LDAS LSM outputs, may be viewed at the primary LDAS web site, built and supported by NASA/GSFC at ***http://ldas.gsfc.nasa.gov***. As time goes on, it is the intent of the participating LSM principals to use in common as many of these surface characteristics and parameter sets as possible, but in many cases that requires changing and validating LSM physics, which is nontrivial. Hence in the present early phase, the three parallel LSMs are only imposing common sharing of horizontal grid, land/water mask, terrain height, and surface forcing.

From the start of the LDAS collaboration in early summer 1998, it took about one year to spin up the computing resources, databases, forcing fields, streamflow routing, supporting web sites, real-time data links, and surface characteristics. Unbroken real-time LDAS forcing and archive began on



Mean monthly water balances (1980–1986) over the Arkansas-Red River Basin from the three Land Surface Models identified in the first paragraph of this report (from Figure 13 of Lohmann et al., 1998).

16 April 1999. The parallel LSMs execute and cycle forward from that start time, using time-steps of the order of 15 minutes and 3–4 soil layers, and they provide hourly output of land states (e.g. soil moisture/temperature, snowpack), water and energy fluxes, and other diagnostic quantities. All LDAS surface forcings (and soon LSM outputs) are archived in the WMO gridded binary ("GRIB") format standard.

For a first LDAS result, we consider the end of July 1999 (following 3.5 months of cycling), which included the eastern seaboard drought episode (that began to wane in August and dissipated in September owing to tropical storm rainfall). We also choose July because mid-summer is notable for a significant positive precipitation bias in EDAS in the states bordering the Gulf of Mexico (compare LDAS observed and EDAS total July precipitation depicted in left two plots on the back cover). Thus July vividly highlights the LDAS advantages of observed precipitation forcing. (Aside: the cited EDAS bias is dramatically less in the follow-on Eta 6–48 hour free forecast — it is amplified in the EDAS because of a 0–3 hour "spin-down" of Eta convective precipitation after each observation update in the EDAS. It is common for regional/global 4DDA precipitation biases to be larger than corresponding model free forecast biases, owing to the 4DDA "spin-down" response to observation ingest.)

First we focus on 31 July 1999 NOAH and MOSAIC LDAS, which follows 107 days of cycling, including the 30 days of observed July total precipitation depicted at top left of the back page. The leftmost plots on the first page compare the end-of-July total column soil wetness (fraction between wilting point and saturation) of NOAH (top) and MOSAIC (bottom). We see that the NOAH soil moisture is consistently wetter. The companion rightmost plots compare the NOAH and MOSAIC July total surface evaporation. Here we see that MOSAIC has evaporated more water, consistent with its drier soil wetness in the leftmost plots.

This result is consistent with MOSAIC and NOAH monthly and annual water budget results found in the 1980–1986 retrospective PILPS-2c study of Lohmann et al. (1998). The figure above taken from Figure 13 of the latter study, shows that during the summer months, especially June and July, MOSAIC has a notably larger magnitude of monthly evaporation and soil moisture loss (hence drier soil wetness fraction) than either NOAH or VIC. The MOSAIC evaporation here in LDAS is likely further magnified owing to the fact that both the NOAH and MOSAIC LSMs were "cold started" from EDAS relative soil wetness in mid-April 1999. Hence after only 3.5 months of "spin-up," the MOSAIC LSM could still be spinning down to its preferred drier absolute state. More meaningful intercomparisons will be possible after a full annual cycle of LDAS parallel LSM cycling.

It is noteworthy that the July 1999 drought signature in the United States northeastern and mid-Atlantic states is clearly evident as an extensive region of dry soil in both the NOAH and MOSAIC leftmost plots on the first page. At first glance this signature

seems more vivid in NOAH, but only because the given color scale blurs the true spatial variability in MOSAIC owing to its smaller total range of soil wetness.

In the near future, we will undertake 3-way LSM validation of surface fluxes and soil moisture against such surface observing networks as the OK Mesonet, ARM/CART, Illinois State Water Survey, and flux sites of NOAA's Air Resources Lab (e.g. see T. Meyers, GEWEX News, February 1998). Additionally, we will extensively employ the GOES-derived skin temperatures as a new, truly continental-scale validation tool. Finally, we will begin streamflow simulation and validation.

We turn now to NOAH LDAS versus coupled EDAS comparisons on the back page. While the EDAS July precipitation *pattern is* broadly similar to the observed (leftmost plots), the EDAS precipitation magnitudes have serious positive biases in the Gulf of Mexico states, U.S. southwest monsoon region, and northeast United States. Also, the EDAS has displaced the observed Wisconsin precipitation maximum to the southwest in western Iowa. These EDAS biases and displacements are clearly reflected in the EDAS soil wetness, when compared to the LDAS soil wetness (rightmost plots). Finally, we see that the EDAS positive precipitation bias in the northeast has greatly reduced the area of the northeast drought signature, compared to the well-defined drought signature in the NOAH LDAS (rightmost plots).

To remove any advantage afforded the NOAH LSM by "cold starting" from the EDAS, we will eventually cold start all LSMs anew with mid-April 1999 initial states unique to each LSM, by sufficiently spinning up each LSM through various retrospective forcing means. In a related matter, to properly assess LDAS soil moisture anomalies, each LSM group needs to derive a soil moisture climatology for its LSM. Hence, all LDAS LSM partners are pursuing significant retrospective runs, to complement the real-time LDAS presented here. Also, in the future, as resources permit, we will add other LSMs and partners to our project (e.g., TOPLATS, Common Land Model, and a traditional calibrated lumped model, such as the Sacramento Model). Finally, we will compare LDAS results to EDAS reruns wherein we assimilate the hourly Stage IV precipitation analyses directly into the EDAS (Lin et al., 1999) to eliminate EDAS precipitation biases.

