INTERPRETATION OF SMALL PARTICLE SIGNATURES IN SATELLITE OBSERVATIONS
OF CONVECTIVE STORMS
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ABSTRACT
Strong updrafts in mid-latitude convective storms eject supercooled water droplets into the
tropopause and lower stratosphere (Wang, 2003). These droplets flash freeze at very low
temperatures, causing them to be significantly smaller (< 20 µm) than the particles in the
glaciated anvil top (> 35 µm). Using the Daytime Cloud Optical Microphysical Properties
(DCOMP) retrieval (Walther, et al., 2012) applied to GOES-East data discrete minimain the
effective radius retrieval are observed in the vicinity of the updraft core of thunderstorms.
Several thunderstorms, which occurred between -84 W and -103.5 W and between 28 N and 46
N on April 25, 2008, May 10, 2008, May 22, 2008 and May 8, 2009, were analyzed for small
particle signatures, which were compared to 30 dBzNEXRAD echo top height data. An example
from June 27, 2008 over Illinois of an effective radius retrieval using MODIS data indicates
several small particle signatures that were not observable in GOES retrievals. This example
demonstrates the importance of spatial resolution in correctly identifying updraft-related small
particle regions.

1. INTRODUCTION
Severe thunderstorms in the mid-latitudes
can have updraft speeds up to 60 m/s which
transport supercooled cloud droplets rapidly
to the homogeneous freezing level. This
mechanism results in water vapor being
 injected into the tropopause and lower
stratosphere (Wang, 2003) and has been
reproduced using the Wisconsin
Dynamical/Microphysical Model
(WISCDYMM) (Wang, 2004).

The smaller ice particles can be observed in
satellite imagery using the DCOMP retrieval
(Walther, et al., 2012), which uses one
visible band channel (0.6 µm) and one near-
infrared channel (1.6 µm, 2.2 µm, or 3.75
µm). The three NIR channels allow for the
retrieval to be applied to data from any
sensor with one of the three possible VIS-
NIR band pairs. In our study we applied the
retrieval to GOES-East and MODIS
imagery.

Echo top heights (ETHs) show the
maximum altitude of the 30 dBzisosurface.
Higher heights are associated with stronger
updrafts. The NEXRAD echo top heights
are used to confirm that the small particle
signatures (SPSs) in the satellite imagery
were co-located with the most active
regions of the storms.

2. EXAMPLE RESULTS AND VALIDATION
Figure 1a shows an effective radius retrieval
plotted for a line of supercell thunderstorms
in Texas on April 25, 2008. A line of small
particle signatures is evident which are
coincident with four strong updrafts, visible
in the 30 dBz echo top heights (Fig 1b).
The analysis revealed some strong updrafts in the ETHs did not have an incident SPS and vice versa. To confirm that this was a result of the course spatial resolution of the GOES imager, the DCOMP retrieval was run on MODIS imagery of a storm in Illinois on June 27, 2008. The 1 km MODIS resolution resulted in a significant increase in SPSs retrieved in comparison to the 4 km GOES imagery (not shown).

In the WISCDYMM model, as well as brightness temperature imagery, it is noted thunderstorm updrafts are only 6 – 10 km in diameter. A single GOES pixel is 4 km (at nadir; 5 – 6 km over the US), so a SPS which falls within a GOES pixel will be found, but one which falls at the intersection of 2 or 4 pixels can be averaged out. The MODIS test case illustrates the importance of spatial resolution in detecting important cloud top features and GOES-R ABI should improve detection of SPSs.

4. REFERENCES


Acknowledgements

3. SPATIAL RESOLUTION IMPORTANCE
The authors would like to thank Andy Heidinger and Andi Walther for their expertise and advice on the DCOMP retrieval, Pao Wang and his student Kai-Yuan Cheng for teaching us about the WISCDYMM model and providing model runs.