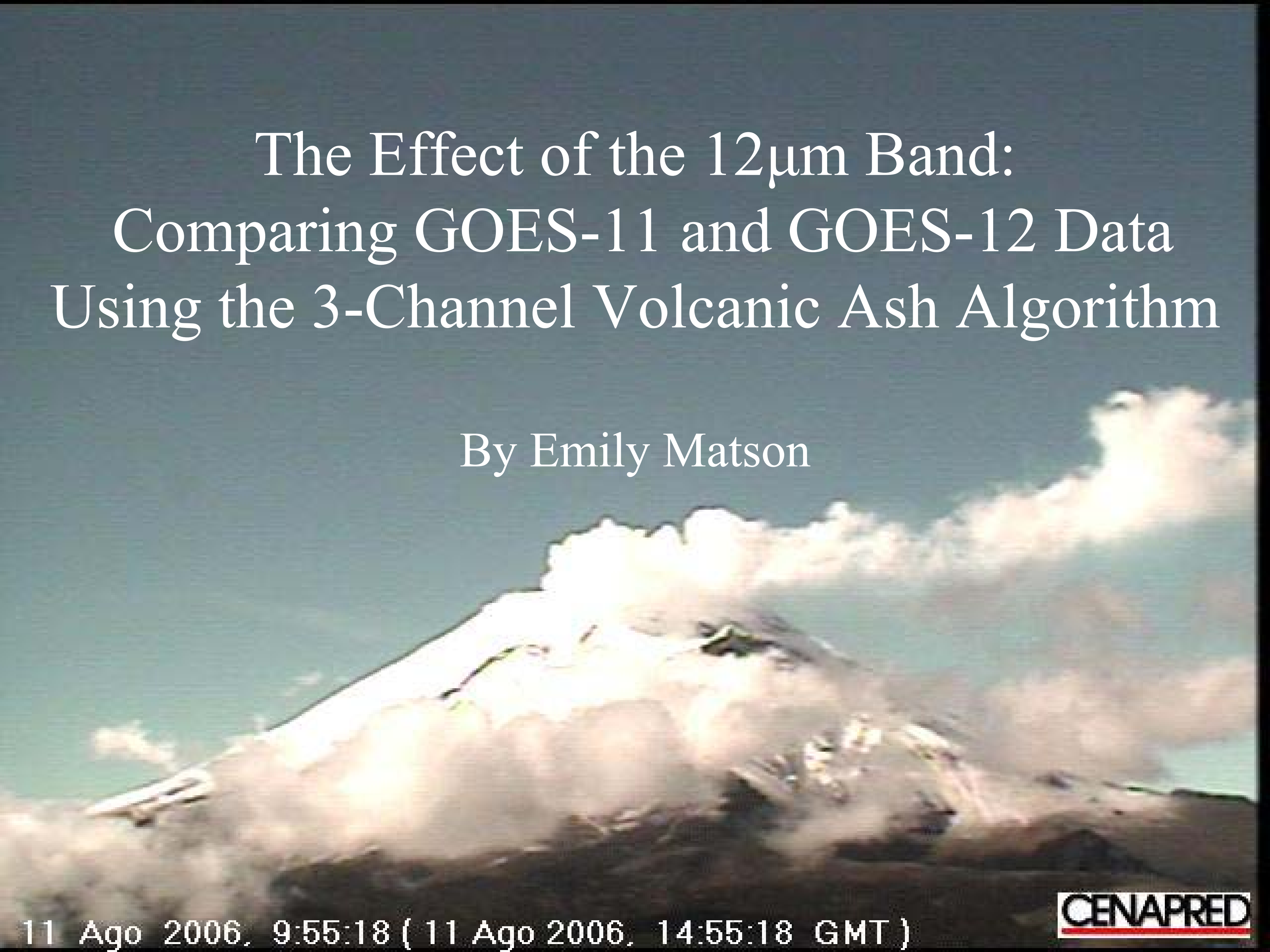
The Effect of the 12μm Band: Comparing GOES-11 and GOES-12 Data Using the 3-Channel Volcanic Ash Algorithm

By Emily Matson



Background

- Loss of 12μm channel on GOES-12
- Addition of 13μm channel for better cloud top height estimates
- Concern that loss of 12μm channel will negatively impact volcanic ash data and cloud data
- Expected degradation in volcanic ash and cloud data, especially for low clouds

	GOES 8-11		GOES 12	
Band	Wavelength (µm)	Resolution (km)	Wavelength (µm)	Resolution (km)
1	0.6	1	0.6	1
2	3.9	4	3.9	4
3	6.7	8	**6.5**	**4**
4	10.7	4	10.7	4
5	12.0	4	-	-
6	-	-	**13.3**	**8**

Importance of Accurate Ash Detection

- Clogs up plane engines and decreases efficiency, can be fatal
- Recent increase in circumpacific air traffic
- Higher temperatures of modern jets within melting range of volcanic glass

From pubs.usgs.org

The Volcanic Ash Algorithms

- Arithmetic combination of brightness temperatures obtained from channels that yields a unitless brightness count B
- Values of B that are large compared to surrounding terrain represent volcanic ash

