GEWEX Modeling Activites and Imperatives

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Global Energy and Water Exchanges Project
GEWEX
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Toujours un temps d'avance

GEWEX Science Questions (GSQs) :

1) Observations and Predictions of Precipitation
How can we better understand and predict precipitation variability and changes ?

2) Global Water Resource Systems
How do changes in LULC and hydrology influence changes in resources ?

3) Changes in Extremes
How does a warming world affect climate extremes, especially droughts , floods and heat waves, and how do land processes contribute ?

4) Water and Energy Cycles and Processes
How can understanding of the effects and uncertainties of water and energy exchanges in the current and chaging climate be improved and conveyed ?

GEWEX Projects with significant Modeling components:

GASS (Global Atmospheric System Study panel)
J. Petch, S. Klein

GLASS (Global Land/Atmosphere System Study)
J. Santanello, A. Boone

GHP (GEWEX Hydroclimatology Panel)
D. Lettenmaier, J. Polcher

Global Atmospheric System Studies : GASS

- Facilitates and supports the community that carries out and uses observations, process studies and numerical model experiments

- Goal ==> develop and improve the representation of the atmosphere in weather and climate models

- Method ==> through the coordination of international scientific projects to contribute to the development of atmospheric models

GASS primarily oversees intercomparison projects (generally 6-8) based on observational field campaigns or more idealized studies which typically take from two to five years

Global Atmospheric System Studies : GASS

- **GABLS GEWEX Atmospheric Boundary Layer Study**
- **Vertical Structure and Diabatic Processes of the Madden-Julian Oscillation**
- **Convective and Cloud Processes During TWP-ICE**
- **Microphysics Project**
- **Boundary Layer Cloud Projects**
- **CGILS CFMIP-GASS Intercomparison of LES and SCMs**
- **Semi-Direct Aerosol Campaign (ISDAC) Mixed-Phase Arctic Clouds**
- **Cirrus Model Intercomparison Project**
- **Grey Zone Project**

Global Atmospheric System Studies : GASS

Cross-Cutting projects/actions:

- GABLS-GLASS project DICE being launched

- SPARC and GASS – soon be discussing how to interact to address possible gap in the study of large scale tropical dynamics

- Model Development Summer School – has the potential to cover real model development for students (towards mitigating « black box » model usage)

