GEWEX WCRP

Global Energy and Water Cycle Experiment

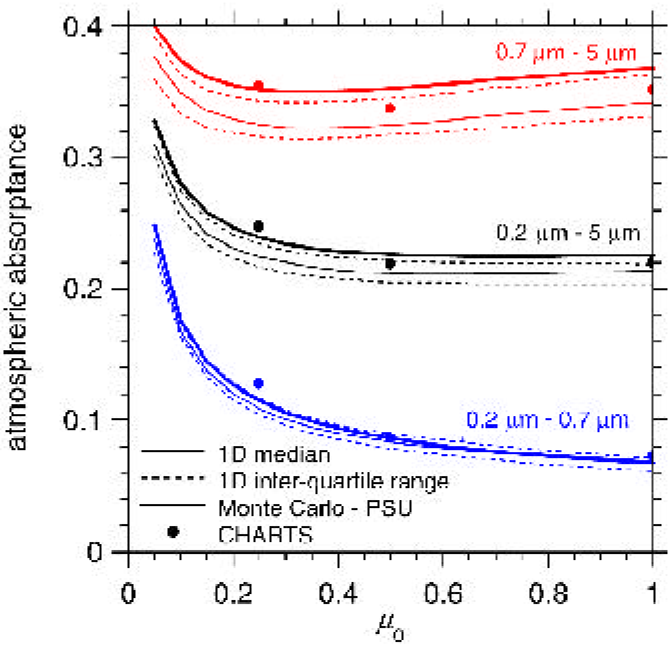
NEWS

Vol. 11, No. 3 August 2001

World Climate Research Programme–WCRP

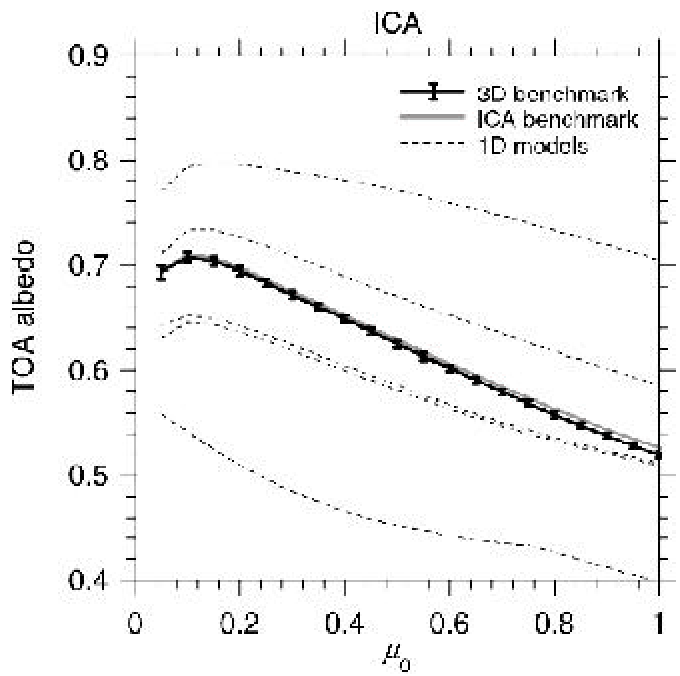
RADIATIVE TRANSFER CODES FROM 25 GCMs SHOW DIFFICULTY IN HANDLING CLOUDS

Overcast Clouds



Broadband atmospheric absorption predicted by solar radiative transfer codes is underestimated in overcast conditions by 20-40 W/m² (even clear skies show underestimates).

Tropical Convective Clouds



Clearly complex but common cloud conditions can cause a wide spread of GCM results. See article on Page 7.

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

(Abbreviated Agenda on Page 6)

IN THIS ISSUE

GEWEX Phase 1 Results Beginning to be Applied Broadly PAGE

COMMENTARY

GEWEX ROLE IN WATER AND WATER CYCLE INITIATIVES

Soroosh Sorooshian, Chairman
GEWEX Scientific Steering Group

As a facilitating organization, WCRP, through its GEWEX program, provides guidance to the sectors of the international research community that are involved with both the hydrometeorological and hydrological aspects of the global water cycle. This has resulted in new global descriptions, improved process representations, and new predictive models of the key elements of the water cycle. While water is a key element in many complex processes of the Earth system (e.g., carbon cycle, food/nutrient/agricultural system, population support), GEWEX has a focused, but not all-encompassing role in the involvement of water in this Earth system.

A critical and particularly important role for GEWEX is to improve predictions of the meteorological elements needed to support water resource users' decisions. Such a role requires a strong understanding of the linkages necessary to support water resource users, but not broad involvement in the full range of water resource functions. This may require several demonstration projects of specific water resource user scenarios. With its GEWEX Hydrometeorology Panel (GHP) and Water Resource Applications Project (WRAP) initiatives, GEWEX is in a great position to define and implement these types of projects. However, the success of these projects and the overall GEWEX contribution to the broader water cycle initiatives depend on our ability to improve spatial resolution and reduce temporal uncertainties in the prediction of several critical meteorological elements, especially precipitation.

The importance of water and the water cycle within the Earth system has been well defined, and numerous organizations worldwide have studied many of its critical elements over the past years. Several new water and water cycle initiatives are now underway (e.g., Joint World Climate Research Programme (WCRP)–International Geosphere-Biosphere Program (IGBP)–International Human Dimensions Programme on Global Environmental Change (IHDP) Water Initiative), and some are attempting to address the full spectrum of water issues ranging from biological/geophysical processes to societal implications. Such a broad spectrum of water issues requires a cooperative and combined effort by many organizations, each with special expertise and a long history of addressing each of these issues. The new initiatives are providing a great opportunity for each of the organizations to work cooperatively with their new partners, and focus their resources on the elements they are most suited to address. As GEWEX fulfils its role and also cooperates with the other organizations, we will improve our ability to predict the water cycle's impact on Earth's climate and water resources.

SEE NEW ISCCP WEBSITE!

New user friendly ISCCP website provides 12–15 years of cloud data ('83–'97). Data are in selected map and plot browse images and with full download capability for the larger data sets.

For more information, see the ISCCP web site at: *http://isccp.giss.nasa.gov/.*

GEWEX NEWS

Published by the International GEWEX Project Office (IGPO)

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@cais.com

WWW Site: http://www.gewex.com

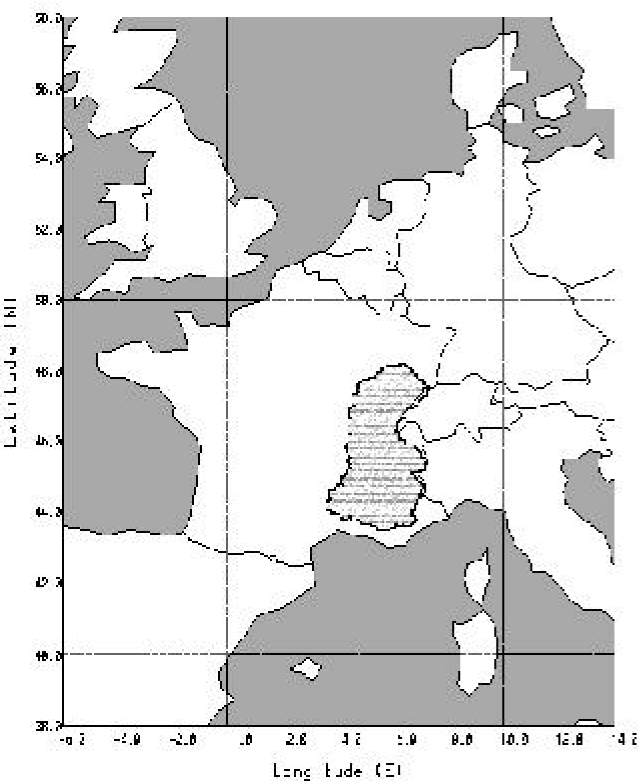
Dr. Paul D. Try, Director, IGPO
Editor: Dr. Paul F. Twitchell
Assistant Editor: Dawn P. Erlich

THE RHÔNE-AGGREGATION EXPERIMENT

Aaron Boone, Florence Habets, and Joel Noilhan

Météo-France/Centre National de Recherche Météorologique, Toulouse, France

The Rhône-AGGregation (Rhône-AGG) Soil-Vegetation-Atmosphere-Transfer (SVAT) model intercomparison project is an initiative within the GEWEX Global Land-Atmosphere System Study (GLASS) (Polcher et al., 2000) Global Soil Wetness Project (GSWP) (Dirmeyer et al., 1999). This project makes use of the Rhône modeling system, which was developed in recent years by the French research community. Three distinct components comprise this system: a distributed hydrological model, an analysis system to determine the near-surface atmospheric forcing and a SVAT model interface. The coupling between the three components of the system is one-way. It was created in an attempt to ensure a consistent dialogue between the atmospheric (precipitation, radiative fluxes, and state variables) and the hydrological variables (evaporation, soil moisture, runoff, ground water and river flow) on a regional scale. The system utilizes high spatial resolution European soil and vegetation databases, but it has been designed such that it is transferable to other regions.



The Rhône basin (86,996 km^2) model domain (hatched area) relative to France and Western Europe.

The entire Rhône model domain size is on the order of that of a coarse-resolution Global atmospheric Climate Model (GCM), but the atmospheric forcing, the soil and vegetation parameters, and the observed river discharges are available at a significantly higher spatial resolution. In addition, there is significant within-basin climate variability and the grid box average altitude ranges over 3000 m. It is then of interest to examine how the simulations from a wide range of SVAT schemes, which are used in GCMs, Numerical Weather Prediction (NWP) models, mesoscale atmospheric models or hydrological models, are impacted by changing the spatial resolution over the domain. **The main goals of the Rhône-AGG are then to examine how various states-of-the-art SVAT schemes are able to simulate the river discharge over several annual cycles** when inserted into the Rhône modeling system, and **to explore the impact of the various scaling or aggregation methods on the simulation of certain components of the hydrological cycle (such as snow cover and surface runoff)**.

The Rhône modeling system was developed in recent years by the French research community (see acknowledgments) with the main goal of this project being the development of an atmospheric interface to a distributed hydrological model applied at a regional scale. It was developed in such a way that it can be transfered to other regions, and it utilizes high spatial resolution European soil and vegetation databases (Habets et al., 1999; Etchevers et al., 2001; Golaz et al., 2001; Ottlé et al., 2001).

This system provides a consistent dialogue between the atmospheric (precipitation, radiative fluxes, state variables) and the hydrological variables (evaporation, soil moisture, runoff, ground water and river flow). Three distinct components comprise the system: a distributed hydrological model, Modélisation Couplée (MODCOU) (Ledoux et al., 1989; Violette et al., 1997), an analysis system to determine the near-surface atmospheric forcing [Système d'Analyse Fournissant des Renseignements Atmosphérique à la Neige (SAFRAN)] (Durand et al., 1993), and a SVAT model interface [Interactions between Soil-Biosphere-Atmosphere (ISBA): Noilhan and Planton 1989; Noilhan and Mahfouf 1996].

