World Meteorological Organization

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

International Science Council

WCRP World Climate Research Programme

31st Session of the GEWEX Scientific Steering Group

25 February – 1 March 2019, Geneva, Switzerland

July 2019

WCRP Publication No.: 11/2019

Bibliographic information

This report should be cited as:

Oevelen, Peter J. van, et al., 2019: 31st Session of the GEWEX Scientific Steering Group. WCRP Report 11/2019; World Climate Research Programme (WCRP): Geneva, Switzerland; 57 pp.

Contact information

All enquiries regarding this report should be directed to wcrp@wmo.int or:

World Climate Research Programme
c/o World Meteorological Organization
7 bis, Avenue de la Paix
Case Postale 2300
CH-1211 Geneva 2
Switzerland

Cover image credit

Image cover page courtesy of deepakhere.mypixels *"Lake Geneva, Switzerland"*

Authorship and publisher's notice

This report was authored by Global Energy and Water Exchanges (GEWEX) Project.

Dr. Ir. P. van Oevelen	*Director, GEWEX International Project Office*
Dr. J. Polcher	*Co-Chair, GEWEX SSG*
Dr. G. Stephens	*Co-Chair, GEWEX SSG*
Dr. K. Findell	*Co-Chair, GLASS Panel*
Dr. G. Balsamo	*GEWEX SSG member*
Dr. M. Bosilovich	*GEWEX SSG member*
Dr. J. Cuxart	*Co-Chair, GHP Panel*
Prof. Dr. P. Dirmeyer	*GEWEX SSG member*
Prof. Dr. Q. Duan	*GEWEX SSG member*
Prof. Dr. T. L'Ecuyer	*Co-Chair, GDAP Panel*
Dr. M. Ek	*Co-Chair, GLASS Panel*
Prof. J. Evans	*Co-Chair, GHP Panel*
Dr. B. Ivančan-Picek	*GEWEX SSG member*
Dr. Chr. Jakob	*GEWEX SSG member*
Dr. D. Klocke	*Co-Chair, GASS Panel*
Prof. Dr. G. Poveda	*GEWEX SSG member*
Dr. R. Roca	*Co-Chair, GDAP Panel*
Prof. Dr. B.J. Sohn	*GEWEX SSG member*
Prof. Dr. Z. Su	*GEWEX SSG member*
Prof. Dr. X. Zeng	*Co-Chair, GASS Panel*

The **G**lobal **E**nergy and **W**ater cycle **Ex**changes (**GEWEX**) project is a core project of WCRP and is dedicated to understanding Earth's water cycle and energy fluxes at the surface and in the atmosphere. We are a network of scientists gathering information on and researching the global water and energy cycles, which will help to predict changes in the world's climate.

WCRP is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Science Council (ISC). See www.wmo.int, www.ioc-unesco.org and council.science.

Disclaimer

Executive Summary

This report documents the proceedings of the 31st Session of the Global Energy and Water cycle Exchanges (GEWEX) Scientific Steering Group (SSG), the annual meeting of the scientists who guide the formation of GEWEX's scientific program as well as the Chairs and Co-Chairs of the GEWEX Panels. The attendees reviewed the progress of GEWEX and its four Panels for the year 2018 and discussed the program's relevance today. Some Panels are undergoing change and growth, such as the Global Atmospheric System Studies (GASS) Panel, while others remain on a path of steady progress, such as the Global Land/Atmosphere System Study (GLASS) Panel and GEWEX Hydroclimate Panel (GHP) or looking at changes as is the GEWEX Data and Analysis Panel (GDAP). The activities of the International GEWEX Project Office (IGPO) for the year concerned mostly the organization of the 2018 GEWEX Open Science Conference and its aftermath, planning meetings and improving their internal operations and presence on social media. The meeting ended with a discussion of possible action items for the coming year and a start was made with the revision of the strategic plan for GEWEX for the coming years.

Contents

1 Introduction and Overview

This report summarizes the main developments in GEWEX during the year 2018 and includes the major items and recommendations from the 31st Session of the GEWEX Scientific Steering Group (SSG-31). The GEWEX SSG 31 meeting was hosted by WCRP at WMO Headquarters in Geneva, Switzerland, from 25 February to 1 March 2019. Also present at the SSG-31 meeting were representatives of the National Aeronautics and Space Administration (NASA), the Japan Aerospace Exploration Agency (JAXA), the Exploitation of Meteorological Satellites (EUMETSTAT), the European Space Agency (ESA), US Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), US Global Change Research Program (USGCRP), United Nations Educational, Scientific and Cultural Organization (UNESCO), the four core and additional programs of WCRP and collaborating partners of GEWEX. This session of the SSG addressed both responses to advice resulting from the latest World Climate Research Programme (WCRP) Joint Scientific Committee (JSC) meeting and developments in WCRP and other global programs. Two of the questions requiring reflection are why GEWEX needs to continue on after 30 years as a core project of WCRP and how it should evolve as WCRP goes through a time of transition. Also worth considering is whether the GEWEX Science Questions are still valid, or if they need to be adjusted, which applies to the GEWEX-relevant WCRP Grand Challenges and the GEWEX strategic plan both.

1.1 GEWEX and GEWEX Panels: Overview of Results, Goals and Plans

This section gives an overview of major results, goals and plans of GEWEX and the GEWEX Panels. The major activities for the GEWEX Panels are described in more detail in Section 2.0.

For GEWEX, 2018 was characterized by activities preparing for and the aftermath of the 8th GEWEX Open Science Conference (OSC), which was held in Canmore, Canada in 2018; the Early Career Researcher (ECR) Workshop held prior to the Conference; and the GEWEX Panel side meetings during the OSC. All GEWEX panels have regarded their panel structure and science plan to some extent, which has resulted in the appointment of new members and projects and finishing some of their older projects.

The Global Atmospheric System Studies (**GASS**) Panel is responsible for all atmospheric processes through understanding physical processes and the coupling of those processes to atmospheric dynamics. With the appointment and start of the new co-chairs, Xubin Zeng and Daniel Klocke, GASS has been revitalized and experiencing a growth phase. The Pan-GASS conference in Australia in February/March 2018 has been highly successful, resulting in recruitment of new Panel members, the launch of four new projects and a comprehensively revised GASS projects webpage. Close collaboration with the Department of Energy, Atmospheric Radiation Measurement Climate Research facility (DOE ARM) is ongoing and communication with WGNE and WWRP is enhanced. Collaboration with the Cloud Feedback Intercomparison Project (CFMIP) of WCRP is sought.

The GEWEX Data and Analysis Panel (**GDAP**) guides the production and evaluation of long term, global atmospheric, surface water, and energy budget products. GDAP has had a busy 2018 with project and panel meetings and discussions on the identity of GDAP. The outcome of these discussions are i) the need to reformulate and restructure the terms of reference for panel members and projects, ii) to increase focus on, and link to Process Evaluation Studies

(PROES), iii) a new paradigm for assessments and iv) the repositioning of GDAP with other bodies like WMO/CGS, WDAC, TIRA and GCOS.

The GEWEX Hydroclimatology Panel (**GHP**) aims to address the GEWEX Science Questions from a regional and integrated perspective. Only at the regional scale can the water cycle be addressed from its physical to human and socioeconomic dimensions.
GHP strategy is to address GEWEX Science Questions and WCRP Grand Challenges through Regional Hydroclimate Projects (RHP) and Cross-Cut projects (CC). The RHP's are an essential tool in this endeavour as they bring together various disciplines on water issues.
Active RHPs are Baltic Earth (Baltic Sea Region), GWF (Canada and other cold regions), HyMEx (Mediterranean) and PannEx (Pannonian Basin). Prospective RHPs are ANDEX (Andes), POST-MAHASRI (Asia) and TPE (Tibetan Plateau).
The Cross-Cut projects allow GHP to propagate knowledge from one region to another and synthesize results at the global scale. They also allow development and testing of applications developed with the new knowledge (actionable science). Current Crosscutting Projects are INTENSE (Sub-daily precipitation), INARCH (alpine hydrology) and Near 0°C (Cold/Shoulder Season) Precipitation. Proposed Crosscutting Projects are MOUNTerrain (mountainous and high-elevation regions) and HRWC (Human Regulation of the Water Cycle) and determining evapotranspiration.
A new activity "GHP Network" is proposed to keep completed RHPs and Prospective RHPs that do not evolve into full RHPs involved in GEWEX activities. These Networks should facilitate collaboration and capacity building activities in areas of GEWEX science.
GHP Networks are a mechanism for new communities to be connected to GEWEX while developing towards a RHP and provide a mechanism for networks developed during RHPs to maintain activity and connections with GEWEX after the RHP has completed.
Global Data Centers linked to GHP collect and distribute important hydrology-related data and include GPCC (Global Precipitation Climatology Center), GRDC (Global Runoff Data Center) and HYDROLARE (Int. Data Centre on Hydrology of Lakes and Reservoirs).

The Global Land/Atmosphere System Study (**GLASS**) Panel's role is to identify and to improve modeling of land-surface processes and land-atmosphere interactions through: i) land-atmosphere coupling, ii) model data fusion and iii) benchmarking. GLASS works with partners to represent the Earth system through a better understanding of the role of land. Current projects in the benchmarking category are the Protocol for the Analysis of Land Surface models (PALS), the PALS Land Surface Model Benchmarking Evaluation Project (PLUMBER), International Land Model Benchmarking (ILAMB), the Global Soil Wetness Project 3 (GSWP3), and the GEWEX Soil and Water Initiative (SoilWat). Projects in the land-atmosphere coupling category are Local Land-Atmosphere Coupling (LoCo); the Land Surface, and Snow, Soil moisture Model Intercomparison Project (LS3MIP). The projects PALS/PLUMBER, GWSP3, LS3MIP, LUMIP, LoCo and DICE/GABLS are all Cross-Cutting Projects.

GEWEX is reviewing its current mission statement and strategy plan based on the WCRP review report. GEWEX is about the balance of the (fresh) water and energy cycle focusing on interaction and should own this. To make sure mission, goals, questions, objectives, etc. stay connected and linked Science Applications Traceability Matrix (SATM) will be used to formulate strategy and priorities for the coming years. The way forward seems to be in the form of Process Evaluation Studies where the use of observations is in a less traditional and less rigid model format to probe process understanding (bottom-up effort). Most GEWEX panels engage in process driven projects already.

The three PROES of GEWEX (Cross Cutting projects), which are being developed are:

1) UTCC PROES: Upper Tropospheric Clouds and Convection
2) GAP: GEWEX Aerosol-Precipitation
3) Warm Rain Process Study

These three PROES are Atmospheric based. GEWEX is looking at new PROES based on Land atmosphere interaction and aspects of the hydrological influence.

1.2 GEWEX Links to WCRP

The review and in-depth study of WCRP and all its projects, working groups, etc., commissioned by its sponsors (ICSU, IOC and WMO) and conducted by a panel of worldwide experts chaired by Julia Slingo, has been concluded. Their findings rendered a 50-page report, which includes a list of seven recommendations. Prominent recommendations include WCRP's need to be more integrated and connected with the weather community (WWRP) and the need of a new strategy plan that focuses on the long-term (10 year timespan) goals and the short-term (5 year timespan) organization of the program and its research. In February 2018, stakeholders met with sponsors in Paris to develop a new strategy plan covering the next 10 years, which has been approved at the Joint Scientific Committee (JSC) meeting in April 2018. WCRP has formulated a new vision stating " *A world that uses sound, relevant and timely climate science to ensure a more resilient present and sustainable future for humankind.* The accompanying new mission of WCRP is *to coordinates and facilitates international climate research to develop, share and apply the climate knowledge that contributes to societal well-being".* The four objectives for the coming period are:

1) Advance sciences that enable integrated and fundamental understanding of the climate, its variations and its changes, as part of a coupled physical, biogeochemical, and socio-economic system.
2) Quantify frontiers of predictions and the associated uncertainties for sub-seasonal to decadal time scales across all climate system components.
3) Quantify the responses, feedbacks and uncertainties intrinsic to the changing climate system on longer timescales.
4) Innovate the generation of decision-relevant information and knowledge about the evolving Earth system.

The urgency for change is felt. Objectives need to be measurable, while WCRP goals are too global, not measurable and no implementation strategy is visible. In time many questions have been and are being posed. It's necessary to look back and see which ones are actually answered and voice what is still unknown. On all topics key questions should be formulated, framing their influence on the world if those questions were answered. Around the 2019 JSC meeting planned in May 2019, discussions between JSC and leaders of all WCRP core-projects and other activities has started on possible ways to implement the WCRP Strategic Plan.

The WCRP Data Advisory Council (WDAC) acts as a focal point for all WCRP data, information, and observation activities with its sister programmes, and coordinates their high-level aspects across WCRP". It coordinates with GCOS and interacts with the four WCRP core programs, SPARC, CliC, GEWEX and CliVar. WDAC activities include: Observations for Model Intercomparisons Project (Obs4MIPS), Surface Fluxes (SurFlux) Task Team, The Intercomparison of Reanalyses (TIRA).

The objective of Obs4MIP is to identify, document and disseminate observations for evaluation in WCRP model Intercomparison. The SurFlux Task Team is working together with Obs4MIP to inject non-gridded in-situ flux datasets into the Obs4MIP Project. It aims to provide a single point-of-contact for surface flux observations and analysis in the WCRP, establish and encourage the publication and use of data, metadata, and documentation standards for global surface flux datasets, and establish conventions for Intercomparisons of global datasets. The main objectives of TIRA are to:

1. foster understanding and estimation of uncertainties in reanalysis data by intercomparison and other means;
2. communicate new developments and best practices among the reanalyses producing centers;
3. enhance the understanding of data and assimilation issues and their impact on uncertainties, leading to improved reanalyses for climate assessment; and
4. communicate the strengths and weaknesses of reanalyses, their fitness for purpose, and best practices in the use of reanalysis datasets by the scientific community.

1.3 GEWEX Interactions (Especially with WCRP Sponsors and Partners)

The National Aeronautics and Space Administration (NASA) conducts satellite missions relevant to GEWEX science. The study of the Earth from space is increasingly important, and NASA is joined by many space agencies and research institutes across the globe in gathering data relevant to the energy and water cycles. NASA will continue to develop the science around current and future satellite missions and is open to International and Interagency partnership. Geostationary has more capabilities and can be used for time resolution nowadays. NASA is developing and expanding its role to meet science and non-science user needs. GEWEX/WCRP can assist NASA build up calibration stations. NASA's Research Opportunities in Space and Earth Science (ROSES) 2018 is soliciting for proposals to form NEWS (NASA Energy and Water Cycle Studies) Process Teams to understand interaction between at least two major reservoirs of water. Proposed research should result in targeted, cutting-edge diagnostics for global climate models and weather forecast centers. Proposals should include how the NEWS process team supports and is supported by GEWEX.

JAXA has launched The Global Change Observation Mission – Water "SHIZUKU"(GCOM-W)", which is the successor of Aqua/AMSR-E satellite and is providing continuous data for climate studies and operational applications. It joins constellation and Global Precipitation Measurement (GPM) constellation. GCOM-W/AMSR2, which was launched in May 2012, is using a multi-polarization and multi-frequency microwave imager. It's observing various water-related Essential Climate Variables (ECV's) over atmosphere, land, ocean and cryosphere in high spatial resolution. The improved on-board calibration target has resulted in the reduction of annual TB (Brightness Temperature) variation due to calibration and improvement of TB stability. AMSR2 Land Surface Temperature (LST) is observing the top of forests over forest areas. It is capable to obtain frequent LST for both day and night. Different AMSR2 products are available, including detailed validation results, including ASW (All-weather Sea Surface Wind Speed), LST, PWL (Total Precipitable Water over Land) and TSI (Detection of Thin Sea Ice), which can contribute to GEWEX science. AMSR-E products are being reprocessed applying the latest AMSR2 algorithms and format to provide long-term analysis. GCOM-C (Carbon Cycle) was successfully launched. Second-generation Global Imager (SGLI) products will be released at the end of 2019. GOSAT-2 has been launched in 2018, while EarthCARE expects to be launched in 2020.Mission definition review of AMSR2 follow-on sensor (AMSR3) is currently ongoing. JAXA's global hydrological simulation model "Today's Earth (TE) utilizes

both global reanalysis and satellite observation data aiming to produce more reliable hydrological dataset and risk indices. Japan (local) 1-km model is about to be released also. JAXA collaborates extensively with other space agencies on data exchange, algorithm development, utilization in operational activities, improvement/validation on rainfall products, etc. (JMA (Japan Meteorological Agency), NASA, NOAA, ESA, EUMETSAT, DLR (German aerospace Center), CNES (The National Centre for Space Studies, CSA (Canadian Space Agency) and ISRO (Indian Space Research Organisation)).

