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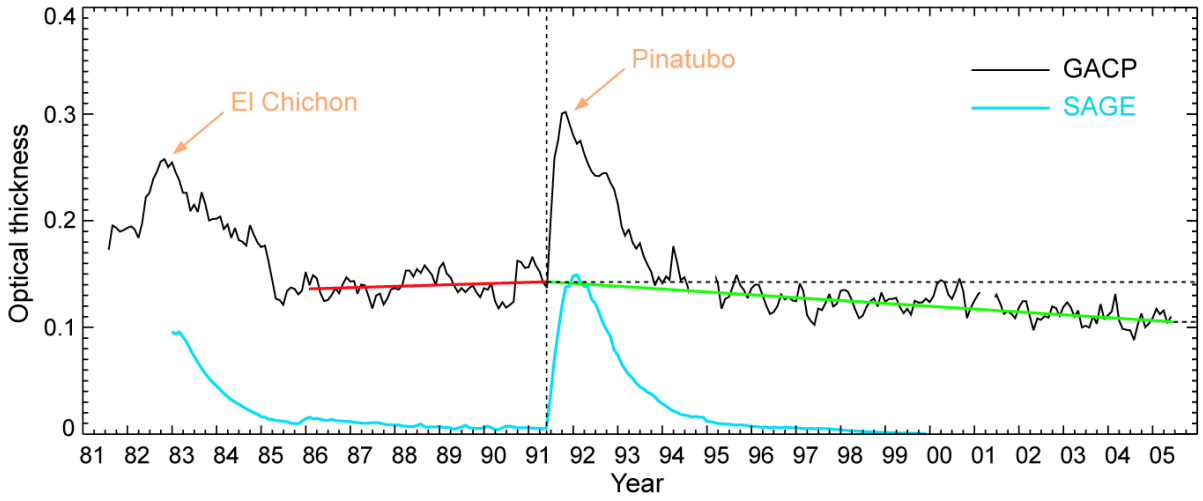
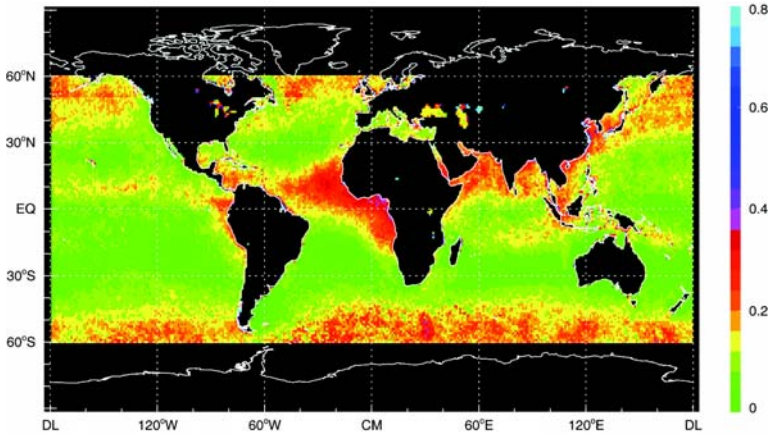
GLOBAL AEROSOL CLIMATOLOGY PROJECT (GACP) DATA SHOW THE POTENTIAL CLIMATE IMPACT OF AEROSOLS



The warming trend of the past decade may be related to increasing amounts of downward solar radiation reaching the Earth's surface. Recent decreases in tropospheric aerosols may also have contributed via both direct and indirect aerosol effects. The ***green line*** *(above) reveals a long-term decreasing tendency in the tropospheric aerosol optical thickness (AOT) and the* ***red line*** *shows the overall behavior of the GACP AOT (January 1986 – June 1991). The regional distribution of AOT for 2002–2005 is shown at the right and a regional comparison with 1988–1991 appears on page 16. See article by M. Mischenko and I. Geogdzhayer on page 4.*



Regional Distribution of AOT for July 2002 – June 2005.

Newsletter Contents

COMMENTARY

GEWEX PROGRESS IN ADDRESSING CLIMATE SCIENCE

Rick Lawford
International GEWEX Project Office

As this issue of *GEWEX News* highlights, GEWEX is making significant progress in applying its data sets to a better understanding of climate processes. The Global Aerosol Climatology Project article on page 4 is encouraging because the authors suggest that we have the capability to use satellite data to monitor the effectiveness of environmental policies. This ability will be enhanced by the plans for reprocessing outlined in the Working Group on Data Management and Analysis report on page 10. On a broader scale, the recent release of the Intergovernmental Panel on Climate Change report has brought increasing awareness of the reality of climate change. However, large uncertainties still exist regarding changes expected in the "wet" component of the climate system, meaning that GEWEX science continues to be critical for this forum.

At both the Pan-GEWEX meeting in October 2006 and the GEWEX Scientific Steering Group (SSG) meeting in January 2007, GEWEX looked seriously at directions for the coming 6–7 years to determine how we can best use our resources to create a scientific legacy. Programmatic uncertainties about the role of GEWEX in implementing the World Climate Research Programme (WCRP) strategic planning framework were resolved at the WCRP Joint Scientific Committee (JSC) meeting in Zanzibar, Tanzania in March 2007. Furthermore, within GEWEX, some uncertainties about the internal structure have been resolved as the GEWEX SSG approved the merger of the Coordinated Enhanced Observing Period and the GEWEX Hydrometeorology Panel into a new entity to be known as the Coordinated Energy and Water Cycle Observing Project (CEOP). The Northern Eurasian Earth Science Partnership Initiative, the newest Regional Hydroclimate Project within this new entity (see page 5) was also approved at the GEWEX SSG meeting.

In its preparations for the JSC meeting, GEWEX led in developing a discussion paper on monsoons and provided inputs to a number of the other WCRP crosscuts (e.g., extremes, decadal prediction, International Polar Year, Atmospheric Chemistry and Climate, and Anthropogenic Climate Change). Dr. Soroosh Sorooshian, chair of the GEWEX SSG, represented GEWEX at the JSC meeting and presented an update of GEWEX activities.

The JSC has requested that the WCRP core projects take the lead on a number of the crosscuts that form the key components of its strategic framework. GEWEX will also have some responsibility in this process as it will co-chair with the Climate Variability and Predictability Project (CLIVAR) the implementation of the monsoon and extreme crosscuts. We have had some discussions about ways in which GEWEX and CLIVAR could coordinate the monsoon activity. Some structure is already in place as Drs. Jun Matsumoto and Bin Wang continue to lead on monsoon activities for GEWEX and CLIVAR respectively. Planning for the Asian Monsoon Year is well underway and should form a strong basis for a fully international program (tentatively called the "International Monsoon Year"). The monsoon effort also has strong links to The Observing System Research and Predictability Experiment (THORPEX) through the Year of Tropical Convection in collaboration with the WCRP monsoon activities (see article on page 8). The extremes activity may take a little longer to emerge because the history of collaboration is not as long or mature as it is in the area of monsoons. GEWEX will also be contributing to a number of the other WCRP crosscuts although the mechanisms need to be defined. The International GEWEX Project Office will be working collaboratively with the WCRP Joint Planning Staff and the other WCRP international projects offices to deal with issues in an integrated way.

Some issues and administrative challenges remain. The travel budget for conducting project meetings, which are so central to GEWEX progress, remains a thorny issue. It appears that it is no longer possible for WCRP and its sponsors to maintain the money set aside by WCRP for GEWEX travel at historical levels in light of the other demands for support. GEWEX is actively assessing options to offset this difficulty.

Although there will continue to be short-term pressures and problems, GEWEX now has a clearer vision for our long-term direction and can be more confident in making research plans and commitments to its partners. It remains for the GEWEX community to take hold of these opportunities and, through collaborative efforts both within WCRP and outside WCRP circles, to broaden our support base and to address the scientific challenges that constitute the heart and soul of the GEWEX project.