The coupling between the three components of the system is one-way. The surface runoff and drainage from ISBA are fed into the MODCOU model at a daily time step. MODCOU then is used to calculate the river routing and the evolution of the water table. It is important to note that the other two components of the system have been developed and calibrated independently of ISBA so that, in principle, different SVAT schemes can easily be inserted into the system.

The Rhône modeling system has been used to successfully simulate the stream flows corresponding to over 100 gauging stations within the basin. In addition, the snow depth was simulated reasonably well compared to observations from 24 sites located within the French Alps (Habets et al., 1999; Etchevers et al., 2001). Due to the relatively high quality of the data set components used for driving and evaluating the system, it is proposed that these data be used by the scientific community at large.

The main objective of this project, is to focus on the problem of parameter aggregation for SVAT schemes that are intended for use in GCMs, atmospheric models or distributed hydrological models. This objective addresses one of the key questions to come out of the La Jolla IGBP/GEWEX workshop (Dolman and Dickinson, 1997), and sets it apart from previous Project for the Intercomparison of Land-surface Parameterization Schemes (PILPS) exercises (Henderson-Sellers et al., 1995).

The Rhône basin is ideally suited for such a test due to the large climatic variability and the significant snow cover. The Rhône-AGGregation experiment is an initiative within the GEWEX/GLASS (Polcher et al., 2000)/GSWP panel of the WCRP, and it is an intermediate step toward GSWP Phase 2. The 4-year simulation period coincides with the GSWP phases 1.0 and 1.5 (1987-1988).

The main scientific questions of Rhône-AGG to be addressed are:

1) How do the various SVAT schemes simulate the discharge compared to the observed values for the entire basin and for various sub-basins for several annual cycles?

2) Are the sub-grid parameterizations for surface runoff and drainage scale dependent? Such parameterizations generally are based on sub-grid variability of topography, precipitation, soil texture/structure, or some combination of the above.

3) How do the varying aggregation methods impact the results? The aggregation methods used by the SVAT schemes can be broadly grouped into three major classifications: mosaic tile approaches, the integration of certain variables over probability distributions, and the use of effective parameters.

4) How does the soil moisture scale fit into the SVAT schemes? And are there general relationships or aggregation rules that may be used or determined?

5) What is the impact of grid resolution on the simulated soil wetness equivalent and the associated snow melt runoff? Are the parameterizations for interactions with vegetation (albedo, roughness) and the parameterization of Fractional Snow Covered Area scale dependent? What is the impact of using area-averaged forcing?

Experiments

Three experiments have been designed in order to address the posed science questions. The timeline for data distribution and the collection of results is shown in Table 1. Preliminary results will be presented at the Rhône-AGG Workshop, and the possibility of doing additional experiments will be discussed.

Table 1. Schedule for Data Distribution, Return of Results and a Workshop

DATE	ACTION
May 2001	Input data distribution by CD
September 2001	Collection of outputs on CD
End of October 2001	First analysis of results; joint workshop with GSWP 1.5

The first or control experiment consists of running the SVAT scheme on the 8 x 8 km grid. SVAT model simulated surface runoff and baseflow (or drainage) will be used to calculate the river discharge using the MODCOU model at CNRM. The results will be compared to the daily observed stream-flow at various gauging stations. The modeled snowpack depth will also be compared with the observations, and the various model results will be intercompared. This simulation will serve as the high resolution baseline result.

The second experiment consists of three simulations at two different grid resolutions. In the first test each SVAT scheme is to be run over the same 4-year period for the 20 sub-areas of the Rhône basin. The boundaries for each of these areas is determined using a 1 x 1 degree grid (which is consistent with the grid configuration used by the GSWP). The second test consists of running the scheme in the same manner as in the first test, but for an intermediate spatial scale grid which consists of 60 approximately 0.5 x 0.5 degree boxes. A third test consists of running the scheme in the same manner and grid configuration as in the first test, but using the dominant surface-type parameters only.

The water cycle is then to be simulated for three sub-catchments within the Rhône basin as in the second test, so that this experiment consists in running the SVAT model for three separate stand-alone or point simulations. The main interests of this experiment are that the basin-scale simulated discharge can be directly compared to the observations since the computational areas correspond to the contributing area of each basin (as opposed to an atmospheric model mesh), and the basins comprise three distinct climate regimes: a low-mountainous basin with light snowfall and heavy convective rainfall in the summer, a relatively low relief continental climate basin, and a relatively high altitude alpine basin. The various SVAT model aggregation methods will be evaluated and intercompared in order to examine if they differ in terms of their scale-dependency.

Acknowledgements: *The authors would like to thank all their colleagues at the many French laboratories that have participated in the development of the Rhône modeling system (BRGM, CEMAGREF, CETP, CIG, LTHE, Météo-France/CNRM and CEN). This work was supported by the Program National d'Etude du Climat (PNEC: National Climate Study Program), and by the Program National de Recherches en Hydrologie (PNRH: National Program for Hydrological Research). IFEN, INRA, the Banque Hydrologie, the French Environment Ministry and Météo-France provided the land-cover, soil, river flow and atmospheric databases. We also wish to thank Jan Polcher for many useful discussions related to the experimental design of this project. In addition, we wish to thank Paul Dirmeyer for making this experiment a sub-set of GSWP 1.5.*

References

Dirmeyer, P. A., A. J. Dolman, and N. Sato, 1999. The Global Soil Wetness Project: A pilot project for global land surface modeling and validation. *Bull. Amer. Meteor. Soc.*, 80, 851-878.

Dolman, H., and R. Dickinson, 1997. Land-Surface parameterizations/soil vegetation-atmosphere transfer schemes workshop, Conclusions and working group reports. IGPO Series Pub. No. 31, 80 pp.

Durand, Y., E. Brun, L. Mérindol, G. Guyomarc'h, B. Lesaffre, and E. Martin, 1993: A meteorological estimation of relevant parameters for snow schemes used with atmospheric models. *Ann. Glaciol.*, 18, 65-71.

Etchevers, P., C. Golaz and F. Habets, 2001. Simulation of the water budget and the river flows of the Rhône basin from 1981 to 1994. *J. Hydrol.*, 244, 60-85.

Golaz C., P. Etchevers, F. Habets, E. Ledoux and J. Noilhan, 2001. Comparison of two hydrological simulations of the Rhône basin, *Phys. and Chem. of the Earth*, 26, (in press).

Habets, F., P. Etchevers, C. Golaz, E. Leblois, E. Ledoux, E. Martin, and C. Ottlé, 1999. Simulation of the water budget and the river flows of the Rhône basin. *J. of Geophys. Res.*, 104, 31, 145-31, 172.

Henderson-Sellers, A., A. Pitman, P. Irannejad, 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.

Ledoux, E., G. Girard, G. de Marsilly, J. Deschenes, 1989. Spatially distributed modeling: conceptual approach, coupling surface water and ground water, NATO, ASI Series C, Vol. 275, Ed. by Morel-Seytoux, pp. 435-454 Kluwer Acad., Norwell, Mass.

Noilhan, J., and S. Planton, 1989. A simple parameterization of land surface processes for meteorological models. *Mon. Wea. Rev.*, 117, 536-549.

Noilhan, J., and J.-F. Mahfouf, 1996. The ISBA land surface parameterization scheme. *Global and Plan. Change*, 13, 145-159.

Ottlé, C. and Co-authors, 2001. Hydro-Meteorological modelling of the Rhône basin: general presentation and objectives, *Phys. and Chem. of the Earth*, 26, (in press).

Polcher, J., P. Cox, P. Dirmeyer, H. Dolman, H. Gupta, A. Henderson-Sellers, P. Houser, R. Koster, T. Oki, A. Pitman and P. Viterbo, 2000. GLASS: Global Land-Atmosphere System Study. *GEWEX News*, WCRP, 10(2), 3-5.

Violette, S., E. Ledoux, P. Goblet, and J. P. Carbonnel, 1997. Hydrologic and thermal modeling of an active volcano: the Piton de la Fournaise, Reunion. *J. Hydrol.*, 191, 37-63.

New International Precipitation Working Group (IPWG)

First row, left to right, Dr, A. Gruber, Dr. J. Schmetz, Dr. V. Levizzani, Mr. K. Ohta, Dr. D. Easterling, Ms. T. Koyama, Dr. D. Hinsman
Second row, left to right, Dr. E. Smith, Mr. R. Carbone, Dr. C. Kummerow, Dr. T. Vonder Haar, Dr. J. Purdom, Dr. P. Menzel

Attendees at the first session of the IPWG (20-22 June 2001), a permanent Working Group of the Coordination Group for Meteorological Satellites (CGMS). The IPWG will focus the scientific community on operational and research satellite based quantitative precipitation measurement issues and challenges. It will provide a forum for operational and research users of satellite precipitation measurements to exchange information on methods for measuring precipitation and the impact of space borne precipitation measurements in numerical weather and hydrometeorological prediction and climate studies.

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

Institut Pierre Simon Laplace, Collège de France, Paris, France
10-14 September 2001

ABBREVIATED AGENDA

Monday, 10 September 2001

0730-0900 Conference Registration

OPENING SESSION: Chair: Dr. David Carson, Director, World Climate Research Programme

0900-1130 Welcoming Remarks – Prof. Xavier Le Pichon, Collège de France
Dr. Jean Louis Fellous, CNES

Introduction to the Conference – Prof. Gérard Mégie, Institut Pierre Simon Laplace, Conference Co-Chair
Prof. Soroosh Sorooshian, University of Arizona, Conference Co-Chair

Keynote Address – Dr. András Szöllösi-Nagy, Director, Division of Water Sciences and Secretary of the International Hydrological Programme, UNESCO

Posters/Break

Special Invited Presentation – Prof. Pierre Morel, University of Maryland

CONFERENCE THEME SESSIONS BEGIN

Theme: Microphysics of Clouds and Cloud/Aerosol Interactions for Parameterizations within Atmospheric Models
(Session Chairs: Robert Schiffer, NASA and Ulrich Schumann, DLR)

1130–1230 Opening Presentation – Lean-Luc Redelsperger, Météo-France
1230–1400 Lunch
1400–1800 Oral Presentations/Poster Introductions/Poster Session
1900 Reception at Muséum National d'Histoire Naturelle, Le Grande Galerie de l'Évolution

Tuesday, 11 September 2001

Theme: Hydrology and Water Resource Impacts from Catchment to Global Scales
(Session Chairs: Eric Wood, Princeton University, and Katia Laval, LMD)

0830-1800 Opening Presentation – Richard G. Lawford, NOAA Office of Global Programs
Oral Presentations/Poster Introductions/Poster Session

