Met Office, FitzRoy Road, Exeter EX1 3PB
Tel: +44-3301-350322
Email: brian.golding@metoffice.gov.uk

February 2021

Dear Colleagues,

I hope that most of you managed to join at least part of the HIWeather Workshop at the end of last year, which was absolutely brilliant! The five online seminars gave excellent introductions to the key issues in the areas covered by the task teams, while the three 19-hour workshops enabled broad participation in the three HIWeather highlight activities: citizen science, the warnings value chain, and the HIWeather book. Over 400 people registered and each webinar recorded an attendance of over 100. I should like to thank all of those who contributed to this success, but especial thanks must go to Martin Wegmann who presided over the technical arrangements throughout and who went above and beyond the call of duty on the three days of the workshop – Thank You Martin!

There have been some important changes of structure and personnel in the past few months. Paolo Ruti has been Head of the Weather Research Division at WMO since HIWeather started and his guidance and support have been invaluable to us. He has now moved on to join EUMETSAT. Estelle de Coning has stepped up to fill his place in an acting capacity. Estelle is familiar to many of us and we are delighted to be working more closely with her. Martin Wegmann came to the end of his appointment in December and his place has been taken by David Hoffman, working remotely from Australia. David has particular responsibility for the warning value chain project. Michael Riemer is currently taking parental leave and will take up the reins of the Processes and Predictability Task Team again in March. No doubt he is by now looking forward to that! Michael Reeder stepped down from our Advisory Group last year. The Advisory Group provides useful advice on people and activities that we should make contact with, as well as casting a critical eye over our work. We thank Michael for his contribution since HIWeather started. As COVID-19 continues to disrupt lives around the world, I would also like to recognise that everyone involved is having to struggle with changes in their working and home lives and to thank you all for continuing to make time and effort to contribute to HIWeather.

Within WMO there have also been some substantial changes in structure in the last year, which have mostly had little direct impact on HIWeather, but which will be increasingly important going forward. The old plethora of Commissions has been replaced by three bodies: an Infrastructure Commission, a Services Commission and a Research Board – the latter being our "parent". This change brings an increased clarity which I hope will enable HIWeather to work more effectively with these other parts of WMO. Recent engagement with the Expert Team on Impact-Based Forecasting augurs well for our future relationship with the Infrastructure Commission, while I have hopes of building a closer relationship with the DRR group in the Services Commission ahead of the 2022 Global Platform for Disaster Risk Reduction.

Looking ahead is difficult in current circumstances but is important if HIWeather is to make a lasting difference. **You** are an important part of that legacy – through your advocacy for an end-to-end multi-disciplinary view of the warnings chain that starts from consideration of the user's need and is validated by assessment of its value. Many of you have initiated research projects that respond to these issues, and which in themselves will also leave legacies – and we are especially grateful to those of you who have signed up as endorsed projects, listed on our website and in this newsletter. The first half of the HIWeather project has also produced several publications: reviews, special issues etc which will be of lasting value. These will culminate in the HIWeather book: "Towards the Perfect Warning" which we hope will take the results of this research into the practice of professionals in emergency management throughout the world. It is really helpful for the connections between these outputs to be recognisable, so if you are writing a HIWeather-relevant paper or giving a related presentation, please include HIWeather in your acknowledgements and, if possible, use the logo and add "WMO/WWRP" as your second affiliation.

I invite everyone reading this to look closely at the Citizen Science and Value Chain projects and to make contact if you have something to offer.

Best Wishes

Brian Golding

Co-Chair

CONTENTS

CALLS & REQUESTS

Citizen Science project:
Submissions for the special issue of the Australasian Journal of Disaster and Trauma Studies are now due. Submission details are available at: http://trauma.massey.ac.nz/.
The survey of citizen science projects is open at https://massey.au1.qualtrics.com/jfe/form/SV_aaWCTHai8RFzBqJ. Please add details of your project.

Warning Value Chain project:
We are developing an inventory of existing examples of where the value chain has been applied, based on a systematic review of academic and grey literature and workshops. If you know of relevant reports in peer reviewed journals or in the grey literature, please could you forward them to the project office at hiwico@cma.gov.cn

HIWeather book:
In order to maximise the value of the book, we are hoping to fund open access publication. We have several contributions committed but need another €4,000 to proceed. Funders will be acknowledged at the front of the book. If you are in a position to contribute please contact the project office at hiwico@cma.gov.cn

HIWeather Endorsement:
The Steering Group (SG) of the High Impact Weather (HIWeather) Project provides endorsement for projects, programs and initiatives that plan to contribute to the goals of HIWeather as outlined in the HIWeather Implementation Plan. Projects seeking endorsement through HIWeather may either be funded or in the process of seeking funding. (More information: http://hiweather.net/Lists/16.html)

Twitter users:
We would like to invite those who use Twitter to communicate about HIWeather relevant topics to use the hashtag #hiweather and 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

RELEVANT MEETINGS

- **AMOS annual conference**: 8-12 February, online.
- **vEGU General Assembly**: 25-30 April, online
  Website https://www.egu21.eu/. Abstract submission closed. Registration open.
- **AMS Washington Forum**: 26-30 April, online
  Website: https://www.ametsoc.org/index.cfm/ams/meetings-events/ams-meetings/2021-ams-washington-forum1/
  Registration opens late February.
- **AMS 34th Conference on Hurricanes and Tropical Meteorology**: 9-14 May 2021, Virtual.
  Pre-Registration Deadline: 15 April 2021
  Website: https://www.ametsoc.org/index.cfm/ams/meetings-events/ams-meetings/34th-conference-on-hurricanes-and-tropical-meteorology/
- **FESSTVal Hybrid Summer School**: 17 May – 7 August 2021, Lindenberg, Germany and online.
  Website http://fesstval.de/concept. Applications close 15 February 2021.
- **UKADR Annual Meeting**: 27-28 May
- **CMOS 55th Congress,** 31 May – 11 June, online
  Website: https://congress.cmos.ca/. Abstract submission now open.
- **RMetS Annual Science Conference:** 22 June, 6 July & 21 September, online
  Website: https://www.rmets.org/event/asc2021. Abstract submission now open.
- **IACS/IAMAS/IAPSO assembly:** 19-23 July, online
  Website: http://baco-21.org/2021/english/main/index_en.asp. Invited presentations.
- **AOGS Annual Meeting**: 1-6 August 2021, Singapore.
  Abstract submission closes: 23 February 2021
  Website: https://www.asiaoceania.org/aogs2021/
- **AOGS-EGU Joint Conference NatHazards2021**: 19-22 September 2021, Yogyakarta, Indonesia.
  Abstract deadline: 1 June, 2021
  Registration deadline: 10 August 2021
  Website: http://nathazards.org/
- **WGSERA Weather & Society workshop**: 29 September – 8 October
- **AMS 30th Conference on Severe Local Storms**: 18-22 October 2021, Santa Fe, NM.
  Abstract Deadline: 14 June, 2021
  Website: https://www.ametsoc.org/30th-conference-on-severe-local-storms1/
- **AGU Fall Meeting**: 13-17 December 2021, New Orleans, New Orleans LA, United States.
  Website: https://fallmeeting.agu.org/

HIWEATHER CITIZEN SCIENCE PROJECT

Citizen science is a broad term that encompasses various types of projects where the public (citizens) work with agencies and academic researchers to undertake scientific research. Citizen science has its beginnings in the physical sciences but has expanded to other areas, including natural hazard research. The motivations, design, and outputs of citizen science projects vary widely. Some projects are highly participatory, where the citizens are involved in the project design, data collection, and analysis. In others, citizens only provide data to projects designed and coordinated solely by the science agencies. Both ends of this spectrum are useful for creating new scientific outputs and enhancing citizen involvement in science. With many new and ongoing citizen projects planned or underway within the High Impact Weather community, this project is designed to share information and provide tools to help groups and agencies develop new activities.

HIGHLIGHTS OF 2020

Despite the pandemic's unprecedented challenges, the HIWeather Citizen Science project started developing tools and providing platforms to help individuals and groups share knowledge and build interest and capacities for citizen science. In 2020, the working group started working on the guidance note, producing a journal special issue, and scoping existing citizen science projects. The group also delivered a series of online webinars and workshops on citizen science with a broad range of speakers and attended by participants across continents.

GUIDANCE NOTE

The working group started developing "**A guidance note for including citizen science in weather, climate, and water projects"**. The note outlines the definition of citizen science, provides a typology of Citizen Science projects, illustrates examples of different types of citizen science projects. The note also raises guide questions for project managers of citizen sciences projects. The draft has gone through a round of revisions with the working group and currently being revised. The note is targeted to be published by Q4 2021.

JOURNAL SPECIAL ISSUE

A call for papers has gone out for a special issue on citizen science of the Australasian Journal of Disaster and Trauma Studies. The special issue will bring together accounts of the research, policy and practice initiatives from researchers, practitioners and the wider HIWeather and other disaster risk reduction community. Papers have been submitted and currently undergoing review. The resulting special issue will be published online, with open access at no cost to authors or readers. The publication is targeted at the end of 2021.

SURVEY OF CITIZEN SCIENCE PROJECTS

In preparation for demonstration projects, the working group first wanted to scope the existing projects. A survey was designed and launched to help capture past and current citizen science project. The survey remains open and accessible through https://massey.au1.qualtrics.com/jfe/form/SV_aaWCTHai8RFzBqJ

WEBINAR SERIES WITH YESS COMMUNITY

In partnership with the Young Earth Systems Scientist (YESS) Community, the working group delivered a webinar series on the topic 'Exploring the role of citizen science in weather, climate, and related projects. Five webinar sessions were held between September to November 2020. Table 1 below summarises the webinar series. The sessions were recorded, and the video links are made available to view as resources for citizen science. 5 webinars by distinguished speakers covered a variety of perspectives on citizen science, attracted large audiences and spirited discussion.

CITIZEN SCIENCE EVENT AT THE 2020 HIWEATHER WORKSHOP

The working group ran a one-day event that included citizen science projects and research presentations and interactive workshops to scope HIWeather citizen science's future. The format of the online workshop spanned through time zones and attracted presentation speakers across continents. There were ten presentations on a variety of topics, some of which were repeated in different time zones.

