GEWEX WCRP

Global Energy and Water Cycle Experiment

NEWS

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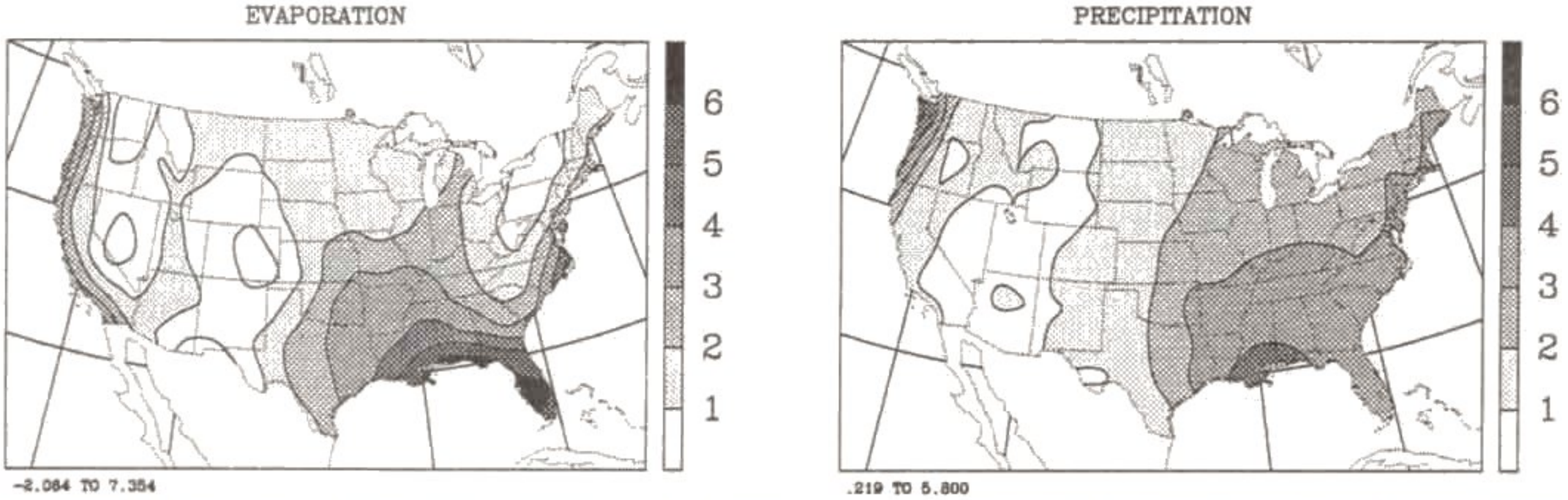
World Climate Research Programme–WCRP



U.S. Annual Mean Hydroclimatology: Geographical differences in evaporation and precipitation (see Florida evaporation maximum) are due to vertically integrated moisture divergence. (Accompanying article on page 3.)

THE GEWEX SURFACE RADIATION BUDGET BUDGET PROJECT

RESULTS AVAILABLE ON LINE

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and
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The Global Energy and Water Cycle Experiment (GEWEX) Surface Radiation Budget (SRB) Project is retrieving fluxes of shortwave (SW) surface radiation over the globe and has the data available now in several forms. These fluxes will be valuable for validating climate models, diagnostic studies of the land and sea processes, investigations of low-frequency variability, and for monitoring regional trends. The SW retrievals are presently based largely on International Satellite Cloud Climatology Project (ISCCP) data. The SRB Project will eventually extend to the longwave (LW) and span the full ISCCP record, which started in July 1983 and will continue until at least 1995.

(Continued on page 7)

WHAT'S NEW IN GEWEX

- GEWEX Committee formed in Australia
- GCIP Project Office to be formed
- Global SRB data now available
- GCIP Integrated Systems Test in 1994
- GCIP subpanels met jointly
- European Conference on the Global Energy and Water Cycle announced

In This Issue

COMMENTARY

CRITERIA FOR GEWEX CONTINENTAL-SCALE BUDGET STUDIES

Dr. Moustafa T. Chahine, GEWEX SSG Chairman

In the Winter 1992/93 GEWEX newsletter I discussed several international activities taking place that support the objectives of GEWEX. In addition to the GEWEX Continental-Scale International Project (GCIP), four additional continental-scale experiments were reviewed in February 1993 by the GEWEX Scientific Steering Group (SSG): (1) the MacKenzie GEWEX Study (MAGS), (2) the Baltic Sea Experiment (BALTEX), (3) the GEWEX Asian Monsoon Experiment (GAME), and (4) the Large-Scale Atmospheric Moisture Balance of Amazonia using Data Assimilation (LAMBADA).

The SSG developed the following statement of criteria, which was approved by the Joint Scientific Committee, for GEWEX continental-scale budget studies:

"The objective of GEWEX is to develop a quantitative understanding of the global hydrologic cycle and energy fluxes, based on global observations and comprehensive climate models. An essential step toward this objective is comparing model formulations of hydrological and energetic processes with corresponding observed properties. The large variability of weather and climate make such comparisons most meaningful when model properties are computed in a forecast mode, i.e., when model fields are driven to follow the observed variations of the atmospheric circulation and surface properties. These tasks will be done in the framework of the regional or continental-scale budget studies of atmospheric and hydrological processes that could secure

(i) The cooperation of a numerical weather prediction (NWP) center that will implement a state of the art atmospheric and surface data assimilation procedure, and deliver estimates of hydrometeorological properties in a form directly comparable to observables.

(ii) A commitment of resources and personnel to pursue the development of suitable atmospheric-hydrological models, develop an atmospheric-hydrological data management and assimilation system, and to conduct an appropriate program of numerical experimentation and climate change studies.

(iii) A regional scientific cooperation mechanism for collecting basic hydrometeorological data sets, including satellite observations, suitable for supporting and validating the above model developments.

(iv) A commitment to participate in the international exchange of scientific information and data in conformity with the general practice of WCRP."

The SSG invites international continental-scale projects that meet these criteria to be considered for the GEWEX program.

EDITOR'S NOTES

GEWEX investigators are encouraged to submit short articles on their findings to the International GEWEX Project Office—IGPO (see below) to be considered for future issues of GEWEX News. Concise illustrations summarizing results are requested. The publication schedule is

ISSUE	ITEMS DUE	PUBLICATION
Summer 1993	15 July	August 1993
Fall 1993	15 Sept.	October 1993
Winter 1993–94	15 Dec.	January 1994
Spring 1994	15 Apr.	May 1994

To announce a GEWEX meeting or submit a meeting summary, send details to the IGPO via E-MAIL (OMNET): INTL.GEWEX; FAX 202–488–5364; TELEX: 740279 GEWX UC; or MAIL to International GEWEX Project Office, 409 Third Street SW., Suite 203, Washington, DC 20024.

CLIMATOLOGICAL ASPECTS OF THE LARGE SCALE U.S. HYDROLOGIC CYCLE

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and
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It is generally believed that we have only a rough qualitative understanding of the Earth's hydrologic cycle. We do not measure well, or even measure at all in many places, many hydrologic processes. To increase our quantitative knowledge of the hydrologic cycle, the international GEWEX Continental-Scale International Project (GCIP) was initiated. As this international program begins, it is important to establish just how well the hydrologic cycle is understood from past imperfect observations. We will then know what improvements the program has brought. Also, we need to use past imperfect observations for understanding low frequency variations in the hydrologic cycle.

We have been constructing a large scale 2.5° atmospheric hydrologic climatology over the United States. The gridpoint climatology consists of precipitation (Roads and Maisel, 1991; Roads et al., 1991), atmospheric precipitable water, atmospheric moisture divergence or convergence, and a residual evaporation (Roads et al., 1992). We use this atmospheric data along with U.S. streamflow outflow (Guetter et al., 1991; Guetter and Georgakakos, 1993) to also construct a large basin scale surface climatology of precipitation, evaporation, runoff, and surface water storage (Roads et al., 1993a, 1993b).

The atmospheric hydrologic cycle is

$$Q_t = C + E - P;$$

precipitable water (Q_t) is increased by convergence of moisture (C) and evaporation (E), and decreased by precipitation (P). (Note that convergence is the opposite of divergence: $C = -D$.) The surface hydrologic cycle is

$$W_t = -S - E + P;$$

surface water (W_t) is decreased by streamflow (S) divergence and evaporation and increased by precipitation.

