Impact Forecasting: EU WS Clustering

July 2015

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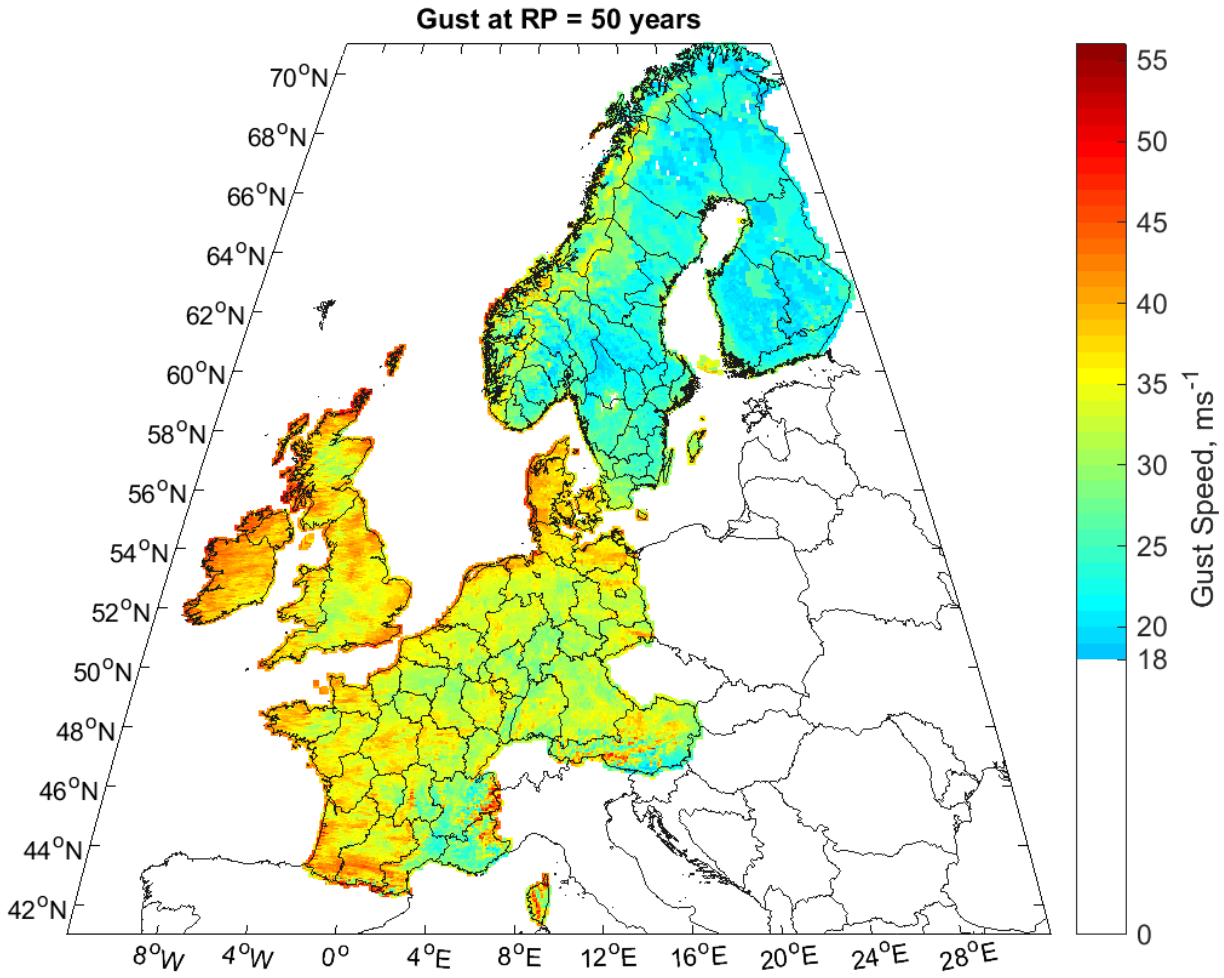
Section 1: IF European windstorm hazard