ULRICH SCHUMANN AWARDED EGU LEWIS FRY RICHARDSON MEDAL

Dr. Ulrich Schumann, Vice-Chair of the GEWEX Scientific Steering Group, was awarded the 2007 European Geophysical Union Lewis Fry Richardson Medal for his fundamental and pioneering work on the realizibility of turbulence models and their wide application in geophysical flows, notably to establish through accurate simulation the chemical effects of aircraft emissions on the stratosphere. Dr. Schumann is the Director of the Institute for Physics of the Atmosphere of Deutsches Zentrum für Luft- und Raumfahrt (DLR).

CHANGES AT THE GLOBAL RUNOFF DATA CENTRE

Dr. Thomas Maurer, Head of the Global Runoff Data Centre (GRDC) since 2000, has recently been promoted to Head of the Federal Institute of Hydrology's (BfG's) Department for Water Balance, Forecasting and Predictions. During his 7 years as Head of GRDC, the number of station-years stored in its database increased by a factor of three and two additional staff members were hired. Mr. Ulrich Looser (*looser@bafg.de*), who had previously managed the South African National Water Quality Database at the Department of Water Affairs and Forestry, replaces Dr. Maurer as Head of GRDC.

GCSS CIRRUS CLOUD MODEL INTERCOMPARISON STUDY

The Cirrus Cloud Working Group of the GEWEX Cloud System Study (GCSS) is conducting a new model intercomparison to improve the representation of cirrus clouds in climate models. The intercomparison will use data from the U.S. Atmospheric Radiation Measurement site in the Southern Great Plains. For more information about the intercomparison and how to participate, see: *http://www.env.leeds.ac.uk/~dobbie/huiyi/gcss/* or contact Dr. Steven Dobbie (*dobbie@env.leeds.ac.uk*) or Dr. Huiyi Yang (*huiyi@env.leeds.ac.uk*).

NEW DATA SETS

TWP Forcing Data. Forcing data for use with single column models and cloud resolving models have been derived from numerical weather prediction analyses for the Atmospheric Radiation Measurement (ARM) Program's Tropical Western Pacific sites of Manus Island and Nauru. The data cover the 1999–2000 period in 6-hour time increments and are available at: *http://www.arm.gov/data/pi_products.stm/.*

Surface Wind Fields. A new near-real-time 6-hourly surface wind analysis for the global oceans with 0.25 degree resolution is now complete for the period from 1 April 2004 to the present. The product integrates satellite observations and atmospheric model analyzes with surface meteorology, and is developed at the Institut français de recherche pour l'exploitation de la mer (Ifremer) under the European integrated project, the Marine Environment and Security for the European Area (MERSEA). The data, documentation, and other useful information can be found at: *http://www.ifremer.fr/cersat/facilities/mwf-blended-nrt/* or at *http://www.mersea.eu.org/forcing-F/1-forcingfield-blended.html.* Data include wind speed, zonal and meridional components, wind stress and the related components.

Turbulent Fluxes. A 15-year data set (1992–2006) of turbulent flux fields at global scales over the oceans (excluding sea ice areas) with a spatial resolution of 1 degree, and weekly and monthly temporal resolutions between 80°S and 80°N is available at Ifremer via ftp upon request (Contact: *Abderrahim.Bentamy@ifremer.fr*). For more information about the data set, see: *http://cersat.ifremer.fr/science/air_sea_interaction/retrieving_turbulent_fluxes_from_satellite.*

GABLS VICE-CHAIR

Prof. Gunilla Svensson, Associate Professor, Department of Meteorology, Stockholm University, Sweden, is now serving as Vice-Chair of the GEWEX Atmospheric Boundary Layer Study (GABLS). Prof. A.A.M. (Bert) Holtslag, Professor and Head of the Meteorology and Air Quality Section, Wageningen University, The Netherlands, has chaired GABLS since its inception in 2001.

GACP DATA SHOW POTENTIAL CLIMATE IMPACT OF AEROSOLS

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The warming trend of the past decade may be related to increasing amounts of downward solar radiation reaching the Earth's surface. This recovery ("brightening"; Pinker et al., 2005) from the previous decline known as "global dimming" (Wild et al., 2005) began in 1990 and may partially be due to diminishing counterbalances to greenhouse gas warming.

Tropospheric aerosols may have contributed to the switch from solar dimming to brightening via both direct and indirect aerosol effects. The solar radiation trend mirrors the recent downward trend in primary anthropogenic emissions of sulfur dioxide and black carbon, which contribute substantially to the global aerosol optical thickness (AOT). The GEWEX Global Aerosol Climatology Project (GACP) product (Geogdzhayev et al., 2005), the longest uninterrupted record of global satellite estimates of the column AOT over the oceans, was used to provide a direct and independent assessment of the global long-term behavior of AOT. The GACP aerosol record is derived from the International Satellite Cloud Climatology Project (ISCCP) DX radiance data set, composed of calibrated and sampled Advanced Very High Resolution Radiometer (AVHRR) radiances. Data from the following sun-synchronous polar-orbiting platforms have been included in the data set: National Oceanic and Atmospheric Administration (NOAA)-7 (August 1981 – January 1985), NOAA-9 (February 1985 – October 1988), NOAA-11 (November 1988 – September 1994), NOAA-14 (January 1995 – June 2001), and NOAA-16 (October 2001 – present).

In the figure at the top of page 1, the global monthly average of the column AOT is depicted by the solid black line for the period August 1981 to June 2005. The two major maxima are caused by stratospheric aerosols generated by the El Chichon (March 1982) and the Mt. Pinatubo (June 1991) eruptions, also captured in the Stratospheric Aerosol and Gas Experiment (SAGE) stratospheric AOT record (Hansen et al., 2002). The quasi-periodic oscillations in the black curve are the result of interannual aerosol variability.

The red line (see figure on page 1) shows that the overall behavior of the GACP AOT during the quiescent period (January 1986 – June 1991) hardly reveals any statistically significant tendency and suggests that the global column AOT value just before the Mt. Pinatubo eruption was close to 0.142. After the eruption, the GACP curve exhibits a superposition of complex volcanic and tropospheric AOT temporal variations. However, the green line reveals a long-term decreasing tendency in the tropospheric AOT, which is statistically significant at the 99 percent confidence level.

Although there have been significant drifts in the equator crossing times for the individual AVHRR instruments, the figure at the top of page 1 shows no obvious artifacts potentially attributable to the drifts. The only exception is the end of the NOAA-14 record when the strong drift of the NOAA-14 orbit resulted in a partial loss of data and a loss of coverage for much of the southern hemisphere, thereby causing a bias in the global average. Overall, however, the GACP AOT record appears to be self-consistent with no drastic intra-satellite variations, and is obviously consistent with the SAGE record. This seems to testify to the robustness of the ISCCP channel-1 radiance calibration and the GACP retrieval algorithm. This conclusion is reinforced by the close correspondence of the calculated and observed top-of-the-atmosphere solar fluxes. Furthermore, GACP AOT retrievals have been successfully validated against precise sunphotometer data taken from 1983 through 2004 by employing a special procedure that, by design, tested the entire retrieval process as well as the radiance calibration.

The advantage of the AVHRR data set over the data sets collected with more advanced recent satellite instruments is its duration, which makes possible the reliable detection of statistically significant tendencies like the substantial decrease of the tropospheric AOT between 1991 and 2005. With all the uncertainties, the tropospheric AOT decrease over the 14-year period is estimated to be at least 0.02.

The significant long-term AOT decrease is quite consistent with the supposed reversal from increasing to decreasing anthropogenic sulfur and black

carbon emissions, owing to the enactment of clean air legislation in many European countries and the United States. The downfall of the local economies throughout the territory of the former Soviet Union had also resulted in a dramatic and well-documented decrease of aerosol emissions and AOT (Geogdzhayev et al., 2005). These factors, coupled with long-range aerosol transport, may have had a significant global impact, potentially causing much of the long-term AOT trend shown on page 1. The long-term regional AOT trends shown on page 16 appear to be generally plausible.