- GOES-11: $B = 60 + 10(T5-T4) + (T2-T4)$

- GOES-12: $B = 5(T2 – 1.5T4 + 1.5T6) – 230$

Procedure

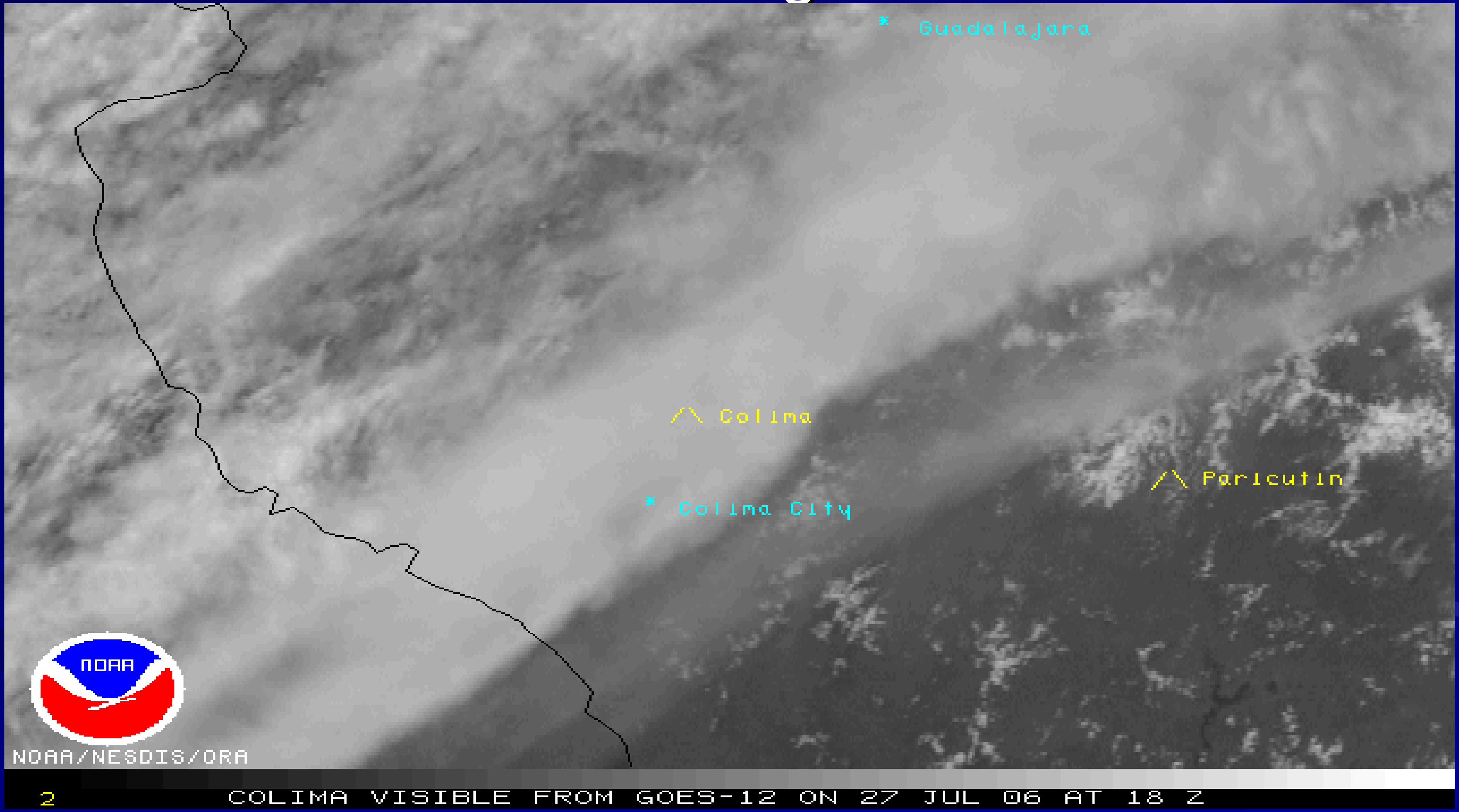
- Compare IR data from volcanic ash algorithm for GOES-11 and GOES-12
- Overlap in GOES-11 (WEST) and GOES-12 (EAST) in Mexico and Central America
- Monitoring volcanoes in overlap area: Colima and Popocatepetl

Data Used

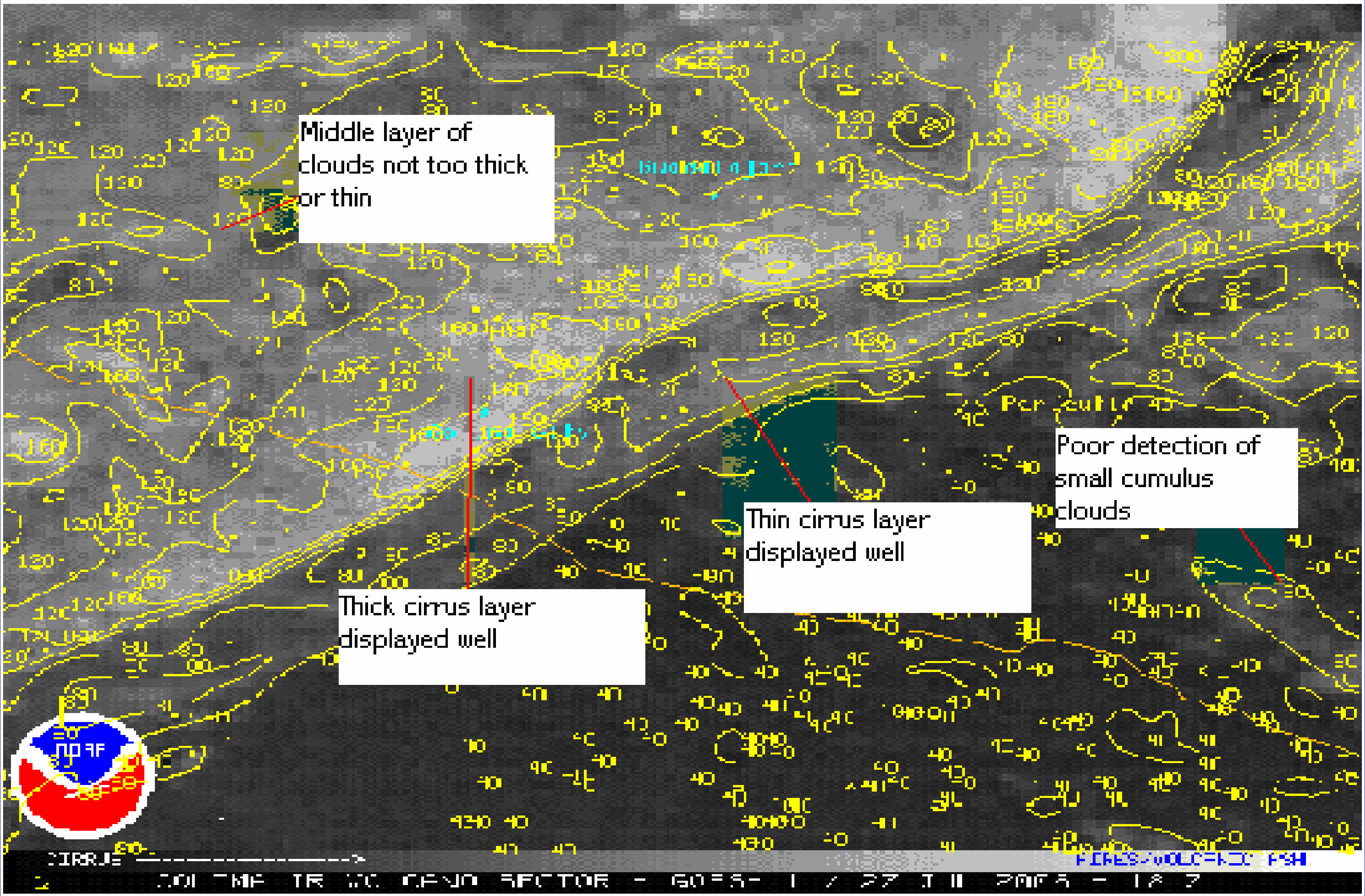
- Data generated on archive at ftp://orbit.nesdis.noaa.gov/pub/smcd/opdb/ematson
- IR data generated with brightness temperature and brightness count contours, VIS data also generated
- Multiple volcanic ash observatories monitored Brightness temperature vs. brightness count scatter plots generated