The European Space Agency (ESA) budget for 2019 is allocated to five main domains:

1) Earth Observations (24.3%)
2) Space Transportation (22.5%)
3) Navigation (13.5%)
4) Human Spaceflight (12,0%)
5) Scientific Program (9.2%)

ESA has 15 satellites in operation and 25 are under development at this time. Earth observation missions are user driven and are defined by science partners in member states, e.g. EU Copernicus, EUMETSTAT Meteorology and Industry InCubed (Investing in Industrial Innovation in Earth Observation). Flagship missions include:

1) FLEX (Fluorescence Explorer; 2022): will map vegetation fluorescence to quantify photosynthetic activity.
2) Biomass Explorer (2022): maps on carbon storage and changes in the world forests.
3) EarthCARE (Cloud Aerosol and Radiation Explorer; 2021): understanding of the role that clouds and aerosols play in reflecting incident solar radiation back out to space and trapping infrared radiation emitted from Earth's surface.
4) Aeolus (2018): acquire profiles of Earth's wind on a global scale.
5) GOCE (Gravity field and steady-state Ocean Circulation Explorer; 2009 -2013): understanding of the gravity field.
6) SMOS (Soil Moisture Ocean Salinity; 2009): global observations of soil moisture over land and salinity over oceans.
7) CryoSat (2010): measuring the thickness of polar sea ice and monitoring changes in the ice sheets that blanket Greenland and Antarctica.
8) SWARM (2013): dedicated to unravel the magnetic field.

ESA is organizing the Living Planet Symposium in Milan on 13 – 17 May 2019.

EUMETSAT has long-term, multi-satellite programmes, with service continuity. It's constantly improving and expanding its portfolio of observations. EUMETSAT works on science and operations for climate data records from historical to future observations and provides operational access to foreign satellite data through agreements. With other agencies EUMETSAT partners in the joint CEOS/CGMS development of high-level architecture for climate monitoring from space WGClimate to address Global Climate Observing System (GCOS) requirements. The major objectives of WGClimate are:

i) Provision of a structured, comprehensive and accessible view as to what Climate Data Records are currently available from satellite missions of CEOS (Committee on Earth Observation Satellites) and CGMS (Coordination Group for Meteorological Satellites) members or their combination;

ii) Creation of the conditions for delivering further Climate Data Records, including multi-mission Climate Data Records, through best use of available data to fulfil GCOS

requirements (e.g. by identifying and targeting cross-calibration or re- processing gaps/shortfalls);

iii) Optimisation of the planning of future satellite missions and constellations to expand existing and planned Climate Data Records, both in terms of coverage and record length, and to address possible gaps with respect to GCOS requirements.

Considering the specific importance of greenhouse gas monitoring as stated in the Conference of the Parties (COP) 21 Paris Agreement, in addition to the Mandate (2018) WGClimate will coordinate activities of CEOS and CGMS defining and implementing an integrated global carbon observing system including a targeted observing system for monitoring the column concentrations of CO2, CH4 and other greenhouse gases from space as well as insuring that these activities are integrated into a broader approach on greenhouse gas monitoring, i.e., WMO IG3IS, GCOS, and GEO-C. It will oversee the implementation of the CEOS Carbon strategy also.

NOAA provides essential environmental information into the hands of those who need it. The mission of NOAA is to conduct research to understand and predict the Earth's oceans, weather and climate, to advance NOAA science, service and stewardship, and transition the results so they are useful to society**.** Its top priorities for the period 2017-2018 are: i) to minimize impacts from severe weather (implement Public Law 115-25) and ii) to increase the sustainable contributions of fisheries and oceans. The Climate Program Office (CPO) is a unique investment in end-to-end monitoring within the US government. It integrates information, engages the community through mission-driven research priorities, and collaborates with national and international communities. From a CPO perspective, GEWEX was always assumed to be involved with fast processes in the climate system, but this is changing. GEWEX needs to play a more interactive role with CPO. Looking ahead for the period 2020 – 2030 Interannual-to-decadal predictability and prediction studies are planned to address key priorities (e.g. make better forecasts; explore marine environment; drive innovative science). Also planned for this period are coordinated observation and modeling approaches to improve understanding and model representations of Earth system processes and interactions (e.g. raise the visibility of the science; integrate across capabilities; develop strategic partnerships).

Topics discussed in the space agency roundtable comprised of "How to address continuity?", and "How might GEWEX help develop a more integrative approach to setting science and applications objectives?". GEWEX could assist space agencies reaching their goals on several levels. GEWEX is able to bring an independent international community together to assess data records and define independent errors, which is essential for integrated analysis (data record stewardship). GEWEX can assist with coordination across agencies to develop new, improved data records, e.g. ISCCP Next gen as a direct contribution to different agencies goals and identify gaps from a GEWEX perspective, e.g. hydrology with sentinel. In addition, GEWEX has a more integrated, Earth system focus rather than a variable centric approach. NASA NEWS project was one example of how integration can be done.

The Pacific Northwest National Laboratory (PNNL), part of the Department of Energy (DOE), has identified storms called Mesoscale Convective Systems (MCSs). MCS's are ubiquitous and play important roles in precipitation and large- scale circulation. Most climate models do not simulate MCSs, as evidenced by their dry/ warm biases and erroneous diurnal cycle of precipitation. Convection permitting modeling holds some promises to simulate MCS cloud structures – important connections between large-scale circulation and precipitation. Different approaches are being developed and tested. MCS tracking, MCS database, and MCS metrics are being developed to support analysis and modeling.

The CLImate & ocean VARiability, predictability and Change (CLIVAR) core program of WCRP has undergone changes in the past year. New Co-chairs have been appointed, the Northern Ocean Regional Panel (NORP) has been installed, which is a joint CLIC/CLIVAR panel aiming to coordinate and facilitate activities on the role of the Northern Oceans in the context of the Global Climate System from a Coupled Ocean-Air-Ice Perspective, and a new CLIVAR Science Plan has been approved. The new scientific priorities are to: i) further investigate the mechanisms of climate variability and changes aspiring to constrain the fluxes of energy and carbon in the climate system better, ii) modulate climate variability and change in ocean processes and iii) tackle climate predictability challenges that exist over a broad range of space and time scales.

In 1989, the US Global Change Research Program (USGCRP) was established to help the United States and the world understand, assess, predict and respond to both the human-induced and natural processes of global change. Thirteen federal agencies are participating in this program, and those with relevant ties to water are mostly collaborating with GEWEX already. The group's work is highly relevant to the WCRP Grand Challenges. The Integrated Water Cycle Group (IWCG), coordinates and integrates global-change relevant water cycle research and advances capabilities and infrastructure that support water cycle observation, modeling and predictability at a range of scales. It develops approaches to apply and translate our understanding and inform decisions surrounding preparedness and resilience. Furthermore, it pursues interagency and end-to-end approaches across the Program. One of its programs is the Climate, Water, and Energy Exchanges (CWEX), which provides a focal point for coordinating interagency collaborative research and capabilities on water's and energy's coupled roles in a changing global climate system and provides a space for agencies and programs to coordinate interactions with relevant efforts of the World Climate Research Program (WCRP), e.g. GEWEX. Potential areas for further collaboration are precipitation metrics, soil moisture and land-atmosphere interactions.

The Joint Coordination Office for WCRP Regional Activities (CORA) is charged with the task of helping raise the profile and visibility of the WCRP regional activities. It will build on the existing WCRP infrastructure. CORA is just getting started (January 2018) and is developing a work plan with the assistance of the WCRP Joint Scientific Committee (JSC) and Joint Planning Staff (JPS).

1.4 GEWEX Outreach and Capacity-Building Activities

GEWEX is leading the WCRP Grand Challenge (GC) on Changes in Water Availability "*Water for the Food Baskets of the World*", which relates to the United Nations Educational, Scientific and Cultural Organization (UNESCO) International Hydrological Programme (IHP) goal to understand uncertainty and translate it back to water security. IHP plays a vital role in providing a scientific knowledgebase for policy advice to manage and cope with challenges to water resources, including disasters and floods, and to increase the resilience of natural and human systems with an emphasis on vulnerable communities. In addition, IHP promotes international cooperation to mobilize research and supports human and technical capacity building. IHP contributes to the implementation of UN goals and commitments such as the Sustainable Development Goals.

The Water Cycle is the main driver for production. As a warmer climate pushes the water cycle into unknown territory and the Terrestrial Water Cycle is not natural anymore, it is a matter of

urgency to understand the new state of the Water Cycle and Food Production in which natural and anthropogenic processes interact.
Activities in 2018 related to "*Water for the Food Baskets of the World*" have been many and diverse, e.g. Townhall and side meetings, workshops, completion of a White Paper and will be continued in the coming period.

GEWEX participates in the WCRP Grand Challenge on weather and climate extremes. This GC is looked at from a service perspective: "*What are frequency and magnitudes of various impact-causing extremes in the near and long term*?" and from a science perspective: "*Causes and mechanisms of variability and change in extremes, how to improve the prediction of change?*" Drought, heatwaves, heavy precipitation and storms are the four main extremes, which are researched using four overarching themes: i) Attribution (contributors to extreme events and changes in frequency and intensity), ii) Documentation (observations sufficient to underpin assessment of extremes), iii) Simulation (reliability, evaluation and improvement of simulation models) and iv) Understanding (role of large-scale, regional and local scale processes and their interaction).

GEWEX is also exploring potential collaboration with the WMO Hydrology Climate Land Water Department and Regional Panels and the Climate and Cryosphere (CliC) Project. A connection to CliC is found on the subjects of observing and modeling the Cryosphere, physical processes and dynamical understanding. Areas of possible future cooperation are High Mountains (water availability) and Polar Regions, building on GEWEX lead of Arctic Observation and Reanalysis Integrated System (ArORIS). In addition, the Earth System Model-Snow Model Intercomparison Project (ESM-SnowMIP) is a collaborative effort between CliC and GLASS. The Land Surface, Snow and Soil Moisture Model Intercomparison Project (LS3MIP), a CliC and GEWEX project, is addressing core research questions of WCRP and is relevant to a large number of WCRP activities.

CORDEX (Coordinated Regional Climate Downscaling Experiment) has suggested working together with GEWEX GHP to organize the 2019 CORDEX Conference in Nanjing in October 2019.

GDAP shares responsibility with the Global Climate Observing System (GCOS) for the Baseline Surface Radiation Network (BSRN), which is essential to setting standards and providing high quality radiation measurements for the evaluation of satellite data sets and climate models.

GEWEX benefits greatly from its strong interactions with other WMO and WCRP initiatives. The Global Data Centers for precipitation, river runoff, and lakes/reservoirs [Global Runoff Data Centre (GRDC), the Global Precipitation Climatology Centre (GPCC) and the International Data Centre on Lakes and Reservoirs (HYDROLARE), respectively] are affiliated activities under GEWEX and are connected through a number of outside bodies to obtain meaningful data for application to research of interest to the broader climate research community.

Under GDAP, the Surface Radiation Budget Project (SRB) is participating in the WCRP Data Advisory Council (WDAC) Surface Fluxes Task. In addition, GDAP has presented a paper to WDAC on "Data Set Quality Assessments: Needs, Benefits, Best Practices and Governance," which provides guidance for a more homogeneous approach towards assessments of data set quality. The GDAP Co-Chairs continue to be active in the WDAC Observations for Model Intercomparisons Project (Obs4MIPs) Task Team and support the open data call.

Cross collaboration opportunities between GEWEX and WCRP core program SPARC (Stratosphere-troposphere Processes And their Role in Climate) concern topics like Quasi-Biennial Oscillation (QBO) in the lower stratosphere and their influence on Madden-Julian Oscillation (MJO) and monsoon/convection impact on Upper Troposphere and Lower Stratosphere (UTLS), including building links to the GEWEX/CLIVAR Monsoon Panel.

The World Weather Research Programme (WWRP) is WMO's mechanism to foster and progress cooperative international research for improved weather and environmental prediction services from minutes to seasons strengthening academic-operational partnerships around the world. Area's for collaboration are Precipitation, the Grand Challenge "Weather & Climate Extremes" and Seamless Earth System Approach bridging Geophysical and Social sphere. More specific on a project level HIWeather can be mentioned. HIWeather is one of WWRP's core projects (2016) and an opportunity for collaboration with GEWEX's GASS and/or GLASS panel. Key objectives of HIWeather are: i) more accurate and reliable forecasts from minutes to seasons and ii) enhance society's resilience to extreme weather and the value of weather information for users. In addition, it might be considered to incorporate WWRP implementation plan in GEWEX's strategy plan.

The mission statement of 'The integrated Land Ecosystem-Atmosphere Processes Study' (iLEAPS) is to foster scientific excellence at the land-atmosphere interface and its impact on societal issues and to provide essential science that links biological, chemical and physical processes from local to global scales in the changing Earth system. The main focus is on capacity building globally and preparing the next generation of leadership through ECS networks. Links between iLEAPS and GEWEX are:

1. Land Surface Modelling Summit – 2020 in Oxford
2. Use of Flux data. Include carbon fluxes in PLUMBER2.
3. Impact of CO2 fertilisation on the water cycle
4. Impact of the water cycle and extremes on the global carbon cycle
5. *Data science. How to analyse satellite data with societal data?*

GEWEX and iLEAPS collaboration is underway through the GLASS Global Soil Wetness Project, Phase 3 (GSWP-3) Project. In addition, the Land-Use and Climate, IDentification of robust impacts (LUCID) activity is an iLEAPS-GLASS supported project. GLASS is also recruiting member(s) from iLEAPS to be actively involved in both the planning and analysis of its new carbon activity.

HyMeX and the Australian Water and Energy Exchanges research initiative (OzEWEX) are collaborating with the Global Earth Observation for Integrated Water Resource Assessment (Earth2Observe) Project and the Hydrological Ensemble Prediction Experiment (HEPEX) in hydrological forecasting. As Earth2Observe reached completion in 2017, new avenues need to be pursued.

GEWEX and CLIVAR joint activities include the new JSC task group on extreme weather and climate, and the WCRP Monsoon Panel. The objectives of the Monsoon Panel are:

1. to advance understanding of monsoon variability and improving its prediction with observations and modelling as cornerstones of research activities (main);
2. to enhance emphasis on linkages across scales and physical processes;
3. to seek for new methods to enhance monitoring, advance diagnostics and improve models;

4. to develop more elaborated process studies coordinated with modelling activities (e.g. CMIP6); and
5. to empower the next generation of scientists around the world to advance our knowledge of monsoon systems, in particular in interested regions.

The Monsoon Panel acts as a hub to facilitate meetings and linkages among international research efforts (capacity building and manage renewal of membership). It continues interacting with IPCC AR6 & CMIP6, GMMIP on the workshop in China in 2019. In addition, it continues to be active on S2S diagnostics (e.g. waves) and is developing plans for future engagements with GEWEX's GLASS and GASS panels.
Some specific plans for the regional monsoons Working Group (WG) are the CORDEX-Africa and climate services for African monsoons, S2S for American monsoons, including a 2019 Summer School and stakeholder engagement for Asian-Australian monsoons.
In addition, the Earth's energy imbalance issue may become a strong collaborative project between GEWEX/CLIVAR with a meeting held in conjunction with the annual GDAP meeting in October of 2017.

Continued collaboration with the Group on Earth Observations (GEO) is provided through the Director of IGPO, who has been active in the Integrated Global Water Cycle Observations (IGWCO) Project. In addition, the Director of IGPO serves on the Board of the FP7 Earth2Observe Project and the Board of the Helmholz Alliance as a user group representative.

To encourage the involvement of young scientists in GEWEX/WCRP activities, IGPO has invited the Young Hydrologic Society (YHS) and the Young Earth System Scientists (YESS) communities to contribute one-half page in each issue of the GEWEX newsletter to advertise their activities. As part of the organization of the GEWEX Conference in 2018, the inclusion of research from both early career scientists and those from lesser-developed countries is important. Funding will be a critical aspect in making in particular the latter aspect a success.

2 GEWEX Panel Status Reports

2.1 Global Atmospheric System Studies Panel (GASS)

Reporting Period : 01 January - 31 December 2018
Starting Date : 2018
End Date (where appropriate) : N/A
URL : http://www.gewex.org/panels/global-atmospheric-system-studies-panel

Membership

Chair(s) and Term Dates : Xubin Zeng, 2017 – Present
Daniel Klocke, 2017 - Present

Members and Term Dates : Irina Sandu, 2018 – Present
Ian Boutle, 2018 – Present
Shaocheng Xie, 2018 – Present
Yongkang Xue, 2018 – Present

Panel Objectives, Goals and Accomplishments during Reporting Period

Overall Panel Objective(s)

The Global Atmospheric System Studies (GASS) Panel facilitates and supports the international community that carries out and uses observations, process studies, and numerical model experiments with the goal of developing and improving the representation of the atmosphere in weather and climate models. Primarily, GASS coordinates scientific projects that bring together experts to contribute to the development of atmospheric models.

