Using sub-hourly data to estimate rainfall frequency and intensity across Europe

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1. MOTIVATION AND AIM

Sub-hourly design rainfall estimates are critical for analysing pluvial flooding, but sub-hourly rainfall observations are often limited. Our project aims to create a predictive framework for estimating local Intensity-Duration-Frequency (IDF) curves across Europe, covering durations from minutes to days (Figure 1).

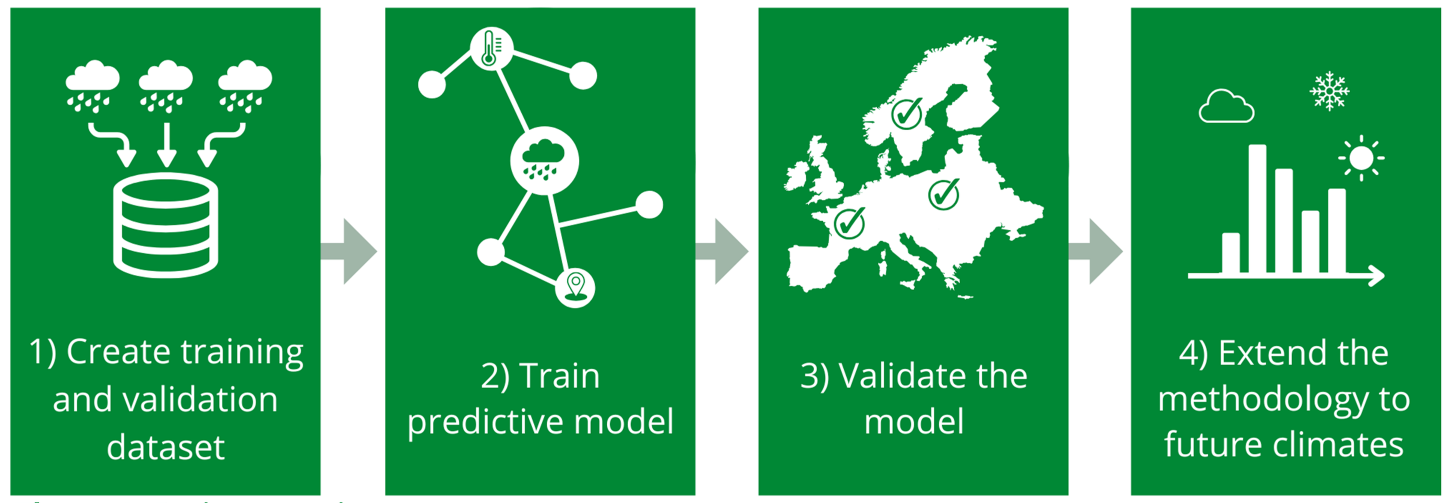

Figure 1. Project overview.

This poster presents the first step: evaluating whether a uniform statistical method can produce consistent IDF estimates from sub-hourly rainfall observations across multiple countries. Only plots representing the 1-hour duration are shown.

2. DATA AND METHODS

	Rainfall observations			National reference IDF datasets		
Country	Provider	Period	Temporal resolution	Source	Period	Temporal resolution
Denmark	SVK	1979–2023	1 min	SVK skrift 32	1979–2019	1 min
Germany	DWD	**1993**–2023	1 min	KOSTRA-DWD-2020	**1950**–2020	1 min
Norway	MET NO	1967–2023	1 min	Seklima IVF-verdier	1994–2023	1 min
Poland	IMGW-PIB	**2004**–2023	**10 min**	PMAXTP project	**1986**–2015	**1 min**
Sweden	SMHI	1996–2023	15 min	SMHI Klimatologie 47	1996–2017	15 min

Table 1. The rainfall data used in this study (2,438 rain gauges) and the national reference IDF datasets used for reference. Differences in observation periods and temporal resolutions are indicated in bold.

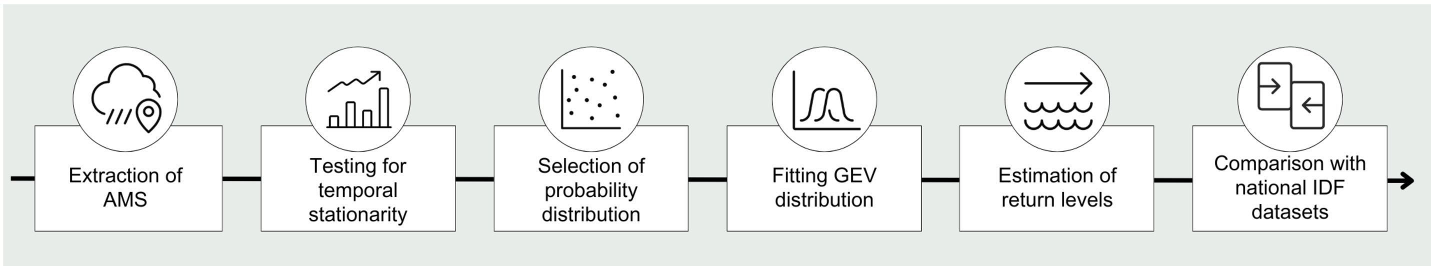

Figure 2. Workflow for estimating extreme rainfall intensities for durations of 15 minutes to 7 days across Northern Europe using annual maximum series (AMS) and L-moments estimation.

