



## The Named Storms Catalogue: unlocking learnings from past events

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10 **Abstract.** Extratropical cyclones are one of the leading causes of widespread damage from extreme weather over the United Kingdom and western Europe due to their strong winds and heavy precipitation. Storm naming has been used as a strategy to communicate risks and enhance preparedness of the general public and key affected sectors. Given the first ten seasons of storm naming, the opportunity arises to collect and characterise for the first time the set of named storms identified by the UK Storm Centre. Collecting information about these events enables to objectively assess what makes them different from  
15 other storms and from one another; and supports preparedness for future events.

This paper introduces the Named Storms Catalogue as an open-source dataset accessible from <https://doi.org/10.5281/zenodo.18877013> (Gonzalez et al., 2026). The catalogue contains a set of storm tracks, storm development and hazard metrics that allow to objectively describe, rank and compare past named storm events, unlocking learning opportunities by the preparedness and resilience as well as the research communities.

20 This dataset introduction describes the content and metrics and the methodologies used to develop them, while a set of case studies highlights how the catalogue can be used to assess and compare past events. The paper presents a preliminary climatology for UK named storms and discusses some ongoing lines of research that the authors are exploring, such as using the metrics included in the catalogue to distinguish named events from others, and to identify different types of storms within the set.

### 25 **1 Introduction**

The passage of extratropical (or mid-latitude) cyclones is a particularly impactful aspect of weather that affects the United Kingdom (UK) and western Europe (Dowdy and Catto, 2017, Catto et al., 2019). These large-scale low-pressure systems drive short-term variability in the weather (Cornér et al., 2025), bringing a large portion of the annual precipitation (85%-90%) and significant wind-driven damage to mid-latitudes (Catto et al., 2019; Schultz et al., 2019), leading to significant  
30 impacts on society and the economy.

There is no official meteorological definition for storms, but they are often used to describe areas of deep and active low pressure with associated strong winds and precipitation over large areas, highlighting the compound nature of their



associated hazards (Pirret et al., 2023; Met Office, 2024a). However, each storm may develop and manifest in different ways, ultimately leading to a range of possible impacts.

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The Met Office and Met Éireann began a storm naming collaboration in 2015, with KNMI (Koninklijk Nederlands Meteorologisch Instituut) joining from 2019, sometimes referred to as the “Western” storm naming group, it is one of several naming partnerships in Europe (Cusack et al. 2017). The purpose of naming storms is to improve communication around impactful storms, with the recognition that the use of a single name promotes clearer, more consistent, authoritative and effective messaging and sharing of information, for example from national meteorological services and in the media (Cusack et al. 2017). This, in turn, helps groups such as the general public, emergency planners, responders and government agencies, take better, more appropriate and safer action in the face of severe weather (Charlton-Perez et al. 2019, Kotroni et al. 2021, Clements et al. 2025). In addition, the use of storm names by the general public, for example in social media, has been shown to provide a rich source of impact information (Spruce et al. 2020).

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A storm is named within the Western storm naming group when it is deemed to have the potential to cause “medium” or “high” impacts in the UK, Ireland and/or the Netherlands. As well as wind, impacts from rain and snow are considered in the naming process. Even though objective guidelines are followed by the meteorological offices to decide when to name a storm event, there is no single deterministic process (i.e., naming is not based on the exceedance of meteorological thresholds), and as a result, a certain level of subjectivity is expected (i.e., storms that could have been named and were not, and vice versa).

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Existing literature has focused on developing climatologies for associated severe weather events affecting the UK, such as accumulated rainfall and precipitation bands (e.g., Herrera et al. 2023, Zhang and Schultz 2023), sting jets (e.g., Gray et al. 2024), compound wind and rainfall impacts (e.g., Owen et al. 2021, Manning et al. 2024) and even cyclones themselves (e.g., Matthews et al. 2016), but no previous work has focused on named storms as a body of research. With the completion of ten seasons of storm naming (Clements 2025), the purpose of this paper is to introduce a comprehensive dataset that describes named storms, including their tracks and a set of metrics describing storm development as well as atmospheric and coastal hazards. Additionally, our study presents a high-level analysis of this dataset, known as the named storms catalogue, focusing on an analysis of their seasonality, the behaviour of the different metrics in the set and how they might be used to compare and rank events. It is hoped that the open release of these data will motivate further analysis.

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## 2 Data and methods

The selection of underlying datasets to develop the Named Storms Catalogue was based on multiple criteria. On one hand, the dataset was required to allow efficient tracking of the cyclones. This meant it needed sufficient spatial and temporal



65 resolution for this task. On the other hand, it had to allow defining metrics that describe the evolution of the systems as well  
as the associated wind and rainfall hazards. Choosing a multi-variate dataset such as a reanalysis ensured that the physical  
consistency between metrics was preserved. Acknowledging that a significant part of the impacts of named storms is linked  
to coastal hazards due to flooding and erosion, a set of complementary datasets were also chosen to represent them.

## 2.1 ERA5 reanalysis

70 ERA5 reanalysis data from January 1979 to August 2025 was considered as the basis for tracking the storms and for deriving  
the storm development metrics (Hersbach et al. 2020). Hourly and 6-hourly fields for mean sea level pressure and 850 hPa  
vorticity were used to track the systems as described below. 300 hPa winds were used to describe the position of the storm  
track with respect to the North Atlantic jet stream. Additionally, hourly total precipitation, 10 m winds and wind gusts were  
used to develop storm footprints and hazard metrics.

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ERA5 is a state-of-the art reanalysis product and is widely used in climate and impacts studies, making it a natural choice for  
building a catalogue of metrics that could be extended backwards to the historical period in a consistent way.

## 2.2 Coastal data

Two datasets produced by the Met Office are used for investigating coastal metrics. First, an ERA5-forced hindcast of the  
80 NEMO-surge model (O'Neill et al., 2023) and second, the Copernicus Marine Service wave reanalysis based on the  
WAVEWATCHIII model, which is also run using a hindcast methodology (Saulter, 2021). They use the Atlantic Margin  
Model (AMM) ocean configuration, the domain for which covers the Northwest European Shelf (UK, North Sea, Irish Sea)  
and extends into the North Atlantic.

Dataset	Period	Domain	Resolution	Timestep
NEMO-surge	1/1/1980 – 31/7/2022	AMM7	7km	15 min
WAVEWATCHIII	1/1/1980 – 31/5/2025	AMM15	1.5km	Hourly

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A key caveat with these datasets is that they are representative of conditions from ~10 km offshore and are yet to be  
downscaled to coastal domains. However, we are considering them to represent coastal conditions as we apply a coastal  
mask to the data when generating maximum values for surge and wave metrics. Although the absolute values may not align  
with coastal observations, they still provide scope to compare storms.

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### 2.3 Tracking algorithms and named storms identification

While reports on named storms that impacted the United Kingdom are systematically collected by the UK Storm Centre, there is no dataset that contains the longitude and latitude locations of these storms (i.e. their tracks) as they develop, mature and decay. Attempting to identify the locations of these cyclones throughout their lifecycle using available analysis charts would be highly subjective (e.g., when does the cyclone become a cyclone?) and time consuming. Therefore, for objectivity and efficiency, the extratropical cyclones were tracked using the TRACK algorithm of Hodges (1994, 1995, 1996, 1999), which is implemented following the method of Priestley et al (2020) and references therein. The first step before running TRACK is to calculate the vorticity field from the zonal and meridional wind fields at 850 hPa. Vorticity is preferred over mean sea level pressure for two reasons:

- The vorticity field is impacted less by the background mean state. For example, the TRACK algorithm can identify cyclonic features (e.g. an open wave cyclone in the mean sea level pressure field) within a larger scale cyclone.
- The 850 hPa vorticity is less sensitive to systematic biases in the background state from reanalyses. Furthermore, other fields (such as the mean sea level pressure) are extrapolated by the model to produce a continuous field, whereas the 850 hPa vorticity field is almost entirely above the land surface around the UK domain and is not subject to any extrapolation.

The calculated 850 hPa vorticity field is then spectrally truncated to T5-42 (i.e. retains wave numbers 5 to 42, which implies degrading to a lower resolution), which removes both the sub-synoptic and planetary scale features such as fronts and the “Icelandic Low”, respectively. Local vorticity maxima are then identified in the truncated vorticity field, using a threshold of  $1.0 \times 10^{-5} \text{ s}^{-1}$  to classify candidate cyclones. To connect the vorticity maxima into a coherent cyclone track, TRACK first applies a temporal nearest neighbour search and then minimises a cost function to optimise track smoothness (for further details, see Hodges 1999). Finally, the cyclone tracks are output to an ascii file containing the time stamp, longitude, latitude and instantaneous vorticity of each point in the track.

