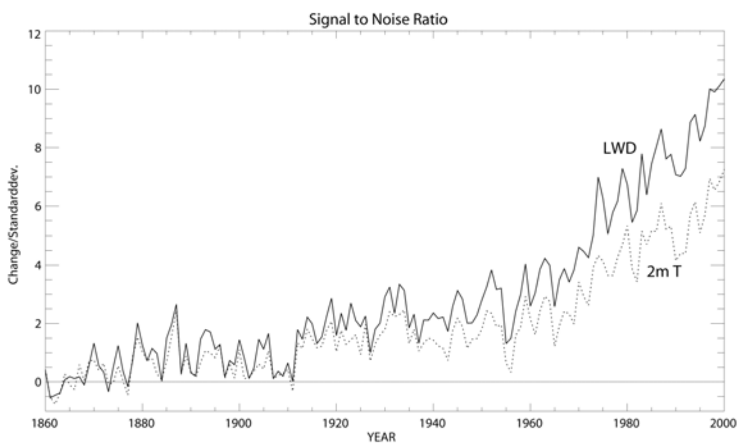
World Climate Research Programme
(A Programme of WMO, ICSU and IOC)

# GEWEX NEWS

Vol. 14, No. 4 | Global Energy and Water Cycle Experiment | November 2004



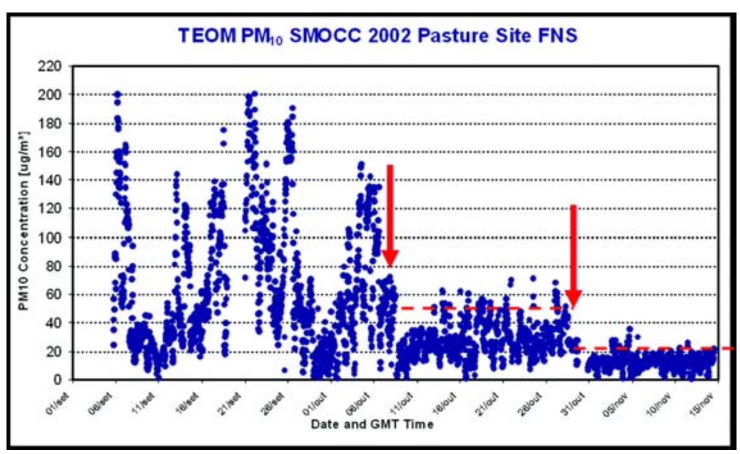
## BSRN LONGWAVE DOWNWARD RADIATION MEASUREMENTS SHOW PROMISE FOR GREENHOUSE DETECTION STUDIES




**THE SIGNAL OF INCREASING LWD EMERGES FASTER FROM ITS BACKGROUND NOISE THAN THE TEMPERATURE SIGNATURE**

*Ratio between the GCM-projected global annual mean change signal in a transient GCM experiment (Roeckner et al., 1999) and the interannual variability in terms of standard deviations in an unperturbed control run ("signal-to-noise ratio") for longwave downward radiation (solid line) and surface temperature (dotted line).* *See article on page 9.*

## LBA SHOWS IMPACT OF AEROSOLS ON CLOUDS




*Evolution of the concentration of aerosols with a diameter less than 10 µm ($PM_{10}$) measured in central Rondônia in a pasture site during September to November 2002. The* ***arrows indicate the first significant rainfall on October 7 and the onset of regular rainfall in the beginning of November.*** *Data from LBA/Smoke, Aerosols, Clouds, Rainfall and Climate (SMOCC) Project.* *See article on page 4.*

**GCSS/ISCCP CLOUD REGIME ANALYSIS POINTS THE WAY FOR GCM MODEL IMPROVEMENT (Page 6)**

*COMMENTARY*

## GEWEX RESEARCH HAS POTENTIAL TO IMPROVE HYDROLOGIC SERVICES

**Soroosh Sorooshian, Chairman**
**GEWEX Scientific Steering Group**

Since its inception GEWEX has had close ties with a number of national meteorological centers, such as the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Prediction (NCEP), the Japanese Meteorological Agency (JMA), and the European Center for Medium-Range Weather Forecasts (ECMWF). These ties have been mutually beneficial as these centers have provided guidance to GEWEX research and they have benefitted from GEWEX results. However, with few exceptions, progress in developing a similar rapport with national hydrologic services has been slower.

GEWEX has expended considerable effort on research that could benefit hydrological forecast services. GEWEX efforts, such as the Global Soil Wetness Project (GSWP) and regional hydrologic modeling projects launched in the Continental Scale Experiments (CSE) have provided a basis for regional hydrologic applications. These efforts have benefited numerical weather prediction systems because the hydrological understanding has led to improved land surface schemes. However, their benefits to hydrologic services have been more limited. GEWEX is exploring strategies for working more closely with hydrologic services through the Water Resources Application Project (WRAP) and the Hydrology Ensemble Prediction Experiment (HEPEX).

One complexity in dealing with operational hydrologic services is the absence of common approaches between the national services, or, even regional branches of the same service. In some countries the national services do not have strong ties to the meteorological services, the hydrologic services are limited and the techniques used are quite empirical in nature. These differences make it difficult for a program like GEWEX, which focuses on large scale hydrologic models, to develop linkages across all the wide-ranging needs of hydrologic services worldwide.

For a number of years, the GEWEX Americas Prediction Project (GAPP) has been funding a core project in the NOAA hydrologic services to help build an Advanced Hydrologic Prediction System (AHPS). Another positive step was the invitation to the Integrated Global Observing Strategy–Partnership (IGOS-P) Integrated Global Water Cycle Observations (IGWCO) Theme and GEWEX to participate in a recent Commission of Hydrology (CHy) meeting, where approximately 50 national hydrological services were represented. This initial dialogue will be followed by ongoing interactions with the Hydrology and Water Resources Division of the World Meteorological Organization (WMO) and, hopefully, the launch of a joint project. In addition, some African national hydrologic services expressed an interest in the African Multidisciplinary Monsoon Activity (AMMA) and it is anticipated that this new initiative will provide an opportunity for strengthening linkages with the African hydrologic services. These linkages could be central for achieving WMO's aspirations for capacity building in these countries. Furthermore, the new WMO Disaster Program may provide a framework for studies related to the hydrologic elements of floods and droughts.

GEWEX progress in providing hydrologic research capabilities and data products in support of national hydrologic services is expected to be strengthened in the coming years. However, to realize this goal, it is essential for the hydrologic community to participate in GEWEX through projects like WRAP and HEPEX.

### Contents

## GEWEX WELCOMES NEW SSG MEMBERS

**Franco Einaudi**

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**Areas of Interest:** Atmospheric dynamics, stability theory of stratified flows, generation and propagation of gravity waves, mesoscale and microscale processes, triggering of condensation and convection by gravity waves, gravity wave-turbulence interactions.

**Kapil Dev Sharma**

Director,
National Institute of Hydrology
India
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Areas of Interest: Modeling and prediction of the water budget.

## EUROPEAN GEWEX COORDINATOR

GEWEX welcomes Peter J. van Oevelen as the European GEWEX Coordinator. Peter's activities will be evenly divided between GEWEX and the European Space Agency.

Since 1992 Peter (MSc. 1991; PhD 2000) has worked at Wageningen University as a research associate and lecturer to undergraduate students. His research activities involved the use of remote sensing in agro-hydrology, meteorology, land degradation and forestry. He has been co- and principal investigator in numerous experiments (e.g., HAPEX-Sahel, NOPEX/Forest-dynamo, Washita'94 and Southern Great Plains'97) and is currently project manager for SAIL-GEONEDIS.

In 1994 he received a Fulbright scholarship to work with Prof. Kavvas at the Department of Civil and Environmental Engineering at the University of California, Davis (USA) on stochastic methods in hydrology and remote sensing. He was the co-founder and technical director of SarVision B.V., a company in Wageningen dealing with monitoring of the natural environment using microwave remote sensing.

# *RECENT NEWS OF RELEVANCE TO GEWEX*

## PLANS PROGRESSING FOR A PAN-WCRP MONSOON WORKSHOP

A pan-WCRP workshop is being planned for the University of California, Irvine on June 15 to 17, 2005. The workshop will examine the ability of models to simulate monsoons in terms of process understanding, data requirements and parameterizations. It will also clarify the roles of CLIVAR and GEWEX in future monsoon initiatives. Planning for the workshop is being led by Professor Tetsuzo Yasunari and Dr. Ken Sperber. A scientific committee is being established and a web site and workshop announcement will be available in the near future.

## IGPO RETREAT

The IGPO staff held a small retreat in October to discuss the GEWEX Phase II implementation strategy and related issues. This strategy will be a basis of discussion at the upcoming GEWEX SSG meeting in China.

## NASA NEWS CALL

The NASA Step I NASA Energy and Water Studies call closed on August 24, 2004. NASA reports that the call has generated a great deal of interest in the community. It is hoped that there will be a number of GEWEX-related projects supported through this effort.

# AEROSOLS IMPACT CLOUDS IN THE AMAZON BASIN

**Maria A. F. Silva Dias[1,2], Paulo Artaxo[2], M. O. Andreae[3]**

**[1]Center for Weather Forecasting and Climate Studies-CPTEC/INPE, Brazil**
**[2]University of São Paulo, Brazil**
**[3]Max Plank Institute for Chemistry, Germany**

## *Physical Properties of Amazonian Aerosol Particles*

Most of the Amazon Basin has a well marked yearly cycle of rainfall with a short dry season, a long wet season and short transitions between the dry and the wet seasons. In the dry season and in the transition to the dry season, biomass burning takes place mainly at the southern and eastern sectors of the Amazon Basin and provides a ten-fold increase in the background number concentration of aerosols and cloud condensation nuclei (Williams et al., 2002). In the wet season, the main source of aerosols and Cloud Condensation Nuclei (CCN) is the natural emissions of biogenic aerosol particles, including coarse mode primary particles and fine mode particles from the gas-to-particle conversion from volatile organic compounds emissions (Artaxo et al., 2002). The main sources of aerosol particles in the coarse mode in Amazonia are soil dust and natural primary biogenic particles, where in the fine mode, secondary organic biogenic particles and biomass burning smoke predominate.

Recently, Claeys et al. (2004) have demonstrated the possibility that oxidation products of isoprene could make a fraction of natural wet season aerosol particles in considerable amounts. Roberts et al. (2002) analyzed the effect of sulfur compounds from decaying organic matter deposited on pre-existing particles, enhancing their capacity to become CCN, showing that the amount of sulfate on the particle was directly related to the activation fraction of the aerosol for a given supersaturation.  Andreae et al. (2004) showed the large impact of pyrogenic particles in cloud properties during the biomass burning season, with large changes in cloud microphysics from natural conditions to heavy biomass burning impacts. Using remote sensing techniques, Koren (2004) demonstrated the suppression of low cloud formation due to biomass burning smoke. Basically, no low clouds were observed with an aerosol optical thickness above 1.5 at 500 nm.