Figure 1 shows the annual mean of components involved in the atmospheric portion of the hydrologic cycle. The precipitable water (upper left panel) has large geographic variations, varying from 10 kg/m^2 over the West, where the orography is quite high and the surface is relatively dry, to 30 kg/m^2 over the Gulf of Mexico coast and Florida. At comparable latitudes, the west coast is drier than the east coast, until the Pacific Northwest is reached.

Precipitation (upper right panel) is characterized by large amounts in the Pacific Northwest and centered along the Mississippi coastline. The Pacific Northwest precipitation exists mainly along the coast, whereas the Gulf of Mexico coast precipitation is spread more uniformly over the entire southeastern part of the United States. The driest region is the Great (Salt Lake) Basin, where precipitation is less than 1 mm/day, increasing slightly in the region of the Grand Canyon.

Evaporation (lower right panel) is calculated as a residual sum of atmospheric precipitable water variations and mainly precipitation and atmospheric moisture divergence. The evaporation is fairly consistent with the precipitation. The largest amounts occur along the coastlines of the Gulf of Mexico and the Pacific Northwest, although the evaporation maxima are not reached in the exact same locations as the precipitation maxima. For example, the evaporation maximum over the gulf coast and Florida is to the east of the precipitation maximum; there is another maximum in the coastal regions of North Carolina. The evaporation maximum along the west coast occurs over Oregon, rather than over Washington where the precipitation is a maximum.

Precipitation and evaporation geographic differences are due to the vertically integrated atmospheric moisture convergence shown in the lower left panel. Note the predominant ocean divergence and predominant land convergence. At smaller scales, the west coast has the strongest divergence; over the Gulf of Mexico and off the east coast a smaller divergence

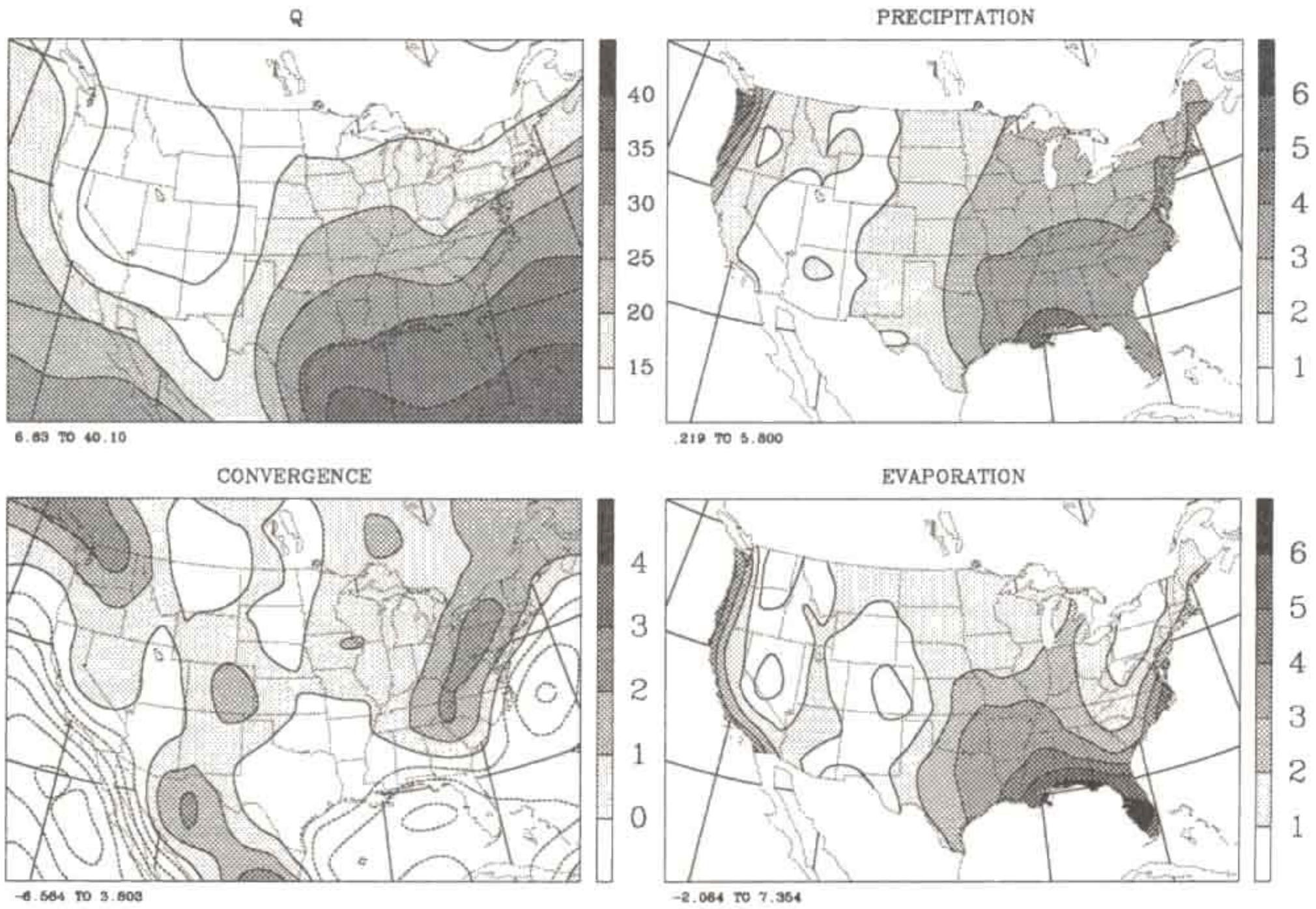

Figure 1: Annual mean U.S. atmospheric hydrology climatology. Atmospheric precipitable water is shown in the upper left panel (mm). Precipitation is shown in the upper right panel (mm/day). The residual evaporation is shown in the lower right panel (mm/day). Atmospheric moisture convergence is shown in the lower left panel (mm/day); negative convergence (divergence) is shown by the dashed lines in the lower left panel.

occurs. The divergence is strongest in low latitude regions where the precipitable water amounts are largest, but the convergence is strongest over the northern coastal areas, as well as the eastern edge of the Sierra Madres and Rocky Mountains.

The seasonal hydrologic budgets for the conterminous United States are shown in Fig. 2. The upper left panel shows the original data, including the residual evaporation, and the streamflow divergence or runoff. Since the annual runoff should be equal to the annual mean convergence of atmospheric moisture, we modify the divergence to give the correct annual mean balance. This corrected divergence is then used to obtain a new residual estimate of evaporation, which is shown in the upper right panel of Fig 2. Comparisons of the new evaporation, as well as the new moisture divergence curves in the upper right panel with the original moisture divergence and evaporation curves in the upper left panel, show that the residual correction to the balance is small but important. The corrected residual evaporation is then used to deduce the variation in the surface water storage, which is the difference between precipitation and evaporation and runoff.

