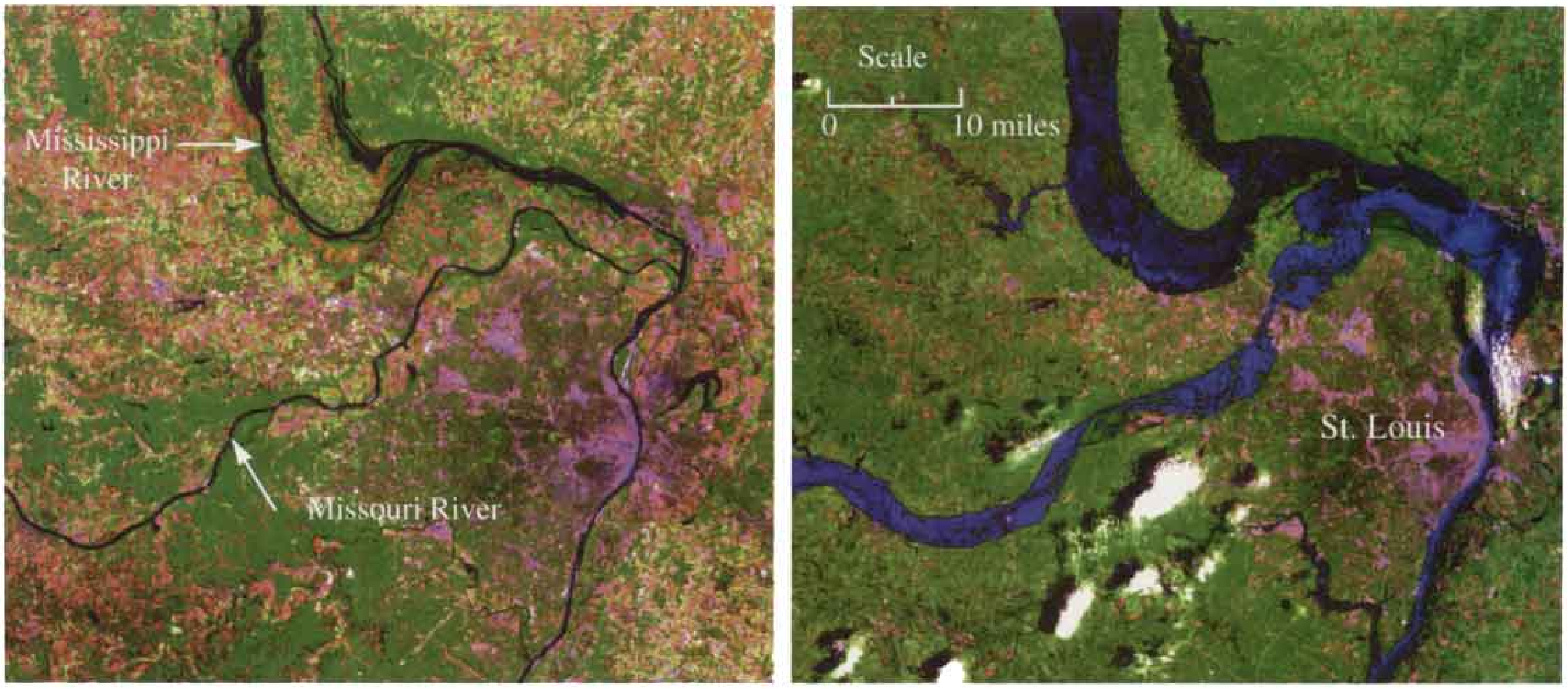
GEWEX WCRP
Global Energy and Water Cycle Experiment
NEWS

Vol. 3, No. 2 Summer 1993

World Climate Research Programme–WCRP



Landsat imagery courtesy of the Earth Observation Satellite Company, Lanham, Maryland, USA.

Drought Year (4 July 1988) **Flood Year (18 July 1993)**

Impact of Climate Variations on Mississippi River basin. The GEWEX Continental-scale International Project (GCIP) focuses on this region. (See GCIP Progress on page 3.)

GEWEX TOPICAL WORKSHOP: UTILITY AND FEASIBILITY OF A CLOUD PROFILING RADAR ON TRMM-2

Deborah Vane
Jet Propulsion Laboratory
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The purpose of this GEWEX Topical Workshop, held 29 June–1 July 1993 at the Jet Propulsion Laboratory (JPL), Pasadena, was to examine the scientific utility and technical feasibility of flying a cloud radar on TRMM-2. The Global Energy and Water Cycle Experiment (GEWEX) has recognized the scientific need for global measurements of vertical cloud profiles for understanding the crucial role of clouds in the climate system. The International Workshop on GEWEX-Dedicated Space Missions, held in Japan in November 1992, endorsed the National Space Development Agency of Japan's (NASDA) proposal for a Tropical Rainfall Measuring Mission follow-on (TRMM-2) (approximately

(Continued on page 6)

WHAT'S NEW IN GEWEX

- GCIP and GVaP presented to U.S. National Academy Committee
- GEWEX workshop recommends cloud radar for TRMM-2
- GCIP Implementation Plan, Vol. I, distributed
- NASA requests GVaP letters of intent
- New GCIP Science Panel Members announced
- GPCP distributes land/ocean precipitation data

[For Contents of this issue, please see page 3.]

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

John Roads and Shyh Chen
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and
Alex Guetter and Konstantine Georgakakos
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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

SYSTEMATIC ERROR OF PRECIPITATION MEASUREMENTS

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In a recent volume of *GEWEX News*, L. Dumenil (1993) discussed the systematic error of General Circulation Model (GCM) precipitation, pointing out that the model-produced rainfall in Little Rock (USA) was much less than observed during winter and spring. The purpose of this communication is to show that even the observed precipitation is much less than the "true precipitation." The reason is the systematic error of precipitation measurement. The body of a free exposed precipitation gauge systematically distorts the wind field, causing an increase in wind speed above the gauge orifice and forcing the development of eddies in and around the gauge. As shown in Fig. 1, the wind speed increase over the Mk2 gauge is between 20% and 30%. This prevents the smaller precipitation particles from entering the gauge. They are carried to beyond the lee of the gauge orifice. In this way, losses of precipitation gauge catch arise, amounting to 3–25% for rain and up to 20–100% for snow. In addition, some losses occur due to wetting of inner walls of precipitation gauges and due to evaporation occurring between the end of a precipitation event and the measurement of water accumulated in the gauge (Sevruk, 1991).

The losses depend on variables showing a distinct spatial and temporal variability. These variables include wind speed and the degree of the gauge site exposure, the weight of precipitation particles, the altitude and the latitude of gauge sites, and the gauge aerodynamical properties. Since different types of precipitation gauges are used in different countries, and the gauge site exposure in a network varies from exposed to protected, the wind-induced losses vary not only between the countries but also from site to site, causing the precipitation data to be spatially inhomogeneous even in the small, local networks. Figure 2 shows error estimates for five Swiss stations instrumented with the Hellmann gauge, and illustrates distinct seasonal and regional pattern. The Locarno station, situated in a valley in the southern part of Switzerland, shows low estimates due to prevailing heavy rainfalls in the summer and generally not frequent snowfall in the winter. In contrast, the estimates for the Davos and San Bernardino stations, situated in the Alps at altitudes above 1500 m a.s.l., are large, mainly due to frequent snowfalls even during the summer. Here, the effect of altitude is obvious. Moreover, the San Bernardino station is exposed and the error estimates in the winter are greater than those for the relatively protected Davos station.

