Bow Echo event July 14 th 2010 in the Netherlands

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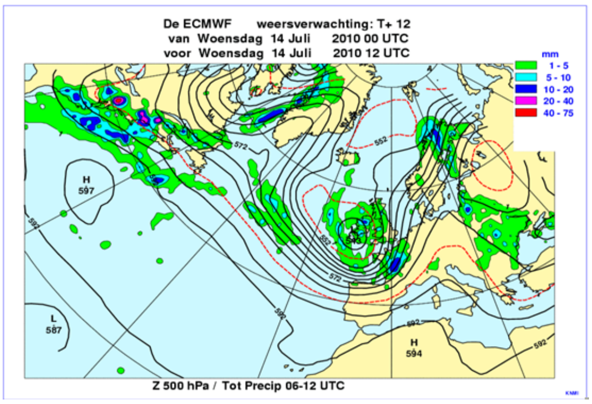
I. INTRODUCTION

In this study, the structure of a bow-echo on a squall line is investigated. This paper will assess the synoptic environment in which this squall line evolved, as well as the mesoscale features of the bow echo, including radar-reflectivity and radial velocity. Furthermore a model study on this case has been performed. With a non hydrostatic model (HARMONIE, resolution 2.5 km) the structure of the bow-segment can be visualized, including the RIJ.

II. PRESENTATION OF RESEARCH

On July 14 th 2010 a squall line with several bow segments crossed the eastern part of the Netherlands from south to north. This event damaged many houses and trees and one camping site was hit severely fatally wounding two persons. A mile north of the camping site five electric poles went down. It was the first time in Dutch history that high winds were the cause of this. In figure 1 we clearly recognise the characteristic weather pattern over Europe for severe thunderstorm development. On the weather chart of 12 UTC we see a low pressure area just south of Ireland with a cold front moving into NW-France. In the warm sector a line of convergence developed in a zone with high Tw. The 500 hPa-map shows a short wave trough over western France. These were the basic synoptic ingredients for severe convection later this day.



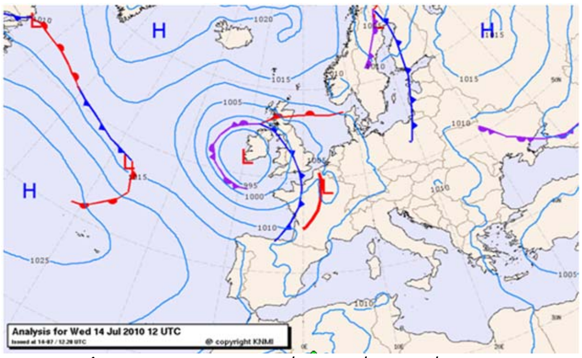


***Figure 1** ECMWF-analyses July 14 th 2010 12.00 UTC, 500Z and precip. 6-12 z, Groundmap-analyses (produced daily by KNMI)*

Mesoscale aspects

Bases on C-radar reflectivity from our Dutch radar composite (based on two radar sites) we were able to recognize the signatures connected to a bow-echo system. Nearest radar site is located 80 km from the area of interest (figure 3and 4), including the RIJ inflow notch and preferred regions om mesovortices (MV).

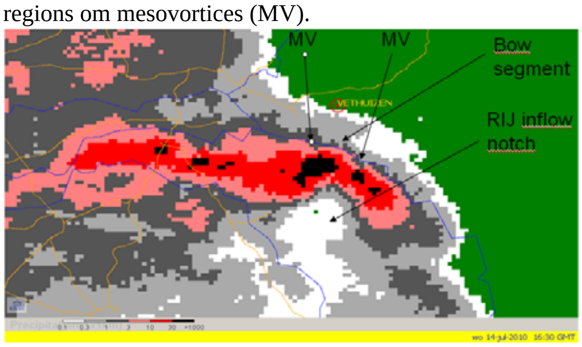


***Figure 3** C-band radar De Bilt; pseudo cappi (1500m) reflectivity images detailed overview of the area of interests in the east of the Netherlands July 14 th 2010 16.30 UTC.*

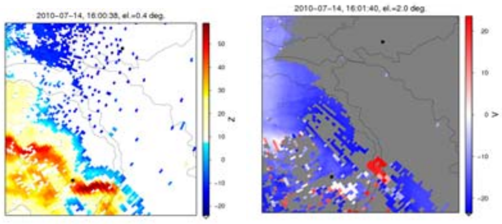


Figure 4 *C-band radar De Bilt; left: reflectivity from elevation 0.4 degrees. Right: Rad velocity elevation 2.0 degrees July 14 th 2010 16.00 UTC*

In figure 4 the 0.4 degrees scan at 16.00 UTC gives a clear signature of the forefront of the gust front. In the absolute radial velocity at 2.0 degrees elevation some aliasing can be seen in the area of the strongest RIJ.

