

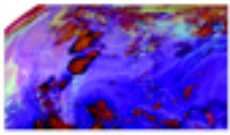
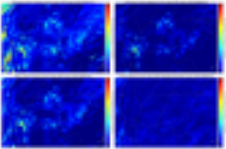
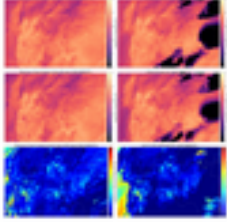
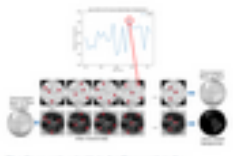
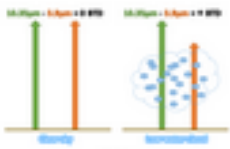
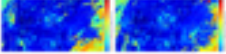


# Surface Emissivity Impacts on GOES-R Series Multi-spectral Imagery Applications



**Surface Emissivity Impacts on GOES-R Series Multi-spectral Imagery Applications**  
 Angela Burke and Emily Berndt  
 (1) University of Alabama in Huntsville and (2) NASA Short-term Prediction Research and Transition (SPoRT) Center



<p><b>Introduction</b></p>  <p style="text-align: center;">OPEN</p>	<p><b>Surface Emissivity Variability</b></p> <ul style="list-style-type: none"> <li>The plots below show how the cloud-cleared 10.3µm-11.5µm BTIC data (CIRA Cloud-cleared Product) at the 500-10.5 varies over different scales of time periods.</li> </ul> 	<p><b>GOES-R Applications</b></p> <ul style="list-style-type: none"> <li>The "false alarm" signature is a constant feature that complicates an already complex scene in the nighttime Microphysics RGB.</li> <li>If an air mass feature is in the cloud-cleared imagery, we should be able to clear it out of the maximum IR02 product.</li> <li>The plots below show how the maximum cloud-cleared brightness temperatures at 10.3µm-11.5µm and the 10.3µm-11.5µm BTIC from July 2018 months compare to the GOES-16 data from June 24, 2018 at 0000Z.</li> </ul> 	<p><b>CIRA Cloud-cleared Product</b></p>  <p style="text-align: center;">OPEN</p>
<p><b>"False-Alarm" Signatures</b></p> <ul style="list-style-type: none"> <li>The distinction between low clouds and fog is especially important to public safety and aviation.</li> </ul>  <p style="text-align: center;">OPEN</p>	<ul style="list-style-type: none"> <li>The standard deviation of the cloud-cleared data is small in IR2, so we can safely assume that we are seeing temperatures that are representative of the surface.</li> <li>In the cloud-cleared data from June 2018, we see the exact shape that we see in the nighttime Microphysics RGB, which indicates that "false-alarm" signature is likely a surface emissivity phenomenon and not a required misinterpretation of feature.</li> <li>Analyzing the minimum, mean, and maximum we can see there is 95% variation in the 10.3µm-11.5µm BTIC over 1 month.</li> </ul>  <p style="text-align: center;">OPEN</p>	<ul style="list-style-type: none"> <li>The extent and intensity of the "false-alarm" signature seen in the monthly composite of the cloud-cleared background appears to match that of</li> </ul> <p style="text-align: center;">OPEN</p>	<p><b>Conclusions &amp; Future Work</b></p> <ul style="list-style-type: none"> <li>Seasonality analysis confirms that the "false alarm" is present for every night of 2018 and is therefore likely a permanent feature of the surface emissivity and not a meteorological phenomenon.</li> <li>Seasonality analysis also shows a slight decrease in intensity of the "false alarm" areas during the winter months, then increasing in spring and summer until the maximum intensity during the fall months.</li> <li>Comparing the maximum BTIC for the June 2018 cloud-cleared composite to the BTIC from the GOES-16 data taken on June 24, 2018 shows that the BTIC is larger in the one data frame in the monthly.</li> </ul> <p style="text-align: center;">OPEN</p>

