# Downscaling GOES R LST to Landsat Spatial Resolution While Maintaining High Temporal Resolution

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## Objectives

- Develop a model for downscaling GOES R LST Data

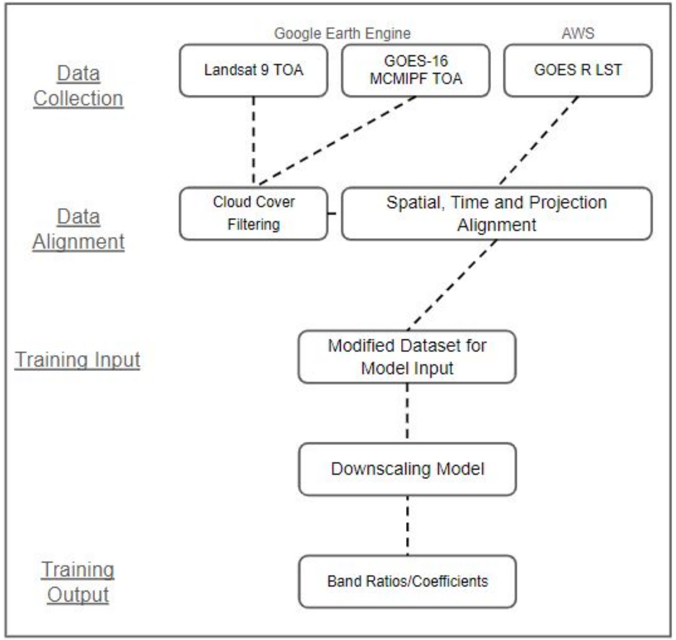
## Outcomes

- Created a **framework** for collecting and aligning high and low resolution data
- **Developed and trained model** to optimize LST ratios which can be saved for future use

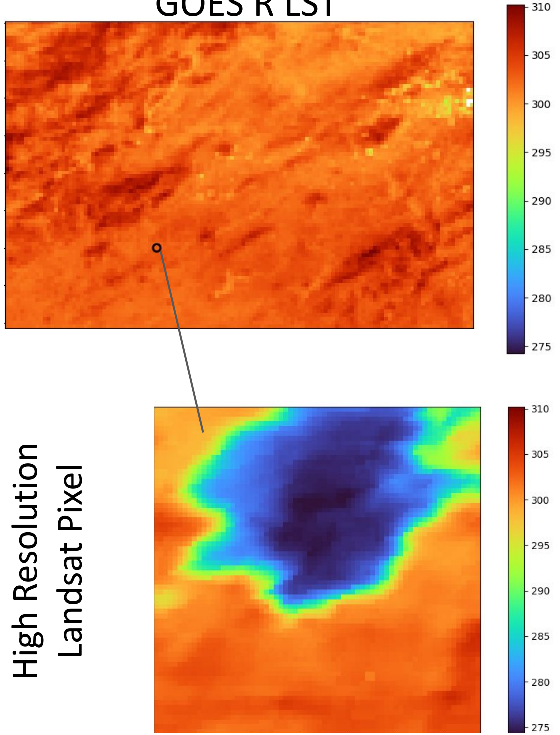
## Future Goals

- Compile **a coefficient LUT** that allows for near-real-time downscaling of GOES-R LST data

## Process

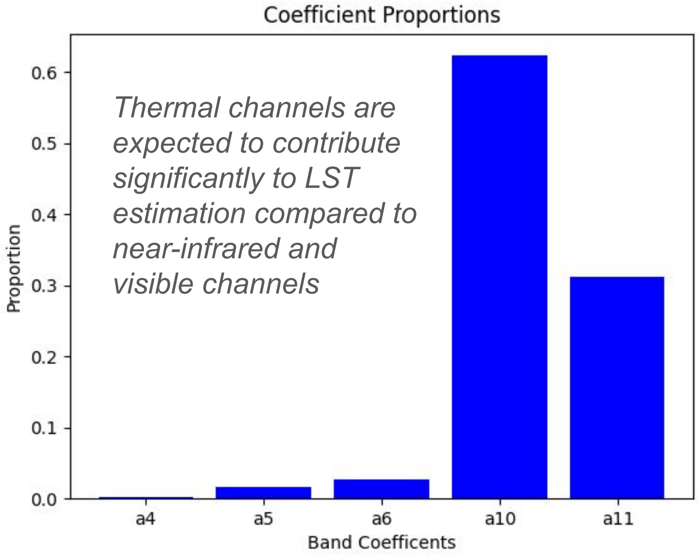



## GOES R LST



# Methodology and Training Results

| Coefficient | Type | GOES R Band | Landsat Band |
|---|---|---|---|
| $a_4$ | NIR | **CMI_02**<br>0.64µm | **B4**<br>0.64-0.67 µm |
| $a_5$ | NIR | **CMI_03**<br>0.86 µm | **B5**<br>0.85-0.88 µm |
| $a_6$ | SWIR | **CMI_05**<br>1.6 µm | **B6**<br>1.57-1.65 µm |
| $a_{10}$ | TIR | **CMI_14**<br>11.2 µm | **B10**<br>10.60-11.19 µm |
| $a_{11}$ | TIR | **CMI_15**<br>12.3 µm | **B11**<br>11.50-12.51 µm |




