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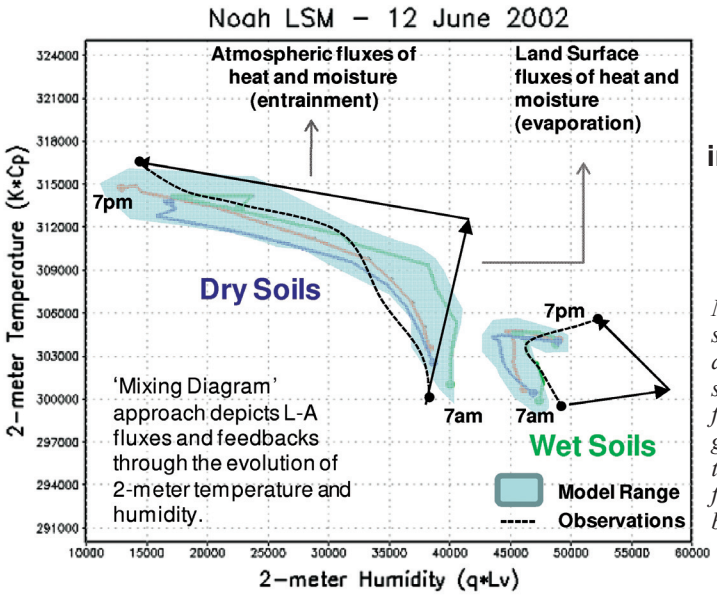
Results from Local Land-Atmosphere Coupling (LoCo) Project

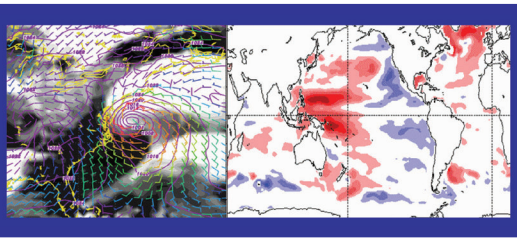


GEWEX LoCo Project results on wet/dry extremes show that the choice of LSM is critical for dry regimes, and that the PBL and LSM are comparable influences on coupled behavior during wet regimes.

See article by J. Santanello et al. on page 7.

Mixing diagram showing the diurnal co-evolution (7AM–7PM) of 2-meter specific humidity and 2 meter-potential temperature on 12 June 2002 at a dry and wet soil location as simulated by a coupled mesoscale model. The shaded regions for each indicate the model range for different land-surface model (LSM)-planetary boundary layer (PBL) scheme couplings (red, green, and blue) versus what was observed (dashed black). Also shown for the dry site are the vectors that represent the fluxes of heat and moisture from the land surface versus those from the atmosphere due to entrainment, both of which are quantified using this approach.

Also Inside



Commentary

Challenges in GEWEX

Kevin E. Trenberth
Chair, GEWEX Scientific Steering Group

The past few months have been exceedingly busy for many of us in the World Climate Research Programme (WCRP) community, largely due to preparations related to the WCRP Open Science Conference (OSC) held in Denver from 24–29 October 2011. Also, many working group and panel meetings were held immediately before and after the Conference. Over 1900 attendees from 86 countries attended this highly successful Conference, including 523 students and early career scientists, and 332 scientists from developing countries. The format of the Conference worked well, with the plenary lectures session followed by poster sessions on the theme of the day, and two oral parallel sessions in the afternoon. I thank and applaud the many GEWEX scientists who helped with the planning, especially those who convened a session. There were four oral parallel sessions and 15 poster sessions directly related to GEWEX activities and they were all well attended.

The Working Group on Numerical Experimentation (WGNE) met the week before the OSC, and GEWEX was represented there by the Chairs of the GEWEX Global Atmospheric System Study (GASS) and Global Land/Atmosphere System Study (GLASS) Panels. In addition, the GEWEX Hydroclimatology Panel (GHP) had a 3-day panel meeting and GLASS had an intense one-day meeting prior to the OSC. The Joint Scientific Committee that provides oversight of WCRP met for two days after the OSC. In August, the GEWEX Radiation Panel (GRP), which has been renamed "the GEWEX Data and Assessment Panel (GDAP)" to better reflect its objectives, met in Tokyo. All of this provided ample information and substance for the GEWEX Scientific Steering Group (SSG) Meeting that was held in Rome on 14–18 November 2011.

The "living" document, "GEWEX Imperatives: Plans for 2013 and Beyond," which outlines the strategic future directions of GEWEX, has been reviewed and is available on the GEWEX website. The document is being used extensively by the GEWEX Panels in planning. However, it has become clear that we now need to include more specific plans and a strategy for their implementation for the immediate future (the next 5–7 years). Accordingly, the SSG spent a substantial amount of time on the planning and drafting of Grand Science Challenges for GEWEX.

The Grand Challenges must be specific and focused, while identifying ways to advance the science, and they must resonate among agencies, program managers, and the public. These Challenges must provide vehicles to encourage the different GEWEX Panels to interact in pursuing a common goal and provide a way forward that is tractable, (e.g., via new observations and computer and model advancements). They must also address possible benefits and impacts and links to issues related to food, water, health, energy, and biodiversity.

The GEWEX SSG has identified four such Grand Challenges that will be further developed in the next few months. The questions are evolving but shape up as follows:

1. **How can we better understand and predict variations and changes in precipitation?** This question focuses on the use and further development of expected improved data sets on precipitation and soil moisture from ongoing and planned satellite missions and in situ observations; evaluation and analysis of these data sets into various products that are used to document mean, variability, patterns, extremes and full probability density functions, and confront models in new ways; improved understanding of atmospheric and land-surface processes and their modeling that in turn feeds into improved simulations of precipitation; and new techniques of data assimilation and forecasts that can lead to better predictions of the

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hydrological cycle. These results should lead to improved climate services.

2. **How do changes in land surface and hydrology influence past and future changes in water availability and security?** There is a need to address terrestrial water storage changes and close the water budget over land through exploitation of new data sets, data assimilation, and improved physical understanding and modeling skill across scales, from catchments to regional to global with links to the entire hydrological cycle, including hydrogeological aspects of ground water recharge. Attention is needed in the use of realistic land-surface complexity with all anthropogenic effects taken into account, instead of a fictitious natural environment. This encompasses all aspects of global change, including water management, land use change, and urbanization. Water quality and especially water temperature, both of which are greatly affected by industrial and power plant use, are of immediate concern, to be followed by nutrients. The ecosystem response to climate variability and responsive vegetation must be included, as must cryospheric changes such as permafrost thawing and changes in mountain glaciers. Feedbacks, tipping points, and extremes are of particular concern. The results should enhance the evaluation of the vulnerability of water systems, especially to extremes, which are vital for considerations of water security and can be used to increase resilience through good management and governance.

3. **How does a warming world affect climate extremes, especially droughts, floods, and heat waves, and how do land area processes, in particular, contribute?** A warming world is expected to alter the occurrence and magnitude of extremes from droughts to rainfall intensity, as well as the geographic distribution of rain and snow. Such changes are related to an acceleration of the hydrologic cycle and circulation changes, and include the direct impact of warmer conditions on atmospheric water vapor amounts, rainfall intensity, and snow-to-rain occurrence. How well are models able to handle extremes and how can we improve their capability? Data sets at high frequency (e.g., hourly) are needed to properly characterize many of these facets of our climate and to allow for assessment against comparable model data sets. Activities are needed to promote analyses of which changes are consistent with our expectations and how we can best contribute to improving their prediction in a future climate. Confronting models with new observationally based products will lead to new metrics of performance and highlight shortcomings and developmental needs that will focus field programs, process studies, numerical experimentation, and model development. Applications will be developed for improved tracking and warning systems, and assessing changes in risk of drought, floods, river flow, storms, coastal sea-level surges, and ocean waves. In most cases, such applications will be done in conjunction with the Climate Variability and Predictability (CLIVAR) and the Climate and Cryosphere (CliC) projects.

4. **How can understanding of the effects and uncertainties of water and energy exchanges in the current and changing climate be improved and conveyed?** This question includes goals of improved consistency between net solar and infrared radiation and sensible and latent heat fluxes at the surface to reveal processes that in turn must be replicated in climate models. This question relates also to uncertainties introduced by incomplete understanding of cloud-aerosol-precipitation interactions and their feedbacks on the climate system. Only through a better understanding of the uncertainties in observations and models will it be possible to discriminate natural variability from longer-term trends of key variables such as temperature and precipitation. Possibilities of new satellite-based measurements, combined with observations at the surface and in the ocean, should enable improved reconciliation between observed changes in the radiative imbalance at the top-of-atmosphere and the inventory of changes in energy throughout the Earth system. Upgraded GEWEX data sets, global reanalyses of atmosphere and ocean, and improved modeling together with advanced diagnostics being planned throughout the GEWEX Panels play key roles in advancing this topic. The result is improved tools and products for climate services.

These science questions will have elements associated with the GEWEX Imperatives: observations and data sets, their analysis, process studies, model development and exploitation, applications, technology transfer to operationalize results, and capacity building and training of the next generation of scientists. They involve all of the GEWEX Panels, and frequently strong interactions with other parts of WCRP and even the International Geosphere-Biosphere Programme. They also contribute to the larger science questions posed by WCRP as a whole.

We welcome your comments, suggestions, and involvement in developing and furthering these topics. Workshops are anticipated to encourage participation and ideas. Please provide expressions of interest or thoughts and reactions to *gewex@gewex.org*.

GEWEX NEWS

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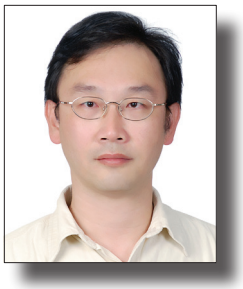
New Members of the GEWEX Scientific Steering Group (SSG)

GEWEX welcomes the following new GEWEX SSG members whose terms begin in January 2012.



Dr. Chia Chou is a Research Fellow at the Research Center for Environmental Changes, Academia Sinica, in Taipei, Taiwan. His areas of interest are tropical dynamics, climate variability and change, and ocean-atmosphere-land interaction.

Dr. Xin Li is in the Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences in Lanzhou, Gansu Province, China. His areas of interest are land data assimilation, remote sensing of hydrology, and the cryosphere.

Dr. Paolo M. Ruti heads the Climate and Impact Modeling Laboratory of the Environmental and Energy Modeling Department at the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) in Italy. His areas of interest are mid-latitude low frequency variability, regional climate processes, linking large-scale flow and regional climate variability, and Mediterranean and African climates.

Prof. Minghua Zhang is the Dean of the School of the Marine and Atmospheric Sciences (SoMAS) of Stony Brook University/SUNY in Stony Brook, New York. His areas of interest are climate modeling and climate feedback processes.

New Co-Chair for Global Atmospheric System Studies (GASS) Panel

Dr. Stephen Klein is the new co-chair of the GASS Panel. He is a research scientist in the Program for Climate-Model Diagnosis and Intercomparison at the US Department of Energy's Lawrence Livermore National Laboratory in California. Dr. Klein co-chairs GASS with Jon Petch, the Manager of the Clouds and Radiation Group at the Met Office in Exeter, UK.

