

July 2019

I am delighted to share our new HIWeather web site with you in this newsletter. Our project website has been created and is maintained by CMA at <http://hiweather.net>. Please contact hiwico@cma.gov.cn to add or amend material on this web site. I would particularly encourage those involved in HIWeather activities to post descriptions of progress there. Our communications website has been created and is maintained by Massey University, New Zealand and will be available shortly.

I attended my second UNDRR Global Platform on Disaster Risk Reduction (GPDRR 2019) preceded by the Multi-Hazard Early Warning Conference (MHEWC-II) in May, along with our Co-Chair David. As last time in Cancun, the whole Global Platform experience was quite overwhelming, with vast numbers of people and lots of parallel sessions ranging from serious science to political statements to sound-bites. As planned, HIWeather got lots of visibility, especially in the MHEWC-II. For the GPDRR, early warnings are just one of many policies that can reduce disaster risk. Nevertheless, with the Secretary General of WMO as opening speaker, the final scientific session on early warnings drew a good crowd. A highlight was the launch of the new Global Assessment Report on DRR, which I have previously circulated links to (<https://gar.unisdr.org/report-2019>). This draws on recent work in climate change and biodiversity to paint a stark picture of the urgency of action to manage the risk of global disaster. Sadly, the supporting papers, including a HIWeather authored value-chain paper, were not published until much later. The link for this paper is <http://www.preventionweb.net/publications/view/65828> and it will eventually be accessible from the main GAR page.

As ever, there was insufficient time to properly follow-up on these meetings before the next one was upon me. That came in the form of some work under the banner of the GCRF fund in the UK. First came a selection meeting for the outline stage of the multi-hazard risk call, followed by the first meeting in Edinburgh of the "Future Cities" research hub, the bid for which was first dreamt up during the Cancun GPDRR. This project aims to address the systemic problems that create new risk when developing cities expand. It is working in four cities: Istanbul, Kathmandu, Nairobi and Quito. A wide range of natural hazards affect the poorer inhabitants of these cities and the work will involve a combination of different mitigation policies, including early warnings. Currently the main focus is on flooding. HIWeather provided a letter of support for this project and will maintain contact as it progresses.

Shortly after this I was in Newcastle on Tyne for the third annual meeting of the UK Alliance for Disaster Research. Like the GPDRR, these meetings are highly inter-disciplinary and feature some very colourful characters. I have extensive notes from this meeting that need to be followed up in August!

I was delighted to be invited to join the MSF and HIVR teleconferences in July and enjoyed catching up on their progress – some of which you will read later in this newsletter – as well as feeding back on the GPDRR. Sharan Majumdar shared the latest copy of the review paper that the MSF team is preparing and I have been able to suggest some inputs. We are hoping to have a complete draft before the Steering Group meeting in October.

My other writing assignment was to outline the book proposal to Springers. Following discussions with the Steering Group I submitted an outline based on the “Five Valleys of Death” version of the early-warning value-chain, with the emphasis on the bridges over the valleys. We now have to refine that and assign authors before the end of the year.

Looking forward, October will be a busy month for me. The WWRP scientific steering committee meets in the first week; I am attending the Herrenhausen conference on building resilience to extreme events in the second week; and the HIWeather steering group meets in the third week. I look forward to seeing some of you at one or more of these events.

Wishing you all every success in your HIWeather activities.



Brian Golding

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1 The Project

Steering Group and Task Teams

Co-chairs: Brian Golding, UK, brian.golding@metoffice.gov.uk and David Johnston, New Zealand, D.M.Johnston@massey.ac.nz

ICO: Qinghong Zhang, Liye Li, China, hiwico@cma.gov.cn.

Processes & Predictability (P&P) theme – lead: Michael Riemer, Germany, mriemer@uni-mainz.de.
Members: John Knox, Peter Knippertz, Andreas Schäfler, Juan Fang, Shira Rabeh-Ruvim, Linus Magnusson, Deanna Hence, Yali Luo, Linda Schlemmer, Robert Rogers

Multi-Scale coupled Forecasting (MSF) theme – lead: Jenny Sun, USA, sunj@ucar.edu.
Members: Paul Joe, Peter Steinle, Sharan Majumdar, Jianjie Wang, Jim Dudhia, Krushna Chandra Gouda, Nusrat Yussout.

Human Impacts, Vulnerability & Risk (HIVR) theme – lead: Brian Mills, Canada, bmills@uwaterloo.ca.
Members: Joanne Robbins, Michael Kunz, Isabelle Ruin, Melanie Gall.

Communication theme – co-leads: Andrea Taylor, UK, a.l.taylor@leeds.ac.uk & Shannon Panchuk, Australia s.panchuk@bom.gov.au

Members: Abi Beatson, Greg Carbin, Melanie Harrowsmith, Amber Silver, Rutger Dankers, Thomas Kox, Claudia Adamo, Jose Galvez, Kiernan McGill, Linda Anderson-Berry, Tim Brown, Vankita Brown, Emily Campbell.

Evaluation theme – lead: Beth Ebert, Australia, e.ebert@bom.gov.au

Members: Amanda Anderson, Barb Brown, Julia Chasco, Martin Goeber, Masa Haraguchi, Rainer Kaltenberger, Chiara Marsigli, Marion Mittermaier, Anna Scolobig, Helen Titley

Xudong Liang, liangxd@cma.gov.cn

NEW MEMBERS

Hugo Remaury (HIWeather Project Officer) hremaury@wmo.int

Hugo have been working on climate-related topics for about 7 years, first through a social science lens at Kansas State University, assessing the feasibility of payment for ecosystem services schemes in Northern Ghana, as part of his second MS thesis. After then, Hugo developed a thorough knowledge of project/programme planning and implementation, knowledge sharing and communication in the field of climate change adaptation, via various field positions and assignments across different areas of work, regions, and within various international organizations (ICARDA/CGIAR, Adaptation Fund/World Bank, IFAD, FAO). Since 2014, Hugo worked with countries seeking funding from financial institutions such as the GCF, the Adaptation Fund and the GEF, but also within such financial institutions in assessing funding proposals received from national partners. As part of his engagement with the Adaptation Fund/World bank, he also represented the Fund in international events and was actively engaged in meetings with both donor and recipient countries, the UNFCCC and other UN organizations. Recently Hugo joined WMO RES department and will interact with HIWeather as project officer.

Nusrat Yussout (MSF) nusrat.yussouf@noaa.gov

Nusrat is the lead of the NSSL Warn-on-Forecast effort. She is expected to play an important role in activities involving high-resolution data assimilation and short-term HIW prediction.

ADVISORY BOARD

John Rees, British Geological Survey and Research Councils UK, representing funding agencies
Jan Polcher, Laboratoire de Meteorologie Dynamique of Centre National de la Recherche Scientifique, France, representing Climate Science

Jennifer Sprague-Hilderbrand, National Oceanic and Atmospheric Administration, USA, representing users
Virginia Murray, Public Health England and UNISDR, representing the UN family

Michael Reeder, Monash University, Australia, representing academia

Funding. The Trust Fund can support HIWeather conference attendance by delegates from developing countries. New contributions are needed to develop and facilitate the work of the project.

International Coordination Office: The ICO in the Chinese Academy of Meteorological Sciences was formally opened during the workshop in November 2018. The ICO has taken over organisation of Steering Group, Advisory Board and Task Team teleconferences, and has launched a project web site at <http://hiweather.net/Index>.

Secretariat: Paolo Ruti and Hugo Remy provides the link to the World Weather Research Programme.

