Satellite Analysis and Validation

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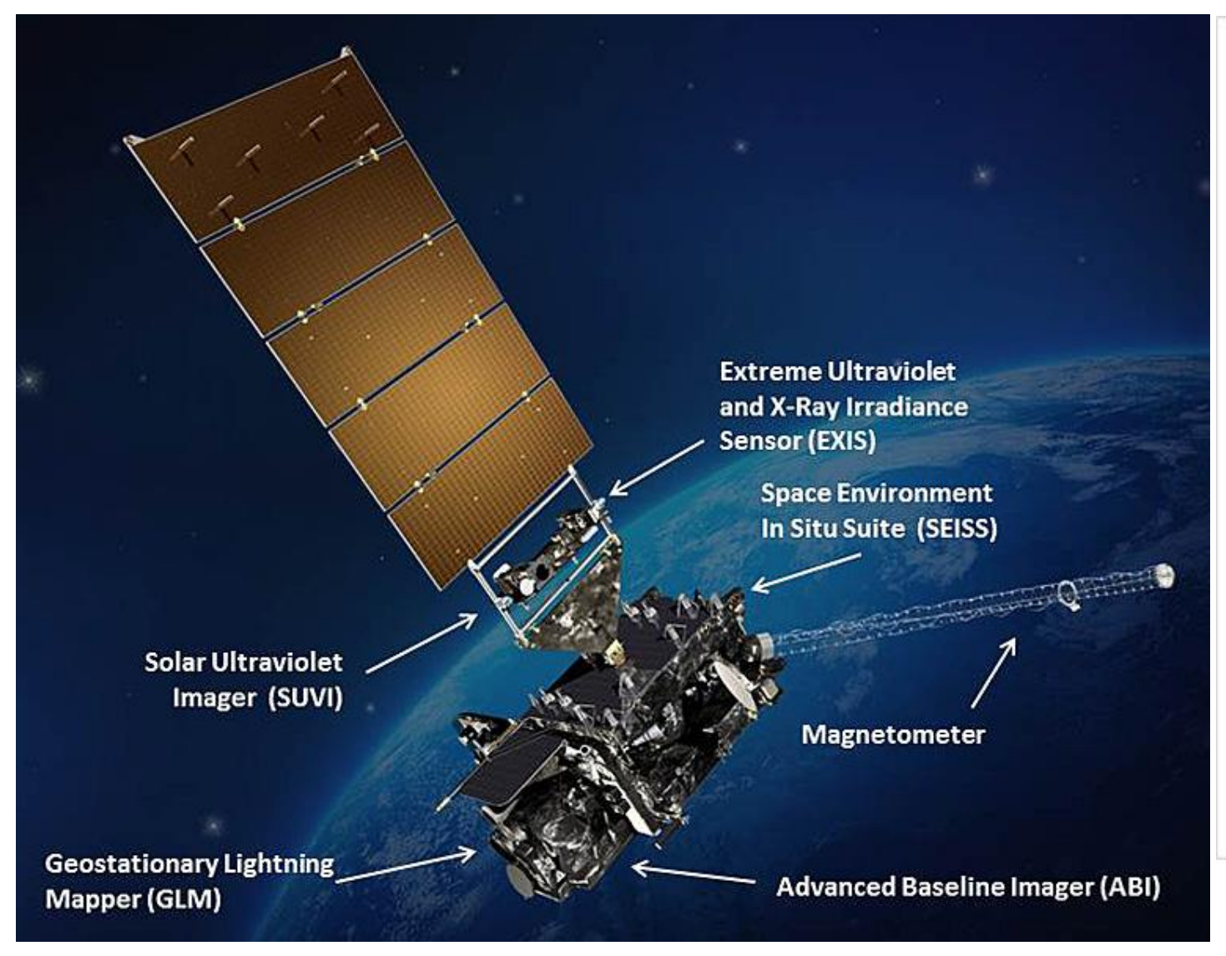