New Position for Olga Zolina

Prof. Olga Zolina, a GEWEX SSG member, is now Associate Professor, Chair of Excellence in Physical Climatology at the University Joseph Fourier and The Centre National de la Recherche Scientifique Laboratory of Glaciology and Environmental Geophysics in Grenoble, France. Her research there is focused on the global and regional moisture and energy budgets with an emphasis on high latitudinal regions.

Masao Kanamitsu (1943–2011)

Masao Kanamitsu, a contributor to GEWEX and one of the world's most eminent leaders in the science of seasonal climate modeling, died of cancer in August. His work is recognized for major contributions in several areas of climate science, including downscaling from global-scale to regional-scale climate simulations, the impact of soil moisture, and the predictability issues of seasonal climate. Dr. Kanamitsu helped develop the framework for numerical modeling, and climate scientists around the world benefitted from his contributions to the research project called "Reanalysis." The comprehensive, dynamically consistent reanalysis of historical meteorological data dating back to the 1940s gave the field a new means for studying and predicting climate behavior. The 1996 reanalysis paper published in the *Bulletin of the American Meteorological Society* that he co-authored has been called the most cited paper in the history of geosciences, having been referenced in nearly 9,000 papers to date since its publication. It provided researchers for the first time with a long and internally consistent historical data set, one which authoritatively integrates many kinds of observational data and can be used to study the recent past record of weather and climate change. *Excerpted from August 24, 2011 Scripps News.*

Konrad Vielhauer (1957–2011)

Konrad Vielhauer, Global Water System Project Science Officer, died of cancer in December. His experience in science management, his systematic oversight, and willingness to share his knowledge and experience with younger colleagues were invaluable assets for the GWSP International Project Office.

Workshop Planned on Application of GRACE Data to Land and Ocean Climate Modeling and Analysis

The Gravity Recovery and Climate Experiment (GRACE) team and the Jet Propulsion Laboratory's Center for Climate Sciences are planning a workshop with GEWEX and the Climate Variability and Predictability (CLIVAR) Project on the application of GRACE observations to land-water storage, large-scale water cycle processes, ocean circulation, and sea level change. **The Workshop will be held at the Woods Hole Oceanographic Institution (WHOI) on 14–16 May 2012**, and will be followed by a Water Cycle Symposium (contact: Raymond Schmitt, WHOI).

The goal of the Workshop is to spark a dialogue with the modeling community to explore how GRACE data can best be used to monitor and simulate a changing water cycle. GRACE data have been successfully used to estimate basin-wide groundwater changes, evapotranspiration or snow-mass, and are now applied to refine drought and flood monitoring. GRACE observations have also helped to improve the National Center for Atmospheric Research Community Land Model, perhaps the first "GRACE-tested" model used in the Intergovernmental Panel on Climate Change Fifth Assessment Report on Earth System Models. Over the oceans, net ocean mass change estimates from GRACE can constrain fresh water fluxes, and ocean bottom pressure changes from GRACE can constrain the large-scale circulation. Given a near-decadal record from GRACE, and in light of the follow-on mission planned for launch in 2016, it is timely to discuss appropriate GRACE climate data records, define data products that have the greatest utility for end-user applications, and understand optimal model evaluation and assimilation methodologies for this data.

Workshop Topics:

1. Current and future developments: How can GRACE improve understanding of the global water cycle?
2. What needs to be done to establish a long-term Climate Data Record of GRACE observations and how would it fit within existing data sets?
3. Challenges: How can GRACE observations best be assimilated into ocean and hydrology models?
4. What specific model aspects can GRACE data improve (e.g., specific model parameters like hydrological permeability, or domain-specific improvements over high latitudes)?
5. Which model development pathways are viable that use GRACE observations in an optimal way (e.g., temporal and spatial resolution), and how can the integral nature of terrestrial water storage changes observed by GRACE be mapped onto disaggregated model components?
6. What realistic and possible GRACE and follow-on data products and improvements would most benefit model applications (e.g., resolution, error quantification)?

Highlights of the 24th Session of the GEWEX Scientific Steering Group

Peter van Oevelen and Dawn Erlich
International GEWEX Project Office

This Session of the GEWEX Scientific Steering Group (SSG) was hosted Dr. Gianni Tartari of the Water Research Institute (ISRA) of the National Research Council of Italy (CNR) in Rome, Italy on 14–18 November 2011. Dr. Enrico Brugnoli, the CNR Director of the Agency for Earth and Environment, and Dr. Maurizio Pettine, the Director of ISRA, provided opening remarks. Special presentations included "Impacts of global changes on water resources: Southern Europe situation" (Michel Vurro); "Stations at High Altitude for Research on the Environment (SHARE)–Water Resources: An integrated project for studying the impact of climate change on high mountains" (Franco Salerno); and "Observations and modeling of the hydrological cycle at the CNR Institute of Atmospheric Sciences and Climate" (Vincenzo Levizzani).

During the agency presentations, Dr. Michael Rast presented some of the current European Space Agency (ESA) alliances with major international Earth system science programs. The Water Cycle Multi-mission Observation Strategy (WACMOS), in collaboration with GEWEX, was the first of these initiatives and resulted in a special issue on "Earth Observations for Water Cycle Science" in *Hydrology and Earth System Science*. A recent collaboration, the GEWEX/ESA Data User Element GlobVapour Workshop on long-term water vapor data sets and their quality assessment, was held on 8–10 March 2011 at ESA's European Space Research Institute in Frascati, Italy.

Dr. Keiji Imaoka presented the Japan Aerospace Exploration Agency (JAXA) plans for the Global Change Observation Mission on Water (GCOM-W1), which is scheduled for launch in March 2012 and will become a part of the A-Train complement of satellites. GCOM-C (climate observation) is planned for launch in 2014. All GCOM data will be freely available to the science community.

Over the past year the SSG and GEWEX science community have developed a mission statement and imperatives that outline the strategic future directions of GEWEX as a part of the process for how GEWEX will contribute to the World Climate Research Programme (WCRP) global framework for climate services. During the SSG meeting, a substantial amount of time was spent in defining Grand Science Challenges for GEWEX (see *Commentary* on page 2). The SSG also reviewed the current and planned activities of the GEWEX Panels, which are summarized below.

The **Global Atmospheric System Studies (GASS) Panel** supports the community that carries out and uses observations, process studies, and model experiments with a focused goal of developing and improving the representation of the atmosphere in weather and climate models. It brings together those involved in the GEWEX Cloud System Study (GCSS), the GEWEX Atmospheric Boundary Layer Study (GABLS), and

the development of radiation codes through the Continuous Intercomparison of Radiation Codes (CIRC). The Panel addresses this primarily through the coordination of scientific projects, which brings together experts from around the world to contribute to the development of atmospheric models. Models are compared both to each other and to relevant global and regional observations. Three new GASS projects are under development.

- The **Madden-Julian Oscillation (MJO) Diabatic Heating Project**, a collaborative project with the WCRP-World Weather Research Programme/The Observing System Research and Predictability Experiment (THORPEX) MJO Task Force, where GASS will investigate the role of diabatic heating and moistening in the simulation of the MJO.
- The **Grey Zone Project**, a collaborative project with the Working Group on Numerical Experimentation (WGNE) to evaluate convection-permitting models [large-eddy simulation models (LES) and high resolution limited-area models (LAMs)] over large domains as a guiding tool for the representation of these processes in global and limited area models with grey-zone resolution.
- The **Indirect and Semi-Direct Aerosol Campaign (ISDAC) Mixed-Phase Arctic Clouds Project**, a joint U.S. Department of Energy Atmospheric System Research Program model intercomparison project to explore the role of dynamical and microphysical processes in mixed-phase Arctic clouds based on observations collected near Barrow, Alaska in April 2008.

The **Global Land/Atmosphere System Study (GLASS) Panel** is planning a follow-up project to the Global Soil Wetness Project-2 in collaboration with the terrestrial carbon cycle modeling community. Results from a pilot error propagation analysis have shown that differences in precipitation lead to non-linear differences in evaporation and runoff whose size and sign depends on the climate and vegetation regime. However, the spread between different land models was generally larger than the spread in the precipitation forcings and showed different spatial patterns, pointing at a model-dependent sensitivity of evaporation and runoff. GLASS is also planning two collaborative projects with the GEWEX Hydroclimatology Panel (GHP): (1) a study of the subtle hydrology and vegetation processes that dominate the study area of the 2nd African Monsoon Multidisciplinary Analysis (AMMA) Land Model Intercomparison Project (AMIP); and (2) a project to demonstrate benchmarking approaches using the Protocol for the Analysis of Land Surface (PALS). See the *GLASS Panel Meeting Report* on page 16.

The focus of the **GEWEX Radiation Panel (GRP)** has evolved over time, from developing data sets of global water and energy variables consistent with the GEWEX mission to fostering the creation of global data sets. With independent products available for the radiative and flux terms of the Earth system, GRP is now focused on creating an integrated reference product in which the individual products use a common space and time grid, as well as common ancillary data and procedures in order to ensure that geophysical signals are due to the data and products themselves, rather than inconsistencies in the assumptions. Once completed, GRP will undertake an assessment of the state of the water and energy budget based upon the new integrated GEWEX reference product. In light of the current focus of GRP activities, a name change from GEWEX Radiation Panel (GRP) to **GEWEX Data and Assessments Panel (GDAP)** was proposed and accepted.

Some results from this Panel include: (1) all GEWEX reference products are on track for reprocessing beginning in the April 2012 timeframe; (2) initial steps have been taken to shift GEWEX products to operational agencies for sustained processing; and (3) the assessment of cloud and radiative flux measurements is scheduled to be published in early 2012. See the *GRP Meeting Report* on page 12.

The **GEWEX Hydroclimatology Panel (GHP)** is in the process of reviewing all of its project activities; and forming recommendations regarding the continuation of these based upon their level of activity and relevance to the GHP Terms of Reference. Building on its strength in regional studies, and following earlier encouragement by the SSG and WCRP, GHP is addressing the need to better utilize regional climate models as a source of information about ongoing and future land-surface water cycle changes. This includes fostering collaborations with other groups with common interests in land-surface processes, such as the Coordinated Regional Climate Downscaling Experiment (CORDEX). See the *GHP Meeting Report* on page 15.

Participants at the 24th Session of the GEWEX Scientific Steering Group.