While vorticity is useful to identify and track extratropical cyclones, the mean sea level pressure field is the one that is primarily used by the expert meteorologists at the Met Office (Operational Meteorologists) for issuing forecasts and warnings to the public. Furthermore, mean sea level pressure is what typical users of Met Office forecasts (and data) are most familiar with so has the greatest value in communication as to where a cyclone is tracking. For this reason, we have also made use of an option within the TRACK algorithm to express the tracks in mean sea level pressure, which have been used for presentation of the catalogue, and for validation (as described below). To do this TRACK identifies the mean sea level pressure minimum within a given radius of the 850 hPa vorticity maximum. For this work, a search radius of  $5^\circ$  from the vorticity maximum is used at each point in time along the track to identify the mean sea level pressure minimum (for more details see Bengtsson et al. 2009). A new ascii file containing the original vorticity data and the longitude, latitude and

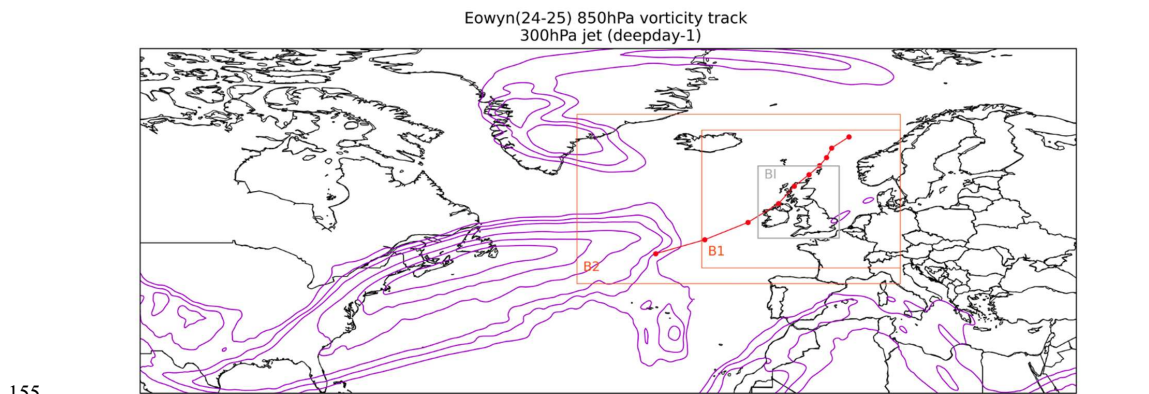


value of the mean sea level pressure minimum at each point in the track is produced. The final step is to identify and retrieve  
125 the tracks of all the named storms in the dataset, which is done by visually inspecting the track files and looking for times,  
locations (longitude and latitude) and mean sea level pressure minima that corresponded to the storm reports that are publicly  
available in the UK Storm Centre (see: <https://weather.metoffice.gov.uk/warnings-and-advice/uk-storm-centre/index>).  
Finally, the TRACK-derived named storm tracks were verified by two Operational Meteorologists who reviewed the  
synoptic charts leading up to and immediately after those published in the storm reports to provide a final independent check  
130 that the correct track was identified.

While the focus was on storms named by the Western Group, some events named by the French, Portuguese or Spanish  
weather services that significantly impacted the UK (e.g. Storm Jorge in February 2020 and Storm Alex in October 2020)  
were adopted by the UK Storm Centre and are therefore included in the named storms catalogue. As a result, the catalogue  
135 collects data for all the named storms for the seasons from 2015/16 to 2024/25, with the exception of one event named by  
AEMET (Spain) and one named by DMI (Denmark) in the 2021/22 season (storms Barbara and Malik, respectively), and the  
addition of storm Herminia (January 2025) which despite not being officially adopted was identified as an impactful event  
by the Civil Contingencies Advisors (see: <https://www.metoffice.gov.uk/services/government/environmental-hazard-resilience/civil-contingencies-advisors>). This accounts for 76 named events. In the case of storm Babet (2023/24 season), the  
140 event developed as the merger of two independent cyclones. As each cyclone was considered to be strong enough to result in  
naming, they were both kept as part of the catalogue and are identified as Babet1 and Babet2.

#### 2.4 Development metrics

Once the named storm tracks had been collected, the next important step was to use them to select a set of storm  
development metrics. Interviews with Operational Meteorologists revealed that there are several characteristics of the  
development of storms that support their decision making in the lead up to naming or warning for an event (with storm  
145 naming and issuing weather warnings being a key responsibility of senior Operational Meteorologists). These characteristics  
are used along with numerical weather prediction forecasts of the impacts of the storms, to provide mechanistic  
understanding of the forecast, to develop a view of the level of uncertainty, and as an informal approach to comparing to past  
storms (hence infer possible impact severity). In this paper we sought to define and calculate these characteristics objectively  
150 to create and document storm development metrics for each storm. This will allow objective assessment of their power in  
discriminating between named storms, and in monitoring different aspects of the storms intensity that are likely to lead to  
hazards and impacts. Although some of these metrics are related to the evolutions of the systems, such as their deepening,  
they were simplified as a single number per storm to allow for easier comparison and ranking. When metrics were  
aggregated over the track, different box domains were considered as described in Figure 1.



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**Figure 1:** 6-hourly 850 hPa vorticity track for storm Eowyn (2024/25 season). The figure highlights the definition of the different aggregation domains: full track (considering all the red points), B2 box, B1 box, and the British Isles box (BI). For reference, the purple contours indicate the position of the 300 hPa jet stream one day ahead of the maximum storm deepening rate.

160 Most metrics were derived by the project team by considering the storms tracks and the relevant ERA5 fields, with the  
 exception of the warm seclusion tests, that were provided by the authors of Gray et al. (2024). Cyclones with a warm  
 seclusion (Shapiro–Keyser cyclones) have enhanced potential to develop sting jets and are generally associated with  
 damaging winds, so this test was identified by the Operational Meteorologists as influential in their decision to name storms.  
 The tests do not cover all the named storms for two reasons. The warm seclusion tests were applied only to cyclones over the  
 165 extended winter period from October to March for the seasons between 1979 and 2024, which is not inclusive of all named  
 storms in the catalogue. Additionally, the tests were applied to a slightly different set of storms tracks, derived from ERA5  
 but with different postprocessing steps (Gray et al. 2024). A track matching algorithm was used to pair the track of Gray et al  
 (2024) with the storms within this analysis (i.e. the named storms). This track matching algorithm did not always find a  
 corresponding track, and due to this and the more limited temporal coverage, only a proportion of the storms in the catalogue  
 170 have a warm seclusion test assigned to them.

**Table 1** presents a summary of the storm development metrics. All the metrics that were obtained from each 6 hourly track  
 point were then aggregated over the different domains described in **Figure 1**.

175 **Table 1: Storm development metrics definitions.** (\*) indicates metrics that are defined on B1, B2 and BI boxes.

Metric	Definition	Acronym
Minimum pressure *	Minimum central sea level pressure (hPa) of the tracked system based on 6 hourly steps 00Z, 06Z, 12Z, 18Z.	Min_slp



Maximum vorticity *	Maximum 850 hPa vorticity (1/s) of the tracked system based on 6 hourly steps 00Z, 06Z, 12Z, 18Z.	Max_vort
Maximum deepening rate (6h/12h) *	Maximum reduction in central sea level pressure of the tracked system in a 6h or 12h period. Deepening rate is expressed in Bergeron (B) units, and a module larger than 1 suggests an explosive development around that period (e.g., Allen et al. 2010).	Max_deep_rate
Maximum speed *	Maximum translation speed (km/h) of the storm based on the tracking of the maximum vorticity feature. Speed is derived from great circle displacements in the 6h position of the maxima and assigned to the time of the end point.	Max_spd
Average speed *	Average translation speed (km/h) of the storm based on the tracking of the maximum vorticity feature.	Mean_spd
Bearing	Direction of approach of the storm when entering a British Isles zone of influence (a box encompassing ~ 11°W-2°E, 50°N-61°N). Direction is derived from assuming a great circle trajectory between the 6h positions of the maxima and assigned to the time of the end point. Bearing is expressed in degrees using the wind direction meteorological convention.	Bearing
Latitude (start, delta)	The start latitude of the available track and the total latitude change until the track reaches the BI box, both measured in degrees.	Lat_st, Lat_dt
Fetch (distance/duration)	The fetch of the cyclone is calculated from the portion of the track that the storm spent over water (generally ocean) before entering the BI box. Fetch has an associated distance (km) and duration (hours).	Fetch_dist, Fetch_time
Warm seclusion	A warm seclusion diagnosis was applied to identify which storms were associated with a Shapiro-Keyser type of cyclone (Shapiro and Keyser, 1990). As described in Gray et al. (2024), the identification of the warm seclusion was performed at the time of maximum 850hPa vorticity and using the minimum sea level pressure at this time as the centre of the cyclone. Then, an algorithm was applied to verify whether a warm area in 850hPa wet bulb potential temperature overlapped with the pressure core of the system, which would be judged as a warm seclusion. The results of applying this algorithm to all named storms was kindly shared by the authors.	Warm_sec

