Global Energy and Water Cycle Experiment

GEWEX NEWS

WCRP

Vol. 4, No. 2 June 1994

World Climate Research Programme–WCRP

TRMM INSTRUMENT	MEASUREMENT	RELATED GEWEX COMPONENTS
Precipitation Radar (PR)	Three-dimensional rainfall structures and accurate rainfall measurements over land and oceans	GEWEX Continental-Scale International Project (GCIP) Global Precipitation Climatology Project (GPCP) International Satellite Cloud Climatology Project (ISCCP) International Satellite Land Surface Climatology Project (ISLSCP)
TRMM Microwave Imager (TMI)	Precipitation, water vapor, cloud properties and surface characteristics	GPCP GEWEX Water Vapor Project (GVaP) ISCCP ISLSCP GCIP
Visible Infrared Scanner (VIRS)	Ocean surface and land temperatures; moisture content of the lower level atmosphere; cloud properties	ISLSCP GCIP GVaP ISCCP
Clouds and Earth's Radiant Energy System (CERES)	Short-wave and long-wave radiation from cloud systems	Surface Radiation Budget (SRB) ISCCP GEWEX Cloud System Study (GCSS) GCIP
Lightning Imaging Sensor (LIS)	Distribution and variability of lightning over the Earth indicating the presence of convective or precipitating clouds	GCSS GCIP ISCCP

Tropical Rainfall Measuring Mission (TRMM) will provide significant new measurements to support GEWEX components. Also, new science teams have been selected and potential additions to ground truth sites identified *(see page 3).*

TRANSPORTABILITY OF GCIP RESULTS

IMPLICATIONS FOR CONTINENTAL-SCALE HYDROCLIMATOLOGICAL SIMILARITY FROM REGIONAL CLIMATE MODEL SIMULATIONS

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B.H. Braswell, Univ. of New Hampshire
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INTRODUCTION

A major component of climate dynamics involves the interaction between global climate and the hydrologic cycle at the continental scale. However, significant uncertainties exist in our understanding of the water and energy cycles over the continents. These are largely a result of imperfect observations and a lack of appropriate technology. Observations tend to be limited in their spatial coverage (e.g., clustered around more populated regions), to vary in quality (e.g., between local, state, and federal agencies), and be limited in type (e.g., evapotranspiration, groundwater, soil moisture, and atmospheric

(Continued on page 5)

WHAT'S NEW IN GEWEX

- First GCIP Data Sets Available
- New PILPS Results
- Director of WCRP Changes on 31 July 1994
- China Forms New GEWEX Committee
- ISLSCP Soil Wetness Index Meeting
- BALTEX Project Scientist Named
- New IGPO Staff Member

In This Issue

COMMENTARY

Moustafa T. Chahine, Chairman
GEWEX Science Steering Group

In July of this year, Prof. Pierre Morel will retire as Director of the World Climate Research Programme. Since 1982, Prof. Morel has brought his considerable talents to bear on the task of successfully developing the GEWEX program. Perhaps Prof. Morel's most significant accomplishment for GEWEX was that of integrating, for the first time, the talents and efforts of researchers in a variety of scientific disciplines to address the global hydrologic cycle. Disciplines as varied as atmospheric science and classical hydrology are now focused on developing connected models of energy and water transfer.

As significant as this accomplishment is, it is by no means singular. Under Prof. Morel's guidance GEWEX has moved from concept to implementation. In the near future, several climatological data sets will be distributed to the research community (some already have been released), including surface and top-of-the-atmosphere radiation, precipitation, surface runoff, cloud and land surface parameters, and soil wetness.

In all successful programs, there are many talented people willing to devote their time and energy to achieve the program's goals. However, there is usually a single individual whose vision creates the program and whose influence molds and shapes it. For GEWEX, that person is Pierre Morel.

Pierre Morel, Director of World Climate Research Programme

It has been a very rewarding personal experience to work these years with Pierre. I am pleased that he was asked formally by Dr. Charles Kennel, NASA Associate Administrator for Mission to Planet Earth, to continue to advance the goals of GEWEX by tying them more closely to the planned observational capabilities of NASA and the research areas of the U.S. Global Climate Research Program. I wish Professor Morel success in this next endeavor.

NEW APPOINTMENT FOR THE INTERNATIONAL BALTEX SECRETARIAT IN GEESTHACHT

The GKSS Research Center in Geesthacht, Germany, supported by a research contract from the Federal Government in Bonn, appointed Dr. Hans-Jorg Isemer as Project Scientist for the Baltic Sea Experiment (BALTEX). Dr. Isemer will support the present activities of Prof. Ehrhard Raschke and will be responsible for the coordination of all ongoing planning activities to implement BALTEX as a long-term multinational project. Dr. Isemer's research interests are in the field of air-sea interactions.

The International BALTEX Secretariat will act as a focal point for all scientific affairs within BALTEX and with interested research institutions of at least 10 countries within the water drainage area of the Baltic Sea and other relevant international bodies. Secretariat support will be provided by Mrs. Wiebke Jansen and further scientific assistance by part-time collaborators at the Institute of Physics at GKSS and by guest scientists from BALTEX countries who are working in this field.

Dr. Isemer can be reached by phone (+49–4152–87–1536), fax (+49–4152–87–1888), Internet (e-mail: ISEMER@GKSS.DE), or by mail (BALTEX Secretariat, GKSS, Postfach 1160, D-21494 Geesthacht, Germany).

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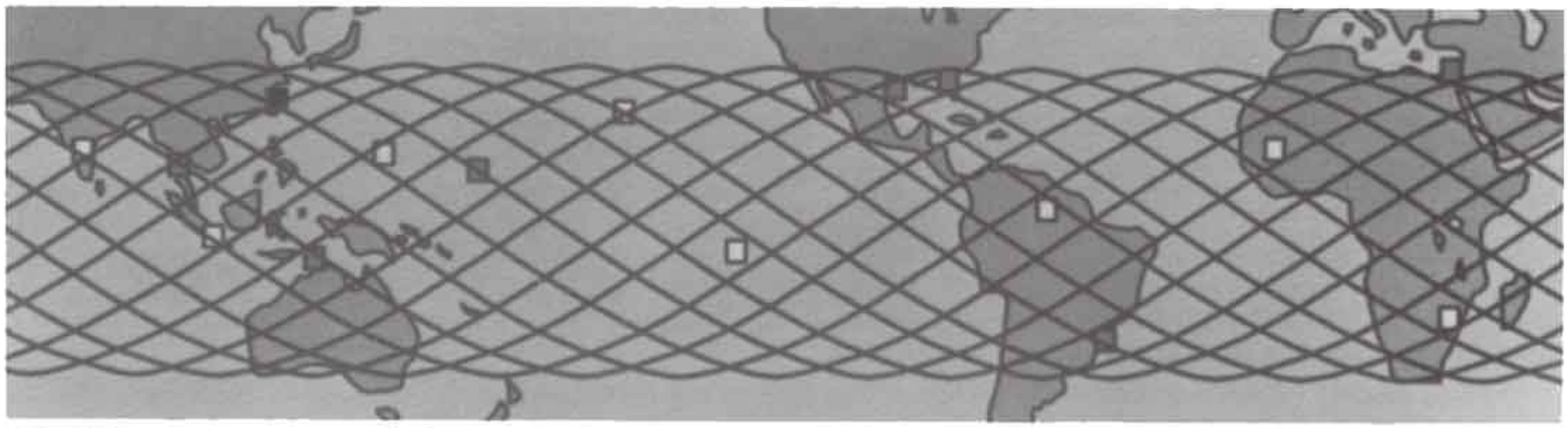

TRMM ground truth track for 35 orbits, with indications of current (solid squares) and potential (open squares) experimental sites.

TROPICAL RAINFALL MEASURING MISSION (TRMM)

John S. Theon
TRMM Program Scientist
NASA Headquarters

The Tropical Rainfall Measuring Mission (TRMM) is the first space mission dedicated to measuring precipitation, the most difficult atmospheric variable to measure and the most crucial driver of the hydrologic cycle and atmospheric dynamics. TRMM will provide a 3-yr data set of tropical rainfall measurements. Combined with cloud models, TRMM observations will provide accurate estimates of the vertical distributions of latent heating in the atmosphere. The data will be used to model and predict how the interactions between the sea, air, and land produce changes in global rainfall and climate. The table on page 1 summarizes the measurement objectives of the TRMM instruments and indicates the related GEWEX components that will derive the most benefit from the data.