Local Land-Atmosphere Coupling (LoCo) Research: Status and Results

Joseph A. Santanello[1], Craig Ferguson[2], Michael Ek[3], Paul Dirmeyer[4], Obbe Tuinenburg[5], Cor Jacobs[5], Chiel van Heerwaarden[6], Kirsten Findell[7], Pierre Gentine[8], and Benjamin Lintner[9]

[1]NASA Goddard Space Flight Center, Maryland, USA; [2]University of Tokyo, Japan; [3]NOAA/National Centers for Environmental Prediction, Maryland, USA; [4]Center for Ocean-Land-Atmosphere Studies, Maryland, USA; [5]Wageningen University, Wageningen, The Netherlands; [6]Max-Planck Institute, Hamburg, Germany; [7]Geophysical Fluid Dynamics Laboratory, New Jersey, USA; [8]Columbia University, New York, USA; [9]Rutgers University, New Jersey, USA

The original structure of the GEWEX Global Land/Atmosphere System Study (GLASS) was designed to support four modes of land-surface modeling: (1) local-scale off-line; (2) large-scale off-line; (3) local-scale coupled; and (4) large-scale coupled (van den Hurk et al., 2011). To date, each of these has been addressed through organized, community-wide intercomparison studies, such as the Project for the Intercomparison of Land Surface Parameterization Schemes (PILPS), the Global Soil Wetness Project (GSWP), and the Global Land-Atmosphere Coupling Experiment (GLACE), with the exception of local land-atmosphere coupling (LoCo). The LoCo Project has instead evolved and, in recent years, gained momentum through process-level modeling and observational studies that focus on the development and application of coupling diagnostics.

The motivation for LoCo has been clear for some time, in that the results of PILPS and GSWP are limited by the lack of atmospheric feedback when running in uncoupled mode. Although the results of GLACE provide an assessment of current global circulation model (GCM) coupling coherence, they cannot isolate and evaluate the processes implied in the coupling that lead to model development. In terms of accurately representing the relationship between soil moisture (*SM*) and precipitation (*P*) and coupling strength in models (particularly in a changing climate), and to have the proper understanding and related improvement, it is necessary to carefully examine and quantify the full series of interactions and feedbacks (i.e., links in the chain) that include the planetary boundary layer (PBL) feedback. In simplified form, the coupling process chain may be presented as:

$$\Delta SM \rightarrow \Delta EF_{sm} \rightarrow \Delta PBL \rightarrow \Delta ENT \rightarrow \Delta EF_{atm} \blacktriangleright \Delta P/Clouds \quad (1)$$

(a) (b) (c) (d)

The equation above emphasizes that the impact of SM anomalies (ΔSM) on cloud development and subsequent precipitation (ΔP) depends on the sensitivities of: (a) the surface fluxes (EF_{sm}) to SM; (b) PBL evolution to surface fluxes; (c) entrainment fluxes at the PBL-top (*ENT*) to PBL evolution; and (d) the collective feedback of the atmosphere (through the PBL) on surface fluxes (EF_{atm}). As a result, there are numerous pathways composed of positive and negative feedback loops inherent in this chain. Equation 1 has omitted the role that additional inherent and external factors (e.g., canopy interception and large-scale convergence) can play in modulating the strength of each link, and therefore must be addressed in LoCo studies as well.

An accurate definition of the "local" versus "non-local" (or global/large-scale) coupling is also needed. The realm of LoCo has been defined by GLASS as "the temporal and spatial scale of all land-surface related processes that have a direct influence on the state of the PBL." The fundamental processes that fall into this realm include the direct moistening/drying and heating/cooling of the PBL and the feedback exerted by this PBL change on surface fluxes (through PBL growth and entrainment); the subsequent formation and disappearance of PBL clouds; the triggering and fuelling of convection; and the accumulation of hydrological anomalies in the soil reservoir and their subsequent impacts on the energy balance. Inherent in this definition is the importance of the diurnal interaction (e.g., convective PBL evolution) in contrast to the seasonal and long-term perspective of GLACE. An overview of recent results and near-term plans for LoCo research and synthesis follows.

Mixing Diagrams and LIS-WRF

The NASA Land Information System (LIS) has been coupled to the Weather Research and Forecasting (WRF) model to serve as a flexible high-resolution testbed with a range of land-surface model (LSM) and PBL scheme options. By evaluating different LSM-PBL couplings and their sensitivities, diagnostic approaches have been developed based on the mixing diagram theory of Betts (2004). As supported by the NASA Energy and Water Cycle Study (NEWS) and demonstrated by Santanello et al. (2009, 2011), the full nature of the coupled heat and moisture fluxes and states can be evaluated over a range of conditions, including extremes. The power in this approach is that it can be applied to any model or observation, and because advection is incorporated, it can be applied across a range of scales.

The figure on the cover shows an example of the different coupling signatures of a dry versus wet soil condition and the impact on the PBL response. From this analysis, the full PBL budgets of heat and moisture, relationship of EF to PBL height (PBLH), and the evolution of the lifting condensation level (LCL) deficit (PBLH minus LCL) can be derived and used to understand the nature of and sensitivity of a particular land-PBL coupling. Results from dry and wet extremes show that the choice of LSM is critical for dry regimes, and that both PBL and LSM are comparable influences on the coupled behavior during wet regimes. The next steps are to apply this methodology to larger (coarse)-scale models and reanalysis products, and to include satellite observations of land and PBL properties.

Land-Atmosphere Feedbacks and Sensitivities

Also focusing on the diurnal processes that govern LoCo, van Heerwaarden et al. (2009) have described the feedbacks that exist between the free atmosphere overlying the PBL and the surface fluxes using a coupled bulk model. Their results show that dry air that is being entrained into the PBL, particularly in the morning, results in a boost of surface evaporation over the remainder of the day. To be able to quantify this influence exactly, Van Heerwaarden et al. (2010) present in a follow-up paper a method to quantify the exact influences

of all forcings and feedbacks that work on the daily cycle of evaporation. One important conclusion that was drawn from this study by comparing measurements obtained at Cabauw, The Netherlands, and Niamey, Niger, is that especially in the mid-latitudes, at moderate temperatures and high evaporation rates, the coupled land-atmosphere system is sensitive to dry-air entrainment. What both studies have shown is the tight and consistent connection of all components of the land-atmosphere system that must be considered in evaluating LoCo.

Terrestrial vs. Atmospheric Coupling

In an effort to better quantify (a) of Equation 1, Ek and Jacobs have produced an analytical breakdown of the SM-Evaporation formulations for bare soil and vegetation, and identified the potential need for a future in-depth study and/or model intercomparison involving the SM connection to bare soil evaporation. The relationships can be reduced nicely and tested with field data for different surface cover characteristics, but more needs to be understood about the sensitivity to how parameters are specified in models.

This work complements the "two-legged" approach towards quantifying coupling. The first leg [terrestrial; (a) from Equation 1 has been couched in terms of an advanced sensitivity index rather than straight correlation of SM-EF (as in the past), in energy flux units from which global maps have been produced based on various model outputs (Dirmeyer, 2011a). This index can replace the surface flux terms in the mixing diagram approach of Santanello et al. (2009) to connect the terrestrial leg to the second leg [atmospheric; (b) from Equation 1], producing a metric that combines both links in the chain (see figure on this page; Dirmeyer et al., 2011b).

Global and Regional Reanalysis-Based Diagnostics

Continuing with large-scale analyses, Jacobs et al. (2011) have produced global maps of LoCo diagnostics for WATCH. This includes application of the convective triggering potential-humidity index (CTP-HIlow) approach of Findell et al. (2003a), the RH-tendency equation of Ek and Holtslag (2004), and the d(theta-e)/d(EF) measure of de Ridder (1997) to different reanalysis products (MERRA, ERA-Interim). These sensitivities can be combined with precipitation and LCL data to create feedback climatologies in terms of metrics like "the fraction of days on which soil-moisture minus precipitation feedback could have been present." The metrics are currently being tested and thresholds are fine-tuned using data from the Southern Great Plains (SGP) site. Tuinenburg et al. (2011) have evaluated the CTP-HIlow framework in a regional setting (India), using atmospheric soundings. This work found that the framework, which was developed for the U.S., was applicable to India with some slight modifications.

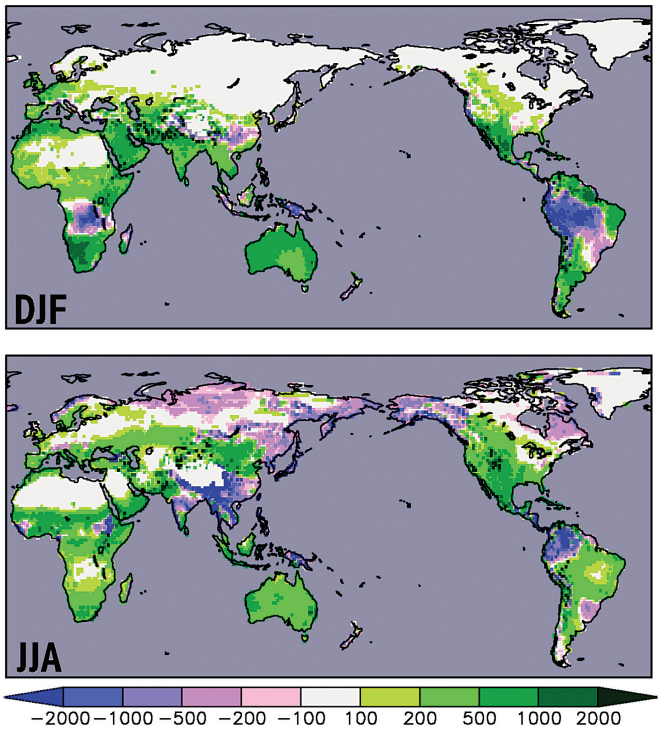
Preliminary results suggest there are inherent difficulties in scale and biases in applying these metrics to coarse-scale and/or satellite-based rainfall estimates, but a stronger signal and measure of coupling is seen when looking at sensitivities across moisture regimes and using in situ data.

Satellite vs. Model-Derived Coupling Assessment

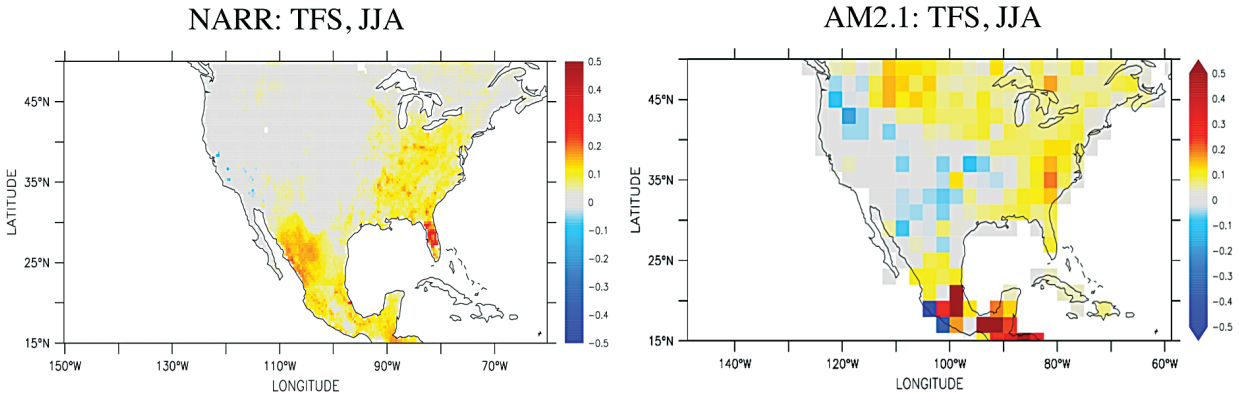
The ultimate utility of LoCo diagnostics and their applications lies in employing global observations, such as those from satellite remote sensing. To this end, Ferguson et al. (2011a,b) have produced a thorough evaluation of current satellite-derived land and PBL products and their application to the CTP-HIlow diagnostic of Findell and Eltahir (2003a), and the SM-LCL framework of Betts (2004). In comparing Atmospheric Infrared Sounder (AIRS) profiles with those of MERRA, a key finding was that the coupling is weaker in remote sensing than is seen in the reanalysis. The next step focused on the land segment (i.e., ΔSM-ΔEF_{sm}-ΔLCL) of coupling, as observed via remote sensing [Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E) SM, multi-sensor EF, and Atmospheric Infrared Sounder (AIRS) LCL], and as modeled off-line in Global Land Data Assimilation System (GLDAS), or coupled in each of the seven global and one regional (North America) long-term global reanalyses. Once again, results suggest that observed coupling is substantially weaker overall. Another important finding was that matching modeled and observed coupling does not concurrently ensure correct water and energy cycling. Future work will examine the climatology of coupling diagnostics in recent past and future products, as well as the SGP testbed.