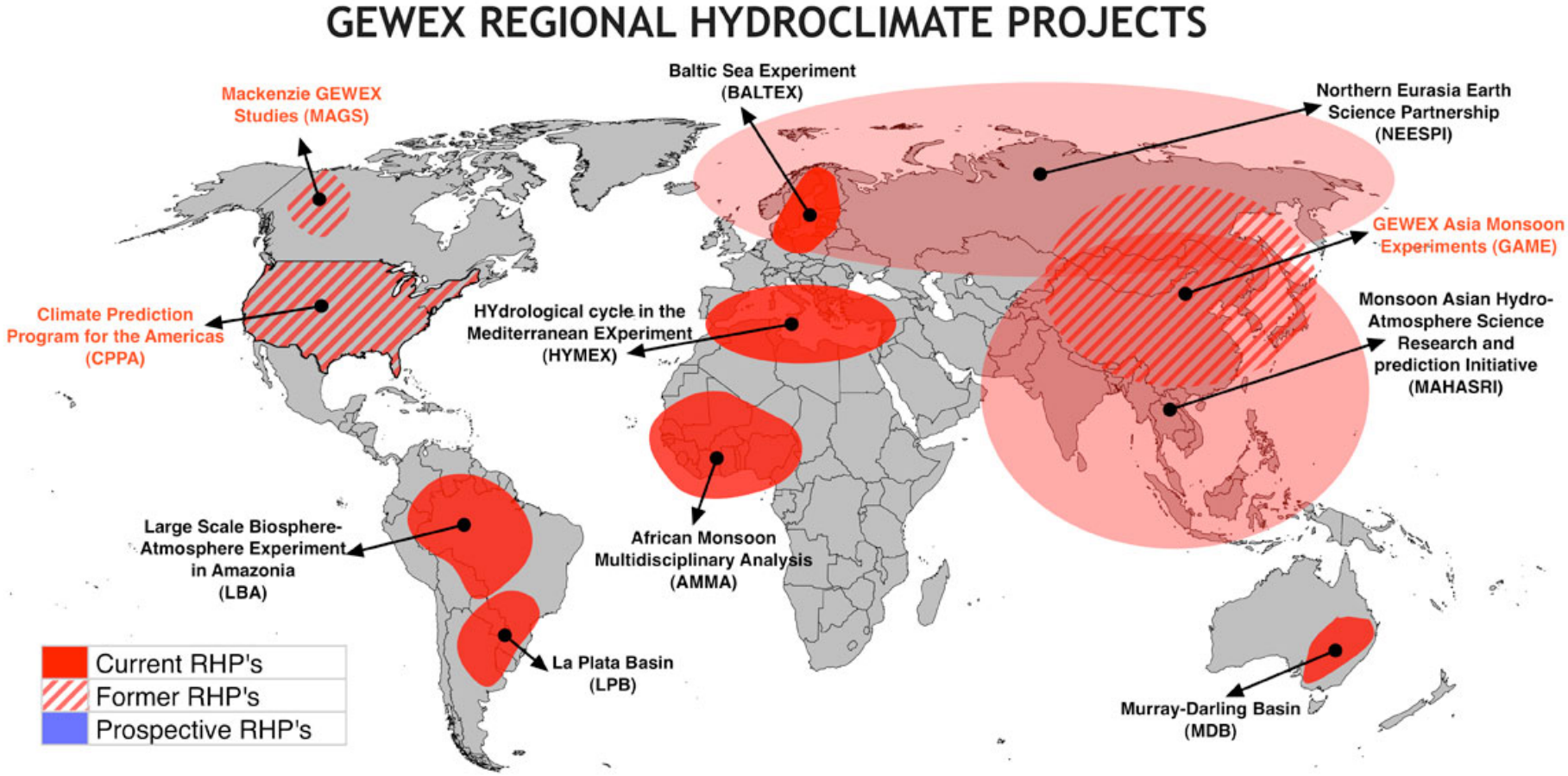
GEWEX Hydroclimatology Panel : GHP

GHP coordinates the plans and the focus of scientific issues related to the development and implementation of the Regional Hydroclimate Projects (RHPs) and has oversight over all GEWEX regional hydroclimate and land-surface projects.

Goal ==> achieving demonstrable skill in predicting changes in water resources and soil moisture as an integral part of the climate system up to seasonal and annual time scales.

Method ==> GHP has 2 main activies, RHPs and cross-cutting projects

GEWEX Hydroclimatology Panel : GHP



GEWEX Hydroclimatology Panel : GHP

- **BALTEX** Baltic Sea Experiment
- **AMMA** African Monsoon Multidisciplinary Analysis Project
- **HyMeX** HYdrological cycle in the Mediterranean Experiment
- **LBA** Large-Scale Biosphere-Atmosphere Experiment in Amazonia
- **LPB** La Plata Basin
- **MAHASRI** Monsoon Asian Hydro-Atmoshere Scientific Research and Prediction Initiative
- **MDB** Murray-Darling Basin
- **NEESPI** Northern Eurasia Earth Science Partnership Initiative

GEWEX Hydroclimatology Panel : GHP

Cross-Cutting projects/actions:

- High-elevation precipitation
- Climate change and water resources
- Hydrological seasonal forecasting - linkages to the Working Group on Seasonal to Interannual Predictions and the Hydrologic Ensemble Prediction EXperiment (HEPEX)
- Regional modeling with linkages with the Coordinated Regional Climate Downscaling Experiment (CORDEX)
- Land surface model validation with GLASS: benchmarking (providing datasets to PALS)
- Validation of global data sets to be undertaken with GDAP

