8th Windstorm workshop abstracts

Session 1: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Name: Irina Rudeva

Submitting Author Affiliation: Bureau of Meteorology

Authors and affiliations: M. Messmer, University of Melbourne

Session topic: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Abstract Title: Synoptic activity during amplified mid-latitude planetary waves.

Abstract:

Extreme weather events in the Northern Hemisphere mid-latitudes have been linked to amplified synoptic planetary waves. In particular, wave 7 was found to be responsible for the anomalously warm temperatures in the European part of Russia and western Europe in July 2018 (Kornhuber et al. 2019). Earlier studies have shown that months of extreme hot or wet events are more strongly related to wave amplitude changes than others. It was suggested that slow moving amplified planetary waves, which can be seen as large meanders of the jet stream, cause the extreme events in the mid-latitudes (Petoukhov et al. 2013).

Here we compiled a climatology of extratropical cyclone frequencies during amplified planetary waves in the Northern Hemisphere. Amplitudes of Rossby waves were found using fast Fourier transformation applied to 500 hPa meridional wind from ERA5. We show that warm anomaly over the European part of Russia and cold anomaly over Eastern Europe can be linked to an increase in cyclone activity to the north of the Black sea. This pattern corresponds with cyclone frequency anomalies for wave 8 in our dataset. However, temperature anomalies in other regions during this event are likely to be associated with other wave numbers, which points to a potential value of wave envelopes approach proposed by Irving and Simmonds (2015) that takes into account a combination of waves that act synergistically to create anomalies observed during particular events.

Name: Oliver Krueger

Submitting Author Affiliation: Helmholtz-Zentrum Geesthacht

Authors and affiliations: D. Krieger, University of Hamburg; F. Feser, Helmholtz-Zentrum Geesthacht; R. Weisse, Helmholtz-Zentrum Geesthacht

Session topic: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Abstract Title: Reconstructions of Northeast Atlantic and German Bight storm activity from the late 19th century onwards

Abstract:

We present reconstructions of past storm activity for the German Bight (North Sea) and the Northeast Atlantic from the late 19th to the early 21st century. These reconstructions are based on high quantiles of geostrophic wind speed, which are derived from triangles of quality-controlled pressure observations available from the International Surface Pressure Databank (ISPD), from the German Weather Service (DWD), from the Danish Meteorological Institute (DMI), and from the Royal Netherlands Meteorological Institute (KNMI). For the German Bight, our analyses benefit from the dense observational network, whereby we enhance the established method of reconstructing geostrophic storminess in an ensemble-like manner to provide a robust estimate of German Bight storminess. Our analyses also comprise uncertainty estimates for the reconstruction of past storm activity derived from a bootstrapping approach that mimics the uncertainty inherent in pressure observations.

The results show that both areas are subject to multidecadal variability. The latest decades are characterized by an increase in activity from the 1960s to the 1990s, followed by a decline lasting into the 2000s with slightly below-average values up until recent years. The results also indicate that the storm climate of the northeast Atlantic drives that of the German Bight. Both relate to large-scale circulation patterns, such as the North Atlantic Oscillation (NAO) measured through a correlation analysis with the NAO index. However, shifts in the large-scale circulation may lessen the relation.

Throughout the time period examined the uncertainty steadily decreases with highest uncertainty in the early periods. The uncertainty notably decreases in the second half of the 20th century when the availability of high-quality pressure observations increases. The results also show that the uncertainty of reconstructions of German Bight storminess is lower than that of the northeast Atlantic due to a better data availability.

The reconstructions will be part of a continued monitoring approach for storm activity for German coastal areas to provide valuable information for stakeholders, such as coastal protection agencies, the renewable energy sector, insurances, and people.

Name: Michael Angus

Submitting Author Affiliation: University of Birmingham

Authors and affiliations: Michael Angus, University of Birmingham, Gregor C. Leckebusch University of Birmingham, Ivan Kunhel, No affiliation

Session topic: Climate change, variability and potential impacts on Europe’s resiliency to windstorms

Abstract Title: The impact of the Atlantic Hurricane season on the subsequent European Windstorm season

Abstract:

Both the Atlantic hurricane season and the European winter windstorm season are influenced by large scale climate features. It is therefore reasonable to ask, are the two seasons related through climate teleconnection patterns? If so, how frequently does a strong season in one follow a strong

season in the other? As reliable measures of seasonal activity such as best track data only cover the recent satellite era (1979 to present) over which statistical relationships are unreliable, it is difficult to assess the significance of any such connection using only observations. This issue is exacerbated by the fact that connections may occur on multiple timescales, from interannual to multidecadal. With the aim of addressing this problem, we use the latest ECMWF seasonal forecast product (SEAS5) to increase the number of "observations" by including storms which were forecast by the multimember ensemble, but not subsequently observed in reality. This allows for a wide range of theoretically possible storm events over 1800 model years and a much larger sample size, increasing confidence in any relationship found between these extreme weather events and associated climate forcing.

Here we first verify that tracks of both tropical and extra-tropical cyclones within SEAS5 are an accurate representation of the climate system, with reference to best track data and reanalysis. The seasonal cycle, interannual variability and spatial variability are all shown to be well represented in both seasons. For tropical cyclones, a post processing step is required to remove some extra-tropical systems, the details of which are discussed. On establishing the viability of SEAS5 for this approach, we calculate the probability of an extreme hurricane and windstorm season occurring in the same model year, where extreme is defined over multiple percentile thresholds. The intensity of the season is defined in three ways: as the total number of events, the total accumulated storm severity index, and the accumulated storm severity index of land impacting storms over Europe. For each intensity measure, the probability of extremes occurring in both seasons is compared to the probability of extremes in both seasons being independent of one another. An extreme Atlantic hurricane season is consistently followed by an extreme European windstorm season less often than if they were independent, across all three intensity measures.

Two possible pathways are investigated that may explain this teleconnection: 1) El Niño Southern Oscillation induced wind shear over the main development region (MDR) and simultaneous rossby wave influence on the North Atlantic Oscillation (NAO) 2) Persistent Atlantic tripole sea surface temperature (SST) pattern, associated with anomalously low tropical SSTs and the positive NAO phase. For each hypothesis, we then build a climatology of model years which satisfy the criteria and examine the impact on windstorm track density of both Atlantic hurricanes and European winter windstorms. Estimates are provided for worst case scenario events, where extreme seasons occur in both the US and Europe. The climate conditions for this worst case scenario are examined to provide new information for stakeholders and prediction services.

Name: Lisa Degenhardt

Submitting Author Affiliation: Freie Universität Berlin and University of Birmingham

Authors and affiliations: J Grieger, Freie Universität Berlin. H Olafsson, University of Iceland. U Ulbrich, Freie Universität Berlin.

