GLASS : Global Land-Atmosphere System Study

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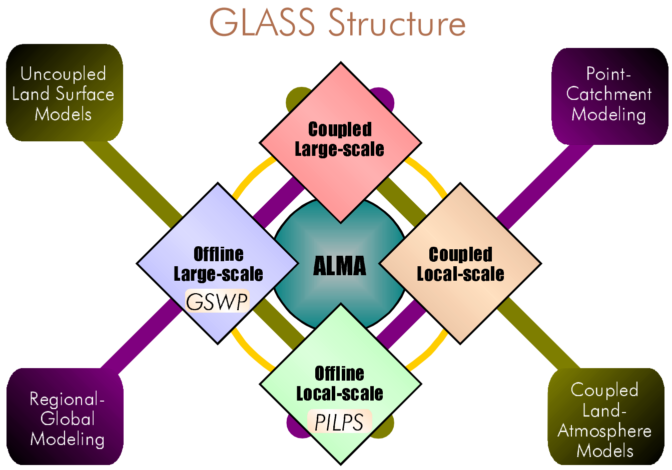
new generation of land surface schemes (LSSs) is emerging. The schemes are evolving from mere general circulation model parameterizations that provide fluxes to the atmosphere into independent models which are increasingly beeing compared to models of hydrology, biogeochemistry and ecology. This expanding scope is driven by the growth of interdisciplinary studies of the earth system. GLASS aims to encourage these developments by coordinating the evaluation and inter-comparison of this new generation of LSSs, and applying them to scientific queries of broad interest.

Workshops organized by GEWEX, The European Centre for Medium-range Weather Forecasts (ECMWF), the International Geosphere-Biosphere Programme (IGBP) and the Institut National des Sciences de l'Univers (INSU) during the last few years have pointed out a number of directions in which innovation in the next generation of LSSs will be necessary. The first point identified was the inclusion of bio-physical processes. There is a need to include the carbon cycle in order to be able to provide the atmospheric models with CO_2 fluxes and to simulate the evolution of the vegetation and thus the feedbacks between climatic variations and the state of the biosphere. The second feature which will set this new generation apart will be the larger importance given to the horizontal complexity of the surface. Indeed previous LSSs were characterized by a very sophisticated description of the vertical processes while retaining simple assumptions on the horizontal variance of surface conditions. The final innovation which will be included in the next generation will be data assimilation methods for either the analysis of the sate of the surface or the evaluation of surface schemes at the global scale. The remotely sensed variables which will become available in the years to come will demand from LSSs new methods for taking advantage of the new information. With this increase in complexity, new feedbacks between the atmosphere and the surface will be simulated and a more systematic analysis of the sensitivity of the climate to surface processes is needed.

Land surface scheme validation and inter-comparison projects such as the Project to Intercompare Land-surface Parameterization Schemes (PILPS) (Henderson-Sellers et al., 1995) and the Global Soil Wetness Project (GSWP) (Dirmeyer et al., 1999) helped to assess the previous generation of LSSs. PILPS made major contributions to their evaluation at the local scale using observed atmospheric forcing and high quality measured fluxes for the validation of the simulated processes. In GSWP on the other hand, the LSSs were used in a mode much closer to their application in GCMs (i.e. on a global grid with a resolution coarser than the typical spatial scales of surface processes). Both of these projects proved very useful and need to be continued with the next generation for the validation of the added processes. However, they also need to be supplemented by new experiments.