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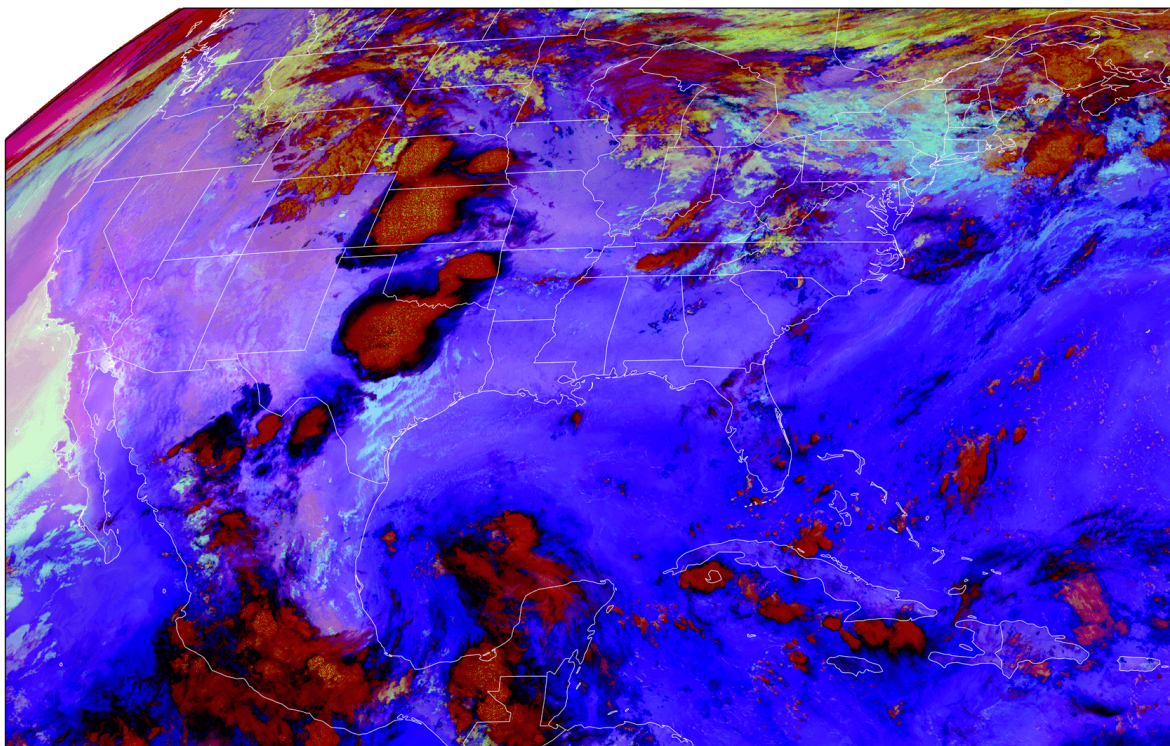


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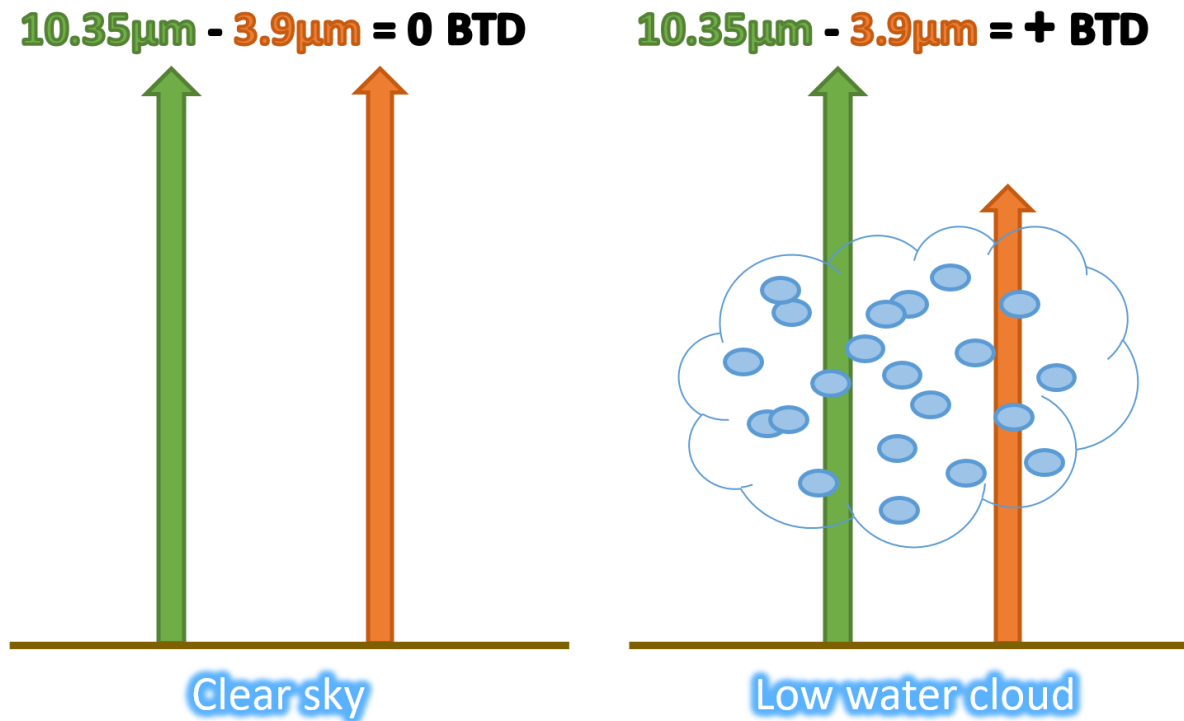
## INTRODUCTION