Session topic: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Abstract Title: The role of upper vs. lower tropospheric baroclinicity on severe storms over Central Europe and Iceland: observational results and climate scenarios

Abstract:

This study analyses a relation between baroclinic instability as quantified by the Maximum Eady growth rate, and the occurrence of severe winter wind storms. ERA-Interim data and model runs of the MPI-ESM-LR climate model are considered for present day climate. The relationship is further investigated for a climate scenario (RCP4.5). Calculations focus on storms influencing three different regions: northern Central Europe, southern Central Europe and Iceland. Storms and cyclones are identified and tracked with established algorithms. The Eady growth rate is computed for both the lower troposphere (centered at 850hPa) and upper troposphere (400hPa), using 3-day mean values.

In terms of track densities, differences between reanalysis and model mean include zonalisation as a typical model bias. Eady growth rate composites for storms crossing the pre-designed areas show regionally enhanced values associated with storms. The associated baroclinicity anomalies in the upper troposphere are shifted northward against their lower tropospheric counterpart for the present climate. The scenario climate signals, however, differ between both vertical levels. While the signal forms a dipole for the low level growth rate, a widespread increase is found for the upper troposphere.

Name: Colin Manning

Submitting Author Affiliation: Newcastle University

Authors and affiliations: C Manning, Newcastle University; L Kendon, Met Office, Exeter; H Fowler, Newcastle University; S Berthou, Met Office, Exeter; N Roberts, Met Office, Reading.

Session topic: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Abstract Title: Assessing the added value of convection permitting climate simulations for the representation of sting-jets and associated extreme wind speeds in European wind storms

Abstract:

This study assesses the added-value offered by a regional convection-permitting climate model (CPM) in its representation of sting-jets (SJs); a mesoscale slanted core of strong winds within a Shapiro-Keyser type of cyclone that can lead to extremely damaging surface wind speeds close to southern side of a cyclone's centre. Low-resolution climate models cannot resolve SJs but do identify strong winds in the same area of the cyclone where the SJ occurs. However, these are usually associated with the "cold conveyor belt" (CCB) of strong winds wrapping around larger more mature cyclones rather than the smaller-scale SJs. As a result, estimates of risk posed by extreme winds due to SJs are difficult to determine and will likely be underestimated in coarse-resolution climate simulations. This is of particular concern as a recent study has found a projected increase in the likelihood of SJs occurring within a storm in a future coarse-resolution climate simulation.

We analyse three 10-year simulations from the UK Met Office, run at a 2.2km resolution over a European domain. The first is a hindcast driven by the ERA-Interim reanalysis dataset (ERAI) for the period 2001-2010, as well as a present day (2001-2010) and future simulation (2100-2109) that follows the RCP8.5 scenario. Both climate simulations are driven by a 25km GCM. To diagnose potential SJ storms in each simulation, we firstly identify cyclone tracks with a cyclone tracking

algorithm and use two criteria to indicate the likely presence of a sting-jet. The first is a positive latitudinal gradient in wet-bulb potential temperature at 850hPa close to the southern side of the cyclone's centre, indicating the presence of the bent-back front associated with a Shapiro-Keyser cyclone. The second is that a core of extreme wind speeds in the storm's footprint is co-located with the abovementioned gradient.

We analyse differences between the CPM and its respective driving data, in terms of storm severity metrics and their future projections, in order to identify any added value of the CPM. Metrics are calculated using grid-points within a 500km and a 200km radius of a cyclone's centre, the latter radius is used to extract winds within the SJ region of a cyclone. An example metric used is the maximum local exceedance of the 98th percentile wind speed within the above radii of the cyclone. In short, we see a tendency towards higher maximum exceedances in SJ storms compared to all storms in both ERAI and CPM, while the CPM produces even higher exceedances than ERAI within SJ storms. This indicates the tendency of high wind speeds to occur within a Shapiro-Keyser storm due to the CCB in both ERAI and the CPM, as well as the added contribution of the SJ in the CPM. Further results will be presented, including climate change projections.

Session 2: Industry applications and storm quantification: alternative views on risk

---

Name: Ed Hawkins

Submitting Author Affiliation: National Centre for Atmospheric Science, University of Reading

Authors and affiliations: P. Craig (NCAS, University of Reading), P. Brohan (UK Met Office), G. Compo (NOAA)

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: Historical extreme storms as a tool for understanding risk

Abstract: Our understanding of extreme windstorms depends on the availability of observations made over many decades. However, billions of potentially useful historical weather observations are effectively lost to science as they are still only available in their original paper form in various archives around the world. The large-scale digitisation of these observations would substantially improve atmospheric circulation reconstructions back to the 1850s, including for extreme storms. Recently, volunteer citizen scientists have been assisting with the rescue of millions of these lost observations taken across western Europe over a hundred years ago. The value of these data for understanding many notable and extreme weather events will be demonstrated with a case study focus on the 'Ulysses' storm of February 1903 which caused substantial damage across Ireland and the UK. Reanalyses of this event are considerably improved when the new rescued observations are included, and better match the locations of known damage. A focus on such historical storms will allow the construction of a longer and more complete sample of extreme events with a range of tracks, so better informing windstorm risks across western Europe.

Name: Julia Lockwood

Submitting Author Affiliation: Met Office

Authors and affiliations: G. Guentchev, Met Office; E. Palin, Met Office

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: Using PRIMAVERA high-resolution global climate models to make a European windstorm event set

Abstract: PRIMAVERA is a European Union Horizon2020 project about creating a new generation of advanced and well-evaluated high-resolution global climate models, for the benefit of governments, business and society in general. The project has been engaging with several sectors, including finance, transport, and energy, to understand the extent to which any improved process understanding arising from high-resolution global climate modelling can – in turn – help with using climate model output to address user needs.

In this talk we will outline our work for the finance and (re)insurance industries. Following consultation with members of the industry, we are using PRIMAVERA climate models to generate a European windstorm event set for use in catastrophe modelling. Previous generations of lower resolution climate models have suffered from windstorms being too low in intensity and an Atlantic storm track which is too zonal. Footprints generated from these older models therefore required complicated bias correction techniques to be adapted for use in catastrophe modelling. These biases are reduced in the high-resolution PRIMAVERA models which could lead to improved estimations of European windstorm risk. We will compare the properties of windstorm tracks and footprints across different resolutions and from different models within PRIMAVERA, and the implications of these differences on estimated insured losses. Finally we will address the question of whether the event sets from each PRIMAVERA model can be combined to form a multi-model event set ensemble covering thousands of years of windstorm data.

