P1B.2 ANALYSIS OF DOWNBURST–PRODUCING THUNDERSTORMS DURING THE VERTIKATOR FIELD EXPERIMENT IN SOUTHERN GERMANY

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1. INTRODUCTION

The VERTIKATOR project aimed at an improved understanding of initiation and development of shallow and deep convection over hilly and mountainous terrain. Interaction of synoptic scale settings with local effects like the heat low over mountain ranges or valley flows on convective transport was a major focus.

During the intensive observation period (IOP) in summer 2002, one investigation area was located in the northern Alpine Foreland between Munich and Innsbruck. A great variety of observations were made, involving several aircraft, radars, lidars, sodars, and a surface mesonet. In addition, routine observations, like radiosondes, satellites and cloud–to–ground (CG) lightning data from the BLIDS network are available.

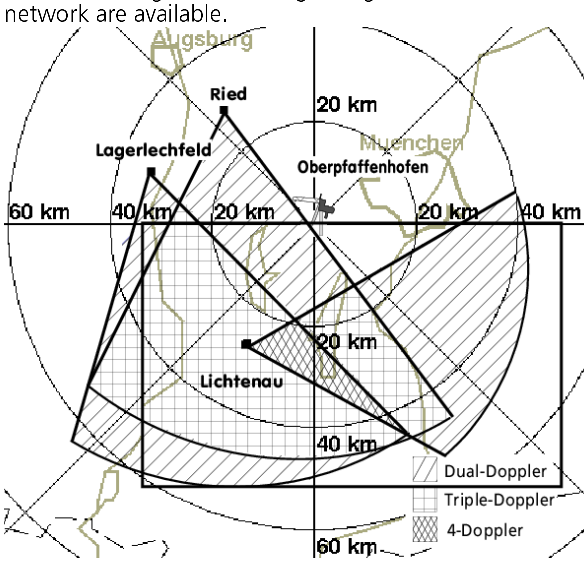

Figure 1. DLR's bistatic radar observation area, with POLDIRAD at the origin. The three bistatic receivers, their apertures and overlaps are indicated. Hatching corresponds to the number of individual wind components available.

The C–band polarization diversity Doppler radar POLDIRAD at DLR provided three–dimensional information on thunderstorm dynamics and microphysics, allowing for identification of different hydrometeor types in the thunderclouds and their anvil regions.

Additional bistatic receivers at Ried, Lagerlechfeld, and Lichtenau (cf. Fig. 1 and Friedrich, 2002) simultaneously measured several individual wind components. So the wind vector field could be determined within the hatched regions in real–time. During the VERTIKATOR Alpine IOP, life cycles of a variety of thunderstorms were observed. In this paper, three downburst–producing thunderstorms are exemplarily presented.

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2. CASE STUDIES

According to the TorDACH storm reports, all storms studied here had both damaging straight–line winds and large hail. On all three days, thunderstorms first formed over the Alps and then moved rapidly into the Bavarian Alpine Foreland.

2.1 F0 microbursts: 20 June 2002

The most notable hailstorm reached its highest intensity at approximately 1540 UTC, when hail of a size up to 3.0 cm occured, sometimes piled up 15 cm high. Yet, microburst winds with this cell only reached F0 intensity. Fig. 2 shows the 1200 UTC Munich sounding.

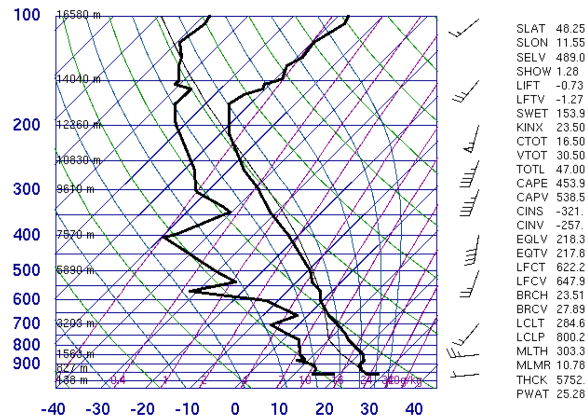

Figure 2. 1200 UTC Munich sounding on 20 June 2002.

2.2 F1 macroburst: 21 June 2002

Storms on this day were more vigorous, likely due to stronger wind shear and higher CAPE compared to 20 June (cf. Fig. 3). One hailstorm (max. hailstone size 3.5 cm) produced a macroburst at about 1500 UTC, with an 18 km long, high–F1 damage swath.

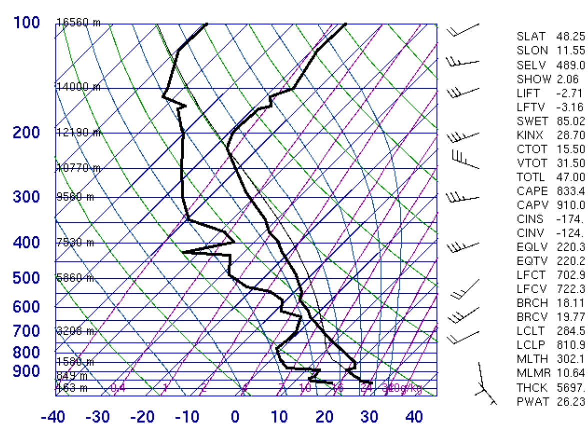

Figure 3. 1200 UTC Munich sounding on 21 June 2002.

