GEWEX NEWS

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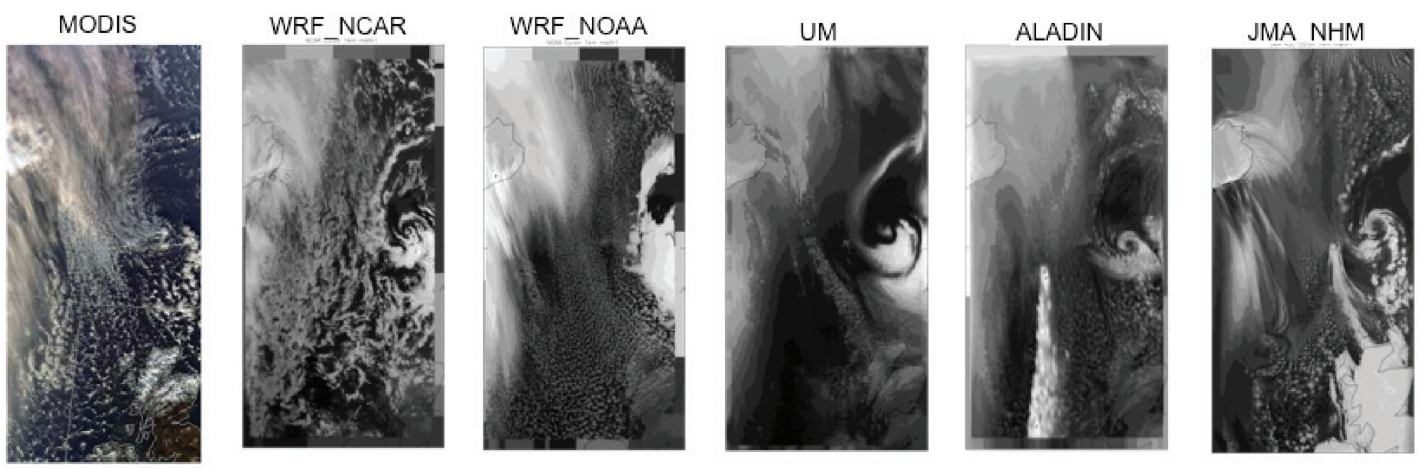
Results from WGNE/GASS Workshop on Model Intercomparison Study in the Grey Zone



A Moderate-resolution Imaging Spectroradiometer (MODIS) longwave image of the cold air outbreak (left panel) and snapshots of simulations of five different mesoscale models. Lighter colors correspond to lower longwave radiation (colder temperatures). Overall the large-scale features are well reproduced and most models simulate a transition to a cumulus regime with a cellular structure. See the workshop report by P. Siebesma on page 7.

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Commentary

Looking Back on a Successful Year for GEWEX

Graeme Stephens and Sonia I. Seneviratne
Co-Chairs, GEWEX Scientific Steering Group

Considering that our terms as Co-Chairs of the GEWEX Scientific Steering Group (SSG) began in January 2014, now seems like a good time to reflect on the accomplishments and milestones in GEWEX during the past year. The 27th meeting of the GEWEX SSG held in Medellín, Colombia provided an ideal venue for this exercise.

The reports provided by the four GEWEX Panels highlighted substantial advances in the past year, including the development of new regional projects within the GEWEX Hydroclimatology Panel (GHP) and dedicated research initiatives, such as the joint Global Land-Atmosphere System Study (GLASS) and Global Atmospheric System Studies (GASS) Diurnal Coupling Experiment (DICE) Project. Further advances were also made in the development of an integrated satellite-based observational product within the Global Data and Assessments Panel (GDAP).

Another area of key development within GEWEX includes activities related to the WCRP Grand Challenges. GEWEX is leading two of the six science challenges but also has connections to four others. In the upcoming year, *GEWEX News* will provide descriptions of GEWEX involvement in the Grand Challenges and how collective research efforts within the GEWEX Panels will address them. This topic was a primary focus of the SSG meeting. See page 5 for the implementation strategy for the Grand Challenge on Understanding and Predicting Weather and Climate Extremes. A range of ambitious undertakings is planned to address this challenge, including important teaching and outreach activities to entrain the new generation of climate scientists.

Another exciting new GEWEX initiative is the creation of a U.S. GEWEX project office, whose functioning is currently being negotiated. As a part of this new U.S. project office, we are developing plans for a North American Regional Hydroclimate Project (RHP). GEWEX has also been fostering the planning of Coupled Model Intercomparison Project-Phase 6 (CMIP6)-related model experiments: the Land Surface, Snow and Soil Moisture MIP (LS3MIP) and the Land Use MIP (LUMIP), which are collectively referred to as LandMIPs (see the November 2014 issue of *GEWEX News*), as well as the HighresMIP experiment. In addition, a small number of new activities are beginning to develop under the GEWEX Process Evaluation Study (PROES). Plans for possible new regional activities in South America were also discussed at the SSG meeting.

Finally, we would like to thank the host of the SSG meeting, Professor Germán Poveda of the National University of Colombia. He and Ph.D. student Ms. María Fernanda Cardenas did an excellent job with the local arrangements. The presentation by Professor Poveda during the meeting highlighted some interesting features of Colombian weather and climate, such as the intense precipitation events that commonly take place in Medellín. We also thank the International GEWEX Project Office for its efficient organization of the meeting, the members of the SSG for their important contributions, as well as the numerous guests, including the new Chair of the WCRP Joint Scientific Committee, Dr. Guy Brasseur, who provided instrumental guidance in the various discussions. We look forward to further progress in the coming year!

New WCRP Liaison for GEWEX

Please join us in welcoming Boram Lee, Senior Scientific Officer and new WCRP liaison to the GEWEX and SPARC core projects. Dr. Lee is also the liaison for the Coordinated Regional Climate Downscaling Experiment (CORDEX) and the Grand Challenges on Climate and Weather Extremes, Water Availability, and Regional Climate Information.