The recent downward trend in the tropospheric AOT may have contributed to the concurrent upward trend in surface solar fluxes. Neither AVHRR nor other existing satellite instruments can be used to determine definitively whether the recent AOT trend is due to long-term global changes in natural or anthropogenic aerosols. This discrimination would be facilitated by an instrument like the Aerosol Polarimetry Sensor (APS), which is scheduled for launch in December 2008 as part of the National Aeronautics and Space Administration Glory mission (*http://glory.gsfc.nasa.gov;* Mischenko et al., 2007). It is thus imperative to provide uninterrupted multidecadal monitoring of aerosols from space with dedicated instruments like APS in order to detect long-term anthropogenic trends potentially having a strong impact on climate.

The above article is a retitled and modified version of an article by M. Mishchenko et al., appearing in Science, Vol. 315, 16 March 2007.

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NEESPI – NEW GEWEX REGIONAL HYDROCLIMATE PROJECT

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The Northern Eurasia Earth Science Partnership Initiative (NEESPI) was accepted as the newest GEWEX Regional Hydroclimate Project (RHP) by the GEWEX Scientific Steering Group in January 2007. The NEESPI study area, which is the largest of all the RHPs, includes the former Soviet Union, Northern China, Mongolia, Fenno-Scandinavia, and Eastern Europe. The Project involves nearly 400 scientists from almost 200 institutions worldwide. The goal of NEESPI is to develop a comprehensive understanding of the Northern Eurasian terrestrial ecosystem dynamics, biogeochemical cycles, surface energy and water cycles, and human activities and how they interact with and alter the biosphere, atmosphere, and hydrosphere of the Earth. The anticipated outcomes from this project include the ability to measure, monitor, and model the processes that will provide accurate future projections of climatic and environmental changes in the NEESPI region.

Not all components of NEESPI are developing at the same rate. In order to mitigate the different paces of development of the various components arising from NEESPI's rapid growth and nonproportional funding, the Project is structured by regional Focus Research Centers (FRCs). NEESPI data support is provided by Science and Data Services Centers located in Moscow and Obninsk in Russia; in Asheville, North Carolina and Greenbelt, Maryland in the United States; and in Beijing, China.

NEESPI DELIVERABLE MILESTONES FOR 2010

- A suite of process-oriented models for each major terrestrial process in all its interactions
- A suite of global and regional models that seamlessly incorporate all regionally specific feedbacks associated with terrestrial processes
- An integrated observational knowledge data bank for environmental studies
- A system in place that can serve the emergency needs of the society

NEESPI FOCUS RESEARCH CENTERS

- Center for Cold Land Processes and Arctic Coastal Studies, Fairbanks, Alaska, USA
- Center for Water System Studies, Durham, New Hampshire, USA
- Center on Aerosol Studies, Atlanta, Georgia, USA
- Center for Land Use Studies, Fort Collins, Colorado, USA
- Center for Biogeochemical Cycle Studies, Jena, Germany
- Center for Land Cover Studies, Jena, Germany
- Regional Center for Dry Land Processes Studies, Beijing, China
- Regional Center for NEESPI Studies in Eastern Europe, Sopran, Hungary
- Regional Center for NEESPI Studies in Siberia, Krasnoyarsk, Tomsk, Russia

NEESPI objectives for the next 3 years are: (1) to have in place a suite of tested land surface and regional climatic models that account for changes in the energy and water cycles in Northern Eurasia; (2) to complete all funded International Polar Year activities; and (3) to organize up to 20 summer schools and/or special courses for training of Earth Science K-12 teachers and a new generation of the NEESPI domain Earth Science researchers.

NEESPI has an open data policy and offers some administrative infrastructure and advice for those wishing to carry out research in Eurasia. NEESPI also encourages the publication of its results in the open science literature. Over 200 NEESPI articles have been published (or are in press) in refereed journals during the past 2 years.

NEESPI has been endorsed by several of the Earth System Science Partnership (ESSP) Programs and Projects: (1) the International Geosphere-Biosphere Program through the International Land Ecosystem-Atmospheric Processes Study; (2) the World Climate Research Programme through GEWEX and the Climate and Cryosphere Project; and (3) ESSP through the Global Carbon Project, Global Land Project, and the Global Water System Project.

For more information about NEESPI, see *http://neespi.org*.

RESULTS FROM THE PILPS SEMIARID EXPERIMENT (PILPS San Pedro)

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The Project for the Intercomparison of Land-Surface Parameterization Schemes (PILPS) Semiarid Experiment (San Pedro) is an initiative within the GEWEX Global Land Atmosphere System Study (GLASS) focused on semiarid lands. These areas constitute one-third of the global land surface (Bastidas et al., 2004). The PILPs San Pedro Experiment used two 4-year (1997–2000) data sets from the United States Department of Agriculture (USDA) Experimental Watershed in the Walnut Gulch in southeastern Arizona, a sub-basin of the Upper San Pedro Basin (Emmerich, 2002). The Lucky Hills site is located in the lower (1372 masl) shrub-dominated area of the basin. The Kendall site is in the eastern part of the watershed (1526 masl).

Nine models participated in the San Pedro Experiment: BATS (the University of California, Los Angeles, United States), CBM (the Commonwealth Scientific and Industrial Research Organization, Australia), ISBA (Meteo France), Noah [Utah State University/the National Centers for Environmental Prediction (NCEP), United States], SEWAB (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt (GKSS) Research Center, Germany)

Site	Lucky Hills	Kendall
Location	110°03'05W 31°44'37N	109°56'28W 31°44'10N
Vegetation	C_3 species	Perennial C_4 grasses
Soils	Loamy sand/very gravelly sandy loams	Gravelly sandy loams containing limestone rock fragments
Canopy Height	1 meter	0.4 - 0.7 meter
Slopes	3-8 percent	4-9 percent
Average Temp.	18.6°C	19.3°C

Characteristics of the Walnut Gulch sites used in the PILPS San Pedro Experiment.

