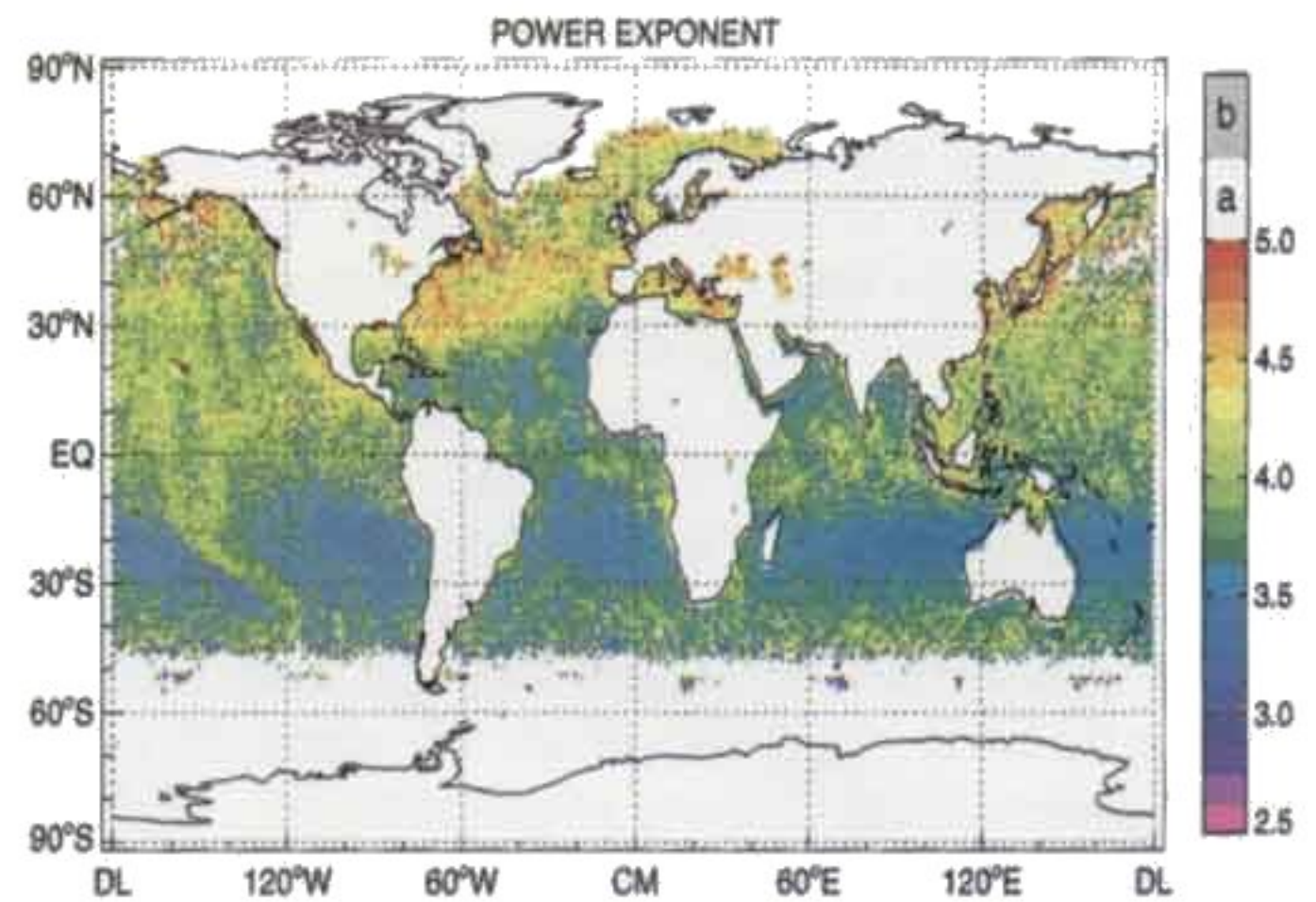
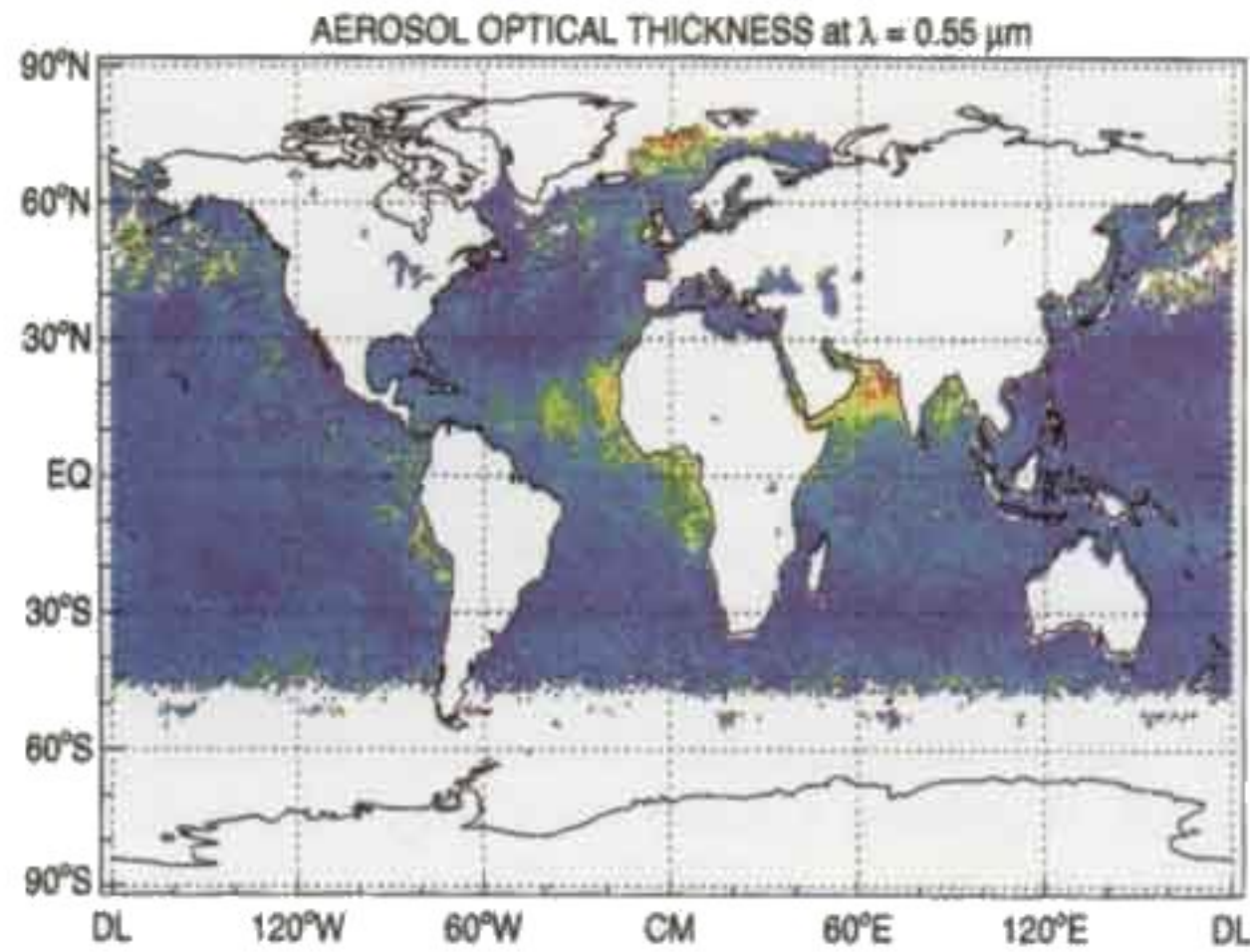


World Climate Research Programme—WCRP

GEWEX PROJECT RESULTS CONTINUE

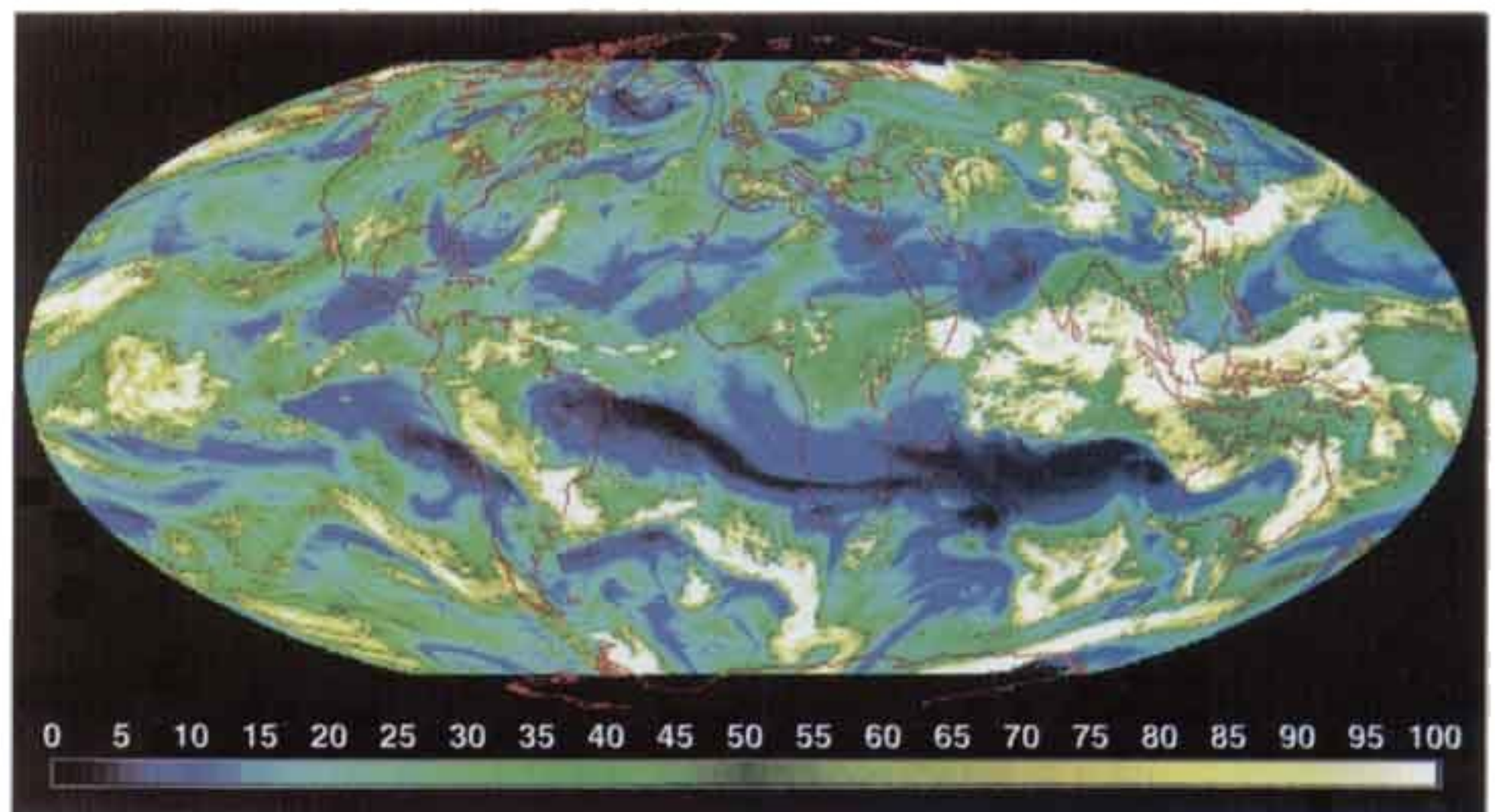
Examples in this issue:

New Satellite Products and New Cloud, Radiative and Land-Surface Model Intercomparisons and Transferability Initiatives



Example of a new **GEWEX Aerosol Climatology Project (GACP)** product from NASA Goddard Institute for Space Studies. Displayed are AVHRR retrievals (July) of aerosol optical thickness (left) showing plumes of aerosols of African and Asian dust and biomass burning. At right, exponent of a power law size distribution showing that smaller exponents (larger particles) are associated with the dust and the opposite for biomass burning plumes. See page 3.

