Talking points for pre-convective cloud features

1. Title
2. The learning objectives for this module center around making optimal use of GOES-R capabilities for identification of various pre-convective cloud types. We'll discuss cumulus cloud lines or streets, stable wave clouds and the undular bore. The other category of clouds we will discuss are typically thought of as over tropical oceans and include cumulus lines already mentioned, as well as cellular cumulus lines.
3. The increased temporal resolution of the GOES-R series will help in identification of pre-convective clouds. We'll start by looking 5 minute temporal resolution visible imagery at 0.64 microns since it's the band with the highest spatial resolution. Over Oklahoma and much of north Texas we observe stable wave clouds oriented perpendicular to winds at inversion top. These their name suggests, these are associated with a stable air mass, in this case, higher CIN well east of the dryline. As we look further west on the east side of the dryline, we observe cumulus streets that are parallel to the low-level wind. These clouds are associated with the unstable air mass where daytime heating erodes the CIN a short distance to the moist side of the dryline in west Texas.
4. Quite often, MCS activity will develop differing air masses which can lead to later convective initiation with daytime heating. In this example, a MCS in northwest Kansas leads to an outflow boundary on its western flank. Within the outflow we can see stable wave clouds, which makes sense since this is associated with the cooler air mass. South of the MCS outflow boundary, we see cumulus streets oriented parallel to the low-level flow. This is the potentially unstable air mass where later convection may occur given sufficient daytime heating to overcome any CIN that exists. Utilize surface observations in tandem with visible satellite imagery to determine where different air masses exist and monitor any boundaries for potential convective initiation. The boundary between the cumulus lines and the stable wave clouds is a common place to find convective initiation.
5. The following loop is from 4 July 2018 on a day with the lake-breeze boundary over the Great Lakes. Cumulus streets develop on the warm side of the lake-breeze boundary, confirming the unstable air mass while on the cold or stable side of the lake-breeze boundary skies remain clear. Satellite imagery can be very useful in this situation where the unstable and stable air masses in the vicinity of the Great Lakes are identified very quickly in an animation of visible imagery.
6. Here is an example of an undular bore as observed from GOES-16 visible imagery at 0.64 microns. The undular bore stretches from Mississippi into Louisiana. The undular bore is characterized as a series of parallel cloud bands. These bands are a reflection of a density current impinging on a stable layer. The orientation of the bands are perpendicular to its motion. An undular bore is characterized by a very stable air mass.
7. This is an example of a transient undular bore in southern New Jersey from 27 July 2018. In the 1 minute visible imagery we observe weakening convection in southern New Jersey spawn an undular bore that moves east and southeastward. Note that we are zoomed in considerably and this is a 1-minute loop so this feature does not last that long and is not large.

8. Here is the corresponding visible imagery at 5 minute temporal resolution and zoomed out further to a scene you might typically use. Note how much more difficult it is to see the undular bore in southern New Jersey. Having 1-minute imagery from the meso sector and zoomed in will allow you to observe features you are much less likely to see in the CONUS sector zoomed out.
9. We now transition to pre-convective clouds that we typically see over a warm ocean surface. For now, focus on the visible band in the upper left. Over much of the scene we see cumulus lines (or streets). Small cumulus is limited in vertical extent by an inversion and become arranged in streets along the wind. These are wind-parallel cloud streets that rarely produce precipitation except when cumulus lines merge. On the southeast edge of our scene we observe cellular cumulus lines. These are circular or globular with sharp edges. Rainfall producing clouds are associated with shallow cumulus clusters aligned in arc shaped formations as well as cumulonimbus. The cumulonimbus can be observed readily in the IR band at 10.3 microns in the upper right panel. Since we're generally interested in what's happening along coastlines or at islands, the 0.86 micron band is quite useful since islands show up considerably better compared to looking at the 0.64 micron visible band. In this case, cumulus lines are developing along some of the islands and extend downstream of them resulting in more vertically developed clouds. In the lower-right we show the 3.9 micron band with the default color table in AWIPS which is useful not only for identifying deeper clouds, but also for the diurnal temperature trend over land, making the islands easier to identify.
10. Keep in mind that many of these low-level cloud features in the pre-convective environment are relatively shallow and thus warm brightness temperatures, therefore not as easy to identify as say thunderstorms. Your best tools from GOES for analysis at night are the 10.3 and 3.9 micron bands. In this example over the Plains, we see numerous outflow boundaries and stable wave clouds or perhaps an undular bore for a brief period in southern Oklahoma. Continuity in following features is particularly important at night since the spatial resolution of the IR bands is less than the visible band. In general, the water vapor bands are not particularly useful for identifying pre-convective clouds, with the possible exception of the 7.3 micron low-level water vapor band which may show these low-level clouds of interest under some circumstances.
11. Time for an interactive exercise, your task is to see what cloud features previously described you can identify in this GOES-16 visible animation, I'll give you some time for analysis and the answer will be provided on the next slide.
12. In the early portion of the loop we observe a MCS across Oklahoma that has left a large region of stable wave clouds in its wake, we also see an area of stable wave clouds in the Texas panhandle but they dissipate with daytime heating. During the afternoon hours, we see the development of cumulus streets associated with the unstable air mass just east of the dryline from far western Oklahoma into the eastern Texas panhandle. The dryline is moving westward by late in the loop with convective initiation along it in this location.
13. In summary, have expectations on what bands in the GOES-R series to use for identification of the various pre-convective cloud types we discussed. Keep in mind these are primarily low-level clouds. Resolution matters, use the highest available which is 0.5 km on the 0.64 micron band. The water vapor bands have a weighting function that peaks too high in altitude to identify

these types of clouds, with the possible exception of 7.3 microns at times. Use band 4 at 0.86 microns to maximize the contrast between land and ocean as needed. At nighttime, use the 3.9 or 10.3 micron channels.