TRMM is a joint project between the National Aeronautics and Space Administration (NASA) and the National Space Development Agency of Japan (NASDA). NASDA is providing the Precipitation Radar (PR), the first of its kind to fly in space, and the launch of TRMM via the H-II expendable launch vehicle from Tanegashima Space Center. NASA is providing the TRMM spacecraft, four instruments, tracking and data systems, data processing, and the integrated ground system. NASA Goddard Space Flight Center will design, build, and test the TRMM observatory. The entire 3-yr TRMM data set will be available through the NASA Earth Observing System Data and Information System (EOSDIS).

Three instruments, the PR, the TRMM Microwave Imager (TMI), and the Visible Infrared Scanner (VIRS), make up the rainfall measurement package. Two additional instruments, the Clouds and Earth's Radiant Energy System (CERES) and the Lightning Imaging Sensor (LIS) will provide data on the Earth's radiation and lightning events. The TRMM observations can be used to correct or calibrate both past and future rainfall estimates from satellites in geostationary orbit so that global rainfall estimates from satellites can be obtained for time periods shorter than 1 month. For this reason TRMM is regarded as a *flying rain gauge*.

The TRMM investigators will obtain radiative cloud properties, as well as their precipitation characteristics in the same location at the same time. These measurements will enable TRMM to provide the global rainfall data set, and they will also help to resolve the controversy about whether and under what conditions clouds act to warm or cool the planet and how differently precipitating clouds modulate radiation, compared to those clouds that do not precipitate.

The TRMM lightning measurements may help classify precipitating clouds. The LIS data will also be used with TMI, PR, and VIRS data to investigate the correlation of the global incidence of lightning with rainfall and other storm properties. TRMM will thus initiate the important effort to relate cloud precipitation, radiation, and electrification.

In order to validate TRMM data, an extensive network of ground-based precipitation observation sites located world wide will be instrumented with radars and rain gauges to provide data allowing for correlation with spaceborne measurements. The figure above shows the TRMM validation sites. Sites that are currently providing radar and rain gauge data are

indicated by solid squares and potential locations for additional sites are identified by open squares. The TRMM 16-orbit (one day) ground track (35° inclination) is included for location reference.

The TRMM investigators are developing algorithms from radar data sets obtained at Melbourne and Darwin, Australia. An algorithm intercomparison workshop is planned for November in Seattle, Washington, to select the best of these algorithms for validating TRMM data. The algorithms are expected to provide greatly improved methods for estimating rain from radar measurements.

Status of TRMM

A new TRMM science team has been selected by NASA from proposals received in response to a joint NASA-NASDA research announcement (NRA) released in 1993. These scientists and those selected for the NASDA science team will coordinate the development of TRMM algorithms.

Many passive microwave algorithms have been developed and tested by the NASA TRMM science team organized under the 1990 NRA. Preliminary global monthly rainfall maps have been produced using passive microwave alone and in combination with the Global Precipitation Index. Several algorithms, such as rain type classification and rainfall profiling, have been proposed and tested with the data obtained from a series of joint U.S.–Japan airborne radar experiments. The data sets from the Tropical Ocean Global Atmosphere–Coupled Ocean Atmosphere Response Experiment (TOGA-COARE), which had seven instrumented aircraft flying in the vicinity of radar-equipped ships, should be particularly valuable.

In conclusion, the TRMM program is well underway in preparation for an August 1997 launch. NASA recently convened a panel to conduct an independent assessment of TRMM, and the program received high marks.

Launch: August 1997
Design Life: 3 yr
Orbit: 370-km altitude

Scientists throughout the world are looking forward to receiving TRMM data, which will provide the basis for enormous improvements in weather forecasting and climate models. The Mission will also provide beneficial data to many countries about droughts, floods, and water resources.

FIRST OF THE GCIP INITIAL DATASETS (GIDS-1) AVAILABLE THROUGH INTERNET

Steve Williams
University Cooperation for Atmospheric Research (UCAR)
Office of Field Project Support (OFPS)

John Leese
GCIP Office

The GEWEX Continental-Scale International Project (GCIP) is compiling several initial data sets (GIDS) prior to the start of the enhanced observing period beginning in 1995. GIDS-1 is now available for on-line access through a distributed data management system in the UCAR Office of Field Project Support. The purpose of compiling GIDS-1 was to create a prototype data set that will be similar to the future data sets collected during the enhanced observing period. GIDS-1 will provide researchers with access to both routine operational as well as high-resolution augmented research network data from the west-central Mississippi River basin for the 3-month period of 1 February through 30 April 1992.

The recent Stormscale Operational and Research Meteorology-Fronts Experiment Systems Test (STORM-FEST) conducted in the central United States from 1 February to 15 March 1992, as shown in Fig. 1, was selected as a "nucleus" to build GIDS-1. This experiment provided a data set that (1) included atmospheric and hydrological data obtained in the center of the GCIP study area; (2) occurred during a hydrologically important time of year (i.e., late winter or early spring); (3) included routine operational data as well as special research observing platforms; and (4) provided similar quality controlled surface and upper air composite data sets as required by GCIP.

Figure 1. Coverage area for GIDS-1 data set (solid line); Mississippi River basin (dashed line).

Operational data for an additional 6-week period was added to the nucleus data set to (1) increase the collection period of GIDS-1 into the spring snowmelt runoff in the Mississippi River basin; and(2) providea direct comparison of the initial 6-week period of intensive observations to the subsequent 6-week period of routine observations for evaluating future GCIP EOP observational enhancements. Data sets of hydrological and land surface characteristics were included as available and as needed byresearchers.

Data for the GIDS-1 will be primarily distributed in two ways: (1) through on-line access, providing electronic transfer and off-line media; and (2) a subset of the most critical data on Compact Disk (CD-ROM). GIDS-1 data is being published on CD-ROM and expected to be available by early summer 1994. A companion CD-ROM being produced by the U.S. Geological Survey (USGS) contains geographic information for the GCIP effort in the Mississippi River basin.

The GIDS-1 on-line data access is available through the distributed data management system known as CODIAC (COoperative Distributed Interactive Atmospheric Catalog). CODIAC is an on-line, interactive, menu-driven data management system that consists of a data catalog, data inventories, station descriptions, and an order entry system. On-line data can be immediately delivered over Internet or can be sent via a variety of removable media such as Exabyte, Digital Audio, or nine-track tape. Off-line data can only be sent via removable media at this time. The system can also deliver data in any number of requested standard formats such as WMO GRIB and BUFR, NetCDF, CMF, EBUFR, and ASCII. Further details about GIDS-1 and the various modules within CODIAC are provided in the GIDS-1 Tactical Data Management Plan.

The CODIAC system may be accessed by two methods: Internet network and dial-up phone modems. However, access via Internet is preferred, as it provides the only means to support the X-terminal emulation required to utilize the full capabilities of the system (i.e., image browse). To gain Internet access to CODIAC, use: TELNET 128.117.90.53; USER: storm; PASSWORD: research. To obtain the current toll-free telephone number contact the NCAR Consultant on Duty at (303) 497–1278. Once logged on to the NCAR Host Connection Account, follow the Internet access instructions above. Please feel free to contact the OFPS at (303) 497–8987 or Internet e-mail: codiac@ncar.ucar.edu for further information or help.

Transportability of GCIP Results

(Continued from page 1)

water balance components are traditionally neglected). The selection of the Mississippi River basin to be a key component of the GEWEX Continental-Scale International Project (GCIP) was based in large part on the availability of data, so that fundamental questions regarding the continental-scale hydrological cycle could be addressed and findings transferred to other continental regions. How does the hydrological cycle vary in time and space within the Continental United States? What are the dominant process controls on this time-space variability? How do these controls change with geographic location and increasing spatial scale? The answers to these questions will help further our understanding of the role of land-atmosphere interaction in the driving climate. From a modeling perspective, they will help to improve land surface parameterizations for hydrometeorological and hydroclimatological studies.

