GEWEX WCRP

Global Energy and Water Cycle Experiment

NEWS

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World Climate Research Programme–WCRP

CEOP RECEIVES SUPPORT AT IGOS-P AND CEOS MEETINGS HELD IN RIO

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University of Tokyo

At the 8th Integrated Global Observing Strategy (IGOS) Partners meeting and the 14th Committee on Earth Observation Satellites (CEOS) Plenary meeting held in Rio de Janeiro, Brazil during the week of November 6, 2000, the World Climate Research Programme (WCRP) presented a proposal on the Coordinated Enhanced Observing Period (CEOP) Project and a presentation on the development of an IGOS water cycle theme. An integrated water cycle observational system would bring together the capabilities of both satellite-based and ground-based (remote and *in situ*) observing systems to support the needs of the research and prediction communities.

CEOP received strong support by the IGOS partners and the CEOS space agencies. Through CEOP, CEOS will be able to contribute greatly to the understanding and prediction of the water cycle through the integrated use of satellites of CEOS members in cooperation with the IGOS partnership. CEOP represents a unique opportunity to improve the scientific basis needed to achieve overall water cycle documentation and prediction goals.

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4TH INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE

Paris, France
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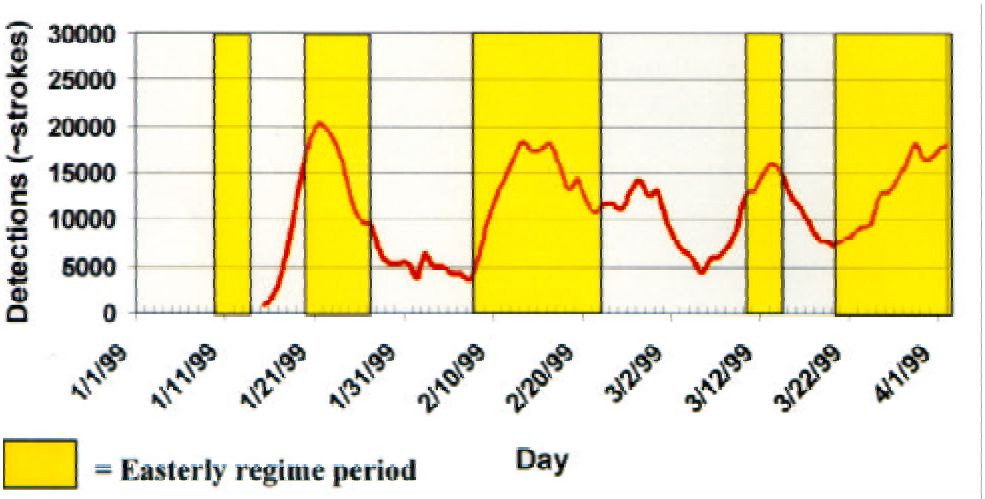
EARLY LBA RESULTS SHOW MAJOR CLOUD AND PRECIPITATION CHARACTER DIFFERENCES IN THE AMAZON



During the rainy season, the daily detection of cloud-to-ground lightning activity for the TRMM-LBA domain of the Amazon shows a factor of four increase during 850 hPa easterly wind regime periods (yellow boxes). The marked oscillations associated with these different convective regimes are apparent in the Brazilian Lightning Detection Network data (installed by NASA/MSFC) radar data and also in TRMM satellite Lightning Imaging Sensor (LIS) data. See page 3. (Figure courtesy of W. Petersen, Colorado State University and R. Blakeslee, NASA/MSFC.)

COMMENTARY: GEWEX SUPPORTS NEW WATER CYCLE INITIATIVES

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GEWEX Scientific Steering Group

Worldwide interest in addressing societal water resource needs (both in terms of quantity and quality) has been given a special level of urgency. The March 2000 World Water Forum in the Hague, The Netherlands, which involved over 50 ministers and close to 4,000 participants, is a strong testament to the importance placed on this issue. This renewed focus on water places the physical and biological aspects of the hydrologic cycle as a central topic. In this context, a number of international activities are being initiated that will hopefully result in a much-needed increase in research funding in these areas.

The water cycle initiatives should be viewed as having two major components: (1) the physical and biological aspects which address a better understanding of the elements of the hydrological cycle and closing of the water balance at various spatial and temporal scales; and (2) the water resources management needs, where issues of supply, demand, scarcity, quality, and public health are to be addressed. In order to adequately address the second component, it is critical that the hydrologic cycle—in its entirety—be better understood in order that the degree of information uncertainty is significantly reduced.

For its part, GEWEX has been a major international program that has focused on many elements of the water cycle during the last several years, with special emphasis on "implementing" global representations of the key parameters of the water cycle, process studies in regional campaigns worldwide, and upgrades to the land-surface and cloud parameterizations in regional and global models. Initial data sets, model upgrades, and regional campaign results were delivered during Phase 1 of GEWEX activities. Phase 2 implementation is addressing joint interactions of parameters, significant exploitation of the new satellite sensors, a collective approach by our regional experiments on closing the water and energy budgets, and an increased emphasis on applying the results to water resource problems. These activities can form the basis for "jump-starting" the plans of the new water cycle initiatives as the key science questions begin to be addressed.

With respect to the interface between the two above-mentioned components, many challenges lie ahead. At the international level, both WMO and UNESCO—through their respective hydrologic and water resource programs—have been in the forefront in helping nations deal with water resources management issues. Undoubtedly, a gap still remains between advances in the physical and biological aspects and those aspects dealing with the operation and implementation of such knowledge. As an experienced implementing project, GEWEX has expressed its readiness and willingness to work on the interface between these two components. Through GEWEX's Hydrometeorology Panel (GHP), a new initiative to build partnerships with programs such as HELP, IHDP (International Human Dimension Program), and IGBP is under way. We expect an enhancement and expansion of current GEWEX activities to place a greater emphasis on providing relevant hydrologic information that would result in more effective management of water resources.

CEOP RECEIVES SUPPORT

(Continued from Page 1)

CEOS contributions to CEOP which were discussed at the meetings include: (a) supporting the implementation of a CEOP Satellite Data Integration Center, (b) establishing a CEOP Satellite Working Group, and (c) providing field campaigns at reference sites with proper access to satellite observations.

Detailed, specific requirements will be prepared by CEOP and directed to the cognizant space agencies for their consideration at the CEOS Plenary to be held Kyoto, Japan in 2001. The first step in the preparation of a water cycle theme proposal is a planning workshop that will be held in Los Angeles, California in the USA.

CONTENTS

LBA INITIAL RESULTS AND STATUS

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Over 200 investigators are involved in 85 Large-Scale Biosphere Atmosphere Experiment in Amazonia (LBA) studies related to physical climate, atmospheric chemistry and composition, carbon storage and exchange, biogeochemical cycles, land surface hydrology and water chemistry, and land use and land cover changes. The First LBA Scientific Conference was held in Belem, Brazil on 26–29 June 2000. Over 260 papers were presented and 7 thematic workshops were conducted at this very successful conference, which highlighted initial results of ongoing investigations with LBA and provided a forum to place LBA in the context of broader Amazonian and tropical ecosystems science. A second conference is planned for mid-2002 in Manaus. LBA results will be published in a special issue of the *Journal of Geophysical Research* in 2001.