PLANNED ACTIVITIES FOR 2021 (DRAFT)

CITIZEN SCIENCE PROJECTS

The team are considering several options for projects in 2021. The survey from 2020 has provided insights of many citizen science projects currently happening in the HIWeather space. Not all citizen science projects have formal websites or have been officially published. Some projects may not necessarily have the chance to share their research outputs and their innovative methods. A Citizen Science Grand Challenge has been proposed with the aim of providing a platform for citizen science projects to be showcased through a HIWeather supported web platform. Several participants have expressed their interest to hear from the citizens of citizen science. This activity would look at ways to provide a platform to highlight citizen's contributions and stories.

PUBLICATION OF GUIDANCE NOTE

This activity will oversee through the publication of the guidance note. This activity will support the ongoing work in revisions, editing, formatting, and publication of the guidance note.

PUBLICATION OF JOURNAL SPECIAL ISSUE

This activity will oversee through the publication of the journal special issue. This activity will support the ongoing work in revisions, editing, formatting, and publication of the journal special issue.

WEBINARS AND WORKSHOPS

HIWeather Citizen Science Working Group will maintain the partnership with YESS-Community to deliver webinars or workshops. The group will continue to explore a range of workshops/ conferences/ training opportunities on citizen science, aimed at sharing practice, creating new networks for knowledge sharing and collaboration.

RELATED LINKS

Concept note of the webinar series with YESS Community on 'Exploring the role of citizen science in weather, climate, and related projects. https://www.yess-community.org/yesscomm_wp/wp-content/uploads/2020/11/YESSHIW-webinar-series.pdf

Compilation of the video recordings of the five sessions of the webinar series with YESS Community on 'Exploring the role of citizen science in weather, climate, and related projects. https://www.yess-community.org/yess-hiweather-webinar-series/

Compilation of the video recording of the 'Successful Citizen Science' presentations during the 2020 HIWeather Workshop. https://drive.google.com/drive/folders/1EoumyYGRCHFxW5cSp483krWR7xmw0dk5?usp=sharing

HIWEATHER VALUE CHAIN PROJECT

The information value chain provides a framework for characterising the production, communication, and use of warnings in terms of its processes, inputs and outputs, relationships, contributions, and operational contexts of stakeholders. Many gaps in knowledge and capability exist which, if addressed, would strengthen the warning value chain. Cataloguing information from case studies of end-to-end warning chains for significant high impact weather events and analysing them using value chain approaches will provide a valuable source of evidence and knowledge for what constitutes an effective warning system.

This project, which is joint with the WWRP Societal and Economic Research Applications Working Group (SERA), will investigate value chain approaches and apply them to analyse the forecast and warning chain for case studies of actual high impact weather events. These events and an array of relevant attributes will be collected in a living database and made available to researchers and National Meteorological and Hydrological Services for analysis to discern better practice in warning chains.

Details of the project are at http://hiweather.net/Uploads/keditor/file/20201130/20201130172214_37595.pdf, or visit the project web page at http://hiweather.net/Content/20.html.

The project kicked off in November 2020 with an international project team of physical and social scientists. It will run until the completion of HIWeather and deliver:

1. A high-level value chain framework tool for decision makers
2. Guidance and tools for more specific and context-appropriate usage of value chain approaches in hydrometeorology
3. A glossary of value chain and warning chain terminology in a hydrometeorological context
4. A living database of hazardous weather events with rich information covering (as much as possible) the components of the forecast and warning value chain, that complements WMO efforts such as the WMO Catalogue of Hazardous Events (WMO 2019).
5. Analysis and advice on best practice warning value chains (from simple to complex) analysed from the database
6. Exchange and integration of practical experiences (NMHSs and partners) and weather-related natural, social, and interdisciplinary science (research community)

Some research questions of interest to HIWeather include:

- What are the average predictability horizons for different types of HIW events and how do these horizons relate to the dominant governing processes?
- What are the improvements in hazard prediction from convection-permitting models related to advanced methods of mesoscale DA, the inclusion of high-resolution observations, or better NWP models?
- To what extent have we been able to define, measure, model, and predict constitutive aspects of risk (dynamic exposure, vulnerability, sensitivity) for individual and cumulative (multi-hazard) threats?
- What is the efficacy of co-producing/ communicating/sharing this risk and impact knowledge with various actors (i.e., as measured in terms of comprehension, application/use in decision- or policy-making, behavioural intent, behavioural response, impact outcomes)?
- What elements of a warning (e.g. hazard, impact, guidance; text, graphics, analogies; scenarios, probabilities, likelihood terms) can be tweaked to ensure a more effective warning and response?
- How does the level of uncertainty in the forecast affect the overall impacts i.e. did cases with higher forecast certainty result in better outcomes in terms of action to prevent impacts than those cases with more uncertain forecasts? And if so why?

VALUE CHAIN WORKSHOP, 2 DECEMBER 2020

Report by Beth Ebert, Carla Mooney, Brenda Mackie, David Hoffman

The second day of the International HIWeather Workshop focussed on the warning value chain and the perfect warning. 26 talks were presented remotely in ten 1-hour sessions starting at noon in New Zealand and extending around the clock to noon in Denver, USA. Those sessions were interspersed by 1-hour breaks during which the workshop attendees were invited to participate in a value chain exercise. Video-recordings of the presentations can be viewed on the HIWeather YouTube Channel and on the HIWeather Workshop website. The topics include the concept of the value chain in a hydro-

meteorological context, implementing new value chains, improving the reliability of forecasts, and improving warning communication and partnership, briefly summarised below.

Concept of the value chain in a hydro-meteorological context

Three invited experts spoke about the methods and benefits of using a value chain approach to understand, measure, and improve the end-to-end warning process. Jeff Lazo outlined the weather information value chain as a tool for characterising and evaluating value (information) in a hydro-met information process that spans from weather, observations, modelling, to warnings, perception and decision making with the aim to reducing costs/damages from hydro-meteorological events. He presented a framework tool in which each stakeholder has their own set of objectives, resources and constraints that influences the value of the service. Juan Pablo Sarmiento described a value chain for disaster risk reduction in which emergency management (short term response) and disaster risk management (long term measures) work to decrease risk levels (measured by risk indicators) and increase resilience. A forensic approach to the value chain is needed to unpack the details of hazard, exposure and vulnerability in high impact weather events. Finally, Adriaan Perrels spoke on identifying and measuring value in the value chain. Value is created when the user gets differential information that allows a better decision than could be made with no information. Weather and climate services are often a "merit good" where the value to the user exceeds the market value and typically assessed economically through the cost/benefit ratio. There are many kinds of value chains and choosing an appropriate structure to describe the warning process requires both understanding of the service and the working environment of the user(s).

Implementing new value chains

Six presentations described value chains of new hydrometeorological and warning services. In Australia new warning services for heat health impact, thunderstorm asthma risk and fire danger are being co-developed with agency and university partners. Advanced flash flood warning systems have been developed in France and Norway, and a value chain methodology was applied to develop new hydrometeorological services in Samoa and Somalia. Good governance is key to the success of these cross-/multi-disciplinary collaborations, as is deep involvement of users in defining the priorities. The importance of incorporating social science in warning chain development is increasingly being recognised.

Improving the reliability of forecasts

Ten speakers discussed improving forecasts and warnings along various parts of the forecast and warning chain. Accurate weather prediction is far from solved, and several large national activities are underway to improve numerical modelling, data assimilation, and nowcasting to inform more accurate warnings of hazards such as heavy rain and floods, wildfire, tropical cyclones, and extreme local winds. Ensemble prediction to support probabilistic forecasting features strongly and enables estimating uncertainty quantitatively that propagates downstream through the value chain. Three presentations described efforts to predict hazard impacts such as building damage and disruption to human activities; however, obtaining data on vulnerability and impacts remains a challenge.

Improving warning communication and partnerships

Making warnings more relevant to users in order to increase their response featured in six presentations. Topics include understanding and communicating the risk of impacts; automated provision of personalised impact-based warnings; understanding how behavioural biases and group dynamics influence disaster response in individuals; using community based exercises as a citizen engagement tool for disaster response; improving cooperation between institutions; and applying a forensic approach to evaluate the full forecast chain in order to recommend improvements to partnerships, communication of forecast uncertainty and coordination between authorities.

Value chain activity

Between the sessions the workshop participants were invited to create their own value chain using an online collaboration tool (Google Jamboard). They could choose to start with a "card deck" of metadata for tropical cyclone Debbie 2017 and arrange it into a value chain, or they could design their own value chain to describe a different event or warning service. Two examples are shown below, illustrating different perspectives that participants brought to the activity.

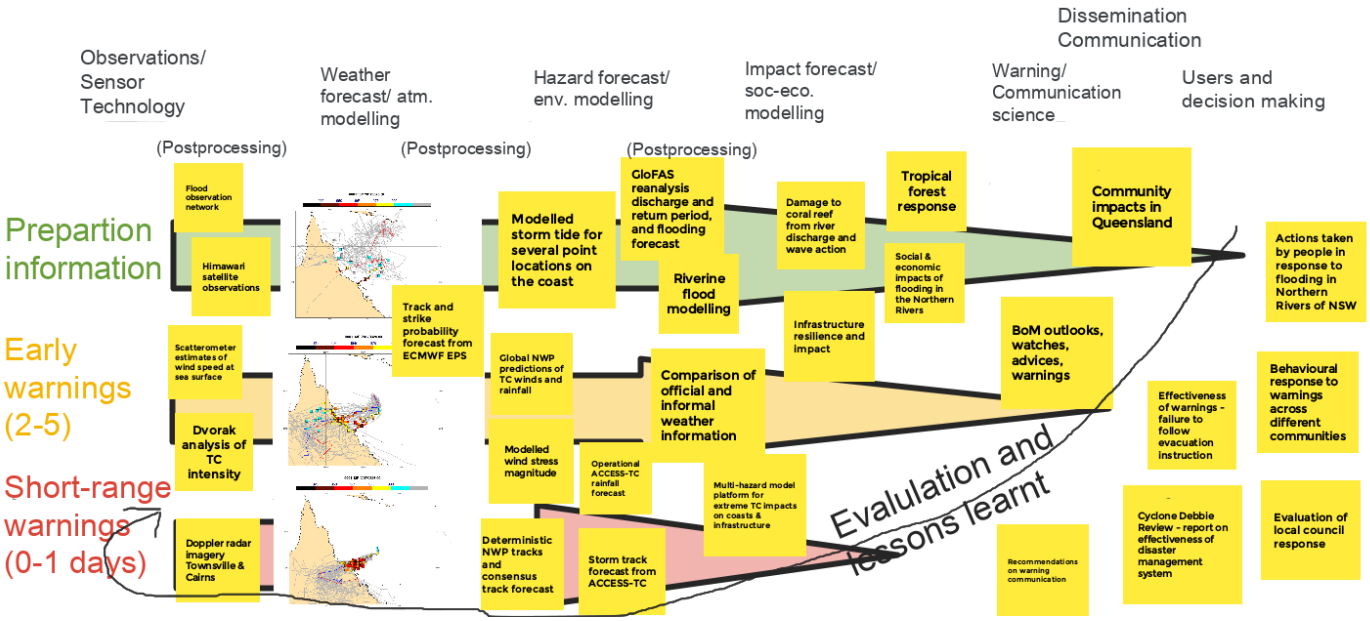
18 value chains were created during the workshop. Participants commented that they found this exercise useful for looking at the big picture and felt it would be useful as a collaborative group activity. It was noted that the value chain should be constructed with the user in the forefront of consideration, yet most often value chains are constructed from the technical perspective. Also, greater focus needs to be placed on evaluation and lessons learned, which are then fed back into the value chain at every point. This will be a focus of the Value Chain flagship project.