## *Impacts of Aerosol Particles in the Atmospheric Radiation Budget*

One of the important impacts of aerosol particles on the radiation budget is through the absorption and scattering of solar radiation reaching the surface. This is basically a dry season phenomenon due to the very high aerosol loading in the atmosphere when mass concentrations can reach an extremely high 600 $\mu g/m^3$, with an aerosol optical thickness over 3 at 500 nm. In addition to pyrogenic particles, biogenic and soil dust aerosols must be taken into account when modeling the physical and optical properties of aerosols in forested regions such as the Amazon Basin (Claeys et al., 2004). The albedo of the surface affects the absorption of short wave radiation by overlying aerosols in the sense that high albedo areas are associated with more absorption and thus have a more pronounced surface negative radiative forcing. Procópio et al. (2004) show that the aerosol radiative forcing in the dry season has different values at the surface, boundary layer, and top of the atmosphere. The average from 7 years of measurements indicates a forcing of –38 watts/m² at the surface, while the forcing in the atmosphere reached +28 watts/m², due to the presence of black carbon aerosol that warms up the atmosphere. The main effect is seen as a cooling of the surface and warming of the boundary layer, which strongly affects the atmospheric stability in low levels. The increased static stability leads to a reduction in turbulence and a negative impact on updraft speed at the cloud base. Since a large scale subsidence inversion is often seen during the dry season, the reduced updraft speed indicates that most cumulus clouds will not evolve into congestus or into cumulonimbus.

## *Microphysical Impact of Aerosols*

During the transition season from dry to wet in 2002, a Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA) intensive field campaign was conducted in the southwest Amazon Basin to measure the impact of aerosols on clouds using an airplane instrumented to measure cloud microphysical properties. Andreae et al. (2004) describes the first results, which show a well defined shift of the drop size spectra to larger droplets from the cloud base to middle levels in clouds inside the polluted air mass when compared to those in cleaner environments, indicating that larger droplets are suppressed at lower levels in the presence of large numbers of aerosols due to the competition for the available moisture (see figure on page 20). The absence of larger droplets is an indication of rain suppression in the first stage of cumulus development and an eventual shift from warm rain to rainfall generated through the ice microphysical processes. Williams et al. (2002) noted that in the transition from the dry to wet season, the convective systems in the Amazon had the typical features of continental thunderstorms with extensive lightning, damaging winds and eventually hail. The triggering of deep convection in a scenario of a cooler surface, an enhanced CCN number concentration, and the absence of frontal systems, would be possible by either forced uplift over topography or in selected spots with large sensible heat flux, such as in slopes, deforested areas, or bare soil areas. In this case, the process of rain formation would have to be through the ice phase, which explains the enhanced lightning in the transition from dry to wet season.

During the wet season, the lower number of lightning strikes indicates a more oceanic behavior of convection, although significant intraseasonal variability is observed. The microphysical properties analyzed in data from a surface disdrometer (Tokay et al., 2002) show that as the low level wind changed from easterlies to westerlies with the approach of frontal boundaries (Rickenback et al., 2002), the character of rainfall changed with a pronounced decrease in the number of larger droplets at the surface. Carvalho et al. (2002) showed that during the easterlies the clouds were more isolated and deeper, while these studies indicate that rainfall had a larger convective fraction during the easterlies. Aerosol concentration varied accordingly with low concentrations during the westerlies when the systems were larger in area. Silva Dias et al. (2002) discussed the possible feedback of clouds and aerosols in the wet season, suggesting that the main effect could be in the local recycling of biogenic material during the westerlies and an export of biogenic material during the easterlies through the enhanced vertical transport to upper levels (Freitas et al., 2004).

### *Large-Scale Impact*

The fact that the atmospheric large-scale environment is dominated by subsidence in the dry season and by large-scale moisture convergence during the wet season (Li and Fu, 2004) makes the analysis of the differences in cloud processes a non-trivial task. However, the transition from the dry to wet season shows a suggestive evolution from the surface budget point of view. Li and Fu (2004), through analysis of a composite of the European Center for Medium-Range Weather Forecasts (ECMWF) reanalysis over the Amazon Basin during the transition from the dry to wet season, suggest that the transition can be divided into three phases: initiating, developing, and mature. The temporal evolution of the dry season is initially dominated by a gradual increase of local sensible and latent heat fluxes forced by increased solar radiation. The developing phase is dominated by the seasonal transition of the large-scale circulation with the change of the cross-equatorial flow, which becomes northerly and is associated with an increase of thunderstorms. The northerly flow increases the net moisture convergence in the area leading to the onset of the wet season in the mature phase. The ECMWF reanalysis used by these authors does not include the explicit effect of aerosols and, thus, the comparison with observed surface fluxes show some differences in the correct sense, for example, lower values in the observations as compared with the reanalysis. It can be argued that the presence of a dense aerosol layer in the dry season would delay the surface flux increase and thus postpone the onset of the rainy season, but by how much has not yet been determined. The figure at the bottom of page 1 shows the evolution of the concentration of aerosols with a diameter less than 10 µm ($PM_{10}$) measured in central Rondônia in a pasture site from September to November 2002. The arrows indicate the first significant rainfall on October 7 and the onset of regular rainfall at the beginning of November.

### *Impact on Precipitation*

It is becoming clear that larger aerosol loadings in the atmosphere cause changes in cloud microphysics, with both *in situ* and satellite measurements indicating smaller droplet sizes with increasing aerosol loading and changes in cloud dynamics. However, the final effect on the precipitation rate and amount is still unclear. Several researchers have looked at possible changes in the precipitation rate with large temporal or spatial changes in aerosols, but there is no clear signal on this critical issue. This area needs attention due to possible changes in precipitation rates and amounts. Additionally, the determination of quantitative aspects of the aerosol indirect effects, as well as the semi-indirect effect, is still in its infancy, with potentially significant changes in the global and regional atmospheric radiation balance.

**Acknowledgements**: This work has been supported by Fundação de Amparo à Pesquisa do Estado de São Paulo, Conselho Nacional de Desenvolvimento Científico e Tecnológico, the European Community, the Max Planck Society and the National Aeronautics and Space Administration.

*(Continued on page 19)*

# CLOUD REGIMES, MODEL EVALUATION AND MODEL DEVELOPMENT

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Developing representations of clouds in models of the atmosphere is a complex process. This is particularly true for those models in which the fundamental scales of cloud system dynamics are not resolved and in which clouds, therefore, need to be represented in the form of parametrizations. All current global climate and Numerical Weather Prediction (NWP) models fall into this category.

Model development necessarily relies on, and often begins with, model evaluation, whose role it is to identify areas in which model simulations are erroneous and, ideally, to prioritize the order in which shortcomings should be addressed. Many techniques for model evaluation have been developed and applied–ranging from the evaluation of the climate of a model to very detailed case studies, such as are carried out in the GEWEX Cloud System Study (GCSS). Such case studies are often conducted with simplified versions of the climate and NWP models, usually employing single column versions of these models (SCM). Detailed observations together with Cloud System Resolving Models (CSRM) are frequently used in such studies to help identify potential flaws in the formulation of the parameterizations in the SCMs.

Given the current focus of GCSS on case studies, it is a valid question how those studies are linked to the errors identified in the full climate or NWP models. Unfortunately, at this point in time, this link, while being recognized as being essential, is weak. Recent research into strengthening the link between large-scale model simulations and case studies has focussed on what can be loosely termed as "regime-dependent model error analysis." The basic idea of this approach is to divide the multitude of cloud states observed in the atmosphere into recurring regimes, either by using cloud observations directly or by exploiting the very strong link between the dynamical state of the atmosphere and associated cloud systems.

The following example illustrates the potential of using regime-dependent model evaluation techniques to identify shortcomings in model parametrizations. It is based on recent studies by Jakob and Tselioudis (2003) and Jakob et al. (2004), who use data from the International Satellite Cloud Climatology Project (ISCCP; Rossow and Schiffer, 1983) to identify cloud regimes in the Tropical Western Pacific (TWP). By performing a cluster analysis on two-dimensional histograms of the statistical distribution of cloud top pressure (CTP) and cloud optical thickness ($\tau$) in 280 km x 280 km grid-areas, these studies identify four major TWP cloud regimes:

1) Suppressed shallow cloud regime (SSC);

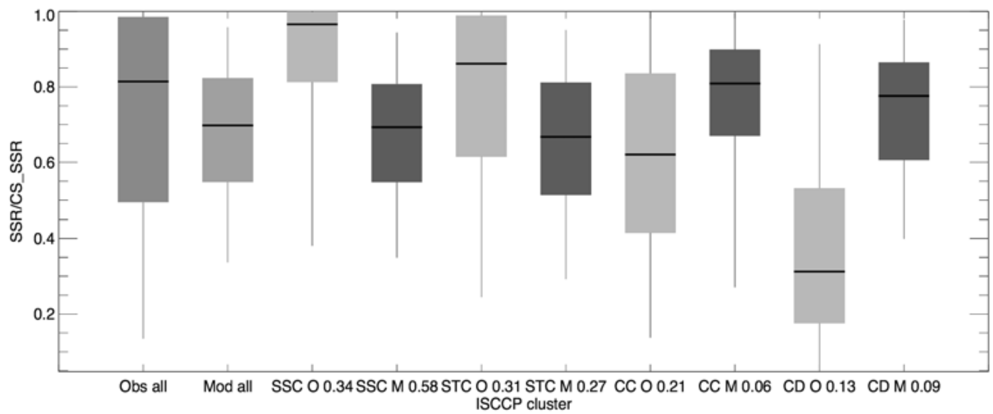
2) Suppressed regime dominated by thin cirrus clouds (STC);

3) Convectively active regime with large cirrus coverage (CC);

4) Convectively active regime dominated by a large coverage with optically thick anvil clouds (CD).

Since it is possible to assign one of the above regimes to every grid-cell of the ISCCP data set every 3 hours, other available data can be distributed by cloud regime to reveal the radiative, cloud and thermodynamic characteristics of each regime (Jakob et al., 2004). Note that current results are restricted to local daytime since satellite channels in the visible part of the spectrum are required to retrieve "$\tau$" in the ISCCP data. It is furthermore possible to simulate the CTP-$\tau$ histograms as derived by ISCCP from cloud fields simulated in climate and NWP models, thereby enabling the evaluation of those models in terms of the observed cloud regime.