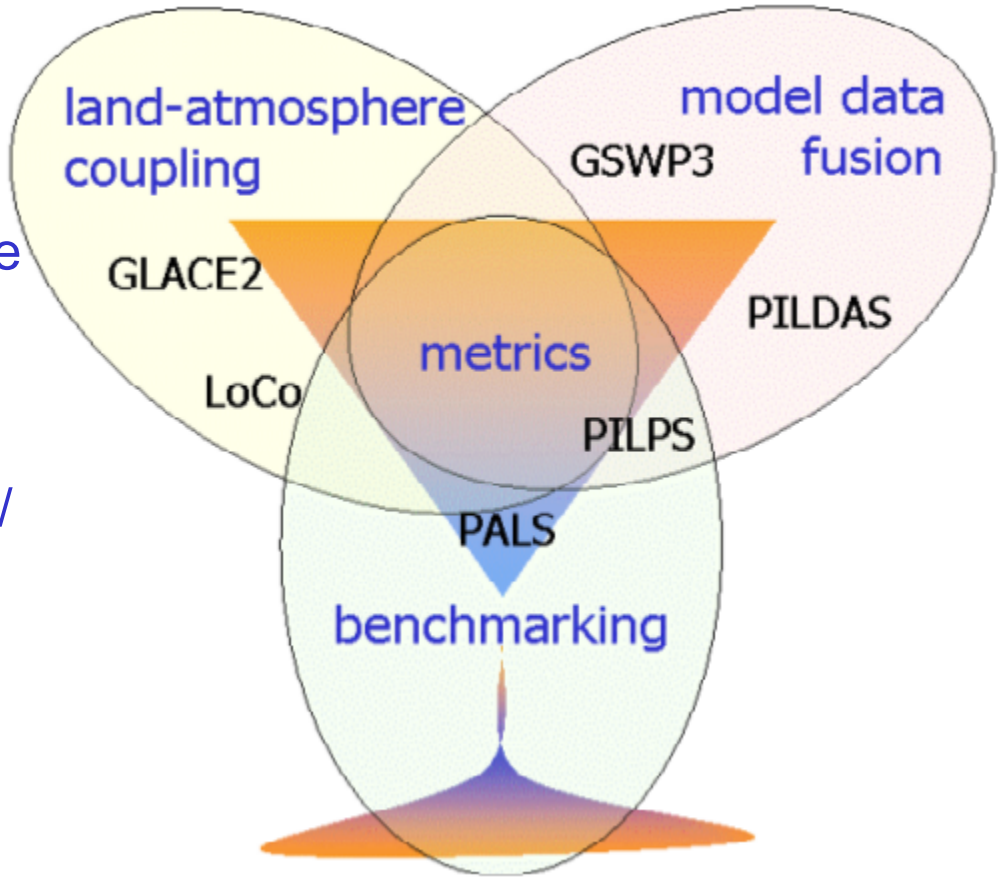
Global Land Atmosphere System Study : GLASS

The aim of GLASS is to promote community activities that improve:

1. our best estimates and the model representation of state variables

2. our understanding of land/ atmosphere feedbacks

3. our understanding of the role of land surface in predictability.



Global Land Atmosphere System Study : GLASS

LOCO: Local Land-Atmosphere Coupling

PALS: Protocol for the Analysis of Land Surface models

GLACE-2: Global Land-Atmosphere Coupling Experiment -2

ALMIP-2: AMMA Land Surface Intercomparison Project Phase 2: Meso to Local Scale

GSWP-3: Global Soil Wetness Project -3

PILDAS: Project for the Intercomparison of Land Data Assimilation Systems

PILPS: Project for Intercomparison of Land-surface Parameterization Schemes

Global Land Atmosphere System Study : GLASS

Cross-Cutting projects/actions:

ALMIP2 – Links to GHP (improved hydrodynamics in LSMs)

GLACE2 – Links to S2S (land sfc adding to predictability)

LUCID2 – Links to iLeaps

Launching in next 12 months:

GSWP3 – Links to carbon community

PILDAS – Links to WGNE

GLASS/GABLS coupling ➔ DICE – Links to GASS

PALS benchmarking – Links to GHP

Being planned

LoCo SGP testbed

Global Land Atmosphere System Study : GLASS

Modeling and the GSQs addressed by GLASS:

• GSQ1: Address linkage of precipitation to land surface processes: GLACE, LoCo, ALMIP2, PILDAS, GSWP3

• GSQ2: to address water resources, need to coordinate model development among disparate disciplines and applications (need to coordinate with iLEAPS, iLAMB…) LUCID2, PILDAS, ALMIP…

• GSQ3: Extremes – Benchmarking critical - Data assimilation and model calibration issues ALMIP2, LoCo, GLACE3, Benchmarking (PALS, iLAMB), CORDEX-GLASS collab?

• GSQ4: Improving water abd energy cycles in LSMs: GSWP3, LoCo, PILPDAS, Benchmarking

Upcoming Workshops in 2013 - GSQs :

WCRP Strategy Workshop for Global Water Resource Systems

WCRP Strategy Workshop on Observations and Predictions of Precipitation

Satellite Soil Moisture Validation and Application Workshop

Workshop on using GRACE data for water cycle analysis and climate modeling

Planning Workshop for a GEWEX Regional Hydroclimate Study on the Hydrology of the Lake Victorian Basin (HyVic)

Workshop on initial results from the GLASS/GASS DICE experiment

Fifth International Workshop on Monsoons

Thank you for your attention…

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EXTRA...

