Global Energy and Water Cycle Exchanges Project

Global Land-Atmosphere System Studies (GLASS) Panel Update

Kirsten Findell and Anne Verhoef, GLASS co-chairs
With materials from the GLASS Panel Project Leaders

Michael Ek, GLASS panel member and WGNE liaison

The 36th Meeting of the Working Group on Numerical Experimentation
1-4 November 2021

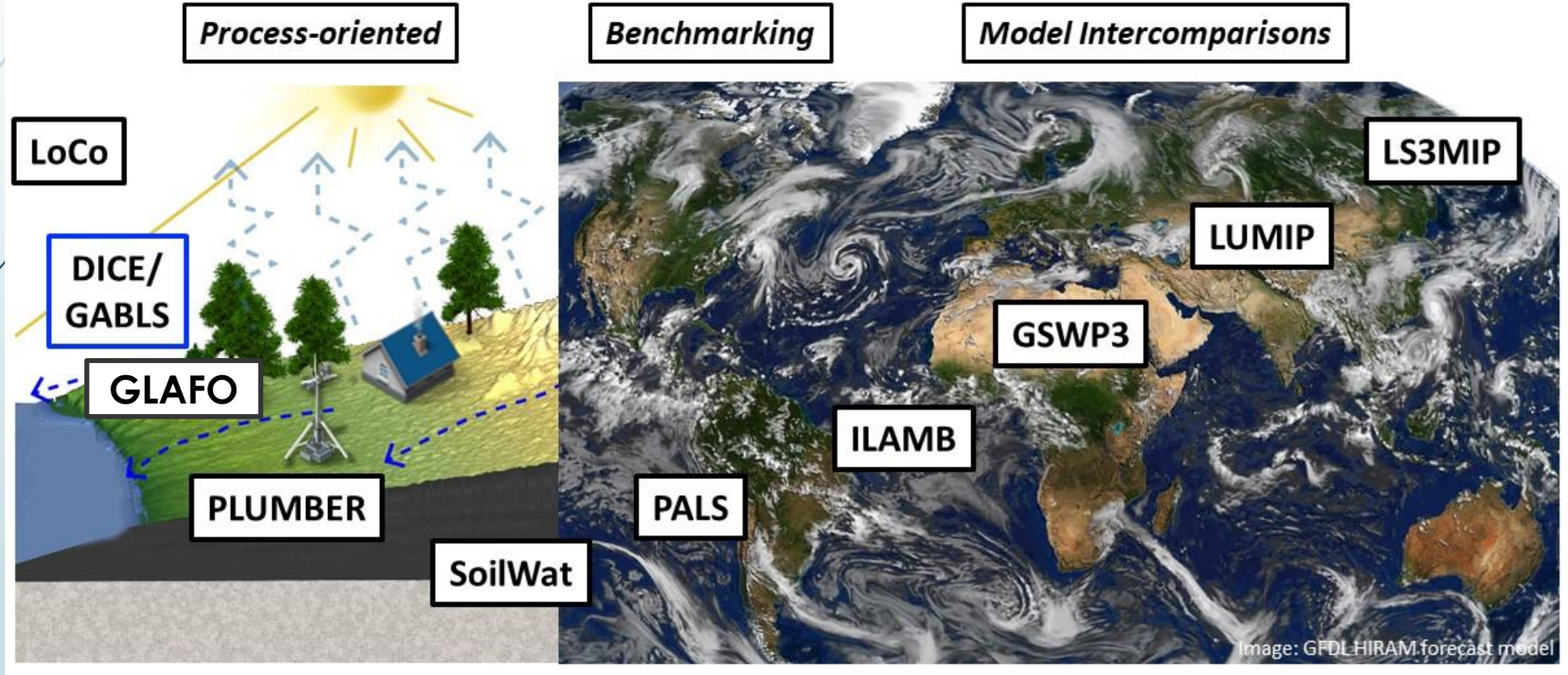
Global Land - Atmosphere System Studies

GLASS Science Objectives and Activities

- **Scientific Objectives of GLASS**:
  - To improve understanding of energy and water cycling on land and in the coupled land-atmosphere system; to improve representation of these processes in earth system models.
- **Activities of GLASS**:
  - To facilitate and support international projects that use observations, process studies, and numerical model experiments to develop and improve the representation of the land and land-atmosphere system in climate models.

