Talking points for discrete storms

1. Title slide
2. Learning objectives
3. This is a schematic of a supercell with satellite signatures that you may see at times in the visible imagery. We have our familiar anvil cirrus with overshooting top, and downstream from the overshooting top the above anvil cirrus. The flanking line is typically observed southwest of the main updraft. The last 2 features are of primary interest here and indicate that a storm is undergoing intensification or is at or near peak intensity. East of or downshear of the flanking line, you may observe inflow feeder clouds as depicted in the visible image. Much like the enhanced-V satellite signature, they are not necessary for severe weather occurrence, there's a number of reasons why you may not observe them, but if you do, think of it is a bonus and keep these numbers in mind. A study found that if inflow feeder clouds are observed, there is a 77% chance of severe weather within 30 minutes, and that number goes up to 85% if coupled with mesocyclone detection from the MDA. West of or upshear of the flanking line you may observe lines of towering cumulus that form above an invigorated RFD, however these are considerably more rare compared to inflow feeder clouds. These clouds do not act as inflow into the storm the way inflow feeder clouds behave, instead they develop above the RFD and are an active area of research. What we know at this time is that when you do observe these clouds, the storm is intensifying and/or near peak intensity.
4. Our first case is from July 9, 2018 with storms in southern Canada that move towards Montana. In this GOES-16 1-minute visible loop, we see multiple regions where convective initiation occurs. We eventually develop 2 dominant supercells which appear intense due to the thick anvil cirrus that continues to grow, the overshooting tops and the crisp edge to the backsheared anvil on the western flank of the storms. Both storms have inflow feeder clouds, but they are evident for a longer period with the southernmost storm. The 1-minute imagery is also useful in detecting where storms are not developing, for example in northern Montana watch how updrafts struggle to develop due to a strong cap until the very end of the loop.
5. Here is an overlay of radar reflectivity from the Glasgow, Montana WSR-88D with the GOES-16 visible image. Note how the core of the storm from the radar perspective is displaced well southeast of the overshooting top as seen in the visible image. This case illustrates why one must be careful when overlaying radar and satellite since features will appear displaced due to parallax, especially at higher latitudes such as what we're looking at here.
6. One of the tools available on AWIPS is the flow following animation, this allows storm-relative animations to be viewed. Storm-relative animations allow the user to more effectively analyze features at cloud top such as overshooting tops, cloud motions and gravity waves. Features in the vicinity of the storm may be viewed more efficiently as well, such as clouds moving into or away from the storm. Storm motion relative to a boundary can be visualized more readily. Storm speed can be seen in relative sense as well. In our example, the loop centered on the left mover moving from the northeast Texas panhandle into the Oklahoma panhandle is clearly moving faster than the right mover, which is what we'd expect. The anvil orientation on the left mover is also different from that on the right mover.

7. The Sandwich product is an image combination of visible and IR imagery. It allows the user to see cloud top temperatures via the IR imagery while simultaneously see low-level clouds in the vicinity of the storm via the visible imagery. In this example, a cold front is moving southeast while new convection develops ahead of it within the warm sector. The sun goes down midway through this loop which is an ideal time to make use of the sandwich product in that the low-level features can be followed for a short period after sunset. In this case, the storm remains just ahead of the cold front long enough for it to intensify rapidly as seen in the cloud top cooling trends and overshooting top signature. A wedge tornado was reported at 01:10 UTC.
8. In this case from 28 June 2018, we have some high level clouds moving through which obscures some of the early development. Soon after convective initiation, we see a thick anvil cirrus spreading outwards rapidly, a glimpse through a hole in the cirrus shows clouds moving towards the storm on its southern flank. These are all indications of a rapidly intensifying storm. Another indication is that the high level clouds in the vicinity of the anvil cirrus dissipate in time, this is due to subsidence in the vicinity of the strong updraft. After this takes place we can discern a storm-split with the left mover moving northeast while the right mover moves east-southeast. The right mover has persistent inflow feeder clouds and outflow from the RFD is evident west of the storm.
9. With the improved spatial and temporal resolution of the GOES-R series, monitoring thunderstorms at night is much easier than it was in the pre-GOES-R era. In this case from 29 June 2018 we see a number of thunderstorms in eastern Montana and western North Dakota where we see a number of signatures in the IR imagery to help us identify storms that are more intense. That’s particularly important in this event since radar coverage is limited over this region. Look for cloud top cooling trends, overshooting tops and the enhanced-v signature. We see a well defined enhanced-v signature on this storm in western North Dakota. The V shaped consists of the colder cloud tops that extend downstream from the coldest brightness temperatures associated with the overshooting top. Between the V shaped cold plume and immediately downstream of the overshooting top we find what is commonly called the warm trench. The enhanced-v signature is typically associated with a severe thunderstorm.
10. One of the biggest differences you will notice between the pre-GOES-R series and the GOES-R series with regards to convection is that gravity waves appear much more readily. Gravity waves appear in the IR and visible bands, but really show up well in the water vapor bands. The gravity waves appear not only as ripples emanating away from overshooting tops along anvil cirrus, but also as waves emanating out away from the storms, beyond the periphery of the anvil cirrus. Since these are so much easier to identify compared to the previous GOES series, this is an area that’s ripe for research, particularly with respect to aviation forecasting.
11. At times, you may be able to observe hail swaths on the ground in the wake of hail producing thunderstorms. In this example, we examine the day cloud phase distinction RGB along with the 3 bands the RGB is comprised of. Hail swaths in the visible imagery appear white since it is quite reflective. However, at 1.6 microns the hail swath absorbs radiation readily, making it appear dark at this wavelength. At 10.3 microns, the hail swath is colder than the surrounding ground, therefore it will have colder brightness temperatures in contrast to the surrounding warm ground. In the day cloud phase distinction RGB, the hail swath shows up as green since there is

