Dual Polarization Radar Winter Storm Studies
Supporting Development of NEXRAD-Based Aviation Hazard Products

Objective

Study the dual polarization radar signatures of all variety of winter storms to relate the winter microphysical states and observed precipitation structures to usable metrics for inferring the presence of a supercooled water icing hazard.

Plates and Dendrites (oblate) provide more return than needles (prolate) for equivalent ratios (Hogan et al., 2002)

Objective

Interpretational Background

The existence of icing conditions depends on both updraft speeds and ice crystal populations (adapted from Korolev and Mazin, 2003)

Polarimetric Radar Observations

Vertical incidence ‘bird bath’ ZDR calibration check results for the Valparaiso University dual pol weather radar

Discussion

Plate Crystals

Ice-supersaturated conditions (Category B)

Location observed as patches and along edges

Weaker updraft

Small reflectivity (-10 to +10 dBZ)

Large +ZDR (+4 dB to +8 dB)

No icing hazard

Dendrite Crystals

Water-supersaturated conditions (Category A)

Defining signatures are +ZDR ‘bright band’ layers

Stronger updraft

Larger reflectivity (10 to 20 dBZ)

Weak +ZDR (+1 to +3 dB)

Icing hazard

Aggregates of Crystals

Ice- or water-saturated conditions

Not evident as a distinct feature

Stronger updraft (if riming)

Largest reflectivity (30 to 40 dBZ)

Weakest +ZDR (0 to +2 dB)

Possible icing hazard

Summary

• Distinct categorizations of dual pol radar signatures have been developed that can be related to microphysics (i.e., robust)

• Recent observations conform with those reported from past studies in the field and laboratory

• Insight gained; more evaluation across NEXRAD network planned

• Categorizations could be helpful, contributing information in an icing hazard algorithm

• Future work: need for simultaneous measurements of ice crystals and cloud water content at a sensitive level

Ice Supersaturation
Growing Hexagonal Plates

Ice-supersaturated conditions (Category B)

Growing Dendrites with Light Riming

Water-saturated conditions (Category A)

Aggregation with Light Riming

Plate Crystals

Simplified diagram of crystal habit

The existence of icing conditions depends on both updraft speeds and ice crystal populations (adapted from Korolev and Mazin, 2003)

Vertical incidence ‘bird bath’ ZDR calibration check results for the Valparaiso University dual pol weather radar

Valparaiso, IN – Dec. 8, 2009 – 2357 UTC – tilt 14 degrees

Valparaiso, IN – Jan 8, 2010 – 1625 UTC – tilt 4.3 degrees

Valparaiso, IN – Feb. 1, 2011 – 1912 UTC – tilt 4.3 degrees

Valparaiso, IN – Feb. 24, 2010 – 1859 UTC – tilt 4.3 degrees

Valparaiso, IN – Nov. 5, 2010 – 0514 UTC – tilt 10 degrees

Water Saturation
Growing Dendrites with Light Riming

Water Saturation
Aggregation with Light Riming

Moorehead City, NC, NEXRAD – Hurricane Irene – Aug. 27, 2011 – 0443 UTC – tilt 8 degrees

Valparaiso, IN – Feb. 1, 2011 – 1912 UTC – tilt 4.3 degrees

Storm List

<table>
<thead>
<tr>
<th>Category</th>
<th>Z (dBZ)</th>
<th>+ZDR (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATEGORY A</td>
<td>1.5 to 3</td>
<td>1 to 3</td>
</tr>
<tr>
<td>CATEGORY B</td>
<td>-10 to +5</td>
<td>&gt;4 dB</td>
</tr>
</tbody>
</table>

Hogan et al. (1999) 1.5 to 3 1 to 3

Moissiev et al. (2009) 5 to 15 1 to 2.5

Kennedy and Rutledge (2011) Hurricane Irene* 13 to 23 2.2 to 3.4


Feb. 1, 2011 – Indiana* 4 to 8 7.5 to 7.9

* –Z and ZDR values reflect maximum range of sectors shown

† Diffusion chamber results on crystal habit (Bailey and Hallett, 2009)

Crystal habit from downburst observations (Magono and Lee, 1966)

*Plate crystals without riming verified by in situ observations (Wolde and Vali, 2000)

†Dendrite crystals with riming verified by in situ observations (Wolde and Vali, 2000)

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