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THE NEW GEWEX

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1. INTRODUCTION

The **Global Energy and Water Cycle Experiment (GEWEX)** is an integrated program of research, observations, and science activities ultimately leading to the prediction of global and regional climate change. It is a core project of the World Climate Research Programme (WCRP). The International GEWEX Project Office (IGPO) is hosted by the United States and located in Silver Spring, MD and the GEWEX web site is at http://www.gewex.org . The appendix provides a list of acronyms.

The WCRP has been carrying out what is called a visioning exercise with a view to revamping the structure and activities of the WCRP with a particular view toward the role of climate research in support of climate services. The timeline is to sunset the current projects and launch new ones in 2013, guided by the Joint Scientific Committee. In particular, the guidance has suggested that core projects would be retained but with revised responsibilities to facilitate climate system research at the interface of the physical Earth system components. The suggested four new core projects should be: 1) Ocean-atmosphere (think CLIVAR); 2) Land-atmosphere (think GEWEX); 3) Cryosphere (think CliC); and 4) Stratosphere-troposphere (think SPARC). Then within each core project there should be a common set of basic "themes" including 1) Observations and analysis; 2) Model development, evaluation and experiments; 3) Processes and understanding; 4) Applications and services; and 5) Capacity building. Coordination across projects on these themes would be via WCRP Modeling and Observations Councils. In preparation for the

The pan-GEWEX meeting in Seattle, August 2010.

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forthcoming changes, the GEWEX Scientific Steering Group (SSG) met in January 2010 in New Delhi and began formulating plans for the future via a new mission statement, a set of imperatives (things that must be done), and a set of frontier challenges for the future. The draft set of these was published in the May 2010 GEWEX newsletter as a basis for the more extensive discussions at the pan-GEWEX meeting in Seattle in August 2010.

In January 2010 the SSG discussed why the three GEWEX panels existing at that time: Radiation (GRP), Modeling (GMPP), and Coordinated Energy and Water Cycle Observations Project (CEOP) should be together under the GEWEX umbrella. The arguments were strong and convincing that we should continue with similar components in any future GEWEX. Figure 1 illustrates the points from the standpoint of the hydrological cycle, featuring radiation, atmospheric processes and land surface hydrology and processes. The original motivation for these being together is that they correspond to the "fast" processes in the climate system, and this still applies. However, since then, there has been further evolution of the panels, as noted below.

Key questions were "how much science falls under land-atmosphere?" and "what about those that do not?" The approach endorsed by the SSG is that while the future GEWEX should indeed be the place where land-atmosphere interactions are featured, it should be much more. In particular, it should retain the global energy and water cycle as a core focus while further highlighting regional aspects. It should indeed also feature hydrological and land surface processes and modeling, and interactions with the atmosphere. However, it should further retain a strong atmospheric component related to the water and energy cycles, and hence scientific issues related to radiation, clouds, convection, precipitation, boundary layers, surface fluxes, runoff, and human influences which should also be included in terms of observations, process understanding and modeling.