Wednesday, 12 September 2001

Theme: The Carbon and Water Cycles and their Interaction with the Climate System
(Session Chairs: Robert Dickinson, Georgia Institute of Technology, and Philippe Ciais, IPSL/LSCE)

0830-1800 Opening Presentation – Richard A. Betts, Hadley Centre
Oral Presentations/Poster Introductions/Poster Session

Thursday, 13 September 2001

Theme: The Global Water Cycle and its Sensitivity to Climate Change
(Session Chairs: Tetsuzo Yasunari, University of Tsukuba and Ronald E. Stewart, Meteorological Service of Canada)

0830–1800 Opening Presentation – Graeme L. Stephens, Colorado State University
Oral Presentations/Poster Introductions/Poster Session

Friday, 14 September 2001

Theme: Remote Sensing and Land-Surface Processes
(Session Chairs: Paul Ingmann, ESTEC, and Carlos Nobre, CPTEC-INPE)

0830–1800 Opening Presentation – Massimo Menenti, Universite Louis Pasteur
Oral Presentations/Poster Introductions/Poster Session
1800 Conference Ends

NEW TYPE OF NWP OUTPUT FOR CEOP

The scientific planning for the Coordinated Enhanced Observation Period (CEOP) has participants from several WCRP projects (e.g., GEWEX, CLIVAR, CliC, etc.), and Numerical Weather Prediction (NWP) centers. One of the key CEOP objectives is the compilation of a series of time coincident data sets. For example, during the CEOP period (2001-2003), *in situ* and satellite observations, model output, and reanalysis products will be assembled into collective data designed for ease of analysis. These data will be used in the development of improved understanding of energy and water cycle processes in three spatial scales (local, regional, and global.) Data obtained during CEOP will include, at the local scale, both *in situ* (conventional and research tower data), satellite (level IB, II and III), and several types of numerical model output.

For studying local processes, energy and water budgets, and model evaluation at the 18 CEOP local reference sites distributed around the globe, a special, high temporal resolution time-series output (containing flux data) generated by NWP centers, will be used. This time series of vertical profiles derived from numerical model output for a specific geographic location is referred to as a Model Output Location Time Series (MOLTS). For example, MOLTS can be developed from a single model run by using the output from the 4DDA (t=0), and the output at hourly, or more frequent intervals for the total length of the forecast run.

For regional studies, numerical model time series output of water and energy fluxes with a moderate spatial (e.g., 30 km) and temporal (e.g., 3 hours) resolution would be used for studying a monsoon system or a regional water and energy budget. For global studies (e.g., climate inter-connectivity), model output of water and energy fluxes with spatial (2.0–2.5 degree) and temporal (3–6 hourly) resolution, would be used.

The value of MOLTS data includes: (1) the ability to produce a composite set of the significant variables needed for surface and atmospheric energy and water budget studies (including diagnostic terms of governing equations) at specific sites, with a significantly reduced data volume as compared to deriving these variables at the same sites from gridded numerical model output; and (2) the ability to produce temporally detailed diurnal cycles of the output in (1) above for comparison with the corresponding temporal detail of field observations at the same geographic locations as the MOLTS.

AN INTERCOMPARISON OF 1D SOLAR RADIATIVE TRANSFER CODES: FROM SIMPLE TO COMPLEX CLOUDY ATMOSPHERES

Howard W. Barker[1] and Graeme L. Stephens[2]

[1]Environment Canada, Downsview, Ontario, Canada
[2]Colorado State University, Fort Collins, Colorado, USA

Earth's climate depends much on interactions between radiation and clouds. However, such interactions are not represented well in Large-Scale Atmospheric Models (LSAM). Assessments of cloud-radiative feedbacks in LSAMs (Cess et al., 1996; 1997) suggest that different representations of cloud-related processes may account for much of the uncertainty associated with estimates of climate sensitivity and climatic change. Moreover, the InterComparison of Radiation Codes in Climate Models (ICRCCM) Programme (Fouquart et al., 1991), supported by the GEWEX Radiation Panel, demonstrated that when 1D solar radiative transfer codes operated on the same simple atmospheric profiles, the range of estimated fluxes often exceeded 20 percent. **Ten years after ICRCCM, it is still entirely unknown to what extent differences in LSAM cloud-radiative feedbacks are due to treatments of cloud physics and radiative transfer for cloudy atmospheres.**

Owing to computational limitations, grid-spacings in LSAMs typically exceed 100 km so unresolved processes must be parametrized. Currently, most LSAM radiation codes assume that clouds are horizontally homogeneous and follow systematic rules for overlap. Numerous studies have shown that these assumptions can significantly bias estimates of domain-averaged fluxes (e.g., Barker et al., 1999). Thus, it seems timely to initiate a follow-on to ICRCCM and assess how well 1D solar codes interpret and handle multiple layers of non-overcast clouds.

The primary objective of this study is to assess how well 1D solar codes predict broadband fluxes when they operate on partially cloudy, 1D atmospheres derived from 3D cloud-resolving model (CRM) simulations. A limited number of clear-sky and homogeneous overcast cases were considered. An elaboration on the methodology and results shown here can be found in Barker et al. (2001).

Results were submitted for 25 1D solar codes and four 3D Monte Carlo (MC) codes. Most participants completed calculations for 12 atmospheric profiles. Participants provided top-of-atmosphere (TOA) albedo (α_p), total atmospheric absorptance (a_{atm}), and surface absorptance (a_{sfc}) integrated spectrally for wavelength intervals [0.2, 0.7] μm, [0.7, 5.0] μm, and [0.2, 5.0] μm. Upwelling and downwelling fluxes were also provided at each model level for the spectral range [0.2, 5.0] μm at cosine of solar zenith angles μ_0 = 0.25, 0.5, and 1.0. To simplify the process and include as many models as possible, all clouds were treated as though they consisted of pure liquid spheres with effective radius 10 µm (even when it was clear, there were ice crystals).

Establishing reliable benchmark fluxes is essential. The first stage involved simple atmospheres where a line-by-line (LBL) model was designated as the ultimate benchmark (the CHARTS model of Mlawer et al., 2000). The MC codes were then compared to the LBL for simple conditions before proceeding to the CRM cases. In most cases, MC and LBL estimates of α_p, a_{atm}, and a_{sfc} rarely differed by more than ~5 percent.

Results

The left panel of the figure on page 1 shows the 50 percent quartile, or median (thin solid line), as well as the 25 percent and 75 percent quartiles (dashed lines) for α_p predicted by 1D models as a function of μ_0 for low overcast atmosphere. The three spectral ranges are color-coded. Also shown are benchmark values for one of the MC codes and the CHARTS LBL model. From these, the median 1D model underestimates atmospheric absorption at overhead sun by ~20 Wm^{-2} (the maximum being 40 Wm^{-2}). Most of this comes from wavelengths longer than 0.7 µm with much of it attributable to 1D codes lacking a water vapour continuum (e.g., Arking, 1999). It is somewhat surprising that 1D codes still underestimate a_{atm} this much and exhibit about the same range of response that they did 10 years ago at the completion of ICRCCM.

Also for low overcast (CLOUD A) panel (c) (see figure on next page), the estimated TOA, shows that most 1D models overestimate α_p for most values of μ_0. This is likely due to at least two factors. First, multiple scattering by droplets enhance photon pathlengths in and below the cloud layer and given that 1D estimates of clear-sky a_{atm} are too small for all μ_0, they remain small for cloudy cases too. Second, many 1D codes employ Slingo's (1989) parametrization for cloud optical properties. As shown in Barker et al. (2001), Slingo's parametrization underestimates asymmetry parameter by 0.01 to 0.02 over much of the solar spectrum and this will boost cloud albedo. The fact that 1D estimates of α_p for small μ_0 come into line with the MC may stem from widespread use of delta two-stream approximations that are known to underestimate cloud albedo at small μ_0. Coupling this with too little atmospheric absorption leads fortuitously to good results.

The range of 1D results and magnitude of underestimation relative to CHARTS for a_{atm} (shown on page 1 left panel, and panel d on next page), is about the same for CLOUD A as for CLEAR. The reason that they are not greater relative to CLEAR may be due to the popularity of Slingo's parametrization (restricting the range of responses) which may underestimate droplet single-scattering albedo (thereby recovering some lost cloudless-sky absorption).

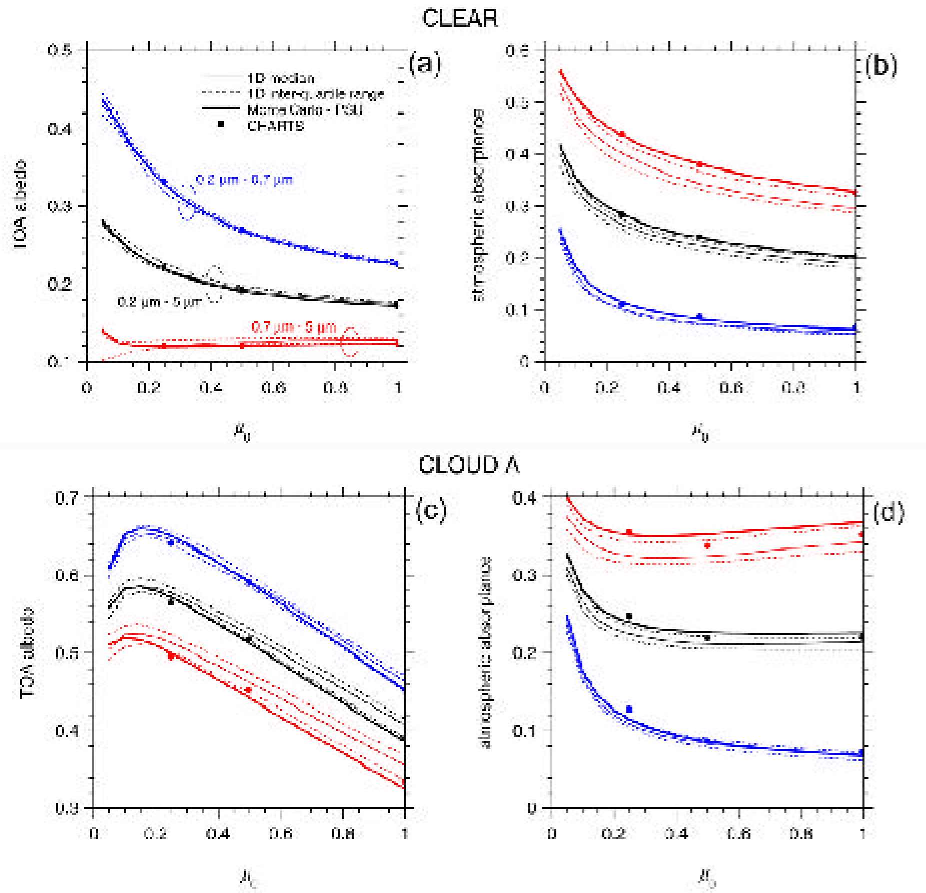
The figure on page 10 shows broadband α_p as a function of μ_0 for three CRM fields. Each field has three plots that correspond to different genres of handling unresolved clouds within 1D codes. Each plot shows 1D model results, respective conditional benchmarks, and means and standard deviations generated by four MC codes acting on the full 3D CRM fields. ATEX was a thin boundary layer cloud with domain size (6.8 km)^2 and horizontal grid-spacing Δx of 100 m (B. Stevens, personal communication, 1997). GATE A consisted of deep convective clouds (less the cirrus anvil), and GATE B (see right panel on page 1, and lower left panel on page 10), was a tropical squall-line with an extensive anvil (Grabowski et al., 1998). Both had domain sizes of (400 km)^2 and Δx =2 km.