Consider the atmospheric hydrologic cycle, shown in the upper right panel of Fig. 2. The dominant component is precipitation, which is slightly larger during the summer than the winter. Evaporation is smallest during the winter. During the summer evaporation becomes slightly greater than precipitation. Convergence of moisture is smallest during the summer; during the winter the convergence is about the same

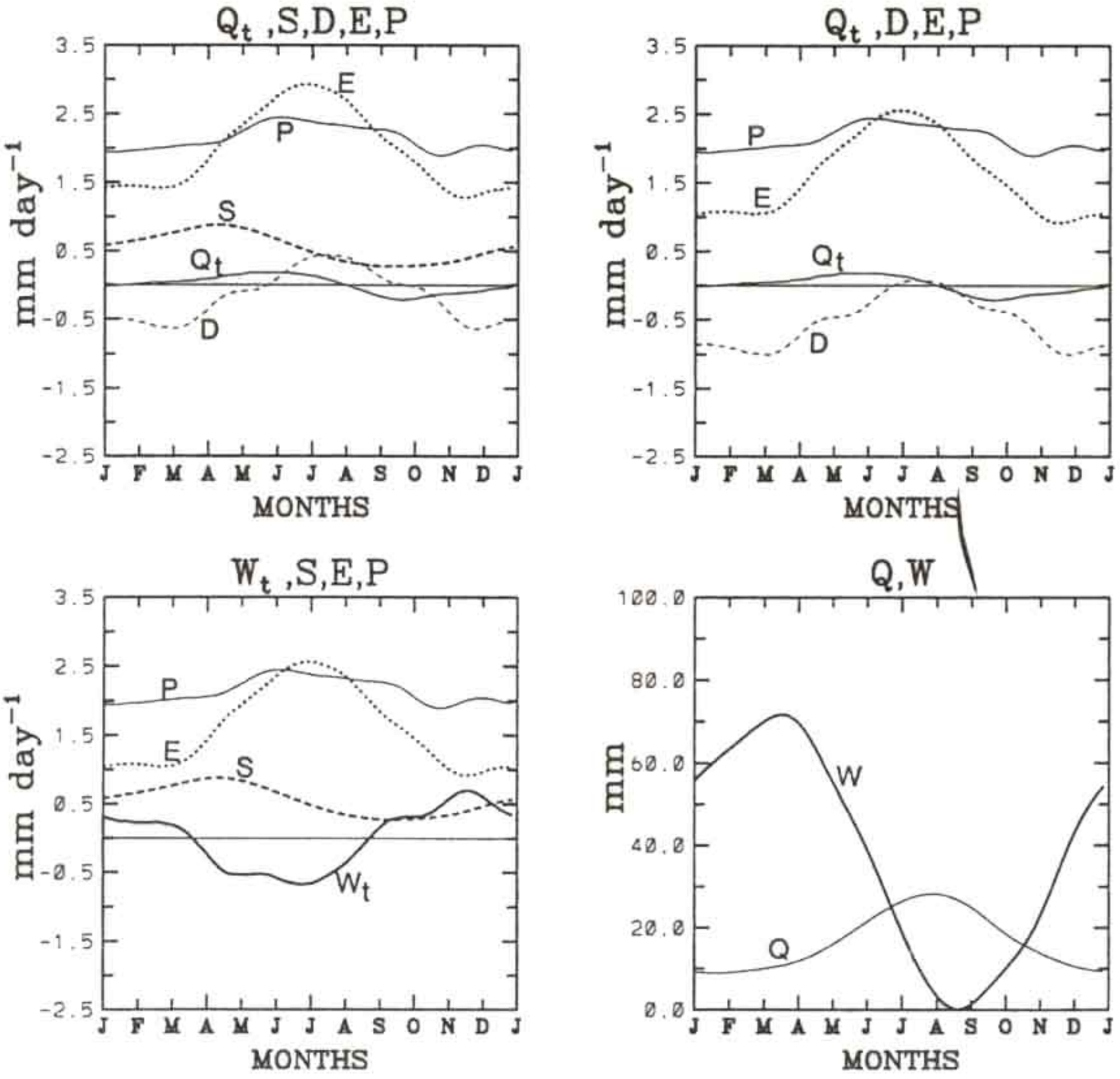

Figure 2. U.S. average of the hydrologic cycle components for the various months January (J) to December (D). The original hydrologic data (mm/day) are shown in the upper left panel. Preliminary residual evaporation, precipitation, runoff, atmospheric moisture divergence, and seasonal variation in the atmospheric moisture storage are also shown. Terms in the atmospheric hydrologic cycle (mm/day) are shown in the upper right panel. All lines denote the same quantities shown in the upper left panel. The residual correction to the moisture divergence is shown in this panel as well as the final residual evaporation estimation. The terms in the surface hydrologic cycle (mm/day) are shown in the lower left panel. The new term shown here is the residual variation in the surface water storage. The seasonal variation in atmospheric moisture and the residual surface water (mm) are shown in the lower right panel.

order as evaporation. The smallest term in the atmospheric hydrologic cycle is the atmospheric moisture storage; atmospheric moisture storage variations are not important for seasonal variations.

By contrast, the residual surface water storage term is important in the surface water budget, which is shown in the lower left panel. Seasonal variations in the water storage are just as important as streamflow divergence or runoff but are still smaller than precipitation and evaporation. As shown in the lower right panel, the surface water increases on the order of 80 mm during the fall to spring months and decreases to zero (plus an arbitrary but unknown positive constant) during the summer months. Presumably, part of this surface water storage is snow (Marshall et al., 1993). Interannual variations in the surface water storage (not shown) are just as large as the seasonal variations.

Various other details of the large scale U.S. hydrologic cycle, deduced from present observations, are described in Roads et al. (1993b). After the GCIP program, we will understand better just how accurate these deductions are.

References

Guetter, A.K., J. McCollum, and K.P. Georgakakos, 1991: The line integral of net outflow from the continental U.S. *Abstract of the Fall AGU Meeting*, San Francisco, CA, December 9–13, 1991.

Guetter, A.K., and K.P. Georgakakos 1993: U.S. outflow variability and anomaly patterns. Submitted to the *Bull. AMS*.

Marshall, S., J.O. Roads, and G. Glatzmaier, 1993: Snow hydrology in a GCM. Submitted to *J. Climate*.

Roads, J.O., and T.N. Maisel, 1991: Evaluation of the National Meteorological Center's medium range forecast model precipitation forecasts. *Weather and Forecasting*, **6(1)**, 123–132.

Roads, J.O., T.N. Maisel, and J. Alpert, 1991: Further evaluation of the National Meteorological Center's medium-range forecast model precipitation forecasts. *Weather and Forecasting*, **6(4)**, 483–497.

Roads, J.O., S.-C. Chen, J. Kao, D. Langley, and G. Glatzmaier, 1992: Global aspects of the Los Alamos General Circulation Model Hydrologic Cycle. *J. Geophys. Res.*, **97**, 10051–10068.

Roads, J.O., K.P. Georgakakos, and A.K. Guetter, 1993a: Interannual variations in the U.S. hydrological cycle. *Proceedings of Conference on Hydroclimatology: Land-Surface/Atmosphere Interactions on Global and Regional Scales*, January 17–22, 1993, Anaheim, CA.

Roads, J.O., S.-C. Chen, A.K. Guetter, and K.P. Georgakakos, 1993b: Large-scale aspects of the U.S. hydrologic cycle. In preparation.

GEWEX COMMITTEE FORMED IN AUSTRALIA

Australia, as the most arid, inhabited continent in the world, recognizes the crucial importance of improved understanding of the hydrologic cycle and its associated energy fluxes. To respond to the need to coordinate water and energy cycle research in Australia, the Australian Academy of Sciences National Committee for Climate and Atmospheric Science recommended the formation of a GEWEX subcommittee. The nine members of this subcommittee represent the major institutes in Australia working on GEWEX research: the Commonwealth Scientific and Industrial Research Organisation, the Bureau of Meteorology Research Centre, the universities, and the Murray-Darling Basin Commission.

In addition to the considerable interest of Australian GEWEX scientists in improved understanding of the continental surface hydrology, there are also active research programs in many of the other GEWEX projects. In particular, the Bureau of Meteorology Research Centre is contributing to the GEWEX Cloud System Study (GCSS) and the Global Precipitation Climatology Project (GPCP); the Commonwealth Scientific and Industrial Organisation (CSIRO), Division of Atmospheric Research, is taking a lead role in the Experimental Cloud Lidar Pilot Study (ECLIPS); and the Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS), based at Macquarie University in Sydney, is a joint investigation between GCIP and the Working Group on Numerical Experiments (WGNE).

Recently funded research includes a joint project between the Flinders University of South Australia, Macquarie University, and the CSIRO Centre for Environmental Mechanics designed to study surface and boundary layer fluxes in the Coleambaly Irrigation Area. A second joint research venture between the CSIRO Centre for Environmental Mechanics and the University of Technology in Sydney focused on retrieving all-sky imagery from cameras on three ships researching air-sea fluxes in the West Pacific warm pool. Analysis of these cloud data will be compared with satellite estimates of cloud and surface fluxes.

