

GEWEX Hydroclimatology Panel (GHP)

Reporting Period: January 2016 – December 2016

Starting date:

End date (where appropriate):

URL: <http://www.gewex.org/panels/gewex-hydroclimatology-panel/>

Chair(s) and term dates: Jason Evans (2012-2019), Jan Polcher (2011-2016, leaving), Joan Cuxart Rodamilans (2017-2020, starting)

1. Major panel accomplishments or significant contributions for the reporting period

- Active GHP very productive: GEWEX achieving maturity generating spin-off activities; CCRN enlarging and ensuring continuation of activities.
- New GHPs OzEWEX and HyVic report significant steps forward leading to organized research activities in their respective areas, each following a different approach. Baltic Earth, already in motion, has very recently become an RHP.
- Increasing interest to organize new activities, such as developing Cross-Cut projects and the prospective PannEx GHP in the Pannonian basin. New activities are foreseen in America and Asia.

2. Panel activities

The GEWEX Hydroclimatology Panel (GHP), has been organized around several Regional Hydroclimate Projects (RHPs) and a number of crosscutting (CC) science topics. The aim of GHP is especially focused on improving the knowledge about global climate change and its impacts at regional scales and to propagate that knowledge from one region to the other, then, synthesizing the results at the global scale.

The objectives of GHP are to contribute effectively to the leading role that GEWEX plays in the hydrological sciences and related modeling activities. The GEWEX Science Questions (http://www.gewex.org/pdfs/GEWEX_Science_Questions_final.pdf) and the related WCRP Grand Challenges (<http://www.wcrp-climate.org/grandcha.shtml>) are key to the strategy for implementation of the Panel activities. Discussions on a number of important issues that range from monsoons, to extremes and how to help coordinate the number of national/regional initiatives in those areas, have been fostered by the Co-Chairs. These include collaborations with groups including GDIS, GDAP, GLASS, CLIVAR, CliC, and WGRC that have common interests in land-surface processes.

In addition, in keeping with the need to be responsive to the WCRP/GEWEX main challenges and scientific questions GHP has organized itself to address the GEWEX science questions from a regional and integrated perspective. The driving premise for this approach is that only at the regional scale can the water cycle be addressed from its physical to human and socioeconomic aspects.

The RHPs (Figure 1) are an essential tool in this endeavor as they bring together various disciplines on the water issues of greatest importance to the advancement of the GSQs.

The Cross-Cut projects allow GHP to propagate knowledge from one region to the other and synthesize results at the global scale. They also allow development and testing of applications developed with the new understanding that they deliver both science advances and applicable outcomes for stakeholders and services.