The figure on page 7 provides an example for such an evaluation using the ratio of surface solar radiation to its clear-sky value. The data used in the comparison was collected by the U. S. Department of Energy's Atmospheric Radiation Measurement Program (ARM; Ackerman and Stokes, 2003) at one of its TWP measurement sites on Manus Island (2.1°S, 147.4°E). The model results are drawn from the model grid-point nearest to Manus in short-range (6 h) forecasts performed as part of the ERA-40 project (Simmons and Gibson, 2000). Three-hourly data (dictated by the availability of the cloud regime identification from ISCCP) for the years 1999–2000 have been used in the comparison. The figure displays the sample distributions of the solar radiation ratio in form of box-whisker diagrams (see the figure caption for a




*Surface solar radiation normalized by clear-sky values at Manus Island for the years 1999-2000. Left-most two boxes: all observations (left) and all ERA40 values (right); Right eight boxes: Observations (light) and ERA40 (dark) distributed by cloud regime (see text for details). Horizontal lines – median; boxes 25-to-75 percentiles; whiskers 5 and 95 percentile.*

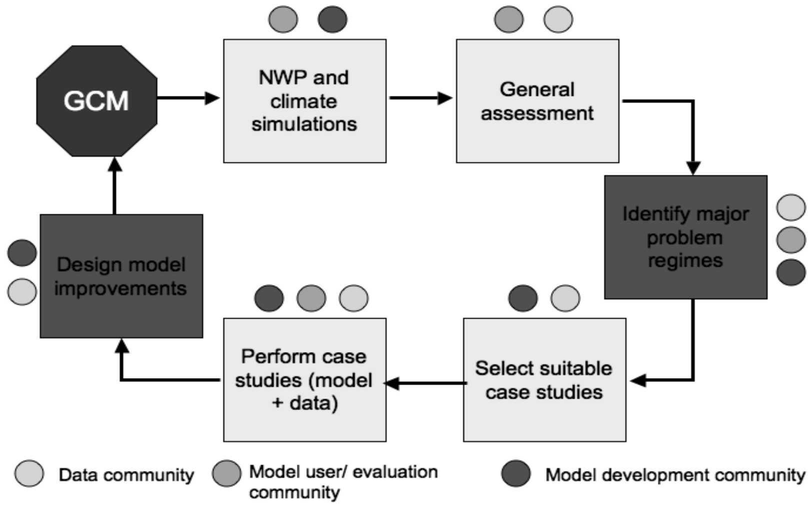
more detailed explanation). The two boxes on the far left show the distributions using all observations (left) and model values (right) in the sample, while the next eight boxes show the observations (light) and model results (dark) stratified by cloud regime. Note that the model cloud regime is identified by the minimum distance of the model CTP-$\tau$ histogram from each of the four observed cloud regime mean histograms.

Overall, the model shows a negative bias in the solar radiation reaching the surface accompanied by an underestimation of the observed variability. While certainly useful, it is very difficult for a model developer to draw conclusions for model improvement based on this result alone, since many model states (in the dynamic, thermodynamic and cloud sense) are mixed together. It is the regime-dependent analysis of model error that helps to reveal the main reasons for the overall model error. **From the figure above it is evident that the largest negative bias in solar radiation exists in the two suppressed cloud regimes (left four boxes), while in convectively active regimes (right four boxes) the model exhibits a positive bias.** The influence of the negative bias in suppressed conditions on the mean bias is further enhanced by the overestimation of the frequency of occurrence of such regimes in the model, as indicated by the numbers next to the regime acronyms in the figure. The model predicts suppressed conditions 85% of the time compared to the observed 65%. It is also apparent that the lack of variability in the overall model results is mainly (but not exclusively) caused by a lack of "between-regime" variability.

A number of other interesting shortcomings can be identified from the figure above. However, the main purpose of displaying it here is to highlight the usefulness of regime-dependent model error analysis. In this case it was shown that a major model error in one of the most convectively active regions on earth is actually caused by errors at (the frequently observed) times when deep convection is suppressed. Further understanding and eventually alleviating this model error will very likely require additional tools, in particular, the use of case studies as routinely performed in GCSS. However, through the analysis performed here it is now possible to identify what kind of case study is required to address the model failure. **Hence, regime-dependent model error analysis can be seen as a crucial link between overall "model climate" assessment and detailed process case studies.**

This link is further illustrated in the figure on page 8, which attempts to conceptualise the process of model development (in particular, that of parameterizations). It is imperative to better understand this process for the community to make progress in the crucial areas of climate and NWP model development. The figure shows the basic steps involved in the process, their links, and the communities involved. It is important to recognize that model development cannot solely rely on the model development community (e.g., parameterization developers) but must include the model user and data communities. These communities have to play crucial roles in analysing models, setting development priorities, providing evaluation tools and data sets, as well as physical insight into the processes that are parameterized in the climate and NWP models.

The centrepiece of the model development process is the GCM, which is used in either NWP or climate simulations. Both the NWP and climate




*Schematic of the model development process.*

community possess standard tools that are regularly applied in the general assessment of the model and help to reveal its overall errors. Actual model development, on the other hand, often relies on case studies, as indicated in the bottom row of the figure above. The two links between the case and GCM studies are the regime-dependent model error analysis advocated above and the implementation of actual parameterization improvements resulting from insight of the various model evaluation activities. The former enables the choice of "the right case study," while the latter constitutes the ultimate aim of the entire process—model improvement. Both are crucial elements in the chain of model development activities. Hence, it is important to strengthen activities in the community in both of these areas.

The above brief analysis of the model development process highlights some interesting challenges to research programs, which often tend to focus on only one aspect of the model development loop. GCSS, for instance, has very successfully addressed the part of the process that relates to case studies in the area of cloud and convection parameterization. From the above discussion it appears advisable to cover the entire process either within a research program or through strong collaboration between programs. Furthermore it is evident from the above figure that no single step in the model development process involves just one community. It is therefore essential for progress that strong links between the model development, model user, and data community are built into any research program that aims to improve models. In GCSS it is our intention to meet these challenges by broadening future activities so that they encompass most of the activities involved in the model development process.

**References**


Ackerman, T. P., and G. M. Stokes, 2003. The Atmospheric Radiation Measurement Program. *Physics Today*, January 2003, 38-44.

Jakob, C., and G. Tselioudis, 2003. Objective Identification of cloud regimes in the Tropical Western Pacific. *Geophysical Research Letters*, 30, 2082, doi: 10.1029/2003GL018367.

Jakob, C., G. Tselioudis, and T. Hume, 2004. The radiative, cloud and thermodynamic properties of the major Tropical Western Pacific cloud regimes. Submitted to *J. Climate*, available from http://www.bom.gov.au/bmrc/wefor/staff/cnj/cjakob.htm.

Rossow, W. B., and R. A. Schiffer, 1983. The International Satellite Cloud Climatology Project (ISCCP): The first project of the World Climate Research Program. *Bulletin of the American Meteorological Society*, 64, 779-784.

Simmons, A. J., and J. K. Gibson (Eds), 2000. The ERA-40 project plan. *ERA-40 Project Report Series No. 1.* pp 62.


**3RD PAN-GCSS MEETING ON CLOUDS, CLIMATE AND MODELS**

**16–20 May 2005**
**Athens, Greece**

Progress in our ability to observe and model cloud systems and their impact on climate will be reviewed. Key areas for discussion will be methodologies and metrics in assessing clouds and precipitation in model simulations; the fundamental role of precipitation in cloud systems; and progress in the representation of clouds in the large-scale and cloud-system models. For more information, see the GCSS homepage: http://www.gewex.org/gcss.html.

# BSRN LONGWAVE DOWNWARD RADIATION MEASUREMENTS COMBINED WITH GCMS SHOW PROMISE FOR GREENHOUSE DETECTION STUDIES

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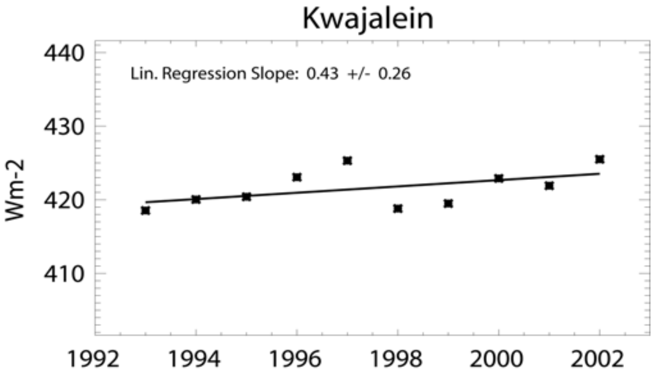
The release of greenhouse gases into the atmosphere is considered a major problem for our planet. The most immediate consequence of an increase in atmospheric greenhouse gases at the Earth's surface is an enhanced emission of thermal radiation from the atmosphere back to the surface (longwave downward radiation – LWD) (Dutton 1993; Ohmura et al., 1998; Wild et al., 1997, 2001; Philipona et al., 2003). LWD can be regarded as the key process that translates the increase of atmospheric greenhouse gases into surface warming.

Simulations with General Circulation Models (GCMs) indicate that LWD will undergo the largest changes of all of the Earth's radiation and energy balance components when the concentration of greenhouse gases in the atmosphere increases, all other factors being consistent (Wild et al., 1997). A projection of how LWD might change towards the end of the 21st century is given in the figure on page 20. This projection is based on a time slice experiment with the global climate model ECHAM5 T106 (Roeckner et al., 2003) and Intergovernmental Panel on Climate Change (IPCC) Emission Scenario A2. The increase is generally larger over land than over the ocean, and peaks in some of the desert regions. **On a global mean basis, the LWD is projected to increase by about 20 $Wm^{-2}$ towards the end of the 21st Century, corresponding to an increase of approximately 2 $Wm^{-2}$ per decade. No other component of the global mean radiation and energy budget is expected to undergo such rapid changes. This makes the LWD an interesting candidate for greenhouse detection studies.**

A quantitative measure of the suitability of a parameter for climate change detection is its signal-to-noise ratio. This ratio indicates how quickly the change signal emerges from the background noise. Global climate models can provide an estimate of how the signal-to-noise ratios of different parameters might look. For this purpose, the GCM simulated change in a specific parameter is related to its natural variability under unforced conditions. For LWD, this is achieved by dividing the time series of global mean LWD change in a transient GCM experiment (Roeckner et al., 1999) with the standard deviation of the LWD in a corresponding unforced control run. This ratio is depicted in the figure in the middle of page 1. The same signal-to-noise ratio is calculated for the GCM-simulated 2-m temperature and then added. **The figure shows that the increase in the LWD ratio significantly precedes the temperature ratio. The greenhouse-induced LWD signal stands out earlier against the noise than the temperature signal.**

**This suggests that the greenhouse signal becomes apparent earlier in LWD records than in records of surface temperature and underlines the potential for climate change detection inherent in LWD observations.** Monitoring the evolution of the LWD is, therefore, an important objective of the Baseline Surface Radiation Network (BSRN, Ohmura et al., 1998), a project of the World Climate Research Programme (WCRP) and GEWEX. BSRN detects important changes in the earth's radiation field, as well as providing reference data for the assessment of model-calculated and satellite-derived radiation fields. At selected sites in contrasting climatic zones, covering a latitude range from 80°N to 90°S, radiative fluxes incident at the surface are measured with instruments of the highest available accuracy (pyrgeometers) and at a very high frequency (minutes). Starting with nine sites in 1992, the network currently has 35 sites reporting their measurements to the central data archive located at the Swiss Federal Institute of Technology.

