

# *Global Energy and Water Cycle Exchanges Project*

## **GEWEX**

### ***Global Land/Atmosphere System Study (GLASS)***

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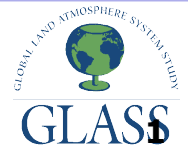
**GLASS panel members and other GEWEX collaborators**

**GEWEX Scientific Steering Group meeting (SSG-28)**

**Zurich, Switzerland, 25-28 January 2016**



**GEWEX SSG-28**  
ETH, Zurich, Switzerland, 25-28 January 2016



Alignment with WCRP Grand Challenges (GC) and GEWEX Grand Science Questions (GSQ)										
	WCRP GC						GEWEX SQ			
GLASS Projects	Regional Climate Information	Sea-level Rise and Regional Impacts	Cryosphere in a Changing Climate	Climate sensitivity: Interactions of clouds, precip, aerosols, radiation	Changes in Water Availability	Science Underpinning Prediction/Attribution of Extreme Events	Observations & Predictions of Precipitation	Global Water Resource Systems	Changes in Extremes	Water and Energy Cycles and Processes
PALS-PLUMBER	X		X			X	X		X	X
ALMIP2					X			X		X
PILDAS							X	X	X	X
GSWP3					X	X		X	X	X
GLACE-CMIP5/6, LS3MIP				X		X			X	
DICE/GABLS	X		X	X						2

# GLASS contributions to the WCRP Grand Challenges as identified by the JSC (1 of 2)

## Provision of skillful future climate information on regional scales (includes decadal and polar predictability)

- GSWP3, LS3MIP
- Benchmarking (defining skillful), MDF (improved prediction and skill), and LAC (process-level improvement in L-A coupling)
- LUCID interactions with CORDEX have been proposed

## Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)

- Links to GABLS4 experiment and stable PBL coupling.
- ESMSnowMIP component of LS3MIP will address coupling between the atmosphere and the cryosphere (namely snow covered areas)
- Possible new project based on CCRN interactions

## Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity

- None direct, but L-A Coupling theme addressing the soil moisture-precipitation feedbacks.
- Improved aerosol emissions in regional to large scale models could possibly be assisted within the context of GSW (better soils data and processes)

# GLASS contributions to the WCRP Grand Challenges as identified by the JSC (2 of 2)

## Past and future changes in water availability (with connections to water security and hydrological cycle)

- GSWP3, GLACE(CMIP), and GPM/GRACE/SMOS/SMAP synergy
- LAC (process-level improvement in water and energy cycle feedbacks)
- Improved understanding of land-surface and hydrological processes in semi-arid zones where water resources are already limited (ALMIP2)
- The human imprint on the hydrological cycle within the new Anthropogenic Influences on the water cycle initiative (GHP+GLASS)

## Science underpinning the prediction and attribution of extreme events

- Benchmarking (model goodness during extreme conditions), MDF (data assimilation and model calibration during extremes), and LAC (improvements in coupling leading to improved predictability of extreme events from local to global scales)
- LS3MIP

# ***GLASS Discussion Items***

## Protocol for the Analysis of Land surface Schemes (PALS)

### Update:

- *New incarnation* of PALS is **not land surface specific** at all (main current use) - can be used for model comparison (i.e. model v model), evaluation (model v obs) or benchmarking (model v benchmarks and obs) for any type of model (including CMIP: need data support for such volumes)
- Outside LSMs, most interest from the **hydrology** community, and some from the **ecology** community. David Fuchs is keen to do an experiment for **convection schemes** (works with Steve Sherwood)
- - To maximise speed we may want to have **PALS mirror sites**. Data need not be duplicated for the system to stay in sync obviously.
- - I think it would be a good place to promote / lead the development / expansion of **ALMA** (and integration with **CMIP CF netcdf**) - the urban, ecology and hydrology communities do not really have an i/o standard and so there's an opportunity (perhaps earth2observe is a counter example).
- - If any other community has even a small amount of time to invest (say a scientific programmer or post doc for even a few hours a week) → PALS could expand its scope.
- Relaunch - perhaps 6 months away - it will *almost certainly* be  
modevaluation.org      or      modevaluation.org/PALS

# ***GLASS Discussion Items***

## **Gaps, reach, and future initiatives:**

- Cold processes (iLEAPS+CliC+GEWEX?), Groundwater, Distributed Hydrology, anthropogenic processes, semi-arid processes, high resolution ( $\sim 10^2\text{m/LSM}$  grey zone?).
- Should we be more explicitly focused on specific events/phenomena such as drought (via seasonal and interannual) prediction?
- LUCID and LUMIP (now evolving into LSMIP) projects both deal with Land Use Land Cover Change (LULCC) in coupled models – goals of each.
- Anthropization in LSMs...action initiated (Sept 2016 with GHP)

## **Transition Period for GEWEX/WCRP: How should GLASS follow?**

- WCRP GSQ & GEWEX Grand Challenges are not necessarily answered by the traditional 'MIP' framework ?
- Models broadening (carbon and water/energy, distributed) and disciplines colliding to answer larger questions). Closer links with iLeaps...
- (How to) increase interaction with GDAP? GEWEX SoilWat...



# Global Land/Atmosphere System Study (GLASS)

Uh oh! These surface fluxes don't look so good.

...and you'll need carbon if you want to drive this out to the seasonal scale!

CLIMATE MODELERS:

How much is this going to cost to fix?

Well... at least several more funding cycles.

...and look at the hydrology in this thing!