- Releases
  - **March 2014:** Western Europe (eight countries)
  - **September 2015:** Nordic + Austria

- Stochastic event set:
  - Based on GCM (Global Circulation Model)
    - The storms are directly extracted from the GCM data
    - Calibrate the biases (GCM & downscaling) on 50 years reanalysis
  - 12,044 events in 4,731 simulated years: about 2.5 storm days/year
  - 7x7km grid (18x18km above the Polar Circle)



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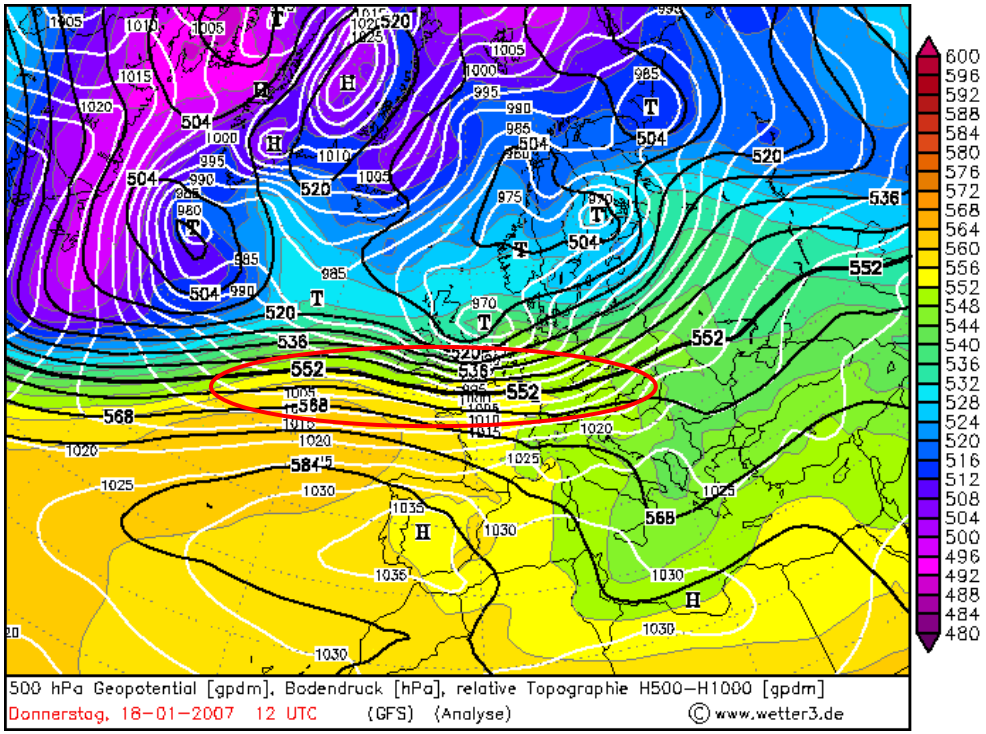
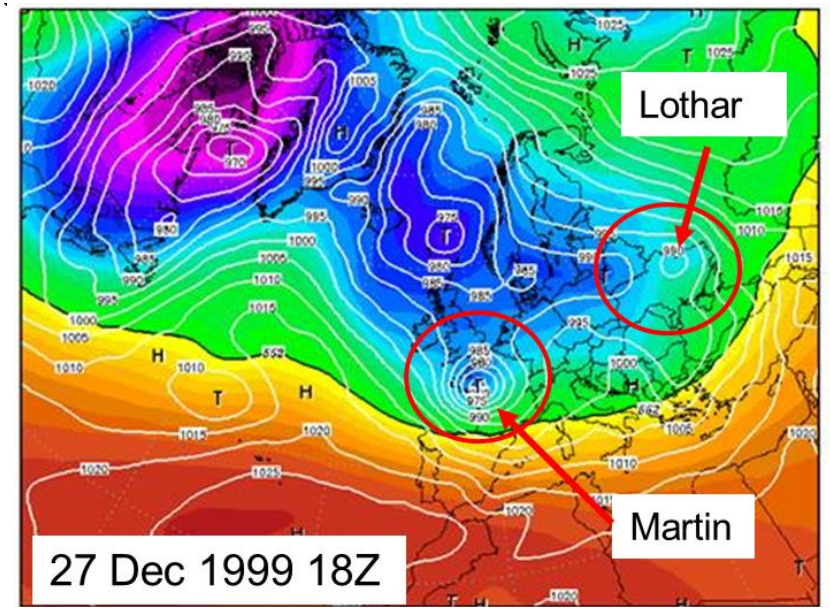
Section 1: Physical basis for storm clustering

