COMMENTARY

NEW MEMBERS TO GEWEX SSG ENHANCE INTERDISCIPLINARY AND INTERNATIONAL GUIDANCE

Soroosh Sorooshian, Chairman
GEWEX Scientific Steering Group

The GEWEX Scientific Steering Group (SSG) has added more new members than usual this cycle. The diversity of this SSG provides an opportunity to enhance our interdisciplinary and international participation and guidance of our ongoing projects, as well as helping to expand the guidance needed for several of our new developing projects. As usual we strive for a balance of expertise within the hydrology, atmospheric physics and radiation, modelling and assimilation, and observational communities while covering the breadth of international aspects. The broad responsibilities we place on the SSG are indicated in The Terms of Reference:

- To formulate the programme for GEWEX, consisting of both observation and theory, for understanding and eventually modelling the global energy and water cycle;
- To provide scientific guidance for the conduct of GEWEX using advice from individual experts or expert groups, as necessary;
- To formulate the concept of an observing system which would fulfill the data requirements for GEWEX taking into consideration possible national contributions to the programme;
- To use existing or, where necessary, propose new mechanisms for assuring the exchange and analysis of GEWEX data and the dissemination of scientific results; and
- To establish scientific liaison with relevant organizations and existing programmes, as appropriate.

I think you will find that our latest membership covers the broad spectrum necessary to provide this guidance for GEWEX. Not explicitly included within these, but implied within the last bullet, is the responsibility to assist in the spread of information about the objectives and plans for our projects among the diverse spectrum of national and international organizations our SSG members are involved with. This will also provide a mechanism for the feedback we need to improve our implementation process.

Please note closely on the following pages the names, affiliations and interests of our SSG members and feel free to communicate directly with them, as well as directly with myself or the IGPO, on ideas, concepts, criticisms, or suggestions for improving any of the many aspects of our overall GEWEX Project.

GLDAS: AN IMPORTANT CONTRIBUTION TO CEOP

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Scientists at NASA's Goddard Space Flight Center (GSFC) have developed a high-resolution Global Land Data Assimilation System (GLDAS) in cooperation with researchers at NOAA's National Centers for Environmental Prediction (NCEP). The goal of GLDAS is to produce optimal output fields of land surface states and fluxes by making use of data from advanced observing systems (See figure on back page). Errors in land surface forcing and parameterization tend to accumulate in modeled land stores of water and energy, leading to incorrect surface water and energy partitioning. GLDAS aims to minimize this effect by constraining the models in two ways. First, by forcing the land surface, primarily by observations (such as precipitation and radiation), the biases in atmospheric model-derived forcing are avoided. Second, by employing land surface data assimilation techniques, observations of land surface storages (soil temperature, soil moisture, and snow depth/cover) can be used to steer unrealistic simulated storages towards reality. These techniques also enable identification and mitigation of observational errors and minimization of the impact of simplified land parameterizations. **The value-added data produced by GLDAS will improve land surface, weather, and climate predictions by providing global fields of land surface energy and moisture stores for initialization.**

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Drivers have been installed in GLDAS for three land surface models (LSMs): Mosaic; the Community Land Model (CLM); and the NCEP, Oregon State University, United States Air Force, and Office of Hydrology model (NOAH). GLDAS runs globally with a 15-minute time step at 0.25° (soon to be 0.125°) and coarser resolutions. A vegetation-based "tiling" approach is used to simulate sub-grid scale variability, with the University of Maryland's 1 km global vegetation data set as its basis. Soil parameters are derived from 5-minute global soils information produced by USDA Agricultural Research Service. GLDAS uses the GTOPO30 global digital elevation model as its standard and corrects input fields accordingly. In addition to an operational, near-real time simulation using the standard parameterization and forcing data, several parallel simulations run with varying combinations of models, forcing data, and advanced options. Forcing options include the global atmospheric forecast model output (from GSFC's Data Assimilation Office, NCEP, and the European Centre for Medium-Range Weather Forecasts) and observation-based precipitation and radiation fields. Advanced options, which are in various stages of planning, implementation, and testing, include a routine for satellite-based updates of leaf area index, canopy greenness and albedo, soil moisture and temperature data assimilation, observation-based snow corrections, simulation of the atmospheric boundary layer, and runoff routing.