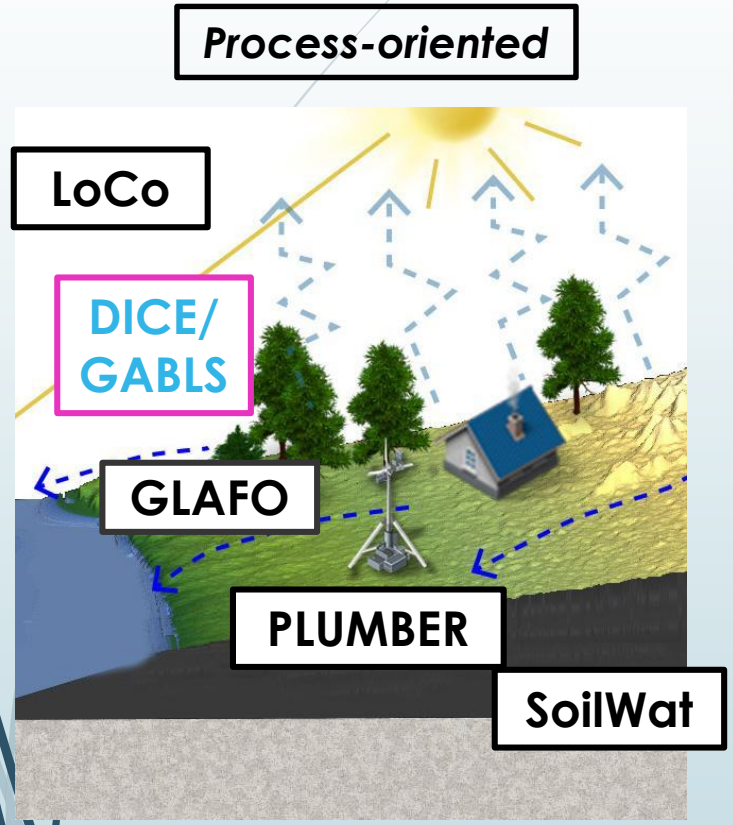
At present, GLASS has nine active projects, and one project on hold.

GLASS Panel Projects: From process to global scale



GLASS Global Land - Atmosphere System Studies

For WGNE: Focus on process-oriented projects



- **LoCo**: Local Coupling Working Group
  - Land-atmosphere interactions at local to regional (to global) scales,
- **TABLE FOR NOW: DICE/GABLS (joint with GASS)**:
  - Single-column land-atmospheric boundary layer model experiments.
- **GLAFO**: GEWEX/GLASS Land-Atmosphere Feedback Observatories.
- **PLUMBER2**: The Protocol for the Analysis of Land Surface Models (**PALS**) Land Surface Model Benchmarking Evaluation Project, phase 2:
  - Offline single-column land model experiments.
- **SoilWat**: Soils and Subsurface processes:
  - Understanding and improving representation of soil physics and groundwater transport in earth system models at local to global scales.

GLASS Global / Land - Atmosphere System Studies

LoCo: The Local Coupling Working Group

LoCo WG Objective:

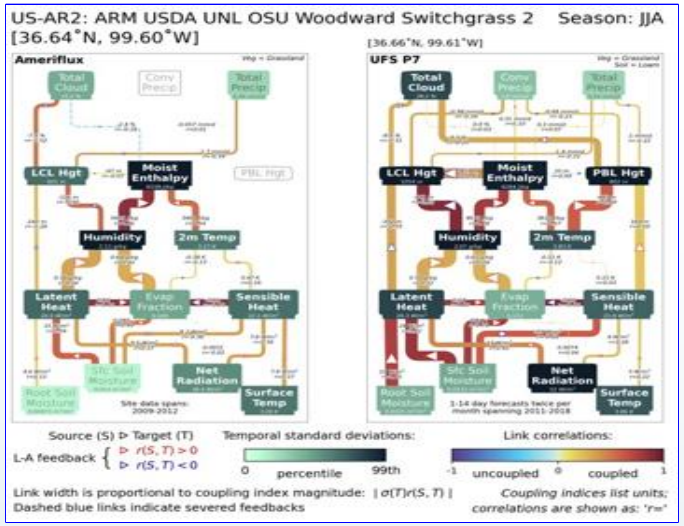
- To understand, quantify, model, and predict ***the role of local land-atmosphere coupling*** in the evolution of land-atmosphere fluxes and state variables and the respective water and energy cycles, including clouds in weather and climate models.

