Talking points for cumulus congestus / growth

1. Title
2. Learning objectives.
3. As a proxy for GOES-R, we'll make use of GOES-14 SRSOR 1-minute visible imagery from this event in west Texas. After assessing the various air masses and boundaries in the visible imagery, monitor boundary segments for enhanced cumulus growth or congestus. In this example, we see an enhanced cumulus field. 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. The 1-minute imagery allows you to see cumulus congestus and orphan anvils in much greater detail compared to current GOES scanning schedules (at 15 minute interval or even RSO).
4. We move on to the next time period for the same case in west Texas. Early in the loop, we observe an orphan anvil to the north. Shortly afterwards to the south, we see 2 regions where cumulus congestus leads to cumulonimbus. In other words, convective initiation occurs. Two features to look for to gain confidence in convective initiation are a well established updraft with associated overshooting tops and long shadows that are projected by the anvil. We meet both of these criteria in the 2 thunderstorms that develop. By the end of the loop we see flanking line development on the southwest flank of the storm, and even inflow feeder clouds briefly on the northern storm.
5. Let's switch to a different case, this is from 11 May 2014, we're looking at the GOES-14 SRSOR 1-minute visible imagery over Nebraska and Kansas. A surface low exists over north central Kansas, with a dryline extending southwest of the low and a warm front east/northeast of the low. Early storms develop along the dryline in southwest Kansas. The more interesting area is near the surface low in north central Kansas near the Nebraska border. Since a relatively strong cap was in place, it took some time for convective initiation to take place. Early on we see a field of cumulus congestus near and just east of the surface low. Multiple attempts at failed convective initiation are represented by the orphan anvils that stream off to the northeast. The 1-minute imagery helps you see these details and in particular the region where the most vigorous updrafts persist, leading to convective initiation. Note the shadows being projected by the anvil cirrus as the thunderstorm initiates. Perhaps just as importantly, the 1-minute imagery can depict areas where thunderstorms are not developing, for example, look further east along the warm front of where we've been looking in southeast Nebraska. After some early signs of a few orphan anvils the field of congestus is being suppressed by the capping inversion
6. Here's a different case over Colorado and Wyoming in a situation with a relatively strong cap in place. In this GOES-14 SRSOR 1-minute visible loop, lower elevations in the Plains remained capped, however thunderstorms do eventually develop over higher elevations. In this situation, you will observe numerous orphan anvils, perhaps even short-lived thunderstorms that move to

a lower elevation to dissipate. The key in monitoring the 1-minute imagery in this situation is assessing the persistence of updrafts, anvil shadows and also a knowledge of local terrain.

7. In this case over Indiana, we again look at the GOES-14 SRSOR 1-minute visible loop. In this situation the flow aloft is westerly, we make use of that to our advantage by noting when the enhanced cumulus field grows sufficiently to develop towering cumulus and then cumulonimbus, the anvil develops and takes on a very different orientation to the flow at low levels. The anvils that develop move towards the east, making them stand out from the lower level clouds. 1-minute imagery will once again benefit by seeing indications of these early on.
8. As a proxy for GOES-R imagery, we'll look at a case from the Himawari satellite in April 2016. We're looking over eastern India and northern Bangladesh. During this loop, we see convective initiation in 2 regions. The imagery from Himawari is the same spatial resolution as will be available on GOES-R, however this imagery is at 10 minute temporal resolution whereas GOES-R would have higher temporal resolution (5 minute or potentially even 1-minute). Nevertheless, the lesson here is to use multiple channels when assessing convective initiation. The top panels show the IR band at 10.4 microns and the visible channel at 0.64 microns. As you monitor the visible band for applications we've been discussing related to cumulus growth up to cumulonimbus occurrence, continue to monitor the IR band as well. 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. In the bottom 2 panels I chose to display the mid and lower water vapor channels at 7.0 and 7.3 microns respectively. These could be used to assess potential for an elevated mixed layer or elevated cold front, as well as short waves and jet streaks that could assist in the development of convection.
9. Time for an interactive exercise. In this loop of 1-minute visible imagery over North Dakota, study the loop for a bit and think about where you would expect convective initiation within an hour after the end of this loop. Apply the principles we've been discussing, as a hint I'll point out the convergence boundary of interest.
10. Now let's discuss what we're seeing, the boundary segment in south central North Dakota shows an extensive buildup of cumulus congestus and by the end of the loop we see the start of an anvil, which would give us confidence in convective initiation very soon. Due west of that position along another part of the boundary, there are some indications of cumulus congestus building up, but not nearly as pronounced as further east. Then further northwest along the boundary we see cumulus congestus along with some orphan anvils. There is also some indication of intersecting boundaries in that sector as well.
11. Now we look at what happened in the hour following the previous loop. Along the boundary segment in south central North Dakota, convective initiation occurs, recall this was an area with extensive congestus growth and indications of the start of an anvil in the previous loop. Due west of that position along a different segment of the boundary, there is some congestus and weak looking orphan anvils, but nothing developed during this time period. Further northwest, we see some convection developing, although not as rapidly as south central North Dakota. There are multiple orphan anvils along with some slowly growing anvils although the anvil

shadows are not standing out, suggesting the convection at this time is not intense. This example provides a rather typical scenario with numerous complexities to be concerned about, however keep in mind the 1-minute imagery gives you the best available data for monitoring the transition from cumulus congestus to convective initiation.

12. In summary, we discussed GOES-R capabilities in analysis of cumulus congestus / growth up to the point of 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 in the GOES-R era. 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.