Idealized Models and GCM-based Approaches for LoCo Diagnosis

Findell et al. (2011) have shown recent progress in developing SM-P coupling metrics and applying them to reanalysis and



"Two-legged" metric of model estimated land-atmosphere coupling combining the sign and strength of the linkage from soil moisture to surface evapotranspiration and the magnitude of the energy flux into the daytime PBL per unit mass of air in the PBL. Units are J/kg. Positive values indicate a combination of soil moisture control on surface fluxes and strong surface flux contribution to PBL properties, based on a 47-year simulation of the ECMWF GCM. Negative values are over areas where land feedbacks to the atmosphere are absent.



The Triggering Feedback Strength (TFS, Findell et al., 2011) for NARR data and GFDL's AM2.1.

climate model output with a larger intercomparison planned. Initial results have shown that surface flux partitioning [i.e., (b) in Equation 1] influences the triggering of afternoon rainfall (i.e., "TFS") but not rainfall amounts "AFS" in both the North American Regional Reanalysis (NARR) and GFDL's AM2.1 model. In addition, the figure above reveals that AM2.1 broadly captures the high sensitivity of afternoon convective probability to surface fluxes in Mexico and the eastern U.S. seen in NARR, but a dry bias in the western and central U.S. produces a negative TFS signal not seen in NARR. Next steps are to calculate these metrics for other GFDL models and model configurations, and to develop and apply idealized model frameworks to better understand how the interplay of local surface fluxes and large-scale moisture convergence and advection influences LoCo in both models and observations.

To this end, Lintner et al. (2011) have developed a process-based, semi-analytic model that breaks down components of SM-P sensitivity and demonstrates the role of moisture convergence in the sensitivity of precipitation to soil moisture in wet regimes. A probabilistic bulk coupled mixed-layer and convection model has also been developed by Gentine et al. (2011) that for the first time performs a smooth transition between dry and wet convection and couples the mass flux, the essential boundary condition of convection schemes, to the growth of the mixed layer without parameterization. This toy model will be ideal for synthetic studies of land-PBL interactions.

Future Work

The LoCo Working Group will continue to work on process-level diagnostics of coupling in its respective modeling activities. In the meantime, GLASS has proposed a focused observationally driven testbed for LoCo research that would center on the U.S. SGP and span approximately 10 years of recent satellite coverage. The first phase is the development of a consistent data set of all LoCo-related variables as defined by the current working group diagnostics. Using this testbed, current models and methods of various projects and groups can evaluate and synthesize LoCo results, diagnostics, and their consistencies.

A joint GLASS-GABLS experiment is being planned that will evaluate the full diurnal cycle behavior of coupled single-column models and leverages expertise of both GEWEX Panels on improving deficiencies in understanding and parameterization of stable and convective land-PBL coupling. Both a LoCo workshop and GLASS-GABLS sessions are planned for the Pan-GASS Meeting on 10–14 September 2012 in Colorado.

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Meeting/Workshop Reports

NASA Drought Workshop

10–11 April 2011
Silver Spring, Maryland, USA

Richard Lawford[1], David Toll[2], Bradley Doorn[3], and Ted Engman[2]

[1]International GEWEX Project Office, Silver Spring, Maryland, USA; [2]NASA Goddard Space Flight Center, Greenbelt, Maryland, USA; [3]NASA Headquarters, Washington, DC, USA

The Workshop brought together 74 experts in drought research to review the need for global-scale drought monitoring products and explore ways to make National Aeronautics and Space Administration (NASA) information products more effective in informing water security and management concerns. In addition, the potential role of NASA products in meeting the requirements for monitoring agricultural and hydrological droughts and ways to enhance the agency's contributions to drought monitoring for water management were discussed.

US Drought Monitoring Activities and Users

The NASA Water Resources Applications Program addresses drought through partnerships, leveraging, and outreach activities such as workshops. NASA remote sensing and modeling activities combine different data types for global drought monitoring, and NASA drought products are used by the US Drought Monitor (USDM) and the North American Drought Monitor. NASA has developed tools for assessing changes in soil moisture, terrestrial water stress, and vegetation. The NASA Water Science Program provides global observations of various components of the water cycle, such as the Soil Moisture Active-Passive Mission (SMAP), which will provide global mapping of soil moisture with high resolution to support drought monitoring. NASA drought-related data, including maps, tools, and services, are available via the Goddard Earth Sciences (GES) Data and Information Center (DISC).

The National Integrated Drought Information System (NIDIS) Drought Portal provides information for U.S. drought-related decisions and coordinates national drought monitoring and forecasting systems. The National Oceanic and Atmospheric Administration's (NOAA) "Coping with Drought" research program supports NIDIS by funding projects that demonstrate how scientific information can be used to reduce drought vulnerability. The NOAA Climate Prediction Center produces monthly and seasonal drought outlooks and contributes to the USDM.

The Bureau of Reclamation relies on drought monitoring to fine tune its allocation commitments for rivers. The U.S. Army Corps of Engineers Institute for Water Resources has developed analysis software to support drought monitoring. The Environmental Protection Agency (EPA) is a user of drought monitoring information, particularly when droughts are affecting water quality or ecosystem services. The U.S. Geological Survey produces maps and station-specific graphs for monitoring hydrologic drought.

The U.S. Department of Agriculture Foreign Agricultural Service maintains an operational and data archival system to monitor drought impacts on global crop production. The U.S. Agency for International Development Office of Food for Peace obtains its guidance from the Famine Early Warning Systems Network (FEWS NET).

Drought Monitoring at the International Level

The Group on Earth Observations (GEO) addresses drought through the Water and Agriculture Societal Benefit Areas (SBAs), and is beginning to coordinate operational agricultural monitoring systems. Interoperability is promoted through the Global Agricultural Drought Monitoring and Forecasting System. Two primary Water SBA activities involve assessing the impacts of drought and monitoring drought on a global basis.

The Regional Visualization and Monitoring System (SERVIR), a data analysis and visualization system, is providing regional drought information through its nodes in the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC, in Panama), the Regional Center for Mapping of Resources for Development (RCMRD, in Kenya), and the International Centre for Integrated Mountain Development in Nepal. SERVIR enables NASA to bring its global data into systems that meet local needs.

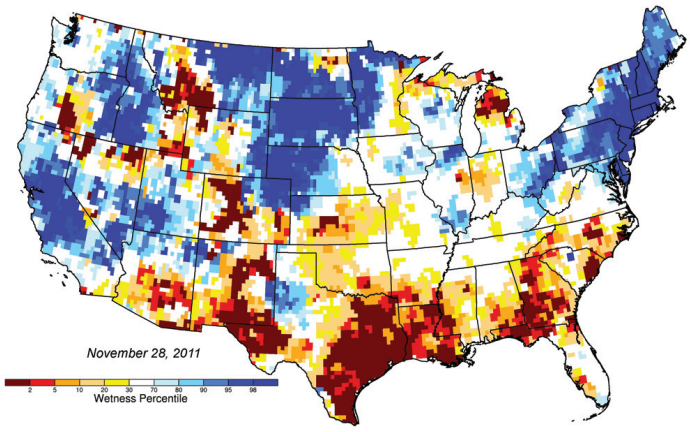
Research Developments

NASA satellite data enhance drought monitoring products by increasing their accuracy and enabling better decisions regarding drought plans. The Atmosphere-Land Exchange Inverse Model applies inverse modeling to thermal remote sensing data to derive evaporative demand (ET) and water stress for Europe, the Nile Basin, northeast Africa, and the US ET derived from National Land Data Assimilation System (NLDAS) outputs and the reference ET-Eo (the atmospheric demand for water from the surface) are being used to drive indices and models used in U.S. drought monitoring.

Soil Moisture severity-area-duration envelope curves are being used to provide drought climatologies to compare historical droughts. The role of drought monitoring information in decision-making has been assessed by applying country-scale decision rules to the intensity of these historical droughts.

The Vegetation Drought Response Index (VegDRI) integrates satellite-based observations of vegetation, climate-based drought indices, and the biophysical characteristics of vegetation to produce maps of drought-related vegetation stress. Assimilated Gravity Recovery And Climate Experiment (GRACE) data enable the assessment of drought impacts on subsurface water. GRACE drought products are being expanded to the global scale.

Simulations carried out with the Climate-Weather Research and Forecasting model indicate that NASA data products could improve precipitation forecasts and possibly lead to increased returns of 25%–40% for farmers who use irrigation. The 14-day forecast appears to bring maximum profitability for farmers who rely on irrigation. Precipitation Estimation from the Artificial Neural Network (PERSIANN) data are being used to cal-



Groundwater and soil moisture drought indicator maps like the one above are produced by NASA and are available on the National Drought Mitigation Center's website at: http://drought.unl.edu.

culate the standardized precipitation index and to assess its role in waste resource management by comparing it to fluctuations in the groundwater levels in the South Caspian Sea region.

Data assimilation models provide products for all drought-related components of the water cycle, including their climatologies over decades. Soil moisture estimates from remote sensing data generally compare well to the interannual variability of top layer soil moisture in land-surface models. However, remotely sensed ET shows large disparities except over humid regions. Achieving consistency across variables for drought monitoring remains a challenge.

NOAA North-American Land Data Assimilation System (NLDAS) water and energy budget variables are used in drought detection and drought climatologies. Assessments indicate that NLDAS soil moisture products are suitable for agricultural drought monitoring and prediction. A Phase 2 NASA NLDAS with Precipitation-development Regressions on Independent Slopes (PRISM)-adjusted daily gauge analyses redistributed by hour is under development. FEWS NET over Africa is being enhanced using the NASA product-based LDAS and Land Information System Architecture based on a Southern Malawi case study.

