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HIWeather

20th June 2017

I write this on World Refugee Day. Although refugees from conflict tend dominate the headlines, vast numbers of refugees are created by weather-related hazards and projects like HIWeather & S2S have the ability to enable early interventions that will prevent many from becoming refugees. Keep up the good work!

It has been a very busy three months of HIWeather-related meetings! On April 11th, I represented HIWeather at the WMO GAW (Global Atmospheric Watch) symposium in Geneva. The morning discussions were on integrated observing and I was particularly interested in suggestions to better integrate air quality monitoring and meteorological observing. In the afternoon we discussed modelling, with integration again a key theme. I also had an early morning meeting with Veronique Bouchet, chair of GURME (GAW Urban Research Meteorology & Environment), about links between the HIWeather and GURME projects. One outcome will be the involvement of GURME in the autumn HIWeather conference.

At the recent WMO Executive Council 69 in Geneva, the Chinese Meteorological Agency (CMA) and WMO signed a Memorandum of Understanding (see photo below) for CMA to host the HIWeather International Coordination Office in Beijing. The HIWeather Steering Group is delighted that CMA will be hosting the ICO and looks forward to collaborating with them in achieving the HIWeather vision and goals.

The HIWeather Steering Group held a very productive meeting in Berlin on 6th May at which arrangements for the autumn conference were agreed. The following day, the evaluation task team organised a workshop on the Value Chain concept, which highlighted its ability to provide a guide to key issues in designing a warning system as well as exposing the wide variety of understanding of what it means. A subgroup will document the concept and how it might be used. From 8th to 11th May, the Verification working group of WWRP (JWGFVR) held its workshop, also in Berlin, at which the results of the User-Oriented Verification challenge were announced. The HIWeather evaluation theme was well represented and I gave a talk on the relevance of the value chain to HIWeather. On my way home, I spent 11th May in Warsaw, presenting HIWeather, particularly the impact-based approach to warning, to the heads of forecasting of the European Met Services.

The last week of May saw both David Johnston and me in Cancun, Mexico for the UNISDR Global Platform in Disaster Risk Reduction, along with 6,000 other delegates! Monday and Tuesday were taken up with a WMO-sponsored conference on Multi-Hazard Early Warning Systems. The format was mainly panel discussions involving some very inspiring speakers, including David. Lunch slots were occupied by parallel side meetings, including one on urban resilience to hazards, in which I gave a presentation. In both this conference and the following Global Platform meeting, the need for partnership between the physical and social sciences was repeatedly stressed, as was the need to build warning systems on a knowledge of the current hazard-response ability of communities. Since returning from Mexico, I have been involved in preparing for the expected announcement of a UK funding opportunity in research for overseas development, which we hope to align closely to HIWeather objectives.

Looking ahead, in August I shall be presenting HIWeather to the Australian Meteorological and Oceanographic Society's 30th anniversary meeting in Melbourne and to the IAPSO-IAMAS-IAGA assembly in Cape Town. Beth Ebert is organising a workshop on the Value Chain at the Bureau of Meteorology to coincide with my visit there. The highlight of the autumn will be the conference on Predictability and Prediction of High Impact Weather at Landshut in Southern Germany on 9-12 October, of which more details are given below. Please submit your abstracts by 1st July. Then I shall be taking HIWeather to the Commission for Atmospheric Sciences meeting in Bali at the end of October.

Wishing you all every success in your HIWeather activities.

The Project

Steering Group

Co chairs: Brian Golding, UK and David Johnston, New Zealand

Processes & Predictability theme – lead: George Craig, Germany; members: John Knox, Peter Knippertz, Jeff Kepert.

Multi-Scale Coupled Forecasting theme – lead: Jenny Sun, USA; members: Paul Joe, Peter Steinle, Sharan Majumdar, Jianjie Wang, Jim Dudhia.

Impacts, Vulnerability & Risk theme – lead: Brian Mills, Canada; members: Joanne Robbins, Jeff Lazo, Michael Kunz, Isabelle Ruin.

Communication theme – co-leads: Sally Potter, New Zealand and Shannon Panchuk, Australia; members: Abi Beatson, Greg Carbin, Melanie Harrowsmith, Amber Silver, Rutger Dankers, Andrea Taylor, Thomas Kox, Claudia Adamo, Jose Galvez, Kiernan McGill, Linda Anderson-Berry, Tim Brown, Vankita Brown.

