Talking points for pre-convective cloud features

1. Title
2. The learning objectives for this module center on 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 next 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 GOES-R will help in identification of pre-convective clouds. 5 minute temporal resolution will be available over the CONUS routinely, and more importantly, when you are in a mesoscale sector, 1-minute imagery will be available which will greatly aid your ability to identify pre-convective clouds. In this 1-minute imagery from GOES-14 SRSOR, note how easy it is to identify low-level cumulus streets parallel to the low-level wind in southeast Wyoming. These clouds mark the unstable air mass. The picture shows the cumulus lines in southeast Wyoming during this 1-minute visible satellite loop. To the north of the cumulus lines exist stable wave clouds, these clouds are perpendicular to the winds at inversion top and mark the stable air mass. The boundary between the cumulus lines and the stable wave clouds is a common place to find convective initiation.
4. The following loop of 1-minute visible imagery illustrates why it's important to identify various types of pre-convective clouds. Not only does convective initiation typically develop along the boundary between the two air masses, but also storms may follow along these boundaries potentially making them more intense than other nearby storms. Storm motion must be monitored with the 1-minute visible imagery to asses if the storm moves towards the more stable air mass (thus being less of a severe threat) or along the boundary (potentially being a greater severe threat).
5. In this GOES-14 SRSOR 1-minute visible loop, we can identify stable wave clouds, for example, in central Oklahoma, southeast Kansas, extending into Arkansas and we can see unstable cumulus lines for example, from north central Oklahoma into south central Kansas. It's important to note that stable wave clouds may transition to cumulus lines due to daytime heating, for example in north central Kansas we see this transition take place just south of the MCS outflow boundary. In the later half of the loop, south of the MCS in Missouri, we observe parallel lines of low clouds in a stable region, these type of clouds are the result of an undular bore. The undular bore moves perpendicular to the orientation of the cloud bands. Remember the unstable and stable terminology we're using here is relative to surface based convection, we do see elevated convection develop over central Oklahoma in a region of stable wave clouds.
6. As a proxy to GOES-R, we will make use imagery from the AHI instrument on the Himawari satellite. In this example over Bangladesh, we are viewing Band 3 which is at 0.64 microns. This is at 0.5 km spatial resolution so this is the way the visible imagery on the same ABI band will appear in GOES-R. A northwest to southeast oriented outflow boundary exists over eastern Bangladesh. South of the boundary we observe cumulus lines, parallel to the low-level winds marking the unstable air mass. North of the boundary, we observe stable wave clouds. Across the Bay of Bengal, we see an undular bore propagating southward. Since these features are

low-level, the visible band is ideally suited for analyzing these types of clouds with the highest spatial resolution possible.

7. We now turn to Himawari band 13 which is at 10.4 microns. We can still see these features but they are considerably more subtle compared to the visible imagery at 0.64 microns. At nighttime, this band would be one of available bands to track these types of clouds. If convection did develop along one of the bands, the colder clouds top would readily stand out in this band.
8. Band 7 at 3.9 microns is another option to track these low-level clouds, particularly if it was nighttime. There are other IR bands available, but we recommend either 10.4 or 3.9 microns for tracking low-level clouds at night.
9. We now switch gears to pre-convective clouds that we typically see over warm ocean. In this example from the visible band 3 at 0.64 microns in the tropical west Pacific, we see cumulus lines or streets over the center of the scene. Small cumulus are 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 eastern and western edges of the 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 the cumulonimbus.
10. This is the same time period we just looked at except now we're looking at IR band 13 at 10.4 microns. The low-level boundaries are more subtle compared to the visible imagery, but the advantage to this band is that it highlights colder cloud tops which focuses your attention on potential rainfall regions.
11. In this visible loop over the tropical western Pacific, we see cumulus lines and cellular cumulus lines as well similar to the animation we just analyzed.
12. However, if we switch to band 4 at 0.86 microns. This provides clarity in what we are seeing, some of the cumulus lines we observe are actually developing along islands and extend downstream of them. Remember that land shows up readily in this particular band.
13. Band 5 at 1.6 microns also shows islands readily, however the resolution is at 2 km, while that of band 4 at 0.86 microns is at 1 km. For this reason we would recommend using the 0.86 micron band to highlight the contrast between land and water.
14. What happens if it's nighttime? This is the same region a few hours later around sunset in the 0.64 micron band.
15. Here is the same loop we just looked at except using IR band 7 at 3.9 microns. We could have chosen band 13 at 10.4 microns to identify the islands at night, however it's more subtle than making a longer loop that spans during the day in the 3.9 micron band. At 3.9 microns, the diurnal temperature trend over land shows up readily allowing you to readily identify the islands.
16. Time for an interactive exercise ….
17. The correct answer is B) Undular bore in Band 3 / 0.64 microns. The feature of interest here is the undular bore south of Hainan island as viewed by the Himawari satellite. The real question comes down to, are we looking at the 0.64 or 0.86 micron band since this is a visible loop. Remember the 0.86 micron band would clearly show contrast between land and water,

highlighting Hainan island. Since the contrast is poor, actually quite dull between land and water, this is the 0.64 micron band.

18. In summary, have expectations on what GOES-R bands 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 10.4 micron channels. There are other IR channels available on GOES-R, but these 2 are recommended.