Dr. Lee has a Ph.D. in climatology from the Université de Paris VI, France, and Masters and Bachelors degrees in atmospheric science from the Seoul National University in Korea. Before joining WCRP, Boram worked for the Marine Meteorology and Oceanography Programme of the World Meteorological Organization (WMO) until 2014, where she was responsible for international coordination of marine affairs, including coastal risk forecasting and warning, through the Joint WMO-Intergovernmental Oceanographic Commission (IOC) of UNESCO's Technical Commission for Oceanography and Marine Meteorology. In addition to her management tasks, Boram's experience comprises several research and development projects in marine meteorology and associated applications for coastal disaster risk reduction; she has led the development and coordination of the WMO Coastal Inundation Forecasting Demonstration Project that is currently being implemented in five countries/regions, as well as other related research projects.

Dr. Lee worked at the IOC from 2003–2011 as a Programme Specialist. She was a visiting scientist at the National Institute for Agro-Environmental Sciences of Japan in 2002, and a research scientist at the Korea Meteorological Administration from 1995 to 2001. Since 2010, Dr. Lee has also served as adjunct professor at the College of Ocean Science at the Jeju National University in the Republic of Korea.

Highlights of the 27th Session of the GEWEX Scientific Steering Group (SSG)

Peter J. van Oevelen and Dawn P. Erlich
International GEWEX Project Office, Columbia, Maryland USA

The 27th Session of the GEWEX SSG was hosted by Prof. Germán Poveda with the assistance of Maria Fernanda Cardenas at the National University of Colombia in Medellín on 16–19 February 2015. During the meeting the SSG reviewed the research projects of the GEWEX Panels and their progress in aligning their activities with the WCRP Grand Challenges.

Prof. Poveda gave an informative talk about the intense precipitation events that occur in Colombia. One of the rainiest regions of the world is located in the lowlands of the Pacific Coast of Colombia, where the average precipitation ranges from 8,000 to 13,000 mm per year!

Anil Mishra of the Hydrological Systems and Water Scarcity Section of the International Hydrological Programme (IHP) of UNESCO gave a presentation on local, regional and global challenges for water security. UNESCO defines water security as the capacity of a population to safeguard access to adequate quantities of water of acceptable quality for sustaining human and ecosystem health on a watershed basis, and to ensure efficient protection of life and property against water related hazards. GEWEX is leading the WCRP Grand Challenge on Changes in Water Availability, which relates to the IHP goal to understand uncertainty and translate it back to water security. Future GEWEX activities within this Grand Challenge are planned with IHP, including co-hosting a summer school on water availability.

Global Atmospheric System Studies (GASS) Panel

Stephen Klein chairs the Panel. GASS provides leadership for the scientific community involved in improving the representation of atmosphere processes in weather and climate models through coordination of scientific projects that bring together experts in process-modeling, observations, and the development of atmospheric model parameterizations.

GASS has six new projects that span topics from process-level studies of aerosol-cloud interactions and radiative transfer to full large-scale model diagnosis of the causes for warm-biases in continental summertime surface air temperatures, and transformation of marine air masses as they advect over sea-ice. GASS is planning to co-organize its third Pan-GASS meeting with the first Pan-GLASS meeting to be held in 2016.

GEWEX Data and Assessment Panel (GDAP)

GDAP is chaired by Jörg Schulz. Panel activities include the production of data products and conducting assessments on the quality of products and radiative transfer codes. GDAP is planning new assessments on precipitation and soil moisture data, and is exploring how to expand the GEWEX standard products to include terrestrial water budget terms. The aerosol optical depth (AOD) assessment is evaluating trends in AOD over the last decade and satellite data-climate model comparisons. Trend analysis was used in the water vapor assessment to compare total column water vapor (TCWV) and water vapor profiles on a global scale. The TCWV trends were shown to be significantly different, particularly in tropical land regions. This led to the recommendation to the Global Reference Upper Air Network (GRUAN) co-chairs to consider adding a tropical land-surface station during the upcoming GRUAN network expansion. By use of homogeneity tests these differences in TCWV were found to be caused by break points in the time series, which temporally coincide with changes in the observing system.

GEWEX Hydroclimatology Panel (GHP)

GHP, co-chaired by Jason Evans and Jan Polcher, is organized around its Regional Hydroclimate Projects (RHPs) and a number of crosscutting science topics (see the annual meeting report on page 10). The overall objective of GHP is to improve knowledge about global climate change and its impacts at regional scales, and to transfer that knowledge from one region to another, ending with the results synthesized at a global scale.

The Panel has recently begun a scoping exercise for a regional effort located in the United States. A planning committee has been tasked with a drafting a white paper that specifies the main science issues to be addressed, the tools and possible funding sources, social issues to be considered, links with other groups and studies (both national and international), and outreach opportunities. The area around the Colorado River Basin within the Western U.S. climatic region is currently "considered" the preferred choice, given its importance as a major supply of fresh water.

One of the RHPs, the Saskatchewan River Basin, was replaced by the Changing Cold Regions Network (CCRN). The new RHP includes both the Saskatchewan River and Mackenzie River Basins, and has been approved by the SSG.

Global Land/Atmosphere System Study (GLASS) Panel

GLASS supports three goals related to improving models: better estimates and representations of (land) states and fluxes, improved interaction with the overlying atmosphere, and maximization of the utilized fraction of inherent predictability. GLASS is organized into three themes—Benchmarking, Model Data Fusion (MDF), and Land-Atmosphere Coupling (LAC). Joseph Santanello served as the co-chair of GLASS with Aaron Boone until Michael Ek succeeded him in 2015.

GLASS has reached out to other Panels within GEWEX and to GEWEX's sister organizations to form projects useful to the broader community, working with GHP on a number of ventures and with the GEWEX Atmospheric Boundary Layer Study (GABLS) on the Diurnal Coupling Experiment (DICE). It also works with the WCRP Climate and Cryosphere Project (CliC) on the Earth System Model Snow Model Intercomparison Project (ESMSnowMIP) as a part of the Land Surface, Snow and Soil Moisture MIP (LS3MIP), and continues to engage with the Working Group on Numerical Experiments (WGNE) on benchmarking and data assimilation activities. A joint GABLS/CliC project to assess the thermal coupling and momentum flux in a polar climate has been proposed for the Dome-C site in Antarctica.