List of Panel Goals
Adjust yearly

- Initiate at least two new projects
- Expand the panel by adding at least four new panel members
- Increase cooperation with other international programs (particularly WGNE and WWRP) by attending both WGNE and WWRP steering group meetings and establishing 1 or 2 direct links (i.e. GASS representatives on WGNE and WWRP).

List of Key Results
Adjust yearly with respect to goals

- Four new projects initiated, another is close to being launched (see below)
- Panel members recruited, based on projects (see Panel Membership above). Panel needs to develop further.
- Enhanced communication with WGNE and WWRP: Discussion of Klocke and Zeng with WWRPleaders during the GEW EX Open Science Meeting in May 2018; direct engagement of WGNE and WWRP in developing GASS projects; Klocke attended the WWRP SSG meeting and gave a GASS update in November 2018; GASS Panel member Irina Sandu has a joint membership in GASS and WWRP Polar Program

Committee; Klocke gave a GASS update to the WGNE SSGmeeting via video conference in October 2018.

Other Science Highlights

Not part of the 2-3 major accomplishments

- Highly successful Pan-GASS Conference in Australia from 26 February – 2 March 2018, with a report in GEWEX News (Zeng and Klocke 2018) and a BAMS Article (Zeng et al. 2018) to highlightthe challenges and opportunities in global atmospheric system studies.
- Close collaboration with the DOE ARM (Atmospheric Radiation Measurement) and ASR(Atmospheric System Research) Programs: ARM Technical Director Jim Mather attended, and gave an oral presentation on, the Pan-Gass Conference in February 2018; Zeng gave an invitedtalk on the GASS-ARM/ASR partnership at the ASR/ARM PI's meeting in March 2018; ARMobservations will be used in GASS projects; ARM/ASR provides small support for GASS-related meetings, and ARM is willing to host GASS data.
- Streamlining the GASS relationship with PROES (GAP, UTCC): GEWEX Upper TroposphericClouds and Convection Process Evaluation Study (UTCC PROES), building a bridge between GDAP and GASS, will now be covered by GASS; the possibility of a link to the WCRP SPARC(Stratosphere-troposphere Processes And their Role in Climate) Project was discussed at the lastUTCC PROES meeting; UTCC provides a link of GEWEX to the WCRP SPARC (Stratosphere-troposphere Processes And their Role in Climate) Project; Zeng gave an invited talk on GASS-ACPC/GAP relation at the ACPC Conference in April 2018; GAP (GEWEX Aerosol Precipitation) Project as a PROES is now covered by GASS; GAP is closely related to the joint iLEAPS/GEWEXACPC (Aerosols, Clouds, Precipitation and Climate) Initiative.
- Pursuit of collaboration with the WCRP CFMIP (Cloud Feedback Model Intercomparison Project):Zeng gave an invited talk on GASS at the CFMIP Conference in October 2018, followed by the conversation between leaders of GASS and CFMIP on future joint projects.

Panel Activities during Reporting Period

List of Panel Activities and Main Result

- Four new projects initiated, another is close to being launched (see next)
- Four new GASS Panel members appointed (see Panel Membership above)
- Collaborations with WGNE, WWRP, GEWEX/GLASS in developing GASS projects (see next)
- Streamlined relationship of GASS with PROES (GAP, UTCC) (see above)
- Formalized partnership with DOE ARM/ASR (see above)
- Pursuit of collaboration with WCRP CFMIP (see above)
- UTCC PROES: This activity, together with a working group, was established in 2015 to advance our understanding on climate feedback of upper tropospheric clouds. Since then the activities were yearly reported to the GDAP Panel. Highlights in 2018: construction of a website by the FrenchData Center AERIS (https://gewex-utcc-proes.aeris-data.fr/), the 4th UTCC PROES workshop in October 2018, hosted by Sorbonne University in Paris (presentations available at the website and summary in GEWEX News Feb 2019).
- We have comprehensively revised the GASS projects web site, dividing projects into CurrentProjects, New Projects to be launched, and Finished Projects.

The Finished Projects are listed here, and no updates are provided:

* Microphysicso
* Boundary Layer Cloud
* Polar Cloud
* Cirrus Model IntercomparisonoClouds Above the United States and Errors at the Surface (CAUSES)
* CFMIP-GASS Intercomparison of LES and SCMs (CGILS)
* GEWEX Atmospheric Boundary Layer Study 3 (GABLS-3)
* Grey Zone Project: Cold Air Outbreak Intercomparison Case
* Vertical Structure and Diabatic Processes of the Madden-Julian Oscillation: A joint projectwith the MJO Task Force using YOTC data

List of New Projects and Activities in Place and Main Objective(s)

- Surface Drag and Momentum Transport project, Objective: bringing together the observational and modelling communities for efforts to constrain and thereby improve the representation of drag processes (such as orographic drag, convection momentum transport etc), Leads: Irina Sandu,Louise Nuijens, Annelize van Niekerk. The first phase in this project, called COORDE(COnstraining ORographic Drag Effects), was launched in September 2018 and the analysis of thefirst submitted results is currently under way. This activity aims at understanding the impact of resolved and parametrized orographic drag on the atmospheric circulation through the COORDEnation of model experiments and output from several modeling centres. The protocol of the COORDE inter-comparison project follows the study of Van Niekerk et al. (2018). COORDE is led by Annelize van Niekerk and Irina Sandu. The idea is to use high and low resolution simulations over some of the most complex mountain chains to identify caveats of blocking and gravity wave drag parametrizations. This is an excellent partnership between WGNE and GASS:WGNE did the initial surface drag project, while we take the next step as a GASS/WGNE joint project to focus on understanding orographic drag processes and their representation in models. An article will be published in the next issue of GEWEX News. The second phase will focus on convective momentum transport and will likely be related with the upcoming EUREC4A fieldcampaign (Jan/Feb 2020) and the modelling activities around it. This should start in 2020.
- Impact of Initialized Land Temperature and Snowpack on Sub-Seasonal to Seasonal Prediction (LS4P), Objective: quantify impact of surface and subsurface initialization on sub-seasonal to seasonal predictions and assess the relative role in comparison to sea-surface temperature,Leads: Yongkang Xue, Tandong Yao, Aaron Boone. Close interaction with WWRP and WGNE:Discussion of Klocke and Zeng with WWRP and WGNE leaders during the GEWEX Open Science Meeting in May 2018; sent the initial White Paper to WGNE and WWRP; furtherinteraction with WWRP/WCRP S2S (Sub-seasonal to Seasonal) Prediction Project and otherrelevant projects; this led to the revision of the final project white paper. This also has a closecollaboration with GEWEX GLASS and the GEWEX GHP, particularly the Third Pole Environment(TPE) program.
- Demistify: An LES and NWP Fog Modeling Intercomparison, Objective: Identify the ability of models to simulate radiation fog and identify key processes, Leads: Ian Boutle. This project is closely related to NWP in WWRP.
- Improving the Simulation of Diurnal and Sub-Diurnal Precipitation over Different Climate Regimes,Objective: understand and improve the diurnal cycle in atmospheric models in different climateregimes, Leads: Shaocheng Xie, David Neelin, Peter Bechtold, Hsi-Yen

Ma. This project will make use of a hierarchy of models including SCMs/CRMs/LESs, Cloud Permitting Models, and GCMs to diagnose and investigate the associated processes and model biases in depth by comparing withobservational data from DOE ARM and other sources. It is relevant to weather and climateprocess understanding and model improvements. http://portal.nersc.gov/project/capt/diurnal/.

- GEWEX Upper Tropospheric Clouds and Convection Process Evaluation Study (UTCC PROES) – now part of GASS; Objective: to gain a better understanding of the interconnection between theconvection and the properties of the outflowing anvils; Lead: Claudia Stubenrauch.
- GEWEX Aerosol Precipitation (GAP) Project as a PROES – now covered by GASS; Objective: to enhance our understanding of aerosol-precipitation interactions on a regional to global scale;Leads: Sue van den Heever and Philip Stier.

List of New Projects and Activities Being Planned, including Main Objective(s) and Timeline, Lead(s)

- Second Phase of the "Grey Zone" Project Based on the EUREC4A and Phase III of the GATE Field Campaigns WGNE/GASS White Paper on Scale-Awareness, Stochasticity, and ConvectiveOrganization, Objective: It is designed to have two parts: 1) focusing on shallow convection, and 2) exploring deep convection, Leads: Lorenzo Tomassin, Rachel Honnert, George Efstathiouk, Adrian Lock, Pier Siebesma. This project represents another excellent partnership between WGNE and GASS: The first phase was already a joint WGNE/GASS activity, while we take the next step as a GASS/WGNE joint project. This is also related to the WCRP CFMIP project. This project has gone through iterations with international programs (WGNE, WWRP) and the GASS community, and it will be launched in early 2019.
- Physics-dynamics coupling; Objective: to improve the understanding and numerical treatment of physics-dynamics coupling in atmospheric models; Leads: Hui Wan and Ben Shipway. Whitepaper has been prepared; we plan to launch it in second half of 2019.
- There are early discussions about a follow up on the GABLS projects. Details will be provided nexttime.
- Joint effort on the surface flux project of WGNE along with other programs; more details will beprovided next time

Science Issues and Collaboration during Reporting Period

Contributions to Developing GEWEX Science and the GEWEX Imperatives.

a. Data Sets
All data relevant to GASS projects (forcing data, model output, and validation data) will be available to the community; DOE ARM is willing to host GASS data.

b. Analysis
GASS projects are expected to develop new analysis tools and software that will be available to the community.

c. Processes
GASS projects are about process understanding and model treatment (e.g., precipitation, clouds, surface fluxes, coupling surface to atmosphere, aerosols, dynamics-physics coupling).

d. Modeling
GASS projects aim to improve different aspects of atmospheric models and related processes

e. Application
GASS projects intends to improve both weather and climate models

f. Technology Transfer
GASS projects intends to transfer improved model treatments to weather and climate centers

g. Capacity Building
GASS email list includes 500+ people (from graduate students to senior scientists in developed and developing countries); all GASS project white papers are circulated on this email list; junior scientists and scientists with limited resources are also encouraged to participate in GASS projects.

List contributions to the GEWEX Science Questions and plans to include these.

a. Observations and Predictions of Precipitation
- Three existing GASS projects directly address precipitation: the precipitation diurnal cycle,land impact on S2S prediction, and GAP
- Two projects to be launched in 2019 will also address precipitation: the gray zone project andthe physics-dynamics coupling project.

b. Global Water Resource Systems
- *One GASS project (land impact on S2S prediction) is directly related to the global waterresources systems.*

c. Changes in Extremes
- *All GASS projects aim to improve weather and climate models, including their capability in studying weather and climate extremes.*

d. Water and Energy Cycles
- *All GASS projects aim to improve weather and climate models, including their capability in studying the water and energy cycles.*

Other Key Science Questions
List 1 – 3 suggestion that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project

- *How can we quantify the local and remote impacts of land-atmosphere interaction versus remote impacts of ocean-atmosphere interaction on weather and climate over land (e.g., water for thefood baskets, extremes)?*
- *How do dynamics and physics interact in earth system models?*

Contributions to WCRP including Current Grand Challenges

Briefly list any specific areas of your panel's activities in particular to the grand challenges "Extremes" and "Water for the Food Baskets" which is not covered under 2.

- *Weather and climate extremes: All GASS projects aim to improve weather and climate models,enabling the modeling study of weather and climate extremes.*
- *Water for the food baskets: Several current and planned GASS projects (precipitation diurnalcycle, land impact on S2S prediction, GAP, gray zone, and physics-dynamics coupling) addressprecipitation that is directly related to water for the food basket.*
- *Clouds, circulation and climate sensitivity: UTCC PROES, the gray zone project and the physics-dynamics coupling project (to be launched by GASS in 2019) are directly relevant to the study of clouds, circulation and climate sensitivity.*
- *Near-term climate prediction: the GASS project on the land impact on S2S prediction is directlyrelevant to near-term climate prediction; the GASS COORDE project is also very relevant forprediction on all time scales.*

Cooperation with other WCRP Projects, Outside Bodies and links to applications

e.g. CLIVAR, CliC, SPARC, Future Earth, etc.

- WWRP/WCRP S2S (Sub-seasonal to Seasonal) Prediction Project: the GASS project on the land impact on S2S prediction cooperated with the WWRP/WCRP S2S Prediction Project in the development of the white paper and implementation.
- WCRP/WMO-CAS WGNE: Two GASS projects are joint with WGNE, and additional GASS projects are also related to WGNE.
- WWRP: We have involved WWRP in the development of GASS project white papers
- WCRP CLIVAR: Earth Energy Imbalance:more details will be provided next time.

Workshops and Meetings

List of Workshops and Meetings Held in 2018

Meeting title, dates and location

- *2018 UMAP 2nd PanGass Meeting Feb 26 - Mar 2, 2018, Lorne, Australia; a GEWEX News article (Zeng and Klocke 2018) was published to summarize the outcome.*
- *2018 UTCC PROES Workshop, Oct 22 - 23, 2018, Paris, France. A GEWEX News article (Stubenrauch et al. 2019) will be published in February 2019.*
- *2018 LS4P Workshop, Dec 8-9, 2018, Washington D.C., USA; a GEWEX News article (Xue et al. 2019) will be published in February 2019.*

List of Workshops and Meetings Planned in 2019 and 2020

Meeting title, dates and location and anticipated travel support needs

- 2019 UCP Meeting (with the Gray Zone workshop), Feb 25 – Mar 1, 2019, Berlin, Germany
- GASS panel meeting in the second half of 2019, co-located with a GASS project meeting
- GASS WGNE meeting 23-27 September 2019, Offenbach, Germany
- CFMIP meeting 1-4 October 2019, Mykonos, Greece
- WWRP SSG, November 2019, Geneva, Switzerland
- There will be additional GASS meetings to be planned by individual GASS projects
- The requested travel budget would be $15K/year (request emailed to Peter van Oevelen)

Other Meetings Attended On Behalf of GEWEX or Panel in 2018

- WWRP Geneva, Switzerland in October 2018; Klocke gave a GASS update.
- DOE ARM/ASR Vienna, Virginia, USA in March 2018; Zeng gave a GASS update and discussedcollaborations.
- ACPC Boulder, USA in April 2018; Zeng gave a GASS update and discussed collaborations.
- GEWEX Canmore, Canada in May 2018; Klocke and Zeng helped to organize the conference.
- CFMIP Boulder, USA in October 2018; Zeng gave a GASS update and discussed collaborations.
- WGNE Tokyo, Japan (per video conference) in October 2018; Klocke gave a GASS update.

Publications during Reporting Period

List of Key Publications

- Zeng, X., D. Klocke, B.J. Shipway, M.S. Singh, I. Sandu, W. Hannah, P. Bogenschutz, Y. Zhang, H. Morrison, M. Pritchard, and C. Rio, 2018: Future Community Efforts in Understanding and Modeling Atmospheric Processes, Bull. Amer. Meteor. Soc., doi: 10.1175/BAMS-D-18-0139.1.
- Zeng, X., and D. Klocke, 2018: Understanding and Modeling Atmospheric Processes: the 2nd Pan-GASS Meeting, GEWEX News, p. 19, February/May 2018 Issue.

2.2 GEWEX Data and Analysis Panel (GDAP)

Reporting Period : 01 January – 31 December 2018
Starting Date : 2018
End Date (where appropriate) : NA
URL : https://www.gewex.org/panels/gewex-data-and-analysis-panel/

Membership

Chair(s) and Term Dates : Rémy Roca (2016 - Present)
Tristan L'Ecuyer (2016 - Present)

Members and Term Dates : Claudia Stubenrauch (2007 - 2018)
Hirohiko Masunaga (2010 - Present)
Andrew Heldinger (2011 - Present)
Tianjun Zhou (2011- Present)
Wouter Dorigo (2013 - Present)
Chris Kummerow (2014 - Present)
Seiji Kato (2017 - Present)
Isable Trigo (2017 - Present)
Eui-Seok Chung (2019-present)

Panel Objectives, Goals and Accomplishments during Reporting Period

Overall Panel Objective(s)

- Assess the current state of the observational capability to document the global water and energy cycle elements with emphasis on the consistency and the GEWEX science questions fitness for purpose with a climate driven focus and emphasis on satellite-based datasets. Sponsor ground-based references networks. Trigger new international initiative in support of the GEWEX Science questions and the panel activity.