The purpose of this brief note is to report on recent research into process controls on the time-space variability of the U.S. continental-scale hydrological cycle (see Famiglietti et al., 1994, for a more detailed description). This work is part of a longer-term effort directed at understanding the underlying mechanisms that explain how and why the water and energy balance varies within the Continental United States. This first and most basic level of analysis seeks to understand the relative roles of soil moisture, precipitation, evapotranspiration, runoff, and snow depth in controlling the overall water balance over the continent. We introduce the concept of hydroclimatological similarity in which subcontinental-scale regions are classified as having similar hydroclimatology if their process controls are similar. In the remainder of this report we discuss our methodology, results, and implications of these results with regards to the GCIP effort and coupled hydrological-atmospheric modeling.

METHODS

To better understand the dominant modes of variability in the continental-scale hydrological cycle we performed a principal component analysis (PCA) on the surface hydrology output of the National Center for Atmospheric Research (NCAR) nested regional climate model (Giorgi et al., 1993*a*, 1993*b*). The regional climate model is a limited area meteorological model nested in either general circulation model

(GCM) output or large-scale observations. The output of interest in this work came from a recent multiyear simulation of the regional climate model nested in the NCAR community climate model (CCM) output over the Continental United States. A previous analysis of this output (Giorgi et al., 1994) has shown that the regional climate model reproduces the basic seasonal and spatial hydrological characteristics of the major U.S. drainage basins.

The principal component analysis was conducted on the 60-km model output fields of surface soil moisture content (upper 10 cm), total soil moisture content (upper 1–2 m), precipitation, evapotranspiration, runoff, and snow depth. The analysis was performed on both seasonal and annual time scales. The PCA defines a new coordinate system for the six-dimensional water balance space in which the new axes (eigenvectors), when ordered, explain the maximum amount possible of remaining variance in the data. The eigenvectors are defined as linear combinations of the weighted water balance variables, so that interpretation of the weights (i.e., their relative magnitudes and signs) indicates which variable, or group of variables, dominates the mode of variability of successive principal components.

Note that our intention here was not to substitute modeled data for observations. Rather, our goal was to demonstrate a methodology for understanding process controls and spatial variability using currently available data that represent the fully-coupled land-atmosphere system. The plan is to repeat this work in more detail using high-resolution observations as GCIP products become available, and with coupled hydrological-atmospheric models, as land parameterizations develop to the point where subgrid-scale spatial variability is more realistically represented (see e.g., Famiglietti and Wood, 1994).

RESULTS

The results of the PCA are shown in histogram form in Fig. 1. Two features of this histogram are immediately evident. First, the results of the PCA are similar for seasonal and annual time scales. Second, most of the variability in the continental scale hydrologic cycle is explained by the first two or three principal components. The first eigenvector explains 53% to 58% of the variance, the second another 24% to 36%, and the third an additional 6% to 15%. In fact, the first and second principal components alone account for roughly 77% to 88% of the variability.

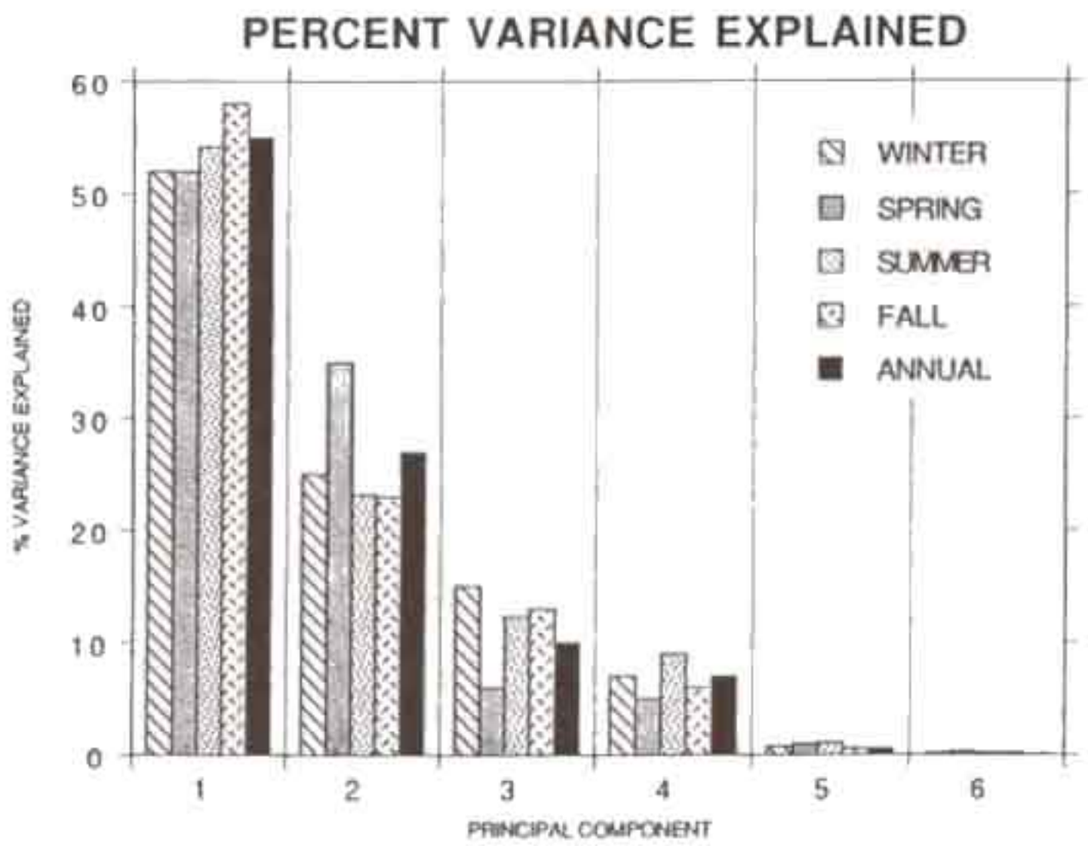

Figure 1. Percent variance in the continental-scale hydrologic cycle explained by successive eigenvectors.

Analysis of the eigenvectors indicates that the dominant mode of variability associated with the first principal component is highly correlated with the spatial pattern of seasonally and annually averaged precipitation rates. This result is not surprising in that seasonal and annual precipitation controls seasonal and annual wetness and thus evapotranspiration and runoff. However, the percent variance explained by this first eigenvector was lower than anticipated based upon intuition alone.

The analysis showed that the dominant mode of variability associated with the second principal component is highly correlated to both snow depth and soil moisture content in the upper 10-cm soil layer. Snow depth, of course, controls runoff resulting from snowmelt. Our interpretation of the correlation to soil moisture content in the upper soil layer is that this mode in variability is a reflection of the frequency of weather events that manifests itself in rapid wetting and drying at the soil surface.

Based on the results described above, we introduce the concept of hydroclimatological similarity—that two locations with the same first and second principal components have the same hydroclimatology. At present, this definition is limited to the first and second principal components because of the ability to develop physical interpretations for their dominant modes of variability, and because higher order components often represent system noise. In Fig. 2 the Continental United States is classified into regions of similar hydroclimatology based on