3. RESULTS

- **Stationarity:** After correcting for multiple testing (FDR), the AMS showed no significant non-stationarity (KPSS test).
- **Extreme value distribution:** GEV is appropriate across all countries based on L-moment ratio diagrams (Figure 3). This was confirmed by KS tests.
- **Spatial pattern:** Location and scale parameters exhibit a north-south gradient; no systematic spatial pattern in the shape parameter (Figure 4).

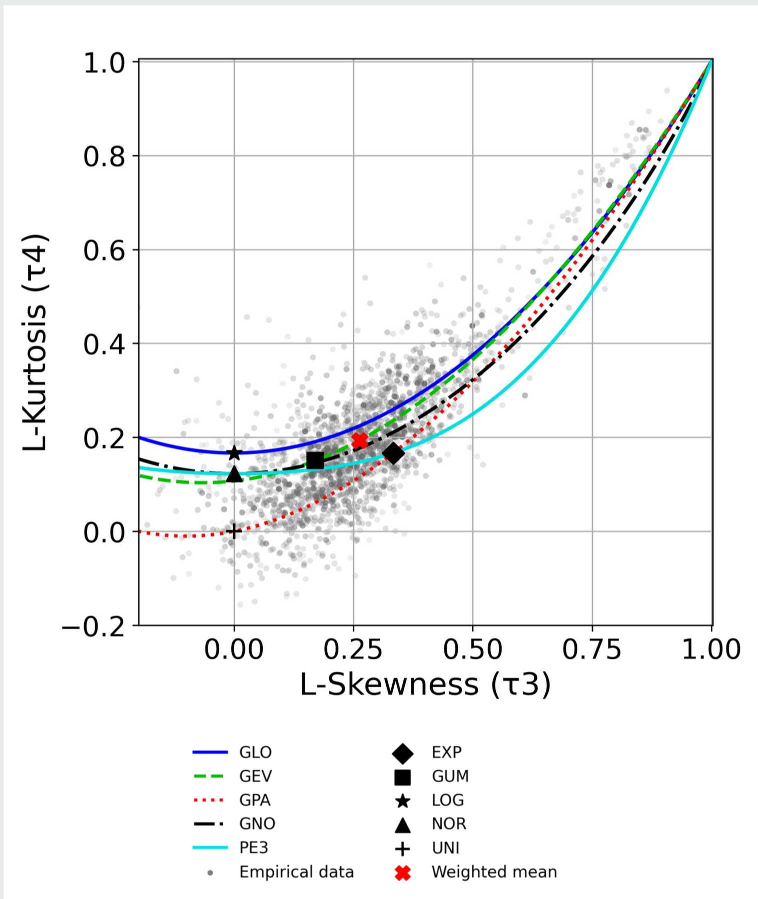

Figure 3. L-moment ratio diagram for the AMS. Grey points show sample values; lines and black symbols represent theoretical distributions.