As land surface schemes are applied from the plot scale to the regional scale and in a forced or coupled mode, the new experiments will specifically have to address the issues of sub-grid scale variability of the surface and the feedbacks existing between surface processes and the atmosphere. The complementarity of the various applications of LSSs provides a richness of research and can be illustrated for instance with the case of simulated soil moisture. In the PILPS experiments the soil moisture simulated with the atmospheric forcing observed at a site could be compared to the measured values (Shao and Henderson-Sellers, 1996). In GSWP only the soil moisture anomalies at the $1^\circ \times 1^\circ$ could be evaluated as the models use different water holding capacities which were all different from the one which can be deduced from observed values (Entin et al., 1999). When



using a LSS coupled to an atmospheric column model the relationship between the soil moisture and the atmospheric conditions can be explored at the local scale. This set-up was used to determine how the assimilation of near surface temperature and humidity could help improve the simulated soil moisture by Douville et al (2000). Finally, with coordinated GCM sensitivity experiments the impact of the different approaches to soil moisture modelling on climate change could be evaluated (Crossley et al., 2000). Unfortunately, we are not presently able to say how the results obtained in PILPS, for instance, can be related to the uncertainty in soil moisture changes found for a climate with increased greenhouse gas concentrations. Thus a coordination of projects is needed to take full advantage of the diversity of application areas for LSSs.

The aim of GLASS is to foster an evaluations of the next generation LSSs and to coordinate the evaluation of LSSs in their different applications. GLASS will also serve as an interface between the land-surface community and other GEWEX projects. The proposed structure of GLASS (See Figure) highlights the spatial scales at which the schemes are applied and the degree of interaction allowed with the atmosphere. This defines four actions which will coordinate inter-comparisons in their field of land-surface scheme applications. GLASS will also include one transversal action (ALMA : Assistance for Land-surface Modelling Activities) which will provide an infrastructure and technical support for these inter-comparisons.

The action dedicated to local scales and off-line simulations is the continuation of the PILPS project. The next inter-comparisons will be carried out over the Torne basin in Sweden and over a mature forest at the Russian Valdai site. These experiments will allow to evaluate cold-season processes in LSSs. It is expected that in the near future a PILPS experiment will be launched to evaluate the newly gained ability of land-surface schemes to simulate CO_2 fluxes.

The action concentrating on global off-line applications of LSSs is the continuation of GSWP. Before the next phase of GSWP can be launched with the ISLSCP Initiative II data, sensitivity experiments will be carried out to evaluate the impact of errors in the forcing data. Experiments are also planed to evaluate our ability to take into account the spatial variability of soil wetness at a $1^\circ \times 1^\circ$ resolution. Later, with the 10 years of ISLSCP-II data the simulation of inter-annual variability by LSSs will be evaluated.

The local coupled action will concentrate on data assimilation issues. The first step towards this goal will be to set-up a simplified coupled system in which the LSSs and their interaction with the atmosphere can be compared. With this tool in hand the simulated interactions between sub-grid variability and the planetary boundary layer will be compared. It will also serve to evaluate data assimilation methods for land-surface schemes.

In the global coupled action, the sensitivity of the atmosphere to land-surface processes will be studied using an ensemble of general circulation models and LSSs. The two issues which are most in need of model independent assessments are the role of land-surface processes in climate variability and in the sensitivity of climate to anthropogenic forcing. This action will work in close collaboration with the two AMIP diagnostic sub-projects which deal with the validation of surface processes in GCM simulations.

ALMA will help the other four actions described above by providing data exchange standards and software to manage the data. ALMA will also help participating groups with the implementation of the PILPS-4c coupler (Polcher et al., 1998) and ensure the exchange of software and expertise with the aim of facilitating participation in GLASS projects.

GLASS will be managed by a science panel composed of the leaders of the five actions and representatives of GEWEX Hydrometeorology Panel(GHP), ISLSCP, IGBP/BAHC (Biospheric Aspects of the Hydrologic Cycle) and WGNE. Its role will be to coordinate the five actions and ensure that all application areas of LSSs benefit from progress made in the various projects. The panel will hold its first meeting this summer and at the that time the implementation plan of GLASS will be finalized. The first local scale off-line experiment (PILPS-2e) will begin this month and the data exchange protocol to be used has been developed in collaboration with ALMA. Other actions have submitted projects for funding and will start before the end of the year. The evolution of GLASS can be followed on its web site at : *http://hydro.iis.u-tokyo.ac.jp/GLASS/*.

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