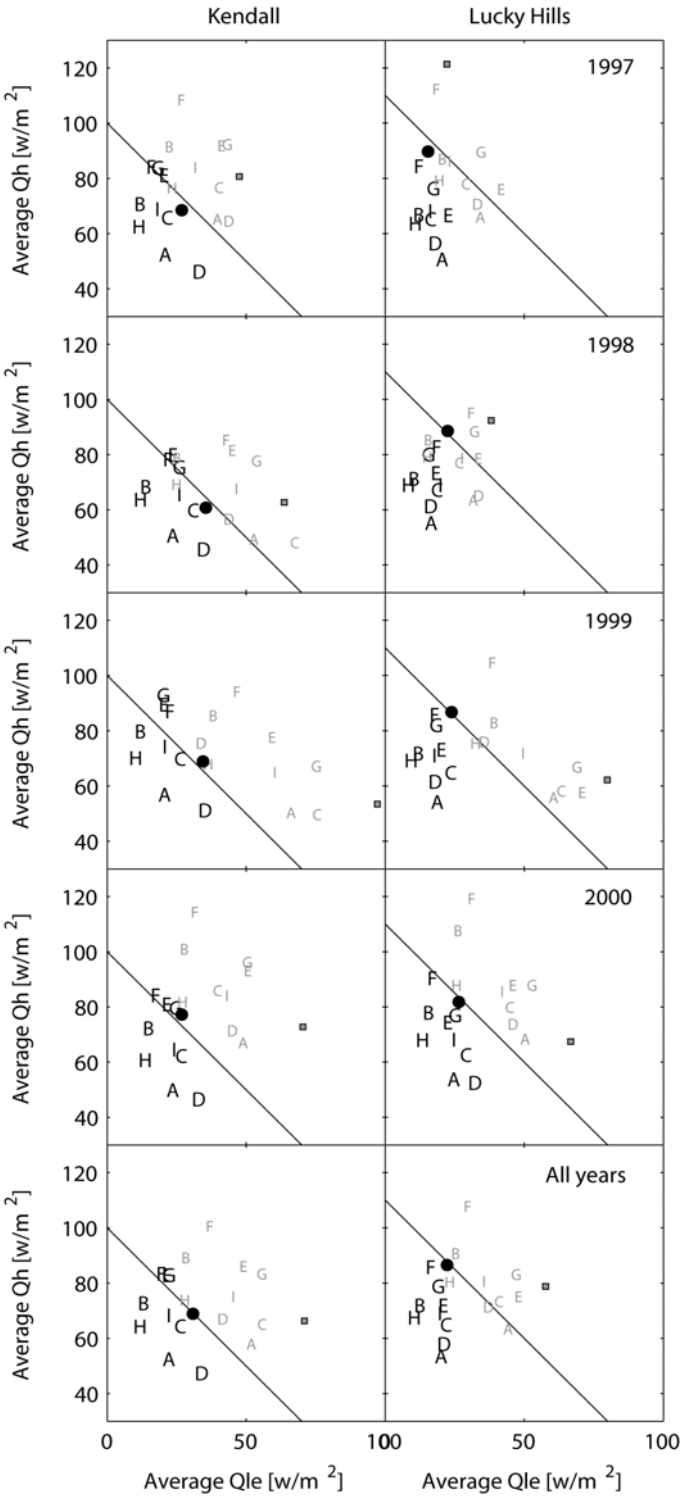
SPONSOR (Institute of Geography, the Russian Academy of Sciences, Russia), SSiB (Center for Ocean-Land-Atmosphere Studies (COLA), United States), SWAP (the Institute of Water Problems, Russian Academy of Sciences, Russia), and VIC (the University of Arizona, United States).

The model runs were performed offline using the provided forcings. Split-sample validation tests were performed on these results using goodness of fit [Correlation Coefficient Squared (R^2), Index of Agreement (IA), Nash-Sutcliffe Efficiency, Root Mean Square Error (RMSE), and Bias] and similarity measures (Hausdorff norm). The time scales considered for these analyses were monthly, daily average, annual, and seasonal (with particular attention to the North American Monsoon).

Interannual closure checks showed that all of the schemes have energy balance residuals less than ± 2.0 Wm^{-2}. The mean annual ground heat flux is zero for three models (ISBA, SSiB, SWAP) while three models (BATS, SEWAB, Noah) lose ground heat and two (CBM, SPONSOR) have positive mean annual ground heat fluxes. The models failed to adequately represent the annual net radiation. All of the models underestimated the net radiation in Lucky Hills and only two (SEWAB, SPONSOR) were not below the observed net radiation in Kendall. One model (SWAP) is an outlier, whose computed net radiation is less than 50 percent of the observed.

The figure at the right presents the energy balance closure and the net radiation decomposition for both sites for all the years. Large differences in the surface energy partitioning between latent and sensible heat fluxes have been observed among models and between sites. The Bowen ratio for the Lucky Hills site (shrub) is 4.86, opposed to 2.23 for the Kendall site (grass). The among-model range of Bowen ratios for the grassland site varies from 1.38 to 5.30, while in the shrub site it ranges between 2.65 and 6.27. The differences found in Bowen ratio values suggest the possibility that the different biomes are not being represented adequately. In Lucky Hills, most of the models (except SSiB and CBM) represent well the annual latent heat flux but underestimate the sensible heat flux by more than 15 percent. In Kendall, only one model (Noah) represents the mean annual latent heat adequately; the rest underestimate it. Three models (CBM, SEWAB, SPONSOR) overestimate the sensible heat.

Soil moisture measurements were also available in a discontinuous basis for the years 1997 and 1998. The comparisons between those observations showed differences of orders of magnitude with



Energy Balance closure and net radiation decomposition for both sites and all periods. Energy partition: sensible heat (Qh) vs. latent heat (Qle) for Kendall (grass) and Lucky Hills (shrub) sites. Dark letters represent the entire period, light gray the monsoon period (July–September). The circle and the square are observed values. A-BATS, B-CBM, C-ISBA, D-Noah, E-SEWAB, F-VIC, G-SPONSOR, H-SSiB, I-SWAP.

very low values reported by CBM and ISBA and very large values from SWAP. SEWAB adequately tracks the scatter soil moisture observations from 1997 and 1998 at both sites. Noah and VIC accurately tracked the soil moisture changes at the Lucky Hills (shrub) site but did poorly at the grass site.

Quantitative and qualitative comparisons between model-predicted runoff events and observations from two gauges near the flux towers were performed. Runoff was observed only during the monsoon periods. In total, about 40 runoff events have been recorded during the 4 years for each site. Model results were very different, ranging from close to zero values by ISBA, Noah and SEWAB to large values by CBM, SPONSOR and SSiB. SWAP, VIC and BATS produced runoff values somewhat similar to the ones observed; however, a binary evaluation in the form of a hit table (see figure at the top of page 16—the Kendall site) reveals that the majority of the models produce runoff when none is present in the gauges. Noah has the highest hit rate (Observed NO/Predicted NO, and Observed YES/Predicted YES) despite not being able to simulate the magnitude of the runoff.

This research shows that semiarid environments cannot be lumped into a single functional type classification, as is customary in the land surface community. It constitutes a preliminary step towards identifying parameter sets that can be safely transferred between locations with similar physical characteristics, thus providing parameter estimates that can be considered truly regional based on a consistent behavior across semiarid biomes. Partial results have been published in Bastidas et al., 2006; Rosero and Bastidas, 2007; and two papers are in preparation.

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YEAR OF TROPICAL CONVECTION – A JOINT WCRP-THORPEX ACTIVITY TO ADDRESS THE CHALLENGE OF TROPICAL CONVECTION

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Cumulus convection, particularly the manner in which it organizes and influences the associated cloud processes, strongly affects the transport of heat, moisture, and momentum in the atmosphere, as well as the Earth's radiation budget, and is therefore of fundamental importance to atmospheric circulation. Much of the uncertainty in predictions of weather and climate variability is linked to cumulus parameterization issues, combined with our lack of understanding of the interactions between the mesoscale, synoptic, and planetary scales. This leaves scientists at a disadvantage in their attempts to model fundamental properties of the tropical atmosphere, such as the Intertropical Convergence Zone (ITCZ), monsoons, the Madden-Julian Oscillation (MJO), easterly waves, tropical cyclones, bulk budgets of cloud microphysical quantities, and the diurnal cycle. Moreover, many tropical weather/climate disturbances have a strong influence on the extra-tropics. This can occur through direct poleward migration of synoptic systems or through the initiation of Rossby wave trains, with the latter driven by a wide range of processes and time scales (e.g., synoptic, MJO/intraseasonal, El Niño Southern Oscillation/interannual).