GEWEX Global Water Vapor Project (GVaP) holds first workshop to address upper tropospheric humidity measurements and retrievals. At right is a **EUMETSAT** example of global tropospheric humidity derived from observations of the upwelling radiance in the strong water vapor band at $6.7 \mu\text{m}$ by five geostationary satellites, namely: **GOES-8** and **-9**, **GMS-5**, **Meteosat-5** and **-6**, on 14 May 1998 at 08:00 UTC. See page 6.



WHAT'S NEW IN GEWEX

- Abstracts due on 15 November 1998 for Third International GEWEX Scientific Conference (see page 14)
- NASA Aerosol Data Processing Facility Established
- GEWEX Hydrometeorology Panel (GHP) Senior Scientist Position Established
- GHP Transferability Strategy Key To New Initiative
- GEWEX/ACSYS Planning a Model Intercomparison Study
- GVaP Conducts Intercomparison of Radiative Transfer Models

COMMENTARY

**GEWEX MODELING
AND PREDICTION PANEL (GMPP):
FROM PARAMETERIZATION
TO PREDICTION**

**Moustafa T. Chahine, Chairman
GEWEX Scientific Steering Group**

The GEWEX Modeling and Prediction Panel (GMPP) is one of three major elements of the GEWEX research program. GMPP was established to develop and improve cloud and land-surface parameterization schemes and ensure their successful integration into General Circulation Models (GCM). A broader and even more challenging objective of GMPP is to incorporate the scientific insight from all GEWEX studies, exploiting the information from GEWEX global data sets and process studies to demonstrate extended predictions of precipitation, water storage and runoff over continental regions, as an element of seasonal-to-interannual climate predictability. GMPP responsibility extends to providing validation and accurate computation of the radiation budget and fluxes, and response to changes in external parameters, as an element of decadal-to-centennial climate variability.

GMPP includes two activities organized earlier to advance climate modeling: (1) the Project for Intercomparison of Land-surface Parameterization Schemes (PILPS) seeks to improve understanding of model formulations of land-atmosphere interactions; and (2) the GEWEX Cloud System Study (GCSS) seeks to improve parameterization of cloud systems in atmospheric models. Significant advances by both PILPS and GCSS have been made in a short time despite the limited amount of the needed field data. PILPS has completed the intercomparison of a wide range of parameterization schemes under equilibrium off-line simulations subject to artificial forcing data and has subsequently evaluated their accuracy with observational data. GCSS, based on determining the effect of clouds acting as systems (not as individual clouds), has focused on four different types of clouds: boundary layer, high-level cirrus, extra-tropical layer, and precipitating convective systems. Several case studies have been undertaken successfully and the sensitivity of large-scale parameters to different

treatments in cloud resolving models has been demonstrated.

More recently, GMPP advanced its modeling efforts one step further in association with the WCRP/CAS Working Group on Numerical Experimentation (WGNE) to improve the accuracy of predictions by weather and climate models. Two parallel activities were added that integrate the land surface parameterization schemes and the cloud and boundary layer processes into GCMs to develop fully coupled land-surface atmospheric models. These activities have engaged the most advanced numerical weather prediction centers in America, Asia and Europe.

In the framework of WCRP, the future goals of GMPP are very demanding. As part of GEWEX, GMPP should aim to demonstrate improved and extended predictions of the principal components of the global energy and hydrology cycle on time scales up to annual. Furthermore, GMPP must engage the recently formed JSC/CLIVAR Working Group on Coupled Modelling (WGCM) to meet WCRP's Grand Challenge of developing and validating models capable of simulating the climate system and predicting its variations on a wide range of space and time scales.

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GLOBAL AEROSOL CLIMATOLOGY PROJECT (GACP): STRUCTURE, EARLY PRODUCTS AND PLANS

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NASA Headquarters

Michael Mishchenko
Goddard Institute for Space Studies

Ina Tegen and Igor Geogdzhayev
Columbia University

Tropospheric aerosols are thought to cause significant direct and indirect climate forcing, but the magnitude of this forcing remains highly uncertain because of poor knowledge of global aerosol characteristics and their temporal changes. The standard long-term global product, the one-channel Advanced Very High Resolution Radiometer (AVHRR) aerosol optical thickness over ocean, relies on a single predefined aerosol model and can be inaccurate in many cases. Furthermore, it provides no information on aerosol column number density, thus making it difficult to estimate the indirect aerosol effect on climate. The Total Ozone Mapping Spectrometer (TOMS) data can be used to detect absorbing aerosols over land, but are less sensitive to aerosols located at low altitudes. Therefore, innovative approaches must be employed in order to extract a more accurate aerosol climatology from available satellite and other measurements and enable more reliable estimates of the direct and indirect aerosol forcings.

The main objective of the Global Aerosol Climatology Project (GACP), established in 1998 as part of GEWEX, is to analyze satellite radiance measurements and field observations in order to infer the global distribution of aerosols, their properties, and their seasonal and interannual variations for the full period of available satellite data. The resulting data sets and analysis products will be used to improve understanding and modeling of the climate forcing due to changing aerosols, including both the direct radiative forcing by the aerosols and the indirect radiative forcing caused by effects of changing aerosols on cloud properties. In Phase I of GACP, a 20-year global climatology will be compiled of aerosol forcing data from satellite observations and field measurements for use in climate models. To accomplish this, the Earth Science Enterprise of NASA

Headquarters has established a processing center at the Goddard Institute for Space Studies (GISS), and a science team has been formed to study aerosol forcing of climate. The science team includes U.S. and international participants whose research is funded by other sources. The first meeting of the science team is scheduled for 18–20 November 1998 in New York City.

The primary function of the processing facility at GISS is to provide the science team with a "working instrument" for the development of advanced global aerosol climatologies and to make these aerosol climatologies broadly available. It is expected that the overall objective of GACP will be accomplished primarily through a systematic application of multichannel aerosol retrieval algorithms to the full period of satellite measurements. The retrieval algorithms and strategies will be suggested, developed, and, in many cases, validated by the science team. An additional responsibility of the science team is to review the results of applying the retrieval algorithms to satellite data by the GISS facility and to make decisions as to what the next step should be and, finally, what climatology should be accepted as standard. The responsibility of the processing center is to provide state-of-the-art radiative transfer software and suitable computer resources, to test and refine the retrieval algorithms using ground-based/*in situ* data and future EOS results, and reprocess the full period of satellite data at appropriate times as improved algorithms or data calibrations are achieved. The results of this work will be routinely reported to the science team.

It is expected that initial retrievals will use channels 1 and 2 AVHRR data. Still further refinements of aerosol climatologies may be possible by merging different data streams, e.g., using *in situ*/ground-based data and data from polar and geostationary satellite instruments. These refinements will also be supervised and reviewed by the science team.

Current retrievals of aerosol optical properties from satellites are predominantly from low reflectance oceanic regions. Additional techniques for using satellite measurements over land are envisioned by the members of the science team. Further, results from 3-dimensional aerosol chemistry/transport models will be used to fill in coverage gaps. These models compute aerosol distributions from source emissions

using prescribed meteorological fields to calculate aerosol transport, mixing, transformation, and deposition. Such calculations will be carried out for each of the important aerosol types individually. Ground-based measurements and satellite-derived aerosol distributions will be used to validate and constrain these models. On the other hand, the results from transport models can be used as "first guess" scenarios in satellite retrievals. In this way both satellite retrievals and model transport calculations of distributions of aerosol properties can be improved iteratively. Improved satellite instruments, retrieval algorithms and models are planned for NASA's Earth Observing System (primarily the EOS AM platform). Development of AERONET, an international network of surface stations for the retrieval of aerosol parameters is well underway. As these improvements become available, the combined aerosol product will become increasingly more accurate.

It is planned that the aerosol climatologies will be used by the members of the science team in making radiation and transport model calculations aimed at examining the direct and indirect effects of aerosols on climate. These model calculations will provide useful feedback helpful in further refining and improving the climatologies and enhancing their information content.

An important responsibility of the GISS processing facility is to establish and continually update an Aerosol Climatology World Wide Web home page (<http://www.giss.nasa.gov/gacp>) which will make existing and future global aerosol data sets easily accessible. The project home page will also be used to display and coordinate activities of individual research projects funded through the NASA Radiation Science Program.

The processing facility at GISS is already functioning and is producing early transport modeling and satellite retrieval results. As an example, the figure on the back page represents the sum of model-derived annual mean aerosol optical thickness for five main aerosol species (sulfates, sea salt, soil dust, organic aerosols, and black carbon). The individual aerosol transport models, from which these results are derived, were developed by Chin et al. (1996) for sulfates, Tegen and Fung (1995) for soil dust, Tegen et al. (1997) for sea salt, and Liousse et al. (1996) for organic aerosols and black carbon.

