Global Energy and Water Cycle Exchanges Project

Global Land-Atmosphere (L-A) System Studies (GLASS) Panel: Key Research Activities and New Results

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With materials from the GLASS Panel Project Leaders
Presenter: Volker Wulfmeyer, incoming GLASS co-chair,
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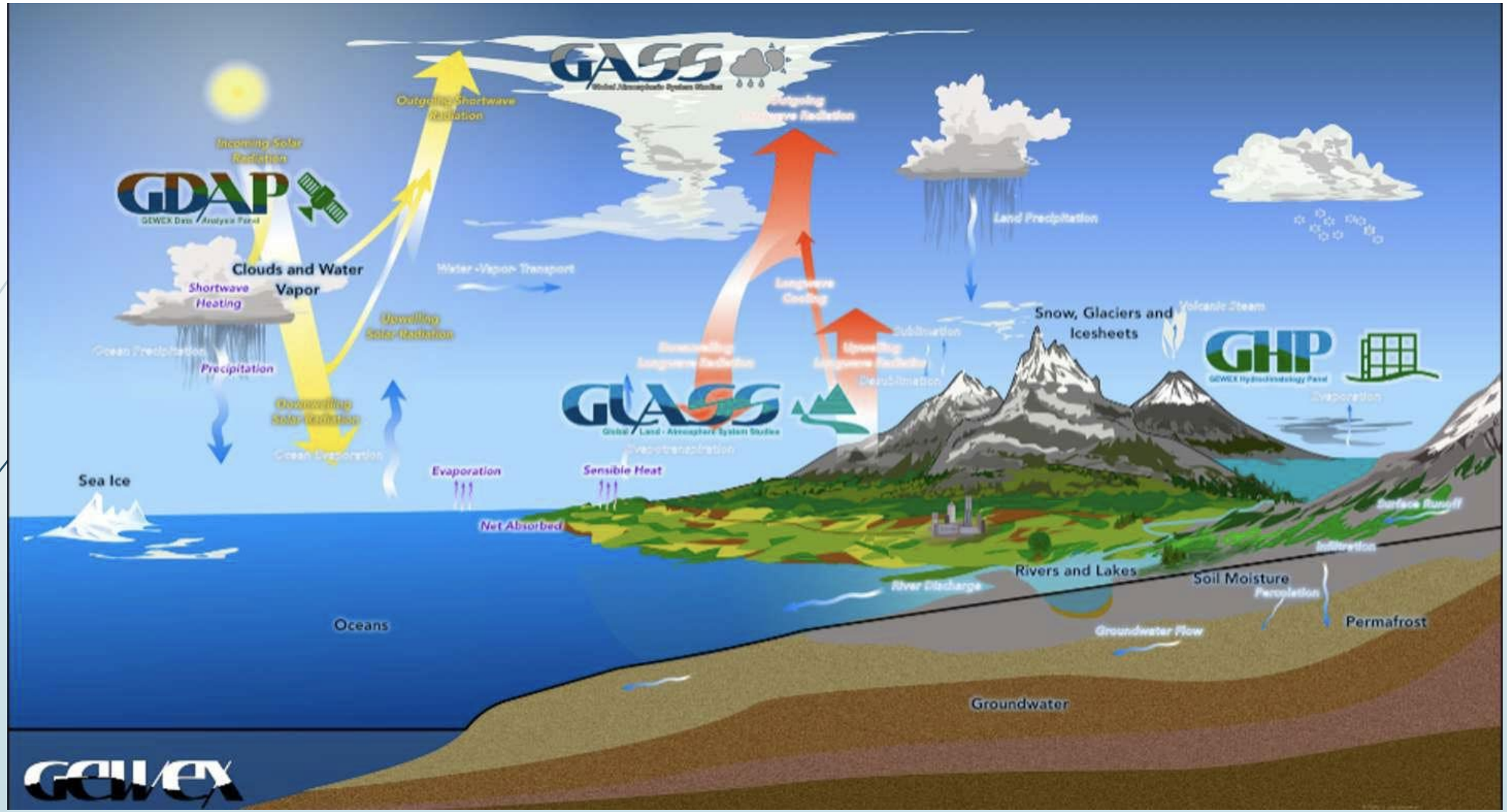
WGNE Annual Meeting, Toulouse, France, 2024

Global Land - Atmosphere System Studies

GEWEX's Four Panels



- **GDAP**: GEWEX Data Analysis Panel
- **GASS**: Global Atmospheric System Studies
- **GLASS**: Global Land–Atmosphere System Studies
- **GHP**: GEWEX Hydroclimatology Panel