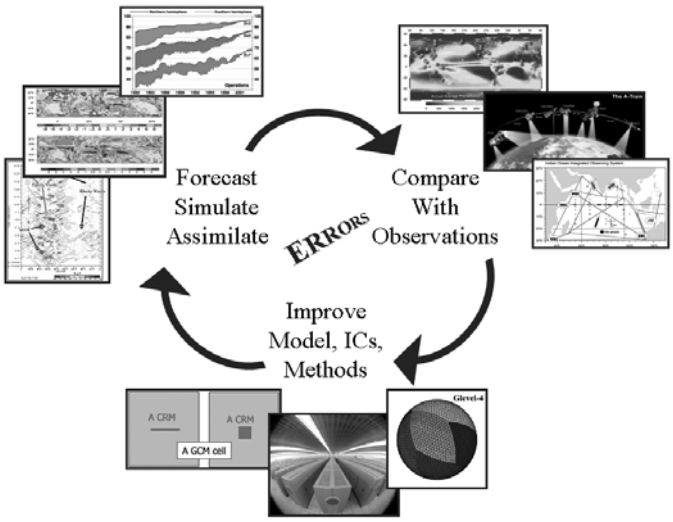
The World Climate Research Programme (WCRP) and The Observing System Research and Predictability Experiment (THORPEX) are proposing a Year of Coordinated Observations, Modelling, and Forecasting of Tropical Convection (a.k.a., the Year of Tropical Convection–YOTC). This activity will blend the strengths of the global, focus-year approach of the First Global Atmospheric Research Program (GARP) Global Experiment with the Intensive Observation Period approach of the GARP Atlantic Tropical Experiment and the Coupled Ocean-Atmosphere Experiment, where in this case the "intensive observations" come from the vast new resources discussed above. The YOTC timeframe (2008–2009) coincides with the WCRP/THORPEX contribution to the United Nations Year of Planet Earth and the International Polar Year.

The fundamental science questions to be addressed by YOTC are: (1) How is organized tropical convection influenced by, and how does it feed back to, the large-scale circulation? (2) Under what

circumstances and with what mechanisms do energy and momentum transfer from the convective scale to the mesoscale, from the mesoscale to the synoptic scale, and from the synoptic scale to the large/planetary scale? (3) How does organized tropical convection interact with the extra-tropics?

The overarching goals of the program are to achieve significant gains in forecast skill by 2012 in the following three areas: (1) Short- to medium-range tropical weather forecasts; (2) Extended-range/sub-seasonal forecasts of the MJO; and (3) Medium to extended range extratropical forecasts derived from an improved representation of tropical weather/climate and tropical-extratropical interactions.

Addressing the science questions and meeting the goals above are at the heart of WCRP's and the World Meteorological Organization's World Weather Research Programme (WWRP) research and application objectives. For WCRP in particular, these questions and goals closely align with the charters, capabilities, and resources of GEWEX and the Climate Variability and Predictability (CLIVAR) Project. GEWEX provides leadership in terms of large-scale field program expertise, significant understanding and modelling capabilities in terms of cloud processes and radiation, and a number of valuable data sets (e.g., Coordinated Energy and Water Cycle Observations Project–CEOP reference sites). CLIVAR provides modelling expertise and infrastructure, principally in terms of the coupled ocean-atmosphere-land-system and the overlapping *in situ*/field programs [e.g., the Indian Ocean and Tropical Ocean Global Atmosphere (TOGA)/Tropical Atmosphere Ocean (TAO) Arrays]. THORPEX, on the other hand, brings its inherent ties to the operational weather forecast centers, along with its very tangible and directed efforts at achieving



Schematic of the proposed activity and a qualitative representation of its analysis framework.

gains in forecast skill at medium to extended ranges. Moreover, its development and plans for the THORPEX Interactive Grand Global Ensemble (TIGGE) data set is key, as so much of YOTC's analysis path and success metrics will be able to utilize and capitalize on this new and exciting resource. In addition, the WWRP Tropical Meteorology Research Programme's focus on tropical cyclones and monsoons, along with their close connections to the National Meteorological and Hydrological Services in tropical countries, make it a natural partner in this activity.

Originating from a WCRP-THORPEX co-sponsored workshop in March 2006 (Moncrieff et al., 2007), the concept of YOTC was subsequently developed and presented to national and international forums. A draft science plan for YOTC (YOTC, 2007) has been prepared that identifies a number of specific target phenomena that will be the focus of the research, modelling, and forecasting activities for the intensive observation period (IOP)/year. These include: (1) convectively coupled waves and the MJO; (2) easterly waves and tropical cyclones; (3) the diurnal cycle; and (4) monsoons. Each target phenomenon will have a focused working group associated with it that will develop a more specific implementation plan for that phenomenon, including the coordination of the pertinent observational, modelling, and forecasting resources and the design of a feasible analysis and modelling framework.

At the March 2007 WCRP Joint Scientific Committee (JSC) meeting in Zanzibar, Tanzania, the YOTC was presented and endorsed, with the chief advisory component occurring under the context of the joint CLIVAR/GEWEX Pan-Monsoon Initiative. YOTC has also been endorsed by the WWRP JSC, who will provide support for a meeting to be held later in 2007. As YOTC relies on already available observational resources, the intensive observation period/year mainly consists of data, archiving, formatting, and coalescing activities, along with research, analysis, and modeling framework planning that will occur in conjunction with working group meetings and one or more international workshops. It is expected that the bulk of the research and analysis will be undertaken subsequent to the IOP/year—the latter part of 2009 and beyond, yielding the associated model and forecast improvements by 2012.

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Moncrieff, M. W., M. A. Shapiro, J. M. Slingo, and F. Monteni, 2007. Organised tropical convection and the global circulation: A THORPEX and WCRP collaborative research opportunity. *WMO Bulletin*, in press.

YOTC, 2007. YOTC–Draft science plan and PowerPoint summary, *http://hydro.jpl.nasa.gov/tmp/WCRP.THORPEX. YOTC.pdf.*

WORKSHOP/MEETING SUMMARIES

WORKING GROUP ON DATA MANAGEMENT AND ANALYSIS MEETING

13–15 November 2006
College Park, Maryland

William B. Rossow
City College of New York, New York, USA

The Fourth Session of the GEWEX Radiation Panel Working Group on Data Management and Analysis (WGDMA) was held at the University of Maryland, College Park. Topics covered at the meeting included a plan for radiance recalibrations, a review of data product assessments, and planning for retrieval algorithm refinements. The progress of the SeaFlux Project towards producing global products of ocean surface turbulent fluxes of heat and water was also reviewed.

Dr. Kenneth Holmlund provided an overview of the recently launched European polar orbiting weather satellite, METOP-A, which carries several new sensors, including an enhanced ozone instrument (GOME), a scatterometer (ASCAT), a radio occultation receiver (GRAS) for GPS-based atmospheric soundings, and an infrared atmospheric sounding interferometer (IASI) for advanced temperature/humidity/ozone soundings.

Dr. Robert Adler reported that all Global Precipitation Climatology Project (GPCP) products are currently up to date. The transition of the polar infrared algorithm from the High Resolution Infrared Radiation Sounder to the Atmospheric Infrared Sounder was completed this year, and an adjustment was made to the monthly, multi-satellite product to remove a spurious shift that occurred in 1986. Although the focus of GPCP continues to be on improving the long-term global record of precipitation, additional effort will be directed toward increasing the time resolution while maintaining consistency with the longer record, and increasing the information content (primarily, the phase of precipitation) of the products. Work will also focus specifically on improving results in mountainous and high-latitude (snow) areas. In the next version of the products (Version 3), in addition to the longer-term (1979 to current) heritage product, a 1º product with 3-hour or daily time steps will be produced from the early 1980s using the International Satellite Cloud Climatology Project (ISCCP) B1 radiance data set and a 0.25º, 3-hour product from the Tropical Rainfall Measuring Mission. The gauge analysis will also be upgraded to a version that has more homogeneous sampling, and corrections for orographic effects that are being developed. It appears feasible to begin testing these changes by the end of 2007 and begin the reprocessing of the whole data record in 2008.