Case Study #1: Colima Images from 27 July 18:00 UTC

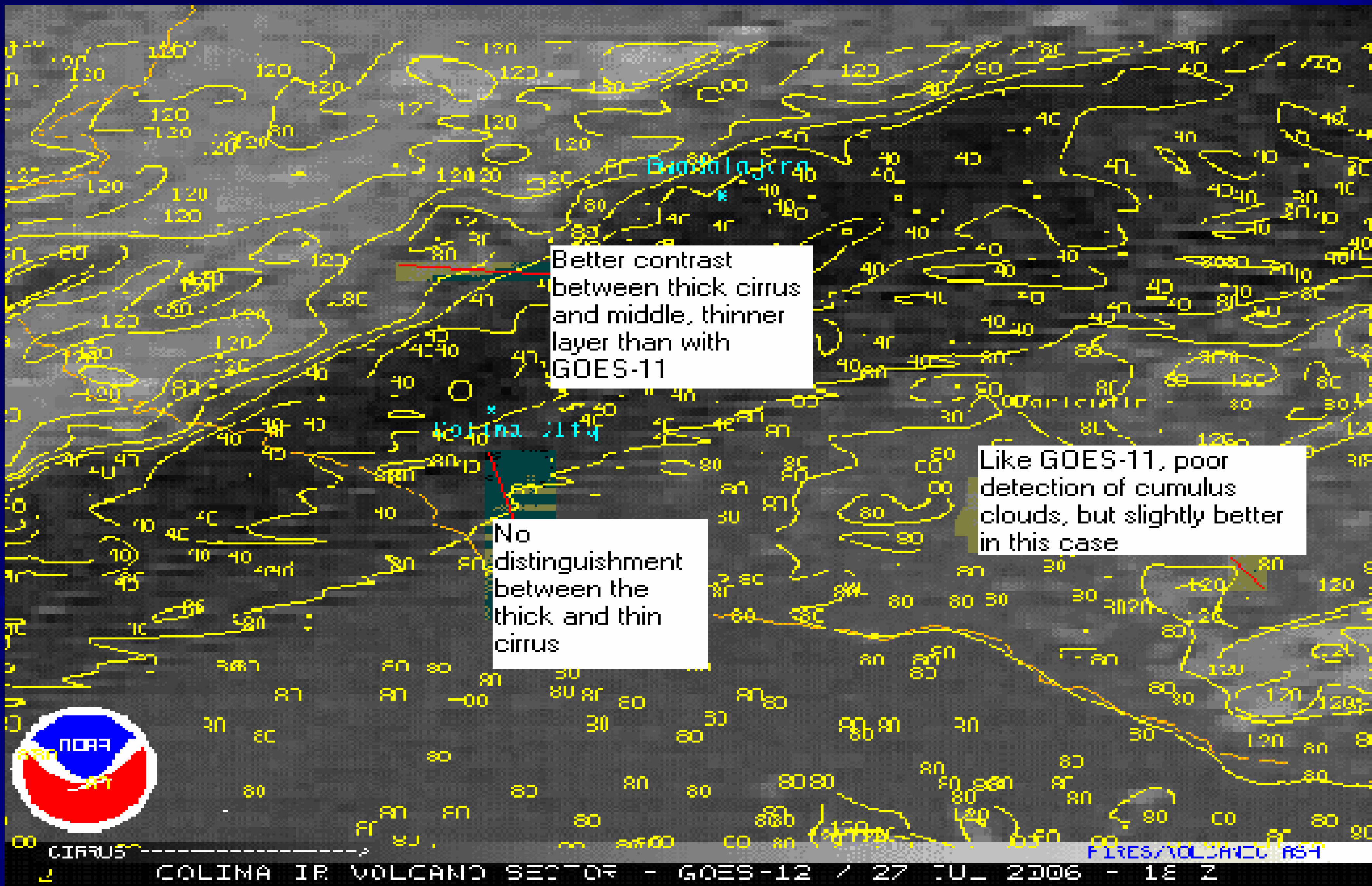
VIS Image



GOES-11 IR Image

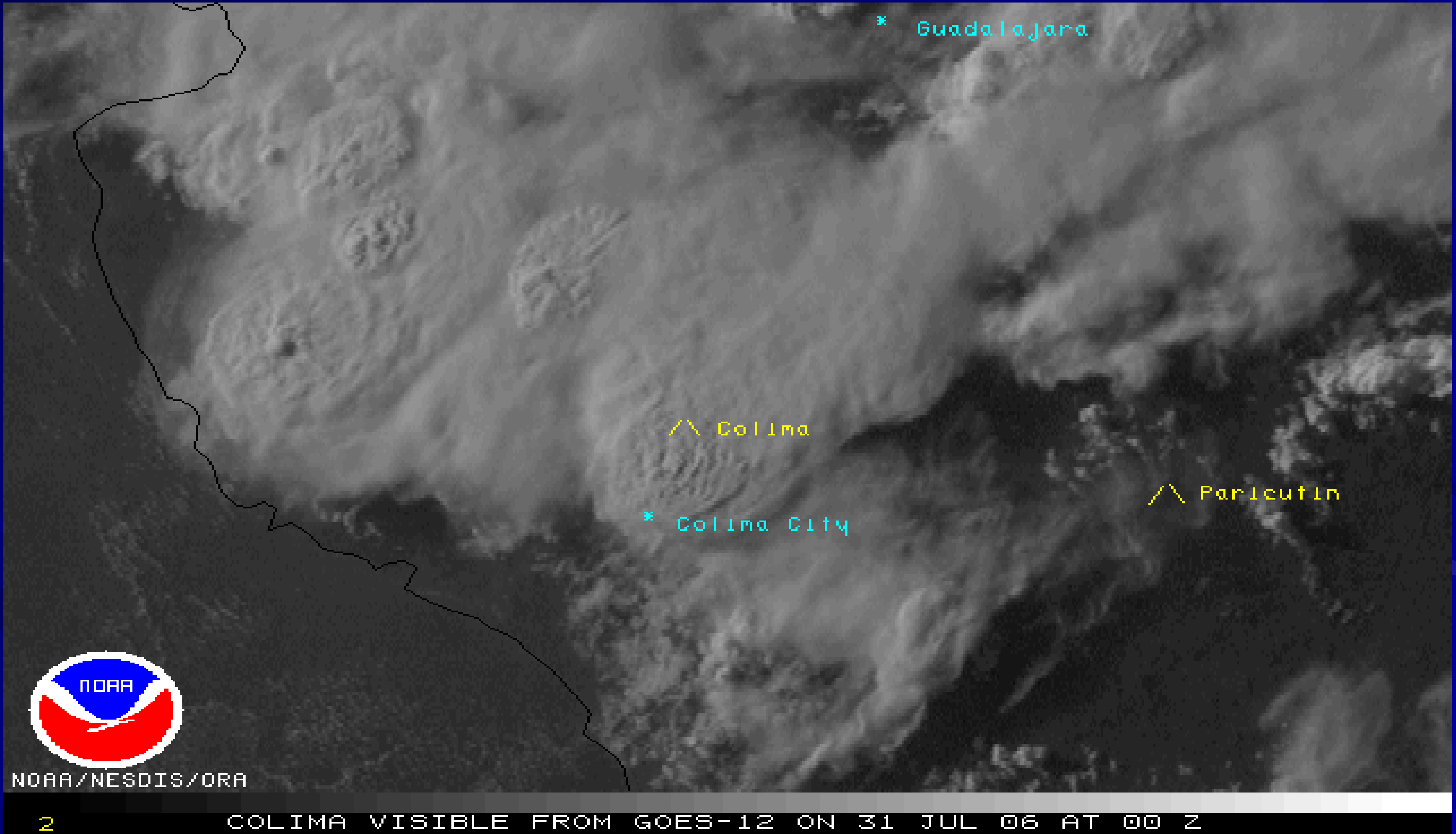


GOES-12 IR Image