The 1D codes classed as 'ICA' attempt to account for horizontal fluctuations of cloud and possibly overlap. The ICA benchmarks track the full 3D values. Some of these codes are in experimental mode and so exhibit wide ranges of performance from case to case. The 1D codes classed as 'exact overlap' attempt to overlap plane-panel homogenous clouds in manners resembling the CRM fields. Note that the exact overlap benchmark is almost always more reflective than the full 3D; the exception being at low μ_0 where cloud side illumination elevates full 3D α_p. They are, however, always greater than the ICA benchmarks. The 1D codes of this genre tend to track their benchmark though variance is large; especially for GATE A which put these codes to a stringent test.

Maximum/random overlap is the most populated category. Benchmark estimates of α_p for this genre are always less than those for exact overlap on account of less cloud exposed to radiation. Often, for example ATEX and GATE A, they are even less reflective than ICA. This attests to it being an extreme approximation that can radically underestimate total cloud fraction. Nevertheless, corresponding 1D codes tend to follow, though almost always underestimate their benchmark (the three most reflective 1D codes are also the three most reflective in the simple cases too). **It should be noted that if codes in this class were to include the effects of horizontal variability, their estimates of a $_p$ would be even smaller than shown here.**

Conclusions

The few clear-sky and homogeneous overcast cloud cases considered here revealed that the majority of 1D codes in use today underestimate atmospheric absorption of solar radiation. For overhead sun and the standard tropical atmosphere, most models underestimate by ~20 Wm^{-2} relative to an LBL code that compares favourably to detailed observations. These er-



Model performances generally diminish as clouds become more complicated. This is expected to have ramifications for cloud–radiation interactions as simulated by global climate models.

rors carry over to, and complicate, complex cloudy cases. Nevertheless, 1D codes treat unresolved clouds more or less the way they intend to and this helped make assessment of different methodologies possible.

The most common class of 1D model in this study is maximum/random overlap of homogeneous clouds. Based on results shown here, a more desirable approach would be to use a general overlap scheme (i.e., from the exact overlap genre) and outfit it with a means of addressing horizontal fluctuations. Very few models, however, consider horizontal variability. Hopefully, this study will fuel more research into these types of 1D codes for it is clear that horizontal variable cloud must be accounted for in 1D codes.

***Acknowledgements*:** Participants in this study were: J. Bergman, B. Bonnel, K. Campana, E. E. Clothiaux, S. Clough, S. Cusack, J. Delamere, J. Edwards, K. F. Evans, Y. Fouquart, V. Galin, Y. Hou, S. Kato, J. Li, E. Mlawer, J.-J. Morcrette, W. O'Hirok, P. T. Partain, P. Räisänen, B. Ritter, E. Rozanov, M. Schlesinger, K. Shibata, P. Sporyshev, Z. Sun, M. Wendisch, and N. Wood. Thanks also to the providers of CRM data: W. Grabowski, V. Grubisic, M. Moncreiff, B. Stevens, and X. Wu.

References

Arking, A., 1999. Bringing climate models into agreement with observations of atmospheric absorption. *J. Climate*, **12**, 1589-1600.

Barker, H. W., G. L. Stephens, and Q. Fu, 1999. The sensitivity of domain-averaged solar fluxes to assumptions about cloud geometry. *Q. J. R. Meteorol. Soc.*, **125**, 2127-2152.

Barker, H. W., + 28 others (see Acknowledgements), 2001. Assessing 1D Atmospheric Solar Radiative Transfer Models: Interpretation and Handling of Unresolved Clouds. To be submitted to *J. Geophys. Res*.

Cess, R. D., et al., 1996. Cloud feedback in atmospheric general circulation models. *J. Geophys. Res.*, **101**, 12,791-12,794.

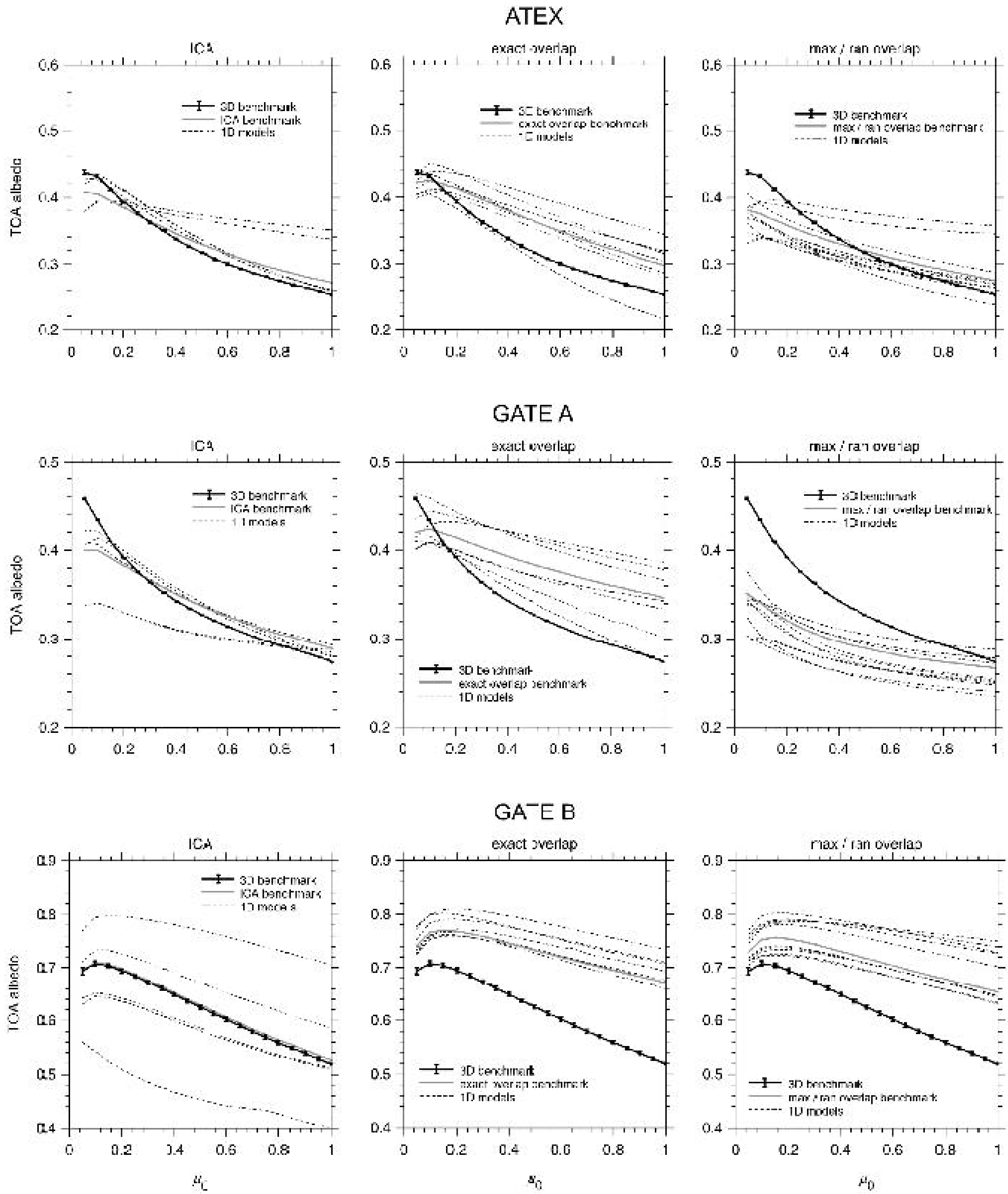
Cess, R. D., et al., 1997. Comparison of the seasonal change in cloud-radiative forcing from atmospheric general circulation models and satellite observations. *J. Geophys. Res.*, **102**, 16,593-16,603.

Fouquart, Y., B. Bonnel, and V. Ramaswamy, 1991. Intercomparing shortwave radiation codes for climate studies. *J. Geophys. Res.*, **96**, 8955-8968.

Grabowski, W. W., X. Wu, M. W. Moncrieff, and W. D. Hall, 1998. Cloud-resolving modeling of cloud systems during phase III of GATE. Part II: Effects of resolution and the third spatial dimension. *J. Atmos. Sci.*, **55**, 3264-3282.

Mlawer, E. J., P. D. Brown, S. A. Clough, L. C. Harrison, J. J. Michalsky, P. W. Kiedron, and T. Shippert, 2000. Comparison of spectral direct and diffuse solar irradiance measurements and calculations for cloud-free conditions. In press *Geophys. Res. Lett.*, **27**, 2653-2658.

Slingo, A., 1989. A GCM parameterization for the shortwave radiative properties of water clouds. *J. Atmos. Sci.*, **46**, 1419-1427.



Upper row shows plots of broadband TOA albedos a_p as functions of m_0 for the ATEX cloud field. The title of each plot indicates genre of cloud treatment by 1D clouds. Each plot shows the mean and standard deviation of full 3D benchmarks as computed by four Monte Carlo codes (heavy solid lines), the conditional benchmark computed by one of the Monte Carlo codes (heavy gray lines), and all the 1D codes in a particular class (dashed lines). Middle and lower rows are as in the upper row except they correspond to the GATE A and GATE B cloud fields.

FIRST USE OF ALMA IN PILPS 2e

(ALMA-AN INFRASTRUCTURE FOR GLASS)

Jan Polcher[1], Laura Bowling[2] and Dennis Lettenmaier[2]

[1]Laboratoire de Météorologie Dynamique du CNRS
[2]University of Washington, Seattle, Washington, USA

The GEWEX Land-Atmosphere System Study (GLASS) Project has set up an infrastructure project in order to support the four areas of land-surface scheme intercomparisons it coordinates. The aim is to provide the community with the means to perform efficiently the experiments proposed under GLASS. **The first task performed by the Assistance for Land-surface Modeling Activities (ALMA) was to set up standards for data exchange. This article reports on its first use in the PILPS 2e experiment** (see May 2000 issue of *GEWEX News*, and page 14 in this issue) and the improvements which have been made in preparation of the next experiment, the Rhône AGGregation Experiment (see page 3). ALMA also aims to provide the community with general diagnostic tools for the analysis of results and standard interfaces for the coupling of land-surface schemes with atmospheric models.