The overall timeframe for LBA is 1996–2005. Between 1996 and 1998, several preliminary activities took place, including the installation of the measurement and monitoring components. LBA data collection activities began with an intensive observing period in January–March 1999 with the combined Wet Season Atmospheric Mesoscale Campaign (WET–AMC) and LBA Tropical Rainfall Measuring Mission (TRMM) Validation experiment over SW Amazonia (Rondonia), followed by a smaller campaign from September to November to study atmospheric processes during the wet-up transistion period from the dry to wet season, and the role of aerosols from biomass burning. Over the past 18 months, ten continuous monitoring sites, including flux towers for water, energy, and carbon fluxes have been established covering a range of climatic conditions and vegetation types in Amazonia. These continuous measurements will run through 2004 and will also include measurements from TRMM, Terra, ENVISAT, Chinese-Brazilian Earth Resources Satellite, and Landsat-7 platforms.

Scientific results from the first 2 years of LBA research have shown very distinct features of atmospheric evolution in the Amazon Region, in particular, of the cloud and precipitation regime. The character of precipitation over Amazonia varies from a very continental behavior in the beginning of the rainy season to a more maritime regime during the rainy season. More important, during the rainy season there is an alternation between a more maritime and more continental regime associated with large scale controls, such as the presence or absence of large scale low-level convergence provided by approaching mid-latitude frontal boundaries or even the establishment of the South Atlantic Convergence Zone. Rainfall is more continuous throughout the day and occurs also at night when a large scale forcing is present. Radar profiles indicate low reflectivities in the upper half of the troposphere and a minimum of lightning is detected. In the absence of large scale forcing, convective systems form in the afternoon, are more isolated, have large reflectivities above the 0°C isotherm, and lightning is observed. Large scale forcing is seen locally in the southern half of the Amazon basin as a low level westerly regime; while during the break periods the low level flow is dominated by easterlies. The changes in lightning flash density between the easterly and westerly wind regimes are significant as they indicate marked changes in cloud vertical structure (see figure on page 1). Similar regime variability in the lightning flash densities have also been observed by the TRMM LIS. The differences in sub-grid convective cloud structure between the wind regimes is verified from the precipitation radar on the TRMM satellite and the TRMM-LBA ground-based field radar data (Petersen et al., 2000; Cifelli et al., 2000).

Large seasonal variability in the Amazon Basin has been observed for concentrations of aerosol particles, cloud condensation nuclei (CCN) and trace gases. This seasonal variability is mostly caused by biomass burning emissions in the dry season (July–October). In terms of aerosol concentrations, typical wet season values detected by NOAA 14 sensors, are 10–15 micrograms per cubic meter ($\mu g/m^3$) for particles less than 10 micrometers, while in the dry season very high concentrations in the range of 250–400 $\mu g/m^3$ are observed over large areas in Amazonia. **In terms of aerosol optical depth measurements using a network of sun-photometers, background aerosol column amounts to 0.10–0.15 at 550 nanometers in the wet season. In the dry season, values of 2.5–3**

are observed over large areas. Taking into account that Smoke Clouds Aerosol and Radiation-Brazil Experiment (SCAR-B) measurements show a direct radiative forcing of -80 watts/m^2 per unit of optical depth, this high aerosol loading accounts for 200 to 250 w/m^2 of radiation deficit at 500 nm. **This large aerosol direct radiative forcing has certainly had an impact on the Amazonian ecosystem that still remains to be addressed. Also, the large atmospheric aerosol loading appears to be altering the precipitation regime in areas heavily impacted by biomass burning emissions.** In measurements from southeast Asia, a signficant reduction in precipitation was observed due to enhanced CCN amounts. Similar mechanisms are suggested to be also occurring in Amazonian regions that are heavily impacted by biomass burning. There is a possibility that the large amounts of aerosols in the end of the dry season are delaying the beginning of the wet season in Amazonia by a few weeks. Further experiments are planned to assess this important issue.

Early results from LBA hydrological studies are advancing the application of models for water management. A water budget closure system (WBC-LBA) for computing high-resolution water balance elements is being established. By integrating existing scientific tools, such as algorithms that produce high-resolution climatology fields, water balance and river transport models, and a recently established GIS-based WWW site that serves as a data repository for participating hydrometeorological agencies, the WBC-LBA will produce high resolution gridded fields for precipitation, temperature and other climatic variables, evapotranspiration, soil water, drainage basin storage, runoff and river discharge that are consistent with the observational record of data collected at hydrometeorological monitoring stations. Runoff and convergence field predictions will be tested by an atmospheric model applied over the experimental domain. Both retrospective (1960–present) and LBA contemporary time frames will be analyzed.

A new version of the HYDrological Routing Algorithm (HYDRA) is being developed for the Amazon, which will simulate time-varying flow and storage of water in hydrological systems, including rivers, floodplains, wetlands, lakes, and human-made reservoirs.

A hydrological model for Brazilian macro basins is also being developed which will integrate existing meteorological, topographic, vegetation and pedological data, together with remote sensing derived products. The model will be used primarily as a real-time monitoring tool capable of providing updated information about soil moisture and river discharges to support several economic activities related to water management. In addition, the model's results will be used in off-line mode to initialize weather forecast models. To provide guidance to policy makers in planning mitigation actions, seasonal forecasts will be used in the model to try to assess the impact of extreme climatic events.

Research is underway to understand and model the influence of land-cover change on the streamflow of Amazonian river basins with areas of approximately 10,000 km^2. To achieve that goal, the research will try to quantify the influence of both climate and land-cover change on river flow in mesoscale Amazonia to understand processes governing those influences, and to define the range of basin size over which land use affects the hydrology of rivers. The results will be expressed in the form of a mathematical model, checked against the response of river flow, driven by measurements of rainfall, energy sources and terrain characteristics, derived initially from ground-based measurements and eventually from satellites. The model will be applicable to mesoscale basins in other physiographic regions of the Amazon Basin.

By the end of 2000, microscale basins will be set up close to Manaus to gain understanding of the carbon exchanges between soil vegetation and atmosphere on a pristine forest. The hydrological component will try to understand the main mechanisms of runoff generation on tropical basins, the functioning of deep root in the dry season and the role of interception in the partitioning of energy. This research will be crucial to conceptualize macroscale hydrological models. Additonal information about LBA is available at **http://www3.cptec.inpe.br/lba/index.html.**

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GLOBAL AEROSOL CLIMATOLOGY PROJECT ADVANCES

Michael Mishchenko[1], Joyce Penner[2], and Donald Anderson[3]