- The Nighttime Microphysics RGB is a multi-spectral imagery product from the GOES-R series Advanced Baseline Imager (ABI) created by NASA SPoRT
- Utilized by National Weather Service Forecasters and the aviation community to quickly analyze complex cloud fields at night
- Combines data from 3 infrared bands to discriminate between different types of clouds
  - Based on emissivity properties of different cloud particles at 3.9 $\mu\text{m}$ , 10.35 $\mu\text{m}$ , and 12.4 $\mu\text{m}$
  - For more information about the Nighttime Microphysics RGB, please visit the NASA SPoRT training page [here](https://weather.msfc.nasa.gov/sport/training/quickGuides/rgb/QuickGuide_NtMicro_GOESR_NASA_SPoRT_20170914.pdf) ([https://weather.msfc.nasa.gov/sport/training/quickGuides/rgb/QuickGuide\\_NtMicro\\_GOESR\\_NASA\\_SPoRT\\_20170914.pdf](https://weather.msfc.nasa.gov/sport/training/quickGuides/rgb/QuickGuide_NtMicro_GOESR_NASA_SPoRT_20170914.pdf))

## "FALSE-ALARM" SIGNATURES

- The distinction between low clouds and fog is especially important to public safety and aviation



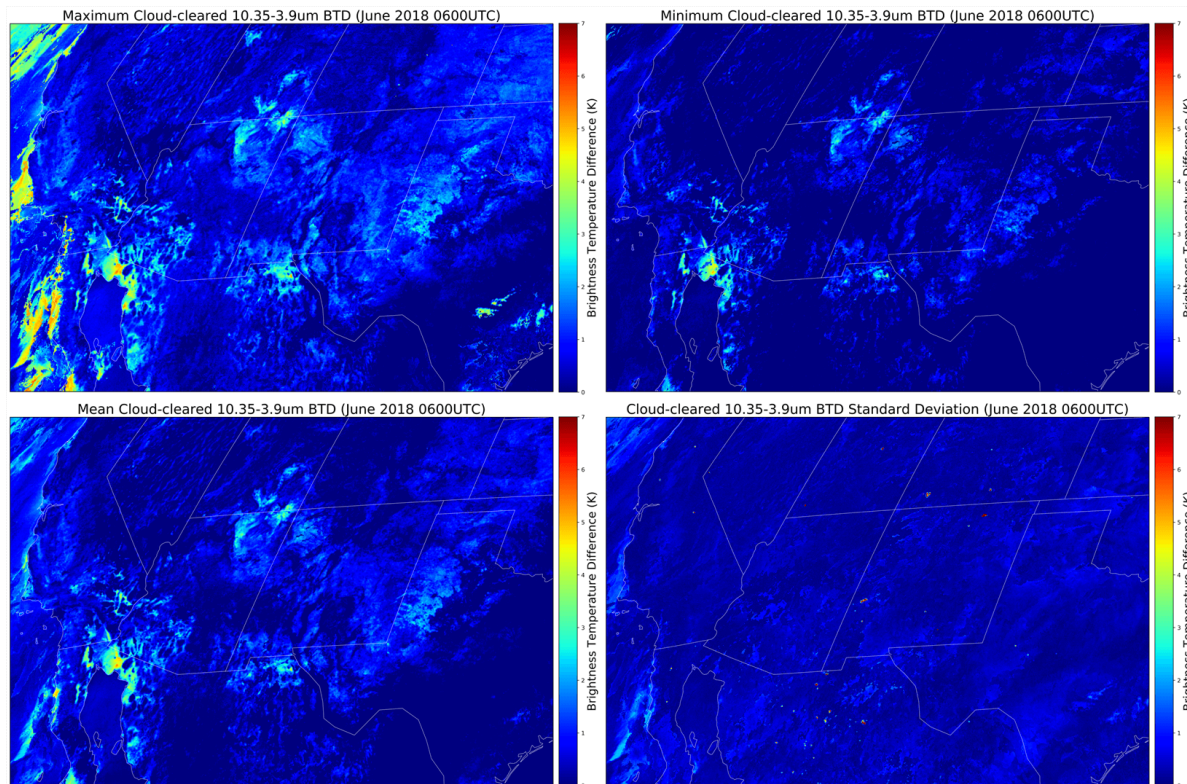
- The green channel of the Nighttime Microphysics RGB uses the 10.35 $\mu$ m-3.9 $\mu$ m Brightness Temperature Difference (BTD) to highlight low clouds and fog
  - Small water particles found in low clouds and fog selectively absorb energy at 3.9 $\mu$ m while transmitting 10.35 $\mu$ m energy
  - However, this assumes that the surface has an emissivity of 1 at both 10.35 $\mu$ m and 3.9 $\mu$ m
  - If we zoom in to Southwest U.S. region, we can see that this is not the case