GLASS's Local Coupled Land-Atmospheric Modeling (LoCo) Working Group is collaborating with the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Climate Research Facility-Southern Great Plains (SGP) campaign and has produced an ARM-supported data set for coupling studies over the SGP. In addition, a radiosonde campaign led by LoCo will commence in summer 2015 to augment the current ARM-SGP sonde launches for application to LoCo studies.

Panel Links to the WCRP Grand Challenges

There are many GEWEX Panel linkages to the WCRP Grand Challenges and some of these are described below. A number of GASS projects will contribute to the "Clouds, Circulation and Climate Sensitivity" Grand Challenge, including the Grey Zone (see the first workshop report on page 7), Weak Temperature Gradient, Low-cloud Feedbacks, and Radiative Processes in Observations and Models. In addition, idealized modeling frameworks are needed to study the response of convection and climate over warm land-surfaces. Within GHP, the Northern Eurasia Earth Science Partnership Initiative (NEESPI) RHP studies cyclonic activity at high latitudes. Another RHP, the Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI), analyzed the interannual variations of AOD, cloud effective radius, and precipitation for 2000–2012 based on El Niño-Southern Oscillation phases.

Two upcoming GASS projects could align with the Grand Challenge on "Changes in Water Availability": (1) the Clouds Above the United States and Errors at the Surface (CAUSES) warm bias project, with its focus on the coupling of energy and water cycles at the land-atmosphere interface over summertime land masses; and (2) the HiRes crosscut project to evaluate water cycle processes in high-resolution models. GDAP can also contribute to this Challenge by providing past precipitation amounts and the distribution of rain rates.

The individual and the integrated GDAP data products enable research related to three of the Grand Challenges: Clouds, Circulation and Climate Sensitivity; Changes in Water Availability; and potentially Understanding and Predicting Weather and Climate Extremes. Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity is supported by the GDAP Integrated Product.

For the Grand Challenge on Understanding and Predicting Weather and Climate Extremes, the GHP RHP called CCRN is studying the effects of land use changes and drainage on eastern prairie hydrology, flooding, and drought, and developing a hydrological model for predicting these changes. Another RHP, the HYdrological cycle in the Mediterranean EXperiment (HyMeX), has a strong focus on hydrometeorological extremes (heavy precipitation, floods, heat waves, droughts), while the RHP NEESPI studies extreme precipitation and heat waves. MAHASRI works on the attribution of extreme daily rainfall events in the Philippines and Southeast Asia: the project was able to statistically show the global warming effect for increasing extreme rainfall in wider regions in the Indochina Peninsula. Within GDAP, the re-engineered GDAP products (1-degree, 3-hourly time steps) may allow detection of extremes and processes related to extremes in the data. The publication by Lockhoff et al. (2014) has already found some skill at large scales in Global Precipitation Climatology one-degree-daily products.

The Cryosphere in a Changing Climate Grand Challenge is addressed by two RHPs within GHP. CCRN conducts focused analysis and modeling of cryospheric process response to warming. Key areas are the biomes of the Rocky Mountains (including glacier processes), Boreal Forest, Prairies, and the sub-Arctic. The second, NEESPI, has investigated changes in snowfall and river ice.

The next SSG meeting is scheduled for 25–29 January 2016 at ETH in Zurich, Switzerland.

Participants of the 27th Session of the GEWEX Scientific Steering Group.

References

Lockhoff M., O. Zolina, C. Simmer, and J. Schulz, 2014. Evaluation of Satellite-Retrieved Extreme Precipitation Over Europe Using Gauge Observations. *J. Climate*, 27, 607–623. DOI: *http://dx.doi.org/10.1175/JCLI-D-13-00194.1.*

Implementation Plan for the WCRP Grand Challenge on Understanding and Predicting Weather and Climate Extremes

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WCRP has identified six Grand Science Challenges to be addressed by the climate research community in the coming decade. These represent some of the most important and challenging scientific questions for addressing current research gaps. GEWEX is leading the Grand Challenge on Understanding and Predicting Weather and Climate Extremes (Extremes GC).

Weather and climate extremes have enormous societal, ecological and economic impacts; nevertheless, their study, particularly on a global scale, has been limited. The Intergovernmental Panel on Climate Change (IPCC) did not address extremes until its Second Assessment Report published in 1995, where it concluded that data and analyses related to extremes were "poor and not comprehensive." While much scientific progress has been made in recent years through subsequent IPCC reports and international coordination efforts (e.g., tropical cyclones), scientists are still limited in their ability to monitor extremes consistently, to understand what drives them, and the certainty in how they might vary in the future due to climate change. Primarily, this is because of limitations in observing systems and in the ability of models to realistically simulate extremes, particularly on short timescales and when the results have complex mechanistic relationships (e.g., droughts). However, in some cases it is also due to limited understanding of the processes that strengthen and exacerbate extremes, and of the environmental conditions leading to the extreme. Rare events by nature also pose complex statistical challenges. These issues represent a significant limitation for the scientific analysis of extremes and, consequently for providing policymakers and stakeholders with advice on how to manage the risks associated with extreme climatic or weather events.

In 2014, a White Paper prepared on the Extremes GC (*http://www.wcrp-climate.org/index.php/gc-extreme-events*) posed eight "Grand Science Questions" that would help meet the challenge presented by WCRP. Broadly, these questions covered how to address data issues and analyze observed changes in extremes, how to better understand and attribute changes in extremes, and how to better simulate and predict extreme events. Subsequently, the authors of the White Paper developed an implementation plan for addressing each of the Grand Science Questions within a framework of four overarching themes: (1) Document, (2) Understand, (3) Attribute, and (4) Simulate. All of the themes will interact, be driven by, and contribute to the Extremes GC. A small team of established and emerging leaders is coordinating each theme and is tasked with pushing forward the implementation. For each theme the implementation was divided into two parts, one of these dealing with coordination needs across and between existing activities, and the other highlighting what new activities, such as research and data gathering, are required. With that in mind, crosscutting activities were proposed that address several of the Grand Science Questions and link to the WCRP Grand Challenges (e.g., Water Availability, Regional Climate Information).

