Talking points for GOES-R rainfall rate baseline product

1. Welcome to the training session on the GOES-R rainfall rate baseline product. Bob Kuligowski is the developer of this product, I'm Dan Bikos and will narrate the training.
2. Learning objectives
3. Estimates of instantaneous rainfall rate are output every 15 minutes at full ABI IR pixel resolution with a latency of less than 5 minutes and are available over the full disk day and night since IR bands are utilized. Rainfall rates up to 3.9 inches per hour can be output by the algorithm.
4. The motivation for this product can be easily understood by first understanding the differences between satellite-based rain rates derived from a microwave instrument versus that from an infrared instrument. Microwave-based rain rates are generally more accurate than IR, but less timely since they are on polar orbiting satellites. Meanwhile, IR-based rain rates are generally less accurate than microwave but more timely than microwave since they are available from geostationary satellites. The solution is use the more accurate microwave-based rain rates to calibrate an IR algorithm and thus optimize the accuracy, frequency and timeliness of the product. The GOES-R rainfall rate product makes use of GOES-R ABI bands and is calibrated against the CPC combined microwave field known as MWCOMB. The ABI bands used as input are bands 8, 10, 11, 14 and 15. These bands contain information about the cloud phase and particle size and help to discriminate.
5. Note that this calibration was done offline and is fixed in the initial version of the product; a future version will allow the calibration to be updated in real time using recent ABI IR and microwave rain rate data.
6. Several assumptions are made when estimating rain rate from IR data. One is that the cloud-top temperature is related to cloud-top height. Another is that the cloud-top height is related to the strength of the updraft transporting moisture into the cloud, and further that updraft strength is related to rainfall rate. Generally speaking, colder clouds are associated with heavier rain and warmer clouds are associated with light or no rain.
7. The performance of the rain rate algorithm is improved when the data are divided into three cloud type categories based on thresholds between the various band brightness temperatures given here. They are called water, ice, and cold-top convective clouds, but these are not exact classifications—the purpose is to separate clouds with different relationships between the IR brightness temperatures and the rain rates. Separate calibrations are also applied over 4 geographic regions over 30 degree latitude increments which yields 12 distinct rainfall classes in the algorithm.
8. When using satellite QPE, it is critical to remember that while our primary interest is in rainfall rates at ground level, satellites detect cloud-top or cloud level-characteristics. One of the differences between the two can be location: in sheared environments, rain rate shafts are not vertical so the surface rainfall can be displaced by up to a few pixels from the locations indicated by the IR imagery. Also, satellites cannot directly observe orographic effects, subcloud evaporation of hydrometeors, and subcloud phase changes. Some of these issues can be addressed with the help of NWP model data. Examples include using relative humidity fields to

reduce rain rates in arid regions, or using wind fields to attempt to adjust for orographic enhancement.

9. Now we'll review strengths and weaknesses of the product. Satellite rain rate estimates are best for deep convective rain. Satellite rain rate estimates perform poorly for stratiform precipitation. Weaknesses of IR retrievals include underestimating or missing shallow stratiform clouds that are near or warmer than 0 degrees Celsius which can include orographic clouds or very shallow convective clouds such as trade-wind showers. Also, cirrus associated with convection can be incorrectly identified as rainfall regions, even with the help of additional spectral bands.
10. This is an example of the GOES-R rainfall rate baseline product as displayed in AWIPS for Hurricane Michael. Units are inches per hour. Note the overall decrease in rainfall rate after the hurricane makes landfall.
11. For this animation of Hurricane Michael, we'll make use of the tracking meteogram tool for a circle over the Gulf of Mexico in the path of the hurricane. The first thing you probably notice is that rainfall rate values exceed those that are shown on the color bar. Recall that the maximum values the product is designed for is 100 mm/hr, which is about 3.9 inches per hour. We see this upper limit in the tracking meteogram tool on the right, and you will also see these values in the AWIPS cursor readout. The color bar saturates a white color for any values above 3.0 inches per hour or greater. Think about how you could make use of the tracking meteogram tool to assess rainfall rates heading towards your region of interest, although keep in mind that biases will vary from case to case and generally speaking convective rainfall rate estimates are more accurate than stratiform rainfall rate estimates.
12. Here is the GOES-R rainfall rate animation for Hurricane Florence. Note that the areal coverage of the highest rainfall rates are not as high as Hurricane Michael, instead we see bursts in higher rainfall rates. Recall that unlike Michael, storm motion slowed down considerably as it approached land, leading to significant flooding in the Carolinas.
13. Consider what else you might analyze along with the GOES rainfall rate product. Here's a 4 panel example from AWIPS to provide some possible ideas. Certainly the IR band at 10.3 microns as shown in the lower left is a good idea since the trends in IR brightness temperatures will help you interpret trends in the GOES rainfall rate product. Other options could be one of the water vapor bands, as the mid-level water vapor band at 7.0 microns is shown in the upper right which can provide details of the environment around the storm. Perhaps monitoring for mid-level drying is a concern, if so, you might want to consider the 700-500 mb PW from the advected layer Precipitable water product as shown in the lower right panel.
14. Noise as a result of instrument warming due to the Loop Heat Pipe issue on GOES-17 significantly degrades the accuracy of the GOES Rainfall Rate product. The GOES Rainfall Rate product from GOES-17 data will not be useable for at least several hours a day within six weeks or so of each equinox when the sun shines directly on the instrument. Mitigation work is ongoing to determine how long the data are not useable. Keep in mind that GOES-16 is NOT affected by this issue.
15. An important caveat

16. Summary