(*Note: This document is available with full-size figures at http://www.emc.ncep.noaa.gov/mmb/gcp/pubs/GEWEXNEWS_NOV99.html*)

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NEW GEWEX APPOINTMENTS

- The GEWEX Hydrometeorology Panel (GHP) new chairman is **Dr. Carlos Nobre**, nobre@cptec-inpe.br.
- The Baltic Sea Experiment (BALTEX) new secretary is **Dr. Jens-Meywerk**, Jens.Meywerk@gkss.de.

SEASONAL AND INTER-ANNUAL VARIABILITIES OF ATMOSPHERIC WATER BALANCE IN GEWEX STUDY REGIONS

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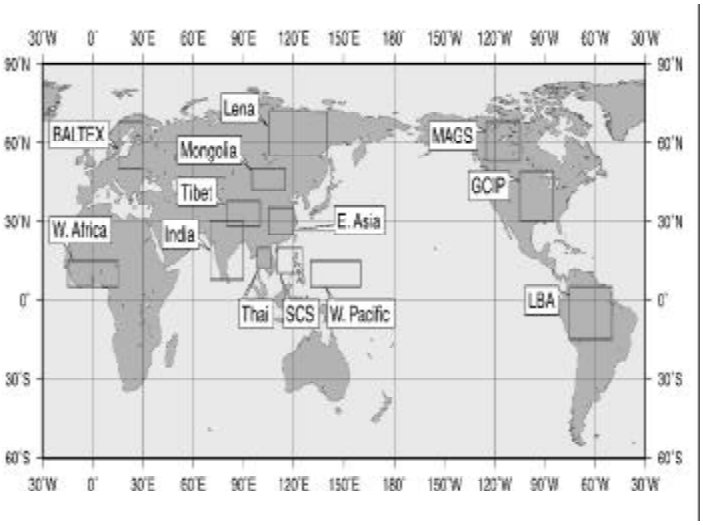
Precipitation depends upon moisture transport and convergence, and evapotranspiration from the surface. Seasonal and interannual variability of precipitation (P) is determined by the characteristic of water vapor transport and convergence (C) and evapotranspiration (E), and their mutual dependencies. The C in the atmosphere is basically controlled by large-scale atmospheric circulation, whereas E is strongly controlled by surface conditions (e.g., SST, soil moisture and vegetation) and near-surface atmospheric conditions. The interactions among P, C, and E should differ from region to region, and season to season, depending upon climatological and geographical conditions.

Yasunari et al. (1999) surveyed seasonal and interannual variabilities of P, C and E over the Continental-Scale Experiment (CSE) regions under the GEWEX Hydrometeorology Panel (GHP). They sought to understand seasonal and regional dependencies of P variability on C and E, and their relative importance, which involves specific feedbacks of each region. The 15 year (1979–1993) reanalysis data from the European Centre for Medium Range Weather Forecasts (ECMWF), i.e., ERA data, are a basic data source for computing atmospheric water vapor convergence (C) for some regions of the world. The vertically integrated atmospheric water vapor convergence is computed from the surface to 10 hPa for each specified region based on four-times-daily relative humidity, temperature, geopotential height and wind (u, v) field for the 15 years (Yatagai and Yasunari, 1998), and is converted to monthly mean data. P is adopted from CMAP analysis (Xie and Arkin, 1997), which is a merged product of in situ rain-gauge data and satellite-derived rainfall data (from OLR and SSM/I). E is evaluated as a residual of the atmospheric column mean water vapor budget, i.e., $E = P - C$, where the local time change of the column water vapor content (precipitable water) is neglected.



Selected Regions for Atmospheric Water Balance

Before we examined the nature of the interannual variablility, we compared the 15-year mean atmospheric water balance. The regions selected (see figure above) are eight GAME-related subregions—the Indian subcontinent (IND), the Tibetan Plateau (TBT), Thailand (TH), the South China Sea (SCS), the tropical Western Pacific (WP), the Yantze-Huaihe river basin in China (HBX), Mongolia (MN), and Lena River Basin in Siberia (LE); the Amazon River Basin of LBA (LBA); the Mississippi River Basin of GCIP (GCP); the Mackenzie River Basin of MAGS (MGS); the BALTEX region (BTX); and the forthcoming CATCH-related Western African monsoon region. On the first page, the seasonal changes of P, C and E in the regions of IND, HBX, GCP and LBA are shown. In most of the regions, the seasonal cycle of P corresponds well to that of C. In the HBX region, however, E maintains a nearly comparable order to C through the season cycle.

Since we focus on the contribution of C and E to P, particularly, in the rainy (or monsoon) season, these three parameters of the peak rainy month for each region are plotted (circles) in the P-C-E diagram in the figure on the back page. As is clearly shown, P of the ocean regions is around 400 mm/month, with C contributing more than 50% of the total amount. Over all the land-based regions in the tropics, P ranges from 200 to 300 mm/month, but the C-E ratio differs considerably from region to region. In the India and Tibet regions, C accounts for most of P (more than 70%), but in the West African monsoon region, E accounts for about 60% of P. In the Amazon and Thailand regions, C and E account for nearly equal amounts. In the HBX

region, where the Meiyu (or Baiu) frontal rain dominates in the peak rainfall month (June or July), E contributes most of P (about 150 mm/month). It is noteworthy that in all the high latitude regions (MN, LE, GCP, MGS and BTX), P is nearly balanced by E, though the amount of P (about 50 mm/month) is very small compared to the other subtropical and tropical regions.