At individual sites, the GCM experiments suggest that two decades of observational LWD records should be sufficient to detect statistically significant increases at the 95% level. First analyses of the available observational time series of LWD in the BSRN database show an overall increase over the past decade. An example is given in the figure on the next page, which shows the time series of the annual mean LWD at Kwajalein (Marshall Islands, Tropical Pacific). This indicates that the first signs of the increased greenhouse forcing might already be apparent in the worldwide network of LWD observations. Interestingly, the rate of the overall increase in observed LWD is very close to the land-averaged increase simulated by a GCM (Roeckner et al., 1999) over a comparable period. This suggests that the response of the climate system to enhanced greenhouse gas concentrations, reflected in the increased LWD is well captured in the models. The overall consistency between models and observations gives confidence in our understanding of the greenhouse effect and its sensitivity to changes in atmospheric constituents. The continuous monitoring of LWD within BSRN will allow scientists to accurately trace future changes in this relevant quantity, and assure a permanent verification of our theories and projections on how changes in greenhouse gases might affect the climate system (Wild et al., 2004). A paper covering




*Time series of annual mean longwave radiation as measured at the BSRN station Kwajalein (Marshall Islands, Tropical Pacific).*

this issue is in preparation for submission to a reviewed journal.

***Acknowledgements:*** This study is supported by the National Center of Competence in Climate Research sponsored by the Swiss National Science Foundation. E. Dutton, A. Roesch and H. Gilgen and the BSRN station scientists are highly acknowledged for their valuable input. The high resolution ECHAM simulations became possible through the generous CPU time provided by the Swiss Center for Scientific Computing. The transient GCM data are kindly provided by MPI Hamburg.

**References:**

Dutton, E. G., 1993. Broad band thermal irradiances – global extreme and intermediate surface conditions, *J. Atmos. Ocean. Tech.* 10, 326-336.

Ohmura and 15 co-authors, 1998. Baseline Surface Radiation Network (BSRN/WCRP), a new precision radiometry for climate research, *Bull. Amer. Meteor. Soc.*, 79, 2115-2136.

Philipona, R., B. Dürr, C. Marty, A. Ohmura, and M. Wild, 2003. Radiative forcing measured at Earth's surface-corroborate the increasing greenhouse effect, *Geophys. Res. Lett.*, 31, L03202 10.1029/2003GL01876.

Roeckner, E., L. Bengtsson, J. Feichter, J. Lelieveld, and H. Rodhe, 1999. Transient climate change simulations with a coupled atmosphere-ocean GCM including the tropospheric sulfur cycle. *J. Climate*, 12, 3004-3032.

Roeckner, E., and 13 co-authors, 2004. The atmospheric general circulation model ECHAM5: Part 1 model description. Max Planck Institute for Meteorology Report No. 249, Hamburg, 140 pp.

Wild M., A. Ohmura, and U. Cubasch, 1997. GCM simulated surface energy fluxes in climate change experiments. *J. Climate*, 10, 3093-3110.

Wild M., A. Ohmura, H. Gilgen, J. J. Morcrette, and A. Slingo, 2001. Evaluation of downward longwave radiation in GCMs. *J. Climate*, 14**,** 3227-3239.

Wild, M., A. Ohmura, H. Gilgen, and D. Rosenfeld, 2004. On the consistency of trends in radiation and temperature records and implications for the global hydrological cycle. *Geophys. Res. Lett***,** 31, doi: 10.1029/2003GL019188.

## 12-YEAR SURFACE RADIATION BUDGET DATA SET

**Paul W. Stackhouse Jr.[1], Shashi K. Gupta[2], Stephen J. Cox[2], J. Colleen Mikovitz[2], Taiping Zhang[2], and Marc Chiacchio[2]**

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Under the auspices of the GEWEX Radiation Panel, a 12-year-plus (July 1983 to October 1995) global data set of shortwave (SW) and longwave (LW) Surface Radiation Budget (SRB) parameters on a 1° x 1° grid has been developed as a part of the National Aeronautics and Space Administration (NASA)/GEWEX SRB Project at the NASA Langley Research Center. Together with radiation budget measurements at the top-of-atmosphere (TOA), the SRB data products help provide a picture of radiative processes as a function of space and time at the boundaries of the atmosphere. SRB data sets are also finding increasing use in renewable energy, architecture, and agriculture industries.

Since surface fluxes cannot be directly measured by satellite-borne sensors, they are generally derived with radiation algorithms using measured radiances and meteorological inputs from satellite measurements and/or other operational sources. SRB makes use of two sets of algorithms: primary and quality-check. The primary SW algorithm is adapted from Pinker and Laszlo (1992) and the primary LW algorithm is an adaptation of Fu et al. (1997). The quality-check SW algorithm is known as the Langley Parameterized Shortwave Algorithm (LPSA; Gupta et al., 2001) and the quality-check LW algorithm from Gupta et al. (1992). All except the quality-check SW algorithm provide 3-hourly fluxes that are then averaged to daily, monthly/3-hourly, and monthly products. The quality-check SW algorithm provides daily fluxes only, which are also averaged into monthly values.

Meteorological inputs for this project were obtained from many satellite data archives and data assimilation products. Cloud properties were derived on a 1° x 1° resolution using International Satellite Cloud Climatology Project (ISCCP; Rossow and Schiffer 1999) pixel-level (DX) data sets. Other meteorological input, namely, the temperature and humidity profiles were taken from the Goddard Earth Observing System-1 (GEOS-1) reanalysis product of the Global Modeling and Assimilation Office at NASA Goddard Space Flight Center. Ozone data were obtained from the Total Ozone Mapping Spectrometer archive.

| Parameter | GEWEX Algorithms Mean | Min. | Max. | Quality-Check Algorithms Mean | Min. | Max. |
|---|---|---|---|---|---|---|
| SW Down | 186.2 | 184.6 | 188.9 | 184.2 | 183.3 | 185.6 |
| SW Net | 164.6 | 162.0 | 168.1 | 160.9 | 160.0 | 162.1 |
| LW Down | 343.9 | 341.9 | 345.9 | 345.2 | 343.4 | 347.2 |
| LW Net | -53.2 | -54.2 | -52.3 | -47.2 | -48.0 | -46.0 |
| Total Net | 114.4 | 107.8 | 115.8 | 113.7 | 112.0 | 116.1 |
| SW CRF | -56.9 | -58.0 | -54.8 | -58.5 | -59.4 | -57.0 |
| LW CRF | 34.7 | 33.7 | 35.9 | 35.6 | 35.2 | 36.2 |
| Total CRF | -22.2 | -24.3 | -18.9 | -22.9 | -24.2 | -20.8 |

*Twelve-year global averages of SRB fluxes and cloud radiative forcing (CRF), along with values for the extreme (minimum and maximum) years.*

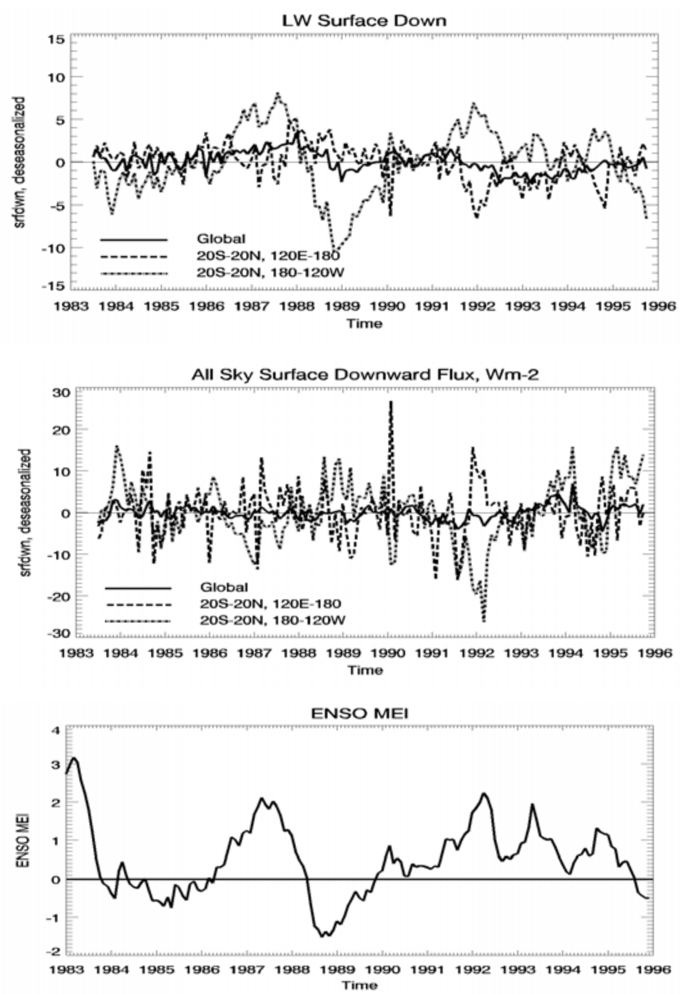
Global annual averages based on complete 12-year results (July 1983–June 1995) along with minimum and maximum values of important SRB parameters are presented in the table above. Deseasonalized anomaly time series of global averages of downward SW and LW fluxes (hereafter, DSF and DLF)) are presented in the figure at the right, which shows the DSF and DLF time series for boxes representing the tropical eastern Pacific and tropical western Pacific. The 1987 and 1992 El Niño events are readily apparent. The cloudiness anomalies of the 1992 El Niño and their effects on the surface fluxes are shown in the figure on page 20 (top left). The anomalies are the differences of March 1992 values from the 12-year March average. Positive cloud amount anomaly in the eastern Pacific gives rise to a positive anomaly in DLF and a negative anomaly in DSF. The effects in the western Pacific are nearly opposite.

