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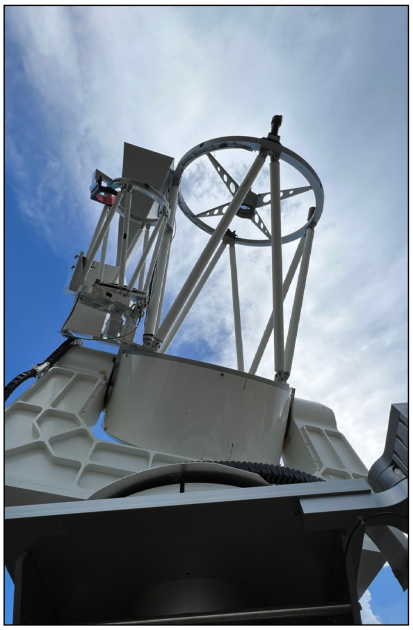
# The GLASS Panel: 25 Years of Improving the Modeling of Surface Fluxes and Land–Atmosphere Interactions



The GEWEX Land/Atmosphere Feedback Observatory (GLAFO) station at the University of Hohenheim in Stuttgart, Germany, during the 2023 GLASS Panel Meeting. GLASS, one of four GEWEX Panels, celebrates its accomplishments over the past 25 years starting on page 6. For a year-in-review of GLASS and an overview of its reorganization, see the meeting report on page 15, and be sure to check out the Pan-GLASS 2026 conference information on page 16.

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## Commentary

**Jan Polcher**
Co-Chair, GEWEX Scientific Steering Group

The GEWEX community is very lucky to have had a group of land surface modelers over the last 25 years that believe in international collaboration to advance and share our understanding of the processes that govern land surface–atmosphere interactions. In this issue of the GEWEX Quarterly, you will find a brief history of how the Global Land-Atmosphere System Studies (GLASS) Panel was set up to promote this activity and how it has evolved over the years. You can also find more information on the first Pan-GLASS Conference (*https://www.gewexevents.org/meetings/glass2026/*) at the end of the issue. For the climate research community in general, the development of Land Surface Models (LSMs) promoted by GLASS has been essential, as it allows us to provide more relevant information on our changing water resources in our weather forecasts and climate predictions. If some of GEWEX's cross-cutting activities like irrigation, groundwater, floods, or RivEx are to have a lasting impact on our prediction capacities, then GEWEX will have to rely on the GLASS community to implement the new knowledge in LSMs. I see two challenges for the land surface modeling community and GEWEX in general in the coming years.

The global and regional climate modeling communities are moving to km-scale resolution. For atmospheric processes, it is a desirable evolution. As the GASS community has convincingly demonstrated, with the explicit resolution of storms in atmospheric models, some of the uncertainties inherent in parameterizations are overcome. At these resolutions, models will also need LSMs for their lower boundary conditions. This raises the question of whether or not our current LSMs are suited for these resolutions. The reply to this question is not as obvious as for the atmosphere. When topography is better resolved, water transports at the surface and within groundwater will need to be explicitly represented. They organize our landscapes not only at the level of the slope, but also within continental scale catchments, and they organize the development of vegetation and spatially structure the fluxes to the atmosphere. The assumption in current LSMs that plant functional types are randomly distributed within a grid box will not be valid anymore. Downhill water flows are also used by humans to shape landscapes to our needs. It thus becomes more important to represent anthropogenic processes on land surfaces. We have to start thinking about landscape-resolving LSMs just as the atmospheric community is working on storm-resolving atmospheric models.

On the other end of the spectrum, GEWEX should also support the World Meteorological Organization (WMO)'s annual State of Global Water Resources reports (*https://wmo.int/publication-series/state-of-global-water-resources*), which are low resolution, but near real time. Within GEWEX, we have the competency needed to produce first estimates for some of the variables driving the continental water cycle in the first few months of each year. The land surface modeling community has the expertise to coordinate a regular modeling exercise that will run LSMs and global hydrological models up to December of the previous year with the adequate forcing. This will give access to variables that are not observed but essential to establish the state of global water resources.

With these activities, GEWEX can support WMO's objective to monitor the variability and changes in the continental branch of the hydrological cycle and provide important information to society on how climate change and our usage of water impact our resources. Although it is recognized that water is the cutting edge of climate change, few attempts are being made to monitor these resources, making WMO's effort all the more important. Arguably water is also the most strategic resource for societies and thus there is resistance from some countries to share information internationally on the state of water stores or fluxes. But isn't it the responsibility of the scientific community to overcome these difficulties and provide a global stocktake of the water resources that are of such critical importance to humanity?

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## New Panel Members

Dr. Benard Juma is a hydro-environmental research scientist and lecturer at the Hydraulic and Hydrologic Systems Laboratory of the Institute for Meteorological Training and Research (IMTR/WMO-RTC Nairobi). His work focuses on flood risk modeling, hydro-climatic extremes, and anticipatory action in Eastern Africa, drawing on research across hydraulics, hydrology, climatology, geosciences, extreme value analysis, and disaster risk reduction to improve flood forecasting, preparedness, and safeguarding vulnerable communities. He integrates advanced modeling with field-based insights to support evidence-led decision-making. Dr. Juma is Kenya's National Project Focal Point for the Climate Risk and Early Warning Systems for East Africa (CREWS-EA) Project, contributing to research, regional coordination, and strengthening early warning systems. He co-leads the Research, Innovation, and Learning Pillar of the Kenya Anticipatory Action Technical Working Group (AA TWG) and reviews for multiple hydrological and environmental science journals. He is a member of the International Association of Hydrological Sciences (IAHS), advancing hydrological research for sustainable solutions in Africa. He also promotes STEM mentorship for elementary and high school children—especially girls from disadvantaged backgrounds—inspiring future scientific and engineering careers. Dr. Juma joins the GEWEX Hydroclimatology Panel (GHP), contributing to international hydroclimate research and collaboration.

Dr. Jon Cranko Page is currently a postdoctoral researcher at the University of Oulu in Finland. His earlier education included a BA in Mathematics from the University of Oxford, a Hydrology and Water Resources MSc from Imperial College London, and a PhD in Climate Science at UNSW Sydney.

His research is driven by the desire to understand how predictable terrestrial fluxes are within the carbon and water cycle. Combining in situ eddy covariance measurements with empirical and process-based flux modeling, he aims to identify the level of information within meteorology and site characteristics relative to the observed and modeled fluxes. The ultimate goal is for this benchmarking to usefully inform the development of land surface models. Jon happily jumps into any carbon-water interaction opportunities and he is excited to help develop the benchmarking work of the GLASS Panel in any way he can. Apart from his research, he is also involved in data processing for a new eddy-covariance tower in northeastern Finland and helping to coordinate the PhD Pilot within the Digital Waters Flagship (also in Finland). Outside of science, Jon is a keen cyclist and occasionally disappears for weeks on long hikes.

## Celebrating and Fostering Community Among Students and Early Career Hydrologists

**Amanda Donaldson[1,5], Abigail Dischner[2,5], Adam Price[3,6], and Sujana Timilsina[4,7]**

[1]Postdoctoral Fellow, University of Texas, Austin; [2]PhD Student, Indiana University Bloomington; [3]Research Hydrologist, U.S. Forest Service; [4]PhD Student, University of Texas, Austin; [5]2025 H3S Outreach Co-Chair; [6]2025 H3S Chair; [7]2025 H3S Chair Elect

We're wrapping up another amazing year within the American Geophysical Union (AGU) Hydrology Section Student and Early Career Subcommittee (H3S)! We will be accepting applications for the 2026–2028 cohort in December! Please check out our website at https://www.agu-h3s.org/ soon for details.

We are thrilled to celebrate another successful year of professional development and outreach activities led by our group. Namely, we had an outstanding engagement for our "Navigating (Beyond) Academic Waters" webinar series with over 140 participants! These webinars are co-developed with the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) and the series can be viewed on YouTube (https://www.youtube.com/@CUAHSI/playlists).