While it is expected that the implementation plan will be a "living document" that will be updated as plans and ideas progress, the current focus is on what is believed to be doable over the next few years. For that reason the main implementation strategy is focused on four core events: (1) heatwaves, (2) droughts, (3) heavy precipitation, and (4) storms. All activities are broadly embedded within WCRP, and also within the Climate and Ocean-Variability, Predictability and Change (CLIVAR) Project and the Stratosphere-troposphere Processes And their Role in Climate (SPARC) Project. Furthermore, they will build on many existing activities that already have international community and coordination in place, and that are also connected to the relevant research activities of the High Impact Weather Initiative within the World Weather Research Programme. The plan for implementation is summarized by the figure on the next page.

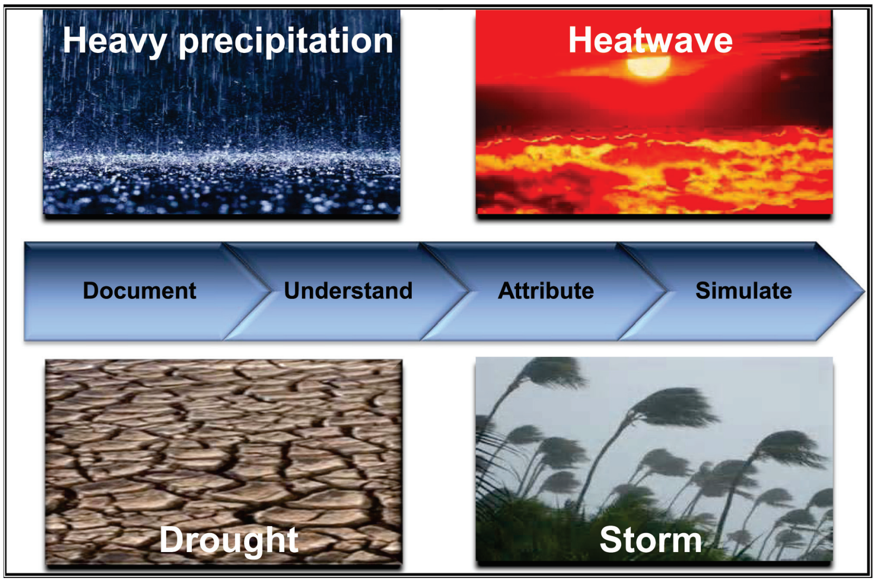
Document Theme *(Leads: Lisa Alexander and Ali Behrangi)*

This theme deals with assessing and documenting past changes in extremes. Observations are the key foundation for understanding long-term climate variability and change; however, they are often not well constrained, and critical gaps exist in the amount, quality, consistency and their availability, especially with respect to extremes. The current suite of climate extremes data sets is inadequate to properly assess climate variability and change, or to provide the required underpinning for detection and attribution studies and model evaluation. This is due to data limitations (in time and space), differences in how extremes are defined, the spatial representativeness of point-based measurements, scaling issues between observations and models, and uncertainties in variable estimates from satellite retrievals. Data from existing sources that are relevant to extremes need to be collated and better disseminated to identify regions and time periods where we can fill in gaps and better understand uncertainties. Activities planned include developing strategies for data collection and indices calculation, coordination and best practice, which may ultimately lead to requirements for new initiatives or software.

Understand Theme *(Leads: Sonia Seneviratne, Olivia Martius, and Robert Vautard)*

The focus of this theme is on the investigation and characterization of physical mechanisms leading to the occurrence of extreme events, such as heat waves, droughts, and floods. Recent investigations have shown that the interaction between large-scale phenomena (weather types, modes of variability) and regional-scale land-atmosphere feedbacks or forcings can be critical for these extremes (as has been highlighted in the vari-

Extremes Grand Challenge



Schematic showing the four research themes and four core events that will be addressed as part of the Extremes Grand Challenge.

ous phases of the GEWEX Global Land-Atmosphere Coupling Experiment, GLACE). A better quantification of these processes, thanks to enhanced interactions between relevant research communities, is essential to reduce uncertainties in projections, improve subseasonal to decadal predictability of extremes, and as the attribution of past trends and single events. Targeted activities include multi-model experiments and assessments to evaluate and quantify the underlying processes, in particular within the Coupled Model Intercomparison Project (CMIP6), as well as several workshops and training schools. A white paper or review article will be prepared to synthesize the results obtained for the broader climate research community. There will be close links with all of the three other themes.

Attribute Theme *(Leads: Xuebin Zhang and Friederike Otto)*

A key challenge for the community is to provide access to the latest information on how extremes have varied in the past and are projected to vary under a changing climate with a range of plausible greenhouse gas emission scenarios. The understanding of the extent to which humans are responsible for observed changes in extremes and particularly in the likelihood of individual extreme weather provides a constraint for model-projected future changes. They are addressed both by evaluating changes in the global or large-scale pattern in the frequency or intensity of extremes (e.g., observed widespread intensification of precipitation extremes attributed to human influence, and increase in frequency and intensity of hot extremes) in observations and in model simulations under various external forcings and by quantifying a fractional attribution factor for the occurrence of specific events. Much of this theme will be addressed to a large extent by building on the work of the existing International Detection and Attribution Group (IDAG) and event attribution communities.

