FROM ATMOSPHERIC DYNAMICS TO INSURANCE LOSSES

An Interdisciplinary Workshop on European Storms

Joaquim G. Pinto, Florian Pantillon, Patrick Ludwig, Madeleine-Sophie Déroche, Giovanni Leoncini, Christoph C. Raible, Len C. Shaffrey, and David B. Stephenson

Windstorms are extreme midlatitude cyclones and one of the major natural hazards that cause damage and losses in Europe. However, the processes involved in their intensification and generation of disastrous impacts, such as widespread wind damage and flooding, are not fully understood. Initiated in 2011, the European Storm Workshop series (www.stormworkshops.org) brings together the academic community, weather services, and risk model developers from insurance and engineering consulting companies. The goals are to stimulate interdisciplinary research on midlatitude storms and to bridge the gap between fundamental research and practical implementations.

INTERDISCIPLINARY WORKSHOP ON EUROPEAN STORMS

What: The seventh European Storm Workshop gathered scientists and insurance industry experts from 10 countries to facilitate an interdisciplinary exchange regarding novel scientific advances and developments in risk modeling, allowing specialists with different backgrounds working in European windstorm research to discuss the priorities for future research.
When: 10–12 October 2018
Where: Karlsruhe, Germany

The seventh European Storm Workshop took place in October 2018 at the Karlsruhe Institute of Technology (KIT) in Germany. Over 60 participants from 10 countries discussed the latest results and developments in windstorm research and its industry applications, including 26 nonacademics. The workshop featured a total of 30 oral and poster presentations split into three sessions, allowing plenty of opportunities for exchange and discussion. Presentations and the discussions they generated focused on the dynamics of European windstorms (extreme midlatitude cyclones), their predictability and variability from weather to climate time scales, risk assessments, and academic–insurance industry

AFFILIATIONS: Pinto and Ludwig—Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Karlsruhe, Germany; Pantillon—Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Karlsruhe, Germany, and Laboratoire d'Aérologie, Centre National de la Recherche Scientifique and Université de Toulouse, Toulouse, France; Déroche—Group P&C Risk Management, AXA, Paris, France; Leoncini—Zurich Insurance Company Ltd, Zurich, Switzerland; Raible—Climate and Environmental Physics, and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland; Shaffrey—National Centre for Atmospheric Science, and Department of Meteorology, University of Reading, Reading, United Kingdom; Stephenson—Department of Mathematics, University of Exeter, Exeter, United Kingdom
CORRESPONDING AUTHOR: Joaquim G. Pinto, joaquim.pinto@kit.edu

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collaborations. The workshop included keynote lectures given by speakers from both academia and the insurance industry. Highlights of each session are discussed below.

DYNAMICS OF EUROPEAN WINDSTORMS. The aim of this session was to discuss new progress in understanding European windstorm dynamics. A major discussion topic was the combination of perils associated with windstorms such as extreme precipitation, severe wind gusts and/or storm surges (so-called compound events). The complexity of these events in terms of impacts makes them a crucial topic for both researchers and the insurance industry. For example, Margarida Liberato (University of Trás-os-Montes and Alto Douro) presented a consistent catalog of exceptional, high-impact windstorms for Iberia, which lead to both wind and rainfall extremes. Extreme events were also the focus of the keynote by Helen Dacre (University of Reading), who reported on advances in the understanding of the relationship between warm conveyor belts and atmospheric rivers (Dacre et al. 2019). She showed the importance of low-level cyclone airflow, known as the feeder airstream, which originates ahead of the cyclone and flows rearward toward the cyclone center. Some of the moisture transported by the feeder airstream is supplied to the base of the warm conveyor belt where it ascends to form precipitation, while the rest remains at low levels, forming the leading edge of an atmospheric river. Lea Eisenstein (KIT) presented a modeling study of the first detected sting-jet windstorm over continental Europe ("Egon" in January 2017). Devastating sting jets are associated with strong wind gusts lasting for a few hours over a distinct region located between the cold and warm jet of Shapiro–Keyser cyclones (Hewson and Neu 2015). Accurately modeling the sting jet, which is essential to assess its loss potential, requires high spatial resolution. Convection-permitting simulations show that the characteristics of this storm were largely consistent with other known cases over the North Atlantic and the British Isles (Clark and Gray 2018), but the cyclone was also clearly affected by topography over continental Europe. Possible changes in the characteristics of windstorms in a future climate were the subject of Dominik Büeler's (ETH Zurich; KIT) presentation. Based on idealized studies, he reported that, while the intensity of moderate cyclones may decrease in a warmer world, an intensification is expected for strong cyclones, which is partly associated with latent heating effects. Such results are of great importance for the insurance industry, as more windstorms have the potential to cause higher losses.