We also hosted a webinar focusing on effective and relevant writing practices for Broader Impact statements in research proposals and job applications. We will be continuing this important conversation through a reflections blog post in our December newsletter. In addition, we hosted a town hall titled *What's next for the AGU Hydrology Section: Building an Equitable and Inclusive Community in Hydrologic Sciences* (session details at https://agu.confex.com/agu/agu25/meetingapp.cgi/Session/249860) in collaboration with the AGU Hydrology section at the AGU Fall Meeting in December 2025.

Other exciting happenings led by H3S at the AGU Fall Meeting included a town hall on *Strategies to Navigate Early-Career Path* (session details at https://agu.confex.com/agu/agu25/meetingapp.cgi/Session/249031) and, for the third consecutive year, we led a science communication session on *Thinking Outside the Box Plot: Communicating Science Beyond the Paper* (session details at https://agu.confex.com/agu/agu25/meetingapp.cgi/Session/267732). Stay up to date with all our events through our various platforms (visit our website at https://www.agu-h3s.org/ for more information) and subscribe (https://www.agu-h3s.org/contact) to our newsletter.

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# Canada's Regional Hydroclimate Project for GEWEX: Transitioning from the Global Water Futures Programme to the Global Water Futures Observatories Facility

**John Pomeroy and Chris DeBeer**

Centre for Hydrology and Global Institute for Water Security, University of Saskatchewan, Saskatoon, Canada

## History

Canada has a long history of involvement and contributions to GEWEX dating back to the early 1990s, when regional hydroclimate projects (RHPs) were formed around coordinated research activities in major cold regions river basins of western Canada. The Mackenzie GEWEX Study (MAGS; *https://gwfnet.net/sites/mags/*) was an early Canadian contribution to GEWEX that focused on the 1.8 million km$^2$ Mackenzie River Basin and had the objectives to 1) understand and model the high-latitude water and energy cycles that play roles in the climate system, and 2) improve our ability to assess the changes to Canada's water resources that arise from climate variability and anthropogenic climate change (Stewart et al., 1998; Woo et al., 2008). The study was carried out between 1994 and 2005 and produced the first comprehensive large-scale assessment and synthesis of cold region atmospheric and hydrologic processes in northern Canada.

The Saskatchewan River Basin (SaskRB) RHP commenced in 2012 and was expanded in 2014 to include the Mackenzie River Basin as part of the Changing Cold Regions Network (CCRN; *https://ccrnetwork.ca/*) research programme. This broader RHP for western Canada had the overall aims to integrate existing and new sources of data with improved predictive and observational tools to understand, diagnose, and predict interactions amongst the cryospheric, ecological, hydrological, and climatic components of the changing Earth system at multiple scales, with a geographic focus on western Canada's rapidly changing cold interior (see DeBeer et al., 2021, and the *HESS* special issue, *https://hess.copernicus.org/articles/special_issue919.html*).

CCRN ended in early 2018, but at that time the new Global Water Futures (GWF; *www.globalwaterfutures.ca*) programme provided an opportunity to expand this RHP geographically across Canada and as a more broadly-based and interdisciplinary initiative. The GWF Canadian RHP commenced that year with its coast-to-coast-to-coast domain covering the Yukon, Mackenzie, Fraser, Columbia, Saskatchewan–Nelson, Great Lakes–St. Lawrence, and Saint John River Basins, including transboundary portions of these basins in the United States. This encompassed a vast range of physiographic and climatological regions, from the Sub-Arctic Taiga, Tundra, and southern Arctic, through the western Cordillera, the vast Boreal Forest, the northern Prairie region, the Great Lakes, the St. Lawrence lowlands, and the Maritime region in the east.

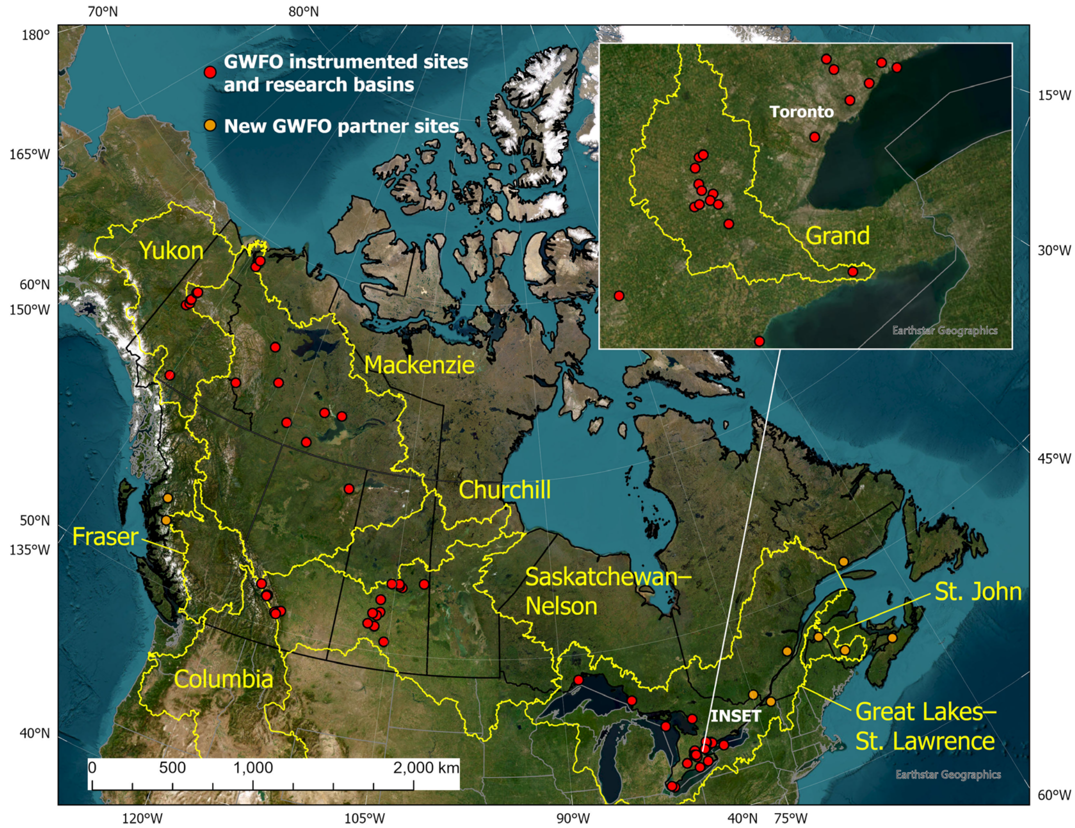
## The Global Water Futures Programme

GWF was conceived in 2015 to address a grand challenge for water science in Canada and globally: 'How can we best prepare for and manage water futures in the face of dramatically increasing risks?' With a $78M investment from the Canada First Research Excellence Fund (CFREF) and significant leveraged support from its lead partner institutions [University of Saskatchewan (USask), University of Waterloo, McMaster University, and Wilfrid Laurier University], GWF aimed to position Canada as a global leader in water science for the world's cold regions and to provide strategic tools to manage water futures for Canada and the world. It was a major undertaking to develop and operate this large university-led, transdisciplinary, multi-institutional water research programme, and much of what was done was new and unique. A recent paper describes how GWF did this and shares some of the important lessons learned and reflections (DeBeer et al., 2025).

With end-user needs at the forefront, driving GWF strategy and shaping its science, GWF focused on three main objectives:

1. Deliver new capability for providing disaster warning to governments, communities, and the public, including Canada's first national flood forecasting and seasonal flow forecasting systems, new drought warning capability, and water quality models and monitoring that warn of hazards to health and drinking water supply;
2. Diagnose and predict water futures to deliver improved scenario forecasting of changing climate, landscape, and water for the future, with information outputs tailored to the needs of users; and
3. Develop new models, tools, and approaches to manage water-related risks to multiple sectors, integrating natural sciences, engineering, social, and health sciences to deliver transformative decision-making tools for evidence-based responses to the world's changing cold regions.

