Meeting/Workshop Reports

GLASS Panel Meeting

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The Global Land/Atmosphere System Study (GLASS) Panel meeting was held at the University of Tokyo with 16 GLASS Panel members and guests attending, five remotely. The meeting occurred prior to the 4th Hydrology Delivers Earth System Science to Society (HESSS4) conference, which took place 17–19 May and included several GLASS-related presentations. At the GLASS meeting, community and associated crosscutting activities under the three panel elements were reviewed, including: (1) land model benchmarking to improve knowledge and representation of land-surface processes; (2) understanding land-atmosphere interaction and feedbacks; and (3) the role of the land surface in predictability.

Local Land-Atmosphere Coupling (LoCo) Project

Ahmed Tawfik presented the status of the LoCo Project—now in its second decade. The project is composed of 17 mostly young scientists from around the globe who have been very active in publishing and promoting LoCo-related work. This work includes the Coupling Metrics Toolkit (COMET), LoCo metric "cheat sheets," a book chapter on land-atmosphere interactions, and a core LoCo article for the *Bulletin of the American Meteorological Society* (in progress). Publications are available on the LoCo website at *http://www.gewex.org/loco/*. A great deal of energy in recent years has gone into supporting improved observations of land-atmosphere coupling, most notably in terms of the surface layer, soil moisture and the Atmospheric Boundary Layer (ABL). Numerous field campaigns were conducted or planned over the U.S. Southern Great Plains (SGP) and other regions. Many initiatives were proposed to promote improved ABL retrieval from space via the Decadal Survey, Global Climate Observing System/Essential Climate Variables (GCOS/ECVs) and the associated NASA-dedicated task group. There are plans to produce a LoCo-DICE [Diurnal Coupling Experiment, a joint GLASS and Global Atmospheric System Studies (GASS) Panel activity] analysis and paper, and focus on single-column model benchmarking (i.e., vertical benchmarking) to compliment the ongoing Protocol for the Analysis of Land Surface models (PALS)/PALS Land Surface Model Benchmarking Evaluation Project (PLUMBER) efforts.

PALS/PLUMBER

Gab Abramowitz provided an update on PALS (*http://www.modelevaluation.org*) and discussed the scope of a new PLUMBER activity. Changes to PALS include: (1) analyses are no longer restricted to a particular package or language; (2) a distributed architecture will allow analyses to be co-located with big data; (3) the potential for an Application Programming Interface (API) access to allow remote continuous integration testing of science in a model, not just code; and (4) a more generic design that can be used with any model type or component, not just land-surface models (LSMs). Under PALS, model intercomparison projects (MIPs) are transparent (analysis scripts are viewable, and experiments can be replicated) and MIPS are ongoing (new model additions will automatically be analyzed, and new analyses can be added retrospectively). This flexibility and greater capability means, for example, that MIPs such as the Global Soil Wetness Project (GSWP), PLUMBER and the legacy Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS) experiments could be available and (re)analyzable quickly.