Simulate Theme *(Leads: Gabi Hegerl, Erich Fisher, and Jana Sillmann)*

There is a lack of understanding in the types of events for which current models can provide credible and robust simulations for, and in the identification of key processes for climate models to capture in order to produce credible simulations of weather and climate extreme events, and thus improve prediction of those events. Furthermore, the ability of models to simulate small-scale extremes depends upon resolution and sometimes requires downscaling. These issues will be addressed through various approaches including the evaluation of extremes at the level of storylines or processes, developing strategies to compare and evaluate events that require high resolution (such as tropical cyclones), and producing long-control simulations to characterize the variability in both circulation states and extremes. Where models do simulate the fundamental underlying processes that produce extremes, dynamically based scaling approaches need to be developed in order to be able to better link processes at model scales with local scales.

We recommend that high frequency data be preprocessed for easy extraction of information relevant to extremes and be more readily accessible to the user community. Intra-seasonal to seasonal prediction and near-term prediction of probability of extreme events at impact relevant space and time scales will play an increasingly important role for climate services. Activities are planned that include developing best practices for model evaluation that will bring together dynamicists, severe weather specialists, statisticians, and modelers. These could take the form of a white paper or review article based upon CMIP5 data analysis. This topic will be closely linked to all other topics, particularly those of understanding and attributing extremes.

The Extremes GC will address these four overarching themes through a series of targeted workshops, meetings, and summer schools. For example, a workshop motivated primarily by the need to address the "Document" theme and the WCRP Grand Challenge Science Question "How can we improve the collation, dissemination and quality of observations needed to assess extremes and what new observations do we need?" is planned for Sydney, Australia at the end of February 2015 (*http://www.wcrp-climate.org/index.php/extremes-data-wkshp-about*). Another workshop on "Advancing our understanding and modeling of climate extremes by combining physical insights with statistical methodology" is planned for Oslo, Norway in October 2015 that targets the "Understand" and "Simulate" themes (*http://www.wcrp-climate.org/extremes-modeling-wkshp-about*).

A large focus of this Grand Challenge is on supporting and training the next generation of emerging leaders in this field. To that end a series of summer schools has been developed that focus on the definition, observations, attribution, and physical drivers of extremes, as well as providing the tools and networks to link to the statistics and impacts communities.

The first of these summer schools was held in Trieste, Italy in July 2014 (*http://www.wcrp-climate.org/index.php/ictp2014-about*). There was a highly competitive application process with only 35 places available from a pool of 236 applications; about half of the attendees from developing countries. The summer school resulted in seven early career researcher-led papers based on the research problems tackled by the students during the training, which will appear in a special issue of the journal *Weather and Climate Extremes* later this year. This outcome is seen as a very successful contribution to our crosscutting activity to train the next generation of leaders in this field, enhance capacity, and ensure the future direction of research by young researchers with outstanding potential.

Another International Summer School is planned for Ticino, Switzerland in August 2015 (*http://www.c2sm.ethz.ch/education/summerschool2015*) to train future leaders in the field of extremes research. It will also include an interface with impacts research featuring presentations and workshops by representatives of the impacts community, including the Red Cross and Red Crescent, SwissRe, and MeteoSwiss. This is very important if the extremes research community is to provide relevant and actionable information to end-users.

As to broader meetings, a WCRP-wide open science conference on weather and climate extremes will be organized in 2017, where the achievements within the Extremes Grand Challenge will be presented and provide valuable input into the next IPCC Assessment.

These are just some of the examples of how we envisage the future and progress of the WCRP Grand Challenge on Understanding and Predicting Weather and Climate Extremes. An overview of the Extremes Grand Challenge and the Implementation Plan is available at: *http://www.wcrp-climate.org/index.php/grand-challenges*. The authors welcome feedback and input from the GEWEX community on this important topic.

First Workshop of the Grey Zone Project

Hamburg, Germany
1–3 December 2014

A. Pier Siebesma
Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands

As a result of ever-increasing computer resources, more and more weather prediction and climate models can now operate at horizontal resolutions in the range of 1–10 km. Models operating in this range, for which the name "the Grey Zone" has been coined, are capable of partially resolving atmospheric processes connected to vertical overturning, such as the convective transport of heat and moisture associated with clouds. A partial parameterized description of these processes is still needed and requires scale-aware parameterizations (i.e., parameterizations that reduce their impact with increasing resolution).

The Smagorinsky model for the subgrid contribution of boundary layer turbulence is a classic example of a scale-aware parameterization and has been one of the main reasons for the success of Large Eddy Simulations (LES). However, the Smagorinsky model can only be applied if part of the atmospheric turbulence is resolved and this is only true at scales substantially smaller than 1 km. Little is known about how to design scale-aware parameterization of clouds and convection at scales larger than 1 km. It is a common practice of modelers to simply switch off convection parameterizations at an arbitrary resolution in the Grey Zone, rather than to explore the potential of scale-aware parameterizations of cloud and convective processes.

At the annual meeting of the Working Group of Numerical Experimentation (WGNE) in Tokyo in 2010, Martin Miller proposed a project that would explore the behavior of models operating in the Grey Zone by systematically varying the resolution with and without parameterized convection for a number of relevant convective atmospheric cases.

The Grey Zone Project

WGNE initiated the Grey Zone Project in collaboration with the GEWEX Panel on Global Atmospheric System Studies (GASS). The objectives of the Project are to: (i) gain insight and understanding of model behavior in the Grey Zone with and without conventional cloud and convection parameterizations; and (ii) provide guidance and benchmarks for the design of new scale-aware convection parameterizations that can operate in the Grey Zone.

In practice this can be achieved through expensive numerical simulations at an ultra-high turbulent eddy resolution (Δx = 100~200 m) that can serve as a reference for other models that operate at lower resolutions. By repeating these simulations systematically at coarser resolutions in the range of 500 m to 10 km, with and without convection and cloud parameterizations, the project will provide information on how these parameterizations behave at these resolutions and can demonstrate the impact of switching off convection parameterizations at a certain resolution.

CONSTRAIN: A Cold Air Outbreak Case

The first Grey Zone Project case is a model intercomparison of a cold air outbreak observed during the CONSTRAIN field campaign over the North Atlantic Ocean, north of the British Isles. The exploration of a cold air outbreak has been a long-standing need of both the weather and climate modeling communities and this case serves a double purpose: (i) the exploration of the capability of models in general to simulate a cold air outbreak in a realistic way; and (ii) quantification of how the model performance degrades with coarser resolutions in the Grey Zone.

