A Close Look at a Severe Mesoscale Convective System during the "Kyrill"-Winter Storm over Central Europe

Christoph Gatzen[1], Helge Tuschy[2,3], Pieter Groenemeijer[4,3], Oscar van der Velde[5], Johannes Dahl[6], Jan Hoffmann[7], Angel Dimitrov

1. MC-Wetter, Berlin, Germany, gatzen@estofex.org
2. Institute of Meteorology and Geophysics, Innrain 52, A-6020 Innsbruck, Austria, mesoscale_2@hotmail.com
3. European Severe Storms Laboratory, Oberpfaffenhofen, Germany.
4. Insitut für Meteorologie und Klimaforschung, Forschungszentrum/Universität Karlsruhe, Karlsruhe, Germany.
5. Laboratoire d'Aérologie, Université Paul Sabatier, Toulouse, France.
6. Deutsches Zentrum für Luft- und Raumfahrt e.V., Oberpfaffenhofen, Germany.
7. Freie Universität Berlin, Berlin, Germany
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I. Introduction

On 18th January 2007, the extraordinary strong low-pressure system "Kyrill" crossed Scotland and the North Sea and finally was located over Denmark during the evening hours. It was one of the most intense storm systems that affected central Europe for decades. In association with such winter storms, deep convection can contribute significantly to the peak wind gusts near the surface.

This case study addresses a mesoscale convective system that developed along the cold front of "Kyrill" moving across Central Europe during the day. The process of pre-frontal destabilization is analysed as well as the development and organisation of the mesoscale convective system. Additionally, a mesoscale analysis shows characteristics of the pre-frontal environment and convection over eastern Germany, where at least 3 strong tornadoes occurred (ESSL/ESWD, 2007).

II. Mesoscale Setting

Using the ingredients-based theory for severe convection, the development of instability and wind shear during the "Kyrill" storm is discussed. As satellite images show an impressive dry intrusion overspreading the warm sector, WRF model runs are used to analyse the process leading to destabilization of the maritime air mass. Furthermore, data of the wind profiler stations of the German Weather Service (DWD) are used to show how vertical wind shear developed. The decision-making for a convective forecast is discussed, addressing favourable as well as limiting factors for the development of organized convection and expected weather scenarios.

III. The Structure of the Mesoscale Convective System

With the Doppler radar network of the DWD, a close look at the mesoscale convective system is possible. Echo top reflectivity, vertical cross sections, and Doppler velocity data as well as cloud radar scans are shown to demonstrate the development of deep convection and bow echoes along the propagating cold front.

Over Germany, high-resolution surface observations allow for a detailed analysis of cold pools in the range of the MCS indicated by pressure, wind, and temperature fields.

Combining the results of this section with an analysis of measured peak wind gusts during the passage of the cold front, it is discussed if this event can be classified as a strongly-forced derecho (Johns and Hirt, 1987; Gatzen, 2004).

IV. Reasons of the Confined but Significant Tornado Occurrence over Eastern Germany

Over eastern Germany, at least 3 strong tornadoes occurred in the evening hours along or just ahead of the propagating cold front. Including high resolution surface data, soundings, and wind profiler data, an air mass characterized by a well-mixed boundary-layer is noticeable over a region north of the Erzgebirge mountains with Berlin at its northern boundary. In this region, lee effects from the central German low mountain range mountains may have support this mixing in the warm sector air mass. As a consequence, a weak frontal boundary is present ahead of the propagating cold front.

In the range of this boundary, a couple of small, but very intense convective cells where detected by the radar. One of those crossed Berlin, leading to hail and the record precipitation intensity of the winter season. The structure and lifetime as well as the thermodynamic environment of these convective cells is discussed. Furthermore, the strong tornadoes occurring in eastern Germany were likely associated with these convective cells.

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V. References

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