<NAME> Linus Magnusson
<INSTITUTION> ECMWF

Tropical cyclone Debbie

- Mark this frame with a personal identifier in the top-left corner (e.g. your name/institution) so that others know it's taken.
- Create a value chain by using either one of the provided ones in the intro frame (copy + paste), as many or few segments provided below on the left or come up with your own one.
- Use the stack of 30 sticky notes on the right with information on TC Debbie and arrange them along your value chain. Alternatively, delete all sticky notes and create your own ones for a case study of your choice.
- Frame #2 provides instructions on how to use Jamboard if you're unfamiliar with it.

(delete this text field when you don't need it anymore)

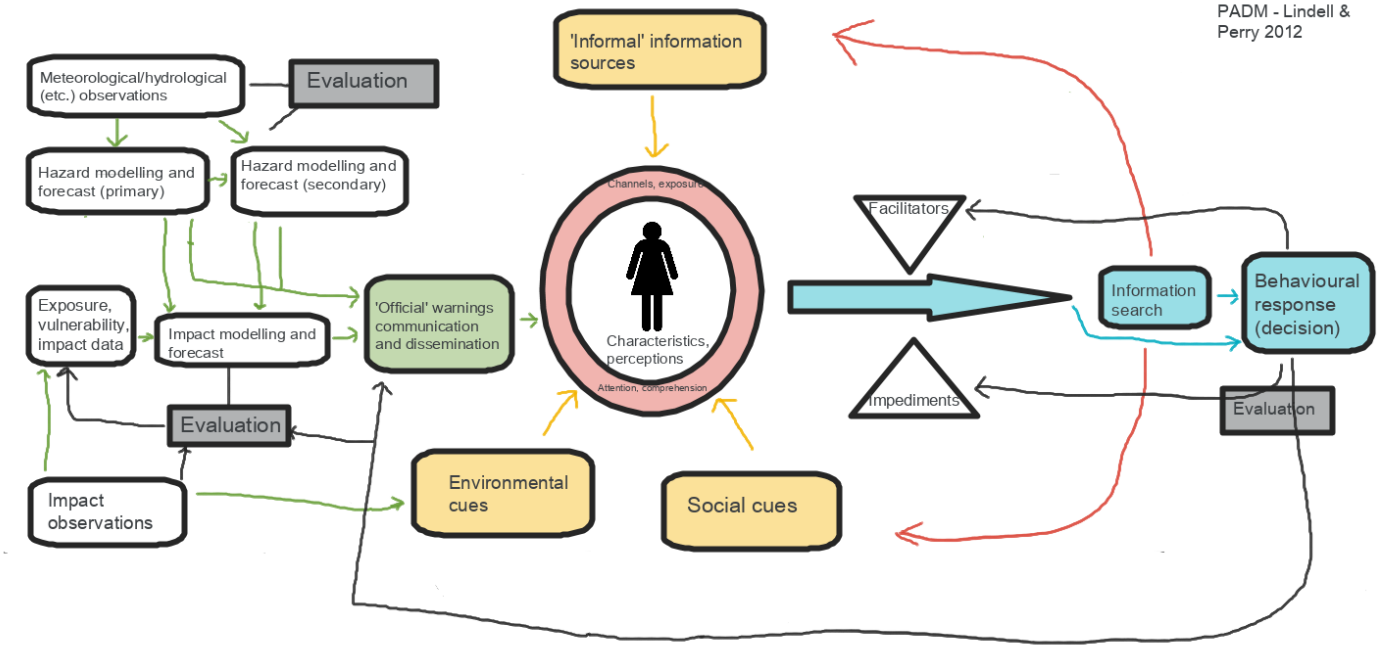


Sally Potter v2
GNS Science, NZ
s.potter@gns.cri.nz

Sally's on-the-fly people-centred value chain

Caveat: I don't know much about value chains

Takes into account PADM - Lindell & Perry 2012



HIWEATHER BOOK: "TOWARDS THE PERFECT WARNING"

HIWeather is working with Springer publishers to bring out a book that summarises current and emerging good practice in the production and communication of weather-related warnings. Titled "Towards the perfect warning: bridging disciplinary gaps through partnership and communication", the book aims to take a whole-system approach, emphasising the essential role of partnership in delivering the information needed for the user to make critical decisions. The book is aimed primarily at emergency management professionals, including those in weather services and related environmental protection bodies who contribute to the production of warnings. It will also provide a valuable pedagogical resource for those studying or training in disaster risk reduction. The structure of the book is built around the five "valleys of death" in the HIWeather warning chain concept (see Zhang et al, 2019, Increasing the value of weather-related warnings, Science bulletin, 64, 647-649 *http://hiweather.net/Uploads/ue/file/20190723/1563869466819765.pdf*). The book consists of:

1 Introduction

2 Early warning systems & their role in disaster risk reduction

3 From warning to decision/action - a partnership of communicators and decision-makers – turning a message into a protective action

4 From impact forecast to warning - a partnership of scientists and communicators - turning information into an actionable message

5 From hazard to impact - a partnership of physical and social scientists – observing and modelling impacts that result from weather-related hazards

6 From weather to hazard – a partnership of physical scientists in connected disciplines – observing and modelling weather-related hazards

7 Bridging the fifth valley – a partnership of observation scientists with forecasters – observing and modelling the weather

8 End-to-end partnerships – linking the whole chain together to reduce the impact of weather-related hazards

The writing of each chapter is being led by a coordinating author, and there are currently 47 contributing authors. A first complete draft was discussed in detail on day 3 of the HIWeather workshop in December, and the chapter teams are now working to finalise their chapters.

TASK TEAM ACTIVITIES

PROCESSES & PREDICTABILITY

P&P	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)
	FESSTVaL (Field Experiment on submesoscale spatio-temporal variability in Lindenberg)
	PRECIP (Prediction of Rainfall Extremes Campaign in the Pacific)

NAWDEX (NORTH ATLANTIC WAVEGUIDE AND DOWNSTREAM IMPACTS EXPERIMENT)

Lead: Andreas Schäfler

In June 2019 ECMWF organized a workshop aimed to increase the interactions between observation campaigns and numerical weather prediction (NWP) centers. From the HIWeather community, for example the NAWDEX and FESSTVal campaigns were represented. The workshop led to great discussions how to increase the interactions, and how NWP centers 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*

On 10-12 March 2020 ECMWF organized a workshop focused on warm conveyor belts (WCB). Due to COVID-19, this was an online event. Several of the talks presented results from the NAWDEX campaign for example. The key questions for the workshop tackled predictability, observations, modeling and impacts of WCB and also the closely related atmospheric rivers.

MULTI-SCALE, MULTI-LEAD TIME 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 lead time 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.

Linus Magnusson finalized his report: ECMWF Severe Event Catalogue for Evaluation of Multi-scale Prediction of Extreme Weather, which can be found here: *https://www.ecmwf.int/en/elibrary/19230-ecmwf-severe-event-catalogue-evaluation-multi-scale-prediction-extreme-weather*

In the spring issue of ECMWF Newsletter, an article about the February storms in north-western Europe highlighted new forecast products for extreme weather on various time scales: *https://www.ecmwf.int/en/newsletter/163/news/forecasting-februarys-wet-and-stormy-weather-parts-europe*

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 Working Group on Nowcasting and Mesoscale Research (WGNMR)

RELAMPAGO was 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)

Lead: Yali Luo

Two review papers on the science and prediction of heavy rainfall are published in 2020. One focuses on the early-summer heavy rainfall over southern China during 2008-2019 (Luo et al., 2020 JMSJ) and the other more broadly summarizes the studies on heavy rainfall over China during the past four decades (Luo et al., 2020 JMR). Despite some impacts of the COVID-19, the 2020 field campaign of the Southern China Monsoon Rainfall Experiment (SCMREX) was successfully carried out, with the IOP running continuously from 1 May to 30 June, 2020. The most recent research progresses of SCMREX were reported at the virtual meeting of WMO/WWRP Working Group on Tropical Meteorological Research (WGTMR) on 14 July 2020. It was planned that during the Third Phase of SCMREX (2021-2024), field campaigns, physical mechanism studies and NWP studies will continue with the improved observing capability and adjusted research focuses. The physical mechanism studies will make more efforts to unravel the interactions of aerosol-convection-precipitation and the independent/interactive influences of complicated surface (i.e., cities, topography, and water), and also to examine the research results in a broader context by comparing with other regions. The NWP studies will further the polarization radar data assimilation, improving model physics schemes, and developing perturbation methods for ensemble forecast at the convection-permitting resolutions.

1. Luo, Y., J. Sun, Y. Li, and Coauthors, 2020: Science and Prediction of Heavy Rainfall over China: Research Progress since the Reform and Opening-Up of New China. J. Meteor. Res., 34(3): 427-459. https://doi.org/10.1007/s13351-020-0006-x

2. Luo, Y., R. Xia, J. C. L. Chan, 2020: Characteristics, Physical Mechanisms, and Prediction of Pre-summer Rainfall over South China: Research Progress during 2008-2019. J. Meteor. Soc. Japan, 98, 19-42, doi:10.2151/jmsj.2020-002.