Goals:

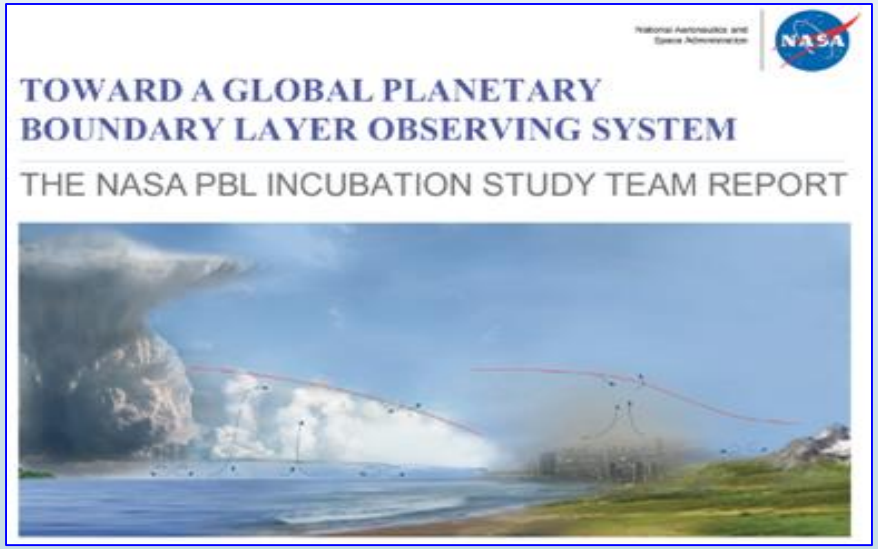
- Promote the importance and development of ***improved observations*** of the L-A system, namely in the PBL, as well as improved utilization of soil moisture and surface fluxes measurements in models, e.g. GLAFO (slide 7).
- Pursue ***adoption of LoCo metrics*** by operational NWP and Climate Centers.
- ***Expand the scope and reach of LoCo*** in terms of processes and scales beyond that of warm season thermodynamics and beyond that of 1-D column assumptions.

LoCo Achievements

- **Enhanced adoption of LoCo paradigm at operational centers, use of LoCo metrics and diagnostics for integrative analysis:**
  - E.g., NOAA's CLASP Climate Process Team and UFS development both stress LoCo process understanding; funding of LoCo-driven initiatives through NOAA COM, SMAP and MAP, THP Scoping Study.
- **NASA PBL Study Team**: supportive of LoCo-inspired PBL incubation activities, and vision of monitoring PBL from space.
- Field campaigns (past and future) include LoCo-driven activities:
  - GRAINEX & LAFE (US Great Plains), LIAISE (Spain).
  - Community paper on supplementing FLUXNET sites with PBL profilers.
- **Enthusiasm for LoCo science seen in successful AGU & AMS sessions convened by LoCo WG members.**



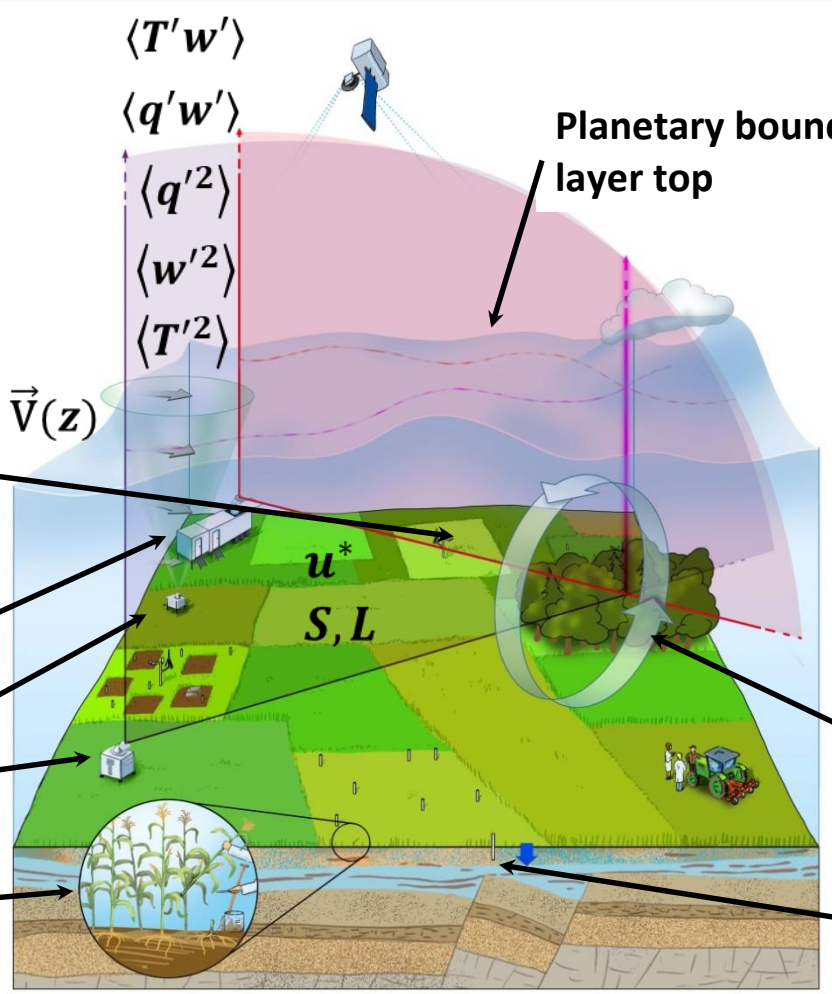
Pipe diagram showing coupling strength indices during JJA at an AmeriFlux site and the corresponding model grid cell. (Paul Dirmeyer, George Mason Univ., US)