Name: Chris Webber

Submitting Author Affiliation: AIR Worldwide

Authors and affiliations: C. Webber, E.Robinson, S. Latchman; AIR Worldwide

Session topic: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Abstract Title: Sensitivities of European Extratropical Cyclone Insured Losses to the North Atlantic Oscillation

Abstract: The North Atlantic storm track is greatly influenced by synoptic scale weather patterns, which constrain storminess throughout Europe and affect insured losses. The North Atlantic Oscillation (NAO) is often cited as the teleconnection that controls most of the variance in European storminess. A positive NAO index is indicative of atmospheric conditions that are conducive to both increased frequency and intensity of European wind storms. Furthermore, literature widely finds a more northerly storm track into Europe, given a positive NAO index. The relationship between NAO and insured losses is less obvious however, with exposed property located heterogeneously throughout Europe. The non-linearities associated with a shifting storm track and changes to both storm frequency and intensity lead to regionally varying relationships between NAO index and insured loss. We utilise our industry recognised catastrophe model for European wind storm to

identify regional loss sensitivities to the NAO Index throughout Europe and share lessons learnt with respect to linking synoptic scale teleconnections to insured loss throughout Europe.

Name: Richard Dixon

Submitting Author Affiliation: University of Reading/CatInsight

Authors and affiliations: R. Dixon, University of Reading. L. Shaffrey, University of Reading. S. Franklin, Institute of Environmental Analytics. D. Clifford, Institute of Environment Analytics

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: Insurance industry losses from 6000 years of windstorms in a high resolution ensemble climate model

Abstract: We present the method and a short summary of key results from converting a high-resolution 100-ensemble climate model simulation of 1951-2010 into European insurance industry losses.

The results have highlighted shifts in windstorm risk over time that may not be necessarily distinguishable from a single historical dataset; an insight into the structure of storm footprints in the tail of the loss distribution that can be used as a second set of eyes alongside catastrophe models; the marked impact of the North Atlantic Oscillation on windstorm losses and some "grey swans" that may be of interest to insurers.

Session 3: Industry applications and storm quantification: climate services perspective

Name: Bernd Eggen

Submitting Author Affiliation: Met Office

Authors and affiliations: J Strachan, Met Office; A Hall, Telespazio VEGA UK Ltd; J Lanfranco, GOPA Com. S.A., Belgium

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: What the Copernicus Climate Change Service Evaluation and Quality Control Framework Can Do for the Insurance Community

Abstract

An accessible, credible and relevant source of climate information is useful for the insurance community, so that informed decisions can be made to address existing and emerging climate-related risks. Climate information services for insurance, developed by the Copernicus Climate Change Service (C3S), such as the operational European Windstorm Service (and the forerunner “Windstorm Information Service” – WISC), need to be fit for purpose.

Climate information (data, services and expert advice) can be used to support decision making in the insurance sector, through the provision of an up-to-date catalogue of wind storms and their associated impacts on the ground. The underpinning data (storm tracks and footprints) comes from ERA5 and will be continuously updated; the new storm tracks and footprints add to and complement those produced in WISC (which used ERA-Interim). While WISC used dynamic downscaling for storm footprints, the new operational service uses statistical downscaling. There are additional "Tier 3" indicators for risk and loss estimates and all data will soon become available on the Copernicus Climate Data Store (CDS), ensuring ease of access and integration with the CDS Toolbox.

In the talk and during the poster session we would like to engage as constructively and candidly as possible with (potential) users of the C3S windstorm data to record their views and experiences with the available data sets, any quality issues they may have and gaps that they would like to see addressed by C3S as the operational service evolves.

The insurance sector aspects of the "C3S_513 Evaluation and Quality Control Framework for the Sectoral Information Systems" project is led by the Met Office, with support from Telespazio VEGA UK Ltd, who are the overall project lead. User engagement activities are led by GOPA Com.

Name: Alan Whitelaw

Submitting Author Affiliation: CGI IT UK Limited

Authors and affiliations: G-J Marseille, KNMI; H van der Brink, KNMI; K Whan, KNMI; J Wijngaard, KNMI; K Hodges, University of Reading; T Haer, VU Amsterdam

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: Copernicus Climate Change Service Operational Windstorm Service - Update and Way Forward

Abstract

The Copernicus Climate Change Service (C3S) provides authoritative climate information and tools to enable development of mitigation and adaptation strategies. C3S Sectoral Information Services include a windstorm service aimed mainly at insurers. Initially this service provided tracks and dynamically downscaled footprints from ERA-20C and ERA-Interim as well as summary data, derived risk and loss estimates and a synthetic event set. The operational service is now producing tracks and statistically downscaled footprints from ERA5 as well as updated summaries, risk and loss data. These data will be made available for download via the C3S Climate Data Store (CDS) and for analysis in the CDS toolbox.

The service has been presented at the previous two EWW meetings. The aim of this presentation is to provide an update on the Multiple Linear Regression (MLR) approach used for the statistical downscaling and to provide comparisons of the outcomes with the earlier historical footprints. The MLR downscaling approach is based on combining predictor variables from the ERA5 wind gust forecasts, gust estimates from windshear between 10m and 100m and gust estimates based on station elevations. These are combined using a power law that was shown to provide better representation of wind gusts when compared to station observations. The model was trained and cross-validated using 18 fold cross validation over time, ie 18 years of data for the 6-month storm season per year run 18 times with a different year set aside for validation in each case. Spatially a

random set of 30 stations, 10% of the total, was also extracted for validation on each run. The model was selected based on minimising RMSE and bias.

A summary of the revised tracks, summaries, risk and loss information will also be provided. The presentation will also provide a brief overview of how to access the data. Finally, in addition to discussion of the work to date, it will be valuable to discuss options for how the work can best be taken forward to serve the needs of the insurance user community.

Name: Bernd Becker

Submitting Author Affiliation: Met Office

Authors and affiliations: B. Becker, Met Office, T. Perotin, AXA

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: Generation of stochastic winter wind storm events in Europe based on the last generation of dynamical and statistical methods. An AXA joint research initiative.

Abstract

Building on the experience gained from the XWS, Met Office historical wind storm catalogue, WISdOM and WISC initiatives, a new stochastic wind storm event set is introduced. The new set explores novel ideas in combining coarse climate model simulations with high resolution NWP, reanalysis and observational data. Scale separation, pattern matching, quantile mapping and an altitude bias correction scheme are applied to combine rare, unobserved but physically plausible events with realistically simulated high resolution weather predictions and local site observations to provide a large statistical event set. The production of the event set and its utility in providing a meaningful hazard component in the AXA risk model will be presented.

Name: Laura Dawkins

Submitting Author Affiliation: Met Office

Authors and affiliations: L. Dawkins, Met Office; Tristan Perotin, AXA

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: A comparison of approaches for representing windstorm footprints using observations and meteorological models, and the impact on insurance loss estimation: A joint research initiative, Met Office and AXA

Abstract

In the event of a European windstorm, insurance companies such as AXA benefit from having the most accurate representation of the windstorm footprint at the earliest opportunity. This allows for the prompt identification of the most affected areas and hence which clients most urgently need assistance, and the timely estimation of the associated losses to inform business. Currently, windstorm footprints are often quantified using either station wind gust observations, known to be relatively accurate but spatially heterogeneous, or the output from meteorological forecast models, which are spatially complete but known to be biased.

