Hail Size and Melting Considerations in Thunderstorms

NWS Louisville, KY

Hail Size and Melting Considerations

Two primary factors associated with surface hail size:

- Hail generation and initial size in storm
- How much melting occurs as hail falls to ground

Factors Contributing to Hail Generation and Size in Storm

- Storm type: supercells produce larger hail than quasi-linear convective systems (QLCSs) and pulse storms; incipient cells (intense updraft) produce larger hail than after cells congeal into a mesoscale convective system (MCS)
- Storm tilt: updraft/downdraft separation promotes hail growth
- Updraft strength: increases hail generation and residence time in storm
- Dry air aloft (~800-500): leads to evaporative cooling which promotes hail growth and size
- Steep mid-level lapse rates: suggests presence of mid-level cool/dry air; promotes strong updraft
- Echo tops: taller storms can tap colder air aloft (high refl above -20° C levels) and increase hail residence time in cloud
- Cell/boundary mergers: promotes stronger updraft and better chance for hail formation
- Values of WBZ height: hail is most favorable with height of 7-12 kft; less favorable if < 6 kft (air mass too cool, although small hail/graupel likely from low-top storms) and if >> 12 kft (melting)

The *size* of hail at surface can't be determined from looking at reflectivity values in a storm alone

Factors Contributing to Hail Size at Surface

- Large stones: better chance to reach ground than small stones which melt faster on their descent
- Stones melt faster in wet environment than in dry (RH has strong effect); dry air in ~800-500 mb layer is very important to produce evaporative cooling and limit hail melting during descent (why stones are smaller or non-existent during MCSs due to saturated environment – and weaker updraft)
- Hail falling within rain melts at a much greater rate than hail falling separate from rain (especially for small hail)
- Vertical wind shear is critical in surface hail size to separate the updraft and downdraft and limit duration hail falls in heavy rain. May be more important than vertical thermal and moisture profiles.
- Greatest rate of melting: small stones in wet environments (high RH and within rain)
- Least rate of melting: very large stones (≥ golfball) in dry environments outside of heavy rain shaft, even in warm environment with high freezing level
- Melting may be main factor why high DVIL fails in determining large hail potential, particularly in warm season with weak flow/shear environments. Hail size depends more on near-storm environment and storm structure (storm tilt, hail falling in/out of rain, etc.) than on the NWS Doppler radar Digital VIL (DVIL) product

Factors Contributing to Hail Size at Surface

- High DVIL: high cores/hail (>65 dBZ) aloft may never reach ground hail is melting as it falls and collides with raindrops. Ultimately, hail becomes peas or just large, cold rain before hitting ground
- Pulse storms in weak flow and even in drier envir will struggle to produce large hail due to hail falling within heavy rain (melting) and insufficient residence time in storm; microburst possible
- Equal refl in 2 storms ≠ equal hail sizes: Equal values can be generated from 1) fewer # of large stones with low density/size distribution, and 2) many small stones with high density/size distribution



March 2, 2012: Morning supercell (left) with 65-71 dBZ at 1000 agl – lots of non-severe hail covering ground; afternoon supercells in srn IN with same dBZ values – much larger hail, but fewer stones

Example: March 2 Morning Hail Storm over Jefferson County



Over 65dBZ to 21,000 feet (-20°C level is about 19,000 feet) – DVIL maxed out too

Example: March 2 Morning Hail Storm over Jefferson County



KLVX April 26, 2012 Hail Storm over Allen County, KY



- KLVX: 75 dBZ at 0.5°, 50-55 dBZ at 35-40 kft, 30-35 at 47 kft
- Hail spike gives illusion of a hook echo of a supercell storm. Associated storm-relative velocity (SRM) data apparently shows midaltitude radial convergence (MARC) in extreme southwest Allen County
- Neither of these features (hook, MARC) are correct. Both are artifacts of hail spike
- Large hail occurred from this storm



KOHX April 26, 2012 Hail Storm over Allen County, KY



- KOHX: 71 dBZ at 0.9°
- Dual pol correlation coefficient data (right) showed very low CC (blue) on back side of storm. Low values (<0.9°) of CC suggest large hail
- Blue is behind storm, not coincident with hail. It needs to be coincident