GWF sustained the work of 65 research projects and core teams. Its research projects were selected through a competitive peer-reviewed process with the help of an International Science Advisory Committee. Indigenous community projects were co-developed and co-led with the communities and evaluated by an Indigenous Engagement Committee. GWF's core teams provided programme support in communications, data management, and knowledge mobilisation, and led strategic developments such as new computer modelling and collecting observations from over 70 instrumented research sites. GWF's four partner universities hired 40 new freshwater professors, and the funding provided to more than 200 faculty members at 23 universities across Canada led to the hiring and training of over 1700 undergraduate and graduate students, postdoctoral fellows, research scientists, technicians, and visiting scientists in groundbreaking scientific research. The research findings generated by this increased capacity are beginning to change freshwater and climate adaptation policy priorities and management practices across Canada and are providing the foundation for the country's essential climate and water prediction capability.




*Canada's RHP in GEWEX and the major river basins comprising it. GWFO supports world-leading cold regions water science and modelling efforts focussed around its network of instrumented sites, deployable systems, and water laboratories, and through its leadership of other global programmes.*

GWF studies have investigated diverse aspects of hydrology, water quality, aquatic ecology, wildfires, health and wellbeing, water prediction and monitoring, science-art approaches to communication, the impacts of climate change on water resources, permafrost and glacier dynamics, and the effects of human activities on water ecosystems. Many studies employed advanced techniques such as remote sensing, supercomputer-based modelling, environtmental DNA, and isotopic analysis. Overall, the interconnectedness of GWF research areas and their relevance to pressing local and global challenges has been remarkable. GWF researchers have not only contributed to research, but have also worked with hundreds of partner groups and led numerous international research programs and committees, as well as started key science-art and other initiatives such as Transitions, the Virtual Water Gallery, and Women Plus Water. Major contributions to the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Climate Research Programme, the World Meteorological Organization, and Future Earth have led to the UNESCO Chair in Mountain Water Sustainability, Ecohydrology Demonstration sites for UNESCO's Intergovernmental Hydrology Programme, the International Year for Glaciers' Preservation – 2025, and the UN's Decade of Action for Cryospheric Sciences (2025–2034).

After nine years of operation, GWF came to its conclusion in August 2025. Its advances and achievements are being compiled into a comprehensive synthesis and a series of topical and regional science papers, plain language summaries, and easy-to-visualize infographics. This will be a legacy of the programme and a contribution to GEWEX as the RHP for Canada. However, despite the end of GWF, Canada's involvement in GEWEX will continue—much of the observational, laboratory, and data management components of GWF carry on as part of the nine-university Global Water Futures Observatories facility (GWFO; *www.gwfo.ca*), launched in April 2023, and in the national research that GWFO supports.

### The Global Water Futures Observatories Facility and Its Contribution to GEWEX

GWFO is a national, multi-university water research facility supported by the Canada Foundation for Innovation's (CFI) Major Science Initiatives (MSI) Fund from 2023 to 2029 with possibility of renewal in 2029. Led by USask, GWFO is a $40.5M research facility of 64 in situ instrumented observation sites in strategically selected water bodies and research basins; 15 deployable measurement systems that are mobile and used for specialised measurement campaigns such as snow surveys, lake aquatic ecology and chemistry surveys, evaporation, and other intensive observations; and 18 university-based environmental and aquatic analysis facilities. It operates as a partnership between USask, University of Waterloo, McMaster University, Wilfrid Laurier University, University of Windsor, Trent University, Carleton University, Western University, and University of Toronto. This sustains GWF's unique freshwater observing network and sophisticated data telemetry, storage, management, and visualisation systems as a national facility, and brings in new partners from the Real-Time Aquatic Ecosystem Observation Network (RAEON; *https://raeon.org/*) in the Great Lakes region. GWFO is expanding its observatories across Canada through partnerships with additional institutions in Quebec, Alberta, and British Columbia to make this a truly coast-to-coast-to-coast network. GWFO provides the infrastructure and resulting open and publicly available water data, which informs the development and testing of water prediction models, monitors changes in water sources, underpins diagnosis of risks to water security, and helps design solutions to ensure the long-term sustainability of Canadian and global water resources.

GWFO is funded as an observational and analytical facility but leverages other sources of support to maintain a world-class science programme around the observatories. The network of Canadian water experts who operate the facility are global leaders in their specific fields and they contribute key insights and novel scientific advances. GWF's broad science questions remain relevant and provide direction for ongoing work as new and emergent issues arise, and GWFO relies on a User Advisory Panel comprised of representatives from a wide range of end-user groups who provide insights and guidance on the user science and decision support needs underpinned by GWFO. Intensive water research supported and carried out by GWFO and its members contributes to essential Canadian initiatives, such as a national hydrological and streamflow prediction system and strategies for flood and drought forecasting, and to the new Canada Water Agency, a federal agency that is responsible for coordinating the management, protection, and sustainability of Canada's freshwater resources across all regions and jurisdictions. GWFO provides leadership internationally through the International Year for Glaciers' Preservation – 2025, the Decade of Action for Cryospheric Sciences, the UNESCO Chair in Mountain Water Sustainability, and the International Network for Alpine Research Catchment Hydrology, a GEWEX cross-cutting project. Through these activities and other new opportunities, our vision is to carry on as a GEWEX RHP and the premier national water research facility for Canada, and a global leader in cold regions water observation, understanding, modelling, and prediction.

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# The GLASS Panel at 25 Years

**Kirsten L. Findell, Gab Abramowitz, Martin Best, Aaron Boone, Nathaniel Chaney, Paul A. Dirmeyer, Michael Ek, Andy Pitman, Jan Polcher, Joseph A. Santanello, Bart van den Hurk, Anne Verhoef, and Volker Wulfmeyer**
Former or current GLASS Panel co-chairs

## Introduction

Land modeling has shown rapid development in recent decades. While characterizing energy and water fluxes were the primary focus of studies through the 1990s, the 2000s brought increasing attention to coupled land–atmosphere (L-A) interactions and to the global carbon cycle, triggering the development of model characterizations of vegetation phenology, dynamic vegetation structure, and carbon pools. Continued development through the 2010s and into the 2020s broadened the capacity of those models with improved representations of soil physics and related soil hydraulic properties, plant water stress (including plant hydraulics) and root water extraction, wetlands, urban areas, irrigation, soil water and ground water, nutrient cycles, cryosphere processes, and more.

This expanding scope is driven by the growth of interdisciplinary studies of the Earth system, including efforts to understand processes from the sub-surface (e.g., impacts of soil characteristics on groundwater recharge), to the surface (e.g., impacts of soil moisture on surface flux partitioning), to the near-surface atmosphere (e.g., impacts of turbulent surface fluxes on the convective boundary layer). However, additional drivers of land model development stem from the recognition of the role of the land in impacting and modulating extremes (heatwaves, floods, droughts, etc.), and the emerging needs of policy-makers examining adaptation and mitigation measures that are responsive to climate projections. Modern land models are often employed to examine regional vulnerability to changing water resources, heat extremes, or flood risks. They are increasingly being used to map a range of human interventions in the land system, including land use change (Findell et al., 2017), agricultural practices (McDermid et al., 2023), surface radiation management (Seneviratne et al., 2018), or various alterations of local nutrient cycles (Sinha et al., 2017).

For 25 years, the Global Land-Atmosphere System Studies (GLASS) Panel has been encouraging such developments by coordinating the evaluation and intercomparison of each new generation of land models and their applications to scientific queries of broad interest. Here we revisit that 25-year history, highlighting key developments in land process representation and understanding, modeling and understanding land-atmosphere interactions, and improvements in land-relevant observations and the land model benchmarking efforts those efforts enable. We conclude with some thoughts on the immediate future of GLASS.