Here, we present an application of the Youngman and Stephenson (2019) computationally efficient statistical modelling approach for combining both sources of information to achieve an optimal representation of the windstorm footprint, given the available data. We compare how well this 'recalibrated' footprint is able to represent wind gust observations not included in model training, in relation to two alternative approaches: one based on a geostatistical model of the observations only; and the other based on nonparametric interpolation of the meteorological forecast model footprint only.

We find that the recalibrated footprint consistently out performs the two alternative approaches, based on a 10-fold cross validation applied to 20 extreme European windstorms (occurring 2007-2019). We then show how this improved representation of the windstorm footprint, used jointly with AXA's claims data, derives more reliable vulnerability curves (linking hazard intensity to damage intensity), and hence improves risk modelling to ensure enough capital is available to meet the obligations of a major catastrophe.

Youngman, B. D. and D. B. Stephenson (2019). Spatial inference for hazard event intensities using imperfect observation and simulation data. Preprint available from http://empslocal.ex.ac.uk/people/staff/by223/youngman-stephenson_recalibration.pdf.

Posters

Poster 1:

Name: Laura Batchelor

Submitting Author Affiliation: The University of Exeter

Authors and affiliations: J.Catto, The University of Exeter. D.Stephenson, The University of Exeter.

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: Co-occurrence of extreme precipitation and wind associated with extratropical cyclones over Europe

Abstract:

The co-occurrence of extreme precipitation and winds associated with extratropical cyclones can have a severe impact on society and this co-occurrence is highly important when assessing risk. Until now there has been little done in analysing the co-occurrence of precipitation and wind extremes, and in particular linking these extremes to extratropical cyclones. The aim of this project is to find out why certain locations have higher co-occurring extremes than other locations and relate this back to extratropical cyclones, building on the work of Martius et al. [2016]. Precipitation accumulation and wind gusts from ERA5 reanalysis data and GSOD observational station data are used to quantify the co-occurrence of extreme precipitation and wind over Europe. These different datasets are used to investigate the uncertainties in the co-occurrence of extremes. A co-occurrence is recorded if the precipitation accumulation and maximum wind gust occur within the same time period and are above a particular percentile for that grid point. Over the winter half year (October – March) the highest co-occurrence in Europe is found over the west coast of Spain and Portugal, in patches over the Northern coast of the Mediterranean and over Iceland. The lowest co-occurrence is

found over the east coast of Spain, north west of the Mediterranean, Sweden, North Finland, Austria and the Carpathian Mountains. An investigation into the sensitivity to the temporal resolution reveals that when extending the time period from hourly, to 6 hourly, to daily more noise occurs, particularly over the North Atlantic Ocean. However, the same patterns of co-occurrence are found, particularly where very high co-occurrence occurs and where very low co-occurrence occurs. Grid point analysis at multiple locations is done to access how the co-occurrence of precipitation and wind gust extremes behave and vary at different locations. Illustrative case studies of storms are also shown to demonstrate the importance of extratropical cyclones for the co-occurrence of extremes over Europe.

Poster 2:

Name: Richard Dixon

Submitting Author Affiliation: CatInsight

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: European Windstorm Research Priorities for the Insurance Industry: 2019 Revisit

Abstract: Tbc

Poster 3:

Name: Emanuele Silvio Gentile

Submitting Author Affiliation: University of Reading

Session topic: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Abstract Title: The impact of atmosphere, ocean and waves coupling on extreme surface wind forecast

Abstract:

Localized extreme winds are an important meteorological hazard. Starting from storms Helene and Ali, September 2018, a number of case studies are being performed to gain a physical understanding of extreme winds and gusts. These experiments use the newly developed Met Office UK Environmental Prediction (UKEP) model system, which represents the feedbacks that exist between land, ocean and atmosphere. The aim is to determine whether, and if so how, coupling can improve the predictions of the atmosphere and particularly extreme surface winds.

Poster 4:

Name: Hilde Haakenstad

Submitting Author Affiliation: Hilde Haakenstad

Authors and affiliations: Hilde Haakenstad, MET-Norway and Øyvind Breivik, MET-Norway

Session topic: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Abstract Title: NORA3 - a non-hydrostatic regional hindcast for the North Sea, the Norwegian Sea and the Barents Sea

Abstract:

The first wind and wave hindcast for Norwegian waters, NORA10, extends back to 1957 and is still being updated. However, since the initiation of NORA10 in 2006, substantial progress has been made in NWP and wave modelling. A new hindcast for the North Sea, the Norwegian Sea and the Barents Sea, NORA3, is now under production. The hindcast is produced by the non-hydrostatic convection-permitting NWP model HARMONIE-AROME and the MyWaveWAM wave model. The spatial resolution is 3 km. The atmospheric component is forced with boundary conditions and initial conditions from ERA-5 whereas the wave model is forced with two-dimensional spectra from ERA-5 along the open boundaries. The hindcast will be suitable for extreme value analysis of wind since meso-scale weather structures are captured by the non-hydrostatic model and will thus serve as a tool for investigating the high-resolution wind and wave climate in the area. Preliminary results from the period 2010-2018 indicate that the model captures high-wind situations well, and coastal wind conditions are particularly well modelled. NORA3 will be made publicly available through MET Norway's servers.

Poster 5:

Name: John Hillier

Submitting Author Affiliation: Loughborough University

Authors and affiliations: J. Hillier, University of Loughbrough. P. De Luca, University of Loughborough. R. Wilby, University of Loughborough. N. Quinn, University of the West of England. S. Harrigan, CEH.

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: Observations Relating Extreme Multi-Basin River Flows to Very Severe Gales

Abstract:

Fluvial foods are typically investigated as 'events' at the single basin scale. However, applying a recently developed methodology to identify the largest multi-basin peak flow events allows a statistically significant relationship between them and episodes of very severe gales (VSG) to be identified; such a systematic link has previously only very tentatively been proposed for extra-tropical cyclone seasons, where damaging wind and rain are commonly non-synchronous. Annual maximum river peak flow (AMAX) data during 1975-2014 for 261 non-nested catchments (i.e. with no other sites upstream) in Great Britain are used, and a 13-day window is selected. A simple correlation between metrics that are proxies for damaging wind and flooding is statistically

significant (r = 0.41, p = 0.0088). Also, taking the most severe 50% and 30% of years for wind and flow respectively, co-occurrence is expected 6.6 times in 40 years whilst 10 are observed (p = 0.021; simulation with n = 10,000), making co-occurrence of the extremes 52% more likely than expected by chance. This has implications for emergency response and financial planning (e.g. insurance).

Poster 6:

Name: Matthew Priestley

Submitting Author Affiliation: University of Exeter

Authors and affiliations: D Ackerley (Met Office), J Catto (University of Exeter), K Hodges (University of Reading), R McDonald (Met Office)

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: The Northern Hemisphere storm track and bomb cyclone representation in CMIP6

Abstract:

Extratropical cyclones are the leading driver of the day-to-day weather variability and wintertime losses for Europe. In the latest generation of coupled climate models, CMIP6, it is hoped that with improved modelling capabilities come improvements in the structure of the storm track and the associated cyclones. Here, the current ensemble of CMIP6 models are tested as to their representation of the storm track using an objective cyclone identification and tracking in both northern hemisphere winter and summer. Any developments and improvements since the previous generation of models in CMIP5 are discussed, with focus on the impact of model resolution on storm track representation. Furthermore, we investigate whether the models can sufficiently represent the location and deepening of rapidly intensifying bomb cyclones in the North Atlantic and particularly their presence near to the European continent.