During the design of the PILPS 2e experiment, ALMA defined the data exchange convention. This required deciding on a data format (netCDF), but more importantly, choosing a meta-data convention that allows unambiguous description of the data in files exchanged within the land-surface modelling community. To facilitate the design of intercomparison experiments, the definitions, sign conventions, names, and units of the forcing variables for the land-surface schemes were selected. In addition, an extensive list of possible output variables was established. The idea is that intercomparison experiments can then choose from this list the variables they wish to see reported by their participants. This ensures that all experiments will use the same units, sign conventions and that the definitions of output variables do not change from one study to the next.

For many of the PILPS 2e participants this was their first encounter with the netCDF data format. For the experiment coordinators and ALMA, it was the first time that the definitions of the selected output variables were used.

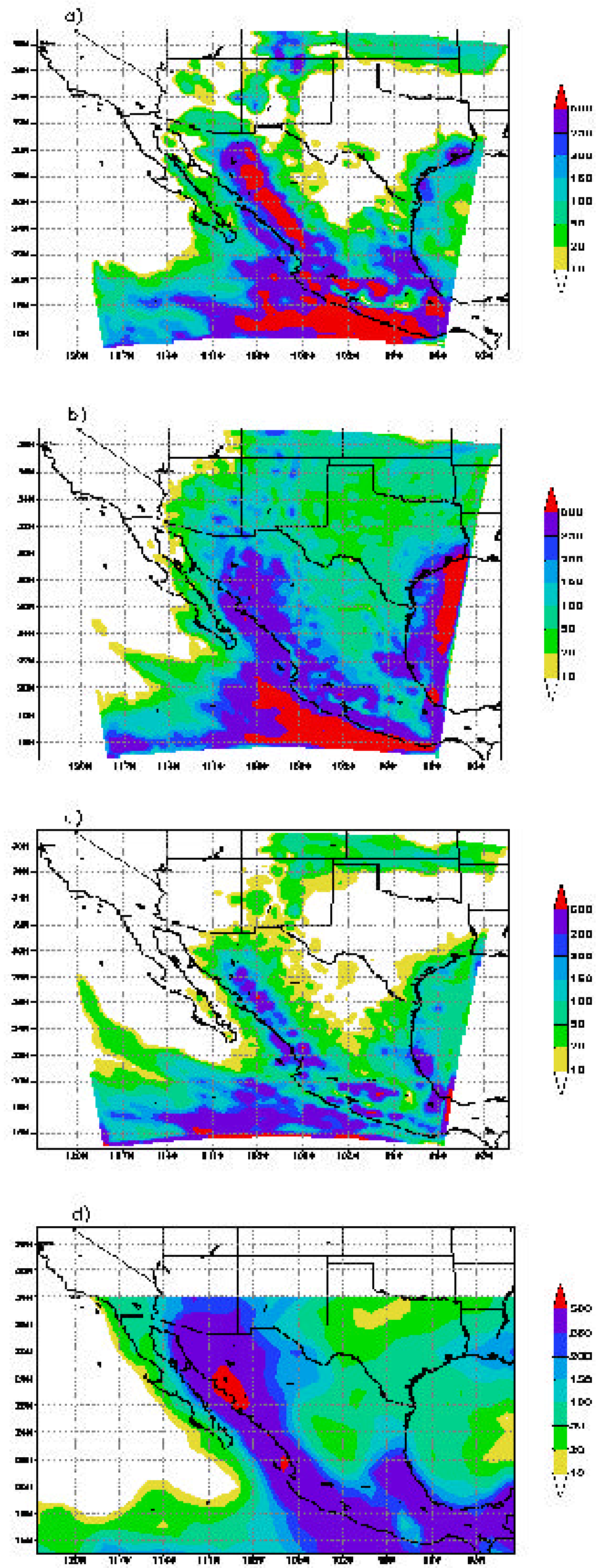
The response of the PILPS 2e users to the data exchange convention generally varied in relation to their previous familiarity with the netCDF data format, or similar formats like GRIB, and according to their access to computer resources. When asked about the use of netCDF, participant responses varied between "perfect" and a "flexible and good data format for running Land Surface Models (LSMs)" to "a huge problem to deal with in terms of computer time" and "very unwieldy and unnecessarily complex for this type of study." Of the 15 participants who responded to survey questions regarding the use of netCDF posed by the PILPS-2e organizers, seven acknowledged difficulties using netCDF for the first time, but expressed positive feelings regarding the continued use of the format. Four modeling groups expressed only positive feedback, whereas four of the groups seemed to find little benefit in the use of netCDF. Nevertheless, only one modelling group returned files with errors that could be directly attributed to unfamiliarity with the netCDF format.

The variable definitions resulted in some confusion, which was addressed through a web site of frequently asked questions (*www.hydro.washington.edu/Lettenmaier/CurrentResearch/PILPS-2e/index.htm)*. Despite these efforts, 62 percent (13 of 21) of the models participating in PILPS 2e had some problem with the definition of variables that prevented the closure of either the water or energy balance.

Although the PILPS 2e coordinators were not able to reap the full benefits of the ALMA conventions which were intended to reduce definition errors, they found the netCDF data format to be quite powerful. The self-describing file format made it possible to make diagnostic plots quickly, as the results were received, and to verify that variables were spatially coherent and reasonably defined. Freely available software and utilities designed for use with netCDF simplified the analysis of problem data sets and the production of over 120 diagnostic plots for the experiment workshop. Each model produced over 6 GB of output. In the case of one model, the output files were not received until the Saturday before the beginning of the workshop on Monday, but summary plots, including the late model output, were available to model participants at the beginning of the workshop. The coordinators were left with the impression that the number of format-related errors was reduced and the preparation of diagnostic information was simplified in this experiment as compared to previous PILPS phases.

A number of groups have provided the programs they have written to run their land-surface schemes with the ALMA convention. This code is now available in the software bazaar. It provides examples that can either be used as they are for other schemes or as a source of inspiration for the development of original solutions. To facilitate the exchange of information between participants of

(continued on page 14)



Average precipitation (in mm) for July 1999 given by MM5 using (a) the Grell, (b) Betts-Miller, and (c) Kain-Fritsch schemes, and (d) from the PERSIANN system.

NORTH AMERICAN MONSOON RAINFALL AND FLOWS RESPOND TO REPRESENTATION OF DEEP CONVECTION

David J. Gochis, W. James Shuttleworth, and Zong-Liang Yang

Dept. of Hydrology and Water Resources, University of Arizona, Tucson, USA

The adequate representation of convective processes is important in regional climate models and is particularly important when representing monsoon systems, but there is currently no universally accepted framework for representing convection in models with grid scales that prohibit their fully explicit representation. This article describes the results of an investigation (Gochis et al., 2001) of the sensitivity of the Pennsylvania State/NCAR MM5 model (Version 3.4) to convective precipitation processes. The investigation was carried out as a precursor for the upcoming North American Monsoon Experiment (NAME), being an important component of the GEWEX Americas Prediction Project (GAPP).

The convective parameterization schemes of Betts-Miller as implemented by Janjic (Betts 1986, Betts and Miller, 1986; Janjic, 1994), Grell (Grell, 1993; Grell et al., 1994), and Kain-Fritsch (Kain and Fritsch, 1990) were tested with MM5 running in a pseudo-climate mode from 16 May through 1 August 1999. A two-way interacting nested configuration with grid scales 90 km and 30 km was used, with the coarse grid domain covering approximately 125°W – 85°W and 10°N – 45°N, and the fine grid domain covering most of Mexico and the Southwestern United States. Atmospheric lateral boundary conditions for the coarse domain were taken from the NCEP/NCAR re-analysis data (Kalnay et al., 1996) and sea-surface temperatures taken from the Reynolds and Smith (1994) data, linearly interpolated to 6-hourly values. Because assumptions in the Grell and Kain-Fritsch formulations preclude their application at the grid scale of the coarse domain, the Betts-Miller scheme was in each case used for the coarser (90 km) grid. The model output was saved every 3 hours and model results for the initial phase of the 1999 North American Monsoon (NAM) were compared with each other, with surface climate station observations, with data from seven radiosonde sites, and with selected remotely sensed data.

The figure on this page shows the spatial distribution of modeled precipitation from the three simulations along with a satellite-derived estimate of precipitation from the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN) system (Sorooshian et al., 2000). The Kain-Fritsch scheme produces more extensive precipitation than the other schemes and, in general, appears to have better overall agreement with the PERSIANN estimates. The three schemes give substantial differences in the magnitude of the modeled rainfall over many subregions of the NAM region, notably in Arizona and New Mexico, the Sierra Madre Occidental, the central Mexican plateau, and near southern Mexico. Modeled precipitation was also compared with daily total rainfall observations from Douglas (2001) in Mexico and from the cooperative climate station network in the U.S. Gochis et al. (2001) report large, statistically significant subregional differences between the three simulations, strongly confirming the sensitivity of the regional monsoon precipitation pattern to the representation of deep convection.

Gochis et al. (2001) also compared the monthly mean profiles for July of temperature, specific humidity, equivalent potential temperature, and wind calculated by the model with observations at seven sounding stations (Chihuahua, Guaymas, Mazatlan, Manzanillo, Guadalajara, Tucson, Del Rio). The Grell scheme consistently produced a modeled atmosphere that was cooler and drier than observed, especially at mid levels and at the northernmost stations, as did the Betts-Miller scheme, although in this case the difference was less pronounced. Comparison of equivalent potential temperature errors with height suggests that the Grell scheme tends to yield a less stable atmosphere compared to observations while the other two schemes did not show such a consistent tendency. All the simulations underestimated the low-level *v* component of the wind, and all simulations exhibited difficulty in simulating the low-level *u* component of the wind when compared to pilot balloon observations taken from the northern Gulf of California. Overall, the Kain-Fritsch scheme appeared to yield a modeled atmosphere that most resembled the radiosonde observations.

Arguably the aspect of the Gochis et al. (2001) study that is most significant in the context of **NAME are the general results that (a) very substantial differences in the precipitation distributions are generated when using different convective precipitation schemes in MM5, and (b) these differences are associated with striking differences in average atmospheric flow patterns within the North American Monsoon system, (July-average) modeled, surface-to-600 Pascal integrated moisture flux streamlines, and total column precipitable water content given by the three schemes**. There are markedly different circulation patterns between the three simulations, the most significant being in the critical core monsoon region of the Gulf of California. In the Kain-Fritsch simulation, moisture is transported from well south of the mouth of the Gulf of California northward into the convective regions over the Sierra Madre Occidental and onwards into southern Arizona and New Mexico. The Betts-Miller simulation has a similar flow (see back page), but with a much larger westerly component, while the simulation using the Grell scheme develops a very different streamline pattern that inhibits northward flow over much of the Gulf of California (shown on back page). It is likely that differences in the moisture transport fields and differences in local moisture cycling are responsible for the discrepancy between the underlying precipitable water fields.