## Land Model Development Prior to GLASS

In the late 1980s and early 1990s, numerical models of the land were designed to provide lower boundary conditions to the atmosphere, thus the descriptor "land surface models" (LSMs). Development of more physically-based representations of the processes which drive the energy and water cycles over continents began with the emergence of "big leaf" characterizations of vegetative controls on surface processes (e.g., Sellers et al., 1986). The first effort to assess the added value of this new generation of models used year-long simulations by three LSMs at two European point locations, forced by atmospheric data from the UK Met Office climate model. This study highlighted the conceptual nature of many model parameters and suggested that similar intercomparisons should be done with observed climate data (Polcher et al., 1996). In parallel, Ann Henderson-Sellers and Andy Pitman initiated intercomparisons of LSMs, first driven by synthetic data and later by observations, coordinated through GEWEX's Project for Intercomparison of Land Surface Parameterization Schemes (PILPS). This effort used observations from the Cabauw grassland site in the Netherlands (Chen et al., 1997) to compare LSM performance over a complete annual cycle and evaluate their predicted fluxes against observations. These point-scale validations and later catchment-scale intercomparisons of LSMs enabled researchers to explore LSM behaviors across diverse climates and address new scientific questions regarding L-A interactions, and were essential to the expansion of the community that showed the need for the GLASS Panel.

During the same time period, the International Satellite Land Surface Climatology Project (ISLSCP) set out to build the atmospheric forcing needed to drive LSMs at the global scale (Sellers et al., 1996). For the period 1987–1988, 6-hourly estimates of the necessary variables were generated on a 1°x1° grid. Paul Dirmeyer led an LSM intercomparison effort, aiming to establish consensus estimates for non-observed fluxes and variables such as evaporation and soil wetness (Dirmeyer et al., 1999). This became GEWEX's first Global Soil Wetness Project (GSWP).

Two new PILPS projects helped maintain focus on the original purpose of LSMs: providing lower boundary conditions to atmospheric models (Henderson-Sellers et al., 1995). PILPS-3 analyzed Atmospheric Model Intercomparison Project (AMIP) simulations to identify if differences in atmospheric processes originating over continents could be attributed to the underlying LSMs. PILPS-4 defined a standard coupling interface between continental surfaces and the atmosphere in order to compare simulations of one atmospheric model driven by various LSMs, facilitating the inter-comparison and inter-operability of LSMs (Polcher et al., 1998).

Given the diversity of efforts underway in land modeling at the end of the 1990s, GEWEX leadership felt that stronger coordination was needed. A workshop in Gif-sur-Yvette, France, in October 1999 led to the formation of the first GLASS Panel, with the inaugural meeting in Sydney, Australia, in 2000. The initial goals and rationale for GLASS were threefold: (i) enable modeling of the carbon cycle, (ii) represent horizontal complexity of the land (i.e., subgrid variability), and (iii) enrich modeling work with observations (Polcher et al., 2000). These three facets of scientific growth have remained fundamental to GLASS Panel work throughout its 25 years, though with varying degrees of emphasis. Carbon cycle work was minimal in the early GLASS years, largely to avoid duplication of ongoing efforts in the International Geosphere-Biosphere Programme (IGBP, succeeded by Future Earth); in fact, specific objectives within all three themes have changed as needs and capabilities have evolved. Those evolving needs and the projects designed to address them are discussed below.

**GLASS's First Dozen Years**

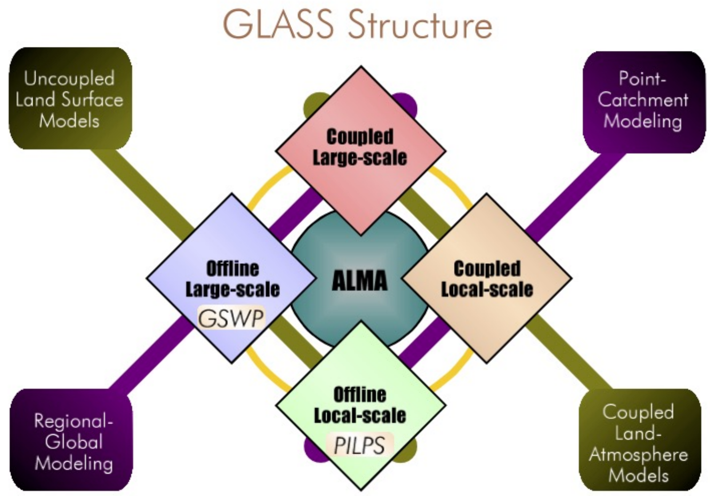


***Figure 1***. *The initial project structure for GLASS (Polcher et al., 2000)*

The initial project structure of GLASS (Figure 1) was centered on a conceptual model with two axes, with one dimension focused on coupled versus uncoupled L-A systems, and the other on local (single point, 1D vertical) versus global (or at least regional, distributed, 3D) spatial scales (van den Hurk et al., 2011). This resulted in four elements: the existing projects PILPS and GSWP anchored local and global uncoupled systems, respectively. The Global Land-Atmosphere Coupling Experiment (GLACE) project began shortly after Figure 1 was conceived, targeting global scales and coupled land-atmosphere systems. The local land-atmosphere coupling (LoCo) initiative, the local-scale coupled element, was realized a few years later (with naming credits going to Christa Peters-Lidard).

In addition to the activities happening within GLASS during this time period, several other international research programs also deployed activities aimed at coordinating land-relevant science. In particular, IGBP had a program focused on the representation of vegetation and the terrestrial biosphere, which complemented the hydrological/physical focus of GLASS. In later years these communities showed increasing overlap in both membership and scope.

Around the same time, urban modeling activities were emerging within land modeling communities. GLASS initiated the first urban model comparison project (PILPS-Urban; Grimmond et al., 2011; Best and Grimmond, 2015), which demonstrated the importance of the water and energy cycles within the urban environment. In particular, the project highlighted the need to include urban greenspaces in order to correctly model surface heat and moisture fluxes.

The early 2010s served as an inflection point for GLASS, where the structure evolved from the 2x2 matrix described above into the "martini glass" themes of Land-Atmosphere Coupling (LAC), Model-Data Fusion (MDF), and Benchmarking (Figure 2). These focal areas were each considered crucial to make substantial advancements in modeling the land system. These ideas still feature prominently in the desire to make integrated or holistic assessments (LAC as an expression of such an integrated approach), combine physical modeling with data-driven approaches (MDF being a precursor of present-day use of artificial intelligence and hybrid modeling), and the call for transparency and significance of scientific findings (elaborated by extensive benchmarking of approaches used).

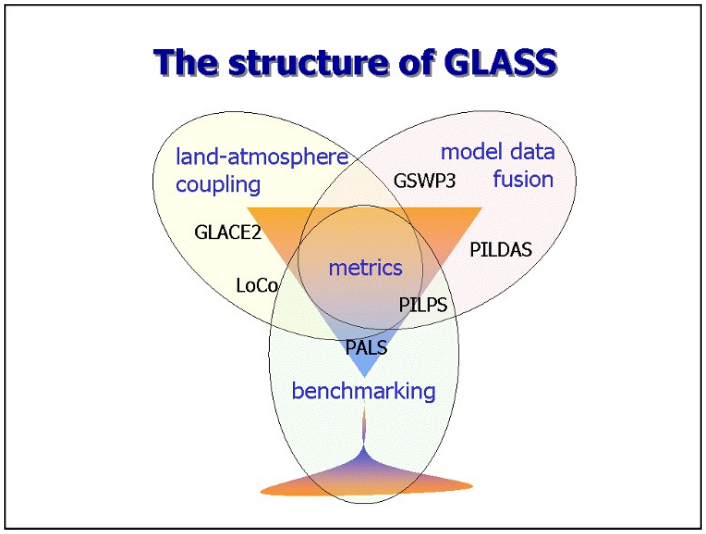


***Figure 2**. The structure of GLASS during the 2010s (van den Hurk et al., 2011)*

### The Second Half of (the) GLASS

During GEWEX Phase III (beginning around 2013), GEWEX's focus was on quantitative understanding of water and energy coupling (Stephens et al., 2023). Given GLASS's land-atmosphere focus, this included a shift from relatively ad hoc evaluation of land models to a more systematic approach using the growing suite of relevant observations, especially from flux towers. This allowed the community to both directly compare LSMs to observations, and use machine learning-based benchmarks to show how much information LSM meteorological drivers contained about the fluxes they were predicting. Additionally, these data allowed for the quantification of performance expectations for various particular metrics of interest. This systematic analysis approach was standardized in and facilitated by the Protocol for Analysis of Land Surface models (PALS; Abramowitz, 2005; Abramowitz, 2012) and *modelevaluation.org*. Further efforts were pursued through a collection of model intercomparison projects (MIPs), initially the PALS Land Surface Model Benchmarking Evaluation Project (PLUMBER; Best et al., 2015; Haughton et al., 2016), followed by PLUMBER2 (Abramowitz et al., 2024), and Urban-PLUMBER (Lipson et al., 2024).

