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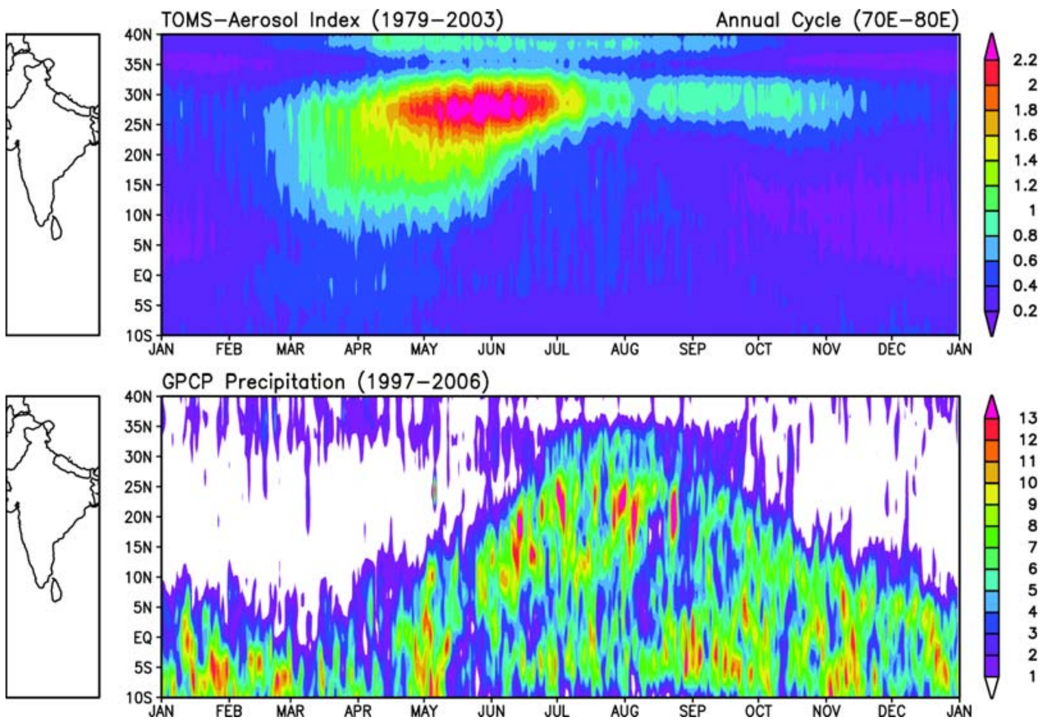
SATELLITE AND GPCP DATA SHOW CO-VARIABILITY OF AEROSOLS AND PRECIPITATION OVER THE INDIAN MONSOON REGION



The time-latitude cross section of climatological daily variations of Total Ozone Mapping Spectrometer–Aerosol Index (TOMS-AI) (upper panel) and the GEWEX Global Precipitation Climatology Project (GPCP) 5-day mean rainfall (lower panel) over the Indian subcontinent show that the high aerosol region in Northern India during June–July overlaps with the rain area, indicating that aerosols may interact with clouds and rain in this region and that aerosols may not be completely washed out by monsoon rains. TOMS-AI is non-dimensional. Rainfall is in units of mm/day. ***See article by W. Lau et al. on page 4.***

Newsletter Contents

COMMENTARY

THE ROLE OF PROJECTS WITHIN WCRP: 2008 AND BEYOND

Soroosh Sorooshian
Chair, GEWEX Scientific Steering Group

I decided to review my previous commentaries over the past 2 years and reflect on some of the critical issues facing GEWEX and the World Climate Research Programme (WCRP). In the May 2006 issue of GEWEX News I spoke about a shift of strategy within WCRP and the Joint Scientific Committee (JSC), moving away from the Coordinated Observation and Prediction of the Earth System (COPES), towards a number of "Cross-cut" initiatives such as Anthropogenic Climate Change, monsoons, extreme events, and a few others. Discussions are continuing regarding the best strategy for addressing the cross-cut initiatives vis-à-vis their relationships to the current projects. This year's JSC meeting agenda is geared towards this issue.

In my November 2006 commentary, I introduced the idea of the merger of the Coordinated Enhanced Observing Period with the GEWEX Hydrometeorology Panel as a major outcome of the First Pan-GEWEX Meeting, involving over 100 members of GEWEX panels and working groups in Frascati, Italy. I am pleased to inform you that much progress has been made thanks to the leadership of Drs. Toshio Koike and John Roads, as well as many others. I also addressed the financial difficulties that WCRP is facing and the potential impact on its four core projects, especially GEWEX, which in my view suffered a disproportionate funding decrease. This was also the year that the documentary movie "An Inconvenient Truth," featuring former U.S. Vice President Al Gore, was released and drew much needed attention to climate issues. My wishful thinking at the time was that the publicity-generated interest in climate issues would create a greater appreciation for the value of programs such as WCRP and its core projects that attempt to address the critical research issues of the complex and interconnected Earth climate system.

I predicted in February 2007 that this year would be the most challenging regarding the relationship between the core projects and WCRP. This proved to be correct and although the situation has improved since the 2007 JSC meeting in Zanzibar there are still issues that need to be resolved.

In August 2007, I addressed the recently released Intergovernmental Panel on Climate Change (IPCC) Assessment Report 4 which clearly could be interpreted as a strong justification for the value of projects such as GEWEX. There is still a high degree of uncertainty associated with the ability of models to predict regional climate. Needless to say, addressing these issues is the primary thrust of much of the current research by GEWEX and other WCRP projects.

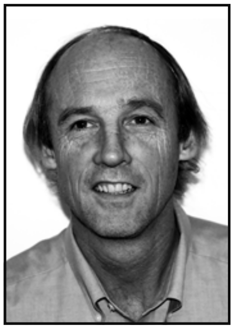
The highlight of the November 2007 issue was a thoughtful review article entitled "Can GEWEX become the cutting-edge of WCRP?" by our distinguished colleague Pierre Morel, the founding Director of WCRP. By now you may ask yourself, what is the point of this review exercise? Here we are in 2008 and IPCC and former U.S. Vice President Al Gore were co-recipients of the 2007 Nobel Peace Prize. We should all be jubilant about the remarkable successes and achievements of the international climate community, many of whom are members of the WCRP in one way or another. **As for GEWEX, as well as other WCRP projects and working groups, work has continued addressing many of the "nuts and bolts" issues of observations, process studies, and modelling.** I also regard the strong and increasing support by the national funding agencies around the world for proposed initiatives for projects that address these needs as a great success. One example would be the recent decision by the National Aeronautics and Space Administration to go ahead with the soil moisture mission, Soil Moisture Active/Passive. This trend is a strong endorsement of the grassroots efforts by the working groups of WCRP projects.

This brings me to the role of WCRP and other international research coordinating bodies, such as the International Geosphere-Biosphere Programme. The most critical role they have played to date has been to facilitate opportunities through travel support for the projects and their working groups in order to meet, innovate and prioritize research and observation requirements. After all, it is the projects that are producing the results that have been enabling the scientific advances and it would be unfortunate to find ourselves in the position of diminishing travel funds for WCRP's building blocks, namely the projects. The JSC has played a critical role to ensure that initiatives of projects do not occur in isolation and, hence, "make the whole to be greater than the sum of its parts." However, as the initiatives originate in the projects and the projects deliver the scientific products **it is imperative that funding for these coordinating bodies continue, if not in fact be substantially increased.**

Irrespective of how we decide to reorganize, merge, and/or streamline the various activities, it is incumbent upon us as climate researchers involved in various WCRP and other international climate programs to insure that the planning of the highly critical research activities prioritized by the core projects will be preserved and continue to be supported.

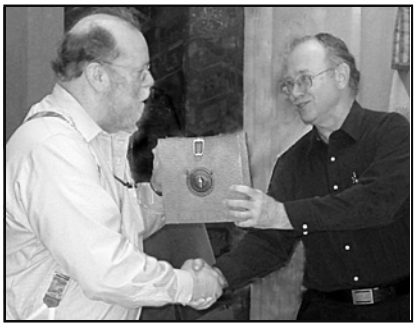
My prediction for the year 2008 is positive and full of hope for the future of the WCRP. We in GEWEX look forward to working with the new WCRP Director, Dr. Ghassem Asrar and the JSC to ensure continuity in addressing critical scientific issues.

NEW GEWEX RADIATION PANEL CHAIR



Christian Kummerow

Professor Christian D. Kummerow, Department of Atmospheric Science, Colorado State University, assumed chairmanship of the GEWEX Radiation Panel (GRP) in January. From 1997–2000, he was the Project Scientist for the Tropical Rainfall Measuring Mission at the National Aeronautics and Space Administration Goddard Space Flight Center. Prof. Kummerow replaces Professor William B. Rossow, City College of New York, who chaired the GRP for the past eight years. Prof. Rossow will continue as chairman of the GRP Working Group on Data and Management and Analysis and the International Satellite Cloud Climatology Project.



Rick Lawford (right) thanks Bill Rossow (left) for his past leadership as GRP Chair. Photo taken at the 2008 GEWEX Scientific Steering Group Meeting.

THIRD GABLS INTERCOMPARISON CASE PLANNED

During the June 2007 GEWEX Atmospheric Boundary Layer Study (GABLS) Workshop (*GEWEX News*, August 2007), a third GABLS Single Column Model (SCM) intercomparison and evaluation case was planned. This case will allow models to interact with the surface instead of a prescribed surface temperature, and will use simple but realistic stable boundary conditions to enable a quantitative evaluation of the models with observations. Data from Cabauw, The Netherlands, will be used in the study, which will focus on the model representation of the decoupling at sunset, the development of the inertial oscillation, and the morning time transition to convective conditions.