## 2.5 Hazard metrics

A selection of metrics describing the hazards associated with the storms have also been developed. The metrics describe the meteorological and coastal hazards of relevance to impacts across a range of sectors. Since systemic and comprehensive datasets describing the direct impacts of storms are lacking, these metrics act as proxies for the impacts. Five key hazards were initially considered for the metrics: 3 s wind gusts, accumulated precipitation, precipitation rate, surge residual, and wave significant height. Two further coastal hazards were calculated: wave power (wave significant height + wave period), and water level (sea surface height + ½ wave significant height, where sea surface height can be broken down into tide + surge residual). Given that named storms are known to drive compound hazards and impacts, different combinations of the above were also considered. For consistency and to enable application to model output, ERA5 was also used as the basis for these metrics, or ERA5-forced ocean models as discussed in Section 0.



A storm “footprint” was created for each hazard, considering the complete period that the storm is deemed to have affected the British Isles. For accumulated precipitation, overall grid point accumulation was calculated for the period. For the other  
190 hazards, the maximum value for each grid point was selected. Masks were then applied to these footprints to isolate the areas of interest. For the meteorological hazards, this area was British Isles land. For the coastal hazards, a coastal mask was created from the ERA5 land-sea mask, keeping grid points where the land fraction was smaller or equal than 0.5. From these masked footprints, overall maximum values for each storm were identified from grid points that fall within a 10° radial area of a track point of the storm.

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To estimate the potential for significant impacts, we identified climatological thresholds for each of the five key hazards and calculated areas of the masked footprints that exceeded the threshold: both total area per hazard, and compound areas, the latter summing the area where pairs of hazards both experienced exceedances of their respective thresholds. These thresholds are percentile values of a 1991-2020 reference period and are monthly- and grid-point-varying. Suitable percentiles were  
200 identified via sensitivity testing, aiming to generate exceedance areas that were large enough for comparison between storms: for meteorological hazards, 98<sup>th</sup> was chosen, and for coastal hazards, 99<sup>th</sup>. For storms whose period crossed two months, the threshold of the earlier month was chosen for consistency.

Based on the formulation presented in Manning et al. (2024), a wind severity index (WSI) was calculated based on the 6-  
205 hourly storm track. For each track point location suggesting hazards over the British Isles, the exceedance of the monthly-varying 98<sup>th</sup> percentile of 1991-2020 10 m wind speed was assessed for each grid point over land within a 10° radial area of the track point. For those land points, the exceedance fraction was accumulated over the radial area, and then over subsequent times of influence over the British Isles, to result in a single metric per storm. Rainfall severity index (RSI) was also calculated in a similar manner, with accumulated precipitation exceedance assessed with respect to the monthly-varying  
210 rolling 6-hourly accumulated rainfall 98<sup>th</sup> percentile of 1991-2020. A compound severity index (CSI) was calculated by assigning each grid point a 1 or a 0 based on whether wind and rain exceedances both occurred there or not. These ones were then accumulated over space and time as above to generate a compound metric for co-occurrence of severe wind and rain.

Approximate durations of impactful wind speed and accumulated rainfall (considering track points are 6 hours apart) were  
215 derived by taking the time between the track points where the first and last exceedances contributing to their severity indices occur and adding 6 hours on – 3 hours for each end of the track. A compound duration metric for contribution to both indices, along with the total duration of influence of the storm over the British Isles box, are also recorded.



**Table 2 summarises the storm hazard metrics. All areas are in km<sup>2</sup>, and durations are in hours.**

<b>Metric</b>	<b>Definition</b>	<b>Acronym</b>
Maximum wind gust	Maximum hourly 3s wind gust (m/s) during the storm period identified from all land grid points within a 10° radial area of track points influencing British Isles land.	Mxgust
Wind gust exceedance area	Area of wind gust exceedance of the monthly-varying grid-point based 1991-2020 98 <sup>th</sup> percentile.	GustExA
Maximum accumulated precipitation	Maximum accumulated precipitation (mm) over the storm period identified from all land grid points within a 10° radial area of track points influencing British Isles land.	MxAcP
Accumulated precipitation exceedance area	Area of accumulated precipitation exceedance of the monthly-varying grid-point based 1991-2020 98 <sup>th</sup> percentile.	AcPpExA
Maximum precipitation rate	Maximum precipitation rate (mm/h) during the storm period identified from all land grid points within a 10° radial area of track points influencing British Isles land.	Mxppr
Precipitation rate exceedance area	Area of precipitation rate exceedance of the monthly-varying grid-point based 1991-2020 98 <sup>th</sup> percentile.	PprExA
Joint gust/accumulated precipitation exceedance area	Area of joint exceedance of hazards' respective 98 <sup>th</sup> percentiles.	GPA
Joint gust/precipitation rate exceedance area	Area of joint exceedance of hazards' respective 98 <sup>th</sup> percentiles.	GRA
Joint acc. precipitation/precipitation rate exceedance area	Area of joint exceedance of hazards' respective 98 <sup>th</sup> percentiles.	PRA
Wind severity index	Based on Manning et al. (2024), exceedance fraction of the 1991-2020 98 <sup>th</sup> percentile of 10m wind speeds for each grid point over land within a 10° radial area around each track point, then aggregated over the radial area and track points.	WSI
Wind hazard duration	Approximate duration of severe wind hazards.	WindDur
Rain severity index	Based on Manning et al. (2024), exceedance fraction of the 1991-2020 98 <sup>th</sup> percentile of rolling 6-hourly accumulated precipitation for each grid point over land within a 10° radial area around each track point, then aggregated over the radial area and track points.	RSI



Rain hazard duration	Approximate duration of severe rainfall hazards.	PpDur
Compound severity index	Accumulation of occurrences of both wind and rain threshold indices when observed over a land grid point within the radial area.	CSI
Compound hazard duration	Approximate duration of compounding severe wind and rainfall hazards.	CompDur
Storm influence duration	Approximate duration of track influence on the British Isles.	InfDur
Maximum surge residual	Maximum surge residual (m) over the storm period identified from UK+Ireland coastal grid points (those with $0 < \text{land fraction} \leq 0.5$ ).	MxSrg
Surge residual exceedance area	Area of the coastal grid points with surge residuals exceeding the monthly-varying grid-point based 1991-2020 99 <sup>th</sup> percentile.	SrgEx
Maximum wave significant height	Maximum wave significant height (m) over the storm period identified from UK+Ireland coastal grid points (those with $0 < \text{land fraction} \leq 0.5$ ).	MxWvSH
Wave significant height exceedance area	Area of the coastal grid points with wave significant heights exceeding the monthly-varying grid-point based 1991-2020 99 <sup>th</sup> percentile.	WvSHEX
Joint surge residual/wave significant height exceedance area	Area of joint exceedance of hazards' respective 99 <sup>th</sup> percentiles.	CompSrgWv
Maximum wave power	Maximum wave power ( $\max(\text{wave significant height}) + \max(\text{wave period at variance spectral density maximum})$ ) over the storm period is identified from UK+Ireland coastal grid points (those with $0 < \text{land fraction} \leq 0.5$ ).	MxWvPow
Maximum water level	Maximum water level (m) ( $\max(\text{sea surface height} + \frac{1}{2} \text{ wave significant height})$ ) over the storm period is identified from UK+Ireland coastal grid points (those with $0 < \text{land fraction} \leq 0.5$ ).	MxWatLev