At its inaugural meeting, the Australian GEWEX committee agreed to initiate a national report on GEWEX-related activities and proposed a scientific workshop at which future initiative would be discussed and coordinated. In addition, a GEWEX Continental-Scale International Project (GCIP) type experiment is likely to be initiated. Two areas are being considered: the Murray-Darling basin in southeast Australia and the monsoonal tropics in the north of Australia.

The Murray-Darling is the world's fourth largest river system with a total drainage area of 910,000 km, about one third of the area of the Mississippi-Missouri basin. Covering one seventh of the Australian Continent, the Murray-Darling supplies water to 16 cities and produces one third of Australia's total natural resource-based output. Irrigation, salinization, soil erosion, and water contamination are all important practical issues of relevance to GCIP. At the same time, tropical savannas have been identified as a critical biome for global climate and global change studies; they occupy 40% of the tropical land surface. They are inhabited by large and rapidly growing numbers of humans, and they are undergoing profound changes in composition and productivity. Tropical savannas through fire and the consequent emissions of gases to the atmosphere play a prominent role in global biogeochemical cycles. The tropical north of Australia offers a potential base for GCIP investigations linked to the rivers draining into the Timor Sea from northern savannas and tropical moist forests and associated with GEWEX atmospheric research based around Darwin.

Australia's Global Energy and Water Cycle Experiment (GEWEX) Subcommittee Membership

Professor A. Henderson-Sellers, Climate Impacts Centre, Macquarie University (Chair)

Dr. M.J. Manton, Bureau of Meteorology Research Centre, Melbourne

Dr. J.M. Hacker, School of Earth Sciences, Flinders University

Dr. J.J. Landsberg, Director, Natural Resources Management, Murray-Darling Basin Commission

Dr. M. Platt, Leader, Radiation and Climate Programme, CSIRO Division of Atmospheric Research

Dr. D. Graetz, Global Change Group, CSIRO Division of Wildlife and Ecology

Professor T.A. McMahon, Department of Civil and Agricultural Engineering, The University of Melbourne

Dr. K. McGuffie, Department of Applied Physics, University of Technology, Sydney

Dr. M. Raupach, CSIRO Centre for Environmental Mechanics

NOTICE

GEWEX News has been informed the telephone number for the Global Precipitation Climatology Centre (GPCC) has been changed and was incorrectly cited in the preceding issue of GEWEX News. The new telephone number is 49-69 80 62-29 81 and the Fax number is 49-69 80 62-29 93. For information on planned products and those now available from GPCC, contact Bruno Rudolf at the above numbers at Deutscher Wetterdienst, GPCC, Frankfurter Str. 135, D-W6050 Offenbach/Main, Germany.

Surface Radiation Budget

(Continued from page 1)

The SW results using two independent satellite-based retrieval algorithms, developed by teams led by Rachel Pinker (University of Maryland) and W. Frank Staylor (NASA Langley), are available. Both algorithms have done well in regional comparisons with ground truth. Monthly (52-parameter) and daily (10-parameter) files are produced in the 280 km by 280 km equivalent area grid of ISCCP. The processing record now includes January, April, July, and October of 1985–88.

Figure 1 provides an example of the seasonal cycle of SRB Project SW fluxes at a grid box over Germany wherein several surface flux measurements are routinely made. When available, surface radiometric

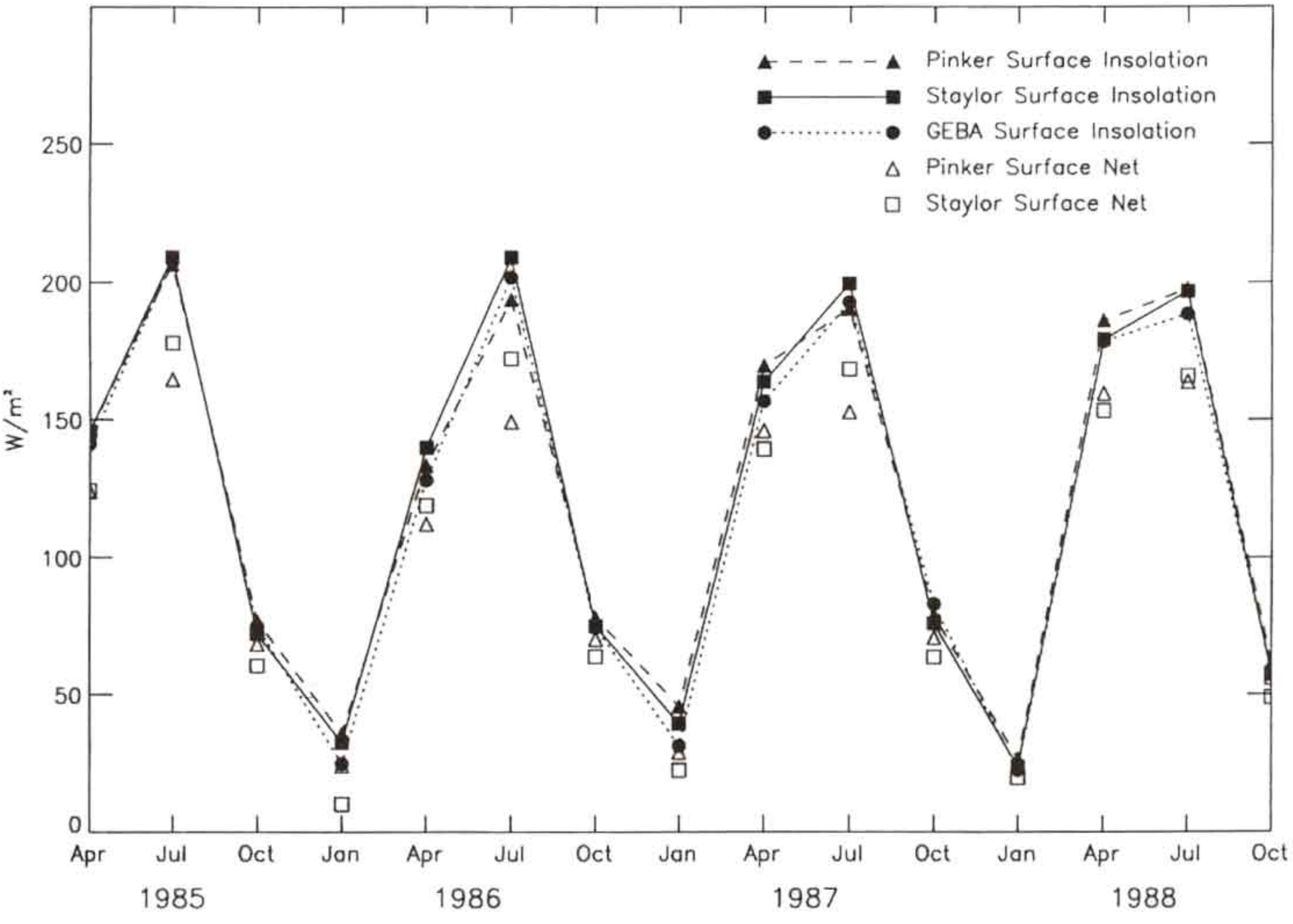

Figure 1. Surface radiation at 51.25N, 10.0E.

observations of the Global Energy Balance Archive—GEBA (compiled by the Swiss Federal Institute of Technology and available courtesy of Atsumo Ohmura) are included in the SRB Project files, in addition to the satellite-based retrievals. The Pinker and the Staylor satellite-based retrievals compare well with GEBA observations. The satellite-retrieved SW net flux values (the absorbed irradiance) are also indicated in Fig. 1. Interannual variability (IAV) is also apparent; the insolation values in April 1987 and April 1988 are higher than in 1985 and 1986.

The IAV is more notable in deseasonalized tropical data. Figure 2 shows the Southern Oscillation Index (SOI), the standardized difference of the Tahiti and Darwin sea level pressure anomalies, which is a primary mode of global climate variability and the average of the deseasonalized Pinker and Staylor retrievals for selected areas. Over the central equatorial Pacific (1.25N, 161.25W), the 1987 El Niño–Southern Oscillation (ENSO) is clearly associated with a decrease in SW insolation. Near the opposite lobe of the Walker Circulation (2.75N, 136.25E), the insolation has increased by a smaller amount. The 1987 ENSO was also associated with teleconnections to the midlatitudes, including the Global Energy and Water Cycle Experiment (GEWEX) Continental-Scale International Project (GCIP) region.