The Coordinated Enhanced Observation Period (CEOP) was initiated by the international efforts of GEWEX and is focused on the measurement, understanding and modeling of water and energy cycles within the climate system. It is motivated by the synchronism of the new generation of Earth observing satellites and GEWEX Continental Scale Experiments (CSEs). Its primary goal is to develop a consistent data set for 2003-2004 to support research objectives in climate prediction and monsoon system studies. The requirements of the international climate research community at large have been taken fully into account in planning the assembly of the data set. CEOP also will assist studies of global atmospheric circulation and water resources availability. CEOP has gained the interest of a broad range of international organizations, as evidenced by the proposal for an Integrated Global Water Cycle Observations (IGWCO) theme within the framework of the International Global Observing Strategy Partnership (IGOS-P), which has re-affirmed CEOP as "the first element of the IGWCO." The CEOP implementation plan can be viewed at: http://www.gewex.org/ceop/ceop_ip.pdf.

CEOP aims to integrate the many streams of data coming from new space-based observation systems into a coherent database relevant to CEOP science issues, which will facilitate analytical investigations.

GLDAS is a valuable tool for CEOP because it assimilates the information from multiple models and observation platforms to provide the best available assessment of the current state of the land surface. The international GEWEX and CEOP communities have recognized that GLDAS can be leveraged and further developed to address the needs of CEOP. CEOP is specifically interested in the generation and application of GLDAS results in regional climate analysis, model initialization, and comparison with results from field campaigns and modeling experiments. The use of GLDAS model location time series (MOLTS), which are time series of land surface model output for points of interest, will be one of the primary tools to enable this globally-consistent intercomparison. Each GLDAS MOLTS will be particularly relevant because it will be generated based on a GLDAS subgrid "tile" with a vegetation class that matches that of the observation. Furthermore, GLDAS MOLTS can be produced using each of the land surface models that GLDAS drives (currently three; five planned). These comparison exercises and the data produced by the continental scale experiments also will provide much-needed validation for the GLDAS project.

CEOP has requested that NASA further develop GLDAS as a central "CEOP data integration center", including the following aspects:

- A test bed for evaluating multiple land surface models.
- Long term land model baseline experiments and intercomparisons.
- Linking and inclusion of reference site observations with globally consistent observation and modeling to enable GEWEX-CSE land transferability studies.
- Land initialization for seasonal-to-interannual coupled predictions.
- Evaluation of numerical weather and climate predictions for land.
- Integration of remotely sensed land observations in land/atmospheric modeling for use in CEOP and higher level understanding.
- A quality control check on observations.
- 4DDA "value-added" GLDAS-CEOP data sets.
- The production of GLDAS MOLTS.
- The expansion of GLDAS to include selected atmosphere and ocean observations.

· The development of a long-term archive function.

The GLDAS contribution to CEOP is expected to have the following timeline:

· Data Integration Period (2002-2005): Compile the forcing data (observations and analyses) and assimilation data including radiance observations (level 1), high-level satellite data products, *in situ* observations, and NWP land analyses into a long term archive. Produce MLDAS (Molts LDAS) by reconfiguring GLDAS to run only MOLTS points for explicit linkages to CEOP reference sites.

· Reanalysis Period (2006-2007 work activity): Reprocess CEOP data in a globally consistent 1/8 degree resolution; global land reanalysis including multiple land model products (NOAH, CLM, VIC, etc.) and data assimilated value-added analysis.

For more information on GLDAS, please visit http://ldas.gsfc.nasa.gov.

SUPER (CLOUD) PARAMETERIZATIONS: FAST FORWARD TO THE FUTURE

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are the column-physics components of GCMs, surgically extracted from their host GCMs and driven by observations of large-scale weather systems. **GCSS has actually demonstrated that CSRMs give better results than SCMs, through a number of case studies.**

Current climate-simulation models typically have on the order of 10^4 grid columns, averaging about 200 km wide. A global model with grid cells 2 km wide will have about 10^8 grid columns. The time step will have to be roughly 10^2 times shorter than in current climate models. The CPU requirements will thus be $10^4 x 10^2 = 10^6$ times larger than with today's lower-resolution models. In a few more decades such global CSRMs will become possible.

There is another approach, Super-Parameterizations. We can run a CSRM as a "super-parameterization" inside a GCM. Wojciech Grabowski of NCAR, Chair of GCSS WG 4, implemented a 2D CSRM inside a simplified global model with globally uniform SSTs (no mountains, etc.) Each copy of the CSRM represents a "sample" of the volume inside a GCM grid column. Statistics computed using the CSRM are based on this "sample" in much the same way that statistics from an opinion poll are based on interviews with a sample of the population. Grabowski's approach was to use a 2D CRM, and cyclic lateral boundary conditions

Inspired by Grabowski's idea, Marat Khairoutdinov of CSU embedded his 2D CSRM as a super-parameterization in the atmosphere sub-model of the Community Climate System Model (CAM). This global model has realistic topography, SSTs, etc. The CSRM takes the place of the stratiform and convective cloud parameterizations, and in the future will also replace the PBL parameterization. Because he was already familiar with both the CAM and the CSRM, Marat was able to get the super-parameterization working in the CAM in about a month.