[VIDEO] <https://www.youtube.com/embed/xjW-55tDsjk?feature=oembed&fs=1&modestbranding=1&rel=0&showinfo=0>

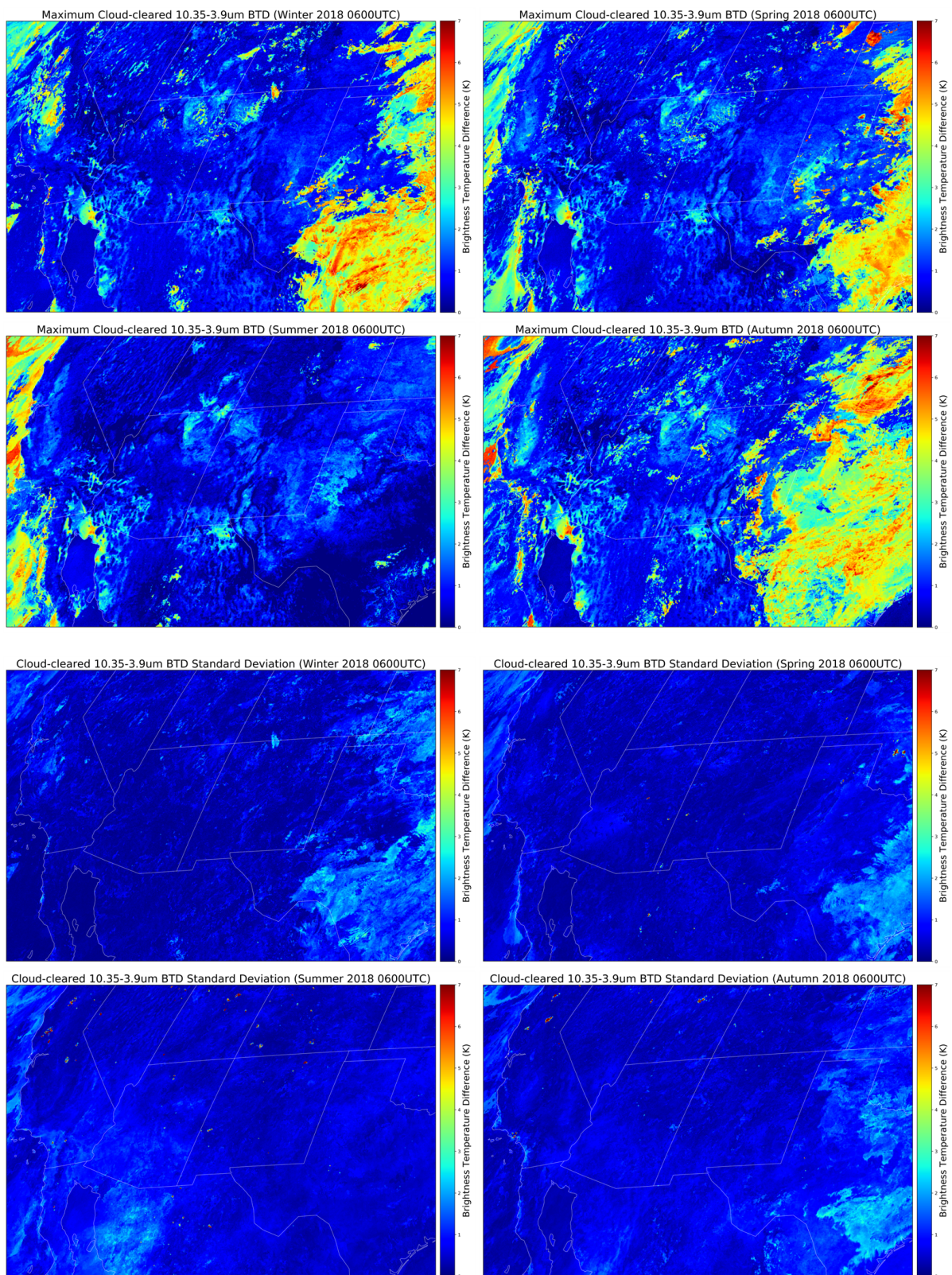
- Some property of the surface emissivity in the desert southwest is mimicking the positive signal that low clouds produce in the 10.35 $\mu$ m-3.9 $\mu$ m brightness temperature difference (BTD)
- A cloud-cleared background should expose this phenomena as a true "false alarm" which can then be filtered out of the RGB product to improve interpretation of complex cloud scenes