Using the 15-year monthly values of P, C and E, we computed the linear correlations between P, and C and E for each region. In most of the regions, P and C exhibit a high linear correlation at a significance level exceeding 1% significant level, but the correlation between P and E is weaker even when the mean contribution of E to P is large. In addition, some regional characteristic tendencies of the gradient (C *vs.* E) of the linear regression were noticed, suggesting different physical processes or feedbacks involved in the P-C-E relations. In the same P-C-E diagram (back page), the interannual ranges of the three components are drawn for each region, based on the linear regressions between P and C. Interestingly, the C vs. E gradients for the tropical warm water pool region (SCS, WP) are positive, implying that some positive feedback processes, e.g., wind-evaporation feedback (Emanuel, 1986), dominated between C and E over these regions, presumably based upon the strong association between wind speed and low-level convergence.

In most of the land-based regions, C vs. E gradients are negative, implying negative feedbacks, e.g., cloudiness-insolation-surface flux feedback between C and E. The range (variance) of C is considerably large in the tropical Asian monsoon region (THI), but relatively small in the Amazon and West Africa. In the East Asian monsoon region (HBX), the C-E gradient is nearly flat or slightly positive, suggesting some positive or "thermostat" feedback controlling the nearly constant E. The water-fed rice paddy fields that dominate this region may be responsible for this feedback. In the high latitude regions, although P varies year to year depending upon C, it is most likely that E primarily determines the basic mean value of P for each region. This suggests that, in the high latitudes, soil moisture, vegetation, surface energy, and water balance may be more important in precipitation climatology than in the lower latitudes.

This study has preliminarily unraveled the relative contribution of C and E on P for various regions, specifically focusing on the major CSE regions. This approach will offer an effective tool for evaluating and modeling the variability of water cycling processes in the climate system. Independent estimations of P, C and E as a closure of the water cycle are being coordinated in each region of the Earth as part of GHP activity.

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GEWEX PROJECTS MOVE FORWARD

International Satellite Land-Surface Climatology Program

The ISLSCP Initiative II 10-year data set kick-off meeting was held at NASA/GSFC on October 27–29. Over 50 scientists participated in reviewing potential data sets and defining the parameters for the 1x1 degree co-registered land-surface, near-land surface and atmospheric data sets to be made available on-line and on CD-ROM in 2002. As of September 30th, 8,921 Initiative I CD-ROMs have been distributed. An ISLSCP Science Panel meeting is being planned in conjunction with the BAHC Science Steering Committee in April 2000 in Caracus, Venezuela.

Baltic Sea Experiment

The Baltic Sea Experiment (BALTEX) enhanced observational period, named BRIDGE, started October 1999, and may be extended in several components to the end of the year 2002 to provide a complete overlap with the Coordinated Enhanced Observational Period (CEOP) of the other GEWEX Continental Scale Experiments.

INTERACTION BETWEEN SNOW COVER AND SPRING FLOODS

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Institute of Geography
Russian Academy of Sciences

The Institute of Geography of the Russian Academy of Sciences conducts research on snow cover and its link between the climate and hydrological processes. This article's objective is to report on a study about the interconnection of the regional pattern of spring river flooding, snow cover, precipitation and air temperature. The data used included snow cover and river runoff (Krenke et al., 1997), air temperature and precipitation (Apassova and Grusa, 1982), and hydrometeorological observations (see figure). Catchments with natural flow were chosen to be no more than 20000 square kilometers for spring flood analysis. The snow constituent (contribution of snow cover to spring floods) of the spring flooding was determined using the method of B.I. Kudelin (1968).

Research results (see figure) for mountainous regions such as the Kamchatka Peninsula have shown that positive snow cover storage anomalies are reflected in spring flood anomalies. The higher terrain regions studied are also regions where winter cyclones often occur. For regions where anticyclone (low temperature) regimes prevail, such as the Lena basins, the snow constituent (of less than 70 mm) of spring floods is found to be not well correlated.

In this study the highest figures of the snow constituent reached are reported for the rivers of the northern region of the Far East, the Kamchatka Peninsula and also for the Yenisei Basin. The change of the snow constituent (130–200 mm) correlates with the change in snow storage and precipitation.

The study has revealed that there are regions with stable positive and negative anomalies of the snow constituent and the spring flood of the rivers; their situation being determined by the snow storage features dependent upon the climate and orographic peculiarities of the region.

The stability of the anomalies is determined by the relation of the interannual variability of the parameters (temperature, precipitation, snow cover and river runoff) considered. In summary, the snow cover performs the function to link the climate with hydrological processes.

Acknowledgment: The research has been held with the support of the Russian Fund of Basic Researches (Grant 99-05-65572).