Global Datasets Analysis and Assessments
Atmospheric Processes - Dynamics
Land-Atmosphere Interactions and Processes
Regionally Focused Processes and Hydroclimate Projects

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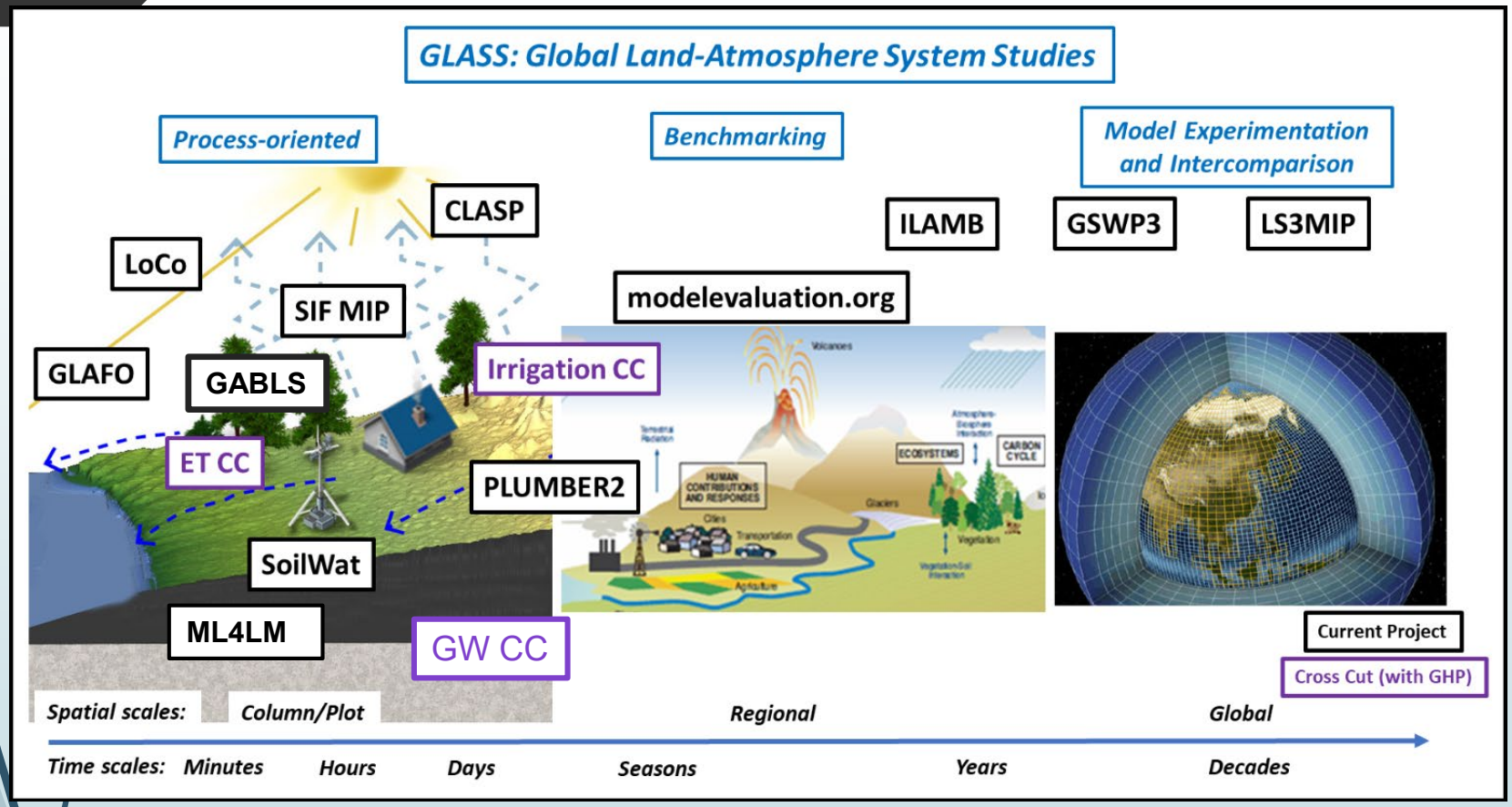
GLASS Panel Projects: From Column to Global Scale



- **ILAMB**: International LAnd Model Benchmarking
- **Modelevaluation.org:** web application for evaluating and benchmarking computational models.
- **GSWP3**: Global Soil Wetness Project, phase 3
- **LS3MIP**: Land Surface, Snow and Soil Moisture MIP