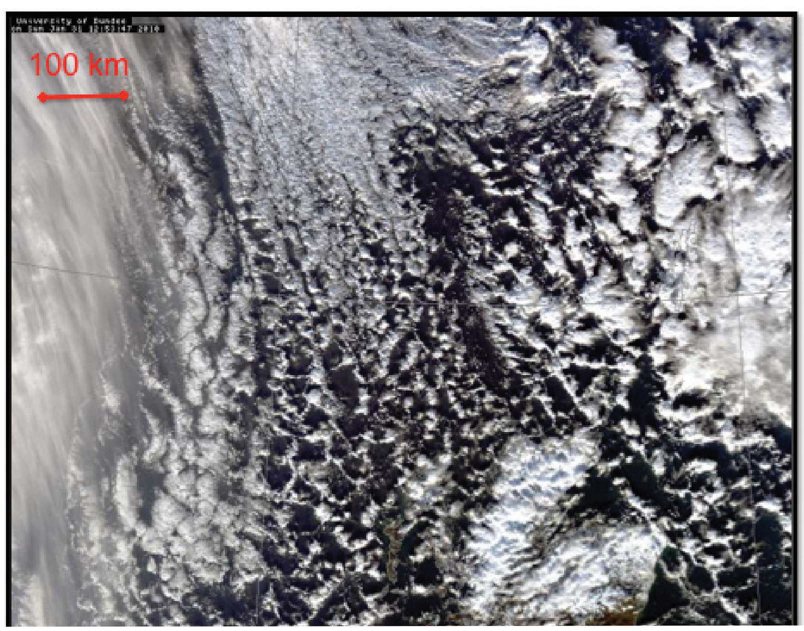
The figure below shows a Moderate Resolution Imaging Spectrometer (MODIS) visual satellite image of a typical cold air outbreak, such as was observed during CONSTRAIN on 31 January 2010, where cold air from the polar cap is swept off the ice edge over open water. The convection begins as organized rolls near the ice edge but eventually changes into open cellular convection as the boundary layer evolves. These cellular structures are as large as 50 km and their spatial structures influence the convective transport. Realistic simulations of such events have been a challenge for a long time for both operational weather and climate models, as well as for LES models. For this reason an intercomparison case such as a cold air outbreak was designed for global models, mesoscale models, and LES models. A detailed case description can be found on the web (*http://appconv.metoffice.com/cold_air_outbreak/constrain_case/home.html*). Global model runs were requested at their highest possible resolution (typically 5 km) and at a lower resolution (typically 10 km). The mesoscale simulations are defined on a 750 km x 1500 km domain that encompasses most of the image shown on the cover and are requested at horizontal resolutions of 1, 2, 4, 8, and 16 km. The LES codes were required to run in a Langrangian mode using a smaller domain of 100 x 100 km^2, which is advected in a southern direction over the warmer seas to simulate the subtropical stratocumulus to cumulus (Sc-Cu) transition.

The Workshop

The first workshop of the Grey Zone Project was organized by Lorenzo Tomassini at the Max Planck Institute for Meteorology in Hamburg, Germany. Nearly 50 scientists came together to present and discuss model results from the intercomparison study based on the CONSTRAIN cold air outbreak, and novel ways of representing physical processes (clouds, convection, and turbulence) in models that operate in the Grey Zone with respect to these processes. A large number of modeling centers participated with a wide range of models, including seven global and mesoscale models, and six LES models.

The first day of the workshop was dedicated to presentations and discussions of the model results of the intercomparison study. Stephan de Roode analyzed and presented the LES model results. All large eddy simulations reproduced the stratocumulus-topped boundary layer during the first phase of the simulation. The timing of the break-up into cumulus clouds organized in an open cell structure varies strongly from model to model. The Met Office Large Eddy Model (MOLEM) showed a fast transition after 5 hours while the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) LES model did not show a transition at all. Sensitivity studies with LES codes reveal that precipitation efficiency plays a crucial role in this respect. Decreasing the droplet number concentration or increasing the ice to water ratio in the mixed-phase stratocumulus clouds enhances the precipitation efficiency and accelerates the transition to the broken cumulus clouds and the associated open cellular structure.

The mesoscale model results were analyzed and presented by Paul Field. The figure on the cover shows snapshots of the top of the atmosphere longwave (LW) radiation of five different mesoscale model results after 24 hours of the simulation along with a LW radiation MODIS satellite image as a reference. Lighter colors correspond to lower LW radiation (colder temperatures). Overall the large-scale features are well reproduced and most models do simulate a transition to a cumulus



A visual MODIS satellite image of the cold air outbreak north of the British Isles on January 31, 2010, 12 UTC, which encompasses a large part of the domain simulated by the participating mesoscale models.

Participants at the first workshop of the Grey Zone Project.

regime with a cellular structure. The results for the stratocumulus phase region are varied, but condensed water amounts are generally underestimated. The microphysics and related precipitation efficiency is the single most important factor determining the amount of cloud condensate in the atmosphere and consequently controls the transition.

Switching off the convection scheme at 1-km resolution runs did have some impact, but the resulting changes were generally smaller than the typical intermodel differences. This is partly due to the fact that the convection scheme is not overly active with relatively low clouds (cloud top is around 3 km). A substantial part of the mixing is achieved by the boundary layer scheme. Preliminary analyses of the mesoscale runs at coarser resolutions show that area-averaged metrics, such as radiation fields, do not vary greatly with resolution.

The global model results were analyzed and presented by Lorenzo Tomassini. The results were similar to the mesoscale model runs. In some global models the stratocumulus phase was even missing, but otherwise they all simulated a cellular cumulus structure, albeit with a too-low condensed water content.