If you are interested in participating, contact Fred Bosveld at fred.bosveld@knmi.nl. The deadline for sending in model results is 1 May 2008. Model results sent in before this date will be included in a preliminary intercomparison that will be presented at the American Meteorological Society 18th Symposium on Boundary Layer and Turbulence, 9–13 June 2008 in Stockholm, Sweden. In addition, an intercomparison of Large Eddy Simulation Models and an evaluation with the Cabauw data is currently in preparation. Contact Sukanta Basu (sukanta.basu@ttu.edu) for more information. See *http://www.knmi.nl/samenw/gabls* for details of the case.

ARM/GCSS MODEL COMPARISON PLANNED USING TWP-ICE FIELD CAMPAIGN DATA

The current scientific focus of the GEWEX Cloud System Study (GCSS) Precipitating Cloud Systems Working Group (PCSWG) is to understand the key differences in oceanic and land convection. Building on the recent Tropical Ocean Global Atmosphere-Coupled Ocean Atmosphere Response Experiment (TOGA-COARE) case study, the next PCSWG multi-model comparison will make use of the Tropical Warm Pool International Cloud Experiment (TWP-ICE) field campaign based in Darwin. This comparison will be carried out in collaboration with the Atmospheric Radiation Measurement (ARM) Program Cloud Modelling Working Group. It will also build on the links made with the Stratospheric Processes And their Role in Climate (SPARC) community during the joint GCSS/SPARC/International Global Atmospheric Chemistry Workshop held in May 2006, by considering the impact of convection on the tropical tropopause layer.

In this case study, Cloud Resolving Models (CRMs), Limited Area Models (LAMs) with convection-resolving inner domains, Numerical Weather Prediction (NWP) and climate models, and single column versions of NWP and climate models (SCMs) will be compared with *in situ* and remote-sensing data from aircraft, satellite, and ground-based platforms. Full details of the comparison will be announced on the PCSWG web site at *http://www.convection.info/*. The case leaders are Ann Fridlind (CRMs), Christian Jakob (SCMs) and Maria Russo (LAMs).

BOOKS PUBLISHED WITH GEWEX RESULTS

The Mackenzie GEWEX Study (MAGS) concluded in December 2005 after over a decade of atmospheric and hydrologic research on the Mackenzie River Basin in Canada. Over 100 co-authors contributed to the 2-volume book, **Cold Region Atmospheric and Hydrologic Studies: The Mackenzie GEWEX Experience**, (published by Springer) which provides the scientific accomplishments of the MAGS Project. For more information about MAGS and its data sets see *http://www.usask.ca/geography/MAGS/lo_Data_e.htm*.

Assessment of Climate Change for the Baltic Sea Basin (BACC) published by Springer offers an up-to-date overview of the latest scientific findings in regional climate research on the Baltic Sea Basin, including climate changes in the recent past, climate projections up until 2100 using regional climate models, and an assessment of climate change impacts on terrestrial, freshwater and marine ecosystems. One of the key findings presented in the book is that air temperatures in the Baltic Sea basin could rise up to 5 degrees Celsius between now and 2100. BACC is a project within the Baltic Sea Experiment (BALTEX), a GEWEX Regional Hydroclimate Project.

SEASONAL CO-VARIABILITY OF AEROSOL AND PRECIPITATION OVER THE INDIAN MONSOON AND ADJACENT DESERTS

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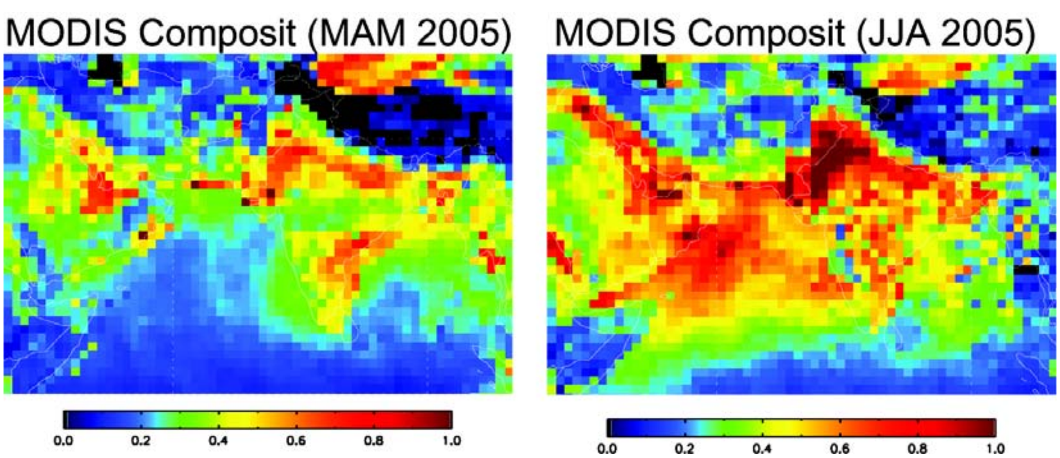
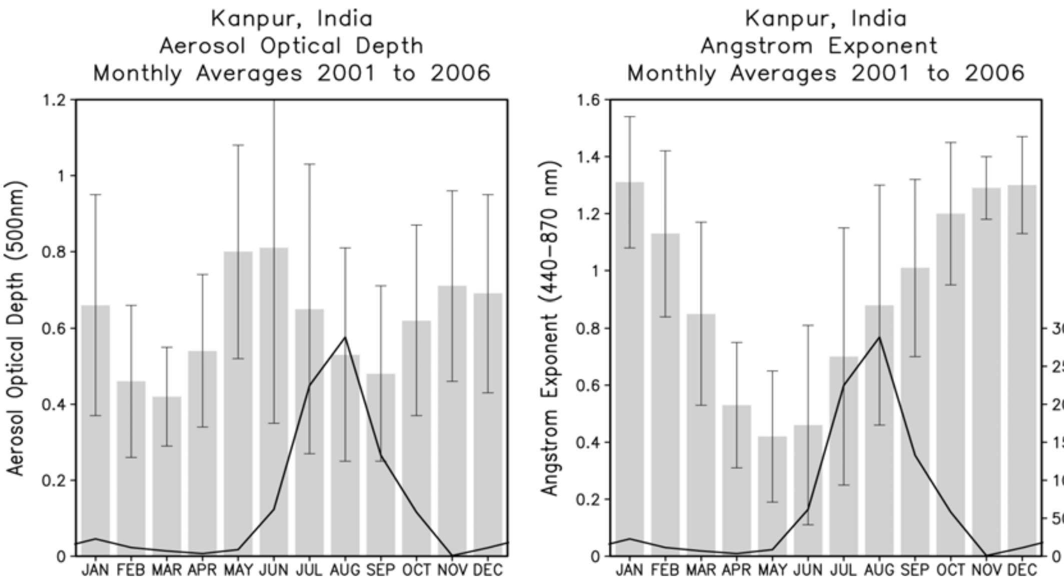
Recent studies have proposed various scenarios in which absorbing aerosols (mainly dust and black carbon) may have an impact on monsoon moisture and rainfall from daily weather to multi-decadal scale climate change (Lau and Kim, 2006; Ramanathan et al. 2005; Prasad and Singh, 2007; Lau et al., 2008). While the climatological variations of aerosol and precipitation are relatively well known within the respective scientific community, the large-scale seasonal variations of aerosol, their sources, and transport, with respect to monsoon rainfall have not been well documented. Because climate anomalies are most commonly defined based on seasonal climatology, knowledge of the co-variability of aerosols and rainfall on seasonal time-scales is important to understand the fundamental physical properties of possible monsoon rainfall and aerosol interactions from both natural and anthropogenic origins. In this article, we show preliminary results using aerosol optical thickness (AOD) from satellite retrieval and the ground-based Aerosol Robotic Network (AERONET, Holben et al., 1998), as well as rainfall from the Global Precipitation Climatology Project (GPCP) to document the seasonal cycles of aerosols and rainfall over the Indian monsoon region.

The figure below shows the spatial distribution of AOD over the Indian monsoon region during March–April–May (MAM) and June–July–August (JJA) based on the latest version (Collection-5) of Moderate Resolution Imaging Spectro-radiometer (MODIS) data, which includes the Deep Blue Algorithm for the retrieval of aerosol over bright land surfaces (Hsu et al., 2004). The large build-up of aerosols during MAM to JJA over the Indo-Gangetic Plain (IGP), northwestern India, Pakistan, the Arabian Sea, and Middle Eastern deserts is quite dramatic, with most of these regions experiencing large aerosol loading (AOD>0.8). Notice in particular the accumulation of aerosols against the slopes of the Himalayas; this is a key element of the so-called "Elevated Heat Pump" hypothesis (Lau et al., 2006), which postulates that such an accumulation of absorbing aerosols during late spring and early summer may spur enhanced heating of the middle and upper troposphere over the Himalayas and the southern Tibetan Plateau. The atmospheric heating produces a rising motion and brings in more moist air from below; this sets off positive feedback involving enhanced deep convection in northern and central India and adds to the low level monsoon flow.

The co-variability of absorbing aerosols and rainfall over the Indian subcontinent can be seen in the climatological (1979–2003) time-latitude section of Total Ozone Mapping Spectrometer–Aerosol Index (TOMS-AI) and in GPCP rainfall (see figure on page 1). TOMS-AI measures the relative strength of aerosols based on absorptivity in the ultra-violet spectrum, and is the only global, long-term, daily satellite data available for the period 1979 to 2004, albeit with a data gap from 1993 to 1996. However, TOMS has now been replaced by the improved Ozone Measuring Instrument (OMI) on Aura. The increase in the atmospheric loading of absorbing aerosols, primarily from dust (with some contribution from black carbon), which precedes the northward movement of the monsoon rain band, is very pronounced during the April–June time period in northern India (>20^{o}N). The reduction of aerosols, due to rain washout during the peak monsoon season (July–August) is also very clear. Unmistakably, both aerosols and rainfall are related to the large-scale circulation that controls a large part of the seasonal variation. Notice that the high aerosol region in northern India during June–July overlaps with the rain area, indicating that aerosol may interact with clouds and rain in this area and that aerosols may not be com-



MODIS total aerosol optical thickness over the region spanning the Middle East, Arabian Sea, the Indian subcontinent, western China, and the Bay of Bengal during March-April-May (MAM) 2005 (left panel) and June-July-August (JJA) 2005 (right panel).