The 1991 Mt. Pinatubo eruption and subsequent recovery are dominant features of the time series of TOA and surface SW fluxes over tropics, as shown in the figure at the top of page 12. The DSF in the tropics showed nearly a 9 Wm$^{-2}$ peak suppression and recovery in the months following the eruption in the 20$^{o}$S to 20$^{o}$N latitude band. The primary SW algorithm also produces TOA fluxes; an 8 Wm$^{-2}$ increase in reflected flux is noted.

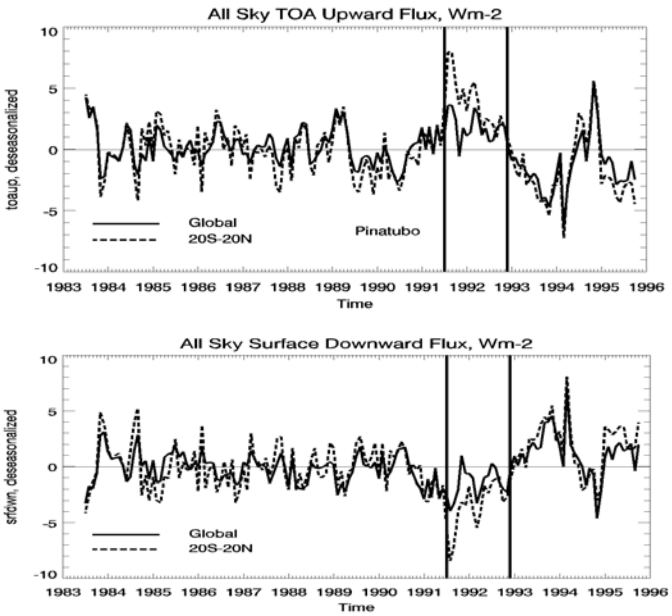
Surface fluxes derived in this project were validated primarily with ground-based measurements obtained from the Baseline Surface Radiation Network (BSRN). Difference statistics from the validation of 3-hourly, daily, monthly/3-hourly, and monthly average DSF and DLF with BSRN measurement data for the 1992–1995 period are shown in the table at the bottom of page 12. Much of the DSF bias occurs at polar sites where ISCCP has difficulty differentiating cloud and ice. Exclusion of the polar sites was found to reduce the 3-hourly bias to –2.9 Wm$^{-2}$ and the monthly bias to –0.2 Wm$^{-2}$.

Efforts are underway to extend this data set through 2001 and beyond in step with the availability of the ISCCP data. Also, newer reanalysis products (e.g., GEOS-4 in place of GEOS-1) are already being used and can be made available during an evaluation period. All algorithms are being improved as validation, analysis, and intercomparison are being completed. Work to intercompare and use NASA's Clouds and the Earth's Radiant Energy System (Wielicki et al., 1996) data products to assess and improve algorithms is also underway.

This current data set is identified as SRB Release 2 and is available to the worldwide science community from the Atmospheric Sciences Data Center (ASDC) at NASA/LaRC from the website: http://eosweb.larc.nasa.gov/PRODOCS/srb/table_srb.html.




*Deseasonalized anomaly time series of monthly average downward shortwave and longwave fluxes for the July 1983–October 1995 period produced under the NASA/GEWEX SRB Project. The El Niño Southern Oscillation Index (SOI) is shown for comparison.*




*Deseasonalized anomaly time series for TOA and surface SW fluxes. The forcing and recovery from the 1991 Pinatubo eruption are the dominant features over the tropics.*

**References**

Fu, Q., K. N. Liou, and A. Grossman, 1997. Multiple scattering parameterization in thermal infrared radiative transfer. *J. Atmos. Sci.*, 54, 2799-2814.

Gupta, S. K., W. L. Darnell, and A. C. Wilber, 1992. A parameterization for longwave surface radiation from satellite data: Recent improvements. *J. Appl. Meteor.*, 31, 1361-1367.

Gupta, S. K., D. P. Kratz, P. W. Stackhouse Jr., and A. C. Wilber, 2001. The Langley Parameterized Shortwave Algorithm for surface radiation budget studies (Vers. 1.0). *NASA/TP-2001-211272*, 31 pp. Available on-line at: http://techreports.larc.nasa.gov/ltrs/ltrs.html

Pinker, R., and I. Laszlo, 1992. Modeling surface solar irradiance for satellite applications on a global scale. *J. Appl. Meteor.*, 31, 194-211.

Rossow, W.B. and R. Schiffer, 1999. Advances in understanding clouds from ISCCP. *Bull. Amer. Meteor. Soc.*, 80, 2261-2287.

Wielicki, B. A., B. R. Barkstrom, E. F. Harrison, R. B. Lee III, G. L. Smith, and J. E. Cooper, 1996. Clouds and the Earth's Radiant Energy System (CERES): An Earth Observing System experiment. *Bull. Amer. Meteor. Soc.*, 77, 853-868.

| Parameter | 3-Hourly (24 hour) $Wm^{-2}$/% | Daily $Wm^{-2}$/% | 3-Hourly (Monthly) $Wm^{-2}$/% | Monthly $Wm^{-2}$/% |
|---|---|---|---|---|
| SW Bias | -5.7/3.2% (-2.3/1.1%) | -4.3/2.5% (-0.4/0.2%) | -6.4/3.5% (-2.9/1.4%) | -3.4/2.0% (-0.2/0.1%) |
| SW RMS | 82.6 (88.8) | 39.1 (35.2) | 39.5 (36.5) | 23.0 (18.5) |
| LW Bias | -0.6/0.2% | -4.8/0.2% | -0.5/0.2% | -5.2/1.7% |
| LW RMS | 32.6 | 26.6 | 19.9 | 15.5 |

*Validation against BSRN data for the 1992–1995. Parenthetical shortwave values exclude polar sites.*

## *GEWEX RELEVANT PUBLICATIONS OF INTEREST*

### Influence of Soil Moisture on Boundary Layer Cloud Development

**Reference:** Ek, M.B. and A.A.M. Holtslag, Feb. 2004. *J. Hydrometeorology*, Vol. 5, pp. 86-99.

**Summary/Abstract:** The daytime interaction of the land surface with the atmospheric boundary layer (ABL) is studied using a coupled one-dimensional (column) land surface-ABL model. This is an extension of earlier work that focused on modeling the ABL for 31 May 1978 at Cabauw, Netherlands. Previously, it was found that coupled land-atmosphere tests using a simple land surface scheme did not accurately represent surface fluxes and coupled ABL development. Here, findings from that earlier study on ABL parameterization are utilized, and include a more sophisticated land surface scheme. This land surface scheme allows the land-atmosphere system to respond interactively with the ABL. Results indicate that in coupled land-atmosphere model runs, realistic daytime surface fluxes and atmospheric profiles are produced, even in the presence of ABL clouds (shallow cumulus). Subsequently, the role of soil moisture in the development of ABL clouds is explored in terms of a new relative humidity tendency equation at the ABL top where a number of processes and interactions are involved. Among other issues, it is shown that decreasing soil moisture may actually lead to an increase in ABL clouds in some cases.

### Impact of Orographically Induced Spatial Variability in PBL Stratiform Clouds on Climate Simulations

**Reference:** Terra, R., C.R. Mechoso, A. Arakawa, 2004. Impact of Orographically Induced Spatial Variability in PBL Stratiform Clouds on Climate Simulations. *Journal of Climate*: Vol. 17, No. 2, pp. 276–293.

**Summary/Abstract:** This paper examines the impact of orographically induced mesoscale heterogeneities on the macroscopic behavior of planetary boundary layer (PBL) stratiform clouds, and implements and tests a physically based parameterization of this effect in the University of California, Los Angeles (UCLA), atmospheric general circulation model (AGCM). The orographic variance and associated thermal circulations induce inhomogeneities in the cloud field that can significantly alter the PBL evolution; an effect that has been largely ignored in existing climate models.

The impact of this effect on AGCM simulations is examined and the mechanisms at work are studied by analyzing a series of Cloud System Resolving Model simulations.

### Evaluation of Clouds and their Radiative Effects Simulated by the NCAR Community Atmospheric Model Against Satellite Observations

**Reference:** Lin, W. Y. and M. H. Zhang, 2004. Evaluation of Clouds and their Radiative Effects Simulated by the NCAR Community Atmospheric Model Against Satellite Observations. *Journal of Climate*: Vol. 17, No. 17, pp. 3302-3318.

Cloud climatology and the cloud radiative forcing at the top-of-the-atmosphere (TOA) simulated by the NCAR Community Atmospheric Model (CAM2) are compared with satellite observations of cloud amount from the International Satellite Cloud Climatology Project (ISCCP) and cloud forcing data from the Earth Radiation Budget Experiment. The comparison is facilitated by using an ISCCP simulator in the model as a run-time diagnostic package. The results show that in both winter and summer seasons, the model substantially underestimated total cloud amount in the storm tracks and in the subtropical dry regions of the two hemispheres, and it overestimated total cloud amount in the tropical convection centers. The model, however, simulates reasonable cloud radiative forcing at the TOA at different latitudes.

### Cloud Absorption Anomaly Debate

No *GEWEX News* issue emphasizing clouds would be complete without addressing and referring to the **Cloud Absorption Anomaly (CAA**) debate which can be best summarized from the following reference: "**The renewed (CAA) debate was ignited by three studies claiming that the solar radiation absorbed by clouds is substantially underestimated by (GCM/Climate) models. — It is now clear that the CAA is largely an artifact which does not emerge from a carefully designed closure test using the state-of-the-art radiative transfer.**"

**Reference:** Li, Z., 2004. On the solar radiation budget and cloud absorption anomaly debate. Observation, Theory, and Modeling of the Atmospheric Variability, (ed. Zhu), World Scientific Pub. Co., p 437-456. Available at: http://www.atmos.umd.edu/~zli/PDF_papers/a05_li_z_final.pdf.

## *WORKSHOP/MEETING SUMMARIES*

### 8TH BSRN WORKSHOP AND SCIENTIFIC REVIEW

**26–30 July 2004**
**Exeter, United Kingdom**

**Ellsworth Dutton**
**NOAA/CMDL**

The 8th biennial GEWEX Baseline Surface Radiation Network (BSRN) workshop was hosted by the British Met Office in their new facility. Over 60 individuals attended this workshop, including scientists from the 53 field sites and the central data archive located in Zurich, scientific panel members, intensive data users, instrument manufacturers, and representatives from WCRP and the Global Climate Observing System (GCOS).

The goal of BSRN is to promote and extend high quality surface radiation budget measurements over a globally and climatically diverse coordinated set of ground-based stations. Topics covered during the workshop included the recent agreement between WCRP and GCOS that BSRN would also be identified as the GCOS Global Baseline Surface Radiation Network; the extensive use and application of BSRN data to issues in climate research, progress in advances in radiation measurement technology, and reports from the working groups.

