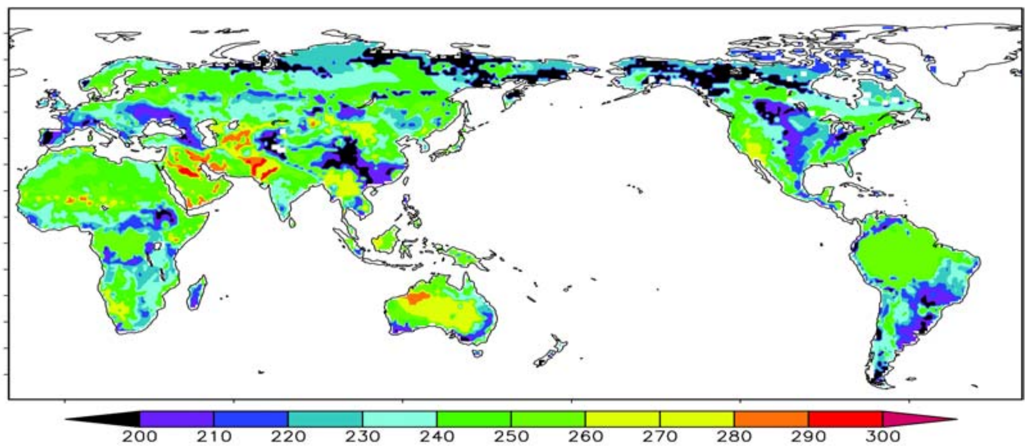
World Climate Research Programme
(A Programme of WMO, ICSU and IOC)

NEWS

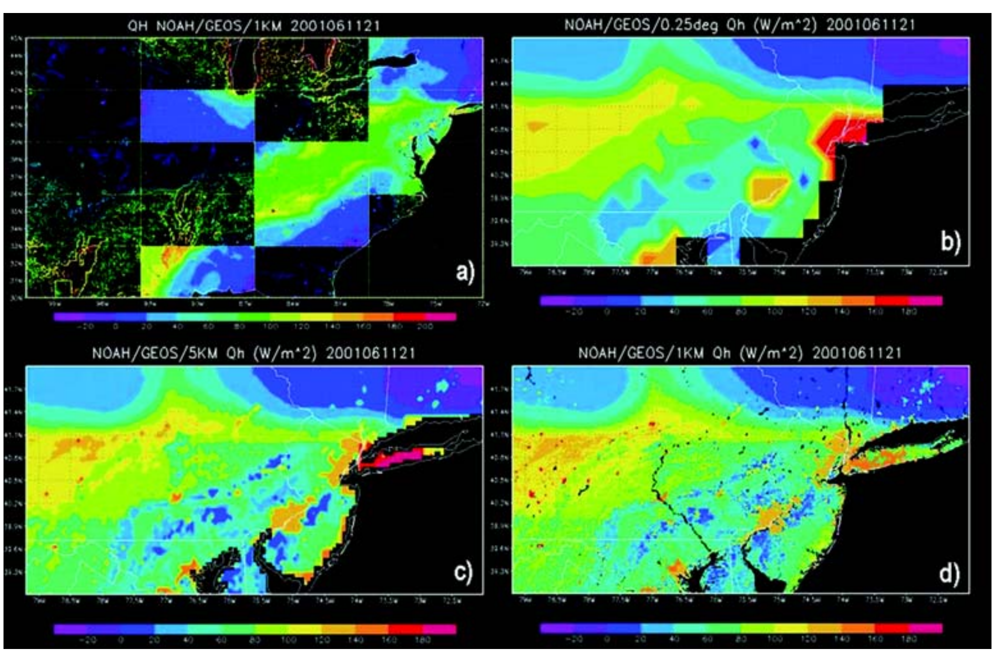
Vol. 14, No. 3 | Global Energy and Water Cycle Experiment | August 2004

GSWP-2 FACILITATES USE OF SATELLITE DATA IN MODEL VALIDATION BY PRODUCING BRIGHTNESS TEMPERATURE MAPS



Second Global Soil Wetness Project (GSWP-2) couples land surface models with a mircrowave emissions model to provide a global 1-degree map of the synthetic L-band H-polarized brightness temperature corresponding to the incidence angle and equator crossing time of the HYDROS Satellite for 1 June 1992. *See article on page 10.*

NEW 1-KM RESOLUTION MAPPING OF SURFACE FLUXES HELPS TO DRIVE CLOUD RESOLVING MODELS



The new Land Information System (LIS) Project is now providing 1-km surface fluxes. Sample latent heat flux snapshot from LIS/Noah simulation for 11 June 2001. (a) 5-km simulation (contours) overlaid by a 1-km simulation (shaded). (b) ¼-degree simulation. (c) 5-km simulation. (d) Full 1-km simulation. *See article on page 8.*

What's New

- **CALL FOR PAPERS: 5th International Scientific Conference on the Global Energy and Water Cycle (www.gewex.org/5thconf.htm)**
- **Workshop on Trends in Global Water Cycle Variables organized to support IPCC Assessment (http://www.gewex.org/trendswkshp.htm)**

COMMENTARY

EARTH OBSERVATIONS: A RENEWED OPPORTUNITY AREA FOR GEWEX?

Rick Lawford, Director
International GEWEX Project Office

Given the recent reorganization in a number of space agencies, the above title may seem poorly timed. However, that is not necessarily the case. Space agencies are maintaining strong commitments to missions such as Cloudsat, the National Polar-Orbiting Operational Environmental Satellite System (NPOESS), the Soil Moisture and Ocean Salinity Mission (SMOS), the Hydrosphere State Mission (HYDROS) and the Global Precipitation Mission (GPM) that will open new scientific frontiers for GEWEX researchers. In addition, activities related to the high level satellite committee of the World Meteorological Organization (WMO), the Integrated Observing Strategy (IGOS) and the Global Earth Observing System of Systems (GEOSS) have resulted in new opportunities to influence the direction of future Earth observing activities. Although some may question the benefits of these planning exercises, it is important for GEWEX and the World Climate Research Programme (WCRP) to continue to position themselves through these activities. Possible benefits to GEWEX and the WCRP could include strengthened support for our research programs, greater stability for data streams upon which we rely, and a greater recognition for water and energy cycle issues in the priorities of the agencies that fund our projects.

Within the IGOS Partnership (IGOS-P), space agencies and international programs consider the full range of satellite and *in situ* observing systems that provide environmental data. Through the development of themes, IGOS-P is creating new opportunities for dialogue between the research and applications communities. For example, within the IGOS Global Water Cycle Observations (IGWCO) theme, recommendations about supportive missions can be brought to senior managers in space agencies through the Committee on Earth Observing Satellites-Strategic Implementation Team (CEOS-SIT). These activities should supplement the high level WMO satellite committee, which also provides statements on WCRP satellite data needs. Granted the processes are new and still have growing pains, but evidence of the effectiveness of this exchange should soon be evident to the community.

The GEOSS initiative is a new multi-nation activity that was initiated at the first Earth Observing Summit in Washington in the summer of 2003. Since completing its framework document, the GEOSS activities are now focused on developing a 10-year implementation plan for observational systems. Prof. Toshio Koike, the chief scientist for the Coordinated Enhanced Observing Period (CEOP), is participating on the four-member task team that is preparing the implementation plan. His role is providing the GEWEX and WCRP communities with an opportunitiy to make significant inputs to these planning documents.

In the past, GEWEX has had a leading role in developing data products. Although GEWEX remains a leader in developing satellite products, there is now a much larger community using satellite data. With the exception of some regional projects with a strong prediction focus, most GEWEX support comes through space agencies. To maintain their support we need to demonstrate the value of satellite products in understanding the climate system, in improving climate predictions, and in applications such as water resource management. In the future, linkages to GEOSS, IGOS and WMO should give GEWEX a more effective role in consolidating viewpoints on satellite data needs from our community and integrating them into clear statements of priority for the space agencies.

Contents

RECENT NEWS OF RELEVANCE TO GEWEX

PLANS ADVANCE FOR THE 5TH INTERNATIONAL GEWEX SCIENCE CONFERENCE

Plans have been progressing for the 5th International Scientific Conference on the Global Energy and Water Cycle, June 20–24, 2005. The abstract submission and registration pages are complete (http://www.gewex.org/5thconf.htm). The American Meteorological Society is now a cosponsor and notices about the Conference will be published in a forthcoming *Bulletin of the American Meteorological Society* issue.