Dr. Paul Stackhouse reported that new Surface Radiation Budget (SRB) Project versions (No. 2.5) of the shortwave (SW) and longwave (LW) flux products were released in 2006 that made improvements (e.g., switching to the NASA/Goddard Earth Observing System–4 atmospheric data set), and corrections (e.g., fixing filling procedures for low solar zenith angles), and extended the data record from July 1983 through June 2005. A newer version of the SW fluxes (No. 2.7), which has additional improvements in the treatment of the incident solar flux is complete. Extensive evaluation activities have been underway that exploit the detailed Baseline Surface Radiation Network data sets. The radiation assessment activity has shown that, although there are absolute differences in mean fluxes among the observational products, the seasonal to interannual variations agree very well quantitatively. However, agreement of the main reanalysis products is not as good. Improvements discussed included: (1) testing alternative climatological aerosol products; (2) exploiting the new Earth's Radiant Energy System (CERES) angular distribution models, particularly for ice and snow surfaces; (3) including explicit spectral dependence in surface albedo; and (4) allowing for a temperature discontinuity between near-surface air and the skin. Other longer-term investigations involve (1) alternative data sets for ozone and other trace gases (to include their variation); (2) variations of solar irradiance; and (3) a treatment of cloud microphysics variations. New products being considered are ultraviolet, photosynthetically active radiation, and “window” fluxes.

The main focus of preparations for reprocessing includes efforts to re-evaluate the radiance calibrations used by ISCCP, which provides the cloud property inputs to SRB, and to find a common global atmospheric product (e.g., temperature, humidity) that covers the whole time period and has little or no change of character (i.e., spurious interannual variations). SRB continues to improve the treatment of clouds, aerosols and surfaces in its products and to develop new products (mainly fluxes in particular spectral intervals). These activities, together with improvements suggested by the assessment results, will set the stage for reprocessing the whole product in 2008 or 2009, depending upon ISCCP and Global Aerosol Climatology Project (GACP) schedules.

Dr. W. Rossow reported that all ISCCP data products (B1/B3 radiances, DX/D1/D2 cloud products) for July 1983 to June 2005 have been processed and delivered. The amount of possible data successfully processed, in terms of global coverage, every 3 hours for 22 years, is 92 percent with a minimum of 70 percent in late summer of 1984, and a maximum of 98 percent since mid 2002. Processing is currently on hold as efforts are directed at transferring and re-establishing the calibration for the new "afternoon" polar orbiter, the National Oceanic and Atmospheric Administration (NOAA)-18; dated deliveries beyond June 2005 are expected in early 2007. Two new data products were completed in 2006: the Convective Tracking Product and a complete survey of cloud particle sizes, both liquid and ice, that will be released in early 2007.

Notable developments include the increasingly active participation in ISCCP by China, which is now contributing data from their geostationary weather satellite (FY-2C), and the advent of full operations by the advanced imager (SEVERI) on METEOSAT-8. The operations of GOES-10 and METOP-A, and the possible addition of data from Brazil raises the question about the multi-satellite merger approach, which will be investigated in the coming year. The NOAA National Climatic Data Center reported continued progress in refurbishing the B1 radiance data set (10 km sampling) and some success in recovering older geostationary data prior to July 1983. A specific study of polar cloud detections has been completed showing that estimates of total cloud amount involve significant cancellation of detection errors. More detailed investigations show that some additional improvements can be made in the homogeneity of radiance calibration record. The ongoing cloud assessment has begun to identify some possible improvements for ISCCP products.

Current plans are to complete ongoing evaluations and revisions of radiance calibration by mid 2007 and to reprocess all data products based on the B3 radiances (30-km sampling) by the end of 2007. The largest remaining issue is finding a global atmospheric temperature and humidity data set that does not have spurious interannual variations. Progress towards reprocessing to produce significantly improved products with higher (consistent) space-time resolutions are well underway and these products should be available by the end of 2009.

The next WGDMA meeting will be held 5–7 September 2007 at the City College of New York, New York City.

WORKSHOP ON HYDROLOGY DELIVERING EARTH SYSTEM SCIENCE TO SOCIETY

28 February – 2 March 2007 Tsukuba, Japan

Rick Lawford[1] and Taikan Oki[2]
[1]International GEWEX Project Office, Maryland, [2]University of Tokyo, Japan

Drs. Taikan Oki and Stefan Uhlenbrook organized this international workshop to launch the International Association of Hydrological Sciences (IAHS) report, "Hydrology: Integrating Science to Meet World Water Challenges." The workshop brought together a number of hydrological scientists from Japan as well as the international hydrology community.

In view of Japan's recently announced plan to launch a strategy for creating innovation, the timing of this workshop was very appropriate. Prof. Taizo Yakushiji of the Council for Science and Technology outlined Japan's innovation strategy. Dr. Oki indicated that the workshop was intended to address two central questions, namely:

- What are the current gaps between societal expectations for hydrological prediction and the capabilities of our modeling systems?

- What kind of topics in directions in hydrology will pose challenges for our scientific studies and technological developments in the coming decades?

A number of presentations given at the Workshop outlined critical issues for the future. Dr. Zbigniew Kundzewicz provided a comprehensive overview of the science of hydrology and the ways in which it interfaces with society, while Dr. Hoshin Gupta demonstrated the role of models—including numerical, conceptual and scenario models—in communicating science and uncertainty to the public. Listing a range of human effects on water that went well beyond climate change, Dr. Petra Doell demonstrated the importance of trends in factors such as water use and agricultural land use. In addition, Dr. Hansaki established how the analysis of water stress required higher time resolution than the usual annual maps in order to effectively represent the seasonal and interannual variability in water stress.

The Project for Ungauged Basins (PUB) was described by Dr. Murugesu Sivapalan and the need for hydrologic modelling discussed in this context. As outlined by Dr. Yasuto Tachikawa, information on the strengths of various models, such as hydrologic models that can show where runoff is generated in a basin, is a necessary attribute for models used in flood prediction. Models are needed to distinguish between the effects of large-scale changes in a basin, such as climate change, and local changes including land-use change. In some areas, evapotranspiration is an important but poorly known process. Dr. Kenji Tanaka gave a number of examples where land surface models are now able to simulate the effects of surface conditions on the local water cycle.

Scale dependencies are an important aspect of hydrologic processes. As shown by Drs. Nobu and Uhlenbrook, the scale characteristics of different hydrologic processes largely determine how the underlying topography affects runoff regimes. Observational and modelling studies need to take advantage of our knowledge of these scale dependencies. Prof. Eric Wood described the important role of remote sensing in providing new insights about these processes at relevant scales. As Prof. Toshio Koike demonstrated, assimilation systems offer a strong capability to bring these data sets together, as has been done in the Coordinated Energy and Water Cycle Observations Project (CEOP). However, hydrologic systems to exploit satellite data are only in their early stages. Although we have many products, the error characteristics of these products are not well known.

In assessing the adequacy of information needed as inputs to hydrologic models Dr. Shinta Seto demonstrated that comparisons between various precipitation products are needed to understand the errors associated with the estimates. Accurate measurements are needed to map precipitation because, as shown in Dr. Chris Milly's talk (presented in abstentia), precipitation records show that hydrologic records can no longer be considered as stationary. Other variables also show trends, but according to Dr. Tasuku Tanaka, additional research is required to develop suitable algorithms to reliably derive them from satellite data. Dr. Dennis Lettenmaier showed that there is a range of factors beyond climate change such as changes in policy for dam management that are contributing to changes in winter flow regimes in Siberia.

Decidedly, more attention needs to be given to the implementation requirements of integrated river management. This management approach will lead to requirements for the production of new types of data sets that bring together water chemistry and ecological data in the same context as stream flow and water level data. Dr. David Wegner showed several case studies where integrated data sets were needed for effective watershed planning. New ways of disseminating this information will be required as scientists broaden their user base to include communities that are making water management decisions at the local scale.