- **LoCo**: Local Coupling WG
- **GLAFO**: GEWEX/GLASS L-A Feedback Observatories
- **SIFMIP**: Solar-Induced Fluorescence MIP
- **CLASP**: Coupling of Land and Atmospheric Sub-grid Parameterizations
- **SoilWat**: Soils and Subsurface processes
- **PLUMBER2**: The Protocol for the Analysis of Land Surface Models (**PALS**) Land Surface Model Benchmarking Evaluation Project, phase 2
- **GABLS:** GEWEX Atmospheric Boundary Layer Study
- **ML4LM:** ML for Land Models

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GLASS Panel Goals

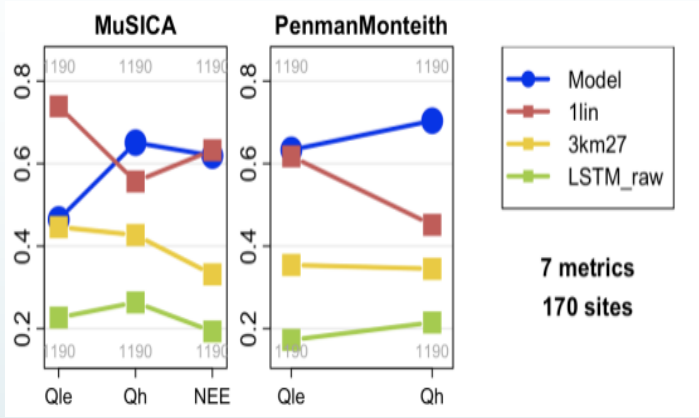
- Improve understanding and representation of **bio-geophysical processes** in land models, especially over **heterogeneous** surfaces, with a focus on turbulence and surface flux parameterizations (including MOST), surface flux partitioning, as well as vegetation and soil processes
- Develop and apply **cutting-edge metrics** and methods to confront land model **performance**
- Leverage novel developments, i.e., **Machine Learning techniques**, and comprehensive 4-D in-situ and remotely sensed observations of the L-A system

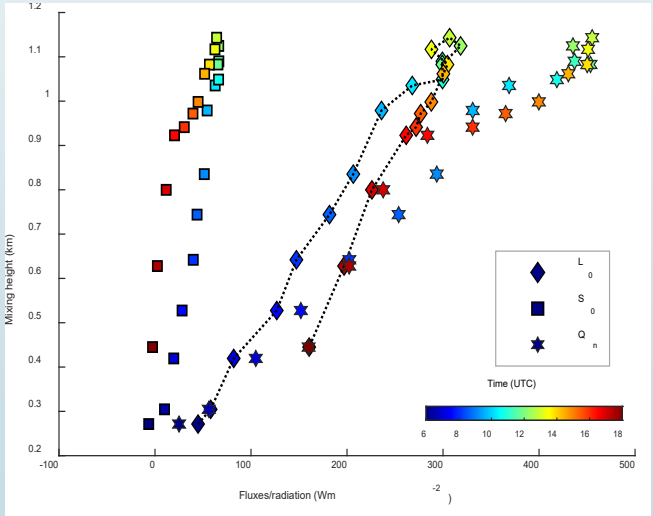
GLASS 2023 Key Results

Lead: Gab Abramowitz

Lead: Volker Wulfmeyer

- **PLUMBER2**: LSMs perform worse than the empirical model suite, which causes a poor comparison overall against empirical benchmarks. No LSM can outperform an out-of-sample linear regression prediction of fluxes, with instantaneous SWdown as the **only** predictor
- First GLAFO results available to study turbulence parameterizations and interaction between surface fluxes and PBL depth. DWD MOL in Lindenberg, Germany, Ruisdael Observatory in the Netherlands, and Huancayo in Peru became **GLAFOs**; New GLAFOs are under discussion/in preparation at ARM SGP and Southern Africa





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GLASS 2023 Key Results

Lead: Nate Chaney

Lead: Nick Parazoo

- **CLASP**:
  - The HydroBlocks model illustrates the important role turbulence parameterizations can have on the **temporal persistence of simulated LST**
  - **Secondary circulations** due to surface thermal heterogeneity over the SGP site resolved in LES experiments can be qualitatively reproduced in a two-column model that interact via a parameterized circulation
  - The role of surface thermal heterogeneity on the macroscale atmospheric response was studied by a series of **3 km WRF experiments** run over the Contiguous United States over the summers of 2021-2023
- **SIF-MIP**:
  - Model output submitted from **3 modeling groups and 3 tower sites**, based on reanalysis forcing.
  - Tower observed SIF output has been formatted and **made available with DOIs**.
  - Initial results show **significant spread in estimated carbon and water exchange**. Much work is needed to ensure modelling teams are following protocol, as is always an issue with MIPs