AMMA PROJECT RECEIVES EU FUNDING

The African Monsoon Multidisciplinary Analyses (AMMA) Project has been successful in securing a large grant from the European Union to cover the costs of people, radar networks, flux towers, lidars and aircraft time. AMMA draws heavily on the French science community to provide leadership for the Project. AMMA plans to seek to be upgraded to Continental Scale Experiment status at an upcoming GEWEX Hydrometeorology Panel meeting.

WORKSHOP ON TRENDS IN GLOBAL WATER CYCLE VARIABLES TO SUPPORT IPCC

This workshop, to be held November 3–5 in Paris, France, brings together invited experts to discuss secular trends in the global water cycle and their possible significance for assessments of climate change. Trends in the historical record will be considered with an emphasis being placed on those in the past 20 to 30 years that can be seen globally in satellite and integrated satellite *in situ* data products. For more information about the Workshop, see the web site at http://www.gewex.org/trendswkshp.htm.

PAN-WCRP MONSOON MEETING

As a result of a decision at the JSC meeting to improve the coordination among monsoon activities in WCRP, a meeting was held at the CLIVAR conference in May 2004 to discuss options. As a result of those discussions, it has been agreed that a workshop will be held on June 15–17, 2005 in Irvine, California to deal with the various aspects of monsoons. A planning committee is now being set up to prepare for this workshop.

INTERVIEWS HELD FOR THE EUROPEAN GEWEX COORDINATOR

There was strong response to the advertisement for a joint position for a person to work 50 percent of their time for the European Space Agency and half their time as the European GEWEX coordinator. Interviews were held in late June 2004 and a qualified candidate has been offered the position. We hope to be able to introduce you to the successful candidate in the next Newsletter.

GEWEX SUMMER EXECUTIVE MEETING

On July 21–22, 2004, the Chair of the GEWEX Scientific Steering Group, the GEWEX Panel Chairs, and the International GEWEX Project Office staff met at the University of Maryland, Baltimore County, to review progress in GEWEX and to begin to prepare for the January 2005 SSG meeting. The Executive meeting was preceded by a 1-day briefing on GEWEX for the U.S. federal program managers at the National Academy of Sciences. The active interaction between program managers and GEWEX program leaders provided useful feedback for the program. Central activities taking place over the next 6 months include a series of assessments for GEWEX Radiation Panel products, a review of the role and future of the Continental Scale Experiments at the upcoming GEWEX Hydrometeorology Panel meeting and a workshop on trends in global data sets. GEWEX also plans to focus on the development of an implementation strategy for Phase II over the next 6 months.

SOIL MOISTURE – WHAT IS YOUR DEFINITION?

(See page 11)

WATER CYCLE ROADMAP WORKSHOP HELD IN SEATTLE

As a follow-up to the 2003 US/Japan bilateral meeting on the water cycle, a number of scientists from Japan, the USA, and to a lesser extent Europe met in Seattle on July 25–27, 2004 to discuss a roadmap for water cycle observations and to comment on the draft version of the 10-year GEOSS Implementation Plan. Organizers for the workshop included Norman Miller, Toshio Koike, Eric Wood and Rick Lawford.

ENSEMBLE STREAMFLOW FORECASTING IN SNOWMELT DOMINATED RIVER BASINS

Martyn Clark[1], Lauren Hay[2], Andrew Slater[1], Kevin Werner[3], David Brandon[3], Andrew Barrett[1], Subhrendu Gangopadhyay[1], and Balaji Rajagopalan[1]

[1]CIRES, University of Colorado
[2]USGS Water Resources Division
[3]Colorado Basin River Forecast Center

A common solution to the streamflow forecasting problem is to (1) run a hydrologic (or land-surface) model up to the start of the forecast period to estimate basin initial conditions, and (2) run the model into the future, with an ensemble of forecast inputs, to produce an ensemble of forecasted streamflow. The River Forecast Centers in the United States have used this "Ensemble Streamflow Prediction" (ESP) method for many years. The skill of the ESP approach depends on uncertainties in: (1) local-scale forecasts used to drive the hydrologic/land-surface model; (2) the model's estimate of basin initial conditions; and (3) the hydrologic/land-surface model itself. This article summarizes our research on all three aspects of the streamflow forecasting problem.

The operational use of Numerical Weather Prediction (NWP) model output for hydrologic applications is hampered by large biases in surface climate fields, as well as poor (local-scale) forecast skill in many regions. Clark and Hay (2004) evaluated potential hydrologic applications of medium-range NWP model output. Before using the NWP forecasts as input to their hydrologic model, they used regression-based methods to remove NWP model biases and extract (local) basin-scale forecast information. Results showed the skill of NWP-based streamflow forecasts to be strongly dependent on the hydro-climate regime (see figure at the bottom of page 16). In snowmelt-dominated basins, the ensemble streamflow forecasts had lower error, and higher probabilistic skill, than the climatological control case in which historical data were used to construct the forecast ensemble. In rainfall-dominated basins, the post-processed NWP forecasts added little skill over the climatological control case. Work is ongoing to develop alternative downscaling approaches that improve over the simple regression-based methods (Gangopadhyay et al., in press; Gangopadhyay et al., under review).

As an extension of the Clark and Hay paper, Werner et al. (under review) conducted a feasibility study to assess the use of medium-range NWP model output for operational streamflow forecasting applications using the Colorado River Headwaters with the state of Colorado as the test-basin (20,850 km^2). The Colorado River Headwaters is modeled by the Colorado Basin River Forecast Center as 26 connected sub-basins, meaning that forecasted precipitation and temperature fields must replicate the observed space-time variability in station time series. To meet this requirement, Clark et al. (2004a) implemented and tested a heuristic ensemble re-ordering method developed by John Schaake at the National Weather Service (NWS) Office of Hydrologic Development. This method was effective in reproducing the observed spatial correlation structure, the temporal persistence, and the inter-variable correlations. The resultant streamflow forecasts had lower error and higher probabilistic skill than the climatological control case in which historical data was used to construct the forecast ensemble (Werner et al., under review).

For seasonal time scales, Clark et al. (2004b) and Werner et al. (in press) developed generic methods to condition streamflow forecasts on probabilistic climate forecasts. The first approach is based on a weather generator that produces alternate (conditioned) weather sequences for use in hydrologic/land-surface models (Clark et al., 2004b). The approach has three main steps: (1) conditionally re-sample years from the historical record, such that the Cumulative Distribution Function (CDF) from the re-sampled set of years is equivalent to the CDF from a selected probabilistic forecast; (2) re-sample (daily, 6-hourly) data from the conditioned subset of years to construct a desired number of (ensemble) weather sequences; and (3) re-order the ensemble members to preserve the observed space-time variability.

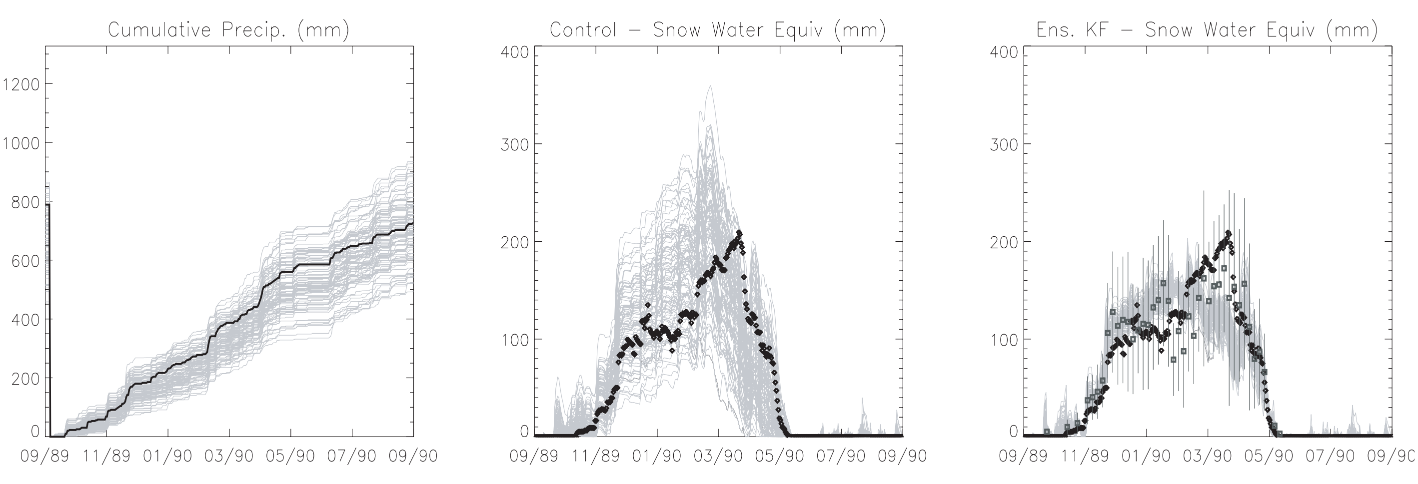
The second approach (Werner et al., in press) involves forcing a hydrologic model with *unconditioned* weather sequences from historical years, assigning weights to the weather sequence (streamflow trace) associated with each historical year – based on climate indices or probabilistic climate forecasts – and using these weights to construct a modified (conditioned) probabilistic streamflow forecast. This method has been tested for three sub-areas of the Colorado River basin: (1) the Salt River (Arizona); (2) the Upper Colorado River (western Colorado); and (3) the Green River (southwest Wyoming). The method produced multi-season streamflow forecasts with higher probabilistic skill than operational methods, with most significant forecast improvements evident in the Salt River basin where El Niño/Southern Oscillation (ENSO) signals are strong. We are currently implementing these new methods in the NWS operational streamflow forecasting systems.