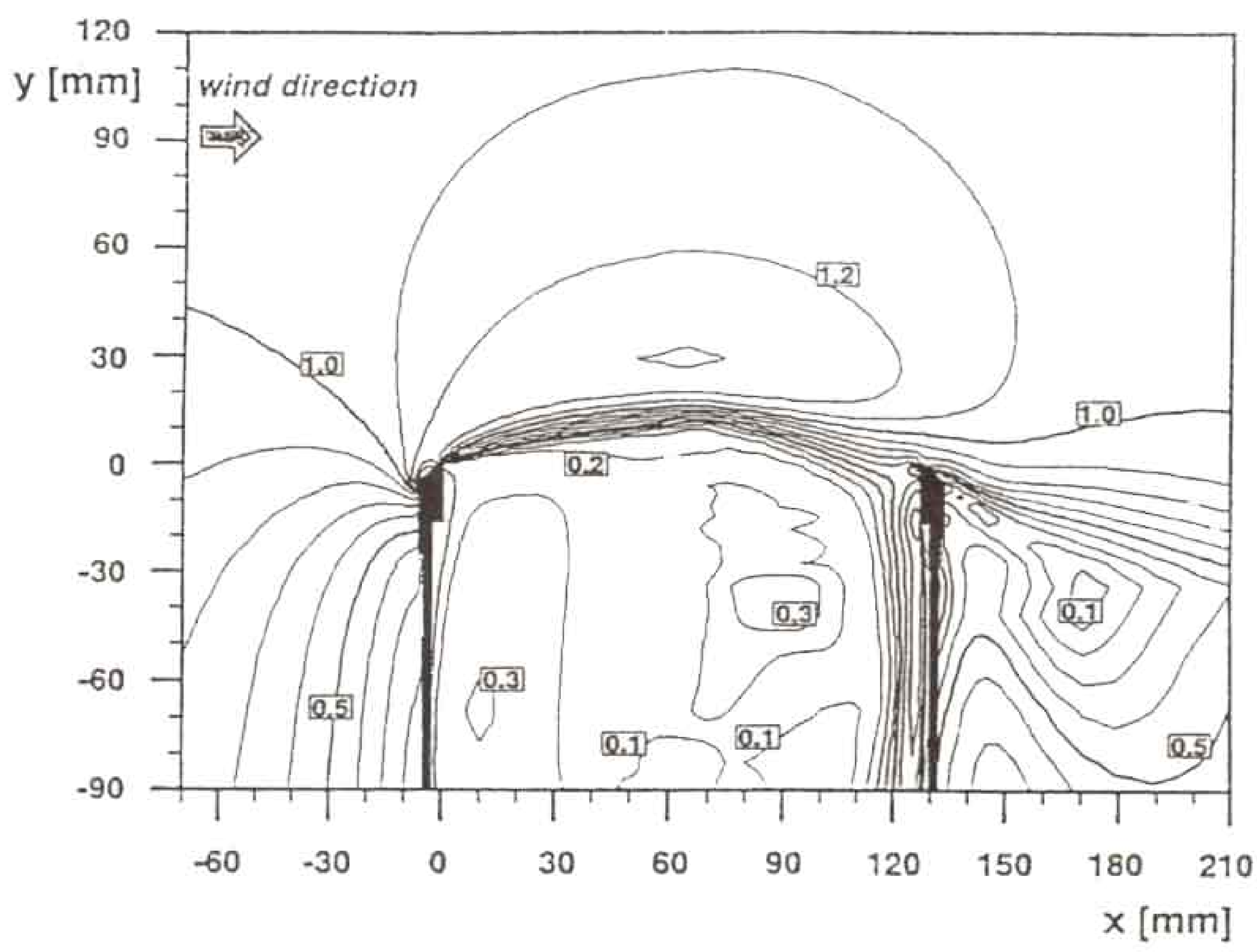


Fig. 1. Contour lines of normalized wind speed in and around the Mk2 precipitation gauge (British Meteorological Office) based on flow simulation using the Phoenics computer programme, according to Nespor et al. (1993).

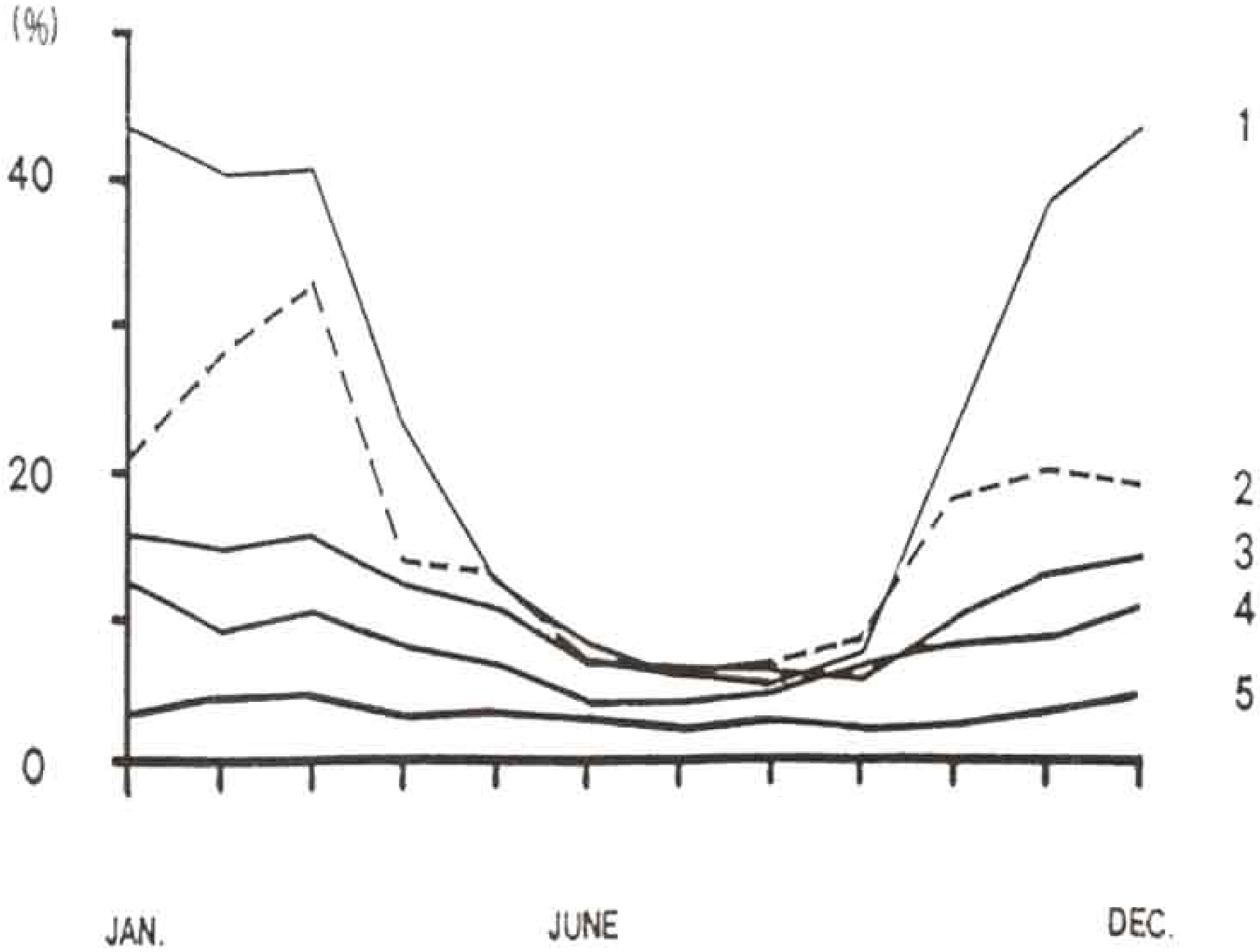


Fig. 2. Wind-induced losses and wetting losses of precipitation measurement in per cent for five Swiss stations: 1 - San Bernardino (1628 m a.s.l.); 2 - Davos (1580 m a.s.l.); 3 - Geneva (416 m a.s.l.); 4 - Zurich (556 m a.s.l.) and 5 - Locarno (336 M a.s.l.).