List of Panel Goals
Adjust yearly

- Fine tune the identity and the overall panel objectives. Renew the panel composition. Sponsor assessments. Close unfinished assessments and projects.

List of Key Results
Adjust yearly with respect to goals

- The integrated product has been made available to the public (after a substantial delay). A article for the GEWEX newsletter is about to be submitted.
- One new panel member has been recruited. One old panel members has quit. Panel needs to be renewed substantially.

Other Science Highlights
Not part of the 2-3 major accomplishments

- -

Panel Activities during Reporting Period

List of Panel Activities and Main Result

- Integrated product: the data have been released. While the final integrated product does not solve all problems, it does constitute GDAP's best effort at synthesizing the diverse products, and thus represents far more than a simple collection of individual water and energy parameters, albeit perhaps less than a fully consistent set of parameters at all levels. In addition, as is often the case, products evolve continuously and an integrated product evolves with the individual components. Nonetheless, there is currently an 18 year time series available
- Water vapor Assessment phase 2: lead M. Schroder, H Brogniez and B Ho. The second phase of the project has been approved and will continue the successful assessment of various water vapor related datasets. A kick off meeting of the Phase 2 is organized in Spain June 13-15, 2019.
- The Precipiation assessment is on going and now a joint effort with IPWG (lead H Masunaga). A special issue on extreme precipitation is on going at ERL with many submissions in support of the assessment.
- The Cloud assessment is now finished.
- The aerosols assessment has been stopped without any deliverable after more than 10 years in action.

List of New Projects and Activities in Place and Main Objective(s)

- -

List of New Projects and Activities Being Planned, including Main Objective(s) and Timeline, Lead(s)

- ISCCP-NG (2019-2022)
  This new project aims at elaborating the a follow up to the ISSCP project. The Earth observing capabilities from geostationary orbit have advanced substantially over recent years. With the launches of Himawari-8 in 2015 and GOES-17 in 2018, the global geostationary constellation is now comprised of sensors with 10 or more channels, viewing the earth at sub-hourly time scales and with resolutions finer than 5 km. With the launch of Meteosat Third Generation (MTG) planned for 2021, the global geostationary constellation will have 10 common spectral channels.
  There is a clear need to exploit this new Earth observing capability for cloud climatology. However, the scientific needs will vary widely among potential users of current geostationary data sets, and an eventual ISCCP-NG data record, in addition to the programmatic priorities among sponsoring agencies and international partners. The primary goal of the workshop is to define the scientific scope, the technical contents and methods needed for ISCCP-NG as well as to discuss the needed international cooperation to generate, validate, document, and provide the data set to users. A scoping meeting is organized in October 2019.
- Land Surface - Atmosphere interactions from global water and energy perspective (2020-2023).
  This new activity is aiming at stimulating land -atmosphere interactions dicussions to better understand how global, regional, and local datasets may best be integrated to close land surface energy and water budgets and establish relationships between

surface properties, estimated surface fluxes, and the movement of energy. The first activity is centered around a first workshop to be held Q1 2020.

- EEI Assessment (2019 - 2022). The need for this new assessment has been identified at the WCRP Workshop on imbalance in Toulouse and was endorsed by the panel in December 2018. The identified leaders are B. Meyssignac (CNES, France) and T. Boyer (NOAA, USA).

Science Issues and Collaboration during Reporting Period

Contributions to Developing GEWEX Science and the GEWEX Imperatives.

a. Data Sets
-

b. Analysis
-

c. Processes
-

d. Modeling
-

e. Application
-

f. Technology Transfer
-

g. Capacity Building
-

List contributions to the GEWEX Science Questions and plans to include these.

a. Observations and Predictions of Precipitation
-

b. Global Water Resource Systems
-

c. Changes in Extremes
-

d. Water and Energy Cycles
-

Other Key Science Questions
List 1 –3 suggestion that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project

- -

Contributions to WCRP including Current Grand Challenges
Briefly list any specific areas of your panel's activities in particular to the grand challenges "Extremes" and "Water for the Food Baskets" which is not covered under 2.

- GDAP & GC Extreme meeting on Precipitation extremes, Germany, July 2018 The WCRP Grand Challenge (GC) on Weather and Cli-mate Extremes and the GEWEX Data and Analysis Panel (GDAP) held a joint workshop on "Precipitation Extremes" at Deutscher Wetterdienst (DWD) in Offenbach, Germany from 9-11 July 2018. The workshop objectives were to:• Identify the form of a new International Precipitation Working Group (IPWG)/GEWEX Precipitation assess-ment chapter on extreme precipitation, including the selection of chapter leads and other contributors• Finalize a best practice guidance document for the WCRP Extremes GC on data use for assessing precipi-tation extremes, including the consideration of satellite-based measurements• Integrate the efforts of the remote sensing community in the literature on precipitation extremes that will be assessed for the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6)The workshop had 23 invited participants, bringing together experts from the communities addressing climate-scale perspectives in extreme precipitation observations to identify gaps and agree on common goals for future work. As part of the groundwork for the meeting, the organizers pre-pared a range of satellite-based, ground-based, and reanalysis datasets in the same format and on the same grid so that these could be compared and assessed at the workshop. Preliminary investigations performed by participants during the event were promising, highlighting both discrepancies and convergences between datasets.

Cooperation with other WCRP Projects, Outside Bodies and links to applications
e.g. CLIVAR, CliC, SPARC, Future Earth, etc..

- CLIVAR: Earth Energy Imbalance.

Workshops and Meetings

List of Workshops and Meetings Held in 2018
Meeting title, dates and location.

- 2018 GDAP & GC Extreme meeting on Precipitation extremes, Germany, July 2018
- 2018 GDAP Meeting November 2018, Lisboa, Portugal
- 2018 WCRP Workshop: the Earth's Energy Imbalance and Its Implications (EEI), November 2018, Toulouse, France
- 2018 UTC PROES Workshop, October 2018, Paris, France

List of Workshops and Meetings Planned in 2019 and 2020
Meeting title, dates and location and anticipated travel support needs.

- 2019 GDAP Meeting to be determined
- 2020:GEWEX Integrated Product Workshop.
  The workshop brings together expertise in satellite and ground-based Earth observations to better understand how global, regional, and local datasets may best be integrated to close land surface energy and water budgets and establish relationships between surface properties, estimated surface fluxes, and the movement of energy. An overarching goal of the workshop is to establish pathways for integrating the global energy and moisture datasets with observations collected at established field sites to understand mutual interactions between land surface processes, the atmospheric

boundary layer, and convection. The workshop will also seek to assess the overall consistency between surface fluxes in the newly released GEWEX Global, 1 degree, 3-hourly Integrated Water and Energy Product as well as identify additional parameters that should be included in the product going forward. Talks are solicited that address all aspects of energy and water cycle consistency both from the global satellite perspective, as well as existing ground based measurement sites such as ARM that can shed additional light on critical processes at a local scale. Talks that combine these satellite and ground-based perspectives or highlight the benefit of adding particular datasets to the Integrated product for new process insight are especially welcomed.
Venue: Universidad de Castilla □ La Mancha, Toledo, Spain
Dates: March 16-18, 2020.
Organizing Committee:
Christian Kummerow, Colorado State University, USA
Francisco Tapiador, U. Castilla □ La Mancha, Toledo, Spain
Isabel Trigo, Instituto Português do Mar e da Atmosfera, Lisbon, Portugal
Wouter Dorigo, Vienna University of Technology (TU Wien), Austria

Other Meetings Attended On Behalf of GEWEX or Panel in 2018

- Joint WDAC/GCOS meeting in Marakech, Moroco, March 2019.
- WDAC-7 meeting, including the SP discussion March, Geneva,Swisserland, March 2018
- BSRN science conference in Boulder Colorado, USA, July 2018

Publications during Reporting Period

List of Key Publications

- Roca, R., Alexander, L. V., Potter, G., Bador, M., Jucá, R., Contractor, S., Bosilovich, M. G., and Cloché, S.: FROGs: a daily 1°×1° gridded precipitation database ofrain gauge, satellite and reanalysis products, Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2019-51, in review, 2019.

2.3 GEWEX Hydroclimatology Panel (GHP)

Full Panel Name (Acronym) : GEWEX Hydroclimatology Panel Reporting **Period**
Starting Date: : 01 January -31 December 2018
End Date (where appropriate) : NA
URL : https://www.gewex.org/panels/gewex-hydroclimatology-panel/

Membership

Chair(s) and Term Dates : Jason Evans, 2013 -2019
Joan Cuxart, 2017 -2021

Members and Term Dates : Sylvester Danuor, 2017 -2019
Francina Dominguez, 2018 -2020
Craig Ferguson, 2015 -2020
Xin Li, 2016 -2021
Silvina Solman, 2014 -2019

Panel Objectives, Goals and Accomplishments during Reporting Period

Overall Panel Objective(s)

- To understand and predict continental to local-scale hydroclimates for hydrologic applications by concentrating on improving our understanding of environmental water and energy exchanges at the regional scale and from an integrated perspective.

List of Panel Goals
Adjust yearly

- The GEWEX Hydroclimatology Panel (GHP) aims to understand and predict continental to local-scale hydroclimates for hydrologic applications. GHP concentrates on improving our understanding of environmental water and energy exchanges at the regional scale and from an integrated perspective. Addressing the water cycle at the regional scale allows us to better understand the many components of the system, from its physical to economic to social aspects. There are three types of projects within GHP that allow us to do this:
  i) Regional Hydroclimatological Projects (RHPs) are an essential tool in understanding and predicting hydroclimates as they bring together various disciplines on water-related issues;
  ii) Cross-Cutting Projects allow GHP to propagate knowledge from one regionto another and synthesize results at the global scale. They also facilitate the development and testing of applications derived this new understanding,
  iii) Global Data Centers collect and distribute important hydrology-related data.

List of Key Results
Adjust yearly with respect to goals

- Mature RHPs (HyMeX and CCRN) have largely reached their scientific objectives, characterizing more deeply, with new observations and modelling exercises, parts of the hydrological cycle in their regions and are also managing to transfer the new knowledge into applications for weather and climate. CCRN is now being continued by GWF extending the regional scope in Canada and HyMeX is finishing the last planned activities, with the semi-arid irrigated experiment LIAISE planned for 2020. Baltic Earth,

successor to BALTEX and now a fully working RHP, is focused on the improved understanding of their region, with a strong focus on biogeochemical and marine processes. At the initiating status, PannEx is organizing itself into Task Teams able to fulfil the action's objectives.

- Two initiating RHPs have not been successful in reaching the fully working status. OzEWEX is mainly acting as a networking activity and HyVic ceased to report to the Panel. A new activity within GHP is proposed, GHP Networks, that will provide a space within GEWEX for activities like OzEWEX and also for ended RHP's that may want to maintain a collaborative structure.
- "Cross-cuts": INARCH on mountain hydrology, Precipitation near 0ºC in the changing environment and INTENSE on subdaily precipitation are very active and report significant advances.
- Data Centers for the Global Runoff (GRDC) and Global Precipitation Climatology (GPCC) maintain their activities, with less information reaching the panel about HYDROLARE on lakes and reservoirs.

Other Science Highlights

Not part of the 2-3 major accomplishments

- Coordination with CORDEX activities is being set by several RHPs.
- GHP Networks are proposed to provide continuity to ending actions in the GEWEX world and also to welcome activities that have a regional aspect and do not aim to structure as an RHP.
- A RHP session has been organized in the European Meteorological Society meeting (Kobenhavn, Sept 2018) with title "Regional Hydroclimate Projects helping understand water cycle processes and drivers" where meteorological activities of the three active European RHPs (HyMeX, Baltic Earth and PannEx) may gather and interact.

Panel Activities during Reporting Period

List of Panel Activities and Main Result

- Baltic Earth: 2nd Baltic Earth Conference (June), workshop on regional climate modelling (March) and workshop on multiple drivers for changes in the Baltic Sea in November. Initiation of an activity on climate change modelling with regional earth system models and of the design of coordinated experiments linked to regional coupled ocean atmosphere models (focus: ocean mixed layer dynamics, upwelling, sea level dynamics and volume transports). Research on the carbon cycling in the Baltic Sea being set. Establishment of an Advanced Earth System Model capacity, composed of 8 Helmholtz research centers. The Panel reports on publications mainly related to regional circulations and climate sensitivity, regional sea level change and coastal impacts, near-term climate prediction and carbon feedbacks in the climate system.
- GWF (Global Water Futures): This project is the continuation of Changing Cold Regions Network (CCRN), expanded in territorial coverage and re-shaping its main goals, fresh started in 2019 as RHP. The present summary deals with the CCRN final outputs. The coordinated analysis with modelling and observations of changing land, ecosystems water and climate was made for the Sub-Arctic, Boral forest, western cordillera and the Prairies in inner western Canada., with special emphasis in outreaching activities. The final report is found at http://ccrnetwork.ca/documents/Reports/CCRN_Final_Progress_Report.pdf. There effective progress about the main themes is detailed, including an inventory of observable local-scale change -including extreme events-, the deployment of enhanced field instrumentation, linked to the enhanced local-scale process understanding

- HyMeX: This RHP is approaching its end in 2020, after a very intense activity, both experimental and by numerical simulation, in the Mediterranean basin. Analysis of the campaigns made in the first half of the action keeps going on, while two new campaigns have taken place this year. Firstly, EXAEDRE in Corsica to study the electrical and microphysical environment of clouds . Secondly the PERLE (Pelagic ecosystem response to dense water formation in the Levant experiment) action aims at describing the formation and spreading of Levantine Intermediate Water (LIW), and determining its role on the distribution of nutrients and on the structuration of the planktonic ecosystems in the eastern Mediterranean, which will last until 2020. An experimental and modelling effort over semi-arid terrain with irrigation (LIAISE) is already being organized and will take place in 2020. The community indicates its will to continue working together and they could stay linked to GEWEX by using the new GEWEX-Networks scheme.
- OzEWEX: This action has been working very effectively as a Network, but it has not progressed in the terms expected for an initiating RHP. Therefore it is proposed to their leaders to reflect on how they want to continue to be linked with GEWEX, perhaps benefiting from the new GEWEX-Networks scheme.
- PannEx: This RHP was granted initiating status end 2017. During this year the Task teams are being formed to address effectively the Flagship Questions and Crosscut actions defined in their White Book, with include items related to agronomy, air quality, sustainable development or water management. The nine task teams in constructions are:
  i) Agro-climatological and Agro-biological Systems,
  ii) Energy Production
  iii) Special Observations and Data Analysis
  iv) Ecosystem Services
  v) Urban Climate and Air Quality
  vi) Outreach and Education
  vii) Micrometeorology and Agronomical Process Modelling
  viii) Water Balance at the basin scale
  ix) Modelling from Climate to Flash Floods.

  Teams plan to meet next June to start their activities in Novi Sad (Serbia). ESA opened a call on Drought in the Danube basin and the Black Sea area oriented with PannEx aims.
- INTENSE: A Cross-cut action devoted to hydrological extremes and subdaily precipitation for the period 2014-20. The data acquisition is concluded at this point with more than 25000 hourly data records worldwide, the database is transferred to DWD and will be given to Copernicus. Papers summarizing the work done so far have been published in Nature and Journal of Climate, among others. The funded project FUTURE-STORMS about convection-permitting models for a European domain at a resolution of 2.2 km has started.
- INARCH: A Cross-Cut action devoted to increase the understanding and prediction of the alpine cold regions hydrological processes, in particular defining consistent measurement strategies. There are currently 26 INARCH research basins in the Americas and Eurasia. Data are collected for these catchments together with model reanalyses and downscale climate model outputs. Two workshops were held in Switzerland and Chile, the latter trying to establish links with the Andean-related community.

- Near 0ºC precipitation: the changes in location and frequency of these events are explored by this Cross-Cut action, that has its end planned for 2019, but may eventually be extended further. The main effort is to produce reliable datasets, statistical and physical analysis is in progress in the aspects for which this is possible. Analysis of numerical simulations is also underway, that in the frame of CMIP5 show for Canada a northwards tendency displacement. Reanalyses have been used to inspect which areas are experiencing changes recently.

List of New Projects and Activities in Place and Main Objective(s)

- See below.

