Global Land Atmosphere System Study (GLASS)

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GLASS is a proposal by GMPP/WGNE, in collaboration with other GEWEX panels and BAHC, to coordinate the development and evaluation of the next generation of complex land-surface schemes.

- The **aim** is to improve land-surface schemes for the benefit of numerical weather prediction and climate models.
- GLASS proposes to achieve these goals by providing a structure to facilitate and promote land-surface scheme (LSS) intercomparisons.

1. Evolution towards the next generation of complex land-surface schemes

The end of the 80' saw the implementation of the first complex LSSs in GCMs. The community is currently moving towards the next generation of complex LSSs.

The higher complexity of the schemes will move them from the status of GCM parameterizations to that of independent models.

Three workshops have contributed to this evolution :

- IGBP/GEWEX, La Jolla, 1997
- ECMWF/GEWEX, Reading, 1998
- GEWEX/INSU, Gif-sur-Yvette, 1999

1.1. New features in the next generation LSSs

The greening of the surface :

⇒Introducing the carbon cycle.

⇒Dynamical vegetation.

Vertical vs. horizontal complexity :

More emphasis on the horizontal complexity of LSSs :

⇒It is needed for surface hydrology.

⇒Model evaluation and data assimilation will benefit.

Land/Atmosphere interactions : Our understanding of the sensitivity of the atmosphere to surface processes needs to be improved before new feedbacks are introduced.

Integrator of observations : LSSs will be used in assimilation mode to construct global datasets of surface variables.

2. Achievements in LSS validation

PILPS :

⇒ Established the first generation of complex LSSs.

⇒ Introduced some basic concepts in the community.

⇒ Showed how difficult the coupled problem is.

GSWP :

⇒ Raised the question of the meaning of soil moisture at the $1° \times 1°$resolution.

What is needed for the next generation ?

⇒ Validate the new processes with off-line point simulations.

⇒ Address the sub-grid variability issues.

⇒ Study the interaction of LSS with the planetary boundary layer.

⇒ Perform coordinated sensitivity experiments with GCMs.

⇒ Help modelers participate in inter-comparison projects.

2.1. From the point to the GCM grid-box.

Land surface schemes are applied from the plot scale to the regional scale and in a forced or coupled mode.

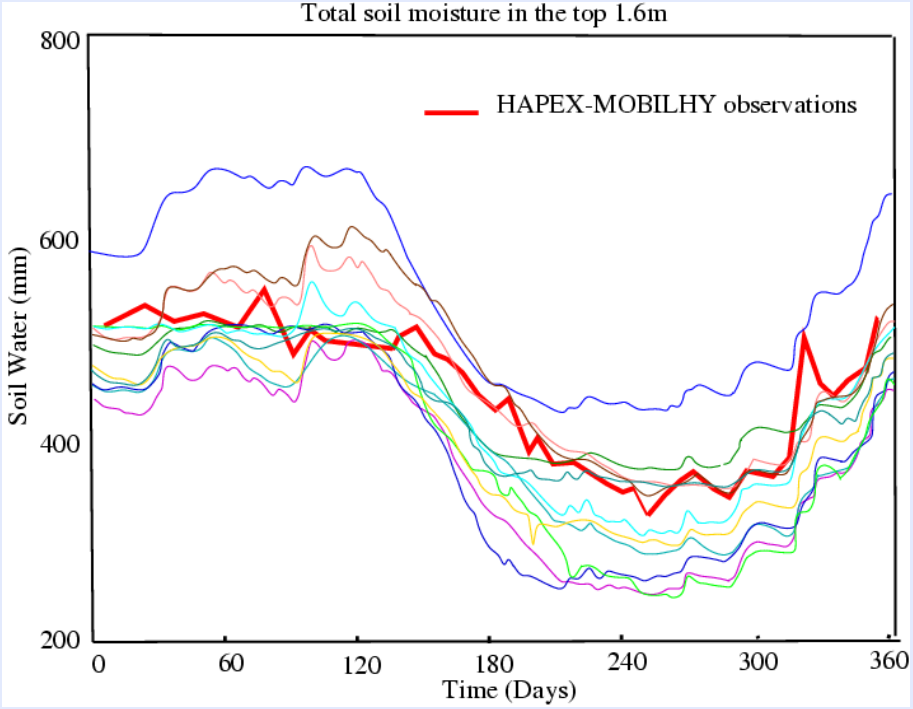
Because of the high heterogeneity of the surface and the complex interactions between the surface and the planetary boundary layer, it is not clear how the concepts used by LSS transfer from one application area to the other.