Communication: The HIWeather web site can be reached at <http://hiweather.net/Index>. It contains the Implementation Plan, Steering Group and Task team membership and HIWeather presentations. It is available for task teams to post meetings and progress. A communications web platform for the project has been set up at Massey University, New Zealand and is currently being populated. I use Linked-In to post items of interest about HIWeather and copy my posts to Twitter using the hashtag #HIWeather.

Meetings: The Steering Group meets quarterly, usually by teleconference. The next physical meeting will be following on 14-16 October in Geneva. Task teams meet by teleconference at intervals to suit their work. The Advisory Board aims to meet at least once a year by teleconference.

TASK TEAM EVENTS

HIWeather breakout session took place on June 17th at the Australasian Natural Hazards Management Conference: <http://www.massey.ac.nz/massey/learning/departments/school-of-psychology/research/disaster-research/events-and-news/anhmc-workshop.cfm>

A MSF (Multi-Scale coupled Forecasting) task team teleconference was conducted on 11 July. We discussed the status and issues of the HIW prediction review paper draft and decided to have Brian Golding to condense the draft before the other members making further contributions. Jenny Sun briefed the team on the idea of a high-resolution model inter-comparison activity that is expected to be collaborative efforts with DAOS and NMR working groups.

2 Relevant Scientific Activities

Calls and requests

General Call: We would like to invite those who use Twitter for communication about HIWeather relevant topics to add their Twitter name to the database that Emily Campbell has compiled: https://docs.google.com/spreadsheets/d/1Aw1B2FjW66T_yoLCWSb6KzvDZR_e2wTBqYOsFFYRU5M/edit?usp=sharing

Call: Submissions are still open for the special issue of Sustainability on “Understanding and Preparing for Uncertainty in Sustainable Disaster Risk Management”, being guest edited by Emma Hudson-Doyle, Douglas Paton, and David Johnston. Authors have until October 31st to submit: https://www.mdpi.com/journal/sustainability/special_issues/Uncertainty_DRR

Request: Sara Harrison (S.Harrison@massey.ac.nz, Massey University) is looking for any researcher or practitioners who are looking at IBF and wildfires, and would appreciate being put in touch with anybody doing work in this space.

Call for special issue: *Development and Application of Seamless Prediction Systems* in Meteorologische Zeitschrift (MZ). Major components of a seamless prediction system are 1) observations, 2) observation and NWP based nowcasting systems, 3) (ensemble-based) numerical weather prediction systems, 4) postprocessing and 5) applications to reduce weather related hazards. Your contribution might focus on one or

more key components of a seamless predictions system or present several outputs in a seamless way already. Please submit your manuscript to the MZ latest until 31.Dec.2019

Activities

- 1) **European Meteorological Society Annual Meeting:** Copenhagen, Denmark, September 9-13 2019. (<https://www.ems2019.eu/>) Abstract submissions are closed. Early registration rate available until 23rd July.
- 2) Herrenhausen conference on "**Extreme Events: Building Climate Resilient Societies**", Hanover, Germany, October 9-11, 2019. (<https://www.volkswagenstiftung.de/en/events/calendar-of-events/herrenhausen-conferences/extreme-events-building-climate-resilient-societies>). Registration is closed.
- 3) **WMO High Mountain Summit**, 29-31 October 2019, Geneva, Switzerland, see <https://highmountainsummit.wmo.int/en>
- 4) **Meteorological Society of NZ**, Annual Conference, 25 to 27 November 2019, Wellington, New Zealand
- 5) **AGU** Fall Meeting, 9-13 December 2019, San Francisco, USA
- 6) **AMS**, Annual Meeting, 12-20 January 2020, Boston, USA

3 HIWEATHER RESEARCH

HIWeather Project Index	
P&P	Review the state of wind hazard forecasting
	NAWDEX (North Atlantic Waveguide and Downstream Impacts Experiment):
	Multi-scale, multi-leadtime predictability of high-impact weather
	RELAMPAGO-CACTI (Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations - Cloud Aerosols and Complex Terrain Interactions)
	SCMREX (Southern China Monsoon Rainfall EXperiment)
	PRECIP (Prediction of Rainfall Extremes Campaign in the Pacific)
MSF	MOUNTAOM (RDP alongside the 2022 Winter Olympic Games in Beijing)
	Review the current state of nowcasting & forecasting high impact weather
	Intercomparison of km-scale DA & nowcast/forecast systems
	SURF (Study of Urban Rainfall and fog/haze)
	ICE-POP2018 (RDP/FDP alongside the Pyeongchang Winter Olympic Games in South Korea)
	UK Environmental Prediction (UKEP) project
HIVR	Formal (statistical) impact model intercomparison
	Impact data collection
	Fire weather evaluation
	Review & classification of impact modelling
COMM	Unconventional data sources for impact modelling, evaluation & communication
	Review of approaches to communicating high impact weather.
	Training Materials
	Review of the role of trust, salience and beliefs on people's responses to weather warnings
	Communicating uncertainty
	Post-event case studies
	Communication platform
	HIGHWAY (Lake Victoria Basin Nowcasting project)
GCRF African Science for Weather Information and Forecasting Techniques (GCRF African SWIFT)	
EVAL	Evaluating the effectiveness of impact-based, extreme weather warnings and behavioural recommendations.
	Warning response
	Global Hazard Map
	Weather Information Value Chain
	Probabilistic forecasting and evaluation of Tropical Cyclones
	Mesoscale Verification Inter-comparison over Complex Terrain (MesoVICT)
	Societal and Economic Research Applications (SERA) Workshop
	Value Chain review by WWRP SERA Working Group
	Verification Challenge
Method(s) to measure avoided losses due to improved warnings	

Review the state of wind hazard forecasting

Lead: John Knox

Identify wind metrics that relate to impacts; describe the state-of-the-art in observing and predicting them; identify processes that lead to high impacts; make recommendations for targeted work to address weaknesses in understanding, observing and prediction. The writing team is working to a target of completion in 2019.

NAWDEX (North Atlantic Waveguide and Downstream Impacts Experiment):

Lead: Andreas Schäfler (Processes & Predictability task team)

[ECMWF workshop on "Observational campaign for better weather forecasts":](#)

In June 2019 ECMWF organized a workshop aimed to increase the interactions between observation campaigns and numerical weather prediction (NWP) centres. The workshop involved contributions from NWP centres, past and future campaigns and operational activities that provide "special" observations. From the HIWeather community, for example the NAWDEX and Festival campaigns were represented. The workshop led to great discussions how to increase the interactions, and how to NWP centres can help to motivate future campaigns.

Read more about the workshop here: <https://www.ecmwf.int/en/about/media-centre/news/2019/experts-explore-how-observational-campaigns-can-improve-weather>

Multi-scale, multi-leadtime predictability of high-impact weather

Leads: Shira Raveh-Rubin, Linus Magnusson, Michael Riemer

Objectives: Assess the predictability of different ingredients to HIW events as a function of leadtime and identify the physical processes that limit predictability (see [Di Muzio et al, 2019](#) for tropical-cyclone-like Mediterranean cyclones). In collaboration with the Multiscale Forecasting theme, assess the role of assimilating high-resolution data to capture the mesoscale dynamics and improve short-term prediction. Starting with high-impact weather related to dry intrusions ([Catto and Ravel-Rubin, 2019](#); [Ravel-Rubin and Catto, 2019](#)), develop general recommendations how to assess this insight for other types of high-impact weather.