List of New Projects and Activities Being Planned, including Main Objective(s) and Timeline, Lead(s)

- New RHPs are in the horizon are:
  i) ANDEX, a prospective hydroclimate research project for the Andes, finds itself in the writing of its White Book, defining aims and tasks. Its main subjects identified are the hydroclimate characterization of the region, the environmental changes taking place, the monitoring of the Andes' Cryosphere and the study of high impact events.
  ii) The TPE Water Security is exploring the possibility to organize itself as an RHP after the input received during the Santiago meeting. The proposed subjects include: atmospheric circulations and remote sensing of the TPE area, with emphasis on the land-atmosphere-water interaction processes, considering climate projections, hazards and adaptation.
  iii) The "Post-MAHASRI" action in the Monsoon area is being organized and a formal proposal is expected in the next GHP meeting. Focus is expected to be on observational campaigns and high-resolution modelling studies, together with studies on variability of the Asian Monsoon.
- Discussions continue about a USA-fostered RHP centered on the Western Cordillera of North America (eventually including Canada and/or Mexico), linked to the Grand Challenge Food Baskets of the World. The main focus would be on changes in the partitioning between ET and runoff due to current and foreseen changes in climate and land-use. Data analysis and of process understanding through multi-scale field experiments and modelling exercises would be the basis of the action.
- New Cross-Cut initiatives under exploration are on:
  i) Water Management in Models,
  ii) Determining Evapotranspiration, for which a workshop is planned in October in Australia, and
  iii) MOUNTerrain, about precipitation in mountains, that needs a fresh re-start after a first try a few years ago.

Science Issues and Collaboration during Reporting Period

Contributions to Developing GEWEX Science and the GEWEX Imperatives.

h. Data Sets

- The active RHPs (HyMeX, Baltic Earth and CCRN/GWF) maintain their datasets and generate new ones as their activities progress, either with new campaigns or with the expansion of their networks. OzeWEX, which is functioning as a network, has as a priority the data collection, collation and hosting. PannEx is still in the initial phase and data sets are been defined.

- Cross-cuts also produce new data sets: i) INTENSE has completed a database on sub-daily precipitation and has obtained complementary numerical model data, ii) INARCH is compiling data from the 26 basins that form the network; iii) Precipitation near 0ºC has gathered observational data from the northern hemisphere, together with congruent numerical model data
- Data Centers on precipitation and runoff report continuous feeding of their data bases, whereas no new information is available from HydroLARE on basin water levels.

i. Analysis
Most actions use the same basic information inputs: analysis of existent data bases, generation of data in observational campaigns to study specific process and numerical modelling to have a comprehensive description of the processes in place, always checking against available observational information.

j. Processes
As described above, each action focuses on some particular aspects. Precipitation extreme events and the role of the sea surface waters is the dominant issue in HyMeX, the functioning of the Baltic Sea region as a complex biogeochemical earth system is Baltic Earth main aim, similarly to CCRN, that was more oriented to changing land, ecosystems water and climate. Cross-Cuts as described above tackle specific processes in a trans regional perspective, so far mostly devoted to precipitation (subdaily, in mountains or near 0ºC).

k. Modeling
Due to the variety of purposes that the different GHP actions have, many kinds of model types and simulation strategies are used. In the study of processes, detailed modelling is used at short-time scales, including single-column modelling, large-eddy simulation and high-resolution mesoscale modelling. In what refers to climate studies, they range from regional models with various techniques and time scales to global earth system modelling at the century scale. Impact of severe weather events is usually studied with mesoscale models, often taking advantage of operational forecasting systems.

l. Application
The overall objective of the GHP actions is to generate data bases and methodologies that can become of use in the centers that study the earth system, many of them being Meteorological and Hydrological Services providing direct service to society.

m. Technology Transfer
Data bases, model comparisons, parameterization testing have a direct impact in the day-to-day operational activities of weather and climate modelling centers, for instance in the generation of improved reanalyses, observed time series and expected trends.

n. Capacity Building
In most of the GHP actions capacity building is high, firstly because of the continuous improvement of the scientific and technical capabilities of the personnel involved and secondly because there is a sustained flow of PhD subjects related to the actions that contribute to the maintenance, renewal and eventually enlargement of the related scientific community.

List contributions to the GEWEX Science Questions and plans to include these.

e. Observations and Predictions of Precipitation
Those provided by HyMeX, CCRN, OzEWEX, INTENSE, INARCH, Precipitation near 0ºand GPCC, usually obtained from National Services, but also from research networks. PannEx and GWF will contribute to this subject as well as they progress.

f. Global Water Resource Systems
Besides precipitation (listed in the previous point), INARCH and CCRN have a well-defined hydrological component, also covered by the GRDC data center on Runoff. PannEx has planned to work intensively on the water management at the basin scale.

g. Changes in Extremes
The study of the occurrence and trends of extremes in the present climate is made by all GHP actions. The future changes are usually studied in the frame of regional climate modelling, by specific studies or through coordinated actions, such as in CORDEX.

h. Water and Energy Cycles
Most RHPs do not devote an equivalent effort to all parts of the energy and water cycles. Concerning the water cycle, precipitation is well addressed in general, while only some RHPs analyse the hydrological part, and evapotranspiration is not a subject of organized research to the date, which is a well-detected limitation. Concerning the energy cycle, measurements are well treated in GEWEX under GDAP, while the reflection at the regional scale could be much deeper in GHP, either observationally or numerically.

Other Key Science Questions
List 1 –3 suggestion that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project

i) Monitor water use over land and Introduce water management in models
ii) Characterize properly evapotranspiration, observationally and in models
iii) strengthen effectively community work regionally (through RHPs) and across regions (through CCs and other actions), improving communication and harmonizing the way tools are used.

Contributions to WCRP including Current Grand Challenges
Briefly list any specific areas of your panel's activities in particular to the grand challenges "Extremes" and "Water for the Food Baskets" which is not covered under 2.

- Most GHP actions contribute to the "weather and climate extremes" grand challenge by database building, campaigning and modelling.
- "Melting ice and global consequences" is an important subject for Baltic Earth and CCRN/GWF and it will be for ANDEX and TPE-WS if they become RHPs.
- "Regional sea level change and coastal impacts" is a main item for Baltic Earth in general and for HyMeX essentially on severe weather impacts.
- "Water for the food baskets of the world" is an issue that is being considered in the new actions, such as PannEx or the actions in an exploratory phase like ANDEX or the Western USA RHP.
- "Carbon feedbacks in the climate system" is explored in Baltic Earth, that has a very important biogeochemical component.
- "Near-term climate prediction" is considered, but normally handled within other actions such as CORDEX.
- "Clouds, circulation and climate sensitivity": usually these are matters taken into account in modelling studies within RHPs.

Cooperation with other WCRP Projects, Outside Bodies and links to applications
e.g. CLIVAR, CliC, SPARC, Future Earth, etc..

- Within GEWEX: cooperation is sustained with the other panels (GDAP, GASS and GLASS)
- Within WCRP: by its regional nature over land, there is interaction with CliC related to the GHP activities in high mountains and high latitudes. Cooperation with CORDEX is increasing as each RHP is interested in performing regional climate studies.
- With Future Earth: there are contacts with the research action iLEAPS (Integrated Land Ecosystem-Atmosphere Processes Study) in the building of an activity related to evapotranspiration.

Workshops and Meetings

List of Workshops and Meetings Held in 2018
Meeting title, dates and location.

- 2018 GHP -ANDEX -INARCH Meeting, October 2018, Santiago, Chile

List of Workshops and Meetings Planned in 2019 and 2020
Meeting title, dates and location and anticipated travel support needs.

- SSG-31 Geneva (Switzerland), February 2019
- 2019 GHP meeting & ET workshop, Sydney (Australia), October 2019

Other Meetings Attended On Behalf of GEWEX or Panel in 2018

- PannEx IPC meeting, Ljubljana (Slovenia), June 2018
- Baltic Earth 2nd science Conference, Helsingor (Denmark), June 2018
- GEWEX Science conference, Canmore (Canada), May 2018
- SSG-30 Washington DC (USA), January 2018

Publications during Reporting Period

List of Key Publications

- See the individual action reports.

2.4 Global Land/Atmosphere System Study (GLASS)

Reporting Period : 01 January - 31 December 2018
Starting Date : N/A
End Date (where appropriate) : N/A
URL : https://www.gewex.org/panels/global-landatmosphere-system-study-panel/

Membership

Chair(s) and Term Dates : Mike Ek, 2015 - Present
Kirsten Findell, 2019 - Present

Members and Term Dates : Gab Abramowitz, 2008 - Present
Eleanor Blyth, 2011 - Present
Souhail Boussetta, 2018 - Present
Nathan Brunsell, 2013 - Present
Martyn Clark, 2017 - Present
Paul Dirmeyer, 2000 - Present
John Edwards, 2014 - Present
Craig Ferguson, 2011 - Present
Pierre Gentine, 2015 - Present
Chiel van Heerwaarden, 2012 - Present
Hyungjun Kim, 2010 - Present
Sujay Kumar, 2015 - Present
David Lawrence, 2014 - Present
Aude Lemonsu, 2017 - Present
Pere Quintana Seguí, 2017 - Present
Joshua Roundy, 2016 - Present
Joseph Santanello, 2011 - Present
Anne Verhoef, 2018 - Present
Tomo Yamada, 2012 - Present
Kun Yang, 2017 - Present

Panel Objectives, Goals and Accomplishments during Reporting Period

Overall Panel Objective(s)

- Encouragement of Land-surface modeling developments by coordinating the evaluation and intercomparison of the new generation of Land Surface Schemes (LSSs) and their applications to scientific queries of broad interest, including the proper representation of land-atmosphere interactions with focus on the role of land.
- To develop a protocol for evaluating experiments to address the central question, “Does my land-surface model describe the processes in the climate system sufficiently well?”
- To develop an optimal system to create global land-surface data sets in which information is extracted from both land-surface models and sophisticated observations.
- To estimate the contribution of memory in the land system to the overall predictability of regional atmospheric phenomena at seasonal time scales.

List of Panel Goals

Adjust yearly

- To advance the evaluation and representation of land surface models from component/process level (e.g., soil hydraulic functions, surface flux partitioning, etc.) to land-atmosphere coupling and fully integrated behavior within general circulation and earth system models.
- To advance the understanding of the role of land in earth system models from weather to climate time scales via model intercomparisons.

List of Key Results

Adjust yearly with respect to goals

- Model intercomparison projects are largely on the CMIP6 analysis cycle. PLUMBER2, PALS, LUMIP, ILAMB, LS3MIP, and GSWP-3 all improved their platforms, protocols, and forcing datasets in anticipation of the extensive analysis cycle expected in 2019.
- SoilWat was very active,with major assessments of model treatment of numerous individual processes.
- LoCo saw the publication of a BAMS article summarize the first decade of work developing a process-level paradigm for understanding land-atmosphere interactions. The topic has moved center-stage in many modeling centers and funding agencies, suggesting that the years ahead will see substantial focus on representation of land-atmosphere interactions during the model development process.

Other Science Highlights

Not part of the 2-3 major accomplishments

- -

Panel Activities during Reporting Period

List of Panel Activities and Main Result

- SoilWat: Comprehensive papers on treatment of (1) infiltration, (2) surface evaporative capacitance, and (3) bare-soil evaporation in modern land surface models
- PLUMBER2: Protocol drafted. Site data for ~200 locations passed QC requirements.
- PALS: modelevaluation.org web portal prepared to host and upload data and analyses. The new site has a much more flexible structure that is no longer specific to LSMs. Successfully incorporated ILAMB as an analysis package within modelevaluation.org.
- LoCo: Published a LoCo overview article in BAMS (July 2018), after a ~decade of work in developing a process-level paradigm and suite of metrics for integrative analysis.Land-atmosphere interactions and application of LoCo-style metrics made prominent appearances in multiple proposal calls from funding agencies.
- LUMIP: Production of full set of historical and future land use trajectories. Threehistorical datasets esimates (low, medium, high) years850 to 2014; Eight future trajectories spanning all the Tier 1 and Tier 2 ScenarioMIP scenarios.
- ILAMB: Overview paper published describing the ILAMB project. An additional paper published decribing application of ILAMB to CLM assessment.
- LS3MIP: Preparing experiment protocol, data request and forcing data for the CMIP6 analysis cycle.
- GSWP-3: Improved forcing datasets. Preparing for CMIP6 cycle.

List of New Projects and Activities in Place and Main Objective(s)

- SoilWat: Determination of global thermal properties from soil texture and mineralogy data. Completion of assessment of treatment of groundwater in global hydrological/climate models. Development of (1) new generation PTFs using vegetation attributes to inject soil structure into soil hydraulic properties including infiltration response at different scales and (2) new methods for imposing additional physical constraints on soil hydraulic parameters estimation.
- PLUMBER2: This second phase of the PLUMBER experiment will kick off in 2019 using the new modelevaluation.org web portal.
- PALS/modelevaluation.org: Process and host full suite of FLUXNET2015, La Thuile and OzFlux site data.
- LoCo: GRAINEX field campaign held in Summer 2018 over Nebraska, focused on impact of irrigation on L-A interactions. Over 70 in-situ soil moisture probes and met data, 12 flux towers, and 2 profilers along with enhanced sondes were conducted during 2 IOPs over irrigation and non-irrigated regions. NASA also flew the GREX (L-band) instrument during IOP2 (July) for high resultion transects of soil moisture. Modeling and analysis studies are underway and the data is available to the public at: https://data.eol.ucar.edu/master_list/?project=GRAINEX
- LUMIP: Analysis projects in cycle with the CMIP6 timeframe to understand the effects of LULCC on climate and biogeochemical cycling (past-future), the impacts of land management on surface fluxes of carbon, water, and energy, and the potential for land-management strategies with promise to help mitigate the impacts of climate change.
- ILAMB: Formulation of metrics related to the diurnal cycle. Improved techniques accounting for uncertainty in observations.
- LS3MIP: Analysis projects in cycle with the CMIP6 timeframe to assess the performance of current land surface modules within Earch System Models and quantify land surface feedbacks in a changing climate.
- GSWP3: Working with LS3MIP modeling groups to produce a century-long comprehensive and extensive set of quantities for hydro-energy-eco systems on 0.5 degree grids.

List of New Projects and Activities Being Planned, including Main Objective(s) and Timeline, Lead(s)

- LoCo: LIAISE (Aaron Boone, Martin Best) -Summer 2020 Iberian Peninsula campaign focused on L-A interactions, including surface (SM, flux) and atmospheric (PBL) observations, aircraft, and ground measurements. Also contains an anthropocene (irrigation) component.
- LoCo: Organization of Tropical East Pacific Convection (OTREC) field campaign (Ben Lintner): The goal of OTREC is to understand the formation of tropical convective clouds and rainfall over the southwestern Caribbean and eastern Pacific. Comprehensive observations and measurements during OTREC (in August-September 2019) will be obtained, and of particular relevance to LoCo, a principal aim of the coordinated radiosonde launches andGNSS column water vapor retrievals is to understand how the Central American landmass modifies tropical waves and associated convection propagating from the Caribbean to the eastern Pacific. (Lintner participating in this NSF-funded effort, on a project led by PI Yolande Serra [U. Washington] and in collaboration Dave Adams [UNAM], Ana Maria Duran Quesada [U. Costa Rica], and Marcial Garbanzo [U. Costa Rica])
- LoCo: Ruisdael Observatory -Wageningen (Chiel van Heerwaarden) -100m resolution network over Netherlands to improve L-A understanding and weather prediction:

https://www.wur.nl/en/newsarticle/Ruisdael-Observatorium-Ruisdael-Observatory-will-model-the-Dutch-atmosphere-with-a-resolution-of-100-metres.htm

- LoCo: LAFO (U. Hohenheim; Volker) Observatory -April 2019: https://lafo.uni-hohenheim.de/en/1670

Science Issues and Collaboration during Reporting Period

Contributions to Developing GEWEX Science and the GEWEX Imperatives.

a. Data Sets

- SoilWat: From pre-2018 efforts: https://doi.pangaea.de/10.1594/PANGAEA.870605
- PLUMBER: Land surface model forcing data from 200-300 FLUXNET sites.
- LoCo: NYS Mesonet flux tower data being prepared as an addition to the PLUMBER2 datasets.
- LoCo: Using NYS Mesonet for regional calibration of NASA-SMAP.
- LUMIP: Land-use Harmonization version 2 (historical and future land use change scenarios for use by all CMIP6 modeling groups.
- GSWP3: Hyungjun Kim. (2017). Global Soil Wetness Project Phase 3 Atmospheric Boundary Conditions (Experiment 1) [Data set]. Data Integration and Analysis System (DIAS). https://doi.org/10.20783/DIAS.501

b. Analysis

- SoilWat: Scrutiny of Pedotransfer functions for hydraulic and thermal properties
- LUMIP: Wide range of analysis projects on impacts of land cover and land use change on climate and biogeochemistry.
- ILAMB: Comprehensive multi-model assessment capability.
- GSWP3: Trend analysis, Long-term mean balance, Interannual variability (& return period of extreme).
- LS3MIP: Impact of terrestrial water storage memory to regional hydroclimatic cycle, trend analysis, long-term mean balance, interannual variability (return period for extreme events)..

c. Processes

- SoilWat: Infiltration, surface evaporation, soil water transfer, soil heat transfer, soil-groundwater interactions
- PLUMBER: Surface flux partitioning
- LoCo: Land-atmosphere interactions: flux partitioning at the land surface, boundary layer growth and development, convective triggering
- LUMIP: Improved understanding of land impacts, as mediated by land use, on climate and weather

d. Modeling

- SoilWat: Mainly using Hydrus 1-D as a common platform to explore differences between model parameterisations (e.g. with regards to hydraulic and thermal functions); A new surface evaporation capacitor (SEC) model -dynamic near surface domain representation.
- PLUMBER: Improving land model representation of surface flux partitioning.
- LUMIP: Support for modeling of transient land use change.

e. Application
- -

f. Technology Transfer
PALS/modelevaluation.org is creating an infrastructure beneficial to the whole LSM community.

g. Capacity Building
Improving the capability of our current land surface and climate models.