It has been suggested by Durkee et al. (1991) and Nakajima and Higurashi (1997) that retrieval algorithms combining AVHRR channel 1 and 2 data can be used to determine not only the total aerosol optical thickness, but also an additional aerosol parameter. Since the number of unknown aerosol parameters is many more than one (e.g., real and imaginary parts of the refractive index, effective radius, and a measure of the width of the aerosol size distribution), there is, in general, a choice of the additional parameter to be retrieved. The two-panel figure on the front page exemplifies two-channel AVHRR retrievals of the aerosol optical thickness and the exponent of a power law size distribution. Larger values of the exponent correspond to smaller average aerosol sizes, and vice versa. The left and right panels show monthly mean values for July 1986. The maps of optical thickness clearly show that the most prominent plumes of aerosols are associated with continental sources such as African and Asian dust and biomass burning. The smallest exponent values and, thus, the largest particle sizes are most likely associated with dust and sea salt aerosols. **These early results show that two-channel AVHRR retrievals may serve as an important tool in achieving the main GACP objectives.**

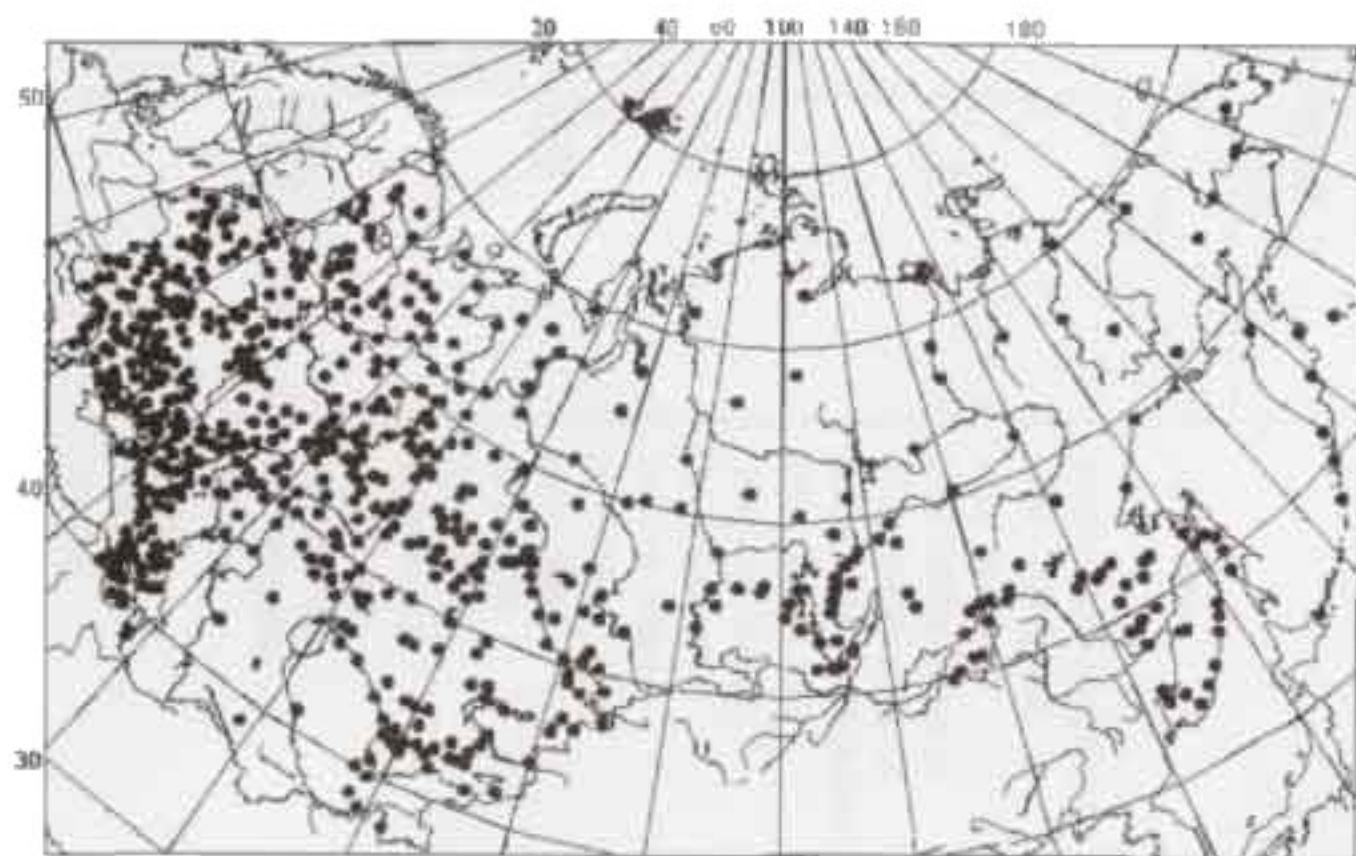
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IMPACT OF ENSO ON SNOW COVER IN THE FORMER SOVIET UNION

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As was shown recently in the May 1998 issue of *GEWEX News*, there is a relationship of upper Mississippi River Basin snowfall in the northern United States to the El Niño Southern Oscillation (ENSO) (Kunkel and Angel, 1998). **The global significance of ENSO is also evident from its impact on snow cover in the Former Soviet Union (FSU) on the continent of Northern Eurasia.** This impact was analysed using snow survey data on representative forests and open fields for the 1966–1990 period. These data were obtained from a new database (Krenke et al., 1997) that includes 600 stations distributed over the entire FSU territory. Only stations with complete information for the 1966–1990 period were selected from the database (see figure below). The maximums for each station were calculated as a weighted average between forests and open field measurements and weighed according to the rate of forestation within a radius of 50 km.



Location of snow survey stations used in this study.

According to Kunkel and Angel (1998), four El Niño events (strong warming of the ocean surface) in 1965–66, 1968–69, 1972–73, 1982–83 and four La Niña events (weak warming of the ocean surface) occurred in 1970–71, 1973–1974, 1975–76, and 1988–1989 over the past 25 years. For each station the relationship was calculated between seasonal maximums of snow storage averaged for four El Niño years and the other 21 years, and, for four

La Niña years and the other 21 years. The dates of maximums for individual stations are different. The fields of these relationships (anomalies) were recalculated in 2x2 degree grids.

In El Niño years (top left panel on back page), positive anomalies cover the southern and central parts of FSU, including Central Asia states, east of Caucasus, and Southern and Eastern Siberia. The strongest positive anomalies appear in the southern mountains and in the Central Yakutiya. Extremes are to the west of Gissaro-Alay in Central Asia and in Kuznetskiy Ala Tau in Southern Siberia. Negative anomalies of snow cover in El Niño years cover the north of Western and Middle Siberia and the most part of the Russian Plain (East European Plain). The distribution of snow cover anomalies in La Niña years is almost opposite. (See top right panel on back page.) Anomalies are positive over the main part of the Russian Plain and over the northern part of Middle and Eastern Siberia. Negative anomalies of snow cover appear in the western part of the Russian Plain, in Central Asia, almost all Kazakhstan and south of Siberia, including the southern mountains.

In general, **El Niño years correspond to positive anomalies of snow cover in the southern part of the country, especially in the mountains. La Niña years correspond to positive anomalies in the northern part of the country from the Russian Plain to the mountains of North-Eastern Siberia.** North Atlantic cyclones seem to increase in La Niña years and Mediterranean cyclones do so in El Niño years. Snow cover correlates reasonably well with winter precipitation anomalies and very poorly with winter air temperature. An exception to this is the thin snow cover over the Russian Plains in El Niño years due to high air temperatures.

This work was backed by the Russian Fund of Fundamental Investigations (Grant No. 96-05-15375).

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REPORT ON THE FIRST GVaP WORKSHOP ON UPPER TROPOSPHERIC HUMIDITY MEASUREMENTS AND RETRIEVALS

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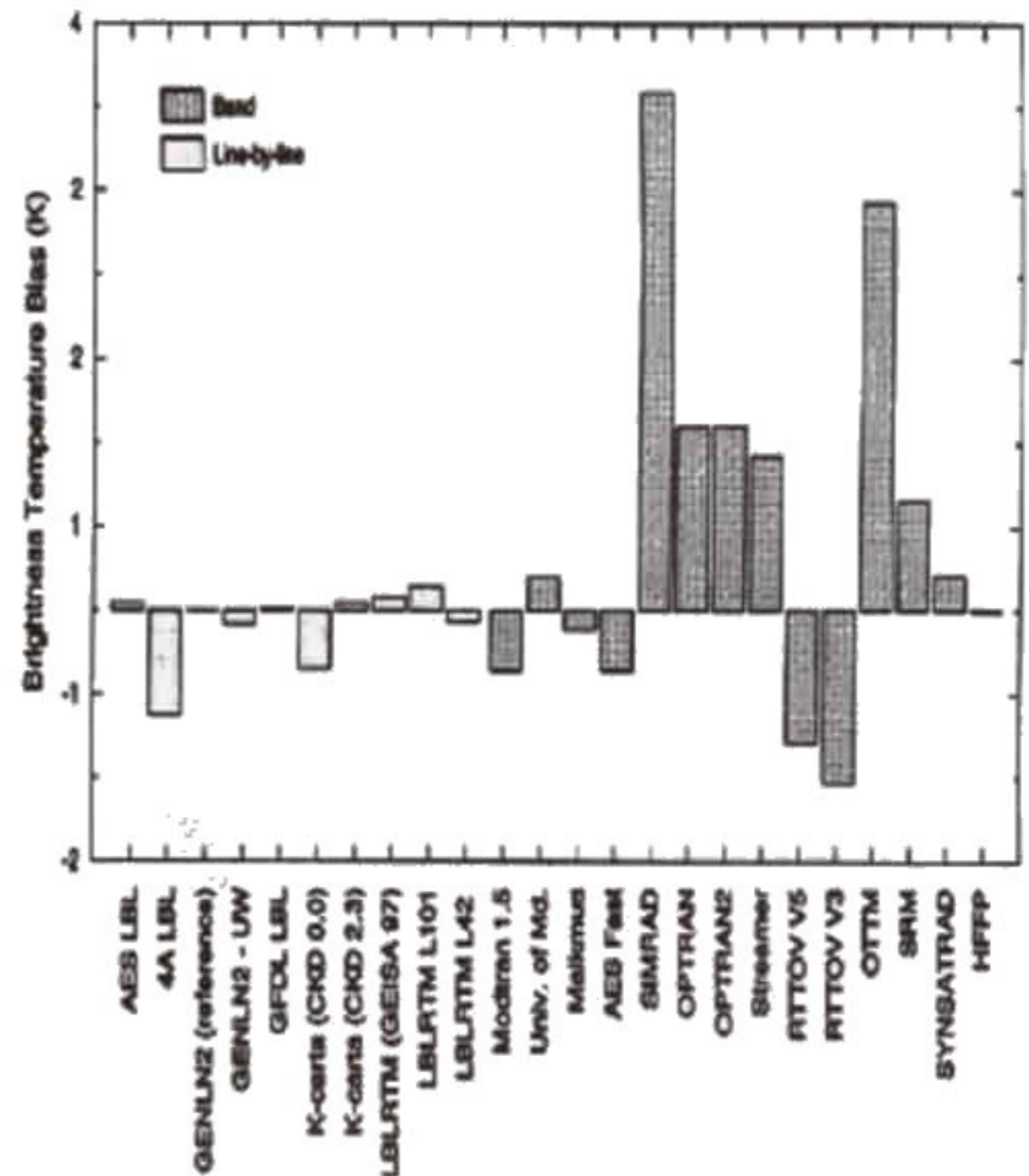
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Water vapor is widely recognized to be a key climate variable, serving to link an assortment of complex and poorly understood processes. Reducing current uncertainties involving water vapor in the climate system requires accurate global measurement, modeling, and long-term prediction of water vapor. Towards this end, the GEWEX Global Water Vapor Project (GVaP) was given a responsibility to "establish an accurate and validated water vapor climatology on the relevant space and time scales" (Chahine, *GEWEX News*, November 1997). In order to help meet this research objective, a series of workshops are planned to target key areas of uncertainty. The first of these meetings, a GVaP Workshop on Upper Tropospheric Humidity Measurements and Retrievals, was held in Darmstadt, Germany, on 2–3 June 1998 at the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT).