Dr. Paul Stackhouse, Surface Radiation Budget (SRB) Project Manager, showed how BSRN and SRB have been working together. The goal of SRB is to determine the global surface radiation budget and is heavily dependent on BSRN data for validation and other comparisons. SRB uses essentially all surface irradiance data generated by BSRN.

Prof. Atsumu Ohmura, who is primarily responsible for the BSRN archive and is involved with some of the more extensive research using BSRN data, gave a presentation on the first 15 years of BSRN. He not only covered some of the details related to getting the network started, but gave examples of how it has grown and prospered to the extent that it considerably exceeds what was originally expected. Supporting and transitioning the BSRN archive through this growth became an unexpected challenge that was ably met by Prof. Atsumu and his group in Zurich. He gave several examples of the broad applications of, and results from, acquired BSRN data.

Dr. Hans Teunissen, GCOS Secretariat, stated that GCOS welcomes the contributions of BSRN to developing the global surface radiation products identified among the "Essential Climate Variables" defined in the *Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the United Nations Framework Convention on Climate Change*. He noted the importance of expanding the network to full global coverage and the participation of dedicated analysis centers to ensure generation of the needed climate products on a continuing basis. Dr. Howard Diamond, US GCOS Program Manager, reviewed the GCOS programs that his office has been supporting and the extent of interest there is in the United States in addressing climate observing issues as outlined in the *US Strategic Plan for Climate Change*.

Dr. Ellsworth Dutton, BSRN Project Manager, presented an overview of BSRN activities. He noted the recent launch of the Geostationary Earth Radiation Budget (GERB) instrument on Meteosat II, which will produce 15-minute surface radiation estimates over a fixed footprint centered on Europe and Africa. GERB scientists have expressed interest in using BSRN data. A recent comparison between BSRN and International Satellite Cloud Climatology Project (ISCCP) results show that the mean differences of the monthly averages over the entire BSRN network are less that 3 $Wm^{-2}$ for both downwelling solar and thermal infrared radiation and are less than the specified uncertainty of the BSRN data and probably the ISCCP product, as well. Much larger differences are noted in some regions and require further investigation. Preliminary results from a recent BSRN solar diffuse irradiance comparison showed further progress towards establishing an international diffuse reference.

Presentations on some promising new BSRN observing stations in eastern China, northern Canada, central France, The Netherlands, and central Brazil were given by Drs. Zhanqing Li, Bruce McArthur, Martial Haeffelin, Wouter Knap, and Sergio Colle, respectively. These, along with stations proposed, are considered for first designation of prospective candidate site status, pending demonstration of their capability to produce sustained surface radiation budget data from systems meeting BSRN specifications and deliver that data to the central BSRN archive for review and subsequent distribution.

A number of data application and research presentations were given, including a presentation by Dr. Rolf Philipona on the apparent detection of the greenhouse warming signal using thermal irradiance measurements over the Alps. To arrive at his conclusion he incorporated the high absolute accuracy of the newly proposed World Reference Standard for infrared (IR) irradiance observations, along with a decade of network observations with adjustments for the effects of temperature and water vapor. Bruno Dürr gave a presentation on the details of a methodology for inferring the greenhouse effect from surface infrared irradiances. Dr. Martin Wild presented results, which may provide a new method for the early detection of greenhouse effects (page 9).

Drs. Andreas Roesch and Crystal Schaaf reviewed the utility and merits of comparisons between Moderate Resolution Imaging Spectroradiometer (MODIS) and BSRN products. There appears to be a definite need for more observational data to address the MODIS albedo products and the limitations in both satellite and surface-based capabilities require expansion of this type of comparison. The BSRN group has been addressing refinements and enhancements to its albedo measurement capabilities that could help address some issues these presentations raised, like the impact of low sun angles.

Dr. Hayasaka gave a presentation on his attempts to investigate and analyze historical solar radiation records from China, where there is considerable limitation in much of the earlier data. Dr. Bruce Forgan demonstrated the statistical limitations of the historical sunshine duration records when compared to more quantitative records now routinely produced. Using a 120 $Wm^{-2}$ direct solar beam as a threshold distinction between sun and no sun, Forgan showed that a difference of more than one hour per day, relative to the historical records produced by the Campbell Stokes Sunshine Recorder, can be made with daily mean sunshine duration uncertainties on the order of 0.5 hours.

Extensive work on the determination of cloud physical and radiative properties and signals from surface irradiance measurements was presented by Dr. Chuck Long. He demonstrated that considerable information on cloud cover and radiative effects can be obtained from high resolution irradiance observations, like those obtained at the BSRN sites.

A new working group on Oceanic Observations and a New Sites committee were established to investigate new potential oceanic observing sites and address the issues associated with recruiting and establishing new BSRN sites, respectively. The existing Working Group on Infrared Measurements was disbanded since all work on improving IR measurements has been completed. The new IR international standard will be established in part as a result of the work of this group.

# 10TH ANNUAL MEETING OF THE GEWEX HYDROMETEOROLOGY PANEL

## 13–16 September 2004
## Montevideo, Uruguay

**John Roads**

**Scripps ECPC, UCSD, La Jolla, California**

The GEWEX Hydrometeorology Panel (GHP) meeting was held near the Río de la Plata and was hosted by R. Terra of the Instituto de Mecánica de los Fluidos e Ingeniería Ambiental, Universidad de la República and chaired by J. Roads. The La Plata Basin (LPB) Project was approved as a GEWEX Continental Scale Experiment (CSE) at the 2004 meeting of the GEWEX Scientific Steering Group (SSG).

The GHP meeting began with welcoming remarks by R. Terra, G. Sommeria (World Climate Research Programme-WCRP), S. Sorooshian (Chair, GEWEX SSG), and R. Lawford (Director, International GEWEX Project Office). J. Roads summarized the current status of GHP activities and the objectives of the meeting. GHP is expected to continue its transition from intrinsically focused regional experiments toward the development of a global understanding of energy and water cycles. During the first two days of the meeting, the CSE and affiliated CSE representatives, GEWEX and affiliated global projects, and GHP working groups made summary presentations on their progress and plans for the coming year. A wide-ranging discussion on the future of the GHP was held on Wednesday and two focused workshops were held among the attendees on the last day.

Updates on CSE activities were provided by R. Stewart (Mackenzie GEWEX Study-MAGS), J. Huang (GEWEX Americas Prediction Project-GAPP), J. Marengo (Large Scale Biosphere-Atmosphere Experiment in Amazonia-LBA), C. R. Mechoso (LPB), H. Isemer (Baltic Sea Experiment-BALTEX), T. Yasunari (GEWEX Asian Monsoon Experiment-GAME), and A. Seed (Murray-Darling Basin-MDB). Of special concern are the pending completion of GAME (2004) and MAGS (2005) CSE activities. T. Yasunari noted, in particular, the need to develop a new GAME CSE that would merge CLIVAR and GEWEX activities, similar to the US GAPP and Pan American Climate Studies (PACS) efforts under the NOAA Climate Prediction Program for the Americas (CPPA) and the WCRP Coordinated Observation and Prediction of the Earth System (COPES). T. Lebel presented the status of the developing African Monsoon Multidisciplinary Analysis (AMMA) Project, a GHP affiliate program that is likely to become the next CSE as African scientists are entrained into the project.

Updates on the GHP affiliated global projects and programs were provided by B. Rudolph (Global Precipitation Climatology Centre-GPCC), T. Maurer (Global Runoff Data Centre-GRDC), R. Lawford (International Satellite Land Surface Climatology Project-ISLSCP), T. Koike (Coordinated Enhanced Observing Period-CEOP), P. Aggrawal (International Atomic Energy Agency-IAEA), and A. Hall (International Association of Hydrological Sciences-IAHS). Of special note was the new working group, Stable Water Isotope Intercomparison Group (SWING), which is sponsored by IAEA. SWING plans to develop a comparison of models simulating global water isotopes as depicted by the IAEA global database. The GHP was also pleased to see the ongoing development of CEOP. M. Kitsuregawa, T. Nemoto, E. Ikoma, and B. Burford outlined several innovative ways in which CEOP is undertaking the development of CEOP data integration activities.

Updates on the GHP working groups were provided by S. Williams (Data Management Group-DMG), J. Roads (Water and Energy Budget Synthesis-WEBS), L. Martz (Water Resources Application Project-WRAP), P. Aggrawal (SWING), R. Stewart (Extremes), and J. Marengo (Predictability). Of special note was the development of the CEOP *in situ* database, which began under the GHP/DMG and is now beginning to set global standards for archiving and disseminating *in situ* hydrometeorological data. G. Takle, W. Gutowski, and B. Rockel provided an update on the Transferability Working Group (TWG), which has begun making several regional model intercomparisons over the various CSE regions. A summary of this group's activities will be presented to the Working Group on Numerical Experimentation (WGNE)/GEWEX Modeling and Prediction Panel (GMPP) meeting in October and at the GEWEX Scientific Steering Group Meeting in January 2005. TWG held an informal workshop at the end of the GHP meeting to further plan activities during the coming year. The Extremes and Predictability working groups also held an informal workshop to better focus their working group activities in line with developing COPES and Hydrology Ensemble Prediction Experiment (HEPEX) activities.

A number of presentations were made describing relevant global activities. G. Sommeria described the COPES activities; J. Familgetti described the plans by the NASA Software Working Group (SWWG) for a surface water mission; J. Schaake described the development of the ensemble prediction study of HEPEX; R. Lawford described the Integrated Global Observing Strategy (IGOS) plans of which CEOP is the first element and is being developed within the international ad hoc Group on Earth Observations (GEO) framework. R. Lawford also described the Global Water System Project (GWSP), which provides a human dimension component to the physical focus of GHP activities.

On the last day, various GHP issues were discussed, such as the criterion for being a CSE, which includes a number of technical and scientific criteria. All of the CSEs are currently making progress toward these criteria, in concert with the affiliated global projects and programs. In particular, the various GHP working groups were initiated in order to expand the intrinsically regional foci of the CSEs toward better global understanding. The GHP requested the working groups develop definitive plans leading to tangible and lasting contributions from publications, data sets, etc.

The 11th annual GHP meeting in 2005 will be hosted by MDB Project in Melbourne, Australia.