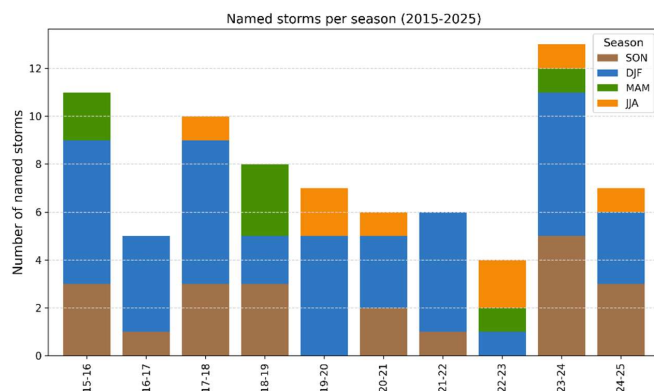


## 220 3 Results

### 3.1 Characterisation of the storm set

#### 3.1.1 Temporal and spatial distribution of the events

Given that this catalogue is the first documented effort to collect and objectively characterise a set of named storm events for the British Isles, this section first focuses on describing their seasonal and geographic frequency. Figure 2 presents the counts of storms per season, defined as September to August of the following year, and their split according to the meteorological seasons. The most active season within the naming period was 2023/24, with 12 named storms, most of them evenly distributed over SON and DJF. This was preceded by the least active season of 2022/23 with only four events from December to August. Storm season 2016/17 had only five storms, all in the cold season. Despite the limited length of the record, this suggests a strong interannual variability in the number of named storms which will be the focus of further research.



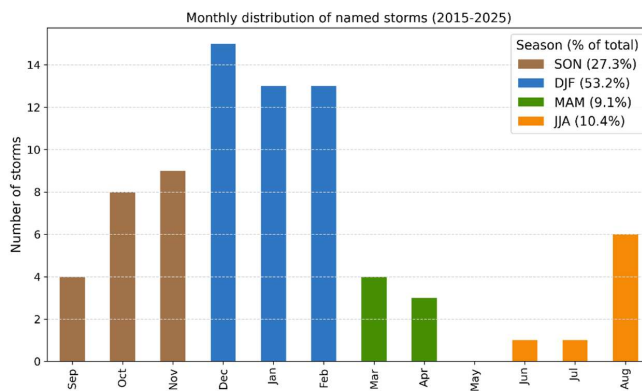
**Figure 2: Count of named events per storm season, starting from September. Colours classify the number of storms per meteorological season.**

The seasonal distribution of events is described in more detail in Figure 3, that presents the total count of storms per month. December has seen the highest number of events affecting the British Isles over the 10 years of storm naming, with an average of 1.5 storms per season. Up to date, no named storm has had influence over the British Isles during the month of May, and only one named event has affected the months of June or July. Named storms are however more likely during August than during any spring month or September according to this limited record. This is, however, consistent with fewer explosively developing systems (or “bomb cyclones”<sup>1</sup>) around the UK in MAM relative to DJF and SON (Figure 8 in Ackerley et al. 2025). It is important to highlight that since storms are named based on their potential for impacts,

<sup>1</sup> Cyclones that have a reduction in central mean sea level pressure of more than 24 hPa in 24 hours, see Sanders and Gyakum (1980)



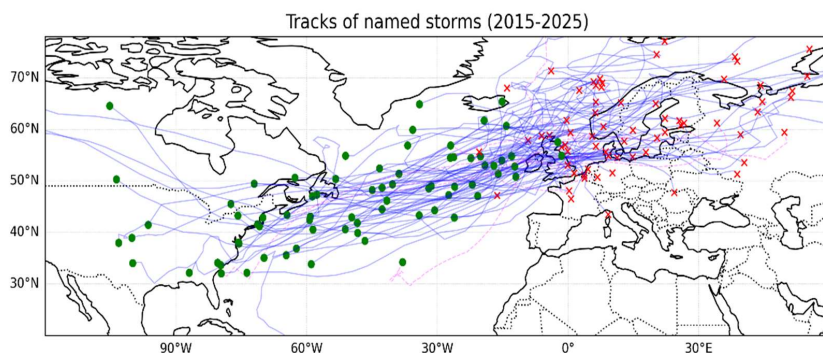
meteorologically weaker systems get named in the summer due to the increased exposure of the population during this season.



245 **Figure 3: Seasonal distribution of named storms by month for the period Sep 2015 - Aug 2025. Colours indicate the seasons and the percent distribution by season is described in the legend.**

The collection of named storms tracks is presented in Figure 4, which depicts the trails taken by all the storms' vorticity centres as detected by the tracking algorithm. The starts of the tracks (green dots) are evenly distributed along a SW-NE band crossing the North Atlantic Ocean, with only a few tracks starting east of 10° W.

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**Figure 4: 850hPa vorticity tracks of the named storms in 2015-2025. Green dots and red crosses indicate start and end points, respectively. Storms named by other meteorological offices have dashed magenta tracks.**



One way of exploring the overall exposure to named storms is through the development of a track density field, which is presented as an aggregation to a  $2^\circ$  grid in Figure 5. This shows that the area that has been under the influence of the most named events is located in NE England, centred around Newcastle.

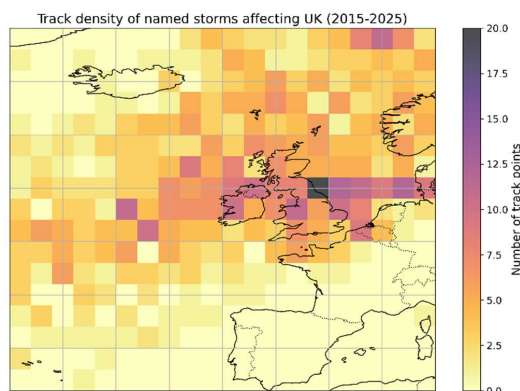
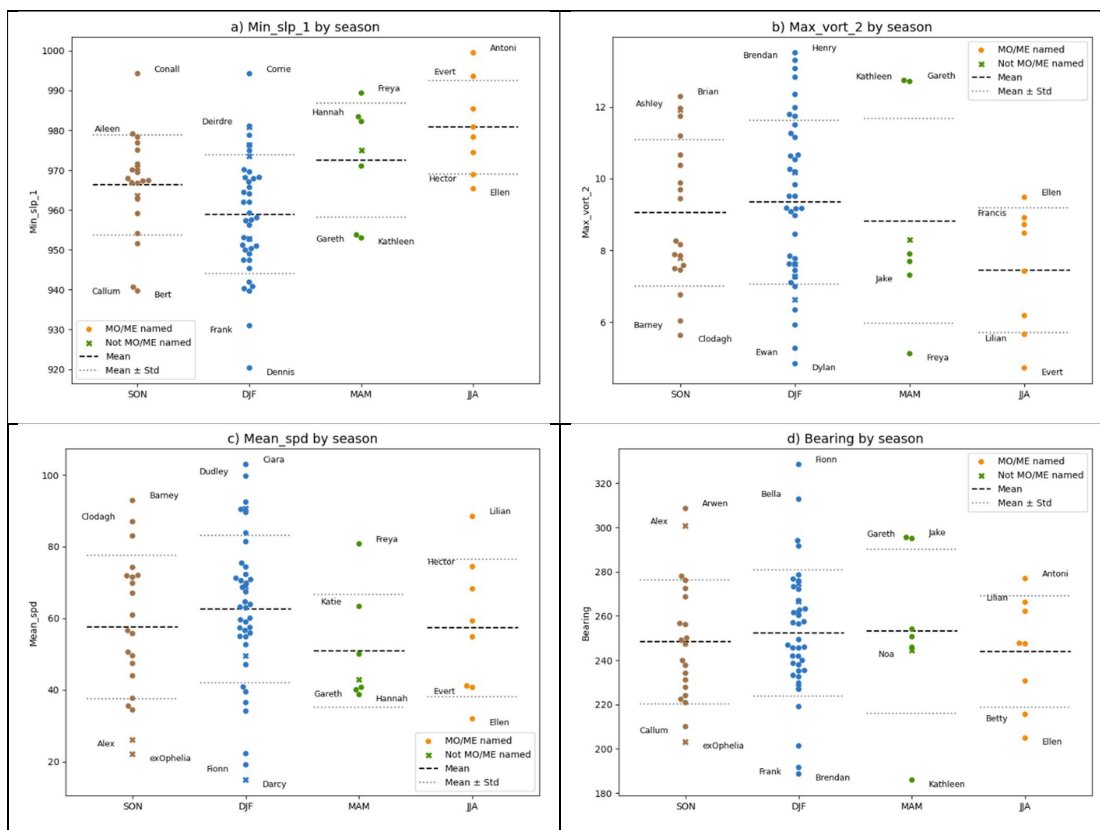


Figure 5: Named storms track density. Number of named storms track points crossing each  $2^\circ \times 2^\circ$  box in 2015-2025.