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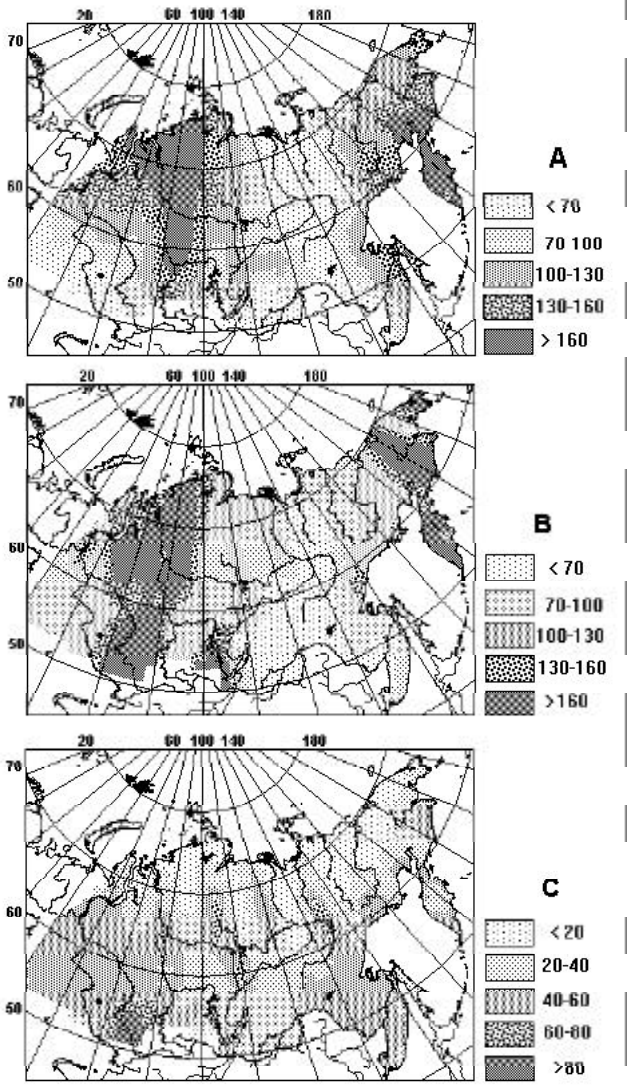


Temporal variability of the mean annual parameters, (A) Snow constituent of spring river flood (mm), (B) snow water equivalent, April (mm), (C) precipitation, April (mm).

WORKSHOP/MEETING SUMMARIES

GCSS WORKSHOP

14–16 July 1999
Reading, UK
Brian Ryan
CSIRO Atmospheric Research

The fifth workshop of the GCSS Working Group 3 was hosted by the UK Meteorological Office (UKMO) and held at the UKMO College. The results of the workshop were as follows:

- The revision of the Cold Front Research Program (CFRP) methodology paper for the Monthly Weather Review was set, September 1999. The goal to complete a draft of a synthesis paper was set for late December 1999 using the CFRP, Canadian Atlantic Storms Program II (CASP II) and Beaufort and Arctic Storms Experiment (BASE) cases.

- A study of the north-east and north-west Atlantic Basins aimed at documenting the cloud property variations in a frontal regime as the first step in developing a methodology to generalize the Cloud Resolving Model (CRM) studies of specific field experiments. The workshop established the effectiveness of the large-scale survey technique in identifying model problems in generating mid-level cloud and in providing the setting for the Fronts and Atlantic Storm-Track Experiment (FASTEX) case studies.

- The design of a GCSS study based on FASTEX IOP 16 moved forward. The initial simulations for FASTEX study were presented and October 1999 was set for the design of simulations to be sent to the UKMO. A report on the intercomparison is planned for presentation to the GCSS Science Panel Meeting in December.

- The problem of the representation of clouds in a GCM forced by subgrid scale orography was re-examined with focus recommended to be on upslope clouds and stably stratified gravity wave generated clouds. An important problem identified was to test if the concepts used in gravity wave drag schemes were valid for parameterizing the generation of subgrid scale orographic clouds in GCMs.

The workshop showed that the working group had gained knowledge from the previous CFRP, CASP II and BASE studies and this experience was applied to the new FASTEX case. The working group recognized FASTEX as a unique data set that gives the rare opportunity to validate the Limited Area Model (LAM) and Cloud Resolving Model (CRM) FASTEX case studies against an ISCCP/GCM ensemble study. The workshop developed a proposal to use the complete set of FASTEX cases to achieve this objective.

GEWEX ACTIVE IN THE XXII GENERAL ASSEMBLY OF IUGG

19–30 July 1999
Birmingham, UK

At the 1999 International Union of Geology and Geophysics (IUGG-99), there were identified GEWEX focused Symposia and Workshops plus many other GEWEX principal investigator presentations throughout the two week agenda.

The joint inaugural Cloud System, Radiation and Parameterization Symposia demonstrated a growing research area. It attracted over 100 papers from the research and operational communities on cloud systems, radiation and cloud fields, and parameterization. Approaches included numerical, dynamical and statistical modeling, as well as the analyses of field experiment and satellite data. Results are pertinent to GEWEX's Cloud System Study (GCSS) and GEWEX Radiation Panel (GRP).

A session on multiscale cloud systems focused on how convection interacts with the larger scales and dynamically couples the physical processes, a fundamental element of the atmospheric water cycle. Papers on the statistics of cloud fields, surface-based remote sensing, and various measurements over the tropical Pacific were presented. Especially significant for GRP, a 40-day explicit simulation of TOGA COARE cloud systems realized top-of-atmosphere, tropospheric, and surface energy budgets accurate to within observational error (10 W/m^2).

Evaluation of multiscale simulations requires observations of clouds, radiation and precipitation spanning an unprecedented dynamic range. Space-borne instruments on TRMM and the nascent CLOUDSAT and PICASSO will be crucial.

Papers on radiative transfer and cloud morphology stressed the importance of macroscale spatial structure in three-dimensional radiative transfer code development. Those on microphysical processes stressed convectively generated cirrus and the role of small ice particles, and called for improved parameterizations of ice physics.

Advances were reported on boundary layer clouds and precipitating cloud systems. The horizontal extent of stratocumulus (usually underestimated) was more realistic in dynamically and physically advanced global models. Progress was demonstrated in modeling and parameterizing stratocumulus entrainment, and in coupling shallow convection with surface exchange. Cloud overlap, a key issue in cloud radiation interaction, was quantified using Numerical Weather Prediction models and satellite measurements. Cloud-resolving models and theory have improved parameterizations of deep convection, and contributed new ideas in convective momentum transport and convective triggering.