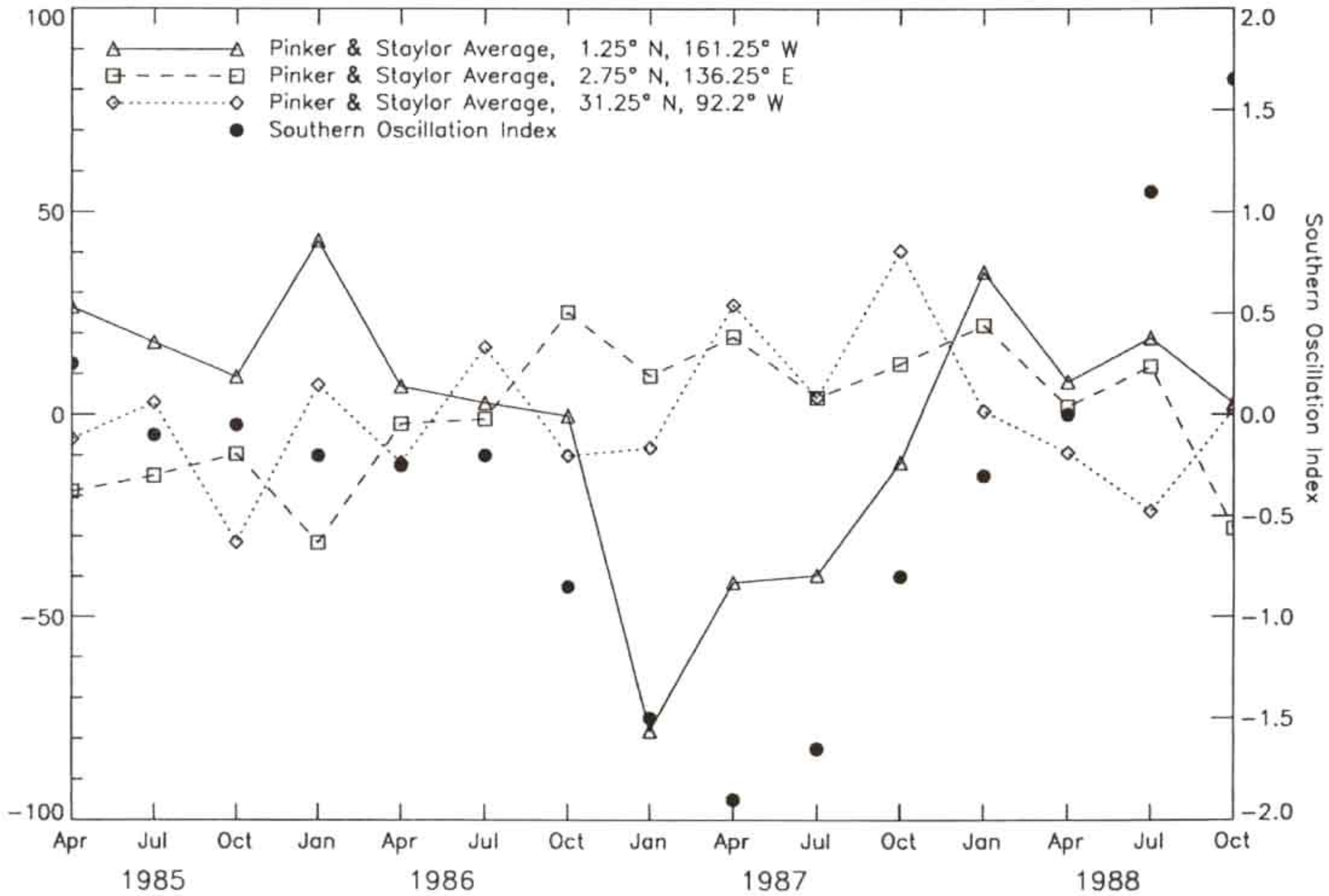

Figure 2. Deseasonalized surface insolation and Southern Oscillation Index.

In Fig. 2, the IAV in surface insolation over the lower Mississippi Basin (31.25W, 92.2N) may be related to ENSO.

The SRB Project data may be accessed on line through the NASA Langley Distributed Active Archive CenterDAAC(userserv@eosdis.larc.nasa.gov,PHONE: 804–864–8656, FAX: 804–864–8807). Abbreviated monthly averaged results are available by FTP (charloc@sarsun.larc.nasa.gov).

The Satellite Data Analysis Center (SDAC), headed by Charles Whitlock, processes the SRB algorithms under the direction of the World Climate Research Programme (WCRP) Radiation Office (Robert Schiffer). The SRB Project is coordinated by the SRB ad hoc Science Working Group (A. Arking, T. Charlock—Chair, R. Ellingson, C. Frohlich, W. Liu, J. J. Morcrette, R. Pinker, J. Schmetz, E. Smith, W. Staylor, and R. Stuhlmann). The WCRP Baseline Surface Radiation Network—BSRN (John DeLuisi) is a companion to the SRB Project that will provide accurate, long-term measurements of surface radiometric fluxes at about 30 sites worldwide.

WASHITA MACHYDRO-92 REMOTE SOIL MOISTURE SENSOR EVALUATION

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Greenbelt, Maryland, U.S.A.

A Multisensor Aircraft Campaign for Hydrology (MACHYRDO) was conducted in June 1992 over the Little Washita Watershed, a U.S. Department of Agriculture (USDA) research facility near Chickasha, Oklahoma. The goals of this campaign were

1. To evaluate microwave sensors capability to provide quantitative measurements of soil moisture over space and time.
2. To incorporate remotely sensed data (including soil moisture data) into catchment scale hydrologic models.

The Little Washita Watershed is a 650-sq km drainage basin situated in the southern part of the Great Plains in southwest Oklahoma (Fig. 1). The climate is classified as moist and subhumid, with an average annual rainfall of about 640 mm. It is the site of a long-term (more than 24 yr) USDA Agricultural Research Service (ARS) hydrologic monitoring facility that is currently being rejuvenated by upgrading the instrumentation as well as by adding new measuring stations as part of the USDA Global Change initiative. The upgrading includes modernized and new stream gauging stations as well as a number of Mesonet stations. This site is adjacent to or part of other major science activities, including a proposed atmospheric