The desire to understand what determined the "coupling hotspot" areas found in GLACE (Koster et al., 2004), and in particular why the models had such diverse coupling strengths, led to the DIurnal land-atmosphere Coupling Experiment (DICE; Best et al., 2025), a joint experiment with the GEWEX Atmospheric Boundary Layer Study (GABLS), bringing the surface and boundary layer communities closer together. This resulted in a number of new insights that started to explain the controlling mechanisms for land-atmosphere coupling in models.

Increased effort was also directed towards local process scales, with further development of the LoCo initiative (Santanello et al., 2018). LoCo was charged with identifying integrated, process-level metrics that could be applied to models and observations in order to quantify the L-A coupling strength and its representation in regional and global models at weather to climate time scales. At the time, LoCo was a unique type of GLASS project: community based (with participation well beyond the GLASS membership) and without a MIP structure imposed, supporting organic metric development and scientific applications related to L-A coupling (e.g., convection, extremes, precipitation, data assimilation, predictability). An important focus was the need for improved observations to confront models and metrics across the "process chain" connections from soil moisture to surface fluxes to boundary layer evolution, ambient weather, clouds, and precipitation. Adoption of LoCo metrics by operational centers is a long-term goal of the project that has made recent progress, though it remains a challenge due to operational center limitations and priorities.

Growth of efforts to improve understanding and representation of the complexity of the land surface also expanded during this phase. The SoilWat collaboration with the International Soil Modelling Consortium (ISMC) began in June 2016 with a workshop in Leipzig, Germany, bringing together two research communities to improve the representation of soil and subsurface processes in climate models. Initial efforts focused on review papers characterizing the state of soil hydrological modeling in land models, and on their soil hydraulic properties and related pedotransfer functions (PTFs; used to calculate parameters for soil hydraulic functions based on more readily available soil data, such as texture and porosity). The Soil Parameter MIP and related initiatives have helped improve understanding of how key soil physical processes related to water and heat flow are represented in LSMs, the utility of and uncertainties stemming from available soil maps and PTFs (Weihermueller et al., 2021; Weber et al., 2024), how soil-plant-water interactions can be improved (e.g., Vereecken et al., 2019; Vanderborght et al., 2021), and how groundwater processes are implemented in climate models (Condon et al., 2021). The current crosscutting groundwater effort between GLASS and GHP, the GEWEX Groundwater Network, hones in directly on this last point. Renewed impetus was given to the SoilWat effort with a recent workshop that took place in Reading, UK, in July 2025, with the operational centers showing a keen interest to improve their below-ground parameterizations in close collaboration with soil experts.

The Land Atmosphere Feedback Experiment (LAFE) conducted at the Atmospheric Radiation Measurement Program Southern Great Plains site in August 2017 (Wulfmeyer et al., 2018) was the first field experiment designed to provide comprehensive observations of the full land-atmosphere system. Surface networks usually do not consider planetary boundary layer measurements, and meteorological observatories often do not provide observations concerning the soil and land cover or their heterogeneities. Discussion of these issues led Volker Wulfmeyer to propose the concept of the GEWEX Land-Atmosphere Feedback Observatory (GLAFO) during the July 2019 GLASS Panel meeting in Boulder, Colorado. The basic idea of the GLAFO is to merge the information content of surface networks and meteorological observatories where available, or to establish new sites where comprehensive measurements of key soil, land cover, and atmospheric variables are performed simultaneously (Wulfmeyer et al., 2020). This allows for comparable characterizations of L-A coupling strengths in different climate zones. In the years since that 2019 meeting, GLAFO has become one of the central projects of the GLASS Panel. The first GLAFO prototype has been running continuously at the University of Hohenheim in Stuttgart, Germany, since 2018 (Späth et al., 2023) and the first GLAFO in South America was recently established at the Huancayo Observatory in Peru.

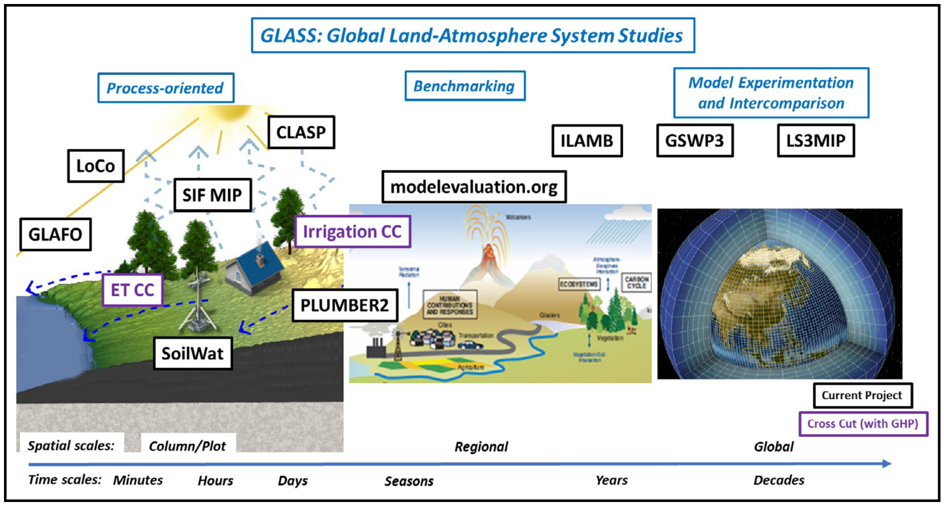


***Figure 3****. GLASS Panel projects circa 2023, from column to global scales*

More recent additions to the GLASS portfolio (Figure 3) include Coupling of Land and Atmospheric Sub-grid Parameterizations (CLASP) and the Solar-Induced chlorophyll Fluorescence Model Intercomparison Project (SIF-MIP). CLASP looks at the role of sub-grid surface heterogeneity on atmospheric responses, with efforts designed to improve the parameterization of heterogeneous sub-grid exchange between the land and atmosphere and characterize its implications for surface climate, variability, and extremes (Chaney et al., 2023). SIF-MIP brings process-level inquiry into the carbon cycle into GLASS for the first time. The interaction of fluorescence with photochemistry at the leaf and canopy scales provides opportunities to diagnose and constrain model simulations of photosynthesis and related processes through direct comparison to and assimilation of tower, airborne, and satellite data. SIF-MIP focuses on targeted assessments of simulations from an ensemble of process-based land models, forced with local meteorology and analyzed against tower-based continuous far-red SIF, net and gross carbon (net ecosystem production, gross primary productivity), and surface energy exchanges (evapotranspiration and sensible heat flux).

### Looking Ahead

Building on previous GLASS efforts, the current Panel is revisiting many of the assumptions of earlier generations of land models (Chaney et al., 2024). This is especially important given several persistent, critical challenges in L-A process understanding and modeling. These include representations of:

- Surface heterogeneities on L-A feedbacks,
- Turbulence at the L-A interface (the need for alternatives to Monin-Obukhov similarity theory),
- Soil processes,
- Surface energy balance closure, and
- Entrainment in the convective boundary layer.

Most current GLASS Panel initiatives target aspects of these challenges. Resolving them satisfactorily will likely involve utilizing the lessons learnt from machine learning-based benchmarking, and embodying these kinds of testing mechanisms into a community-based scientific testing platform, highlighting the importance of PLUMBER2 and the new Machine Learning for Land Models (ML4LM) project, and necessitating tighter engagement with observational communities. Robust cross-activity interactions highlight the Panel-wide focus on these persistent issues.