Results to date suggest that super-parameterizations can enable more realistic simulations of important climate processes such as the MJO and we have demonstrated that super-parameterizations can be incorporated into GCMs with a modest effort. There are many *a priori* reasons to believe that superparameterizations have the potential to provide more realistic and more reliable simulations of climate.

Super-Parameterizations: What do we get from using them?

- Explicit deep convection, including mesoscale organization (e.g., squall lines), downdrafts, anvils, etc.
- Explicit fractional cloudiness
- Explicit cloud overlap in the radiative sense
- Explicit cloud overlap in the microphysical sense
- Convective enhancement of the surface fluxes
- Possible explicit 3D cloud-radiation effects
- Convectively generated gravity waves
- The ability to compare global model results on the statistics of mesoscale and microscale cloud organization with observations from new platforms, such as CloudSat
- The ability to assimilate cloud statistics based on high resolution observations

GLDAS: AN IMPORTANT CONTRIBUTION TO CEOP
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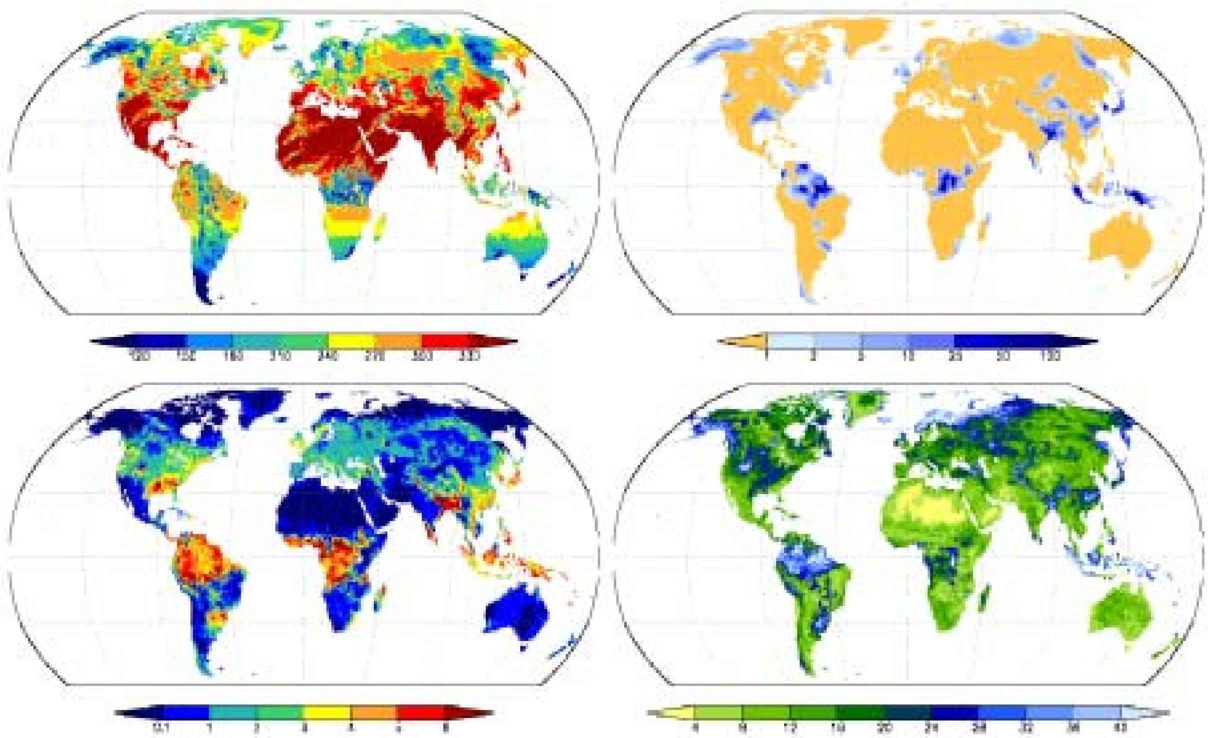

GLDAS forcing and output, 30 April 2002. Mean observation-based downward shortwave radiation [W/m²] (top left); total precipitation [mm] (top right); total evapotranspiration [mm] (bottom left); mean root zone soil water content [%] (bottom right).

GCSS ARM workshop participants at Kananaskis Village. ***See workshop report on page 14.***

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