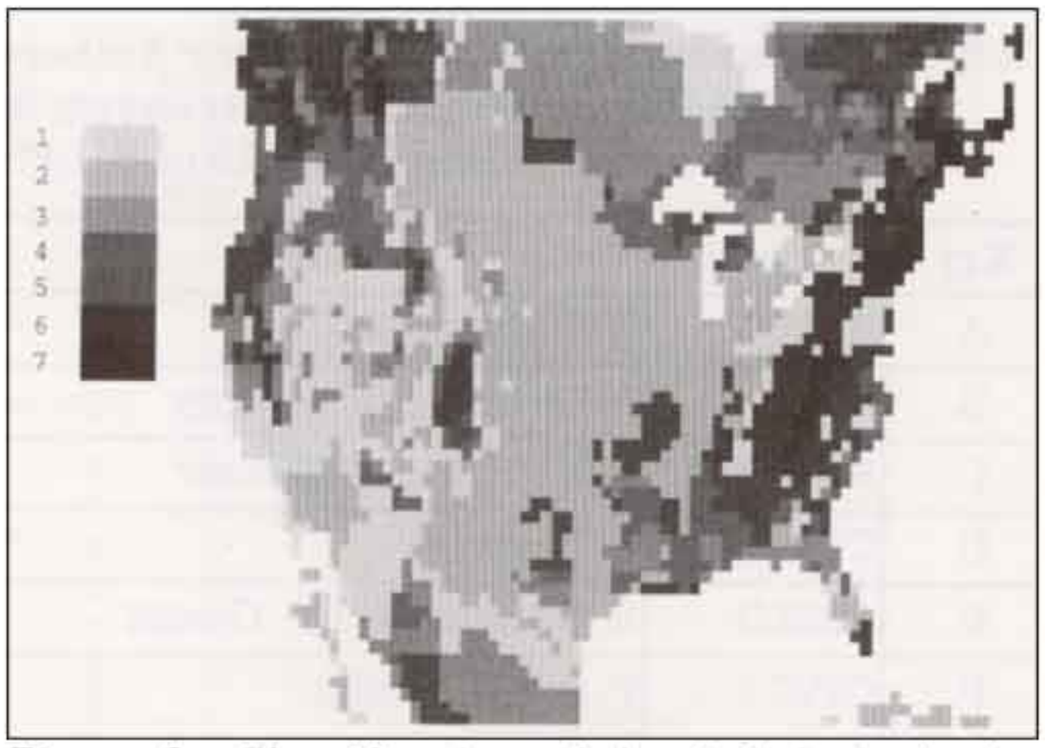

Figure 2. Classification of the U.S. hydrological cycle into seven regions of continental scale hydroclimatological similarity based on principal component analysis of regional climate model output.

clustering analysis in principal component space. Such a scheme differs from more standard climate classification schemes because it is based on dominant modes of variability rather than specific indices such as vegetation or seasonal wetness. It is interesting to note, however, that the classification scheme proposed here actually incorporates elements of those more classical schemes. For example, the first principal component is dominated by the pattern of precipitation and thus seasonal wetness and evapotranspiration, not unlike the Thornthwaite (1948) scheme. The second principal component reflects the time variability of weather events, as in air mass frequency schemes (Hidore, 1966). Finally, patterns of vegetation, which form the backbone of Köppen-type schemes (Köppen, 1931), are implicit in the system described here since they strongly influence the hydrological cycle of the regional climate model.

IMPLICATIONS

The general features of the similar regions shown in Fig. 2 are consistent with recognizable spatial patterns related to actual physiographic provinces. For example, the hydroclimatology of the Pacific Northwest differs from that of the Great Basin, the Rocky Mountains, the Mississippi River basin, the Gulf Coast basin, and the Appalachian Mountains. However, close inspection of Fig. 2 reveals some inconsistencies in the regions classified as similar, e.g., are the northern Great Plains truly similar to northern Mexico? As mentioned, the concept of hydroclimatological similarity will be developed further as both observations and models improve in the future.

At present the classification may have implications for the GCIP effort and the development of coupled hydrological-atmospheric models: First, such a classification can provide a framework for understanding how hydrology-climate interaction is the same within regions and different between regions. With regards to GCIP, it may suggest that some effort be spent understanding differences between the Mississippi River basin and other regions shown in Fig. 2, rather than concentrating entirely on the Mississippi. Second, the classification provides a framework for improving both macroscale hydrological models and regional climate models. As our understanding of the spatial variation in process controls improves, land parameterizations can be modified on a region-specific basis so that the inconsistencies described above can be minimized.

REFERENCES

Famiglietti, J.S., B.H. Braswell, and F. Giorgi, 1994: Process controls and similarity in the U.S. continental-scale hydrological cycle from EOF analysis of regional climate model simulations. Submitted to *Hydrological Processes*.

Famiglietti, J.S., and E.F. Wood, 1994: Multi-scale modeling of spatially-variable water and energy balance processes. *Water Resources Research*, in press.

Giorgi, F., M.R. Marinucci, and G.T. Bates, 1993*a*: Development of a second generation regional climate model (RegCM2) I: Boundary layer and radiative transfer processes. *Mon. Wea. Rev.*, **121**, 2794–2813.

Giorgi, F.M., R. Marinucci, and G.T. Bates, 1993*b*: Development of a second generation regional climate model (RegCM2) II: Convective processes and assimilation of lateral boundary conditions. *Mon. Wea. Rev.*, **121**, 2814–2832.

Giorgi, F., S.W. Hostetler, and C. Shields-Brodeur, 1994: Analysis of the surface hydrology in a regional climate model. *Quart. J. Roy. Met. Soc*, in press.

Hidore, J.J., 1966: An introduction to the classification of climate. *J. Geog.*, **65**, 52–57.

Köppen, W., 1931: Grundiss der klimkunde, Walter de Gruyter & Co., Berlin.

Thornthwaite, C.W., 1948: An approach toward a rational classification of climate. *Geograph. Rev.*, **38**, 55–94.

RECENT PROGRESS IN PILPS

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The Project for Intercomparison of Land Surface Parameterization Schemes (PILPS) (Henderson-Sellers and Dickinson, 1992) is an ongoing research project that is nearing completion of the first phase. In Phase 1*a* of PILPS (Pitman et al., 1993) each land surface model was linked with forcing data from a general circulation model (GCM) and results from a multiyear simulation were reported. These experiments were off line where no feedback between the surface and the atmosphere could exist. A significant amount of scatter was shown among different model results in Phase 1*a*. This could be partly explained in terms of the original instructions not being precise or not being correctly or completely followed by individual groups.

Phase 1*b* involved rerunning some of the Phase 1*a* off-line experiments with more careful and tighter prescriptions of all model parameters. Twenty-three models have joined PILPS in Phase 1*b*. For the purpose of individual model comparison, however, only 19 models, which have conducted both Phases 1*a* and 1*b*, are included in this analysis. The names of the models are listed in Table 1. We found that, in general, the amount of scatter has been reduced for many of the model output variables. As an example, the annually averaged evapotranspiration against sensible heat fluxes from both (a) Phase 1*a* and (b) Phase 1*b* participating models for grasslands and tropical forest experiments are illustrated in Fig. 1 and Fig. 2, respectively. Comparing the two figures, we see a reduction in the amount of scatter, particularly in the simulation of sensible heat. For instance, for the grassland experiment (see Fig. 1), the range of evapotranspiration for different models is from 26.0 to 65.7 (mm/month) for Phase 1*a*, but it is from 26.5 to 65.9 (mm/month) for Phase 1*b*. The range of sensible heat flux is from –22.3 to 22.5 (W m^{-2}) for Phase 1*a*, but it is from –23.6 to 8.0 (W m^{-2}) for Phase 1*b*. For the tropical forest experiment (see Fig. 2), however, the conclusion does not seem to be straightforward. The range of evapotranspiration for different models is from 91.1 to 144.6 (mm/month) for Phase 1*a*, but it is from 95.2 to 190.2 (mm/month) for Phase 1*b*. The sensible heat flux is from –27.5 to 51.0 (W m^{-2}) for Phase 1*a*, but it is from –45.3 to 34.2 (W m^{-2}) for Phase 1*b*.

TABLE 1. Names of the Models and Their Authors Who Have Conducted Experiments in Both Phase 1*a* and Phase 1*b* of PILPS

Key	Model	Author
A	BATS	R.E. Dickinson
B	BEST	A.J. Pitman, J.G. Cogley
C	BUCKET	A. Robock, A. Schlosser
D	CLASS	D. Versegy
E	CSIRO	E. Kowalczyk, J.R. Garratt
F	GISS	F. Abramopoulos, C. Rosenzweig
G	ISBA	J. Noilhan, J.-F. Mahfouf
I	LEAF	R. Avissar, R. Pielke
J	LSX	S. Thompson, G. Bonan
K	GFDL	P.C.D. Milly
M	MIT	D. Entekhabi, R. Scott
N	MOSAIC	R. Koster, M. Suarez
O	NMC-MRF	K. Mitchell, H. Pan
P	CAPS	L. Mahrt, M. Frech, M. Ek
Q	PLACE	P. Wetzel, A. Boone
S	SECHIBA	N. de Noblet, K. Laval
T	SSIB	Y. Xue
U	UKMO	J. Lean
V	VIC	E. Wood, D. Lettenmaier, Xu Liang

It was assumed that some of the differences seen in Phase 1*a* result from differences in albedo, aerodynamic resistance, and water availability. Based on this hypothesis, a series of additional experiments were performed in Phase 1*b*. Comprehensive analysis on the Phase 1*b* result is underway and will be discussed at the PILPS Meeting to be held on 21 July 1994, as part of the GEWEX European Conference at the Royal Society Headquarters in London. A detailed report will be available at this conference.