Histograms showing monthly climatology of Aerosol Optical Depth (left panel) and the Angstrom exponent (right panel) over Kanpur, India. Thin line bars denote monthly standard deviation from the climatological mean. Solid curve indicates monthly rainfall accumulation in millimeters.

pletely washed out by monsoon rains, due to the rapid build-up from local emissions and transports from outside the region.

Additional details of aerosol characteristics can be deduced from the monthly distribution of AOD and the Angstrom exponent of aerosol from the single-site AERONET observations at Kanpur, India (26.47ºN, 80.35ºE), located within the IGP. Looking at the figure above, the climatological monthly rainfall over Kanpur is superimposed for comparison. The AOD has a double maximum in the annual cycle (i.e., a strong semi-annual component). The first peak is associated with the build-up of absorbing aerosols during May–June, as observed in the figure on page 1 before the peak of the monsoon rain during July–August. Notice that even during the rainfall peak, though reduced from its maximum peak value (~0.8), the background aerosols are still found to be very high (~0.5–0.6), which indicates that not all aerosols are washed out by the monsoon rain. Heavy rain occurs in small regions for short periods during the monsoon season, while dust aerosols are spatially widespread. Aerosol burden can rapidly increase in just few days or even hours after major monsoon rain events from local emission and dust transport from adjacent desert regions. In addition, when monsoon rainfall diminishes during monsoon breaks, aerosol can continue to build up to high concentrations. The second AOD peak during November–January is likely caused by the build-up of Atmospheric Brown Clouds (ABC) from industrial emissions and biofuel burning, which is favored by stable meteorological conditions associated with subsiding air-mass and a lack of the rainfall that prevails over northern India during the winter monsoon (Ramanathan and Ramana, 2005). Hence, the semi-annual cycle may largely be a reflection of the seasonal variations of the meteorological condition.

The bulk properties of the aerosols can be gleaned from the variations of the Angstrom exponent, a measure of the spectral dependence of the optical thickness that is inversely proportional to the size of the particle. The lower Angstrom exponents found during April–June indicate coarse particles (effective particle radii >1 mm) absorbing aerosols such as dust. The higher values in November–January signals fine aerosols (effective radii <1 mm) from industrial pollution, which is likely to consist of a mixture of absorbing (black carbon) and non-absorbing (sulfate) aerosols. Because of the prevailing subsiding conditions over the IGP during the winter monsoon, it is possible that the fine particles are more confined within the atmospheric boundary layer and below clouds; hence, they are not detected by the TOMS-AI. This may account for the absence of a second peak in the TOMS-AI. More detailed analyses are required to confirm these conjectures. Both the AOD and the Angstrom exponent indicate large interannual variability, as evident in the large monthly standard deviation.

The 5-day air-mass back trajectories during April through June in 2005 show the transport of dust particles to Kanpur from deserts in northwestern India and even further west. In April–May, dust particles originate from the Arabian Peninsula and travel far distances over Saudi Arabia, Iraq and Iran, and across the Arabian Sea to reach Kanpur. In the month of June, the trajectories trace dust sources from Afghanistan, as well as dust transport from the Arabian Peninsula en route to northern India over the Arabian Sea. During the monsoon season, the prevailing low level monsoon westerly flow could enhance transport and bring a large quantity of dust from the Middle Eastern deserts and moisture from the Arabian Sea into northern India. This suggests that the heavy AOD loading over the Arabian Sea during JJA is likely from dust (see figure on page 4). Recent studies also suggest an abundance of sea salt aerosols over the Arabian Sea during the monsoon season (Satheesh and Srinivasan, 2002). Determining the characteristics of aerosols, as well as the processes of aerosol buildup and dissipation in connection with rainfall variations, is crucial in unraveling the possible impacts of aerosols on precipitation over monsoon land regions.

Current results suggest that aerosol and precipitation in monsoon areas and adjacent deserts are closely linked to large-scale circulation, and are intertwined with the complex monsoon diabatic heating and dynamical processes during pre-monsoon and monsoon periods. The deserts provide not only the large-scale radiative forcing on monsoon regions, but also dust particles that are transported into monsoon regions, interfering with the monsoon diabatic heating processes. We will be remiss if we do not mention that aerosols are fundamental as cloud condensation nuclei in the microphysical processes of cloud and precipitation formation. Given these considerations, it is important that future studies take into account the effects of aerosol forcing, particularly dust, as an integral part of the monsoon climate system.

References

Holben, B. N., and coauthors, 1998. AERONET–A federated instrument network and data archive for aerosol caracterization. *Remote Sens. Environ.*, 66, 1–16.

Hsu, N. C., S. C. Tsay, M. D. King, and J. R. Herman, 2004. Aerosol properties over bright-reflecting source regions. *IEEE Trans. Geosci. Remote Sens.*, 42, 557–569.

Lau, K.-M., and K.-M. Kim, 2006. Observational relationships between aerosol and Asian monsoon rainfall and circulation. *Geophys. Res. Lett.*, 33, L21810.

Lau, K.-M., M.-K. Kim, and K.-M. Kim, 2006. Asian summer monsoon anomalies induced by aerosol direct forcing: the role of the Tibetan Plateau. Climate Dynamics, 26(7-8), 855–864.

Lau, K.-M., and coauthors, 2008. The Joint Aerosol-Monsoon Experiment (JAMEX): A new challenge to monsoon climate research. *Bull. Am. Meteorol. Soc*. (in press).

Prasad, A. K., and R. Singh, 2007. Changes in aerosol parameters during major dust storm events (2001–2005) over the Indo-Gangetic Plains using AERONET and MODIS data. *J. Geophys. Res.*, 112.

Ramanathan V., C. Chung, D. Kim, T. Bettge, L. Buja, J. T. Kiehl, W. M. Washington, Q. Fu, D. R. Sikka, and M. Wild, 2005. Atmospheric brown clouds: Impact on South Asian climate and hydrologic cycle. *Proc Natl Acad Sci* 102: 5326–5333.

Ramanathan V., and M. V. Ramana, 2005. Persistent, widespread and strongly absorbing haze over the Himalayan foothills and Indo-Gangetic Plains. *Pure and App. Geophys.* 162, 1609–1626.

Satheesh, S. K., and J. Srinivasan, 2002. Enhanced aerosol loading over Arabian Sea during the pre-monsoon season: Natural or anthropogenic? *Geophys. Res. Lett.*, 20, 1874.

A GODDARD MULTI-SCALE MODELLING SYSTEM WITH UNIFIED PHYSICS

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The foremost challenge in parameterizing convective clouds and cloud systems in large-scale models is the coupled physical processes (e.g., radiation and surface processes) that interact over a wide range of scales, from microphysical to regional (or mesoscale). This makes the comprehension and representation of convective clouds and cloud systems in global circulation models (GCMs) and climate models one of the most complex scientific problems in Earth science. It is generally accepted that properly representing physical cloud processes in GCMs is central to significantly advance water and energy cycle prediction skills.

Cloud-resolving models (CRMs, also called cloud ensemble models, or cloud-system resolving models) are based on the non-hydrostatic equations of motion and have been extensively applied to cloud-scale and mesoscale processes over the past four decades. GEWEX Cloud System Study (GCSS) model comparison projects have indicated that CRMs agree with observations in simulating various types of clouds and cloud systems from different geographic locations. CRMs now provide statistical information useful for developing more realistic, physically-based parameterizations for climate models and numerical weather prediction (NWP) models. Currently, NWP and regional-scale models can be run at grid sizes of a few kilometers or better (similar to CRMs) through nesting techniques.

A CRM, however, is not a global model and can only simulate cloud ensembles over a relatively small domain (i.e., 500–1000 x 500–1000 km^2). To better represent convective clouds and cloud systems in large-scale models, a coupled GCM and CRM [termed a super-parameterization, or, multi-scale modeling framework (MMF)] is required. The use of a GCM enables global coverage, while the CRM allows for better and more sophisticated physical parameterizations (i.e., CRM-based physics). In addition, the MMF can utilize current and future satellite programs that provide precipitation, cloud, aerosol and other data at very fine spatial and temporal scales.

A multi-scale modelling system with unified physics has been developed at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC). The system consists of an MMF, the coupled NASA Goddard finite-volume GCM (fvGCM) and the Goddard Cumulus Ensemble model (GCE, a CRM); the state-of-the-art Weather Research and Forecasting model (WRF) and the stand-alone GCE. These models can share the same microphysical schemes, radiation (including explicitly calculated cloud optical properties), and surface models that have been developed, improved and tested for different environments. The figure on page 8 shows a schematic of the Goddard multi-scale modelling system. More information on the modelling system and its simulated data sets can be found at *http://atmospheres.gsfc.nasa.gov*.