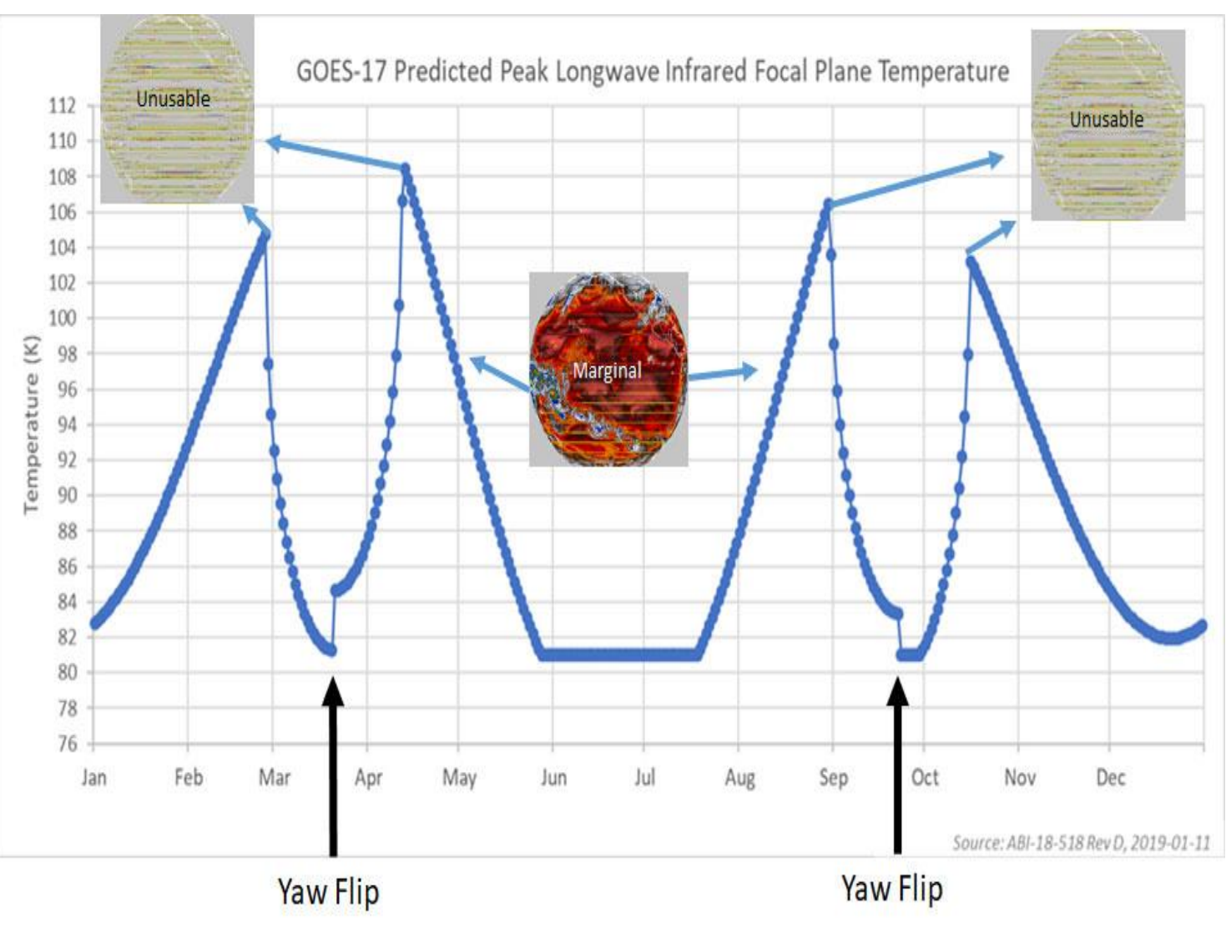
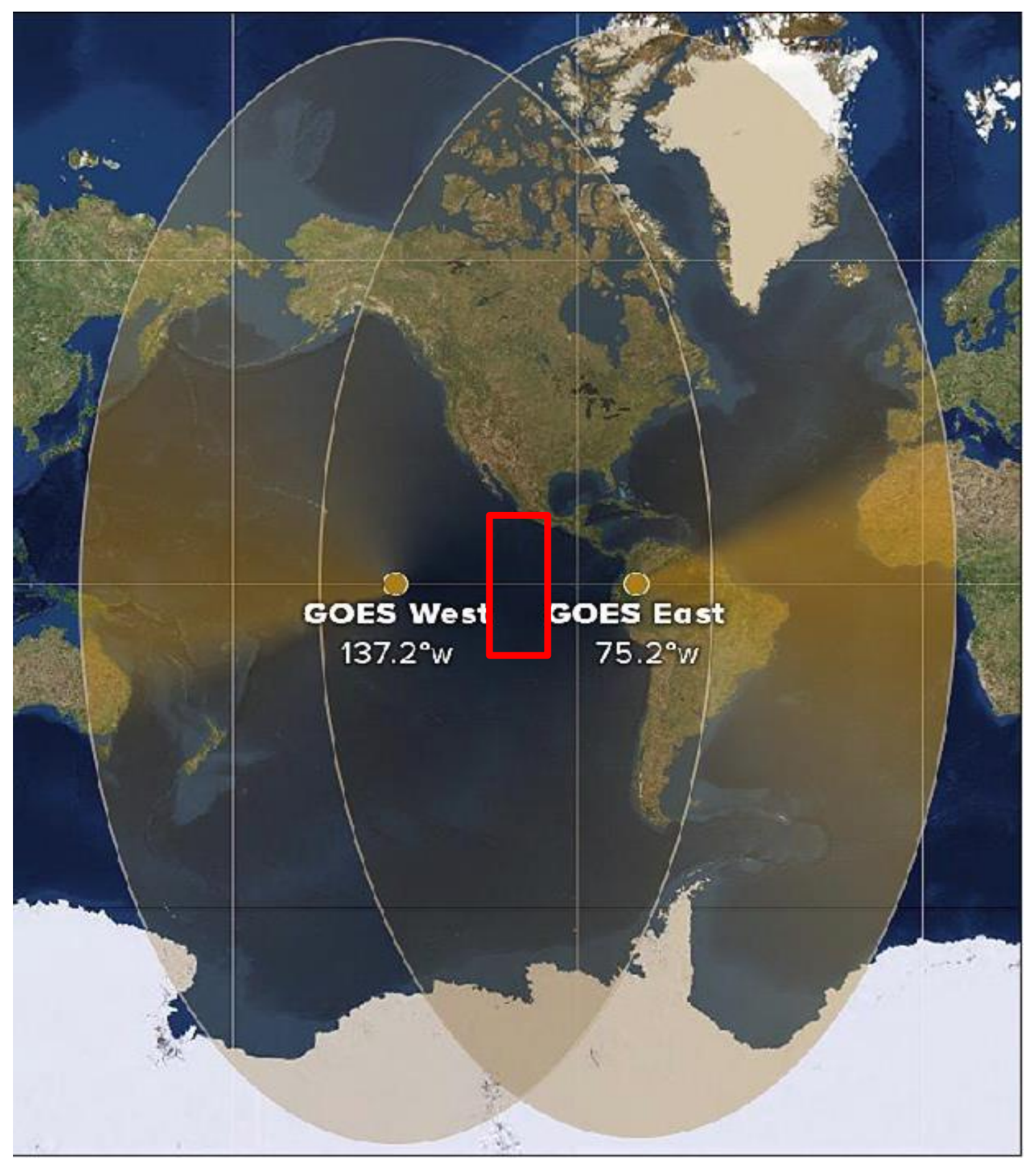
Motivation

