GEWEX Global Land-Atmosphere System Study (GLASS)

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1. About GLASS:

The goal of GLASS is to encourage the development of the next generation of Land Surface Schemes (LSS) by coordinating their evaluation and inter-comparison, and applying them to scientific queries of broad interest. Membership of the Panel is:

Luis Bastidas, Martin Best, Paul Dirmeyer (chair), Ann Henderson-Sellers, Paul Houser, Randy Koster, Taikan Oki, Christa Peters-Lidard, Andy Pitman, Bart van den Hurk, and Nicolas Viovy.

2. Status:

GLASS is divided into four actions that constitute a two-by-two matrix; one axis being coupled (land-atmosphere) versus offline (land-only) modeling, and the other being local (point, plot and catchment scale) versus large-scale (continental to global) modeling. There is also a data management and software component called ALMA (Advancing Land-surface Modeling Activities).

The GLASS science panel met in Kyoto, Japan on 15-17 September 2004. The meeting was held in conjunction with a workshop on the Second Global Soil Wetness Project (GSWP-2). Current information on GLASS projects can be found at: http://hydro.iis.u-tokyo.ac.jp/GLASS/.

Community: GLASS is having an increasing number of direct interactions with other elements of GEWEX and the broader scientific community. The components of GMPP are becoming more closely knit, and the local coupled action (LoCo) is pursuing a close collaboration with GABLS. With GHP there is continuing significant interaction with ISLSCP (mainly through GSWP), CEOP (ALMA and potentially LoCo) and AMMA. There are plans for GSWP-2 to contribute to GRP efforts to compile global energy and water cycle datasets over land (LandFlux), particularly for those components that are not well observable by satellite. Beyond GEWEX, GLASS has been involved in early planning for COPES, particularly in its modeling strategy. Also, the active component of the local coupled action (GLACE) is a joint project with the CLIVAR Working Group on Seasonal-Interannual Prediction (WGSIP). There is also coordination with the new IGBP Integrated Land Ecosystem – Atmosphere Processes Study (iLEAPS), as the GLASS chair is the designated GEWEX liaison to that effort. GLASS has also become active in the current IPCC efforts, including lending our expertise to model output analysis efforts in Working Group 1, and a proposal (by A. Pitman) of a multi-model study into the global impacts of land use change on the climate signal. A second phase of SnowMIP is beginning, and we have been approached by that community seeking guidance and perhaps membership in GLASS. GLASS continues to be closely aligned with the various operational efforts in land data assimilation in Europe and the U.S. NASA's Land Information System (LIS) has used GSWP-2 as a testbed for its attempts to run multiple LSS in a common framework for land data assimilation. Finally, interaction is beginning with the urban modeling community as an important frontier for weather and climate prediction, as the resolution of forecast models continues to increase.

PILPS: The San Pedro experiment (PILPS-SP) has been delayed, and a new timeline has been set. Poor communication resulted in the project being underpublicized, but that has been corrected and participation now appears to be good. Several groups have submitted results of step 1 (uncalibrated simulations over the Arizona sites), and steps 2 and 3 (release of validation data and multi-criteria algorithms for calibration) are underway. The website for the experiment is http://www.sahra.arizona.edu/pilpssanpedro/.

PILPS C-1 (Carbon) is concluding its analysis phase, other past PILPS projects are still generating publications (see accomplishments), and an Isotope-PILPS has been approved and is moving ahead in 2005. Collaboration in the AMIP project continues (AMIP2 DSP-12) generating publications as results from AGCMs are released through PCMDI.

GSWP: The Second Global Soil Wetness Project (GSWP-2) is wrapping up its main modeling phase, and is now moving into the analysis phase. 16-18 models are participating. Baseline simulations and sensitivity studies have been completed by most of the modeling groups and have been sent to the Inter-Comparison Center (ICC) at the U. Tokyo for QC, inter-comparison and redistribution. There is no final deadline for submissions, but late entries are less likely to be included in multi-model analyses or publications. A multi-model analysis (monthly and daily data) for the 10-year period is currently being produced, and should be released about the time the SSG meets. Papers on the application of a forward microwave brightness temperature model to LSS output to simulate L-band sensor measurements has been completed (Gao et al. 2004), and a paper on the issues of multi-model averaging techniques and transferability of calibration parameters is in preparation. The 19th Conference on Hydrology at the AMS Annual Meeting in San Diego has a full session on GSWP-2. The ICC has launched a web site giving the scientific community accesses to images and data from all of the participating models at http://haneda.tkl.iis.u-tokyo.ac.jp/gswp2/. See http://www.iges.org/gswp/ for more information on the project.

GLACE: The Global Land-Atmosphere Coupling Experiment (GLACE) is the principal multi-model project underway in the large-scale coupled action. The experiment has produced a paper in the journal *Science* (Koster et al. 2004) which has brought considerable attention to the role of the land surface in climate predictability and variability, and the spatial variability of the strength of land-atmosphere coupling. Two additional papers will have been submitted to *J. Hydrometeor*. describing the experiment results in more detail, including a breakdown of the separate contributions of the terrestrial and atmospheric components of the hydrologic cycle to the overall coupling between soil moisture and precipitation. Two more papers are in preparation that will describe results from a subset of models that performed the experiment with multiple version of their models, and an assessment of the real-world land-atmosphere coupling strength and the models' ability to represent it correctly. A full description of the experiment is available online at http://glace.gsfc.nasa.gov/.

