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The Morphology of Cyclonic Windstorms

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The aim of this study is to help facilitate the correct interpretation and use of model analyses and predictions of windstorms in the extra-tropics, and to show that 'storm detection' does not just depend on the efficacy of the identification/tracking algorithm.

Under the auspices of the IMILAST (Intercomparison of MId-LAtitude STorm diagnostics) project, 29 damaging European cyclonic windstorms have been studied in detail, using observational evidence as the main tool. Accordingly a conceptual model of windstorm evolution has been constructed. This usefully has its roots in the evolution one sees on standard synoptic charts, and highlights that three types of damage footprint can be associated. Building on previous work these are referred to as the warm jet, the sting jet and the cold jet footprints. The jet phenomena themselves each relate to the proximity of fronts on the synoptic charts, and accordingly occur in airmasses with different stability characteristics. These characteristics seem to play a large role in determining the magnitude of surface gusts, and how those gusts vary between coastal and inland sites. These aspects will be discussed with examples, showing that one cannot simply characterise or rank cyclones using wind strength on a lower tropospheric level such as 850hPa. A key finding that sets the sting jet apart, and that makes it a particularly dangerous phenomena, is that gust magnitude is relatively unaffected by passage inland, and this seems to relate to the atmosphere in its environment being destabilised from above. For sting jets wind strength may be greatest below 850hPa.

Unfortunately neither current generation global re-analyses, nor global climate models seem to be able to simulate sting jets. This is for various reasons, though their low resolution is key. This limitation has been recognised previously, and the standard way to address this has been to use a re-calibration technique. The potential pitfalls of this approach will be highlighted using the aforementioned windstorm set to illustrate. Based again on case studies it will be shown that spatial resolution in a numerical model needs to be of order 10-20km to capture most major windstorms. However even then some of the smaller systems, which can be equally damaging, will be missed.