Soil moisture will be used here as an example to show how these different applications of LSSs complement each other and how they contribute to our understanding of surface processes.

This reasoning also applies to other variables or concepts used in LSSs.

2.2. Soil moisture : local and off-line.

Because of its large spatial heterogeneity soil moisture measurements are only representative of small areas.
PILPS-2 compared LSSs forced with atmospheric data from available measurement sites. Soil moisture simulated by LSSs can be validated at the local scale with *in-situ* observations.

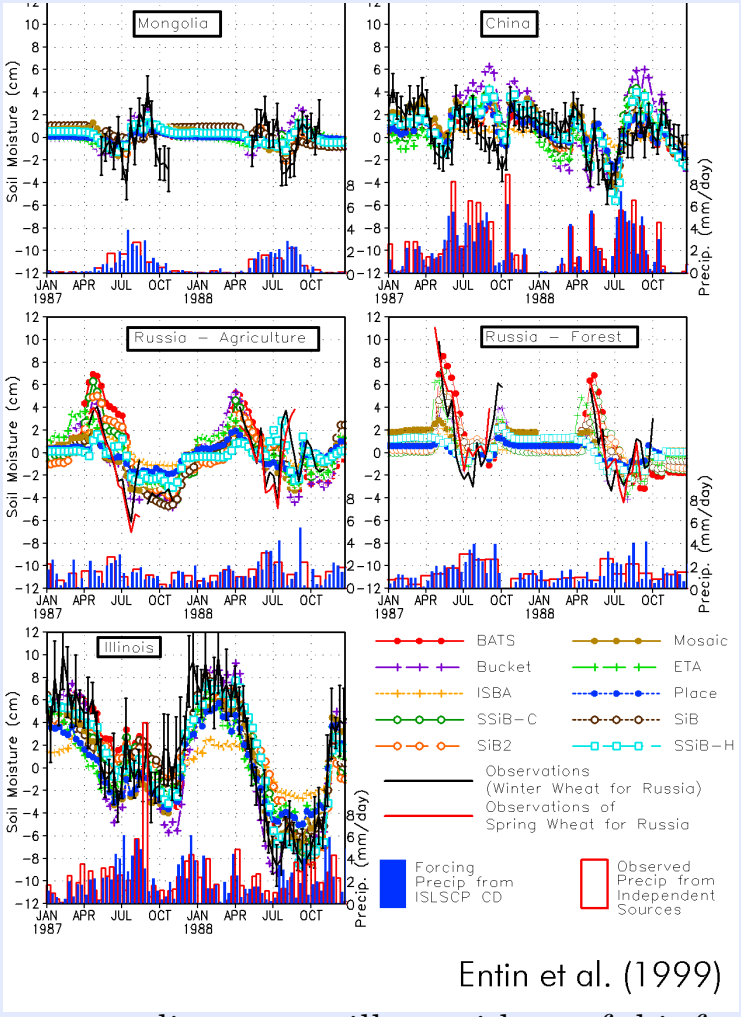


Shao et al., 1996, Global and Planetary Change

2.3. Soil moisture : global and off-line.

In the GSWP experiments LSSs are applied globally at a resolution of 1° × 1° using observed atmospheric data.

This utilization is closer to the GCM application but poses the problem of soil-moisture validation.



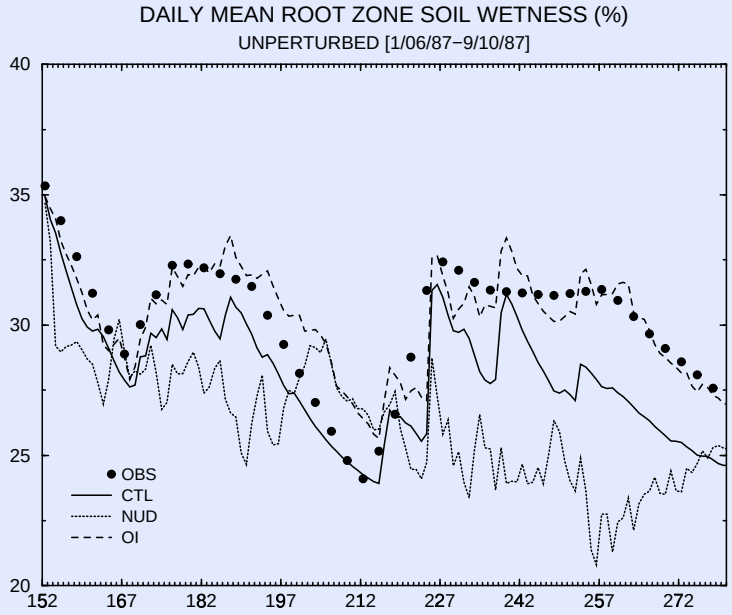
Entin et al. (1999)

Observed soil moisture anomalies may still provide useful information at these scales.