A considerable amount of forecast skill in snowmelt-dominated river basins is derived from knowledge of the amount and extent of the accumulated snowpack. Thus, updating the model's estimate of basin snowpack conditions at the start of the forecast period has potential to greatly increase the skill of the streamflow forecast. Barrett (under review) used estimates of snow-covered area from visible satellite imagery to update model estimates of basin snow-covered area for two headwater basins in the Upper Colorado River. Application of a direct insertion technique for snow updating actually *degraded* the skill of streamflow simulations. Exclusion of forested pixels produced streamflow simulations with lower error than the case when all pixels were included for updating, which is symptomatic of the low accuracy of visible satellite estimates of snow-covered area under forest canopies. Quantifying errors in snow-covered area products presents an outstanding challenge to using satellite products in hydrologic forecast models.

In an alternative approach, Slater and Clark (in preparation) used station observations of Snow Water Equivalent (SWE) in an ensemble Kalman filtering scheme for snow updating. Model error is estimated by running SNOW-17 with ensemble forcings of precipitation and temperature (Clark and Slater, in preparation) – the error in model states (i.e., SWE) is computed based on the model's ensemble spread. Observation errors (i.e., errors in SWE) are taken as the cross-validated error from the SWE interpolation. Results show that snow updating using the ensemble Kalman filter provides improved snowpack simulations for stations in the upper Colorado river basin (see figure below).

The hub of a model-based streamflow-forecasting system is the hydrologic/land-surface model itself. Model performance depends on both techniques for estimating model parameters, as well as model structure. Hay (in preparation) developed an hierarchal approach to parameter estimation. Hay disaggregated the hydrologic modeling system into modules (solar radiation, evapo-transpiration, surface runoff, groundwater recharge, etc.), identified calibration/validation data sets for each module (e.g., groundwater recharge estimated through hydrograph separation), and calibrated each module in a stepwise/iterative manner. This approach was tested over 67 basins across the contiguous USA, and is found to result in considerable improvements over *a priori* parameter estimates. Work is continuing to address issues of parameter uncertainty and model complexity.

This article has summarized recent work in developing experimental streamflow forecasting methods for snowmelt-dominated river basins. Most of our work has focused on developing local-scale forecasts of model forcings (e.g., precipitation and temperature), for forecast lead times from days



Results of snow updating at Grizzly Peak, Colorado for the water year 1989/90. Ensemble results are gray lines, while truth is plotted as asterisks, showing: a) the ensemble of cumulative precipitation forcing; b) raw ensemble simulations from SNOW-17; c) snow updating results from the Ensemble Kalman Filter – the circles are our estimated observations, complete with error estimates.

through to seasons. These methods have resulted in tangible increases in forecast skill, in both experimental and operational applications. Other, more embryonic, research has focused on improving estimates of basin initial conditions, and addressing parameter and structural issues in hydrologic and land-surface models. Early results indicate that more attention in these areas will result in significant increases in the skill of streamflow forecasts.

References

Barrett, A. P. (under review). Integrating remotely sensed snow cover with a distributed hydrologic model. Paper submitted to *Hydrologic Processes*.

Clark, M. P. and L. E. Hay, 2004. Use of medium-range weather forecasts to produce predictions of streamflow. *J. Hydrometeor.,* 5, 15-32.

Clark, M. P., S. Gangopadhyay, L. E. Hay, B. Rajagopalan, and R. L. Wilby, 2004a. The Schaake Shuffle: A method to reconstruct the space-time variability of forecasted precipitation and temperature fields. *J. Hydrometeor.,* 5, 243-262.

Clark, M. P., S. Gangopadhyay, D. Brandon, K. Werner, L. E. Hay, B. Rajagopalan, and D. Yates, 2004b. A resampling procedure to generate conditioned daily weather sequences. *Water Resources Research*, 40, W04304, doi:10.1029/2003WR002747.

Clark, M. P., and A. G. Slater (in preparation). A method for generating high-resolution ensemble grids of surface climate fields. Paper in preparation for submission to the *J. Appl. Meteor*.

Gangopadhyay, S., M. P. Clark, B. Rajagopalan, K. Werner, and D. Brandon (in press). Effects of spatial and temporal aggregation on the accuracy of statistically downscaled precipitation estimates in the Upper Colorado River basin. Paper in press in *J. Hydrometeor.*

Gangopadhyay, S., M. P. Clark, and B. Rajagopalan (under review). Statistical downscaling using k-nearest neighbors. Paper under review in *Water Resources Research*.

Hay, L. E., (in preparation). An hierarchal approach to parameter estimation. Paper in preparation for submission to the *J. Hydrometeor.*

Slater, A. G., and M. P. Clark (in preparation). Snow data assimilation via ensemble Kalman methods. Paper in preparation for submission to the *J. Hydrometeor*.

Werner, K., D. Brandon, M. P. Clark, and S. Gangopadhyay (in press). An evaluation of approaches for using climate indices for seasonal volume forecasting with the ensemble streamflow prediction system of the NWS. Paper in press in the *J. Hydrometeor*.

Werner, K., D. Brandon, M. P. Clark, and S. Gangopadhyay (under review). Incorporating Medium-Range Numerical Weather Prediction Model Output into the Ensemble Streamflow Prediction System of the National Weather Service, Paper submitted to the *J. Hydrometeor*.

ISLSCP INITIATIVE II UPDATE

J. Collatz[1], F. Hall[2], E.B. deCoulston[3], and D. Landis[3]

[1]NASA GSFC, [2]JCET/GSFC, [3]SSAI/GSFC

The International Satellite Land Surface Climatology Project (ISLSCP) sponsored the production of the first co-registered, peer-reviewed, documented interdisciplinary data collection called Initiative I, which included global, monthly surface meteorology, vegetation, soils, surface routing and runoff, atmospheric radiation data and clouds for 1987 and 1988 at a 1-degree spatial resolution.

The ISLSCP Initiative II collection is greatly expanded in both time and spatial resolution. Initiative II is a 10-year core global data collection spanning the years 1987 to 1995 with improved spatial and temporal resolution (one-quarter to 1 degree) using improved data generation algorithms. In addition, Initiative II includes some data sets spanning the 18-year period, 1982–1999. The data collection includes additional carbon and socioeconomic data sets uniquely designed to support global carbon cycling studies. Initiative II provides a comprehensive collection of high priority global data sets in a consistent data format and Earth projection.

The full Initiative II collection consists of 47 different data types with 230 different parameters shown below (number of parameters in parentheses).

- Carbon (15)
- Vegetation (29)
- Hydrology, Topography and Soils (39)
- Near-Surface Meteorology (95)
- Snow and Sea Ice (4)
- Oceans (1)
- Radiation and Clouds (45)

Each of the 47 data sets and its documentation has undergone two peer reviews, one by reviewers familiar with the data set (but not the producer of it) and a second reviewer, a potential user who has no previous experience with it. These reviews are nearly complete to be followed by an evaluation of the entire collection prior by the Initiative II staff and a small group of users. This collection-overview evaluation will include an evaluation of the individual data series against each other and independent data sources and an evaluation of the value of the ISLSCP II collection as a whole. Initiative II data sets are now in production and scheduled for completion mid 2005. Much of the data is already available at http://islscp2.sesda.com/.

