# 7th European Windstorm Workshop

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# Poster presentations

## Session 1: Dynamics of European windstorms

### Anatomy of a windstorm in the light of a Doppler lidar

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Wind gusts are responsible for most damages in winter storms over central Europe but capturing their small scale and short duration is a challenge for both modelling and observation systems. This motivated the Wind and Storms Experiment (WASTEX) dedicated to investigate the formation of gusts during the passage of extratropical cyclones. The field campaign took place during the winter 2016–2017 on a former waste deposit located close to Karlsruhe in the Upper Rhine Valley in southwest Germany. The key instrument of the field campaign was a scanning Doppler lidar, which provides accurate wind observations in the boundary layer with high spatial (50–100 m) and temporal (10 Hz) resolutions and with a range of several km. The Doppler lidar was complemented with observations from a Doppler C-band radar and a 200-m instrumented tower located nearby. Twelve extratropical cyclones were sampled during WASTEX. The observations reveal several peaks in wind gusts during the passage of storm "Thomas" on 23 February 2017. A first peak corresponds to a drop in humidity and is due to the breakthrough of foehn winds to the surface. It ends a period of coherent wind structures in the boundary layer as observed by the Doppler lidar. A later peak is associated with convection embedded in the cold front and results in the strongest observed gust. The observations are poorly reproduced by convection-permitting COSMO forecasts, which rely on a gust parameterization, but even large-eddy simulations with the ICON model struggle at capturing the timing and intensity of the peaks. These results question the ability of weather and climate models at representing wind gusts.

### A global climatology of explosive cyclones using a multi tracking approach

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Explosive cyclones (EC) are mid-latitude systems characterized by a strong deepening

(more than 24hPa over a 24h-period) and are often linked to extreme weather events in both hemispheres. In this work, we introduce a climatology of EC for both hemispheres based on the IMILAST dataset (Neu et al.,2013). These cyclone track lists have been obtained by applying different cyclone tracking algorithms to the same original dataset (ECMWF Era-interim Reanalysis 1979-2009 with 1.5 resolution).

Despite considerable differences in the total number of EC detected by the methods, there exists a good level of agreement among the methods concerning cyclogenesis and track density of EC as well as their main characteristics, seasonality and trends. EC are shown to be deeper, faster and long lasting with respect to ordinary cyclones in both hemispheres, though EC in the Southern Hemisphere are even more intense than those in Northern Hemisphere. On the other hand , EC in the Northern Hemisphere are characterized by a stronger deepening rate over 6h and 24h.

More specifically , in the Northern Hemisphere Atlantic EC (in particular in the eastern part of the basin) are , compared to Pacific EC, usually faster, deeper and characterized by higher (geostrophically adjusted) deepening rate. For both basins, EC in the western part of both basins are characterized by higher normalized deepening rates with respect to the corresponding EC in the eastern parts. In the Southern Hemisphere, EC south of Africa and Australia are usually faster, deeper and with higher deepening rate with respect those southeast of America. Further, EC close to Southern America and Southern Africa are, in turn, characterized by higher geostrophically adjusted deepening rate, normalized deepening rate and duration with respect to EC formed south of Australia.

## Session 2: Predictability and variability from weather to climate timescales

### Radiative impact of clouds on the global warming responses of the northern hemisphere mid-latitude storm tracks and eddy-driven jet streams

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Clouds and their radiative interactions with the circulation are a large source of uncertainty in climate models. We investigate the role of cloud-radiative interactions for the response of the extratropical circulation to global warming using the atmospheric component of the ICOsahedral Non-hydrostatic model ICON. The model is run with the physics package developed for numerical weather prediction. Sea surface temperatures (SSTs) are prescribed to isolate the role of atmospheric cloud-radiative interactions. We perform two sets of global warming simulations. In the first set, global warming is mimicked by increasing SSTs uniformly by 4K. In the second set, global warming is mimicked by increasing SSTs by a pattern derived from the ensemble average of CMIP3 coupled climate models. We apply the cloud-locking method to differentiate between the role of the SST increase and the role of atmospheric cloud-radiative interactions. The annual-mean storm tracks and eddy-driven jet streams exhibit a poleward shift in the North Pacific and North Atlantic with a strengthening in the exit region over Europe. The cloud-radiative impact causes a substantial part of the poleward shifts. It is almost zonally symmetric and largely independent of the imposed SST pattern. The zonally symmetric cloud-radiative impact is consistent with a zonal cloud-radiative forcing in the mid-latitudes. The responses of the storm tracks and eddy-driven jet streams to surface warming exhibit strong seasonal cycles. For example, the North Atlantic storm