In addition to the spatial inhomogeneity, temporal inhomogeneity exists owing to either changes of gauge types or exposure during the observation period. The adjustment of time series for this kind of inhomogeneity using statistical methods does not eliminate the spatial inhomogeneity. It can be eliminated only when the correction procedures for the wind-induced losses are applied. Such procedures exist at present for only a few types of precipitation gauges (e.g., for the German Hellman gauge and the Russian Tretyakov gauge). They are based on time consuming field intercomparison measurements using special gauges as reference (e.g., pit gauge or snow fences). However, using computational fluid dynamics as based on the gauge construction parameters seems to be a more convenient alternative, as shown in Fig. 1. The correction procedure could be derived for any type of gauge using adapted software; and field tests will not be needed. Thus, it would be possible to correct the relevant precipitation data worldwide and to obtain the homogeneous global precipitation data set for the analysis of climate change effects and water balances as well as the calibration of GCMs.

With corrective measures in mind, the International Association of Hydrological Sciences/World Meteorological Organization (WMO) GEWEX Committee launched a precipitation measurement project with the objectives as follows:

1. To analyze the problem of ground precipitation measurement in all aspects relevant to measurement accuracy, representativeness, and standardization, as well as spatial and temporal homogenization of historic precipitation records.

2. To propose specific measures towards a reliable global precipitation data set representing the ground truth for the calibration of data obtained by remote sensing techniques, and serving as input for climate-related studies.

The project will include the results of the WMO Solid Precipitation Measurement Intercomparison, applications of corrections of systematic error of precipitation measurement to global and national data sets and precipitation maps, and the results of computational fluid dynamics and wind tunnel experiments of wind-induced error. Furthermore, methods of analysis of changes of precipitation measurement techniques and exposure of gauge sites with regard to inhomogeneities in precipitation time series will be reviewed.

References

Dumenil, L., 1993: Near surface systematic errors in GCMs—dynamics vs. land surface processes. *GEWEX News*, **2(2)**, 2-3.

Sevruk, B., 1991: Accuracy of climatological precipitation data. In D.E. Parker (Ed.): Observed climate variations and change: Contributions in support of section 7 of the 1990 IPCC scientific assessment. Meteorological Office, Bracknell, UK, XXIII.1–XXIII.12.

Nespor, V., B. Sevruk, R. Spiess, and J.A. Hertig, 1993: Modelling of wind tunel measurements of precipitation gauges. *Atm. Envir.* (in press).

GEWEX Topical Workshop

(continued from page 1)

55° inclination), aiming at launch in the year 2000. In addition to the original TRMM instruments, the November workshop recommended consideration of a cloud profiling radar. The Joint Scientific Committee's Working Group on Radiative Fluxes has also expressed their support of this effort.

Approximately 50 scientists attended the JPL workshop, representing Japan, Canada, the United Kingdom, the European Space Agency (ESA), the Centre National d'Etudes Spatiales (CNES), the World Climate Research Programme, the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and several academic institutions. Invited presentations were given, addressing scientific requirements, application of the data, and aspects of the design and use of a cloud profiling radar.

The participants strongly endorsed the concept of a 94-GHz, nadir-pointing, cloud profiler for the TRMM-2 mission (see Fig. 1). The workshop produced a set of agreed-upon statements and recommendations which are summarized below. The full workshop report is expected to be completed in late September.

Principal recommendations

1. Urgent action should be taken to formalize a development program for a 94-GHz, nadir-pointing, cloud profiling radar (CPR) with a view to launching it at the earliest opportunity.
2. Relative costs and benefits must be investigated for accommodating the CPR either on TRMM-2 or on a dedicated satellite.
3. In parallel with the above activities, there should be an intensification of studies using airborne and ground-based cloud radars, together with *in situ* observations and supporting theoretic and laboratory work.
4. A cloud radar science panel should be established and it should begin work as soon as possible to develop science and implementation plans.
5. Near-term engineering development studies of key technical items (such as the radar transmitter) should

- **NADIR-LOOKING 94-GHz PROFILING RADAR TO MAP CLOUD REFLECTIVITY**
- **DETERMINE REFLECTIVITY vs. HEIGHT BY SHORT-PULSE RADAR RANGING**
  - **CLOUD BASE HEIGHT**
  - **CLOUD LAYER THICKNESS**
  - **MULTIPLE LAYER DETECTION**
- **ESTIMATED CLOUD PROFILING CAPABILITY:**
  - **INTRINSIC HORIZONTAL RESOLUTION ≈ 800 m**
  - **VERTICAL RESOLUTION = 500 m**
  - **MINIMUM DETECTABLE REFLECTIVITY ≤ -30 dBZ**
  - **MULTIPLE PULSES INTEGRATED**
    - **EFFECTIVE HORIZONTAL RESOLUTION ≈ 800 m x 2.3 km**
- **PRELIMINARY RADAR SYSTEM CHARACTERISTICS**
  - **MASS: 125 kgm**
  - **POWER: 225 W**
  - **ANTENNA: 2 m DIAMETER**
  - **DATA RATE: 2 kbps**