Poster 7:

Name: Len Shaffrey

Submitting Author Affiliation: NCAS, University of Reading

Authors and affiliations:

Session topic: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Abstract Title: The WINDSURFER project: Past, current and future European wind and wave risk

Abstract:

Extreme winds pose major risks to life, property and forestry, while extreme ocean waves can impact on offshore infrastructures and coastal communities. For example, the three windstorms (Anatol, Lothar, Martin) that struck in Dec 1999 inflicted 8 billion Euros of insured losses to property and infrastructure across Europe. In Jan 2005 Windstorm Gudrun inflicted substantial damage to forestry. Gudrun felled approximately 75 million cubic metres of trees in Sweden alone, which is equivalent to the annual Swedish forestry harvest. Extreme waves driven by strong winds can also have substantial impacts on the energy sector and offshore infrastructures. For example, a

windstorm on 12 December 1990 generated a significant wave height of about 12 m in the central North Sea (close to the 100-year return level), causing extensive damage on the Ekofisk platforms.

WINDSURFER is a three-year project that brings together eight leading research institutions across Europe to co-develop new methods, tools and assessments of extreme wind and wave risk with a focus on the

Insurance, Forestry and Energy sectors. There are major gaps in our scientific understanding of extreme wind and wave risk, namely i) Present-day risks from extreme winds and waves are poorly constrained; ii) The impact of climate change on future wind and wave risk is uncertain; and iii) Substantial improvements are required in modelling the socioeconomic impacts of wind and waves.

The poster will describe some of the activities and first results from the WINDSURFER project to address the above knowledge gaps including the development of new methods and tools to better quantify current extreme wind and wave risk. In particular, results will be shown from i) new reanalysis and hindcast datasets of observed wind and wave extremes and ii) a compendium of historical European Storms from 1900-1940. WINDSURFER is one of the funded projects in the ERA4CS ERA-NET.

Poster 8:

Name: Linda van Garderen

Submitting Author Affiliation: Helmholtz Zentrum Geesthacht

Authors and affiliations: F. Feser, Helmholtz Zentrum Geesthacht. T.Shepherd, Reading University

Session topic: Climate change, variability and potential impacts on Europe's resiliency to windstorms

Abstract Title: A Spectrally Nudged Global Storyline: Attributing the Effect of Climate Change in Historical Extreme Events.

Abstract:

Within climate-change science, we see that global changes in extremes, such as increasing numbers of heatwaves, provide an indicator of climate change. However, every extreme event is unique, and aggregation achieves its statistical power by blurring over those differences. Rather than asking what extreme events tell us about climate change, we may ask what climate change tells us about extreme events that have happened.

Extreme events are associated with unusual dynamical conditions. Whereas the thermodynamic aspects of climate change are clear, the signal-to-noise ratio of the dynamical aspects is small. We thus adopt the hypothesis that the historical record of dynamical conditions is largely accidental, i.e. it arose by chance, and would have been different in a different climate. In this work we develop a method for estimating the effect of known, thermodynamic aspects of climate change on the meteorological consequences of those dynamical conditions.

In particular, we simulate historical extreme events twice. The first time is in the world as we know it, with the events occurring on a background of changing climate forcers and the associated warming of sea-surface temperatures. The second time is in a 'counterfactual' world, where this background is held fixed over the past 100 years. The historical storyline of observed dynamical conditions is enforced through spectral nudging of the large-scale dynamical fields (vorticity and

divergence) in the free atmosphere towards reanalysis data within the ECHAM6 atmospheric model. In this way the thermodynamic and surface properties of the model are free to respond to the climate forcing and global warming.

Although such singular attribution has been performed for particular extreme events, usually with regional models, we are not aware of a previous application to the global historical record. Here we present some first results.

Poster 9:

Name: Alexander Vessey

Submitting Author Affiliation: University of Reading

Authors and affiliations: Kevin Hodges (University of Reading), Len Shaffrey (University of Reading), Jonathan Day (ECMWF), Tom Philp (AXA XL)

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: Arctic Storm Characteristics between Storm Tracking Algorithms and their Structure

Abstract:

Arctic sea ice has reduced significantly over recent decades and is projected to reduce further over this century. This has made the Arctic more accessible and increased opportunities for the expansion of business and industrial activities into the Arctic. As a result, the exposure and risk of humans and infrastructure to extreme storms will increase in the Arctic, including northern Europe.

Our understanding of the current risk from storms comes from analysing the past, for example, by using storm tracking algorithms to detect storms in reanalysis datasets. However, there are multiple storm tracking algorithms available, and differences in storm characteristics can arise between these algorithms. This can introduce uncertainty to current storm characteristics. The results from this study show that Arctic storm distribution and frequency are substantially different when storms are detected in reanalysis datasets using a storm tracking algorithm based on 850 hPa vorticity or a tracking algorithm based on mean sea level pressure.

The structure of Arctic storms is not as well understood as mid-latitude storms. In this study, the composite structure of Arctic storms has been determined and contrasted with that of mid-latitude North Atlantic storms. Results show that the role of barotropic and baroclinic processes in Arctic storm development differ between winter and summer.

Poster 10:

Name: Michael Walz

Submitting Author Affiliation: Swiss Re

Authors and affiliations: M. Gloor, Swiss Re, D. Renggli, Swiss Re

Session topic: Industry applications and storm quantification: alternative views on risk

Abstract Title: How much flavour can climate model data add to benchmarking a 200-year return period European winter storm event?

Abstract:

Assessing losses induced by extreme but very rare winter storm events (e.g. 200-year return period losses) is very important for the (re)insurance industry, for example, with regards to regulatory capital requirements. However, there are hardly any benchmarks available beyond the 20-year return period level. Often this gap is attempted to be closed by century-long reanalysis (e.g. NOAA 20CR) paired with extreme value theory. In order not to rely on statistics purely, we employ CMIP5 ensembles of decadal hindcast experiments to assess loss levels and their uncertainties directly from physically realistic scenarios.

Windstorms in the CMIP5 models are identified using a wind tracking algorithm and quantified using a storm severity index (SSI). Exceedance probability curves (EPCs) for selected European countries and the entire of Europe are scaled with a 20-year loss event and compared with EPCs of Swiss Re's operational hazard set (~60,000 artificial storm footprints). Furthermore the sensitivity of the SSI to the exponent (vulnerability component) is investigated.