track shows a strengthening in the exit region and an expansion over Europe during winter. During summer, the storm track shifts poleward. During all seasons, the cloud-radiative impact plays an important role for the storm track and eddy-driven jet stream responses to global warming. In summary, our results emphasize the importance of cloud-radiative interactions for future changes in the extratropical circulation.

## Seven decades of North Atlantic storm climate statistics based on a spectrally nudged ECHAM6 simulation

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Co-Authors: Frauke Feser

A recently conducted globally downscaled re-analysis (ECHAM6 spectrally nudged towards NCEP/NCAR forcing, 1948-2015, T255 which amounts to a grid box distance of about 50 and 75 km depending on geographical latitude) is studied due to its performance in representing extratropical storms over the North Atlantic area. In particular we study the occurrence of storm tracks in terms of annual quantity combined with the spatial location of severe storms in each storm season as well as the variations of these characteristics over time. We compare our results with the ERA Interim and ERA5 re-analysis, the storm track data bank conducted by the WISC project (Windstorm information service) as well as with observations from the German Weather service (DWD) derived manually from weather charts.

We show that the downscaling procedure is able to reproduce an atmospheric dataset of temporal and spatial high resolution which shows added value compared to its forcing data NCEP/NCAR: The simulation of deep sea level pressure and the low pressure systems accompanying high wind speeds are substantially reinforced. In the case of reproducing North Atlantic wind storm climate and its long-term variability the ECHAM_SN simulation is comparable to reanalysis products by ECMWF and has the advantage to serve as multi-decadal coherent atmospheric climate data for climate research, encompassing now almost seven decades.

## North Atlantic winter storm changes under global warming of 1.5°C and 2°C

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Severe extratropical winter storms, accompanied by hazardous wind and precipitation, can cause severe damages with complex socio-economic consequences for communities in Europe. In this study, we investigate potential changes in simulated winter storminess and extreme precipitation under 1.5°C and 2°C global warming scenarios of the HAPPI (Half A Degree Additional Warming, Prognosis and Projected Impacts) project. This approach allows an assessment of climate change impacts under different temperature targets, which provide information relevant to policymakers, economists and local communities. Our results show that the very high-resolution (0.25°x0.25°) horizontal and temporal (3hr) output of the atmospheric model CAM5 is not only refining regional-scale features of the extremes, but also improves the representation of large-scale atmospheric circulation, which governs storm tracks over the North Atlantic.

Our analysis of the future response for the 2°C warming scenario indicates a poleward shift and intensification of the storms over the Euro-Atlantic region. A key result

is that the shift occurs mainly after exceeding the 1.5°C global warming level, when the mid-latitude jetstream manifests a strengthening north-eastward. This phenomenon causes an increase in the mean as well as daily and sub daily precipitation and wind extremes (e.g. their return values) and storminess over Northern Europe with a maximum over the northwestern coasts of the British Isles and Scandinavia. Findings of this study indicate that near-future changes in winter storm activity over the North Atlantic and Western Europe will increase nonlinearly with further warming rather than linearly.

## Variability of compound extreme events in the Euro-Atlantic region and its association to extratropical storms

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Weather and climate extremes have gained great attention to the general public and policy makers recently. Extratropical cyclones and frontal systems are central components of weather over mid latitudes. These phenomena are associated with compound weather conditions, including dramatic changes in temperature, wind and extreme precipitation. In fact, wind extremes and heavy precipitation events occurring in the winter over land in the mid latitudes are mostly associated with extratropical cyclones. It is well known that the Iberian Peninsula, due to its location, is prone to the occurrence of these compound extreme events and associated hazards (Liberato et al., 2013; 2014). In this paper hydrometeorological compound extreme events in the Euro-Atlantic region are characterized. Moreover their variability is assessed and compound extreme events are related to North Atlantic extratropical cyclones.