RELAMPAGO-CACTI

(Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations - Cloud Aerosols and Complex Terrain Interactions)

Linked to HIWeather through the WGNMFR

RELAMPAGO is funded by the US National Science Foundation to observe convective storms that produce high impact weather in the lee of the Andes in Argentina. It also involves contributions from NASA, NOAA, Argentina (MINyCT), Brazil (CNPq and FAPESP), Chile (CONICYT), universities across the region, Argentina's national meteorological service (SMN) and Brazil's space agency (INPE). Observations during the main observing period, Nov-Dec 2018, successfully captured many storms. See press report at: <https://www.abc.net.au/news/2019-01-23/weather-scientists-find-one-of-worlds-largest-hail-stones/10735666>

SCMREX (Southern China Monsoon Rainfall Experiment)

During the pre-summer rainy season (April–June), southern China often experiences frequent occurrences of extreme rainfall, leading to severe flooding. The China Meteorological Administration (CMA) initiated a nationally coordinated research project, SCMREX, endorsed by WMO, as a WWRP RDP, consisting of four major components: field campaign, database management, studies on physical mechanisms of heavy rainfall events, and convection-permitting numerical experiments including impact of data assimilation, evaluation/improvement of model physics, and ensemble prediction. Pilot field campaigns were carried out in 2013–15. See <https://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00235.1>, which describes i) the scientific objectives, pilot field campaigns, & data sharing of SCMREX; ii) provides an overview of heavy rainfall events during SCMREX-2014; and iii) presents examples of preliminary research results and explains future research opportunities.

PRECIP

Leads: Rob Rogers

The U.S. NSF has recently funded a project entitled **Prediction of Rainfall Extremes Campaign in the Pacific (PRECIP)**, led by Michael Bell and Kristen Rasmussen (Colorado State University), which seeks to improve the fundamental understanding and predictability of the processes that produce extreme precipitation through an ingredients-based physical framework. The project will investigate the universal aspects of the extreme rainfall problem by testing hypotheses that are not directed at one specific weather phenomenon. Rather, research observations will be collected during four event types that meet a global definition of 'extreme' rainfall across the spectrum of rainfall intensity and duration: (1) deep convective cores, (2) wide convective cores, (3) broad stratiform regions, and (4) tropical cyclones (TCs; termed "typhoons" in the West Pacific).

With high total column water vapor in the region as a fundamental precondition, field observations will be used to test hypotheses related to the presence and roles of key ingredients and processes across the different scales of heavy rainfall scenarios.

PRECIP will be conducted in collaboration with the Taiwan-area Atmospheric and Hydrological Observation and Prediction Experiment (TAHOPE) and Japanese Tropical cyclones-Pacific Asian Research Campaign for Improvement of Intensity estimations/forecasts (T-PARCII). An array of ground-based platforms will be situated on Taiwan island during summer 2020. There is also an effort underway to obtain funding to support the deployment of a NOAA WP-3D aircraft, which would operate out of Okinawa, Japan. The WP-3D's tail Doppler radar (TDR) would obtain high-density, three-dimensional measurements of wind fields in organized precipitation structures including mesoscale convective systems, the Mei-Yu front, diurnal convection, and tropical cyclones/typhoons. Research missions also support the calibration/validation of satellite measurements and instrumentation development (e.g., Doppler wind Lidar, Scanning radar altimeter, Coyote UAS, etc.) for the heavy precipitation environment and sampling of other aspects of the local environment (e.g., boundary layer thermodynamic and kinematic structure). The extreme rainfall and typhoon reconnaissance effort during the period leading up to the 2020 Tokyo Olympics will provide a focal point for an education and outreach effort promoting the positive role of international science collaboration to address global problems such as extreme weather.

MOUNTAOM (RDP alongside the 2022 Winter Olympic Games in Beijing)

China will be hosting the 2022 Winter Olympic Games in the mountains to the northwest of Beijing. A research activity is underway in the Chinese Meteorological Administration to develop capability in forecasting the relevant weather parameters in this area. The project has six research themes. It is planned to mount an annual field programme, the first of which was held in winter 2017. LES modelling experiments are being conducted with nested grids from 1km down to 37m. The project has an International Advisory Committee, the chair of which is Prof Joe Fernando.

Review the current state of nowcasting & forecasting high impact weather

Leads: Sharan Majumdar and Jenny Sun

Objectives: Document current state of high impact weather nowcasting/forecasting with an emphasis on flood and high wind warnings; Identify gaps

The writing team is being assembled and it is planned to submit to BAMS in 2019.

Intercomparison of km-scale DA & nowcast/forecast systems

Lead: Jenny Sun

Objectives: Demonstrate state-of-the-art of km-scale DA & nowcast/NWP systems for HIW warning with an emphasis on floods & high winds

Had an email discussion with the co-chairs of the Data Assimilation and Observations System (DAOS) working group regarding the possible collaboration on an high-resolution HIW forecasting system intercomparison project. The next is to have a small group meeting call to discuss the scope and how to proceed.

SURF (Study of Urban Rainfall and fog/haze)

Lead Miao Shiguang (CMA/IUM).

Linked to HIWeather through GURME and the MSF task team

The Institute of Urban Meteorology is carrying out the SURF field experiment to study urban pollution and extreme precipitation in Beijing. 2017 was the third season of field data collection. Case study results were presented in the Conference on Predictability & Multi-Scale Prediction of High Impact Weather in October 2017.

ICE-POP2018 (RDP/FDP alongside the Pyeongchang Winter Olympic Games in South Korea)

Led by KMA and linked to HIWeather through the WGNMFR and MSF task team the IOP period is complete. See <http://www.wmo.int/pages/prog/arep/wwrp/new/RDP-FDP.html> for details.

UK Environmental Prediction (UKEP) project

Lead: Huw Lewis

The [UK Environmental Prediction](#) initiative is a national collaboration led by the Met Office, [Centre for Ecology & Hydrology](#), [National Oceanography Centre](#) and [Plymouth Marine Laboratory](#). It develops and evaluates the UK's first fully coupled regional prediction system at kilometre scale, encompassing atmosphere, ocean, wave, land surface, and biogeochemistry model components and their interactions. The aim of the initiative is to enable multi-disciplinary research on Earth system processes at high resolution and to improve future operational applications. The latest research in UK Environmental Prediction was discussed at a workshop in Reading with over 50 scientists from collaborating institutes in June 2019. The workshop gathered together a broad range of researchers from the Met Office, [NERC](#) centres, academia (representing 8 different UK universities), government agencies including the [Environment Agency](#) and [Public Health England](#). One of the exciting aspects of working with coupled systems, illustrated during the workshop, is the need to join together and share different perspectives and expertise from across weather and climate, marine and hydrological science disciplines. This led to a number of new cross-disciplinary links and networks being formed. Most time during the workshop was spent by participants working in small multi-disciplinary groups to develop proposals for research and practical user-focussed applications. The discussion within the groups focused on how to improve modelling and observation capabilities, closing gaps in the scientific knowledge and demonstrating the skill of coupled prediction tools through evaluation experiments. The working groups were focused around three selected areas:

A. Estuarine and coastal environments

Project proposals include work to better simulate and assess the transport and evolution of pollutants from land to ocean, and work to represent the highly detailed estuary and coastline geographies better within modelling systems.

B. Regional coupled prediction for environmental change

Project proposals include work to characterise the impact of representing the interactions between atmosphere, land and oceans on the present-day climate in the UK and in other regions such as south-east Asia where air-sea interactions are known to be important.