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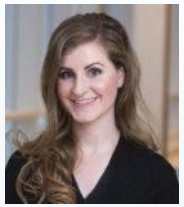
GLASS 2023 Other Science Highlights



- First **PLUMBER2** paper is submitted and is in review. Preprint is here: https://egusphere.copernicus.org/preprints/2024/egusphere-2023-3084
- **Irrigation CC** (Lead: Patricia Lawston-Parker) convened a special issue on the use of observations for understanding irrigation and its impact on the climate system
- **LoCo** (Lead: Joe Santanello) continues to influence local coupling components and aspects of field campaigns (LAFE/LAFO/GLAFO, GRAINEX, LIAISE, AMF3).
- Steady progress on soil parameterizations via **SoilWat** project (Lead: Yijian Zeng) and relating review and science papers, e.g., on combining root and soil hydraulics in macroscopic representations of root water uptake
- **GLAFO** is pioneering approaches to derive surface and entrainment fluxes and the energy balance closure (EBC) using combined measurements of surface layer and horizontal profiles (scanning remote sensing, FODS, towers, isotopes, etc.)
- Future focuses of **CLASP will** revolve around how surface heterogeneity impacts turbulence and mean advection at thus feeds back *on surface fluxes*

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List of New Projects and Activities in Place

- **GW-CC**: Laura Condon, together with Stefan Kollet, has set-up a new initiative that involves a dedicated **GEWEX groundwater activity (a GHP-GLASS cross-cut)**. A kick-off workshop will take place at the OSC in Sapporo.

- **GLAFO-GABLS-LoCo:** A new GABLS (led by John Edwards) is in preparation oriented around LAFO and ARM SGP. The unique observations at these sites will provide the verification of a simulations with land-atmosphere model systems such as the UK Met Office Unified Model, ICON-JSBACH, WRF-NOAHMP-Gecros, WRF-NOAHMP-Hydro-Iso, and PALM

- The new project Land-Atmosphere Feedback Initiative (**LAFI,** PI: Volker Wulfmeyer), the Collaborative Research Unit (RU) 5639 of the German Research Foundation (DFG) was funded with participants of 11 research institutes in Germany. This project will be strongly interwoven with **GLAFO** & GLASS activities.

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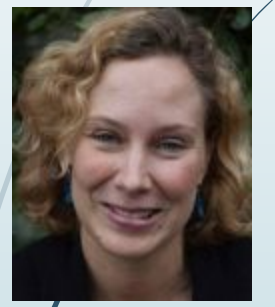
New Projects and Activities Being Planned

- Souhail Boussetta (ECMWF), with inputs from Gab Abramowitz and others, is in the process of setting up a new project that fits well with the Panel's renewed panel goals. This concerns **ML4LM**: Machine learning for Land Models



- The AFESP (Advancing the Frontiers of Earth System Prediction https://research.reading.ac.uk/earth-system-prediction) **VaaSS** (**"Vegetation as a soil sensor"**) project led by Anne Verhoef on "Towards a high-fidelity integrated forecasting system via ground-breaking and ambitious data-assimilation of the dynamic soil-vegetation hydraulic continuum". A 5-year funded (University of Reading & ECMWF) collaborative research project has been established between the **SoilWat** leads (Zeng & Verhoef) and ECMWF (with Souhail Boussetta as one of the co-Investigators, and Patricia de Rosnay as passive/active MW and DA expert).

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Planned Workshops/Meetings (2024-25)

- Various **project presentations and discussions** at GEWEX OSC in Sapporo, Japan, July 2024 (including GLAFO, SoilWat, PLUMBER2, GW-CC)
- Following on from our past **GEWEX-ISMC** workshops in Leipzig, Germany (2016) and with key SoilWat members in attendance at the first **ET-CC** meeting in Sydney (https://soil-modeling.org/activities/soilwat/gewex-soilwat-initiative) we plan to hold a 3rd **GEWEX-ISMC** meeting between 14-16 July 2025, at the University of Reading, UK.
- Pan-GLASS meeting in 2027?

Thank you

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