### 260 3.1.2 Storm metrics

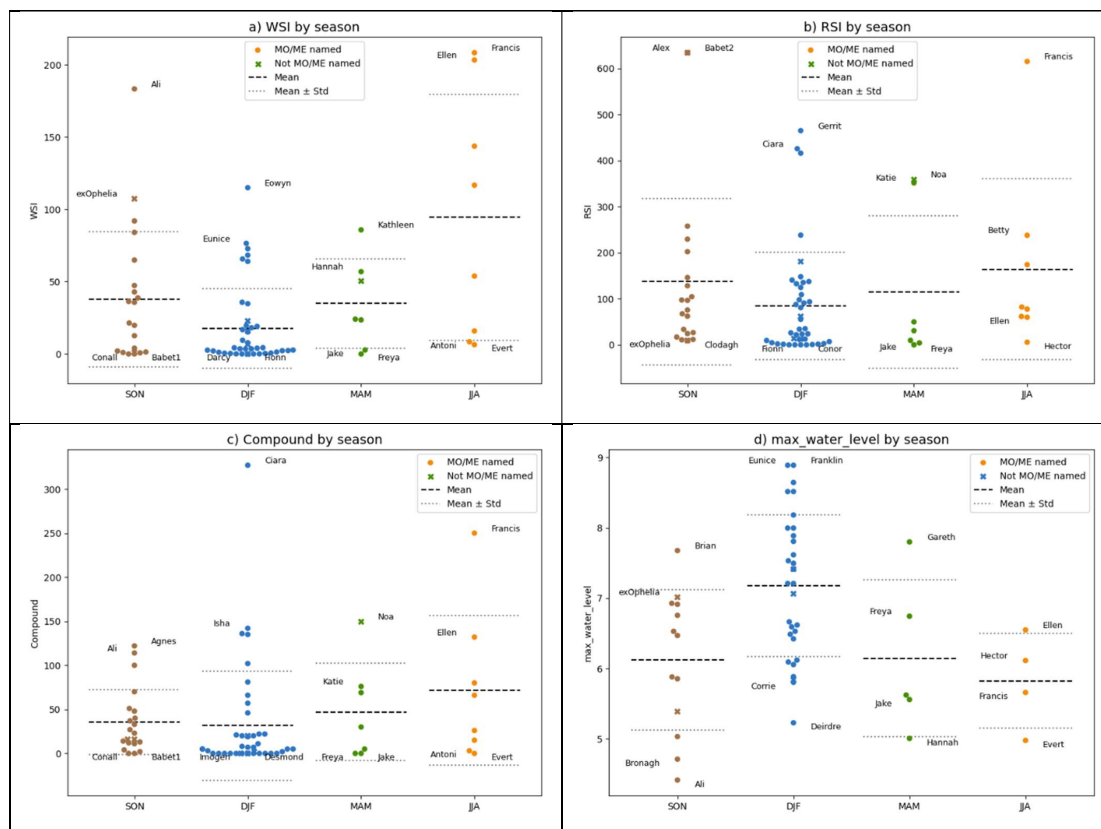
The analysis of the storm metrics allows exploration of typical ranges from named events and to identify particularly extreme storms. For example, Figure 6 presents swarm plots of some storm development metrics classified by season, including labels that identify the two strongest and weakest events. These sample metrics show that winter (DJF) storm metrics tend to span the full range, with autumn (SON) storms with just a slightly smaller range, acknowledging the limitations of the small sample size. The metrics that represent the strength of the storm (i.e., min\_slp and max\_vort) also reveal that the events that are highlighted as the strongest/weakest tend to depend on the specific metric, regardless of the season. Winter storms are on average stronger by both metrics than other seasons, though this difference is only statistically significant for a limited set of cases (based on a two-sided t-test with 95<sup>th</sup> confidence level). In the case of maximum vorticity, the difference is only significant between DJF and JJA, whereas in the case of minimum sea level pressure, DJF is different from all other seasons and SON is different from JJA. The events' speeds (panel c) also show some seasonal dependence, with storms tending to be faster in winter and autumn, but not statistically different. The direction of approach of the storms towards the British Isles (bearing, panel d) is on average from the SW and does not reveal significant differences between the seasons, but the spread between events and seasons is large.



275 **Figure 6:** Swarm plots of some storm development metrics by season. Dark dashed line shows the average value and the grey dotted lines identify the average plus and minus one standard deviation. Panels include a) minimum central sea level pressure over box 1 in hPa; b) maximum central vorticity over the smaller box 2 in 1/s; c) average translation speed over the full track in km/h; and d) the storm bearing in degrees, using wind direction convention. Refer to Table 1 for metrics definitions.

280 Similarly, typical ranges can be explored from the storm hazard metrics as in the examples of Figure 7. These metrics show different patterns in the seasonality, with for example the three severity indices (panels a-c) showing stronger summer values, though acknowledging the reduced storm set, and that no corrections have been implemented to account for changes in the background climate of the period. The seasonal differences were only statistically significant between DJF and JJA and for the case of WSI. Maximum water level (panel d), as a metric for coastal hazards, does show higher values for winter, but only statistically different than SON and MAM. The events that are highlighted as extremes do change with the variable, as in the case of the storm development metrics. This reinforces the experiences captured through engagement with resilience practitioners across sectors, highlighting the multi-dimensional nature of storm impacts.

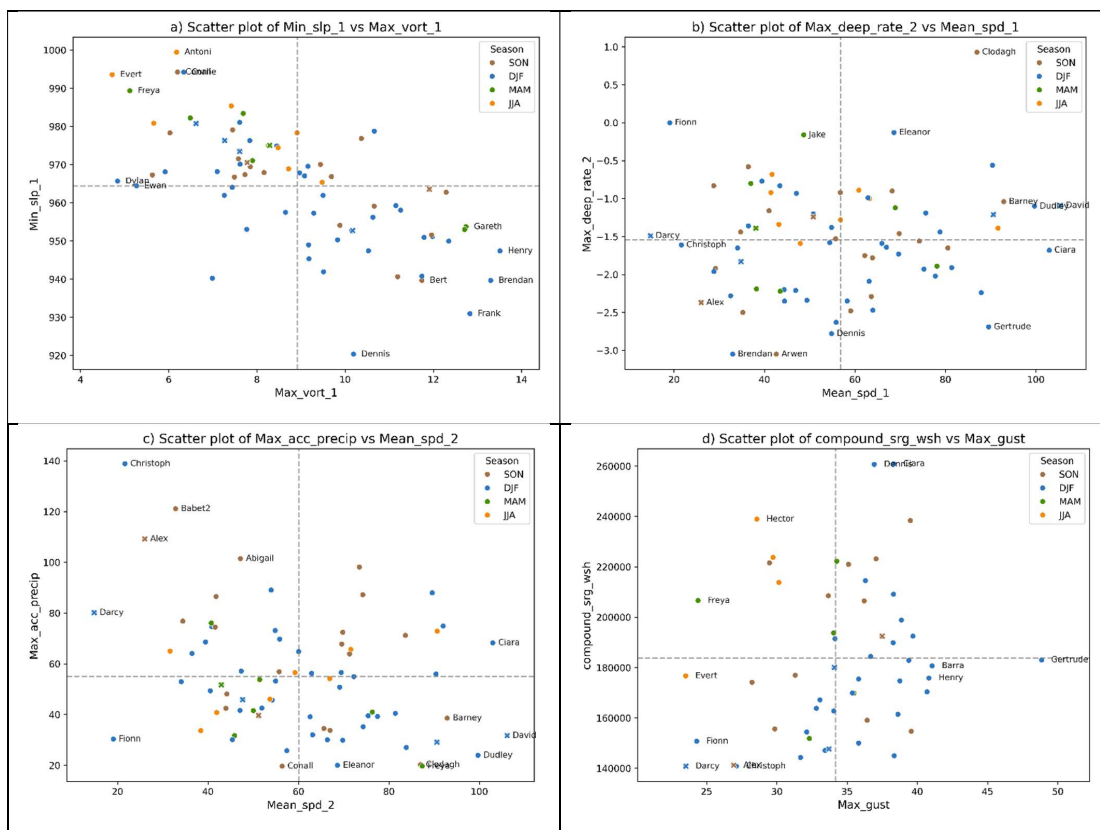
285



290 **Figure 7:** Swarm plots of some storm hazard metrics by season. Dark dashed line shows the average value and the grey dotted lines identify the average plus and minus one standard deviation. Panels include a) Wind severity index; b) Compound (rainfall and wind) severity index; c) Rain severity index; d) Maximum water level in m. Refer to Table 2 for metrics definitions.