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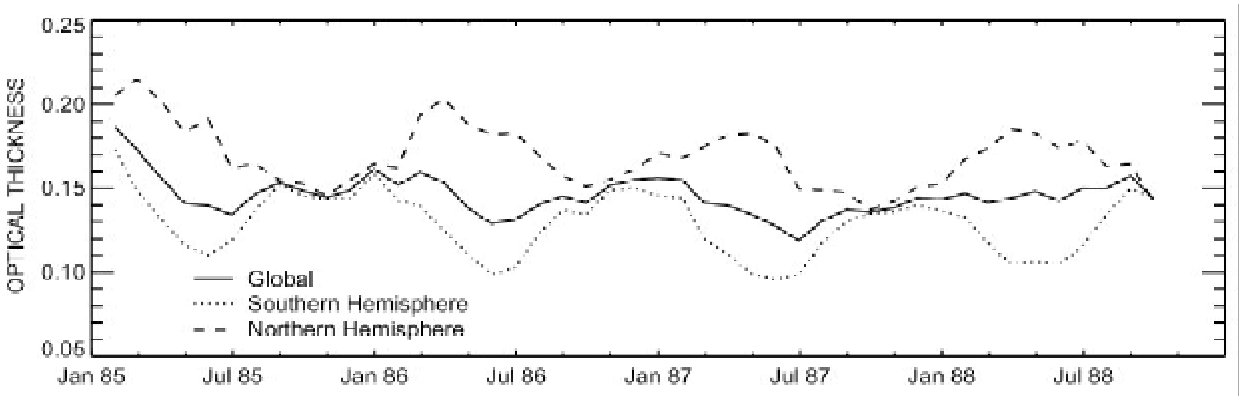
The NASA/GEWEX Global Aerosol Climatology Project (GACP) held its third Science Team meeting 11–13 October 2000 in Lanham-Seabrook, Maryland. The main objective of the meeting was to assess the progress achieved by individual investigators, as well as by the project as a whole, and to discuss future program directions. As usual, the agenda of the meeting was quite full and consisted of individual progress reports, four invited presentations, and several plenary discussions. The individual progress reports were grouped by the following categories: (i) Satellite retrievals, (ii) Radiation balance/direct aerosol effect, (iii) Field data, (iv) Modeling studies, and (v) Indirect aerosol effects. The plenary discussions focused on the following topics: (i) Status (Where are we? What do we want for our final product? Are there areas where additional coordination would enhance the product?); (ii) Utilization of field data to enhance aerosol satellite retrievals/modeling studies; (iii) How to put together a global aerosol climatology; and, (iv) Planning for the next phase of GACP.

The meeting began with a summary of the satellite component of GACP presented by Michael Mishchenko. Several changes and improvements in the two-channel retrieval algorithm and the results of global aerosol retrievals for the period of NOAA-9 observations were summarized. The entire data set is available at the GACP web site **http://gacp.giss.nasa.gov**. The figure below depicts the aerosol column optical thickness (τ). The Angstrom exponent (A) averaged over the Northern and Southern hemispheres as well as over the entire globe was also presented. **The global average of (τ) is close to 0.15 and the global average of (A), not shown, is close to 0.8. The aerosol optical thickness is systematically larger in the Northern than in the Southern hemisphere due to the significant Sahara dust contribution.**

Joyce Penner summarized the results of the modeling intercomparison project. The project was conducted under the auspices of the Intergovernmental Panel on Climate Change and included the participation of 11 different modeling groups. The models were first compared to a set of ground-based observations (average error of order 25%), but the comparison with the other species was not as good. However, even for sulfate, the total burden varied by more than a factor of 2. Five groups were able to model all the major aerosol components (sulfate, organic carbon, black carbon, dust and sea salt) and were able to provide enough information to develop estimates of optical depth. A standard set of sources were specified for the intercomparison, and optical depths were estimated offline so that all results used the same extinction coefficients and relative humidity. Thus, differences between the models are directly related to differences in predicted aerosol concentrations. Optical depths were compared to 3 different sets of satellite-derived optical depths. **The comparison showed that the average difference between the models and satellite-retrieved optical depth was 0.05, while the average difference between the retrievals was also of this order. Differences of**



Aerosol optical thickness averaged over Northern and Southern Hemisphere as well as the entire globe.

about this same order of magnitude can also result from uncertainties in source strengths of dimethylsulfide emissions and sea salt. The modeled optical depths as well as the satellite-retrieved optical depth for the month of January are shown on the back page.

Invited presentations by Ralph Kahn and Yoram Kaufman focused on recent aerosol retrievals using MISR and MODIS data and demonstrated a significant improvement of the retrieval capability of the new generation of satellite instruments compared to one- and two-channel algorithms based on AVHRR data. James Hansen summarized the results of a workshop on long-term monitoring of tropospheric aerosols held on September 13 and 14, 2000 at GFDL. The workshop emphasized the need for specialized aerosol instruments on NOAA NPOESS platforms capable of retrieving detailed aerosol characteristics (bi-modal size distribution, refractive index/ chemical composition, optical thickness, number concentration, and single-scattering albedo) with the accuracy required for global long-term monitoring of the direct and indirect aerosol forcing of climate and identifying its anthropogenic component. Jean-Louis Brenguier described the results of the Parameterization of the Aerosol Indirect Climatic Effect (PACE) workshop held on 1–3 May 2000 at the Goddard Institute for Space Studies and co-sponsored by GACP. PACE is a joint project funded by the European Commission. The main objective of the project is to combine *in situ*/ground-based measurements, satellite observations, and advanced modeling in order to specifically study the indirect aerosol effect on climate and develop parameterizations suitable for use in global circulation models.

The final discussion focused on the need to summarize the current status of developing a unified aerosol climatology for the entire period of AVHRR observations and to define future program directions. It was pointed out that significant progress has been achieved in the development of multi-channel retrieval algorithms, critical assessment of potential information content of the existing satellite data sets and their limitations, reconciling differences in aerosol scenarios predicted by different modeling groups, and using field data for validating satellite and modeling results. **The expected result of the first phase of GACP will be three satellite climatologies of aerosol properties (based on one- and two-channel AVHRR retrievals and on TOMS data) and potentially several climatologies based on various transport-chemistry models. Given large calibration uncertainties in the AVHRR data and the limitations of one- and two-channel retrieval strategies, the satellite climatologies may need to be recalibrated by using more advanced global MISR and MODIS retrievals as a benchmark. A concerted effort will be required to merge all satellite and modeling products into a single aerosol climatology suitable for use in global circulation models.**

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USE OF REANALYSIS LAND SURFACE WATER BUDGET VARIABLES IN HYDROLOGIC STUDIES

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Reanalyses provide the land surface modeling community with a comprehensive global set of land surface water and energy fluxes and associated state variables at a sub-daily time interval over extended periods of one or more decades. For example, the NCEP/NCAR reanalysis (Kalnaý et al., 1996) has been completed for 1948–2000 and the more recent NCEP/DOE reanalysis (Kanamitsu et al., 2000) has been completed for 1979–2000. Because global data based directly on observations for most land surface moisture and energy fluxes are either not available, or are plagued by sparse observation networks, the use of reanalysis "data" for characterization of continental to global scale hydrologic features is an attractive (and in some cases the only) option, notwithstanding known biases in reanalysis surface variables (see Kalnay et al., 1996).

One example of the use of reanalysis data for model evaluation is illustrated by Irannejad et al.

(2000), who summarize the methodology to be applied in the AMIP II Diagnostic Subproject 12 (DSP12) to evaluate the performance of alternative land surface schemes (LSS) coupled to atmospheric models. The stated purpose of that study is "...to analyse the surface energy and water budgets as a function of LSS complexity." Acknowledging the paucity of global observational data sets against which the different LSS formulations included in DSP12 can be compared, Irannejad et al. (2000) consider NCEP/NCAR Reanalysis, NCEP/DOE Reanalysis, and Variable Filtration Capacity (VIC) model output from a global study of Nijssen et al. (2000) as posssible validation data sets.

Preliminary comparisions of the two NCEP reanalyses with the off-line VIC simulations (in which the model was forced with observed precipitation, temperature, and other surface forcings derived from these variables) lead Irannejad et al. (2000) to indicate that the VIC-derived latent heat is generally biased downward relative to the reanalyses. In fact, we will show that, for several reasons, the latent heat from both NCEP reanalyses are probably biased upward, and that extreme caution must be taken if such "data" are to be used for model evaluation (See back page figure).

