Verifying Flash Flood Advisory Boundary Locations using GOES-16 ABI Imagery: A Case Study of Tropical Storm Beta (2020)

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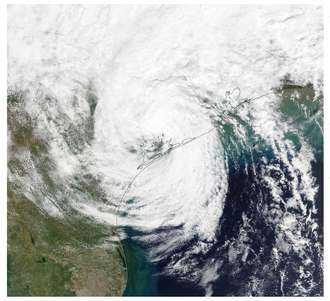
ABSTRACT

With an increasing amount of severe flash floods worldwide, meteorologists are seeking more efficient and accurate ways to issue warnings to populations. Despite the increasing coverage of Doppler radar networks, large parts of the world still lack these valuable instruments to track storms and measure precipitation rates. Although satellite products to calculate precipitation rates in these areas including the GOES Rainfall Rate/Quantitative Precipitation Estimation product do somewhat assist meteorologists in determining flash flood advisory boundaries, this study focuses on an extrapolation-based method to determine relative rainfall amounts. This is fueled by the growing presence of weather stations on the ASOS network worldwide. Based on satellite data at an ASOS station with a known amount of rainfall, we can determine whether flash flood conditions are occurring at a nearby location. In this study, we explored the correlations of GOES ABI data with rainfall totals over a one-hour period. This can compound and serve as verification for traditional radar-based estimates. Using imagery from GOES-16 ABI bands, I examined a situation in the Houston metropolitan area with two nearby ASOS stations with a significant difference in one hour rainfall.

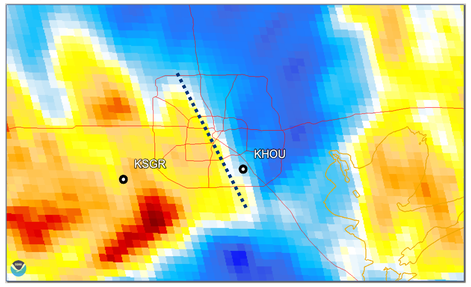
RESEARCH QUESTION

How can GOES ABI data be used to detect flash flood conditions and determine boundaries for flash flood advisories?

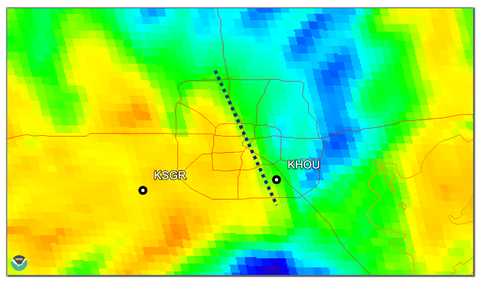
METHODS and DATA



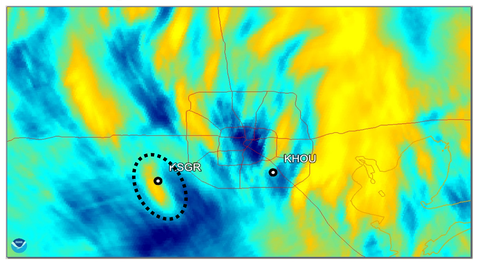
- Tropical Storm Beta made landfall near the Matagorda Peninsula on the SE Texas Coast on September 21, 2020, prompting the issuance of several flash flood warnings in the Houston metropolitan area
- The nonuniform rainfall patterns caused some locations to experience significantly more flash flooding than others
- In this study, a 1-hour period from 12:53 to 13:53 UTC was examined, in which Hobby Airport (KHOU) received 1.11 in of rain, while nearby Sugarland Airport (KSGR) received only 0.02 in



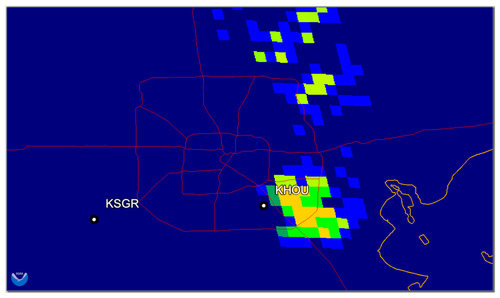
- Band 13 (10.3 μm) shows a significant correlation between the one-hour average value of satellite radiance and rainfall that fell in an area
- This band was selected as it can provide an estimation of relative intensity of convection and effectively differentiated between the rainfall in the two airports



- Band 16 (13.3 μm) verifies the data provided by band 13, showing a clear boundary between areas of heavier and lighter rainfall
- Although band 16 can indicate colder clouds and more intense storms than what is present, this is irrelevant due to the small scale of the study (the viewing angle of the satellite is uniform throughout the area)



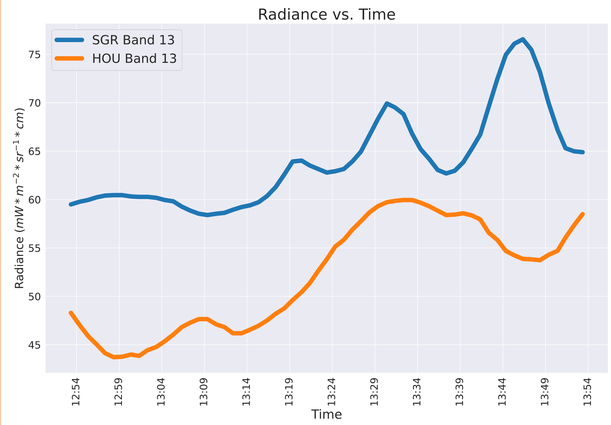
- Band 2 (0.64 μm) also displays higher intensity rainfall occurring at KHOU with an area of low rainfall at KSGR
- However, the reflective nature of band 2 makes this a secondary band to use for verification due to the general cloud cover in tropical storm conditions (resulting in more uniform reflectance) combined with the night/day transition occurring when the image was taken



- The Rainfall Rate/Quantitative Precipitation Estimation derived product is a tool to use to provide rainfall rates in an area and help determine if flash flood advisories are needed
- However, this product does not run on mesoscale data and provides a crude approximation for rainfall rates
- This product is less reliable than an extrapolative method - if locations with known rainfall rates exist, they should be used to determine areas that need flash flood advisories

RESULTS and CONCLUSIONS

- GOES imagery can provide effective verification for radar-based flash flood warnings
- IR bands, such as Band 13 (10.3 μm) provide intensity information and allow for identification of clear boundaries
- When radiance data is averaged over one hour, there is an inverse correlation between rainfall totals and radiance



- KSGR had higher radiance values for the entire period examined, verifying the lower rainfall total that was recorded by the KSGR ASOS station
- Similar trends were visible in bands 2, 16, and 11
- In addition to using this data to verify flash flood advisory data, meteorologists can improve warning accuracy in areas that lack radar infrastructure
- The frequency of flash flooding is increasing globally, and it is simply not possible to set up weather radar in some remote areas
- **GOES imagery is a useful tool for detecting flash flood conditions and verifying flash flood advisory boundary locations**

References

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GOES ABI Band Guides
http://cimss.ssec.wisc.edu/goes/GOESR_QuickGuides.html
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