On the basis of this study, it is evident that the representation of convection in regional climate models has a strong influence not only on local, model-estimated precipitation, but also on the simulated circulation patterns within the NAM. This suggests that improving the representation of convective precipitation in forecast models, especially in regions with significant topography and especially in the core monsoon region, is an important priority for GAPP within NAME.

References

Betts, A.K., 1986. A new convective adjustment scheme. Part I: Observational and theoretical basis. *Q. J. R. Met. Soc*., 112, 677-691.

Betts, A.K., and M.J. Miller, 1986. A new convective adjustment scheme. Part II: Single column tests using GATE wave, BOMEX, ATEX and arctic air-mass data sets. *Q. J. R. Met. Soc*., 112, 693-709.

Douglas A.V., 2001. Unpublished data. Email: *sonora@creighton.edu.*

Gochis, D.J., W.J. Shuttleworth and Z-L Yang, 2001. Sensitivity of the modeled North American Monsoon regional climate to convective parameterization. *Submitted to Mon. Wea. Rev*, May 2001.

Grell, G.A., 1993. Prognostic evaluation of assumptions used by cumulus parameterizations. *Mon. Wea. Rev*., 121, 764-787.

Grell, G.A., J. Dudhia, and D.R. Stauffer, 1994. A description of the fifth generation Penn State/NCAR mesoscale model (MM5). NCAR Tech. Note NCAR/TN-380+STR, 138pp.

Janjic, Z.I., 1994. The step-mountain eta coordinate model: Further developments of the convection, viscous sublayer, and turbulence closure schemes. *Mon. Wea. Rev*., 122, 927-945.

Kain, J.S. and M. Fritsch, 1990. A One-dimensional entraining/detraining plume model and its application in convective parameterization. *J. Atmo. Sci.*, 47, 2784-2802.

Kalnay and Coauthors, 1996. The NCEP/NCAR Reanalysis Project. *Bull. Amer. Meteor. Soc.*, 77, 437-471.

Reynolds, R.W. and T.M. Smith, 1994. Improved global sea surface temperature analyses. *J. Climate*, 7, 929-948.

Sorooshian, S, K.L. Hsu, X. Gao, H.V. Gupta, B. Imam, D. Braithwaite, 2000. Evaluation of PERSIANN system satellite-based estimates of tropical rainfall. *Bull. Amer. Meteor. Soc*, 81, 2035-2046.

(continued from page 11)

GLASS experiments an e-mail discussion group has been created. The mode of functioning is described on the ALMA web page (*http://www.lmd.jussieu.fr/ALMA*). It is hoped that it will provide quick help for users of the ALMA convention and encourage the exchange of code and expertise.

The ALMA convention as it was used in PILPS-2e contained a few errors and misleading definitions. In order to correct for this and allow the introduction of new variables a second version of the convention has been introduced. The first version will remain available as a reference and to facilitate the transition to the second version a detailed description of the changes has been made. Most of the corrections that were made deal with the consistency within the list of variables. Definitions of some variables like surface temperature for instance, needed to be reformulated in order to assure that they are understood correctly.

New variables have been introduced so that processes represented by some schemes can be documented for the intercomparison projects. For instance, it is now possible to close the budget of liquid water in the snow pack from the list of variables in the ALMA convention. The three-dimensional structure of snow can also be archived now. **In order to allow future GLASS experiments to validate the output of the schemes with satellite observations of surface processes a new table dedicated to this topic has been created including variables that can be diagnosed from surface schemes and correspond to standard products obtained by remote sensing. The first variable in this new table is the upward long wave flux as it is computed by the International Satellite Cloud Climatology Project (ISCCP).**

The first application of the ALMA convention clearly demonstrated its potential. The PILPS 2e experience showed that the participating land-surface modellers had to adapt their working environment to the new way of exchanging data, and this "overhead" no doubt limited the benefits that were realized in this first application. For subsequent experiments, only small changes to the PILPS 2e setup will be needed, and this should greatly reduce the work required to run the Rhône aggregation experiment. The e-mail discussion forum will facilitate the communication between participants and thus allow for a quicker resolution of problems. Unavoidably, the ALMA convention will evolve with land-surface schemes and, hopefully, it will provide through the list of diagnostic variables, an accurate picture of the capabilities of these models.

WORKSHOP/MEETING SUMMARIES

PILPS 2e WORKSHOP

19–20 March 2001
Seattle, Washington USA

Laura Bowling, Bart Nijssen and Dennis Lettenmaier

University of Washington, Seattle, Washington USA

The Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS) Phase 2e, the Arctic model intercomparison experiment, is designed to evaluate spatially the performance of uncoupled land surface schemes in high latitudes, as described in the May 2000 of *GEWEX News* and the PILPS 2e experiment design plan (*www.hydro.washington.edu/Lettenmaier/CurrentResearch/PILPS-2e/index.htm*). A workshop of the participants was held at the University of Washington to provide a forum for discussion of preliminary results from Stage 1 of the experiment. A total of 20 institutions from 10 countries participated in the Stage 1 experiment. **Results from 10-year model simulations of land surface schemes (LSS) as applied to the Torne/Kalix River system, a Baltic Sea Experiment (BALTEX) study region in northern Scandinavia, were reviewed**. Possible additional exploratory runs, and the publication of results were also discussed. The workshop also served as a first assessment of the standardized output interface for data developed by the Assistance for Land Surface Modeling Activities (ALMA) part of the GEWEX Global Land-Atmosphere System Study (GLASS) (see article beginning on page 11).

The Torne/Kalix River system has a combined area of 58,000 km^2 which was represented by 218 1/4^o computational grid boxes. Most of the basin can be characterized as low topography forest and mire areas. The mountains in the northwest make up 7–8 percent of the total drainage basin and include Mount Kebnekaise, the highest point in Sweden (elevation 2117 m). Approximately 1/3 of the basin lies between 200 and 500 meters above sea level. The runoff regime is characterized by a maximum following snowmelt in the forest and swamp regions. A natural bifurcation on the Torne River diverts an average of 57 percent of the discharge above Junosuando/Tarendo to the Kalix River.

Each of the modeling groups was provided forcing data for the period 1979–1988 for model 'spin-up', while the period 1989–1998 was used for the intercomparison (participants were not provided with observations for this period). The forcing data consists of incoming shortwave and longwave radiation, wind speed, air temperature, specific humidity and snow and rain precipitation. The simulations were conducted at an hourly (or finer in the case of a few models) time step.

Three types of model output were provided by the participants:

1) Calibration and validation runs. Model forcing data and observed streamflow were provided to each modeling group for two sub-catchments of the Torne/Kalix system, the Ovre Abiskojokk and the Ovre Lansjarv (566 and 1341 km^2, respectively). For two validation catchments (Pello and Kaalasjarvi, 2622 and 1472 km^2), only model forcing data were provided to the participants. The participants were asked to transfer model parameters to the validation catchments, and to the Torne-Kalix basin as a whole, at the modelers' discretion.

2) Base-runs. For these runs, the modelers used 10 years (1989-1998) of forcing data to simulate the surface energy and moisture fluxes of each of the 218 1/4^o grid cells.

3) Re-runs. Due to problems that emerged with some of the forcing data sets, 10 years (1989-1998) of revised forcing data were provided to the participants. The most significant revision was a generally upward adjustment in downward solar radiation (see figure at top of back page).

The hourly meteorological forcings provided to the participants were produced by interpolating from station data, and/or a 1^o gridded data set provided by the Swedish Meteorological and Hydrological Institute (SMHI), and processed by the University of Washington. Adjustment of precipitation totals for gauge undercatch and orographic enhancement was performed following methods recommended by SMHI scientists. Daily surface winds (10 m) were taken from the NCEP/NCAR reanalysis, linearly interpolated in space, and held constant for each 24-hour period. Longwave and shortwave radiation were calculated from the derived air temperature, cloud cover and humidity data sets using the method of TVA (1972).

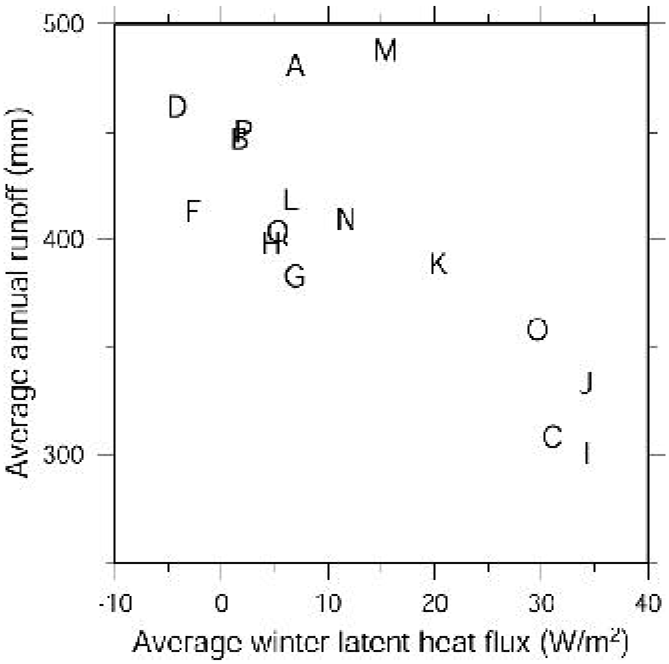
After the intercomparison experiment was underway, several participants suggested that the downward shortwave radiation seemed to have a low bias. The bias resulted from the calculations used to reduce radiation at the top of the atmosphere to clear sky radiation at the ground surface, using generalized coefficients taken from TVA (1972). It was removed by using the Eagleson (1970) method with the turbidity factor estimated based on station data. The station used (Kiruna) is located near the border of the Torne and Kalix basins at approximately 500 m elevation. Solar radiation was also calculated using the Eagleson method with the same turbidity factor for Luleå, a station on the coast just south of the Kalix basin, which produced good agreement with observations. The revised solar radiation was subsequently distributed to the participants. Hourly disaggregated precipitation and a corrected wind data set were also distributed at this time. Approximately one-half of the models completed the reruns with the revised data before the workshop. The results of both the base runs and the partial reruns are summarized briefly here.

The surface energy and water balance was calculated for all 21 models, based on the simulated data provided by each modeling group to the organizers. Many of the models showed significant energy balance deficiencies for the base run. Although the reported results for the reruns improved the energy balance deficiencies, some problems remained. Errors in closing the water balance were generally less pronounced than in the case of the energy balance; however, there were still problems with many models. Most of these errors were related to confusion associated with reporting protocols and have been or are being resolved.

