SEVERE BOW ECHOES IN GERMANY

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I. INTRODUCTION

Severe wind gusts in excess of 26 m/s highly contribute to the threat of hazardous weather in Germany. Organized deep moist convection does likely play an important role for the generation of severe wind gusts in Germany as indicated by former and recent publications (e.g. Dotzek, 2005; Kaltenböck, 2004; Hubrig, 2004; Gatzen, 2004; Haase-Straub et al., 1997; Pistotnik et al, 2011; Gatzen et al, 2011). Bow echoes that are frequently capable of producing severe winds can be an important contributor to the severe wind gust occurrence (e.g. Klimowski et al, 2003). In Germany, a classification of severe wind gusts with respect to the occurrence of bow echoes has not been published so far. An analysis of the severe bow echoes can be used to compare German bow echoes to results in the United States (e.g. Burke and Schultz, 2004; Klimowski et al, 2004).

II. DATA AND METHODOLOGY

A 15- year data set (summer seasons 1997-2011) of maximum wind gust measurements of the WMO network in Germany was checked for the occurrence of wind gusts in excess of 26 m/s. At the time and location of the wind gust observations, radar images archived every 15 minutes at a 2x2 km horizontal resolution were analysed to classify the events as bow echoes or non-bow echoes.

The analysis of radar images was done manually. To classify a radar echo as bow echo, a set of characteristics were checked analogous to Klimowski et al (2000) and Burke and Schultz (2004). Given the outflow-dominated character of a bow echo, the reflectivity image of the storm was checked to have a convex leading edge characterized by a tight reflectivity gradient, with the radius of the system increasing with time. In contrast to the studies by Klimowski (2000) and Burke and Schultz (2004), radar velocity data were not available for this work.

The non-bow echo events were divided into squall-line events, supercell events, single cell events, and narrow cold-frontal rain bands. For the bow echoes that were identified, a classification based on the origin of the bow echo was done analogous to Klimowski et al (2004). This classification includes cell bow echoes, supercell bow echoes, squall-line bow echoes, classic bow echoes, and bow echo complexes. A schematic overview of these different bow echo classification given by Klimowski et al (2004) was used for this work.

It has to be noted that the analysis of the radar structure of a given storm can lead to unclear results. Especially small and short-lived bow echoes are difficult to detect given the temporal and spatial resolution of the radar data. Additionally, bow echoes that are embedded in a squall line were sometimes not clearly distinguishable from squall-lines with curved sections that were likely not bow echoes.

Another important issue is that cold-season (October-March) severe wind gusts were not included in this work. Most severe wind gusts that occurred in the winter were related to synoptic-scale pressure systems rather than organized deep moist convection. As a consequence, this study concentrates on the severe wind gusts occurring from April to September.

III. RESULTS

In the 15-year data set, more than 300 severe wind events were found in the summer season in Germany. About 50 percent of these events were analysed to be not bow echoes, with a large fraction being squall-line and single cell events. From the bow echoes that contributed to one half of all severe wind events, most were embedded in squall-lines. The second largest group of bow echoes were classic bow echoes. Cell bow echoes and bow echo complexes were not that frequent with a fraction below 10 percent of all wind events. Furthermore, 16 events have been analysed as possible derechoes with a path length between 400 and more than 1000 km. Mostly all possible derechoes were associated with classic bow echoes or bow echo complexes and predominantly occurred in July.

The seasonal distribution of bow echoes indicated a maximum in the months June and July, followed by August and May. Only a few events occurred in April, and bow echoes in September were very rare.

The distinction between strongly and weakly forced severe wind events indicated that most bow echoes occur with strongly-forced situations. Only a few events were characterized by weak-forced situations. Furthermore, most events were associated with a south-westerly mid-level flow. Only a few events developed within a north-westerly flow pattern.

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