## Cost Function

$$J(\alpha_4, \alpha_5, \alpha_6, \alpha_{10}, \alpha_{11}) = E_{GOESR} + E_{ground} + E_{Regularization}$$

$$E_{GOESR} = (LST_{GOESR} - LST_{aggregated})^2$$

$$E_{ground} = (LST_{Landsat} - LST_{ground})^2$$

$$E_{regularization} = \lambda \cdot (1 - \alpha_{10})$$

Optimized cost function using **gradient descent** and **back propagation** techniques

## Methodology

This method aims to downscale GOES-R LST to Landsat resolution by finding an optimal downscaling matrix based on a linear combination of ratio matrices from different spectral bands. The **coefficients of this combination** reflect the contribution of various channels, with thermal channels dominating and NIR channels making minor adjustments.

During application, the combined ratio is scaled to ensure the aggregated downscaled LST matches the original GOES-R LST.

# Analysis

- Downscaled LST exhibits a consistent but more detailed distribution compared to GOES-R LST.
- Comparison with in-situ LST indicates that the downscaled LST achieves better accuracy in periods with higher heterogeneity, as observed in the 09-30 case.

# Areas of Improvement

1. Conduct comprehensive validation
2. Fine tune algorithm
3. Solar angle correction for applying downscaling to images at different times of the day

# Downscaled Output

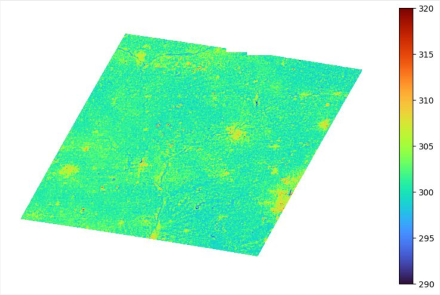
In-situ Validation | Downscaled LST | GOES R LST

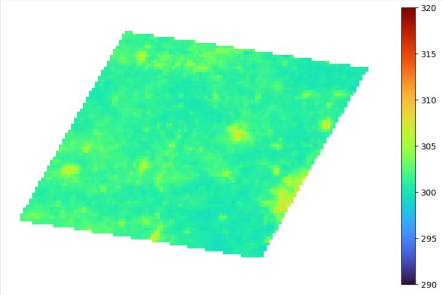
## 2023-09-01

In-situ:
**302.944**

Downscaled:
**302.161**

GOES LST:
**302.5725**



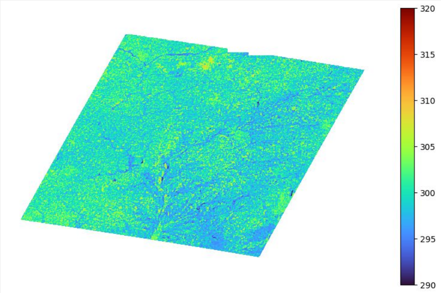



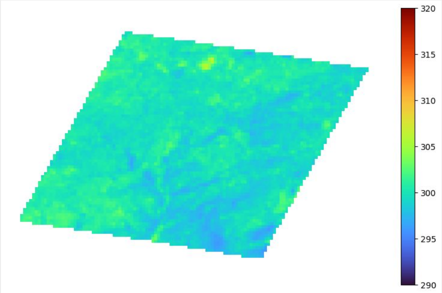

## 2022-09-30

In-situ:
**296.308**

Downscaled:
**297.669**

GOES LST:
**301.213**




**References**

[1] Fei Xu, Xiaolin Zhu, Jin Chen, Wenfeng Zhan, A stepwise unmixing model to address the scale gap issue present in downscaling of geostationary meteorological satellite surface temperature images. Remote Sensing of Environment, Volume 306, 2024, 114141, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2024.114141.

[2] Yaser Abunnasr, Mario Mhawej, Fully automated land surface temperature downscaling based on RGB very high spatial resolution images, City and Environment Interactions, Volume 19, 2023, 100110, ISSN 2590-2520, https://doi.org/10.1016/j.cacint.2023.100110.