GLASS

# **WCRP Grand Challenges (GC) and GEWEX Grand Science Questions (GSQ)**

*WCRP engages the international climate research community in a number of Grand Science Challenges through community organized workshops, conferences strategic planning on:*

- Regional Climate Information
- Sea-level Rise and Regional Impacts
- Cryosphere in a Changing Climate
- Changes in Water Availability
- Clouds, Circulation and Climate Sensitivity
- Science Underpinning Prediction/Attribution of Extreme Events

*GEWEX Science Questions related to following research areas:*

- Observations and Predictions of Precipitation
- Global Water Resource Systems
- Changes in Extremes
- Water and Energy Cycles and Processes



## **GEWEX Science Questions :**

To address the contributions that water and energy cycle science can make to society in four major areas.

**Observations and Predictions of Precipitation:** How can we better understand and predict precipitation variability and changes?

**Global Water Resource Systems:** How do changes in land surface and hydrology influence past and future changes in water availability and security?

**Changes in Extremes:** How does a warming world affect climate extremes, esp. droughts, floods, and heat waves, and how do land area processes, in particular, contribute?

**Water and Energy Cycles and Processes:** How can understanding of the effects and uncertainties of water and energy exchanges in the current and changing climate be improved and conveyed?

## Other key science questions that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project (1-3 suggestions)

The impact of the land surface, soil moisture and vegetation (interactive phenology), and L-A coupling on Seasonal/Drought Prediction.

Not a SQ per say, but would help science progress :

Improved Benchmarking methods/tools/datasets for the community as a whole. A common modular interface for LSMs (new ALMA), such that different models and components can be more easily transferred to other's platforms, intercompared, and swapped. This would also include a common land-atmosphere coupling modularity such that different atmospheric and land models can be intercompared in order to evaluate the impact of each on the coupling results.

Pressing Model developments/improvements: Improved cold season processes (interactions between permafrost and greenhouse gas emissions), ground water interactions, anthropogenic processes (irrigation, aquifer uptake, crop harvest, improved LULCC), and the LSM "grey zone" (in anticipation of ever-higher resolution research and NWP applications: lateral fluxes of mass and energy.)

# How do changes in the land surface and hydrology influence past and future changes in water availability and security?

(Water Use, Resources, and Sustainability)

It seems this challenge is really the overarching challenge of all land hydrology for climate studies. As a result, this challenge also intersects directly with other entities (iLEAPS, CLiC, LUMIP...). This challenge might boil down to coordinating model development from previously disparate disciplines and applications.

Related current GLASS activities:

- LUCID : historical and future LULCC (POC: Nathalie & Andy)
- GSWP3 : 20C analysis of the evolution of the global water budget (POC H. Kim)

Future :

- \_New GHP-GLASS initiative on modeling anthropogenic effects in LSMs

# How can we better understand and predict precipitation variability and changes?

## Related current GLASS activities:

- GLACE – Land/soil moisture impact on precipitation and predictability (POC: Sonia; 1 and 2 complete; CMIP in progress), LS3MIP to begin within CMIP6 framework.
- LoCo – Regional/Local Process-Level Quantification of land-PBL interactions and impact of land surface on precipitation (POC: Joe)
- ALMIP2 – Specific precipitation event studies and heterogeneity issues in soil moisture-precipitation feedbacks : different methods to compute precipitation forcing (POC: Aaron, nearly complete)
- PILDAS – Land DA of soil moisture; multi-variate coupled DA (precip and soil moisture) in a future phase (POC: Rolf)
- GSWP3 – Precip as a key forcing for 20<sup>th</sup> Century simulations – this effort should quantify the error bounds on the ‘land reanalysis’ generated due to precipitation uncertainty (POC: Hyungjun)
- Benchmarking – How does Precip uncertainty impact offline and coupled model evaluation – spread of LSM physics vs. spread due to precipitation errors (POC: Martin, Gab)

## Future activities:

Incorporation of new satellite products (GPM, SMOS, SMAP) into these efforts more explicitly.

# How does a warming world affect climate extremes, and especially droughts, floods and heat waves, and how do land area processes, in particular, contribute?

## Related current GLASS efforts:

- PILDAS - DA w/ Calibration for improved soil moisture representation during extreme conditions.
- LoCo - quantification during extremes to get at model behavior & how LSMs impact the persistence of droughts/floods and feedbacks. Seasonal drought prediction needs a lot of improvement with the emphasis on the land impact
- ALMIP2 - inherently encompasses dry extremes/feedbacks over AMMA with monsoon precipitation.
- GLACE2-CMIP is examining impact of soil moisture on extremes in CMIP5 (IPCC report just out on the subject).
- Benchmarking - should look at model performance stratified by regime (e.g. PLUMBER)

## Future activities:

- LS3MIP
- (along with GSWP3)



# How can understanding of the effects and uncertainties of water and energy exchanges in the current and changing climate be improved and conveyed?

## Related current GLASS efforts:

- GSWP3 – Land reanalysis and sensitivity of surface fluxes to forcing uncertainties including radiation.
- LoCo – Determining Processes; How are land and PBL fluxes quantified and interact with each other.
- PILDAS – Constraining LSMs with observations for improved land surface energy balance.
- Benchmarking – Assess land surface energy balance in models vs. empirical models, and evaluating the ‘goodness’ of a model prediction.

## Future activities:

- GLASS-GDAP – Improve connection between SRB, Landflux and GLASS modeling and prediction and consistency between data products and models.
- Anthropogenic Influences on the Global Water Cycle initiative: better characterize and prediction the impact of the human imprint on the water cycle