We analyzed and compared data from two of the most critical tools for monitoring and forecasting weather: the Advanced Baseline Imagers (ABI) on the geosynchronous satellite GOES-16 (east) and on GOES-17 (west). While maintaining an agreement between these two imagers is always important, it is even more essential because of problems with GOES-17. The loop heat pipe (LHP), a device that cools the ABI, is not operating at its designed capacity; as a result, the images in some GOES-17 ABI channels are degraded at certain times of day, and certain times of the year when the cooling system malfunctions in radiating the sun's energy.





Objective & Procedure



The goal is to compare GOES-17 values to GOES-16 values, then identify errors within a range of interest (ROI) near the equator.

1. Using Python software, we carefully performed a comparison between the two ABIs where their fields of view partly overlap.
2. NOAA compared the mean value in the ROI. We confirmed their analysis and computed a histogram of the radiance values.
4. We analyzed band 8, which is the frequency channel for upper-level water vapor
5. We then filtered band 8 to only consider the radiances for clear sky grid cells.

Results: Mean Temperature Curve

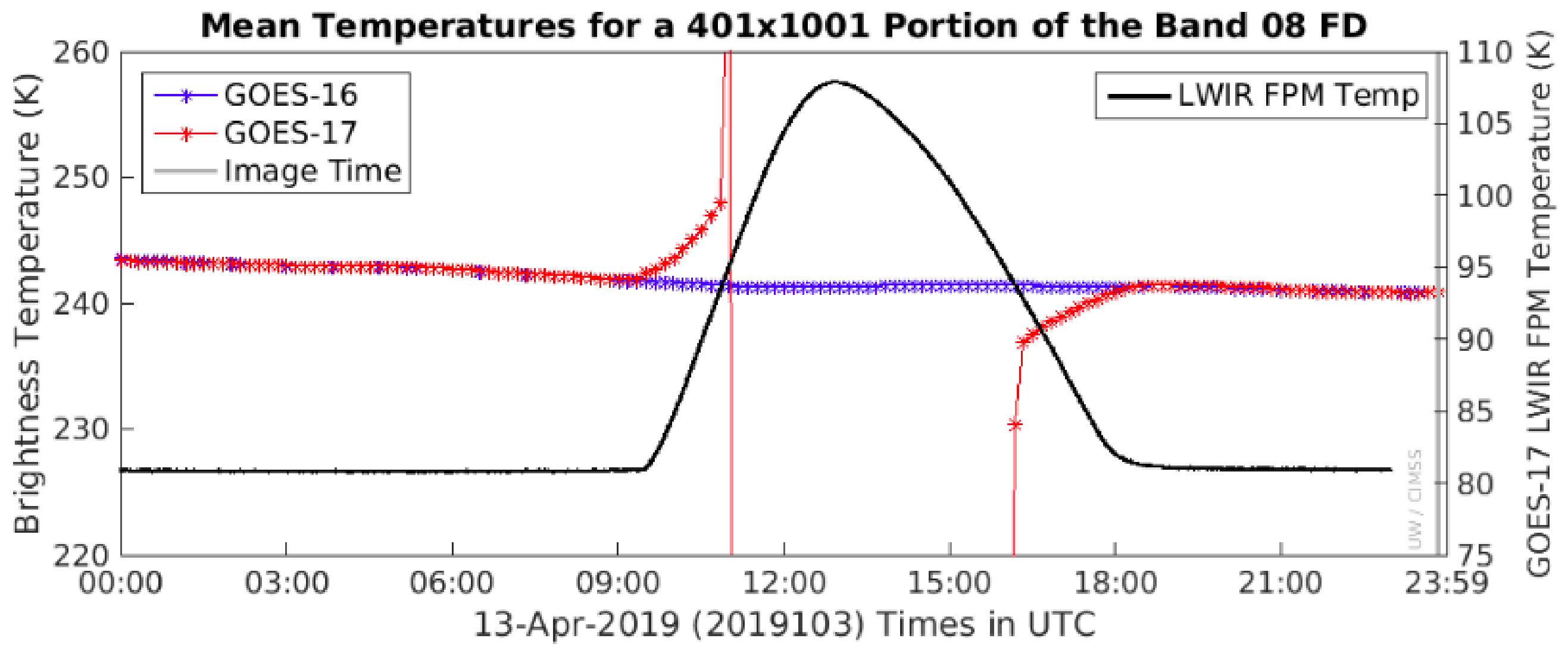


Figure 1 (Schmit, T.)