GLASS Global / Land - Atmosphere System Studies

GLAFO: GEWEX/GLASS Land-Atmosphere Feedback Observatories

PIs: Volker Wulfmeyer, University of Hohenheim
Dave Turner, NOAA ESRL

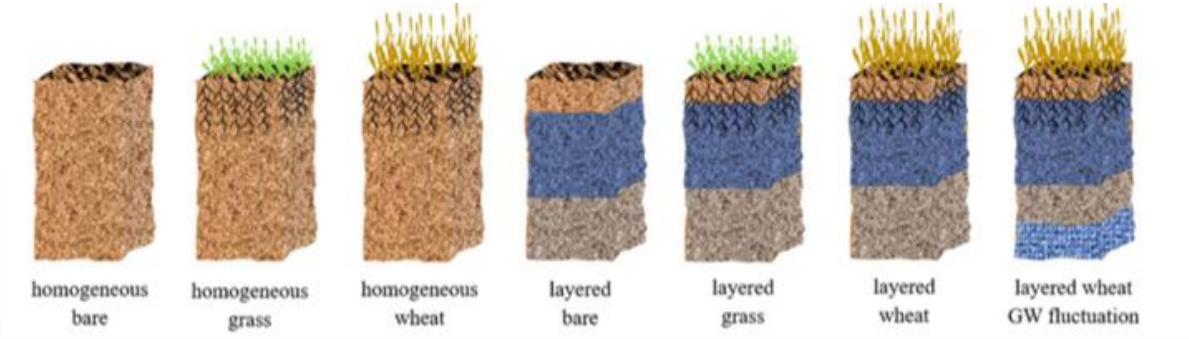


Objectives:

- Understand and characterize L-A feedback with advanced metrics.
- Develop and operate GLAFOs from groundwater to lower troposphere.
- Study transport and exchange processes at land-PBL interfaces.
- Identify the role of vegetation with respect to L-A feedback.
- Assess processes/scales at which L-A feedback is sensitive to hydrology.
- Investigate scale interactions and land heterogeneity from turbulent to micro- to mesoscale processes.

Global / Land - Atmosphere System Studies

SoilWat



SoilWat WG Objective:

- The GEWEX-ISMC* SoilWat Initiative brings together two research communities to improve the representation of soil and subsurface processes in climate models