Local Land-Atmosphere Coupling (LoCo) Project

Motivation

- The results of prior GLASS intercomparisons (PILPS and GSWP) are limited by the lack of atmospheric feedback when running in uncoupled mode.
- GLACE assessed current GCM coupling coherence- but did not isolate and evaluate the coupled processes that would lead to model development.
- Need to accurately depict relation between soil moisture, precipitation and coupling
- Requires *examination and quantification of interactions and feedbacks* in the planetary boundary layer.

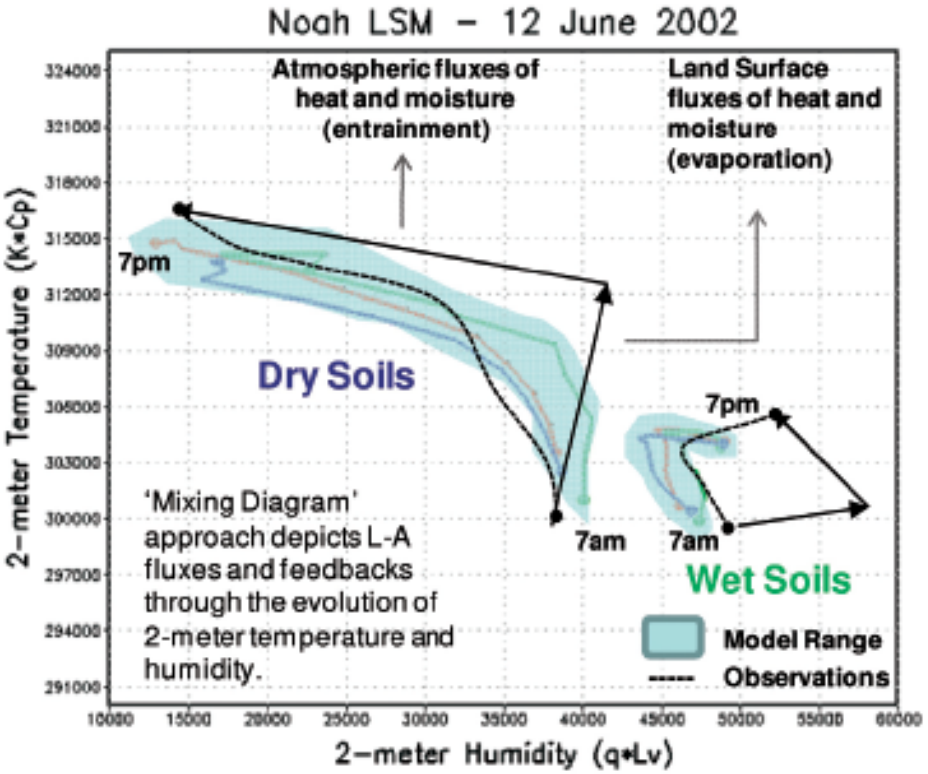
Participants and Methods

A growing number of international PIs employing a range of:

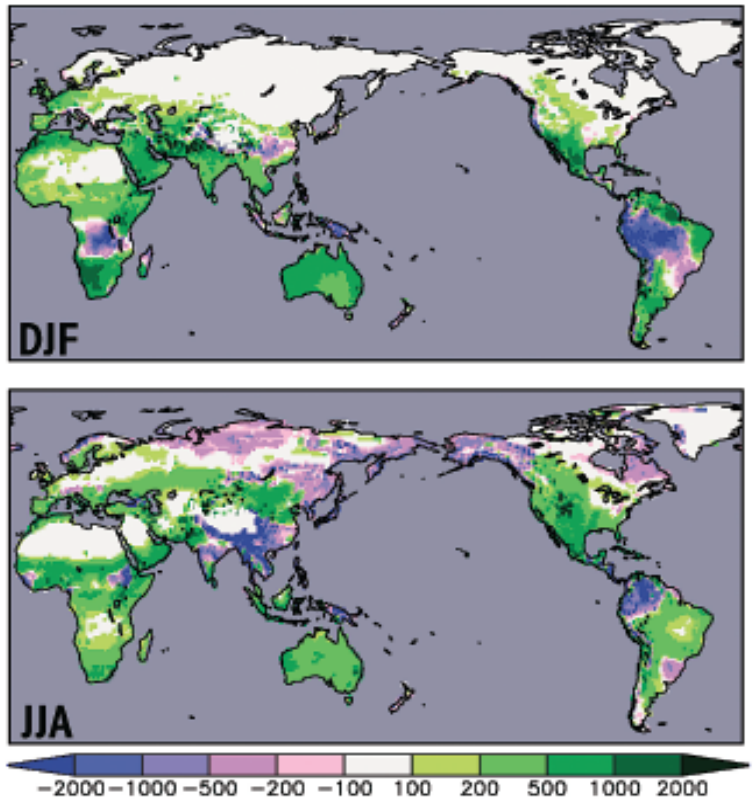
- Models (single-column to MM to GCM to Reanalysis)
- Scales (local to 1D to global)
- L-A Coupling Diagnostics