2.4. Soil moisture : local and coupled.

A single column atmospheric model coupled to a LSS can be used to improve our understanding of the interactions and to evaluate data assimilation methods.

Using 4 month of the FIFE data the ECMWF compared a nudging (NUD) and an optimal interpolation (OI) technique to assimilate 2m temperature and humidity observations.



The IO method yields soil moisture values and fluxes which are in good agreement with observations.

Douville et al., 2000, Q.J.R.M.S

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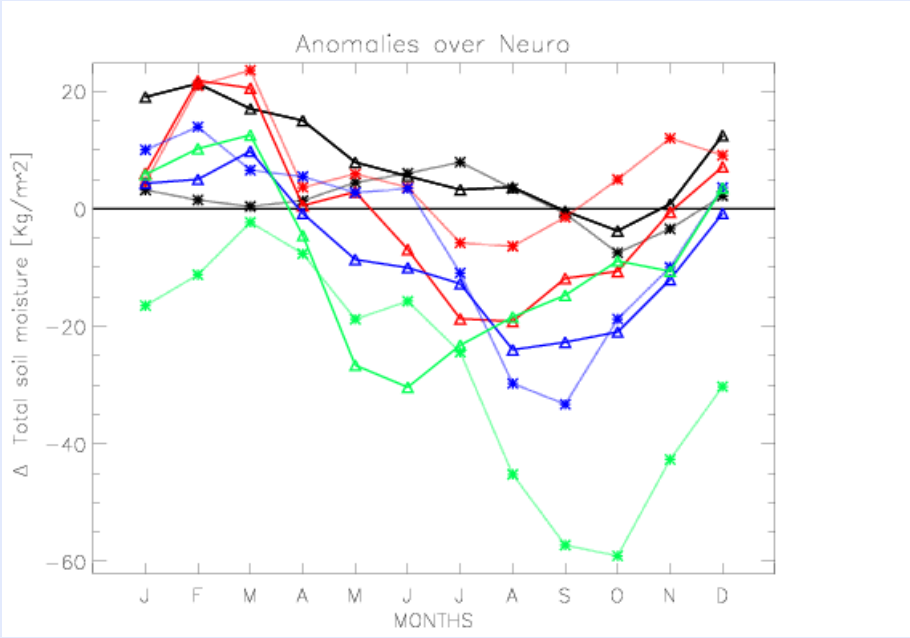
2.5. Soil moisture : global and coupled.

LSSs coupled to GCMs are for instance used to predict the impact of climate change on water resources.

A European project addressed this issue by performing time slice experiments in a doubled CO_2 environment with 4 GCMs (4 colors) coupled to 2 LSSs each .



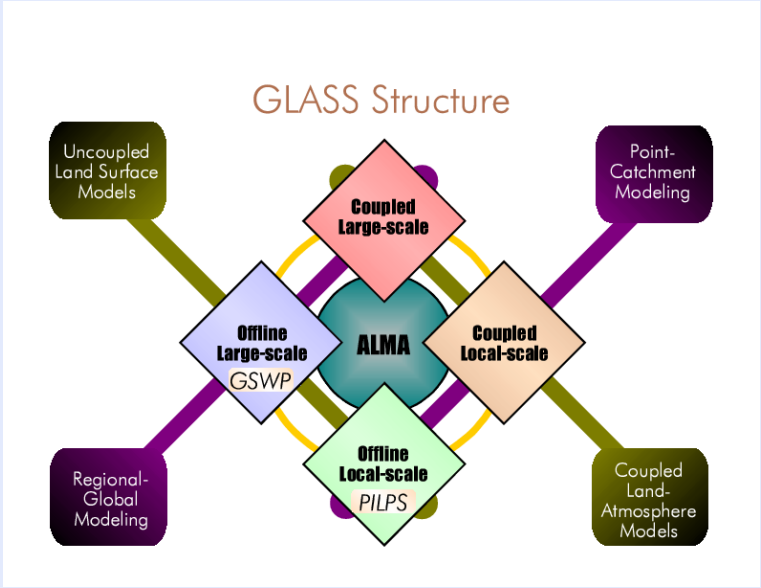
The uncertainties in the predicted soil moisture changes over Northern Europe is caused in part by different sensitivities of the LSSs.