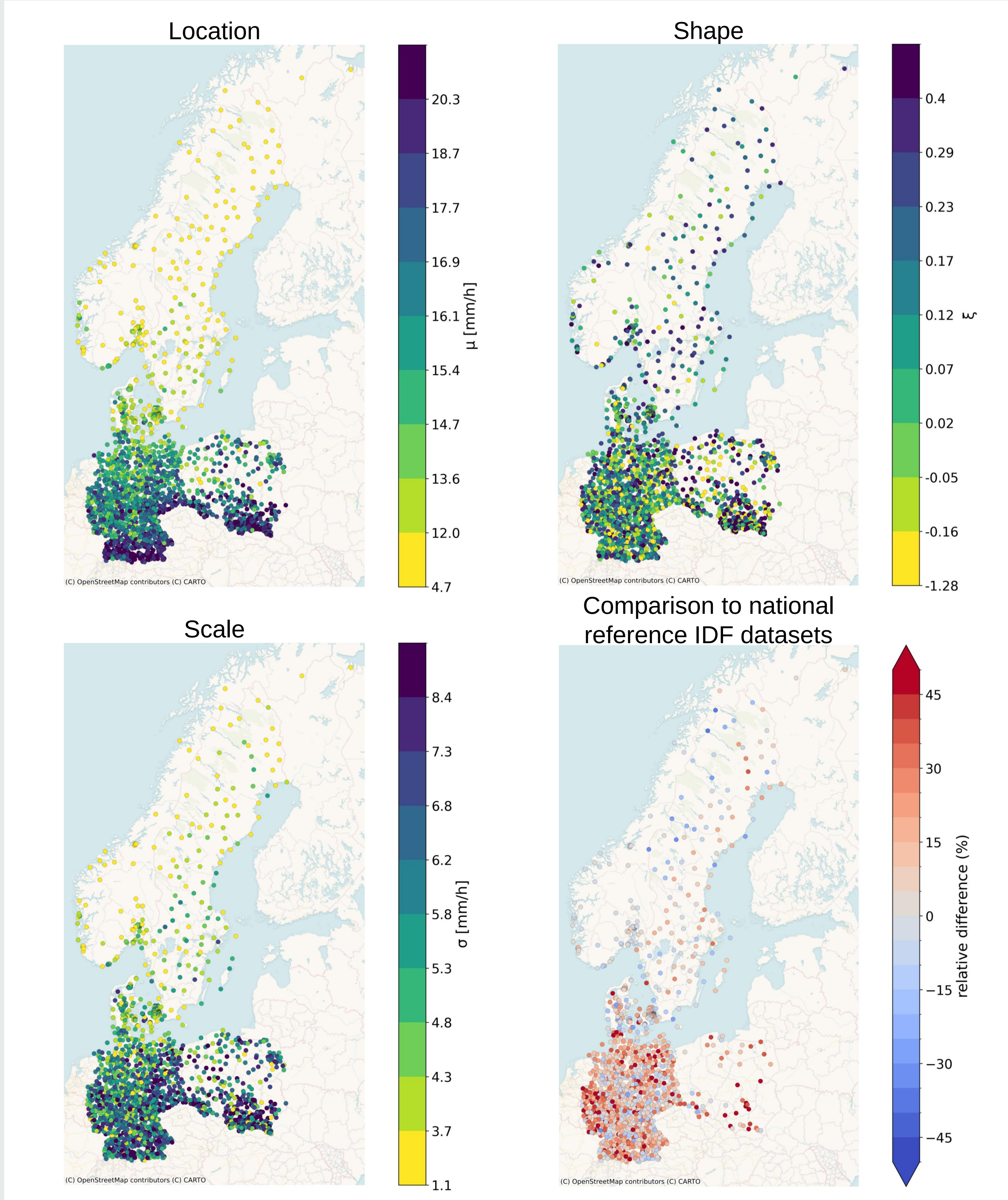

Figure 4. GEV parameters estimated with L-moments (location, scale and shape) and relative difference between the 10-year return level from this study and the national reference IDF datasets. Parameter estimates are binned by quantiles.

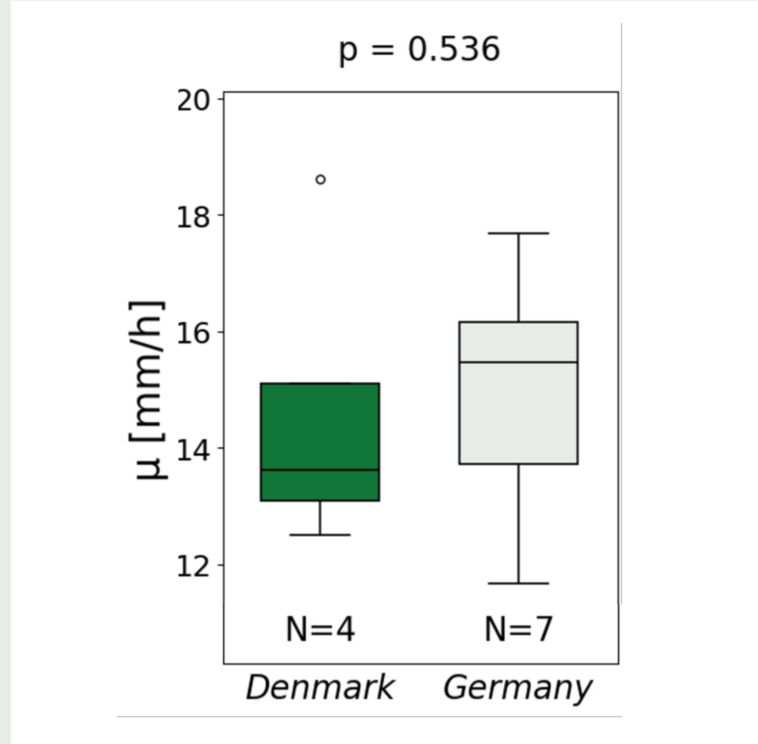

Figure 5. Box plots of the GEV location parameter estimates along the Danish-German border. Rain gauges within 25 km of the border are sampled. p-value of a two sample KS-test is shown.

- **Border consistency:** Visual differences in the location parameter along the Danish-German border (Figure 4) were not statistically significant (two-sample KS test, Figure 5). No significant inconsistencies were found at any national borders.
- **Return level comparison:** Return level estimates show moderate to strong agreement with national IDF datasets(Figure 4). Mean relative error for the 10-year return period ranges from -3.2% to 14.5% across durations; 12% for 1-hour event.

4. CONCLUSION

Consistent results across countries and high agreement with national reference IDF datasets — when based on the same rainfall data — support the use of a uniform GEV-based method to build a harmonized training dataset for IDF prediction.

[EGU abstract]

Abbreviations

AMS	Annual Maximum Series
FDR	False Discovery Rate
GEV	Generalized Extreme Value
KPSS test	Kwiatkowski–Phillips–Schmidt–Shin test
KS test	Kolmogorov–Smirnov test

The project is funded by Scalgo and the Innovation Fund Denmark