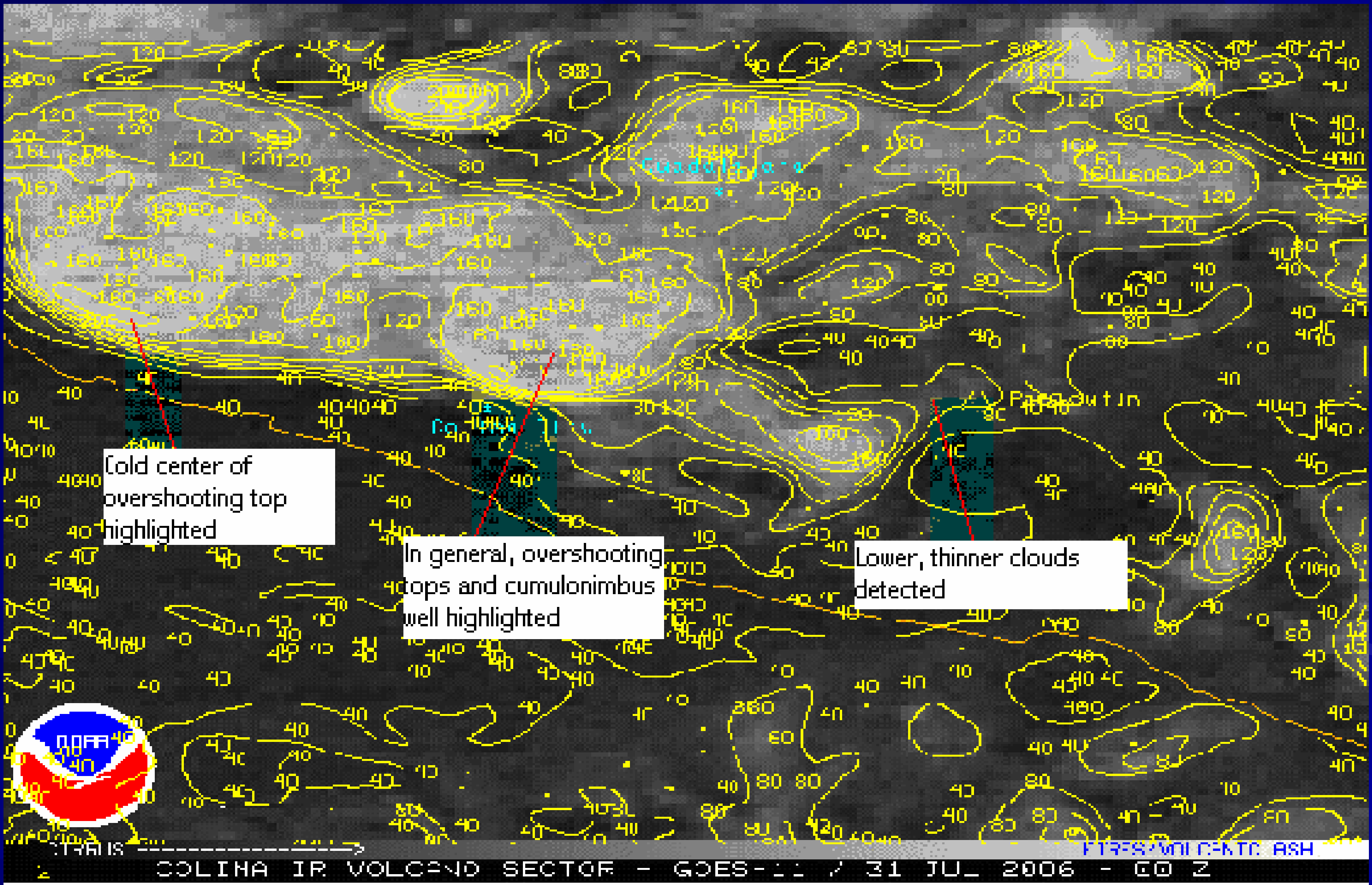


Case Study #2: Colima Images from 3 July 0:00 UTC

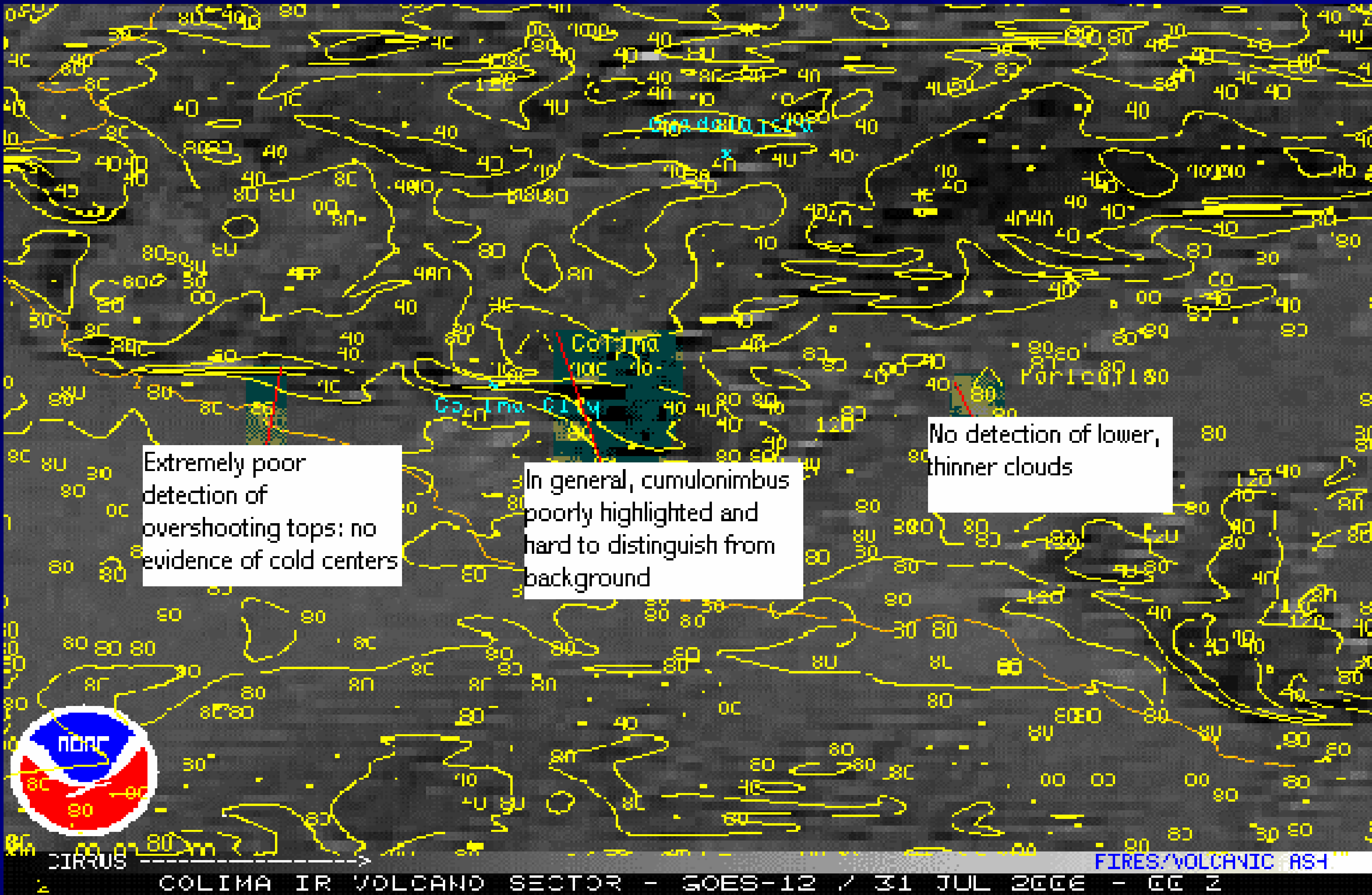
VIS Image



GOES-11 IR Image