Polcher et al., 1998, GEWEX News.

3. Organization and management

GLASS will coordinate LSS inter-comparisons from local to global scales and from off-line forcing to fully coupled.

It will ensure progress in all applications of LSSs and advance our understanding of the concepts needed to represent surface processes at various scales.



- The 4 scientific actions will coordinate projects in their field. A 5th action will provide the infrastructure.
- The science panel of GLASS will coordinate the 5 actions.
- The science panel will ensure that GLASS contributes to land-surface modelling needs of other GEWEX activities and BAHC.
- WGNE, IGBP/BAHC and the GEWEX panels will be represented on the science panel.

3.1. Local-scale/Off-line action

Coordination : Ann Henderson-Sellers, Andy Pitman

PILPS will continue the phase 2 projects. Next in line is PILPS 2e on the Torne River Basin. It will validate cold-season processes in LSSs. Other projects will follow :

- A CO_2 flux validation with the EuroFlux data from Loobos will be organized.
- Valdai mature forest data will be used to explore the snow/vegetation interactions.
- A PILPS experiment with ARM/CART data will prepare a parameter estimation exercise and an inter-comparison with a simplified coupling.
- South Ontario field measurements will be used to validate cold-season processes with high quality data.

Contacts with CSE's will be established in view of organizing PILPS experiments in climatic zones not yet used.
PILPS-2e will launch the ALMA activities and set new standards for collaboration in LSS inter-comparisons.

3.2. Global-scale/Off-line action

Coordination : Paul Dirmeyer, Taikan Oki

GSWP-2 will use the ISLSCP-II data to perform global off-line simulations over a 10 year period. Inter-annual variability of soil moisture will be the focus.

In the meantime GSWP-1.5 will help prepare phase 2. The following questions will be addressed :

- How Sensitive are LSSs to errors in the forcing data ?
- How well can LSSs be validated at the global scale with remote sensed data ?
- Are the drying out cycles of LSSs comparable ?
- Do LSSs operate in similar soil moisture stress ranges ?

With the help of a high resolution data the scale aggregation of soil moisture by LSSs will be explored. It will help understand the meaning of soil wetness at a $1° \times 1°$ resolution. Data from the Rhône Basin will be used.

3.3. Local-scale/Coupled action

Coordination : Hoshin Gupta, Paul Houser, Pedro Viterbo

This group will concentrate on the ARM/CART data. It will distribute a simplified single column model and extend the PILPS experiments.

The scientific questions are :

- What are the feedbacks between the PBL and LSSs ?
- How does the PBL interact with the surface heterogeneity ?
- Is the sensitivity of the LSS different in off-line and PBL-coupled modes ?

The parameter estimation procedure will ensure that the effective parameters are the same in all schemes.

This action build on PILPS inter-comparisons and will lead into the evaluation of data assimilation methods.

3.4. Global-scale/Coupled action

Coordination : Peter Cox, Randy Koster

Two aspects of land-surface atmosphere interactions are considered to require ***model independent assessments*** :

- Climate sensitivity to anthropogenic forcing
- Climate variability and predictability.

The first experiment will evaluate the impact of improved surface conditions on short term forecasts. This will be achieved with a flux correction of atmospheric fluxes; precipitation in the first phase. These experiments should yield information on :

- The geographical distribution of the strength of the land-atmosphere feedback,
- its inter-model variation,and
- its role in the predictability of the hydrological cycle.

The coupled action will maintain close contact with the two AMIP diagnostic sub-projects which deal with the role of LSSs in determining the quality of the climate simulated by GCMs.

3.5. Advancing Land-surface Modeling and Analysis (ALMA)

Coordination : Jan Polcher, Taikan Oki

The aim is to facilitate the inter-comparison activities within GLASS.