FESSTVAL (FIELD EXPERIMENT ON SUBMESOSCALE SPATIO-TEMPORAL VARIABILITY IN LINDENBERG)

Lead: Linda Schlemmer

FESSTVaL has been initiated by the Hans-Ertel-Center for Weather Research and was planned to take place in the summer months of the year 2020 at the Meteorological Observatory Lindenberg - Richard-Aßmann-Observatorium (MOL-RAO) of the German Weatherservice (DWD) near Berlin. To identify the sources of sub-mesoscale variability, the measurement campaign focuses on three main aspects: atmospheric boundary layer structures, cold pools, and gusts of wind. In order to capture phenomena at the submesoscale (500 m – 5 km), a hierarchical measurement strategy will be realized. This includes wind profiling stations with several coordinated Doppler Lidars, two mobile thermodynamic profilers, more than 100 stations with near-surface measurements, more than 20 automatic weather stations, an X-Band radar, and a number of energy balance stations. This equipment is supplemented by the extensive ground-based remote sensing array at the MOL-RAO. Complementing to this, the added value of a citizen-science measurement network is investigated during the campaign with “Internet-of-things” based technology and low-cost sensors build and maintained by citizens. The FESSTVaL measurements will be complemented by high-resolution large-eddy simulations (ICON-LES).

Due to COVID-19, FESSTVaL has been postponed to 2021. In 2020, preparatory measurements were taken close to the respective home universities to circumvent travel restrictions. This preparatory effort will support a hopefully successful campaign in summer 2021. More information is at https://fesstval.de/en/

PRECIP

Lead: 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. 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).

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). Due to Covid-19, the field phase of this joint field campaign was postponed until the spring and summer of next year (2021). Ground-based assets involved in data collection include dual-frequency/dual-polarization radar, disdrometers, and profilers, while airborne assets include the Taiwanese Dotstar and Japanese G-II aircraft. The NOAA P-3 aircraft will not be available for airborne missions in support of this campaign next year. The extreme rainfall and typhoon reconnaissance effort during the period leading up to the 2021 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.

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

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

Lead: Sharan Majumdar

A review of the current state of high impact weather nowcasting/forecasting with an emphasis on flood and high wind warnings has been accepted by BAMS in 2020 and will appear shortly.

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 a 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 WGNMR and MSF task team the IOP period is complete. See the science plan at *https://gpm.nasa.gov/sites/default/files/document_files/08%20ICEPOP2018_plan.pdf*

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. One of the exciting aspects of working with coupled systems, illustrated during a workshop held in June 2019, is the need to join together and share different perspectives and expertise from across weather and climate, marine and hydrological science disciplines. For further information on the UK Environmental Prediction collaboration, contact *huw.lewis@metoffice.gov.uk* or visit *https://www.metoffice.gov.uk/research/approach/collaboration/ukenvironmentalprediction*

HUMAN IMPACTS, VULNERABILITY & RISK

HIVR	Formal (statistical) impact model intercomparison
	Impact data collection
	Review & classification of impact modelling

FORMAL (STATISTICAL) IMPACT MODEL INTERCOMPARISON

Lead: Martin Goeber

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

IMPACT DATA COLLECTION

Leads: Joanne Robbins and Rainer Kaltenberger

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

REVIEW & CLASSIFICATION OF IMPACT MODELLING

Leads: Brian Mills & HIVR task team

An outline has been agreed and writing of the chapter on disruptive winter weather is well advanced. It is anticipated that the hazard-specific chapters may be published separately as they are completed.

COMMUNICATION

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)

UNCONVENTIONAL DATA SOURCES FOR IMPACT MODELLING, EVALUATION & COMMUNICATION

Leads: Sara Harrison and Amber Silver

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:

- 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 conventional and unconventional (e.g., social media, crowdsourcing) data for impact models & warnings: Sara Harrison, Sally Potter (New Zealand). Sara has published a paper on Volunteered Geographic Information for severe weather early warning: *http://trauma.massey.ac.nz/issues/2020-1/AJDTS_24_1_Harrison.pdf*
- Thomas Kox and colleagues have a new citizen science project in Munich on weather impacts and weather observations with school children. Review of approaches to communicating high impact weather.
-

PUBLICATIONS & TRAINING MATERIALS

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

Julie Demuth has circulated UCAR COMET training module on communicating impact-based warnings. https://www.meted.ucar.edu/training_module.php?id=1597#.XqDuVP8za71.

See also the NOAA training module on communicating risk: the impact-based forecast and warning services approach: https://www.meted.ucar.edu/training_module.php?id=1597#.XyxmEyhKhaQ

We are continuing to collate existing training materials for weather communication. Links can be shared with Andrea Taylor (a.l.taylor@leeds.ac.uk).

COMMUNICATING UNCERTAINTY

Lead: Sally Potter

The aim of this project is to review and publish the implications of uncertainty in weather forecasts and warnings across the whole spectrum of HIWeather. A discussion of uncertainty was held in the webinar on 26 October.

A publication on communicating model uncertainty, associated with HIWeather, has been published: https://www.sciencedirect.com/science/article/pii/S2212420918306630?via%3Dihub

Collated essays on uncertainty from an AMS special session have been shared by Julie Demuth: https://items.ssrc.org/category/chancing-the-storm/

INFLUENCE OF TRUST, SALIENCE AND BELIEFS ON WARNING RESPONSE

Lead: Amisha Mehta, Communication Task Team

Amisha has joined the Communication Task Team to lead a review into the influence of trust, salience and beliefs on warning response. The role of trust, uncertainty and beliefs on people's perceptions and responses to weather warnings is the focus of a webinar on UTC 26 Oct 8pm (see webinar section of this newsletter for more details).

Anyone interested in being part of this activity is encouraged to contact Amisha at a.mehta@qut.edu.au.

A research study is underway to examine how participants trust weather forecasts and agency warnings in the context of flood events. This work is part of a program funded by the Bushfire and Natural Hazards Cooperative Research Centre and co-designed with Victoria State Emergency Services and the Australian Government Bureau of Meteorology.

HIGHWAY (LAKE VICTORIA BASIN NOWCASTING PROJECT)

Link: Andrea Taylor

The "HIGH impact Weather lAke sYstem" project is part of the UKAid WISER programme. HIGHWAY implemented co-designed and sustainable early warning systems in the Lake Victoria area. Reports on the development and implementation of forecasting and warning systems by the project are at https://www.metoffice.gov.uk/about-us/what/working-with-other-organisations/international/projects/wiser/highway. In 2019 HIGHWAY supported a field campaign over the Lake Victoria Basin, coordinated by NCAR. Results of this campaign are available at http://catalog.eol.ucar.edu/highway.

GCRF AFRICAN SCIENCE FOR WEATHER INFORMATION AND FORECASTING TECHNIQUES (AFRICAN SWIFT)

Link: Andrea Taylor (Communication TT)

A 4-year Global Challenges Research Fund (GCRF) 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.

African SWIFT made international news in May with press coverage highlighting the project's successful implementation of nowcasting. Media highlighted how SWIFT uses EUMETSAT satellites and NWCSAF software to produce accurate, hour-by-hour forecasts as severe weather approaches. In addition to saving lives, nowcasting will also help direct rescue and clear-up operations following high-impact events and will be essential in protecting the economy. Read the full story published by the University of Leeds.

Across the month of June, African SWIFT hosted SWIFT Progress: Transforming Weather Forecasting Science in Africa, a month-long series of virtual meetings and knowledge-sharing webinars. The programme included a keynote event featuring lead researchers from the CINSERE, ForPAc and HIGHWAY projects. During the hour-long session, Dr. Issa Ouedraogo, Emmah Mwangi and Jim Wilson each shared key insights in forecasting and climate resilience, including lessons, achievements and pathways forward. Visit the SWIFT website for the webinar recording and guest speaker slides. https://africanswift.org/

EVALUATION

EVAL	Warning response
	Global Hazard Map
	Probabilistic forecasting and evaluation of tropical cyclones flooding
	Fire weather evaluation
	Societal and Economic Research Applications (SERA) Workshop
	Verification Challenge
	Method(s) to measure avoided losses due to improved warnings

WARNING RESPONSE

Lead: Anna Scolobig

Dr. Philippe Weyrich was awarded the ETH Zurich 2020 Medal for his PhD Thesis, "To act or not to act: Warning communication and decision-making in response to weather-related hazard" advised by Professor Anthony Patt and Dr. Anna Scolobig. The Thesis received this prestigious award because it presents: "a multi-faceted investigation of how severe weather warnings should be communicated in order to save live and reduce economic damage". Philippe's work has been inspired by interactions with HIW colleagues (Task Teams "User oriented Evaluation", "Vulnerability" and "Communication"). The PhD Thesis is open access and available at:

Weyrich, P., 2020. To act or not to act: Warning communication and decision-making in response to weather-related hazards. Doctoral thesis, ETH Zurich, Diss. ETH No. 26533 *https://www.researchcollection.ethz.ch/handle/20.500.11850/404058*

GLOBAL HAZARD MAP

Leads : Helen Titley and Joanne Robbins

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. We are working with the University of Exeter to investigate if social media data could be used to evaluate the ability of GHM to identify events which cause community impacts.

PROBABILISTIC FORECASTING AND EVALUATION OF TROPICAL CYCLONES FLOODING

Leads: Helen Titley

Ensemble forecasting of tropical cyclones (TCs) 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, but there is huge potential to increase the pull through of ensemble-based uncertainty and probabilistic data in to operational TC forecasts and warnings.

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

FIRE WEATHER EVALUATION

Lead: Amanda Anderson

This NCAR project evaluated coupled fire-weather modelling, and wrapped up in June 2020. Recent work explored the forecast sensitivity to fuel moisture, terrain and ignition location, and spotting capability in the model. The assessment also explored how the sensitivity information can be conveyed to the user.

SOCIETAL AND ECONOMIC RESEARCH APPLICATIONS (SERA) WORKSHOP

Lead: Martin Goeber

This workshop will be held in Offenbach, Germany in 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.

VERIFICATION CHALLENGE

Leads: Beth Ebert

A second competition for evaluation metrics using non-traditional observations (e.g. sensor networks, social media, citizen science, impact data, etc.) was launched at the European Meteorological Society Conference in September 2019, run by the Joint Working Group on Forecast Verification Research (JWGFVR). The contest is aimed to encourage the development and demonstration of verification approaches targeted to use new and non-traditional observations. New verification metrics and visualisations are encouraged.

The challenge is open to individuals and teams. Entries are due 30 April 2021. The winner will receive an all-expense paid attendance and keynote talk at 8th International Verification Methods Workshop to be held in 2021. The challenge supports the WWRP's HIWeather, Sub-seasonal to Seasonal Prediction (S2S), and Polar Prediction (PPP) projects.

METHOD(S) TO MEASURE AVOIDED LOSSES DUE TO IMPROVED WARNINGS

Leads: Masa Haraguchi and Michael Kunz

This study will write a review paper that categorizes methods to estimate avoided losses. It will focus on heatwave and tropical cyclones, connecting to loss data from disaster reports from the World Bank.