Phase 2 of PILPS, in which comparison experiments with observation will be carried out using the data from Cabauw, Netherlands, has completed the

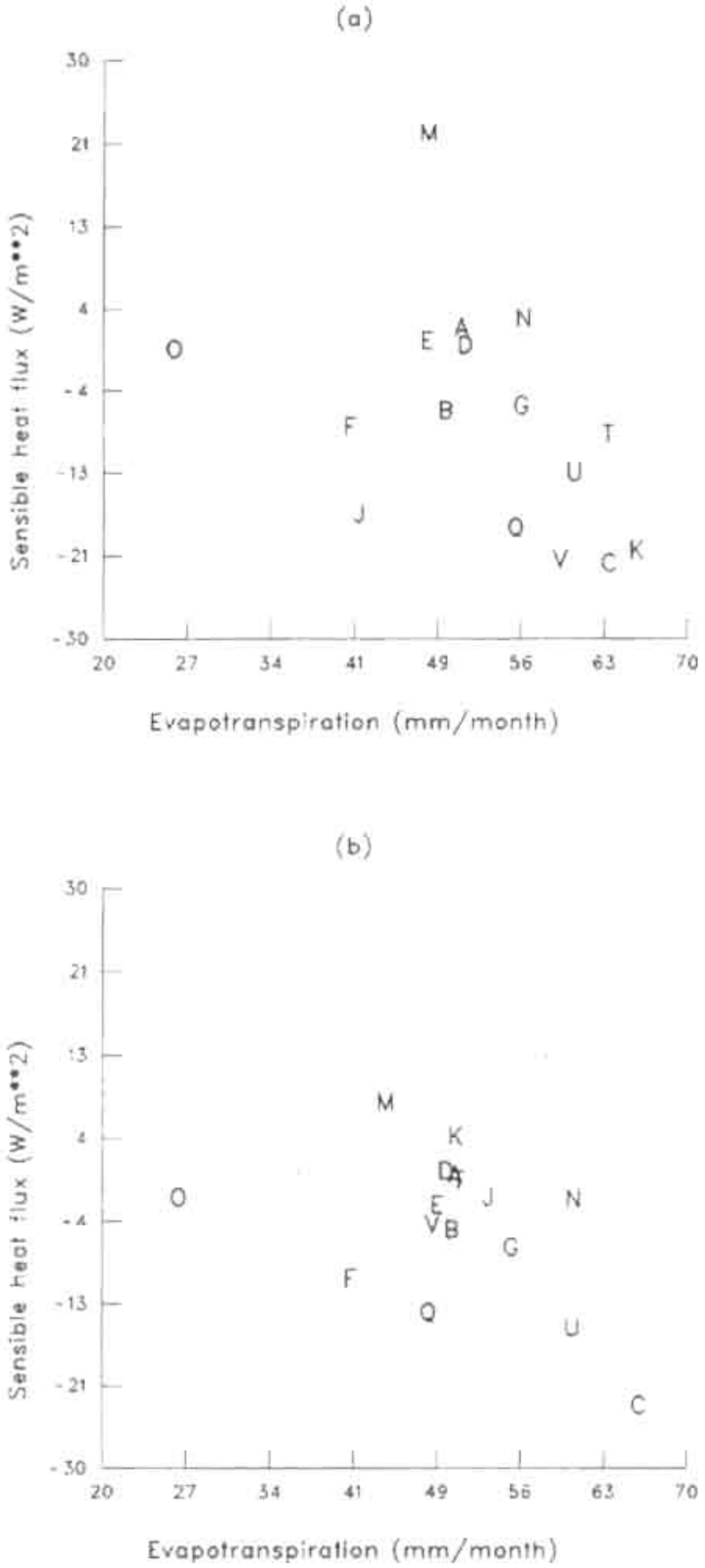

Figure 1. Annually averaged sensible heat against evapotranspiration from the models participating in (a) Phase 1a and (b) Phase 1b of PILPS for grassland experiment. See Table 1 for identification of models.

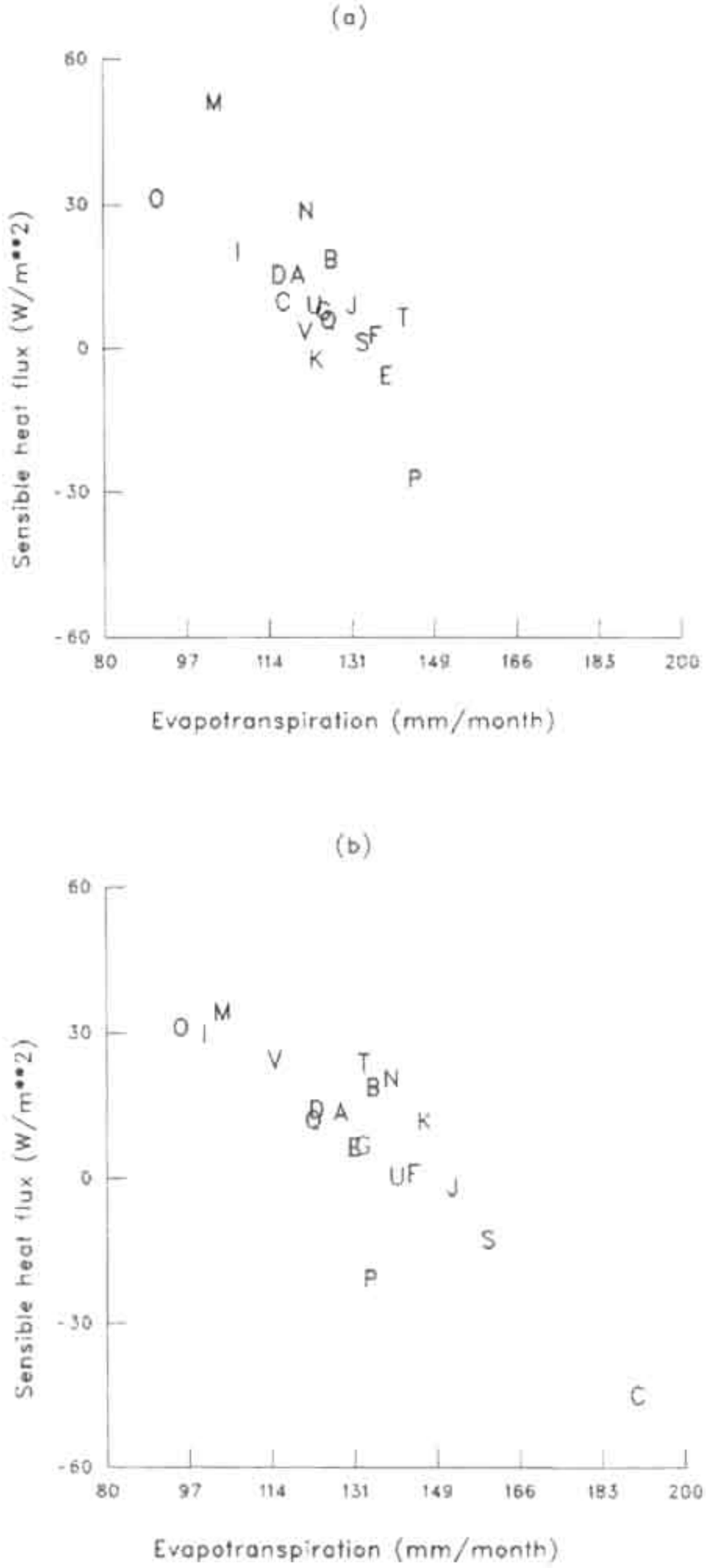

Figure 2. Same as Fig. 1 except for tropical forest experiments.

data distribution stage. If groups are interested in participating, please contact Dr. T. Chen, Climatic Impacts Centre, Macquarie University, Sydney, NSW 2109, Australia, Fax: +61 2 805-8428 or E-mail: pilps@mqmet.cic.mq.edu.au.