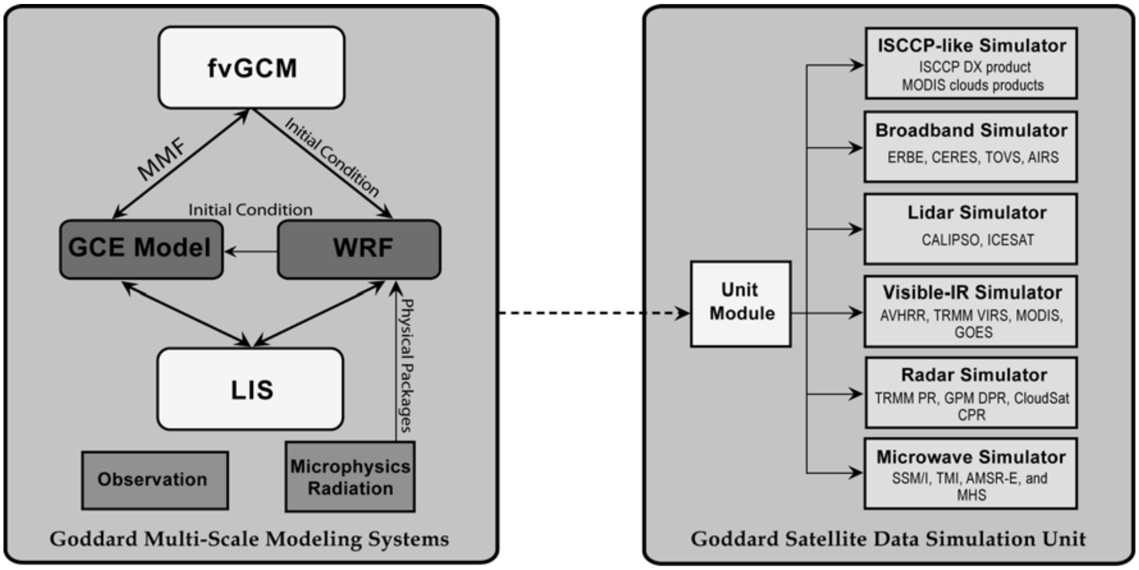
The new Goddard MMF based on the coupled fvGCM-GCE (Tao et al., 2008a) is the second MMF developed worldwide, following Colorado State University (CSU). Despite differences in model dynamics and physics between the Goddard and CSU MMFs, both simulate stronger Madden-Julian Oscillations (MJOs), better cloudiness (high and low), single Inter-Tropical Convergence Zones (ITCZ) and a more realistic diurnal variation of rainfall than traditional GCMs (see figure at the bottom of page 16). The MMF results are based on detailed 2D GCE model-simulated hourly rainfall output. Satellite retrieved-rainfall is based on a 5-satellite constellation, including the TRMM Microwave Imager (TMI), Special Sensor Microwave Imager (SSMI) from the Defense Meteorological Satellite Program (DMSP) F13, F14 and F15, and the Advanced Microwave Scanning Radiometer–Earth Observing System (AMSR-E) onboard the Aqua satellite.

The MMF-simulated diurnal variation of precipitation shows good agreement with merged microwave observations. For example, the MMF-simulated frequency maximum was in the late afternoon (1400–1800 LST) over land and in the early morning (0500–0700 LST) over the oceans. The fvGCM-simulated frequency maximum was too early for both oceans and land. Both MMFs also have similar biases, such as a summer precipitation bias (relative to observations and their parent GCMs) in Asian monsoon regions. However, there are notable differences between the two MMFs; for example, the CSU MMF simulates less rainfall over land than its parent GCM, which is why it simulates less global rainfall than its parent GCM. The Goddard MMF simulates more global rainfall than its parent GCM because of a high contribution from its oceanic component. To fully understand the strengths and weaknesses of the MMF approach in climate modelling, a more detailed comparison between the two MMFs for longer simulations is needed (i.e., 10-year integrations or longer), including simulated cloud properties from their CRM components as well as their improvements and sensitivities.

Various Goddard physical packages (i.e., CRM-based microphysics, radiation and land surface process) have recently been implemented into WRF (Tao et al., 2008b). The CRM-based packages have enabled improved forecasts (or simulations) of convective systems [e.g., a linear convective system in Oklahoma (International H_2O project (IHOP-2002), an Atlantic hurricane (Hurricane Katrina, 2005), high latitude snow events (Canadian CloudSat Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) Validation Project, C3VP 2007), and a heavy orographic-related precipitation event in Taiwan (Summer 2007)]. WRF has also been modified so that it can be initialized with the high-resolution fvGCM. The 3ICE scheme with a cloud-ice-snow-hail configuration agreed better with observations in terms of convective line width and rainfall intensity for both the IHOP and Taiwan events as high density hail particles, which are associated with strong vertical velocities, fall quickly (over 10 m/s). For the Atlantic hurricane case, varying the microphysical schemes had no significant impact on the track forecast but did affect the intensity. For the snow events, the vertical and horizontal cloud species distributions (or radar reflectivity) were the same for the 3ICE and 2ICE schemes due to the weak vertical velocities (less than 0.5 m/s) involved.

The GCE has been developed and improved at Goddard over the last two and a half decades, and more than 100 refereed journal papers have been published on applications of the GCE to improve our understanding of precipitation processes (Tao, 2003). The improved GCE has also been coupled with a NASA TRMM microwave radiative transfer model and precipitation radar model to simulate satellite-observed brightness temperatures at different frequencies (Simpson et al., 1996). The new, coupled GCE allows us to better understand cloud processes in the tropics as well as improve precipitation retrievals from NASA satellites. The GCE was recently enhanced to simulate the impact of atmospheric aerosol concentrations on precipitation processes and the impact of land and ocean surface processes on convective systems in different geographic locations (Tao et al., 2007). Any new physical packages are first tested in the GCE and then implemented into WRF and the MMF, allowing the multi-scale modelling system to have unified physics.

Many recent and future Earth-observing missions can provide measurements of clouds, radiation, precipitation, aerosols, land characteristics and other data at very fine spatial and temporal scales. Since the multi-scale modelling system can explicitly simulate cloud processes at the natural space and time scales of cloud-dynamical processes, cloud statistics—including radiances and radar reflectivities/attenuation—can be directly extracted from CRM-based physics and compared against measurements. This multi-scale modelling system could be a new pathway for using satellite data to improve our knowledge of the physical processes responsible for variations in global and regional climate and hydrological systems.



The Goddard Multi-scale Modelling System with unified physics. The coupling between the coupled NASA Goddard finite-volume GCM (fvGCM) and Goddard Cumulus Ensemble (GCE) model is two-way, while the coupling between the fvGCM and the Weather Research and Forecasting model (WRF), and WRF and the GCE is one-way. The Land Information System (LIS) was developed at the Goddard Hydrological Sciences Branch. LIS has been coupled interactively with both WRF and GCE. Additionally, WRF has been enhanced by the addition of several of the GCE model's physical packages (i.e., a microphysical scheme with four different options and short- and long-wave radiative transfer processes with explicit cloud-radiation interactive processes). The Goddard Satellite Data Simulation Unit can convert the simulated cloud and atmospheric quantities into radiance and backscattering signals consistent with those observed from NASA Earth observing satellites.

A comprehensive unified simulator, the Goddard Satellite Data Simulation Unit (SDSU), has been developed at GSFC. The Goddard SDSU is an end-to-end multi-satellite simulator unit, designed to fully utilize the multi-scale modelling system. It has six simulators at present: a passive microwave simulator, a radar simulator, a visible-infrared spectrum simulator, a lidar simulator, an International Satellite Cloud Climatology Project (ISCCP)-like simulator, and a broadband simulator. All are hardwired with an integrated module that controls input-output and flow processes simulator (see figure above). The SDSU can compute satellite-consistent radiances or backscattering signals from the simulated atmosphere and condensates consistent with the unified microphysics within the multi-scale modelling system. For example, it can generate estimates of retrieved microphysical quantities that can be directly compared with high-resolution CloudSat and future GPM products (see figure at top of page 16). These simulated radiances and backscattering can be directly compared with the satellite observations, establishing a satellite-based framework for evaluating the cloud parameterizations. This method is superior to the traditional method of comparing satellite-based products, since models and satellite products often use different assumptions in their cloud microphysics. Once a cloud model gains satisfactory agreement with the satellite observation, simulated clouds, precipitation, atmosphere states, and satellite-consistent radiances or backscattering will be provided to the science team as an *a priori* database for developing physically based cloud and precipitation retrieval algorithms. Thus, the SDSU coupled with the multi-scale modelling system can utilize and support NASA's ongoing and future Earth Observing System missions, such TRMM, the A-Train Project and the Global Precipitation Measurement (GPM) Mission. The SDSU is being developed at NASA GSFC in collaboration with university institutions, including the Hydrospheric-Atmospheric Research Center (HyARC) at Nagoya University and Colorado State University.

References

Simpson, J., C. Kummerow, W.-K. Tao, and R. Adler, 1996. On the Tropical Rainfall Measuring Mission (TRMM), *Meteor, and Atmos. Phys.* 60, 19–36.

Tao, W.-K., 2003. Goddard Cumulus Ensemble (GCE) model. Application for understanding precipitation processes, *AMS Meteorological Monographs – Cloud Systems, Hurricanes and TRMM*, 107–138.

Tao, W.-K., J. Chern, R. Atlas, D. Randall, X. Lin, M. Khairoutdinov, J.-L. Li, D. E. Waliser, A. Hou, C. Peters-Lidard, W. Lau, and J. Simpson, 2008a. Multi-scale modeling system: Development, applications and critical issues, *Bull. Amer. Meteor. Soc.* (accepted).

Tao, W.-K., J. Shi, S. Chen, S. Lang, S.-Y. Hong, G. Thompson, C. Peters-Lidard, A. Hou, S. Braun, and J. Simpson, 2008b. Studying precipitation processes in WRF with Goddard bulk microphysics. Part I: Comparisons with other schemes, *Mon. Wea. Rev.*, (accepted).

Tao, W.-K., X. Li, A. Khain, T. Matsui, S. Lang, and J. Simpson, 2007. The role of atmospheric aerosol concentration on deep convective precipitation: Cloud-resolving model simulations. *J. Geophy. Res.,* 112.