The VIC model (see Nijssen et al., 1997; 2000 for summaries) is similar to other land surface schemes to the extent that it represents land surface moisture and energy fluxes over large areas. As shown by Nijssen et al. (1997), Maurer et al. (2000) and others, a distinguishing feature of the model is its ability to reproduce streamflow for major continental rivers. Therefore, when forced with observed precipitation, the land surface water budget is closed, at least in the long-term average. Depending on the quality of the precipitation and streamflow data used, the large-area estimates of long-term mean evapotranspiration produced by the VIC model can be assumed to be quite accurate. Nijssen et al. (2000), which was the source of the VIC output used by Irannejad et al. (2000), show that the global VIC surface fluxes generally lie in the middle of the range of several global water balance climatologies (see Table 1). For instance, the annual average evapotranspiration from global land areas simulated by VIC was 483 mm, and for the climatologies varied from 424 to 562 mm, with a mean of 495 mm. For the NCEP reanalyses, the range is 631–713 mm, much higher than the range of the climatologies.

Table 1. Comparison of water balance over global land areas (excepting Antartica and Greenland)

Model (M) or Climatology (C)	P	ET	R
VIC (M)	727	483	244
NCEP/NCAR Reanalysis (M)		631	
NCEP/DOE Reanalysis (M)		650	
DOE (VIC Grids) (M)		713	
Lvovitch (C)	834	540	294
Baumgartner & Reichel (C)	746	480	266
Korzun (C)	727[a]	424[b]	303
Oki et al. (C)	727[a]	562[b]	165
Oki (C)	727[a]	483[b]	244
Means	769	495[c]	252

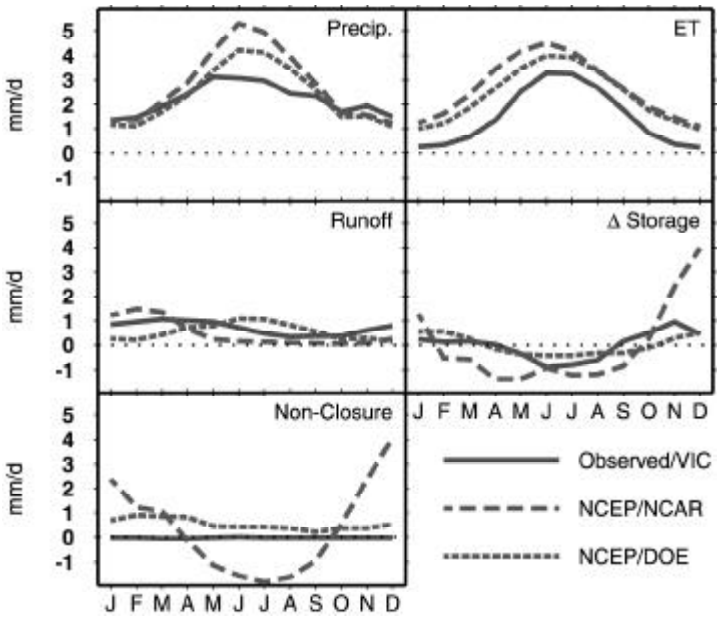
[a] *precipitation climatology from Global Precipitation Climatology Project (gauge-only) product*

[b] *based on cited runoff and GPCC precipitation*

[c] *excluding reanalysis products*

Within the Mississippi River basin, where much more detailed (and presumably accurate) surface data are available than in the global data used by Nijssen et al. (2000), the results are even more illuminating, and suggest why the reanalysis latent heat predictions may be biased upward. The left panels of the figure on the back page show that the precipitation for both reanalyses over the Mississippi River is biased upward relative to observations. Certain improvements in the NCEP/DOE as compared with the NCEP/NCAR reanalysis reduce this precipitation bias somewhat, but a major source of the upward bias, which has to do with the convective parameterization in the underlying model, remains. Furthermore, neither reanalysis closes its land surface water budget; soil moisture nudging is used to force the model's soil moisture toward climatology in NCEP/NCAR, and soil moisture in the NCEP/DOE reanalysis is adjusted using inferred infiltration based on a pentad precipitation database. As shown in the figure on the next page, in both cases the (absolute) magnitude of the nudging is significant. For the period 1988–97 over the Mississippi River basin the adjustment averages 1.6 mm/d for NCEP/NCAR and 0.5 mm/d for NCEP/DOE. The result is that the reanalysis evapotranspiration tends to be biased upward, because much of the excess moisture (precipitation and surface imbalance due to nudging) is evaporated.

Although this analysis is comprehensive with respect to all terms in the surface water bal-



Comparison of reanalysis average monthly water budget components with VIC simulations over the Mississsippi River basin for 1988-97. Precipitation for VIC is observed, other VIC values are output of model forced with surface observations.

ance only for the Mississippi River basin, it seems likely that the apparent upward bias globally has a similar cause. By contrast, the VIC simulations are forced to close the surface water balance, and as shown by Nijssen et al. (2000), the model is able to reproduce reasonably well (and certainly much better than the reanalyses) global runoff from many large continental rivers. We believe, therefore, that it is quite likely that the latent heat predicted by VIC, both within the Misssissippi River basin and globally, provides more accurate estimates than do the reanalyses, which we believe are biased upwards.

The results presented by Irannejad et al. (2000) and evaluated herein suggest that the caution previously noted by various authors regarding use of reanalysis surface variables be reiterated. Kalnay et al. (1996) note that in the NCEP/NCAR reanalysis, the precipitation used to drive the land surface model is a class "C" variable (meaning that it is only remotely related to observations) as are other land surface fluxes, including latent and sensible heat, that are predicted by the land surface scheme. Kalnay et al. (1996) recommend that class "C" variables be used with caution since they have no direct relationship to observations and are highly influenced by the assimilation model. Betts et al. (1996) in an early assessment of the NCEP/NCAR reanalysis, observed the now well-known precipitation biases. It is not surprising, therefore, that the NCEP reanalyses tend to give high values for latent heat.

Finally, there is some hope that ongoing and planned reanalysis efforts will produce better estimates of land surface fluxes that might be more appropriate for model evaluation than are currently available products. ECMWF has recently initiated a new reanalysis effort, which includes data assimilation protocols that should result in more reliable surface products. NCEP is in the planning stages for a regional reanalysis effort, which will include assimilation of observed precipitation in such a way that the surface water budget should close, or at least nearly close, with precipitation that is close to observations. If these new products fulfill their promise, they may meet the need for globally coherent moisture and energy flux products that can be used for model evaluation.