Initial results show that the exponent of the SSI (found via manual calibration) has a large impact on resulting losses. Furthermore, the EPCs for different regions (e.g. UK vs. Scandinavia) look fairly different, especially with regards to the tail of the EPCs. This leaves the question how well suited are CMIP5 models really for investigating extreme winter storm events, in particular for regions which are outside of the prominent winter storm corridor (i.e. Scandinavian countries)?

Poster 11:

Name: Kirien Whan

Submitting Author Affiliation: The Royal Netherlands Meteorological Institute

Authors and affiliations: E. Ioannidis, LATMOS, K.Whan, KNMI, M.Schmeits, KNMI

Session topic: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Abstract Title: Probabilistic wind speed forecasting using parametric and non-parametric statistical post-processing methods

Abstract:

Skillful and reliable forecasts of extreme wind speeds are crucial for many aspects of society. We develop probabilistic wind speed forecasts using parametric and non-parametric calibration methods. We calibrate 10m wind speed forecasts from the non-hydrostatic Harmonie-Arome MetCoop ensemble prediction system over Denmark and surroundings, using station-based observations in the period December 2016 - September 2017. We separate statistical modesl per season, fitting to all 97 stations at once, and use cross-validation. We use more than 40 potential predictors for wind speed. The most important predictors are ensemble mean and standard deviation of 10m wind speed, and land type.

We compare the forecast skill of two statistical methods: Ensemble Model Output Statistics (EMOS), using a variety of candidate distributions, and Quantile Regression Forests (QRF). The skill of the post-processed and raw forecasts is verified using the Brier Skill Score (BSS), continuous ranked

probability skill score (CRPSS), and reliability diagrams. The truncated normal distribution (NOtr) was the most skillful EMOS distribution, and was generally more skillful than QRF. For the higher wind speed thresholds, the BSS for QRF is worse than for NOtr and the raw forecasts, despite QRF scoring equally compared to the other methods in the CRPSS. The worse performance of QRF compared to the NOtr for higher wind speeds is likely due to the small training set.

Poster 12:

Name: Xiaoyu Xiong

Submitting Author Affiliation: University of Exeter

Authors and affiliations: B. Youngman, University of Exeter, T. Economou, University of Exeter

Session topic: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Abstract Title: Data fusion with Gaussian processes for estimation of environmental hazard events

Abstract:

Environmental hazard events such as extra-tropical cyclones or windstorms that develop in the North Atlantic can cause severe societal damage. Environmental hazard is quantified by the hazard footprint, a spatial area describing potential damage. However, environmental hazards are never directly observed, so estimation of the footprint for any given hazard is primarily reliant on station observations (e.g., wind speed in the case of a windstorm event) and physical model hindcasts. Both data sources are indirect measurements of the true footprint, and here we present a general statistical framework to combine the two data sources for estimating the underlying footprint. The proposed framework extends current data fusion approaches by allowing structured discrepancy between physical model and the true footprint, while retaining the elegance of how the ``change of support'' problem is dealt with. Simulation is used to assess the practical feasibility and efficacy of the framework, which is then illustrated using data on windstorm Imogen.

Session 4: Flooding and wind extremes from a dynamical perspective

Name: Jennifer Catto

Submitting Author Affiliation: College of Engineering, Mathematics and Physical Sciences, University of Exeter, UK

Authors and affiliations: A. Dowdy, Bureau of Meteorology, Melbourne, Australia

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: The role of cyclones, fronts and thunderstorms in compound precipitation, wind, and wave extremes

Abstract:

Cyclones (in the midlatitudes or tropics), fronts, and thunderstorms are very important for weather-related hazards globally. For example, they may be responsible for extreme precipitation, extreme wind, or extreme wave heights, and their co-occurrence. Understanding the occurrence of such compound extremes and the responsible physical mechanisms will lead to better preparedness for the impacts of extreme events throughout the world, and improve disaster risk reduction.

We have used objective identification of cyclones and fronts applied to ERA-Interim data, as well as a global lightning dataset to identify 7 storm types. A seasonal analysis identifies the frequency that these storm types occur and tends to highlight different preferred storm types for different regions. By identifying extreme events as those above the local 98th percentile in the ERA-Interim data, and their co-occurrence, we have also identified 7 hazard types, including a so-called “triple hazard” of compound extreme precipitation, wind, and waves.

This method allows a number of novel concepts to be explored, with results showing that the highest risk of extremes occurs for a type of “triple storm” event characterised by the simultaneous occurrence of a cyclone, front and thunderstorm. By linking the storm types and the hazards, we can identify the key physical mechanisms by which the compound hazards occur. For the North Atlantic and Western Europe region, the combined cyclone and front storm type is responsible for most of the extreme events, including the triple hazard. The combined cyclone, front and thunderstorm storm type, despite being the least common storm type is also associated with more than 20% of the triple hazard events during winter.

Name: Florian Pantillon

Submitting Author Affiliation: Laboratoire d'Aérologie, Université de Toulouse

Authors and affiliations: L. Eisenstein, KIT, F. Pantillon, LA and KIT, P. Knippertz, KIT

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: Dynamics of sting-jet storm "Egon" over continental Europe: impact of surface properties and model resolution

Abstract:

Intense Shapiro-Keyser cyclones are often accompanied by a sting jet (SJ), an airstream that descends from the cloud head into the frontal-fracture region and can cause extreme surface gusts. Previous case studies have concentrated on the North Atlantic and the British Isles. Here we present the first-ever detailed analysis of a SJ over continental Europe and investigate the influence of topography on its dynamical evolution based on observations and high-resolution simulations using the ICOsahedral Nonhydrostatic model (ICON). Windstorm Egon intensified over the English Channel and then tracked from northern France to Poland on 12–13 January 2017, causing gusts of almost 150 km/h and important damages. ICON reproduces the storm dynamics, although it delays the explosive deepening, shifts the track southward over Belgium and Germany and underestimates gusts over land. Storm characteristics show weak sensitivity to varying grid spacing between 1.6 km and 6.5 km, while switching off the convection parametrisation at 3.3 km grid spacing improves correlations with surface observations but deteriorates the mean error. Trajectories reveal typical SJ characteristics such as mid-level descent, strong acceleration and conditional symmetric and other mesoscale instabilities, while evaporative cooling is stronger than in previous cases from the literature, preventing drying during descent. The SJ identification and the occurrence of mesoscale

instabilities depend considerably on model resolution, convective parametrisation, output frequency and employed thresholds for trajectory selection. Sensitivity experiments with modified surface characteristics show that the combined effects of warm-air blocking by the Alps, higher roughness over land and reduced surface fluxes cause Egon to fill more quickly and to move on a faster, more northern track across Germany. While the SJ response is complex showing some compensating effects, surface gusts strongly increase when roughness is reduced. These results suggest that weather forecasters in continental Europe should be more aware of the potential risks associated with SJs.