C. Concurrent and combined natural hazards

Project proposals include work to assess the vulnerability of regions in the UK to worse-case scenarios when natural hazards from multiple sources combine and potentially interact, e.g. when strong storms, large waves, high tides, high river flows and saturated land occur at the same time.

Some of the new proposals developed during the workshop will be undertaken as research projects within the current UK Environmental Prediction collaboration, while others will form the basis for new funding proposals among the wider community. For further information on the workshop outcomes and the UK Environmental Prediction collaboration, contact huw.lewis@metoffice.gov.uk

Formal (statistical) impact model intercomparison

Lead : Martin Goeber with input from HIVR and Evaluation task teams

Develop Masters student module to examine simple and physically-based impact models

Impact data collection

Link: Rainer Kaltenberger and Joanne Robbins

A review paper is being prepared on how met services collect and use impact data.

Fire weather evaluation

Link: Amanda Anderson

This project at NCAR is evaluating coupled fire-weather modelling. Currently looking at the forecast sensitivity to fuel moisture, terrain and ignition location, and benefit of spotting capability in the model.

Review & classification of impact modelling

Leads: Brian Mills & HIVR task team

The scope of the review is being prepared.

Unconventional data sources for impact modelling, evaluation & communication

Lead: Abi Beatson

An unconventional data research network has been formed. Several activities are underway to investigate tools for gathering social media data from the public, and on the use of weather warnings by the public using data from social media. Activities include:

- Real-time reporting and social data intelligence: Abi Beatson (JCDR, New Zealand)
- Twitter data analysis: Hywel Williams (U. Exeter, UK)
- Use and interpretation of warnings on social media by the public: Amber Silver (U. at Albany, US), Shannon Panchuk (BoM, Australia)
- Citizen science: Lisa McLaren (JCDR, New Zealand)
- Role of social media for impact models & warnings: Sara Harrison, Sally Potter, Abi Beatson (New Zealand)

Review of approaches to communicating high impact weather.

Lead: Andrea Taylor, Communication task team.

A special issue of the International Journal of Disaster Risk Reduction under the title, "Communicating High Impact Weather: Improving warnings and decision making processes" is available at

<https://www.sciencedirect.com/journal/international-journal-of-disaster-risk-reduction/vol/30/part/PA>.

Training Materials

Lead: Shannon Panchuk

Current plans are to link into the work of the WMO Expert Team on Impact-Based Forecasting & Warning and to NOAA in the USA.

Review of the role of trust, salience and beliefs on people's responses to weather warnings.

Leads: Shannon Panchuk and Linus Magnusson

HIW case studies of the forecast value chain will be reviewed. Tropical Idai in March 2019 will be the first case studied. An index of previous WMO surveys of weather service severe weather warnings has been prepared by Juyeon Bae and will be used by this and other activities as a starting point. Linus Magnusson has assembled discussions of severe weather events from the ECMWF newsletters 2014 - 2019. The collection of articles is:

https://www.ecmwf.int/sites/default/files/medialibrary/2019-04/ecmwf_nl_severe.pdf

About Tropical Cyclone Idai:

In March 2019 the tropical cyclone Idai hit southern Mozambique, causing around a thousand fatalities. The event was a multi-hazard event, with extreme wind, rainfall and following flooding. ECMWF forecasts supported the humanitarian response to the disaster. The forecasts and the following response is described

in ECMWF Newsletter 160. The case has also a potential for a multidisciplinary investigation of the forecast value chain within the HIWeather.

Read more here:

<https://www.ecmwf.int/en/newsletter/160/news/ecmwf-works-universities-support-response-tropical-cyclone-idai>

Communicating uncertainty

Lead: Sally Potter

Review and publish the implications of uncertainty in weather forecasts and warnings across the whole spectrum of HIWeather. Literature review underway. Once completed, materials and research will be summarised and guidelines developed for weather forecasters to communicate uncertainty better.

Post-event case studies

Lead: Shannon Panchuk

An index of previous WMO surveys of weather service severe weather warnings has been prepared by Juyeon Bae and will be used by this and other activities as a starting point.

Communication platform

Lead: Emily Campbell.

Outputs from HIWeather communication activities will be freely available on the HIWeather Communication Platform, including best practice guidelines and reviews. The Platform is expected to be launched shortly.

HIGHWAY (Lake Victoria Basin Nowcasting project)

HIWeather link: Andrea Taylor

The “HIGH impact Weather lAke sYstem” project falls in the UKAid WISER programme and runs from October 2017 to March 2020. The expected outcome of HIGHWAY is increased access to and use of co-designed and sustainable early warning systems to inform regional, national, sub-national and community level planning and decision-making in the East African region and to improve resilience and reduce the loss of life and damage to property supporting sustainable economic development in the East African region. In Spring 2019 the international partners participating in HIGHWAY supported an Enhanced Observing Period field campaign over Lake Victoria Basin, coordinated by NCAR. This has collected surface station observations, radar and forecasting reports from both National Meteorological Services and private networks. In parallel, work has been progressing on interpreting lightning observations over the Lake. All the observations collated will be used to understand the meteorology of Lake Victoria and its surrounding region. To complement the aims of HIGHWAY and its field campaign and additionally aligning with the aims of the GCRF African-SWIFT project, the HyVic-Pilot flight campaign was conducted in January 2019. The NERC/Met Office FAAM aircraft was deployed over Lake Victoria and successfully completed two flights across the lake. The flights sampled the diurnal shift in the land-lake and lake-land breezes, as well as the humidity at lower levels over the lake which contributes to night time thunderstorms. See <https://www.metoffice.gov.uk/about-us/what/international/projects/wiser/highway>.



GCRF African Science for Weather Information and Forecasting Techniques (GCRF African SWIFT)

Link: Andrea Taylor (Communication TT)

A 4-year UKAid project to improve African hourly to seasonal forecasting capabilities, funding 80 scientists in 5 UK and 10 African institutions, with WMO as an advisory member. During 23 April-6 May, a team of GCRF African SWIFT researchers and operational forecasters is meeting in Nairobi, Kenya to conduct a weather forecasting testbed. Hosted by SWIFT partners, the [Kenya Meteorological Agency](#) (KMD), the testbed brings together researchers and operational forecasters from across West and East Africa, to engage in the developmental testing of forecasting systems in a quasi-operational environment. The SWIFT testbed will evaluate the NWC SAF Nowcasting software, to determine how the tools can be adapted to African weather systems, and so advance forecasting techniques in Africa. They will also test and evaluate **convection permitting ensemble (CP ensemble)** forecasts, designed by SWIFT partners at the UK Met Office specifically for the Testbed, to provide measures of confidence in the accuracy of forecasts of storms. During the testbed, the Nairobi teams are engaging directly with African forecast user groups at a **Stakeholder Workshop** that is running concurrently with the testbed. See <https://africanswift.org/>

During the last twelve months the African SWIFT project has been exploring potential user demand for impact based forecasting in three West African countries (Ghana, Senegal, and Nigeria), through a series of national workshops. The workshops have shown strong support for this approach amongst decisions makers in climate sensitive sectors, who expressed a need for forecast information focussing on the consequences of severe weather. This has been echoed in workshop discussions with decision makers in Kenya. At the recent African SWIFT Science meeting and summer school, Andy Hartley (Met Office) provided an introduction to IBF to attendees from NMS and early career scientists.

Evaluating the effectiveness of impact-based, extreme weather warnings and behavioural recommendations.