The Water Fluxes and Water Availability Over Continental Regions Symposium focused on our understanding of water fluxes and water availability over continental regions and provided an opportunity for physical scientists to interact with water resource users. The Symposium was divided into three major themes: the role of land surface processes on the water cycle, the role of atmospheric processes on the water cycle, and large-scale water budget studies and applications. In total, 32 presentations were made at the Symposium. This included presentations from each of the continental-scale experiments of GEWEX as well as from many other investigations. It is clear that a substantial amount of progress is being made in the use and development of remote sensing and other observational tools for determining components of the water cycle, that diagnostic studies are improving our understanding of water cycling, and that models for simulating the water cycle are improving. Nevertheless, we have a long way to go before gaining acceptable confidence in our capabilities. Users certainly want and need such improvements.

The two-day Workshop on Regionalization of Parameters of Hydrological and Atmospheric Land Surface Models, was held 27–28 July 1999. It was attended by more than 100 participants. The first day of the workshop was used to identify regional parameter estimation issues in the morning and to review case studies in the afternoon. The second day was used for focused discussion on three topics followed by a planning session for the international Model Parameter Estimation Experiment (MOPEX) which is a project operating under the oversight of several international activities including the IAS/WMO committee on GEWEX. Discussion topics on the second day included additional insights from the poster session, promising research approaches and data requirements and strategies.

The MOPEX meeting reviewed the current status of the project. MOPEX data sets for river basins in the Arkansas and Red River Basins in the United States were made available via the internet a year before the workshop and several participants used some of these data in their presentations. Data sets for more than 100 additional locations in the Mississippi River Basin and in Australia and New Zealand are expected to be available in the next few months. Expansion of the database to other locations worldwide was strongly supported by the meeting and several participants offered to help to make this happen.

It was agreed a special workshop on regional parameter estimation should be held during the next two years, and an organizing committee for the workshop was formed. In addition, it was agreed there should be a session on regional parameter estimation at the IAHS meeting in Maastricht. Also, the MOPEX steering group will convene again at that time.

Also in Birmingham, an evening workshop was held focused on the outcome of the Project for Intercomparison of Land-surface Parameterization Schemes (PILPS) Strategy Forum held in Hawaii, February 1999. Thirty to forty participated in discussions distributed within three themes. Discussions under the theme of building on strengths included the forest modelers benefiting from PILPS, the Arctic System Study linkage regarding frozen catchment studies and the development of an improved snow gauge to address the overestimate of snowfall in forests. The discussion on coupled PILPS experiments included the ongoing progress of linking PILPs with atmospheric global circulation, tropical cyclone, and regional climate modelers. The discussions on further developing PILPS strengths included the preliminary results from the Multi-Criteria Prototype Intercomparison of Land-surface Parameterization Schemes (McPILPS) that differentiate and quantify errors in land surface schemes by category; namely instrumental, model and parameter.

(Contributors include: M. Moncrieff, R. Stewart, J. Schaake and A. Henderson-Sellers).

SECOND WCRP INTERNATIONAL CONFERENCE ON REANALYSES

23–27 August 1999
Reading, Berkshire, UK
Roger Newson, WCRP

The Second WCRP International Conference on Reanalyses was held at Wokefield Park, Reading Berkshire, UK, with participants from 30 countries. The importance of the reanalyses as for investigation of many aspects of climate, particularly interannual variability, and for model validation and predictability studies, had already been recognized and endorsed at the First WCRP International Conference on Reanalyses held in Silver Spring, Maryland, USA, October 1997.

At the present conference, too, the value of reanalyses for a wide variety of scientific studies and applications was shown including diagnostics of atmospheric behavior and interactions with the ocean, land and cryosphere. The importance of improving data quality, from filling in gaps in the observational database, to continuing efforts to obtain past data sets, was also a common theme. Another repeated comment was that reanalysis products should be made available on CD-ROMs and on the internet.

Present reanalyses products were considered by participants to be a good basis for studying interannual variability. However, reanalyses for detection of long-term trends present difficulties due to the observing system changes over the period of the reanalyses and the unknown biases in observing systems that are not eliminated by reanalysis. For trend analyses, there is a need to identify and document all the changing characteristics of data. This would require a major investment of resources whose availability is not apparent. Continuing use and application of existing reanalysis products will likely emerge for many purposes. In addition, new reanalyses will be conducted and form the basis for new studies. The three main centers are briefly:

- NCEP: a second reanalysis for a limited period 1979-1998 is being undertaken using an updated forecast model and data assimilation, improved diagnostic outputs, and including corrections for the known problems in the first NCEP/NCAR reanalysis. This will also provide the bridge to a much more advanced next generation reanalysis planned for about 2003 or later.

- ECMWF: a 40-year reanalysis project (ERA-40) is in preparation for the period 1958-present. A much wider selection of data sources will be used in the ERA-40 reanalyses that will likely reflect the radical changes in the observing system since 1958.

- NASA/DAO: Major upgrades have been made to the data assimilation system (the Goddard Earth Observing System, GEOS) employed in NASA's first reanalysis, with a physical-space three dimensional variational analysis algorithm having been included and a revised scheme with the capability of assimilating TRMM and SSM/I precipitation observations, as well as GPS data.

A report of the Second International Conference on Reanalyses is in preparation and will be available from WCRP.