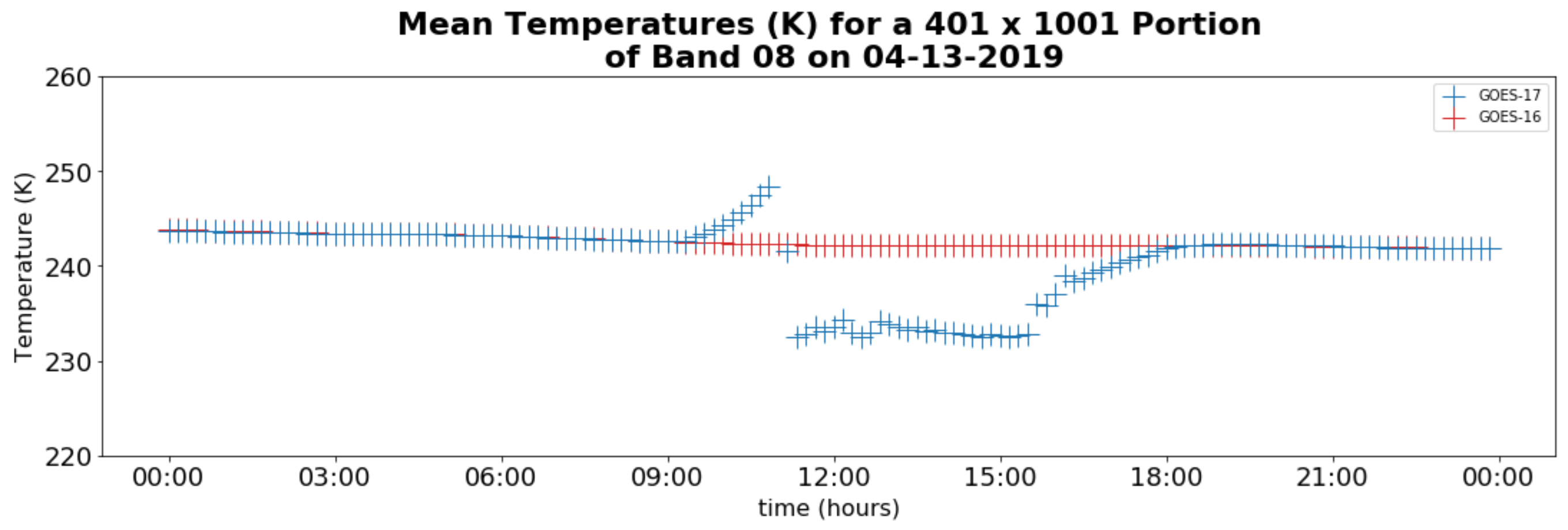


Figure 2

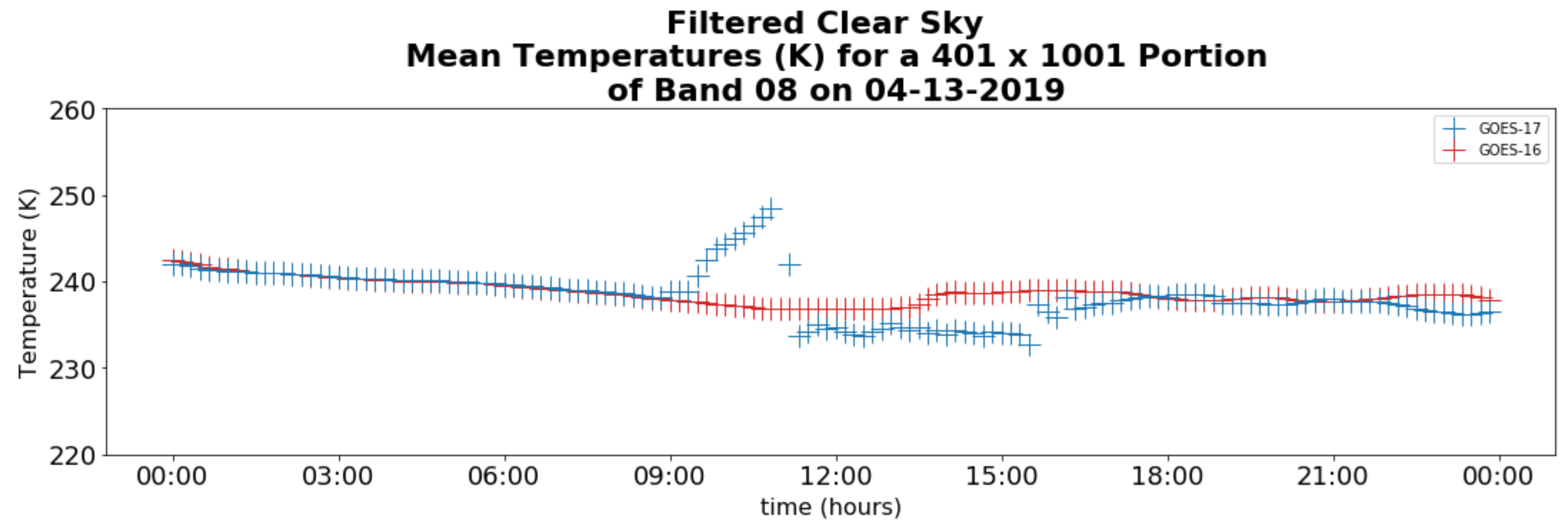


Figure 3

Spectral Radiance & Brightness Temperature

Convert spectral radiance to brightness temperature (T):

$$T = [\ fk_2 / (\log^{-1}((fk_1 / L_\lambda) + 1)) - bc_1\ ] / bc_2$$

To convert brightness temperature to spectral radiance (L_λ):