In addition to the technical challenges noted above, a transformation in the demands placed on the land modeling community has occurred. The urgency of societal needs related to changing weather and climate extremes pushes the Panel towards broader efforts focused on solutions such as improved drought predictions, or sustainable water resources for societies and ecosystems, or guidance on where to plant forests safely to mitigate carbon emissions. Such capabilities require km-scale models that accurately represent human interventions in the Earth system and enable the mapping of trade-offs between multiple consequences of these interventions. The current projects focused on irrigation and urban processes are a start; efforts to establish a GLASS working group on anthropogenic impacts on L-A interactions are underway, with a clear focus on the technical modeling aspects of these issues.

An important attribute connecting the GLASS Panel's work across its 25 years is the commitment to collaborative, international science as a means of accelerating progress. While land model development happens at multiple institutions across the globe, advancement of the science is facilitated by interactions across these institutional boundaries. The cultivation and curation of data sets designed to help test and improve models requires the leadership and drive of global collaborative science organizations like the World Climate Research Programme (WCRP), GEWEX, and GLASS. Such data sets can be used to improve understanding of mechanistic processes, as forcing data sets to drive model intercomparison projects, or as benchmarking data sets to determine the performance and viability of independent models.

Throughout GLASS's timeline, we see the Panel leading the charge for high-quality, land-relevant data sets to help advance the science. An important component of this process is the determination of consistent conventions and standards to facilitate the broad use of observational and model-based data sets. The Assistance for Land-surface Modeling Activities (ALMA; see Figure 1) provided this data standardization structure for the first set of GLASS projects, ensuring consistent variable names and sign conventions, as well as definitions of the terms needed for budget closures. Benchmarking and model-data fusion emerged as important aspects of GLASS's subsequent years, requiring GLASS leadership through efforts like PALS, PLUMBER, and its follow-on projects, such as the Ukkola et al. (2017, 2022) effort to produce viable flux tower data sets that met gap-filling and quality control needs for LSM applications. That GLAFO emerges now through the auspices of GLASS furthers this legacy of GLASS leadership in the vision of what can be achieved, and highlights once again the benefits of international collaboration. The increased attention to human adaptation and mitigation interventions calls for standardization of data protocols, model coupling interfaces, and experimental designs that connect the physical domain to the domain of sectoral technical and socio-economic information that characterizes key drivers of major trends.

In closing, we return to the three ambitious themes that sparked the initial formation of GLASS: (i) enable modeling of the carbon cycle, (ii) represent horizontal complexity of the land (i.e., subgrid variability), and (iii) enrich work with observations. While these themes remain central to today's GLASS Panel, we can be proud of the massive strides taken in each area over the 25 years of GLASS's work to date. As we look towards the next 25 years of GLASS, we envision continued efforts to advance understanding and modeling of land and land-atmosphere processes, as well as an expansion of work focused on human interventions in the water, energy, and carbon cycles. We invite the global land surface community to join us at the upcoming Pan-GLASS meeting in Stuttgart, Germany, in July 2026 (*https://www.gewexevents.org/meetings/glass2026/*) to expand this vision and help drive this ambitious research agenda forward.

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## Meeting/Workshop Reports

# ANDEX 2025 Annual Meeting

**13–18 October 2025**
**Mendoza, Argentina**

**Mariano Masiokas[1], Nicole Reyes[2], and Jhan-Carlo Espinoza[3,4]**

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From October 13 to 18, the city of Mendoza, Argentina, hosted the ANDEX 2025 Annual Meeting, a key event aimed at strengthening scientific collaboration among Andean countries and the broader region. The meeting, held at the Scientific and Technological Center (CCT) of Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) Mendoza, brought together more than 100 participants, including scientists, students, professionals, and institutional representatives. Attendees from Argentina, Chile, Bolivia, Peru, Ecuador, Colombia, Brazil, Paraguay, France, the United States, and New Zealand shared recent research progress and defined priorities for the coming years on topics related to climate, water resources, the cryosphere, ecosystems, and Andean societies.

The opening ceremony featured welcoming remarks from Dr. Andrea Pattini, the Director of CCT CONICET Mendoza, who highlighted the importance of collaborative science for the sustainable development of Andean countries. A major milestone of the event was the presentation of the ANDEX Science and Implementation Plan (*https://www.gewex.org/gewex-content/uploads/2025/10/SCIENTIFIC-IMPLEMENTATION-PLAN_202504-6.pdf*), approved in 2025 by the GEWEX Hydroclimatology Panel (GHP). This document is now available in both Spanish and English. The First ANDEX Compendium was also launched, compiling recent scientific advances developed from researchers from Andean countries. In addition, several oral presentations showcased progress from ANDEX projects and other related collaborative initiatives, fostering new opportunities for regional cooperation.

The ice breaker ceremony featured a photographic and art exhibition dedicated to Andean glaciers and landscapes, showcasing some of the most remarkable glacier scenes captured by local researchers, along with paintings from Pablo González, a renowned local climber, writer, and artist. Throughout the week, this experience was enriched by the "Andean Glaciers VR" project, a virtual reality initiative presented by Nicolás Villaume (National Geographic Explorer) that offered participants an immersive journey through the Andean cryosphere. The exhibition was held in the context of the International Year of Glacier Preservation, declared by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Meteorological Organization (WMO).


*Participants of the second JovenANDEX poster session*

The participation of young researchers and professionals was particularly noteworthy during the Second JovenANDEX Poster Session, which featured 49 posters displayed in the halls of CCT CONICET Mendoza. Throughout the week, and within the framework of the ANDEX-Academia project, thematic workshops were led by ANDEX specialists on topics such as Andean Glaciology, Mountain Hydrology, Climate Modeling, Andean Paleoclimate, and Vulnerability and Adaptation to Climate Change. The Regional Information for Society (RIfS) project of the World Climate Research Programme (WCRP) also organized an interactive session that explored the dialogue between science and policy in the Andean region.

The meeting concluded with a round table with local scientists (René Garreaud from the Center for Climate and Resilience Researchin Santiago, Chile), decision makers (Rubén Villodas and Salvador Calí from the water agencies of the Mendoza and Salta provinces in Argentina), and a representative from the Chilean Consulate in Mendoza (Sergio Marinkovic), who provided valuable insights on the role and relevance of ANDEX in a wider regional context. On the last day, the group (about 80 people) visited the Aconcagua Provincial Park and the upper Mendoza river basin where they had the chance to see the south face of Aconcagua (6962 m), the highest mountain in the world outside the Tibetan Plateau in Asia.

*Scenes from the 2025 ANDEX Meeting, including a visit on the final day of the meeting to the Aconcagua Provincial Park (bottom)*

The success of this meeting was made possible thanks to the commitment and dedication of the Local Organizing Committee, formed by scientists and personnel from CCT CONICET Mendoza, Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA), and Instituto de Ciencias Humanas, Sociales y Ambientales (INCIHUSA), as well as the support of partner institutions and associated projects, including the Institut de Recherche pour le Développement (IRD, France), Institut Franco-Argentin d'Études sur le Climat et ses Impacts (IFAECI, Buenos Aires), the Global Cryosphere Watch program of the WMO, and the AccelNet-Andean Climate Change - Observations, Research and Discovery (ACCORD) and Conéctate A+ projects, whose financial and logistical support was instrumental in enabling the participation of many young researchers.

Beyond the scientific sessions, the meeting fostered a renewed sense of community and collaboration among Andean researchers, reaffirming ANDEX's role as a key unique platform for integrated, interdisciplinary, and transdisciplinary research in the Andes.

Finally, it was announced that the ANDEX 2026 Annual Meeting will take place at the University of Cuenca (Ecuador) in July next year.

To view photos from the event, visit the folders at *https://drive.google.com/drive/folders/1_GRZxevGm5FuAi48i2SXTb-pLIFJu-uxD*.