HIGHLIGHTS OF THE 20TH SESSION OF THE GEWEX SCIENTIFIC STEERING GROUP

Peter van Oevelen and Dawn Erlich
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The 20th Session of the World Climate Research Programme (WCRP) Global Energy and Water Cycle Experiment (GEWEX) Scientific Steering Group (SSG) was held at the Palacio San Martin, Ministry of Foreign Affairs in Buenos Aires, Argentina, 4–8 February 2008. The Ministerio de Relaciones Exteriores, Comercio Internacional y Cult and the Ministerio de Ciencia, Tecnología e Innovación Productiva sponsored the meeting, which was hosted by Prof. Carlos Eduardo Ereño [professor at the University of Buenos Aires and staff scientist for the American and Asian-Australian Monsoon Panels, Climate Variability and Predictability (CLIVAR) Project Office]. Thirty-eight experts from 12 countries attended the meeting, which was opened by Ambassador Maria Ester Bondanza, the Director General of the Environment in the Argentina Ministry of Foreign Affairs.

Several Argentinean presentations were made at the meeting, including an overview of South American scientific issues related to WCRP (Dr. Carolina Vera, CIMA), Argentina Space Agency activities (Dr. Raul Colomb, CONAE), observations for water management (Alvaro Soldano, NWI) and the GEO Latin American Capacity Building Program (Rick Lawford, International GEWEX Project Office).

In addition to the annual review of the GEWEX activities the SSG focused on identifying how GEWEX can most effectively address the new priorities of WCRP, including the two WCRP crosscuts (Monsoons and Extremes) that GEWEX is co-leading with CLIVAR. The Monsoon Crosscut is the most developed and the Asian Monsoon Year is well underway. In this regard, Jim Hurrel (CLIVAR SSG Co-Chair) addressed CLIVAR-GEWEX cooperation and also provided a perspective on how the links could evolve during the coming years. The Extremes Crosscut (the GEWEX component was formerly known as the GEWEX Worldwide Integrated Study of Extremes, WISE) is being developed at the GEWEX Coordinated Energy and Water Cycle Observations Project (CEOP) level but will entrain other groups as well. Both GEWEX and CLIVAR are planning workshops on Extremes this year and representatives from the projects will attend both meetings to begin the scoping process for a joint strategy.

The SSG approved plans by the GEWEX Modelling and Prediction Panel (GMPP) to merge with the Working Group on Numerical Experimentation (WGNE) while keeping the GMPP structure within GEWEX intact. The merger aims at strengthening the parameterization efforts within both WCRP and the World Weather Research Programme. The GEWEX Radiation Panel (GRP) proposal to begin working towards global data products that can be used for climate and trend analysis was accepted. Development of a CEOP Strategic Implementation Plan (SIP) began after the decision to form a new hydroclimate panel by merging the GEWEX Hydrometeorology Panel and the former Coordinated and Enhanced Observation Period. The SIP is near completion and shows how new activities are being developed and existing ones are being streamlined and coordinated. CEOP is also developing a strategy with the Global Water Systems Project (GWSP) to map a common way to address climate variability and its impacts on water.

On behalf of the GEWEX SSG we acknowledge and thank the following agencies for sending representatives to the meeting: European Space Agency, Japanese Aerospace Exploration Agency, National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA). The contribution by agency representatives is regarded as an essential, informative and necessary part of the discussions on current and future GEWEX activities.

In addition, we thank the following organizations for their financial support to the meeting: WCRP, US Department of Energy, NOAA, NASA, and the CLIVAR Project Office. We also wish to express our appreciation for the assistance from WCRP's Joint Planning Staff, and in particular Vladimir Ryabinin for securing WCRP travel funding and making it available in as timely a manner as possible.

Participants at the GEWEX SSG Meeting.

WORKING GROUP ON DATA MANAGEMENT AND ANALYSIS MEETING

5–7 September 2007
The City College of New York, NY, USA

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

In addition to the annual review of projects, the GEWEX Radiation Panel's Working Group on Data Management and Analysis (WDGMA) met to assess the progress and plans for a coordinated reprocessing of all data products. W. Rossow began the review of projects, reporting that the International Satellite Cloud Climatology Project (ISCCP) radiance and ancillary data sets through December 2006 (23.5 years) and cloud products through June 2006 (23 years) have been delivered. The ISCCP data record shows a partial recovery of global mean cloud cover to 66.5 percent, from its minimum of 64.5 percent in 1999–2000 with a maximum of 69 percent occurring in 1986–1987, and a small increase (0.2) in global mean cloud optical thickness over the last 6 years.

M. Mishchenko reported that the Global Aerosol Climatology Project (GACP) climatology of monthly mean aerosol optical depth (AOD) and Angstrom coefficient (size index) over global oceans has been produced for the period of August 1981–June 2005. The record shows two major volcanic events (El Chichon and Mt. Pinatubo). In the longer record there appears to be a gradual decline of total AOD since 1995. The Stratospheric Aerosols and Gas Experiment (SAGE) indicates that the stratospheric AOD is less than 0.01 during this time period. This change is interpreted to be a nearly 30 percent decrease in tropospheric aerosols over the last decade.

C. Clayson (SeaFlux Project), a new member to the WGDMA, reported that a detailed comparison of available global surface turbulent flux products for 1999 has been completed. Comparisons are being made with numerical weather prediction (NWP) reanalysis products and moored array results from other years. The global comparisons show a spread of the flux products of about 30 Wm^{-2} for latent heat flux and 20–40 Wm^{-2} for sensible heat flux in the tropics and at high latitudes (the ranges are larger if the reanalyses are included). To obtain the surface fluxes at the desired time resolution, a new skin-sea surface temperature (SST) product is needed. The first version of an experimental product has been completed and production of a new global product is planned for mid-2008.

R. Adler reported that the monthly and pentad Global Precipitation Climatology Project (GPCP) products now cover the period of February 1979 through June 2007, with the daily product covering the last 10 years. Analysis of the long-term variations of tropical precipitation, taking account of the signals associated with volcanic and El Niño Southern Oscillation (ENSO) events, shows a small increase of about 3 percent over almost 30 years. This systematic variation appears to be limited to lower latitudes. There is also some evidence of partial offsetting changes over land. Work continues in developing a Version 3 analysis to reduce bias errors in mountainous areas; to update the microwave algorithm over ocean for finer time resolution; to include more recent instruments in the merged product; and to eliminate the "boundary" in the gauge analysis by using a more homogeneous sample population. In addition, changes are being investigated to add rain/snow discrimination and increase the space-time resolution over the whole record.

P. Stackhouse reported that Surface Radiation Budget (SRB) Project data processing for July 1983–June 2005 is complete. A number of changes were introduced to the product over the last year and significant effort was devoted to evaluation studies as part of the Radiation Assessment. The comparison to the Global Energy Balance Archive (GEBA) shortwave fluxes showed a bias of less than 1 Wm^{-2} (well within the uncertainty of GEBA data) and RMS differences of monthly mean values of 23 Wm^{-2}. The bias with Baseline Surface Radiation Network (BSRN) site measurements is somewhat larger (8 Wm^{-2}) but still within uncertainty; longwave bias is about 2 Wm^{-2}. RMS differences of monthly mean values are 15–25 Wm^{-2} (shortwave) and 12–17 Wm^{-2} (longwave). Similar agreement is found with the shorter Center for Environmental Remote Sensing record. Funding to continue production has been approved.

The status of the product assessment activities was reported as follows. The Precipitation Assessment has completed its report, with outside and GRP reviews, and is in the process of being published. The Radiation Assessment completed its workshops and is now writing its report. The Cloud Assessment has compiled results from the first two workshops and will hold the last workshop in 2008.

R. Ferraro summarized activities at the Microwave-Land Center, highlighting the implementation of an Advanced Microwave Sounding Unit (AMSU)-based precipitation algorithm as well as studies of enhancements to the Goddard Profiling Algorithm (GPROF) for cold season precipitation. L. Chiu summarized activities at the Microwave-Ocean Center, highlighting production of a new version of the product with updated Special Sensor Microwave Imager (SSM/I) calibrations. J. Janowiak summarized activities at the Geosynchronous Center, including an investigation of the use of the ISCCP B1 (10 km spatially sampled radiances) in the IR-precipitation algorithm, which would reduce inhomogeneities in the GPCP product. U. Schneider summarized activities at the Gauge Center of the Global Precipitation Climatology Centre (GPCC), noting changes to the products to introduce a weather-dependent gauge correction (instead of using climatology) and discrimination of the precipitation amounts into three types (liquid, ice, and mixed). G. Huffman summarized activities at the Merge Center, including successful implementation of the high latitude portion of the merged product using Atmospheric Infrared Sounder (AIRS) instead of High Resolution Infrared Radiation Sounder (HIRS).

Summaries of ongoing studies to improve passive microwave algorithms were also presented. C. Kummerow presented an update of ongoing development and evaluation of the GPROF algorithm used for the Tropical Rainfall Measuring Mission (TRMM). The main upgrade is to replace the cloud-resolving, model-generated *a priori* database with one based on TRMM precipitation radar (PR) and the TRMM Microwave Imager (TMI) measurements. Also being developed are parametric algorithms (no tuning) that can work over land and sea ice if accurate surface emissivity models exist. R. Ferraro reported on studies to improve a microwave-based snowfall algorithm and to develop regime-classification approaches for microwave precipitation algorithms that include snowfall cases. L. Chiu proposed continuing the simple emission-based microwave precipitation product as a heritage baseline for newer products but calibrating to TRMM starting in the year 1998.

Several high resolution precipitation products have been developed and are now being evaluated. P. Arkin described a systematic evaluation of these new products [the Program for Evaluation of High Resolution Precipitation Products (PEHRPP)] proposed by the International Precipitation Working Group (IPWG). G. Huffman described the TRMM Multi-satellite Precipitation Analysis (TMPA) developed at NASA Goddard Space Flight Center (GSFC) (25 km, 3 hr); K. Hsu described the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN) product developed at the University of California, Irvine (25 km, 1 hr); J. Janowiak described improvements made to AMSU-based retrievals over land and ocean, as well as ongoing work to incorporate METOP-A data into the CPC MORPHing technique (CMORPH) product (25 km, 1 hr); and T. Smith described another effort to merge the maximum amount of microwave-based precipitation estimates, including SSM/I, AMSR-E, AMSU and TMI.