Evaluation theme - Beth Ebert, Australia; members: Julia Chasco, Barb Brown, Anna Scolobig, Manfred Dorninger, Pertti Nurmi, Martin Goeber, Helen Titley, Marion Mittermaier, Jing Chen, Chiara Marsigli.

Advisory Group

John Rees, British Geological Survey and Research Councils UK, representing funding agencies

Jan Polcher, Laboratoire de Meteorologie Dynamique of Centre National de la Recherche Scientifique, France, representing Climate Science

Jennifer Sprague-Hilderbrand, National Oceanic and Atmospheric Administration, USA, representing users

Virginia Murray, Public Health England and UNISDR, representing the UN family

Michael Reeder, Monash University, Australia, representing academia

Funding. The Trust Fund will 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: A Memorandum of Understanding between WMO and the CMA has been signed for CMA to host the ICO in Beijing.
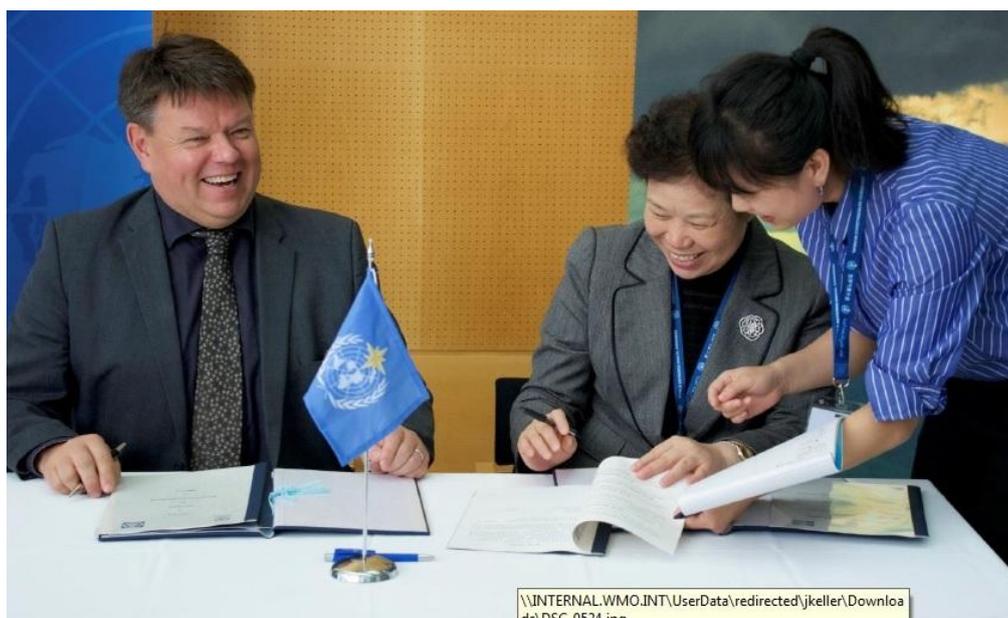
Signing the MoU for the HIWeather International Coordination Office

Secretariat: Julia Keller is providing valuable assistance within the WMO secretariat. Paolo Ruti provides the link to the World Weather Research Programme.

Communication: The HIWeather administrative web site can be reached at http://bit.ly/1RKapbc. It contains the Implementation Plan, Steering Group and Task team membership and HIWeather presentations. It is available for task teams to post meetings and progress. A communications web platform for the project has been set at Massey University, New Zealand and is currently being populated. I use Linked-In to post items of interest about HIWeather and copy my posts to Twitter using the hashtag #HIWeather.

Meetings: Steering Group meetings are held approximately quarterly, usually by teleconference. The last meeting was prior to the Verification workshop in Berlin in May. Task teams meet by teleconference at intervals to suit their work and progress.

Relevant Scientific Meetings

Models to Decisions (M2D) network Annual Conference, Exeter University, 11-14 July 2017. http://blogs.exeter.ac.uk/models2decisions/

Royal Meteorological Society Annual Conference "Weather and Climate Impacts: from research and services to application and policy", Exeter University, 13-14 July 2017. https://www.rmets.org/annual2017

AMOS 30th Anniversary Celebration, "Science for Life", Melbourne, 22-23 August 2017. https://www.amos.org.au/Main/Upcoming_Events/AMOSFestivalofSciences.aspx

IAPSO - IAMAS – IAGA Joint Assembly, Cape Town, 27 August – 1 September 2017, including session on High-impact Weather and Climate Extremes of which Brian Golding is co-convenor. http://iapso-iamas-iaga2017.com/.