Wind vector fields at 1458 UTC (cf. Fig. 4) reveal the downburst structure and peak at a velocity range of 40 to over 50 m s^{-1}, consistent with the observed high F1 forest damage. Two things should be noted: i) the symmetry axis of the downburst was oriented at a relatively small angle to the POLDIRAD radials. Therefore, this downburst and its intensity would have been hard to detect from the POLDIRAD Doppler velocity field alone. ii) on the rear flank of the northeastward propagating downburst, a reflectivity notch can be seen in the grayscale Z–field of Fig. 4. This is known to be a reliable sign of storm severity.

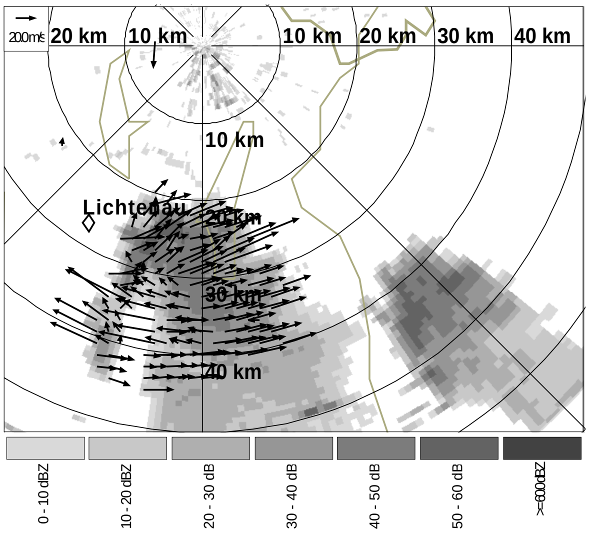

Figure 4. 1.1° PPI measured at 1458 UTC on 21 June 2002. Greyscale denotes radar reflectivity factor Z, arrows indicate horizontal wind field determined from the bistatic receivers.

2.3 F1 microbursts: 9 July 2002

The period from 8 to 10 July 2002 formed the main evaluation period for the VERTIKATOR Alpine field campaign, marking the transition from a hot, clear–sky period with a strong Alpine heat low, to the formation of isolated severe storms on 9 July, and to a derecho–producing situation on 10 July (Gatzen, 2003).

On 9 July, storms developed in the warm sector air mass ahead of a cold front crossing Europe. At 1200 UTC, convection developed within the northern Alps. The first convective cells propagated north–easterly into the Alpine Foreland a few hours later, reaching the radar observation area (Fig. 1) at about 1500 UTC. The Munich area was affected around 1730 UTC, and cell mergers started at about 1800 UTC. Storms continued until after 2100 UTC, then showing very many impressive long–range intracloud lightning flashes.

Hail up to 3.0 cm size and several F1 microbursts occured over southern Germany, leading to e. g.train delays caused by fallen trees. The high downburst potential of that day is visible from the Munich sounding evolution shown in Fig. 5: 1200 UTC (top) to 1800 UTC (bottom). It closely follows the examples given by Wakimoto (2001) for dry and wet microburst environments. At 1800 UTC, a more than 300 hPa deep layer with steep lapse rates, and increasingly dry air near the ground had formed. This is a neccessary ingredient for development of vigorous downdrafts from thunderstorms.

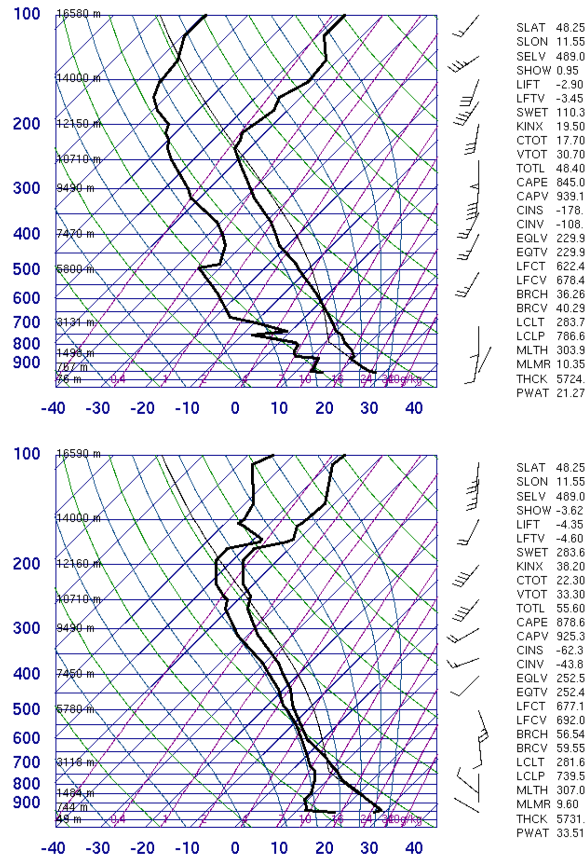

Figure 5. 1200 UTC (top) and 1800 UTC (bottom) Munich soundings on 9 July 2002.

3. CONCLUSIONS

1. In the warm season, orographically forced thunderstorms moving into the Alpine foreland have repeatedly shown considerable microburst potential.

2. The bistatic radar was much better suited to detect downburst structure and intensity than POLDIRAD alone.

3. Thermodynamic soundings with deep, steep lapse rate layers, supporting wet or even dry mircrobursts do exist in Europe. In our case, the nearby Alps likely have assisted in creating these soundings.

4. For 21 June and 9 July, a comparison of BLIDS CG data to the total lightning and polarimetric radar analysis of Dotzek et al. (2001) might be possible.

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