Overall, the model results suggest that for this cold air outbreak case, the uncertainties in microphysics and boundary layer mixing are a larger source of errors than the potential lack of scale-awareness of the convection schemes used. It should also be emphasized that some of the intermodel differences, including those presented in the figure on page 8, are due to differences in the setup and the prescribed forcings. A second round will therefore be organized that will likely result in a decrease in the multi-model spread.

On the second day of the workshop, new developments of turbulence and convection parameterizations in the Grey Zone were presented and discussed. Many new analysis methods and new proposals for parameterization modifications were presented. Some of them are already in a semi-operational setting with beneficial effects mainly on the spatial mesoscale structures of clouds and precipitation. Examples of these developments include:

1. Scale-dependent blending of turbulence schemes by introducing a weighting factor that interpolates as a function of horizontal resolution between the 3D Smagorinsky length scales used in LES codes and the 1D length scale traditionally used in turbulence parameterizations in large-scale models.

2. Reducing the strength of the cloud base mass flux in the Grey Zone for shallow cumulus parameterizations using a similar weighting factor as in (1) above.

3. Including stochastic elements in cumulus convection parameterizations or, even simpler, in the temperature field in the boundary layer.

In general, there was a lot of interest from the workshop participants in intercomparisons with a focus on the relationship between model performance and resolution, and applying this to future cases with deep cumulus convection. More information on the workshop is available at: *http://www.knmi.nl/samenw/greyzone/*.

New resubmissions for the next step in the CONSTRAIN intercomparison study can be sent in until 1 April 2015. The final results will be reported in a number of papers in the fall of 2015.

Annual Meeting of the GEWEX Hydroclimatology Panel and Joint Session on the Global Drought Information System

Pasadena, California
10–13 December 2014

Jan Polcher[1], Jason Evans[2], and Sam Benedict[3]
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The GEWEX Hydroclimatology Panel (GHP) meeting was held at the California Institute of Technology and hosted by Dr. Graeme Stephens, Director of the Center for Climate Sciences at the NASA Jet Propulsion Laboratory and Co-Chair of the GEWEX Scientific Steering Group (SSG). A joint session of GHP and the Global Drought Information System (GDIS) Project was held on the first day with the goal of promoting closer collaboration between the regional efforts within GHP and GDIS related to drought monitoring and forecasts through the sharing of data, modeling expertise, and local capacity building. After the joint meeting, the GHP evaluated ongoing and planned activities within the Panel and their relationship to the GEWEX Science Questions. The meeting presentations are available at: *http://www.gewexevents.org/ghp-agenda*.

Drs. Stephens and Sonia Seneviratne (Co-Chairs of the GEWEX SSG), Peter van Oevelen (Director of the International GEWEX Project Office, IGPO), and Jan Polcher and Jason Evans (Co-Chairs of GHP) provided presentations at the opening of the meeting that highlighted the WCRP Grand Challenge (GC) related to changes in water availability. This GC is being led by GEWEX and is one of the highest societal priorities, and therefore of great importance to governments and agencies that sponsor climate research. Other items discussed included plans for the formation of a U.S. GEWEX Project Office under the auspices of the U.S. Global Change Research Program, and a growing interest in promoting a GEWEX high-resolution modeling initiative that could evolve on the international level. IGPO will assist with these developments and remain a central element of the U.S. contribution to WCRP/GEWEX for the foreseeable future.

Updates were provided for each element of the two main components of GHP—the Regional Hydroclimate Projects (RHPs) and the research topic-based Crosscutting Projects.

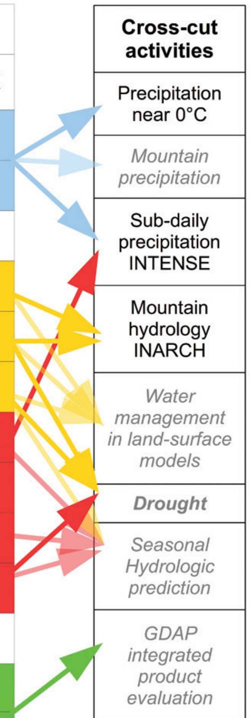
Regional Hydroclimate Projects (RHPs)

The presentations by the project managers of the RHPs highlighted the contributions that each RHP is making to the GEWEX Science Questions (GSQs). Details were provided as to: (i) the level of coordination with stakeholders to jointly

Participants at the Annual Meeting of the GEWEX Hydroclimatology Panel and Joint Session on the Global Drought Information System.

GHP activities in relation to GSQs

GEWEX Science Questions		Regional Hydroclimate Projects					
		MAHASRI	NEESPI	HyMeX	CCRN	HyVic	OzEWEX
Observations and Predictions of Precipitation	How well can precipitation be described?	y	y	y	y	y	y
	How do changes in climate affect the characteristics?	y	y	y	y	y	y
	How much confidence do we have in predictions?	y		y			y
Global Water Resource Systems	How do changes in the land surface and hydrology influence water resources?	y	y	y	y	y	y
	How does climate change impact water resource systems?	y	y	y	y		y
	How can new observations lead to improved management?	y			y		y
Changes in extremes	Observing system requirements	y	y	y	y		y
	Modelling capabilities			y	y	y	y
	Modelling processes involved in extremes			y	y	y	y
	Improved early warning systems	y			y	y	
Water and energy cycles	Can we balance the budget at TOA?						
	Can we balance the budgets at the surface?			y			y
	Can we track the changes over time?			y			y
	Can we relate changes and processes?						
	Cloud-aerosol-precipitation feedbacks						



produce tools and applied data sets; (ii) the interactions with modeling groups showing improvements in model developments that are specifically associated with any progress on high resolution modeling and their validation with data sets, and application by services; and (iii) the involvement of early career scientists and related outreach initiatives.

The sunset date for the Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI) was extended one year to March 2016. The Northern Eurasia Earth Science Partnership Initiative (NEESPI) will conclude at a Synthesis NEESPI Workshop to be held on 9–12 April 2015 in Prague. Both MAHASRI and NEESPI are considering follow-on studies that will build upon the legacy of their work. A mid-term project review of The Hydrological cycle in the Mediterranean Experiment (HyMeX) will take place in 2016. The regional studies around the Saskatchewan and Mackenzie River Basins in Canada are now designated as the Changing Cold Regions Network (CCRN) RHP and replace the Saskatchewan River Basin Project (SaskRB).