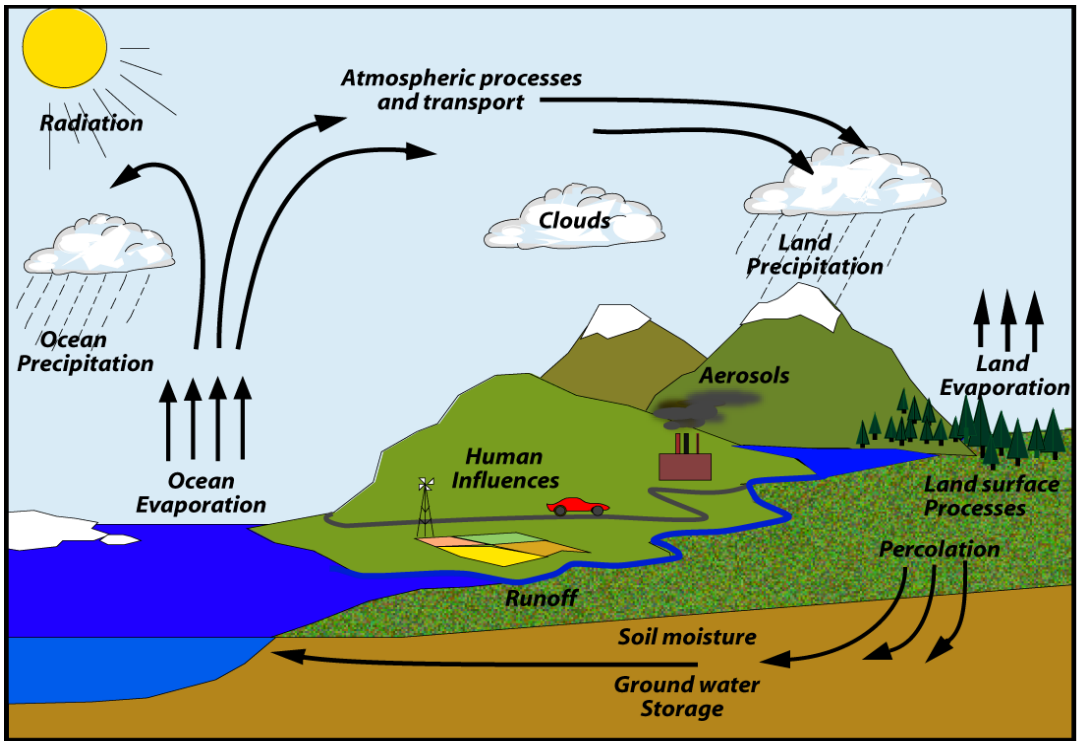

Fig. 1 depicts the hydrological cycle schematically and thus the driving by radiation and energy, the atmospheric dynamics that move water and energy around and produce clouds which block the sun, the complex land surface complete with human influences and the interactions with the atmosphere, and the surface and below surface processes that complete the water cycle (adapted from Trenberth et al. 2007; *J. Hydromet*.).

2. NEW NAME AND MISSION

While the old GEWEX name [Global Energy and Water cycle Experiment] was liked by many for its uniqueness (e.g., in a Google search) and name recognition, the "EX" part is clearly obsolete. Accordingly, a new name post-2013 was suggested to be: *"Global and Regional Energy and Water" (GREW).* However, there were strong sentiments expressed for the old acronym and a suggestion for an alternative name is "*Global and regional Energy and Water Exchanges*". Please feel free to let me know your opinions.

The revised mission statement is:

To measure and predict global and regional energy and water variations, trends, and extremes (such as heat waves, floods and droughts), through improved observations and modeling of land, atmosphere and their interactions; thereby providing the scientific underpinnings of climate services.

The following seven imperatives have been approved by the SSG:

Datasets: **Foster development of climate data records of atmosphere, water, land, and energy-related quantities, including metadata and uncertainty estimates.**
Analysis: **Describe and analyze observed variations, trends and extremes (such as heat waves, floods and droughts) in water and energy-related quantities.**
Processes: **Develop approaches to improve process-level understanding of energy and water cycles in support of improved land and atmosphere models.**
Modeling: **Improve global and regional simulations and predictions of precipitation, clouds, and land hydrology, and thus the entire climate system, through accelerated development of models of the land and atmosphere.**
Applications: **Attribute causes of variability, trends and extremes, and determine the predictability of energy and water cycles on global and regional bases in collaboration with the wider WCRP community.**
Technology transfer: **Develop diagnostic tools and methods, new observations, models, data management, and other research products for multiple uses and transition to operational applications in partnership with climate and hydro-meteorological service providers.**
Capacity building: **Promote and foster capacity building through training of scientists and outreach to the user community.**

The header in each case highlights the link between the imperative and the themes outlined by the JSC. There is still much to be done to flesh out these imperatives with more details about what they mean in terms of the actions to be taken, the lead groups in GEWEX and interactions with other parts of WCRP, and the other organizations involved.

Following from the pan-GEWEX meeting in August, a number of structural changes have been made to GEWEX and its committee structure, which is summarized by Fig. 2 in its current form with names of the chairs of the various subgroups.