# SoilWat 2025: Soils at the Heart of Weather and Climate?

**14–16 July 2025**
**Reading, UK**

**Anne Verhoef[1] and Yijian Zeng[2], on behalf of the SoilWat 2025 Scientific Organizing Committee and attendees**

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From 14–16 July 2025, over forty researchers with expertise across soil physics, hydrology, land surface and Earth system modeling, micrometeorology, plant physiology, and remote sensing met at the University of Reading, UK, for the SoilWat 2025 Workshop (*https://www.gewexevents.org/meetings/ismc-soil-wat2025/*). Hosted under the GEWEX Soil and Water (SoilWat) initiative and co-sponsored by the International Soil Modelling Consortium (ISMC; *https://soil-modeling.org/*), the workshop focused on how to better represent soil processes in land surface and Earth system models used for weather and climate research.

Participants engaged in discussions around a central question: how should we improve our treatment of soil processes in land surface models to support kilometer-scale models, digital twins, and climate adaptation, while keeping our models physically grounded and computationally affordable?

### 1. Why Revisit Soils Now?

Recent droughts, floods, and heatwaves have exposed the limitations of current land surface schemes. In many models, soil hydraulic and thermal properties are still prescribed from texture-based pedotransfer functions and legacy global soil maps. These inputs often fail to capture soil structure, management impacts, or the very dry end of the soil moisture range that strongly controls evapotranspiration, runoff generation, and feedbacks to the boundary layer.

At the same time, new observational capabilities, from flux tower networks and cosmic-ray neutron sensors to satellites (e.g., delivering soil moisture, vegetation optical depth, and solar-induced fluorescence data), offer richer constraints on soil–plant–atmosphere interactions than were available even a decade ago. SoilWat 2025 used this momentum to re-assess which soil processes and underlying properties matter most for surface fluxes, land–atmosphere coupling, and related extremes.

### 2. Emerging Themes

Discussions converged on several recurring themes:

#### *From fixed parameters to evolving soil properties*

Participants argued that key soil properties (porosity, bulk density, hydraulic and thermal conductivities) should increasingly be treated as dynamic, co-evolving with climate, vegetation, and land use, rather than as unchanging inputs derived from texture alone. This naturally puts soil structure and pore-size distributions at center stage.

*Participants of the SoilWat 2025 Workshop*

***Making soil schemes scale-aware***

As kilometer-scale Earth system models become standard, there is a growing need for soil parameterizations that clearly state the spatial scale they represent and that are developed and tested accordingly. Approaches such as spatial tiling based on hydrologic similarity, and methods that use visible to near-infrared –short-wave infrared soil reflectance to derive hydraulic parameters, were highlighted as promising directions for capturing sub-grid heterogeneity in land surface models.

***Better linking of soils, roots, and plant hydraulics***

Several contributions showed how soil structure, root distribution, and plant hydraulic traits jointly shape drought responses, recovery, and even mortality risk. Integrating dynamic root models and plant hydraulics into land surface schemes was seen as essential for credible projections of vegetation resilience under extremes.

***Hybrid modeling and data assimilation***

Participants saw strong potential in combining process-based models with machine learning (ML) and data assimilation to exploit diverse observations while retaining physical interpretability. Physics-informed ML emulators, rather than unconstrained black boxes, were considered particularly useful for sensitivity analysis, parameter estimation, and exploring structural uncertainties in soil and root representations.

**3. Community Actions and Next Steps**

A key outcome of SoilWat 2025 was agreement on a set of community-led activities that cut across individual land surface models and institutions. These include:

- a coordinated effort on developing and testing unified hydro–thermal parameterizations and shared benchmark data sets,
- model experiments that explore dynamic soil properties and soil-structure evolution in land surface models,
- joint evaluation of soil–surface–atmosphere interface processes, and
- stronger links between soil and root modeling and emerging GEWEX Land–Atmosphere Feedback Observatories (GLAFOs) and other long-term observational sites.

These activities are being developed in close collaboration with ISMC working groups (*https://soil-modeling.org/science-panels/working-groups*) and with relevant GEWEX Panels, especially the Global Land-Atmosphere System Studies (GLASS) Panel. The intention is to design multi-model intercomparison experiments that share forcing data, soil and vegetation information, and evaluation metrics, thereby enabling robust comparison of different soil processes and their impact on land–atmosphere coupling.

**4. Outlook**

A recurring message from the workshop was that soils should no longer be treated as a static lower boundary for the atmosphere. Instead, they are dynamic components of the climate system whose evolving hydraulic and thermal behavior strongly shapes water and energy fluxes, related extremes, and adaptation options.

By bringing together communities that rarely sit in the same room, SoilWat 2025 helped build a shared research agenda for the coming years. The SoilWat initiative will continue to serve as a bridge between GEWEX activities and the broader soil and land modeling communities, working towards more realistic and better-constrained representations of soil processes in weather and climate models.

# The 2025 GLASS Panel Meeting

**16–18 July 2025**
**Reading, UK**

**Nathaniel Chaney[1], Anne Verhoef[2], and Volker Wulfmeyer[1]**

[1]GLASS Panel Co-Chair; [2]Former GLASS Panel Co-Chair

From 16–18 July 2025, the Global Land–Atmosphere System Studies (GLASS) Panel held its annual meeting at the University of Reading, UK. The three-day event gathered Panel members, project leads, and liaisons from related Panels, projects, and international communities. A unifying theme was GLASS's transition toward a renewed structure, culminating in broad support for reorganizing the Panel into working groups to deepen engagement across the global community.

The meeting opened Wednesday afternoon with an overview by Panel chairs Anne Verhoef and Nate Chaney, who summarized the past year's activities and underscored the importance of strengthening GLASS's international community. The Panel formally endorsed holding the first Pan-GLASS meeting in 2026. This was followed by an extended discussion on restructuring GLASS into working groups to better support its mission. New members Marc Calaf and Teshome Asaminew introduced their work, and invited GEWEX Scientific Steering Group (SSG) member (and ex-GLASS member) Martin Best concluded the session with a historical overview that clarified GLASS's original objectives and evolution.

Thursday focused on updates from ongoing GLASS projects and related international efforts. John Edwards opened with progress from the GEWEX Atmospheric Boundary Layer Study Phase 5 (GABLS5), which has completed initial large eddy simulation experiments and is preparing comparisons with single-column models and new observations from the GEWEX Land/Atmosphere Feedback Observatory (GLAFO) project. Jon Page (standing in for Gab Abramowitz) then highlighted recent results from Protocol for the Analysis of Land Surface models (PALS) Land Surface Model Benchmarking Evaluation Project Phase 2 (PLUMBER2), including the 2024 publication confirming persistent challenges in land surface models' representation of surface fluxes and energy partitioning. Souhail Boussetta reported on the Machine Learning for Land Modeling (ML4LM) project's strong momentum, driven largely by a successful webinar series promoting machine learning applications in land surface modeling. Jennifer Brooke presented advances from the Land Surface Interactions with the Atmosphere over the Iberian Semi-Arid Environment (LIAISE) Irrigation Model Intercomparison Project (MIP) and potential collaborative directions with GLASS. The session continued with an update on the Coupling of Land and Atmospheric Subgrid Parameterizations (CLASP) project from Nate Chaney, including proposed spin-off intercomparisons of spatial patterns of simulated surface states and fluxes. Volker Wulfmeyer concluded with highlights from GLAFO, including a new site established in Huancayo, Peru.

After lunch, Yijian Zeng summarized the highly productive GEWEX-International Soil Modeling Consortium (ISMC) GEWEX Soil and Water (SoilWat) project workshop held earlier in the week (14–16 July) in Reading (organized by SoilWat co-leads Anne Verhoef and Yijian Zeng), noting that it identified the most pressing gaps and most tractable opportunities for soil process modeling in land models. Edward Hanna (SSG co-chair for the Climate and Cryosphere program, or CliC) then presented WCRP's CliC project, prompting discussion on joint work in cold region land–atmosphere interactions. Liaisons Yunyan Zhang (GEWEX Data and Analysis Panel) and Josh Roundy (GEWEX Hydroclimatology Panel) shared updates from their respective Panels, leading to discussions on engaging their communities in the Pan-GLASS meeting and learning from their organizational approaches. The day concluded with an update from Nick Parazoo on GLASS's Solar Induced Fluorescence Model Intercomparison Project (SIF-MIP) project.