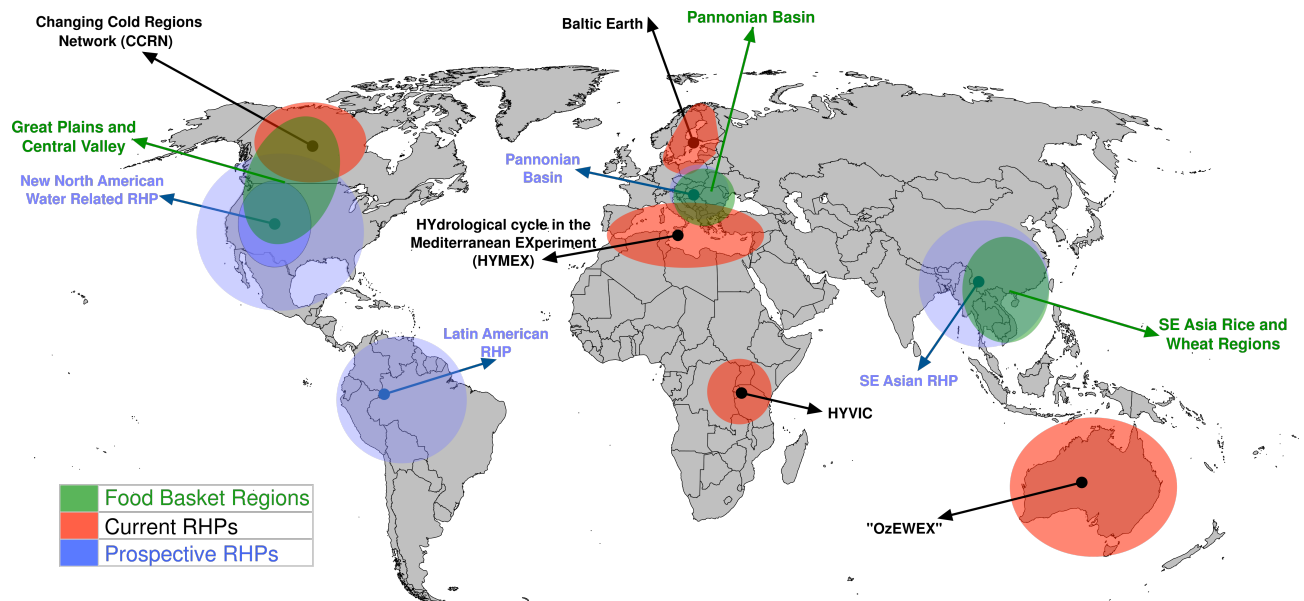


Figure 1: GHP Regional Hydroclimate Projects (RHPs) and Water for the Food Baskets of the World focus regions

GHP Regional Hydroclimatic Projects List

Recently completed

- MAHASRI (Jun Matsumoto)

Currently active

- CCRN (Howard Wheeler)
- HyMex (Philippe Drobinski)

Initiating

- OzEWEX (Albert VanDijk/Seth Westra)
- HyVic (Fred Semanzzi)
- BalticEarth (Markus Meier)

Proposed

- Pannex (Monika Lakatos/Ivan Güttler)

GHP Cross-Cut Projects List

Currently active

- INTENSE (Sub-daily precipitation) (H. Fowler)
- Cold/Shoulder Season Precipitation Near 0°C, (R. Stewart/P. Groisman)
- INARCH (Mountain Hydrology) (J. Pomeroy)

Proposed

- MOUNTerrain (Mountainous Terrain rainfall) (J. Renwick)
- Including water management in large scale models (R. Harding/J. Polcher)

3. New projects in place

Baltic Earth applied for, and was granted, initiating RHP status. It becomes the newest RHP and builds upon the legacy left by the previous BALTEX projects.

4. New projects and activities being planned, including timeline

New Projects

Baltic Earth (new RHP since fall 2016)

This programme intends to achieve an improved Earth System understanding of the Baltic Sea region, inheriting the Baltex network of scientists and infrastructures. This will be made through an interdisciplinary and international collaboration by an holistic view of processes on land, sea, atmosphere and the anthroposphere. Knowledge gaps will be identified and addressed, for instance by funded projects. Service to society and education will be key points. The community in charge is very mature and a lot of activity is present. Six Grand Challenges have been defined in the Science Plan: i) salinity dynamics; ii) land-sea biogeochemical linkages; iii) natural hazards and extreme events; iv) sea level and coastal dynamics of the Baltic Sea; v) regional variability of water and energy exchanges; and vi) multiple drivers of regional Earth system changes.

The Pannonian Basin RHP (Pannex) held its second workshop in order to get feedback from local scientists on the draft white paper and garner further participation from the regions scientists. Five Flagship Questions have been defined dealing with Agronomy, Air Quality, Sustainable Development, Water management and Education. A third workshop is planned for March 2017 in Cluj-Napoca, Romania, where reflection on the Science and the Implementation plans will start. This should progress Pannex towards initiating RHP status in 2017 or 2018.

A workshop to investigate the potential for a *Regional Hydroclimate Project in Latin America* is being planned for May 2017.

The potential *cross-cut "Water management in large scale models"* held a successful workshop in September 2016. Subsequent activities are being planned including submission of a formal cross-cut proposal to GHP.

Planned Activities

RHPs

HyMex

This RHP explores the water cycle in the Mediterranean basin, with focus on high-impact weather events and social vulnerability and adaptation capability. The long term observation plan will extend until 2020, whereas two special observation periods were held in the NW mediterranean in 2012 (flash-floods) and 2013 (dense water formation). This has allowed to advance toward a very efficient observing and model chain such as convection permitting simulations, coupling between models of the different parts of the Earth system, including data assimilation.