The reports of the Satellite Processing Centers began with K. Knapp describing how NOAA National Climatic Data Center (NCDC) processes polar orbiting data. The launch of NOAA-N to replace NOAA-18 is planned for 2009 and the replacement of METOP-2 is planned for 2011. W. Rossow reported on behalf of the Japanese Meteorological Agency representative, A. Okuyama, that data collection from MTSAT-1R, with MTSAT-2 as backup, has been routine. GMS-1 radiance data from December 1978 through November 1979 were discovered at the University of Wisconsin and provided to JMA by NOAA. These data will be processed for ISCCP and GPCP. K. Holmlund, European Organization for the Exploitation of Meteorological Satellites reported that METOP-2 entered full operational service in October 2007. METEOSAT-9 and METEOSAT-7 (over the Indian sector) are providing data to ISCCP. Y. Liu, China Meteorological Organization reported that processing FY-2C data for ISCCP has been routine since the summer of 2005. Deliveries of B1/B2 radiance data from FY-2C are now up to date.

K. Knapp reported that all functions of the ISCCP Central Archives are now more fully automated. Older, pre-ISCCP data sets have been recovered from SMS-1, 2, GOES-1, 2, 3 and 4, and GMS-1; recovery of METEOSAT-1 is being investigated. The B1 collection now contains data from 29 geostationary satellites and 14 polar orbiters. Work also continues to provide online access to the complete set of GEWEX global data products using a Thematic Real-time Environmental Distributed Data Services (THREDDS) server approach. A calibration comparison between Advanced Very High Resolution Radiometer (AVHRR) and HIRS has been completed. One of the first uses of the recalibrated, refurbished B1 IR radiances was to redo the hurricane intensity climatology. A common format for all B1 data is being investigated.

In W. Rossow's report on activities at the Global Processing Center he noted that algorithm evaluation and revision studies have focused on the polar regions, exploiting the detailed datasets available from the Surface Heat Budget of the Arctic (SHEBA) experiment. The availability of Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) data now makes it possible to refine the algorithm changes both over the whole Arctic and over the Antarctic where conditions may differ from the SHEBA case. Development continues on more specialized cloud products to facilitate research on specific cloud types, including a subset of tropical convective clouds with cloud tops that penetrate into the stratosphere, pattern-analyses of cloud top pressure, and optical thickness histograms reported in the D1 data set for the whole tropics ($\pm15^{\circ}$ latitude) for an extended low-latitude zone ($\pm35^{\circ}$) encompassing the Hadley circulation regime and northern and southern midlatitudes (30–65°). Planned revisions of the ISCCP processing for the next reprocessing include refined radiative retrievals to account better for surface and aerosol effects, as well as the treatment of ice clouds. Switching the analysis from the 30-km sampled B3 radiance data to the 10-km sampled B1 radiance data makes a redesign of the products possible.

In the final plenary session to consider common issues, the GPCP group recommended continuation of the heritage products even if newer (i.e., higher resolution, modern-instrument-anchored) versions are produced.

These can be used for calibration purposes and may be ended after more experience is gained with the new products. The tentative suite of GPCP products would be: (a) 3-hr, 25-km starting in 1998 (possibly limited to ±50 latitude); (b) global, daily, 50-km starting in 1983 using ISCCP B1 IR radiances; (c) global, pentad, 50-km starting in 1979; and (d) global, monthly, 50-km starting in 1979. A test year (probably 2004) will be processed using all available algorithms. The gauge data set that will be used is the GPCC V4 Full Reanalysis. A snow/rain discrimination will be added based on near-surface air temperatures, but snow algorithms are still being studied. The results in mountainous regions should be improved by the new gauge analysis; however, no global adjustment scheme is available. For periods when no geostationary satellite IR radiances are available over the Indian Ocean, AVHRR data will be used to fill in the gaps.

The new B1-based ISCCP products will handle the availability of more satellite data than the minimum required for global coverage by releasing the so-called DS data set—this is gridded data like D1 but separate by satellite—in addition to the DX product. When the switch to B1 radiances is made, the production of B2/B3 will cease. The new design for D1/D2 based on the B1 data can allow for reporting results at a finer resolution; during the coming year, the structure of the 2-dimensional histograms of cloud top pressure and optical thickness as a function of spatial scale will be investigated. A possible idea would be to report the histograms and cloud type information on the current 2.5°-equivalent equal-area grid (heritage product) but report the area-mean cloud properties on a finer grid (0.5°). Note that the precision of the cloud amount values depends on the number of satellite pixels used to determine it; thus, using too fine a grid can degrade the results. With the switch to B1U, ISCCP reprocessing will begin in early 2009.

The common atmospheric temperature-humidity product could be one of three: (1) SRB proposed the new National Aeronautics and Space Administration reanalysis Modern Era Retrospective-analysis for Research and Applications (MERRA); (2) SeaFlux is developing its own near-surface temperature-humidity data sets over oceans that might be merged with a global product, and (3) NOAA is developing a new HIRS-based analysis. All projects will continue to produce a suite of products that best serve their purposes but will also produce one product designed to have a common space-time sampling interval, common grid and definition of day. The target will be 3-hr, 1° but common daily, monthly products will also be considered. Higher resolution products, if possible, will also be produced. Moreover, common radiances (visible, infrared, microwave) will use the same calibrations. The plan is to commence reprocessing of all products in 2009.

EFFECTS OF REGIONAL SOIL MOISTURE ANOMALIES ON PBL MOISTURE AND PRECIPITATION OVER THE CENTRAL UNITED STATES

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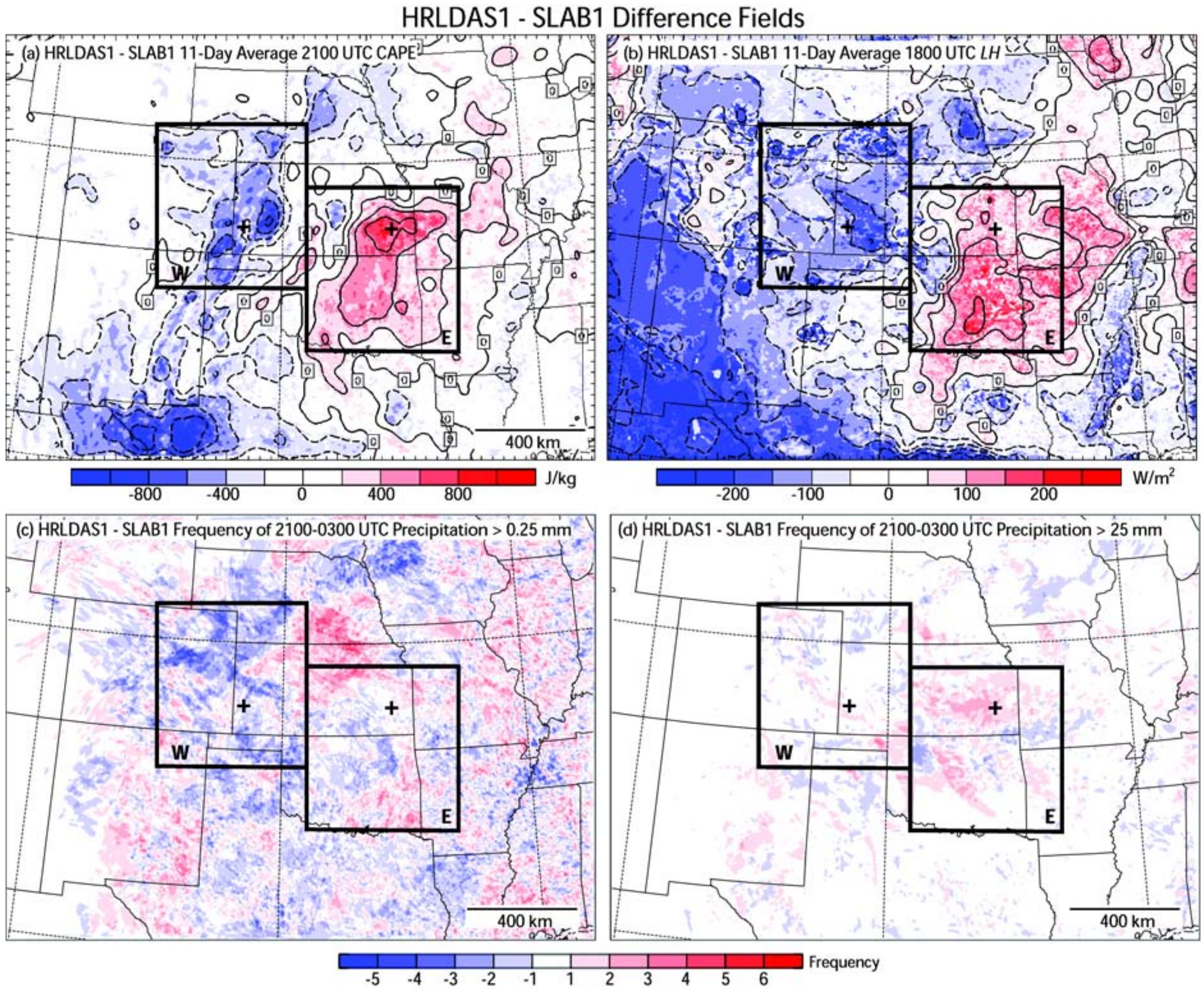
Soil moisture can influence continental precipitation over a broad spectrum of temporal and spatial scales ranging from localized differences in convection initiation to persistent (e.g., seasonal or greater) regional precipitation anomalies. Koster et al. (2004) noted that sensitive areas for soil-induced seasonal precipitation anomalies are typically transition regions between wet and dry climates, where evaporation rates—and thus precipitation—may be strongly influenced by soil wetness or moisture availability (the degree of saturation in the soil).