European Meteorological Society Annual Meeting, Dublin, 4 – 8 September 2017. Session OSA1.3/ES1.1: Impact forecasting and impact modelling of weather and natural hazard events. http://www.ems2017.eu/

WMO Data Assimilation Symposium, Florianopolis, Brazil, 11 - 15 September, 2017, http://www.cptec.inpe.br/das2017/

International Conference on The Impact of Hazard, Risk and Disasters on Societies, Durham, UK, 19 - 22 Sep 2017. https://www.dur.ac.uk/ihrr/10th-anniversary/ihrr10/

Conference on Predictability and Multi-Scale Prediction of High Impact Weather, Landshut, Germany, 9-12 October 2017 – see https://hiw2017.wavestoweather.de & announcement below. Deadline for abstracts is July 1st.

UKEP (United Kingdom Environmental Prediction) Workshop, Reading, 22-23 November 2017.

American Geophysical Union, Fall Meeting, New Orleans 11-15 December 2017. http://fallmeeting.agu.org/2017/

American Meteorological Society, Annual Meeting, Austin, 7-11 January 2018. https://annual.ametsoc.org/2018/

Conference on Predictability and Multi-Scale Prediction of High Impact Weather

October 9th-12th 2017 in Landshut, Germany

Recent advances in numerical weather prediction, and in particular the development of high-resolution or convective-scale NWP systems, have opened new possibilities and posed new challenges in the forecasting of high impact weather. The Conference on Predictability and Multi-Scale Prediction of High Impact Weather aims to advance progress in this field by bringing together the academic and operational research communities. The meeting is co-sponsored by the HIWeather project of the World Research Program and by Waves to Weather, a Collaborative Research Center funded by the German Research Foundation. With a focused agenda and participation limited to 100-200 people, there will be ample opportunities for discussion and networking.

Abstracts are solicited for oral and poster presentations including, but not limited to, the following areas:

- The role of scale interactions and error growth in limiting the predictability of high impact weather
- Impact of diabatic processes on predictability of high impact weather
- Multi-scale prediction systems, including data assimilation strategies for improved high impact weather prediction
- Probabilistic forecasting, including statistical post-processing methods
- Evaluation and improved modeling of cloud and PBL processes
- Prediction of high impact weather in urban areas
- Integrated environmental prediction
- Extreme weather events such as floods, damaging winds or heat waves

Abstract submission deadline: 1 July
Decision on abstracts: 1 August
Registration deadline: 1 September

For more information, including abstract submission, registration and keynote speakers, please visit

hiw2017.wavestoweather.de

The conference will be held in the historical city of Landshut in Bavaria. Overlooked by Trausnitz castle, the city center features many historical buildings from the gothic and renaissance periods. The city is conveniently located about 30 km from the Munich International Airport.

HIWeather Research

a. **HIWeather Multi-Hazard Early Warning System Demonstration Project (FDP)**: Demonstrate / evaluate a state-of-the-art, end-to-end, multi-hazard warning system based on km-scale coupled ensemble impact predictions & advanced communication methods in one or more developing countries in collaboration with existing SWFDP(s).
Leads: Peter Steinle, co-chairs, task team leads.
Objectives: Demonstrate benefits of advanced weather & coupled modelling; measure value chain & identify causes of biggest losses; build capacity through participation & training; transfer capability to academic, private & government institutes in the region; establish on-going capability that can be maintained locally.
Actions: Develop concept paper (early 2017)
        Identify participants and funding for trial FDP - possibly Lake Victoria (2017)
        Execute and evaluate trial FDP (2018-9)
        Execute and evaluate full FDP (2022-3)

b. **Review the state of wind hazard forecasting**
Lead: John Knox
Objectives: Clarify the wind metrics that relate to impacts; describe the state-of-the-art in observing and predicting these metrics; identify processes that lead to high impacts; make recommendations for targeted work to address weaknesses in understanding, observing and prediction.
Actions: Identify participants (2017)
        Carry out review (2017-8)
        Document and publish (2018-9)
John Knox is preparing a plan for the review.