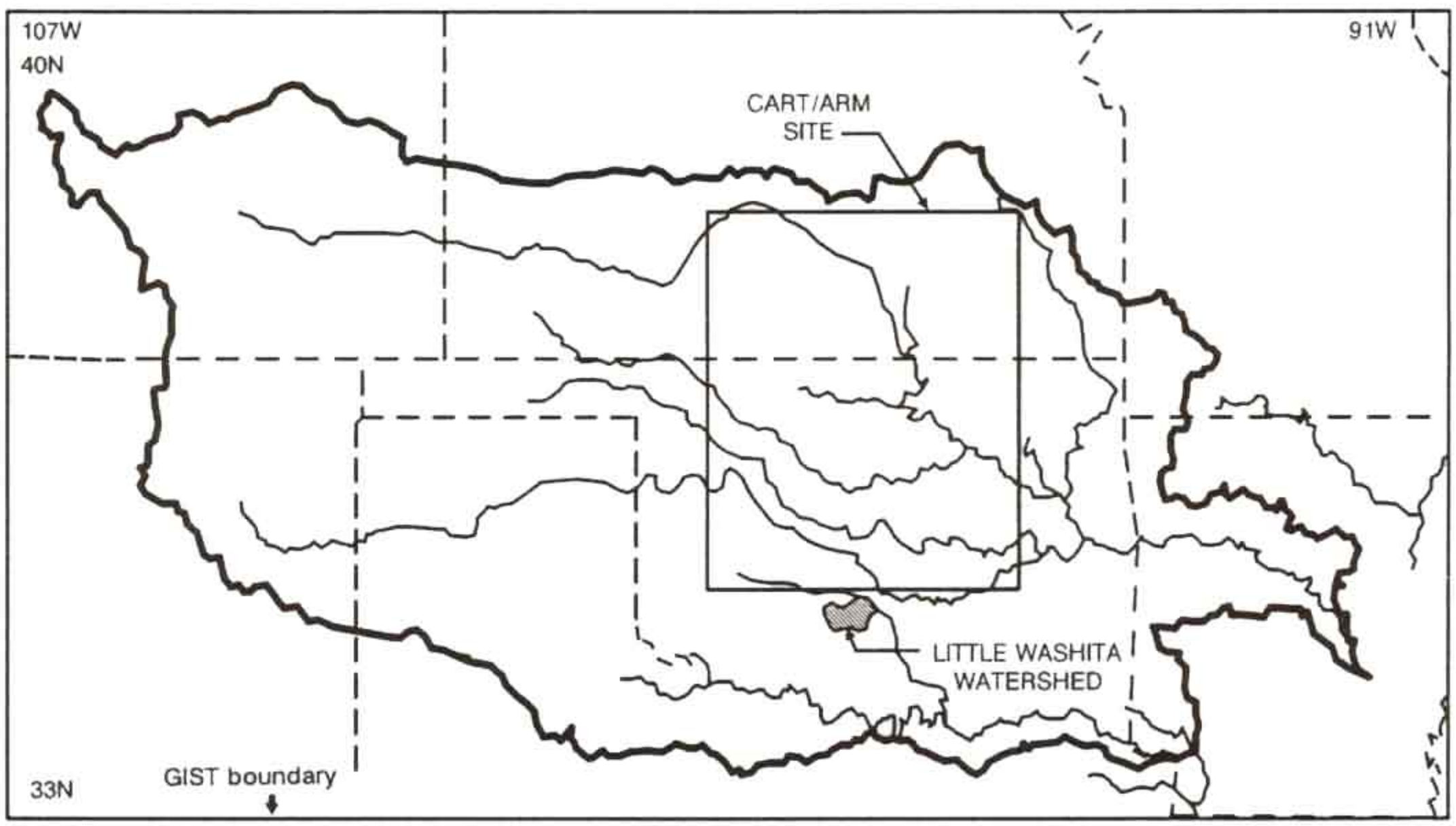

Figure 1. Map showing the location of the Little Washita Watershed with relationship to the DOE CART/ARM site and the GCIP Integrated Systems Test (GIST) area (33–40N, 97–107N), which includes the drainage areas of the Arkansas–Red River basins (dark outline).

mesoscale research initiative, the Cloud and Radiation Testbed (CART) site for the Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Program, and the GCIP program. This is also the SIR-C/X Synthetic Aperture Radar (SAR) supersite; SIR-C/X is the National Aeronautics and Space Administration (NASA) Shuttle Imaging Radar (SIR) experiment scheduled for the space shuttle in 1994.

Two Ames Research Center based NASA aircraft participated in the experiment, the DC-8 and the C-130. The DC-8 carried the three frequency polarimetric SAR, and the C-130 carried NS001, the Landsat Thematic Mapper Simulator; TIMS, the Thermal Imaging Mapper; ESTAR, the Electronically Steered Thinned Array Radiometer; an L-band passive microwave instrument; a 37-GHz radiometer; and a USDA laser profiler. The planes were based out of Oklahoma City, approximately 50 km north of the study area.

The general strategy of the experiment was to fly the aircraft at any time that changes in the hydrologic conditions appeared large enough (drying or after rain) to expect measurable differences. Flight lines were designed to satisfy two strategies: (1) to provide complete, wall-to-wall coverage of the entire area to characterize the soil moisture and other hydrologic conditions, and (2) to provide low level and high resolution flights of prechosen sites for instrument evaluation and algorithm development. The hydrologic conditions during the experiment were ideal because we were able to follow a drying period from very wet to dry over a period of 10 days. Figure 2 illustrates the range of soil moisture conditions during the experiment. It had rained for 26 consecutive days in Oklahoma when we arrived and initial conditions were very wet. The first day of the experiment was the last day of rain, June 9. We were able to fly each day (June 10 through 18, except for the 15th, which was a crew rest day) with both aircraft and a full complement of instruments. Preliminary indications are that all instruments worked well throughout the experiment.

During the experiment a large amount of ground data was collected to cover all hydrologic variables. Included in the ground data collections were rainfall (32 weighing gauges and the WSR-88D), streamflow (4 stations), soil moisture (700 gravimetric samples per day, capacitance probes, neutron meters and Nuclear Magnetic Resource), radiosondes (4 per day), flux stations (4 Bowen ratio and eddy correlation), and the Goddard Space Flight Center (GSFC) radar truck. At the time of each overflight, approximately 40 people participated in the ground data collection activities.

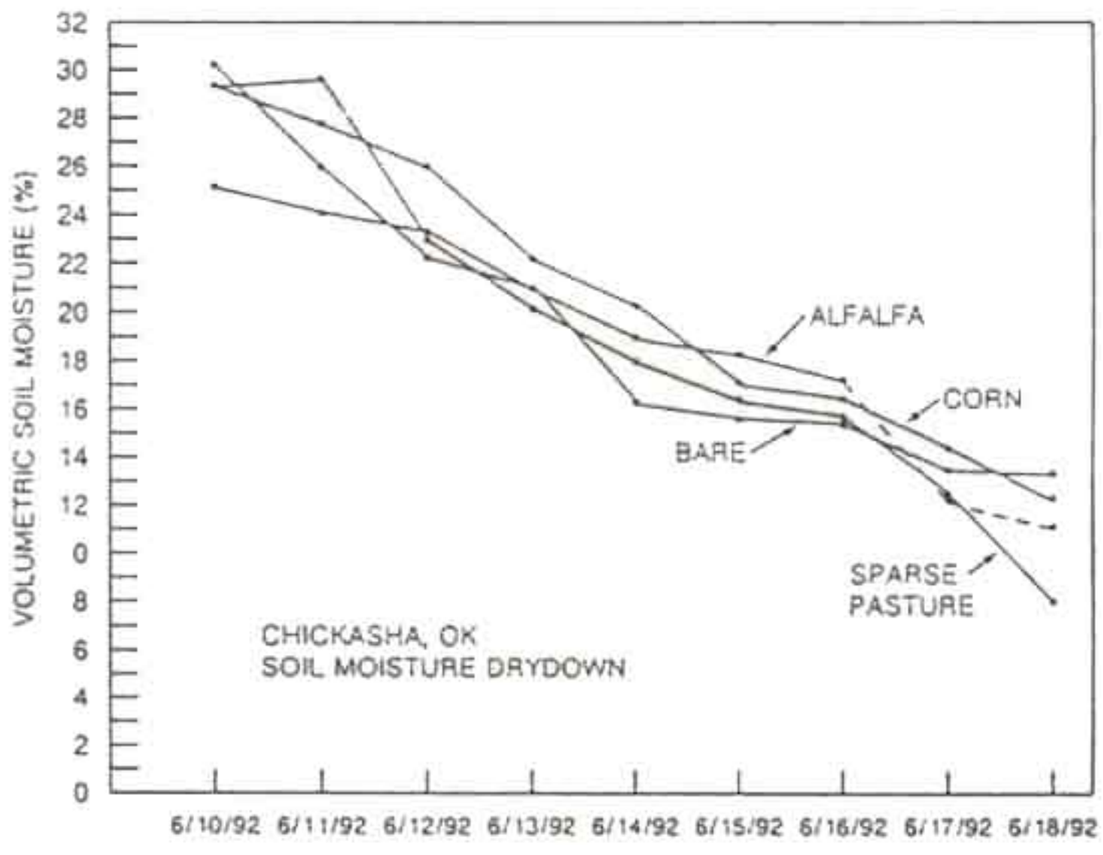

Figure 2. Measured decrease in 0–5-cm volumetric soil moisture for several fields with different vegetation covers during a recent experiment in the Little Washita River basin near Chickasha. Dashed part of alfalfa curve indicates that canopy was cut on 17 and 18 June 1992.