The purpose of the workshop was to intercompare top-of-atmosphere radiances in the 6.3- μm water vapor absorption band as simulated by different radiative transfer codes. At present there are several space-borne sensors which measure the upwelling radiance in this spectral range to retrieve information on the moisture content of the upper troposphere. Among these are space-borne instruments that sense in the 6.7- μm band and have provided a 20-year radiance record of upper tropospheric humidity (UTH). The derivation of UTH from these observations is being done at a variety of institutes throughout the world. A EUMETSAT example is shown on page 1. Interpretations of space-based instrument measurements depend on the availability of models that provide an accurate description of the transfer of radiation in this spectral domain through a cloud-free atmosphere. Common to all UTH retrieval methodologies is a dependence on "forward" radiative transfer calculations. There are a number of models, of

varying origins and levels of complexity that can be used to perform such calculations. Unfortunately, little is known regarding the differences between the various radiative transfer codes and their effects on the retrieval of UTH fields. Such issues are of considerable importance both for climatological assessment of UTH, as well as operational utilization of water vapor radiance measurements. The first GVaP workshop on tropospheric humidity was designed to address this need by providing a systematic intercomparison of radiative transfer codes using identical spectral response functions and a carefully selected set of 43 representative temperature and humidity profiles. The major findings of the workshop are summarized here. A more complete discussion of the results is in preparation.



The bias in simulated brightness temperature for each of the 24 models computed with respect to the GENLN2 LBL model.

A total of 24 different models, ranging from detailed line-by-line (LBL) models to coarse spectral resolution band models to channel-specific parametric models, participated in the intercomparison. The figure above shows the difference in mean brightness temperature, averaged over the 43 independent thermodynamic profiles, for each model relative to that computed from a reference LBL

model (chosen to be the median of the LBL models). For the vast majority of models (22 out of 24), the simulated brightness temperatures agree with the reference LBL calculations to within approximately 1 K. Exceptions are evident for older band models (OTTM and SIMRAD) which exhibit biases in excess of 2 K. These larger biases are believed to result, in part, from the absence of water vapor continuum absorption in the 6.3- μm region for the older models. The highest degree of commonality is found among the LBL models for which the majority agree to within 0.2 K. For reasons not completely clear at this moment, one LBL model (4A LBL) differs systematically from the others by roughly 0.7 K. The other outlying LBL model (K-carta with CKD 0.0) uses an older parameterization of the CKD water vapor continuum absorption. With the exception of the two older band models, the remaining band models typically agree with the reference LBL results to within 1 K. However, this does not mean that the band models agree with each other to within 1 K. For example, two of the more widely used models (RTTOV and OPTRAN) exhibit differences with respect to the reference LBL model of less than 1 K; however, the biases are of the opposite sign. Hence the relative difference between these two models is nearly 2 K. Such a discrepancy will lead to systematic biases both in retrieving UTH as well as in direct assimilation of the water vapor radiances. Recent analysis has identified an error in Version 5 of the RTTOV model which may account for a portion of this bias. Updated results of the RTTOV Version 5 model will be included in the formal manuscript.

The workshop also investigated the effects of model parameterizations, such as continuum absorption by water vapor and oxygen, on the simulated radiances. Inclusion of continuum absorption by both species reduces the radiance at top of atmosphere by roughly 1.8 K, with about 80% of the reduction due to the water vapor continuum and about 20% due to the oxygen continuum. Thus, accurate treatment of continuum absorption is a necessity for UTH retrieval. For variational (1D-Var) UTH retrievals or direct assimilation of radiances in an NWP model it is also necessary to compute the gradient of the transmittance model with respect to absorber concentration (commonly referred to as the Jacobian). Four of the models participated in a comparison of the gradient of their brightness temperatures with respect to water vapor for two extreme profiles. Preliminary results show that these calcu-

lations can be particularly sensitive to the vertical discretization of the forward models. Further work is needed to explore the impact of such differences on data assimilation.

Any retrieval strategy depends heavily on the ability to quantitatively relate radiances to absorber concentrations. Therefore, systematic differences in transmittance models will inevitably introduce differences in the derived products even when using the same retrieval method. Since water vapor typically reduces the upwelling radiance in this spectral region, a model that overpredicts the radiance would require a larger amount of water vapor to yield the correct brightness temperature. **Analysis of current retrieval strategies suggest that a 1 K uncertainty in the simulated brightness temperature corresponds to roughly a 12–15 percent relative uncertainty in UTH.** Note that errors in simulated brightness temperature scale linearly with the relative uncertainty in UTH. Hence, a constant error in brightness temperature introduces a smaller absolute uncertainty at the dry end of the UTH spectrum and a larger absolute uncertainty at the moist end. It is emphasized, however, that consistency among the various radiative transfer models does not necessarily imply accuracy. Validation of radiative transfer models, especially of reference calculations produced by line-by-line models, can only be achieved only through a comparison of radiative transfer calculations (based upon accurate observations of both the input parameters, e.g., temperature and trace gas concentrations) with observed spectral radiances. The ability to perform such comparisons hinges on the existence of accurate *in situ* measurements as well as an accurate understanding of satellite instrument calibration and spectral characterization.

The relative convergence among the variety of radiation codes utilized in this workshop represents an advancement in the understanding of radiative processes in this spectral region. The primary conclusions from the workshop may be summarized as follows:

- **LBL calculations typically agree to within ~ 0.2 K with the exception of one model.**
- **Majority of band models agree to within ± 1 K of reference LBL results.**



*Some of the participants at the 4th GHP meeting in Boulder, Colorado.
(Photograph courtesy of University Corporation for Atmospheric Research)*

**UTH MEASUREMENTS
AND RETRIEVALS**

(Continued from page 7)

- Continuum absorption by both H₂O and O₂ is important in this spectral region, collectively reducing the simulated brightness temperatures by ~2 K.

In addition to intercomparing radiation codes, the development of UTH climatologies was also discussed. At present several different climatologies exist. The characterization of these climatologies in terms of intrinsic errors and uncertainties will require comparison of the satellite retrievals with independent observations. Such efforts are currently underway and will be the subject of future workshops which will include satellite/satellite and satellite/*in situ* comparisons, as well as studies of satellite calibration and spectral characterization uncertainty.

**GEWEX HYDRO-
METEOROLOGY PANEL
ADVANCES ITS GLOBAL
APPLICATIONS STRATEGY**

**Rick Lawford
GCIP Office**

Determining regional water and energy budgets over land areas, and representing the underlying physical processes in coupled land-atmosphere models is a primary activity of the five Continental-Scale Experiments (CSE) established around the globe by the GEWEX program. The five experiments include the GEWEX Continental-scale International Project (GCIP) in the Mississippi River Basin led by the USA; the Baltic Sea Experiment (BALTEX) in the drainage basin of the Baltic Sea led by Germany; the GEWEX Asian Monsoon Experiment (GAME) in eastern Asia led by Japan; the Mackenzie GEWEX Study (MAGS) in the Mackenzie River Basin led by Canada; and, the Land Biosphere-Atmosphere Program (LBA) in Amazonia led by Brazil. In 1995, the GEWEX Hydrometeorology Panel (GHP) was established to coordinate the work of the CSEs and to develop a central focus that would facilitate the transfer of the knowledge generated in these projects to global climate models.

The GHP is developing a strategy that will consolidate its activities and shape the priorities within the CSEs over the next 5 to 7 years. The strategy will enable the CSEs to effectively address their overall goal which is to "work with other WCRP initiatives to

NOTICE

**THIRD INTERNATIONAL
SCIENTIFIC CONFERENCE
ON THE GLOBAL ENERGY
AND WATER CYCLE**

Beijing, China
16-19 July 1999
(see page 14)

demonstrate skill in predicting changes in water resources and soil moisture on time scales up to seasonal and annual as an integral part of the climate system." GHP is striving to realize this goal by 2005. A central component of this goal is the determination of the role of land in atmospheric predictability on all time scales.

Considerable progress was made in developing plans for addressing these issues at the 4th GHP meeting and the associated workshop held in Boulder, Colorado, during the period 14–18 September 1998. The meeting was attended by representatives from each of the Continental Scale Experiments, as well as representatives from the International Satellite Land-Surface Climatology Project (ISLSCP), the Global Runoff Data Centre (GRDC), the Global Precipitation Climatology Project (GPCP), the International Association of Hydrologic Sciences (IAHS), the Flow Regimes from International Experimental and Network Data (FRIEND), the GEWEX Modeling and Prediction Panel (GMPP), the GEWEX Global Water Vapor Project (GVaP) and the GEWEX Scientific Steering Group (SSG). A workshop was held to review the research activities of each of the CSEs in the light of the Panel's new initiatives, and to explore a number of scientific topics of concern to the Panel. **Highlights from the meeting were the adoption of the GHP Global Applications and Transferability Strategy; progress in planning the Coordinated Enhanced Observing Period (CEOP); the appointment of a GHP senior scientist; and the establishment of a GHP Data Management Subcommittee.** The meeting was chaired by the GCIP representative and current GHP chair, Rick Lawford.

At the outset of the meeting, Dr. Moustafa Chahine, Chair of the GEWEX SSG, announced that the position of a GHP Senior Scientist had been created and a suitable candidate for the position had been found. After further discussion and negotiation, the terms of reference for this position were revised and the successful candidate (Dr. Ronald Stewart) was announced.

The GHP Global Applications and Transferability Strategy provides a framework for coordinating activities between the various CSEs. Dr. Stewart reported on this strategy which will serve as a framework for future GHP initiatives. The plan was accepted by each of the CSEs with some modifications based on discussions at the

meeting. The document will be used as a strategy document to guide the design of future applications activities and transferability studies involving two or more CSEs.

A status report was given by Dr. Toshio Koike on the CEOP. Based on the resulting discussion, a small working group met to further develop the scientific rationale and implementation steps.

Dr. Pavel Kabat's report on ISLSCP described the scientific findings from past experiments such as the Boreal Ecosystem-Atmosphere Study (BOREAS) and plans for AMERIFLUX. The joint GAME presentation by Drs. Koike and Taikan Oki highlighted the results of the successful GAME Intensive Observing Period (IOP) that was held in three areas during the past summer. Unique data sets for model development and validation will soon be available from Tibet, Thailand and southeast China. Drs. Ehrhard Raschke and Hans-Jorg Isemer reported on BALTEX. The third BALTEX conference was a major success and a number of new results flowing from the project were presented. Preliminary climatological analyses of energy and water budgets were presented for the BALTEX region along with the results of various modeling studies.