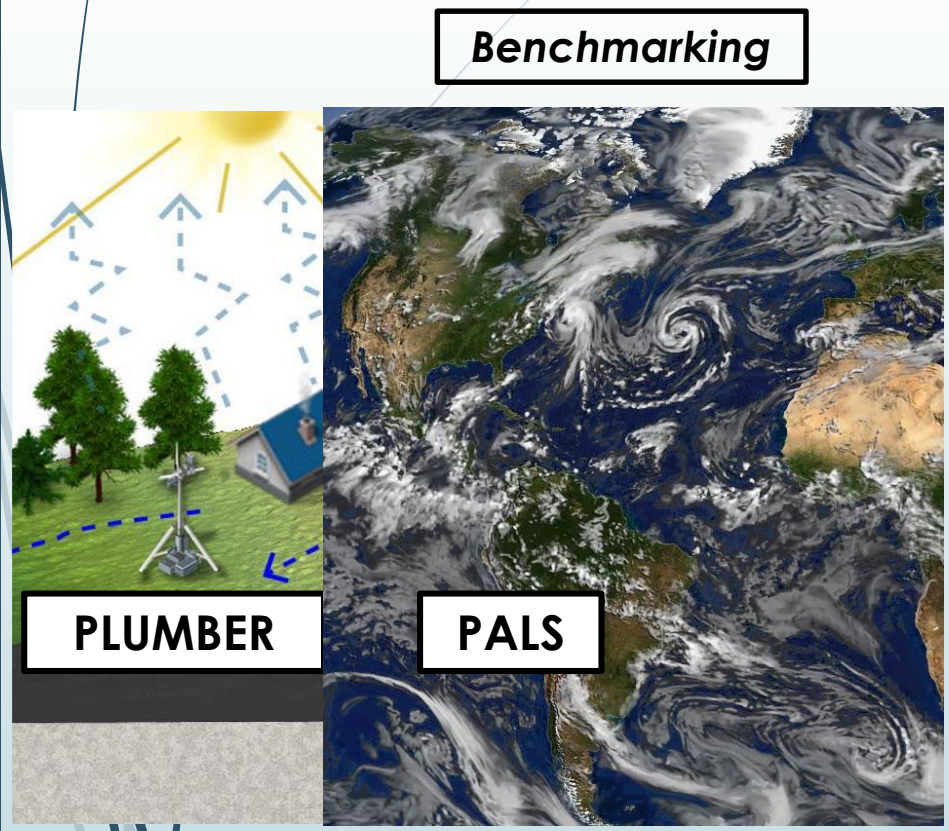
Goals: SoilWat is broadly organized around three initiatives:

- To conduct an in-depth survey on how ***key soil physical processes and properties*** (related to water and heat flow) are represented in Land Surface Models (***LSMs***).
- A systematic assessment of the utility of ***resolved soil maps*** and ***sensitivity of climate models*** to improved the quality and resolution of soil maps: ***SP-MIP***
- A survey of how ***groundwater*** is implemented in climate models and define strategies for better incorporation of groundwater in climate models.

Achievements: Providing guidance on the representation of soils, i.e. composition, thermodynamics, hydraulics, data sets; guidance from Soil Parameter-MIP to understand uncertainties in soil hydraulic parameters & land model behavior.

* International Soil Modelling Consortium

Land Model Benchmarking Projects



- **PLUMBER2**: The Protocol for the Analysis of Land Surface Models (PALS) Land Surface Model Benchmarking Evaluation Project, phase 2.
  - Offline single-column land model experiments.
- **PALS/modelevaluation.org**: Broader implementation of PLUMBER, web-based platform for benchmarking models against observations.
  - Hosts experiments: forcing data is on web platform, users run experiments locally then upload simulations, me.org runs analysis routines to compare simulations to benchmarks and other models.

PLUMBER2: The Protocol for the Analysis of Land Surface Models (PALS) LSM Benchmarking Evaluation Project, phase 2

PLUMBER2 WG Objective:

- ***PLUMBER2*** is a model intercomparison project for land models. The project is conducted within the ***Protocol for the Analysis of Land Surface Models (PALS) benchmarking*** system. PALS is now Modelevaluation.org.

Goals:

- ***Evaluation*** of multiple leading ***land surface and ecosystem models*** for water and carbon fluxes.
- PLUMBER2 provides ***forcing and evaluation datasets*** for a model intercomparison project for land surface models.
- The dataset is a collection of ***170 flux tower sites***, spanning multiple biomes and climate zones globally. Provides meteorological variables to force models and flux variables for evaluation. The original data were derived from the FLUXNET2015, La Thuile and OzFlux collections