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.naturalhazardspartnership.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, which is endorsed by HIWeather, is working in Kathmandu, Nairobi, Istanbul and Quito (*https://www.de.ed.ac.uk/project/gcrf-urban-disaster-risk-hub*) to develop resilient urban development plans.

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).

In addition, Waves to Weather scientists are going to participate in an international field campaign on the Cape Verde islands in summer 2021, called ASKOS (*http://askos.space.noa.gr*). This project is built around planned calibration/validation aircraft measurements conducted during the same period. Cape Verde during boreal summer is ideal for a study of tropical wave phenomena. The midlevel African easterly jet allows for the formation of synoptic-scale African easterly waves (AEWs) that typically reach their maximum intensity close to the coast of West Africa. AEWs interact with convection and its mesoscale organization through modifications in humidity, temperature and vertical wind shear, and often serve as initial disturbances for tropical cyclogenesis. In addition, the tropical atmosphere sustains different types of planetary waves that frequently interact with the monsoon and AEWs. To support our research in this area, we plan frequent radiosonde ascents from Cape Verde to complement the measurements from space and aircraft.

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 are conducting a small project on **impact prediction**, currently looking at impacts of wind on infrastructure. Partners include forecasters and State Emergency Services. High resolution ensemble NWP is coupled to a wind damage function to derive probabilistic spatial maps of damage severity, using East Coast Lows as demonstration events.

Future Warning Services (FWS) framework: In February 2018 the Australian Fire and Emergency Services Authority Council (AFAC) Warning Group commissioned social research to build a sound evidence base for a national three-level warning framework for all hazards. The Australian Bureau of Meteorology has embarked on a three-year Public Services Transformation to improve the impact and value of our services. The includes new and enhanced impact-based warning services that provides warnings that are clear, accurate, location specific, relevant and contextual. We are developing a framework to guide the preparation of a product roadmap that systematically priorities the future development of services. People can get a copy of the PST business case by emailing public-services@bom.gov.au. Phase one included a product and service audit, which highlighted opportunities for improvement. The Future Warning Framework outlines four key goals:

Goal 1. Adopt Australia's Total Warning System

Goal 2. Issue Best Practice Warnings

Goal 3. Implement Scaled Three Level Warnings

Goal 4. Develop Impact-based Warnings

The Framework adopts the principles developed by the Australian Institute for Disaster Resilience to ensure alignment with national and international best practice in warning service.

The 'Reducing Illness and Lives Lost from Heatwaves' (RILLH) is a multi-agency collaboration between the Australian Bureau of Meteorology (BOM), Australian Bureau of Statistics (ABS), Department of Health (DOH), and Geoscience Australia (GA). The RILLH is a data-integration partnership project and asks three questions; 'who is most at risk?', 'where are they?', and 'how can services to vulnerable groups be improved through heat-health warnings and targeted interventions?'. This project seeks to answer these questions by mapping vulnerability against Excess Heat Factor (EHF), the scale used to define heatwave intensity by the Bureau of Meteorology and many Australian States and Territories. Through the utilisation and analysis of health and health service data, weather observations, neighbourhood community and environmental characteristics, the project is building a national 'map' of heat health vulnerability which will be underpinned by a Heat Vulnerability Index. It is anticipated that the core methodology of multi-agency collaboration and integration of data used in this project can be applied to other natural hazards as well. The results will support emergency response and planning in the immediate term and will inform and shape spatially target intervention strategies including impact forecast warning systems, social registries and community outreach, social media targeting, and urban planning. For more information contact Shannon Panchuk (shannon.panchuk@bom.gov.au)

NEW ZEALAND CONTRIBUTIONS

Within New Zealand, Resilience to Nature's Challenges (https://resiliencechallenge.nz/), is a five-year Government-funded research programme that has recently started mid-2019. The Weather & Wildfire theme, co-led by Richard Turner (NIWA) and Sally Potter (GNS Science), is aiming to improve our understanding of extreme weather and wildfire impacts on communities and infrastructure, and co-design mitigation solutions (including improving impact-based warnings) with key stakeholders. We are using three scenarios – an ex-tropical cyclone, severe winter storm, and wildfire on a rural-urban interface. The programme has been aligned to support the goals of the WMO HIWeather programme. The Weather & Wildfire theme is linked to other themes within the programme, that will also contribute to HIWeather, notably the Resilience in Practice Model, co-led by Julia Becker (Massey University) and the Urban theme co-led by David Johnston (Massey University). The New Zealand Meteorological Society conference will be held on 23-27 November 2020 in Christchurch.

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 in 2019 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

Joint initiative towards a International Fujita scale to assess tornado and wind damage (with European Severe Storms Lab) is still growing. Recently, there was a poster presentation at EMS Annual Meeting in 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. Next face-to-face meeting of the IF-Scale steering committee is planned along with the ESSL Tornado and Windstorm Damage Assessment Workshop in August 2020 in Wr. Neustadt, Austria. https://www.essl.org/cms/upcoming-events/workshop-damage-assessment/. Spread the message!

The EUMETNET EMMA/Meteoalarm PM carried out a survey on implementation of impact-oriented warnings among Meteoalarm members in Europe in August 2018 – May 2019. 79 questions covered topics from warning format, production process of warnings, dissemination of warnings, verification of warnings, warning strategy, crowdsourcing and cross-border collaboration 32/37 of European NMHSs replied, making it a valuable dataset for potential initiatives on the regional / global scale in the field of IoW. Results were presented at the EMS Annual Meeting in Copenhagen, 9-13.9.2019. Publication is planned for 2020.

European Weather Observer –ZAMG and ESSL are in contact with a number of European NMHSs to work on and refine a pan-European, standardized set of human-assessed (hydro, meteo, geo) crowdsourcing reporting parameters and enable exchange through a standardized API. In 2018 a first set of reporting parameters was defined by DHMZ, FMI, KNMI, ESSL, ZAMG and other ESSL collaborators (i.e. European spotter groups). Our common proposal is, that European NMHSs shall act as national data hubs for weather- and impact observations enabling exchange of data between NMHS level and European level. Currently a consortium of participating NMHSs is formed. A standardized API between all partners will enable real time data exchange using the MQTT protocol. NMHSs are invited to provide API to subnational collaborators (e.g. spotter groups, emergency authorities). The API can be easily implemented in existing web pages and apps, e.g. https://wettermelden.at . Recently a presentation was held at EMS Annual Meeting in Copenhagen, 9-13.9.2019. https://meetingorganizer.copernicus.org/EMS2019/EMS2019-887-2.pdf

CHINESE CONTRIBUTIONS

Recently, 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 lighting 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 project 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/.

ENDORSED PROJECTS

SMART 2022

The small-scale intensive observation experiments are under way in the two Olympic mountain areas. A short-term forecasting system has been developed with multi-source data fusion, adaptive downscaling, and machine learning, which can provide 100-meter resolution and 10-minute update of 0-24-hour weather forecast under complex terrain for Beijing Winter Olympics. The 24-240-hour weather forecasting methods for the games is developed based on the Chinese numerical weather prediction model GRAPES. The seamless forecast methods for 0-240 hours of key points of Winter Olympics has also been developed combining machine learning, other methods and forecasters' experience based on the above grid-point forecasts. Special meteorological service methods for Winter Olympics, such as automatic processing of graph and text, traffic meteorology and helicopter rescue, have been formed. Some of the achievements will be applied to meteorological services of the upcoming Winter Olympics test series

NAWDIC (NORTH ATLANTIC WAVEGUIDE, DRY INTRUSION, AND DOWNSTREAM IMPACT CAMPAIGN)

An International field campaign focusing on mid-latitude dynamics with the aim to provide required observations for understanding the tropopause structure and downstream high impact weather (HIW) in the eastern North Atlantic winter. NAWDIC will build directly on insights of the North Atlantic Wave guide and Downstream impact EXperiment (NAWDEX; Schäfler et al. 2018) and is scheduled to take place in the winter of 2024 or 2025. For more information about NAWDIC, please visit *https://internal.wavestoweather.de/campaign/projects/nawdic/wiki*

PICS: TOWARDS INTEGRATED NOWCASTING OF FLASH FLOOD IMPACTS

Flash floods are destructive and sudden phenomena that cause a lot of damages and regularly claim lives. The French PICS project relies on an interdisciplinary team of researchers in meteorology, hydrology, hydraulics, economics and social sciences and a user group of operational stakeholders to demonstrate the usefulness of integrated nowcasting systems from rainfall forecasting to the prediction of flash-flood impacts on small, fast-response watersheds.

Since the start of the project in 2018, many advances have been made to improve each step of the forecasting chains. Lovat et al. (HESS, 2019), Jay-Allemand et al. (HESS, 2020), Peredo et al. (HSJ, submitted) proposed several improvements for flash-flood hydrological modeling, and Hocini et al. (HESSD, 2020) compared several automated flood inundation mapping methods.

Currently, we investigate integrated nowcasting chains including ensemble hydrological prediction, flood inundation mapping based on high quality lidar data, insurance claims modeling, and the modeling of human exposure and behaviour.

COSMO-AWARE

The AWARE project goal is to experiment a number of forecast methods and evaluation approaches that are linked to high impact weather HIW and to provide COSMO Community with an overview and recommendations as to how HIW situations should be handled. During the last months, an overview of available observation sources for convective events is under preparation. It considers, in particular, non-standard and proxy sources of data. Effort is given to identify observation requirements for monitoring selected hazards and/or for assessing forecast accuracy as well as to quantify the role of observation uncertainty. With respect to verification methods, the extreme value theory was applied to extremely vast contiguous precipitation areas predicted by STEPS nowcasting in Central Russia. The vast areas were fitted to the Generalized Pareto distribution using the peaks over threshold method. A summary measure of nowcasting quality is proposed based on the estimates of Generalized Pareto parameters in observations and nowcasting. Moreover, an overview of the QPF products (deterministic and probabilistic) provided to the end-user (forecaster or hydrologist) in Emilia-Romania (Italy) is prepared. It discusses the best ways of representing forecasts and their validation data to the forecasters. AWARE project will have a virtual meeting to discuss its progress in the various Tasks during March, date will be announced on web page (http://www.cosmo-model.org/content/tasks/priorityProjects/aware/default.htm).

OTHER RELATED ACTIVITIES

GHHIN (GLOBAL HEAT HEALTH INFORMATION NETWORK).