It can also be interesting to explore relationships between metrics to evaluate redundancy in the information they provide, but also to identify extreme events in the combined space. Some of such examples are presented in the scatterplots of Figure 8. For example, panel a shows that there is a strong relationship between the storms' minimum central pressure and their vorticity, and panel b shows no significant relationship between the storms' speed and the deepening rates. Panel c, however, shows a much weaker relationship suggesting that slower storms tend to explain higher accumulated precipitation, and panel d could be interpreted to suggest that for winter storms (blue dots), the compound surge and wave height effects are stronger for stronger maximum wind gusts.

295



300 **Figure 8:** Sample scatterplots between metrics. The quadrants are defined by the metrics' average values as dashed grey lines. a) min\_slp\_1 vs. max\_vort\_1, b) Max\_deep\_rate\_2 vs. Mean\_spd\_1, c) Max\_acc\_precip vs. Mean\_spd\_2 and d) compound\_srg\_wsh vs. Max\_gust.

### 3.2 Case studies

This section describes in more detail some case study events that were selected to represent a range of conditions such as key hazards, different strengths and the role of the seasonality. The purpose is to use these storms as examples that introduce the full range of tools available in the dataset to assess and compare events.

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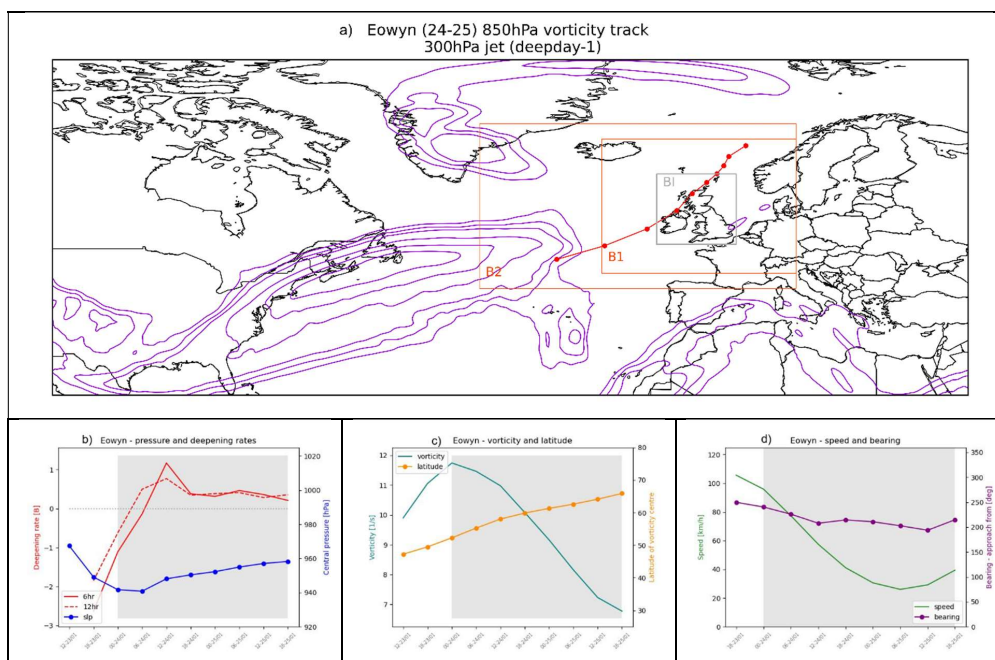
#### *Storm Éowyn – January 2025*

Storm Éowyn was the fifth storm in the 2024/2025 season and affected the Northern Ireland and central Scotland in late January 2025 (Suri et al., 2025). Most significant impacts of the storm were wind related, with the Met Office issuing a red



warning for wind. It is considered the strongest UK windstorm since 1998 and caused significant disruption due to some  
310 activities being stopped preventively such as schools, rail and ferry services, but also due to power outages (Kendon, 2025).  
Over Ireland, Éowyn broke all previous wind speed and wind gust records and was categorised as “Hurricane force”, a  
unique occurrence over the naming period (Ireland Storm Centre 2025). This storm has recently been used to illustrate the  
cascading impacts of such events on critical infrastructure (Cha et al. 2025).

315 Figure 9 describes the evolution of the storm as captured by ERA5. The 6-hourly track captured the cyclone when it was  
already within the B2 box, and deepening at explosive rates, reaching its minimum central pressure and maximum vorticity  
right before entering the BI box (denoting the area in close proximity to the British Isles). Through its influence on British  
Isles, the system progressed on a SW to NE track with decreasing translation speed.



320 Figure 9: Evolution of storm Éowyn in ERA5. Panel a) displays the 6-hourly vorticity track in red and the 300hPa jet stream  
contours the day before the storm’s maximum deepening rate in purple contours. The bottom panels display the evolution of some  
storm development metric for each 6-hourly point with the grey background indicating the period when the storm had influence  
over the British Isles box: b) central sea level pressure in blue and deepening rates for 6-hour and 12-hour periods in red  
325 continuous and dashed lines, respectively, c) central vorticity in teal and latitude in orange; and d) translation speed in green and  
bearing in purple.



For each named storm, the catalogue includes the full range of metrics described in Section 2, alongside the assessment of how the storm ranks for each metric, which allows to assess and compare its severity. Table 3 presents the storm development metrics for Éowyn, highlighting the cases in which the metrics are within the top 10 strongest, as is the case of the minimum central pressure and the deepening rates. Table 4 presents the hazard metrics in a similar way, showing that the event was particularly strong in terms of both winds (second strongest gusts, sixth strongest WSI) but also compound hazards, with top 10 compound exceedance areas and CSI. Together, these metrics reinforce the idea that this was a particularly strong storm (deep and explosively evolving system) that led to significant hazards both in terms of wind gusts but also due to the compounding rainfall hazard extent.

335 **Table 3: Storm development metrics for storm Éowyn. Units and definitions as in Table 1. Values in between brackets indicate the ranking per metric considering all named storms in the catalogue, with 1 meaning the strongest and 77 the weakest. Top 10 ranking values are highlighted in grey.**

Impact dates	Avspd	Avspd1	Avspd2	Mxspd	Mxspd1	Mxspd2
24-Jan-25	55.9(46)	55.9(38)	55.9(41)	105.6(32)	105.6(14)	105.6(26)
Mnslp	Mnslp1	Mnslp2	Mxvor	Mxvor1	Mxvor2	Mxdrate
940.8(7)	940.8(7)	940.8(7)	11.7(13)	11.7(12)	11.7(13)	-2.6(5)
Mxdrate1	Mxdrate2	bear	fetch_km	fetch_hr	lat_st	lat_dt
-2.6(3)	-2.6(5)	233.2	1209.3(56)	12.0(60)	47.3(39)	5.0(40)

Table 4: As Table 3 but for the storm hazard metrics, described in Table 2.

MxAcP	Mxgust	Mxppr	AcPpExA	GustExA	PprExA	GPA	GRA
69.7(20)	45.7(2)	5.4(25)	185643(5)	208130(17)	183841(4)	122779(3)	128436(4)
PRA	InfDur	WSI	WindDur	RSI	PpDur	CSI	CompDur
149087(2)	96(12)	115(6)	30(23)	124.5(23)	24(40)	135(6)	24(13)

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### *Storm Ellen – August 2020*

The second case study selected corresponds to storm Ellen, that impacted the UK between the 19<sup>th</sup> and 21<sup>st</sup> of August 2020, closely followed by storm Francis (25<sup>th</sup> August). This event was selected to allow a comparison with a late summer named storm event, that followed a very similar track across the British Isles as storm Éowyn. Storm Ellen was reported to bring very strong winds that caused significant disruption to the transport and power sectors, mainly in Ireland, Wales and other parts of western UK (Ireland Storm Centre 2020, Kendon 2020). Together with Francis, these storms were two of the 10 strongest August windstorms in the previous 50-year records (Kendon, 2020). Over Ireland, the storm triggered all three red, orange and yellow status warnings for wind, and broke several wind speeds and gusts records (Ireland Storm Centre, 2020).