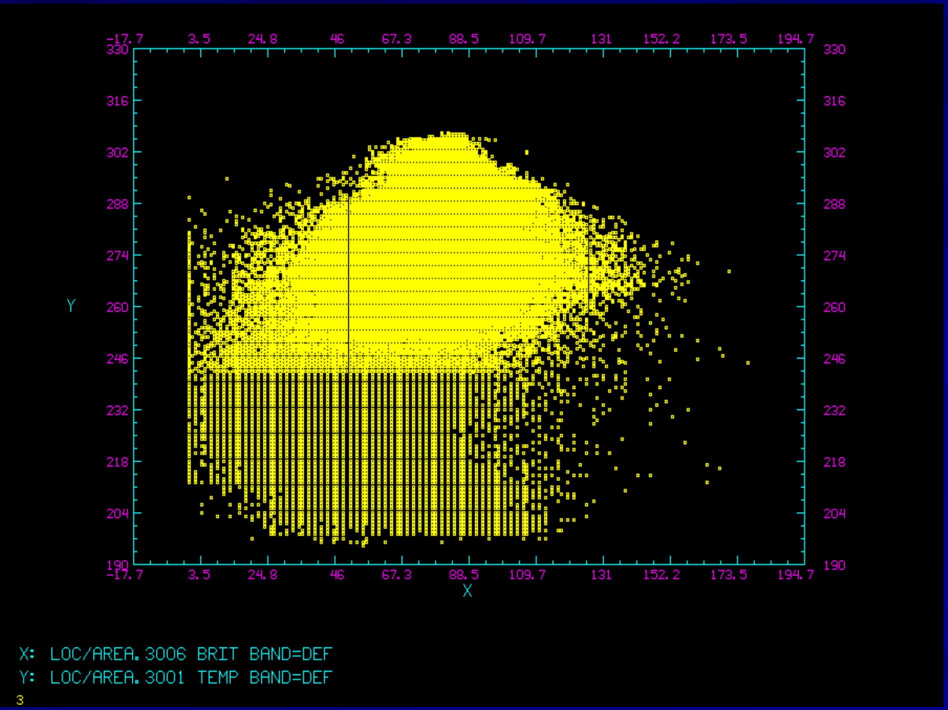


GOES-12 IR Image

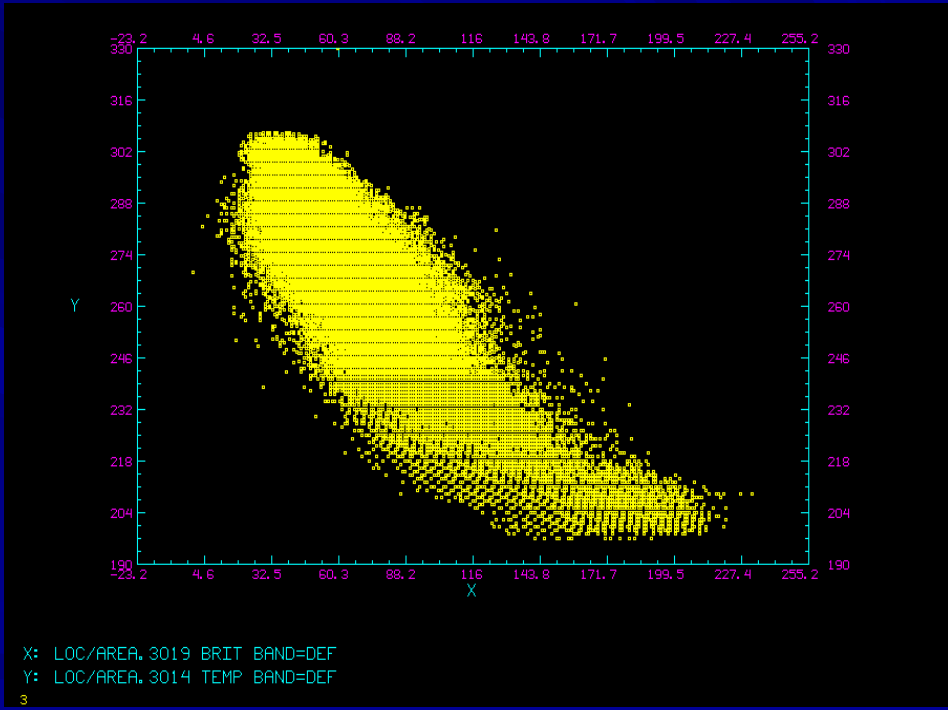


Case Study #3: Brightness temperature vs. brightness count for Colima 19 July 0:00 UTC

For GOES-12 :