PREDICTABILITY AND VARIABILITY FROM WEATHER TO CLIMATE TIME SCALES. This session discussed the current state of knowledge of the predictability of cyclones on different time scales. Aiko Voigt (KIT) illustrated with various examples the importance of cloud–radiative interactions on the midlatitude atmospheric circulation and cyclone activity. Understanding these interactions is crucial for an adequate assessment of climate change projections, as clouds are one of the largest sources of uncertainty (Bony et al. 2015). Recent studies suggest that thermal radiation effects can weaken idealized cyclones by modifying potential vorticity (Schäfer and Voigt 2018). Given that the cloud–radiative impact is important for both weather and climate, a better understanding of cloud–circulation coupling is needed to quantify the response of cyclone activity to global warming. Len Shaffrey (University of Reading) presented a critical evaluation of the significant increase in Northern Hemisphere storminess detected in ECMWF's first atmospheric reanalysis of the twentieth century (ERA20C), which had not been reported in this form by other studies. This century-long trend is apparently related to a significant and unrealistic decrease in surface pressure over the Arctic. This decreasing trend in pressure is not seen in observational data and leads to an increase of the meridional pressure gradient between the high and midlatitudes and therefore of midlatitude storminess (Bloomfield et al. 2018). Hence, the long-term storminess trends present in ERA20C should be regarded with caution. Finally, Florian Pantillon (Centre National de la Recherche Scientifique; KIT) presented recent advances on the prediction of wind gusts over central Europe based on statistical postprocessing of an operational convection-permitting weather forecast ensemble. While ensemble model output statistics (EMOS) substantially improve the average gust forecasts, there are still a few cases which are poorly forecast despite the use of EMOS (Pantillon et al. 2018). For these cases, it is crucial to accurately represent frontal convection, which is the source of some of the most destructive gusts during windstorms over central Europe (Ludwig et al. 2015).

WINDSTORM RISK AND INSURANCE COLLABORATIONS. Applications of windstorm research were discussed focusing on the insurance industry. One key aspect to improve the assessment

of windstorm risk is access to both observational and model data. Alan Whitelaw (CGI IT U.K. Limited) presented the operational windstorm service for the insurance sector provided by the Copernicus Climate Change Service. Expanding upon previous efforts (Roberts et al. 2014), it provides an extended database of windstorm tracks and high-resolution wind footprints (https://wisc.climate.copernicus.eu/wisc/#/). The new developments combine dynamical and statistical downscaling to cover a larger number of events. The use of numerical prediction models for windstorm risk purposes has increased in recent years, but they remain computationally very expensive and are not easily implemented by private companies. As an example of collaboration with the scientific community, Robin Locatelli (AXA) and Bernd Becker (Met Office) presented a research partnership aiming at providing high-resolution gust footprints for historical events. These footprints were combined with claims data to develop vulnerability curves for the European market. Using statistical modeling, David Stephenson (University of Exeter) discussed various approaches to quantify the dominant extremal dependence class for realistic windstorm footprints and found little evidence of asymptotic extremal dependency. When fitting the data with statistical distributions, the Gaussian copula appears to perform well, which allows the statistical simulation of windstorm footprints (Dawkins and Stephenson 2018). This approach opens the possibility of using geostatistical models for fast simulation of windstorm hazard maps, which can complement dynamical modeling approaches. Finally, one crucial issue for the estimation of aggregated insurance losses is the occurrence of multiple windstorms within a season, a phenomenon known as storm clustering. Based on high-resolution climate model simulations, Matthew Priestley (University of Reading) showed that serial clustering leads to an increase in annual aggregated losses of 10%–20% for return periods longer than 3 years (Priestley et al. 2018). This was another successful example of how basic research can have important industrial applications.

CURRENT CHALLENGES AND FUTURE PERSPECTIVES. Future directions and emerging topics were debated in three breakout groups, which covered a wide range of areas including new opportunities to further our understanding of European windstorm risk. For example, the potential to reassess historical windstorm risk through international projects on data discovery and the development of new multidecadal reanalysis was discussed to overcome the current limitations associated with the short historic record. Similarly, new opportunities to understand climate change impacts on future windstorm risk will arise with the upcoming phase 6 of the Coupled Model Intercomparison Project (CMIP6) and the High Resolution Model Intercomparison Project (HighResMIP) climate model projections (e.g., Haarsma et al. 2016). A better understanding of the importance of the different cyclone relative air flows ("conveyor belts"; Hewson and Neu 2015) for total property damage was also identified as a key priority. Other emerging areas of scientific interest include improved seasonal forecasts of the North Atlantic Oscillation (e.g., Scaife et al. 2014), which might help windstorm risk estimation for the insurance industry. Additionally, validation and calibration methods of extreme storms were debated. Given the limited sample size of the historic records, there is a need to develop methods beyond the standard quantile mapping approaches in order to correct biases of extreme events. Overall, the breakout discussions highlighted the strong synergy between academia and the insurance industry in terms of open research questions, providing compelling evidence of the need for sustained collaboration and dialogue. A general consensus was reached to keep organizing future workshops. The program and presentations are available on our website (www.stormworkshops.org/workshop2018.html).

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