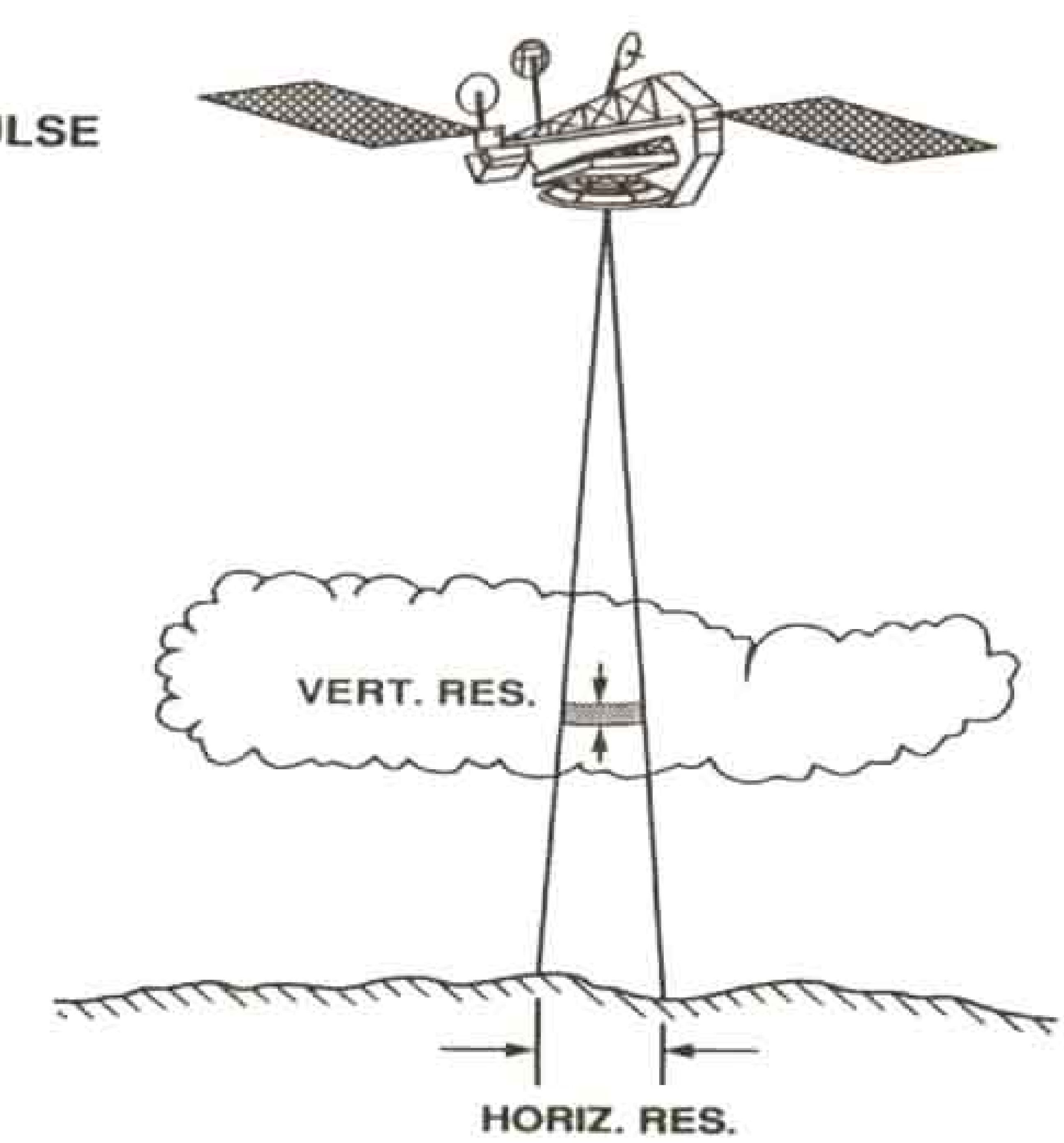


Fig. 1. Spaceborne cloud radar system design.

be conducted immediately to reduce the implementation risks.

The scientific need and requirements for cloud profiling radar

1. The global climate problem cannot be solved without a better understanding of the role of clouds.

2. The key science issues relate to the effects on the large-scale atmospheric circulation of the vertical, as well as horizontal, gradients of cloud-induced heating (both directly via the radiative and latent heating due to clouds, and indirectly via their effect on environmental water vapor).

3. Existing and planned measurements, while providing top-of-atmosphere radiation information, do not provide the essential vertical profiles of cloud and resultant heating.

4. The required vertical cloud structure can be obtained only by millimeter-wave radar.

5. Systematic measurements of vertical cloud profiles need to be obtained globally (to at least $\pm 55°$ latitude) to validate and develop parameterizations of cloud-induced effects in global General Circulation Models (GCMs) and climate models.

6. The global measurements require the use of a spaceborne cloud profiling radar. A simple nadir-pointing system, with a minimum sensitivity of –30 dBz, a vertical resolution of 1/2 km and a mission life of at least 3 yr, would provide an adequate sample of the large-scale cloud variability of significance to climate.

7. The global measurements need to be supported by detailed measurements of the microphysical, radiative, and thermodynamic properties of individual cloud systems, including the use of airborne cloud radar, together with cloud-resolving models as part of the GEWEX Cloud System Study (GCSS). Studies using airborne and ground-based cloud radars are also required to develop retrieval algorithms for the spaceborne cloud radar. ■

GCIP AND GVaP PRESENTED TO NATIONAL RESEARCH COUNCIL OF THE U.S. NATIONAL ACADEMY OF SCIENCES

The International GEWEX Project Office (IGPO) responded to an invitation to present to the National Research Council (NRC) Climate Research Committee (CRC) the status and plans for the GEWEX Continental-scale International Project (GCIP) and GEWEX Water Vapor Project (GVaP) on 11 and 12 May 1993. The National Research Council is the principal operating agency of the United States National Academy of Sciences to assist agencies in long-term planning. The meeting was held at the National Academy of Sciences Beckman Center in Irvine, California.

The GEWEX discussions were opened with an introduction provided by Dr. Moustafa T. Chahine, GEWEX Science Steering Group Chairman. Dr. John Schaake, GCIP Science Panel Chairman, outlined the science basis for GCIP. Dr. Michael Coughlan, National Oceanic and Atmospheric Administration Office of Global Programs, described the GCIP implementation planning. Dr. Eugene Rasmusson, University of Maryland, discussed the coordination of GCIP science activities. These coordination efforts were manifested by presentations by Dr. Franklin Robertson, GCIP Atmospheric Science Subpanel Chairman and Dr. Eric Wood, GCIP Hydrometeorology Subpanel Chairman. Dr. John Leese, IGPO, briefed for the GCIP Data Committee efforts on data acquisition planning. Dr. Coughlan concluded the first day's presentations with a summary of GCIP funding by U.S. agencies.

The GVaP presentations were made on the following day. Dr. S.H Melfi, NASA Goddard Space Flight Center (GSFC) and Project Leader of GVaP, introduced the program and the speakers to follow. Dr. Graeme Stephens, Colorado State University, spoke on the global climatology focus of GVaP. Dr. Melfi then described the purpose and planning for a water vapor reference station. Dr. David O'C. Starr, GSFC, discussed the intercomparison studies and Dr. Walter Dabbert, National Center for Atmospheric Research, presented new water vapor sensor research results.

The two days of the GEWEX presentations were summarized by Dr. M. Chahine for the CRC members and invited guests. ■

THE NEED FOR CORRECTION OF SYSTEMATIC ERRORS IN CONVENTIONAL PRECIPITATION CLIMATOLOGIES: GEWEX/GCIP IMPLICATIONS

Pavel Ya. Groisman, Robert G. Quayle,
David R. Easterling
National Climatic Data Center, USA

Quantifying biases in point-source precipitation measurements and conversion of those measurements to areal averages that are required for definitive hydrological research and climate model applications will be important contributions to GEWEX/GCIP programs.

The Problem

Use of conventional precipitation climatology for GCM model-data comparisons and other hydrological applications can lead to biased results (cf. Dumenil 1993). When the simulated cold season precipitation is half of that measured by the meteorological network, this error may or may not be considered significant, depending on the application of the model. However, if modelers attempt to improve the models using the conventional climatology, they may inadvertently introduce some systematic errors. The same is applicable to modern indirect methods of precipitation measurement (radars, satellites). For example, the WSR-88D program calibrates its data using records of conventional precipitation gauges from operational meteorological networks. The errors to which we refer are (1) systematic undercatch that is present in most widely used point source data sets; and (2) subsequent area estimates that do not account for systematic sampling errors. The combined effect of these biases can compromise GEWEX/GCIP research results.

Current precipitation data sets

The United States meteorological network consists of more than 13,000 stations. Of these, some 9,000 stations produce hourly and/or daily precipitation data that are processed, quality controlled, and archived in digital data sets at the National Climatic Data Center (NCDC) in Asheville, North Carolina. These data or subsets of these data are widely distributed by NCDC in many ways, including: the *Local Climatological Data* bulletin; the *Hourly Precipitation Data* bulletin; the U.S. Historical Climatology Network (HCN); and the contiguous United States Climate Division Data Base (CDDB). Over the contiguous United States, the HCN and to a lesser extent, the CDDB are likely the best available sources of monthly scale precipitation data. This is because of the careful selection process for long term quasi-homogeneous stations in the HCN and the high density of stations in the CDDB. However, we believe that these data are not entirely adequate to meet the diverse needs of many historical precipitation research projects. Consider, for example, estimates of long-term mean annual precipitation for Colorado obtained via differing methods from the HCN and CDDB databases, and digitized manually from subjectively analyzed climatological maps produced by the United States (U.S. Department of Commerce, 1968) and Russian (World Water Balance, 1974) climatologists (Table 1). The averages derived from the maps are 15% to 35% higher than the estimates based on averages computed from point-source (station) data. These differences can be attributed to the systematic biases associated with point precipitation measurements and to inaccuracies associated with deriving area averages from point precipitation measurements over complex terrain. These biases affect precipitation estimates to varying degrees for all regions of the United States and the globe and are discussed briefly below.