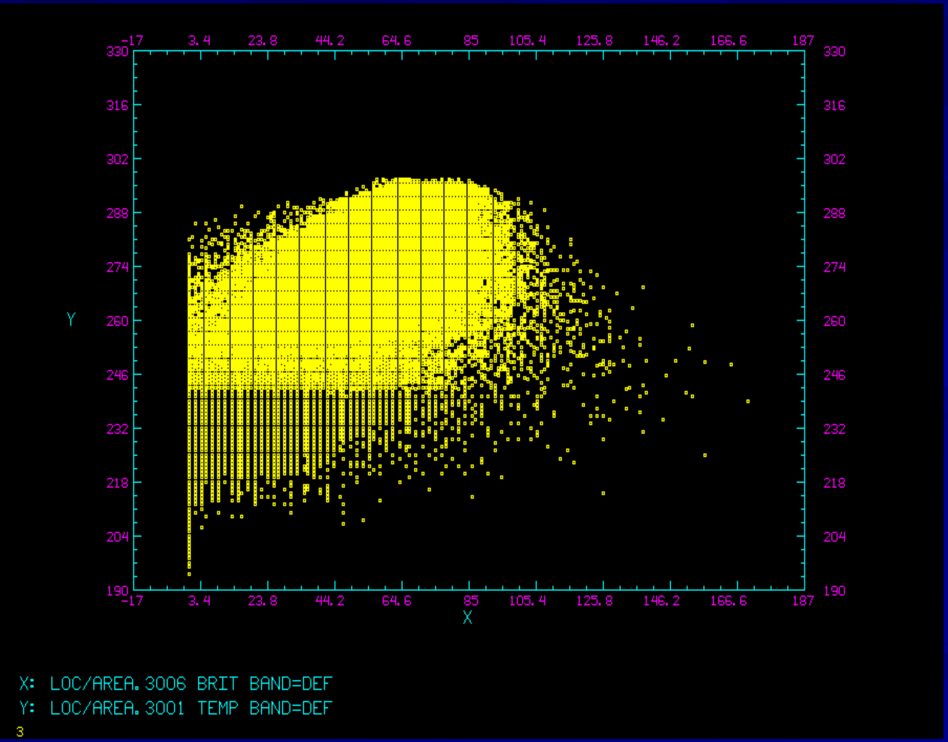


For GOES-11:

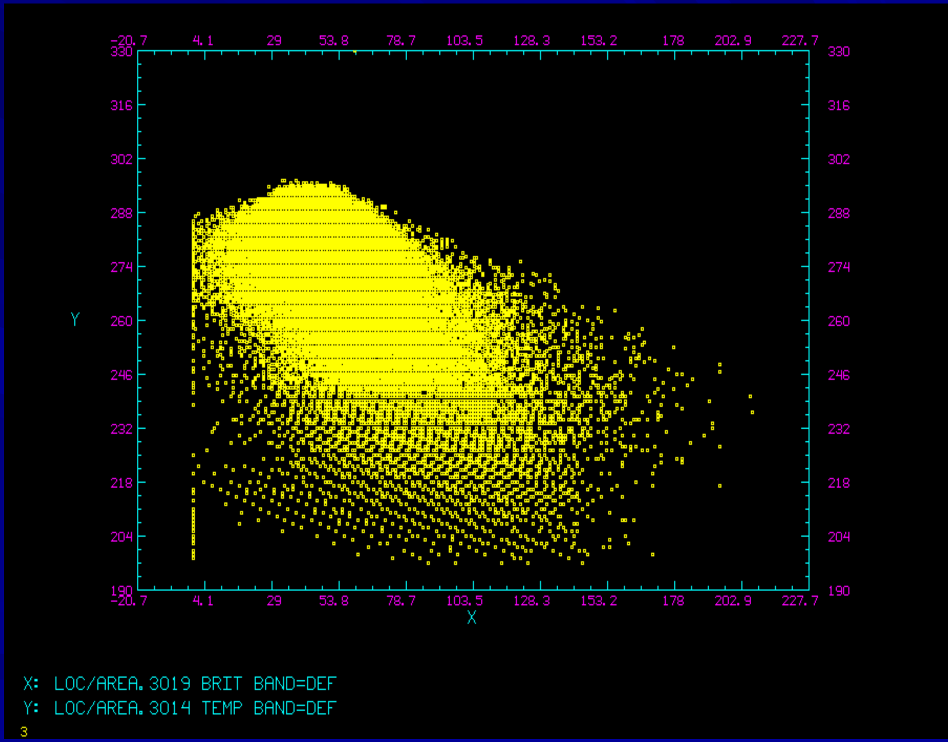


Additional Scatter plots for Colima 19 July

For GOES-12 10:00 UTC:

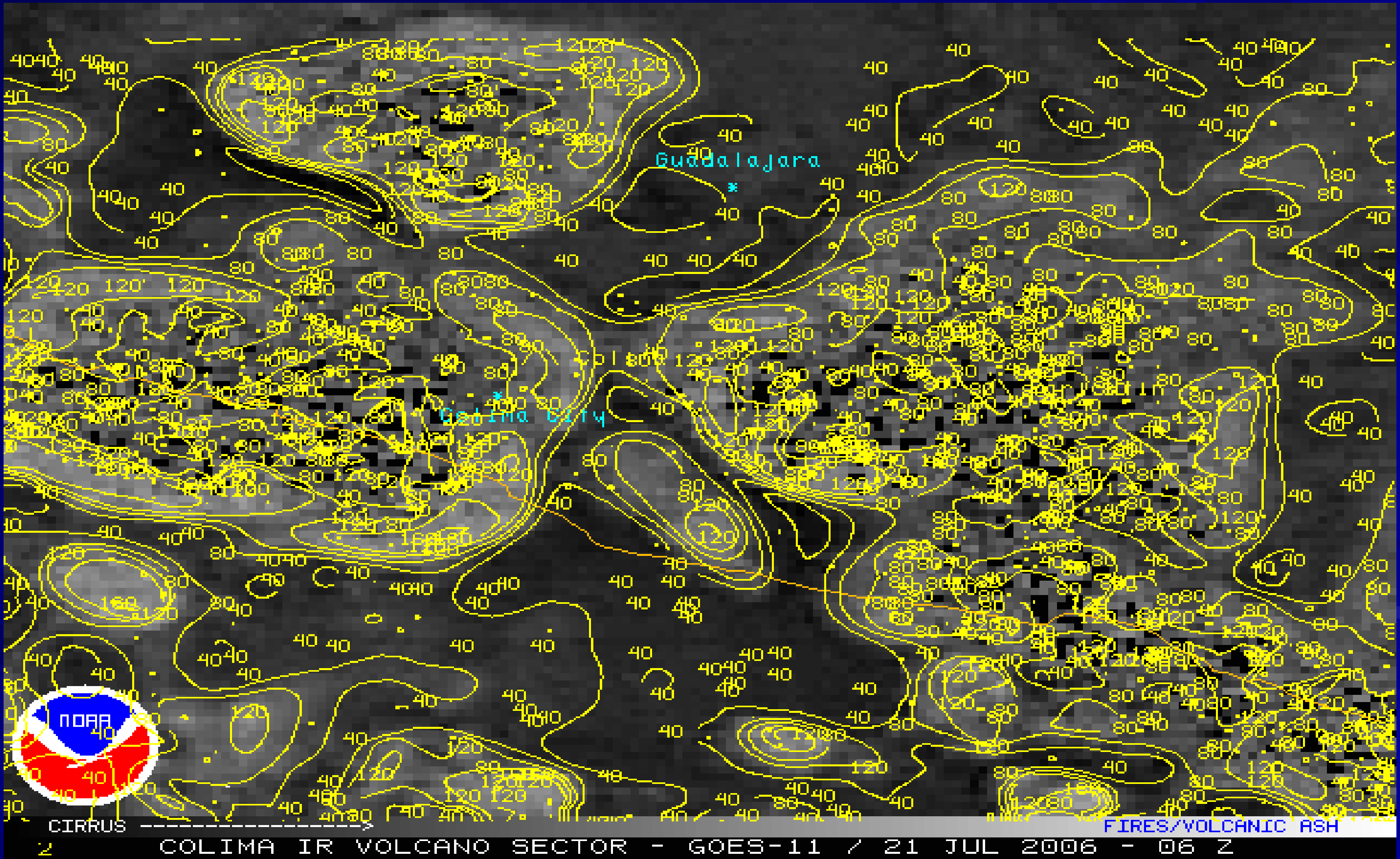


For GOES-11 11:00 UTC:

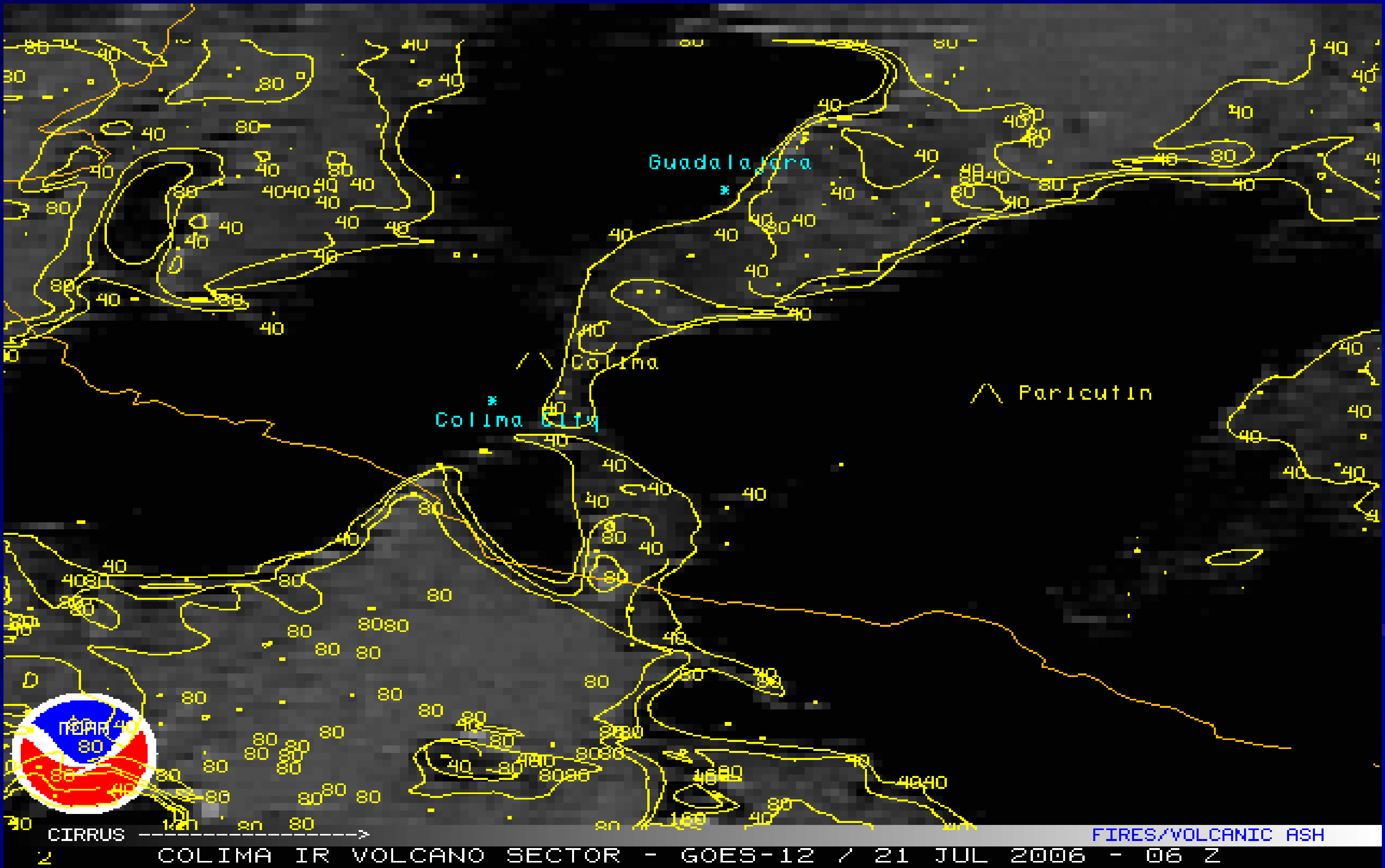


Night Data for Colima from 21 July 6:00 UTC

GOES-11 IR Image:

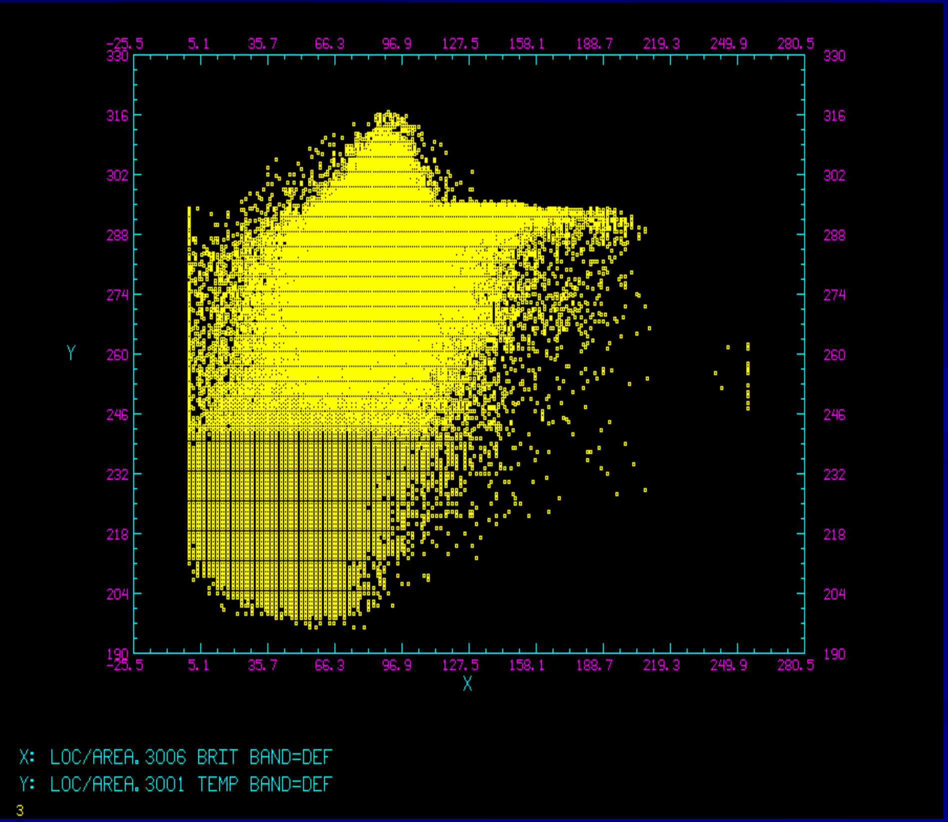


GOES-12 IR Image

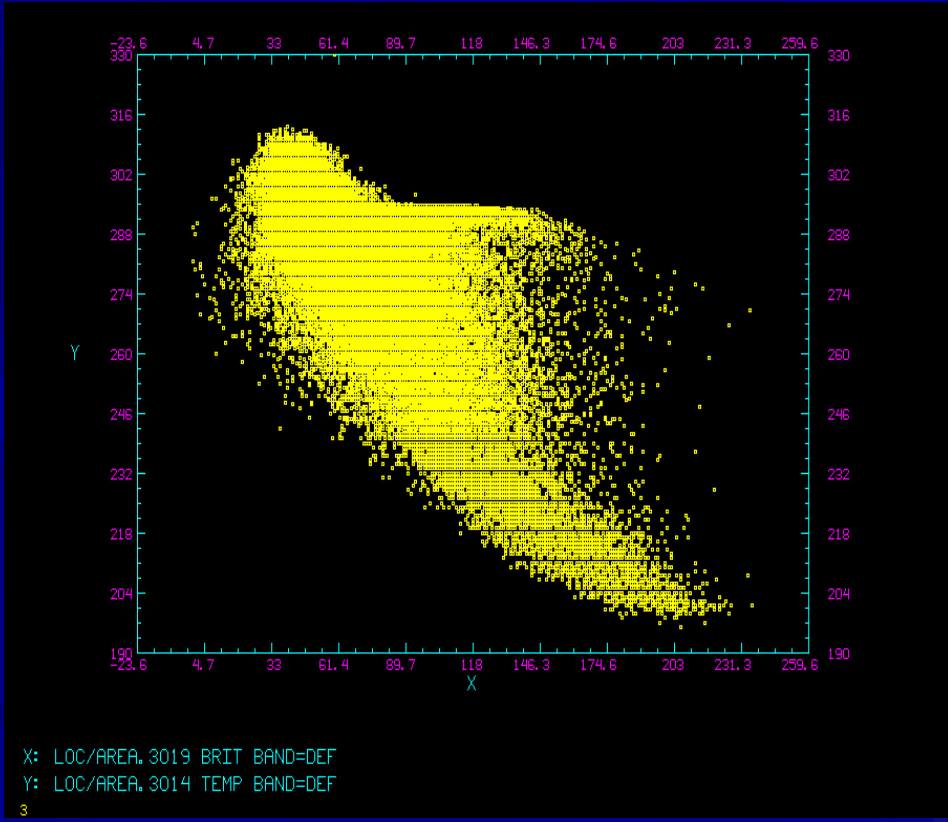


Case Study #4: Colima Scatter plots from 30 July

For GOES-12 at 22:00 UTC:



For GOES-11 at 17:00 UTC:



Errors

- Displacement to the east of convective clouds in GOES-11 due to viewing angle
- Sun angle: data at midday especially important
- Attenuation, contamination, and lack of background contrast

Image of GOES from www.accessnoaa.noaa.gov

Conclusions

- Cirrus clouds (especially thin) detected much better by GOES-11
- Low clouds detected better by GOES-11
- GOES-11 far superior in highlighting cumulonimbus clouds, especially overshooting tops, and their cold centers
- Cumulus clouds and mid-level clouds detected equally by both

Conclusions

- GOES-11 shown to contrast thick cloud layers and detect thin cloud edges with more clarity
- In general, GOES-11 algorithm had better data correlations than GOES-12
- GOES-12 scatter plots with better correlation at night, GOES-11 with worse due to noise from Channel 2
- Emphasized importance of 12µm band

References

- Conway, Eric D. and The Maryland Space Grant Consortium. <u>An Introduction to Satellite Image Interpretation</u>. Baltimore: The John Hopkins University Press, 1997.
- Ellrod, Gary P. “Improvements in Volcanic Ash Detection Using GOES Multi-Spectral Image Data.” <u>NOAA/NESDIS</u> (1998).
- Ellrod, Gary P. and Schreiner, Anthony J. “A First Look at Volcanic Ash Detection in the GOES-12 Era.” <u>NOAA/NESDIS</u>(2004). Retrieved 11 July 2006 from ams.confex.com
- Ellrod, Gary P. and Schreiner, Anthony J. “Volcanic ash detection and cloud top height estimates from the GOES-12 imager: Coping without a 12μm infrared band.” <u>Geophysical Research Letters</u> 31 (2004).
- Feltz, Wayne F.; Heidinger, Andrew K.; and Pavolonis, Michael J. “Improved Satellite-Based Volcanic Ash Detection and Height Estimates.” <u>NOAA / NESDIS</u> (2006). Retrieved 5 July 2006 from ams.confex.com

- Haines, Stephanie L. “Inter-comparison of GOES-8 Imager and Sounder Skin Temperature Retrievals.” Huntsville, Alabama (2001). Retrieved 18 July 2006 from weather.msfc.nasa.gov
- Kidder, Stanley Q. and Vonder Haar, Thomas H. Satellite Meteorology: An Introduction. San Diego: Academic Press, 1995.
- Kite-Powell, Hauke L. “Benefits of NPOESS for Commercial Aviation – Volcanic Ash Avoidance.” Marine Policy Center, Woods Hole Oceanographic Institution(Jan. 2001) Retrieved 11 July 2006 from www.economics.noaa.gov
- LaDue, Jim and Pryor, Ken. “Basics of Remote Sensing from Satellite.” Retrieved 28 June from www.orbit.nesdis.noaa.gov
- Schmit, T. J. et. al. “Introducing the GOES-M Imager.” *National Weather Digest*, Vol. 3 (Dec., 2001) pp. 28-37. Retrieved 18 July 2006 from cimss.ssec.wisc.edu

Acknowledgements

Special thanks to the author’s mentor, Mr. Kenneth Pryor; research advisor, Mrs. Wu; mentorship coordinator, Mr. Pearce; and Gary P. Ellrod for his extensive research on the volcanic ash product.