Figure 10 presents the evolution of the event as represented by ERA5. The tracking of the cyclone started in the Labrador Sea and progressed towards the BI box with several changes in direction. This can be reflecting challenges of the tracking algorithm to locate and follow the storm centre, in particular during its earlier, weaker stages. This can also be seen as very changeable storm speeds and bearing (Fig.11d). The storm continued to deepen, reaching its minimum central pressure as it started influencing the British Isles, with a very similar behaviour for the maximum vorticity.

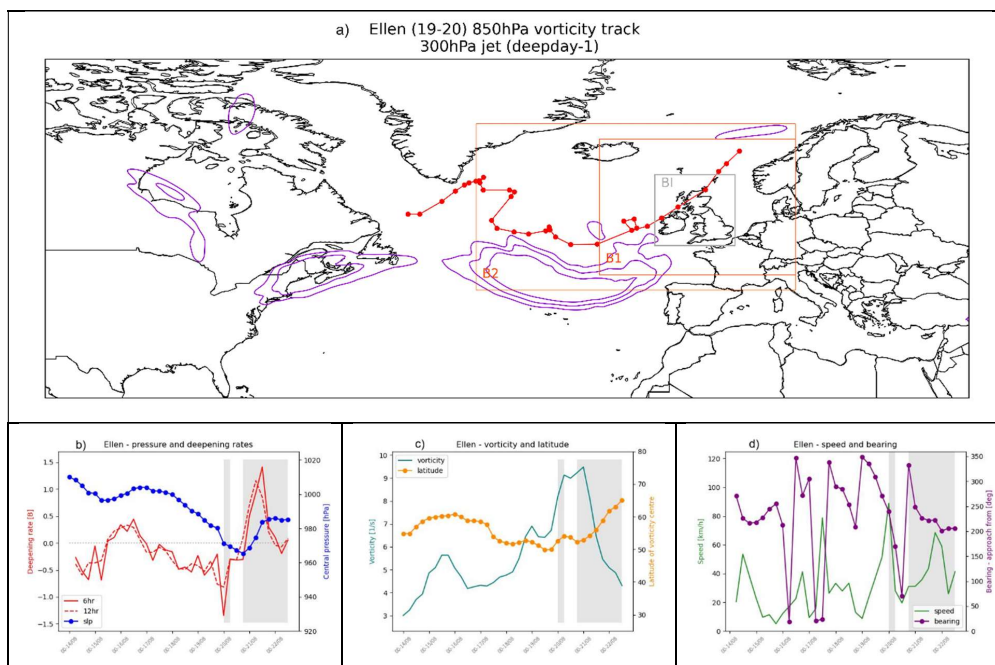


Figure 10: As Figure 9 but for storm Ellen.

A summary of the storm development metrics is presented in Table 5, that shows that the storm was relatively average to weak for most metrics, with the exception of fetch duration, for which it ranked fourth longest.

Table 5: As Table 3 but for storm Ellen.

Impact dates	Avspd	Avspd1	Avspd2	Mxspd	Mxspd1	Mxspd2
19-20 Aug 2020	31.9(72)	43.2(54)	31.6(73)	88.9(51)	88.9(33)	88.9(48)
Mnslp	Mnslp1	Mnslp2	Mxvor	Mxvor1	Mxvor2	Mxdrate
965.4(36)	965.4(36)	965.4(36)	9.5(33)	9.5(30)	9.5(32)	-1.3(50)
Mxdrate1	Mxdrate2	bear	fetch_km	fetch_hr	lat_st	lat_dt
-1.3(40)	-1.3(49)	204.8	4209.0(26)	144(4)	54.8(64)	-2.3(73)



Table 6, however, highlights that this storm was particularly strong for some wind and compound hazard metrics, such as the  
 gust exceedance area (sixth largest), WSI (second strongest), compound hazards duration (longest) and surge exceedance  
 360 (third largest), despite being a summer storm.

**Table 6: As Table 4 but for storm Ellen.**

<b>MxAcp</b>	<b>Mxgust</b>	<b>Mxppr</b>	<b>AcPpExA</b>	<b>GustExA</b>	<b>PprExA</b>	<b>GPA</b>	<b>GRA</b>
65.0(25)	29.7(63)	6.6(10)	75954(19)	269559(6)	71879(30)	75954(8)	71120(14)
<b>PRA</b>	<b>InfDur</b>	<b>WSI</b>	<b>WindDur</b>	<b>RSI</b>	<b>PpDur</b>	<b>CSI</b>	<b>CompDur</b>
47345(19)	78.0(20)	203.2(2)	48(3)	59.9(40)	60(9)	132(7)	42(1)
<b>MxSrg</b>	<b>SrgEx</b>	<b>MxWvSH</b>	<b>WvSHEX</b>	<b>MxWvPow</b>	<b>CompSrgWv</b>	<b>MxWatLev</b>	
0.9(42)	299755(3)	6.3(69)	227056(18)	18.4(71)	223724(5)	6.5(29)	

***Storm Eunice – February 2022***

The last case study included in this description corresponds to storm Eunice in the 2021/22 season, commonly remembered  
 365 as the central storm in the quick succession of three named events: Dudley, Eunice and Franklin. From this set of events,  
 Eunice stands out for the two rare red warnings issued by the Met Office for consecutive days, and this event being the most  
 severe and damaging to affect England and Wales since February 2014 (Kendon, 2022). Met Éireann also issued a red wind  
 warning for the SW coasts of Ireland (Ireland Storm Centre, 2022). This storm was chosen to highlight an event with strong  
 coastal impacts.

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Storm Eunice was characterised by strong winds that led to large waves. The overlap between a strong storm surge on top of  
 high spring tides severely affected western and southern coastlines and the Severn Estuary. For the first time, the whole of  
 the Welsh coastline was highlighted as being at severe risk of flooding. Fortunately, severe coastal flooding in the Bristol  
 Channel and Severn Estuary was avoided as defences held, and the storm surge did not overlap with high tide, in some  
 375 places by only 90 minutes. (Kendon, 2022). Over Ireland, the storm broke wave height records off the Cork coast (Ireland  
 Storm Centre, 2022).

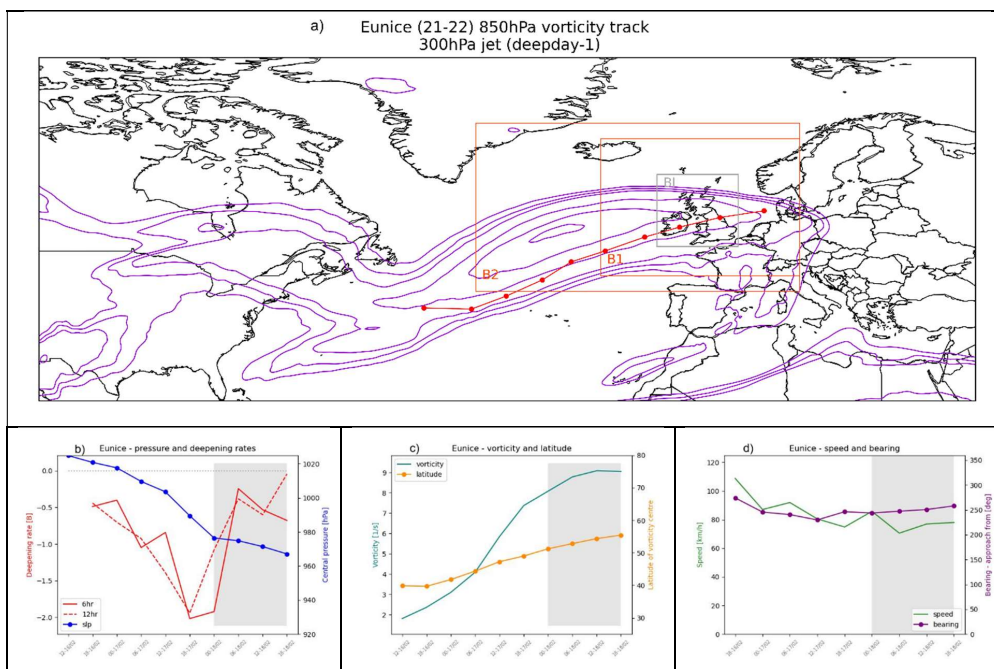


Figure 11: As Figure 9 but for storm Eunice.