List contributions to the GEWEX Science Questions and plans to include these.

a. Observations and Predictions of Precipitation
- LoCo: Many papers on soil moisture-precipitation coupling.
- GSWP3: A bias-corrected century-long daily precipitation dataset.
- LS3MIP: Impact of snow and soil-moisture on predictablity in present and warmer worlds.

b. Global Water Resource Systems
- *All projects are motivated to improve understanding and prediction of global water resources.*
- *LoCo: Paper synthesizing future water availability projections based on CMIP5.*

c. Changes in Extremes
All projects are motivated to better understand and predict how extremes will change.

d. Water and Energy Cycles
Improving understanding of soil water process, land surface models, land-atmosphere interactions and feedbacksall enhance understanding of water and energy cycles.

Other Key Science Questions
List 1 – 3 suggestion that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project

- *How will we improve measurement and modeling of land-atmosphere interactions over managed (agricultural) and built (urban) environments beyond the instrumented grasslands of SGP-ARM and Cabauw, Netherlands?*
- *How can LoCo metrics better inform and be integrated into operational model development cycles, as well as to constrain multi-variate data assimilation?*
- *Community is interested in expanding assessment of land use to include all forms of land management. Humans are modifying as much as 75% of the global non-ice land surface (only about 25% has undergone land use change). Understanding the details of how land management is affecting land-to-atmosphere fluxes is imperative, as well as representing water management in land models.*
- *Incorporate diagnostics of land-atmosphere interactions into ILAMB.*

Contributions to WCRP including Current Grand Challenges
Briefly list any specific areas of your panel's activities in particular to the grand challenges "Extremes" and "Water for the Food Baskets" which is not covered under 2.

- *LUMIP is interested in impacts of agricultural activities on climate as well as vulnerabilities of agriculture due to climate change.*

Cooperation with other WCRP Projects, Outside Bodies and links to applications
e.g. CLIVAR, CliC, SPARC, Future Earth, etc.

- TheSoilWat initiative is intricately linked to the activities by the International Soil Modelling Consortium (ISMC):https://soil-modeling.org
- LoCo: Collaboration with CORDEX group (NARCCAP) and Rachel McCrary on applying LoCo metrics to RCM output to assess variability in L-A coupling
- GSWP3and LS3MIPcollaborations with ESM-SnowMIP (CliC), ISI-MIP

Workshops and Meetings

List of Workshops and Meetings Held in 2018
Meeting title, dates and location

- *2018 GLASS Panel Meeting, 1-2 May 2018, Canmore (AB), Canada*
- *SoilWat break-out meeting at EGU (10 April 2018, Vienna, Austria)*
- *SoilWat Session at ISMC symposium (5 November 2018 Wageningen, the Netherlands)*
- *SoilWat break-out meeting AGU (9 December 2018, Washington, USA•LoCo: PBL from Space Workshops I (May 29) and II (Oct 3) 2018 in Pasadena and Greenbelt, respectively.*
- *LoCo: LAFE Workshop during AMS BLT Conference, June 2018 in OKC.*
- *LoCo: L-A Interaction Sessions at AMS 2018 and 2019 and AGU 2018, convened by LoCo WG members*
- *LUMIPand LS3MIP: LandMIP meeting in Toulouse, October 2018*
- *ILAMB meeting on soil carbon datasets; ILAMB discussed at CESM Land Model Working Group meeting and at DOE E3SM meetings (Feb, June, November); On the agenda at LandMIP meeting in Toulouse in October 2018; AGU and Japan AGU.*

List of Workshops and Meetings Planned in 2019 and 2020
Meeting title, dates and location and anticipated travel support needs

- SoilWat: Break-out meetings at EGU, AGU and possibly at the GEWEX meeting in Sydney, Australia.
- LoCo: EGU 2019, 7-12 April 2019, Vienna: AS4.20/BG1.16/CL4.29/HS11.28: Land-Atmosphere Interactions: Implications from Past to Future Climate (co-organized) Convener: Volker Wulfmeyer Co-conveners: Wim Thiery, Matthias Mauder, Linda Schlemmer, Chiel van Heerwaarden, Diego G. Miralles, Ryan Teuling,Sonia I. Seneviratne
- LUMIP: Aspen AGCI meeting in August or Septmber, 2019 (currently seeking funding through US and European funding agencies)
- LUMIPand LS3MIP: CMIP6 analysis meeting in Barcelona, March, 2019
- GLASS panel meeting 6-8 August 2019, at NCAR in Boulder, Colorado, USA

Other Meetings Attended On Behalf of GEWEX or Panel in 2018

- LoCo: ISWG Workshop #2, July 2018 in Lisbon, Portugal
- LoCo: DTC Testbed Workshop at NCEP, July 2018
- LoCo: US Climate ModelingSummit (CMS) at NCEP, April 2018
- LoCo: GEWEX GASS UMAP 2018, Land-atmosphere interaction session by Yunyan
- LoCo: October 25-26, 2018: Ferguson attended, as GLASS liaison, the GHP meeting in Santiago, Chile.
- LoCo: October 22-24, 2018: Ferguson attended the ANDEX meeting in Santiago, Chile.
- LoCo: December 8-9, 2018: Ferguson presented at the GASS LS4P workshop

- LoCo: December 12, 2018: Ferguson attended the GEWEX Water for Foodbaskets Townhall at AGU.

Publications during Reporting Period

List of Key Publications

SoilWat:

- Van Looy, K., Bouma, J., Herbst, M., Koestel, J., Minasny, B., Mishra, U., Montzka, C., Nemes, A., Pachepsky, Y., Padarian, J., Schaap, M., Tóth, B., Verhoef, A., Vanderborght, J., van der Ploeg, M., Weihermüller, L., Zacharias, S., Zhang, Y. and Vereecken, H. (2017) Pedotransfer functions in Earth system science: challenges and perspectives. Reviews of Geophysics, 55 (4). pp. 1199-1256. ISSN 1944-9208 doi: https://doi.org/10.1002/2017rg000581
- Montzka, C., Herbst, M., Weihermüller, L., Verhoef, A. and Vereecken, H. (2017) A global data set of soil hydraulic properties and sub-grid variability of soil water retention and hydraulic conductivity curves. Earth System Science Data, 9 (2). pp. 529-543. doi: 10.5194/essd-9-529-2017.
- Or, D., and Lehmann, P. (2019). Surface evaporative capacitance: How soil type and rainfall characteristics affect global-scale surface evaporation. Water Resources Research, 55. https://doi.org/10.1029/2018WR024050
- Lehmann, P., Merlin, O., Gentine, P., & Or, D. (2018). Soil texture effects on surface resistance to bare-soil evaporation. Geophysical Research Letters, 45, 10,398–10,405. https://doi.org/10.1029/2018GL078803
- Rahmati, M. et al. (2018). Development and analysis of the Soil Water Infiltration Global database. Earth Syst. Sci. Data, 10, 1237-1263, https://www.earth-syst-sci-data.net/10/1237/2018/essd-10-1237-2018.html

LoCo:

- Santanello, J. A., P. A. Dirmeyer, C. R. Ferguson, K. L. Findell, A. B. Tawfik, A. Berg, M. B. Ek, P. Gentine, B. Guillod, C. van Heerwaarden, J. Roundy, and V. Wulfmeyer, 2018: Land-atmosphere interactions: The LoCo perspective. Bull. Amer. Meteor. Soc., 99, 1253–1272, doi: 10.1175/BAMS-D-17-0001.1.
- Many additional manuscripts from the LoCo community listed in the LoCo project report.

ILAMB:

- Collier, N., F.M. Hoffman, D.M. Lawrence, G. Keppel-Aleks, C.D. Koven, W.J. Riley, M. Mu, J.T. Randerson, 2018: The International Land 1 Model Benchmarking (ILAMB) System: Design, Theory, and Implementation. JAMES, doi.org/10.1029/2018MS001354.
- Lawrence, D.M. and co-authors, 2019. The Community Land Model version 5: Description of new features, benchmarking, and impact of forcing uncertainty. Submitted to J. Adv. Model. Earth Syst..
- Bonan, G., D. Lombardozzi, W. Wieder, K. Oleson, D. Lawrence, F. Hoffman, and N. Collier, 2019. Model Structure and Climate Data Uncertainty in Historical Simulations of the Terrestrial Carbon Cycle (1850-2014). Submitted to GBC.

Annex 1: List of Participants

GEWEX SCIENTIFIC STEERING GROUP

Jan Polcher, Co-Chair
Laboratoire de Météorologie Dynamique du CNRS
Paris, France
Email: jan.polcher@lmd.jussieu.fr

Graeme Stephens, Co-Chair
Center for Climate Sciences
Jet Propulsion Laboratory
Pasadena, CA, USA
Email:
mailto:Graeme.Stephens@jpl.nasa.gov

Gianpaolo Balsamo
Coupled Processes Group
Earth System Modeling Section
ECMWF
Reading, UK
Email: mailto:gianpaolo.balsamo@ecmwf

Michael Bosilovich
Global Modeling and Assimilation Office
NASA/GSFC
Greenbelt, MD, USA
Email: mailto:Michael.Bosilovich@nasa.gov

Paul Dirmeyer
George Mason University
Fairfax, VA, USA
Email: mailto:pdirmeye@gmu.edu

Qingyun Duan
Beijing Normal University
Beijing, China
Email: mailto:qyduan@bnu.edu.cn

Germán Poveda
Universidad Nacional de Columbia
Department of Geosciences and Environment
Medellín, Colombia
Email: mailto:gpoveda@unal.edu.co

Christian Jakob
Monash University
Clayton (VIC), Australia
Email: christian.jakob@monash.edu

B.J. Sohn
Seoul National University
School of Earth and Environmental Sciences
Seoul, Korea
Email: sohn@snu.ac.kr

Remko Uijlenhoet
Hydrology and Quantitative Water Management Group
Department of Environmental Sciences
Wageningen University
Wageningen, The Netherlands
Email: Remko.Uijlenhoet@wur.nl

Bob Su (via GoToMeeting)
University of Twente
Enschede, The Netherlands
Email: z.su@utwente.nl

GEWEX PANEL REPRESENTATIVES

Joan Cuxart
GHP Co-Chair
University of the Balearic Islands
Palma, Majorca, Spain
Email: joan.cuxart@uib.cat

Michael Ek
GLASS Co-Chair
NOAA/NWS/NCEP/EMC
College Park, MD, USA
Email: Michael.ek@noaa.gov

Jason Evans
GHP Co-chair
UNSW
Sydney, Australia
Email: jason.evans@unsw.edu.au

Kirsten Findell
GLASS Co-Chair
GFDL/NOAA
Princeton (NJ), USA
Email: kirsten.findell@noaa.gov

Rémy Roca
GDAP Co-Chair
Director of Research
OMP/LEGOS
Toulouse, France
Email: Remy.Roca@legos.obs-mip.fr

Xubin Zeng
GASS Co-chair
University of Arizona
Tucson, AZ, USA
Email: mailto:xubin@email.arizona.edu

WCRP REPRESENTATIVES

Pavel Kabat
Chair, WCRP JSC
Climate Services
IIASA & Wageningen University
Geneva, Switzerland
Email: pkabat@wmo.in

Boram Lee
Senior Scientific Officer
World Climate Research Programme
World Meteorological Organization
Geneva, Switzerland
Email: blee@wmo.int

WCRP JSC MEMBER

Detlef Stammer
Chair JSC
CEM, Univ. Hamburg
Hamburg, Germany
Email: detlef.stammer@uni-hamburg.de

AGENCY DELEGATES AND OTHER INVITEES

Tommaso Abrate
WMO CLWD/CLW
Geneva, Switzerland
Email: tabrate@wmo.int

Eleanor Blyth
Centre for Ecology and Hydrology
Wallingford, United Kingdom
Email: emb@ceh.ac.uk

Beatriz Balino
University of Bergen
Bergen, Norway
Email: Beatriz.Balino@uib.no

Dominique Berod
WMO CLWD/CLW
Geneva, Switzerland
Email: dberod@wmo.int

Paul Bowyer
GERICS
Hamburg, Germany
E-mail: paul.bowyer@hzg.de

Johannes Cullmann
WMO CLWD/CLW
Geneva, Switzerland
Email: jcullmann@wmo.int

Jared Entin (via GoToMeeting)
NASA
Washington, DC, USA
Email: Jared.K.Entin@nasa.gov

Diego Fernandez Prieto
ESA
Noordwijk, The Netherlands
Email: Diego.Fernandez@esa.int

Francoise Guichard
Meteo France
Toulouse, France
Email: rancoise.guichard@meteo.fr

Neil Harris (via GoToMeeting)
Cranfield University
Bedford, UK
Email: Neil.Harris@cranfield.ac.uk

Gabi Hegerl (via GoToMeeting)
University of Edinburgh
Edinburgh, Scotland
Email: gabi.hegerl@ed.ac.uk

Wayne Higgins
NOAA
Washington, DC, USA
Email: wayne.higgins@noaa.gov

Iréne Lake
SMHI
Norrköping, Sweden
Email: irene.lake@smhi.se

L.Ruby Leung
PNNL
Richland (WA), USA
Email: ruby.leung@pnnl.gov

Anil Mishra
UNESCO
Paris, France
Email: a.mishra@unesco.org

Teruyuki Nakajima
JAXA
Tsukuba - Ibaraki, Japan
Email: terry-nkj@nifty.com

Michael Rast
ESA
Frascati, Italy
Email: Michael.Rast@esa.int

Paolo Ruti
WMO/WWRD
Geneva, Switzerland
Email: pruti@wmo.int

Jennifer Saleem Arrigo
(via GoToMeeting)
USGCRP
Washington DC, USA
Email: jsaleem-arrigo@usgcrp.gov

Jörg Schulz
Eumetsat
Darmstadt, Germany
Email: Joerg.Schulz@eumetsat.int

Mike Sparrow
WMO-WCRP
Geneva, Switzerland
Email: msparrow@wmo.int

Peter van Oevelen
Director
International GEWEX Project Office
Washington, DC, USA
Email: gewex@gewex.org

Fernande Vervoort
International GEWEX Project Office
Washington, DC, USA
Email: gewex@gewex.org

Annex 2: SSG Agenda

Monday 25 February 2019

09:00 – 09:30 Opening, Welcome, Introduction – *Peter van Oevelen, Pavel Kabat*
09:30 – 10:00 Co-Chairs Report on GEWEX – *Graeme Stephens, Jan Polcher*
10:00 – 10:30 JSC Report on WCRP and SP – *Detlef Stammer & Pavel Kabat*
10:30 – 11:00 Report of WMO Chief Scientist and Director Research – *Pavel Kabat*
11:00 – 11:30 Break
11:30 – 12:00 Discussion
12:00 – 12:15 GEWEX Panel Highlights GASS – *Xubin Zeng, Daniel Klocke*
12:15 – 12:30 GEWEX Panel Highlights GLASS – *Mike Ek, Kirsten Findell*
12:30 – 12:45 GEWEX Panel Highlights GHP – *Joan Cuxart, Jason Evans*
12:45 – 13:00 GEWEX Panel Highlights GDAP – *Remy Roca, Tristan L'Ecuyer*
13:00 – 14:30 Lunch
14:30 – 14:50 NASA – *Jared Entin* (Remote)
14:50 – 15:10 JAXA – *Terry Nakajima*
15:10 – 15:30 ESA – *Michael Rast*
15:30 – 15:50 EUMETSAT – *Jörg Schulz*
15:50 – 16:10 NOAA – *Wayne Higgins*
16:10 – 16:30 Break
16:30 – 18:00 Space Agency Round Table – Moderator: *Graeme Stephens*
19:30 No Host Dinner at Azar & Co

