Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

Bow Echo event July 14th 2010 over the Netherlands

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In this study, the structure of a bow-echo on a squall line is investigated. This poster will focus on the radar measurement of the meso scale 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. Finally an algorithm is introduced for calculating convective gusts.

1. Introduction

On July 14th 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.

2. Mesoscale aspects

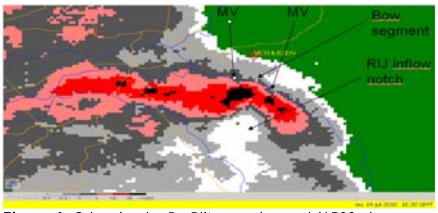

***Figure 1**. C-band radar De Bilt; pseudo cappi (1500m) reflectivity images detailed overview of the area of interests in the east of the Netherlands July 14 th 2010 16.30 UTC.*

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, including the RIJ inflow notch and preferred regions with mesovortices (MV).

On figure 1 we clearly can recognize the bow echo signatures like the RIJ notch in the rear side and the bow segment itself. We used an hand method which tries to estimate the highest wind gust based on (negative) buoyancy (NAPE) due to evaporation or melting of precipitation, precipitation loading (LOAD), and incorporation of horizontal momentum. Both the NAPE and the LOAD can be estimated by the information retrieved from a sounding. 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.

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

Based on sounding De Bilt July 14th 2010 12 UTC the estimate is around 50 m/s.

3. Radial velocity

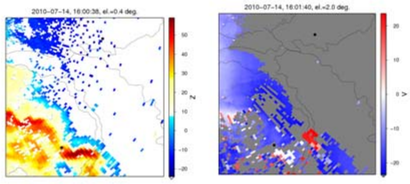

***Figure 2**. C-band radar De Bilt; left: reflectivity from elevation 0.4 degrees. Right: Rad velocity elevation 2.0 degrees July 14 th 2010 16.00 UTC*

The 0.4 degrees scan at 16.00 UTC gives a clear signature of the leading edge 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 (see figure 2). In figure 3 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).

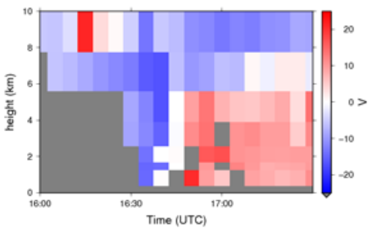

***Figure 3**. C-band radar De Bilt; vertical profile of radial wind above Vethuizen 16.00 -17.30 UTC July 14 th 2010.*

4. Model study on this case

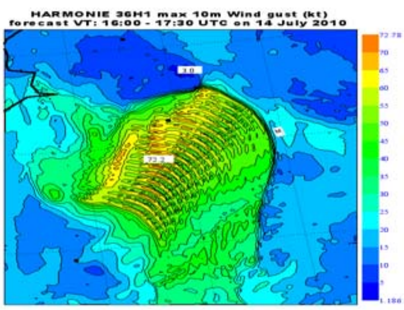

***Figure 4**. Simulation of Harmonie-run*

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.

5. Calculation of convective gusts

The calculation within Hirlam looks at the value of NAPE at the altitude which corresponds with the maximum height of the boundary layer (pre-determined in a 24 hours period then not to be bothered by the collapse of the boundary layer during the evening and night). The NAPE is determined by the difference in the wet- and dry bulb temperature and integrated over the maximum boundary layer depth. The shear is also included in the calculations by scaling 0-3500 m-wind shear (wind shear 0: * 0.25 NAPE, wind shear 30 m / s: NAPE * 1, interpolation in between).

In figure 5 you can see an example of predicted convective wind gusts with values in excess of 100 knots. In the near future we will determine the value of the method by statistical analysis of the model output and observations.

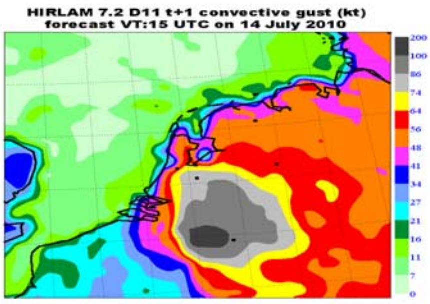

***Figure 5**. Hirlam calculation of convective windgust for July 14th 2010 15 UTC.*

References

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