GEWEX HYDROMETEOROLOGY PANEL (GHP) MEETING

13–19 September 1999
Geesthacht, Germany
Rick Lawford

The fifth annual meeting of the GEWEX Hydrometeorology Panel featured a workshop dealing with water and energy budgets and a second workshop on the GEWEX Coordinated Enhanced Observing Period (CEOP). In addition a number of issues critical to the future directions of the GHP were discussed. Representatives from each of the Continental-scale Experiments, GRDC, CATCH, ISLSCP, and GPCP participated along with Prof. Hartmut Grassl, the Director of the World Climate Research Programme, Prof. Soroosh Sorooshian, the Chair of the GEWEX SSG, and representatives from other groups such as the International Association for Hydrological Sciences, the IGPO and WCRP.

The Water and Energy Budget Workshop was the first session to assess the ability of CSEs to close the Water and Energy Budgets for their regional areas of interest. Each of the CSEs has made progress in this area although the presentations reflected a diversity of approaches in evaluating the degree to which the respective budgets have been closed. Some groups have been successful in combining new data and state-of-the-art data assimilation systems to improve their ability to close budgets. In other areas, ratios such as runoff coefficients and precipitation efficiency are used to assess the way in which the water cycle functions and their current ability to close budgets.

The analyses are also a basis for basin comparisons. The Mackenzie Basin has relatively lower precipitation efficiency than lower latitude basins. More than 50% of the moisture originating over the Amazon tends to be recycled in the Amazon while 60%–70% of the Mississippi River Basin rain arises from moisture originating over land areas outside the Basin, as well as from the Gulf of Mexico and the Pacific Ocean. Studies in the Mississippi showed that individual models tend to close water budgets in different ways resulting in large differences. New data show that ground thaw rates and vegetation processes have a major effect on water fluxes in the northern parts of the Lena Basin. In other areas, such as the Tibetan Plateau, problems have been experienced in closing the water budget at individual flux tower sites. Studies over the Baltic Sea reflect large seasonal differences in the relative contributions of land and sea surfaces to the P-E term. A number of the CSEs have used reanalysis fields to assess basin budgets, and while these products provide data and consistency that have never been available before, their accuracy and resolution need to be improved to close water budgets.

The GHP has consolidated its work on process studies and mesoscale modeling. Relative to the criteria for CSEs established at the outset of the GHP, all CSEs are fully functional for most criteria although the newer ones are still implementing some functions. Nested modeling appears to be a useful approach for some studies where high-resolution land-based forcing is an issue. **The CATCH project was adopted as an official affiliate GHP project (rather than a CSE) with the expectation that other basin studies might also seek the same status in the future. These smaller basins are recognized as being an important component of GHP's planned transferability studies.**

A report was given on the GEWEX/ACSYS high latitude hydrologic model intercomparison project that has recently been launched. Steve Williams, chair of the Data Working Group, reported on their progress and plans (including a CD-ROM) for the next year. GCIP has also been supporting a project that provides land-based parameter data sets for the CSEs. The need for more dialogue with the water resources community was discussed and steps are being taken to establish a GHP working group to address this problem. The GPCP presentation emphasized its interest in obtaining validation data sets from the CSEs. GHP will be responsive to this need. Dr.

Fifth GHP Meeting Participants at Geesthacht
Photograph courtesy of GKSS

Wolfgang Grabs announced his imminent departure from the GRDC to the WMO (Geneva) but assured the Panel that GRDC's work on behalf of GHP would continue unabated. Plans for two GHP/ BAHC soil moisture workshops were discussed and some of the problems of root zone soil moisture were described.

A workshop on the Coordinated Enhanced Observing Period (CEOP) was held to refine the maturing plans for this initiative. Each of the CSEs is committed to making contributions to CEOP during the 2001 and 2002 time frame. A special study group was established to formulate a more rigorous science rationale and strategy for model transferability studies. The requirements for reference sites were developed to guide groups wishing to participate in CEOP. A follow-up workshop will be held at the upcoming GEWEX SSG to review the next CEOP science and implementation plans.

Highlights from the CSEs and other GHP activities included upgrades to a number of observational systems. BALTEX is making extensive use of GPS water vapor information in its analysis. BALTEX research has also uncovered the important role of springs in the water balance of the Baltic Sea. CATCH has documented the rapid and consistent timing of the onset of the rainy seasons in Southwest Africa from year to year and the patchiness of the precipitation that is produced. MAGS has completed extensive documentation for the 1994/95 drought year and a special issue of *Atmosphere-Ocean* will include those findings. GCIP is completing its cold season research activities in the North Central part of the Mississippi River Basin. Process and observational studies in this area have led to a number of model improvements including the more effective incorporation

of snow and ground frost into land surface schemes in a number of NWP and climate models. LBA predictability studies have shown that the greatest skill in predicting seasonal precipitation occurs over northeastern Brazil. GAME is making good progress in remote sensing applications through the use of passive microwave data to detect parameters such as the water content of vegetation. ISLSCP is preparing for the launch of its ISLSCP Initiative II data set production activity and the potential contributions of CSEs to the required validation data sets will be discussed at an upcoming ISLSCP workshop. Several of the CSEs noted that they are in the process of submitting applications for renewed or extended funding.

At the close of the meeting, participants expressed appreciation to Prof. Ehrhard Raschke for making the excellent facilities of GKSS available for the meeting. The next chair of the GEWEX Hydrometeorology Panel is Carlos Nobre who leads the LBA project.