Biases in point precipitation measurements

There are several reasons for precipitation undercatch by the standard gauges used worldwide. The main

TABLE 1. Long-Term Mean Annual Areally Averaged Precipitation Estimates for Colorado

Source of data	Period 1891(5)-1970	Period 1931-1960
HCN Areal averages of station data	385 mm	375 mm
CDDB Areal averages of station data	405 mm	380 mm
(U.S.D.C. map, 1968) Manual areal averages	—	—
(W.W.B. map, 1974) Manual areal averages	520 mm	—

ANNUAL PRECIPITATION (mm)

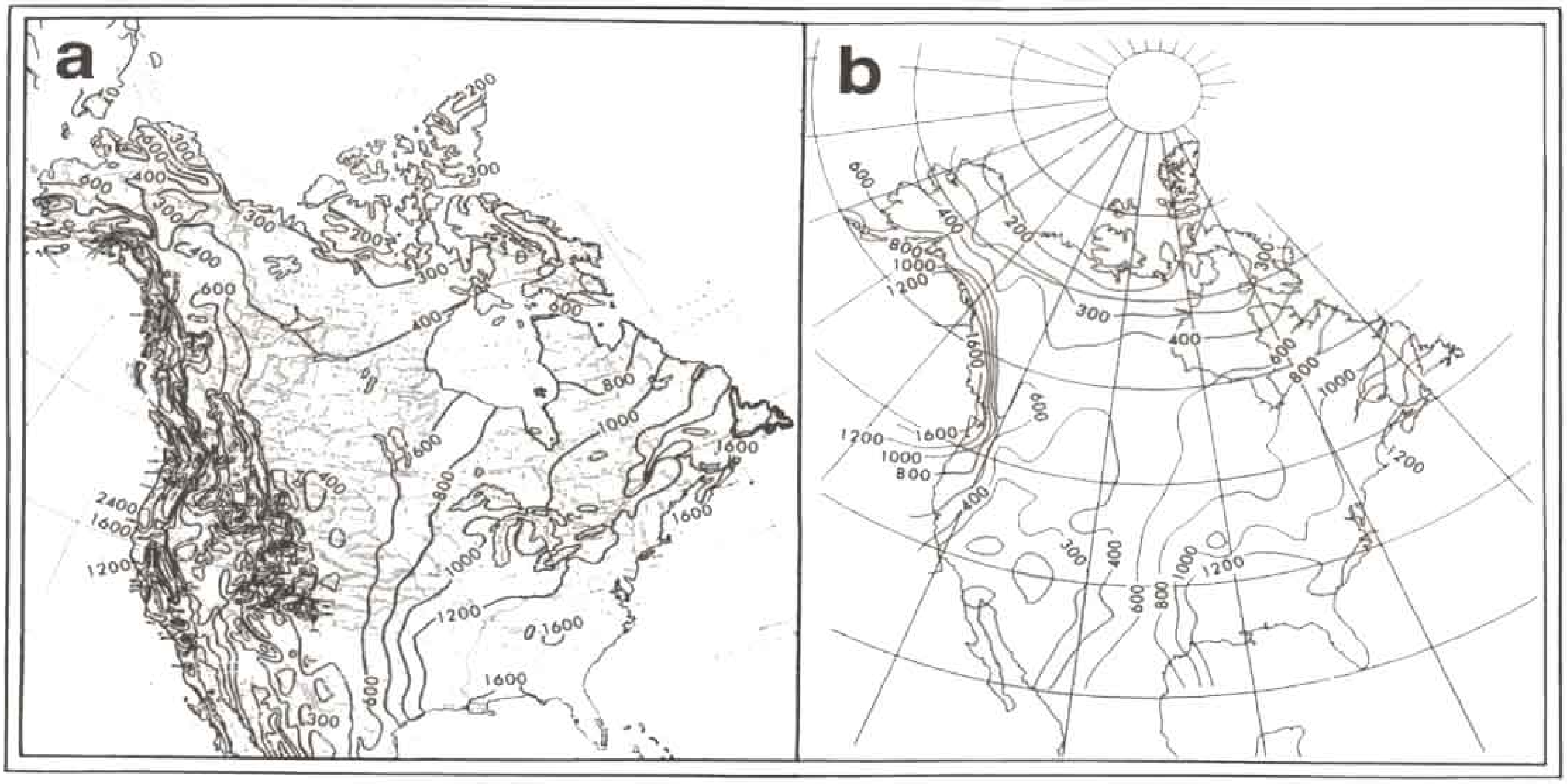


Fig. 1. Mean annual precipitation (mm) over North America (a) from World Water Balance (WWB) (1974); (b) as estimated using the operational meteorological network.

factor is wind-induced turbulence over the gauge orifice, and the resulting error is most pronounced for snow measurement. The absence of a wind sheld and variations of gauge and shield design can seriously complicate the problem. Field experiments show that an appropriate wind shield (such as the modified Nipher shield used in Canada) reduces the wind-related bias in the gauge catch to manageable values that can then be easily adjusted. All elevated snow gauges in Canada have wind shields, but only about 200 U.S gauges that report daily precipitation now have a wind shield. Furthermore, the Alter Shield in use at U.S. stations provides less protection than the Canadian Nipher shield. As a result, the existing U.S. rain gauge network measures rainfall with a bias of 3% to 10% and snowfall with a bias of up to 50% or more (Larkin, 1947; Larson and Peck, 1974; Golubev et al., 1992). In Alaska there are reported total biases up to 400% in measurements of water equivalent of snowfall (Black, 1954).

Biases related to area-averaging

When point precipitation measurements are expanded to area-averaged values for complex terrain, the point value averages are often below the ground truth area mean as a result of neglecting vertical gradients in precipitation and the valley locations of most meteorological stations. Figure 1 shows two maps of annual precipitation over North America. The first map (a) produced during World Water Balance studies (1974), was constructed manually incorporating debiasing adjustments to point measurements and subjective estimates of topographic effects on precipitation. The second map (b) was constructed using only data from 1,900 stations without any consideration of topographic effects. Precipitation in the mountainous West is obviously underestimated on the second map and even Appalachian ridge precipitation estimates are noticeably biased. The area-averaged annual precipitation for the contiguous United States derived from Fig. 1(a) is about 880 mm, and from Fig. 1(b) is 700 mm. When we use data from about 6,000 U.S. cooperative stations (from CDDB), this annual total increases to 735 mm, still below the likely ground truth.

A brief look at an average precipitation map analyzed by an experienced climatologist or hydrologist (cf. Fig. 1a) will give the viewer the impression that highly sophisticated analysis schemes are needed over complex terrain. The main principles that lead experienced climatologists, when extrapolating and interpolating data for ungauged regions to produce precipitation maps, are knowledge of topographic relief and atmospheric circulation patterns of water vapor flow. As an example, consider the various precipitation climatologies for Colorado in Table 1. Simple averaging, even using an extremely dense network (e.g., CDDB) gives results that appear to be inappropriate for hydrological needs. The situation can become even more complex because some averaging methods can overestimate area-mean precipitation values.