LAND SURFACE MODELING IN BALTEX

Heinz-Theo Mengelkamp

Institute for Coastal Research
GKSS Research Center Geesthacht GmbH

A primary objective of the Baltic Sea Experiment (BALTEX) is the understanding and simulating of the exchange processes between the Earth's surface and the atmosphere. Focus is on the improvement of land-surface models (LSM) in weather forecasts and regional climate models, and the inclusion of hydrological processes through coupling the atmospheric models with river routing schemes. The exchange processes between the sea surface/sea ice and the atmosphere play a dominant role over the Baltic Sea area. In order to test and validate LSMs, measurement campaigns have been undertaken over open sea, at coastal areas and over land during all seasons, and include continuous long-term observations at the Coordinated Enhanced Observing Period (CEOP) sites.

The Oestergarnsholm air-sea research project has led to a new understanding of the marine atmospheric boundary layer (MABL): a) the MABL is strongly influenced by the sea state; b) for growing sea conditions (young waves), the waves travel slower than the wind velocity and the turbulence structure of the MABL resembles the boundary layer over land; c) for a more mature sea or mixed sea, some waves are travelling faster than the wind, and the MABL starts to deviate from the boundary layer over land; and d) for swell conditions, dominated by long waves travelling faster than the wind, the MABL is significantly different from the boundary layer over land (Smedmann and Hoegstroem, 2004).

Measurement campaigns over land are concentrated on the surroundings of the BALTEX reference sites in CEOP at Norunda, Sweden (forested areas); Sodankylae, Finland (snow covered surfaces); and Lindenberg, Germany (heterogeneous terrain). In May and June 2003, a major field experiment was carried out around the Lindenberg site as part of the Evaporation over Grid and Pixel Scale (EVA-GRIPS) project under the auspices of the German Climate Research Program, DEKLIM. EVA-GRIPS focuses on the determination of the area-averaged evaporation and sensible heat flux over a heterogeneous land surface, both from experimental data and from modelling activities. The purpose of EVA-GRIPS is the verification and implementation of surface flux averaging strategies into the land surface schemes of the climate model, REMO/ECHAM (Regional), and the German Weather Service forecast model LM (Local) and as a control, the LSM SEWAB (Mengelkamp et al., 2001). The LSMs are objectively calibrated using the MOSCEM algorithm of the University of Arizona (Gupta et al., 1998) with flux data from 12 sites over the EVA-GRIPS experimental area around the Lindenberg observatory of the German Weather Service. Composite flux data are estimated from the point data by weighing them with the respective grid fraction of the vegetation type. The time series of these composite fluxes are used to verify averaging strategies and to deduce grid specific effective parameter through calibration. The mosaic approach has shown the best agreement between observed and simulated grid representative fluxes.

The alliance to the GEWEX community is maintained through regular participation of the LSM SEWAB in the Project for Intercomparison of Land-surface Parameterizations (PILPS; Henderson-Sellers et al., 1995) activities. In PILPS Phase 2e, coupled land-surface hydrological models were compared with runoff and discharge from the Thorneaelv river in Sweden into the Baltic Sea. This exercise provided the opportunity to compare the LSS SEWAB and a coupled routing scheme (Lohmann et al., 1996).

The SEWAB/routing scheme model system was originally developed as a hydrological model for the Odra watershed. It is coupled to the mesoscale model MM5 for flood forecast purposes. Besides a variety of river routing schemes for various watersheds around the Baltic Sea, the conceptual hydrological model, HBV (Bergström and Forsman, 1973), and the distributed model, LARSIM (Richter et al., 2003) cover the whole Baltic Sea catchment area.

At the end of BALTEX Phase I in 2005, coupled atmospheric – hydrological model systems will have been extensively validated for single catchments and for the entire Baltic Sea area.

References

Bergström, S. and A. Forsman, 1973. Development of a conceptual deterministic rainfall-runoff model, *Nordic Hydrology*, 4, 147-170

Gupta, H. V., S. Sorooshian and P. O. Yapo, 1998. Toward improved calibration of hydrologic models: Multiple and noncommensurable measures of information, *Water Res. Res*., 34, 4, 751-763.

(Continued on page 15)

ULTRA-HIGH RESOLUTION OBSERVATION-DRIVEN LAND MODELING NEEDED TO ENABLE THE DEVELOPMENT OF GLOBAL CLOUD RESOLVING EARTH SYSTEM MODELS

Paul R. Houser, Mike Bosilovich, Christa Peters-Lidard, and Wei-Kuo Tao

NASA Goddard Space Flight Center

The relatively crude representation of cloud processes in global climate models has long been recognized as a primary source of uncertainty in climate change predictions. It is well known that the high-resolution time and space complexity of land surface phenomena have significant influence on atmospheric boundary layer turbulence and cloud processes. Scale truncation errors, unrealistic physics formulations, and inadequate coupling between surface fluxes and the overlying atmosphere cause serious systematic errors. Standard subgrid-scale tiling approaches are not able to adequately represent observed heterogeneity and boundary-layer interaction (Bosilovich, 2002), which means that fine-scale model representations are required. The inability to explicitly account for the considerable spatial and temporal variability in terrain topography, surface properties, rainfall, and net surface radiation constitute an organic weakness of current climate models and a cause for substantial errors in model simulations of near-surface climate over land.

Therefore, the land surface research community must progress toward a fully process-scale resolving model of land surface hydrology, atmospheric dynamics, and cloud processes over the global domain (Tao et al., 2003). We must integrate all obviously interdependent land-atmosphere processes into a common ultra-resolution (100s of meters) framework for Earth system modeling, through fusion of traditional land surface hydrology modules with boundary-layer turbulence and cloud process modules. Decisions regarding the model formulations must be guided to the greatest extent possible by the use of observations, as prescribed input, data assimilation constraints, validation or relevance to applications or decision-making.

To this end, we envision two, eventually convergent, paths toward fully interactive land-atmosphere coupling: (1) In the near-term, implement traditional cloud parameterization and atmospheric turbulence schemes and implicitly couple those (through the atmospheric circulation) to patch-based land models at highest possible resolution; and (2) In the long-term, develop true global process-resolving coupled land-atmosphere models in a phased approach, starting with (a) off-line land-cloud process resolving studies, then progressing to (b) land-cloud super-parameterizations based on sampling the relevant process scales, (c) nested land-cloud resolving models in a Global Circulation Model (GCM) framework, and finally (d) to a true global ultra-high-resolution global cloud-land process resolving model. These two paths will eventually converge when computing power allows the resolution of the Earth system model to overlap the resolution of the global cloud resolving model.

The unprecedented availability of new global land-surface remote sensing data over the past decade should be a fundamental driver for the development of new scientific understanding and modeling innovations. Land data assimilation systems have been developed that use sophisticated land surface models to ingest satellite and ground-based observations, as parameters, forcing, and data for assimilation, in order to produce the best possible fields of land surface states and fluxes. The multi-institution North American Land Data Assimilation System (NLDAS) project was the first to embrace this concept (Mitchell et al., 1999). Its success led to the development of Global LDAS (GLDAS) (Houser and Rodell, 2002; Rodell et al., 2004; http://ldas.gsfc.nasa.gov) through the joint effort of scientists at the National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center and the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Prediction (NCEP).

The 1/4-degree resolution, high quality, near-real time and retrospective output fields that have resulted from GLDAS (see the figure at the bottom of page 1), the first of their kind, are providing the basis for global scale studies of the hydrological cycle and meteorological processes. In addition, GLDAS surface state fields are being tested in weather and climate model initialization studies at NCEP and NASA's Global Modeling and Assimilation Office (GMAO), where GLDAS soil moisture fields have been shown to improve the predictability of seasonal precipitation, and are being tested as input to water management decision support systems.

The Land Information System (LIS) Project (http://lis.gsfc.nasa.gov) has streamlined and parallelized the GLDAS code and has executed 1-km resolution, global simulations using 3 different land models on high performance computing platforms. LIS incorporates Assistance for Land surface Modeling Activities (ALMA) and Earth System Modeling Framework (ESMF) standards to facilitate inter-operation with other Earth system models. LIS also employs a Grid Analysis and Display System – Distributed Oceanographic Data System (GrADS-DODS) server framework which allows for seamless access to large observational databases. LIS is currently being coupled to the Weather Research and Forecasting (WRF) and Goddard Cumulus Ensemble (GCE) models to explore surface-layer feedback effects due to assimilation. However, there remain great challenges in representing process-scale land-surface dynamics in Earth system models, such as the need for LSM-compatible groundwater, glacier, ice sheet, and wetland models and schemes for simulating the effects of dams, agriculture, and irrigation on land surface hydrology.