GCIP JOINT SESSION AGREES TO 1994 INTEGRATED SYSTEMS TEST

The GEWEX Continental-Scale International Project (GCIP) Atmospheric, Hydrometeorology, and Water Resources subpanels and Data Collection and Management Committee (DACOM) met at the International GEWEX Project Office (IGPO) 22–24 March 1993, with a joint session on 23 March. The purpose of this meeting was to facilitate cooperative activities in producing the GCIP Implementation Plan, establish schedules for completion of Volumes I, II, and III of the implementation plan and prepare for the start of GCIP with a pilot test. It was agreed that a GCIP Integrated Systems Test (GIST) needed to be conducted before the start of a 5-yr Enhanced Observing Period. The test is planned for 1994 and will take place in the Arkansas-Red River basins with science studies and modeling primarily focused on smaller areas within the GIST region. (See Fig. 1 in the Washita MACHYDRO-92 article, page 10). This test will serve as a precursor to the continental-scale studies and modeling over the entire Mississippi River basin, starting in 1995. It provides an early end-to-end test of a GCIP prototype data management and services system for the GCIP scientific community.

Volume I addresses data collection, model upgrades, and other activities before the Enhanced Observing Period begins in 1995. The GCIP research plan implementation will be addressed in Volume II, and the GCIP data management plan will be presented in Volume III. During the 3 days the atmospheric, hydrometeorology, and DACOM working groups held independent sessions, numerous informal discussions took place among several members of the different writing teams. At the joint session the science subpanels and DACOM presented their status, writing strategy, and schedules. The Water Resources Subpanel did not meet in a separate session.

The Atmospheric Subpanel, chaired by Franklin Robertson, reviewed the October 1992 Implementation Plan draft and assessed the proposed GCIP-derived product requirements and needs for improved land-atmosphere coupled modeling. The group affirmed that the current list of potential elements remains valid and will be further developed for incorporation into Volume II. Examples of refinements currently underway include the development of the science requirements and implementation strategy for GIST, as well as a more indepth articulation of 4-D data assimilation requirements. If GIST performs well in mid-1994, then early science results can be achieved.

The Atmospheric Subpanel concluded its deliberations with a proposed framework built upon the GCIP Scientific Plan objectives and science issues as contained in the October 1992 working papers. In preparing Volume II, the problem of bridging the gap between basin and continental scale, as well as validating the models at global scales, will be a major consideration.

A schedule was established in collaboration with the Hydrometeorology Subpanel. A meeting of the chairmen of the working groups will be held in late April, and frequent electronic communication is planned. A late August goal was set for an integrated Volume II final draft.

On the opening day sessions of the GCIP Hydrometeorology Subpanel, Chairman Eric Wood scheduled a series of presentations by panel members. Topics ranged from global satellite observations to measuring localized surface fluxes. A hydrometeorology implementation strategy was outlined based on the GCIP Scientific Plan objectives, scope (Mississippi basin and time periods), and science issues. Soil moisture, precipitation estimation, regionalization, and transferability were some of the specific science issues addressed by the panel. This panel is also developing research selection criteria and recommending several sites for focused study areas as part of the implementation plan.

The Hydrometeorology Subpanel aims to have a preliminary draft plan ready for critique by June 1993 and a final draft by the end of August. Therefore, the Atmospheric and Hydrometeorology Subpanel schedules, promulgated at the March meeting, are converging towards an integrated research plan, for implementation in time for Volume II to be circulated before the next GCIP Science Panel meeting, scheduled for October 1993.

Co-Chairman Harry Lins of the Water Resources Subpanel reported that the subpanel is focusing on the development of methods for translating the effects of climate variability and change (as simulated by general circulation and mesoscale models) on regional water resources. The activities of this subpanel are designed to provide meaningful hydrologic information to managers and operators of water resource systems. This subpanel has a longer timetable for developing its part in the GCIP implementation planning documents but expects to have a draft plan prior to the next GCIP Science Panel meeting, scheduled for October 1993.

The DACOM session was primarily concerned with a discussion of a preliminary draft of Volume III, the GCIP Data Management Plan, and proposed objectives for GIST. A plan for GIST was reviewed by John Leese, and progress on the GCIP Data Management Plan was briefed by David McGuirk. He showed data flow diagrams for precipitation and upper air and surface atmosphere measurements.

In summary, the 3-day meeting enhanced and accelerated the production of a meaningful integrated series of GCIP implementation volumes. The GCIP implementation planning is a dynamic process. Volume I review comments from the GEWEX Science Steering Group and others have been incorporated into the document. Volume I is now moving forward to publication. It is envisioned the present three volumes will be supplemented by additional documents such as specific operation plans for field studies that may be deemed necessary, modifications due to scientific fundings, or advances in technology.

EUROPEAN CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE

The European Conference on the Global Energy and Water Cycle will be held 18–22 July 1994 at the Royal Society, London. It is being organized by the Royal Society's U.K. GEWEX Forum.

This conference will consist of both invited and contributed papers and posters covering areas related to the water and energy cycle. These are

- Atmospheric processes
- Precipitation
- Surface-atmosphere interactions over land and sea
- Continental scale water budgets
- Global modeling

A call for papers will be issued in summer 1993. For further information contact:

Chairman, Local Organizing Committee for
European Conference on the Global Energy
and Water Cycle
c/o Royal Meteorological Society
104 Oxford Road
Reading, Berkshire, RG1 7LJ
U.K.

SUMMARIES OF MEETINGS

The Fifth Session of the GEWEX Scientific Steering Group
San Diego, California, U.S.A.
1–5 February 1993

This session of the Global Energy and Water Experiment (GEWEX) Scientific Steering Group (SSG) began with a review of the major national and international achievements since the Group met for its fourth session in Tokyo in January 1992. The Scientific Plan for the GEWEX Continental-Scale International Project (GCIP) and a draft of Volume I of the Implementation Plan have been distributed. In addition to GCIP, planning for a few important international continental-scale studies has continued to develop in various regions around the globe. The National Earth Observing Programmes of the U.S.A., U.K., and Japan have also continued to move forward. Plans for a non-sun-synchronous mission with GEWEX specific instruments, including a millimeter-wave cloud radar, have also taken shape. The Science Panel structure and membership for the GEWEX Cloud System Study (GCSS) were formalized, and the Working Group on Radiative Fluxes (WGRF) and the International Satellite Land-Surface Climatology Project (ISLSCP) were accepted as integral parts of GEWEX. Changes in the GEWEX SSG were also made to reflect organization of the initial phase of GEWEX around the three scientific thrusts or subgroups of Atmospheric Radiation Processes, Cloud System Processes, and Land-Surface Processes and Hydrology.

The objective of this meeting was to critically assess progress in each of these major disciplines and, in particular, in implementation plans for GCIP, results of ongoing GEWEX projects, and plans for related national and international surface and space based observational activities.

The GEWEX SSG chairman emphasized in his opening remarks the importance of combining observations and models to develop the understanding necessary to undertake climate prediction and quantify the extent of man's influence on the climate system. The importance of GEWEX is, therefore, rooted in its general objective, to model the global energy and water cycles with unprecedented accuracy, attaining the level of knowledge to predict climate change and understand man's role in those changes.

The GEWEX Global Observation Phase was reported to be taking shape in the form of plans by the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA), and the National Space Development Agency of Japan (NASDA) for a series of polar observing platforms. A conclusion of the meeting was that the planning of those program has reached a level of maturity such that their instrument configurations will nearly fulfill the major requirements of the World Climate Research Program (WCRP) and GEWEX. Exceptions noted by the SSG are global winds, rainrate profiles outside the tropics, and global three-dimensional distribution of clouds.

It was noted that the International Satellite Land-Surface Climatology Project (ISLSCP) has published the results of the main

field experiment accomplished under its auspices. The findings of the First ISLSCP Field Experiment (FIFE) were reprinted in 1992 as a special issue of the Journal of Geophysical Research. One finding of FIFE was that for standard grass and plant types, the normalized difference vegetation index (NDVI) can provide useful estimates of the fraction of photosynthetically active radiation absorbed by the green portion of the vegetation canopy. This spectral albedo is linked to plant conductance, evapotranspiration, and general vegetation state, including stage of growth and water stress. These findings are relevant to GEWEX and GCIP in that they provide the basis for water budget and land process studies on scales of (10–100 km)².

Progress on preparing the GCIP Implementation Plan was discussed. Plans were made to initiate correspondence to establish a project office for GCIP.