LoCo Diagnostics

- The choice of LSM is critical for dry regimes, but both PBL and LSM are comparable influences on the coupled behavior during wet regimes.



From a high-resolution mesoscale model (LIS-WRF) vs. observations: the interplay of soil moisture, ET, and PBL growth that is critical to capture in coupled models.



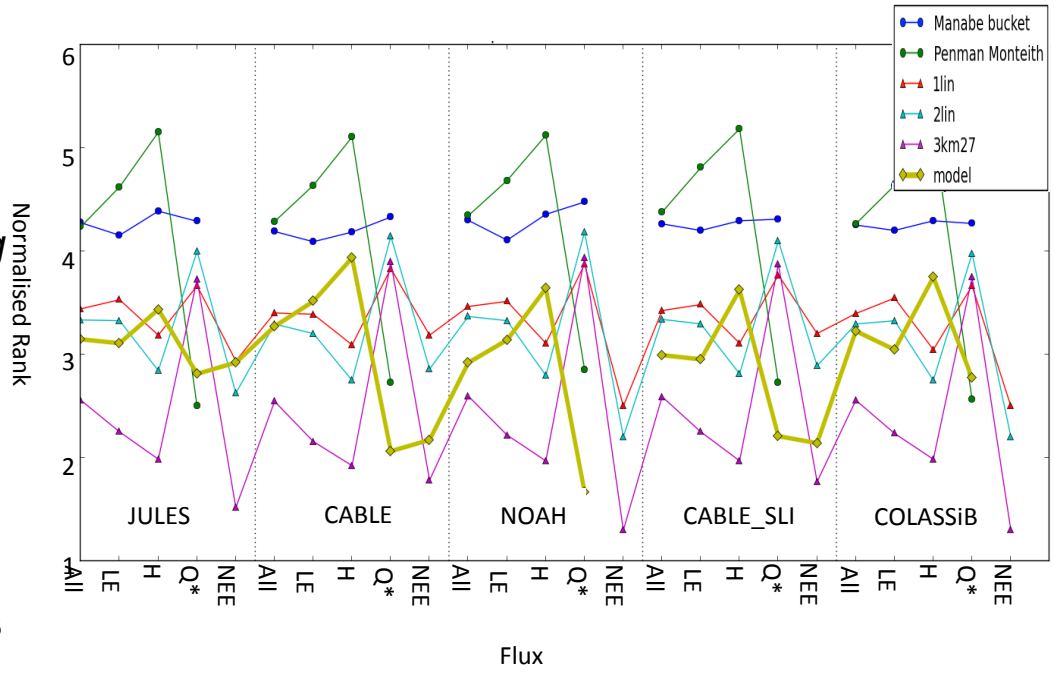
Combined strength of the soil moisture control on evapotranspiration and surface flux control on PBL growth, based on a 47-year simulation of the ECMWF GCM. Positive values indicate strong land surface and soil moisture contributions to the atmosphere.

Protocol for the Analysis of Land Surface models (PALS)

GOAL: An online, automated land surface benchmarking tool. PALS provides standardised reference experiments – users download model driving data, upload simulations. PALS compares results to observational data, other model results and reference benchmarks. PALS provides a standardised testing environment for model comparisons and internal model development programs.

STATUS: flux tower based experiments are now operating.

- 150 users internationally.
- GLASS coordinating the *PALS Land sUrface Model Benchmarking Evaluation pRoject* (PLUMBER) – a model comparison experiment using out-of-sample empirical models as benchmarks.
- 20 sites; 5+ LSMs; 4 variables; 5 benchmarks
- LSMs outperformed by regressions against met forcing data



PLANS: PALS is currently introducing a range of distributed experiments at global, regional and catchment scales.