- The occurrence of cyclone families (e.g. Lothar & Martin) depends on:
  - Steering modes of large-scale atmospheric circulation (e.g. NAO).
  - Energetic Upper level eddy-driven Jet

- Location, occurance, intensity and spatial extend/orientation of the upper level Jet and secondary cyclogenesis on **a seasonal basis** depends on the NAO phase.





Section 1: IF clustering approach

- All events in a year come from process based simulation of global weather and climate with a atmosphere-ocean coupled GCM
  - **Date**, **intensity** and **impacted area** for each event are derived from the GCM
  - The **number of events per year** and the **spatial** and **temporal distance** between events are derived directly from the GCM

- We do not:
  - Make ad hoc assumptions on the maximum intensity and clustering of low frequency storms
  - Reconstruct years (annual clusters) pooling GCM events from a large pool.
  - Move events between years

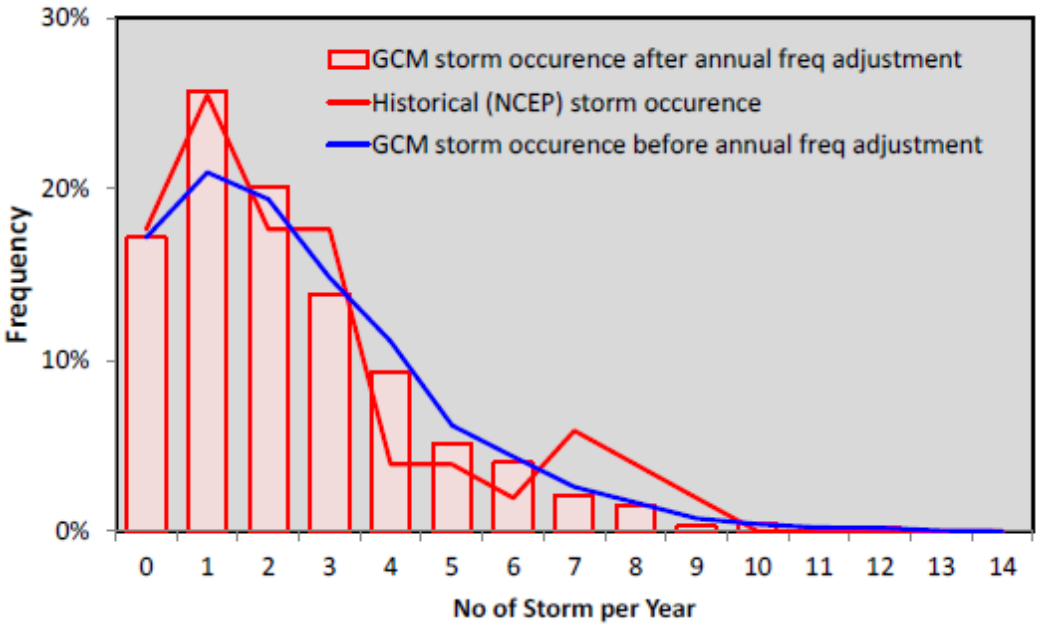
- Objective is to maintain:
  - Spatial and temporal structure, intensity ranking
  - seasonal clustering within the GCM output

Section 1: Observed vs. GCM seasonal clustering

- Distributions of the number of storms per year
  - Extraction threshold is 2.5 strongest activity days (2.2 events) per year