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Liberato et al. 2013 Nat. Hazards Earth Syst. Sci., 13:2239-2251 doi: 10.5194/nhess-13-2239-2013

Liberato 2014 Weather and Climate Extremes, 5-6: 16-28 doi: 10.1016/j.wace.2014.06.002

## Northeast Atlantic Storminess and its Uncertainty in the late 19th and 20th Century

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Geostrophic wind speeds calculated from mean sea level pressure readings are used to derive time series of northeast Atlantic storminess. This study makes use of historic air pressure data available from the International Surface Pressure Databank (ISPD) complemented with data from the Danish Meteorological Institute (DMI) and extends the time series of northeast Atlantic storminess until 2016 including uncertainty estimates. Previous studies mainly concluded that northeast Atlantic storminess is dominated by decadal variability, whereby the remarkable upward trend in storminess from the calmer 1960s to the 1990s, whose high storminess levels are comparable to those found in the late 19th century, is part of an extended interdecadal oscillation. This study confirms previous findings showing that storminess levels have returned to average values.

### Extemes in the Lorenz energy cycle

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## Session 3: Windstorm risk and insurance collaborations

### Operational Wind Storm Service for the Insurance Sector

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European winter wind storms are a major cause of losses to the insurance sector. To help the sector better understand this risk, a storms operational service is currently being implemented. This implementation is the successor of WISC (Windstorm Information Service - part of the Copernicus Climate Change Service (C3S)) to evolve from a Proof of Concept to an operational service. The WISC contract has successfully demonstrated the estimation of economic losses for winter storm events over Europe based on state-of-the-art numerical weather prediction models and economic loss models. This includes a chain of processes, including (i) the identification of storm events from ERA-Interim and/or ERA-20C fields and their tracks, (ii) downscaling of the relatively low resolution ERA wind fields to high resolution fields of wind gust, (iii) subsequent generation of storm footprints and (iv) the calculation of economic losses for the identified storms.

As a result, WISC has proven to be a successful Proof of Concept for an open source tool to estimate economic losses for winter storm events over Europe. The evolution of the Proof of Concept to an operational service, based on open access data, requires, among other things, free access to re-analysis data. ERA5, currently generated at ECMWF, will be used in the implementation of the service which data is indeed open access and free to download for all uses, including commercial use.

All data including ERA5 and wind storm information products are open access and will be made available through the Copernicus Climate Data Store (CDS). Technical support is provided to users. Outreach events are being scheduled to promote and gain feedback from the (re-)insurance sector.

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### SWiFT : an operational prediction tool of the potential losses associated to European winter windstorms.

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Over the last thirty years, ten European winter windstorms cost more than 2 billion USD each and caused many fatalities. An advance estimate of the potential losses associated with an upcoming storm would be of particular interest for public services as well as private companies such as insurers. Indeed, in the aftermath of such disasters, the compensation process, key process of the reconstruction, is often slowed by the unexpected amount of claims. At AXA we have developed an early warning tool called

SWiFT (Severe Windstorms Forecasting Tool), designed to (i) alert on upcoming intense European winter windstorms and (ii) provide estimates of the potential total loss and number of claims for the French exposure portfolio. At AXA, its primary objective is to enable claims management departments to launch anticipated action plans adapted to the size of the upcoming event. SWiFT is organized in two modules: the first one detects and extracts the surface wind speeds associated with an intense upcoming event from meteorological forecasts provided by the NCEP Global Forecasting System; the second one converts the wind speeds into a loss and a number of claims for the French exposure. Entirely developed from the case study of two historical events (Klaus 2009 and Xynthia 2010), SWiFT has been running automatically since the 2013 / 2014 winter season, detecting most of the major events. While SWiFT was first developed for European windstorm, it is now a global tool that is able to detect also tropical cyclones and assess losses on portfolios in exposed regions.

## Learnings from our European windstorm catastrophe model

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The insurance industry strongly relies on catastrophe models for the estimation of the risk of loss from European windstorms. Even though these models have become increasingly sophisticated and mature in recent years and decades, there are still various challenges and issues in their creation, calibration and validation of those models. Using PartnerRe's CatFocus European windstorm model we will demonstrate some key results from recent model calibration and validation exercises.