ALMIP2

Goal: to improve the representation of key surface, vegetation and hydrological processes over West Africa,
Feeds into forecast, regional and global climate modeling, and mesoscale, regional and global scale hydrological modeling. Applications in water resource management, disease prevention and control, and adaptive agricultural practice strategies.

- Experiments over 3 meso-domains along the AMMA-CATCH (latitudinal) transect, during 2005-8 (including the AMMA SOP) with 2 (high resolution precipitation) forcing inputs, 30 minute time step outputs: resolving the diurnal cycle

- Intercomparison (analysis), identification of missing/inadequately modeled processes, Scaling local➔meso➔regional (GCM/RCM grid box) Improved downscaling of GCM scenarios using hydrological models for water management issues/decision making. Results to be used for evaluation in WAMME2, evaluation of CMIP5 simulations…

- Results and observations to be transferred to AMMA-DB: available in 2013 (2014?) to scientific community

- ALMIP2 International Workshop (April 15-17, 2013), 28 participants from 9 countries. Set up protocol for mesoscale sensitivity tests and local scale experiments, calendar for reruns, final analysis, publication (journal special issue for 2014), conference presentations, links with coupled land-atmos projects (results from 18 land surface & 5 hydrological models processed currently)

- Carbon phase of ALMIP2 starting: simple LSMs simulate the vegetation response to the atmospheric forcing on seasonal time scale (for several annual cycles) for the diverse West African climates/vegetation covers? (links to be made with iLeaps?)

GEWEX imperatives/objectives:

➔Model improvement! (processes, sub-grid representations for atmospheric models…GASS)

➔ Help bridge the gap between GHP and GLASS, by evaluating and comparing both hydrological (conceptual and distributed) and LSM models.

Global Land Atmosphere System Study (GLASS)

GLACE2-CMIP5 (Sonia Seneviratne and Bart vd Hurk)

Exp#1A and #1B of GLACE2-CMIP5 have been completed. This involved AR5 reruns of climate change projections using a 1971-2000 soil moisture climatology versus using a seasonal transient cycle of soil moisture and evaluated during the 2070-2100 period.

-3 groups have completed (GFDL, ECHAM, CESM) the full analysis and papers have been submitted.

-Future phases of experiments involve land cover change. Highlights show that the imposed SM anomalies show similar regions as those projecting drought increase, and a larger impact of soil moisture change on daily max temperature.

- Precipitation changes are less clear, and additional analysis will be conducted to analyze the feedbacks and water balance (E-P).

This is expected to be completed over the next 12 months.

Global Land Atmosphere System Study (GLASS)

Links between GLASS and S2S:

• **GLACE2** has given us some measure of and an approach to quantify the impact of land initialization on forecasts ➔ great care should be taken in the land is spun-up and initialized (and any diversity therein).

• **PILDAS** will evaluate operational NWP centers' approaches to land DA, which ultimately will impact S2S-scale prediction through improved initialization (and ultimately coupled DA).

• **PALS** Benchmarking is ramping up and through WGNE, the operational NWP centers have expressed interest in quantifying the 'goodness' of their land model components. In order to do this, one needs a majority of the list of the suggested variables, to benchmark the energy/water/carbon cycle.

1) Observations and Predictions of Precipitation

How can we better understand and predict precipitation variability and changes ?
How well can precipitation be described?
How do changes in climate affect precipitation characteristics ?
How much confidence is there in predictions ?

2) Global Water Resource Systems

How do changes in LULC and hydrology influence changes in resources ?
How do changes in climate effect hydrological processes & water resources ?
Can new obs lead to improved management ?

3) Changes in Extremes

How does a warming world affect climate extremes, esp droughts , floods and heat waves, and how do land processes contribute ?
What are strategic requirements for existing obs systems and data sets, and which obs needs to quantify trends in the intensity and freq of extremes ?
How can models be improved in their simulation and prediction/projections of extremes ?

4)Water and Energy Cycles and Processes

How can understanding of the effects and uncertainties of water and energy exchanges in the current and chaging climate be improved and conveyed ?
Can we balance the energy budget (top of atmos and sfc) ? Track changes over time ? Can we related changes in the sfc energy budget with ocean-atmos processes and long-term variability ? Can we improve confidence in feedbacks associated with cloud-aerosol-precipiation interactions ?