## SURFACE EMISSIVITY VARIABILITY

- The plots below show how the cloud-cleared 10.35 $\mu$ m-3.9 $\mu$ m BTD at 0600UTC (see "CIRA Cloud-cleared Product") in the SW U.S. varies over different scales of time periods



- The standard deviation of the cloud-cleared data is small ( $\leq 1$ K), so we can safely assume that we are seeing temperatures that are representative of the surface
- In the cloud-cleared data from June 2018, we see the exact shape that we see in the Nighttime Microphysics RGB, which indicates that "false-alarm" signature is likely a surface emissivity phenomenon and not a recurrent meteorological feature
  - Analyzing the minimum, mean, and maximum we can see there is little variation in the 10.35 $\mu$ m-3.9 $\mu$ m BTD over 1 month

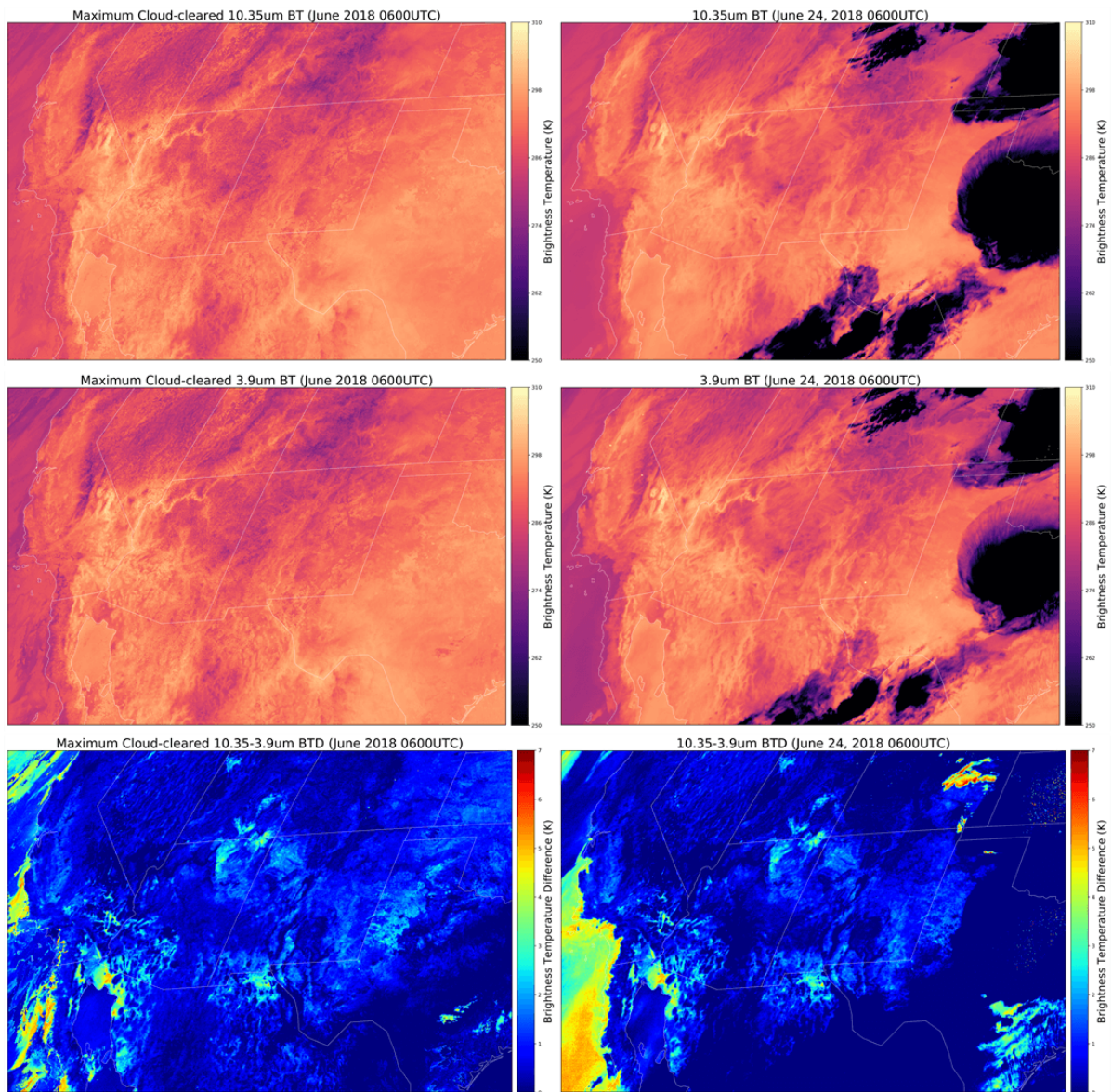


- Analyzing the cloud-cleared 10.35 $\mu$ m-3.9 $\mu$ m BTD seasonally over an entire year shows that "false-alarm" signal is always present and varies slightly with the change in season
  - The maximum 10.35 $\mu$ m-3.9 $\mu$ m BTD is slightly lower during the winter months, and then increases in spring and summer until the maximum in intensity during the fall months
  - The seasonal standard deviation of the cloud-cleared 10.35 $\mu$ m-3.9 $\mu$ m BTD confirms once again the "false-alarm" signal is a feature of the surface emissivity

