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Extreme European Winter Storms: Sensitivities to Detection Methods and Reanalysis Datasets

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This study aims to detect and characterize severe western-European windstorms, as a first step of a project aimed at improving risk assessment for insurers. A catalogue of nine very severe storms, well-known for having caused important damages over Europe, was used as a reference base.

Initially a detection scheme of severe western-European winter storms in the ERA-Interim reanalysis was developed. The relative vorticity at 850 hPa was chosen as the detection variable, since it was found to be selective enough to capture extreme events. Indeed, the nine reference storms all have maxima above the 99th percentile of the 4xdaily distribution. The high spatial resolution of ERA-Interim allows the maximum vorticity to reach very high values; a threshold of 3.10-4 s-1 (corresponding to the 98th percentile), coupled with a condition on event duration, is used to identify 63 extreme events over the period and geographical area considered. Two comparisons, described hereafter, are then performed.

The overall project will be to assess the risk, for an insurance company, due to the potential changes of winter storms' activity in the future climate. The Global Climate Models used for this kind of study have a coarser spatial resolution compared to the ERAI dataset; it is therefore central to estimate the validity of the method for a lower spatial resolution. To do so, the method is applied to the ERA40 Reanalysis 850 hPa relative vorticity field. The relative vorticity distributions and the detected extreme events are compared.

Another test is carried out in order to compare our method based on the 850 hPa vorticity field with the detection method of Murray and Simmonds (1991). This method consists in looking for maxima in the Laplacian of the sea level pressure field (equivalent to the quasi-geostrophic relative vorticity) in the first place, and, in a second step, the minimum of pressure in the vicinity of the maximum found is searched - its (non-) existence will separate the cyclones in (open) closed systems. This scheme is applied to the ERAI dataset and, as mentioned previously, the extreme event sets are compared.

Finally, a study of the large scale environment is initiated using the extreme events detected by the above described method (850 relative vorticity from ERAI dataset). The large-scale environment at the time of occurrence of extreme events was defined by applying an 8-day running mean. For about two-thirds of the events, including the nine reference storms, the large-scale wind at both the 700 and 300 hPa levels shows a well-defined jet at the latitude of western Europe, extending far eastward and with higher than average wind speed. The remaining vorticity events occur within a large-scale environment with weak jets that does not seem as favourable for rapid storm development. Indeed, they are not associated with extreme values of the reanalyzed surface wind, whereas most of the "strong jet" events are.