The Hydrology of the Lake Victoria Basin (HyVic) study was approved as an Initiating RHP and will modify its organizational structure, having been led by an International Planning Committee whose term ended upon approval of HyVic as an RHP. The Australian Energy and Water Exchange (OzEWEX) initiative was approved as an Initiating RHP due to its sufficient number of investigations into a broad range of issues that relate directly to the WCRP GCs and GSQs. GHP was informed that U.S. agencies are preparing to undertake a study to determine the feasibility and scope of a U.S. regional experiment designed to incorporate new observational and modeling capabilities to better understand and predict climate change, and help in the management of U.S. water resources. The Panel will assist a planning committee in a scoping exercise that will result in a proposal that meets the criteria of a GEWEX-style regional project positioned in the U.S.

The Panel acknowledged that Baltic Earth is well aligned with the WCRP Grand Challenges and GSQs, but postponed a decision to approve it as an initiating RHP until after the GHP Co-Chairs meet with the Baltic Earth Science Steering Group about including broader land and hydrological components in the Science Plan.

Two other studies, the Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations (RELAMPAGO) in South America and PannEx in the Pannonia Basin have observational and modeling elements that could be important to GHP goals and objectives. The GHP Co-Chairs pledged their support in assisting the leaders of these emerging studies in preparing white papers that could become the basis for more formal requests for Initiating RHP status within the next 1–2 years.

GHP Crosscutting Projects

GHP Crosscutting Projects are constrained to a 2–3-year period, with the possibility of renewal. The Intelligent Use of Climate Models for Adaptation to Non-Stationary Hydrological Extremes (INTENSE) Project has evolved into a European Research Council funded program with a community effort looking into the collection and analysis of sub-daily precipitation data and model outputs from contributing RHPs, such as HyMeX, OzEWEX, MAHASRI and CCRN. The Cold/Shoulder Season Precipitation Near 0°C Program was accepted as a GHP Crosscutting Project. It will draw upon data from the Arctic and Antarctic, where cooperation with the WCRP Climate and the Cryosphere (CliC) Project will be essential to its success. The International Network for Alpine Research Catchment Hydrology (INARCH) Study was also endorsed as a Crosscutting Project.

Four crosscutting initiative proposals were accepted by GHP: (1) Mountainous Terrain Rainfall (MOUNTerrain); (2) seasonal hydrologic prediction (in concert with the Hydrological Ensemble Prediction Experiment, HEPEX); (3) GEWEX Data and Assessments Panel (GDAP) integrated product regional evaluation; and (4) water management in large-scale models. Each of these initiatives will be given additional time to advance to the level of formal GHP Crosscutting Project and will be addressed, in that context, at the annual GHP meeting in 2015. The close inter-Panel coordination relationship between the Global Land/Atmosphere System Study (GLASS) Panel and GHP in the Land Surface Model Validation and Benchmarking Project will continue, but that effort will not carry forward as a GHP Crosscutting Project.

The Global Precipitation Climatology Centre and the Global Runoff Data Centre gave presentations. These global data centers are affiliated activities under GHP. The continued integration/alignment of activities at these centers with those developing within the crosscutting projects and RHPs was encouraging.

Wrap-Up

GHP will continue to maintain a close working relationship with the WCRP Working Group on Regional Climate. The Panel Co-Chairs agreed to draft a review article for publication in a technical periodical, such as the *Bulletin of the American Meteorological Society* or *Eos*. The Panel agreed that the objective of the GEWEX Process Evaluation Studies (PROES) to create a framework for process evaluation studies is a worthwhile initiative, and that its progress should be reviewed at the next GHP meeting. The next meeting will be held in Africa or Asia in the fourth quarter of 2015.

GEWEX/WCRP Calendar

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

23–27 March 2015—WGNE-30 Session—College Park, Maryland, USA.

8–10 April 2015—36th Meeting of the WCRP Joint Scientific Committee—Geneva, Switzerland.

9–12 April 2015—Ten Years of NEESPI: Synthesis and Future Plans—Prague, Czech Republic.

12–17 April 2015—EGU General Assembly—Vienna, Austria.

18–22 May 2015—GLASS Panel Meeting and Joint GLASS/GABLS DICE Workshop—Toulouse, France.

25–29 May 2015—World Water Congress XV—Edinburgh, Scotland.

14–19 June 2015—Chapman Conference on Evolution of the Asian Monsoon and its Impact on Landscape, Environment and Society—Hong Kong.

15–26 June 2015—1st WCRP Summer School on Climate Model Development: Atmospheric Moist Processes—Hamburg, Germany.

22 June–2 July 2015—26th IUGG General Assembly 2015—Prague, Czech Republic.

29 June–2 July 2015—Workshop on Input Observations for Reanalysis—Reading, United Kingdom.

2–3 July 2015—4th Session of the WCRP Data Advisory Council—Reading, United Kingdom.

7–10 July 2015—Our Common Future with Climate Change—Paris, France.

3–6 August 2015—US CLIVAR Summit—Tucson, Arizona, USA.

23–28 August 2015—14th International Swiss Climate Summer School–Extreme Events and Climate—Ascona, Switzerland.

14–18 September 2015—SOLAS Open Science Conference, Paris, France.

21–25 September 2015—9th HyMeX Workshop—Mykonos, Greece.

29 September–2 October 2015—Annual GDAP Meeting—Xiamen, China.

5–9 October 2015—11th International Conference on Southern Hemisphere Meteorology and Oceanography—Santiago, Chile.

20–23 October 2015—Earth Observation for Water Cycle Science 2015—Frascati, Italy.

17–19 November 2015—International Conference on Water and Energy Cycles in the Tropics—Paris, France.

GEWEX NEWS

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