The SSG was also advised of the progress of the Working Group on Numerical Experiments (WGNE)/GCIP Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS). This effort is moving rapidly toward its goal of achieving greater understanding of the capabilities and applications of land-surface schemes in atmospheric models.

The SSG was informed that the GEWEX Cloud System Study (GCSS) Science Panel, which met recently in Reading, U.K., agreed the emphasis of the study should be placed on cloud resolving models and exploring existing or parallel field studies that relate to the improvement of cloud parameterization schemes in general circulation models.

The meeting also addressed the status of the WCRP radiation projects being implemented in support of GEWEX. A strategy for continuation of the International Satellite Cloud Climatology Project beyond 1995, which included improvements in processing algorithms, was endorsed. Release of the Surface Radiation Budget data, continued expansion of the Baseline Surface Radiation Network, and results of various regional experiments were other issues addressed by the SSG.

Review of the broad base of research and development supported by the Operational Measurements Element of the National Oceanic and Atmospheric Administration (NOAA) Climate and Global Change Program was accomplished. The SSG was informed of analyses in land, atmospheric, oceanic, and stratospheric variables, as well as precipitation, clouds, aerosols, and the radiation budget.

Because of the potential value to GCIP, there was interest in the presentation on the implementation status of the Department of Energy's Atmospheric Radiation Measurement (ARM) Program Cloud and Radiation Testbed (CART) site in the central United States.

The meeting was closed with an agreement to hold the sixth session of the GEWEX SSG from 31 January to 4 February 1994 at a site to be determined. For information on SSG activities, contact S. Benedict, WMO (WCRP) 41, Avenue Giuseppe Motta, 1211 Geneva 2, Switzerland. PHONE: 41–22–730–8247; FAX: 41–22–734–0357; E-MAIL: OMNET/S.Benedict.

Fifth Session of the Working Group on Radiation Fluxes
San Diego, California, U.S.A.
8–12 February 1993

Recent developments and results were presented on radiation flux activities. Included was a discussion on downward shortwave fluxes that concluded data for most regions of the globe agree to within 10 w/m²; however, the larger discrepancies over certain land surfaces were noted. Progress on satellite instrument calibration activities was reported. Briefings were held on projects to resolve the problems associated with the production of global climatological records of longwave irradiance. Projects include the Spectral Radiance Experiment and data collected by the Baseline Surface Radiation Network. (An article on radiation results is found on page 1. More to follow in the next issue.) For information on WGRF activities, contact R. Newson, WMO, C.P. 2300, 41, Avenue Giuseppe Motta, 1211 Geneva 2, Switzerland. PHONE: 41–22–730–8418; FAX: 41–22–734–0354; E-MAIL: OMNET/R.Newson.

Colloquium and Workshop on Multiscale Coupled Modeling
Calverton, Maryland, U.S.A.
22–26 February 1993

A diverse group of at least 128 scientists and program managers from the Global Energy and Water Cycle Experiment (GEWEX) Continental-Scale International Project (GCIP), the GEWEX Cloud Systems Study (GCSS), the GEWEX Water Vapor Project (GVaP), the Atmospheric Radiation Measurement (ARM) Program, the U.S. Weather Research Program (USWRP), and the Aviation Weather Program (AWP) participated in a meeting to discuss the scientific modeling basis for a proposed Cooperative Multiscale Experiment (CME). The central focus of the CME is multiscale studies of mesoscale convective systems (MCS). The CME would be a long-term effort, with one of the major components being a field experiment in the central United States in 1995.

The primary purpose of the colloquium was to assess the current ability of models to simulate accurately the development and evolution of mesoscale cloud and precipitation systems and their cycling of water substance, energy, and trace species. The primary purpose of the workshop was to make specific recommendations for the improvement of mesoscale models prior to the CME, their coupling with cloud, cumulus ensemble, hydrology, and air chemistry models, and the observational requirements to initialize and verify these models.

After representatives discussed their respective programs, keynote talks and other presentations were given that reviewed the current status of modeling abilities and/or approaches. The product of these proceedings is a report that summarizes the colloquium assessments of the current status of coupled multiscale model predictive abilities and the subgrid scale physical parameterization, data assimilation, and computer or numerical approaches used in such models (or subclasses of such models). This report also contains the prioritized recommendations from the workshop for model development and required observations made by the conference participants for use in planning for the CME. Interested parties may contact the meeting organizer, Dr. Steven Koch, at NASA/GSFC, Code 912, Greenbelt, Maryland 20771, for a copy of these proceedings.

WCRP–GEWEX MEETINGS CALENDAR

29 June–2 July 1993—GEWEX TROPICAL WORKSHOP: CLOUD PROFILING RADAR FOR THE TRMM FOLLOW-ON MISSION will be held at the Jet Propulsion Laboratory, Pasadena, California, U.S.A., by invitation only. The purpose of the workshop is to examine the scientific utility and technical feasibility of flying a cloud radar on the TRMM-2 mission opportunity. Contact Ms. Deborah Vane, JPL, 4800 Oak Grove Drive, Mail Stop 246-648, Pasadena, California 91109; PHONE: 818–354–3708; FAX: 818–393–4508; E-MAIL: OMNET/D.Vane.

5–7 July 1993—SEVENTH SESSION OF THE JOINT SCIENCE COMMITTEE WORKING GROUP ON DATA MANAGEMENT WGDM) FOR THE GLOBAL PRECIPITATION CLIMATOLOGY PROJECT (GPCP) will be held at the headquarters of the Japan Meteorological Agency in Tokyo, Japan, by invitation only. For information contact Dr. Phillip Arkin, National Meteorological Center, Washington, DC; PHONE: 301–763–8317; FAX: 301–763–8434; E-MAIL: OMNET/P.Arkin.

11–23 July 1993—IAMAP/IAHS SCIENTIFIC ASSEMBLIES will be held in Yokohama, Japan. This is a joint international program of the International Association of Meteorology and Atmospheric Physics and the International Association of Hydrological Sciences. Several GEWEX components are included in the agenda (see 5 January 1993 issue of EOS). For second circular, contact IAMAP-IAHS, c/o Sankei Convention, Sankei Building, 10F, 1–7–2 Otemachi, Chiyodaku, Japan; PHONE: +81 3 3273 2083; FAX: +81 3 3273 2439 or +81 3 3273 6287; TELEX: 222 8342 SKBJPN.

30 September–1 October 1993—ISLSCP SCIENCE STEERING COMMITTEE MEETING will be held at NASA Goddard Space Flight Center in Greenbelt, Maryland, U.S.A., by invitation only. For information, contact Piers Sellers, PHONE: 301–286–4173; FAX: 301–286–9200; E-MAIL: PIERS@IMOGEN.GSFC.NASA.GOV.

18–21 October 1993—THE FOURTH ANNUAL GCIP SCIENCE PANEL MEETING will be held in Norman, Oklahoma, U.S.A., by invitation only. For information, contact IGPO, Dr. John Leese, PHONE: 202–863–1435; FAX: 202–488–5364; OMNET: INTL.GEWEX or J.LEESE.

18–22 July 1994—EUROPEAN CONFERENCE ON GLOBAL ENERGY AND WATER CYCLE will be held at the Royal Society, London, England. Organized by the U.K. GEWEX Forum, Prof. Keith A. Browning, Chairman. See announcement on page 13.

GEWEX REPORTS/DOCUMENTS

(Available from IGPO)

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. IGPO Publication Series No. 5.

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

GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP)—ATMOSPHERIC SCIENCE COMPONENT: Report on Atmospheric Subpanel Workshop, 18–19 March 1992, Silver Spring, Maryland, U.S.A. IGPO Publication Series No. 3.

IMPLEMENTATION PLAN FOR THE PILOT PHASE OF THE GEWEX WATER VAPOR PROJECT (GVaP), March 1992. IGPO Publication 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, Maryland, 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, Greenbelt, Maryland, U.S.A., 23–26 October 1990, WCRP-66 (WMO/TD No. 460).

GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP): Report of the First GCIP Planning Workshop, Reston, Virginia, U.S.A., 8–10 October 1990. IGPO Publication Series No. 1.

SCIENTIFIC PLAN FOR THE GLOBAL ENERGY AND WATER CYCLE EXPERIMENT, August 1990, WCRP-40 (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.

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