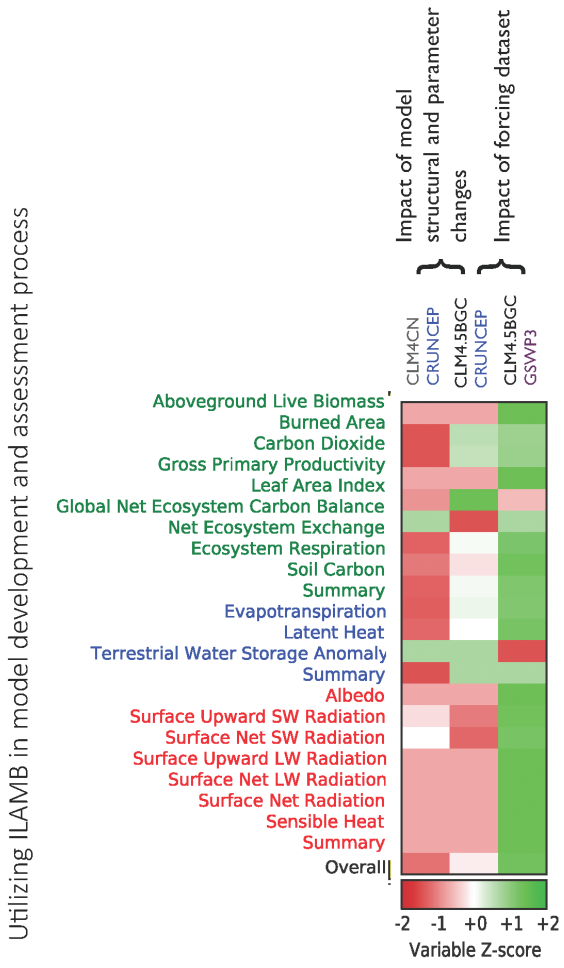
A future project, PLUMBER2, was discussed and a number of related issues were raised, including: (1) more sites are needed (versus the original 20 PLUMBER sites) and better quality-controlled and energy-balance-corrected FLUXNET site data, which could include urban regions; (2) improvement in the hierarchy of empirical models is needed to benchmark against (including energy and mass conservation by these empirical models); (3) more variables are necessary so that process-representation differences in models can be explored; (4) LSMs should be examined within a Budyko framework [i.e., investigating how the dryness index (potential evaporation/precipitation) affects a range of performance metrics]; (5) additional sites are needed that have boundary-layer data so land-atmosphere coupling effects can be investigated, e.g. for LoCo as described above, and for joint GLASS-GASS studies, including future phases of DICE. In this regard, Michael Ek expanded on the topic of future DICE efforts, including possible leverage efforts by the joint National Oceanic and Atmospheric Administration/National Center for Atmospheric Research "Global Model Testbed," which advocates a comprehensive simple-to-more-complex process-level model development hierarchy, including component-level (e.g., land, surface-layer) and single column model testing.

GSWP3 and LS3MIP

Hyungjun Kim gave an update on the status of the Global Soil Wetness Project Phase 3 (GSWP3) and the Land Surface, Soil Moisture and Snow Model Intercomparison Project (LS3MIP). GSWP3 is a global offline land MIP with a 0.5-degree forcing data set that will also be used for LS3MIP, the Land-Use Model Intercomparison Project (LUMIP) Coupled Model Intercomparison Project Phase 6 (CMIP6) and the GEWEX SoilWAT Project (described below). LS3MIP also includes an offline land component ("LMIP") endorsed by CMIP6, which will feature a long-term retrospective GSWP3 experiment starting in 1850 that uses prescribed land-use and land-cover changes derived from the Land Use Harmonization (LUH) data set. The 165-year data set has been frozen and is available for CMIP6 land-related studies.

LUMIP

Dave Lawrence provided an update on LUMIP, which is part of the CMIP6 suite of experiments whose experimental design has been published in Geoscientific Model Development (Lawrence et al., 2016). The historical LUH2 land use data set has been provided to the community and beta versions of the Shared Socioeconomic Pathway futures are also available with final versions expected in northern hemisphere (NH) summer 2017. Included in the LUMIP manuscript is a description of the sub-grid land use tile request (a subset of variables are requested on primary and secondary land, cropland, pastureland and urban land use tiles). For additional information on the LUMIP project, including links to access the LUH2 data, sign up for the LUMIP Google group and updates to the experimental design (available at *https://cmip.ucar.edu/lumip*). Simulations are expected to begin in NH summer 2017 as modeling centers start working on CMIP6.



Colors indicate which of the three simulations performs best for a particular variable. Red colors indicate that a particular simulation performed worst and green colors indicate that the simulation performed better. Each variable includes several metrics (e.g., RMSE, bias, interannual variability, spatial pattern correlation) and potentially several data sets (e.g., for LH Global Bio-Atmosphere Flux gridded data and FLUXNET sites). Variables labeled in red are "forcing" variables, which in these land-only simulations effectively represent an assessment of the forcing data sets.

