



## **Return periods of extreme wind-storms over Europe: An approach with compound indices and ERA-40 data**

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Accurate knowledge of the frequency distribution of strong surface winds is a fundamental base for insurance and other related risk assessments. In practice, applications often use a simplified characterisation of past storms in terms of a compound return period, which describes the expected frequency in the context of a larger domain. In this study, we propose a method for the estimation of such compound return periods using methods of extreme value analysis and apply the method to European winter wind-storms of the past decades that have caused substantial damage.

As the climatological database we use the ERA-40 Reanalysis of the European Centre for Medium-Range Weather Forecasts (ECMWF) that spans the 44 year period 1958-2002. First, a quality assessment of the ERA-40 wind gust data was necessary. Grid points with unrealistic and biased wind gust values were found especially in mountainous regions and in regions with changing land-sea structure (e.g. coast or islands). These grid points were masked for the analysis.

The calculation of compound return periods is based on generic scalar storm indices that summarise the overall intensity and the area affected by the storms. Several indices have been developed to examine the sensitivity to their definition. Estimates of the return periods (including their uncertainty) were then obtained from the 44 year index time series using a peak over threshold model (POT) together with a suitable declustering technique.

The results suggest that a simplified storm characterisation by a compound return period may be feasible for European land areas though with some limitations in accuracy: The majority of the selected winter storms are rare events, i.e. occur on the upper

end of the tail in the wind gust distribution. The resulting return periods vary considerably depending on the domain (land or sea) and the definition of a wind storm index. Using an index calculated over western Europe (land only), return periods of well known events typically vary between  $0.24 \pm 0.01$  years to  $15 \pm 9$  years (95% confidence interval). The considerable uncertainties associated with the short sampling period and with the variability in methodological settings suggest that applications of compound storm return periods should incorporate these uncertainties to the end result.