3. MODELING

The previous GEWEX Modeling and Prediction Panel (GMPP) has been removed. Instead the GEWEX Cloud System Study (GCSS) and GEWEX Atmospheric Boundary Layer Study (GABLS) will be combined and, along with the Global Land/Atmosphere System Study (GLASS), will report to and take advice from the SSG directly. As a result of the discussions it was proposed that GCSS should abandon its previous Working Group structure. Instead, the group will operate through projects. Those can be initiated by any member of the community. A Science Steering Committee (SSC), which will form the GCSS/GABLS Panel, will be responsible for the

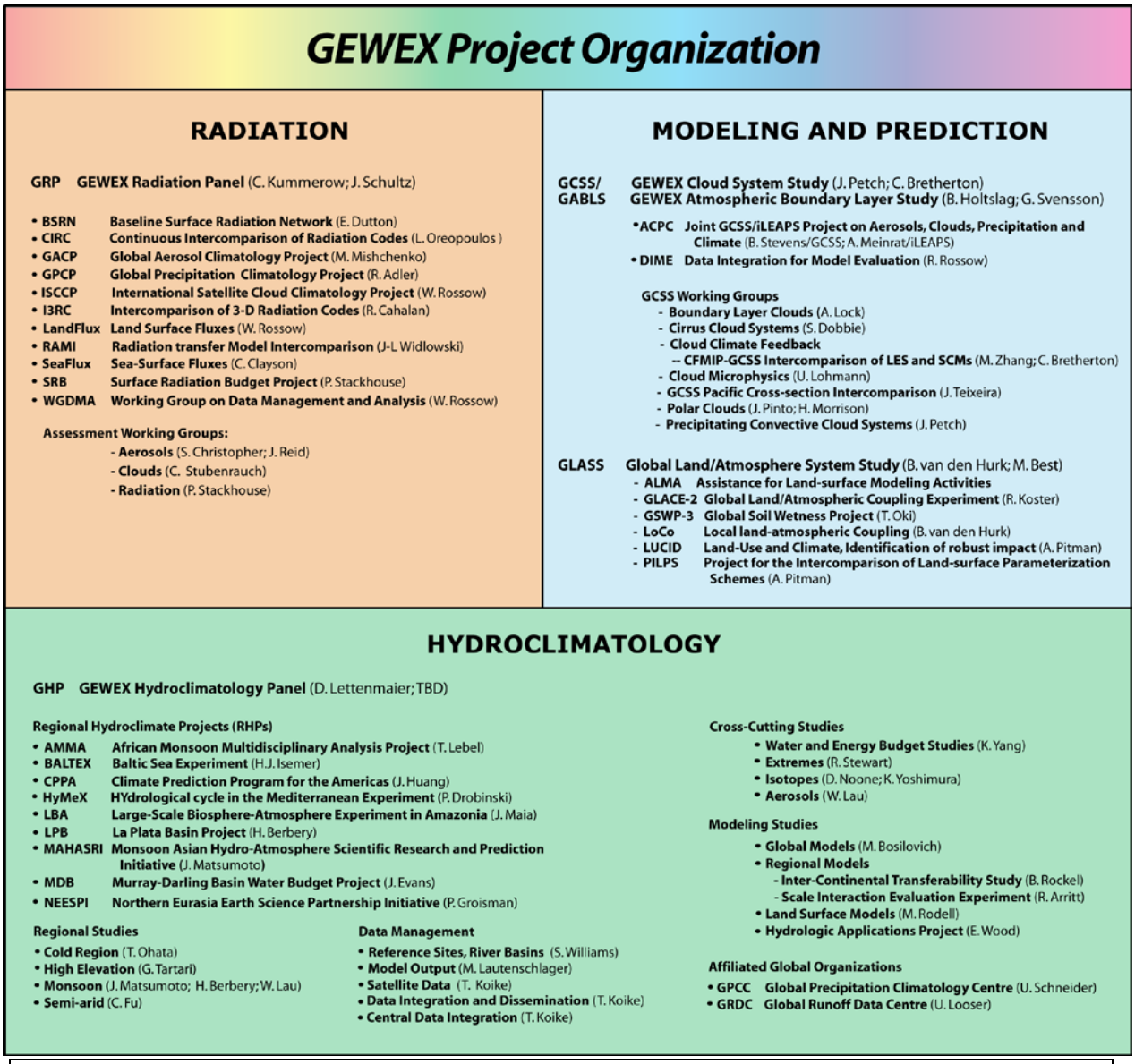

Fig. 2. The GEWEX organization in terms of panels and their chairs as of late 2010.

successful running of the program. This includes the approval of proposals as well as engagement with the community to explore new opportunities. The GABLS activities will be fully integrated into this structure through GABLS-specific projects as well as GABLS membership on the SSC. The GCSS and GABLS brand names will be maintained.