In figure 5 we can see the vertical profile based on the scan from radar site De Bilt. In de radial wind (absolute frame) we can see a sharp gradient, shortly after passage of the bow segment, which climbs up in time (elevated RIJ at a certain distance behind the leading edge).

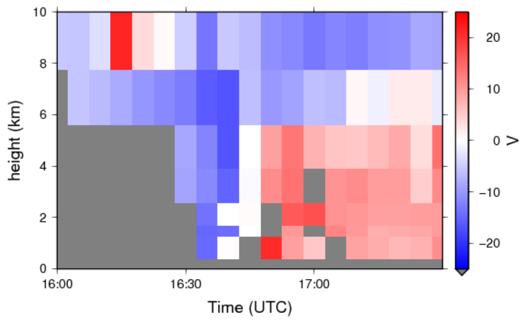


Figure 5 *C-band radar De Bilt Vertical profiles of radial wind above Vethuizen July 14 th 2010 16.00 – 17.30 UTC*

III. THEORETICAL ESTIMATE OF THE CONVECTIVEWINDGUSTS

$$w_0 = \sqrt{\mathrm{NAPE} + \mathrm{LOAD} + \mathrm{HMOM}}$$

NAPE=Negative Available Potential Energy, is downdraft equivalent of CAPE

LOAD= precipitation loading

HMOM= maximum horizontal momentum (strenght RIJ)

Based on radiosonde De Bilt Juli 14 th 2010 12 UTC estimate **highest** windgusts is in the range

40-55 m/s

Both the NAPE, the Negative Available Potential Energy, is downdraft equivalent of CAPE, and the precipitation loading (LOAD) can be estimated by the information retrieved from a radiosonde. The maximum horizontal momentum that can be incorporated by the downdraft has to be determined directly from upper-air soundings or numerical weather prediction models.

Model study on this case

A non hydrostatic model (HARMONIE, resolution 2.5 km) was run at ECMWF using mostly default settings, i.e. non-hydrostatic AROME physics and EDKF convection, but with varying domain size and using either Hirlam or ECMWF boundaries.

In this simulation the bow echo structure become visible with the highest simulated wind speeds along the path of its bowing segment.

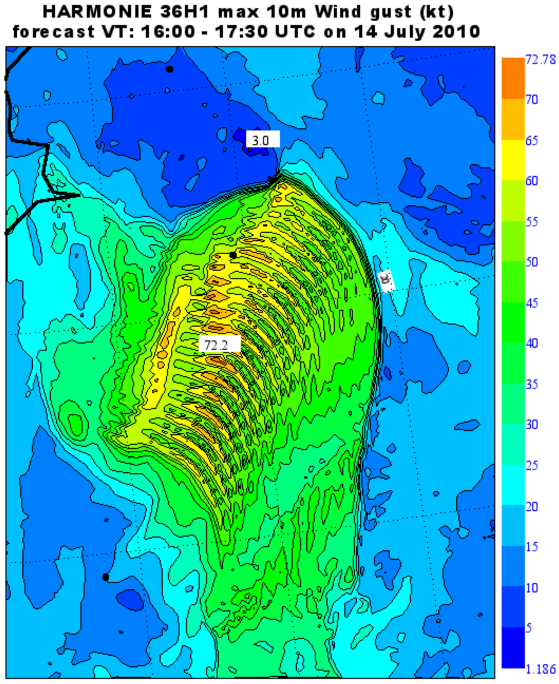


Figure 6 *Simulation of a Harmonie run with 10 m windgusts (knots)*

IV. ACKNOWLEDGMENTS

V. REFERENCES

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