As part of the development of drought monitoring capabilities in the Middle East, NASA sensor and multiple sensor integration are being optimized in a supercomputing environment. Crop shortfalls can be estimated with high accuracy (within 1%) and long lead times with this approach. Other applications include the Middle East and North Africa (MENA) Water Information System Platform, which supports drought monitoring and an LDAS for MENA developed to enhance drought forecasting capacities and related regional applications.

Research needs were identified by a recent World Climate Research Programme drought workshop, which led to drought predictability studies to assess factors causing regions to be prone to drought, a survey of users to determine their information needs, and an inventory of drought events. A drought impacts database will be developed to help refine useful products, calibrate indices, and support effective drought responses.

Summary

Both global-scale and local-scale data are needed for drought monitoring and NASA data fill gaps resulting from inadequate in situ networks, while local-scale data are needed for drought impact assessment. In situ networks are also needed for calibrating satellite data. Internationally, satellite data help circumvent the lack of data sharing and proprietary issues and provide data consistency in time and space. However, these data sets are not always fully used due to insufficient interoperability and local limitations, such as a lack of adequate processing capabilities and sensor continuity, institutional barriers, and problems in time series continuity.

Scientific gaps in available products include the lack of reliable soil moisture measurements at the beginning of the growing season for crop yield estimates, the absence of a framework to integrate observations and models into a functional system for better drought process understanding, and better drought impact assessment. Measurements with sufficient time resolution are needed to resolve the diurnal cycle. Other data gaps include the lack of root zone soil moisture data and a fast response vegetation indicator (such as plant water content measurements) of drought, the limited precipitation data available at high latitudes, and the absence of high resolution snow water equivalent data. Land information systems with data assimilation capabilities and improved agricultural components are needed for improved drought monitoring. New sensors, missions, and systems are needed to address these gaps.

Progress would be accelerated if the Earth observation community adopted open data standards and an international governance system. In addition, more support is needed for capacity building and targeted training in the use of drought products and tools. Cross institution mixing should be encouraged, and more assistance provided in consolidating data and increasing access to procedures, standards, and decision variables.

An improved capability is needed to merge local data with remote sensing data to enable the integration of local-scale information from more sensors, as well as multiscale observations using high and low resolution data merge techniques. New products and tools are needed to integrate and communicate drought monitoring information with precipitation forecasts.

Recommendations

To enable NASA assets to be used more effectively in global drought monitoring, it was recommended that NASA should: (1) promote and encourage interaction with intermediary organizations whose activities bring together providers and users of drought information; (2) build on its successes in getting other groups to adopt its new technologies; (3) inventory organizations and activities that bring together users and providers of drought information; (4) continue its thematic workshops and organize customized training; and (5) engage potential cooperators and users via its systems, regional organizations, professional societies, and United Nations organizations and their programs, while working through appropriate U.S. organizations.

22nd Session of the GEWEX Radiation Panel

Tokyo, Japan
29 August – 1 September 2011

Christian Kummerow
Colorado State University, Fort Collins, Colorado, USA

The GEWEX Radiation Panel (GRP) Meeting was hosted by the Japanese Aerospace Exploration Agency (JAXA). Prof. Hirohiko Masunaga from Nagoya University was the local host and Prof. Christian Kummerow chaired the meeting.

The current focus of the Panel is on creating an integrated product in which the individual GRP products use a common set of ancillary data and procedures in order to ensure that geophysical signals are due to the data and products themselves rather than to inconsistencies in assumptions. Once complete, GRP will then undertake an assessment of the state of the water and energy budgets based upon these new integrated GEWEX products. Reviewing the readiness of GEWEX reference products for this reprocessing with common assumptions was a key objective of this Meeting. With the new focus of the Panel, the members agreed to change its name to the GEWEX Data and Assessments Panel (GDAP).

The first half day was set aside for the second joint meeting with the World Meteorological Organization initiative for the Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM), which is a network of operational space agencies interested in the long-term production of climate data sets, such as those produced by GRP. The joint meetings are intended to lead to implementation strategies that are consistent in creating long-term climate data records, while benefitting from the long-term continuity that only operational systems can provide. Discussions centered largely upon the idea that the operational agencies need to retain someone akin to a Principal Investigator (PI) or small science team intimately familiar with the product to provide guidance for continually improving the product. The operational agencies, meanwhile, would increase the level of automated stability and quality monitoring in order to alert PIs or science teams of any changes.

Teruyuki Nakajima, a member of the World Climate Research Programme's (WCRP) Joint Scientific Committee, provided opening remarks for the stand-alone portion of the GRP Meeting, including an overview of the new WCRP Working Group on Climate Services, which will identify climate information needs and help coordinate and prioritize related efforts across WCRP. This was followed by a presentation by Riko Oki, who gave an overview of upcoming JAXA missions and activities, including a new near real-time Global Rainfall Map and Spectral Latent Heating product (pixel level, grid and monthly data at 0.5-degree resolution).

A new GRP member, Tianjun Zhou from the State Key Laboratory of the Numerical Modeling for Atmospheric Science and Geophysical Fluid Dynamics Group of the Institute of Atmospheric Physics, Chinese Academy of Sciences, gave a presentation on numerical modeling of monsoon changes during past decades. He presented evidence to suggest that tropical ocean warming, in particular the Indo-Western Pacific warming during 1950–2000, is one mechanism for the weakening tendency of both the global land monsoon rainfall and East Asian Monsoon Circulation (see figure on page 13).

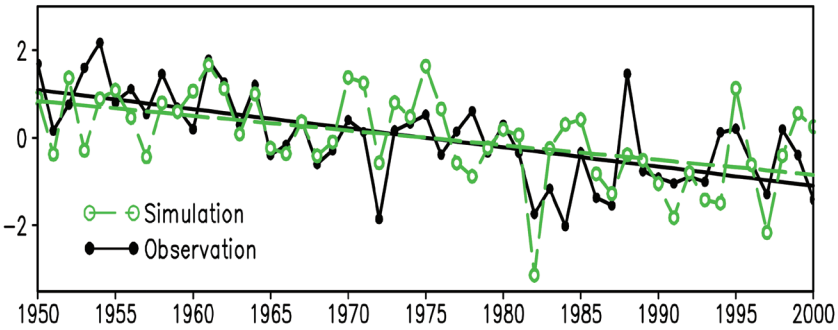
Bill Rossow reviewed the status of the common ancillary data sets being prepared by the Working Group for Data Management for use by each of the GRP products in the next reprocessing. The reprocessed data will serve as the basis for the integrated GEWEX product. The hierarchical map grids and topographic information have been completed. Utilities to convert back and forth from equal area map grids to equal-angle projections are available. The mask has the 1-degree International Geosphere-Biosphere Programme land cover product that includes the Global Land Ice Measurements from Space glaciers database. A combination of the TOMS Ozone Monitoring Instrument and the TIROS Operational Vertical Sounder products for ozone data will be used to produce composite daily 1°–2.5° time series. The Aerosol Comparisons (AEROCOM) product will be used to ensure a consistent aerosol data set over land and ocean. Surface snow will be obtained from the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center (CPC) weekly snow cover analysis at 2° resolution and sea ice from the Ocean and Sea Ice Satellite Application Facility on a daily basis at 0.25° resolution.

Robert Adler began the individual project status updates by reporting that the new Global Precipitation Climatology Project (GPCP) V2.2 product is now available. This version was necessitated by the failure of the last Special Sensor Microwave Imager (SSM/I) instrument, which required a change to the SSMI/Sounder on F17 as the calibrating satellite. About 9 months of overlap exists between SSM/I and SSMI/S, which will allow robust testing of the product across the interface.

GPCP V2 product processing will be transferred to the NOAA National Climatic Data Center (NCDC) for operational processing and the transfer will begin with a 3-year effort to clean up, streamline, test, and validate software from various organizations to work in as close to an automated fashion as possible. NCDC will develop software requirements, standards, and approaches.

Global Precipitation Climatology Centre (GPCC) gridded gauge analysis is merged with the satellite product to form the GPCP global product. Robert Adler presented an update on GPCC for Udo Schneider, which reviewed the standard products being readied, and then focused on the underestimation of precipitation over China, which is expected to be resolved by the recent addition of over 700 gauge stations.

Akiyo Yatagi gave an update on the Asian Precipitation-Highly Resolved Observational Data Integration Towards Evaluation (APHRODITE) rain gauge data set, which represents a significant effort to collect, quality control, and analyze gauge data that are not otherwise found in the Global Historical Climate



The black line with circles represents the global land monsoon precipitation changes derived from observational data. The green line with circles represents the results from the atmospheric general circulation model, CAM2, forced by historical SST. The observations show global land monsoon precipitation decreasing in the last half of the 20th Century. T. Zhou et al. (2008) found that when driven by historical SST, CAM2 can reasonably reproduce the observed global land monsoon precipitation changes. This demonstrates that the observed weakening tendency of the global land monsoon is forced by the tropical ocean warming.

Network (GHCN) and GPCC archives. A daily gridded precipitation product at 0.25° resolution for 1951–2007 (APHRO-V1003R1) has been released, in addition to a higher resolution version, APHRO-JP (0.1°), for 1900–2010 for Japan.

Bill Rossow reported that the D-Version of the International Satellite Cloud Climatology Project (ISCCP) data (gridded, 30-km data) is complete for July 1983–December 2009. The 10-km resolution data (B1) deliveries are up to date and the calibration is finished through December 2009. The cloud detection algorithm has been updated for improved polar cloud detection, and all revisions to the cloud retrieval algorithms are done and are being tested.

Ells Dutton reported that 53 Baseline Surface Radiation Network (BSRN) sites have contributed over 6080 station-months of solar and infrared data since 1992. The Canadian sites located at Alert, Bratt's Lake, and Eureka are in significant danger of losing funding due to cutbacks in the measurement program. BSRN accepted an invitation by the Network for the Detection of Atmospheric Composition Change to become a co-op network.

Paul Stackhouse reported that Release 3 of Surface Radiation Budget (SRB) data has improved documentation, and that a paper describing the details of this version will be published soon. Production of Release 4 will begin in April 2012. It is important to note that both short- and long-wave downwelling radiative fluxes are higher than previous estimates, leading to significant discrepancies with the current precipitation as estimated from GPCP.

While the GEWEX Aerosol Climatology Project built a long-term climate record of aerosol optical depth, it is limited to ocean regions. The Integrated GEWEX Product requires uniform aerosol assumptions across its product suite. In order to obtain coherent estimates of not only aerosol optical depth but also single scattering albedo and the asymmetry factor needed in the radiative transfer computations, the AEROCOM product is being adopted as the common aerosol input data.

Carol Anne Clayson reported that SeaFlux Version 1.0 (1997–2006) is now available in beta release. Of interest is that the locations of the largest surface heat flux tendency do not coincide with the largest uncertainties of the surface heat fluxes. During the next 6 months, the project will investigate the impact of common atmospheric temperature and humidity profiles and sea-surface temperature (SST). Production of SeaFlux V2.0 will begin in the summer of 2012 and include common ancillary data sets and assumptions.