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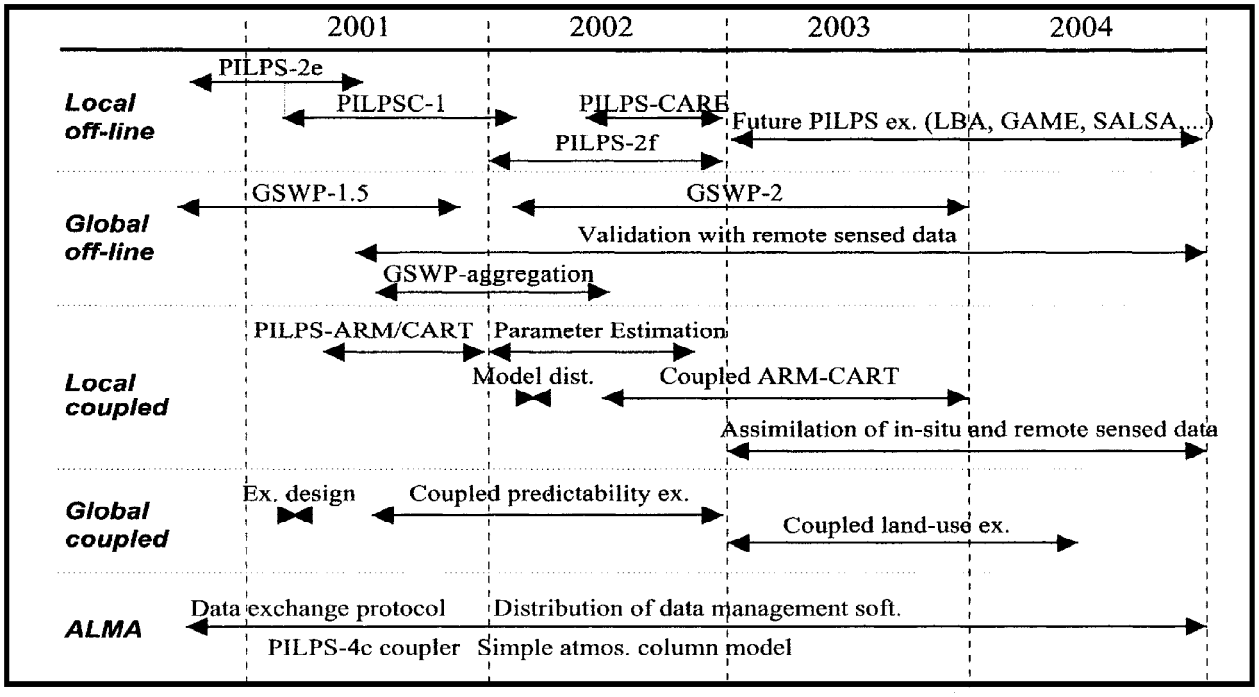

GLASS structure and timeline for scientific tasks

GLASS IMPLEMENTATION UNDERWAY

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The Global Land-Atmosphere System Study (GLASS) Project Implementation Plan defines the activities planned for the next several years. GLASS will coordinate Land Surface Scheme (LSS) intercomparisons from local to global scales and from off-line to fully coupled forcing. Building around the new GLASS structure and the excellent legacy of the Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS) and the Global Soil Wetness Project (GSWP), the above timeline shows, not only the planned schedule, but indicates the LSS focus areas of carbon processes, remote sensing and data assimilation. The following summarizes the GLASS implementation plans.

Local Off-Line Action Group LSS's (PILPS) (A. Henderson-Sellers, A. Pitman): PILPS will continue Phase 2 projects. Emphasis will be given to experiments associated with an improved understanding of how CO_2 is being represented in the current generation of LSS's.

Global Off-Line Action Group (GSWP) (P. Dirmeyer, T. Oki): GSWP 1.5 will be run with an updated version of the ISLSCP-1 data and the GSWP-2 effort will be broadened to include many aspects of the carbon cycle. A key activity will be to encourage the entire LSS community to provide diagnostics corresponding to satellite observations. The software for these diagnostics will be provided.

Local Coupled Off-Line Action Group (H. Gupta, P. Houser, P. Viterbo): This group will concentrate on the Atmospheric Radiation Measurement (ARM)/Cloud and Radiation Testbed (CART) site data, distribute a simplified single column model and extend the PILPS experiments by including the coupling to the atmosphere. Parameter estimation procedure will ensure that the effective parameters are the same in all schemes.

Coupled On-Line Action Group (P. Cox, R. Koster): Priority issues are intercomparison projects that would quantify the impact of (i) surface processes on the predictability of the hydrological cycle, and (ii) land-use and climate change on surface processes and climate.

Infrastructure Action Group (J. Polcher, T. Oki): The Assistance for Land-surface Modeling Activities (ALMA) group will provide an infrastructure to facilitate land-surface scheme intercomparisons. Standardization of the experimental set-ups will allow participants to reuse and exchange the tools needed to conduct the simulation and perform the post-processing. PILPS-2e is the first intercomparison within the ALMA framework.

WORKSHOP/MEETING SUMMARIES

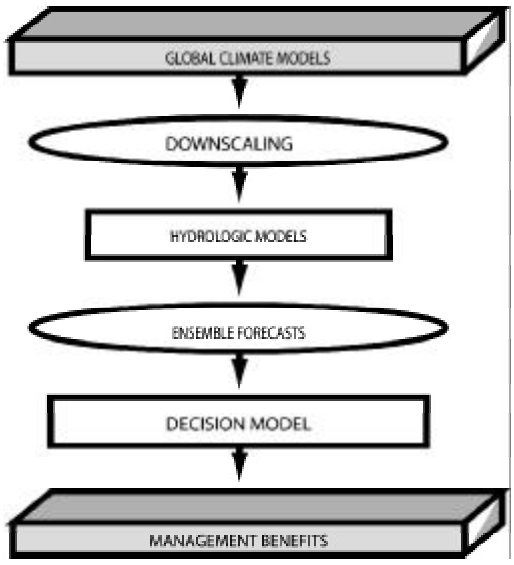
FIRST MEETING OF THE WRAP WORKING GROUP

29–30 August 2000
Palisades, New York

Rick Lawford
GCIP/GAPP Project Office

The inaugural meeting of the GEWEX Water Resources Applications Project (WRAP) working group took place at the International Research Institute (IRI) at Columbia University. The working group was established by the GEWEX Hydrometeorology Panel (GHP) to promote dialogue between GHP and the water resources community regarding current and future contributions of GEWEX to water management. The principal objectives of the meeting were: (1) to determine the scope of WRAP; (2) to develop a strategy and plan for its activities; and (3) to plan a meeting to bring together GEWEX expertise and water resource managers.

The meeting began with presentations aimed at bringing participants to a common level of understanding of the water resource applications and activities of GEWEX. There were presentations on BALTEX, GAME, GCIP/GAPP, MAGS-II and GRDC that showed how these projects involve water resources. One example is a study exploring how the use of ensemble and probability forecasts for the Mississippi River basin (see figure) are meeting the needs of water resource managers.



Transition of research results to water resource applications. Adapted from K.P. Georgakas, A.P. Georgakas and N.E. Graham, GEWEX News, 1988, Vol. 8, No. 3, pp 5-7.

There were also a number of presentations on related programs. They included a presentation on Hydrology for Environment, Life and Policy (HELP) that emphasized HELP use of a multidisciplinary, "bottoms-up" process to define its activities. It builds upon existing networks and is complementary to other international water-related projects. HELP needs hydrologic research that is directly responsive to water-related policy.

The ambitious World Water Development Report (WWDR), being prepared under the auspices of UNESCO and funded primarily by Japan, will assess the state of the world's freshwater resources, both on a global basis and through case studies of individual basins. Among other things, the report will review the methodology of Integrated Water Resources Management (IWRM) and implementation of IWRM at the basin scale. WWDR emphasizes a balanced approach between the assessment of need and availability of water. Coping with water-related stress through adaptation of natural ecosystems and human societies is an important part of this strategy. If the first report is successful and the project becomes financially self sufficient, these reports will be completed every 2 years.

The WMO-Hydrology program features a program for regional Hydrological Cycle Observing Systems. It was noted that data from this initiative are freely available over the internet.