Tuesday 26 February 2019

09:00 – 09:20 WMO Hydrology – *Johannes Cullmann*
09:20 – 09:40 GC Extremes – *Gabi Hegerl* (Remote)
09:40 – 10:00 GC Water for Food Baskets – *Jan Polcher*
10:00 – 10:20 WDAC and TIRA - *Michael Bosilovich*
10:20 – 10:40 DOE – *Ruby Leung*
11:00 – 11:30 Break
11:30 – 11:45 CORDEX – *Iréne Lake*
11:45 – 12:00 CLIVAR – *Detlef Stammer*
12:00 – 12:20 CLIC – *Mike Sparrow*
12:20 – 12:35 SPARC – *Neil Harris* (Remote)
12:35 – 12:50 WMO-WWRP – *Michael Riemer*
13:00 – 14:00 Lunch
14:00 – 14:30 WCRP Strategy Discussion – Moderator: *Pavel Kabat*
14:30 – 14:45 iLEAPS – *Eleanor Blythe*
14:45 – 15:00 UNESCO IHP – *Anil Mishra*
15:00 – 15:15 Monsoon Panel – *Francoise Guichard*
15:15 – 15:30 SSG Past Member Reflections – *Remco Uijlenhoet*
15:30 – 15:45 USGRCP – *Jennifer Saleem Arigo* (Remote)
15:45 – 16:00 CORA – *Paul Bowyer*
16:00 – 16:30 Break
16:30 – 18:00 GEWEX Strategy Discussion – Moderators: *Graeme Stephens, Jan Polcher*

Wednesday 27 February 2019

09:00 – 09:30 GASS – *Xubin Zeng*
09:30 – 10:00 GHP – *Joan Cuxart*
10:00 – 10:30 GDAP – *Remy Roca*
10:30 – 11:00 GLASS – *Mike Ek*
11:00 – 11:30 Break
11:30 – 13:00 GEWEX Panels Discussion – Moderators: *Graeme Stephens, Jan Polcher*
13:00 – 14:30 Lunch
14:30 – 18:00 Afternoon Work Retreat for SSG and Panel Chairs
No program for all others

Thursday 28 February 2019

09:00 – 09:30 GASS Rapporteurs Report – *B.J. Sohn & Christian Jakob*
09:30 – 10:00 GLASS Rapporteurs Report – *Germán Poveda & Qingyun Duan*
10:00 – 10:30 GDAP Rapporteurs Report – *Bob Su & Michael Bosilovich*
10:30 – 11:00 GHP Rapporteurs Report – *Gianpaolo Balsamo & Paul Dirmeyer*
11:00 – 11:30 Break
11:30 – 12:30 Discussion – Moderators: *Graeme Stephens, Jan Polcher*
12:30 – 12:45 IAHS - *Berit Arheimer (Remote)*
12:45 – 13:15 New Member Presentation – *Bob Su* (Remote)
13:15 – 14:30 Lunch
14:30 – 15:00 New Member Presentation – *Christian Jakob*
15:00 – 15:30 IGPO Report + Actions & Recommendations 2018 – *Peter van Oevelen*
15:30 – 16:00 Actions & Recommendations 2019 – *Peter van Oevelen*
16:00 – 16:30 AOB

Annex 3: Rapporteurs Reports on GEWEX Panels

1. Global Atmosphere System Study (GASS)

Rapporteurs: B.J. Sohn and Christian Jakob

1.1. Overview

We congratulate the co-chairs for their excellent work over the past 18 months and we are pleased to see GASS back on its way to its old strength in atmospheric process research. GASS is a crucial panel for GEWEX and there it is great to see its renewed force and enthusiasm!

1.2. Objectives

GASS aims at supporting the international community in parameterizing and modeling various atmospheric processes based on our understanding from observations, for improving weather and climate simulations and prediction

1.3. Status

GASS has developed 4 new projects through which important atmospheric processes can be improved in both weather and climate models. They are surface drag and momentum transport and their influences on the circulation; impact of Initialized land temperature and snowpack on sub-seasonal to seasonal prediction (LS4P); fog modeling; and the improvement of simulation of sub-diurnal and diurnal variations of precipitation. Several others are under construction. GASS has also re-started its collaboration with key groups outside GEWEX, such as the WGNE and the WWRP. This provides it with a good starting point to become the community focus for atmospheric process research.

1.4. Vision

Chairs try to continue previous GASS activities while strengthen its contributions to GEWEX science objectives, by adding new projects and enhancing communications with to WGNE and WWRP, and by pursuing collaboration with WCRP CFMIP.

1.5. Future

After a spin-up phase GASS plans to further expand its activities and collaborations including contributions to the WCRP grand challenges in weather and climate extremes, water for the food baskets, clouds, circulation and climate sensitivity, and near-term climate prediction.

1.6. Key Results

- Initiated four new projects.
- Recruited panel members for each project.
- Enhanced communication with WGNE and WWRP.

1.7. Issues

As has been common in the past, the GASS projects cover a wide range of issues and are of differing size and impact. As they all have their roots in the community and are only approved if there is a certain amount of support and energy, they are all likely to yield interesting results. It is important, though, to balance the bottom-up approach with a way of prioritizing projects that

contribute strongly to the overall GEWEX and WCRP goals over those that are interesting but have weak links to them. We recommend appointing a small number of new panel members (2) whose specific task might be to advise the panel in this regard.
The diurnal cycle project is very far-reaching and ambitious and has our full support. Given its wide scope, it will require careful guidance by the GASS panel and once spun up, it should be explored how it might link to other GEWEX activities. In principle, a project on diurnal variations of the PBL as well as precipitation could become a flagship activity of GEWEX in the medium term. It would be good to spend some extra discussion time on this project at the next GEWEX SSG.
PROES is a very important new activity in GEWEX. Its goal should be to connect the process-based studies of the GASS and GLASS panels with the more regional and global activities of GDAP and GHP and projects outside GEWEX. For this to succeed, PROES requires at least a minimum governance model. We propose to have each PROES project attached to one of the GEWEX panel. Given current activities, there is no obvious assignment preference. We further recommend that GASS and the other GEWEX panels propose potential new PROES activities that might help them to connect process to global thinking.
The GASS panel should be slowly extended to O(10) members. As already discussed, some of the members should not be project leads, but should have the specific role to assist the chairs in identifying priorities and connections to other programs. The SSG should take an active role in identifying suitable candidates. Keeping gender and geographic balance in mind, the main criteria for selection should remain scientific merit and willingness to contribute.
GASS has made great progress in building connections to other programs. Additional ones need to be carefully managed so as to not overwhelm the group's fledgling activities. One focus for the next 12 months should be to connect inwards within GEWEX, while keeping the existing new connections going. A key issue, which goes well beyond GASS, is that of communicating opportunities for collaboration to each other. A recommendation to the new leadership of the WCRP is to produce a simple graphical overview over existing activities and their stated goals within the program. This will assist both the existing activities as well as any attempts on reorganization.

We recommend that GASS put a strong focus on promoting younger scientists to lead projects and specific activities within them. This will create opportunities to lead and build the next generation GASS community.

We also encourage GASS to help facilitate meetings of the projects – both virtual and in person. We consider this essential for their success. Whilst still a while away, thought should also be given to organizing another Pan-GASS meeting in 2021.

Perhaps our biggest recommendation is for GASS to carry on the excellent work of the last 18 months and not become distracted by the somewhat uncertain path forward for the WCRP structure. The science you do is too important!

2. GEWEX Data and Analysis Panel (GDAP)

Rapporteurs: Michael Bosilovich, Jan Polcher and Bob Su

2.1. Accomplishments and Activities

- Chairs have had an eventful year
- Extremes Workshop
  - Global 1 degree daily data set with multiple precipitation products
  - Special Issue
  - Feedback to data developers leading to Improvements
  - What are connections to GC Extremes?
- EEI Meeting
  - One solid outcome, Ocean Heat and EEI need to be take up seperately for the time being
  - Special Collection underway (which journal(s)?)
  - New Assessment for EEI; This should be supported by GEWEX
- New assessments are encouraging!
  - LandFlux reboot, ISCCP next Gen (upcoming workshop)
  - New paradigm: focus on process, cross cuts and uncertainties
- Unclear whom subsequent suggestions and actions are directed to given the structure
-

2.2. 2018 Review: Science Issues

- LandFlux activity has lost momentum and will not likely progress in isolation. It needs to be redefined as part of an integrated view of the land heat budget.
- The aerosol assessment has concluded, but the draft report has been in limbo for 2+ years and needs to be completed.
- Clouds assessment marked as Ended, to be followed up in a few years
- Precipitation assessment merged with IPWG, progressing
  Water Vapor assessment, paper published, moving on to next phase
- What do we know of the global flux from the land to the ocean - has the sea level GC asked us for this?

2.3. Developing Assessments

- Soil Moisture Assessment
  - Should have some connection with a LandFlux reboot
  - Connection to GLASS SoilWat (more a modeling effort), GSWP?
  - Is SM the really relevant variable? If one day we wish to “freshwater imbalance evaluation” would soil moisture in the top 5cm really be the relevant variable?
  - If SM should be a variable GDAP wishes to support, then its relation to the precipitation (and land flux?) estimates needs to be reviewed and analysed. This could be a PROES study!
- LandFlux
  - Review the WDAC SurFlux white paper
  - It is suggested to link the land flux workshop in Toledo 2019 to the ET workshop in Sydney 2019 – these should concern the same processes.

2.4. Improvements

- Reporting Breakdown
    - The SSG needs the requested documentation to adequately gauge the progress of the sub projects, their advances, roadblocks and needs. These are not adequately conveyed in a 30 min time slot, or by ppt .
    - Alterations to membership - any reductions to membership, **needs to be a process**, likely reviewed in GDAP and in SSG, as existing members are in the GDAP for reasons. Losing any likely hinders progress on the overall GDAP mission
    - Unclarity where BSRN, GPCC, GRDC, IGRAC (groundwater) are within GEWEX and if they should be part of GDAP? It is suggested that within GEWEX, GDAP should provide strong leadership to data products assessments and data producers, e.g. space agencies who needs scientific guidance to establish/ promote their integrated Budget.
- Integrated Budget
    - Progress has been made and some data online
    - **Incomplete, but still in motion**. Recommend that this proceed to completion, and advertise the existence of the data, so community of users can review and provide feedback.
    - Need report to more adequately assess the roadblocks and avenues to improve
    - Now that the integrated product process are stabilized, what is the strategy to exchange with the RHPs and allow for a regional analysis of this data? Could the RHPs help evaluate the uncertainty and establish its causes at the regional scale?
- P16. of the status of the assessments, an assessments of the consistency is needed – this was stated as a goal but it does not appear in the process of assessments (i.e. aerosols, clouds, precipitation, water vapor, albedo – **are the different products consistent**; the same can be said on land surface – precipitation, soil moisture, evaporation and the associated energy/heat budgets, or a catchment – changes of storage and fluxes, do we consider the energy budgets)

2.5. Summary

- EEI workshop committee should produce a workshop report, so that the lessons from the workshop can be communicated and built upon. While this appears to be a tremendous success, lessons learned will be beneficial to developing the EEI assessment.

3. GEWEX Hydroclimatology Panel (GHP)

Rapporteurs: Gianpaolo Balsamo and Paul Dirmeyer

3.1. Overview

GHP continues to be a vital and productive panel with a good distribution of regional hydroclimate projects (RHPs) throughout its *pipeline:* recently completed, active, incoming, and in discussion. Global Data Centers continue to operate as essential resources for all elements of GEWEX and beyond. Cross-cutting elements are perhaps the most uneven, in that the currently active projects are more overlays than integrating themes - projects of opportunity. New proposed efforts, e.g., on evapotranspiration and on water management in models, will be more in the expected spirit and show a commendable effort to address important issues. The panel continues to accommodate and balance interests and concerns of researchers with programmatic interests, with care for diversity and inclusion.

3.2. Objectives

As stated: “To understand and predict continental to local-scale hydro-climates for hydrologic applications by concentrating on improving our understanding of environmental water and energy exchanges at the regional scale and from an integrated perspective.”

3.3. Status

RHPs: HyMEX is concluding, Baltic Earth is in final stages, Global Water Futures and PannEx are in early stages. AndEx is on track to be the next RHP to become active. Cross-cuts on sub-daily precipitation (INTENSE), mountain hydrology (INARCH) and 0°C cold shoulder precipitation are active and all focused in the water cycle. Global data centers for precipitation and runoff continue as critical resources within and beyond GEWEX.
In addition to these existing categories, the panel is adding GHP Networks that act as a sort of “RHP-Lite” that both creates an entry point for spinning up new full-fledged RHPs and a vehicle for ending RHPs to continue to make their data and results available after sunsetting. OzEWEX is the first of these. The one main disappointment is that HyVic had to be dropped, leaving no active or potential RHP coverage in sub-Saharan Africa. Meanwhile Lake Victoria is focus of a Severe Weather Research Demonstration Project (SWRDP) in WWRP - a lost opportunity. Much of the Panel membership is overturning and the Panel is looking to strengthen and expand. Francina Dominguez (U. Illinois) will replace Jason Evans as co-chair with Joan Cuxart.

3.4. Vision

GHP is a magnifying lens allowing focus on regions of common hydrometeorological, geological, climate exposure, with national and cross-national interests. This focus allows the gathering of observations, modelling and large-scale process studies that are not achievable at global scale. RHPs in particular provide a vehicle for regional international collaboration that can be otherwise politically difficult - an underappreciated aspect of outreach. At the same time, GHP has a privileged connection with the global perspective, that can create advantages for regionally focused activities. The regional-to-global link is providing a connection between GHP and the other panels and cross-panels activities (e.g. PROES).

3.5. Future

There is a small bubble in the RHP pipeline in that only one incoming project (AndEx) is set to mature into a proper RHP (and could benefit from heritage/links of VOCALS-REx). There are three in discussion, one that has been on the board already for many years (see issues).

The future of new cross-cuts looks very promising as a contribution of what will be important threads stitching together so much GEWEX research involving water management in models, and better determining ET, which is the dominant linkage between energy and water cycles.

3.6. Key Results

The mature RHPs have been reaching their scientific objectives, with fruitful efforts evolving into new programs (e.g., CCRN into GWF, HyMeX into LIAISE and UERRA).
Less successful efforts have been redefined (OzEWEX) or fallen dormant (HyVic).
Cross-cuts are very active and productive.
Data Centers maintain their crucial activities.
CORDEX activities are being set by several RHPs - a good and logical cross-cut.
The synthesis metric of success in science is publications, and all of the reporting projects show strong publication records over the last year. GHP-level review publication(s) can enhance visibility (see “Issues”).

3.7. Issues

Elements that have not been maintaining communication (HYDROLARE, HyVic) or that have stalled (Western US RHP) - need to be firmly addressed and, if necessarily, egressed. Meanwhile, the process of accepting and monitoring RHPs, as well as GHP networks, will benefit from clearly documented criteria and expectations.

The balance of current efforts are skewed toward the water cycle, with underemphasis on the energy cycle - the water cycle is ultimately driven by net radiation, its partitioning, and energy transport. The ET crosscut is one effort that will begin to address this, but this imbalance should be addressed.

Consideration of the Earth’s energy (im)balance is an avenue to address the need to connect across as well as the previous issue. Similarly water (im)balance could be particularly interesting approaching water management and water use at catchment scale.

Dealing with panels wishing to extend beyond planned duration (e.g. HyMex post-2020; could consider HyMex-follow-on?).

Visibility of the chain GEWEX/GHP/RHP reported to be sometimes *loose* for large community efforts RHPs and could benefit from a dedicated publication effort (GHP chairs/RHP PIs) in platforms such as BAMS.

Improved transfer of RHPs achievements (e.g. enhanced observing networks data, Intense Observation Periods) to other initiatives that are looking after data mining/preservation.

Panel Membership has thinned - looking forward to GHP taking this opportunity to fill out the panel membership while continuing to address diversity, bring in bright early-career scientists. During the GEWEX Open Science Conference in 2018 the Young Earth System Scientists (YESS) and Young Hydrologic Society (YHS) prompted interest in connecting with GEWEX and could provide candidates.

Not unique to GHP, but the strong tendency towards stovepiping is evident - reaching across to other panels needs attention - both through new cross-cuts like PROES, and where there are natural links (e.g., LIAISE and GLASS/LoCo, or exploiting GDAP data sets more effectively).