Leads: Philippe Weyrich, Anna Scolobig & Anthony Patt, ETH Zurich

A survey of expected responses to impact-based and non-impact-based warnings amongst Swiss people was carried out. Overall, the results support the conclusion that impact information coupled with behavioural recommendations in warning messages, promote more effective decisions than standard warnings.

Warning response

Link: Anna Scolobig and Philippe Weyrich

Collecting real-time storm warning and response data from an app from a private company; still waiting for a type3 warning to occur to test the response to impact-based and non-impact-based warnings.

Running serious (simulation) games to understand how social media communication and searching are used in warning. A flood simulation game will be tested in May 2019 at a training course for professionals in disaster risk reduction held at the University of Geneva. Another simulation game is tentatively planned for the Bureau of Meteorology and emergency management partners in Melbourne, Australia.

Looking at people's behaviour as measured by post-event surveys, comparing 10 years ago and now.

Global Hazard Map

Leads : Helen Titley and Joanne Robbins, UK Met Office

The Global Hazard Map (GHM) summarises the risk of high-impact weather across the globe over the coming week using forecasts from the Met Office and ECMWF global ensembles. It includes forecast layers for tropical cyclones (strike probability and tracks), 24-hour precipitation accumulation, maximum wind gust in a 24-hour period, 24-hour snowfall accumulation, as well as severe heat waves and cold waves. Performance is evaluated by comparing daily gridded precipitation forecasts against observations, and by assessing the ability of the multi-model precipitation summary layer to highlight events which cause community impacts as recorded in an impact database. The Global Hazard Map is available externally on a

password protected website. It is being trialed with the Severe Weather FDP, hopes to add ShelterBox, an international disaster relief charity that provides temporary shelters after disaster events.

Weather Information Value Chain

Lead: Brian Golding

Workshops, in Berlin in May and Melbourne in August 2017, explored the Weather Information Value Chain as a process for understanding the end-to-end flow of information and value from weather to community benefit, including: what constitutes "value"; what an end-to-end user-driven value chain looks like; how value is added/subtracted as information flows along the chain; ways to measure value; using the value chain to guide investment. A panel discussion at the AMS Washington Forum in March 2019 discussed the importance of routine measurement of the value of weather services. A paper on the value chain was published as part of the Global Assessment Report on Disaster Risk Reduction 2019.

Probabilistic forecasting and evaluation of Tropical Cyclones

Leads: Helen Titley, Munehiko Yamaguchi, Linus Magnusson

Ensemble forecasting of tropical cyclones is vital in capturing the situation-dependent uncertainty in the track and intensity forecasts for existing storms, and in providing probabilistic information about tropical cyclone genesis. We aim to enhance collaboration amongst the research and operational community to aid the development of new and innovative ways to display and verify ensemble probabilistic tropical cyclone forecasts including tracks, strike probability, genesis, intensity, and potential impacts. We will work with the operational TC forecasting community to gather their current and future user requirements and demonstrate the benefits of using ensemble forecasts, with a view to increasing the use of probabilistic information in tropical cyclone forecasting. A questionnaire has been sent to all operational TC forecasting centres asking them about their use of ensemble forecasts including: examples where probabilistic forecasts have been successfully integrated in to operations, occasions where hurdles have prevented them from being fully utilised, and where further model or product development and/or user-oriented evaluation would help encourage their wider use. Results were presented at the Beijing workshop, and will be used to quantify the current level of forecasting skill for TC intensity in global ensemble forecasts.

A new study is underway to investigate ensemble-based predictability of flooding in TCs using the Global Flood Awareness System (GLOFAS).

Mesoscale Verification Inter-comparison over Complex Terrain (MesoVICT).

Leads: Manfred Dorninger and Marion Mittermaier, Evaluation Team

The project continues to encourage investigation of spatial verification methods in complex terrain, including for ensemble forecasts and uncertain observations. A paper entitled, "The set-up of the Mesoscale Verification Inter-Comparison over Complex Terrain (MesoVICT) Project " was published in BAMS at <https://journals.ametsoc.org/doi/full/10.1175/BAMS-D-17-0164.1> and a special collection of articles related to MesoVICT is planned for *Monthly Weather Review* and *Weather & Forecasting*.

Societal and Economic Research Applications (SERA) Workshop

Link: Martin Goerber

This workshop will be held in Berlin in 2020 or 2021, hosted by DWD's Hans Ertel Centre. It will have SERA themes similar to the NCAR's earlier WAS*IS (Weather and Society*Integrated Studies) workshops. The format will include a tutorial for students from weather services, etc., followed by a scientific conference.

Value Chain review by WWRP SERA Working Group

Link: Martin Goerber

This review will provide an overview and meta-analysis, based on the literature, of how the value chain is applied in different fields.

Verification challenge.

Lead: JWGFVR and evaluation task team

A competition for evaluation metrics relevant to end users run by the Joint Working Group on Forecast Verification Research (see http://www.wmo.int/pages/prog/arep/wwrp/new/Forecast_Verification.html) was a great success with 17 entries from 11 countries. See overview paper at https://www.schweizerbart.de/papers/metz/detail/prepub/89677/The_WMO_Challenge_to_Develop_and_Demonstrate_the_B?af=crossref. The 2nd verification challenge will be held in 2020 with the theme of "Using unconventional observations to verify forecasts and warnings".

Method(s) to measure avoided losses due to improved warnings

Link: Masa Haraguchi and Michael Kunz

This study will do a literature search leading to a review paper. It will focus on heatwave and tropical cyclones, connecting to loss data from disaster reports from the World Bank.

4 National Programmes

US Contributions

A joint committee is formulating a US response to the three post-THORPEX projects and will shortly complete an inventory of existing relevant work. Prof. Michael Morgan leads this activity for HIWeather. The US has a wide range of relevant work underway including the Hydrometeorology Testbed (HMT), focusing on rainfall and flood forecasting, and the Hazardous Weather Testbed, focusing on tornado, wind and hail forecasting. CAPS is running 3-km CONUS-domain cycled EnKF data assimilation, including radar data, for selected periods and discussing coupling with hydrology/river stream models for HMT. The National Weather Service FACETS project (<http://www.nssl.noaa.gov/projects/facets/>) is closely aligned with several aspects of HIWeather. The related Weather Ready Nations initiative is particularly relevant and Dr Jennifer Sprague-Hilderbrand is a member of the HIWeather Advisory Group.

UK Contributions

Relevant areas of work include unconventional data sources, km-scale data assimilation and ensemble prediction, km-scale coupled modelling, hazard impact modelling and risk communication. The Met Office recently completed implementation of its new hourly lagged convection-permitting ensemble. Trial results showed a substantial gain in performance (<https://www.metoffice.gov.uk/research/news/2019/mogreps-uk-hourly-cycling-updates>). Impacts work is largely carried out in the Natural Hazard Partnership (<http://www.naturalhazardpartnership.org.uk/>). The recently completed NERC/Met Office Flooding from Intense Rainfall project delivered new radar capability, advances in km-scale data assimilation & coupling with inundation models (<http://www.met.reading.ac.uk/flooding/>). UKRI funds two networks in its “Decision Making Under Uncertainty” theme. NERC/UKAid fund four research projects through the Science for Humanitarian Emergencies And Resilience (SHEAR) programme focusing on co-production of knowledge using a multi-disciplinary and problem-centred approach in sub-Saharan Africa and south Asia (<http://www.nerc.ac.uk/research/funded/programmes/shear/>). See also SWIFT and HIGHWAY, above. The UKRI Global Challenges Research Fund Urban Disaster Risk Hub (“Tomorrow’s Cities”), which is endorsed by HIWeather, is developing its plans for building resilience to natural hazards in Kathmandu, Nairobi, Istanbul and Quito (<https://tomorrowcities.org/>).