Planned activities following a 5 year review:

During the second half of HyMeX, there is a need to continue collecting long-term observations and exploiting the numerous data accumulated during the various field campaigns and the dissemination of the on-going research. Second, some of the HyMeX research lines need now to be tackled in a more continuum-scale (also called seamless) object-oriented approach. Some others will benefit or are enough mature to be addressed within more integrated transdisciplinary perspectives in relation with societal and environmental challenges. Transverse and transdisciplinary approaches have been already developed during the first phase of HyMeX and should be enhanced in the future, on the one hand, for flash-floods (WG3) and social vulnerabilities (WG5) and, on the other hand, for water resources, droughts and impacts (WG2/WG5). Progresses made in knowledge as well as in

development and validation of individual models for atmosphere, ocean, continental surfaces, hydrology and impacts during the first phase also allow envisaging the design of more integrated modelling systems and interdisciplinary approaches driven by social, economic or environmental demands and applications. The two fields identified are: i) the design of more integrated forecasting systems for heavy precipitation, flash-floods and impacts over coastal areas and ii) the water cycle and renewable energy related challenges in the Mediterranean meteorological and climate context. As regard the object-oriented studies, the objects (or phenomena) for which more synergy between process and climate studies is sought are the heavy precipitation (WG3), the Mediterranean cyclones (WG4/WG3) and the ocean circulation and dense water formation (WG1/WG4).

CCRN

It is a project nationally funded (2013-2018) including the Saskatchewan and the Mackenzie river basins. The Network aims to understand, diagnose and predict interactions amongst the cryospheric, ecological, hydrological, and climatic components of the changing Earth system at multiple scales, with a geographic focus on Western Canada's rapidly changing cold interior. It is structured in 5 themes: A: Observed Earth System Change in Cold Regions - Inventory and Statistical evaluation; B: Improved Understanding and Diagnosis of Local Scale Change; C: Upscaling for improved Atmospheric Modelling and River Basin Scale Prediction; D: Analysis and Prediction of Regional and Large Scale Variability and Change; E: User Community Outreach and Engagement.

In Theme A, and as a contribution to other Themes, we will continue our efforts towards the development of scenarios of change for our observatories and for our main ecoregions, based on conceptual and process understanding. Theme B efforts will focus on CRHM historical diagnostic modelling at the observatories, with reporting at our upcoming AGM, and then on synthesizing results and developing individual and synthesis papers, representing the completion of Theme B. Future CRHM analyses will be based on the WRF pseudo-warming simulations (used as driving data) to diagnose future hydrological change and sensitivity, with reporting at our 2017 AGM, and papers to follow. This will represent completion of our last of the four work packages in Theme D. In Theme C we expect to have working models for both major basins ready for subsequent use in Theme D analyses by the fall. We plan to build on the discussions at the AGM regarding scenarios of change and will pull together all the large-scale modelling work and progress on the Theme B CRHM project at the upcoming fall modelling workshop. From here, we will decide on driving products and best approaches moving forward for the large-scale modelling analyses to be done in Theme D. Several focal topics have been added as areas of study in Theme D for the coming year, including a synthesis and examination of the three back-to-back extreme wildfire seasons in western Canada (2014–16), an examination of changes in the timing of the zero degree Celsius isotherm and associated impacts, a review of future projected changes (following review of past change, and linking with scenarios of change), and an examination of the chain-of-events around recent major disasters in our region.

HyVic

Its primary purpose is to provide understanding of the climate over the Lake Victoria Basin (LVB) and improve its predictability and projections to support decision making in the region. The science plan outlines five research themes (Translational Research to Interface with Applications, Severe Weather and Water Currents, Lake Victoria Basin Water and Energy Budgets, Modeling of the LVB Hydroclimatological System, and Monitoring of the LVB Hydroclimatological System) and three mechanisms to coordinate the research themes (HyVic Implementation Sites, HyVic International Panel, and HyVic International Project Office).

The planned activities are:

- (i) HyCristal project: Continuation of HyCristal project funded by DFID, on climate change over East Africa.
- (ii) ICPAC-HyVic CMIP project: ICPAC is the Climate Prediction and Applications Centre serving users to optimize the use of climate information. HyVic aims to provide underpinning knowledge in the development of capacity for using WCRP CMIP climate model simulations. This will in particular entail engaging the international WCRP community to contribute to the proposed new

GHACOF-Climate Change component by building on the present form focusing only on seasonal prediction. Anticipated funding Source: DFID WISER Program.