Ongoing research and solutions to bias problems

Gauge undercatch has been well documented, and physical models to estimate orographically induced precipitation are driven by the same principles used by experienced climatologists. By applying these physical models (of varying complexity), climatological precipitation maps can be reproduced quite well (cf. Rhea, 1978; Mikhailov, 1986; Barros and Lettenmaier, 1993). Automation of the models allows construction of unbiased computerized precipitation maps (and grid fields) in two independent steps. First, point precipitation measurements are adjusted to unbiased values using methods developed by American and Russian climatologists (Legates, 1987; WWB, 1974) and extensive metadata files that are currently being computerized at NCDC (Groisman, 1993). The methodology employs gauge type, exposure and site climatology. These values are then extrapolated and interpolated to regularly spaced grid points (or areas) over all terrain types using one of the above-mentioned models (such as PRISM, under development at Oregon State University). An NCDC project using this approach (supported jointly by NCDC, the Department of Energy, and NOAA's Earth Science Data and Information Management and Climate and Global Change Programs) was begun in 1992. Step one is well underway, but more work will be needed to implement the automated orographic models. We believe this research will be an important component of GEWEX/GCIP and will provide scientists with a valuable source of precipitation data over the United States and Canada.

References

Barros, A.P. and D.P. Lettenmaier, 1993: Dynamic modelling of the spatial distribution of precipitation in remote mountainous areas. *Mon. Wea. Rev.*, **121**, 1195-1214.

Black, R.F., 1954: Precipitation at Barrow, Alaska, greater than recorded. *AGU Trans.* **35(2)**, 203-206.

Dumenil, L. 1993: Near surface systematic errors in GCMs—dynamics vs. land surface processes. *GEWEX News*, **2(2)**, 2-3.

Golubev, V.V., P.Ya. Groisman, and R.G. Quayle, 1992: An evaluation of the U.S. standard 8-inch nonrecording rain gauge at the Valdai polygon, USSR. *J. Atmos. Oceanic Technol.*, **49**, 624-629.

Groisman, P.Ya.: 1993: Towards unbiased estimates of North American precipitation. *Proc. of the Eighth Symposium on Meteorological Observations and Instrumentation*, Anaheim, California, January 17–22, 1993, American Meteorological Society, Boston, MA, j43-j47.

Larkin, H. H. Jr., 1947: A comparison of the Alter and Nipher shields for precipitation gages. *Bull. Amer. Meteorol. Soc.*, **28**, 200-201.

Larson, L.W. and E.L. Peck, 1974: Accuracy of precipitation measurements for hydrologic modelling. *Water Resources Research*, **10**, 857-863.

Legates, D.R., 1987: A climatology of global precipitation. *Publ. Climatol.*, **40**, 84 pp.

Mikhailov, A. Yu., 1986: The evaluation of climatic precipitation fields in the regions of complicated orography. Data of meteorological studies, No. 10, Soviet Geophysical Committee, Institute of Geography, 18-22 (in Russian).

Rhea, J.O., 1978: Orographic precipitation model for hydrometeorological use. Colorado State University, Atmospheric Paper No. 287, 198 pp.

U.S. Department of Commerce, 1968: Climatic Atlas of the United States, Environmental Science Service Administration, Environment Data Service, 80 pp.

World Water Balance and Water Resources of the Earth (WWB), 1974: Gidrometeoizdat, Leningrad, 638 pp. (in Russian; in English published by UNESCO Press in 1978. ■

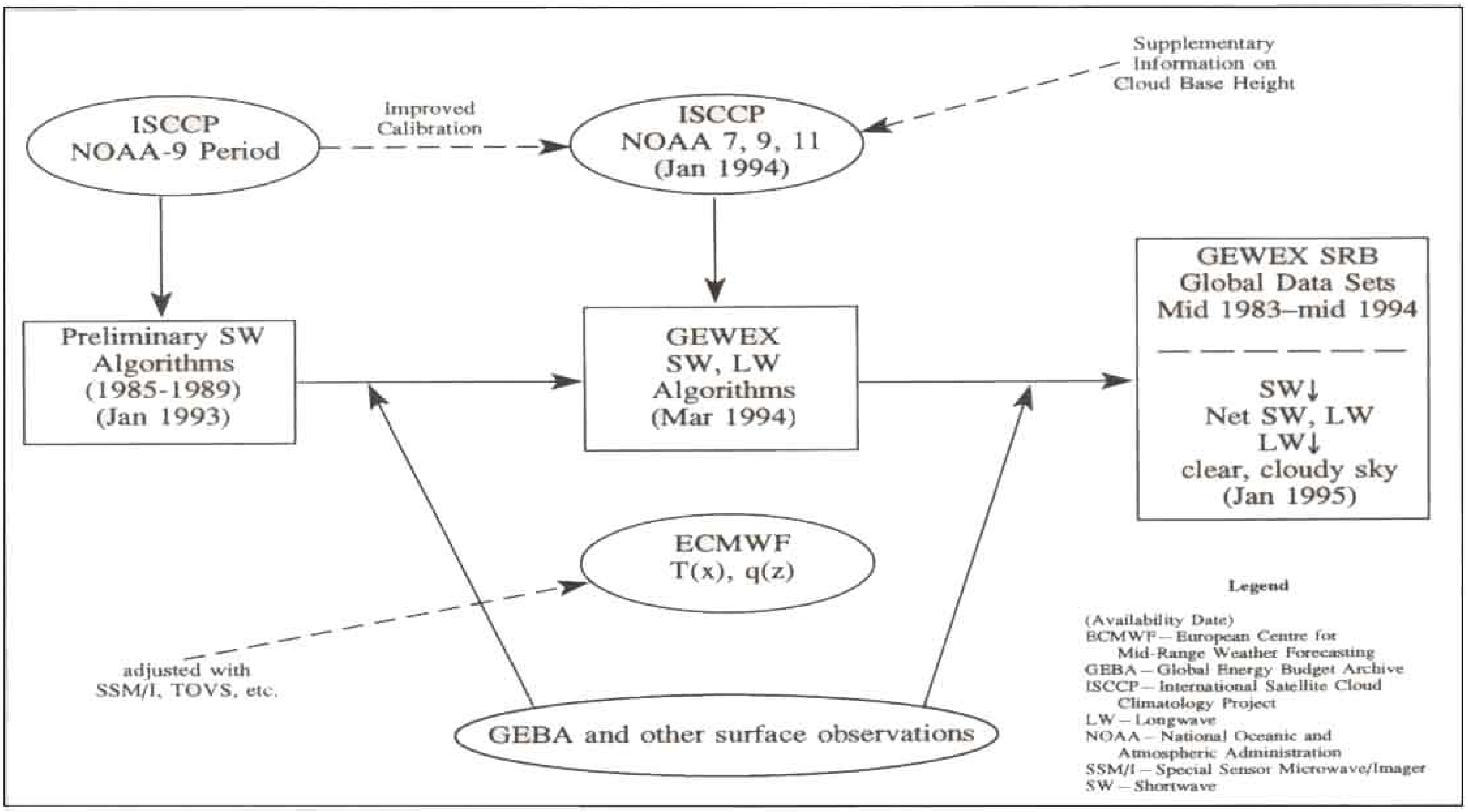
EDITOR'S NOTE

GEWEX investigators are encouraged to submit short articles on their findings for consideration in the Newsletter. Concise illustrations summarizing results are requested. The publication schedule for 1993/1994 is:

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

SURFACE RADIATION BUDGET PROJECT STRATEGY

In the last issue of *GEWEX News* (cf. Charlock et al., Vol. 3, No. 1) Surface Radiation Budget products were described. How the data for these products are acquired, processed and made available is illustrated in the accompanying figure.