Previous studies of the role of soil moisture on deep convection initiation have used either idealized one-dimensional models (e.g., Findell and Eltahir, 2003) or high-resolution three-dimensional models over small domains (e.g., Trier et al., 2004), which precludes the examination of multiple convection lifecycles. In contrast, regional climate models are able to simulate many lifecycles of convection but are exposed to uncertainty in the linkages among land-surface effects, the planetary boundary layer (PBL), and precipitation that arise from the necessary use of cumulus parameterizations. The current study attempts to partially bridge this gap in scales by using a convection-permitting atmospheric model coupled with different land surface models (LSMs) to examine the 12-day atmospheric response to a significant regional soil moisture anomaly. Emphasis is placed on the ways in which soil moisture influences precipitation through its effects on the thermodynamics of the PBL. The 4-km horizontal grid spacing we use in this study, while insufficient to properly represent individual convective storms, is sufficient to resolve the mesoscale characteristics of the convection and its precipitation without the use of a cumulus parameterization.

The 9–21 June 2002 time period that we studied occurred during the International H_2O Experiment (IHOP_2002) (Weckwerth et al., 2004) and encompassed multiple lifecycles of mesoscale organized convection. This period also coincided with a large dry soil anomaly that extended from the Rocky Mountain Region into the adjacent high plains, with wetter than normal soil conditions over parts of the Midwest and southern plains. Koster et al. (2004) indentified parts of this area over the central United States Great Plains as one of several zones on Earth where particularly strong soil moisture/precipitation feedbacks can occur. A set of four simulations using the coupled Weather Research and Forecast (WRF) (Skamarock et al., 2005) model were designed to examine the effects of using different LSMs and initial soil conditions on the PBL



HRLDAS1–SLAB1 12-day mean (day one omitted) difference fields. (a) 2100 UTC CAPE differences with contour intervals of 200 J kg^{-1}, (b) 1800 UTC surface latent heat flux differences with contour intervals of 50 W m^{-1}, (c) frequency difference of 2100-0300 UTC precipitation totals exceeding 0.25 mm, and (d) frequency difference of 2100-0300 UTC precipitation totals exceeding 25 mm.

structure and precipitation. Results from these simulations are reported in Trier et al. (2008). The control simulation (HRLDAS1) uses a high-resolution date-specific initial land-state condition obtained offline with the NCAR High Resolution Land Data Assimilation System (HRLDAS; Chen et al., 2007) and employs the Noah LSM (Ek et al., 2003). An additional simulation (SLAB1) uses the less sophisticated SLAB LSM and a climatologically based (time invariant) soil wetness condition.

The more sophisticated LSM with date-specific initial land-state conditions in HRLDAS1 has a pronounced influence on mean mid-afternoon PBL thermodynamic conditions and subsequent evening precipitation for the 12-day period (see figure above). The mean 2100 Coordinated Universal Time (UTC) (mid-afternoon) HRLDAS1–SLAB1 Convective Available Potential Energy (CAPE) difference field comprises a regional-scale dipole (a) that is closely related to PBL water vapor mixing ratio differences (Trier et al. 2008), which are in turn related to differences in surface latent heat fluxes (b). Differences in the 12-day mean daytime vertical circulation, arising from differences in horizontal gradients of soil wetness, may also play a role in the HRLDAS1–SLAB1 CAPE differences by influencing the static stability at the top of the PBL, which affects the depth of vertical mixing (Trier et al. 2008).

The HRLDAS1–SLAB1 precipitation frequency difference fields for various 2100–0300 UTC (mid-afternoon to mid-evening) precipitation amount thresholds (c, d) exhibit less spatial coherence than the mean CAPE (a) difference fields at the start of the 6-h period. However, for overall precipitation frequencies (i.e., 6-h totals >0.25 mm or ~0.01 in) coherent mesoscale regions with large differences exist in addition to more random, smaller-scale differences (c). Moreover, several of these regions are spatially correlated with the preceding CAPE differences (a), as one might expect when local thermodynamics influence precipitation. One such region comprises the northern part of the western subdomain indicated in (c). In precipitation generation regions such as this western subdomain where

CAPE is generally small, small-to-moderate CAPE differences may exert important local influences on whether precipitation becomes widespread.

A more complex relationship between the afternoon PBL thermodynamics and subsequent evening precipitation occurs over the eastern subdomain in the figure on page 13. Here, the greater mean afternoon CAPE in HRLDAS1 (a) is not associated with greater subsequent overall precipitation frequencies (c). One possible explanation is that a significant fraction of the precipitation in this region is associated with mature, propagating convection (Carbone et al., 2002), which can be strongly influenced by factors controlling its earlier development in remote locations. However, despite a lesser overall frequency of late afternoon and evening precipitation events in the eastern subdomain in HRLDAS1 than in SLAB1 (c), a greater number of heavy precipitation events occur (i.e., 6-h totals >25 mm or ~1 in) (d). While this latter frequency difference is only due to one to two additional events during the 12-day period, it is significant because the majority of the precipitation during the 12-day simulation results from only a few such large events. Fewer overall events that include more heavy events in the eastern subdomain of HRLDAS1 rather than SLAB1 is consistent with stronger daytime subsidence (Trier et al., 2008), but larger CAPE (a). Here, the greater subsidence inhibits convection initiation while the greater CAPE favors heavier rain when the conditional instability is released.

There are several factors that could contribute to the foregoing differences in the atmospheric response over the 12-day period between the HRLDAS1 and SLAB1 simulations, including (1) differences in the initial land-surface condition, (2) differences in the capability for feedbacks from atmospheric inputs (including radiation and precipitation) to influence land-surface conditions during the simulation, and (3) differences in the representation of physical processes within the different LSMs that calculate the surface fluxes. The influence of these different factors is illustrated in Trier et al. (2008) using two different sensitivity experiments. There it is concluded that both the differences in the initial land-surface condition and LSM differences play significant roles in the diurnal cycle of the near-surface potential temperature and water vapor mixing ratio. However, of the two, the initial soil wetness is clearly the most critical to PBL thermodynamics during the late morning through midafternoon, which has important implications in the generation of PBL-based deep convection that follows this period of strong surface heating. The influence of feedbacks to the land surface from atmospheric inputs on mean thermodynamic variables and precipitation over the 12-day period is negligibly small, except over highly localized regions (Trier et al., 2008). Here, the 12-day length of the simulations is likely too short for the initial land-state condition to be "forgotten" and significant coupling/feedback effects to occur. It remains a topic for future research to determine what governs the timescale over which such effects become important.

Acknowledgments

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References:

Carbone, R. E., J. D. Tuttle, D. A. Ahijevych, and S. B. Trier, 2002. Inferences of predictability associated with warm season precipitation episodes. *J. Atmos. Sci.*, 59, 2033–2056.

Chen, F., and co-authors, 2007. Evaluation of the characteristics of the NCAR High-Resolution Land Data Assimilation System during IHOP_2002. *J. Appl. Meteor. Clim.*, 46, 694–713.

Ek, M. B., and co-authors, 2003. Implementation of Noah land-surface model advances in the NCEP operational Eta model. *J. Geophys. Res.*, 108 (D22).

Findell, K. L., and E. A. B. Eltahir, 2003. Atmospheric controls on soil moisture-boundary layer interactions. Part I: Framework development. *J. Hydrometeor.*, 4, 552–569.

Koster, R. D., and co-authors, 2004. Regions of strong coupling between soil moisture and precipitation. *Science*, 305, 1138–1140.

Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M. Barker, W. Wang, and J. G. Powers, 2005: A description of the Advanced Research WRF version 2. NCAR Tech. Note TN-468+STR, 88 pp. [Available from NCAR, P. O. Box 3000, Boulder, CO 80307.]

Trier, S. B., F. Chen, and K. W. Manning, 2004. A study of convection initiation in a mesoscale model using high-resolution land surface initial conditions. *Mon. Wea. Rev.*, 132, 2954–2976.

Trier, S. B., F. Chen, K. W. Manning, M. A. LeMone, and C. A. Davis, 2008. Sensitivity of the PBL and precipitation in 12-day simulations of warm season convection using different land surface models and soil wetness conditions. *Mon. Wea. Rev.*, (in press).

Weckwerth, T. M., and co-authors, 2004. An overview of the International H_2O Project (IHOP_2002) and some preliminary highlights. *Bull. Amer. Meteor. Soc.*, 85, 253–277.

CEOP PLANNING MEETING
Bali, Indonesia
6–9 September 2007

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International GEWEX Project Office

A total of 88 scientists from 24 countries attended the second implementation planning meeting of the newly formed GEWEX Hydroclimate Panel, the Coordinated Energy and Water-Cycle Observations Project (CEOP) co-chaired by Drs. Toshio Koike, University of Tokyo and John Roads, University of California, San Diego. The meeting was held in conjunction with the second Asian Monsoon Year (AMY 08) and the International Monsoon Study Workshops, which were held at the same location from 3–5 September 2007. These meetings were hosted by the Agency for the Assessment and Application of Technology of Indonesia.

CEOP represents the merger of the former GEWEX Hydrometerology Panel and the Coordinated Enhanced Observing Period Project. The meeting focused on the development of a CEOP Strategic Implementation Plan (SIP) and included discussions on contributions to the GEWEX Roadmap, WCRP crosscutting research projects including the Water and Energy Budget Study, Extremes, Aerosols and the Isotope Cross-Cut Studies, as well as regional crosscutting studies (Cold Region Study, High Elevation Study, Monsoons Studies and Semi-arid Region Study).