Many of the policy issues discussed at the workshop involved the use of data for assessing the sustainability of water supply in areas of water stress. Dr. Koichiro Kuraji raised specific concerns on the interaction of scientists and local communities based on his experience with public consultation in Japan. Dr. Shinjiro Kanae looked at the implications of a range of water parameters, while Dr. Terak Merabtene described the indicator approach with which the World Water Assessment Programme is characterizing water problems around the world. Many of the requirements for hydrological information will be met through the provision of predictions of both short-term and long-term variability in supply. Prof. Soroosh Sorooshian showed how programs like GEWEX are contributing to the development of better prediction capabilities, while Prof. Kuniyoshi Takeuchi described the central role that hydrology must play in understanding the anthropocene and forecasting the effects of human development on regional water supplies. Of course, to be effective in benefiting the public, forecasts must also be used in the types of broad warning systems being developed by the International Centre for Water Hazard and Risk Management, as Dr. Akira Terkawa demonstrated.

In their summary comments, Prof. Oki and Rick Lawford identified a number of research needs with relevance to GEWEX, including the need to:

- evaluate the effects of globalization on the needs for hydrologic information
- encourage GEWEX and PUB to collaborate on a large basin project that incorporates *in situ*, remote sensing data and model outputs
- implement a dual path strategy on an experimental basis for estimating precipitation
- direct research at understanding and modeling the different physical processes that are dominant at various scales in a river basin

JOINT CEOP/IGWCO PLANNING MEETINGS

12–17 March 2007
Washington, D.C., USA

Rick Lawford[1], Sam Benedict[2], Douglas Cripe[3], Chu Ishida[4] and Wolfgang Grabs[3]

[1]International GEWEX Project Office, [2]International CEOP Coordinator, [3]Secretariat for the IGWCO Executive, WMO, [4]Japanese Aerospace Exploration Agency

The Integrated Global Water Cycle Observations (IGWCO) Theme of the Integrated Global Observing Strategy Partnership (IGOS-P) held its third annual meeting at the National Academy of Sciences (NAS), in conjunction with the sixth meeting of the Coordinated Energy and Water Cycle Observations Project (CEOP). Over 110 people from 18 countries participated in these meetings. The organizers are grateful to the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the NAS for supporting these meetings, and to the Japan Aerospace Exploration Agency and the University of Tokyo for supporting participant travel.

The first days of the meeting concentrated on CEOP issues while the last three focused on IGWCO issues. The joint CEOP/IGWCO session, held on March 14, provided background about recent joint activities and focused on two topics of mutual interest: drought and capacity building. The ability of remote sensing to monitor drought events was presented in the context of both research projects and operational informational services.

Dr. William Logan, NAS

The CEOP meeting marked the first meeting of the recently merged GEWEX Hydrometeorology Panel (GHP) and former Coordinated Enhanced Observing Period Project, which is now known as the Coordinated Energy and Water Cycle Observations Project (CEOP). This Project will function as a GEWEX panel to oversee all GEWEX hydroclimate projects. The merger will enhance GEWEX efforts in achieving the objectives of the former GHP and CEOP but will require a refocusing of the GHP Continental Scale Experiments into Regional Hydroclimate Projects (RHPs).

The main issue to be addressed in the new CEOP framework is the connection between the CEOP science and data components and the RHPs. Based upon discussion at the meeting, the overall configuration of CEOP will be adjusted to give a clearer picture of the work within the RHPs and how they will contribute to CEOP. New regional climate projects on cold regions, semiarid regions, monsoons and mountain regions were described and the RHPs were asked to identify how they would contribute to CEOP in the following areas: (1) using CEOP data sets, (2) contributing to CEOP data sets, (3) creating commonality with CEOP regional climate projects, and (4) maintaining an open data

Participants at the CEOP/IGWCO Planning Meetings.


Dr. Toshio Koike, Univ. of Tokyo

policy. This action will be the focus of the efforts within the new CEOP framework for the 5-month period; the next CEOP implementation planning meeting is planned for 6–8 September 2007 in Bali, Indonesia.

The IGWCO meeting reviewed the progress of a number of projects. A draft assessment report was presented by Drs. Wolfgang Grabs, Executive Chair of IGWCO and Douglas Cripe, IGWCO Executive Secretariat. The report will serve as a basis for identifying areas where additional work needs to be done before IGWCO, working within the IGOS-P framework, undertakes a 5-year review of the needs for observational systems in the water cycle sector. Highlights from the IGWCO meeting presentations are summarized below.

Precipitation. Through the efforts of the International Precipitation Working Group, progress is being made in evaluating different precipitation products, including the Global Precipitation Climatology Project (GPCP) and the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN). A workshop is planned in Geneva to investigate an integrated precipitation product.

Soil Moisture. Plans for developing an interoperable *in situ* soil moisture network that accommodates the various observational capabilities around the world are being formulated. These efforts are driven by the need to develop and validate the Soil Moisture and Ocean Salinity Mission products and the need for an operational soil moisture product.

Water Quality. The needs of operational water quality monitoring programs and the potential for using remote sensing for water quality measurements were reviewed. The State of Wisconsin has been successful in obtaining funding to develop new applications in this area. Plans have been finalized for a Group on Earth Observations (GEO) Water Quality workshop.

Groundwater. After an overview of the need for groundwater monitoring and options for groundwater monitoring was presented, plans for an IGWCO/GEO workshop were discussed. The workshop will likely be held in the Netherlands in September 2007.


Dr. Chu Ishida, JAXA

Capacity Building. Dr. Chu Ishida summarized the results of the successful Asian Capacity Building Workshop, which has led to the emergence of a significant capacity building element in the Asian Water Cycle Initiative. By adopting the Terrestrial Initiative in Global Environment Research (TIGER) Workshop as the third in a series of regional workshops, the IGWCO commitment to GEO in this area has been fulfilled. Progress has also been made in the development of a Latin America capacity building process as a result of a water cycle workshop held in Buenos Aires in November 2006. Demonstrations of the Goddard Distributed Active Archive Center and CEOP systems at the workshop showed the potential for applying these data sets in their operational environments.


Dr. Jack Kaye, NASA

Breakout sessions addressed the opportunities, user requirements, and expectations with respect to the IGWCO in the areas of Earth observations, data integration and application/capacity building. A number of national program activities were described with an emphasis on the United States. Dr. Gene Whitney gave an overview of the United States GEO Program while a number of colleagues from the U.S. Geological Survey, NASA and NOAA described different observational programs that support or draw from IGWCO activities. In a similar way, programs such as GEWEX and the Global Water System Project and their links to IGWCO were also described. Dr. Lawrence Friedl of NASA described a new initiative of the GEO User Interface committee regarding the definition of user needs and proposed that the Water Cycle Community of Practice take the lead in providing water cycle input.

The results of this meeting will be reported to the IGOS-P meetings in Paris, France at the end of May 2007 by Dr. Wolfgang Grabs. In addition, they will serve as a basis for some of the IGWCO discussions on emerging links with GEO. The presentations for the joint meeting are available at *http://www.gewex.org/ceop-igwco-mtg.htm*.

GEWEX RELEVANT PUBLICATIONS OF INTEREST

Modelling the Interactions Between Aerosols and Liquid Water Clouds with a Self-Consistent Cloud Scheme in a General Circulation Model

Reference: Y. Ming, V. Ramaswamy, L. J. Donner, V. T. J. Phillips, S. A. Klein, P. A. Ginoux, and L. W. Horowitz, 2007. *J. Atmos. Sci.,* Vol. 64, Issue 4, 1189–1209.

Summary/Abstract: To model aerosol–cloud interactions in general circulation models (GCMs), a prognostic cloud scheme of cloud liquid water and amount is expanded to include droplet number concentration (N_d) in a way that allows them to be calculated using the same large-scale and convective updraft velocity field. In the scheme, the evolution of droplets fully interacts with the model meteorology. An explicit treatment of cloud condensation nuclei (CCN) activation enables the scheme to take into account the contributions to N_d of multiple aerosol species (i.e., sulfate, organic, and sea-salt aerosols) and to consider kinetic limitations of the activation process. The prognostic scheme leads to a substantial improvement in the agreement of model-predicted present-day liquid water path (LWP) and cloud forcing with satellite measurements compared to using the empirical relationship.