3.8. Linkage Suggestions

At the SSG meeting, Mike Sparrow gave a presentation on CLiC. There was a “High Mountains” summit going on concurrently - a GEWEX/CLiC led an initiative on water availability in mountain regions could have a GHP connection. ANDEX, GWF, INARCH, are possible points of contact. On large scales, high terrain as a source of (1) surface drag and (2) elevated heat sources of LS4P are GASS bridges as well.

Françoise Guichard noted GHP as a potential point of contact for corresponding regional working group efforts in the joint GEWEX/CLIVAR Monsoon Panel.

4. Global Land/Atmosphere Study (GLASS)

Rapporteurs: Qingyun Duan and Germán Poveda

4.1. Overview

- A strong focus on WCRP grand challenges and GEWEX science questions.
- Enthusiastic panel - A lot of projects and activities
- Projects with long legacies: GSWPs, PALS, iLAMB, PLUMBERs, ...
- Extensive links and collaborations

4.2. Objectives

- Encouragement of Land-surface modeling developments by coordinating the evaluation and intercomparison of the new generation of Land Surface Schemes (LSSs) and their applications to scientific queries of broad interest, including the proper representation of land-atmosphere interactions with focus on the role of land.
- To develop a protocol for evaluating experiments to address the central question, “Does my land surface model describe the processes in the climate system sufficiently well?”
- To develop an optimal system to create global land-surface data sets in which information is extracted from both land-surface models and sophisticated observations.
- To estimate the contribution of memory in the land system to the overall predictability of regional atmospheric phenomena at seasonal time scales.
- To advance the evaluation and representation of land surface models from component/process level (e.g., soil hydraulic functions, surface flux partitioning, etc.) to land- atmosphere coupling and fully integrated behavior within general circulation and earth system models.
- To advance the understanding of the role of land in Earth system models from weather to climate time scales via model intercomparisons.

4.3. Key Results

The GLASS community is very active with a lot of ongoing projects and recently launched or soon to be launched new initiatives, while maintaining extensive links and cross-cuts with other GEWEX Panels and other programs outside of GEWEX.

4.4. Issues

- **Strategic levels:**
  - Relevance to WCRP grand challenges and GEWEX science questions
  - Long term strategy
- **Working levels:**
  - Balance between more complex physics and practicality
  - Processes vs phenomena
  - Links with other panels
- **Traceability/metrics:**
  - Need for reflections on what have been achieved and the next challenges

.

4.5. Suggestions

- Monsoons
  - Re-start ... but sounds weak in terms of man-months involvement è communication needed to 'recruit' / engage more GEWEX scientists?
  - Need links with NOAA?
  - What about WWRP?
- EURO-CORDEX LUCAS Flagship project
  - Just accepted by CORDEX
  - Real follow-up of LUCID at regional scale
  - To be endorsed by GEWEX?
  - LoCo diagnostics could be applied to idealized simulations planned
- S2S
  - What role for GEWEX?
  - Sufficient man-months involvement?
  - Anyone to think about this + connection with WWRP and propose (or not) something for next SSG?
- ISI-MIP/HappiMIP (?) (beyond 'just' GLASS)
  - What links envisaged with ISI-MIP community?
  - Targeted warming for future runs (1.5°C) envisaged last year ...
- Climate services (beyond 'just' GLASS)
  - Shall we think about possible links?
- thoughts about additional projects
  - Including water management in LSMs
    Last year was discussed the possibility to include Human dimensions in synergy with iLEAPS. LUMIP and this 'water management' go in right direction .... But what is the status of contacts with iLEAPS? Shall this be a sub-project of GLASS???
- LIAISE? Iberian semi-arid ... *what's the status of the project?*

4.6. A General Reflection to GEWEX

- Too much interest in Rainfall, and deservedly so.
- Interest in Soil Moisture and ET, and deservedly so.
- Streamflows are hardly mentioned. A fundamental component of the Water Balance Equation and the Earth climate system.
- Measurements are routinely, reliable and easy.
- River basin constitutes a physical and mathematical filter of rainfall's high frequency variability.
- Streamflows integrate all water balance processes inside the river basin (P, ET, SM, GW-SW, Veg,...).
- Long way to go to fully understand runnoff generation. Peak river flows, and floods! Climate Change & LULC.
- Effects of human activities on streamflows.
- Plenty of practical water resources planning and management and societal issues.

Annex 4: Acronyms and Other Abbreviations

Click for a list of Acronyms and Abbreviations related to Climate Research.

ACPC	Aerosols, Clouds, Precipitation and Climate
AGU	American Geophysical Union
ALMIP2	Land Surface Model Intercomparison Project (CMIP)
AMMA	Multidisciplinary Analysis of the African Monsoon
ARM	Atmospheric Radiation Measurement (US Department of Energy)
ARMBE	ARM Best Estimate
AWI	Alfred Wegener Institute
BAMS	*Bulletin of the American Meteorological Society*
BSRN	Baseline Surface Radiation Network
CAUSES	Clouds Above the United States and Errors at the Surface
CC	Cross-Cut Project
CCI SM	Climate Change Initiative-Soil Moisture (ESA)
CCMP	Cross-Calibrated Multi-Platform
CCRN	Changing Cold Regions Network
CCSM	Community Climate System Model
CDR	Climate Data Record
CEH-GEAR	Centre for Ecology and Hydrology Gridded Estimates of Areal Rainfall
CESM	Community Earth System Model
CEOS	Committee on Earth Observation Satellites
CERES	Clouds and the Earth's Radiant Energy System
CFMIP	Cloud Feedback Model Intercomparison Project
CGMS	Coordination Group for Meteorological Satellites
CLASS	Canadian Land Surface Scheme
CliC	Climate and Cryosphere Project (WCRP Core Project
CLIVAR	Climate and Ocean – Variability, Predictability, and Change (WCRP Core Project)
CMAP	CPC Merged Analysis of Precipitation (NOAA)
CMIP	Coupled Model Intercomparison Project (WCRP)
CMORPH	CPC MORPHing technique (NOAA)
CNRM	Centre National de Recherches Météorologique (National Center for Meteorological Research)
COLA	Center for Ocean-Land-Atmosphere Studies
CONVEX	Research Project on Observational Evidence and Process Understanding to Improve Predictions of Extreme Rainfall Change
CORDEX	Coordinated Regional Climate Downscaling Experiment (WCRP)
CPC	Climate Prediction Center (NOAA)
CPO	Climate Program Office
CRCM	Canadian Regional Climate Model
CRHM	Cold Region Hydrological Model
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTEM	Canadian Terrestrial Ecosystem Model
DECK	Diagnostic, Evaluation and Characterization of Klima experiment
DIAL	Differential Absorption Lidar
DICE	Diurnal Land/Atmosphere Coupling Experiment

DOE	Department of Energy
DOIs	Digital Object Identifiers
DWD	Deutscher Wetterdienst (German Weather Service)
EBAF-4	Energy Balanced and Filled (EBAF) Top-of-Atmosphere (TOA) Edition-4.0
ECA&D	European Climate Assessment and Dataset
ECCC	Environment and Climate Change Canada
ECMWF	European Centre for Medium-range Weather Forecasts
ECVs	Essential Climate Variables
EEI	Earth's Energy Imbalance
EGU	European Geophysical Union
EO	Earth Observations
ERA-Interim	ECMWF Re-Analysis (ERA)-Interim
ESA	European Space Agency
ESGF	Earth System Grid Federation
ESMs	Earth Science Models
ESSD	*Earth System Science Data*
ET	Evapotranspiration
ETH	Swiss Federal Institute of Technology in Zürich
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EXAEDRE	Exploiting new Atmospheric Electricity Data for Research and the Environment
EXP1	Long-term Retrospective Experiment
FE	Future Earth
FIDUCEO	Fidelity and Uncertainty in Climate data records from Earth Observations
FMI	Finnish Meteorological Institute
FOCI	Frontiers of Climate Information (WCRP)
FPS	Flagship Pilot Study (HyMeX)
GABLS	GEWEX Atmospheric Boundary Layer Study
GAIA-CLIM	Gap Analysis for Integrated Atmospheric ECV CLImate Monitoring
GAP	GEWEX Aerosol and Precipitation project
GC	Grand Challenge (WCRP)
GCOS	Global Climate Observing System
GDAP	GEWEX Data and Assessment Panel
GDIS	Global Drought Information System
GEO	Group of Earth Observation
GERICS	Climate Service Center Germany
GEWEX	Global Energy and Water Cycle Exchanges (WCRP Core Project)
GFCS	Global Framework for Climate Services
GHP	GEWEX Hydroclimatology Panel
GHRSST	Global High Resolution Sea Surface Temperature
GNSS	Global Navigation Satellite Systems
GLACE	The Global Land–Atmosphere Coupling Experiment
GLASS	Global Land/Atmosphere System Study
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPM	Global Precipitation Mission
GRACE	Gravity Recovery and Climate Experiment

GRL	*Geophysical Research Letters*
GSFC	Goddard Space Flight Center (NASA)
GSMaP	Global Satellite Mapping of Precipitation (JMA)
GSOP	CLIVAR Global Synthesis and Observations Panel
GSQs	GEWEX Science Questions
GSW	GEWEX Soils and Water
GSWP3	Global Soil Wetness Project 3
G-VAP	GEWEX Water Vapor Assessment
HEPEX	Hydrologic Ensemble Prediction Experiment
HESS	Hydrology and Earth System Sciences
HIRS	High Resolution Infra-Red Radiation Sounder
HOAPS	Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data
HyMeX	Hydrological Cycle in the Mediterranean Experiment
HyVic	Hydrology of Lake Victoria Basin
IASOA	International Arctic Systems for Observing the Atmosphere
ICDR	GPCP Monthly Interim Climate Data Record
ICSU	International Council for Science
IDF	Intensity-Duration-Frequency
ICPAC	Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre
IGBP	International Geosphere Biosphere Programme
IGAD	Intergovernmental Authority on Development
IGPO	International GEWEX Project Office
IGWCO	Integrated Global Water Cycle Observations
ILAMB	International Land Model Benchmarking
iLEAPS	integrated Land Ecosystem-Atmosphere Processes Study
INARCH	Alpine Research Catchment Hydrology
INTENSE	INTElligent use of climate models for adaptatioN to non-Stationary hydrological Extremes
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IOCCG	International Ocean Color Coordination Group
IOP	Intensive Observation Period
IPCC	Intergovernmental Panel on Climate Change (WMO, UNEP)
IPSL	Institute Pierre Simon Laplace
IPWG	International Precipitation Working Group
IQuOD	International Quality Controlled Ocean Database
IR	Raman lidar and infrared
ISCCP	International Satellite Cloud Climatology Project
ISI-MIP	Intersectoral Impact Model Intercomparison Project (CMIP)
ISMN	International Soil Moisture Network
ISSI	International Space Science Institute
IUGG	International Union of Geodesy and Geophysics
JAXA	Japan Aerospace Exploration Agency
JMA	Japanese Meteorological Association
JSC	Joint Scientific Committee (WCRP)
KMI	Belgium Meteorological Institute
KNMI	Royal Netherlands Meteorological Institute

LAC	Land-Atmosphere Coupling
LAFE	Land-Atmosphere Feedback Experiment
LAI	Leaf Area Index
LE	Latent Heat
LEGOS	Laboratoire d'Etudes en Géophysique et Océanographie Spatiales
LIAISE	Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment
LIS	Land Information System (NASA)
LoCo	Local Land-Atmosphere Coupling
LoCo WG	Local Land-Atmosphere Coupling Working Group
LSM	Land Surface Model
LST	Land Surface Temperature
LS3MIP	Land Surface, and Snow, Soil moisture Model Intercomparison Project
LUCID	Land-Use and Climate, IDentification of robust impacts
LULCC	Land Use Cover Changes
LUMIP	Land Use Model Intercomparison Project (CMIP)
MAC v1	Max Planck Aerosol Climatology version 1
MAHASRI	Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction
MDF	Model Data Fusion
MEaSURES	Making Earth System Data Records for Use in Research Environments
Med-CORDEX	Mediterranean Coordinated Regional Downscaling Experiment
MERRA	Modern-Era Retrospective Analysis for Research and Applications
MESH	Modélisation Environmentale Communautaire (MEC)–Surface and Hydrology
MIP	Model Intercomparison Project
MOUNTerrain	GEWEX Mountainous Terrain Precipitation Project
NARCCAP	North American Regional Climate Change Assessment Program
NASA	National Aeronautics and Space Administration
NEESPI	Northern Eurasia Earth Science Partnership Initiative
NCA	National Climate Assessment
NCAR	National Centers for Atmospheric Research
NCEI	National Center for Environmental Information
NCEP	National Center for Environmental Prediction
NDVI	Normalized Difference Vegetation Index
nnHIRS	neural network High Resolution Infra-Red Radiation Sounder
NOAA	National Oceanic and Atmospheric Administration (USA)
NWP	Numerical Weather Prediction
OAFlux	Objectively Analyzed Air-sea Fluxes
Obs4MIPS	Observations for Model Intercomparisons
ORA-IP	Ocean Reanalysis Intercomparison project
ORNL	Oak Ridge National Laboratory
ORCHIDEE	Organizing Carbon and Hydrology In Dynamic Ecosystems
OzEWEX	Australian Energy and Water Exchanges
PALS	Protocol for the Analysis of Land Surface models
PannEx	Pannonian Basin Experiment

PBL	Planetary Boundary Layer
PERLE	Pelagic Ecosystem Response to dense water formation in the Levant Experiment
PI	Principal Investigator
PILDAS	Project for the Intercomparison of Land Data Assimilation Schemes
PLUMBER	PALS Land Surface Model Benchmarking Evaluation Project
PMM	Precipitation Measurement Mission
POC	Point Of Contact
Qa	Atmospheric humidity
RAOBS	Paposo Lower Site Radiosondes
RCM	Regional Climate Model
RHPs	Regional Hydroclimate Projects
PROES	Process Evaluation Study
S2S	Subseasonal to Seasonal Prediction Project
SACRA	Global data sets of satellite-derived crop calendars for agricultural simulations
SAFRAN-IP	Système d'Analyse Fournissant des Renseignements Atmosphériques à la Neige for the Iberian Peninsula
SCM	Single Column Model
SCOPE-CM	Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring
SCOR	Scientific Committee on Oceanic Research
SGP	Southern Great Plains ARM site (USA)
SMAP	Soil Moisture Active Passive (NASA)
SMOS	Soil Moisture and Ocean Salinity (ESA)
SoilWat	GEWEX Soil and Water Initiative
SOP	Special Observation Period
SPARC	Stratospheric Processes and their Role in Climate (WCRP Core Project)
SRB	Surface Radiation Budget Project
SSC	Scientific Steering Committee
SSCZP	Soil Systems and Critical Zone Processes
SSG	Scientific Steering Group (GEWEX)
SSMIS	Special Sensor Microwave Imager/Sounder
SST	Sea Surface Temperature
SWOT	Surface Water and Ocean Topography satellite
TIRA	Task Team for Intercomparison of Reanalyses (WCRP)
THORPEX	The Observing system Research and Predictability Experiment
TOA	Top Of Atmosphere
TU Wien	Vienna University of Technology
UCAR	University Corporation for Atmospheric Research
UCI	University of California, Irvine
UKMO	UK Met Office
UKWIR	UK Water Industry Research
UNESCO	United Nations Educational, Scientific and Cultural OrganizationUNFCCC United Nations Framework Convention on Climate Change
UNSW	University of New South Wales, Sydney, Australia
URC	International Radiation Commission

USDA	United States Department of Agriculture
USGCRP	US Global Change Research Program
USRA	Universities Space Research Association
UTLS	Upper Troposphere Lower Stratosphere
UTTC	Tropospheric Clouds and Convection (PROES)
WACMOS-ET	Water Cycle Observation Multi-mission Strategy-EvapoTranspiration
WCRP	World Climate Research Programme (WMO, IOC and ICSU)
WDAC	WCRP Data Advisory Council
WECC	Water, Ecosystem, Cryosphere and Climate (CCRN)
WGIR	Working Group on Information for Regions (WCRP, to be approved)
WGNE	Working Group of Numerical Experimentation
WGRC	Working Group on Regional Climate (WCRP)
WMO	World Meteorological Organization
WMO SPICE	World Meteorological Organization's Solid Precipitation Intercomparison Experiment
WRMC	World Radiation Monitoring Center
WRF	Weather Research and Forecasting
WWRP	World Weather Research Programme
YESS	Young Earth System Scientists Community
YHS	Young Hydrologic Society

The
World Climate Research Programme (WCRP)
facilitates analysis and prediction of Earth system change for use in a range of practical applications of direct relevance, benefit and value to society.

WCRP
World Climate Research Programme