The MAGS presentation by Dr. Stewart highlighted the work that is being done in the Canadian GEWEX Enhanced Study (CAGES) and in climate studies. Pavel Kabat (reporting for Dr. Carlos Nobre) described preparations for the LBA field observation activities and preliminary research results. He also presented a number of simulations showing the effects of El Niño on the seasonal predictions in the Amazon. Dr. Jan Polcher described the advances being made in planning and implementing Couplage de l'Atmosphère Tropicale et du Cycle Hydrologique (CATCH) in West Africa.

The GCIP presentation featured Dr. Jim Shuttleworth describing the land surface modeling work; Dr. Kenneth Mitchell outlining progress with Eta model development through the GCIP core project; Dr. Eric Wood describing a number of projects that GCIP has initiated to apply its models and results to the user community; and Dr. John Leese discussing the observing periods and the data management systems being implemented in GCIP. In addition, Rick Lawford discussed some of the plans that are being developed for the post-2000 period and described GCIP's climate studies and

contributions to the GHP Global Applications and Transferability Strategy.

The GEWEX presentation was followed by an number of other special topic presentations. Dr. Paul Try indicated how the GHP strategy could support other components of GEWEX and how, in turn, GHP could benefit from these other activities. The opportunity to access global data sets is clearly an important contribution of GEWEX to the GHP applications and transferability strategy. Additional reports on GEWEX-related projects were given by Dr. David Randall on GVaP, Dr. Jai-ho Oh on the Korean Monsoon Experiment, Dr. Wolfgang Grabs on the GRDC, and Dr. Bruno Rudolf on the GPCP.

The general project presentations were followed by special lectures on a number of topics including: water and energy budgets, land surface modeling, hydrologic modeling, data assimilation, clouds and precipitation, and soil moisture and vegetation. Dr. John Roads presented an interesting analysis of the model outputs for water budget components in each of the CSE areas. Dr. Jan Polcher reviewed some of the findings of his work with land surface modeling as well as a perspective of the activities of GMPP. Dr. Dennis Lettenmaier described hydrologic models noting that the distributed large-scale hydrologic models are merging with land surface schemes. Data assimilation activities were discussed by Drs. Mitchell and Stan Benjamin. Dr. Mitch Moncrieff discussed the role of cloud resolving models and cloud studies in larger scale modeling. Dr. Raschke demonstrated how well the ISCCP outputs and model outputs compare with data sets for Europe. Dr. Kabat reviewed the contributions of soil moisture and vegetation studies to land surface modeling, placing considerable emphasis on the Global Soil Wetness project and how such products could contribute to the GHP.

A number of other updates were given as part of these presentations. Dr. Alan Gustard described the FRIEND project and the ways in which GHP could interact with it. Dr. John Schaake updated the group on a GHP project on model calibration (known as MOPEX). Dr. Gert Schultz described the needs of the water resources community and reported on the current activities of the IAHS. He cautioned the CSEs that the water resource community is very conservative and unlikely to get excited about prediction products until the proven level of success is very high. Rick Lawford reported on the

results of the GEWEX/ ACSYS workshop on hydrologic modeling held in Quebec City (see page 12). Dr. Jim Shuttleworth described the results of the Tucson Soil Parameterization meeting and discussed plans for a workshop on a global hydrology strategy.

The workshop divided into working groups dealing with modeling, climate assessment of the energy and water budgets in CSEs and water resources. The recommendations from these working groups were raised at the GHP Executive meeting and form the basis for revisions to the GHP Applications and Transferability Strategy. The modeling group emphasized the need for each CSE to produce year-long data sets that meet the standards for model intercomparisons for one or more sites. As a result of the recommendation from the second working group, a workshop focusing on water and energy budgets will be held in conjunction with the 1999 GHP meeting. In another development, Steve Williams presented the needs for more coordinated data management within GHP and especially for the CEOP. Based on his recommendation, the Panel accepted the proposal to develop terms of reference for a subcommittee and to establish it before the next GHP meeting.

The next meeting will be held in Germany (to be hosted by BALTEX) in 1999. Dr. Nobre (LBA representative) will serve as chair of the GHP for the 1999-2000 period.

ANNOUNCEMENT

ARM Appoints Chief Scientist

Professor Thomas Ackerman, Pennsylvania State University, has accepted the position of Chief Scientist for the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Program. He had served as the site scientist for the ARM Tropical Western Pacific Local and a member of the ARM Science Team for almost ten years. Prof. Ackerman is in transition into his new position and will be moving to the Pacific Northwest Laboratory in the summer of 1999.

WORKSHOP SUMMARIES

GCSS WORKING GROUP I: BOUNDARY LAYER CLOUDS

24–26 August 1998
Madrid, Spain

Peter Duynkerke
Utrecht University, The Netherlands

The 5th Workshop of GEWEX Cloud System Study (GCSS) Working Group I was hosted by Instituto Nacional de Meteorologia (INM) and Joan Cuxart Rodamilans (j.cuxart@inm.es) was the local organizer. There were 23 participants coming from the USA, UK, The Netherlands, Spain, France and Belgium. **The GCSS Boundary Layer Cloud WG-I aims to improve physical parameterizations of clouds, other boundary layer processes, and their interactions. Our method is to conduct careful intercomparisons between observations, Single Column Models (SCM) and Large Eddy Simulation (LES) models of cloud-topped boundary layers.** For example, in the figure below, a single cumulus cloud is shown as simulated with an LES model.

The 1998 intercomparison (<http://www.asp.ucar.edu/~bstevens/atex/contents.html>) was based on an idealization of observations made during the Atlantic Tradewind Experiment (ATEX). The case coordinator was Bjorn Stevens (bstevens@ucar.edu). It was chosen for study because it was felt that ATEX represented a more "typical" tradewind regime, one in which cloud fractions were nearer 50 percent. In contrast to the 1997 intercomparison based on the Barbados Oceanographic and Meteorology Experiment (BOMEX) (<http://www.knmi.nl/~siebesma/bomex.html>) the cloud and mixed layers are significantly cooler, but only slightly drier; thus the cloud layer has a much higher relative humidity, and is nearly saturated at the base of the trade inversion. The trade inversion is much stronger and the mixed layer is somewhat deeper than what was observed during BOMEX, reflective of the more upstream-like nature of the boundary layer.

The main objectives of the intercomparison were to address the following:

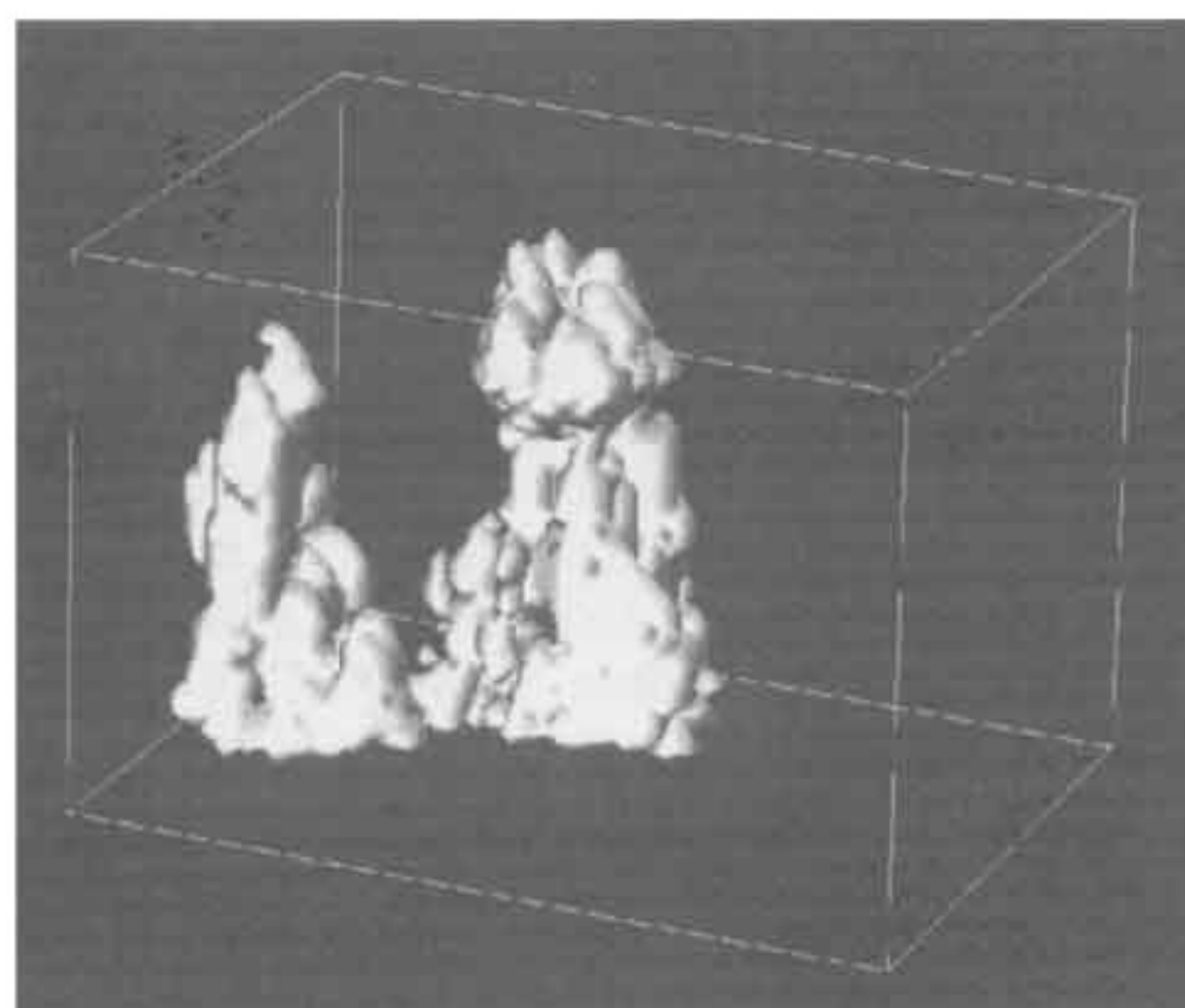
- Do the mass flux relations found to work well for the BOMEX intercomparison generalize to

a more upstream setting with a more humid cloud layer?

- Can the models produce regions of high cloud fraction associated with Trade Cumulus, and if so what factors control the cloud fractions in the trades?
- How important is the representation of entrainment across the trade inversion in setting the bulk boundary layer structure, and to what extent do the models agree in the prediction of this parameter?