The simulations with preindustrial and present-day aerosols show that the combined first and second indirect effects of anthropogenic sulfate and organic aerosols give rise to a steady-state global annual mean flux change of 1.8 Wm^{-2}, consisting of 2.0 Wm^{-2} in shortwave and 0.2 Wm^{-2} in longwave. The ratios of the flux changes in the Northern Hemisphere (NH) to to those in the in Southern Hemisphere (SH) and those over the ocean to that over land are 2.9 and 0.73, respectively. The model response to higher N_d alters the cloud field; LWP and total cloud amount increase by 19 and 0.6 percent, respectively. Largely owing to high sulfate concentrations from fossil fuel burning, the NH midlatitude land and oceans experience strong radiative cooling. So does the tropical land, which is dominated by biomass burning-derived organic aerosol. This study reaffirms the major role of sulfate in providing CCN for cloud formation.

GEWEX/WCRP MEETINGS CALENDAR

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

4–8 June 2007—WCRP WORKSHOP ON SEASONAL PREDICTION, Barcelona, Spain.

4–8 June 2007—5TH STUDY CONFERENCE FOR BALTEX, Island of Saaremaa, Estonia.

19–21 June 2007—GABLS WORKSHOP, Stockholm, Sweden.

25–29 June 2007—22ND AMS CONFERENCE ON WEATHER ANALYSIS AND FORECASTING/18TH CONFERENCE ON NUMERICAL WEATHER PREDICTION, Park City, Utah, USA.

27–29 June 2007—3RD HEPEX WORKSHOP, Stresa, Italy.

2–13 July 2007—XXIV IUGG ASSEMBLY, EARTH, OUR CHANGING PLANET, Perugia, Italy.

23–27 July 2007—IGARSS 2007, Barcelona, Spain.

31 July – 3 August 2007—7TH ASIAN LIDAR CONFERENCE, Bangkok, Thailand.

20–24 August 2007—10TH INTERNATIONAL MEETING ON STATISTICAL CLIMATOLOGY, Beijing, China.

26–30 August 2007—EARTH OBSERVING SYSTEMS XII (OP400), San Diego, California, USA.

27–31 August 2007—2ND INTERNATIONAL CONFERENCE ON EARTH SYSTEM MODELLING, Hamburg, Germany.

27–31 August 2007—3RD ALEXANDER VON HUMBOLT INTERNATIONAL CONFERENCE ON THE EAST ASIAN SUMMER MONSOON, PAST, PRESENT AND FUTURE, Beijing, China.

27 August – 1 September 2007—3RD INTERNATIONAL SYMPOSIUM ON RIVERINE LANDSCAPES, Brisbane, Australia.

1–4 September 2007—XIII WORLD WATER CONGRESS, Montpellier, France.

3–5 September 2007—11th SESSION OF THE WORKING GROUP ON COUPLED MODELLING, Hamburg, Germany.

5–7 September 2007—GRP WGDMA MEETING, New York, NY, USA.

GEWEX NEWS

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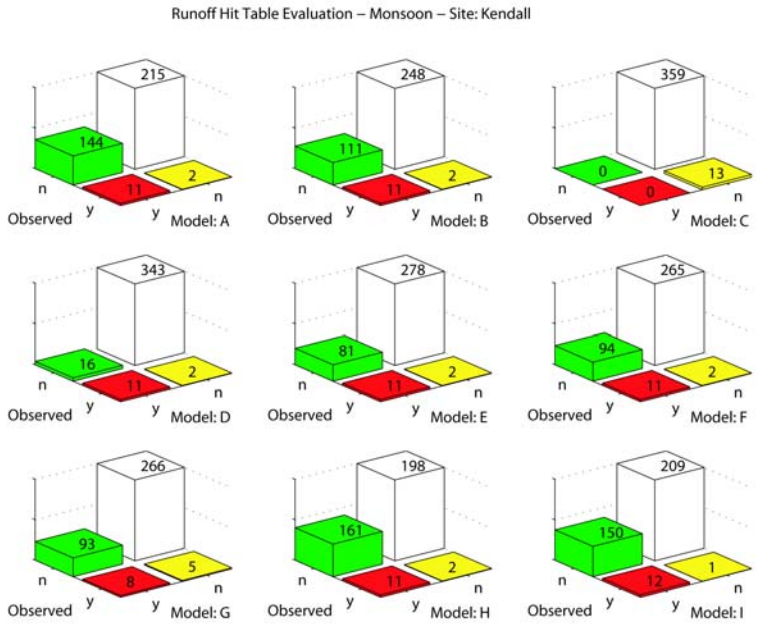
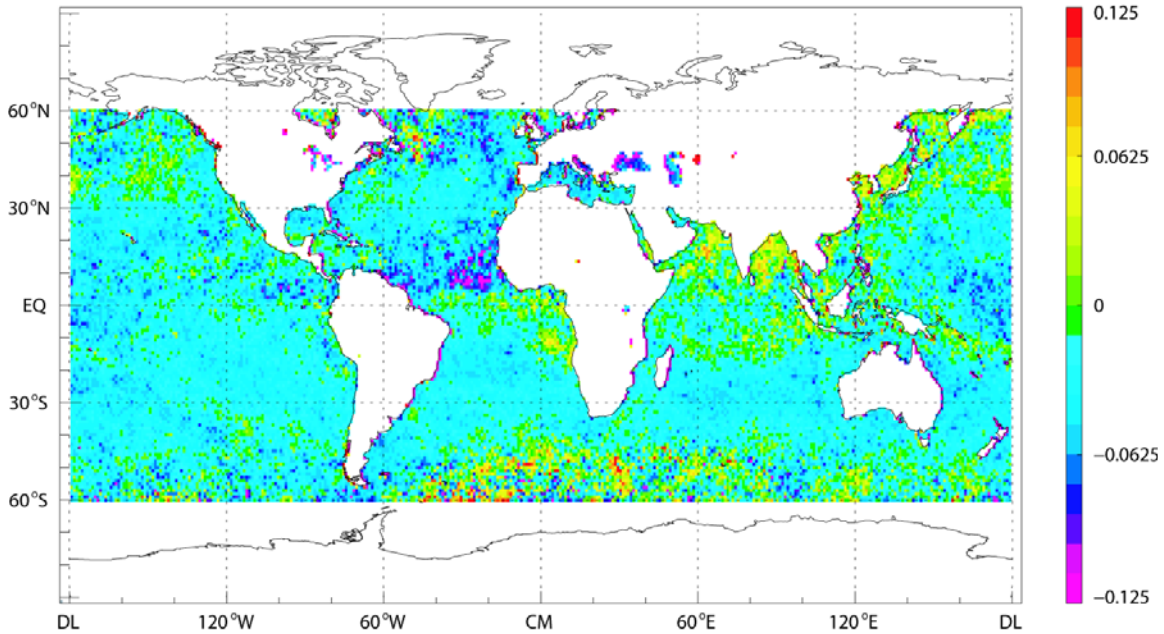
PILPS SAN PEDRO RESULTS SHOW THAT FOR SEMIARID ENVIRONMENTS MOST MODELS PRODUCE RUNOFF WHERE THERE IS NONE



Runoff hit rate for the monsoon period for the Kendall (grass) site. A-BATS, B-CBM, C-ISBA, D-Noah, E-SEWAB, F-VIC, G-SPONSOR, H-SSiB, I-SWAP. See article by Luis A. Bastidas et al. on page 6.

REGIONAL DIFFERENCES IN AEROSOLS SHOW THAT CLEAN AIR LEGISLATION BY SOME COUNTRIES MAY BE REDUCING AEROSOL EMISSIONS



Regional differences between the aerosol optical thickness averaged over the volcano-free periods July 2002 to June 2005 and July 1988 to June 1991. See article by M. Mischenko on page 4.