Following an enjoyable dinner in Reading, the Panel reconvened Friday morning. Garry Hayman opened with an update from the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS) and opportunities for deeper collaboration between GLASS and iLEAPS, including potential joint activities at Pan-GLASS. Xuelong Chen presented his work on eddy covariance measurements over China, and Li Jia and Bob Su then presented updated plans for the Determining EvapoTranspiration (dET) Crosscutting project spanning GHP and GLASS. The remainder of the morning was devoted to refining the GLASS restructuring plan and outlining the Pan-GLASS agenda.

These discussions converged on a consensus to reorganize GLASS around several core working groups aimed at addressing persistent weaknesses in representing surface fluxes and land–atmosphere coupling. While final names remain under development, the working groups will center on: 1) benchmarking; 2) heterogeneous land–atmosphere interactions; 3) surface exchange and boundary layer coupling; 4) observations; 5) anthropogenic impacts on land–atmosphere interactions; and 6) soil and vegetation modeling. Additional groups may emerge as planning continues. Future Panel membership will be tied to co-leading one of these groups, and Panel projects will arise from within and across them.

In closing, the Panel expressed sincere appreciation to the University of Reading and the local organizers for their generous hospitality and technical support. They also thanked Anne Verhoef for her 4-year service as GLASS co-chair and officially welcomed Volker Wulfmeyer as new co-chair. The productive discussions and collegial atmosphere reaffirmed GLASS's commitment to an inclusive, globally engaged community. The Panel now looks ahead to Pan-GLASS 2026 (see meeting information at the GEWEX events site at *www.gewexevents.org/meetings/glass2026*), which will revolve around the new working groups and accelerate efforts to confront foundational weaknesses in land surface and coupled modeling. As the first event of its kind, Pan-GLASS is expected to be a milestone for the international land–atmosphere research community. We look forward to seeing everyone in Stuttgart in July 2026.


The GEWEX Global Land-Atmosphere System Studies Panel (GLASS) will hold its first Pan-GLASS Conference, "Back to the Drawing Board: From Fundamentals to Improved Models of the Coupled Land-Atmosphere System" (https://www.gewex-events.org/meetings/glass2026/).

Pan-GLASS 2026 will bring together experts on Earth system, weather, and climate research, soil and vegetation processes, surface fluxes, planetary boundary layer transport processes, clouds and precipitation, and machine learning. Observationalists, theoreticians, and modelers will join to discuss the key issues of land-atmosphere science.

## Program

The program consists of a combination of plenary and parallel sessions, with keynote and oral presentations. In addition, there is time reserved each day for poster presentations.

## Call for Abstracts

Pan-GLASS 2026 will focus on the main themes mentioned below. For each of these themes, we are calling for studies relying on process-oriented diagnostics, modeling, and new observational data and their synergy, applied to enhance our understanding and modeling capabilities of land-atmosphere interaction. The conference will revolve around the following core themes:

- Advancing soil processes for understanding the soil-plant-atmosphere continuum: from bedrock to stomata.
- Observing and parameterizing turbulence at the land-atmosphere interface: Revisiting Monin-Obukhov similarity theory to improve the modeling of turbulent surface fluxes.
- Leveraging machine learning to benchmark and rethink the modeling of land-atmosphere interactions.
- Understanding and modeling the role of heterogeneity over the land surface in the coupled land-atmosphere system considering all types of land cover from snow to vegetation to urban surfaces.
- Investigations of cloud and precipitation feedbacks.
- Representing anthropogenic influences in the water and energy cycles: Implications for surface and fluxes and PBL dynamics.

Proposals for potential new community projects are particularly welcomed, including proposing a topic and possible approaches OR proposing specific activities in greater detail.

## Early Career Researcher Competitions

Pan-GLASS 2026 will organize two competitions for Early Career Researchers (ECRs): the GLASS Competition on Process Understanding and the GEWEX/WCRP Presentation Competition.

The GLASS Competition prize is awarded to the best oral or poster presentation from an ECR on the improvement of the understanding of the land-atmosphere system. Oral and poster presentations that are entered in the GEWEX/WCRP Presentation Competition will be judged on technical content, technical knowledge of the topic, and presentation delivery.

## Important Dates

Important dates for Pan-GLASS 2026 are below. Registration and abstract submission will open 31 December 2025.

| | |
|---|---|
| Registration & abstract submission open | 31 December 2025 |
| Deadline to request travel support | 31 January 2026 |
| Deadline to apply for ECR competitions | 31 January 2026 |
| Review of abstracts for the ECR competition and travel support applications | 1–28 February 2026 |
| Abstract submission deadline | 28 February 2026 |
| Travel support notifications | First half of March 2026 |
| Review of abstracts | 1–31 March 2026 |
| Notification winners of GLASS and ESMO Competitions | First half of April 2026 |
| Abstract acceptance notifications | 1–7 April 2026 |
| Deadline for early bird registration | 30 April 2026 (midnight GMT) |
| Registration cancellation deadline for full refund | 1 June 2026 |
| 1st Pan-GLASS Conference | 6–9 July 2026 |
| Announcement of ECR competition winners | 9 July 2026 |

## AMS Award Recipients

Congratulations to the following GEWEX community members on their American Meteorological Society (AMS) awards!

**2026 AMS Fellow**

Shaocheng Xie, *Global Atmospheric System Studies Panel (GASS) Co-Chair*

**2026 Recipient of the Jagadish Shukla Earth System Predictability Prize**

Siegfried Schubert, *former GEWEX drought initiative lead and Scientific Steering Group member*

## Submit an Article to GEWEX QUARTERLY

*Share your GEWEX experiences and activities,* including scientific research results and other information associated with global water and energy cycle studies. Articles should be 800–2400 words (1–3 pages) and feature 1–2 figures. If you have an idea for a piece, please contact us at *gewex@gewex.org*.

## Climate and Cryosphere Open Science Conference

Wellington, New Zealand • 9–12 February 2026

As a pan-cryospheric meeting, the Climate and Cryosphere (CliC) Open Science Conference (OSC) will address all elements of the cryosphere and its climate connections. Scientists, researchers, scholars, practitioners, educators, and stakeholders are invited to come together at the nexus of climate and cryosphere to learn from one another, identify knowledge gaps, and address emerging challenges. From modelers and observationalists to social scientists and community organizers, leading and emerging experts as well as early career researchers (ECRs) are welcome to present their work and discuss the state of cryospheric science.

Register now at clic2026.com/registration. More information is available at clic2026.com.

## GEWEX/WCRP Calendar

*For the complete Calendar, see* http://www.gewex.org/events/

11–12 February 2026—Ecosystem Services of Green Building Envelopes: Observations and Modelling—Braunschweig, Germany

23–27 February 2026—WCRP School on Climate Prediction Across Timescales—Buenos Aires, Argentina

9–12 March 2026—5th Workshop on Convective Organization—São Paulo, Brazil

9–13 March 2026—CMIP Community Workshop 2026—Kyoto, Japan

23–27 March 2026—8th International Baltic Earth Winter School on "Earth System Science for the Baltic Sea Region"—Tallinn, Estonia

23–27 March 2026—38th GEWEX Scientific Steering Group (SSG-38)—Bonn, Germany

13–17 April 2026—6th Baltic Earth Conference—Usedom Island, Germany

20–22 May 2026—10th International Conference on Flood Management (ICFM10)—London, ON, Canada

1–5 June 2026—2nd GEWEX Earth's Energy Imbalance Assessment Workshop—Pasadena, CA, USA

22–26 June 2026—19th BSRN Scientific Review and Workshop—Palaiseau, France

24–26 June 2026—2026 GHP Meeting—Medellín, Colombia

6–9 July 2026—2026 Pan-GLASS Conference—Stuttgart, Germany

***GEWEX QUARTERLY***

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