(iii) ICPAC-HyVic data rescue project: Major progress has been made with the DARE pilot project focussing on Tanzania, through the Tanzania Meteorology Agency (TMA), in rescuing rainfall data for 257 stations. The natural next step of this very important project is to upscale the initiative to all the 11 ICPAC member countries. HyVic will contribute by applying its research work and experience on missing data (Angus, 2016; personal communication) by ensuring objective selection of the rain gauge stations for the expanded DARE project region. Anticipated funding Source: DFID WISER Program.

(iv) HyVic workshop: HyVic workshop is planned to, (a) bolster ICPAC's capacity to use WCRP CMIP climate model simulations, and (b) plan the development of the co-designed curriculum with ICPAC and partner universities. Proposed funding Source: Anticipated funding Source: DFID WISER Program.

OzEWEX

The OzEWEX leadership panel, presently consisting of the two co-chairs and WG chairs, decided to change its structure. There are some drivers for this restructure: challenges in some of the WGs to plan or progress activities; varying interpretations of the purpose of WGs; and challenges in finding the resources needed to support WG activities. In the revised panel structure, current WG chairs will instead become Theme Leads and continue to play a liaising and coordinating role. In addition, a small number of active, limited-period projects will be developed and resourced subject to annual review, with Project Leads also becoming part of the leadership group. The changed structure will also more closely resemble other GEWEX leadership structures.

An exciting new OzEWEX activity is the organisation of the first Australian Climate and Water Summer Institute, a prestigious event that will offer ca. 15 of the best students in Australia and New Zealand a unique opportunity, with expenses covered, to work closely with peers and experts from academia and government agencies, to enhance climate and water information and its practical applications. The Institute will take place in Canberra from 5 December 2016 – 21 January 2017, breaking for Christmas and New Year. The selected students will collaborate intensively in small teams for six weeks to work on projects developing an application or improvement to data services and analysis tools from the Summer Institute consortium partners (CSIRO, Bureau of Meteorology, Geoscience Australia, Murray-Darling Basin Authority, National Computational Infrastructure, Bushfire and Natural Hazards CRC, ARC Centre of Excellence for Climate System Science, several universities and some private donors). The formation of the consortium has included the establishment of an overseeing board, and it is anticipated that this board may be approached for advice and assistance in pursuing other OzEWEX project.

Cross-Cut Projects

INTENSE (sub-daily precipitation)

Continued data acquisition and initiatives to update and expand the existing database. Thought given to where to host data collection and calculation of new indices for sub-daily precipitation. Talks are developing with ECA&D among others. Data will be held at an approved data centre (TBD) where freely distributable, and sub-daily seasonal/monthly indices will be developed for all stations. Other station metrics will also be calculated such as diurnal cycle or precipitation-temperature scaling relation. The indices will be made available to the public through a dedicated web site, which will also indicate data availability and links to data providers and licensing arrangements etc. Publications are planned on analysing the indices.

Global scale analysis of trends in sub-daily extreme precipitation. Analysis of the UK data is underway in this regard, developing methods that may be applied more widely in the project including tests of homogeneity. The UK analysis includes assessment of consistency with climate change projections derived from the UK Met Office convection permitting climate model.

Working collaboratively with Andy Prein at NCAR on CPM and observations over the US, trying to understand the role of thermodynamics and dynamics in driving sub-daily precipitation extremes.

A global scale analysis of the extreme precipitation-temperature relationship will be undertaken using sub-daily datasets gathered by INTENSE during a trip by Renaud Barbero to Seth Westra's group at Adelaide University.

INARCH

- Participate in snow model comparisons at sites where inputs can be measured/defined through links with GLASS.
- Reduce measurement uncertainty by implementing WMO SPICE recommendations for solid precipitation measurements at all sites and making contact with Global Cryosphere Watch for how to further improve measurement quality.
- Develop a downscaling toolbox by examining various techniques for statistical, dynamical and medium complexity downscaling.
- Continue climate sensitivity comparative analysis of various alpine basins using "standard virtual basin" modelling to compare the response of snowcover, snowpack, glaciers and hydrology to variations in temperature and precipitation in various climate regimes.