Results from the LandFlux assessment given by Carlos Jimenez showed that all assessed products capture the seasonality of the heat fluxes, as well as expected spatial distributions (major climatic regimes and geographical features). The products correlate well with each other in general; however, there are large evaporative fraction differences, suggesting different partitioning of the radiative fluxes. Overall, the activity constitutes the first systematic characterization of the uncertainty in the existing global estimates of land-surface heat fluxes from a large range of products, including satellite-based (diagnostic) estimates, atmospheric reanalyses, off-line land surface models, and climate model simulations.

Matthew McCabe presented the status of the LandFlux multi-decadal global land-based surface flux data set. His talk covered the state-of-the-art global evapotranspiration (ET), the design of a LandFlux-Evaluation (LandFlux-EVAL) benchmarking database from existing global ET data sets, and the strategy and timeline towards development of GEWEX Version 0 global ET and sensible heat flux products. Three issues emerge when existing product differences are analyzed. The main discrepancy can be attributed to the "forcing" data sets. Nonetheless, based upon the earlier meeting of the LandFlux working group in April 2011, there was a level of consensus that a number of schemes should be implemented with common forcings. The final details are still under discussion, but it is essential that the selected forcing data set is consistent with the other GRP products in order to allow a joint science analysis of the GRP suite of products.

Ken Knapp led a discussion on the preparations for creating and hosting the Integrated GEWEX Product at NCDC. As per agreement, the product would contain data at 1° and 3-hourly intervals and consist of the longest possible common record. Most of the discussion focused on the specifics of the fields that would be archived with the product. Generally, the agreement was to not include all the diagnostic fields from each of the products, but include as many sorting parameters (e.g., terrain type, climate parameters) as possible.

Paul Stackhouse presented the status of the Radiative Flux Assessment. The activity is supported by nearly all the space and weather agencies around the world and its goal is to assess our understanding and capability to derive top-of-atmosphere (TOA) and surface radiative fluxes from analysis of satellite observations. Significant progress was made towards producing a community assessment of TOA and surface radiation flux estimates from satellite and model analysis.

The Clouds and the Earth's Radiant Energy System (CERES) instruments on Terra and Aqua are performing nominally (except for the shortwave channel on FM4, which failed in March 2005). A paper, "Heating of Earth's Climate System Continues Despite Lack of Surface Warming in Past Decade," led by Norman G. Loeb has been submitted to *Nature Geosciences*.

For the Cloud Assessment activity, Stefan Kinne reported that the absolute values of cloud amount, especially high cloud amount, depend mostly on the sensitivity of the instruments to thin cirrus; however, their geographical distributions and seasonality agree quite well. The major challenge of this assessment was to build a database in a common format, including various cloud properties from the 12 participating teams. The database and assessment report will be released soon.

In the Aerosol Assessment update it was noted that the aerosol field has recently grown exponentially with literally dozens of products and applications. Most products can be categorized as simultaneously having aspects of research, development, and production. This is reinforced with the funding situation where money for product development, maintenance, and verification is limited. Developers spend more time "using" than "supporting" their products. By the time the wider community figures out how a product is performing, a new version is released. There is confusion and some rancor in the community as to the actual efficacy and appropriate application of these data sets. The Assessment is therefore critical to bring some order to the field. Phase 1 will consist of a comprehensive literature review and evaluation. An important early conclusion is that the AERONET and Micropulse Lidar Network (MPLNET) are clearly the backbone networks for verification. Phase 2 will consist of detailed independent evaluation and will begin when the Moderate Resolution Imaging Spectroradiometer (MODIS) Collection 6 and Multi-angle Imaging SpectroRadiometer (MISR) Version 23 are officially released, and will examine specific issues in the generation of retrieval and gridded products.

In reference to the Water Vapor Assessment, Joerg Schulz reported on the GEWEX/ESA Data User Element GlobVapour Workshop, which was held in Frascati, Italy, in March 2011. The consensus at the Workshop was that total column water vapor, as well as water vapor profiles and their related temperature profiles, should be assessed. However, a decision was made not to include stand-alone temperature profiles or deep layer temperature data sets, such as those derived from the Microwave Sounding Unit and the Advanced Microwave Sounding Unit (AMSU). Likewise, the assessment will not address SST and land-surface temperature and 2-meter temperature or humidity unless these are integral parts of the vapor profile. Phase 1 of the assessment will begin with 3 years of recent data, when more satellite data sets and more validation data sets are available. Phase 2 will look at longer data sets with less validation data. It was agreed that a validation database would consist of ground-based remote sensing data, quality-controlled radiosondes, and BSRN and CERES radiation flux data.

In a discussion on polar priorities that would help the Panel improve the quality of its global products in the polar regions, where many of the GEWEX variables are notoriously difficult to retrieve, it was suggested that it would be useful to separate different surface types and examine status and future activities separately. The new ISCCP/SRB cloud properties should be revalidated over polar surfaces and the records examined for potential biases due to sea ice and snow cover retreat. Precipitation products over the polar regions are known to be problematic and it was recommended that the Russian North Pole stations and International Polar Year stations be added to the GPCC gauge record. To improve light rain and solid precipitation measurements, the current efforts by Bennartz and Haddad using CloudSat and AMSU data could be integrated. There are also alternate techniques that should be explored, such as accumulation-based precipitation techniques that rely on the Ice, Cloud, and land Elevation Satellite (IceSAT)/CryoSat.

Links with the WCRP Climate and Cryosphere (CliC) Project in the area of sea-ice temperature, which is important for radiative fluxes, will be investigated. There are a number of very positive developments with the sea-ice concentration data set needed for the integrated GEWEX product. A CliC workshop in March 2011 on ice concentration noted the developments of a sea ice climate data record that uses a NASA Team bootstrap algorithm. The Ocean and Sea Ice Satellite Application Facility has reprocessed data (SMMR, SSM/I period, 1978–2009) with a robot technology middleware-based atmospheric correction, dynamic tie points, and a comprehensive error assessment. This product looks very promising.

The Continual Intercomparison of Radiation Codes (CIRC) Project was intended to be the standard for documenting the performance of radiative transfer codes used in large-scale models. CIRC provides benchmark, line-by-line results against which radiative transfer codes of global climate models can be assessed. Despite useful results, the Project is now unfunded.

The meeting concluded with a presentation by B. J. Sohn on clear-sky dry biases and their implications in cloud forcing determination. He argued that the humidity in clear sky scenes is drier than in all sky conditions, but that this effect is not properly accounted for when cloud radiative forcings are computed. The next Panel meeting is planned for 1–3 October 2012 in Paris, France.

Reference

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GEWEX Hydroclimatology Panel Meeting

19–21 October 2011
Boulder, Colorado, USA

Sam Benedict
International GEWEX Project Office, Silver Spring, Maryland, USA

The Second Meeting of the GEWEX Hydroclimatology Panel (GHP) was held at the University Corporation for Atmospheric Research. Dr. Kevin Trenberth, Chair of the GEWEX Scientific Steering Group (SSG), hosted the Meeting, and along with the GHP co-chairs Jan Polcher (who joined remotely) and Dennis Lettenmaier, welcomed over 30 international participants. The Meeting focused on recent project results and plans for the next phase of GEWEX.

The leadership role of GHP in hydrologic sciences and modeling activities within the World Climate Research Programme (WCRP) was acknowledged, as well as the progress of the GEWEX Regional Hydroclimate Projects (RHPs) in seasonal forecasting, the detection and attribution of change, and the development and analysis of climate projections. A Council of Representatives composed of a member from each RHP is being formed to facilitate coordination and cooperation among the the regional projects, and a set of criteria is being developed for the scientific contributions of the RHPs to the overall goals of GEWEX (especially with respect to water cycle modeling and prediction).

Building on its strength in regional studies and encouragement by the SSG and WCRP, the Panel outlined steps to better address the use of regional climate models as a source of information about ongoing and future land-surface water cycle changes. These include fostering collaboration with other groups that have common interests in land-surface processes. In this context, Colin Jones presented an overview of the Coordinated Regional Climate Downscaling Experiment (CORDEX). With the approval of the GHP members, a plan was drafted for having a joint GHP/CORDEX workshop as a precursor to coordination between their activities, including the contribution of the RHPs to the validation of CORDEX model runs.

A brief summary of other items discussed at the GHP Meeting is presented below.

- A new joint GHP/GEWEX Data and Assessments Panel (GDAP, formerly the GEWEX Radiation Panel) activity is being planned to improve the use of GHP regional data sets as a validation tool for the global GDAP rainfall and water balance estimates.

- A joint Climate Variability and Predictability Project (CLIVAR)/GEWEX monsoon initiative is being planned in the Americas, where RHP data and regional studies resources can be applied.

- GHP will continue to provide the GEWEX contribution to the WCRP initiative on extremes using studies that are underway in the GHP Extremes Working Group. These studies relate to frequency of extreme high end precipitation events and their impacts on engineering design and other variables.

- Michael Ek (GHP) and Gab Abramowitz (GEWEX Global Land-Atmosphere Systems Study Panel, GLASS) are leading a joint GHP/GLASS benchmarking initiative to develop a matrix of flux data available from the RHP reference site database and other networks, such as the GEWEX Baseline Surface Radiation Network (BSRN). In this context, it was agreed that there is value in the GHP Model Output Location Time Series (MOLTS) product and it was recommended that the Global Modeling Centers continue to provide MOLTS for selected sites in the new GHP reference site database. It was also recommended that a central archive for MOLTS data be maintained.

- GHP and the Gravity Recovery and Climate Experiment (GRACE) are planning a workshop on 14–16 May 2012 (see page 5) that is focused on the hydrological applications of GRACE data.

- GHP encouraged the continued development of the Canadian Saskatchewan River Basin (SRB) Study as a possible RHP. The Panel also endorsed the concept for an American regional project, the plans for which are still being formulated.

- GHP agreed that the research of the High Elevations Initiative is relevant to GHP objectives and should be continued based upon the development of a new science plan that defines relevant links to the RHPs. A workshop is planned to define the scope of this work and promote interest in its development from a broader community, as well as to determine its proper stewardship within WCRP and GEWEX.

- GHP agreed that the Cold Regions and Semi-arid Regional Climate Foci studies should be brought to closure as elements of GHP. Letters will be sent to the leaders of these activities advising them that the new structure of GHP does not accommodate further endorsement of their efforts as cross-cutting science foci in the Panel. Assistance will be offered with the migration of this work to another group or project in WCRP or GEWEX as may be appropriate.

- The Water and Energy Budget Studies Project has ended. However, a GHP member is developing a proposal for a cross-cutting initiative in the area of water and energy balance assessment over land to fill the need for studies of this type.

GHP, with the implementation of the regional projects and related science foci, is poised to contribute in a number of ways to major issues associated with the improved understanding of the role of water and energy in the climate system. The Panel is moving ahead with actions necessary to make progress on these matters and will meet again in 2012 to assess the status of its progress.