Surface Radiation Budget Project and Schedule

NASA REQUESTS GVaP LETTERS OF INTENT

Water vapor, the most significant greenhouse gas, plays a fundamental role in the energy and water cycle processes. The accurate global measurement, modelling, and long-term prediction of water vapor is a primary goal of international global change science and GEWEX. The GEWEX Water Vapor Project (GVaP) is an effort to improve measurement and global data availability. The concept for GVaP was formulated in the late 1980s, following a series of workshops and meetings.

The National Aeronautics and Space Administration (NASA) has issued a letter to the international research community encouraging submission of a letter of interest and intent proposing research activities in support of the GVaP pilot study. The National Oceanic and Atmospheric Administration (NOAA) also has interest in supporting GVaP-related research and responses to the NASA request will be coordinated with NOAA.

Each investigator submitting a letter of intent will be informed of GVaP activities as they develop and will receive future announcements of opportunity related to the GVaP pilot project. Submissions are to be received by 30 September 1993 in response to the NASA letter and they will be used in further developing the detailed GVaP strategy. Copies of the NASA letter and related GVaP documents can be obtained from the IGPO. ■

CALL FOR ABSTRACTS

EUROPEAN CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE

to be held at The Royal Society, London 18–22 July 1994

Session Topics

Atmospheric Processes
Precipitation Measurement and Analysis
Land-Atmosphere Interactions
Ocean-Atmosphere Interactions
Continental-scale Water Budgets
Global Modelling

The purpose of the conference is to bring together meteorologists, hydrologists, and others involved in the study, via observations, modelling, and theory, of processes affecting the energy and water cycle, on scales ranging from that of the global circulation to small scale processes whose effects are felt both regionally and globally.

Abstracts (200 words, **two copies**) should be submitted by 31 October 1993 to:

The Executive Secretary
Royal Meteorological Society
104 Oxford Road
Reading, Berkshire RG1 7LJ
United Kingdom

When submitting your abstract you are requested to indicate the **conference title** and the **session** in which you wish to make your presentation. Indicate your preference for oral or poster presentation and whether you wish to present in the event your preference cannot be accommodated.

For registration information and abstract forms write to the address above, noting in your communication the conference title. ■

SUMMARIES OF MEETINGS

GEWEX Topical Workshop: Cloud Profiling Radar for TRMM-2
29 June–1 July 1993, Pasadena, California, USA.
(See article on page 1)

Seventh Session of the Joint Science Committee Working Group on Data Management (WGDM) for the Global Precipitation Climatology Project (GPCP)
5–7 July 1993
Tokyo, Japan

The Seventh session of the Working Group on Data Management (WGDM) for the Global Precipitation Climatology Project (GPCP) was held in Tokyo Japan, 5–7 July 1993. The purpose of the Working Group meeting was to review the status of implementation of the project with respect to the operations of its various data centers and the research issues surrounding continued progress in development of a global precipitation climatology. In addition, the meeting was combined with a special Planning Session to address topics related to the continuation of the Project beyond 1995. A Planning Meeting took place in Tokyo on 8–9 July, immediately following the WGDM session.

Satellite data processing centers in several countries continue to provide information to GPCP scientists. The status and plans for geostationary and polar orbiting satellites were reviewed. It was reported that prospects for continuing to receive geostationary satellite data are good.

Polar orbiting satellites continue to provide infrared data to derive the Global Precipitation Index. The Special Sensor Microwave/Imager (SSM/I) data from the U.S. Defense Meteorological Satellite Program continue to be received for processing.

Progress at the Global Precipitation Climatology Centre at Deutscher Wetterdienst to produce merged global precipitation products was reported and products now available were shown. These include merged rain gauge and satellite (infrared and microwave) data to produce global precipitation climatology data sets.

The Surface Reference Data Center component of GPCP at the NOAA National Climate Center in the United States has completed checkout of its workstation.

The Algorithm Intercomparison Centre at Bracknell, United Kingdom, has completed various comparisons of satellite estimates of precipitation against ground-truth measurements. A final workshop on this intercomparison effort is planned for 23–25 August 1993 in Reading, England.

Dr. Phil Arkin, GPCP manager, announced that he is changing positions and his new responsibilities will preclude him from continuing as GPCP Manager. It is expected his replacement will be finalized at the January 1994 GEWEX Science Steering Group Meeting to be held in Frascati, Italy.

IAMAP/IAHS Scientific Assemblies
1–23 July 1993
Yokohama, Japan

GEWEX science was well represented at the Joint International Association of Meteorology and Atmospheric Physics (IAMAP) and International Association of Hydrological Sciences (IAHS) Scientific Assemblies in Yokohama, Japan including a two-day symposium specifically on GCIP, the GEWEX Continental-scale International Project. Over 35 meteorology and hydrology symposia and workshops were held during the IAMAP/IAHS Assemblies, with more than two-thirds addressing, at least in part, GEWEX-related issues. Status and review presentations were made on the implementation of GEWEX and GCIP and on the modeling program for GEWEX. A session on the Project for the Intercomparison of Land-Surface Parameterization Schemes (PILPS) was especially well attended with lively discussions on the results of the first stand-alone intercomparisons of around 21 schemes submitted. These results will be published in detail elsewhere; readers of *GEWEX News* will be advised. Also attracting strong participation from both atmospheric and hydrological scientists was the Saturday, 17 July Workshop on "The Hydrology in Atmospheric Models." While the gap between the two groups may not yet have been bridged, this workshop and discussions in other symposia/workshops went a long way towards articulating the issues. ■

WCRP/GEWEX MEETINGS CALENDAR

25–27 August 1993—GEWEX WATER VAPOR PROJECT WORKSHOP, Fort Collins, Colorado, USA. For information contact Graeme Stephens, Colorado State University, Fort Collins,Colorado,USA.PHONE: (303)491-8550; FAX:(303) 491-8449; E-MAIL: g.stephens@langley.atmos.colostate.edu; or OMNET: G.Stephens.

8–11 September 1993—WORKSHOP ON THE BIOSPHERE-ATMOSPHERE FIELD EXPERIMENT IN AMAZONIA will be held in Sao Jose Dos Campos, SP, Brazil. For information contact Carlos A. Nobre, CPTEC Instituto Nacional de Pacquisas Espaciais (INPE), Sao Jose Dos Campos, SP, Brazil. PHONE: 55 123 41 8977 ext 270, FAX: 55 123 41 1876, E-MAIL: nobre@cptec.inpe.br, or OMNET: INPE.MET.

27–28 September 1993—ISLSCP SCIENCE STEERING COMMITTEE MEETING. NASA Goddard Space Flight Center in Greenbelt, Maryland, by invitation only. For information contact Piers Sellers at: PHONE: (301) 286-4173; FAX: (301) 286-9200; E-MAIL: PIERS@IMOGEN.GSFC.NASA.GOV.

18–19 October 1993—GCIP INTEGRATED SYSTEMS TEST (GIST) DESIGN WORKSHOP, Norman, Oklahoma, USA. For information contact Dr. John Leese. PHONE: (202) 863-1435; FAX: (202) 488-5364; E-MAIL/OMNET: INTL.GEWEX or J.Leese. Hotel and logistics information can be obtained by contacting Mr. K. Hicks, GIST Workshop, STC Meetings Div., 101 Research Drive, Hampton, VA 23666-1340. PHONE: (804) 865-7604; FAX: (804) 865-8721. Early response is requested for hotel reservations and workshop planning.