A professional network of academics, government representative at all levels, professional organizations, international organizations, donor organizations, private sector and non-governmental organizations 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 and to determine the best methods for communicating forecast uncertainty related to these events. See http://www.nssl.noaa.gov/projects/vortexse/

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/. The project catalogue contains forecasting algorithms for hazards and their impacts, many developed in previous EU actions. http://anywhere-h2020.eu/catalogue/

ARISTOTL-EHNSP

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

The centre works 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/. The Risk Data Hub at https://drmkc.jrc.ec.europa.eu/risk-data-hub/#/ may be of particular interest to HIWeather researchers.

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 promotes global collaboration to improve the availability and usability of data on 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 to advance interoperability and usability of such data: research data should be intelligently open or FAIR. The group is working particularly in three important global challenges in **infectious disease,**

sustainable cities, and **disaster risk reduction**: *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. It brings together early career scientists, from both natural and social sciences, working in a field of Earth system science. It is a bottom-up initiative run by its 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*.

JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH

Open access journal dedicated to human and mediated communication issues associated with crises, risks, and emergencies. It has an international editorial board and invites manuscripts of a philosophical, theoretical, methodological, critical, applied, pedagogical or empirical nature. Its includes community or regionally based events and risks, such as hurricanes, floods, wildfires, infectious disease outbreaks or similar threats. See *www.jicrcr.com*.

PARTICIPANTS & MANAGEMENT

STEERING GROUP AND TASK TEAMS

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

***ICO**: Qinghong Zhang, Huiyi Fan, China,* hiwico@cma.gov.cn

Processes & Predictability (P&P) theme
Lead: Michael Riemer, Germany, mriemer@uni-mainz.de (on leave until the end of February)

Members: John Knox, Peter Knippertz, Andreas Schäfler, Juan Fang, Shira Rabeh-Ruvin, Linus Magnusson, Deanna Hence, Yali Luo, Linda Schlemmer, Robert Rogers

Multi-Scale coupled Forecasting (MSF) theme
Lead: Jenny Sun, USA, sunj@ucar.edu

Members: Olivier Caumont, Paul Joe, Peter Steinle, Sharan Majumdar, Jianjie Wang, Jim Dudhia, Krushna Chandra Gouda, Nusrat Yussouf, Yi Wang, Glen Romine

Human Impacts, Vulnerability & Risk (HIVR) theme
Lead: Brian Mills, Canada, bmills@uwaterloo.ca

Members: Joanne Robbins, Michael Kunz, Isabelle Ruin, Melanie Gall, Sara Harrison, Craig Arthur, Linda Anderson-Berry, Urbano Fra. Paleo, Harald Richter, Danielle Nagele

Communication theme
Co-leads: Andrea Taylor, UK, a.l.taylor@leeds.ac.uk *& Sally Potter, New Zealand* s.potter@gns.cri.nz

Members: Sara Harrison, Brenda Mackie, Julie Demuth, Amber Silver, Thomas Kox, Bob Goldhammer, Philippe Weyrich, Emily Campbell, Amisha Mehta, Faye Wyatt, Rutger Dankers, Gina Eosco, Marion Tan

Evaluation theme
Lead: Beth Ebert, Australia, beth.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

***Link to SURF project**: Xudong Liang,* liangxd@cma.gov.cn

***Representatives of WGNE** (Working Group on Numerical Experimentation under WCRP)*
Ariane Frassoni, Brazil, ariane.frassoni@inpe.br
Jian Sun, China, jian.sun.cma@gmail.com

HIWeather book: "Towards the Perfect Warning"
Editor: Brian Golding

Coordinators: Robert Šakić Trogrlić, Anna Scolobig, Cheryl Lafaye Anderson, Joanne Robbins, Brian Golding, Paul Joe

Co-authors: *Colin McQuistan, Marc van den Homberg, Brian Golding, Mirianna Budimir, Alison Sneddon, Sally Potter, Thomas Kox, Rainer Kaltenberger, Philippe Weyrich, Julia Chasco, Nadine Fleischhut, Douglas Hilderbrand, Jane Rovins, David M. Johnston, Will Lang, Brian Mills, Rainer Kaltenberger, Thomas Pagano, Ross Middleham, Rutger Dankers, Isabelle Ruin, John Nairn, Jenny Sun, Michael Riemer, Beth Ebert, Helen Titley, Nusrat Yussouf, Huw Lewis, Graeme Boyce, Mika Peace, Steve Goodman, Krushna Gouda, Peter Li, James LaDue, Jim Wilson, Jeanette Onvlee, Pei Chong, Robert Rogers, George Isaac, Volker Wulfmeyer, Kim Elmore*

Value Chain project:
Lead: Beth Ebert

Members: *Adriaan Perrels, Juan Sarmiento, Carla Mooney, Brian Golding, Bob Goldhammer, Julie Demuth, Brian Mills, Melanie Gall, Jeff Lazo, Helen Titley, Chiara Marsigli, Anna Scoobig, Sharanya Majumdar, Yi Wang, Nusrat Yussouf, Krushna Gouda, Linus Magnusson, Robert Rogers, Rebecca Morss*

Citizen Science project:
Lead: Marion Tan

Members: *Anna Scolobig, Brian Mills, Emily Campbell, Sara Harrison, Harald Kempf, Lisa McLaren, Lauren Vinnell, Andrea Taylor, Chris David, Deanna Hence, Helen Titley, Jennifer Sprague-Hilderbrand, Michael Riemer, Qinghong Zhang, Rainer Kaltenberger, Jenny Sun, Sarah Dance, Ajit Tyagi, Julia Becker, Benjamin Payne, David Johnston, Alicia Cui, Brian Golding*

ADVISORY BOARD

John Rees, British Geological Survey, 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 UNDRR, UK, representing the UN family

MANAGEMENT

FUNDING

A 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 (ICO)

The ICO is hosted by Chinese Academy of Meteorological Sciences, and responsible for the organisation of Steering Group, Advisory Board and Task Team teleconferences and maintenance of HIWeather web site: *http://hiweather.net/Index*

SECRETARIAT

Estelle de Coning and David Hoffmann provide 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 is live at *http://hiweathercomms.net/*. A HIWeather twitter account is available to follow at *https://twitter.com/WMO_HIWeather*.

MEETINGS

The Steering Group meets quarterly, usually by teleconference. The last physical annual SG meeting was held on 14-16 October 2019 in Geneva, with attendance of WWRD, Co-chairs, Task team leaders, and ICO. Task teams meet by teleconference at intervals to suit their work. The Advisory Board aims to meet at least once a year by teleconference.

RELEVANT PUBLICATIONS

This list contains recent publications selected by the editor as being relevant to the work of HIWeather, including most publications by members of the HIWeather task teams. It is inevitably incomplete and is meant to serve as a help to research rather than as a record. Please see the HIWeather website at http://hiweather.net/Lists/23.html for a list of publications by HIWeather members.

Allen, J. T., I.M. Giammanco, M.R. Kumjian, H.J. Punge, Q. Zhang, P. Groenemeijer, M. Kunz and K. Ortega, 2020. Understanding hail in the Earth system, Rev.Geophys, 58. Doi:10.1029/2019RG000665

Bannister, T., E.E. Ebert, J. Silver. E. Newbigin, E.R. Lampugnani, N. Hughes, C. Looker, V. Mulvenna, P. Jones, J. Davies, C. Suphioglu, P.J. Beggs, K.M. Emmerson, A. Huete, H. Nguyen, T. Williams, P. Douglas, A. Wain, M. Carroll, D. Csutoros, 2020: A pilot forecasting system for epidemic thunderstorm asthma in south-eastern Australia. Bull. Amer. Meteorol. Soc., https://doi.org/10.1175/BAMS-D-19-0140.1.

Barthlott, C. and Barrett, A. I., 2020: Large impact of tiny model domain shifts for the Pentecost 2014 mesoscale convective system over Germany, Weather Clim. Dynam., 1, 207–224, doi: 10.5194/wcd-1-207-2020.

Brook, J.P., Protat, A., Soderholm, J., Carlin, J.T., McGowan, H. and Warren, R.A., 2021. Hail Track-Improving Radar-Based Hailfall Estimates by Modeling Hail Trajectories. *Journal of Applied Meteorology and Climatology*.

Bucher, A., A. Collins, B. H. Taylor, D. Pan, E. Visman, J. Norris, J. C. Gill, J. Rees, M. Pelling, M. T. Bayona, S. Cassidy and V. Murray, 2020, New Partnerships for Co-delivery of the 2030 Agenda for Sustainable Development. Int J Disaster Risk Sci 11:680–685. https://doi.org/10.1007/s13753-020-00293-8

Burgeno, J. N. and S. L. Joslyn, 2020, The impact of weather forecast inconsistency on user trust. WEATHER, CLIMATE & SOCIETY 12, 679–694. DOI: https://doi.org/10.1175/WCAS-D-19-0074.1

Calvello M., Devoli G., Freeborough K., Gariano S.L., Guzzetti F., Kirschbaum D., Nakaya H., Robbins J. and M Stahl 2020, LandAware: a new international network on Landslide Early Warning Systems. Landslides, 17, 2699-2702 DOI: 10.1007/s10346-020-01548-7

Cho, J. Y. N. and J. M. Kurdzo, 2020, Weather radar network benefit model for nontornadic thunderstorm wind casualty cost reduction. WEATHER, CLIMATE & SOCIETY 12,789–804. DOI: https://doi.org/10.1175/WCAS-D-20-0063.1

Dacre, H. G. and J. G. Pinto, 2020, Serial clustering of extratropical cyclones: a review of where, when and why it occurs. npj Climate and Atmospheric Science, 3:48 ; https://doi.org/10.1038/s41612-020-00152-9,

Dinápoli, M. G., C. G. Simionato, D. Moreira, 2021, Development and evaluation of an ensemble forecast/ hindcast system for storm surges in the Río de la Plata Estuary. Q J R Meteorol S. 2021;147:557–572. DOI: 10.1002/qj.3933

Dowdy, A.J., Soderholm, J., Brook, J., Brown, A. and McGowan, H., 2020. Quantifying Hail and Lightning Risk Factors Using Long-Term Observations Around Australia. *Journal of Geophysical Research: Atmospheres*, *125*(21), p.2020JD033101.