Global Land/Atmosphere System Study (GLASS) Panel Meeting

23 October 2011
Denver, Colorado, USA

Joe Santanello[1] and Martin Best[2]

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[2]Met Office, Exeter, United Kingdom

The Global Land/Atmosphere System Study (GLASS) Panel, co-chaired by Martin Best and Joseph Santanello, has completed its first year as a stand-alone Panel under GEWEX modeling activities. The first item of business at the Meeting was a discussion on the Terms of Reference for Panel membership. The Panel agreed upon 4-year term limits for Panel chairs, and to have a "young scientist" category of Panel membership. Other topics at the Meeting included updates on current and future activities with a special emphasis on refining plans for three new projects to be launched by spring 2012: (1) the African Monsoon Multidisciplinary Analysis (AMMA) Land-surface Model Intercomparison Project Phase-2 (ALMIP-2); (2) the Global Soil Wetness Project Phase-3 (GSWP-3); and (3) the Project for the Intercomparison of Land Data Assimilation Systems (PILDAS).

Global Land Atmosphere Coupling Experiment (GLACE)

Results from GLACE-2 show that skill in temperature and precipitation increases mainly in areas where the precipitation forcing quality is high (high station density gives better initial soil moisture data), when soil moisture is relatively extreme, and where potential predictability is high (see figure on page 17). Three publications have resulted from this work that review and discuss the diagnostics of predictability, including a new measure related to general circulation characteristics (e.g., blocking over Russia leading to heat waves) and a study of Integrated Forecast System results of 2000–2010 potential predictability.

GLACE-Future, which is in the planning stages, will involve the Coupled Model Intercomparison Project-5 (CMIP5) and Representative Concentration Pathway 8.5 models and will aim to quantify the role of soil moisture-climate feedbacks for climate change projections. The matrix of runs will include 1950-2100 simulations with fixed soil moisture (1970–2000) versus soil moisture from a transient running mean on climatology. Thus far, ECHAM6 [Max-Planck Institute/Swiss Federal Institute of Technology (ETH)], EC-EARTH (Royal Netherlands Meteorological Institute, KNMI), and the Community Earth System Model (CESM)/Community Climate System Model 5 (CCSM5) (National Center for Atmospheric Research) have confirmed participation.

Local Land-Atmosphere Coupling (LoCo)

The GLASS LoCo activity has evolved into a working group comprised of both Panel and non-Panel member research. A thorough review of current and future LoCo research can be found in a companion article on page 7. A LoCo poster cluster was convened by Joseph Santanello during the WCRP Open Science Conference as part of the session on "Improving the Representation of Energy and Water Cycles in Atmospheric Models" (co-conveners: Annette Rinke, Bart van den Hurk, Carlos Jimenez). This cluster included eight posters on various aspects of LoCo research from both the working group and also the greater community, and was successful in entraining new efforts and focus for the U.S. Southern Great Plains (SGP) synthesis study.

LoCo Southern Great Plains (SGP) Testbed

The concept for a focused, observationally-driven testbed for LoCo research centered upon the U.S. SGP was discussed. The first phase would consist of the development of a 10-year data set of all LoCo-related variables that would be used to evaluate disparate models and methods. The Panel agreed that a large LoCo intercomparison project, such as the Project for the Intercomparison of Land-Surface Parameterization Schemes (PILPS), GSWP, or GLACE should not be carried out at this time, and that expansion and momentum should continue using the SGP testbed as a focal point for process studies.

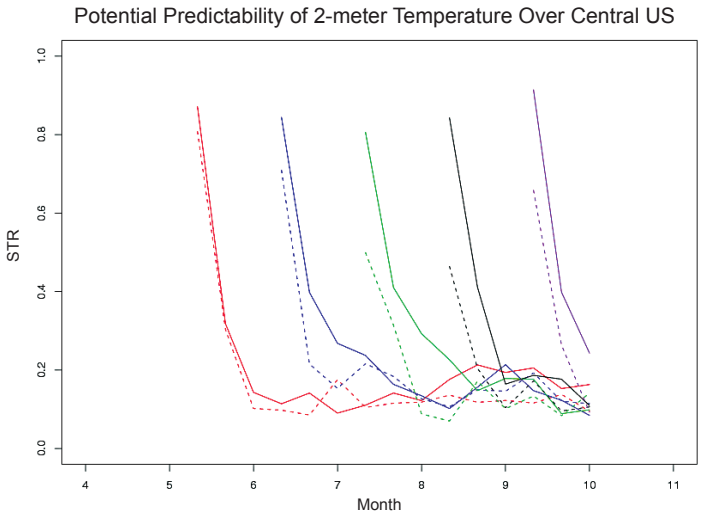
PILPS-Urban Studies

Core results from the recently completed PILPS-Urban studies indicate that: (1) it is important to get the vegetation treatment correct in urban areas; (2) initial soil moisture is important; and (3) simple models are almost as good as complex, heavily parameterized models. Further analysis is ongoing and more papers are expected over the next few years.

Protocol for the Analysis of Land-Surface Models (PALS)

The PALS website at: *http://pals.unsw.edu.au* is designed to analyze in a standard way uploaded single site land-surface model simulations with observations, focused mostly on FLUXNET sites. Currently, PALS is operating as a validation tool, but the ultimate goal of this system is to serve as a true benchmarker of modeling systems. This requires further progress by the benchmarking working group and the community to explicitly define the minimum performance required by a model to achieve predictive goals. For example, empirical models (e.g., evaporation as a function of radiation), climatology and persistence, and simple models (Penman-Monteith) are to be included in PALS.

In a discussion on the limited availability to date of Coordinated Energy and Water Cycle Observations Project (CEOP)-produced data for a demonstration of PALS, it was concluded that the GEWEX Hydroclimatology Panel (GHP) would provide 10–20 high-quality FLUXNET data sets for this purpose. Synchronization with the National Aeronautics and Space Administration development of a Land-surface Verification Toolkit (LVT) is also planned, which will maximize design and development of LVT and PALS. The Benchmarking Working Group in GLASS will drive these efforts forward. During the American Meteorological Society Annual Meeting in New Orleans in January 2012, this group will convene a session on land model benchmarking.



The figure above was derived from GLACE-2-type simulations with the ECMWF forecast model for 2000–2010. Potential predictability is defined here as the ratio between the signal variance (temporal variability of temperature) over the total variance (temporal plus random variability, derived from the spread in an ensemble). Forecasts are shown that have been initialized with "observed" soil moisture (solid lines) and "randomized" soil moisture (dotted line). Higher potential predictability is evident from the "observed" soil moisture and is particularly evident in the forecast range between 10 and 30 days after initialization in summer. All forecasts start on the first day of months May–September and last until 1 October.

ALMIP-2

An international call for participation in ALMIP Phase-2 was announced in mid-November. With an expected start in spring 2012, ALMIP-2 will be coordinated with GHP and the GLASS Benchmarking Working Group. Experiments are being planned with 10 times higher spatial resolution (5 km) than ALMIP-1 and will focus on distributed models and data sets, including subtle hydrology and vegetation processes (e.g., very large rooting depths, land use change, sloping bedrocks removing water from the catchment, strong variability in runoff). The study will cover a 4-year period and will use a blend of in situ, radar, Landsat, and other satellite data, including evapotranspiration (ET) measurements from the U.S. Department of Agriculture Atmosphere-Land Exchange Inverse (ALEXI) model.

GSWP-3

The experimental plan for GSWP Phase 3 was presented by Hyungjun Kim. The white paper was distributed to GLASS members at the WCRP Drought Conference in Barcelona in March 2011. A great deal of work has been completed in preparing the forcing data set based on the 20th Century Reanalysis product, in particular, performing bias correction on a number of critical variables, namely Global Precipitation Climatology Centre (GPCC) precipitation and Surface Radiation Budget (SRB) data. There are three phases, the first being the retrospective run (1901–2008) that will serve as a land reanalysis product. This long historical period was designed to entrain the carbon modeling community and explore possible carbon-related effects or changes in ecosystem function related to those trends and uncertainties in forcings (e.g., precipitation) with multiple data sets. While still focusing on traditional hydrology such as water and energy fluxes, this will enable collaboration with communities, such as the International Land Model Benchmarking (ILAMB) Project in the design and evaluation of GSWP-3.

Originally, the plan for the second phase was to look at future (CMIP5) climate scenarios, but it was recommended that this be moved back as there should be core versus optional experiments in attracting community participation. Along with phase one, the second phase will be a core experiment and instead will look at uncertainties in forcing data (e.g., MERRA, ERA-Interim) from the recent past, 1980 to the present. When learning of the multi-scale synthesis and intercomparison project (MsTMIP) experiments being carried out by the carbon community, it was suggested that the GSWP-3 plan be distributed to that group to determine any overlaps and/or lessons learned that could be incorporated here. The same applies for the Land-Use and Climate, Identification of robust impacts phase two (LUCID-2) Project. A kick-off workshop for GSWP-3 is tentatively planned in Tokyo in spring 2012.

PILDAS

The overarching goal of PILDAS is to organize a community effort through GLASS that provides a framework for comparing and assessing land-surface data assimilation systems, particularly those used in operational centers. PILDAS-1 will focus on the assimilation of synthetic observations of surface soil moisture in preparation for satellite missions. The initial design is for a multi-year period with a limited domain in the U.S. (e.g., the Red Arkansas River Basin). A number of operational centers are committed to PILDAS-1, which is expected to begin in early 2012.

LBA-Data Model Intercomparison Project (LBA-DMIP)

The objective of LBA-DMIP is to bring together international biosphere-atmosphere modeling groups to understand how different models simulate the ecosystems and biogeophysical processes in the Amazon of South America. It has produced a rather extensive analysis of a range of models at eight sites, and made a number of specific recommendations to improve treatment of carbon uptake and canopy interception. This is an ongoing project that has some traditional land-surface and hydrological model involvement, and so it was concluded that GLASS should monitor these results and, particularly in the context of GSWP-3 and ALMIP-2, consider making connections for future projects.

Land-Use and Climate, Identification of Robust Impacts (LUCID)

The objective of LUCID is to quantify the impacts of land-use-induced land-cover changes on the evolution of climate between the pre-industrial epoch and the present day. LUCID-1 is now complete, with six papers published and seven more in preparation. Planning for LUCID-2 is underway, and it was agreed that GLASS should support this work and keep an active member from LUCID involved in GLASS.

GLASS members are also involved with a new International Geosphere-Biosphere Programme initiative to study land-use/land-cover change (LULCC). The goals of LULCC are to provide historical maps of land use and land cover change to enable simulations and impact studies from a climate perspective. Coordination with the GSWP-3 experimental design for the long-term runs (Phase-1) is planned.

Cross-Cutting Activities and Next Meeting

A number of current and developing GLASS links were identified with projects in other GEWEX Panels. In particular, the implementation of CEOP reference site data (i.e., ten to twenty LandFlux sites with additional quality control) in the PALS system. ALMIP-2 will be circulating its proposal through GHP to coordinate activities related both to the AMMA Regional Hydroclimate Project (RHP) and to GLASS modeling. Similarly, new links between the Hydrological Cycle in the Mediterranean Experiment (HyMeX) and GLASS have been identified and a starting point for collaboration will be GLASS representation at the HyMeX conference in May 2012, and inviting a HyMeX scientist onto the GLASS Panel following that. The foci of HyMeX in terms of snow, terrain, groundwater, and runoff are all identified as current gaps in GLASS.