REFERENCES

Henderson-Sellers, A., and R.E. Dickinson, 1992: Intercomparison of land surface parameterizations launched. *EOS*, **73**, 195–196.

Pitman, A.J., A. Henderson-Sellers, F. Abramopoulous, R. Avissar, G. Bonan, A. Boone, J.G. Cogley, R.E. Dickinson, M. Ek, D. Entekhabi, J. Famiglietti, J.R. Garratt, M. Frech, A. Hahmann, R. Koster, E. Kowalczyk, K. Laval, L. Lean, T.J. Lee, D. Lettenmaier, X. Liang, J-F. Mahfauf, L. Mahrt, C. Milly, K. Mitchell, N. de Noblet, J. Noilhan, H. Pan, R. Pielke, A. Robock, C. Rosenzweig, S.W. Running, A. Scholsser, R. Scott, M. Suarez, S. Thompson, D. Verseghy, P. Wetzel, E. Wood, Y. Xue, Z-L. Yang, and L. Zhang, 1993: Results from the Off-line Control Simulation Phase of the Project for Intercomparison of Land Surface Parameterization Schemes (PILPS), GEWEX Technical Note, IGPO Pub. Series, No. 7, 47 pp.

INTERNATIONAL SATELLITE LAND SURFACE CLIMATOLOGY PROJECT (ISLSCP) SCIENTIFIC STEERING COMMITTEE (SSC) MEETING, 21–23 March 1994, Tucson, Arizona

S. Benedict
World Meteorological Organization

The interdisciplinary efforts conducted under ISLSCP address the modeling and data needed to improve understanding of the biospheric interactions with the hydrological cycle—a fundamental requirement for improving the representation of land surface processes in climate models. At the January 1994 GEWEX Scientific Steering Group meeting the ISLSCP was asked to take responsibility for producing global data sets of land surface parameters to be used by the research and modeling community. This effort provides a contribution to World Climate Research Programme (WCRP) data and information system activities and will directly support the GEWEX observational activities.

The purpose of the ISLSCP meeting in Tucson, Arizona, was to review the status of current initiatives and to discuss detailed plans for meeting the objectives of the new role of ISLSCP. Current data set preparations, land cover and land surface properties studies, and issues in near-surface meteorology, hydrology, and snow and ice data collection were also on the agenda for review. Highlights of the meeting included the following:

- A review of the ISLSCP accomplishments for 1993/94 included the collection, regridding to a common 1° x 1° format, and preparation of global land cover, hydrometeorology, radiation, and soils data sets for 1987–88 for release on CD-ROM. This initiative is on schedule for distribution in 1994.

- As a follow-on to the 1994 CD-ROM release, a 1997 CD-ROM product is being defined. The 1997 version will be based on planned reanalyses of existing products with improved algorithms and expanded processing considerations such as coregistered maps and geographical information system-type database structure.

- The ISLSCP data set products will beimportant in improving remote sensing instrumentation and model formulations.

- The use of four-dimensional data assimilation (4DDA) with land surface inputs of radiation and precipitation was highlighted as the basis for observational derivation of global data sets of land fluxes and soil moisture. The GEWEX Soil Wetness Index (GSWI) that the Scientific Steering Group (SSG) projected to be a monthly mean systematic global data set with a spacial resolution of 100 x 100 km was discussed. The Japanese Meteorological Agency has accepted a role in this activity and reported at the meeting that good progress had been made on implementing a 4DDA scheme for application to the ISLSCP GSWI. A meeting has been set for 4–6 October, 1994, to address this GSWI project.

- An update of current experiments included the status of the Boreal Ecosystem-Atmosphere Study (BOREAS) that has been designed to provide a research base for a range of related investigations into the short time scale internal dynamics of the boreal forest biome and their links to the global energy, water, and carbon cycles. An intensive field campaign is currently underway, and another is planned for September 1994.

- Action was accepted to provide a section in the ISLSCP Implementation Plan on ISLSCP coordination with the other GEWEX regional continental-scale projects (BALTEX, GAME, and MAGS). Linkage between ISLSCP and these studies with regard to boundary layer and land surface processes research will enhance efficient use of resources, such as reducing redundancy and promoting intercomparison and refinement of results to address problems of interface flux computations andcorrections.

Table 1 (page 11) summarizes GEWEX continental-scale activities and lists points of contact for each project. The point of contact for ISLSCP is Dr. Piers Sellers, NASA Goddard Space Flight Center, Greenbelt, MD, U.S.A., Telephone: 301–286–4173; Facsimile: 301–286–1757.

It was decided that the next ISLSCP Science Panel Meeting will be held in Boulder, Colorado, 31 October to 2 November 1994. The sessions on 2 November will be joint with the GCIP Science Panel Meeting of 2–4 November 1994, at the same location.

TABLE 1. GEWEX Continental-Scale Projects with Land Surface and Boundary Layer Process Study Initiatives for ISLSCP Coordination

PROJECT	SUMMARY	EOP	POINT OF CONTACT
GEWEX Continental-Scale International Project (GCIP)	Mississippi River Basin: Designed to study terrestrial-atmospheric coupling in a regional, continental scale climate context to provide validation data, diagnostic studies, and model development to improve quantitative predictions of coupled atmospheric and hydrological phenomena.	1995–2000	Dr. M. Coughlan: GCIP Project Office Manager, Dept. of Commerce, National Oceanic and Atmospheric Administration, Office of Global Programs, 1100 Wayne Avenue., Room 1225, Silver Spring, MD 20910, U.S.A., Phone: 301–427–2089; Fax: 301–427–2082
Baltic Sea Experiment (BALTEX)	Baltic Sea Region: Designed to study coupled hydrological processes between complicated terrain, sea, and ice, and the atmospheric circulation to determine the energy and water budgets of the Baltic Sea and related river basins.	1997–2001	Dr. H.-J. Isemer: International BALTEX Secretariat, GKSS Forschungszentrum Geesthacht, Institut für Physik P2, Max-Planck-Strasse, 0-21502 Geesthacht, Germany, Phone: +41 52 87 1833; Fax: +41 52 87 1888
Mackenzie GEWEX Study (MAGS)	MacKenzie River Basin: Will organize coordinated hydrological modeling and process studies of water and energy balances of the Canadian Arctic basin to assess impact of climate variability and change on Canadian water resources.	1994–1997	Dr. T. Krauss: GEWEX Secretariat, National Hydrology Research Centre, 11 Innovation Boulevard, Saskatoon, Saskatchewan, Canada, S7N 3H4, Phone: 306–975–4215; Fax: 306–975–5143
Large-Scale Atmospheric Moisture Balance of Amazonia Using Data Assimilation (LAMBADA)	Amazonia: Will augment upper air sounding and surface meteorological and hydrological networks for use with limited-area mesoscale resolving model analyses to study coupling of energy, moisture, and carbon budget with atmospheric circulation of the region. Will link with intensive eco-climatic studies (BATERISTA).	1997–1998	Dr. C. Nobre: Brazilian LAMBADA/ BATERISTA Office, Center for Weather Forecasting and Climate Research (CPTEC), National Space Research Institute (INPE). Caixa Postal 515, 12201 Sao Jose dos Campos - SP Brazil, Phone: +55 123 41 89 77, ext. 270; Fax: +55 123 41 18 76
GEWEX Asian Monsoon Experiment (GAME)	Asian Monsoon Region: Enhanced surface and upper-air observations will be used with the Japanese Meteorological Agency operational limited area model to estimate total atmospheric and land surface energy and water budgets over eastern Eurasian continent.	1998–1999	Prof T. Yasunari: Chm. Japanese GEWEX National Committee, Institute of Geoscience, University of Tsukuba, Tennodai 1-1-1, 305 Ibaraki, Japan, Phone: +81 298 53 43 99; Fax: +81 298 51 97 64

REPORT OF THE INTERNATIONAL SYMPOSIUM ON GEWEX IN ASIA 3–6 March 1994

Dr. Zhang Wenjian, Secretary-General
Chinese GEWEX Working Committee

This symposium was co-organized by Chinese Liaison Group of GEWEX and Japan National Committee for GEWEX. The objective of this symposium was to exchange scientific information on GEWEX, discuss the strategy of international cooperation related to GEWEX and the GEWEX Asian Monsoon Experiment (GAME), and coordinate GEWEX and GAME activities in Asia. More than 100 participants were present at the symposium with representatives from China, Japan, Russia, and the World Climate Research Programme–World Meteorological Organization (WCRP-WMO), representing about 18 universities and 22 research facilities. The symposium was formally opened by Prof. Zhao Bolin of Peking University.