Feng, J., Y. Duan, Q. Wan, H. Hu, and Z. Pu, 2020, Improved prediction of landfalling tropical cyclone in China based on assimilation of radar radial winds with new super-observation processing. WEATHER & FORECASTING 35, 2523-39. DOI: https://doi.org/10.1175/WAF-D-20-0002.1

Fragkoulidis, G. and V. Wirth, 2020: Local Rossby Wave Packet Amplitude, Phase Speed, and Group Velocity: Seasonal Variability and their Role in Temperature Extremes, J. Clim., 33, 1–53, doi: 10.1175/JCLI-D-19-0377.1.

Gall, M. and C.J. Friedland, 2020. If mitigation saves $6 per every $1 spent, then why are we not investing more? A Louisiana perspective on a national issue, Natural Hazards Rev, 21(1):04019013. DOI: 10.1061/(ASCE)NH.1527-6996.0000342.

Gbangou, T., E. Van Slobbe, F. Ludwig, G. Kranjac-Berisavljevic and S. Paparrizos, 2021, Harnessing local forecasting knowledge on weather and climate in Ghana: documentation, skills and integration with scientific forecasting knowledge. WEATHER, CLIMATE, & SOCIETY 13, 23–37. DOI: https://doi.org/10.1175/WCAS-D-20-0012.1

Ghinassi P., M. Baumgart, F. Teubler, M. Riemer, and V. Wirth, 2020: A budget equation for the amplitude of Rossby wave packets based on finite amplitude local wave activity, J. Atmos. Sci., 77, 277–296, doi:10.1175/JAS-D-19-0149.1.

Gordon, J. N. and N. Yiannakoulias, 2020, A serious gaming approach to understanding household flood risk mitigation decisions. J Flood Risk Man. https://doi.org/10.1111/jfr3.12648

Gómez, I., S. Molina , J. Olcina, and J. J. Galiana-Merino, 2021, Perceptions, uses and interpretations of uncertainty in current weather forecasts by Spanish undergraduate students. WEATHER, CLIMATE, & SOCIETY 13, 83–94. DOI: https://doi.org/10.1175/WCAS-D-20-0048.1

Grazzini, F., Fragkoulidis, G., Pavan, V., Antolini, G., 2020: The1994 Piedmont flood: an archetype of extreme precipitation events in Northern Italy, Bull. of Atmos. Sci.& Technol., doi:10.1007/s42865-020-00018-1.

Grazzini, F., G. Fragkoulidis, F. Teubler, V. Wirth and G. C. Craig,2021: Extreme precipitation events over northern-central Italy. Part(II): Dynamical precursors, Quart. J. Roy. Meteor. Soc. https://rmets.onlinelibrary.wiley.com/doi/10.1002/qj.3969

Grimmond, S., V. Bouchet, L. T. Molina, A. Baklanov, J. Tan, K. H. Schlunzen, G. Mills, B. Golding, V. Masson, C. Ren, J. Voogt, S. Miao, H. Lean, B. Heusinkveld, A. Hovespyan, G. Teruggi, P. Parrish and P. Joe, 2020, Integrated urban hydrometeorological, climate and environmental services: Concept, methodology and key messages. Urban Climate, 33. https://doi.org/10.1016/j.uclim.2020.100623

Hallerstig, M., L. Magnusson, E. W. Kolstad, S. Mayer, 2021, How grid-spacing and convection representation affected the wind speed forecasts of four polar lows Quart. J Roy. Meteorol. S. 2021;147:150–165. DOI: 10.1002/qj.3911

Hardy, S., J. Schwendike, R. K. Smith, C. J. Short, M. J. Reeder and C. E. Birch, 2020, Fluctuations in inner-core structure during the rapid intensification of Super Typhoon Nepartak (2016). MONTHLY WEATHER REV 149 221-243. DOI: https://doi.org/10.1175/MWR-D-19-0415.1

Harvey, B., J. Methven, C. Sanchez, and A. Schäfler, 2020: Diabatic generation of negative potential vorticity and its impact on the North Atlantic jet stream, Quart. J. Roy. Meteor. Soc., 146, 14771497, doi: 10.1002/qj.3747.

Hauser S., Grams C.M., Reeder M.J., McGregor S., Fink A.H., Quinting J.F., 2020: A weather system perspective on winter–spring rainfall variability in southeastern Australia during El Niño, Q. J. Royal Meteorol. Soc., 1-20, doi: 10.1002/qj.3808.

Imhoff, R. O., A. Overeem, C. C. Brauer, H. Leijnse, A. H.Weerts and R. Uijlenhoet, 2020, Rainfall Nowcasting Using Commercial Microwave Links. Geophysical Research Letters 10.1029/2020GL089365

Jucker, M., T. P. Lane, C. L. Vincent, S. Webster, S. A.Wales, V. Louf, 2020, Locally forced convection in subkilometre-scale simulations with the Unified Model and WRF *Q J R Meteorol Soc*. 146:3450–3465. DOI: 10.1002/qj.3855

Keil, C., L. Chabert, O. Nuissier, and L. Raynaud, 2020: Dependence of predictability of precipitation in the northwestern Mediterranean coastal region on the strength of synoptic control, Atmos. Chem. Phys., 20, 15851–15865, doi: 10.5194/acp-20-15851-2020.

Kremer, T., E. Schömer, C. Euler, and M. Riemer, 2020: Cluster analysis tailored to structure change of tropical cyclones using a very large number of trajectories, Mon. Wea. Rev., 148, 1-59, doi: 10.1175/MWR-D-19-0408.1.

Kunz, M., J. Wandel, E. Fluck, S. Baumstark, S. Mohr, and S. Schemm, 2020. Ambient conditions prevailing during hail events in central Europe, Natural Hazards and Earth System Sciences, 20:1867-1887. Doi:10.5194/nhess-20-1867-2020

Lazo, J.K., H.R. Hosterman, J.M. Sprague-Hilderbrand and J.E. Adkins, 2020. Impact-based decision support services and the socioeconomic impacts of winter storms, Bull Am Meteorol S, 101, 626:639. DOI:10.1175/BAMS-D-18-0153.1

Lim, K-S. S., E.-C. Chang, R. Sun, K. Kim, F. J. Tapiador and G. Lee, 2020, Evaluation of simulated winter precipitation using WRF-ARW during the ICE-POP 2018 field campaign, WEATHER & FORECASTING 35, 2199–2213 DOI: https://doi.org/10.1175/WAF-D-19-0236.1

MacLeod D., Kilavi M., Mwangi E., Ambani M., Osunga M., Robbins J., Graham R., Rowhani P. and Todd M (2021) Are Kenya Meteorological Department heavy rainfall advisories useful for forecast-based early action and early preparedness for flooding? Natural Hazards and Earth System Sciences, 21, 261-277 DOI: 10.5194/nhess-21-261-2021

Majumdar, S. J., J. Sun, B. Golding, P. Joe, J. Dudhia, O. Caumont, K. Chandra Gouda, P. Steinle, B. Vincendon, J. Wang, and N. Yussouf, 2021: Multiscale Forecasting of High-Impact Weather: Current Status and Future Challenges. *Bull. Amer. Meteor. Soc*., In Press. DOI: https://doi.org/10.1175/BAMS-D-20-0111.1

Mills, B., 2020. An updated assessment of lightning-related fatality and injury risk in Canada: 2002-17, *Natural Hazards*, 102(3):997-1009. https://link.springer.com/article/10.1007/s11069-020-03942-9.

Mills, B., J. Andrey, S. Doherty, B. Doberstein, and J. Yessis, 2020. Winter storms and fall-related injuries: Is it safer to walk than to drive?, *Weather, Climate & Society*. https://journals.ametsoc.org/doi/abs/10.1175/WCAS-D-19-0099.1.

Mondino, E., A. Scolobig, M. Borga, F. Albrecht, J. Mard, P. Weyrich, and G. Di Baldassarre, 2020. Exploring changes in hydrogeological risk awareness and preparedness over time: a case study in northeastern Italy, Hydrological Sciences Journal, DOI: 10.1080/02626667.2020.1729361.

Mostafiz, R.B., C.J. Friedland, R.V. Rohli, M. Gall, N. Bushra, and J.M. Gilliland, 2020. Census-block-level property risk estimation due to extreme cold temperature, hail, lightning, and tornadoes in Louisiana, United States, Frontiers in Earth Science, 8:601624. DOI: 10.3389/feart.2020.601624

Muofhe, T. P., H. Chikoore, M.-J. M. Bopape, N. S. Nethengwe, T. Ndarana and G. T. Rambuwani, 2020, Forecasting Intense Cut-Off Lows in South Africa Using the 4.4 km Unified Model. Climate, 8, 129; doi:10.3390/cli8110129

Ndalila, M.N., Williamson, G.J., Fox-Hughes, P., Sharples, J. and Bowman, D.M., 2020. Evolution of a pyrocumulonimbus event associated with an extreme wildfire in Tasmania, Australia. *Natural Hazards and Earth System Sciences*, *20*(5), pp.1497-1511.

Nelson, T. C., J. Marquis, A. Varble and K. Friedrich, 2020, Radiosonde observations of environments supporting deep moist convection initiation during RELAMPAGO-CACTI. MONTHLY WEATHER REV 149 289-309.
DOI: https://doi.org/10.1175/MWR-D-20-0148.1

Nisi, L., A. Hering, U. Germann, K. Schroeer, H. Barras, M. Kunz, and O. Martius, 2020. Hailstorms in the Alpine region: Diurnal cycle, 4D-characteristics, and the nowcasting potential of lightning properties, Q J Roy Meteorol So, 146:4170-4194. DOI: 10.1002/qj.3897

Ono, K., M. Kunii, Y. Honda, 2021, The regional model-based Mesoscale Ensemble Prediction System, MEPS, at the Japan Meteorological Agency. Q J R Meteorol S.147:465–484 DOI: 10.1002/qj.3928

Pal, S., F. Dominguez, M. E. Dillon, J. Alvarez, C. M. Garcia, S. W. Nesbitt, and D. Gochis, 2020, Hydrometeorological observations and modelling of an extreme rainfall event using WRF and WRF-HYDRO during the RELAMPAGO field campaign in Argentina. J. HYDROMETEOROLOGY 22 331-351, DOI…

Peace, M., Charney, J. and Bally, J., 2020. Lessons Learned from Coupled Fire-Atmosphere Research and Implications for Operational Fire Prediction and Meteorological Products Provided by the Bureau of Meteorology to Australian Fire Agencies. *Atmosphere*, *11*(12), p.1380.