18–20 October 1993—INTERNATIONAL WORKSHOP ON CLOUD-RADIATION INTERACTIONS AND THEIR PARAMETERIZATION IN CLIMATE MODELS, Washington, D.C. For information 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.

20–22 October 1993—THE FOURTH ANNUAL GCIP SCIENCE PANEL MEETING, Norman, Oklahoma, USA, by invitation only.

10–12 November 1993—GEWEX SURFACE RADIATION BUDGET SCIENCE WORKSHOP, Langley, Virginia, USA. For information contact Thomas P. Charlock, NASA Langley Research Center, Mail Stop 420, Hampton, Virginia 23665. PHONE: (804) 864-5687; FAX: (804) 864-7996.

7–10 December 1993—GEWEX CLOUD SYSTEM STUDY MEETING, Reading, UK. For information contact Dr. Keith Browning, University of Reading, P.O. Box 238, 3 Early Gate, Reading, Berkshire, RG6 2AL, UK; FAX: 44 734 318791.

17–22 January 1994—SIXTH SESSION OF GEWEX SCIENTIFIC STEERING GROUP, Frascati, Italy, by invitation only.

23–28 January 1994—AMERICAN METEOROLOGICAL SOCIETY FIFTH SYMPOSIUM ON GLOBAL CHANGE STUDIES to be held in conjunction with the 74th AMS Annual Meeting in Nashville, Tennessee, USA. Sessions on GEWEX Continental-scale International Project (GCIP) and GEWEX Water Vapor Project (GVaP) are scheduled. For information contact IGPO, Prof. Eric Barron, Pennsylvania State University. PHONE: (814) 865-1619; FAX: (814) 865-3191; OMNET: E.Barron; INTERNET: eric@essc.psu.edu.

18-22 July 1994—EUROPEAN CONFERENCE ON GLOBAL ENERGY AND WATER CYCLE, will be held at The Royal Society, London, England. Organized by the UK GEWEX Forum, Chairman, Prof. Keith A. Browning. **See Call for Abstracts on page 12**. ■

NEW LAND/OCEAN GLOBAL PRECIPITATION DATA SET

The Global Precipitation Climatology Center (GPCC) Offenbach, Germany, of the Global Precipitation Climatology Project (GPCP), has just completed a new global data set of merged satellite (IR and microwave over oceans) and gauge (over land) monthly precipitation data for the 1987–1988 time period. Model data were also used to fill gaps in the 2.5 x 2.5 degree data. The data set comes with display software for browsing in a PC format. Requests for copies should be addressed to: Global Precipitation Climatology Center, c/o Deutscher Wetterdienst, Postfach 10 04 65, 63004 Offenbach am Main, Germany. ■

GEWEX REPORTS/DOCUMENTS (Available from IGPO)

IMPLEMENTATION PLAN FOR THE GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP), Volume I—Data Collection and Operational Model Upgrade, May 1993, IGPO Publication 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, USA.

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

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

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

(Continued on page 15)

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PHONE: 202–863–1435/0012.

(continued from page 14)

GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP) ATMOSPHERIC SCIENCE COMPONENT; Report on Atmospheric Subpanel Workshop 18–19 March 1992. May 1992, 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, 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 Publication 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. ■

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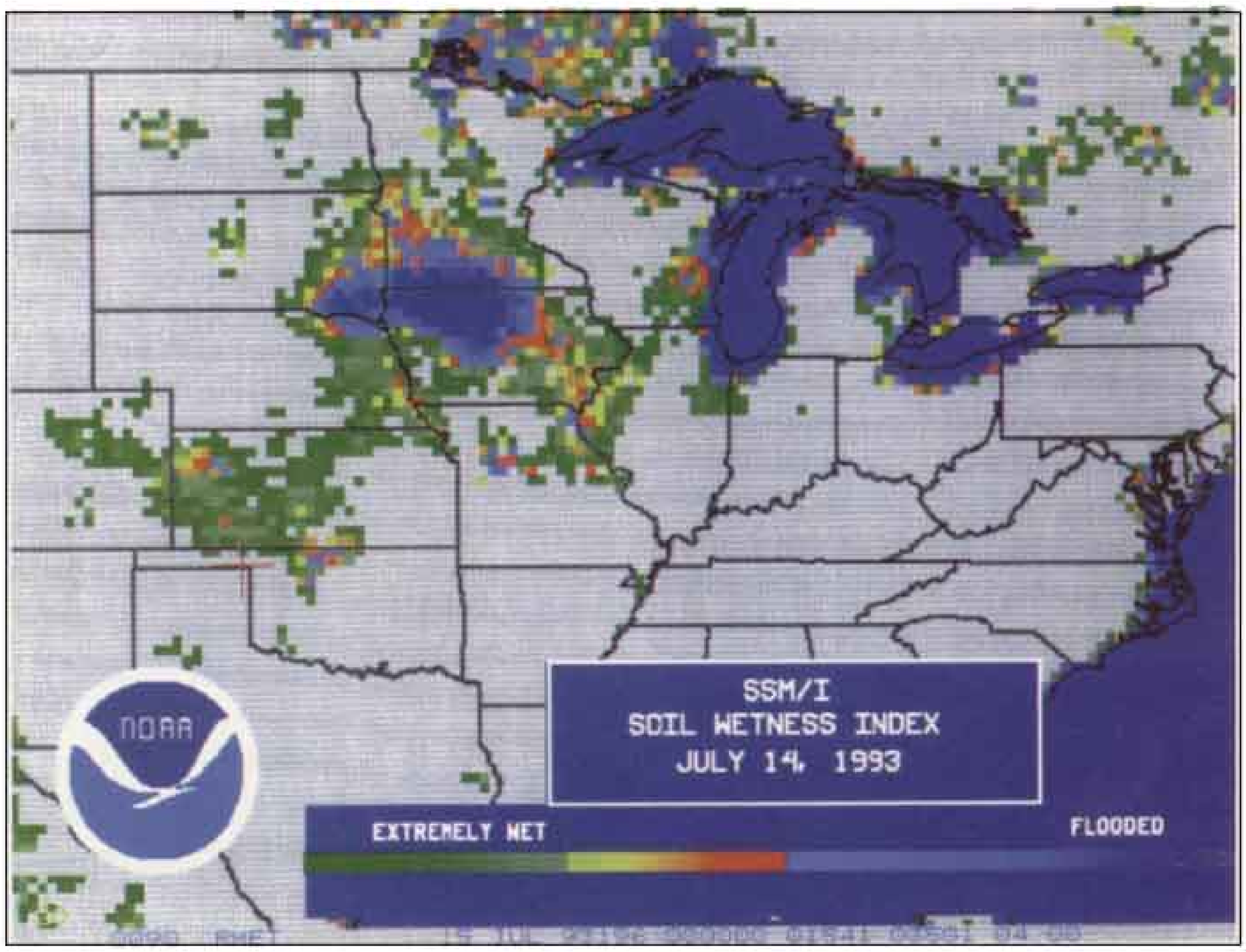

Courtesy of the National Oceanic and Atmospheric Administration (NOAA)/National Environmental Satellite, Data, and Information Service (NESDIS)

Midwest United States Soil Wetness Depiction

Flooding in the Midwest portion of the United States has extended well beyond the immediate vicinity of the Mississippi and Missouri Rivers as depicted in the accompanying figure of soil wetness indices. Using the 19- and 85-GHz channels of the Defense Meteorological Satellite Program's (DMSP) Special Sensor Microwave/Imager (SSM/I) instrument, Drs. Norman Grody and Rao Achutuni of NOAA/NESDIS have been investigating improved algorithms for detecting and mapping soil wetness.

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