c. **Review current state of nowcasting & forecasting high impact weather**
Leads: Sharan Majumdar and Jenny Sun
Objectives: Document current state of high impact weather nowcasting/forecasting with an emphasis on flood and high wind warnings; Identify gaps
Actions: Draft review (2017)
        Workshop (October 2017)
        Publication (2018)
It is planned to prepare a draft ahead of the Conference on Predictability & Multi-Scale Prediction of High Impact Weather in October 2017.

d. **Intercomparison of km-scale DA & nowcast/forecast systems**
Leads: Sharan Majumdar and 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
Actions: Develop concept paper (2017);
        Identify interested participants, datasets & funds (2017)
This proposed action will be discussed at the Conference on Predictability & Multi-Scale Prediction of High Impact Weather in October 2017.

e. **Formal (statistical) impact model intercomparison**
Lead : Martin Goeber with input from HIVR and Evaluation task teams
Actions: Develop Masters student module to examine simple and physically-based impact models (2017)

f. **Identify the added value of impact-based warnings over hazard-based warnings for weather-related hazards**
Leads : Joanne Robbins, Sally Potter with input from the Communication and HIVR task teams
Actions: Further development of proposal ideas assembled by Sally Potter and Joanne Robbins to understand the use and value of impact models/knowledge to operational forecasters (fx production) and the effect of including information on likely impacts on decision making and action by users (i.e., the public) (2017)

g. **Review & classification of impact modelling**
Leads: Brian Mills & HIVR task team
Action: Develop paper (end 2017)

h. **Research Demonstration Project (RDP) focused on the Value Chain**
Leads: Jeff Lazo, Barb Brown, Brian Mills, Manfred Dorninger, Anna Scolobig, Mark Bevan

Actions: The aim is to explore what using the Weather Information Value Chain as an organizing principle for HIW activities (e.g., RDPs). Following the Berlin workshop, a small group is documenting how the value chain could be used in HIWeather.

i. **Factors that affect warning-related decision-making including legal & institutional frameworks.**
   Leads: Anna Scolobig, Julia Chasco
   PhD student, Philippe Weyrich, has just started on this project. He will start soon with some exploratory interviews, probably at Meteoswiss.

j. **Communication along the value chain in different cultures/contexts**
   Lead: Isabelle Ruin, Julia Chasco, Tom Kox
   Action: Concept paper (2017)

k. **Probabilistic forecasting and evaluation of Tropical Cyclones**
   Leads: Helen Titley, Sharan Majumdar, Munehiko Yamaguchi, David Richardson, Barbara Brown, Linda Anderson-Berry
   Objectives: Increase use of *probabilistic* ensemble forecast information in operational tropical cyclone forecasting; link to multi-scale modelling through, e.g., storm wind structure, precipitation (incl. orographic effects), storm surge and impact forecasting.
   Actions: Review best practice in producing, evaluating & using probabilistic TC forecasts
   Targeted HIWeather session at WMO/WWRP International Workshop on Tropical Cyclones. (2018)
   Helen is drafting a questionnaire to send to all operational centres and research groups who predict TCs asking them to provide details of their probabilistic products, methods and future plans and of how they evaluate the products.

l. **Unconventional data sources for impact modelling, evaluation & communication**
   Leads: David Johnston, Abi Beatson
   Action: Research network formed
         Literature review and synthesis: Abi Beatson, PhD student. (2019)

k. **Mesoscale Verification Inter-comparison over Complex Terrain (MesoVICT).**
   The project held a session at the 2016 EMS conference in Trieste followed by a 3-day workshop in Bologna to share initial findings (https://www.arpae.it/dettaglio_evento.asp?idLivello=32&id=2415). A session is planned for the 2017 EMS conference in Dublin. BAMS has agreed to publish a paper on MESOVICT and its results. This project probably has another year or two to run to test the application of spatial verification methods to ensemble forecasts and ensemble observations.