Local Coupled Action: The local coupled action (LoCo) now has a plan and intention to collaborate strongly with GABLS to pursue the role of land-PBL interaction though local coupled modeling. The next GLASS panel meeting is being planned for September in De Bilt jointly with GABLS, to be hosted by Bart van der Hurk and Bert Holtslag (chair of GABLS), to foster interaction between the two communities. In 2005 LoCo will conduct limited preliminary modeling studies with an eye towards improved simulation of the diurnal cycle of surface fluxes, linking with GABLS to also study growth of the daytime boundary layer.

Pan-GLASS Issues: GLASS is also addressing cross-cutting issues in the climate modeling community. One involves the continuing problem of initialization of soil wetness in climate models, and the lack of transferability of soil moisture data sets from one model to another. Proof-of-concept work with the ECMWF and Hadley Centre models has been completed at last, and GLASS is preparing a summary paper on the issue to educate the broader modeling community as to the pitfalls of treating soil moisture as a uniformly defined quantity across models.

3. Future Plans

PILPS: The aim of the *IPILPS* (Isotopes in PILPS/GLASS) initiative is to contribute to an international inter-comparison of current state-of-the-art isotope parameterization efforts in coupled climate, atmospheric and earth system models by promoting comparison among land-surface schemes that incorporate isotopic representation under the auspices of GLASS. Isotopic data exist and, so far, there has been no tuning of models to these data. However, as databases become more prevalent, schemes will be tested against, and tuned to fit, isotopic measurements. There is, therefore, some urgency in establishing an international intercomparison. IPILPS comprises the land-surface modelling component of this GEWEX –wide effort.

PILPS-C1 is considering extending the study to more sites which include different vegetation types (more than 30 sites potentially available) to understand how the inter-biome variability compares with the inter-model variability, and to find which biomes are correctly/incorrectly simulated. There is particular interest in including the year 2003, available for most of European sites, because of the extreme drought over Europe. This will provide a test of model response to high hydric stress and high temperature and can

serve as a test of how models simulate vegetation response to climate change similar to those expected by the end of the 21st century.

GSWP: The most tedious parts of GSWP-2, preparation of forcing data and integration of the models, is largely complete. The scientifically rewarding part of the project is now ramping up. The multi-model analysis will result in not only a new climatology of the land surface, but an assessment of uncertainties as quantified by model spread. A GSWP-2 overview paper centered on the multi-model analysis should be submitted in Spring 2005. Model comparison work will continue, and evaluation of the models with a variety of in situ and remote sensing data will begin in earnest. The suite of sensitivity studies will provide a spectrum of interesting investigations, including the role of uncertainly in precipitation measurements on our estimation of the land surface component of the hydrologic cycle, the role that surface radiative fluxes play in linking the surface energy balance to the water cycle, an assessment of the quality of the major reanalysis products as they relate to global surface hydrology, how differences in the specification of global vegetation coverage by the various global products available impacts the simulation of land surface climate, and what role is played by interannual variations of vegetation in surface hydrologic variability and climate feedbacks. Studies of model uniqueness (are all these LSSs redundant?) and transferability are also planned. There is strong interest within the HYDROS and SMOS communities to use GSWP-2 output data in the continued planning and development of those satellite missions.

Finally, production, application and evaluation of the forcing data for the baseline simulation has revealed where we can do better, and a new baseline forcing data set will be prepared in 2005. All current studies will continue with the runs produced using the original forcing data, but it is likely that improved baseline LSS integrations and a better multi-model analysis will result from this effort.

GLACE: A proposal to NASA has been submitted to expand on the intriguing results of GLACE and cross-couple three LSSs with three AGCMs, so that the separate roles of land model, atmosphere model, and coupled interactions in determining land-atmosphere coupling strength can be examined more thoroughly. Also, as mentioned previously, a proposal for a multi-model land-use change experiment has been proposed. Results would not be complete in time for the current IPCC assessment, but it could still answer the question of whether land use change is as important a signal trend as changes in atmospheric composition.

LoCo: The Local Coupled Action is the most logical point of interface with other GMPP studies, as they tend to operate primarily at this scale. LoCo plans to begin with modeling experiments based on data from the CASES site, HAPEX-Sahel and for transects across one or more of the “hot spots” found in GLACE. Later studies might move to CEOP reference and FluxNet sites. CASES would be a preliminary inroad to GABLS, which has complete a nocturnal boundary layer study for that location. Full convergence of joint planning between LoCo and GABLS will occur with the joint meeting in September 2005. In time, LoCo would also interface with efforts in GCSS and couple current LSSs to LEMs and CRMs.

Pan-GLASS: A synopsis paper on GLASS for a broad audience (e.g. in EOS) is being considered for submission in about one year’s time. The purpose is to bring to the attention of the broader earth science community the important issues in land surface modeling, and its implications for a growing range of research areas.

4. Summary

Overall GLASS has enjoyed a very fruitful and productive year, with noteworthy progress in many areas and wide recognition of our specific efforts in coupled land-atmosphere modeling. The success of GLASS lies in its appeal to participants in a broad range of interests from operational, research and educational institutes. Participants feel they have something to gain beyond what they can accomplish individually, and we all reap the rewards. Its multi-model multi-institutional approach gives its efforts a credibility, applicability, and degree of oversight that increases the quality of science produced. There is still much to be done, but our first five years have laid a sound base for future efforts.