Near 0°C Precipitation

New scientific activities include:

- As more datasets from different regions become available, we will move towards greater standardization and making this information as readily available as possible.
- We have established collaboration with a research group in China that will use our joint analyses of daily and sub-daily data for North America and Russia in order to overcome the deficiency of Chinese sub-daily data about the freezing events occurrence.
- Given the diversity of issues underway and their progress, a synthesis article will be scoped out. This will help to bring together the numerous participants.

5. Science highlights

- A major CCRN effort was centered on a comprehensive focal examination of the extreme weather and flooding in southern Alberta in June 2013, focusing on meteorological, hydrological, and water management aspects of the flood. This has led to a collection of papers being published in a special issue of Hydrological Processes. (See <http://www.ccrnetwork.ca/news-events/news/2016/ccrn-special-issue-papers-on-the-2013-alberta-flood-coming-online.php> for further details and links to all published papers.)
- HymEx continues the analysis of the information gathered during the last five years. It has substantially progressed in the quantification of the Mediterranean water cycle at different scales by modelling and observation, and has a better understanding of the uncertainty propagation in the studies of future climate. Hydrological studies show large improvement, especially in the quantification of freshwater inputs in the Mediterranean and a better understanding of the underground water processes.
- The OzEWEX Trends and Extremes WG published a Special Issue on historical and future changes in Australian natural hazards, including coastal extremes, floods, drought, land and

marine heatwaves, fire, frost, storms, wind and hail. The articles review evidence of changes based on observational and modelling lines of evidence, and propose research directions for the next decade to better understand, quantify and predict changes to each of the natural hazards. Seven articles are available online (McKinnes et al., 2016; Johnson et al., 2016; Crimp et al., 2016; Perkins-Kirkpatrick et al., 2016; Kiem et al., 2016; Walsh et al., 2016; Sharples et al., 2016). A major common challenge identified across hazards was the attribution of changes in natural hazards to climate and non-climate causes. The WG also organised a session at OzEWEX '15 on this topic.

- Assessment of hourly rainfall scaling with temperature in high resolution climate model runs – results show same downturn at high temperatures as seen in observations – paper published in Nature Geoscience in January 2016.
- Using synoptic data across the northern extratropics, we compiled a data set of more than 1,500 long-term time series (40 years of data) of synoptic observations with freezing precipitation information
- INARCH developed specialised science on downscaling atmospheric models in mountain regions through the activities of a working group on the subject. The working group implemented and tested the new ICAR intermediate complexity atmospheric research model at high resolution at various mountain locations and also raised the need for “snow drift resolving” atmospheric models in mountains that made a series of presentations to CORDEX 2016 base.

6. Science issues: Contributions to developing GEWEX science; fit into GEWEX imperatives

Observations and Predictions of Precipitation

- Assessments of various precipitation products and remotely sensed observations, including GPM, and characterization and regionalization of precipitation and drought characteristics over western Canada, with several papers in draft. Relevant publications include: Asong et al. (2015), Khaliq et al. (2015), Masud et al. (2015)
- Analysis of large scale hydrological model performance for the Saskatchewan and Mackenzie basins. Identification of key challenges – input uncertainty, permafrost, cold region lakes and wetlands, mountain hydrology, prairie hydrology, anthropogenic water management. Work initiated to address these with a number of draft papers underway and some recent publications. Much of this work (at various stages of development) had been reviewed and synthesized at a workshop last year (see www.ccrnetwork.ca/science/workshops/2015-modelling-workshop). Relevant publications include: Hassanzadeh et al. (2014, 2015), Mekonnen et al. (2014), Nazemi and Wheeler (2014a, 2014b, 2015a, 2015b).
- INTENSE - Collation of global sub-daily precipitation data (see section 1 above for a summary of progress).
- INTENSE - Development of procedures for the quality control of sub-daily precipitation data has been undertaken for the UK. Future work will examine how the methods developed can be applied more widely in the context of global data acquisition
- HymEx is progressing in the analysis of the Special and Long observation periods, which include many cases of floods.