It was clear that a number of the goals and strategies employed by IRI have potential application in WRAP. Areas of mutual research interests include water resources monitoring and diagnostics (floods, droughts, areas of vulnerability, observed predictability), water resources forecasting (statistical and dynamic) and water resource management issues.

Based on the discussions and agreements reached at the WRAP meeting:

- GEWEX/WRAP, in collaboration with the Continental Scale Experiments (CSE), will participate in regional WWDR workshops

and case studies. (Basins of high interest to WWDR include Rio de la Plata Basin and basins in the GAME area).

- HELP will be encouraged to develop mechanisms for working more closely with GEWEX. Furthermore, GEWEX will be a principal source of hydrologic and hydrometeorological expertise for HELP, within the limits of geography, expertise and resources.

- GEWEX/WRAP will organize the following meetings:

  - 2001 or 2002: Applications of GEWEX products for water resource management.

  - 2003: Special IUGG Workshop on the role of GEWEX hydrology and hydrometeorology science in improved water resources management.

- WRAP will facilitate regional workshops on water resources that are coordinated with or organized by the CSEs. Where possible and appropriate, these workshops should involve other regional hydrologic expertise such as Flow Regimes from International Experimental and Network Data.

- WRAP will develop an overview of the water resource needs through the CSEs. Each CSE was encouraged to hold one or more "scoping diagnostic" workshops in which they would, based on input from regional water resource managers, define the important water resource issues and opportunities for their basin, and find the research needed to address these particular problems. (In cases where the basin is both a CSE and a HELP basin these scoping exercises should involve HELP and also address social and institutional issues of interest to HELP). It is recommended that GHP add a scoping workshop or study as one of its criteria for CSEs.

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

SIXTH GHP MEETING

11-15 September, 2000
Angra dos Reis, Brazil

Sam Benedict
WCRP

The sixth annual meeting of the GEWEX Hydrometeorology Panel (GHP) was hosted by Carlos Nobre, representing the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA). A series of technical presentations were made on topics that covered research of relevance to the global hydrological issues being promoted by WCRP and GEWEX. A focused workshop on the status of the GHP Water and Energy Budget Study (WEBS) was held on the first day of the meeting. Additional time was given to the status of the GHP Water Resources Application Project (WRAP). Each CSE updated their implementation status and the GHP working group for the GHP/GEWEX Coordinated Enhanced Observing Period (CEOP) reported on its progress. Discussions were also underaken to refine further actions required to ensure a successful CEOP process. A review of contributions to GHP by national and international projects and organizations, including those within and outside the GEWEX framework, was given by representatives for the International Satellite Land-Surface Climatology Project (ISLSCP); the International Association of Hydrological Sciences (IAHS); the National Climate Research Program of Korea; the limited international regional study, designated Coupling the Tropical Atmosphere and the Hydrological Cycle (CATCH) in West Africa; the Global Precipitation Climatology Project (GPCP); the Global Precipitation Climatology Center (GPCC); the GEWEX Global Land-Atmosphere System Study (GLASS); and others. The work of the GHP Working Group on Data Management was also reviewed.

From plenary sessions and breakout groups, the steps necessary for GHP to achieve its objectives were established. Steps were determined for significant improvement in the simulation of water and energy fluxes and reservoirs over land on diurnal-to-annual temporal scales, the prediction of these on temporal scales up to seasonal and interannual, and documentation of the seasonal advance of the monsoon system and better understanding of the physical transport mechanisms and their possible physical connections.

Dr. S. Sorooshian, Chairman of the GEWEX-Scientific Steering Group (SSG) characterized the main science and implementation questions for GHP in terms of the key uncertainties facing GEWEX and the broader WCRP climate research community. These questions include whether (a) the global hydrological cycle is accelerating, (b) the extent to which models can reproduce extreme events such as floods and droughts, (c) the ability of models to describe the diurnal cycle (e.g., of precipitation) and (d) the process for evaluations that go from the global scale down to the regional scale. The latter focuses especially on how downscaling to smaller grid scales can be adapted to current parameterization formulations, and how these factors impact the process and need for GHP to close the water and energy budgets over the CSE regions.

Milestones to be set for GHP, that are attainable in the context of the next phase of GEWEX, included: (a) providing sufficient point measurements necessary for model validations at local scales within each CSE; (b) establishing basin budgets from large scale diagnostics (monthly/annual) that would lead to a characterization of diagnostic water and energy budgets for each CSE; (c) assessing model capabilities to simulate water and energy budget variables at all relevant space and time scales for each CSE; (d) applying GEWEX deliverables to evaluate reanalysis products; and (e) confirming WEBS results including, with the support of the GEWEX Radiation Panel (GRP), a goal to quantify fluxes to within 10 W/m^2. The action to document these plans in an article suitable for publication in the *Bulletin of American Meteorological Society* or similar journal was also accepted. The plans address the central challenge of the second phase of GEWEX to exploit the new and more diverse measurements of the new Earth Observing System platforms and the application of scientific results of the CSEs to improve climate prediction capabilities. Dr. Sorooshian also noted that to accomplish this work, GHP must take the lead in promoting the participation of the hydrological modeling community and supporting operational environmental services in their efforts to develop improved and more accurate hydrometeorological predictions.

WATER AND ENERGY BUDGET WORKSHOP

11 September 2000
Angra dos Reis, Brazil

Ronald Stewart
Meteorological Services Canada

A 1-day workshop was held on the Water and Energy Budget Study (WEBS) just before the annual GHP meeting. WEBS is a critical effort within GHP in that it strives to collectively assess our ability to develop observations of basic climate variables, assess our ability to simulate those observations with atmospheric and hydrologic models, assess our ability to develop budgets from observations and models, and clarify levels of uncertainty in these budgets at annual, seasonal, diurnal, interannual and longer time scales over the various continental-scale experiments of GEWEX as well as other areas.

The workshop's specific objectives were to summarize WEBS activities within the various CSEs and other activities of GHP; to clarify our ability to characterize, model and understand water and energy parameters over such regions; and to move towards syntheses of the individual and GHP-wide efforts. Some of the activities are summarized here.

A number of WEBS activities are underway within the Large-Scale Biosphere-Atmosphere Project in Amazonia (LBA). These are associated with specific field campaigns to better observe water and energy fluxes and reservoirs and with the analysis of operational and reanalysis model information. For example, Marengo (2000) is using the NCEP reanalysis as well as observational information to characterize the annual cycle of critical water budget parameters and their variations. In general, there is presently considerable difficulty in the balancing of atmospheric motions with stream flow information, due to a considerable degree of uncertainty in the measurement of basic parameters. Plans for improved measurements over the basin should help to alleviate such uncertainties in the future.