PLUMBER2: Outputs

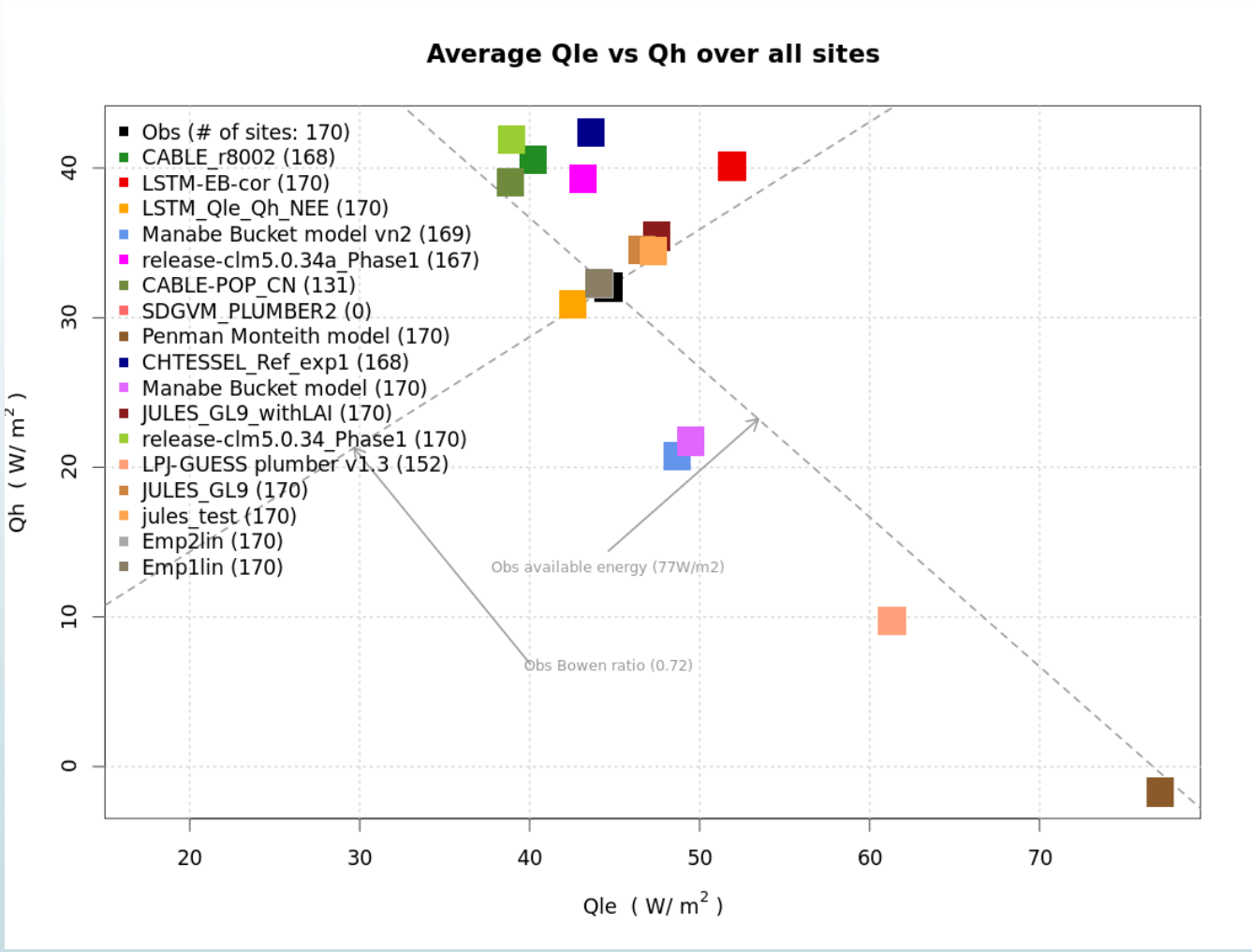
Land models affect NWP and S2S model performance, so need to improve land models:

Existing automated analyses through ***modelevaluation.org***.

Plot to the right: Average latent heat flux vs sensible scatter -->

Multiple analyses planned, e.g.:

- ***Budyko curve*** departure analysis. ***Diurnal*** hysteresis / phase lag.
- Benchmarking ***momentum flux*** as well as heat fluxes.
- ***Others***.
- ***Paper on QC*** is forthcoming



GLASS Global Land - Atmosphere System Studies

GLASS moving forward into 2021

Nascent initiatives:

- **Irrigation**: First workshop to take place on 4 November 2021. A revisit to a GEWEX-sponsored human water management workshop in 2016.
- Improve understanding and predictions of interactions between **urban land surfaces** and the atmosphere
- Efforts to bring to the fore/add to the science that address **coupling between the carbon-, water- and energy balance**
- Efforts to make closer links with the **hydrological and weather services communities**, with the aim to obtain better predictions of hydrological extremes, **floods** in particular.

Global / Land - Atmosphere System Studies

GLASS moving forward into 2021

Recommendations:

- **Diurnal Land-Atmosphere Coupling Experiment** (DICE) and **GEWEX Atmospheric Boundary Layer Study** (GABLS): **Remove** from the list of GLASS projects. *Single Column Modeling (SCM) studies do provide a useful mechanism to examine land-atmosphere interactions at the process level. We can look for future opportunities for new DICE/GABLS projects and add them back to the GLASS portfolio.*
- **Land data assimilation** is another area that could be revisited in GLASS.