New global remote sensing observations provide the foundation for the development of a new generation of Earth system models that will explicitly resolve weather and climate relevant physical, chemical and biological processes, in order to improve dramatically the understanding and prediction of weather and climate. This will require, among other things, an ultra-high-resolution observation-driven land surface model with process-scale hydrology and biogeochemistry dynamics that is implicitly coupled to high-resolution boundary-layer turbulence and cloud microphysics parameterizations. These innovations will be invaluable for a wide range of applications, including satellite data assimilation, observation system design, weather forecasting and climate simulation.

References

Bosilovich, M. G., 2002. On the use and validation of mosaic heterogeneity in atmospheric numerical models. *Geophys. Res. Lett.*, 29, 10.1029/2001GL013925.

Houser, P. and M. Rodell, 2002. GLDAS: An Important Contribution to CEOP. *GEWEX News*, May 2002, 2,8,9,16.

Mitchell, K. E., et al. 2004. The multi-institution North American Land Data Assimilation System (NLDAS): Utilizing multiple GCIP products and partners in a continental distributed hydrological modeling system, *J. Geophys. Res*., 109, D07S90, doi:10.1029/2003JD003823.

Rodell, M., P. R. Houser, U. Jambor, J. Gottschalck, K. Mitchell, C.-J Meng, K. Arsenault, B. Cosgrove, J. Radakovich, M. Bosilovich, J. K. Entin, J. P. Walker, D. Lohmann, and D. Toll, 2004. The Global Land Data Assimilation System. *Bull. Amer. Meteor. Soc.*, 85 (3), 381-394.

Tao, W.-K. and co-authors, 2003. Microphysics, radiation and surface processes in the Goddard Cumulus Ensemble (GCE) model, *Meteorology and Atmospheric Physics*, 82, 97-137.

THE ROLE OF FINE-SCALE LANDSCAPE AND SOIL MOISTURE VARIABILITY IN THE INITIATION OF DEEP CONVECTION

Fei Chen, Thomas T. Warner, Stanley B. Trier, and Kevin W. Manning

National Center for Atmospheric Research

Understanding the feedback between land-surface variability and precipitation has been a central GEWEX issue because of its potential benefit in improving climate predictability. In the summer, mesoscale boundaries play a critical role in the initiation of heavy precipitation. The zones of enhanced convergence along these boundaries have been recognized as areas of deep-convection initiation. The origin of these meso-scale boundaries includes synoptic-scale fronts, outflows from previous storms, orographic features, and differential surface heating. The differential heating can be enhanced by heterogeneities in land-surface conditions. The land surface may have differing impacts, depending on atmospheric conditions. Small-scale ground features, such as vegetation, hillslopes, and urban or industrial areas can also have subtle impacts that can determine the exact boundary and intensity of storms.

Chen et al. (2001) examined the impact of the land surface and terrain on the 1996 flash flood that struck Colorado's Buffalo Creek watershed. Among their findings: the wildfire burn area received particularly heavy rainfall during the flood, possibly because the denuded site transferred more heat into the atmosphere than an area filled with living trees would. That extra heat would enhance a local storm by adding to the buoyancy of updrafts. In a study focusing on heavy precipitation associated with a dryline in the south central United States, Trier et al. (2004) found that fine-scale (L~10 km) boundary-layer circulations that directly trigger deep convection are confined within a mesoscale region containing a deeper and more unstable Planetary Boundary Layer (PBL), and that this region is a result of a surface sensible heat-flux maximum over dry soils. They utilized the soil moisture fields from a high-resolution land data-assimilation system (HRLDAS) and from the National Centers for Environmental Prediction (NCEP) Eta Model Data Assimilation System (EDAS) to initialize the MM5 model. The simulation initialized with EDAS soil moisture did not initiate deep convection along the dryline in Texas (see figure at the top of page 16) as shown in the satellite image because of subtle differences in soil moisture and in the subsequent evolution of the boundary layer.

(Continued on page 15)

UPDATE ON THE SECOND GLOBAL SOIL WETNESS PROJECT (GSWP-2)

Xiang Gao[1], Paul A. Dirmeyer[1], and Taikan Oki[2]

[1]Center for Ocean-Land-Atmosphere Studies, Calverton, Maryland, USA, [2]Institute of Industrial Science, University of Tokyo, Japan

The Second Global Soil Wetness Project (GSWP-2) is the large-scale uncoupled modeling activity of the Global Land-Atmosphere System Study (GLASS), one of three parallel efforts under the GEWEX Modeling and Prediction Panel (GMPP). GSWP-2 is closely linked to the 10-year (1986–1995) International Satellite Land Surface Climatology Project (ISLSCP) Initiative II land surface data set (http://islscp2.sesda.com/), but takes a step forward with corrections to the systematic biases in the National Centers for Environmental Prediction (NCEP)-Department of Energy (DOE) reanalysis fields made by hybridization of the 3-hourly analysis with global observationally based gridded data sets at lower temporal resolution (Zhao and Dirmeyer, 2003, ftp://grads.iges.org/pub/ctr/ctr_159.pdf). Land Surface Scheme (LSS) simulations in GSWP-2 are conducted at a spatial resolution of 1 degree. So far, baseline simulation results from 16 models have been submitted. A major product of GSWP-2 will be global multi-model land surface analyses on daily and monthly intervals from January 1986–December 1995. These multi-model results will be made available in 2005.

A new thrust for GSWP-2 is to link land surface modeling better to applications in remote sensing. GSWP-2 intends to expand the validation and assimilation capabilities of current LSSs beyond those few areas where *in situ* data are readily available. This is done by coupling LSSs with a validated L-band microwave emission model (MEB; Pellarin et al., 2003) to simulate forward brightness temperature as observed from microwave radiometers. Several participating LSSs have been examined for their performance in simulated brightness temperature, which is assessed by comparisons with airborne measurements from several large-scale campaigns held during the GSWP-2 period. Such an assessment constitutes a useful prototype of LSS validation on a global scale when future satellite-based L-band radiometry data are available, such as the NASA Hydrosphere State (HYDROS) mission and the European Space Agency (ESA) Soil Moisture Ocean Salinity (SMOS) mission. The figure at the top of page 1 shows an example of a global 1-degree map of synthetic L-band H-polarized brightness temperature as it would be seen by HYDROS. In the future, comparison of brightness temperature produced by coupled models with satellite-based L-band radiometry data will help us to understand better the performance of various LSSs, as well as provide a reference for quality assurance of remotely sensed brightness temperature imagery.

Modeling sensitivity studies in GSWP-2 involve re-integrating the LSSs over the 10-year period with alternative boundary conditions or forcings to test the response of the models to uncertainties in those data sets. The sensitivity studies within each GSWP participating group are now under way. They include sensitivity to choices in meteorological forcing data, land surface parameters (e.g., global vegetation class maps), and surface vegetation data (e.g., climatological vegetation). Most of the participants have shown strong interest in investigating sensitivity to choice of the near-surface reanalysis product, and choice of precipitation data sets. A new experiment is also added where LSS-native or default parameters are used for soil and vegetation instead of GSWP-2 global fields as a LSS is often developed and calibrated to use specific data sets.

GSWP-2 is a project in progress, and a number of scientific results and data sets will emerge over the next 1-2 years. The latest results from this project will be presented at the GSWP-2 science workshop in Kyoto, Japan on 13–15 September 2004 (http://hydro.iis.u-tokyo.ac.jp/Info/GSWP/); at a special session of the 85th AMS Annual Meeting to be held in San Diego, California on 9–13 January 2005; and at the 5th GEWEX International Scientific Conference in Orange County, California, 20–24 June 2005.

Complete descriptions, access to forcing data, and the latest information concerning the evolving of the GSWP2 project are available at http://www.iges.org/gswp/. This project is supported by National Aeronautics and Space Administration Grant NAG5-11579.

References

Zhao, M., and P.A. Dirmeyer, 2003. Production and Analysis of GSWP-2 near-surface meteorology data sets. *COLA Technical Report*, 159, 38pp.