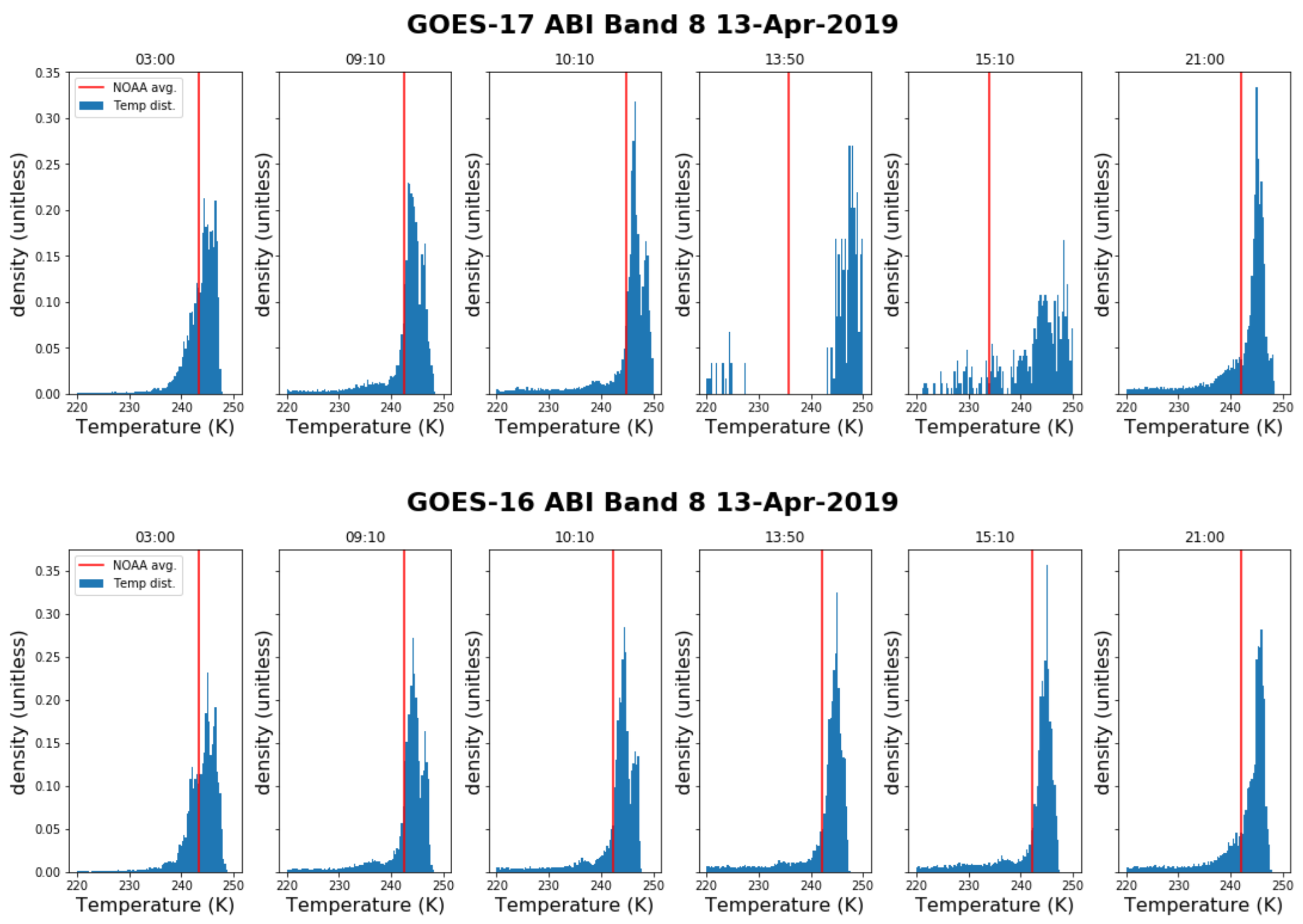
$$L_\lambda = fk_1 / [\ e^{fk2 / (bc1 + (bc2 * T))} - 1\ ]$$

- $fk_{1,2}$, $bc_{1,2}$ = function of central frequency within a given range
- derived from Planck's law:

$$B_\lambda(\lambda, T) = \frac{2hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda k_B T}} - 1},$$

The results are taken from converting radiance to temperature.

Mean Temperature Histograms



The histogram of the day when the HLP problem is most severe is compared to NOAA's recorded mean temperatures .

Discussion

Figure 1 shows GOES-16 and GOES-17 in alignment just before and after the critical HLP problem. Figure 2 reproduces Schmit's findings. Figure 3 indicates that restricting to the clear-sky grid cells leads to some differences in second half of the day. Investigating these differences will be the subject of future work.

References & Software

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2. Schmit, T., et al. (2012, July 30). "Goes-r advanced baseline imager algorithm theoretical basis document for cloud and moisture imagery product ": http://www.star.nesdis.noaa.gov/goesr/docs/ATBD/Imagery
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NumPy, Xarray, Metpy, Matplotlib, Cartopy, Pyresample, and Seaborn

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