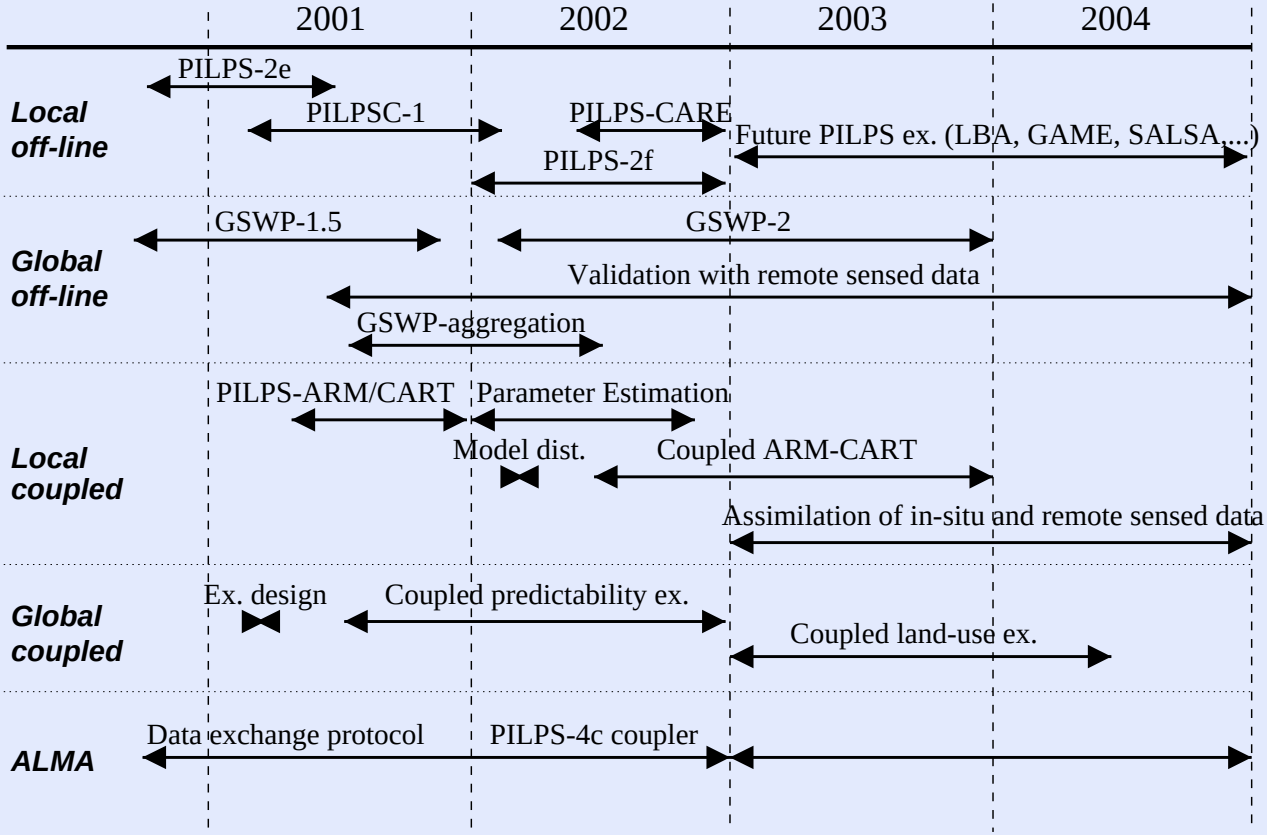
- Provide standards for data transfer. The first version is available and used by the PILPS and LDAS projects.
- Ensure that data from past experiments remains available.
- Distribute software for the modelling and analysis of land-surface processes

Current actions :

- Provide LSS drivers based on the interface defined in PILPS-4c :

  http://www.lmd.jussieu.fr/PILPS4c.html
- PILPS-2e is currently using the standard data transfer methods. ALMA provides the technical support for the users.

4. Time line



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5. Conclusion

The main innovations GLASS will bring to land-surface inter-comparisons are :

- Provide a framework which facilitates the inter-comparison and validation of LSSs.
- Initiate PILPS type inter-comparisons for simulated CO_2 fluxes.
- Integrate the coupling to the atmosphere in the inter-comparisons.
- Encourage validation of LSSs with remote sensed data and work towards data assimilation.
- Establish the role of land-surfaces for the predictability at short to seasonal scales.

The following actions will be taken in the next few month

- The implementation plan will be finalized before the end of the year.
- Ensure links with the other GEWEX panels and IGBP projects.