German Contributions

W2W (Waves to Weather) is a Collaborative Research Center delivering the underpinning science needed to identify the limits of predictability in different weather situations so as to pave the way towards a new generation of weather forecasting systems. See <http://w2w.meteo.physik.uni-muenchen.de/>. The research programme is listed under the headings of Upscale Error Growth, Cloud-Scale Uncertainties and Predictability of local Weather. The second 4-year phase has started July 2019. Results of the project are available in a QJRMS and an AMS journal special collection and on the W2W website (<https://www.wavestoweather.de/>)

WEXICOM (Weather warnings: from EXtreme event Information to COMunication and action) is an interdisciplinary collaborative research project aimed at facilitating transparent and effective communication of risks and uncertainties for individual user groups. See <http://www.geo.fu-berlin.de/en/met/wexicom/index.html>.

Developed pre-operational impact forecasts in partnership with the fire brigade; Collecting citizen science measurements as part of a field experiment, to be used in forecast verification. (Martin Goeber, DWD)

Australian Contributions

An Australian HIWeather community was established at the annual Australian Meteorological and Oceanographic Society (AMOS) meeting. The goal is to foster collaboration within Australia of physical and social scientists, forecasters, and users of forecasts of high impact weather. Anyone who is interested can contact HIWeather@bom.gov.au to join this community.

The Bureau of Meteorology and Geoscience Australia is running a small project on **impact prediction**, currently looking at impacts of rain and wind on infrastructure. Partners include forecasters and State Emergency Services. High resolution ensemble NWP is coupled to wind & rain damage functions to derive probabilistic spatial maps of damage severity, using East Coast Lows as demonstration events.

New Zealand Contributions

Colleagues of David Johnston and Sally Potter at Massey University Met Service, NIWA and GNS Science are developing a portfolio of HIWeather related projects in the Communications theme. These include a project to provide best practice recommendations on the optimal length, order and content of short warning messages for agencies that warn the public about a variety of hazards, including severe weather and flooding. New Zealand and Australia HIWeather collaborators met in June to develop a set of bilateral activities to enhance their shared contribution to the HIWeather Programme.

Argentine Contributions

The Alert.AR project finished in May 2018, having delivered a new warning system. A Health & Heatwave Early Warning System (https://www.smn.gob.ar/smn_alertas/olas_de_calor) was inaugurated this summer as a result of a joint research between the National Ministry of Health and the National Meteorological Service of Argentina. The warning system is based on mortality data and climatological information from the last 40 years for 57 cities of Argentina. A WMO regional workshop on Impact-Based Forecasting & Warning is being hosted in September.

SMN is developing a new Early Warning Service in partnership with emergency managers and citizens. A training day/workshop with all the provincial directors of emergency agencies and their technical teams will be held in June to inform them about how the new EWS will work well in advance of its launch. An event in July in conjunction with the National Secretariat of Science and Technology will include a workshop with all technical scientific bodies that "depend" on the information of warnings and forecasts to issue other types of warnings, announcements or bulletins so they will be able to adjust their own systems. (Julia Chasco, SMN)

European contributions (Rainer Kaltenberger, ZAMG)

Work on International Fujita scale to assess tornado and wind damage (with European Severe Storms Lab) is still growing. Draft document on how to assess damage in the field will be ready early next year. The HIWeather Workshop in Beijing gave an opportunity to connect with respective people from CMA (who are working on a Chinese Enhanced Fujita Scale), further collaboration with several countries on different continents, poster contribution planned for EMS Annual Meeting, Copenhagen, 9-13.9.2019. Information and first IF-scale draft document (v 0.1) can be found at <https://www.essl.org/cms/international-fujita-scale/>, there is also an internal forum for experts to discuss case studies and further refinements, experts who are working in this field are welcome to join our initiative!

Evaluating MeteoAlarm survey in WMO RA6. 29 out of 37 countries replied so there is lots of data to analyse in the next few months. First results were presented at annual EUMETNET MeteoAlarm Partner Group Meeting 2nd-4th April 2019 in Zurich, final results and publication planned for second half of 2019.

European Weather Observer – European standard on weather and impact observations from volunteers. A EUMETNET Crowdsourcing workshop in March in Exeter, UK defined several steps and actions in this field to take place in Europe in the next months.

Chinese Contributions

Four projects lead by researchers from Chinese Academy of Meteorological Sciences (CAMS) have been approved as *National Key Technology Research and Development Plan*:

- 1) “*Development of High Resolution Data Assimilation Techniques and East Asia Atmospheric Reanalysis Datasets*” (Xudong LIANG). The aim is for a 3km grid, decade long reanalysis for East Asia.

2) “*Research on Thunderstorm Electrification-discharge Processes and Lightning Effects*” (Weitao LYU). This project will include basic observational and theoretical approaches to understanding lightning and will use AI approaches to develop a lightning forecasting and warning platform.

3) “*Aerosol-Convective Cloud Interaction Mechanism and Its Model Application Demonstration over Beijing-Tianjin-Hebei Region*” (Jianping GUO https://www.researchgate.net/profile/Jianping_Guo6). This projects aims to improve 24-hour precipitation scores in the Beijing-Tianjing-Hebei region by developing improved mixed-phase parametrization scheme that incorporate aerosol effects. The parametrizations will be developed on the basis of field campaigns.

4) “*Development of Seamless Weather-Climate Model Dynamic Core on Unstructured Grid*” (Jian LI). The aim is to develop a core that gives more accurate solutions and is suitable for future supercomputing architectures.

A five-year Project, named as “*Key Dynamic and Thermodynamic Processes and Prediction for the Evolution of Typhoon Intensity and Structure*” of the Ministry of Science and Technology is led by Prof. Zhemin Tan from Nanjing University and aims to deliver forecast products of track, intensity and structure of typhoon 3-7 days in advance, see: <http://meso.nju.edu.cn/web/typhoon/>

5 Related Activities

GHHIN (Global Heat Health Information Network).

A professional network of academics, government representative at all levels, professional organisations, international organisations, donor organisations, private sector and non-governmental organisations eager to share and engage in issues around heat and health. See <http://www.ghhin.org/>

VORTEX-SE (Verification of the Origins of Rotation in Tornadoes Experiment – SouthEast)

A research program to understand how environmental factors characteristic of the southeastern United States affect the formation, intensity, structure, and path of tornadoes. It will also determine the best methods for communicating forecast uncertainty related to these events to the public, and evaluate public response. See <http://www.nssl.noaa.gov/projects/vortexse/>

PECAN (Plains Elevated Convection At Night)

A large field project that focused on night-time convection in the Central USA. It was conducted across northern Oklahoma, central Kansas and south-central Nebraska from 1 June to 15 July 2015. A description of the field programme and preliminary results was published in the April 2017 issue of BAMS.