TOWN HALL MEETING ON GEWEX GLOBAL WATER VAPOR PROJECT (GVaP): U.S. OPPORTUNITIES

14 October 1999
Potomac, Maryland, USA

The United States National Research Council (NRC) GEWEX panel sponsored a Town Hall meeting at the American Geophysical Union's 2nd Chapman Conference on Water Vapor in the Climate System. According to John Roads, the NRC GEWEX panel chairman, the purpose of the meeting was to gather input from the water vapor research community about possible U.S. involvement in a developing international GEWEX Global Water Vapor Project (GVaP) and about a new U.S. global water cycle initiative, and to discuss the findings of the NRC's newly released report, "GVaP: U.S. Opportunities," which provided an NRC GEWEX panel analysis of the International GVaP Science and Implementation Plans.

Thomas Vonder Haar, co-author of the international GVaP Science and Implementation Plans, outlined the overall goal of GVaP, which is to understand the role of water vapor in hydrometeorological and climatic processes by quantifying its variability, radiative effects, feedbacks, and change due to human activities. Copies of the GVaP Plans can be obtained from Dr. Vonder Haar at Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado.

Richard Rosen, a member of the NRC GEWEX Panel, **reviewed the NRC report, which applauded the ultimate objectives of GVaP and recommended that they be vigorously pursued, especially the effort to gather, assess, and distribute existing water vapor data sets and products in a manner similar to other GEWEX data projects such as GPCP and ISCCP**. The GEWEX panel recommended that the project should make a special effort to: (a) coordinate data set intercalibrations and comparisons with results from validation experiments; (b) highlight upper tropospheric water vapor; (c) create new water vapor products, including a merged global water vapor product; and (d) foster broad community involvement. The report can be obtained from http://www.nap.edu/catalog/9647.html.

Ted Cress, a program manager for the Department of Energy's (DOE) Atmospheric Radiation Monitoring Program (ARM), briefly discussed the evolution of the ARM observational system, which is playing a key role in the calibration/validation of GVaP data set development. Of interest to the community is that NASA intends to launch a number of radiosondes from the ARM sites to help calibrate the EOS AM and PM remote sensing missions.

Numerous comments and suggestions from many attendees of the Town Hall meeting followed these opening remarks, and the wealth of additional information gathered at this Town Hall meeting will be used to help refine the development of GVaP. However, space permits only a few of these to be reported here.

It was noted at the meeting that GVaP would need to articulate what it will provide beyond what exists in the current set of water vapor observations, analysis, and research. It was further suggested that subdaily time scales should be included in the hierarchy of GVaP data products, because many interesting questions can only be answered with high-temporal resolution data.

Several modelers mentioned the desirability of having new water vapor data sets that would help answer questions about the relationship among changes in atmospheric forcing, radiation budgets, and water vapor-cloud interactions, including a suggestion that single column models were important research components of this effort.

Agreement with the NRC report's recommendation that the U.S. should implement the development of a reference radiosonde as part of GVaP was expressed. It was also pointed out that there is only a single radiosonde site where stratospheric launches have occurred every month for the last 30+ years. Another suggestion was that a reference radiosonde might not be optimal for making long-term, stable, reference measurements, and that the technology of choice might ultimately prove to be GPS combined with ground-based lidar and radiometers as well as a reference radiosonde.

The point was raised that DOE is the only U.S. agency to date that has made any explicit commitment to GVaP, despite the mutual advantages between GVaP and agencies such as NASA, NOAA, and NSF. Since there is currently no plan to approach the agencies and effectively advance GVaP, it was recommended an ad hoc panel be established, although it was acknowledged the NRC GEWEX Panel was expecting to fill this role.

A brief description of the Stratospheric Processes and their Role in Climate (SPARC) program was presented with emphasis on an initiative aimed at improving monitoring of water vapor in the stratosphere and the development of a water vapor climatology for the lower stratosphere and upper troposphere. The stratospheric discussion continued with a brief outline of the forthcoming SPARC Water Vapor Assessment (WAVAS), which is concerned with whether the upper tropospheric water vapor concentration is under thermodynamic or dynamic control and what determines the lower stratospheric water vapor concentration.

Also discussed was the Measurement of Ozone and Water Vapor by Airbus In-Service Aircraft (MOZAIC) program, a fully operational European program in which automatic and regular ozone and water vapor measurements are made by long-range passenger airliners flying all over the world. An aim of MOZAIC is to build a large database of these measurements to allow studies of chemical and physical processes in the atmosphere. Collaboration between MOZAIC and the aircraft-based Water Vapor Sensing System in the United States would be useful.

Reports on the 2nd Chapman Conference on Water Vapor in the Climate System are planned to appear in the *SPARC* newsletter and the AGU publication EOS.

WCRP/GEWEX MEETINGS CALENDAR

For calendar updates and listing of GEWEX reports, see the GEWEX Web site: http://www.gewex.com

21–23 November 1999—5TH MAGS WORKSHOP, Edmonton, Alberta, Canada. For information, see http://www1.tor.ec.gc.ca/GEWEX/meetings.html.

6–9 December 1999—8TH SESSION OF GEWEX CLOUD SYSTEM SCIENCE PANEL, Melbourne, Australia.

13–17 December 1999—AMERICAN GEOPHYSICAL UNION FALL MEETING, Moscone Center, San Francisco, California, USA. For information E-mail: meetinginfo@agu.org, Fax: 202-328-0566; or AGU Web Site: http://www.agu.org.

9–11 January 2000—AMERICAN METEOROLOGICAL SOCIETY ANNUAL MEETING, Long Beach, California, USA. For information E-mail: meetings@ams.org or Website: http://meteor.org.