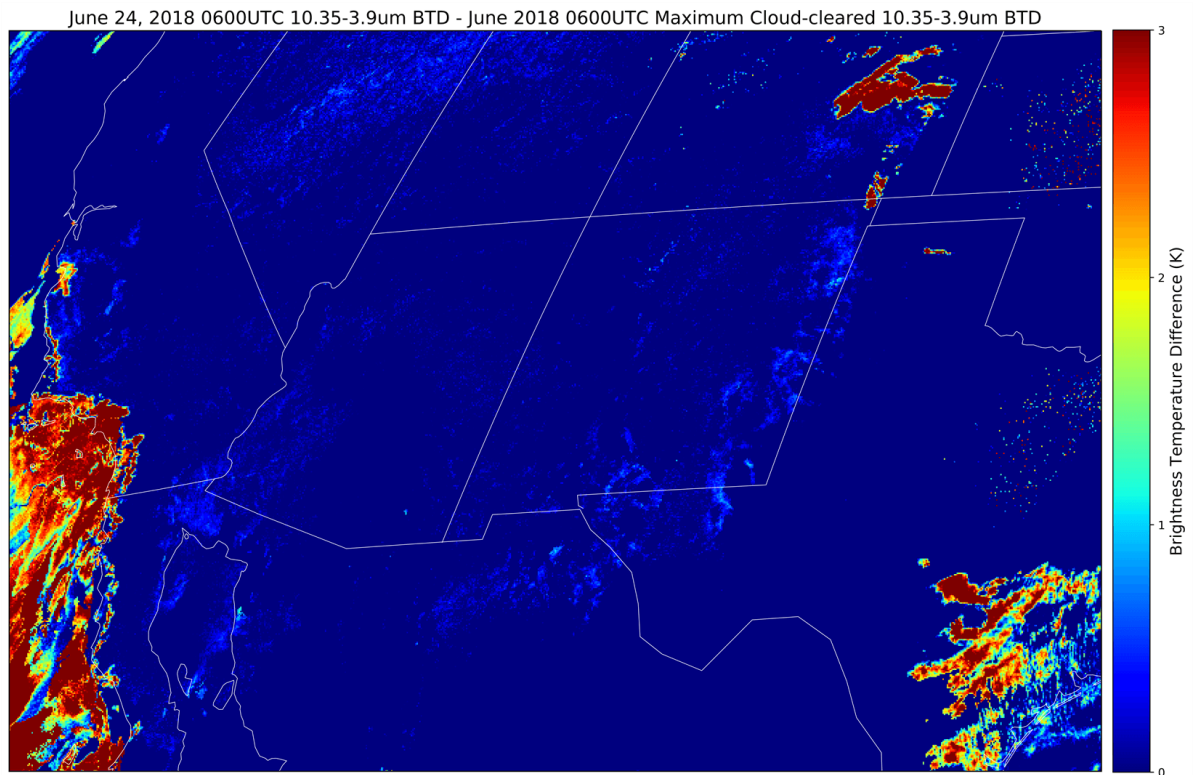


## GOES-R APPLICATIONS

- The "false-alarm" signature is a constant feature that complicates an already complex scene in the Nighttime Microphysics RGB
  - If we can characterize it in the cloud-cleared imagery, we should be able to clear it out of the real-time RGB product
  - The plots below show how the maximum cloud-cleared brightness temperatures at 10.35 $\mu\text{m}$ , 3.9 $\mu\text{m}$ , and the 10.35 $\mu\text{m}$ -3.9 $\mu\text{m}$  BTD from June 2018 monthly composite compare to raw GOES-16 data from June 24, 2018 at 0600UTC

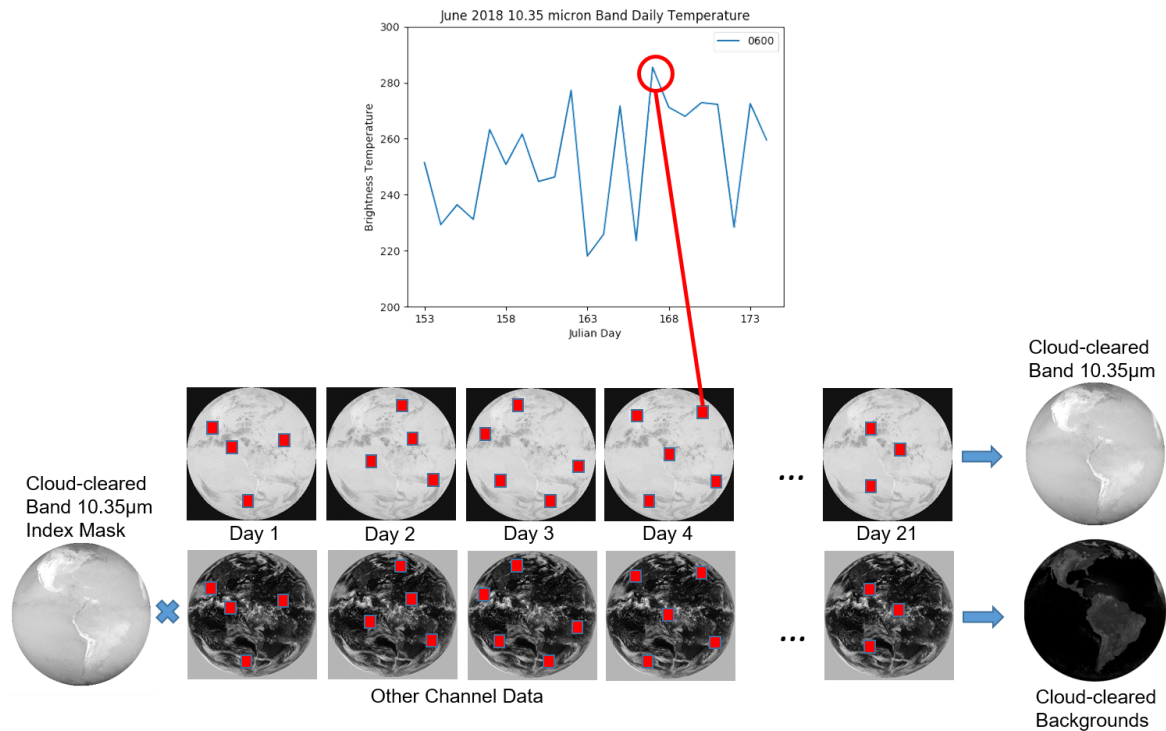


- The extent and intensity of the "false-alarm" signature seen in the monthly composite of the cloud-cleared background appears to match that of the signature seen the raw GOES-16 data
  - If the cloud-cleared background fully characterizes the signature, then subtracting the BTD from both datasets should yield 0K