Like other arctic basins, the Torne is characterized by low available energy. Mean annual incident shortwave radiation ranges between 85 and 105 W/m^2, while mean annual incident longwave radiation ranges between 265 and 280 W/m^2. A significant portion of the basin lies above the Arctic Circle and wintertime incident shortwave radiation is consequently very small. The presence of snow during a large part of the year, roughly from October till June, and the associated high albedo, resulted in a simulated mean annual net shortwave radiation averaged over the basin ranging from about 38 to 53 W/m^2 for the participating models for the base run, and from 54 to 72 W/m^2 for the rerun. Simulated mean annual net longwave radiation also varied considerably between the models and ranged from -27 to -42 W/m^2 for the base run and from -27 to -46 W/m^2 for the rerun.

The mean monthly cycle of net radiation (net shortwave and net longwave) shows that the spread in the model-predicted net radiation is largest in the springtime, when the incident shortwave radiation increases and snow starts to melt. Differences in the simulation of snow ablation and snow albedo led to large differences in net radiation during this period. Differences in surface temperature, and consequently net longwave radiation, were most marked during the winter months, and were much smaller during the summer months when snow was absent.

The mean annual simulated latent heat flux averaged over the basin ranged from 12 to 43 W/m^2 in the base run and 18 to 32 W/m^2 in the rerun. Given the low net radiation flux, all models reported a negative sensible heat flux in the base run, meaning that the atmosphere acted as a source of energy for evaporation and sublimation. The negative sensible heat flux ranged from -23 to -3 W/m² in the base run. In the rerun, all models showed an increase in the sensible heat flux compared to the base run, with some models having a positive mean annual sensible heat flux. Mean annual sensible heat fluxes in the rerun ranged from -10 to +7 W/m². **Perhaps the most important finding of the experiment was large variations in predicted sublimation among models, and the effect of these differences on the modeled energy and moisture fluxes throughout the year.** Averaged over the 10 years, maximum simulated snow water equivalent (SWE – snow accumulation as moisture content) varied between 40 and 300 mm for both the base and the reruns. The maximum mean SWE of all models was 220 mm. For some models, virtually all of the snow sublimated, whereas for other models most of the snow accumulated. Mid-winter melt events are infrequent over most of the basin and have relatively little effect on maximum snow accumulation.



Average annual runoff versus winter (January/February) latent heat flux for the rerun experiment. Each letter represents a different model. The negative slope indicates the effect of winter sublimation on total annual runoff.

Snowmelt is the single largest factor governing annual runoff production in the Torne basin. The spatial variability in runoff production is low, and was fairly consistent between models. This reflects the importance of snowmelt, which has a great deal of spatial coherence in comparison with summer rainstorms, which are responsible for relatively little of the annual runoff.

The predicted seasonal runoff hydrographs were quite variable among models, with annual runoff ranging from 310 to 480 mm for the reruns. Peak monthly runoff ranged from under 1 to over 7.5 mm/day. The observed mean annual discharge of the Torne-Kalix system is 403 mm. The among-model variation in mean annual runoff was found to be primarily related to the model-predicted maximum winter snow accumulation models with lower accumulations of snow on average predicted lower annual runoff. On the other hand, models with similar snow accumulations simulated different mean monthly hydrographs due to differences in the treatment of surface and subsurface storage. Several of the models explicitly simulated surface storage in lakes, and while these models tended to simulate less moisture storage in the soil column, the resulting shape of the simulated hydrographs for these models did not differ much from those without lakes.

The effect of calibration on the simulated water balance was explored for the two "calibration" sub-basins, Ovre Abiskojokk and Ovre Lansjarv. In almost all cases, the fit of the simulated hydrographs, as measured by the root mean squared error, was improved through calibration. The total simulated runoff volumes, however, did not change much. This is consistent with the trends found in the basin-wide runs. In general, changes in model soil parameters had the effect of changing the timing of runoff production, but had much less effect on the amount of annual runoff generated by the models The reason for this relative lack of sensitivity of the annual runoff ratio to model parameters appears to be that evapotranspiration is primarily energy limited in this environment.

We are currently collecting the outstanding results from the rerun experiment and resolving reporting errors for all of the results. Following analysis of the model results by the PILPS 2e community, the data set will be archived and made available to the general scientific community.

References

Eagleson, P.S. (1970). Dynamic Hydrology. New York: McGraw-Hill, pp 33-42.

TVA, 1972. Heat and mass transfer between a water surface and the atmosphere. *Water Resources Report* No. 0-6803 14. Tennessee Valley Authority.

Editor's Note

A joint issue of GEWEX News and BAHC News is being distributed to both GEWEX News and BAHC News subscribers. The joint issue is in place of the May 2001 GEWEX News Vol. 11, No. 2.

GAPP AND NASA LSHP MEETING

30 April to 4 May 2001
Potomac, Maryland USA

Rick Lawford
GAPP Project Office

The NASA Land Surface Hydrology Program (LSHP) and the GEWEX Americas Prediction Project (GAPP) held a joint meeting for the principal investigators to share results, discuss issues, and develop visions for hydrometeorological themes of mutual concern, and to foster unity in plans being made for new phases of their programs.

The meeting began with an overview of the United States water cycle initiatives followed by more than 125 short science presentations over two and a half days. It ended with two days of workshops—focusing on the GAPP implementation plan and three new NASA missions (Cold Land Processes Field Experiment, Soil Moisture Mission, and Water Level and Discharge Mission).

The LSHP research agenda addresses scientific challenges related to global hydrologic variability, predictability, and consequences. Within this framework, LSHP supports modeling and remote sensing work; analysis of regional to global hydrologic processes, terrestrial water and energy balance, land/atmosphere interactions, and hydrologic extremes; and emerging interdisciplinary science in the areas such as ecology, carbon cycle and health. Within the GEWEX program, GAPP, ISLSCP, and LBA are examples of large-scale modeling and remote sensing science studies supported by LSHP.

At this meeting, the transition from GCIP to GAPP was clearly articulated by the collective presentations of principal investigations and the program managers. In addition, this meeting was important in identifying linkages to water cycle research in GAPP and NASA's programs.

During the GAPP implementation plan workshop, sessions were held on warm season precipitation, cold season and orographic hydrometeorology, land surface memory processes, prediction and predictability, and water resources, CEOP and data management issues were also discussed. The first meeting of the new GAPP Data Management Committee also took place during the week, where GAPP data needs, the Data Management Plan, and GAPP heritage data sets were discussed.

The session on warm season precipitation reviewed the need to adopt elements of the North American Monsoon Experiment (NAME) science plan to focus GAPP efforts on observational studies in northern Mexico. The cold season and orographic hydrometeorology component focused on the seasonal cycle of precipitation in the West and the role of spring precipitation in summer stream flow. The land surface memory processes group discussed the need for more research on interactive vegetation. The prediction and predictability group discussed the tools needed for seasonal predictions, and the water resources group discussed the need for longer seasonal forecasts and the role of the Advanced Hydrological Prediction System in water resource studies. The particular geographic regions of emphasis for each of these component studies were also considered. This workshop will lead to a GAPP Implementation Plan and Data Management Plan.

Rick Lawford (right), presenting a plaque to John Leese as part of an event at the GAPP/LSHP dinner recognizing John Leese's retirement from the GCIP office.

GEWEX SEAFLUX INTERCOMPARISON WORKSHOP

17–18 May 2001
San Diego, California USA

Judith A. Curry
University of Colorado, Boulder, Colorado USA

The GEWEX Radiation Panel recognizes the need for high resolution fluxes of surface energy and freshwater. The Surface Radiation Budget Project and Global Precipitation Climatology Project are producing high resolution satellite-derived products of surface radiation flux components and precipitation, respectively. Since there is no parallell effort for surface turbulent fluxes, the GEWEX Radiation Panel has initiated the SEAFLUX project to investigate producing a high-resolution satellite data set of surface turbulent fluxes over the global oceans.

As a result of a workshop held in Boulder, CO, in August 1999, the SEAFLUX Intercomparison Project was initiated to assess the current status of satellite and numerical weather prediction surface flux products, assemble a collection of high quality *in situ* flux data sets to be used to evaluate the global flux products, and make recommendations for improved surface turbulent flux data products.

The first GEWEX Radiation Panel SEAFLUX Intercomparison Project Workshop was held in conjunction with the American Meteorological Society's 11th Conference on Interaction of the Sea and Atmosphere. On the first day of the workshop, participants of the GEWEX SEAFLUX community described data sets that had already been assembled, including *in situ* data sets and satellite data sets. *In situ* data sets from research ships and buoys that have been assembled include 15 deployments from the tropics, 14 from subtropics, 16 midlatitudes, and 5 from high latitudes. Some of the *in situ* data sets include direct turbulence flux measurements, wave information, and skin sea surface temperatures (SST), and can be used to evaluate models of these parameters. Colocated with each of these *in situ* data sets are satellite products from SSM/I, TRMM, AVHRR, Quikscat, NSCAT, and TOVS.

On the second day, the group considered intercomparison and evaluation strategies with a goal to define specific projects. The following specific intercomparison projects have been formulated: a) bulk turbulent flux model evaluation and comparison; b) evaluation of satellite methods to determine skin SST; c) evaluation of scatterometer-derived wind stress and different methods for determining gridded wind fields; d) evaluation of satellite-derived surface air temperature and humidity and latent and sensible heat fluxes for pixels colocated with selected *in situ* data sets; and e) comparison of global numerical weather prediction and satellite-derived flux data sets for 1999. The selection of 1999 for the global flux intercomparison was made because of availability of desired satellite data sets, good *in situ* validation data, and the interests of several scientists in applying the flux products for scientific applications.

A second intercomparison workshop is planned in summer 2002, to present results of the intercomparison projects. An article describing the SEAFLUX project is being prepared for submission to the Bulletin of the American Meteorological Society. An overview of SEAFLUX activities and data sets is found at: *http://paos.colorado.edu/~curryja/ocean/*.

WCRP/SCOR WORKSHOP ON INTERCOMPARISON AND VALIDATION OF OCEAN-ATMOSPHERE FLUX FIELDS

Washington, DC – Potomac, Maryland USA
21–24 May 2001

Glenn White
NOAA/NCEP, Washington, DC USA

One hundred and seven scientists from 16 countries attended the meeting outside Washington, D.C. at which ninety-two papers were presented. The meeting was organized by the WCRP/Scientific Committee for Oceanic Research (SCOR) Working Group on Air-Sea Fluxes (WGASF), which was established following a WCRP workshop on air-sea flux fields in Reading, England in 1995 (White, 1996). WGASF recently completed an extensive report on air-sea fluxes (Taylor, 2001); the report is available from the World Meteorological Organization (WMO) and can be assessed on-line at *http://www.soc.soton.ac.uk/JRD/MET/WGASF.*

After initial presentations, sessions included topics on flux products from modeling and data assimilation, validation of flux products, flux fields from remote sensing and flux measurements and parameterization. On the final day, three working groups addressed the following questions:

1) How can we define the best parameterizations and obtain the highest quality measurements necessary to estimate air-sea fluxes?