In addition, the observations were characterized by a very large diurnal cycle in cloudiness, and in inversion heights. It was of great interest to see to what extent such processes can be represented by the models.

The results of seven LES models and six SCMs have been submitted to the intercomparison. The majority of LES models developed a thin broken stratocumulus deck above the cumulus clouds. The cloud fraction of the cumulus clouds was small (about 5%) whereas the cloud fraction of the stratocumulus was much larger (about 50%). Therefore, it was concluded that the large cloud fraction was due mainly to stratocumulus as has often been observed during the Atlantic Stratocumulus Experiment (de Roode and Duynkerke, 1996). The SCMs



Three-dimensional perspective of a single cumulus cloud (height about 1500 m) from the cloud field simulated with an LES model based on observations of BOMEX (by courtesy of Harm Jonker).

were either based on a mass-flux closure or a moist Reynolds-averaged closure. The latter mainly tended to form a solid stratocumulus deck with 100% cloud cover, whereas the mass-flux closures tended to form cumulus clouds with a too-high liquid water content. A paper will be prepared on the results, to be submitted to Journal of the Atmospheric Sciences.

Most of the leading groups modelling boundary layer clouds have participated in the annual GCSS WG-I workshops. If you would like to keep in touch with our activities, you can join our email list. To join, send a message containing the words "subscribe -l gcss-l@fys.ruu.nl" to server majordomo@fys.ruu.nl. Information concerning activities of GCSS WG-I are available on the world wide web: <http://atmos.washington.edu/~breth/GCSS/GCSS.html>.

Reference

de Roode, S. R., and P. G. Duynkerke, 1996. *Q. J. R. Meteorol. Soc.*, 122, 1597-1623.

GEWEX/ACSYS WORKSHOP ON COLD REGIONS HYDROLOGICAL MODELING

25–27 August 1998
Quebec City, Canada

Rick Lawford, GCIP Office

This workshop was held in response to a recommendation from the ACSYS SSG for an assessment of the requirements for a combined large-scale hydrologic modeling initiative in ACSYS and GEWEX. Participants at the workshop included representatives of the World Climate Research Programme (WCRP), the high-latitude projects of the Global Energy and Water Cycle Experiment (GEWEX), and the Arctic Climate System Study (ACSYS). The workshop was held at Environment Quebec offices in downtown Quebec City. The technical presentations and the working group discussions dealt with the best means of using hydrological model results, to provide ACSYS oceanographers with quantitative information on the flow of fresh water into the Arctic Ocean. The technical presentations stimulated discussion on land-ocean-atmosphere coupling at high latitudes. In addition, there was a comprehensive presentation on the progress in establishing

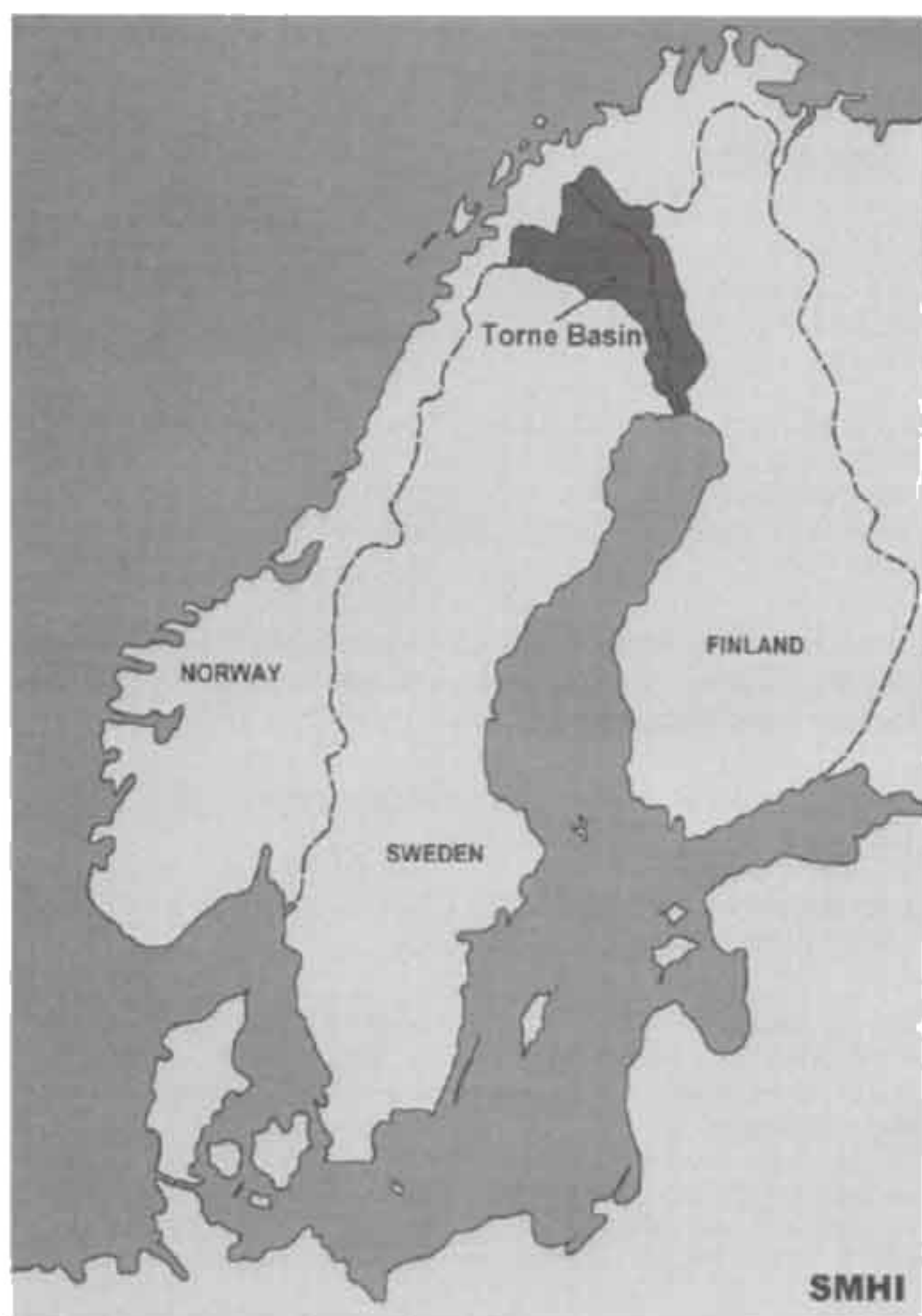
a new WCRP project known as the Climate and Cryosphere (CLIC). The workshop was organized and chaired by Rick Lawford (GCIP Office) and Valery Vuglinski (State Hydrological Institute, St. Petersburg, Russia). Local arrangements for the meeting were made by Jean-Pierre Fortin, University of Quebec.

The workshop opened with comments by Rick Lawford noting the relationship between GEWEX and ACSYS, specifically that GEWEX is concerned with the fresh water production in large basins (e.g., Lena and Mackenzie) while ACSYS has responsibility for estimating the contribution from small basins. Dr. Vuglinsky continued the opening comments with an overview of ACSYS activities on implementing the development of models, including air-sea-interaction factors, for river runoff into the Arctic Ocean. Also, during the opening session, Prof. Victor Savtchenko, WCRP, continued with a description of the need to estimate fresh-water runoff into the Arctic Ocean.

To accomplish this goal, it was necessary to identify models that simulate the high latitude water and energy cycle. **The principal recommendations of the workshop are as follows:**

- (1) **A team, with representatives from ACSYS and the high latitude CSEs should be formed to evaluate the benefits of a model intercomparison, and to develop a plan for a hydrologic modeling intercomparison study using macroscale hydrologic models; and**
- (2) **The intercomparison study should explore the ability of models to simulate runoff from a large basin with relatively complete measurements (the Mackenzie River Basin), from a large basin with limited measurements (the Lena River Basin), and a small river basin with extensive measurements (the Torne Basin in northern Sweden).**

Highlights from the science presentations included Mark Serreze's (University of Colorado) description of how polar variables influence global atmospheric circulation and climate simulations. He noted that high latitude precipitation variability is a problem for modelers and causes difficulty for investigators to correlate ice thickness, salinity, inflow,



Location of Torne Basin, a potential BALTEX contribution to the ACSYS/GEWEX model inter-comparison.

and outflow, to warming or to common indices such as the North Atlantic Oscillation. Laura Bowling, University of Washington–Seattle, discussed plans for the application of the Variable Infiltrations Capacity - n layer model (VIC - nl) to the entire Arctic Basin with emphasis on the Arctic Mackenzie and Ob rivers. She noted that adequate and realistic forcing of the models is a problem, (e.g., obtaining correct values for clouds, snow water equivalent, solar radiation, precipitation). William Quinton, National Hydrological Research Center, Saskatoon, Canada, described the Mackenzie coupled atmospheric/hydrologic scheme and discussed other models, e.g., Canadian Regional (RCM), Canadian Land Surface Scheme (CLASS), and distributed hydrologic model (WATERFLOOD). Douglas Kane, University of Alaska, presented his work on the Kupervuk River. He discussed the interaction between the atmosphere, hydrology (mass and energy flows) terrestrial and aquatic (bio) systems.

Dr. Alexander Shiklimanov, Arctic and Antarctic Research Institute, St. Petersburg, reported on the existence of high-latitude streamflow data sets suitable for hydrological modelers to estimate river runoff. The application of satellite remote sensing data was discussed by Jean-Pierre Fortin, Institut National de la Recherche Scientifique-Eau (INRS-Eau), University of Quebec, with special reference to a model known as HYDROTEL developed at INRS-Eau. Minjiao Lu, from Frontier Research System for Global Change, Tokyo, Japan also described the use of remote sensing data in a hydrological model. In addition to the general science presentations, the high latitude cold season efforts were presented for four of the GEWEX Continental-scale Experiments. Brief summaries of these detailed reports follow.

The status of the GEWEX Asian Monsoon Experiment (GAME) Siberian regional study was reported by Tetsuo Ohato, Hokkaido University. There are 13 organizations from Japan, 11 from Russia, and one from USA participating in GAME-Siberia. The observational network has been established, data sets are being assembled and data archiving is in progress for the Lena River basin. Prof. Ohato also described the efforts of coupling high latitude surface processes with regional and global atmospheric models.

The modeling efforts being conducted as part of the Baltic Sea Experiment (BALTEX), were discussed by L. Phil Graham, Rossby Center, Sweden. BALTEX is a 14 country GEWEX project that combines meteorology, hydrology and oceanography disciplines to (1) develop coupled ocean/atmosphere/land-surface models; (2) conduct intercomparisons and validation of the models; and (3) intercomparison and validation of the representation of individual processes.