In the opening ceremony, representatives of several key national and international organizations presented their views of GEWEX in Asia. Representatives included Mr. Zou Jingmeng, president of the WMO and administrator of China Meteorological Administration (CMA); Vice Administrator Wen Kegang of CMA; Vice Minister He Jing, representing Water Resources of China; Prof. Tetsuzo Yasunari, representing Japan National Committee of GEWEX; Mr. Sam Benedict, representing WCRP-WMO; Prof. and Vice President Chi Huisheng, representing Peking University. Representing their respective organizations all speakers voiced strong support for the GEWEX activities and their intent to take an active approach to the GEWEX-related studies, especially the regional continental-scale project GAME.

There were about 70 presentations at the symposium covering the following sessions:

(1) GEWEX strategy in Asia

(2) Process studies (radiation, cloud, and land-surface processes)

(3) Continental-scale energy and water cycle

(4) Basin-scale hydrologic balance

(5) GAME session

These presentations reflected the achievement attained so far and the present status of GEWEX studies in Asia. In addition, a special plenary session and a GAME working meeting was held, mainly for planning and discussing international cooperation between GEWEX and GAME. In order to carry out GAME, the participants agreed that a co-organizing committee for GAME would be established, consisting of representatives from GAME-related countries. Several subpanels and working groups, including meteorology, hydrology, field experiment, data assimilation and analysis, modeling, and data management and service, will be formed to prepare the work for the major research aspects. During the symposium, the formation of the Chinese GEWEX Working Committee was announced, which consists of 18 representatives from major operational and research organizations related to GEWEX throughout China.

Twelve Japanese and Chinese scientists who participated in the symposium visited the Huaihe River Basin of China soon after the symposium. They investigated the observational sites for HUBEX (a subproject of the GAME—Huaihe River Basin Experiment) and discussed cooperation for the field experiment of HUBEX with the Anhui Meteorological Bureau and the Huiahe River Commission of China.

Meeting in Reading, UK, of GEWEX Cloud System Study (GCSS), 7–10 December 1993, working group leaders preparing the GCSS Implementation Plan.

MEETING ANNOUNCEMENTS AND CALL FOR PAPERS

AGU Chapman Conference on Water Vapor in the Climate System, 25–28 October 1994, Jekyll Island, Georgia

American Geophysical Union (AGU) Chapman Conferences are topical meetings designed to permit organized and indepth exploration of specialized topics. A Chapman conference is currently being planned on water vapor in the climate system. Sessions will be organized on the following topics: the behavior of atmospheric water vapor in the climate system; the role of water vapor in climate change; the current state of the ability to measure atmospheric water vapor; the climatology of water vapor climatology, its variability and trends; and the evaluation of water vapor simulations byclimate models.

The deadline for abstracts is 28 June 1994. Registration deadline is 23 September 1994. For information about abstracts and registration, contact AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009; Telephone: 202–462–6900; Fax: 202–328–0566; E-Mail: meetinginfo@kosmos.agu.org. For scientific program information, contact William Elliott and Dian Gaffen, NOAA Air Resources Laboratory, R/E/AR, 1315 East-West Highway, Silver Spring, MD 20910, Telephone: 301–713–0295. Members of the program committee are Anthony DelGenio, Arnold Gruber, Raymond Hoff, Patrick McCormick, Eugene Rasmusson, Eberhard Ruprecht, Graeme Stephens, and Gerald Stokes.

The World Climate Research Programme (WCRP) Conference on the Dynamics of the Arctic Climate System, 7–10 November 1994, Göteborg, Sweden.

The purpose of this conference is to present contemporary understanding of the interaction of the Arctic with global change and to discuss implementation plans for the Arctic Climate System Study (ACSYS) of WCRP. The conference will have four sessions: Hydrological Cycle, Atmosphere, Sea Ice, and Ocean.

For additional information, contact Conference Chairman Peter Lemke, Alfred-Wegener-Institute, D-27515 Bremerhaven, Germany; Telephone: +49–471–4831–512; Fax: +49–471–4831–425; Telemail:

Alfred.Wegener; OMNET E-mail: plemeke@awi-bremerhaven.de.

XVIII Pacific Science Congress, 5–12 June 1995, Beijing, China

The 18th Quadrennial Congress held by the Pacific Science Association will include 6 symposia and about 20 scientific sessions, including the following topics:

Global Climate and Environment Change
Asia-Pacific Monsoon Meteorology

For abstract and registration forms, contact the XVIII Pacific Science Congress Secretariat, Laboratory of Climate Research, Institute of Atmospheric Physics, Chinese Academy of Sciences, P.O. Box 2718, Beijing, 100080, China; Telephone: (+86–1)2575034; Fax: (+86–1)2562458; E-Mail: fucb%bepc2@scs.slac.stanford.edu.

First Study Conference on BALTEX, 28 August – 1 September 1995, Visby, Sweden

The BALTEX First Study Conference is organized by the International BALTEX Steering Committee, the Swedish National Committee for the International Geosphere-Biosphere Program (IGBP), the WCRP of the Royal Swedish Academy of Sciences, and the Swedish Meteorological and Hydrological Institute (SMHI). The conference site will be in Visby on the island of Gotland.

This 5-day study conference is the first opportunity to review the present state of the art in modeling and measuring energy and water cycles in the Baltic Sea drainage basin. Contributions related to energy and water cycles in the Baltic Sea drainage area are welcome. Extended abstracts, one page long, should be submitted before 28 February 1995. Authors will be notified before 30 April 1995.

The deadline for provisional registration is 31 August 1994. Inquiries should be addressed to Anders Omstedt, SMHI, S-601 76 Norrkoping, Sweden, Telephone: 46 11 15 8000; Fax: 46 11 17 0207; Telex: 64400smhis. A conference fee will be required from the participants.

WCRP/GEWEX MEETINGS CALENDAR

31 May–3 June 1994—CLIMATIC PARAMETERS IN RADIOWAVE PROPAGATION PREDICTION, Moscow. For more information, contact Mr. M.P.M. Hall, Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 OQK, UK, Phone: +44 235 446650, Fax: +44 235 446140, E-Mail: mpmh@ib.rl.ac.uk; Dr. Y.B. Zoubarev, Radio Research Institute, NIIR, 16 Kazokova Str. Moscow 103064, Russia, Phone: +7095 267 0547, Fax: +7095 2610090.

5–8 July 1994—WORKING GROUP ON RADIATION FLUXES (WGRF) Meeting, Luneburg, Germany.

11–14 July 1994—WGDM FOR WCRP RADIATION PROJECTS, Budapest, Hungary.

18–22 July 1994—EUROPEAN CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE. For registration information on this conference, write The Executive Secretary, Royal Meteorological Society, 104 Oxford Road, Reading, Berkshire RG1 7LJ, UK.

25–29 July 1994—WESTERN PACIFIC GEOPHYSICS MEETING, Hong Kong. For more information, contact Dr. X. Gao or Prof. S. Sorooshian, Univ. of Arizona, U.S.A., Fax: 602–621–1422; Japan: Prof. T. Yasunari, Univ. of Tsukuba, Japan, Fax: 81–298–51–9764; Prof. M. Katsumi, Japan, Fax: 81–3–3402–2597.