Pellarin, T., J.-P. Wigneron, J.-C. Calvet, M. Berger, H. Douville, P. Ferrazzoli, Y.H. Kerr, E. Lopez-Baeza, J. Pulliainen, L.P. Simmonds, and P. Waldteufel, 2003. Two-year global simulation of L-band brightness temperature over Land. *IEEE Trans. Geosci. Remote Sens.,* 41, 2135-2139.

SOIL MOISTURE—MUDDY PROSPECTS FOR A CLEAR DEFINITION

Paul Dirmeyer

Center for Ocean-Land-Atmosphere Studies
Calverton, Maryland, USA

Soil moisture is a key state variable connecting the land surface to climate variability and predictability. However, not only is soil moisture sparsely measured around the globe, there is also little agreement on what is meant by soil moisture.

According to the *International Glossary of Hydrology*, "soil moisture" is defined as the moisture contained in the portion of the soil which is above the water table, including water vapor, which is present in the soil pores. Contrast this to "soil water" which is defined as water suspended in the uppermost belt of soil, or in the zone of aeration near the ground surface, that can be discharged into the atmosphere by evapotranspiration. The *Glossary of Meteorology* describes "soil moisture content" as the amount of water in an unsaturated soil, expressed as a volume of water per unit volume of porous media, or as a mass of water per unit oven-dry mass of soil.

None of these "official" definitions are very precise or satisfying. Part of the problem is that soil moisture is a quantity that lies at the interface of several disciplines, each with its own history and jargon. Nevertheless, for the purposes of scientific research, more precise definitions are needed. Soil moisture as a measurable quantity can be characterized in one of three broad categories: in terms of a *water mass* (expressed in units of mass, volume, density or depth), as a *physical index* (usually on a scale of 0-1 or 0-100% based on a ratio of volumes or weights of water to water + soil), or as an *observational index* (based on a remote sensing retrieval algorithm, electrical conductivity, pulse transmission, or some other measurement of a physical property which is known to vary with soil moisture).

The Global Soil Wetness Project (GSWP) has informally adopted the convention of referring to the water mass definitions as "soil moisture," which always have associated units such as kgm^{-3} or mm. Gravimetric measurements of soil moisture, where a soil core is weighed, baked to remove moisture, then weighed again, produce a measurement of soil water mass. Models of the land surface typically calculate closed water budgets, so they usually treat soil moisture in terms of volumetric quantity, which is 0 for totally desiccated soils, and equal to the total volume of the soil pore space when the soil is saturated. Volumetric soil moisture can be easily converted to water mass by multiplying by the density of water, usually assumed constant.

In GSWP, physical indices are referred to as "soil wetness" (always dimensionless). Many models and measurement methods tabulate water in the soil as either a volumetric soil wetness (volumetric soil moisture divided by the total volume of the soil sample), or a saturation ratio (ranging from 0 to 1 from desiccated to saturated, equal to the volumetric soil wetness divided by the soil porosity). There exist nodes for defining indices other than total desiccation and saturation, adding to the confusion in this category. At the dry end, other anchor points for indices include the wilting point (which itself has several definitions and means of estimation) and the lowest measured value. The wilting point is considered to be the soil wetness level below which plants can no longer extract water from the soil, and is used as the base for estimating "plant available water", which itself can be expressed as either a "moisture" or a "wetness." At the wet end of the scale, the field capacity (the amount of water a soil column can hold by capillary retention against gravity in the absence of evaporation), the level of zero vegetation water stress and the highest measured value are also used. Most indices set their lower node equal to 0, and the upper node to 1 or 100%. GSWP-1 defined its "Soil Wetness Index" as ranging from 0 at wilting point to 1 at field capacity. So-called "bucket" soil models implicitly cover only this range, while more sophisticated soil column models in land surface schemes with vegetation and baseflow are capable of soil wetness outside of these bounds, particularly when runoff (another muddy quantity) is parameterized rather arbitrarily as a function of soil wetness.

Observational indices are artifacts of electronic instruments and serve as proxies for direct soil moisture measurements such as gravimetric assays. They may be expressed as voltages, impedances, radiative brightness temperatures, or ratios of brightness temperatures, to name a few. Observational indices can be calibrated to correspond to physical indices or water mass measurements, or cross-calibrated with indices from other electronic instruments. However, many factors can affect calibration, making transferability difficult, especially when soil moisture is being measured by remote sensing. Many assert the future of soil wetness measurement lies in satellite sensors in the microwave band. Several specific frequencies at various polarizations have been proposed and are being developed. However, all of these sense only the first few millimeters of water, whether it be on the soil or in overlying vegetation. Problems include the effects of surface temperature, roughness, ice and vegetation that influence the registered brightness temperature and the need to translate the sensed radiation into a water quantity.

So what is the correct definition for soil moisture? It depends on what you are trying to accomplish. For example, for the agricultural planner concerned about crop water stress, soil moisture is a real and precise quantity with a well known, direct impact on a tangible commodity. Indeed, water mass is a fairly incontrovertible quantity, albeit very difficult to measure adequately. In contrast, many weather and climate modelers treat soil moisture as a means to an end – a fictional quantity in an equation for calculating surface energy and moisture fluxes. In their view, the land surface model gives reasonable heat fluxes to the atmosphere and it is relevant if the underlying soil state variable validates well against observations. Hydrologists, who worry about accurate streamflow predictions, find this approach unacceptable. Given the complexities and uncertainties in soil structure, and its effects on vertical and lateral water movement, it may not be possible to have a single useful definition. However, we do need more discussion and documentation of this issue to have a common understanding of what is meant when we use the term. For more information on the basics of soil moisture, see Chapter 6 of Yu et al. (1993).

Reference

Yu, C., C. Loureiro, J.-J. Cheng, L. G. Jones, Y. Y. Wang, Y. P. Chia, and E. Faillace, 1993. *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil.* Environmental Assessment and Information Sciences Division, Argonne National Laboratory, Argonne, Illinois, USA [http://web.ead.anl.gov/resrad/documents/data_collection.pdf], 158 pp.

GEWEX RELEVANT PUBLICATIONS OF INTEREST

This is a new section to alert readers to papers of possible interest.

Global Soil Moisture from Satellite Observations, Land Surface Models, and Ground Data: Implications for Data Assimilation

Reference: Reichle, R. H., R. D. Koster, J. Dong, A. A. Berg, 2004. *J. Hydrometeorology*, Vol. 5, No. 3, 430-442.

Summary/Abstract: Three independent surface soil moisture data sets for the period 1979–87 are compared: 1) global retrievals from the Scanning Multichannel Microwave Radiometer (SMMR); 2) global soil moisture derived from observed meteorological forcing using the NASA Catchment Land Surface Model; and 3) ground-based measurements in Eurasia and North America from the Global Soil Moisture Data Bank. Time-average soil moisture fields from the satellite and the model largely agree in the global patterns of wet and dry regions. Moreover, the time series and anomaly time series of monthly mean satellite and model soil moisture are well correlated in the transition regions between wet and dry climates where land initialization may be important for seasonal climate prediction. However, the magnitudes of time-average soil moisture and soil moisture variability are markedly different between the data sets in many locations. Absolute soil moisture values from the satellite and the model are very different, and neither agrees better with ground data, implying that a "correct" soil moisture climatology cannot be identified with confidence from the available global data. The discrepancies between the data sets point to a need for bias estimation and correction or rescaling before satellite soil moisture can be assimilated into land surface models.

Impacts of Land Surface Model Complexity on a Regional Simulation of a Tropical Synoptic Event

Reference: H. Zhang, J. L. McGregor, A. Henderson-Sellers, J. J. Katzfey, 2004. *J. Hydrometeorology*, Vol. 5, No. 1, pp. 180–198.

Summary/Abstract: The complexity of land surface models has tended to grow as our knowledge of land surface processes has increased and our appreciation of the importance of land surface processes in the weather and climate system has developed. However, results from the Project for

Intercomparison of Land Surface Parameterization Schemes (PILPS) have revealed poor agreement among current land surface schemes in representing key surface processes such as surface water and energy partitioning when forced with the same meteorological forcing. Three questions then arise: (i) do land surface processes matter in the numerical model simulations of weather and climate? Then, if assured in the affirmative, (ii) how complex should land surface schemes be in current numerical models, particularly when considering that the representations of known important atmospheric processes such as convection and clouds in numerical models are still simple compared with reality? and (iii) can such complexity be represented by parameter tuning?

