Talking points for cumulus congestus / growth

1. Title
2. Learning objectives.
3. Our first example is from May 1, 2018 and we'll start with the GOES-16 1-minute visible loop. Our focus is along a dryline in Kansas for potential convective initiation. Our first indications of convective initiation are an enhanced cumulus field or congestus along some segments of the dryline. Soon after the appearance of cumulus congestus (also known as towering cumulus) we observe shadows being cast by the anvil. We then see orphan anvils, meaning that the towering cumulus that attempted to develop into thunderstorms ceases further growth, and the upper part of the clouds that remain are cutoff and advect in the direction of the mid-level flow. Up to this point, we still do not see convective initiation since we do not observe cumulonimbus with projected shadows from the anvil. These details will be more apparent in 1-minute meso sector compared to the 5-minute CONUS sector.
4. We now progress later in the loop and see regions where cumulus congestus transitions to cumulonimbus. In other words, convective initiation occurs. Two features to look for to gain confidence that convective initiation has occurred are a well established updraft producing persistent deep vertical cloud growth that eventually produces anvil cirrus that continues expanding. The anvil shadows produced are much longer than orphan anvil shadows. More CIN exists further south along the dryline as convection struggles to break through the capping inversion, but succeeds locally in this region.
5. One of the most useful RGB products to assess convective initiation during daylight hours in the GOES-R era is the Day Cloud Phase Distinction RGB. This RGB product makes use of the 10.3 micron IR for the red component, the 0.64 micron visible for the green component and 1.6 micron band for the blue component to identify clouds growing in the vertical and becoming glaciated. Early on, the low-level cumulus field is light blue since it has a small relative contribution from the red component since the cloud top temperature is not that cold, but larger relative contributions from the green and blue components since we have a reflective cloud composed of liquid water. As the cloud transitions from low-level cumulus into congestus the cloud top starts to become glaciated. At 1.6 microns, this transitions from bright to dark which correspond to increasing absorption, which reduces the relative contribution of the blue component. As we transition from congestus to cumulonimbus the color changes from green to yellow since the cloud will have more ice than liquid particles, thus even smaller blue contribution from the 1.6 micron band, while clouds growing vertically will have colder brightness temperatures at 10.3 microns thus a larger red component. The visible band at 0.64 has increasing reflectance thus large relative contribution to the green component. Some shades of red may also be apparent, particularly at the leading edge of anvil cirrus since these areas are less reflective in the visible band, thus less relative contribution from the green component.
6. Our next example is from May 3, 2018 and we'll start with the GOES-16 1-minute visible loop. This example is more complex than the previous case since convection is not persisting in some areas so the CIN is playing a larger role here. In Iowa, the convection seems to be growing

upscale gradually which makes for easier interpretation, however further south in Kansas we have a mix of some convection continuing upscale growth while other regions struggle under a strong cap while yet other regions struggle to get any convection developing. We identify these trends with patterns in the clouds, but the question arises if additional information could be gleaned from the Day Cloud Phase Distinction RGB.

7. The Day Cloud Phase Distinction RGB for the same time period adds additional information to the situation. The region where convection was clearly continuing upscale growth is now highlighted in green to yellow colors indicating more cumulonimbus that exists. In Kansas, we now see regions of convection that appear green, mixed in with some regions that are yellow (indicating further growth) while some areas remain light blue to aqua indicating where convection is struggling against higher CIN. In some areas you can even identify a transition from green back to light blue as the attempt at convection fails. Interpretation is more readily apparent in the RGB product compared to the visible imagery. The key in monitoring the 1-minute imagery for convective initiation is assessing the persistence of updrafts and anvil shadows. Monitor anvil shadow length, persistence, and anvil orientation as well since orphan anvils that are not as vertically developed may exist at a different wind direction compared to upper levels where sustained updrafts exist. All of these signatures will stand out more readily in the 1 minute meso sector compared to the 5 minute CONUS sector.
8. We'll now look at a case from June 6, 2018 associated with a tornadic storm north of Laramie, Wyoming using GOES-16 1-minute imagery for this rapid convective initiation case. Within the scene, we see numerous regions of convective development however our focus will be on the convection that develops within the circle associated with the tornado.
9. This is the corresponding GOES-16 IR loop at 10.3 microns. The IR band will inform you when convective initiation occurs by looking for a sudden decrease in cloud top temperatures. This is one of the benefits of having enhanced IR imagery in that the color scale has sufficient contrast at threshold brightness temperatures when convective clouds typically transition from growing cumulus to cumulonimbus. A plot of minimum brightness temperatures from the tracking meteogram tool in AWIPS is used to identify trends for the storm in the circle. These trends are a useful tool in identifying convective initiation, as well as rapid development. In this example, the cloud top cools from -25 to -56 in just several minutes.
10. Time for an interactive exercise. We make use of a 4-panel display of 1-minute imagery along a dryline in the Texas panhandle that has the Day Cloud Phase Distinction RGB, along with the 3 bands it is comprised of. What can you conclude about convective initiation potential and where do you think it's most likely in the near future? I'll provide some time for you to study the loop.
11. We pick up at the same start time as the previous loop except we go beyond our cutoff time before to see what actually happened. Probably the most important conclusion is that what appeared to be the start of convective initiation with *this region* was actually just an orphan anvil. This example illustrates why it's important monitor for persistent updrafts with anvil cirrus that continues to expand outward. What we may have thought of as convective initiation did not last for that long and the anvil cirrus quickly thinned out as it became detached from the updraft. In the RGB product this was characterized by a very brief changeover from light blue to

green, but then quickly back to light blue. Soon after this initial first attempt at convective initiation, we appear to get convective initiation a short distance just north and south of that region. The northern region appeared to be a start at convective initiation however it was not able to overcome the CIN and it dissipated by the end of the loop. Meanwhile, the region to the south continued to grow and more importantly persist. We conclude that with the transition in colors in the RGB product from light blue to green to yellow as well as the anvil shadow continuing to expand and remain thick. By looking at the 1.6 micron band, you may be able to see the darkening at cloud top associated with ice particles, however it seems to be easier to spot that change in colors in the RGB product. The 10.3 micron band is useful to detect cooling cloud tops growing in the vertical and continuing to grow.

12. In summary, we discussed GOES-R era capabilities in analysis of cumulus congestus / growth for monitoring convective initiation. These techniques are most useful when analyzing 1-minute imagery, but can still be applied in 5 minute imagery as well which will be routinely available on the CONUS scale. Remember to combine the visible imagery at whatever temporal resolution you have to work with alongside other channels since a rapid increase in IR cloud top cooling provides clear indications of convective initiation. Utilize the Day Cloud Phase Distinction RGB as it is particularly useful for convective initiation.