To move beyond 2013, GEWEX has implemented a new **Framework for Atmospheric Model Enhancement (FAME).** The mission of FAME is: *Improving the representation of physical and dynamical processes in the troposphere in models for all purposes and especially weather and climate services.* Its main focus is the improvement of the representation of clouds and precipitation in atmospheric models, which can only be achieved by improving our understanding of the intricate coupling of physical and dynamical processes associated with clouds and precipitation at various scales. The troposphere focus recognizes the complementary continuing lead role of SPARC on the stratosphere and tropospheric-stratospheric interactions.

FAME was proposed in recognition of need expressed by the IPCC in several reports which highlighted the significant shortcomings in models in the simulation of clouds and precipitation with consequences for the simulation of important climate feedbacks and climate sensitivity. Other important factors included the recent revolution in the ability to observe clouds and precipitation, especially from space, and improvements in ability to model the processes involved at the process-scale. The experience of more than 15 years of the GCSS program and almost 10 years of the GABLS program makes the time right for a more concerted effort in atmospheric model improvement that builds on the existing strengths and adds to them the important new research area of physics-dynamics coupling.

The envisaged ingredients of FAME are programs on the PBL (GABLS), clouds, convection and precipitation (GCSS), radiation (currently residing in GRP and SPARC), coupling to dynamical processes (new) and potentially also coupling to numerics (new). FAME will be built around the core approaches identified by the WCRP JSC, e.g., observations, modeling, data analysis and model diagnosis, and process studies. Through the direct involvement of operational modeling centers in FAME as well as through the engagement of scientists throughout the world, the activities in FAME will make major contributions to capacity building and services.

As FAME is focused on providing a means for the improvement of the representation of core physical processes in atmospheric models, it will partner with many other programs to contribute to the research on phenomena that go beyond the physics-dynamics coupling in the atmosphere. Those include partnerships with the land (e.g., GLASS, GHP), ocean (e.g., CLIVAR), aerosol (e.g., ACPC, iLEAPS), atmospheric chemistry (e.g., SPARC, IGAC), stratosphere (e.g., SPARC), and cryosphere (e.g., CliC) communities. Necessarily, these go well beyond GEWEX alone.

FAME could be seen as a natural extension to the existing GCSS/GABLS panel described above if the post-2013 GEWEX structure still allows for such an activity. This would maintain continuity, provide close links to the land and limited area modeling communities and ensure FAME's natural focus on the energy and water cycles. These activities were originally grouped together to provide a focus on relatively "fast processes" as compared with those involving the ocean or cryosphere. FAME could also make a major contribution to a potential cross-WCRP effort on atmospheric model development.

The SSG strongly recommend keeping FAME within the post-2013 GEWEX structure. Questions include how FAME goes forward, whether as a panel or working group. Many of the other modeling activities in WCRP come under working groups. A new group, integrating FAME and possibly called WGAP, short for WG on Atmospheric Processes and modeling for climate, could operate within the new post-2013 GEWEX. However, as the activities relate to the established WGs, especially WGNE, this aspect is yet to be decided after broad consultation with the community.

4. LAND SURFACE AND HYDROLOGICAL SCIENCE

Major changes also occurred in the realm of the regional hydrological projects at the pan-GEWEX meeting. In part these came about naturally from the evolution of the program, and given an extra nudge by the change in leadership. Under the leadership of Toshio Koike, CEOP developed an impressive and extensive program, including the Regional Hydrometeorological Programs (RHPs), associated modeling and data base development, and the Hydrologic Applications Project (HAP). CEOP remains at the core of the GEWEX mission, includes more than a thousand researchers, and provides important regional data, modeling and a valuable end-user interface.

The brief history is that the Continental Scale Experiment (CSE) concept was developed in the 1990s. Its purpose was the development, diagnosis, and testing of coupled land-atmosphere models with a focus on water and energy budget closure at near-continental scales.