I-REACT

EU Horizon2020 project on Improving Resilience to Emergencies through Advanced Cyber Technologies (I-REACT), involving 20 partners, will integrate existing systems to facilitate early planning of weather-related disaster risk reduction activities. I-REACT will co-operate with the European Flood Awareness System (EFAS), European Forest Fire Information System (EFFIS), European Global Navigation Satellite System (E-GNSS), Copernicus, etc. See <http://www.i-react.eu/>

ANYWHERE

An EU Innovation action designed to bridge the gap between R&D in forecasting and warning high impact weather and climate so as to enhance response by emergency managers and first responders across Europe <http://www.anywhere-h2020.eu/>. Work packages include translating weather forecasts into impact forecasts, developing a platform for communicating information to emergency managers. The project is working on 5 pilot sites: Ligurian Sea, Catalonia, Finland/Norway, Swiss Alps. It is a partnership of operational authorities, R&D institutes and private sector businesses. The project catalogue contains a large collection of forecasting algorithms, many developed in previous EU actions. Mostly they concern prediction of the hazard, but a few also deal with the impact. See <http://anywhere-h2020.eu/catalogue/>

Aristotle

Aristotle will deliver multi-hazard capability to the EU Emergency Response Coordination Centre (ERCC), which is responsible for the coordination of human aid upon request of the government of a country affected by natural (and other) hazards. It offers a scalable scientific network including new hazard related services and a pool of experts in the field of Hydro-Meteorology and Geophysics that can support ERCC in crisis situations worldwide. See <http://aristotle.ingv.it/>

European Disaster Risk Management Knowledge Centre

This centre will work at the science-policy interface to help EU Member States respond to emergencies, prevent and reduce the impact of disasters. See <http://drmkc.jrc.ec.europa.eu/>, <https://ec.europa.eu/jrc/en/news/new-knowledge-centre-help-eu-minimise-risk-disasters>

S2S (Sub-seasonal-to-Seasonal Prediction)

Latest news is available at <http://www.s2sprediction.net/static/news>

PPP (Polar Prediction Project)

Latest news is available at <http://www.polarprediction.net/news.html>.

TIGGE (THORPEX Interactive Grand Global Ensemble) and TIGGE-LAM (-Limited Area Model)

The TIGGE dataset (<https://www.ecmwf.int/en/research/projects/tigge>) is one of the major achievements of THORPEX. It now contains over 10 years of global data. On a smaller scale, the TIGGE-LAM dataset provides 5 years of multi-model ensemble data at mesoscale resolution for limited areas. These datasets have been used to investigate a variety of atmospheric processes and there is scope for more use in the context of HIWeather. Opportunities may be driven by analysis of weather phenomena or weather variable thresholds associated with high impact. Within the S2S project, activities related to specific weather phenomena are brought together at <http://s2sprediction.net/> under topic wiki pages. There may be opportunities to do something similar for phenomena relevant to HIWeather. If you are interested, please contact John Methven at Reading University.

CODATA: the Committee on Data of ICSU

CODATA exists to promote global collaboration to improve the availability and usability of data for all areas of research. CODATA supports the principle that data produced by research and susceptible to be used for research should be as open as possible and as closed as necessary. CODATA works also to advance the interoperability and the usability of such data: research data should be intelligently open or FAIR. The group is working with relevant domain experts to develop proposals for major cross-disciplinary data integration projects to advance solutions for three important global challenges in **infectious disease**, **sustainable cities**, and **disaster risk reduction**. See www.codata.org/task-groups/linked-open-data-for-global-disaster-risk-research

The Young Earth System Scientists (YESS) Community

The YESS Community is an international multidisciplinary Early Career Researcher (ECR) network with more than 1000 members from over 80 countries. The network aims on bringing together early career scientists, both from natural and social sciences, who are working in a field of Earth system science. YESS is a bottom-up initiative and fully relies on the engagement and activities of its active members. YESS works closely with WWRP, GAW and WCRP to get ECRs involved and to provide them with a collective voice. YESS invites interested HIWeather master students, Ph.D. students and postdocs (within 5 years after their last degree) to join and engage in the community. See www.yess-community.org and follow YESS on Facebook: www.facebook.com/yesscommunity, Twitter: twitter.com/YESSCommunity or LinkedIn: www.linkedin.com/company/yess-community.

open access journal dedicated to human and mediated communication issues associated with crises, risks, and emergencies around the world. It is supported by an international editorial board comprised of top risk and crisis communication scholars. The Journal invites manuscripts of a philosophical, theoretical, methodological, critical, applied, pedagogical or empirical nature. Its scope includes community or regionally based events and risks, such as hurricanes, floods, wild fires, infectious disease outbreaks or similar threats. See www.jicrcr.com

6 Relevant Publications

- S. Ma et al, 2019, An analysis of perturbation features of convection-allowing ensemble prediction based on the local breeding mode. *Wea & Forecasting*,34, 289-303, DOI: 10.1175/WAF-D-18-0111.1
- E. D. Loken et al, 2019, Spread & Skill in mixed- and single-0physics convection allowing ensembles. *Wea & Forecast*, 34, 305-330. DOI: 10.1175/WAF-D-18-0078.1
- Generaux et al, 2019, Psychosocial management before, during and after emergencies and disasters – results from the Kobe expert meeting. *Int. J. Environ. Res. Public Health*, 16, 1309; doi:10.3390/ijerph16081309
- E. E. H. Doyle et al, 2019, Communicating model uncertainty for natural hazards: a qualitative systematic thematic review. *Int J Disaster Risk Reduction*, 33, 449-476. <https://doi.org/10.1016/j.ijdrr.2018.10.023>
- K. M. Lambrecht et al, 2019, Improving visual communication of weather forecasts with rhetoric. *Bull Amer Meteorol S*, 557-563. DOI:10.1175/BAMS-D-18-0186.1
- Y. Wehbe et al, 2019, Analysis of an extreme weather event in a hyper-arid region using WRF-Hydro coupling, station and satellite data. *Nat. Hazards Earth Syst. Sci.*, 19, 1129-1149. <https://doi.org/10.5194/nhess-19-1129-2019>
- M-C. Oliver et al, 2019, Disaster risk resilience in Colima-Villa de Alvarez, Mexico: application of the resilience index to flash flooding events. *In. J. Env. Res & Pub Health*,16, 2128; doi:10.3390/ijerph16122128
- A.Nori-Sarma et al, 2019, Advancing our understanding of heat wave criteria and associated health impacts to improve heat wave alerts in developing country settings. *Int. J. Environ. Res. Public Health*, 16, 2089; doi:10.3390/ijerph16122089
- S. Heo et al, 2019, The use of a quasi-experimental study on the mortality effect of a heat wave warning system in Korea. *Int. J. Environ. Res. Public Health*, 16, 2245; doi:10.3390/ijerph16122245
- P. Masselot et al, 2019, Toward an improved air pollution warning system in Quebec. *Int. J. Environ. Res. Public Health*, 16, 2095; doi:10.3390/ijerph16122095
- J. G. Pinto et al, 2019, From Atmospheric Dynamics to Insurance Losses: an interdisciplinary workshop on European Storms. *Bull Amer Meteorol S*, ES175-ES178, DOI:10.1175/BAMS-D-19-0026.1
- C. Poku et al, 2019, How important are aerosol-fog interactions for the successful modelling of nocturnal radiation fog. *Weather*, 74, 237-243. doi:10.1002/wea.3503
- J. C. Kealy, 2019, Probing the “grey zone” of NWP – is higher resolution always better? *Weather* 74, 246-249. doi:10.1002/wea.3506
- E. Zmudzka et al, 2019, Assessment of modern hydrometeorological hazards in a big city – identification for Warsaw. *Meteorol Appl.* 26, 500-510. DOI: 10.1002/met.1779
- X. Pedruzo-Bagazgoitia et al 2019, Shallow cumulus representation and its interaction with radiation and surface at the convective grey zone. *Mon Wea Rev*, 147, 2467-2483, DOI: 10.1175/MWR-D-19-0030.1