24–25 January 2000—GCSS WORKING GROUP I MEETING, National Center for Atmospheric Research, Boulder, Colorado, USA.

27–29 January 2000—FIRST COORDINATED ENHANCED OBSERVING PERIOD (CEOP) MEETING, Honolulu, Hawaii.

31 January–4 February 2000—GEWEX 12TH SCIENTIFIC STEERING GROUP MEETING, Honolulu, Hawaii.

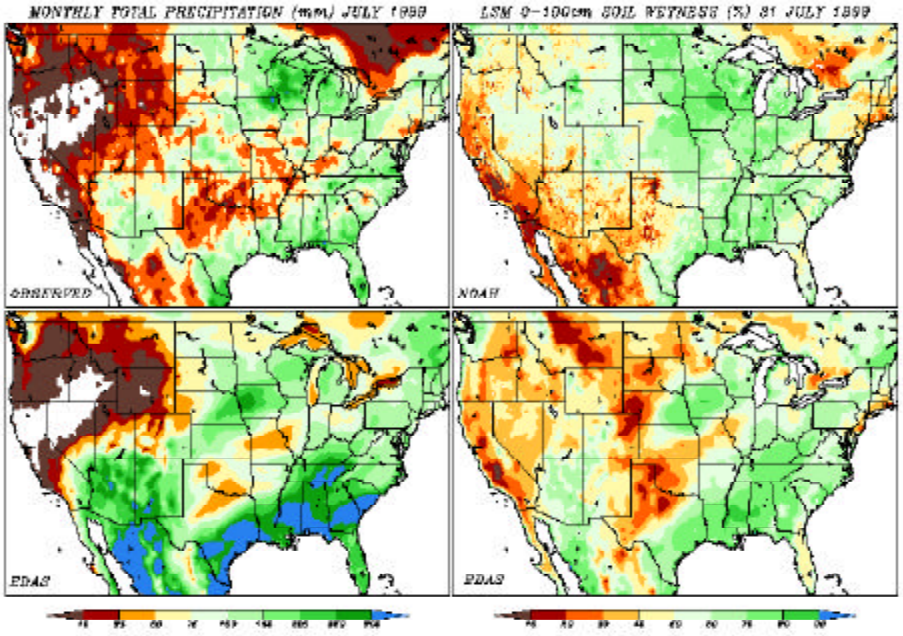
13–17 March 2000—WCRP JOINT SCIENTIFIC COMMITTEE MEETING, Tokyo, Japan.

25–29 April 2000—EUROPEAN GEOPHYSICAL SOCIETY XXV ASSEMBLY, Nice, France.

16–19 May 2000—GEWEX/BAHC INTERNATIONAL WORKSHOP ON SOIL MOISTURE MONITORING, ANALYSIS AND PREDICTION FOR HYDROMETEOROLOGICAL AND HYDROCLIMATOLOGICAL APPLICATIONS, University of Oklahoma, Norman, Oklahoma, USA.

30 May–3 June 2000—AMERICAN GEOPHYSICAL UNION SPRING MEETING, Washington, D.C., USA.

For a complete listing of GEWEX reports and documents, consult the GEWEX Web site: http://www.gewex.com



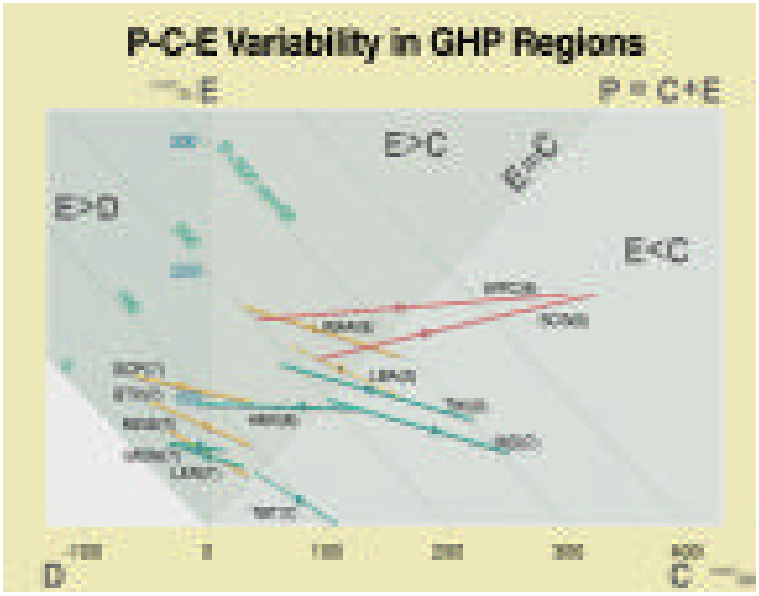
LDAS PROJECT UNDERWAY

Nine groups collaborate to derive a new Land Data Assimilation System (LDAS)—results for July 1999 are shown here (see page 3).

The top upper left is the monthly total precipitation (mm) from LDAS gauge observations, bottom left from the Eta-based 4-D Data Assimilation System (EDAS). The top upper right is a representation of end-of-month soil wetness (percent saturation) for LDAS with EDAS on the bottom.

ATMOSPHERIC WATER BALANCE OVER GEWEX CONTINENTAL-SCALE EXPERIMENT REGIONS

Seasonal and Interannual Variabilities of Precipitation (P), Convergence (C) and and Evapotranspiration (E) show differences and feedbacks (see page 7).



P-C-E diagram with interannual ranges of atmospheric water balances in six CSE regions. Fifteen-year mean values are shown by circles. Green lines indicate GAME regions; yellow lines, the other CSE regions; and red lines, the two tropical oceanic regions.

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