An example was the GEWEX Continental Scale International Project (GCIP) for the Mississippi basin as a well instrumented and analyzed region. This led in turn to the development of RHPs to extend this concept to other regions: MAGS, BALTEX, GAME, LBA, AMMA; and even more recent RHPs, see Fig. 3. The panel set up to provide coordination and oversight was the GEWEX Hydrometeorological Panel (GHP). Then to take advantage of many new satellite and other observations the **Coordinated Enhanced Observing Period (CEOP)** was begun in 1995 and continued into the second phase of GEWEX for 2001-2006. This activity, which also developed extensive data management activities, led by Toshio Koike in Japan, also led to some similar panels to those in GHP and some duplication of effort. Accordingly, this first CEOP activity was combined with GHP and evolved to become the **Coordinated Energy and Water Cycle Observations Project** with the same acronym**,** CEOP, in 2007-2008. The initial observing period grew to become a move to produce a 10 year dataset and archive especially set up for the regional projects. However, other developments had already occurred in observations and data management, which suggested the activity should be wrapped up and refocused, even as it is utilized and hopefully becomes part of the heritage of GEWEX. In particular, the development of the many flux towers around the globe provides alternatives to the CEOP reference sites for local studies of energy, water and biogeochemistry.

Accordingly, the community began what might be called a "back to basics" movement, with recognition of the need to reinvigorate the regional hydrological projects. In particular there was a call by the new co-chair, Dennis Lettenmaeir, for stronger hydrological activities which would foster the next generation of hydrologically realistic land surface schemes and provide a home for projects like PILPS. The recommendation to the SSG was along these lines and thus a new **GEWEX Hydroclimatology Panel** (GHP: note the change in the name from the first version) has been formed to replace CEOP, effective immediately. The SSG also followed up on the recommendation from CEOP to approve a new RHP called the HYdrological cycle in the Mediterranean Experiment (HyMeX), focused on the 20 countries around the Mediterranean Sea and the fresh water and salinity of the Sea itself.