2) How can we validate flux estimates, considering that the truth about air-sea fluxes is not known?

3) How can we improve flux products in the future?

The reports of the working groups and extended abstracts for the papers given at the meeting are available at the WGASF web site given above and will be published by the WMO.

References

Taylor, P.K., Ed., 2001: Intercomparison and validation of ocean-atmosphere energy flux fields. Joint WCRP/SCOR Working Group on Air-Sea Fluxes Final Rep., WCRP-112, WMO/TD-No. 1036, 306 pp.

White, G., Ed., 1996: WCRP Workshop on Air-Sea Fluxes for Forcing Ocean Models and Validating GCMs, Reading, United Kingdom, World Meteorological Organization, WMO/TD-No. 762, 190 pp.

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

GEWEX TOPICS AT AGU MEETING

29 May – 2 June 2001
Boston, Massachusetts USA

Approximately 3000 participants attended the 2001 Annual Spring Meeting of the American Geophysical Society (AGU) Meeting at which joint sessions addressed GEWEX-related topics. In the session "Is the Global Water Cycle Intensifying?", Pierre Morel, University of Maryland, noted how AGU has fostered the bringing together of disciplines such as hydrology and climate. For example, from climate studies, there is an indication that global temperature is increasing. However, one presentation on the GEWEX Global Precipitation Climate Project's 22-year global precipitation data indicated little trend in precipitation. Also, the GEWEX Global Water Vapor project data showed no marked trend in global water vapor. One paper presented the variability of the water storage as a factor to be considered in detecting changes in the global water cycle. Results presented from model studies suggest changes in global monsoon circulation as a way to estimate the hydrological cycle. Apparent interannual variation in the water cycle was found from a coupled land-atmosphere water budget model when applied in the central United States. In summary, a balanced mix of presenters addressed the trends in the water cycle.

The sessions on Land Data Assimilation (LDA), advances for coupled land-atmosphere models were of interest to the GEWEX Science community. The focus of a number of presentations was for global models. The advances were often dealing with the life of soil moisture as related to precipitation. The measurement of soil moisture on a global scale by satellite instruments was addressed in several presentations.

ARCTIC REGIONAL CLIMATE MODEL INTERCOMPARISON PROJECT MEETING

9–10 July 2001
Boulder, Colorado, USA

Judith A. Curry
University of Colorado, Boulder, Colorado USA

The GEWEX Cloud System Study (GCSS) Working Group on Polar Clouds has initiated a study (in collaboration with the ACSYS Numerical Experimentation Group) to evaluate and improve regional climate models in the Arctic. The Arctic Regional Climate Model Intercomparison Project (ARCMIP) recently held a meeting to finalize the design for the first intercomparison experiment (SHEBA) in terms of model forcing and output fields; update participants on validation data and modelling activities from individual groups; and to develop strategies to coordinate with the GCM community, other projects in the GCSS Working Group on Polar Clouds, and the International Arctic Research Consortium (IARC).

To increase the impact of ARCMIP on GCMs, a participant from the NCAR Community Climate System Model (CCSM) group helped in an experimental design whereby GCMs can participate in ARCMIP Experiment 1. This experiment would consist of a GCM running an AMIP-2 experiment, and then submitting the output from the ARCMIP domain for evaluation. Output of 6 hourly fields at the ARCMIP boundaries could then be used to force the regional models, to assess the relative impacts of boundary forcing versus local model physics on problems with GCM simulations in the Arctic.

From discussion of improved coordination with other projects in the GCSS Working Group on Polar clouds, it was decided that the ARCMIP models will participate in the radiative transfer model intercomparison project that is underway using SHEBA data *http://paos.colorado.edu/~curryja/wg5/proj.html*.

GEWEX/WCRP MEETINGS CALENDAR

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

3–5 September 2001—INTL. WORKSHOP ON CATCHMENT-SCALE HYDROLOGICAL MODELING AND DATA ASSIMILATION, Wageningen, The Netherlands.

5 September 2001—WRAP MEETING, UNESCO, Paris, France.

6–8 September 2001—GHP SCIENCE PLANNING MEETING, UNESCO, Paris, France.

10–14 September 2001—FOURTH INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE, Paris, France.

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

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

29 October – 2 November 2001—WGNE/GMPP MEETING, Offenbach, Germany.

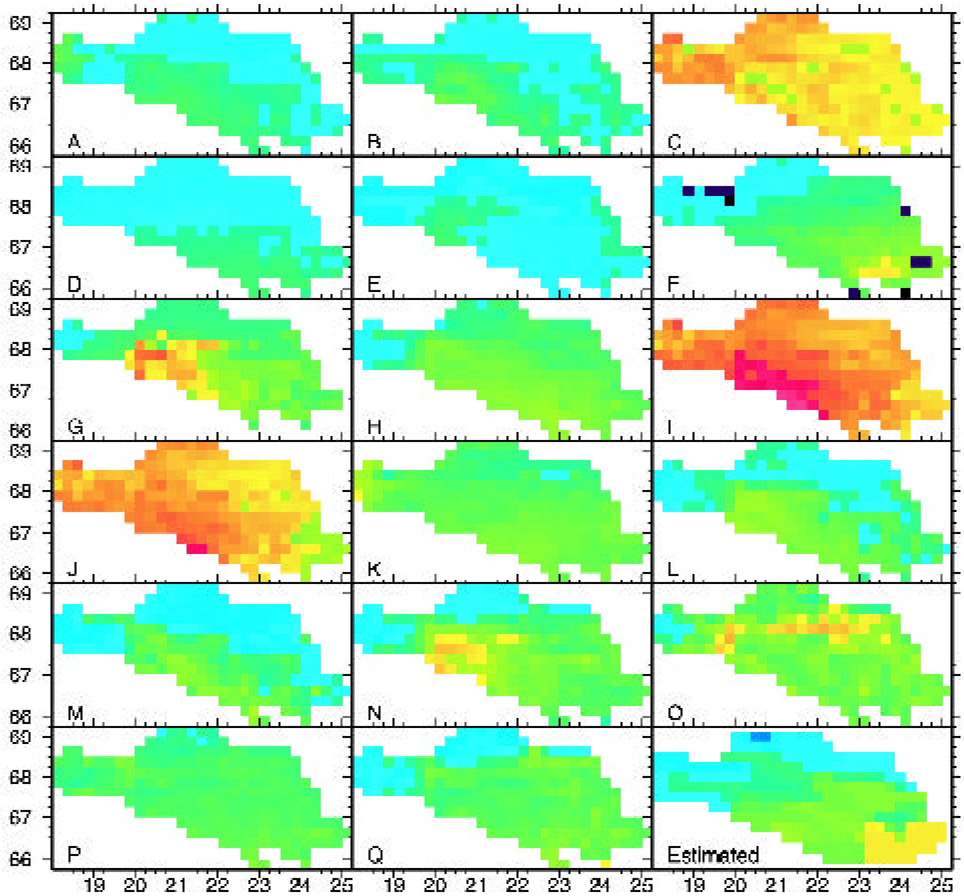
5–7 November 2001—GLASS MEETING AND RHONE-AGG EXPERIMENT WORKSHOP, Toulouse, France.

12–14 November 2001—GRP MEETING, Fort Collins, Colorado, USA.

13–17 January 2002—AMERICAN METEOROLOGICAL SOCIETY, 82ND ANNUAL MEETING, Orlando, Florida, USA.

28 January – 1 February 2002—GEWEX SCIENTFIC STEERING GROUP MEETING, ECMWF, Reading UK.

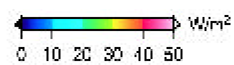
13–17 May 2002—16TH GPCP-WGDM MEETING, Tokyo, Japan.



FIRST APPLICATION OF ALMA

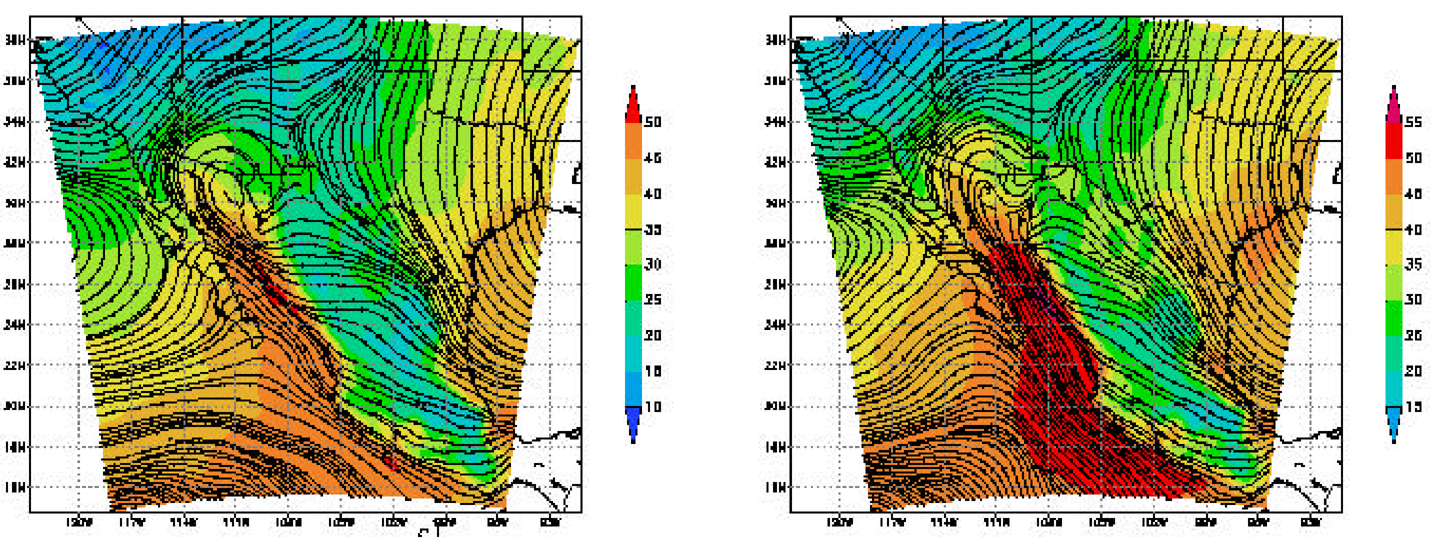
(See page 14 and companion article on page 11)

Mean annual simulated latent heat flux (1989-1998) for 17 models in the rerun experiment. Annual latent heat as estimated from the basin water balance is given in the lower right hand corner. The tendency for less evaporation in the higher elevations in the north, where the majority of the precipitation falls, indicates that evaporation is energy limited in these regions.



ATMOSPHERIC FLOW RESPONDS TO REPRESENTATION OF DEEP CONVECTION

(See article on page 12)



Mean precipitable water (in mm) and surface-600mb integrated moisture flux streamlines for July 1999 given by MM5 using the Grell scheme (left panel), and the Betts-Miller scheme (right Panel)