To assist the CEOP co-chairs in their efforts to encourage support for CEOP Implementation activities and to ensure that the CEOP strategy is consistent with international scientific priorities it was agreed that a CEOP International Strategic Advisory Group (SAG) should be formed. The participants were asked to nominate members for this group and draft a Terms of Reference.

Two new topic areas were highlighted for additional focus within CEOP. One was related to the connections between CEOP and the Group on Earth Observations (GEO) and how CEOP can best homogenize its contributions to the GEO Global Earth Observation System of Systems. In addition, CEOP interactions with the International Association of Hydrological Sciences (IAHS) were discussed.

Participants from Numerical Weather Prediction (NWP) Centers agreed to draft contributions for the CEOP SIP that reflect work at their Centers and other issues related to model studies in CEOP. It was noted that "reforecasts" are an important model product that should be archived by CEOP.

The latest version of the SIP is available at *http://www.eol.ucar.edu/projects/ceop/dm/new/*. The next CEOP Implementation Planning meeting will take place 15–17 September 2008 in Geneva, Switzerland.

GEWEX/WCRP MEETINGS CALENDAR

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

31 March–4 April 2008—29TH SESSION OF THE WCRP JOINT SCIENTIFIC COMMITTEE, Arcachon, France.

13–18 April 2008—EUROPEAN GEOPHYSICAL UNION GENERAL ASSEMBLY, Vienna, Austria.

23–25 April 2008—ASIAN MONSOON YEAR (AMY08) INTERNATIONAL WORKSHOP, Beijing, China.

21–23 May 2008—GEWEX/CEOP EXTREMES WORKSHOP, Vancouver, Canada.

26–30 May 2008—AMMA/ENSEMBLE WORKSHOP ON SEASONAL FORECASTING IN WEST AFRICA, Niamey, Niger.

2–6 June 2008—4TH PAN-GCSS MEETING: ADVANCES ON MODELLING AND OBSERVING CLOUDS AND CONVECTION, MeteoFrance, Toulouse, France.

25–27 June 2008—LOCO/WATCH WORKSHOP, De Bilt, The Netherlands.

7–11 July 2008—10TH SCIENCE AND REVIEW WORKSHOP FOR THE BASELINE SURFACE RADIATION NETWORK, De Bilt, The Netherlands.

9–13 July 2008—15TH INTERNATIONAL CONFERENCE ON CLOUDS AND PRECIPITATION (ICCP2008), Cancun, Mexico.

23–25 July 2008—ISCCP 25TH ANNIVERSARY SYMPOSIUM, NASA GISS, New York, NY, USA.

22–24 September 2008—5TH GRP WORKING GROUP ON DATA MANAGEMENT AND ANALYSIS MEETING, Hong Kong, China.

22–24 September 2008—12TH SESSION OF THE WORKING GROUP ON COUPLED MODELLING, Paris, France.

29 September–2 October 2008—3RD SESSION OF THE WCRP OBSERVATION AND ASSIMILATION PANEL (WOAP), Boulder, Colorado, USA.

14–19 Octber 2008—GEWEX Radiation Panel Meeting, South Korea.

GEWEX NEWS

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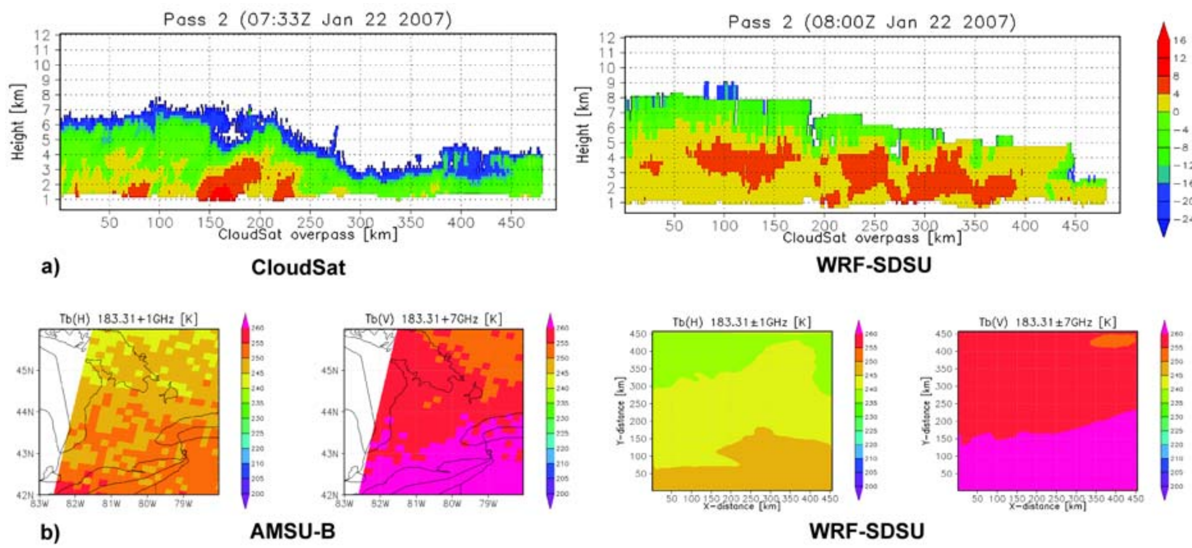
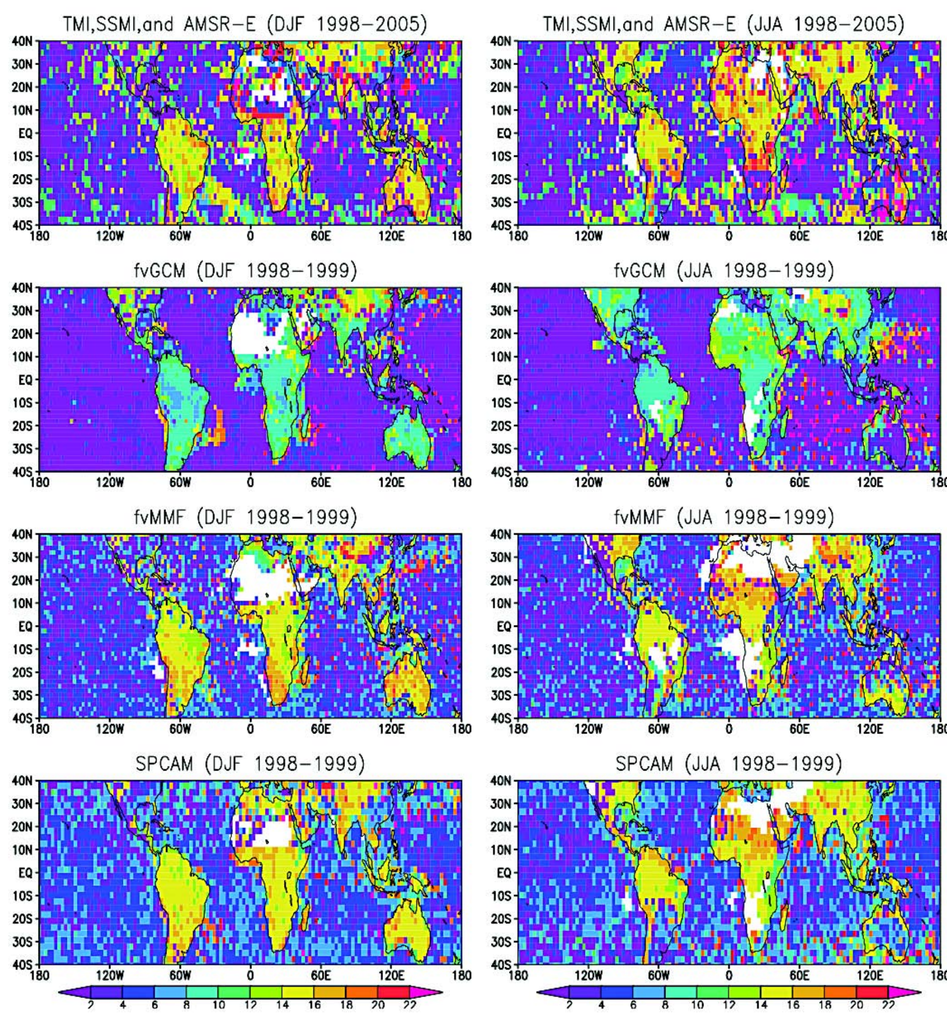
NEW GODDARD MULTI-SCALE MODELLING SYSTEM CAN PROVIDE CLOUD/RADIATION OUTPUT FOR DIRECT SATELLITE DATA COMPARISON



Direct satellite and model comparison over the future Global Precipitation Mission (GPM) ground validation domain shows how the Goddard Satellite Data Simulation Unit (SDSU) can generate estimates of retrieved microphysical quantities that can be directly compared with high-resolution CloudSat and future GPM products establishing a satellite-based framework for evaluating cloud parameterizations. a) CloudSat observed CPR (94.15 GHz) radar reflectivity (left) and WRF-SDSD-simulated 94.15 GHz (right). b) AMSU-B observed brightness temperature at 183.311 GHz and 183.317 GHz (left) with corresponding brightness temperatures simulated from the WRF-SDSU (right). ***See article by W.-K. Tao et al. on page 7.***

MULTI-SCALE MODELLING FRAMEWORK SIMULATES STRONGER MADDEN-JULIAN OSCILLATIONS, CLOUDINESS, SINGLE ITCZ AND MORE REALISTIC DIURNAL RAINFALL VARIATION THAN GCMS



Geographical distribution of local solar time (LST) for the non-drizzle precipitation frequency maximum in winter (left panels) and summer (right panels) as observed by satellite from 1998–2005 (upper panels) and as simulated for 2 years (1998–1999) with the Goddard finite-volume Globel Circulation Model (fvGCM) (middle-upper panels), the Goddard MMF (middle-lower panels) and the CSU Multi-Scale Modelling Framework (MMF) (bottom panels). Blank regions indicate no precipitation. ***See article by W.-K Tao et al. on page 7.***