Many WEBS-related activities are taking place within GCIP/GAPP to understand the water and energy balance for the Mississippi River basin. To accomplish this it is important to define individual components of moisture fluxes at high space and

time resolution. Some preliminary results indicate that the effects of the low level jet may be enhanced by larger scale processes that simultaneously contribute to the moisture flux. **The water cycle and the carbon cycle are highly coupled as indicated by observations showing that the maximum uptake of carbon occurs when transpiration is at a maximum. For example, measurements in Illinois indicate 50 percent of annual water loss through evaporation occurs in the summer months. Furthermore, with wet soils and midday radiation exceeding 650 Wm^{-2}, evapotranspiration can exceed 4 mm/day in crops; GCIP is developing many basin-scale observational products of critical parameters for models.**

Particular emphasis is being placed on the systematic evaluation of both high resolution regional models, as well as lower resolution global models. In addition, model outputs summarized on maps of seasonal and annual averages for water and energy variables are being brought together for a comprehensive journal article that will include an assessment of GCIP's capability to characterize, model and understand the water and energy balance over the central United States. **Based on this comparison the global spectral model balances the water budget to within 40% while the new regional models balance the budget within 20%. According to John Roads (personal communication) the differences between the model energy budgets are probably balanced to within 30%.**

WEBS-related activities in MAGS span a wide range of studies from hillslopes of tens of meters in length through small catchments of a few kilometers in area to basins of the order of 10^6 km^2. These studies use a variety of observational and modeling approaches. There is considerable capability to close budgets at the small scales using both observational and modeling techniques, despite wide variations in surface conditions and the effects of variable slopes. Integration of an observationally based atmospheric balance study with a large scale hydrological modeling study was used to examine our potential to close the water budget for the Mackenzie basin (Strong et al., 2000). **While some issues remain unresolved, the studies suggests that it is feasible to close the Mackenzie budget within the error of measurement at the interannual time scale using monthly observations and model results.** Other water balance studies, particularly, for the 1994/1995 water year, have been carried out using numerical weather prediction, as well as regional climate models; such studies show general agreement with available measurements for some parameters but problems with others (such as orographic precipitation).

A number of WEBS-related studies have already been carried out within BALTEX. Examples include Heise (1996) for the atmosphere and surface and Omstedt and Rutgersson (2000) for the Baltic Sea. The first study relied upon short-range forecast information and it documented the annual cycle of the atmospheric water budget, the surface energy budget over the sea, and the atmospheric energy budget and compared these against available observation. **In general, model and observational results were comparable. Omsted and Rutgersson used observations to demonstrate the close balance between the gain of the Baltic Sea by precipitation and the inflow of rivers.** At the Max-Planck-Institute a water budget study over the BALTEX area was performed where the results of 10-year runs from the global climate model and the regional model were compared. Results show an enhancement of evaporation and precipitation by the regional model over land and the opposite over the Baltic Sea. As well, a regional model intercomparison was performed with 8 models running in various modes (assimilation, forecast and climate) and the results are presently in the process of being published.

The GEWEX Asian Monsoon Experiment (GAME) has undertaken a number of studies that deal with energy and water balances in each of the areas of study. A considerable amount of budget analysis has been undertaken using the European Centre for Medium-range Weather Forecasts (ECMWF) reanalysis products and validating them with point measurements. As regional reanalysis products using GAME measurements become available from Japan Meteorological Agency (JMA) additional WEBS analysis will be undertaken. Extensive analysis of the effects of land cover on heat fluxes have been undertaken in Thailand. This analysis has shown that latent heat fluxes are larger and sensible heat fluxes smaller over the rice paddies than over the forested areas. **As part of the GAME effort flux measurements are being made in each region. Closing the budget for these regions has proven to be a challenge. The imbalance in energy budgets at individual tow-**

ers range from 5 to 25% in Tibet to 25 to 30% in Siberia and 30% in Thailand.

This was an important workshop that allowed the various efforts within GHP to illustrate their current efforts in regards to WEBS. Substantial progress is being made within the regional GHP activities to characterize individual components of the regional water and energy fluxes and reservoirs and to examine the overall budgets. An effort will be made to better collectively summarize the observational and modeling activities that are taking place within the various regions on this issue. In addition, some of the CSEs have already embarked on the production of collective scientific articles to summarize their overall capabilities to observe and model water and energy fluxes and reservoirs. It is also critical to improve the global perspective. We should make better use of GEWEX and other global data products as well as rely upon the examination of reanalysis products; such global products have to be compared against regional ones. Also, more attention needs to be paid towards the development and application of physically based indices for characterization and interpretation purposes. All of these efforts will eventually be summarized within a GHP-wide article that will highlight our collective capabilities to address water and energy balances regionally and globally.

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NEW SHORTWAVE RADIATION BUDGET CD-ROM AVAILABLE FOR 1984-1994

From the University of Maryland, surface and top-of-atmosphere shortwave radiation data are provided based on ISCCP D1 data. To request a CD-ROM, send an e-mail to srb@atmos.umd.edu

CEOP WORKSHOP SUMMARY

14-15 September 2000
Angra dos Reis, Brazil

John Leese
GCIP Office

At the 6th GEWEX Hydrometeorology Panel (GHP) Meeting held 11-15 September 2000, there was a Coordinated Enhanced Observation Period (CEOP) Workshop with broad GHP membership participation. The planning for CEOP has had one guiding goal—to understand and model the influence of continental hydroclimate processes on the predictability of global atmospheric circulation and changes in water resources, with a particular focus on the heat source and sink regions that drive and modify the climate system and anomalies. **The GHP agreed to focus the CEOP scientific effort within two major activities. They are simulation and prediction, and monsoon systems.**

The objective of the simulation and prediction task is to use enhanced observations to document and improve the simulation and prediction of water and energy fluxes and reservoirs over land on diurnal to annual temporal time scales, as well as the prediction of these on temporal scales up to seasonal (for water resource applications). The workshop participants identified what can be done and these were distilled to key items for an implementation strategy. Among the key items for an implementation strategy were the following:

- Build greater involvement of both the meteorological and hydrological modeling community in CEOP by promoting it at the upcoming WGNE and GMPP sessions and holding a CEOP Workshop that brings the broader community of observationists, process studies and modelers together.

- Specify what CEOP will provide to GEWEX Panels, WCRP Project Panels and the data we need from these groups.

- Update global data sets to include CEOP period (including ISLSCP).

- Provide high resolution regional model datasets based around monsoon regions as well as

other energy sources and sinks to the atmosphere.

- Provide Model Location Time Series (MOLTS) around regions and areas relevant to CEOP questions.

- Validate the low-resolution global model output with the "high quality," high-resolution data used in CSE regional models.

The second major CEOP activity identified at the 6th GHP session was to document the seasonal march of the monsoon systems and better understand their physical driving mechanisms and their possible physical connections. Again, from the discussions on what can be done, several key items for the monsoon systems implementation strategy were the following: (1) articulate a few key science issues relevant to the objective; (2) make use of ensemble predictions with "enhanced" initial conditions (IC)/boundary conditions (BC); (3) carry out a series of ensemble seasonal simulations with IC/BC; and (4) conduct empirical (diagnostic) studies.

The GHP agreed that the implementation of CEOP will begin with a short build up period of about three months, starting on 1 July 2001, to produce an initial seasonal dataset. The Enhanced Observing Period will cover two annual cycles from 1 October 2001 through 30 September 2003. The CEOP Research Phase will begin in a formal sense with the availability of the initial seasonal data set about the end of September 2002.

The International CEOP Workshop, scheduled for 27 February to 1 March 2001, in Greenbelt, Maryland will contribute to this planning effort.

GEWEX/WCRP MEETINGS CALENDAR

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

4–5 December 2000—LBA-HYDRONET WORKSHOP, Cachoeira Paulista, SP Brazil

11–13 December 2000—ISCCP WORKING GROUP ON DATA MANAGEMENT AND SCIENCE ADVISORY TEAM MEETING, NASA Goddard Institute for Space Studies, New York City, NY, USA.

8–10 January 2001—WORKSHOP TO DEVELOP AN INTEGRATED GLOBAL OBSERVING STRATEGY FOR THE WATER CYCLE, Los Angeles, California, USA.