l. **User-oriented metrics challenge.**
   A competition for innovative evaluation metrics relevant to end users was run by the Joint Working Group on Forecast Verification Research (see http://www.wmo.int/pages/prog/arep/wwrp/new/Forecast_Verification.html) and has been a great success. There were 17 entries from 11 coutries and the winner was Helge Gössling from Alfred Wegener Institute in Germany with his entry "Integrated Ice Edge Error (IIEE) & Spatial Probability Score (SPS)". All entrants are encouraged to submit a paper to a special issue of *Meteorologische Zeitschrift*. The JWGFVR plans to run another challenge ahead of its next workshop in 2020.

m. **Review of approaches to communicating high impact weather.**
   Lead: Andrea Taylor, Communication task team.
   Twenty-four abstracts were submitted in response to the Call for Papers for the special issue of the International Journal of Disaster Risk Reduction under the provisional title, "Communicating High Impact Weather: Improving warnings and decision making processes". The deadline for submission is the end of July.

n. **NAWDEX (North Atlantic Waveguide and Downstream Impacts Experiment):**
   Lead: Processes & Predictability task team.
   The field phase is complete and acquired some good data including the extratropical transition of Tropical Cyclone Karl. Further information can be found at http://nawdex.ethz.ch/news.html. Flight data are currently being curated ready for release to the analysis and modeling groups.

o. **HIGHWAY** (**Lake Victoria Basin Nowcasting project**)
   This project is expected to form a core part of the DfID WISER programme (Weather and Climate Information Services for Africa). Discussions are taking place between DfID and the WMO with a view to agreeing a project plan.

p. **Communication of warnings of extreme fire weather** (tbc)
   Lead: Tim Brown, Desert Research Institute, Communication task team

National Programmes

US Contributions
A joint committee is formulating a US response to the three post-THORPEX projects. 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 has recently joined the Advisory Group and Communications task team with a view to building links. The NCAR Societal Impacts Program at the Research Applications Laboratory is closely aligned with HIWeather and contributes strongly to the evaluation theme (http://www.ral.ucar.edu/research/sip/).

UK Contributions
A summary of Met Office contributions to HIWeather has been prepared, which it is planned to extend to include NCAS, and potentially other UK partners. Key areas of work include unconventional data sources, km-scale data assimilation and ensemble prediction, km-scale coupled modelling for the UK, hazard impact modelling and risk communication. The impacts work is largely carried out with partners in the Natural Hazard Partnership (http://www.naturalhazardspartnership.org.uk/). The NERC/Met Office funded FfIR (Flooding from Intense Rainfall) project is addressing several aspects of HIWeather, including new radar observations, km-scale data assimilation and coupling with rural & urban inundation models (http://www.met.reading.ac.uk/flooding/). The Met Office/NERC UKEP project to develop a coupled km-scale atmosphere, ocean, land surface hydrology prediction system has started phase 2, having successfully demonstrated sensitivity to coupling in short range forecasts. Research Councils UK has funded two new networks in its "Decision Making Under Uncertainty" theme. One of them "Models to Decisions (M2D)" will hold its first annual conference in July.

The UK Natural Environment Research Council (NERC) and Department for International Development (DfID) have funded four research projects through the Science for Humanitarian Emergencies & Resilience (http://www.nerc.ac.uk/research/funded/programmes/shear/) programme, targeting lower to middle income countries in sub-Saharan Africa and south Asia, focusing on co-production of knowledge using a multi-disciplinary and problem-centred approach. ForPAc (towards Forecast-based Preparedness Action: Probabilistic forecast information for defensible preparedness decision-making and action) focuses on flooding and drought in East Africa (primarily Kenya) promoting the use of risk information for preparedness action (http://gtr.rcuk.ac.uk/projects?ref=NE%2FP000568%2F1). LANDSLIP (Landslide Multi-Hazard Risk Assessment, Preparedness and Early Warning in South Asia: Integrating Meteorology, Landscape and Society), focuses on early warning of landslides in India (http://www.landslip.org/). FATHUM (Forecasts for AnTicipatory HUManitarian action) focuses on flooding in Africa (https://www.insis.ox.ac.uk/forecasts-anticipatory-humanitarian-action-fathum) and "Citizen science for landslide risk reduction and disaster resilience building in mountain regions", focuses on landslides in Nepal (http://gtr.rcuk.ac.uk/projects?ref=NE%2FP000207%2F1). A call for proposals is anticipated for the Global Challenge Research Fund, which will provide an opportunity for disaster risk reduction projects with an ODA focus.

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. 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.