A multimode Chameleon Surface Model (CHASM) with different levels of complexity in parameterizing surface energy balance is coupled to a limited-area model (DARLAM) to investigate the impacts of complexity in land surface representations on the model simulation of a tropical synoptic event. A low pressure system is examined in two sets of numerical experiments to discuss the following. (i) Does land surface parameterization influence regional numerical weather simulations? (ii) Can the complexity of land surface schemes in numerical models be represented by parameter tuning? The model-simulated tracks of the low pressure center do not, overall, show large sensitivity to the different CHASM modes coupled to the limited-area model. However, the landing position of the system, as one measurement of the track difference, can be influenced by several degrees in latitude and about one degree in longitude. Some of the track differences are larger than the intrinsic numerical noise in the model estimated from two sets of random perturbation runs. In addition, the landing time of the low pressure system can differ by about 14 h. The differences in the model-simulated central pressure exceed the model intrinsic numerical noise and such variations consistent with the differences seen in simulated surface fluxes. Furthermore, different complexity in the land surface scheme can significantly affect the model rainfall and temperature simulations associated with the low center, with differences in rainfall up to 20 mm day^{-1} and in surface temperature up to 2°C. Explicitly representing surface resistance and bare ground evaporation components in CHASM produces the most significant impacts on the surface processes. Results from the second set of experiments, in which the CHASM modes are calibrated by parameter tuning, demonstrate that the effects of the physical processes represented by extra complexity in some CHASM modes cannot be substituted for by parameter tuning in simplified land surface schemes.

Temporal Interpolation of Global Surface Skin Temperature Diurnal Cycle Over Land Under Clear and Cloudy Conditions

Reference: Aires, F., C. Prigent, and W. Rossow, 2004, *J. Geophys. Res.*, *109*, D04313, doi:10.1029/2003JD003527.

Summary/Abstract: The surface skin temperature is a key parameter at the land-atmosphere interface. An accurate description of its diurnal cycle would not only help estimate the energy exchanges at the interface, it would also enable an analysis of the global surface skin diurnal cycle and its variability within the last 20 years. Two main applications of such a data set can be identified. First, the surface skin temperature could be used to evaluate surface models and could also provide an additional constraint on latent and sensible heat flux calculations. The second main application of a surface skin temperature data set is related to climate change studies. Incomplete space and time coverage complicates the analysis of global trends from the *in situ* meteorological network; however, skin temperature can be estimated from satellite infrared radiance observations.

This study is based on the 3-hourly surface skin temperature estimated by the International Satellite Cloud Climatology Project (ISCCP) from the infrared measurements collected by the polar and geostationary meteorological satellites. The diurnal cycle of surface skin temperature is analyzed almost globally (60N–60S snow-free areas), using a Principal Component Analysis (PDA). The first three components are identified as the amplitude, the phase, and the width (i.e., daytime duration) of the diurnal cycle and represent 97% of the variability. PCA is used to regularize estimates of the diurnal cycle at a higher time resolution. A new temporal interpolation algorithm, designed to work when only a few measurements of surface temperature are available, is developed based on the PCA representation and an iterative optimization algorithm. This method is very flexible: only temperature measurements are used (no ancillary data), no surface model constraints are used, and the time and number of measurements are not fixed. The performance of this interpolation algorithm is tested for various diurnal sampling configurations. In particular, the potential to use the satellite microwave observations to provide a full diurnal surface temperature cycle in cloudy conditions is investigated.

WORKSHOP/MEETING SUMMARIES

4TH STUDY CONFERENCE ON BALTEX

24–28 May 2004
Gudhjem, Bornholm, Denmark

Hans-Jörg Isemer
GKSS Research Centre, Germany

More than 110 scientists from 15 countries gave 78 oral and 36 poster presentations at the Conference, which was organized jointly by Risø National Laboratory, the Technical University of Denmark and GKSS Research Centre. The Conference was organized into the following sessions: Improved understanding of water and energy cycle processes: (remote sensing applications, diagnostic studies and field experiments, numerical modelling); trends and variability in the regional climate during the past two centuries; development and validation of advanced modeling tools for regional climate studies; projection of future climate change at river catchment and basin scales during the 21st century; and applications for water resources management, including extreme events, long-term changes and studies on air and water quality.

Speakers at the opening session, including Professors Sven-Erik Gryning (Risø) and Hartmut Graßl (MPI Hamburg), stressed that the Conference was held at an important time in the BALTEX programme. After about 10 years of successful basic research contributing to new data sets, better process understanding and model development of the water and energy cycles of the Baltic Sea basin, BALTEX has recently defined revised objectives for Phase II of the programme. A future focus of BALTEX will be on applications of its past achievements to other fields, both in scientific research and beyond, where knowledge of the water and energy cycle is of fundamental importance. Nearly 30 percent of all presentations given were alluding already to aspects of the revised BALTEX objectives for Phase II, such as investigations on past and future climate, as well as contributions to water resource management.

The following statements summarize major achievements of the BALTEX programme that were highlighted at the Conference:

- Improved understanding of the processes in the air land surface, air-sea surface, and air-sea ice boundary layers through the exploitation of a variety of new and experimental data sets and models.
- Improved precipitation data sets for both the sea and over land, based on both gauge and radar data.
- New measurements and improved understanding of the water mass exchanges within the deep basins of the Baltic Sea and of turbulent mixing in the Baltic Sea.
- A better understanding of major Baltic Sea inflow events and an improved modeling of extreme inflow events.
- The water and heat budgets of the Baltic Sea have been investigated with increasing detail; the accuracy of the individual terms needs to be addressed, and further efforts towards analyzing the budgets, as well as their long-term trends and variability for the entire Baltic Sea basin are still necessary.
- Two coupled model systems, RCAO and BALTIMOS, are progressing from their development and validation phases to applications, the potential of these systems has been demonstrated.
- The necessity of studying and understanding processes at different scales was highlighted.
- The need for a stronger focus on uncertainty assessment, including ensemble runs of future scenarios is evident.

The next BALTEX Conference is scheduled to be held in 2007 on the Estonian island Saaremaa.

Participants at the 4th Study Conference on BALTEX.

LAND SURFACE MODELING IN BALTEX

(Continued from page 7)

Henderson-Sellers, A., A. Pitman, P. Love, P. Irrannejad, and T. Chen, 1995. The project for intercomparison of land-surface parameterization schemes (PILPS): Phases 2 and 3. *Bull. Amer. Meteor. Soc.*, 94, 489-503.

Lohmann, D., R. Nolte-Holube, and E. Raschke, 1996. A large scale horizontal routing model to be coupled to land surface parameterization schemes. *Tellus*, 48A, 708-721.

Mengelkamp, H.-T., Kiely, G., and Warrach, K., 2001. Evaluation of hydrological processes added to an atmospheric land-surface scheme, *Theor. Appl. Climatol*, 69, 199-212.

Richter, K.-G., P. Lorenz, M. Ebel, and D. Jacob, 2003. Analysis of the water cycle of the BALTEX basin with an integrated atmospheric hydrological ocean model, *Proc. 4th Study Conf. on BALTEX*, Bornholm, May 2004, 154-155.

Smedmann, A.-S. and U. Hoegstroem, 2004. The marine boundary layer – new findings from the Oestergarnsholm air-sea interaction site in the Baltic Sea, *Proc. 4th Study Conf. on BALTEX*, Bornholm, May 2004, 41-42.

THE ROLE OF FINE-SCALE LANDSCAPE AND SOIL MOISTURE

(Continued from page 9)

Results from these and other recent research studies provide some hope that the careful treatment of land-surface physics and soil moisture in convection-resolving models can lead to increased rainfall predictability. In particular, this should be achievable by improving: 1) the representation of land surface processes, 2) the initialization of soil properties, and 3) the specification of various vegetation characteristics by combining modeling, new remote sensing capabilities, and data-assimilation techniques. It is, however, a more daunting challenge to incorporate the complex mesoscale interactions among the land surface, the boundary layer, and clouds, in large-scale climate models. These interactions play a critical role in determining the timing and location of convection initiation, and the intensity of precipitation, but operate on subgrid scales. Our understanding of these complicated interactions is still primitive, but a coordinated research program, within GEWEX, on coupled land-atmosphere modeling and comparison of simulations with field data will be a major step forward.

References

Chen, F., T. Warner, and K. Manning, 2001. Sensitivity of orographic moist convection to landscape variability: A Study of the Buffalo Creek, Colorado, flash-flood case of 1996. *J. Atmos. Sci.,* 58, 3204-3223.