International Land Model Benchmarking (ILAMB) Project

Dave Lawrence also gave an update on the ILAMB Project, where two versions of the ILAMB package have been released to the community. ILAMB Version 2 will be developed as open-source software, written primarily in Python. The current version assesses approximately 25 carbon, hydrology, energy and climate variables using 60 global, regional and site level data sets. Metrics for root-mean-square error (RMSE), absolute error, interannual variability, spatial patterns, variable-to-variable comparisons and more are included. An example is shown in the figure below, illustrating the impact of model structural improvements [Community Land Model 4 (CLM4) versus CLM4.5] compared against the impact of forcing data sets [Climatic Research Unit-National Centers for Environmental Prediction (CRUNCEPv4) versus GSWP3v0] using the ILAMB package. The package currently generates thousands of plots and is being utilized in model assessment and development, and to support analysis of MIPs. Example output from ILAMB, assessing output from simulations from several generations of the CLM [forced with GSWP3 and CRUNCEP data sets], is available at: *http://ilamb.ornl.gov/CLM/*. Note that results at this location are subject to change as both the ILAMB package and CLM are being finalized; figures from this example of the package should not be used for publication. Anyone interested in contributing data sets or metrics is encouraged to contact ILAMB project leads (Dave Lawrence, Forrest Hoffman, Jim Randerson, Bill Riley, Charlie Koven, Gretchen Keppel-Aleks or Nate Collier). The final workshop report of the May 2016 ILAMB workshop (Hoffman et al., 2017) is available at *https://www.ilamb.org/*. Finally, the ILAMB and PALS projects are exploring options to coordinate efforts for the mutual benefit of both projects.

Crosscuts and Joint Projects—GASS

John Edwards reported on the links between projects in the GLASS and GASS panels. Many of the projects within GASS are heavily focused on cloud processes, but two have a particularly strong relationship to the land surface. The GEWEX Atmospheric Boundary Layer Study (GABLS), led by Bert Holtslag and Gunilla Svensson, has conducted several intercomparisons of stable boundary layers involving both single-column studies using the physical schemes from numerical weather prediction and climate models, and also large-eddy simulation models. As the project has evolved, an increasing emphasis has been placed on more stable boundary layers and on coupling to the land surface (i.e., the GLASS-GASS joint project on DICE with an initial focus on the U.S. SGP). The current intercomparison, GABLS4, led by Eric Bazile, is concerned with simulation of the diurnal cycle of the boundary layer at a site on the Antarctic Plateau (the so called "DICE-over-ice" project). Recent progress was discussed at a workshop on stable boundary layers in March 2017 in Delft, The Netherlands. The Clouds Above the United States and Errors at the Surface (CAUSES) Project, led by Cyril Morcrette and Hsi-Yen Ma, is concerned with understanding the origin of continental warm biases in near-surface air temperature in the summer in both weather and climate models, making extensive use of data from the Atmospheric Radiation Mea-

surement site in the U.S. Great Plains in Oklahoma. Understanding the impact of clouds is a key part of this project, but current results indicate that surface processes also play a role.

SoilWat

Vincent Humphrey and Aaron Boone, and Anne Verhoef (remotely) gave updates on the status of the joint GEWEX and International Soil Modeling Consortium (ISMC) GEWEX Soil and Water (SoilWat) initiative. The goals of the project are to conduct an in-depth survey on how key soil physical processes (water and heat flow) are represented in climate and hydrological models, to make a systematic assessment of the utility of resolved soil maps, and sensitivity of climate models in improving the quality and resolution of soil maps and to survey how groundwater is implemented in climate models (and how this might lead to a global database of historical and current groundwater levels). The first two of these are under way with active surveys and a Soil Parameter MIP (SP-MIP) that closely follows LS3MIP protocols (van den Hurk et al., 2016).