14–19 January 2001—81ST AMERICAN METEOROLOGICAL SOCIETY MEETING, Albuquerque, New Mexico, USA. Special symposia include: Global Aerosol Climatology; Symposiums on Global Change Studies and Integrated Observing Systems.

29 January–2 February 2001—GEWEX SCIENTIFIC STEERING GROUP MEETING, Barcelona, Spain.

27 February–1 March 2001—INTERNATIONAL CEOP WORKSHOP, NASA/GSFC, Greenbelt, Maryland, USA.

5–7 March 2001—GAME TROPICS WORKSHOP, Phuket, Thailand.

7–9 March 2001—INTERNATIONAL WORKSHOP ON GAME- ASIAN AUTOMATIC WEATHER STATION (AWS) NETWORK (AAN)/RADIATION. For more information: http://erc2.suiri.tsukuba.ac.jp/Project/aan/aan.html.

19–24 March 2001—WCRP JOINT SCIENTIFIC COMMITTEE MEETING, Boulder, Colorado, USA.

4–6 April 2001 —GAPP PRINCIPAL INVESTIGATORS MEETING AND GAPP IMPLEMENTATION PLAN WORKSHOP, Potomac, Maryland, USA.

2–6 July 2001—THIRD STUDY CONFERENCE ON BALTEX, Aland, Finland. For information consult website: http://w3.gkss.de/baltex/.

10–13 July 2001—CHALLENGES OF A CHANGING EARTH--A GLOBAL CHANGE OPEN SCIENCE CONFERENCE, RAI Conference Center, Amsterdam, The Netherlands. Abstracts are due 31 March 2001. For information: http://www.sciconf.igbp.kva.se/fr.html.

14–15 July 2001—JOINT ISLSCP/BAHC SCIENCE PANEL MEETING, Amsterdam, The Netherlands.

18–27 July 2001—SIXTH SCIENTIFIC ASSEMBLY OF THE INTERNATIONAL ASSOCIATION OF HYDROLOGICAL SCIENCES (IAHS)-S5 SOIL-VEGETATION-ATMOSPHERE TRANSFER SCHEMES AND LARGE SCALE HYDROLOGICAL MODELS, Maastricht, The Netherlands.

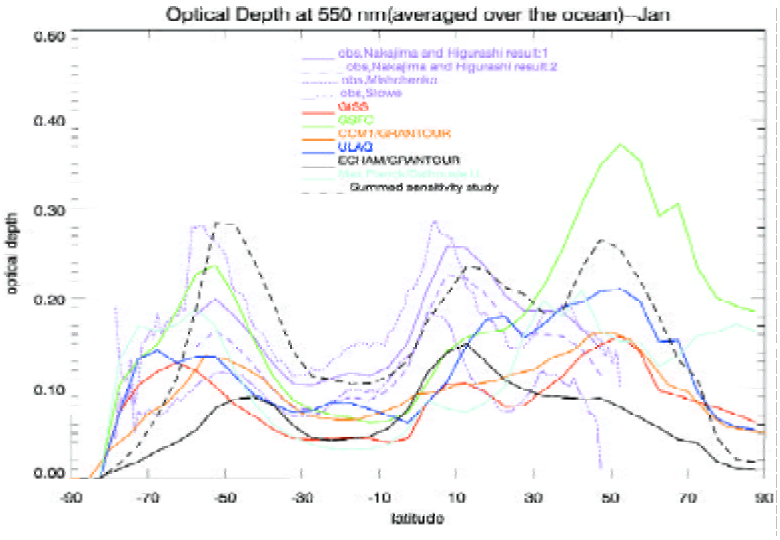
10–14 September 2001—FOURTH INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE, Institut Pierre Simon Laplace, Collège de France, Paris, France. For information: http://www.ipsl.jussieu.fr/gewex.

1–2 October 2001—SIXTH GAME INTERNATIONAL SCIENCE PANEL MEETING**,** Aichi Trade Center, Nagoya, Japan.

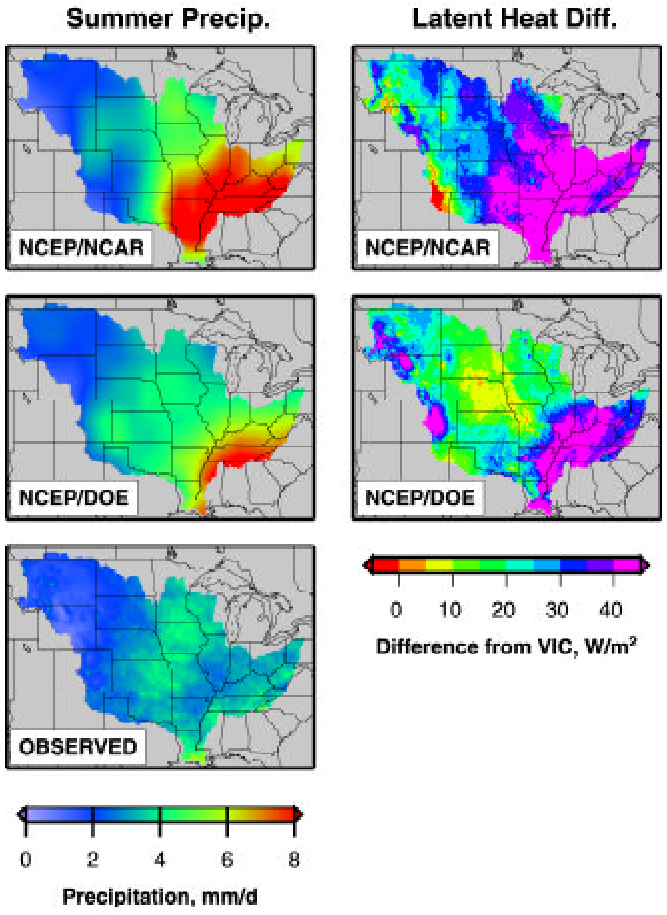
3–5 October 2001—FIFTH INTERNATIONAL STUDY CONFERENCE ON GEWEX IN ASIA AND GAME, Nagoya, Japan.

MODELS AND SATELLITE-DERIVED OPTICAL DEPTH AVERAGE 0.05 DIFFERENCES

Aerosol optical depth derived from AVHRR satellite analysis following Nakajima et al. (1999) (labeled result 1 and result 2), Mishchenko et al. (1999) and Stowe et al. (1997) for January. The results from Nakajima refer to 1990, while those from Mishchenko and Stowe refer to an average over the years 1985 to 1988. The results derived from the models which participated in the GACP and IPCC-sponsored workshop are also shown. The case labeled summed sensitivity study shows the derived optical depth for the ECHAM/GRANTOUR model using a factor of two increase in the DMS flux and the monthly average sea salt fluxes derived using the SSM/I wind fields (See page 5).



REANALYSIS COMPARISONS PROVIDE PROMISE FOR CLOSING BUDGETS



Left panels: Average precipitation in mm/day over the Mississippi River basin for summer (June, July, August) for 1988-97 for NCEP/NCAR and NCEP/DOE reanalyses, and gridded observed values (used in the VIC model). Right panels: 10-year average (1988-97) latent heat differences between NCEP/NCAR (upper) and NCEP/DOE (lower) reanalyses and VIC over the Mississippi River basin. VIC was forced by observed precipitation, and closely reproduced observed runoff (See page 6).

GEWEX NEWS

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