*Attendees at the 10th annual GHP meeting: (front l-r) P. Aggrawal, R. Terra, S. Sorooshian, G. Sommeria, J. Roads, J. Huang, R. Stewart, B. Rockel; (second l-r) R. Lawford, A. Seth, A. Hall, J. Matsumoto, C. Emmanuel, C. R. Mechoso, H. Berbery, T. Satomura, J. Familgetti, W. Gutowski; (back l-r) J. Schaake, B. Burford, D. Erlich, G. Takle, A. Basu, M. Bollasina, T. Yasunari, T. Maurer, J. Marengo, S. Williams, H. Isemer, T. Nemoto, T. Koike, E. Ikoma.*

## FIRST RADIATIVE FLUX ASSESSMENT WORKSHOP

**4–6 October 2004**
**Zurich, Switzerland**

**William Rossow[1], Atsumu Ohmura[2], Ehrhard Raschke[3], Paul Stackhouse[4], Bruce Wielicki[4]**

**[1]NASA Goddard Institute for Space Science**
**[2]Swiss Federal Institute of Technology**
**[3]Institute for Meteorology, Hamburg**
**[4]NASA Langley Research Center**

During the past 30 to 40 years important progress has been made in determining components of the radiation budget over the entire globe at the upper and lower boundaries of the atmosphere using satellite observations. One of the chief purposes of GEWEX is to observe, understand and model the global hydrological cycle and energy fluxes. To date long-term radiative flux data sets have largely been analyzed and assessed independently of the water cycle. The need to assess the remaining uncertainties of the radiative fluxes is crucial to the next step of integrating the observational understanding of the radiative and hydrological cycles. Serious questions are being asked about the quality and reliability of these data sets, especially when used to monitor the small, slow changes of climate. These questions must be answered quantitatively with a systematic determination of possible improvements and uncertainty limitations. For this purpose, a workshop, hosted by the Swiss Federal Institute of Technology (ETH), Zurich, and initiated and organized by Dr. Atsumu Ohmura and Dr. Ehrhard Raschke, was held on the "Validation of Radiative Fluxes at the Top-of-the-Atmosphere (TOA) and Surface Derived from Satellite Measurements and Climate Modeling." The workshop had the following objectives:

- Conduct a survey of all available data sets on the radiation budget at TOA and at the ground.
- Develop a strategy for assessing the range of uncertainties in such data on various time and space scales.
- Identify and solicit requirements from stakeholders.

The participants were divided into TOA and Surface Working Groups (WGs). Each WG developed a strategy to survey existing data sets and proposed a set of intercomparison tasks to develop more comprehensive error budgets and analysis. The Surface WG involved both those responsible for surface measurements and surface radiation data product providers. General circulation model and reanalysis groups were represented at the meeting and provided input for the accuracy requirements for model evaluation. Each WG agreed on the following data product intercomparisons:

- Collect, document, characterize and provide error estimates for the main long-term data sets and post at least the monthly mean data sets online for further evaluation and analysis.
- Evaluate the monthly-mean, large-scale (regional) variability of radiative fluxes by comparing various products and investigating causes for differences. Also compare with model variability.
- Evaluate systematic variations of radiative fluxes (diurnal, seasonal, cloud type), and compare with model variations.
- Evaluate the instantaneous accuracy of the radiative fluxes.

The Surface WG had the additional tasks of the collection and evaluation of surface measurements from existing surface radiation networks. These measurements will be used in the evaluation of surface flux products from an observational perspective. Comprehensive uncertainty budget information will be developed for each data set.

To carry out the broadest possible evaluation, a web site will be established on which will be posted: (1) goals and requirements statements; (2) the assessment plan; (3) all the monthly mean data sets to be compared/assessed (with ftp access to full time resolution versions); and (4) tools for analysis of the radiative flux differences by cloud type. The monthly mean data will be in the form of maps of shortwave/longwave fluxes, upwelling and downwelling, clear sky and global/zonal monthly means for land/water/all.

During the next several months, draft plans for this flux assessment activity will be developed and made available via the internet as described above. A polling of surface measurement and radiative flux data producers will be conducted and sets of data and statistics for limited time and space scales will be solicited. This will be followed by a period of collaborative intercomparison with the goal to conduct a second workshop in 2005.

## GRP AND WGDMA MEETINGS

**18–22 October 2004**
**Kyoto, Japan**

**William Rossow**
**NASA Goddard Institute for Space Science**

The GEWEX Radiation Panel (GRP) meeting was preceded by a 2-day meeting of the GRP Working Group on Data Management and Analysis (WGDMA). Both meetings were hosted by the Research Institute for Humanity and Nature.

The main topics of discussion at the WGDMA meeting were: (1) the status of the data product assessment activities; (2) the status of the data processing projects; (3) the rationale and readiness of the projects to continue beyond 2005 as requested by the GEWEX Scientific Steering Group and endorsed by the World Climate Research Programme (WCRP) Joint Scientific Committee; (4) activities to produce integrated data products for the diagnosis of variations of the global energy and water cycle; and (5) plans for next year and the extended projects (if approved).

Last year the GRP initiated four data product assessment activities covering the GEWEX data products for radiative fluxes [Surface Radiation Budget (SRB)/Baseline Surface Radiation Network (BSRN) but including Earth Radiation Budget (ERB) projects], precipitation [Global Precipitation Climatology Project (GPCP)/Global Precipitation Climatology Centre (GPCC)], clouds (International Satellite Cloud Climatology Project-ISCCP) and aerosols (Global Aerosol Climatology Project-GACP). Although the emphasis is on the evaluation of the usefulness of the GEWEX data products for studying annual to decadal variations, the assessments will also include comparisons with other available long-record data products, as well as use newer data products to investigate the causes of the variations shown in each data set. All four activities are now guided by working groups that have drafted study plans. The precipitation and radiative flux groups have already held planning workshops (3–4 August 2004 in College Park, Maryland and 4–6 October 2004 in Zurich, Switzerland, respectively).

All the data projects reported continuation of routine data processing with no major problems and all participants indicated their willingness to seek approval to extend their projects through 2010. The rationale that was developed for this extension included three elements: (1) the opportunity to exploit more recent research and data products from advanced instruments to make improvements in the analysis algorithms; (2) the opportunity to reprocess all of the data products to improve their long-term homogeneity and accuracy by developing improved calibrations and sampling based on recent research results and cross-calibrations among several long-term data products; and (3) the opportunity to work on transitioning more of these projects to operational agencies to sustain the climate record. The participants agreed if the projects are approved for extension, that an important new concept would be to conduct a **coordinated** reprocessing of all the products in the 2007–2009 period to improve their physical consistency and enhance their usefulness for studying variations of the global energy and water cycle.

GPCP noted plans to cosponsor with the International Precipitation Working Group, a comparison of satellite algorithms for producing higher time resolution precipitation data products. The GPCC reported that it is now a Global Climate Observing System (GCOS) element for long-term monitoring of precipitation and is working on the separation of the monthly mean gauge data by precipitation type. The GPCC is also considering reprocessing of the main gauge collection at a higher time resolution.

ISCCP reported that preparations are underway to bring new satellites online: METEOSAT-8 (MSG-1), FY-2C (recently launched) and MTSAT. EUMETSAT reported the completion of a METEOSAT recalibration effort; results are now to be compared to the ISCCP calibration. A major achievement by the ISCCP Central Archives [National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC)] is the refurbishment of the ISCCP B1 data set (spatial sampling at 10 km) and its transformation into a uniform data product. This makes possible an enhancement of the density of the ISCCP products during the planned reprocessing in 2007.

The Clouds and Earth Radiation Energy System (CERES) Project reported that the first advanced top-of-atmosphere flux products with improved angle models were released this year and that the full atmospheric radiative flux profile and cloud products should be released in 2005. The first results from the Geostationary Earth Radiation Budget (GERB) suggest important results to come from the study of very high time resolution radiative flux measurements. The SRB reported that it will complete extension of its time record beyond 1995 to 2004 using the newest NASA reanalysis [Goddard Earth Observing System (GEOS-4)] by fall 2005 and is planning a complete reprocessing in 2006 using new, improved aerosol data products. BSRN reported preparing a merger of the GEBA and BSRN archives to produce much longer time records of surface solar insolation and to incorporate data sets reporting surface sensible and latent heat fluxes over land areas. To address the continuing lack of comprehensive surface radiative flux measurements over oceans, the BSRN has formed a working group to investigate availability and quality of ocean radiative flux data sets from various sources, including buoy networks and experimental ship deployments.

Activities are underway at the National Aeronautics and Space Administration (NASA) Goddard Institute for Space Science (GISS) and NCDC to foster more integrated studies using the current GEWEX data products by providing them all in one location and in some merged forms. The current plan is to: (1) put monthly mean versions of all the global products (including products from other sources, in addition to GRP projects) on one web site (with links to all the project web sites) and produce a common-format merged version for a common time period (likely 1989-2000, at first); (2) add the BSRN/GEBA and GPCC long-term products (with links to their web sites for access to more detailed versions), and (3) collect the full resolution versions of all the global products onto a single server with modern online analysis tools.

The main topics of discussion at the GRP meeting were: (1) a review of GEWEX/WCRP and earth-satellite agency activities; (2) formulation of a more focused cloud-aerosol research plan; (3) a review of other radiation-related activities; (4) plans for the next SeaFlux and LandFlux activities; (5) how GRP activities contribute to the Coordinated Observation and Prediction of the Earth System (COPES); (6) how to advance the use of the data products to understand the causes of the variations of the global energy and water cycle; (7) the proposed precipitation cross-cut and how it relates to other GRP precipitation activities; and (8) plans for next year.

It was recommended that: (1) GACP continue, but begin merging multiple sources of satellite aerosol measurements (e.g., Advanced Very High Resolution Radiometer, Total Ozone Mapping Spectrometer and Stratospheric Aerosols and Gas Experiment); and (2) the Working Group on Column Atmospheric Profiling (formerly CPROF) move aggressively to develop common cloud products because a network of such long-term sites, if suitably enhanced to include cloud, aerosol, water vapor and wind profiling, could serve as the keystone for study of cloud-aerosol interactions. Development of such new measurement capabilities is needed to support new directions in GEWEX Cloud System Study modeling studies that focus on cloud microphysics (including aerosol effects).

A merger of the GRP Intercomparison of Radiation Codes used in Climate Models (ICRCCM) and the Department of Energy Atmospheric Radiation Measurement (ARM) Program Broadband Heating Rate Profile (BBHRP) activities has produced a plan for a Continuous Intercomparison of Radiation Codes (CIRC) activity to set up a facility for both radiative transfer model tests and radiation closure experiments: a working group has been formed and plans drafted to create a web-based resource for these purposes. This activity is especially crucial because there have been significant advances in the sophistication (physics included) of global circulation model radiation codes.