Global Water Resource Systems

- The ERA-Interim precipitation, incoming solar radiation (ISR), air temperature, air humidity, and wind speed, are compared with their SAFRAN counterparts. Also, interpolated in situ ISR observations are used in order to consolidate the evaluation of this variable. The daily precipitation estimates produced by ERA-Interim over France correlate very well with SAFRAN. However, the values are underestimated by 27%. A GPCP-corrected version of ERA-Interim is less biased (13%).

Changes in Extremes

- A major CCRN effort was centered on a comprehensive focal examination of the extreme weather and flooding in southern Alberta in June 2013, focusing on meteorological, hydrological, and water management aspects of the flood. This has led to a collection of papers being published in a special issue of Hydrological Processes. (See <http://www.ccrnetwork.ca/news-events/news/2016/ccrn-special-issue-papers-on-the-2013-alberta-flood-coming-online.php> for further details and links to all published papers.) Relevant publications include: Fang et al. (2016), Harder et al. (2015), Kochtubajda et al. (2016), Liu et al. (2016), Pomeroy et al. (2016a, 2016b), Shook et al. (2015), Whitfield and Pomeroy (2016). See outreach brochure summarizing our findings at www.ccrnetwork.ca/outputs/outreach/docs/CCRN_2013Flood_Poster.pdf.

Water and Energy Cycles

- Using an oceanic regional reanalysis for the Mediterranean, a first result concerned the clear warming and saltening trend visible in the deep water masses since the beginning of dense observations in the Gulf of Lions in 2007 (Houpert et al., submitted, Somot et al., submitted)
- Use of soil moisture monitoring networks for improving observation of soil freeze-thaw processes and evaluation of soil moisture scaling properties at resolutions applicable to the NASA Soil Moisture – Active Passive (SMAP) mission, upscaling of energy and water balance components from point- to field-scales, and evaluation of wetlands and soil moisture using RADARSAT-2 in prairie and taiga–tundra ecoregions. Relevant publications: Adams et al. (2015), Burns et al. (2016), Champagne et al. (2016), Djamai et al. (2015), Manns et al. (2015), Rowlandson and Berg (2015), Rowlandson et al. (2015), Roy et al. (2016).
- INARCH - Water and energy cycles in mountain catchments are dominated by snow mass and energy exchange processes such as blowing snow, snow interception, sublimation, and melt. The following example provided by Kabir Rasouli shows how annual fluxes of these processes vary by ecozone in the Reynolds Creek Research Watershed, Reynolds Mountain East sub-basin operated by Dr. Danny Marks of USDA and how sensitive they are to perturbed climate. The four climate scenarios are a) control period of current climate, b) P=100%, T= +5 C, c) P=120%, T=+5C. d) P=80%, T=+5C
- HymEx is quantifying the water cycle with special effort on the continental hydrological aspects.

9. Other key science questions that you anticipate your community would want to tackle in the next 5-10 years within the context of a land-atmosphere project (1-3 suggestions). Briefly list any specific areas of your panel's activities that would contribute to the WCRP Grand Challenges as identified by the JSC (not covered under 9).

Regional Sea-Level Rise

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Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)

- CCRN will determine whether future changes cross 'tipping points' in Earth system behaviour, leading to further extremes and dramatic system changes, such as deglaciation, permafrost disappearance and terrestrial ecosystem transition. Local scale assessments have begun in Theme B with several publications (Pomeroy et al. (2015b), Rasouli et al. (2014, 2015)), and planned CRHM historical and future diagnostic modelling (see <http://www.ccrnetwork.ca/science/workshops/crhm-workshop-2016/index.php>)

Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity

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Past and future changes in water availability (with connections to water security and hydrological cycle)

See GEWEX Science Questions section above.