Australian Contributions
An **Australian HIWeather community** was established at the annual Australian Meteorological and Oceanographic Society (AMOS) meeting in February in Canberra. 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 will start a small project on **impact prediction** this July, co-funded by the Bushfire & Natural Hazards CRC, starting with wind (to establish systems and approaches) and moving to wind & rain. Partners will include forecasters and State Emergency Services.

New Zealand Contributions

Colleagues of David Johnston and Sally Potter at Massey University and GNS Science are developing a portfolio of HIWeather related projects in the Communications theme. Also, a New Zealand HIWeather network has been formed, linking a range of organisations.

Related Projects

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

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

PECAN (Plains Elevated Convection At Night)

A large field project that focused on night-time convection in the Central USA. It was conducted across northern Oklahoma, central Kansas and south-central Nebraska from 1 June to 15 July 2015. A description of the field programme and preliminary results is in BAMS early online release at http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00257.1. See also http://www.nssl.noaa.gov/projects/pecan/

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

Funding for major US components of the RELAMPAGO field programme to study the huge thunderstorms of the La Plata Basin in Argentina has been secured. The extended observing period will be from August 2018 to April 2019 with the Intensive Observing Period in November/December 2018. The US DOE is also funding a study of Cloud Aerosols and Complex Terrain Interactions, looking at orographic clouds and their representation in models in the same area and time period. The two projects will share airborne resources. More information is available at https://publish.illinois.edu/relampago/. Observations will feed into the Argentine Weather Service ALERT.AR programme to improve severe weather warnings.

SURF (Study of Urban Rainfall and Fog/Haze)

The Institute of Urban Meteorology is carrying out the SURF field experiment to study urban pollution and extreme precipitation in Beijing. A RDP proposal is being prepared for submission to WWRP.

ICE-POP2018 (RDP/FDP alongside the Pyeongchang Winter Olympic Games in South Korea) The objectives of the RDP/FDP are similar to SNOW-V10 and FROST-2014, but with stronger emphasis on high-resolution data assimilation and modelling. (http://www.wmo.int/pages/prog/arep/wwrp/new/RDP-FDP.html).

I-REACT – EU Horizon2020 3-year project on Improving Resilience to Emergencies through Advanced Cyber Technologies (I-REACT) involving a consortium of 20 partners will integrate existing systems and assets 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 – EU Horizon2020 project aimed at producing a Europe-wide early warning system for weather-related hazards. http://www.anywhere-h2020.eu/

Aristotle

Aristotle will deliver multi-hazard capability to the Emergency Response Coordination Centre (ERCC) of EU DG ECHO, which is responsible for the coordination of human aid upon request of the government of a country affected by natural (and other) hazards. It has been designed to offer a flexible and scalable scientific network including 24/7 services that can provide new hazard related services to the ERCC and to create a pool of experts in the field of Hydro-Meteorology and Geophysics of Europe that can support the ERCC with regard to situation assessments in crisis situations worldwide. A website is being built at http://aristotle.ingv.it/

European Disaster Risk Management Knowledge Centre – The new centre will work at the science-policy interface to help EU Member States respond to emergencies, prevent and reduce the impact of disasters. See http://drmkc.jrc.ec.europa.eu/, https://ec.europa.eu/jrc/en/news/new-knowledge-centre-help-eu-minimise-risk-disasters

S2S (Sub-seasonal-to-Seasonal Prediction):
The Extreme Weather sub-project, which has direct links to HIWeather, holds its teleconference in the last week of June. See http://www.s2sprediction.net/static/news for news, including the latest S2S newsletter.

PPP (Polar Prediction Project):
Latest news is available at http://www.polarprediction.net/news.html.

Recent Papers etc:

WMO press releases:

> South East European MHEWS. https://public.wmo.int/en/media/news/wmo-and-usaid-support-regional-multi-hazard-early-warning-advisory-system-south-east

> Caribbean SWFDP: https://public.wmo.int/en/media/news/severe-weather-forecasting-demonstration-project-expands-eastern-caribbean

Bushfire & Natural Hazards CRC: Hazard Note No 32 on Soil Moisture modelling & 27,28 on Digital Volunteering (Citizen Science). https://www.bnhcrc.com.au/hazardnotes

BAMS: Kain et al Collaborative efforts between the US and UK to advance prediction of high impact weather (severe weather testbed). http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00199.1