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

GEWEX/WCRP MEETINGS CALENDAR

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

30–31 August 2004—GAPP PRINCIPAL INVESTIGATORS MEETING, Boulder, Colorado, USA.

13–15 September 2004—GSWP-2 SCIENCE WORKSHOP, Kyoto, Japan.

13–16 September 2004—10TH MEETING OF THE GEWEX HYDROMETEOROLOGY PANEL, Montevideo, Uruguay.

15–17 September 2004—GLASS PANEL MEETING, Kyoto, Japan.

17–18 September 2004—CEOP MONSOON MEETING, Montevideo, Uruguay.

21–23 September 2004—GCSS SCIENCE PANEL MEETING, NASA GISS, New York, NY, USA.

23–25 September 2004—WCRP OFFICERS, CHAIRS AND DIRECTORS MEETING, Geneva, Switzerland.

11–15 October 2004—20TH SESSION OF THE CAS/JSC WGNE/8TH SESSION OF THE GMPP, Exeter, UK.

18–19 October 2004—GRP WORKING GROUP ON DATA MANAGEMENT AND ANALYSIS (WGDMA), Kyoto, Japan.

20–22 October 2004—15TH SESSION OF THE GEWEX RADIATION PANEL, Kyoto, Japan.

3–5 November 2004—IGWCO/GEWEX/UNESCO WORKSHOP ON TRENDS IN GLOBAL WATER CYCLE VARIABLES, Paris, France.

1–5 December 2004—GAME INTERNATIONAL SCIENCE PANEL MEETING AND 6TH INTERNATIONAL STUDY CONFERENCE ON GEWEX IN ASIA AND GAME, Kyoto, Japan.

20–24 June 2005—5TH INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE, Orange County, California, USA.

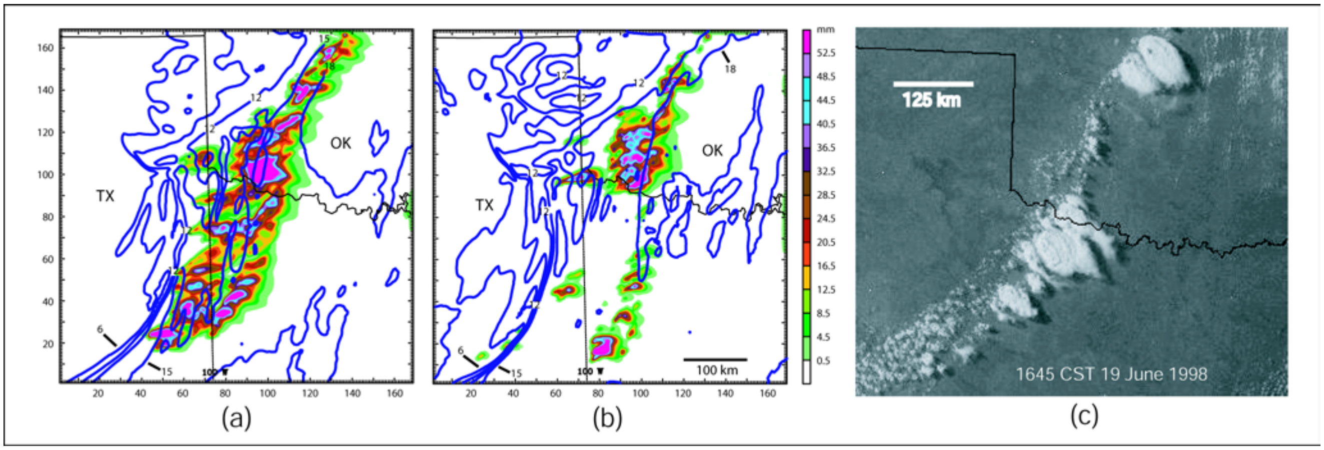
GEWEX NEWS

Published by the International GEWEX Project Office

Richard G. Lawford, Director
Dawn P. Erlich, Editor

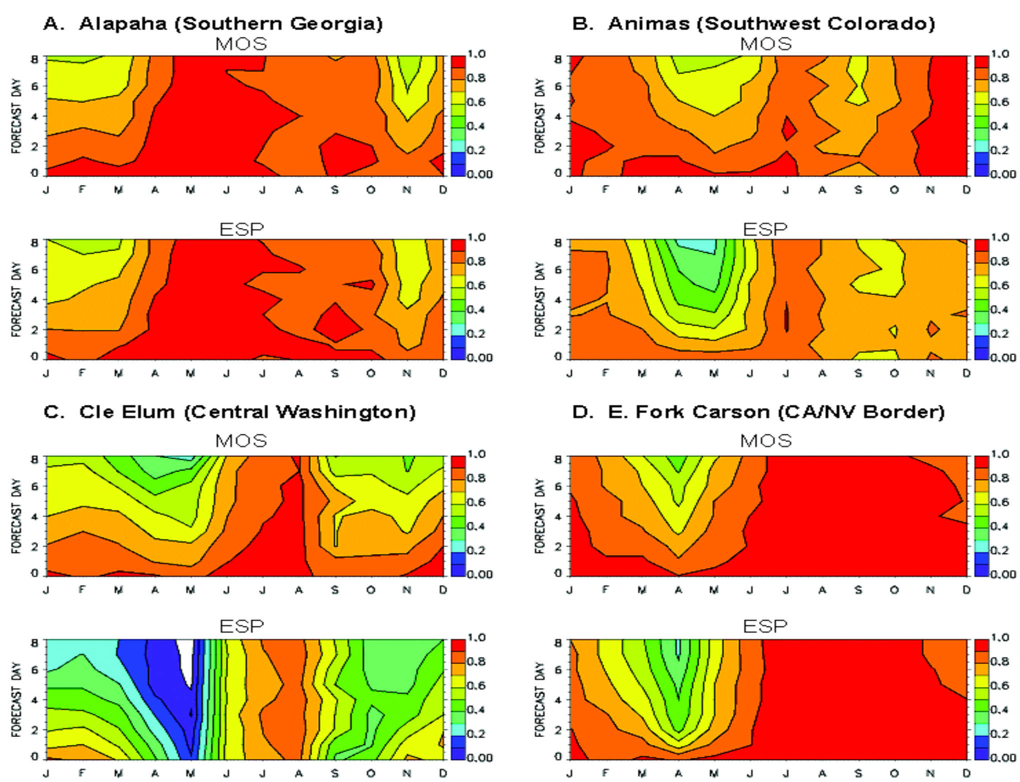
Mail: International GEWEX Project Office
1010 Wayne Avenue, Suite 450
Silver Spring, MD 20910, USA
Tel: (301) 565-8345
Fax: (301) 565-8279
E-mail: gewex@gewex.org
WWW Site: http://www.gewex.org

THE ROLE OF FINE-SCALE LANDSCAPE AND SOIL MOISTURE VARIABILITY IN THE INITIATION OF DEEP CONVECTION



Simulated 3-h precipitation from 1500 to 1800 CST 19 June 1998, color coded at 4-mm intervals starting at 0.5 mm, and 1500 CST 19 June surface water vapor mixing ratio in blue contours, with 3-g kg^{1} intervals starting at 6-g kg^{-1}, for the MM5 3-km domain: (a) MM5 simulation initialized with HRLDAS soil moisture. (b) MM5 simulation initialized with NCEP EDAS soil by moisture. (c) GOES-8 visible satellite imagery for 1645 CST 19 June 1998. *See article on page 9.*

ENSEMBLE STREAMFLOW FORECASTING IN SNOWMELT DOMINATED RIVER BASINS



The Ranked Probability Skill Score for probabilistic streamflow forecasts for each forecast lead time and month, using synthesized ensembles from downscaled Numerical Weather Prediction (NWP) model output (MOS), and the climatological control case in which historical data were used to construct the forecast ensemble (ESP). Results are shown for four hydrologically diverse river basins in the contiguous United States: (a) the Alapaha (southern Georgia, 3626 km^2), (b) the Animas (southwestern Colorado, 1792 km^2), (c) the Cle Elum (Central Washington, 526 km^2), and (d) the east fork of the Carson (on the California/Nevada border, 922 km^2). Note that downscaled NWP model output improves forecast skill in the Animas, Cle Elum, and the east fork of the Carson during the spring snowmelt period when streamflow in these basins is highest and most variable. *See article on page 4.*