Science underpinning the prediction and attribution of extreme events

- INTENSE - Data collection activities will contribute information (overarching theme: document) that could underpin detection and attribution studies and model evaluation by collating and quality controlling sub-daily precipitation data (providing data that is extensive in time and space). INTENSE is also examining how sub-daily precipitation extremes may be defined through the use of relevant indices that have to date only been established on daily timescales.
- INTENSE - Analysis of local scale thermodynamics and large-scale predictors will improve understanding and characterisation of physical mechanisms leading to the occurrence of floods and droughts (overarching theme: understand), and the relationships between these events.
- By linking observations with the latest generation of climate models (and in particular the emerging high-resolution regional climate models) INTENSE will assess the deficiencies of models in the simulation of key processes and events. It will contribute valuable information as to the types of events that current models can provide credible and robust simulations for, and where high-resolution models offer added value on the projected change signal compared with coarse resolution models (overarching theme: simulate).

Near Term Climate Prediction (New)

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Carbon Feedbacks in the Climate System (New)

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10. Cooperation with other WCRP projects (CLIVAR, CLIC, SPARC), outside bodies (e.g., IGBP) and links to applications

CCRN

- The International Network for Alpine Research Catchment Hydrology (INARCH; <http://www.usask.ca/inarch/index.php>) is a GEWEX Hydroclimate Panel project that is an international spin-off from CCRN, led by Professor John Pomeroy. CCRN and INARCH are closely linked and share many common research priorities and objectives. A workshop will be held in mid-October, that members of CCRN will attend.
- The Cold/Shoulder Season Precipitation Near 0°C project is a GHP cross-cut project that addresses multiple aspects of precipitation phase transitions, and is led by CCRN investigators. There are many areas of overlap between these projects; in particular, CCRN is conducting a detailed assessment of changes in the 0°C isotherm, with objectives that are directly linked to this project.
- Another GHP cross-cut project is focused on Including water management in large scale models, and is led by several CCRN investigators, including the Principal Investigator. Considerable progress on this issue has been achieved through CCRN studies, and both

initiatives have goals to include newly developed reservoir schemes into models, such as MESH. A workshop will be held in late September, that members of CCRN will attend.

INARCH

Collaboration with UNESCO IHP and information collaboration with SPICE and Global Cryosphere Watch (CliC).

11. Applications and/or Links to the Global Framework of Climate Services

N/A

12. Outreach and Capacity-Building Activities

OzEWEX - the first Australian Climate and Water Summer Institute, a prestigious event that will offer ca. 15 of the best students in Australia and New Zealand a unique opportunity, with expenses covered, to work closely with peers and experts from academia and government agencies, to enhance climate and water information and its practical applications. The Institute will take place in Canberra from 5 December 2016 – 21 January 2017, breaking for Christmas and New Year. The selected students will collaborate intensively in small teams for six weeks to work on projects developing an application or improvement to data services and analysis tools from the Summer Institute consortium partners (CSIRO, Bureau of Meteorology, Geoscience Australia, Murray-Darling Basin Authority, National Computational Infrastructure, Bushfire and Natural Hazards CRC, ARC Centre of Excellence for Climate System Science, several universities and some private donors).

13. Workshops/meetings held

- CCRN modelling workshop, Saskatoon, SK, November 28-29, 2016
- CCRN 4th Annual General Meeting - OAC Centennial Arboretum Centre, University of Guelph, Guelph, ON, November 2-4, 2016
- CCRN Special Observation and Analysis Period (SOAP) workshop, Saskatoon, SK, October 3-4, 2016
- Cold Regions Hydrological Model (CRHM) Expert Workshop, Saskatoon, SK, June 6–7, 2016
- CCRN Theme D synthesis workshop, University of Manitoba, Winnipeg, MB, May 10-11, 2016
- The INTENSE project held a community-building workshop in Newcastle, UK from 13th-15th September 2016 entitled “Sub-daily rainfall extremes: data, processes and modeling.” This aimed to: (a) Explore best practice for using sub-daily rainfall data, including quality control; (b) Examine current research theories around processes affecting sub-daily rainfall extremes (mainly observations); (c) Identify a set of sub-daily extreme rainfall indices useful to a wide variety of users; (d) Discuss progress on convection-permitting models and the current gaps in our understanding, and how to best combine observational and modelling studies; (e) Plan the next steps in this area, including a publication from the workshop.
- Near 0C precipitation - June 22-23 2016 (Toronto) - main issue was near 0°C data quality over Canada

14. Workshops/meetings planned. Include travel support needs anticipated (for WCRP). Include tentative meetings planned for up to 2 years (for IGPO planning purposes)