- This plot shows a positive difference between the 10.35 $\mu$ m-3.9 $\mu$ m BTD from June 24, 2018 and the the maximum of the monthly composite of the cloud-cleared 10.35 $\mu$ m-3.9 $\mu$ m BTD over the "false-alarm" areas
  - This indicates that the 10.35 $\mu$ m-3.9 $\mu$ m BTD from the raw GOES-16 data is actually larger than the maximum BTD in the monthly cloud-cleared composite
  - The cloud-cleared background captures much of the false-alarm signatures, but does not capture the true maximum in 10.35 $\mu$ m-3.9 $\mu$ m BTD seen in the actual imagery

## CIRA CLOUD-CLEARED PRODUCT



The Cooperative Institute for Research in the Atmosphere (CIRA) Cloud-cleared product was created by Matt Rogers and Stever Miller. For each pixel in the GOES-R ABI's Full Disk scene, it assigns the warmest 10.35µm pixel in a 21-day period as the temperature of the surface/cloud-free environment. This assumes that in a 21-day period, GOES will observe at least one cloudless instance for each pixel in the scene, and that cloudless pixel should also be the warmest pixel in the 10.35µm in that same time period. The index of the clear pixel is then used to delineate the temperature of the clear pixel at the other wavelengths observed by the GOES-R ABI.

## CONCLUSIONS & FUTURE WORK

- Seasonality analysis confirms that the "false-alarm" is present for every night of 2018 and is therefore likely a permanent feature of the surface emissivity and not a meteorological phenomenon
- Seasonality analysis also shows a slight decrease in intensity of the "false-alarm" areas during the winter months, then increasing in spring and summer until the maximum in intensity during the fall months.
- Comparing the maximum BTM for the June 2018 cloud-cleared composite to the BTM from the GOES-16 data taken on June 24, 2018 shows that the BTM is larger in the raw data than in the monthly composite of the cloud-cleared data. This indicates that the actual maximum BTM does not coincide with the warmest 10.35 $\mu$ m brightness temperature in a 21-day period.
- Future work will include further analyzing seasonality from 2019 data, experimenting with characterizing the emissivity of the "false-alarm" regions, and ultimately using the emissivity to remove the "false-alarms" from the SPoRT Nighttime Microphysics RGB to improve interpretation of the product.

Sorry but time is up!

## ABSTRACT

Value-added imagery products from the GOES-R series Advanced Baseline Imager are used to identify features of interest for operational forecasters, including: blowing dust, smoke, volcanic ash, cloud cover, atmospheric moisture, biomass fires and snow cover. These features each have a specific spectral signal that algorithms are designed to detect, but those signals are not always unique to just a single feature. Sometimes, the surface can mimic the spectral signal associated with an atmospheric feature of interest, creating a false alarm in a value-added product which negatively impacts interpretation of that product. This case study focuses on one such situation where areas of desert in the southwestern United States mimic the positive value associated with low clouds in the Brightness Temperature Difference (BTD) between the 10.35 $\mu\text{m}$  and 3.9 $\mu\text{m}$  channels, producing a false alarm. In order to characterize these “false alarm” areas, this study uses the cloud-cleared background product from the Cooperative Institute for Research in the Atmosphere (CIRA) to create a dataset of the cloud-free surface. Previous results have shown that cloud-cleared backgrounds of the 10.35  $\mu\text{m}$ -3.9 $\mu\text{m}$  BTD have successfully identified areas of positive BTDs in the cloud-free environment, proving that it is a property of the surface emissivity and a true “false alarm”. This study builds on that previous research to further characterize the seasonality of the “false-alarm” regions and to catalogue how they impact interpretation of multi-spectral imagery products from the GOES-R series ABI, especially the Nighttime Microphysics RGB created by NASA Short-term Prediction Research and Transition (SPoRT) Center.

## SWITCH TEMPLATE