Further discussion of already planned activities to produce merged data products to foster diagnosis of the variations of the global energy and water cycle in the context of the proposed Global Water and Energy Budget Study (GWEBS) cross-cut identified a number of conclusions and actions. The importance of the assessment activities has increased because we need to know how physically consistent these data products are in order to use them in an analysis of the global energy and water cycle. Moreover, this activity sets the stage for a coordinated reprocessing of all the data products, if the projects are extended through the end of this decade. It was decided to capture the Coordinated Enhanced Observing Period (CEOP) site subsets of the GRP data products as part of the global data product merger activity to provide a better connection under the GWEBS activity between GRP global analyses and the regional studies of GEWEX Hydrometeorology Panel.

Plans for next year include a review of the GRP strategic plan, particularly with regard to defining its role in cloud-aerosol research activities; a review of plans for CIRC, WGCAP, SeaFlux and the Global Soil Wetness Project workshop; articulation of the direct use of data products in applications; evaluation of the results of data product assessments. A key emphasis of the revision of the GRP strategic plan will be to identify specific collaborations with several other GEWEX and WCRP groups that will be needed to advance the goals.

## AEROSOLS IMPACT CLOUDS

*(Continued from page 5)*

**References**

Andreae, M. O., D. Rosenfeld, P. Artaxo, A. Costa, G. Frank, K. M. Longo, M. A. F. Silva Dias, 2004. Smoking rain clouds over the Amazon. *Science*, 303, 1337-1342.

Artaxo, P., J. V. Martins, M. A. Yamasoe, A. S. Procópio, T. M. Pauliquevis, M. O. Andreae, P. Guyon, L. V. Gatti, A.M. Cordova Leal, 2002. Physical and chemical properties of aerosols in the wet and dry season in Rondônia, Amazonia. *J. Geophys. Res*. 107 (D20): 49.1-49.14.

Carvalho, L. M. V., C. Jones, M. A. F. Silva Dias, 2002. Intraseasonal large-scale circulations and mesoscale convective activity in tropical South America during the TRMM-LBA campaign. *J. Geophys. Res.* 107. (D20): 9.1-9.20.

Claeys, M., B. Graham, G. Vas, W. Wang, R. Vermeylen, V. Pashynska, J. Cafmeyer, P. Guyon, M. O. Andreae, P. Artaxo, W. Maenhaut, 2004. Formation of secondary organic aerosols through photooxidation of isoprene. *Science*, 303, 1173-1176.

Freitas, S. R., K. M. Longo, M. A. F. Silva Dias, P. L. Silva Dias, R. Chatfield, E. Prins, P. Artaxo, G. Grell, F. Recuero, 2004. Monitoring the Transport of Biomass Burning Emissions in South America. *Environmental Fluid Mechanics, 4, (in press)*.

Koren, I., Y. J. Kaufman, L. A. Remer, J. V. Martins, 2004. Measurement of the Effect of Amazon Smoke on Inhibition of Cloud Formation. *Science*, 303, 1342 - 1345.

Li, W. and R. Fu, 2004. Transition of the Large-Scale Atmospheric and Land Surface Conditions from the Dry to the Wet Season over Amazonia as Diagnosed by the ECMWF Re-Analysis. *J. Climate*, 17, 2637-2651

Procopio, A. S., P. Artaxo, Y. J. Kaufman, L. A. Remer, J. S. Schafer, B. N. Holben, 2004. Multiyear analysis of amazonian biomass burning smoke radiative forcing of climate. *Geophysical Res. Letters*, 31, L03108, doi:10.1029/2003GL018646.

Rickenback, T., R. N. Ferreira, J. Halverson, D. L. Herdies, M. A. F. Silva Dias. 2002. Modulation of convection in the south western Amazon basin by stationary fronts. *J. Geophys. Res*., 107, D20, p. 7.1-7.13.

Roberts, G. J., J. Zhou, P. Artaxo, E. Swietlicki, M. O. Andreae, 2002. Sensitivity of CCN spectra from the Amazon Basin on chemical and physical properties of the aerosol. *J. Geophys. Res*. 107 (D20): 10.1029.

Silva Dias, M.A.F., et al, 2002. Clouds and rain processes in a biosphere atmosphere interaction context in the Amazon Region. *J. Geophys. Res*., 107, 46.1-46.23.

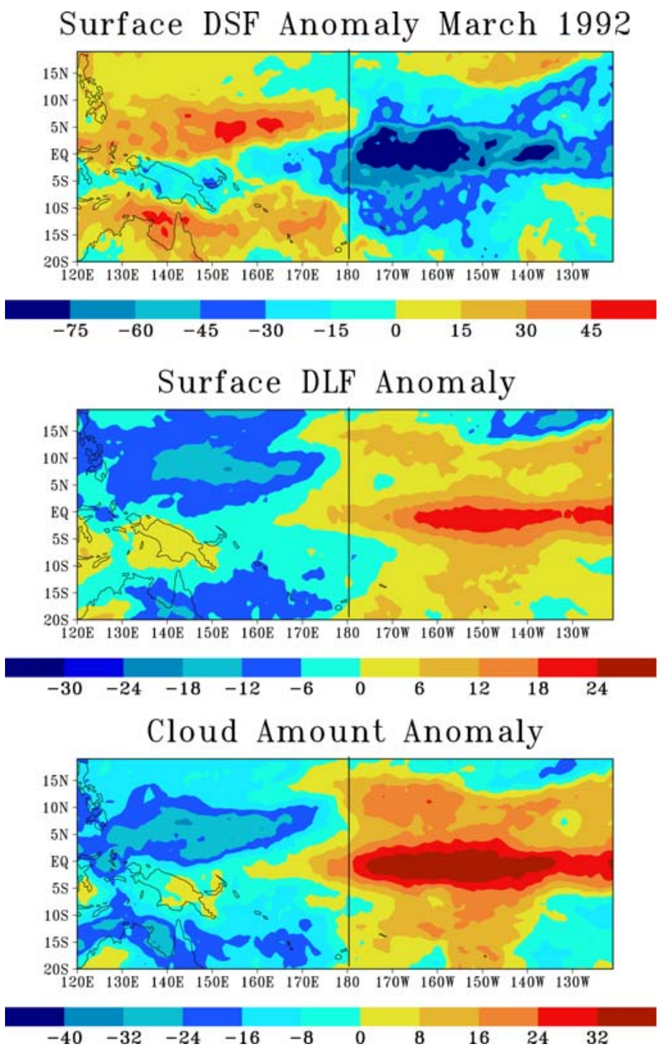
Tokay, A., A. Kruger, W. F. Krajewski, P. A. Kucera, A. J. Pereira Filho, 2002. Measurements of drop size distribution in the southwestern Amazon basin. *J. Geophys. Res.*, 107, D20, doi:10.1029/2001JD000355.

Williams E., et al., 2002. Contrasting convective regimes over the Amazon: implications for cloud electrification. *J. Geophys. Res*. 107 (D20): 50.1-50.19.

**GEWEX/WCRP MEETINGS CALENDAR**

***For a complete listing of meetings, see the GEWEX web site (http://www.gewex.org)***

## CLOUDINESS ANOMALIES OF THE 1992 EL NINO AND THEIR EFFECTS ON SURFACE FLUXES




*Anomalies of downward shortwave flux (DSF), downward longwave flux (DLF), and total cloud amount over the tropical Pacific Ocean for March 1992 El Niño episode.* *See article on page 10.*

***GEWEX NEWS***

Published by the International GEWEX Project Office

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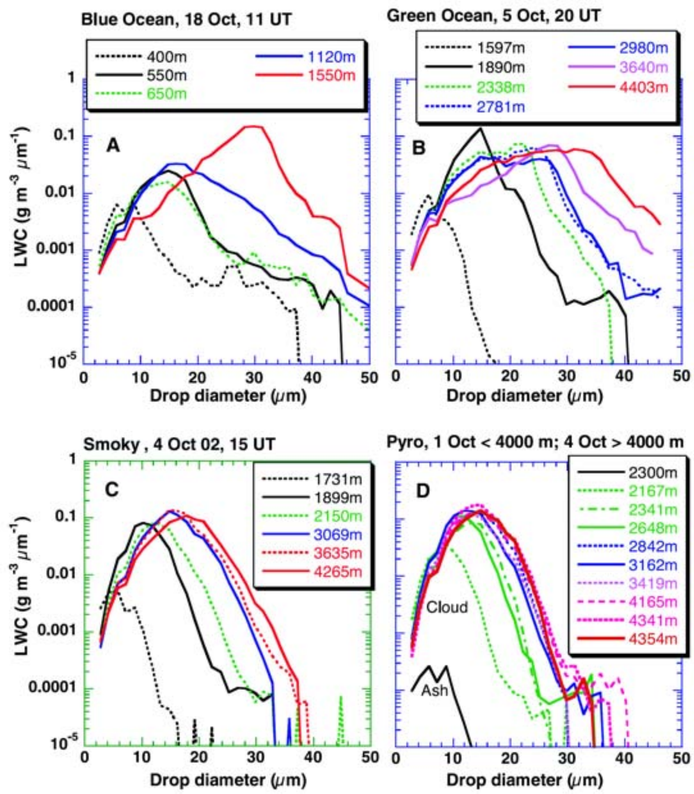
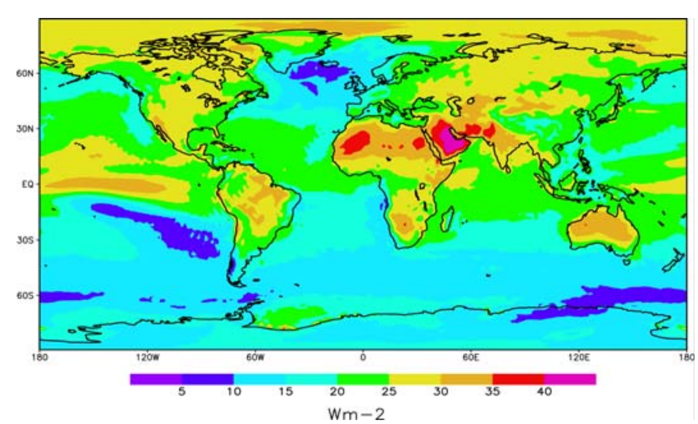
## CLOUD DROPLET SPECTRA FOR DIFFERENT HEIGHTS AND FOUR AEROSOL CONDITIONS




*Four aerosol conditions in Amazonia: Blue Ocean (oceanic area); Green Ocean (Amazon Basin wet season); Smoky (cloud in light smoke conditions); Pyro (cloud in heavy smoke conditions).* *See article on page 4.*

## HOW LONGWAVE DOWNWARD RADIATION MIGHT CHANGE TOWARDS THE END OF THE 21ST CENTURY




*Change in downward longwave radiation towards the end of the 21st century under the IPCC SRES A2 scenario, as projected in an experiment with the ECHAM5 T106 GCM (Roeckner et al., 2003).* *See article on page 9.*