a strong contribution from the visible band, which is the green component. There is little contribution at 1.6 microns since ice absorbs and also from 10.3 microns since it's only slightly colder than the surrounding ground.

12. At times you may be able to see hail swaths on the ground after the hail has melted. If the hail size and intensity is sufficiently large, vegetation is damaged by the hail and is noticeable in visible bands on GOES. The hail swaths show up most clearly in the GOES ABI GeoColor imagery as can be seen in this before and after imagery from July 2018. In late July 2018, a persistent northwest flow aloft led to multiple rounds of severe thunderstorms with hail that tracked southeast. In the after image on the right, the hail damage swaths can be seen in the imagery, black lines are shown slightly to the right of each hail damage swath for clarification. Solid lines denote swaths from storms on July 26, while dotted lines denote storms from July 29. Note how these hail damage swaths were absent in the imagery in the before image on the left from July 10.
13. One of the more useful RGB products for analyzing discrete storms during daytime hours is the day convection RGB. The RGB is useful in identifying where more intense convection is located, as well as differentiating between young and older convection. When trying to understand RGB products, it's useful to look at the various components for the RGB which is what we show in this 4 panel. The red component is the split water vapor difference shown in the upper right, the green component is the day fog difference shown in the lower left and the blue component is the split snow difference shown in the lower right. In the RGB product, the strongest convection is depicted in yellow colors with a strong relative contribution from red due to cold cloud tops and a strong relative contribution from green since the 3.9 micron band is large for small ice particles. Ice particles do not have time to grow within strong convective updrafts. The large red and green components is why we see yellow. Older or dissipating convection shows up as orange or red since the green component would be smaller due to larger ice particle size and warmer cloud tops decrease the red component.
14. Monitoring the intensity of discrete storms could be done on AWIPS in a display similar to this with a look at the product in the 4 panel display and the tracking meteogram tool over the storm of interest. For the storm indicated in the circle in the 10.3 micron panel, we observe cloud top cooling trends with the 10.3 micron data, in the upper right is the MRMS composite reflectivity, the lower left is MRMS MESH and the lower right is MRMS CG lightning density. Using different data types in combination provides the most effective way at maintaining situational awareness.
15. Another useful tool in analyzing discrete storms is data from the Geostationary Lightning Mapper or GLM from GOES. In this 4 panel display we look at 3 GLM gridded products along with visible imagery from the ABI in an overlay with NLDN CG lightning. Using GLM data along with lightning data from the ground based network is recommended since each sensor has its own strengths and weaknesses, but in combination can make up for the other sensor's weakness.
16. Derived motion winds can be very useful in looking at the environment around discrete storms. In this example over Iowa, note the low-level wind bards in purple and blue which are just above the surface up to 775 mb. Those wind barbs are significantly more veered than the wind bards

in the METARs indicating that the low-level shear in this case was very high. Non-supercell tornadoes were being observed during this time period.

17. Derived motion winds are calculated based on the level in the vertical of the cloud, so that a variety of cloud heights will provide winds at a variety of vertical levels, which can provide useful information on the vertical shear profile. You may also be able to identify regions of localized low-level convergence and associated boundaries for convective initiation or intersections with existing storms. Another use of the winds is to validate familiar model analyses or forecasts. Other applications of derived motion winds include assessment of storm motion, upper level difluence and monitoring a data source that provides a more rapid update compared to familiar hourly model analyses.
18. Interactive exercise
19. Summary