The coupled atmospheric/hydrologic models applied in the Mackenzie GEWEX Study (MAGS) were reviewed, and a strategy was outlined to realistically describe the vertical and horizontal water budget of the Mackenzie River Basin. William Quinton also described the Canadian GEWEX Enhanced Study (CAGES) which had just started in the basin. CAGES is designed to provide enhanced data sets for testing and validating models.

The GEWEX Continental-scale International Project (GCIP) connection to high-latitude energy

and water cycle research was presented by Rick Lawford. GCIP contributes through the cold season energy and water cycle process studies conducted in the northern and high altitude regions of the Mississippi River Basin. More importantly for ACSYS, are the cold season budget and model studies, particularly the transferability of the macroscale hydrologic models (e.g., VIC model) developed under GCIP to the other projects focussed on high-latitude modeling.



Dr. Barry Goodison discussing cryospheric science.

Also at the workshop, Barry Goodison, Atmospheric Environment, Canada, presented an overview on the science and present status in launching the new WCRP global cold regions project, CLIC. The CLIC definition of the cryosphere includes the ice sheets, ice shelves, ice caps and glaciers, sea ice, seasonal snow cover, lake and river ice and seasonally frozen ground on permafrost. Examples of science areas where CLIC links to GEWEX and ACSYS are: (1) role of the cryosphere for the surface energy/moisture balance of the land and oceans, (2) variability of seasonal storage of fresh water by the cryosphere, (3) sea ice and its interactions with atmosphere and ocean, and (4) role of freezing/melting in modulating river discharge.

The science presentations and CSE status reports identified issues such as transferability of models, the nature of available hydrologic models, the availability of data sets and possible river basins for model intercomparison studies. Working groups met to discuss hydrologic modeling issues and data requirements. The recommendations of the Working Groups will be published in the workshop report.

WCRP/GEWEX MEETINGS CALENDAR

*For calendar updates, see the GEWEX Web Site:
<http://www.cais.com/gewex/>*

2-6 November 1998—JOINT JSC/CAS WGNE AND GEWEX MODELING AND PREDICTION PANEL MEETINGS, Montreal, Canada.

9-13 November 1998—GEWEX CLOUD SYSTEM STUDY AND WORKING GROUP ON NUMERICAL PREDICTION WORKSHOP ON CLOUD PROCESSES AND FEEDBACKS OF LARGE-SCALE MODELS, European Centre for Medium-Range Weather Forecasts, UK.

16-18 November 1998—4TH CANADIAN GEWEX/MAGS WORKSHOP, Montreal, Canada. See web site or contact Secretariat; E-mail: Geoff.Strong@ec.gc.ca.

18-20 November 1998—FIRST GACP SCIENCE TEAM MEETING, New York, New York, USA.

1-4 December 1998—GEWEX CLOUD SYSTEM STUDY SCIENCE PANEL, Kauai, Hawaii, USA.

10-15 January 1999—AMERICAN METEOROLOGICAL SOCIETY ANNUAL MEETING, Dallas, Texas, USA. The meeting theme is "Climate and Global Change: Focus on the Americas." For information on GEWEX related sessions consult recent issues of the Bull. American Meteorological Society Meeting Announcements or contact American Meteorological Society Meeting Department, 45 Beacon Street, Boston, MA 02108-3693. Tel. (617) 227-2426, or E-mail: amsmtgs@ameteor.org.

25-29 January 1999—GEWEX SCIENTIFIC STEERING GROUP, Tuscon, Arizona, USA.

15-20 March 1999—WCRP JOINT STEERING COMMITTEE MEETING, Kiehl, Germany.

19-23 April 1999—EUROPEAN GEOPHYSICAL SOCIETY XXIV GENERAL ASSEMBLY, Hague, The Netherlands. GEWEX related sessions include: Parameterization of moist convection; Energy and water cycles on a regional scale: modelling, direct and remote measurements; Hydrology in GCMs: current performance and future developments; and Soil-Vegetation-Atmosphere Transfer Schemes in GCMs. For further information consult <http://www.copernicus.org/EGS/EGS.html>.

16-19 June 1999—THE THIRD INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE, Beijing, China. This conference will be held in conjunction with the 4th Study Conference on the GEWEX Asian Monsoon Conference. In addition to monsoon topics other topics will include: precipitation and cloud systems, cloud and radiation processes within the atmosphere and at the surface, water and carbon cycle connection and its role in global and regional hydrological cycles, high latitude and high altitude hydrology, ocean-atmosphere-ice/snow exchange, observations, data analyses and modeling studies related to GAME, satellite remote sensing and TRMM related studies. Abstracts (**due 15 November 1998**) can be sent by e-mail to yhding@public.bta.net.cn. For further information contact Prof. Ding Yihui, National Climate Centre, China Meteorological Administration, No. 46, Baishiqiao Road, Western Suburb, Beijing 100061, China, or GEWEX Web Site: <http://www.cais.com/gewex>.

19-30 July 1999—GHP-RELATED SYMPOSIA AND WORKSHOPS AT THE 22ND GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS (IUGG), Birmingham, UK. For further information contact School of Earth Sciences, Univ. of Birmingham, Edgbaston, Birmingham B15 2TT, UK; Fax: 44 121 414 4942; E-mail: IUGG99@bham.ac.uk.

23-27 August 1999—2ND INTERNATIONAL REANALYSIS CONFERENCE, UK (date tentative).

GEWEX REPORTS AND DOCUMENTS

(Available from IGPO)

GCIP MISSISSIPPI RIVER CLIMATE CONFERENCE, PROGRAM AND ABSTRACTS VOLUME, St. Louis, Missouri, June 8-12, 1998, IGPO Publication Series No. 30.

GLOBAL SOIL WETNESS PROJECT, PRELIMINARY REPORT ON THE PILOT PHASE, August 1998, IGPO Publication Series No. 29.

TACTICAL DATA COLLECTION AND MANAGEMENT REPORT FOR THE 1995 ENHANCED SEASONAL OBSERVING PERIOD (ESOP-95), IGPO Publication Series No. 28.

MAJOR ACTIVITIES PLAN FOR 1998, 1999 AND OUTLOOK FOR 2000 FOR THE GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP), IGPO Publication Series No. 26 (This is the updated version of IGPO Series Pub. No. 16 and 25).

CABAUW SENSITIVITY EXPERIMENTAL RESULTS FROM THE PROJECT FOR INTERCOMPARISON OF LAND-SURFACE PARAMETERIZATION SCHEMES (PILPS), December 1996, IGPO Publication Series No. 24.

GCIP COUPLED MODELING WORKSHOP, SILVER SPRING, MARYLAND, 9-10 MAY 1996, November 1996, IGPO Publication Series No. 23.

BEHIND THE SCENES OF THE PHASE 2(A) EXPERIMENT OF THE PROJECT FOR INTERCOMPARISON OF LAND-SURFACE PARAMETERIZATION SCHEMES (PILPS): THE CABAUW STORY, August 1996, IGPO Publication Series No. 22.

TACTICAL DATA COLLECTION AND MANAGEMENT PLAN FOR THE 1994 GCIP INTEGRATED SYSTEMS TEST (GCIP), June 1996, IGPO Publication Series No. 20.

INTERNATIONAL SATELLITE LAND SURFACE CLIMATOLOGY PROJECT (ISLSCP) ACTIVITY PLAN 1996-1998, September 1996, IGPO Publication Series No. 19.

POTENTIAL INTERNATIONAL SATELLITE LAND SURFACE CLIMATOLOGY PROJECT (ISLSCP) CONTRIBUTIONS TO THE GEWEX CONTINENTAL-SCALE INTERNATIONAL PROJECT (GCIP), September 1996, IGPO Publication Series No. 18.

INTERNATIONAL SATELLITE LAND SURFACE CLIMATOLOGY PROJECT (ISLSCP) INITIATIVE II: GLOBAL DATA

SETS 1986-1995, September 1996, IGPO Publications Series No. 17.

INTERNATIONAL GEWEX WORKSHOP ON COLD-SEASON/REGION HYDROMETEOROLOGY, Summary Report and Proceedings, Banff, Alberta, Canada, September 1995, IGPO Publication Series No. 15.

PROJECT FOR INTERCOMPARISON OF LAND-SURFACE PARAMETERIZATION SCHEMES (PILPS), Soil Moisture Simulation. December 1994, IGPO Publication Series No. 14.

LAND-SURFACE CLIMATOLOGIES OF AMIP-PILPS MODELS AND IDENTIFICATION OF REGIONS FOR FUTURE INVESTIGATION (PILPS Phase 3A). November 1994, IGPO Publication Series No. 13.

GEWEX CLOUD SYSTEM STUDY (GCSS) SCIENCE PLAN, May 1994, IGPO Publication Series No. 11.

GEWEX PAMPHLET (fivefold glossy).

UTILITY AND FEASIBILITY OF A CLOUD PROFILING RADAR: Report of the GEWEX Topical Workshop, 29 June-1 July 1993, Pasadena, California. April 1994, IGPO Publication Series No. 10.

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

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

GCIP PAMPHLET (trifold glossy).

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.