Name: Margarida Liberato

Submitting Author Affiliation: Instituto Dom Luiz (IDL), Faculdade de Ciências da Universidade de Lisboa & Universidade de Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal

Authors and affiliations: A. Gonçalves, Instituto Dom Luiz (IDL), Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: Wind and precipitation extremes on the Iberian Peninsula and associated cyclones

Abstract:

This study aims at analysing the extreme events and associated named storms occurring over the Iberian Peninsula during the 2017-2018 and 2018-2019 extended winters. Firstly an assessment of the strong winds, heavy precipitation and socio-economic impacts in mainland Portugal is presented. Secondly, a characterization of the extratropical cyclones and associated synoptic conditions is performed. Finally, the extreme events are classified, ranked and put into perspective on the long term variability in order to evaluate how their frequency of occurrence and magnitude fit the identified multi-decadal variability.

Acknowledgements:

This work is supported by Fundação para a Ciência e a Tecnologia – FCT, Portugal, under project “eCSAAP - expert Crowdsourcing for Semantic Annotation of Atmospheric Phenomena” (CMU/CS/0012/2017).

Name: Frauke Feser

Submitting Author Affiliation: Helmholtz-Zentrum Geesthacht, Germany

Authors and affiliations: O. Krueger, Helmholtz-Zentrum Geesthacht, Germany and K. Woth, Wasserstraßen- und Schifffahrtsamt Tönning, Germany

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: North Atlantic winter storm activity in modern reanalyses and pressure-based observations

Abstract:

In this study, the winter storm activity over the North Atlantic during the last decades is assessed in modern reanalysis data sets, a dynamically downscaled global simulation, geostrophic wind speed data, and observations. To analyze long-term changes in meteorological extreme events such as extratropical storms, homogenous observational data on time scales of decades or longer would be needed. Such data is available in the form of global reanalysis data for about the last 40-70 years, but the longest one only for coarse resolutions that prevent a realistic description of high-resolution features. Therefore, global National Centers for Environmental Prediction - National Center for Atmospheric Research (NCEP-NCAR) reanalysis data were dynamically downscaled using the state-of-the-art atmospheric general circulation model ECHAM6.

We analyzed this global spectrally nudged simulation and various modern high-resolution reanalyses for extratropical storms over the North Atlantic in comparison to observations. The observations comprise a storm index derived from geostrophic wind speed triangles, which provide a very homogenous measure of storm activity over time and low pressure systems counted from weather analyses. The similarity of the geostrophic wind speed storm index to reanalyzed high wind speed percentiles and storm numbers confirms its suitability to describe storm activity for multi-decadal time scales. The results show that high wind speed, storm numbers, and spatial storm track distributions are generally similar in high-resolution reanalysis and downscaled data sets and they reveal an increasing similarity to observations over time. Strong decadal variability emerged in storm frequency, but no long-term changes for the last decades were detected.

Name: Christian Passow

Submitting Author Affiliation: Freie Universität Berlin

Authors and affiliations: C. Passow, Freie Universität Berlin; U. Ulbrich, Freie Universität Berlin; H. Rust, Freie Universität Berlin

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: Feature-based classification of European windstorms

Abstract:

Scientific work on European windstorms has mostly been focusing on local damages produced, on their location (tracks) and spatial extension, and on the severity measured with Storm Severity Indices of different definitions. Some studies also noted differences in the characteristics of a storm field, in particular variations in the maximum wind speeds and gusts. These can be induced by convection associated with latent heat release, for example, but also other mechanisms are possible. As a step towards a better understanding of such variations, we intend to classify windstorms based on their characteristics. Applying a clustering procedure reveals the existence of different classes of windstorms, each exhibiting different characteristics in intensity, duration, spatial extension or location. Additional differences between the clusters can be found in some key meteorological variables such as precipitation and temperature. We further discuss possible avenues to predict classes based on these meteorological variables using modern machine learning algorithms.

Name: Oliver Halliday

Submitting Author Affiliation: National Centre for Atmospheric Science, University of Reading.

Authors and affiliations: O Halliday, National Centre for Atmospheric Science (NCAS), University of Reading. L Shaffrey, National Centre for Atmospheric Science (NCAS), University of Reading. D Tsaknias, Lloyds Banking Group. H Cloke, University of Reading. A Siddaway, Lloyds Banking Group.

Session topic:

Abstract Title: Understanding the risk from correlated windstorms and floods in the UK

Abstract:

Both windstorms and flooding pose a significant threat to the United Kingdom. Winter Atlantic windstorms, prevailing from the west, encounter infrastructure causing significant financial loss: the great October storm of 1987, for example, eliminated western elements of the National Grid. Such storms can associate with heavy precipitation, compounding flood risk to densely populated areas. In parallel, extensive flood events can originate from a long, relentless series of slow-moving, otherwise insignificant fronts, as in the case of the winter floods of 2013/14 in the South East. The UK Met Office and Environment Agency estimate the NPV financial loss attributable to the 1987 and 2013/14 events at £5.5bn and £1.3bn, respectively. The question of correlation between windstorm and flood events remains open, with the risk a 1987-scale event "colluding" with more routine but still economically adverse meteorology of the 2013/14 season being, currently, unquantified. If correlated, insurers are under-estimating both capital requirements and risk policy price, exposing them to substantial liabilities.

Here, we undertake a collaborative project between leading academics and insurers, designed to improve understanding of the spatial-temporal distribution of risk from extreme, compounded windstorm and flood events. Using a combination of hydro-meteorological and socio-economic data, we undertake a UK-scale study aimed at a holistic understanding of correlated windstorm and flood events and translating that knowledge into a prediction of risk and hence financial loss. A preliminary statistical analysis of ?40 years of winter ERA-interim reanalysis daily maximum winds and accumulated E-OBS precipitation data has already shown modest wind-rain cross-correlation in Spearman and Pearson correlation coefficients, particularly in the western UK. We find that the degree of correlation grows when coarsening the time series to longer windows (or accumulation periods). The correlation peaks at 21 days for the coarse ERA-i and E-OBS data products. Initial studies with the higher resolution CHESS precipitation product and selected hydrological station data mirror these observations.

Session 5: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Name: Oscar Martinez-Alvarado

Submitting Author Affiliation: National Centre for Atmospheric Science, University of Reading

Authors and affiliations: S Gray, Department of Meteorology, University of Reading. D Suri, Met Office. D. Ackerley, Met Office

Session topic: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Abstract Title: A prototype real-time sting jet precursor tool for forecasters

Abstract: European windstorms are a major cause of hazardous weather, mainly due to intense or sustained wind, rainfall or snowfall. For example, windstorm Daria in 1990 was the most devastating and costly of recent storms with an insured loss of $8.2bn (indexed to 2012 values). Strong surface winds within these storms typically arise from the three low-level wind jets, associated with the so-called warm conveyor belt that ascends ahead of the cold front, the cold conveyor belt that wraps rearwards around the cyclone to the north, and (in some extreme cyclones) a transient, smaller-scale feature termed a sting jet that can lead to strong winds and gusts, especially in the dry air ahead of the convex "cloud head" seen in satellite images of extreme cyclones. Previous research has shown that sting jets are likely to be common, with about 30% of North Atlantic storms containing a precursor to sting jets, and likely to become more common in a warming climate. Possible sting jets are currently identified by forecasters using satellite imagery to spot distinctive cloud features in the cyclone, which is only possible once the cyclone is at the stage when sting jets are occurring.