- **GHP annual meeting** (This meeting is planned late each October.)
- **OzEWEX annual meeting** (planned November/December)

- **HyMex annual meeting** (planned each September). 10th Annual workshop in Barcelona (4-7 July 2017)
- **CCRN annual meeting** (planned each November) CCRN 5th Annual General Meeting - Delta Bessborough Hotel, Saskatoon, SK, November 1-3, 2017
- CCRC - Scenarios of future change follow up workshop, National Hydrology Research Centre, Saskatoon, SK, March 20-21, 2017
- CCRN - Spring modelling workshop on land and water futures, location TBD, Saskatoon, SK, June 19-20, 2017
- HyVic workshop: HyVic workshop is planned to, (a) bolster ICPAC's capacity to use WCRP CMIP climate model simulations, and (b) plan the development of the co-designed curriculum with ICPAC and partner universities. Proposed funding Source: Anticipated funding Source: DFID WISER Program.
- Baltic Earth: i) workshop on "Coupled atmosphere-ocean modeling for the Baltic Sea and the North Sea" (7-8 Feb 2017; Warnemünde (IOW), Germany); ii) Joint ESA-Baltic Earth workshop on remote sensing applications (29-31 March 2017, Helsinki, Finland)
- PannEx 3rd workshop, Cluj-Napoca (Romania), 20-22 March 2017

15. Other meetings that were attended on behalf of GEWEX or your Panel

AGU, EGU

16. Issues for the SSG

N/A

17. List of key publications (*where appropriate*)

Chan, S.C., E.J. Kendon, N.M. Roberts, H.J. Fowler and S. Blenkinsop. The characteristics of summer sub-hourly rainfall in a high-resolution convective permitting model. *Environmental Research Letters*, in press.

Kendon, E.J., N. Ban, N.M. Roberts, M.J. Roberts, S. Chan, H.J. Fowler, G. Fosser, J. Evans and J. Wilkinson. Using new high resolution models to assess the reliability of regional climate projections. *Bulletin of the American Meteorological Society*, in press.

Blenkinsop, S., E. Lewis, S. Chan and H.J. Fowler, 2016. Quality control of an hourly rainfall dataset and climatology of extremes for the UK. *International Journal of Climatology*, DOI: 10.1002/joc.4735.

Chan, S.C., E.J. Kendon, N.M. Roberts, H.J. Fowler and S. Blenkinsop, 2016: Downturn in scaling of UK extreme rainfall with temperature for future hottest days. *Nature Geoscience*, 9, 24–28, DOI: 10.1038/NNGEO2596.

Pomeroy, J.W., R.L.H. Essery and W.D. Helgason. 2016. Aerodynamic and radiative controls on the snow surface temperature. *Journal of Hydrometeorology*, DOI:10.1175/JHM-D-15-0226.1.

Weber, M., M. Bernhardt, J.W. Pomeroy, X. Fang, S. Harer and K. Shulz. 2016. Description of current and future snow processes in a small basin in the Bavarian Alps. *Environmental Earth Sciences*, 75(17), 1223. doi:10.1007/s12665-016-6027-1.

Pomeroy, J.W., X. Fang and D. Marks, 2016. The Cold Rain-on-Snow Event of June 2013 in the Canadian Rockies – Characteristics and Diagnosis. *Hydrological Processes*. DOI:10.1002/hyp.10905.

Fang, X., and J. Pomeroy, 2016. Impact of antecedent conditions on simulations of a flood in a mountain headwater basin. *Hydrological Processes*. DOI: 10.1002/hyp.10910.

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18. List of members and their term dates (including changes)

- Prof. Jason Evans - co-chair - 2013-2020
- Dr. Joan Cuxart Rodamilans - co-chair - 2017-2020*
- Dr. Nicole van Lipzig - 2014-2017*
- Dr. Silvina Solman - 2014-2017*
- Prof. Christel Prudhomme - 2015-2018*
- Dr. Ben Zaitchik - 2015-2018*
- Dr. Craig Ferguson - 2015-2018* (GLASS representative)
- Prof. Sylvester Danour - 2016-2019*
- Prof. Xin Li - 2016-2019*