Porson, A. N., J. M. Carr, S. Hagelin, R. Darvell, R. North, D. Walters, K. R. Mylne, M. P. Mittermaier, S. Willington, B. Macpherson, 2020, Recent upgrades to the Met Office convective-scale ensemble: An hourly time-lagged 5-day ensemble. *Q J R Meteorol S*. 146:3245–3265. DOI: 10.1002/qj.3844

Renner, M., A. Kleidon, M. Clark, B. Nijssen, M. Heidkamp, M. Best and G. Abramowitz, 2020, How well can land-surface models represent the diurnal cycle of turbulent heat fluxes? J. HYDROMETEOROLOGY 22 77-94
DOI: https://doi.org/10.1175/JHM-D-20-0034.1

Rodwell, M. J., J. Hammond, S. Thornton, D. S. Richardson, 2020, **User decisions, and how these could guide developments in probabilistic forecasting** *Q J R Meteorol S*. 146:3266–3284 DOI: 10.1002/qj.3845

Rogers, D.P., L. Anderson-Berry, A.-M. Bogdanova, G. Fleming, H. Gitay, S. Kahandawa, H. Kootval, M. Staudinger, M. Suwa, V. Tsirkunov, and W. Wang, 2020. COVID-19 and lessons from multi-hazard early warning systems, Advances in Science.

Sanchez, C., J. Methven, S. Gray, M. Cullen, 2020, Linking rapid forecast error growth to diabatic processes *Q J R Meteorol S*.146:3548–3569. DOI: 10.1002/qj.3861

Schäfler, A., B. Harvey, J. Methven, J.D. Doyle, S. Rahm, O. Reitebuch, F. Weiler, and B. Witschas, 2020: Observation of jet stream winds during NAWDEX and characterization of systematic meteorological analysis errors, Mon. Wea. Rev., 148, 2889-2907, doi:10.1175/MWR-D-19-0229.1.

Schröttle, J., M. Weissmann, L. Scheck, and A. Hutt, 2020, Assimilating visible and infrared radiances in idealized simulations of deep convection. MONTHLY WEATHER REV 148 4357-4375 DOI: 10.1175/MWR-D-20-0002.1

Spensberger, C., Madonna, E., Boettcher, M., Grams, C.M., Papritz, L., Quinting, J.F., Röthlisberger, M., Sprenger, M. and Zschenderlein, P., 2020: Dynamics of concurrent and sequential Central European and Scandinavian heatwaves, Q. J. Royal Meteorol. Soc., Accepted Author Manuscript, doi:10.1002/qj.3822

Spruce M.D., Arthur R., Robbins J and Williams H.T.P, 2021, Social sensing of high impact rainfall events worldwide: a benchmark comparison against manually curated impact observations. In review with Natural Hazards and Earth System Sciences. https://nhess.copernicus.org/preprints/nhess-2020-413/

Stern, D.P., Kepert, J.D., Bryan, G.H. and Doyle, J.D., 2020. Understanding atypical midlevel wind speed maxima in hurricane eyewalls. *Journal of the Atmospheric Sciences*, *77*(5), pp.1531-1557.

Stratman, D. R., N. Yussouf, Y. Jung, T. A. Supinie, M. Xue, P. S. Skinner, and B. J. Putnam, 2020: Optimal Temporal Frequency of NSSL Phased-Array Radar Observations for an Experimental Warn-on-Forecast System. Wea. Forecasting, in press. https://doi.org/10.1175/WAF-D-19-0165.1

Su, C.H., Eizenberg, N., Jakob, D., Fox-Hughes, P., Steinle, P., White, C.J. and Franklin, C., 2020. BARRA v1. 0: Kilometre-scale downscaling of an Australian regional atmospheric reanalysis over four midlatitude domains. *Geoscientific Model Development Discussions*, pp.1-34.

Su, C., J. N. Burgeno and Su. Joslyn, 2021, The effects of inconsistency among simultaneous forecasts on weather-related decisions. WEATHER, CLIMATE & SOCIETY 133–210. DOI: https://doi.org/10.1175/WCAS-D-19-0089.1

Sutton, J. and L. M. Fischer, 2021, Understanding visual risk communication messages: an analysis of visual attention allocation and think-aloud responses to tornado graphics WEATHER, CLIMATE & SOCIETY 13173–188, DOI: https://doi.org/10.1175/WCAS-D-20-0042.1

Towe, R., G. Dean, L. Edwards, V. Nundloll, G. Blair, R. Lamb, B. Hankin, S. Manson, 2020, Rethinking data-driven decision support in flood risk management for a big data age. J Flood Risk Man. https://doi.org/10.1111/jfr3.12652

Vannitsem, S., Bremnes, J. B., Demaeyer, J., Evans, G. R., Flowerdew, J., Hemri, S., Lerch, S., Roberts, N., Theis, S., Ben Bouallègue, A. A. Z., Bhend, J., Dabernig, M., De Cruz, L., Hieta, L., Mestre, O., Moret, L., Odak Plenković, I., Schmeits, M., Taillardat, M., Van den Bergh, J., Van Schaeybroeck, B., Whan, K., and Ylhaisi, J., 2020: Statistical Postprocessing for Weather Forecasts – Review, Challenges and Avenues in a Big Data World, Bull. Amer. Meteor. Soc.,doi: 10.1175/BAMS-D-19-0308.1.

Vaughan, A., Walsh, K.J. and Kepert, J.D., 2020. The Stationary Banding Complex and Secondary Eyewall Formation in Tropical Cyclones. *Journal of Geophysical Research: Atmospheres*, *125*(6), p.e2019JD031515.

Vellinga, M., D. Copsey, T. Graham, S. Milton and T. Johns, 2020 Evaluating benefits of two-way ocean-atmosphere coupling for global NWP forecasts WEATHER & FORECASTING 35, 2127–2144. DOI: https://doi.org/10.1175/WAF-D-20-0035.1

Vogel, P., Knippertz, P., Gneiting, T., Fink, A. H., Klar, M., Schlueter, A., 2020: Statistical forecasts for the occurrence of precipitation outperform global models over northern Tropical Africa, Geophys. Res. Lett., doi:10.1029/2020GL091022.

Vogel, P., P. Knippertz, A. H. Fink, A. Schlueter and T. Gneiting, 2020, Skill of global raw and postprocessed ensemble predictions of rainfall in the Tropics. WEATHER & FORECASTING 35, 2367–2385. DOI: https://doi.org/10.1175/WAF-D-20-0082.1

de Vos, L. W., A. M. Droste, M. J. Zander, A. Overeem, H. Leijnse, B. G. Heusinkveld, G. J. Steeneveld, and R. Uijlenhoet, 2020, Hydrometeorological Monitoring Using Opportunistic Sensing Networks in the Amsterdam Metropolitan Area. Bull. Am. Meteorol. S. https://doi.org/10.1175/BAMS-D-19-0091.1

Ward, P.J., V. Blauhut, N. Bloemendaal, J.E. Daniell, M.C. de Ruiter, M.J. Duncan, R. Emberson, S.F. Jenkins, D. Kirschbaum, M. Kunz, S. Mohr, S. Muis, G.A. Riddell, A. Schäfer, T. Stanley, T.I.E. Veldkamp, and H.C. Wellmann, C., Barrett, A. I., Johnson, J. S., Kunz, M., Vogel, B., Carslaw, K. S., Hoose, C., 2020: Comparing the impact of environmental conditions and microphysics on the forecast uncertainty of deep convective clouds and hail, Atmos. Chem. Phys., 20 (4), 2201–2219. doi:10.5194/acp-20-2201-2020.

Ward, P.J., V. Blauhut, N. Bloemendaal, J.E. Daniell, M.C. de Ruiter, M.J. Duncan, R. Emberson, S.F. Jenkins, D. Kirschbaum, M. Kunz, S. Mohr, S. Muis, G.A. Riddell, A. Schäfer, T. Stanley, T.I.E. Veldkamp, and H.C. Winsemius, 2020. Review article: Natural hazard risk assessments at the global scale, Natural Hazards and Earth System Sciences, 20:1069-1096. Doi:10.5194/nhess-20-1069-2020

Wellmann, C., A.I. Barrett, J.S. Johnson, M. Kunz, B. Vogel, K.S. Carslaw, and C. Hoose, 2020. Comparing the impact of environmental conditions and microphysics on the forecast uncertainty of deep convective clouds and hail, Atmospheric Chemistry and Physics, 20(4):2201-2219.

Weyrich, P., E. Mondino, M. Borga, G. Di Baldassarre, A. Patt, and A. Scolobig, 2020. A flood-risk-oriented, dynamic protection motivation framework to explain risk reduction behaviours, Natural Hazards and Earth System Sciences, 20(1):287-298.

Weyrich P., Ruin I., Terti G., Scolobig A., 2021, Using serious games to evaluate the potential of social media information in warning decision-making, accepted 14th January 2021 in *International Journal of Disaster Risk Reduction*.

Wilhelm J., S. Mohr, H.J. Punge, B. Mühr, M. Schmidberger, J.E. Daniell, K.M. Bedka, and M. Kunz, 2020: Severe thunderstorms with large hail across Germany in June 2019, Weather, doi:10.1002/wea.3886.

Wilson, J., D. Megenhardt and J. Pinto, 2020, NWP and Radar Extrapolation: comparisons and explanation of errors. MONTHLY WEATHER REV, 148, 4783-4798. DOI: https://doi.org/10.1175/MWR-D-20-0221.1

Winsemius, 2020. Review article: Natural hazard risk assessments at the global scale, Natural Hazards and Earth System Sciences, 20:1069-1096. Doi:10.5194/nhess-20-1069-2020

Wirth, V., 2020: Waveguidability of idealized midlatitude jets and the limitations of ray tracing theory, Weather Clim. Dynam. Discussion, doi: 10.5194/wcd-2020-3.

Xiao, X., J. Sun, X. Qie, Z. Ying, L. Ji, M. Chen and L. Zhang, 2021, Lightning data assimilation scheme in a 4DVar system and its impact on very short-term convective forecasting. MONTHLY WEATHER REV, 149, 353-373. DOI: https://doi.org/10.1175/MWR-D-19-0396.1

Yang, G-Y., S. Ferrett , S. Woolnough, J. Methven and C. Holloway, 2021, real-time identification of equatorial waves and evaluation of waves in global forecasts. WEATHER & FORECASTING, 36, 171–193. DOI: https://doi.org/10.1175/WAF-D-20-0144.1

Zschenderlein, P., Pfahl, S., Wernli, H., and Fink, A. H., 2020: A Lagrangian analysis of upper-tropospheric anticyclones associated with heat waves in Europe, Weather Clim. Dynam., 1, 191–206, doi: 10.5194/wcd-1-191-2020.

.