September 1994—BALTEX IMPLEMENTATION PLANNING MEETING.

19–23 September 1994—INTERNATIONAL GCIP/MAGS WORKSHOP ON SCALING IN HYDROMETEOROLOGICAL/HYDROLOGICAL PROCESSES AND MODELS, Victoria, British Columbia, Canada.

19–23 September 1994—WMO CONFERENCE ON THE ECONOMIC BENEFITS OF METEOROLOGICAL AND HYDROLOGICAL SERVICES, Geneva, Switzerland.

28–30 September 1994—EIGHTH SESSION OF THE GPCP WGDM Offenbach, Germany.

4–6 October 1994—ISLSCP SOIL WETNESS INDEX MEETING (contact IGPO).

25–28 October 1994—WATER VAPOR CLIMATE SYSTEM, Jekyll Island, Georgia, U.S.A. See announcement on page 12.

31 October–2 November 1994—ISLSCP SCIENCE PANEL MEETING, Boulder, Colorado. Joint session with GCIP on 2 November (invitation only).

31 October–4 November 1994—ECMWF/GCSS WORKSHOP ON MODELLING, VALIDATION, AND ASSIMILATION OF CLOUDS, Reading, UK.

2-4 November 1994—FIFTH GCIP SCIENCE PANEL MEETING, Boulder, Colorado (invitation only).

7-10 November 1994—WCRP CONFERENCE ON DYNAMICS OF THE ARCTIC CLIMATE SYSTEM, Göteborg, Sweden. See announcement on page 12.

13-16 December 1994—GCSS SCIENCE PANEL MEETING, Victoria, BC, Canada.

January 1995—JOINT WCRP/IGBP WORKING GROUP ON LAND SURFACE EXPERIMENT (invitation only).

30 January -3 February 1995—GEWEX SSG, Melborne, Australia (invitation only).

12-14 April 1995—GPCP THIRD ALGORITHM INTERCOMPARISON PROGRAMME (AIP-3) WORKSHOP, Melbourne, Australia (tentative dates).

1-5 May 1995—ATMOSPHERE MODEL INTERCOMPARISON PROJECT (AMIP) CONFERENCE, Monterey, California.

5-12 June 1995—XVIII PACIFIC SCIENCE CONGRESS, Beijing, China. See announcement on page 13.

28 August-1 September 1995—FIRST STUDY CONFERENCE ON BALTEX, Visby, Sweden. See announcement on page 13.

GEWEX REPORTS/DOCUMENTS
(Available from IGPO)

UTILITY AND FEASIBILITY OF A CLOUD PROFILING RADAR. Report of the GEWEX Topical Workshop, 29 June–1 July 1993, Pasadena, California. IGPO Pub. Series No. 10.

IMPLEMENTATION PLAN FOR GEWEX CONTINENTAL-SCALE PROJECT (GCIP), VOLUME III: Strategic Plan for Data Management. March 1994, IGPO Pub. Series No. 9.

IMPLEMENTATION PLAN FOR GEWEX CONTINENTAL-SCALE PROJECT (GCIP) VOLUME II: Research. March 1994, IGPO Pub. Series No. 8.

PROJECT FOR INTERCOMPARISON OF LAND-SURFACE PARAMETERIZATION SCHEMES (PILPS); Results from Off-line Control Simulations (Phase 1A). December 1993, IGPO Pub. Series No. 7.

GCIP BROCHURE (trifold glossy).

IMPLEMENTATION PLAN FOR THE GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP), Volume I: Data Collection and Operational Model Upgrade. May 1993, IGPO Pub. Series No. 6.

A PRELIMINARY SCIENCE PLAN FOR A LARGE-SCALE BIOSPHERE-ATMOSPHERE FIELD EXPERIMENT IN AMAZON BASIN, Report on Workshop convened 18–20 June 1992 at NASA Goddard Space Flight Center, Greenbelt, Maryland, U.S.A.

INTERNATIONAL SATELLITE LAND SURFACE CLIMATOLOGY (ISLSCP) WORKSHOP REPORT, 23–26 June 1992, Columbia, Maryland, U.S.A.

PROJECT FOR INTERCOMPARISON OF LAND-SURFACE PARAMETERIZATION SCHEMES (PILPS): Report on PILPS Workshop, 24–26 June 1992, Columbia, Maryland, U.S.A., and First Science Plan. September 1992, IGPO Pub. Series No. 5

GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP) DATA WORKSHOP: Summary report on 5–8 May 1992 Workshop. June 1992, IGPO Pub. Series No. 4.

GEWEX CONTINENTAL-SCALEINTERNATIONAL PROJECT (GCIP) ATMOSPHERIC SCIENCE COMPONENT: Report on Atmospheric Subpanel Workshop 18–19 March 1992. May 1992, IGPO Pub. Series No. 3.

IMPLEMENTATION PLAN FOR THE PILOT PHASE OF THE GEWEX WATER VAPOR PROJECT (GVaP), March 1992. March 1992, IGPO Pub. Series No. 2.

SCIENTIFIC PLAN FOR THE GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP)–WCRP–67, February 1992 (WMO/TD/No. 461). (Second printing now available.)

THE ROLE OF WATER VAPOR IN CLIMATE, A STRATEGIC RESEARCH PLAN FOR THE PROPOSED GEWEX WATER VAPOR PROJECT (GVaP): Report of Workshop, Easton, MD, U.S.A., 30 October–1 November 1991. NASA Conf. Pub. 3210.

GLOBAL ENERGY AND WATER CYCLE EXPERIMENT (GEWEX)—REPORT OF THE FIRST GEWEX TEMPERATURE/HUMIDITY RETRIEVAL WORKSHOP, WCRP-XX, Greenbelt, MD, U.S.A., 23–26 October 1990.

GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP). REPORT OF THE FIRST GCIP PLANNING WORKSHOP, RESTON, VIRGINIA, U.S.A., 8–10 October 1990. April 1991, IGPO Pub. Series No. 1.

SCIENTIFIC PLAN FOR THE GLOBAL ENERGY AND WATER CYCLE EXPERIMENT—WCRP–40, AUGUST 1990. (WMO/TD–No. 376).

GLOBAL CLIMATE CHANGE—A SCIENTIFIC REVIEW PRESENTED BY THE WORLD CLIMATE RESEARCH PROGRAMME (WCRP), January 1990. The WCRP is the international scientific program chartered jointly by the International Council of Scientific Unions and the World Meteorological Organization to provide a quantitative understanding of climate and predictions of global and regional climate changes on all time scales. This document is a review of global climate change as of 1990.

IGPO Welcomes New Member to the Staff

Dawn Erlich has joined the IGPO staff and will be assisting Dr. Paul Try in the planning and implementation of GEWEX programs. She will have primary responsibility for coordinating the efforts of the International Satellite Land Surface Climatology Project (ISLSCP) and the GEWEX Water Vapor Project (GVaP). Ms. Erlich has a long and varied history in the earth sciences. She began her career in 1975 as a programmer in the Physical Oceanography Laboratory of NOAA Atlantic Oceanographic and Meteorological Laboratories. She later went to the Research Triangle Institute in NorthCarolina where she analyzed satellite advanced very high resolution radiometer (AVHRR) and visible data for ocean current studies. Since 1985, Ms. Erlich has provided technical and program management support to NASA Headquarters earth science programs. For the past 4 yr she supported the TOPEX/POSEIDON, Advanced Earth Observing Satellite (ADEOS), and Tropical Rainfall Measuring Mission (TRMM) programs. Her degree is in environmental sciences from the University of California at Los Angeles.

Prof. Pierre Morel, Director of WCRP (right), presenting certificate to Dr. Phillip Arkin in recognition of Dr. Arkin's service to WCRP as manager of the Global Precipitation Climatology Project from 1986 to 1994.

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Attendees at the Sixth Session of GEWEX Scientific Steering Group (SSG) meeting at Frascasti, Italy, 17–22 January 1994, on an occasion to honor Professor Pierre Morel (center first row) at his last official GEWEX SSG Meeting as Director of the World Climate Research Programme.

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