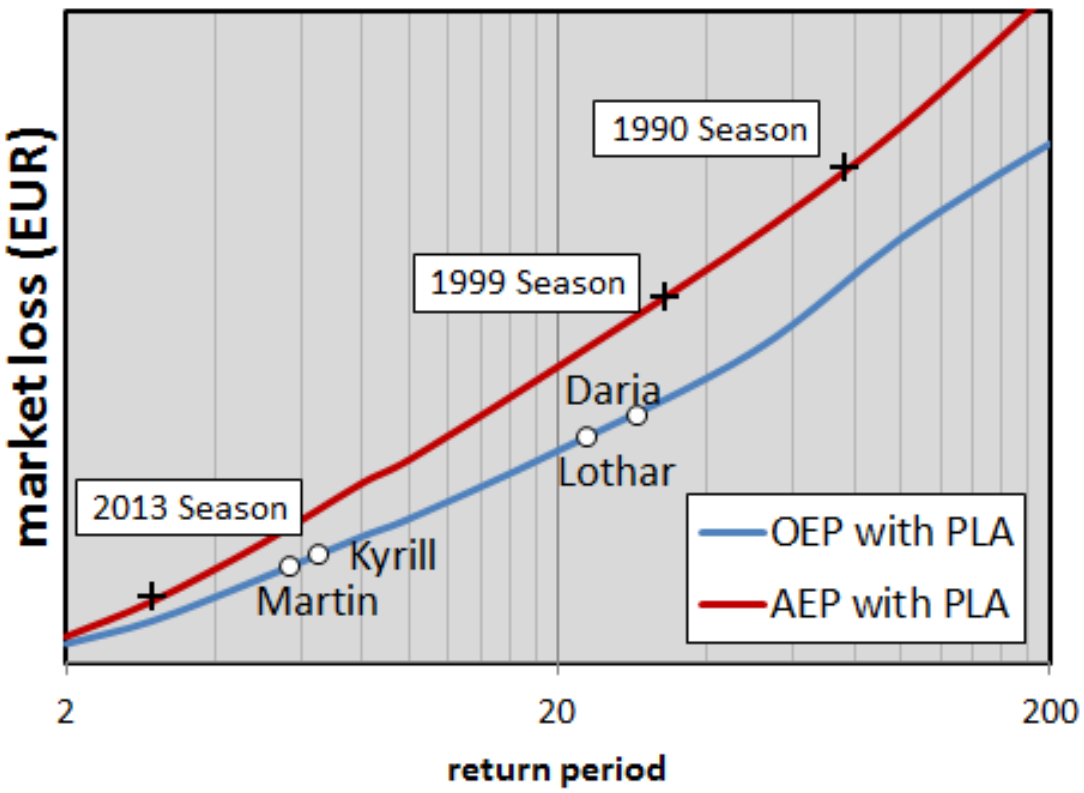
- IF Model (GCM generated)
  - Mean: 2.2 events per year
  - Variance: 3.9
  - Dispersion (Variance / Mean): 1.76

- NCEP (1957 – present)
  - Mean: 2.2 strong events per year
  - Variance: 3.7
  - Dispersion (Variance / Mean): 1.72



Section 2: IF Clustering results

- Return periods for notable seasons.
  - **1990**: 75 yrs PR, (Daria, Vivan, Webke, Herta, plus other smaller storms).
  - **1999**: 30-35 yrs RP, (including, Lothar, Martin, and Anatol).
  - **2013**: 3 yrs RP, (including Christian, Xaver, Dirk and Tini).