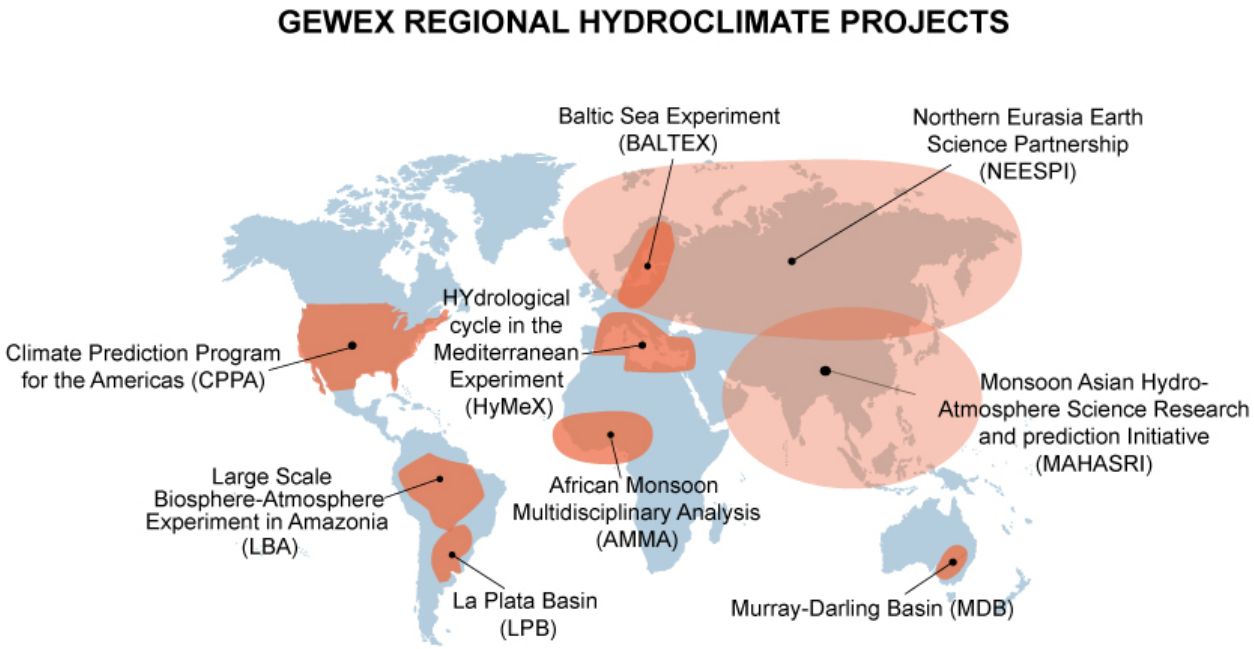

Fig. 3: The GEWEX present and former RHPs, see http://www.gewex.org/projects-ghp.html

GHP is thus the home for hydrologic science and modeling within WCRP and there is considerable scope for developments in this area, e.g. in seasonal forecasting, the detection and attribution of change, and the development and analysis of climate projections. Challenges remain in dealing with monsoons and to help coordinate the multitude of national initiatives in this area. There are opportunities for linkages with GLASS in bringing disciplines together in the development of next generation Land Surface Models as well as increasing interactions with CORDEX. Changes in the management structure are likely to accompany the new consolidation of efforts as GHP realizes its considerable potential.

5. GEWEX DATASETS

The original GEWEX datasets were developed under the auspices of the GEWEX Radiation Panel (GRP) which continues, but is also looking for a name change as it does a lot more than radiation. It does deal with all of the global satellite data related to energy and water and their synthesis into products, and is currently leading and promoting reprocessing of the datasets with a goal of creating climate data records of sufficient quality to be useful for examining trends. Some of the datasets, such as GPCP and ISCCP, are well known and already used extensively, but the scientists are confident that they can be made much better and more consistent with each other, and with better estimates of uncertainties.

In general GRP is working well toward the new goals and has produced simulators, that take into account the sampling and characteristics (such as thresholds) of the observations to enable intercomparisons of satellite products with model data. Interactions with other parts of GEWEX were fostered by the pan-GEWEX meeting, and the GEWEX datasets have potential for great use in evaluating and improving models on issues such as clouds and indirect effects of aerosols, precipitation frequency, intensity and amount, and in providing the context for the RHPs.

6. EXTREMES

The recent summer record breaking flooding in Pakistan, India and China, and heat-waves and wildfires in Russia highlight the extremes of the hydrological cycle of drought and floods that are changing from human activities. Dealing with extremes in WCRP is a cross-cutting activity that involves all projects although GEWEX plays a leading role. Olga Zolina, who is a member of the GEWEX SSG, led the WCRP extremes workshop involving some 150 people at UNESCO in late September. Breakout groups were held on issues of 1) data requirements and availability (such as the need for hourly precipitation data to properly characterize extremes); 2) representation of extremes in models, including scaling and spatial issues (how station data relate to grid squares, comparing apples to apples); and 3) methodologies for estimating extremes across areas and disciplines, including statistical methods. Continuing issues are sorting out the human changes in extremes and how to best communicate with the general public on such technical attribution issues.

For instance, it is likely that the southeast Asian floods and the Russian drought were linked by the monsoonal circulation and teleconnections associated with the anomalous latent heating of the atmosphere associated with the heavy rains. The pattern of the rains was related to the rapidly developing La Niña but the previous El Niño had left behind a residue of abnormally high sea surface temperatures in the Indonesian-northern Indian Ocean region that provided an enhanced supply of moisture to the monsoon rains. No doubt those elevated temperatures have a global warming component. The persistent “blocking high” over Russia led to drought that was probably more intense and longer lasting owing to global warming, with increased risk of heat waves and wild fires. While these connections are very likely, they are hard to prove as models do not reproduce monsoon rains very well, and blocking is poorly simulated. These scientific challenges extend across the WCRP.

Climate change is manifested mainly through changes in extremes, because a modest climate change results in the same weather experienced prior to the change (green area of Fig. 4) most of the time. Indeed it is when natural variability is working in the same direction as global warming, as they have been in much of 2010, the records are broken.