Figure 11 presents the evolution of the system, showing a vorticity track that started in the west Atlantic and progressed from a WSW direction with relatively steady translation speed. The cyclone underwent explosive cyclogenesis within the B2 box, but its minimum central pressure continued to decrease during its track across the British Isles.

Table 7: As Table 3 but for storm Eunice.

Impact dates	Avspd	Avspd1	Avspd2	Mxspd	Mxspd1	Mxspd2
18-Feb-22	83.8(10)	77.8(15)	83.8(12)	108.8(23)	85.8(40)	108.8(18)
Mnslp	Mnslp1	Mnslp2	Mxvor	Mxvor1	Mxvor2	Mxdrate
967.1(40)	967.1(40)	967.1(40)	9.1(39)	9.1(36)	9.1(37)	-2.0(22)
Mxdrate1	Mxdrate2	bear	fetch_km	fetch_hr	lat_st	lat_dt
-2.0(14)	-2.0(21)	245.5	3173.5(38)	36.0(42)	39.9(18)	11.3(24)

The storm development metrics associated with this event (Table 7) are generally unremarkable, with the exception of its fast translation speed across the Atlantic. The coastal hazard metrics in Table 8, on the other hand, highlight a very high-

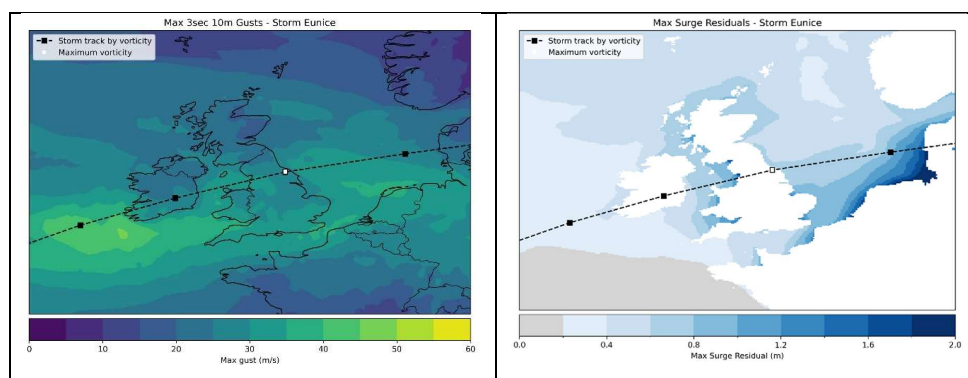


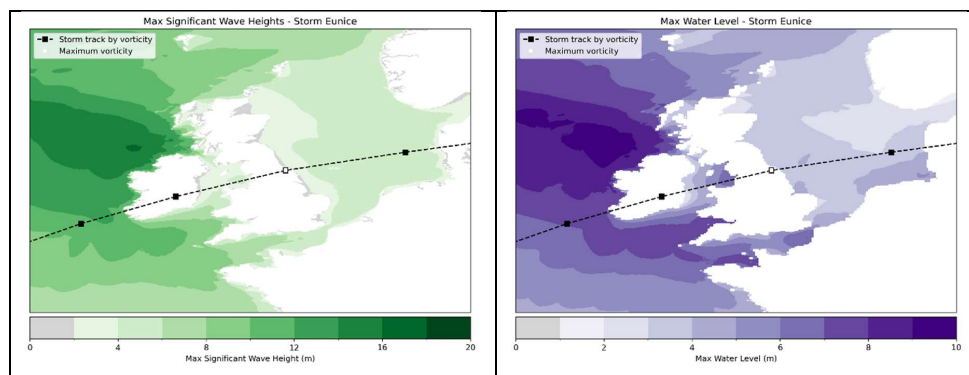
ranking event both for waves, surges and maximum water level. The storm's wind gusts do not rank significantly high, despite this storm having been documented to show very strong winds and indications of the presence of a sting jet (Volonté et al. 2024). In the case of storm Eunice, the strongest wind conditions were observed offshore and only impacting narrow areas of coastal Wales and southwest England (Figure 12a), which can explain why its severity is not properly captured in  
 390 ERA5.

**Table 8:** As Table 4 but for storm Eunice.

MxAcP	Mxgust	Mxppr	AcPpExA	GustExA	PprExA	GPA	GRA
27.0(71)	36.3(28)	4.7(46)	0.0(77)	171253(22)	69568(32)	0.0(77)	45422(21)
PRA	InfDur	WSI	WindDur	RSI	PpDur	CSI	CompDur
0.0(77)	30(68)	76.5(11)	18(53)	140.5(18)	18(57)	5.0(52)	6.0(58)
MxSrg	SrgEx	MxWvSH	WvSHEX	MxWvPow	CompSrgWv	MxWatLev	
1.1(19)	280305(9)	14.9(2)	232439(12)	32.5(4)	214471(10)	8.9(2)	

The catalogue also contains footprint maps for the storm, such as those included in Figure 12. The wind gusts footprint in  
 395 panel a) highlights that the strongest gusts were observed to the SW of Ireland, off the coasts of Cork, but strong winds also affected the Bristol Channel and the Irish Sea. These explain the high value of surge residuals in these regions (panel b). Maximum significant wave heights and water levels, in panels c and d, respectively, show very high values also affecting the northern coasts of Ireland and western Scotland, which could also indicate a residual impact from storm Dudley that followed a more northerly track.





400 **Figure 12: Example hazard maps corresponding to storm Eunice. a) Maximum wind gusts (m/s) storm footprint, b) maximum surge residuals (m), c) maximum significant wave height (m) and d) maximum water level (m).**

#### 4 Discussion and conclusions

This manuscript has presented a new dataset describing the first ten years of named storms over the UK. This catalogue presents a comprehensive set of metrics that describe and compare the evolution and hazards associated with these past  
405 severe weather events. The resulting tracks and their associated metrics have been reviewed and validated by expert Operational Meteorologists at the Met Office to confirm that they represent the storm systems that were named within the UK Storm Catalogue.

A comprehensive set of metrics that describe the systems' development and their associated land and coastal hazards are part of the catalogue, including several metrics of compound hazards. The compounding impacts of wind, rainfall and coastal  
410 hazards are fundamental to the understanding of the full severity of the events, and this dataset allows for their systematic assessment. This study has presented an initial characterisation of the storm metrics, such as their seasonality and typical ranges. Additionally, a set of case study events were introduced in this paper to highlight to potential users of the catalogue dataset how the different components of the set can be used to characterise and compare events.

Ongoing work led by the authors has focused on the use of the metrics to assess whether a storm would be a likely candidate  
415 to be named (in the absence of non-meteorological factors influencing the impact of a storm), which allows to extend the record to climate datasets, both historical – to investigate the magnitude and drivers to interannual variability in the number of (potential) named events per season – and future – to explore the presence of trends and the level of uncertainty in the projections for named events. Another active line of research focuses on using the catalogue to identify different storm types in the record, both in terms of their evolution and their associated hazards.



420 Early users of the catalogue have highlighted the opportunities that it has unlocked such as finding analogues of forecasted storms in the named storms record or establishing connections between storm metrics and measures of impacts. It is also believed to be an asset in an academic context, both as a teaching tool and to promote further research.

#### Data and code availability

The named storms catalogue is publicly available at <https://doi.org/10.5281/zenodo.18877013> (Gonzalez et al, 2026). This dataset contains the tracks, metrics and footprints for all the listed storms and a pdf version of the catalogue.

425 The code to develop the storm metrics has undergone the Met Office quality assurance review process and can be shared upon request.

#### Author contributions

**PLMG:** Conceptualization, Data Curation, Formal Analysis, Methodology, Project Administration, Software, Supervision, Visualization, Writing (original draft preparation, review and editing). **DA:** Conceptualization, Data Curation, Formal Analysis, Methodology, Project Administration, Software, Supervision, Visualization, Writing (original draft preparation, review and editing). **EM:** Conceptualization, Data Curation, Formal Analysis, Software, Visualization, Writing (original draft preparation). **DS:** Conceptualization, Data Curation, Formal Analysis, Validation, Writing (review and editing). **EW:** Conceptualization, Data Curation, Methodology, Project Administration, Funding acquisition, Supervision, Writing (review and editing). **MW:** Data Curation, Validation. **JAL:** Project Administration, Funding acquisition, Supervision, Writing (review and editing). **DHN:** Writing (original draft preparation).

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