- V. Karsisto & L. Loven, 2019, Verification of road surface temperature forecasts assimilating data from mobile sensors. *Mon Wea Rev*, 147, 539-558, DOI: 10.1175/WAF-D-18-0167.1
- J. Du et al, 2019, Measure of Forecast Challenge & Predictability Horizon Diagram Index for ensemble models. *Mon Wea Rev*, 147, 603-615. DOI: 10.1175/WAF-D-18-0114.1
- C. Morcrette et al, 2019, Development and evaluation of in-flight icing index forecast for aviation. *Mon Wea Rev*. 147, 731-750. DOI: 10.1175/WAF-D-18-0177.1
- N. Snook et al, 2019, Evaluation Of convection-permitting precipitation forecast products using WRF, NMMR & FV3 for the 2016-7 NOAA Hydrometeorology Testbed flash flood and intense rainfall experiments. *Mon. Wea. Rev.* 147, 781-804. DOI: 10.1175/WAF-D-18-0155.1
- G. K. Zewdie et al, 2019, Applying deep neural networks and ensemble machine learning methods to forecast airborne Ambrosia pollen. *Int. J. Environ. Res. Public Health* 2019, 16, 1992; doi:10.3390/ijerph16111992
- W. J. Keat et al, 2019, Convection initiation and storm life cycles in convection-permitting simulations of the Met Office Unified Model over South Africa. *Quart J Roy Meteorol S*, 145, 1323-1336. DOI: 10.1002/qj.3487
- A. Tsiringakis et al, 2019, On- and off-line evaluation of the single-layer urban canopy model in London summertime conditions. *Quart J Roy Meteorol S*, 145, 1474-1489. DOI: 10.1002/qj.3505
- H. W. Lean et al, 2019, The impact of spin-up and resolution on the representation of a clear convective boundary layer over London in order 100m grid-length version of the Met Office Unified Model. *Quart J Roy Meteorol S*, 145,1674-1689. DOI: 10.1002/qj.3519
- R. Pohorsky et al, 2019, The Climatological Impact of recurving North Atlantic tropical cyclones on downstream extreme precipitation events. *Mon. Wea. Rev.* 147, 1513-1532. DOI: 10.1175/MWR-D-18-0195.1
- J. D. Duda et al, 2019, Comparing the Assimilation of radar reflectivity using the direct GSI-based ensemble-variational (EnVar) and indirect cloud analysis methods in convection-allowing forecasts over the continental United States. *Mon. Wea. Rev.* 147, 1655-1678. DOI: 10.1175/MWR-D-18-0171.1
- M. Baumgart et al, 2019, Quantitative view on the processes governing the upscale error growth up to planetary scale using a stochastic convection scheme. *Mon Wea Rev*, 147, 1713-1731. DOI: 10.1175/MWR-D-18-0171.1
- M. Lagasio et al, 2019, Predictive capability of a high-resolution hydrometeorological forecast framework coupling WRF cycling 3DVar and Continuum. *J Hydromet*, 20,, 1307-1337. DOI: 10.1175/JHM-D-18-0219.1
- S. Han & P. Coulibaly, 2019, Probabilistic flood forecasting using hydrologic uncertainty processor with ensemble weather forecasts. *J Hydromet*, 20, 1379-1398. DOI: 10.1175/JHM-D-18-0251.1
- L. Zhou et al, 2019, Toward convective-scale prediction within the next generation global prediction system. *Bull Amer Meteorol S*, 1225-1243. DOI:10.1175/BAMS-D-17-0246.1
- I.M. Karaye et al, 2019, Factors associated with self-reported mental health of residents exposed to Hurricane Harvey. *Progress in Disaster Sci*, 2, <http://dx.doi.org/10.1016/j.pdisas.2019.100016>
- R. Ciurean et al, 2018, Review of multi-hazards research and risk assessments. British Geological Survey OR/18/057. <http://nora.nerc.ac.uk/id/eprint/524399/>.
- Fakhruddin, B., Bostrom, A., Cui, P., Yu, L., Zou, Q., Sillmann, J., Johnston, D., Jimenez, V., Ying, E., Chan, Y., Chan, G.K.W., Hung, H., Huang, Z., Wong, C.K.P., Lim, C.K.P., Anuar T., Komoo J.I.K., Schueller, L., Thiebes, B., Booth, L., Abad, J., Baills, A., Fleming, K., Zuccaro, G., Lian, F., Lucy Jones, L., Han, Q., Shaw, R., Lwasa, S. (2019). Integrated Research on Disaster Risk (IRDR). Contributing Paper to the 2019 edition of the Global

Assessment Report on Disaster Risk Reduction (GAR 2019).

https://www.preventionweb.net/files/65873_f301fahkruddinintegratedresearchond.pdf

Golding, B., Mittermaier, M., Ross, C., Ebert, B., Panchuk, S., Scolobig, A., Johnston, D. (2019). A Value Chain Approach to Optimising Early Warning Systems. Contributing Paper to the 2019 edition of the Global Assessment Report on Disaster Risk Reduction (GAR 2019).

https://www.preventionweb.net/files/65828_f212goldingetalvaluechain.pdf

Fundel, V. J., Fleischhut, N., Herzog, S. M., Göber, M., & Hagedorn, R. (2019). Promoting the use of probabilistic weather forecasts through a dialogue between scientists, developers, and end-users. *Quarterly Journal of Royal Meteorological Society*. doi.org/10.1002/qj.3482

Lewis HW, Castillo Sanchez JM, Arnold A, Fallmann J, Saulter A, Graham J, Bush M, Siddorn J, Palmer T, Lock A, Edwards J, Bricheno L, Martínez-de la Torre A, Clark, J (2019): The UKC3 regional coupled environmental prediction system. *Geoscientific Model Development*. 12 (6). 2357-2400. <https://doi.org/10.5194/gmd-12-2357-2019>

Lewis HW, Castillo Sanchez JM, Siddorn J, King RR, Tonani M, Saulter A, Sykes P, Pequignet A-C, Weedon GP, Palmer T, Staneva J, Bricheno L (2019): Can wave coupling improve operational regional ocean forecasts for the north-west European Shelf? *Ocean Science*. 15. 669-690. <https://doi.org/10.5194/os-15-669-2019>

Lewis HW, Siddorn J, Castillo Sanchez JM, Petch J, Edwards JM, Smyth T (2019): Evaluating the impact of atmospheric forcing and air–sea coupling on near-coastal regional ocean prediction. *Ocean Science*. 15. 761-778. <https://doi.org/10.5194/os-15-761-2019>

Di Muzio, E., M. Riemer, A. H. M. Fink, and M. Maier-Gerber, 2019: Assessing the predictability of Medicanes in ECMWF ensemble forecasts using an object-based approach, *Quart. J. Roy. Meteor. Soc.*, 145, 1202-1217

JL Catto, S Raveh-Rubin, 2019. Climatology and dynamics of the link between dry intrusions and cold fronts during winter. Part I: global climatology, *Climate Dynamics*, 53, 1873–1892

S Raveh-Rubin, JL Catto, 2019. Climatology and dynamics of the link between dry intrusions and cold fronts during winter, Part II: Front-centred perspective. *Climate Dynamics*, 53, 1893–1909

Taylor, A. L., Kause, A., Summers, B., & Harrowsmith, M. (2019). Preparing for Doris: Exploring public responses to impact-based weather warnings in the UK. *Weather, Climate, and Society*, (2019).