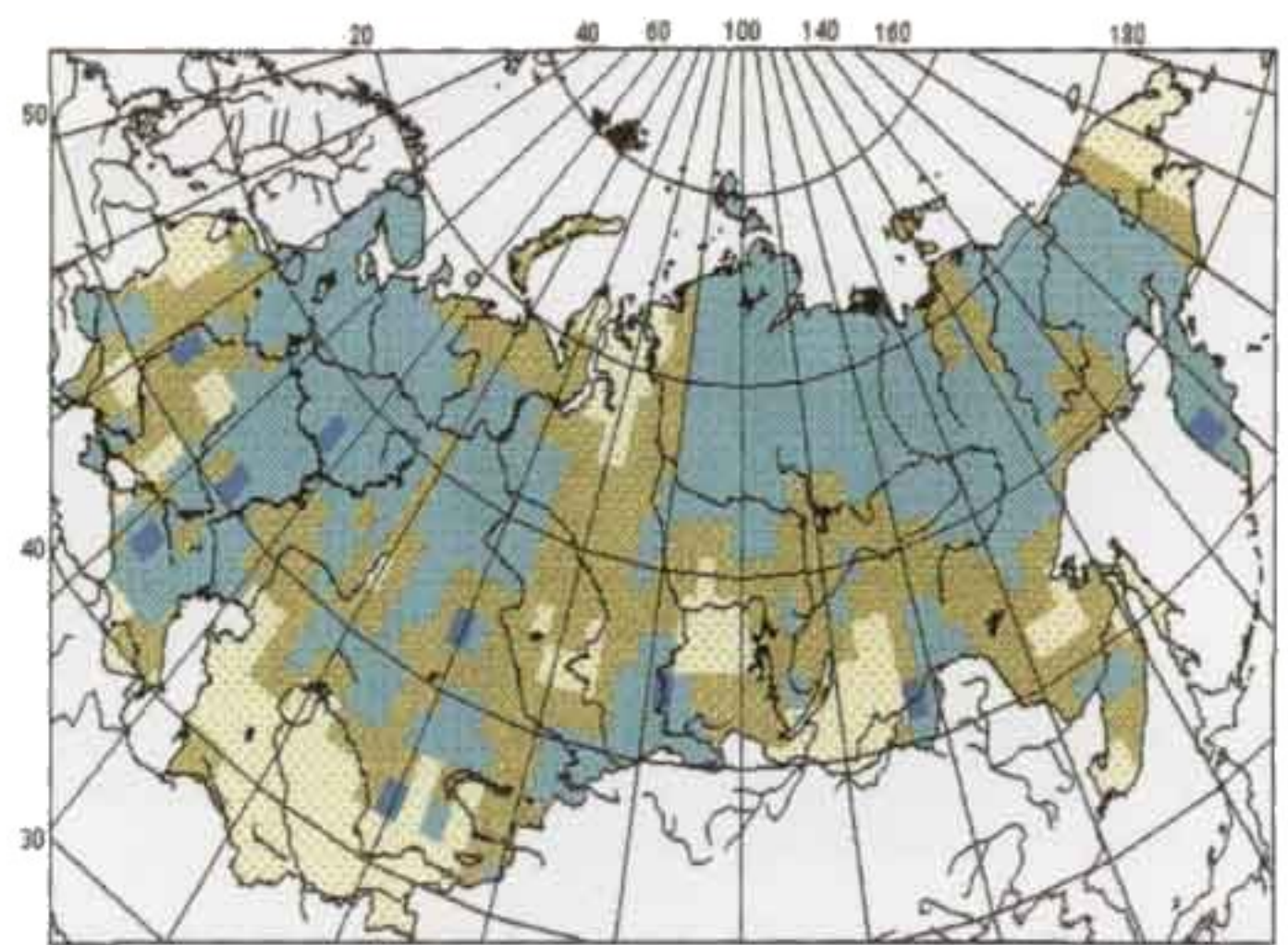
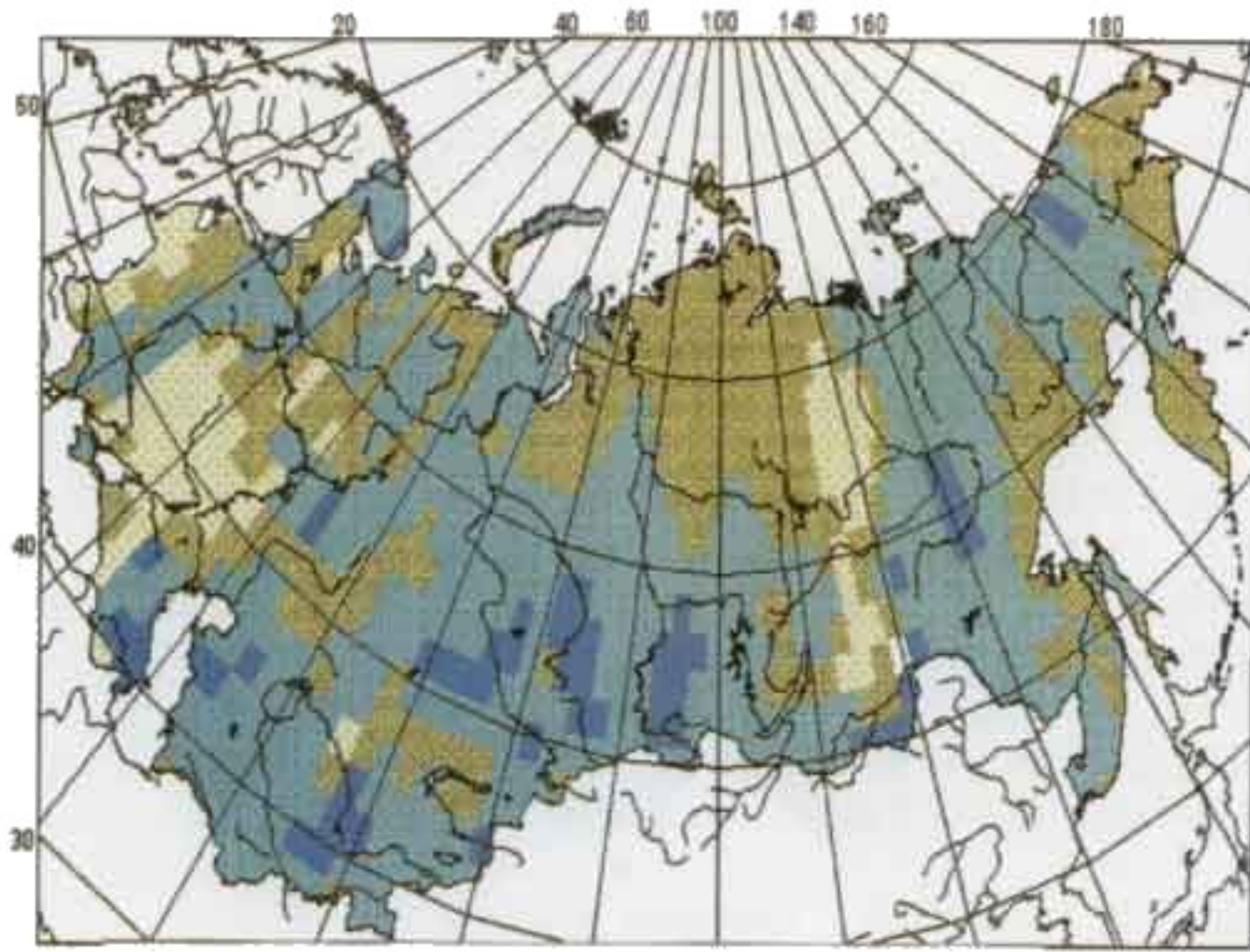
INTERNATIONAL SATELLITE LAND SURFACE CLIMATOLOGY PROJECT (ISLSCP) WORKSHOP REPORT, 23-26 June 1992, Columbia, Maryland, USA.

For complete listing of GEWEX reports and documents, consult the GEWEX Web Site:
<http://www.cais.com/gewex/>

CORRECTION

In the August 1998 *GEWEX News* article "Assessment of Benefits of Climate Forecasts for Reservoir Management in the GCIP Region," the complete and correct affiliation of the lead author, Konstantine P. Georgakakos is the Hydrologic Research Center and Scripps Institute of Oceanography.

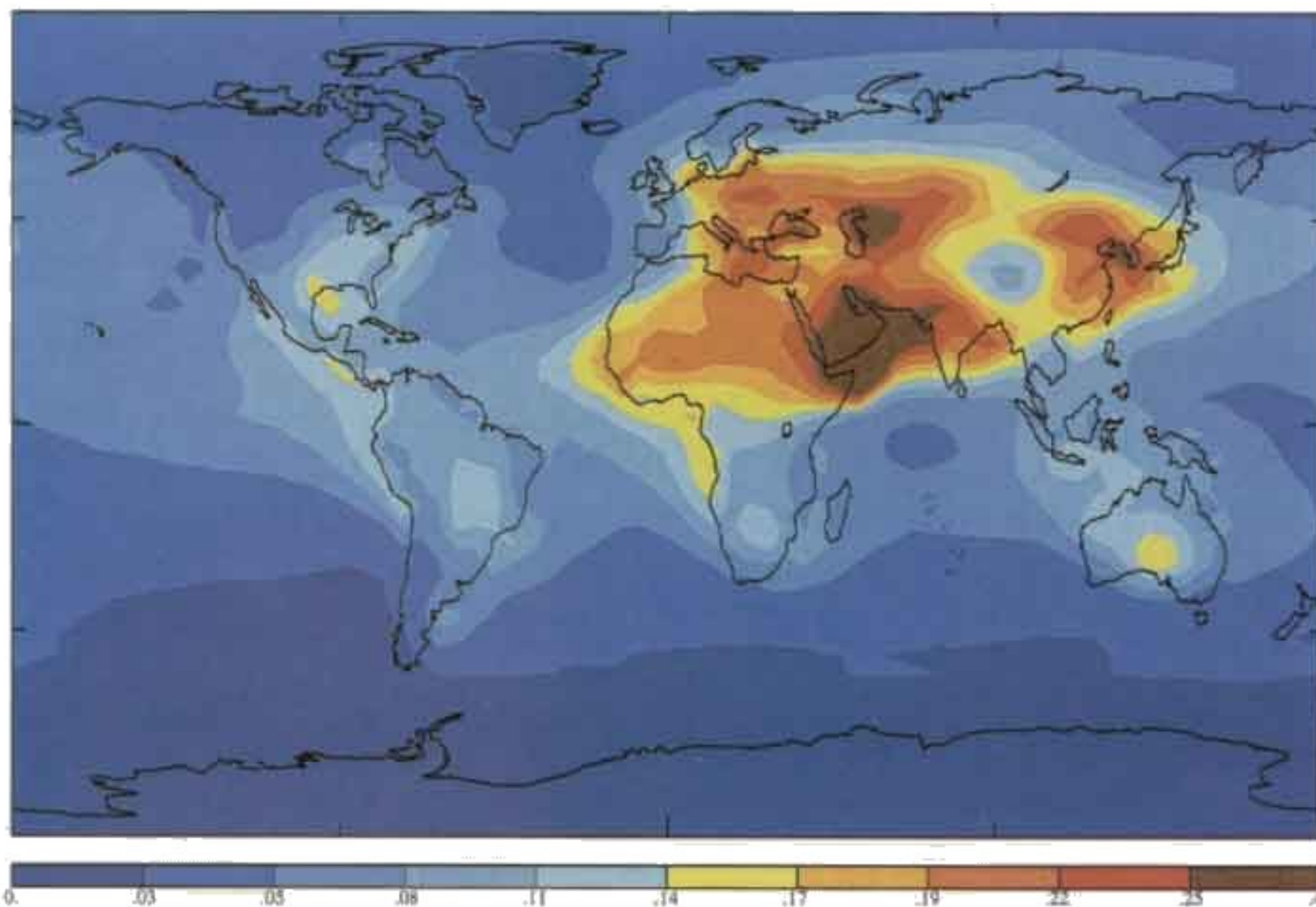
Former Soviet Union Data Show ENSO Snow Relationship



0 - 0.75 1.00 - 1.25 0.75 - 1.00 1.25 - 1.50 > 1.50

Snow Water Equivalent (SWE) (mm) anomalies: El Niño years (4) compared to other years in 25-year database.

SWE Anomalies: La Niña years (4) compared to other years in 25-year database (see page 5).



GEWEX Aerosol Climatology Project (GACP) is expected to use Source Emissions and 3D Transport Models to fill gaps in global satellite coverage capabilities especially over land. Shown is the total mean annual global aerosol optical thickness. The total includes sulfates, sea salt, soil dust, organic aerosols and black carbon. See article on page 3.

GEWEX NEWS

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