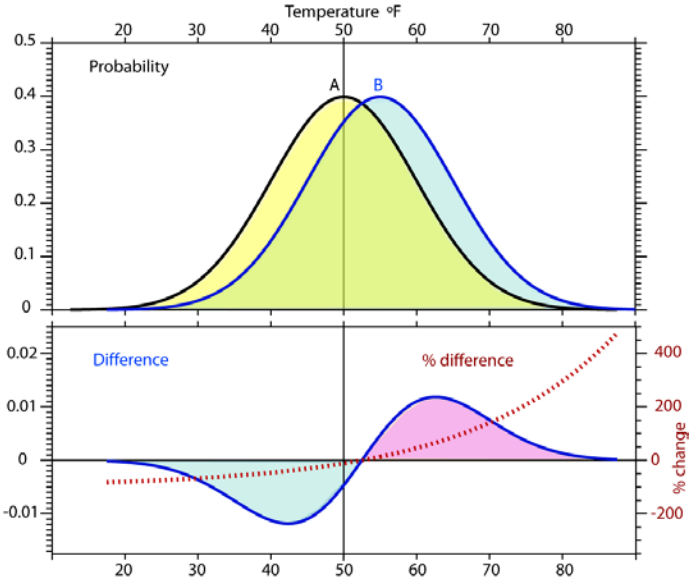

Fig. 4. A small change in the average temperature value can have a large effect on extremes. Top: The probability of different temperature readings when the mean temperature is 50°F and standard deviation 10°F (black curve, A), and when the mean temperature rises 5°, to 55° F (blue curve, B) with the same spread. Bottom: the solid blue curve (scale left) is the difference in probability and the dashed red curve (scale right) is the percentage change.

7. CLOSING REMARKS

We are looking forward to the future with considerable excitement at the science we can achieve through collaboration and friendly competition, with the help of coordination through GEWEX.

ACRONYMS

ACPC: Aerosols, Clouds, Precipitation and Climate Initiative (iLEAPS/GEWEX/IGAC)
AMMA: African Monsoon Multidisciplinary Analysis Project
BALTEX: Baltic Sea Experiment
CAS: WMO Commission for Atmospheric Sciences
CEOP: Coordinated Energy and Water Cycle Observations Project
CEOP: Coordinated Energy and Water Cycle Observations Project
CLIVAR Climate Variability and Predictability Project
CLiC: Climate and Cryosphere Project
CORDEX: COordinated Regional climate Downscaling EXperiment
CSE: Continental Scale Experiment
FAME: Framework for Atmospheric Model Enhancement
GABLS: GEWEX Atmospheric Boundary Layer Study
GCIP: GEWEX Continental Scale International Project
GCSS: GEWEX Cloud System Study
GEWEX: Global Energy and Water Cycle Experiment
GHP: GEWEX Hydroclimatology Panel
GLACE: Global Land Atmospheric Coupling Experiment
GLASS: Global Land Atmosphere System Study
GMPP: GEWEX Modeling and Prediction Panel
GPCP: Global Precipitation Climatology Project
GRP: GEWEX Radiation Panel
HEPEX: Hydrological Ensemble Prediction Experiment
HyMeX: HYdrological cycle in the Mediterranean Experiment
IGAC: International Global Atmospheric Chemistry
IGBP: International Geosphere-Biosphere Programme
IGPO: International GEWEX Project Office
iLEAPS: Integrated Land Ecosystem-Atmospheric Processes Study
IPCC: Intergovernmental Panel on Climate Change
ISCCP: International Satellite Cloud Climatology Project
JSC: WMO/ICSU/IOC Joint Scientific Committee (for WCRP)
LBA: Large-scale Biosphere Atmosphere Experiment in Amazonia
LPB: La Plata Basin
MAGS: Mackenzie GEWEX Study MAHASRI Monsoon Asian Hydro-Atmospheric Science Research and prediction Initiative
MDB: Murray Darling Basin
NEESPI: Northern Eurasian Earth Science Partnership Initiative
RHP: Regional Hydrometeorological Program
SSC: Science Steering Committee
SPARC: Stratospheric Processes And their Role in Climate (WCRP)
SSG: Scientific Steering Group
SST: Sea Surface Temperature
WCRP: World Climate Research Programme
WGNE: WMO (CAS)/JSC Working Group on Numerical Experimentation