The idea of a joint GLASS-GEWEX Atmospheric Boundary Layer Study (GABLS) project on land-planetary boundary layer (PBL) coupling was discussed. It was thought that the extension of the stable boundary layers to a full diurnal cycle analysis (in the form of a column model testbed) would interest both groups, as well as revisiting the GABLS-1 intercomparison during the Cooperative Atmosphere-Surface Exchange Study–1999 (CASE99) study in the SGP.

GLASS was represented by Joseph Santanello at the 27th Working Group for Numerical Experimentation (WGNE) meeting held in October 2011 in Boulder, Colorado. Potential cross-cutting activities were presented and discussed, mostly furthering the participation of operational centers and models in PILDAS, and investigating the potential for PALS to be used as a coupled model benchmark for operational centers. The PALS demonstration study will rely heavily on National Centers for Environmental Prediction involvement and will therefore serve as a pilot study, the results of which will be relayed to WGNE members. One hurdle will be acquiring observations in near real time for PALS, which could require saving operational model output streams. WGNE is also very supportive of a joint GLASS-GASS project, similar to the GABLS proposal discussed above, with the long-term objective of improving the diurnal cycle of convection representation in coupled models. This has long remained a challenge for the community.

The next GLASS Panel meeting will be held in conjunction with the 1st Pan-GASS Meeting on 10–14 September 2012 in Boulder, Colorado (see announcement on page 20). This will allow for a dedicated session on the GLASS-GABLS experiments and a session or workshop on LoCo and the SGP testbed.

ECMWF/GABLS Workshop on Diurnal Cycles and the Stable Atmospheric Boundary Layer

7–10 November 2011
Reading, United Kingdom

Anton Beljaars[1], Bert Holtslag[2], and Gunilla Svensson[3]

[1]ECMWF, Reading, UK; [2]Wageningen University, Wageningen, The Netherlands; [3]Stockholm University, Stockholm, Sweden

Sixty participants from Europe, Japan, North and South America, and Australia attended the Workshop, which was co-sponsored by the European Centre for Medium-Range Weather Forecasting (ECMWF) and the GEWEX Atmospheric Boundary Layer Study (GABLS). The purpose of the Workshop was to review the ongoing research related to the diurnal cycles and stable atmospheric boundary layer, and to make recommendations for future work, particularly on the options for improved parameterization in large-scale models.

The Workshop was divided into two-and-a-half days of oral and poster presentations covering the topics mentioned above, and one day of working group discussions followed by a plenary discussion session. Many of the participants are actively involved in GABLS (*http://www.gewex.org/gass_panel.html*), which is an international platform for boundary layer research applied to regional and large-scale models. The GABLS Project began 10 years ago with an initial study that defined a series of cases for model intercomparison and model evaluation of the stable boundary layer (SBL). Large Eddy Simulation (LES) models and observations were used extensively as references. The Study showed that the spread between models is large and that many models have highly diffusive boundary layers schemes, mainly to avoid "decoupling" of the atmosphere from the surface in low wind conditions and to maintain sufficient drag at the surface. It was also confirmed that the more research-oriented schemes (which tend to be less diffusive) have a better boundary layer structure in terms of profiles of temperature, wind speed, and direction. The GABLS-3 LES intercomparison case is based on a moderately stratified, baroclinic, mid-latitude boundary layer observed over Cabauw in The Netherlands. Encouraging news is that intermodel dispersion between LES models is fairly low within the most recent GABLS-3 intercomparison and that it shows very realistic boundary layer structures.

One of the strategic goals of ECMWF is to improve the quality of near-surface weather products, such as temperature, wind, and atmospheric composition. It is well known that the diurnal cycles of temperature and wind are strongly influenced by small-scale atmospheric processes in the SBL, and in particular by turbulent diffusion, gravity waves, and radiation, but also by the thermal coupling with the underlying soil through vegetation and snow. Most large-scale atmospheric models use rather diffusive boundary layer schemes that result in SBLs that are too thick and show too little wind turning. Climate projections also show strong temperature signals at high latitudes that are affected by these processes.

The Workshop presentations focused on all the physical aspects relevant for a realistic simulation of the SBL. The scientific issues were further discussed in the working groups covering: (1) processes; (2) tools (e.g., LES) and observations; (3) parameterization schemes; and (4) land-surface interactions. The working groups were asked to make recommendations for large-scale modelers and for further research in GABLS.

Participants at the ECMWF/GABLS Workshop.

Conclusions from the Workshop:

- Uncertainty in the formulation of diffusion in stable situations remains high, and no clear way forward was identified. However it is obvious that the effects of mesoscale variability and terrain heterogeneity are important and need further study.
- Because it is now well accepted that the SBL is highly interactive with the underlying surface, it was recommended to base further study on the coupled system. For LES models it was recommended to have at least a simple representation of the surface energy balance in future simulations.
- The uncertainty in the momentum budget is large in models. Sensitivity experiments show a direct impact of drag over land on the planetary scales. To diagnose this aspect further, a model intercomparison study was proposed.
- Many models have biases in long wave downward radiation even in clear sky situations. Verification studies using Baseline Surface Radiation Network data were recommended.
- More diagnostic studies of large-scale models are needed to assess the behavior of the boundary layer and its interaction with the surface. It was recommended to use super-sites [e.g., the Coordinated Energy and Water Cycle Observations Project (CEOP) and the Flux Tower Network (FluxNet)] with a comprehensive set of observations, such as those in the context of the planned Coordinated Regional climate Downscaling Experiment (CORDEX)-Europe Initiative or a possible Arctic activity.
- Large-scale modelers are encouraged to use turbulent energy equations to support the turbulence closure.
- Recommendations for the land-surface include: (1) the use of a shallow top soil to represent fast time scales; (2) the introduction of multi-layer snow schemes to replace slab models; (3) full exploitation of as many observational sites as possible to derive relevant model parameters; and (4) the use of data assimilation techniques to "inverse model" land-surface parameters.

To view the presentations, poster abstracts, and working group reports, see: *http://www.ecmwf.int/newsevents/meetings/workshops/2011/GABLS/index.html.*

GEWEX/WCRP Calendar

For the complete Calendar, see the GEWEX website: http://www.gewex.org/

22–26 January 2012—92nd AMS Meeting—New Orleans, Louisiana, USA.

20–24 February 2012—Chapman Conference on Remote Sensing of the Water Cycle—Kona, Hawaii, USA.

12–15 March 2012—CLiC SSG Meeting—Innsbruck, Austria.

20–23 March 2012—Workshop on the Physics of Climate Models—Caltech, Pasadena, California, USA.

26–29 March 2012—ICSU/IGBP/IHDP/WCRP Conference: Planet Under Pressure: New Knowledge, New Solutions—London, UK.

2–4 April 2012—WCRP Polar Climate Initiative Workshop—Toronto, Canada.

11–13 April 2012—Global Drought Information System Workshop—Frascati, Italy.

22–27 April 2012—EGU General Assembly 2012—Vienna, Austria.

7–11 May 2012—4th WCRP International Conference on Reanalyses—Silver Spring, Maryland, USA.

7–11 May 2012—6th HyMeX Workshop—Primosten, Croatia

14–16 May 2012—GEWEX/GRACE Workshop on application of GRACE data to climate modeling and analysis—WHOI, Woods Hole, Massachusetts.

14–17 May 2012—GDAP Water Vapor Assessment Workshop—Frankfurt, Germany.

28 May – 2 June 2012—5th International Conference BALWOIS 2012 on Water, Climate and Environment—Ohrid, Republic of Macedonia.

2–6 July 2012—4th AMMA International Conference—Toulouse, France.

16–20 July 2012—33rd Session of the WCRP Joint Scientific Committee—Beijing, China.

1–3 August 2012—12th Meeting of the GEWEX Baseline Surface Radiation Network (BSRN) Project—Potsdam, Germany.

10–14 September 2012—1st GEWEX Pan-Global Atmospheric System Studies (GASS) Meeting—Boulder, Colorado.

10–14 September 2012—GEWEX/GLASS LoCo Workshop and Panel Meeting—Boulder, Colorado.

Global Drought Information System Workshop

ESA/ESRIN, Frascati, Italy
11–13 April 2012

http://www.clivar.org/organization/extremes/activities/GDIS-workshop

Among the key recommendations of a recent World Climate Research Programme Workshop on Drought Predictability and Prediction in a Changing Climate, is the development of an experimental **Global Drought Information System (GDIS)**. The timeliness of such an effort is evidenced by the wide array of relevant ongoing national and international (as well as regional and continental scale) efforts to provide drought information, including the US and North American drought monitors, and various integrating activities such as GEO and the Global Drought Portal.

This Workshop will focus on the steps necessary to develop an experimental GDIS that builds upon the extensive world-wide investments already been made in developing drought monitoring, drought risk management, and short term climate prediction capabilities. The success of a GDIS will be measured by its ability to provide timely drought-related information and predictions that can inform decision-making.

1st Pan-Global Atmospheric System Studies Meeting

NCAR, Boulder, Colorado, USA
10–14 September 2012

The **Global Atmospheric System Studies (GASS)** is the new GEWEX Panel supporting the community that carries out and uses observations, process studies, and model experiments with a focused goal of developing and improving the representation of the atmosphere in weather and climate models.

Topics to be covered in the **1st Pan-GASS Meeting** will include the modeling of deep convective, boundary layer, and polar clouds; the representation of cloud microphysical processes; the use of large eddy simulation models to study boundary layer cloud feedbacks; the interactions of aerosols with clouds; and the representation of the stable boundary layer and the near surface diurnal cycle over land.

If you are interested in attending the meeting, contact the GASS co-chairs, Jon Petch (*jon.petch@metoffice.gov.uk*) and Steve Klein (*klein21@llnl.gov*).

To subscribe to the GASS mailing list, go to: *http://lists.gewex.org/mailman/listinfo/gass*.

CALL FOR ABSTRACTS
Deadline Extended

WCRP
World Climate Research Programme

4th WCRP International Conference on Reanalyses

Silver Spring, Maryland USA
7-11 May 2012

Characterizing the uncertainty and quality of reanalyses is a task that reaches far beyond the community that develops them and into the network of interdisciplinary researchers, especially those who use the reanalyses products in their research and applications. The **4th World Climate Research Programme (WCRP) International Conference on Reanalyses (ICR4)** provides an exciting opportunity to review and discuss the major observations and modeling research associated with reanalyses, including uncertainties and the complexity of the Earth system.

Papers are invited for all topics of the Conference: (1) Status and Plans; (2) Validation and Metrics; (3) Data Assimilation; (4) Space and In Situ Observations; (5) Application in Support of Climate, Weather and Environmental Services; and (6) International Collaborative Efforts.

For Conference information and to submit an abstract, see: ***http://icr4.org***.

ABSTRACTS DUE: 13 February 2012