POLARIMETRIC RADAR SIGNATURES IN DAMAGING
DOWNBURST–PRODUCING THUNDERSTORMS

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POLARIMETRIC RADAR SIGNATURES IN DAMAGING
DOWNBURST–PRODUCING THUNDERSTORMS

A THESIS APPROVED FOR THE
SCHOOL OF METEOROLOGY

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### List of Abbreviations, Acronyms, and Symbols

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<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
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<tbody>
<tr>
<td>δ</td>
<td>Backscatter differential phase shift, measured in degrees</td>
</tr>
<tr>
<td>$\phi_{DP}$</td>
<td>Differential phase shift, measured in degrees</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>Radar pulse wavelength</td>
</tr>
<tr>
<td>$\rho_{HV}(0)$</td>
<td>Co–polar correlation coefficient</td>
</tr>
<tr>
<td>AGL</td>
<td>Above ground level, measured in units km</td>
</tr>
<tr>
<td>ARL</td>
<td>Above radar level, measured in units km</td>
</tr>
<tr>
<td>BZ90</td>
<td>Balakrishnan and Zrnic 1990a and 1990b</td>
</tr>
<tr>
<td>D</td>
<td>Particle diameter</td>
</tr>
<tr>
<td>K</td>
<td>Complex refractive index</td>
</tr>
<tr>
<td>$K_{DP}$</td>
<td>Specific differential phase shift, measured in units deg km$^{-1}$</td>
</tr>
<tr>
<td>N(D)</td>
<td>Number distribution of particles with diameter D</td>
</tr>
<tr>
<td>PPI</td>
<td>Plan position indicator radar scan</td>
</tr>
<tr>
<td>PR</td>
<td>Polarimetric radar</td>
</tr>
<tr>
<td>PRECIP98</td>
<td>Precipitation 1998 project</td>
</tr>
<tr>
<td>PRF</td>
<td>Pulse repetition frequency</td>
</tr>
<tr>
<td>PSD</td>
<td>Particle size distribution</td>
</tr>
<tr>
<td>R84</td>
<td>Rasmussen, et al. 1984</td>
</tr>
<tr>
<td>RHI</td>
<td>Range height indicator radar scan</td>
</tr>
<tr>
<td>S–Pol</td>
<td>National Center for Atmospheric Research S–band polarimetric radar</td>
</tr>
<tr>
<td>STEPS</td>
<td>Severe Thunderstorm Electrification and Precipitation Study</td>
</tr>
<tr>
<td>S87</td>
<td>Srivastava 1987</td>
</tr>
</tbody>
</table>
WB88  Wakimoto and Bringi 1988
Z  Radar reflectivity factor, measured in units dBZ
$Z_{DR}$  Differential reflectivity, measured in units dZ
Abstract

Polarimetric radar (PR) data from several downburst–producing thunderstorms are examined. Very high local values of specific differential phase (K_{DP}) are frequently found to coincide with the first appearance of a divergent low–level radial velocity couplet. Considered along with high reflectivity factor (Z) and low differential reflectivity (Z_{DR}) values, this indicates the bulk presence of a hail and rain mixture at low levels within the downdraft column. These observations are corroborated by a decrease in co–polar correlation coefficient (\rho_{HV}(0)) toward the ground, indicating an increasing mixture of hydrometeor types.

Previous modeling studies show that melting hail is a large contributor to downward accelerations, enhancing wet microbursts. Wind tunnel studies state that melting hailstones form a water torus during their descent, with frequent shedding of water drops of various size. A local increase in K_{DP} is therefore expected, as shed drops produce a large number of new oblate hydrometeors. Bulk hydrometeor characteristics deduced from these PR observations are compared to these model and wind tunnel studies. It is surmised that diabatic cooling due to the phase change of melting hail is a large contributor to the development of these downbursts.