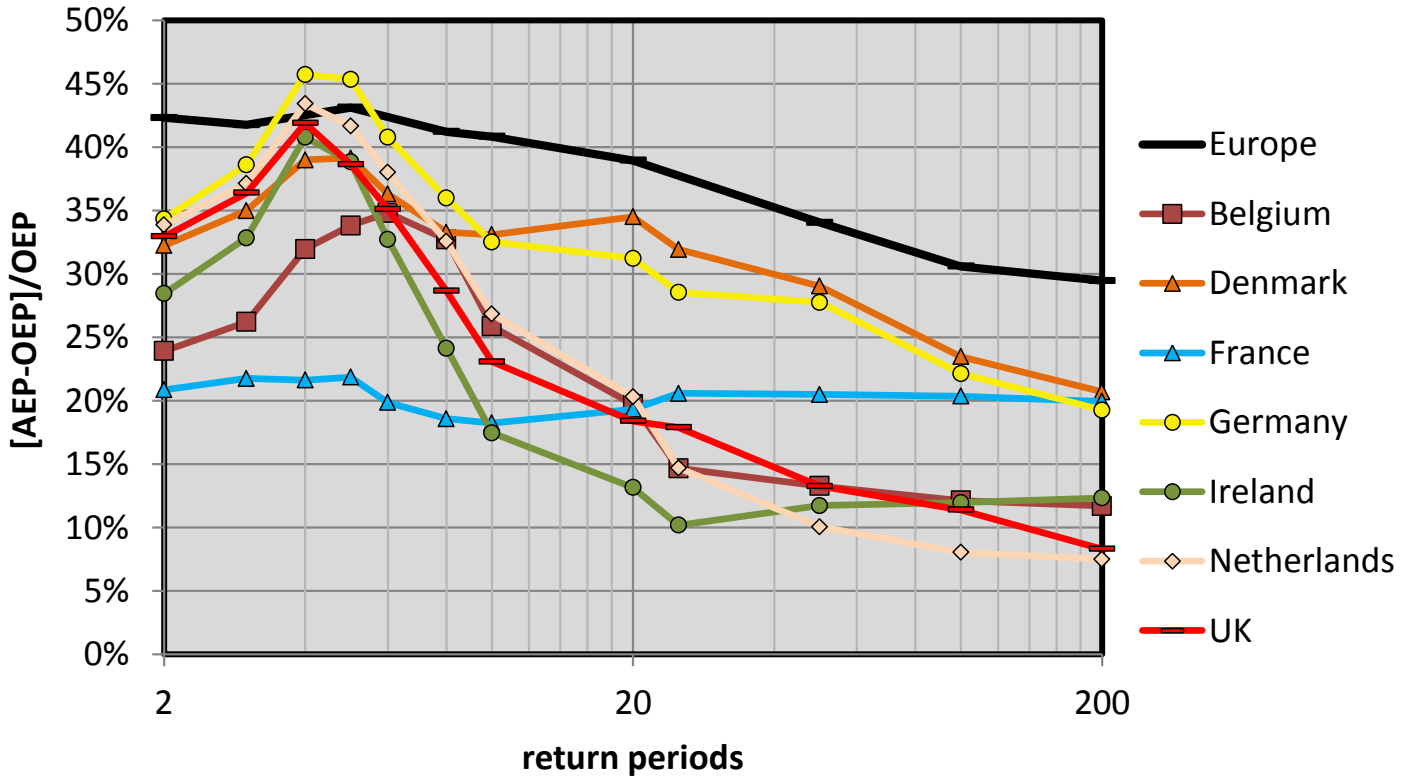
The plotted **Occurrence Exceedance Probability** and **Annual Exceedance Probability** curves are based on the IF European 2011 market portfolio.

The losses for the storms and the seasons are estimations compiled from PERILS and other sources, inflated to 2011.

Section 2: IF Clustering results

- The difference between OEP and AEP is a function of the geographical position (e.g. proximity to N. Atlantic or the N. Sea) and the size of the country

- Market 2011 portfolio AEP-OEP difference:
  - 2 to 20 yrs: 45-40% of the OEP
  - 20 to 200yrs: 40-30% of the OEP