GLASS Panel Interactions with other Projects—GHP

Additional crosscutting projects in GEWEX and other groups were discussed. In the GEWEX Hydroclimatology Panel (GHP), process level improvements in land are a shared interest with GLASS. Craig Ferguson, GLASS liaison with GHP, reviewed GHP projects, including Regional Hydroclimate Projects (RHPs) and crosscutting projects such as subdaily precipitation (Intelligent use of climate models for adaptation to non-Stationary hydrological Extremes, INTENSE), cold/shoulder season precipitation near 0°C and mountain hydrology (International Network for Alpine Catchment Hydrology, INARCH). In this regard, Gab Abramowitz summarized the issue of how water management and human influences (on both water and energy cycles) are treated in large-scale models, which is of interest to GLASS and GHP, and the subject of a 2016 joint workshop. Future activities are being planned. Aaron Boone updated the Panel on the status of "Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment" (LIAISE), a regional project with seasonally stressed vegetation and often a high degree of heterogeneity, and the need to better model the surface energy budget and properly represent the seasonal dry-down period. The likely timing for the measurement program in LIAISE is May 2019–May 2020, with linkages between GLASS, GHP and other projects.

Hydrological Cycle in the Mediterranean Experiment

As the liaison between GHP and GLASS, Pere Quintana Seguí gave an update on the work of the HyMeX Droughts and Water Resources science team towards the improvement, understanding and quantification of drought in the Mediterranean. This work is built around three themes: (1) defining drought, (2) understanding drought processes, and (3) predicting drought. Drought description work has been done at the regional/country level, such as examination of drought trends in Italy and Tunisia. As data sharing between countries is difficult, the aim is to use a common methodology to harmonize results. Interesting work has been performed using hydrological models forced by downscaled long-term reanalysis data in order to reconstruct past droughts for a period of 140 years in France. Remote sensing data (RSD) is also being used to describe drought (vegetation, precipitation, soil moisture), and to quantify the water levels behind smaller dams, since in many countries reservoir-level data are not available. Additionally, RSD are being assimilated in LSMs at different scales (single plot to an entire country). At the larger scales, LSMs are used to estimate river flow and fresh water inputs into the Mediterranean Sea. In terms of prediction, there is an effort to study the applicability of seasonal forecasts for water resource management in small Mediterranean basins, with interesting results. HyMeX research has been carried out under several projects, and in this regard, the future LIAISE campaign will examine the role of the land surface during the dry-down period in Iberia.

WCRP and Other Organizations

Michael Ek reported on liaison activities with the WCRP Modeling Advisory Council (WMAC) and the World Meteorological Organization Working Group on Numerical Experimentation (WGNE). The broad goal of WGNE and WMAC is to improve global weather and climate models and coordinate high-level aspects of modeling across WCRP. The GLASS presence in these groups is focused on land-modeling and land-atmosphere interaction. Paul Dirmeyer provided updates on the activities of the Sub-seasonal to Seasonal (S2S) Prediction Project activities and the joint GEWEX-Climate and Ocean: Variability, Predictability and Change (CLIVAR) Monsoon Panel efforts. Most relevant to GLASS is the increasing interest in land initialization, which includes soil moisture and snow, and the impact on S2S predictive skill, which is relevant for proper modeling of monsoon circulations. Rich Ellis reviewed the link between GEWEX and the Integrated Land Ecosystem Atmosphere Processes Study (iLEAPS), where the focus of iLEAPS is on ecosystems and land-use changes and their effects on biogeochemical cycles and land-atmosphere interaction, which involves a strong overlap on a number of topics with the GEWEX focus on energy and water. This includes a future iLEAPS-GEWEX collaborative project on the Arctic (ArcticMIP), where the importance of modeling high-latitude processes is being addressed, and will be discussed at the Arctic Terrestrial Modeling Workshop in Oxford in September 2017. Such a focus on the Arctic could also involve and improve GEWEX-wide participation, i.e., land-model benchmarking (GLASS), land-atmosphere interaction studies (GLASS and GASS), regional hydrology (GHP) and remotely sensed data sets working with the GDAP, thereby increasing GLASS-GDAP interaction.

References

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