In this contribution we present first results from a prototype system to predict within an operational forecasting system which cyclones will develop sting jets several days in advance. An established diagnostic is used which is based on the detection of Downdraught Slantwise Convective Available Potential Energy (DSCAPE) as a precursor to sting jets, analogous to the diagnosis of large values of CAPE as a precursor for thunderstorm development. In addition to the presence of sufficient instability, the diagnosis also considers the location and the environment within which the instability is present to decide whether or not a given windstorm is likely to produce sting jets. The prototype system, including easily-interpreted graphical output, will be implemented at the United Kingdom's Met Office to inform its forecasters of the presence of a precursor to sting jets within forecast windstorms. The tool will be applied to operational global domain ensemble forecasts, focusing on the two to five days lead time. We will present details on the implementation, including a new way to compute DSCAPE from single vertical soundings, as well as early results from the trial period to take place in autumn 2019.

Name: Hilke S. Lentink

Submitting Author Affiliation: Institute of Meteorology and Climate Research (IMK), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Authors and affiliations: P. Ludwig, Karlsruhe Institute of Technology, J.G. Pinto, Karlsruhe Institute of Technology

Session topic: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Abstract Title: The impact of 1-way and 2-way nesting on the simulation of European windstorms

Abstract: Regional climate model simulations are typically performed with 1-way nesting, in which the boundary information from the lower resolution domain is made available for higher resolution simulations on a smaller domain. The 2-way nesting strategy is computationally more expensive but enables a feedback of information from high resolution into the low resolution domain. In this way, the development of small scale features within the area of interest can affect the evolution of the lower resolution larger-scale simulations, which can be particularly interesting in the case of e.g. strong convection. Mid-latitude windstorms are generally driven by large-scale factors like the jet stream, but a strong contribution from convection can often be identified. Nevertheless, the impact of 1-way and 2-way nesting on the forecast of windstorms is not well determined.

In this study, we quantify the impact of 1-way and 2-way nesting on the development of European windstorms under several atmospheric conditions: (a) strong synoptic forcing, (b) synoptic forcing together with strong diabatic heating and (c) weak synoptic forcing. We do this with the new NWP model ICON from the German weather service which enables both 1-way and 2-way nesting. Using ERA-5 reanalysis data for initialization, modeling is performed on three different horizontal resolutions 13.2 km, 6.6 km and 3.3 km, where in the former two the convection is parameterized, and in the latter most convection is explicitly computed, except shallow convection.

In situations with a strong synoptic forcing (e.g. windstorm Kyrill, 2007), the 2-way nesting does not lead to different results compared to 1-way nesting. In case of storms with a high diabatic contribution, differences between the 1-way and 2-way nested simulations are clearly present. These differences encompass not only changes in e.g. wind gust intensity (and thus destructiveness) but also dynamical aspects, in which the upscale error growth leads to a change in larger-scale storm development.

Name: Gregor C. Leckebusch

Submitting Author Affiliation: University of Birmingham, UK

Authors and affiliations: Michael A. Walz, SwissRe, Markus G. Donat, ARC Centre of Excellence for Climate System Science and Climate Change Research Centre, University of New South Wales, Sydney, New South Wales, Australia

Session topic: Predicting windstorms: weather forecasting and seasonal to decadal prediction

Abstract Title: Seasonal Forecasting of European Windstorms and robust estimation of loss potentials.

Abstract: As extreme wind speeds are responsible for large socioeconomic losses in the European domain, a skillful prediction would be of great benefit for disaster prevention as well as the actuarial community. Here we evaluate the patterns of atmospheric variability and the seasonal predictability of extreme wind speeds (e.g., >95th percentile) in the European domain in the dynamical seasonal forecast system European Centre for Medium-Range Weather Forecasts (ECMWF) System 4 and compare to the predictability using a statistical prediction model. Further we compare the seasonal forecast system with ECMWF Re-Analysis (ERA)-Interim in order to advance the understanding of the large-scale conditions that generate extreme winds. The dominant mean sea level pressure patterns of atmospheric variability show distinct differences between reanalysis and System 4 as most patterns in System 4 are extended downstream in comparison to ERA-Interim. This dissimilar manifestation of the patterns across the two models leads to substantially different drivers associated with the generation of extreme winds: While the prominent pattern of the North Atlantic Oscillation could be identified as the main driver in the reanalysis, extreme winds in System 4 appear to be related to different large-scale atmospheric pressure patterns. Thus, our results suggest that System 4 does not seem to capture the potential predictability of extreme winds that exists in the real world. This circumstance is likely related to the unrealistic representation of the atmospheric patterns driving these extreme winds. Hence, our study points to potential improvements of dynamical prediction skill by improving the simulation of large-scale atmospheric variability

Name: Florian Pantillon

Submitting Author Affiliation: Laboratoire d'Aérologie, Université de Toulouse

Authors and affiliations: F. Pantillon, Laboratoire d'Aérologie and KIT, B. Adler, KIT, U. Corsmeier, KIT, A. Hansen, Universität Hamburg, P. Knippertz, KIT, A. Wieser, KIT

Session topic: Flooding and wind extremes from a dynamical perspective

Abstract Title: Gust formation during a windstorm in the light of Doppler lidar observations and large-eddy simulations

Abstract: Damaging gusts in windstorms are represented by crude subgrid-scale parameterizations in today's weather and climate models. This motivated the Wind And STorms EXperiment (WASTEX) that took place in winter 2016-17 in the Upper Rhine Valley near Karlsruhe, Germany. Extratropical cyclone "Thomas" was observed on 23 February 2017 with a fast-scanning Doppler lidar, which measures radial wind with ~70-m sampling, complemented by realistic large-eddy simulations using the ICOsahedral Nonhydrostatic (ICON) model with grid spacings down to 78 m. During the storm onset, the downward mixing of a low-level jet and a dry and warm layer results in a peak in wind and a sudden drop in dew point within the warm sector characterized by unprecedented high temperatures for the season. Operational, 2.8-km deterministic forecasts poorly predict the storm onset, while a successful ensemble member highlights the role of upstream orography in the downward mixing. Lidar observations further reveal the presence of wind structures advected by the background flow and lasting for 5-10 minutes during the storm onset. They result from a combination of convection- and shear-driven instability that is uncommon during WASTEX. Large-eddy simulations also contain coherent structures elongated in the wind direction that are qualitatively similar but too coarse compared to the observed ones. The size of structures is found to exceed the effective model resolution by one order of magnitude due to their elongation. These results emphasize the need for sub-km scale measuring and modelling systems to improve the representation of gusts in windstorms.