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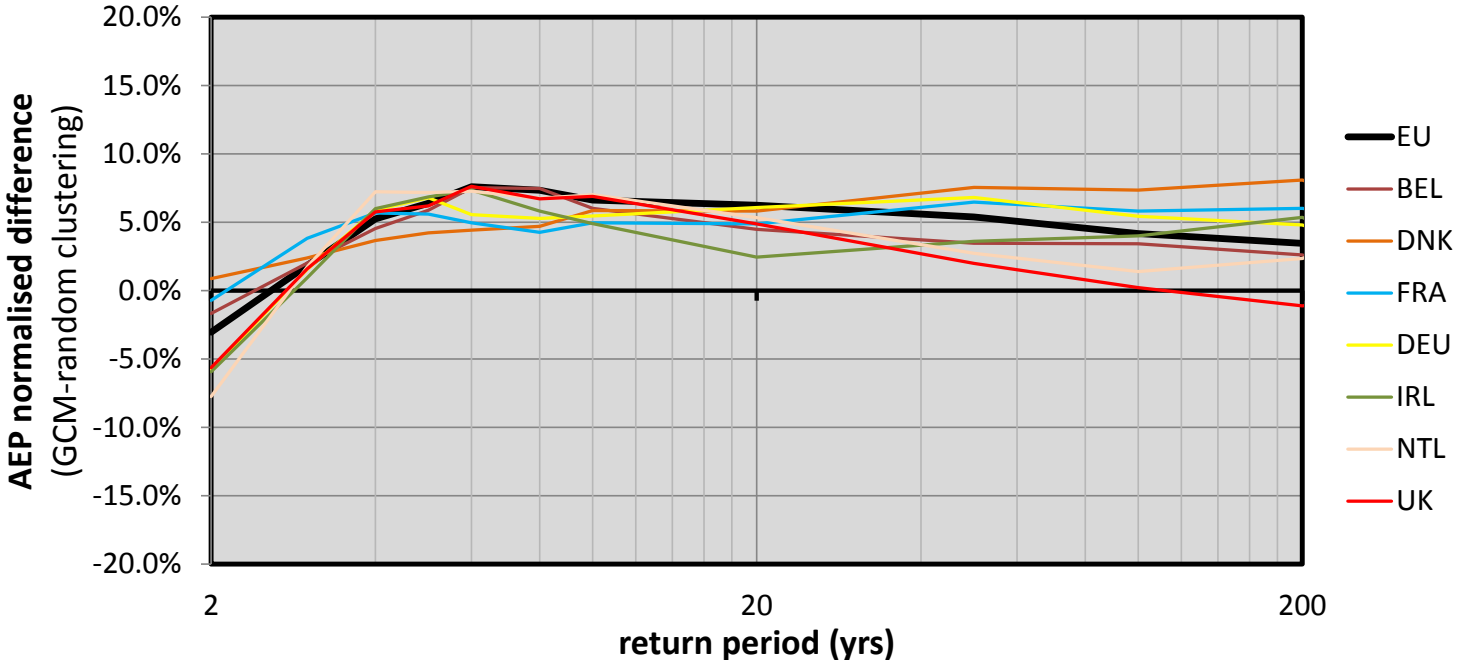
Section 2: GCM vs random annual clustering

- Net difference between the GCM based AEP and a randomly clustered AEP per country. The randomly clustered event set is sampled using a Poisson distribution. Positive values indicate that the GCM based AEP is above the Poisson based one (**over-dispersion**)



- The GCM clustering over-dispersion tends to **level off** above **ten years return period**
- More traditional clustering views in the market usually based on statistics from the 1960-2010 record **tend to place the region of levelling off well beyond ten years return period**

Section 3: Summary/Conclusion

- Stochastic annual clustering in the model is:
  - NOT based on assumptions extracted from the NCEP reanalysis
  - Incorporates the clustering generated from the GCM

- The resulting clustering pattern (compared against a random annual storm grouping) suggests an upper cap around 10-20 years RP.

- Further work in cooperation with J. Pinto and colleagues (Univ. Reading & Univ. Cologne) is under way.
  - Analyse multi-decadal variability of seasonal clustering in IF model database
  - Detailed analysis of storm clusters in winter 2013/2014
  - Analysis of dynamics of clustering in high resolution GCMs

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