



# Improving estimates of land surface temperature at hourly scale for thermal and ecological assessment

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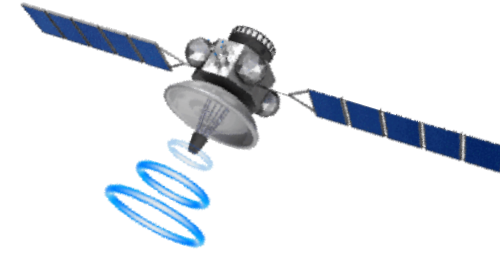
Iowa State University

2022.08.17

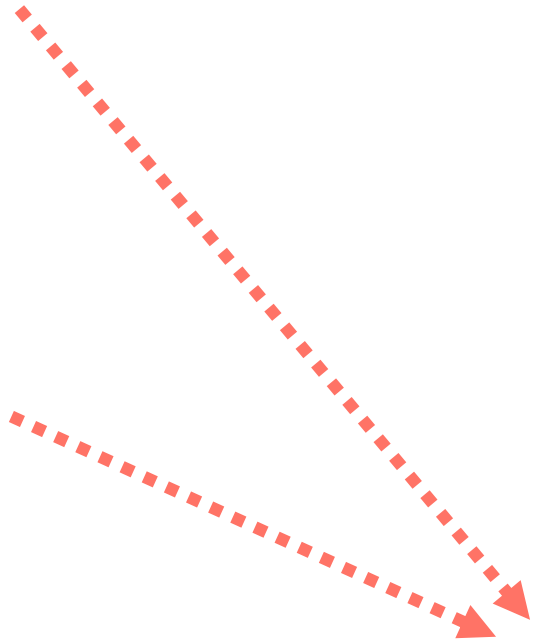
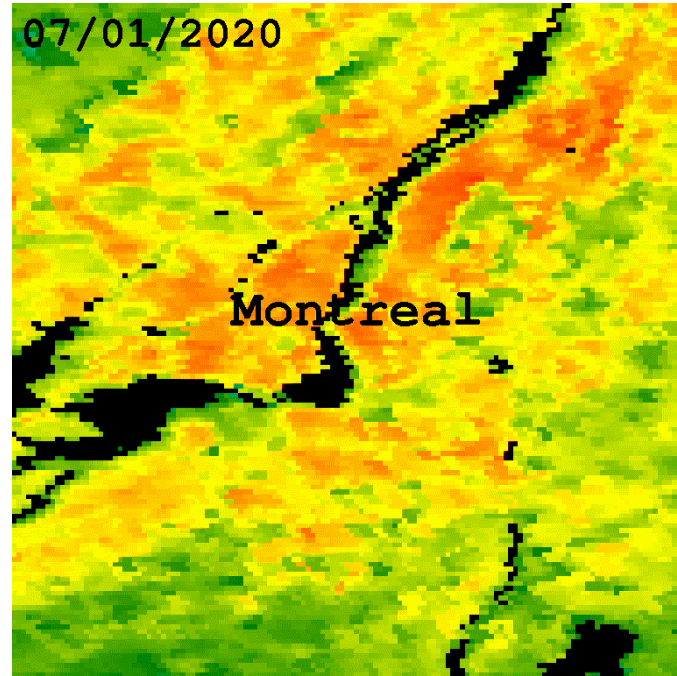




# Urban Thermal Environment

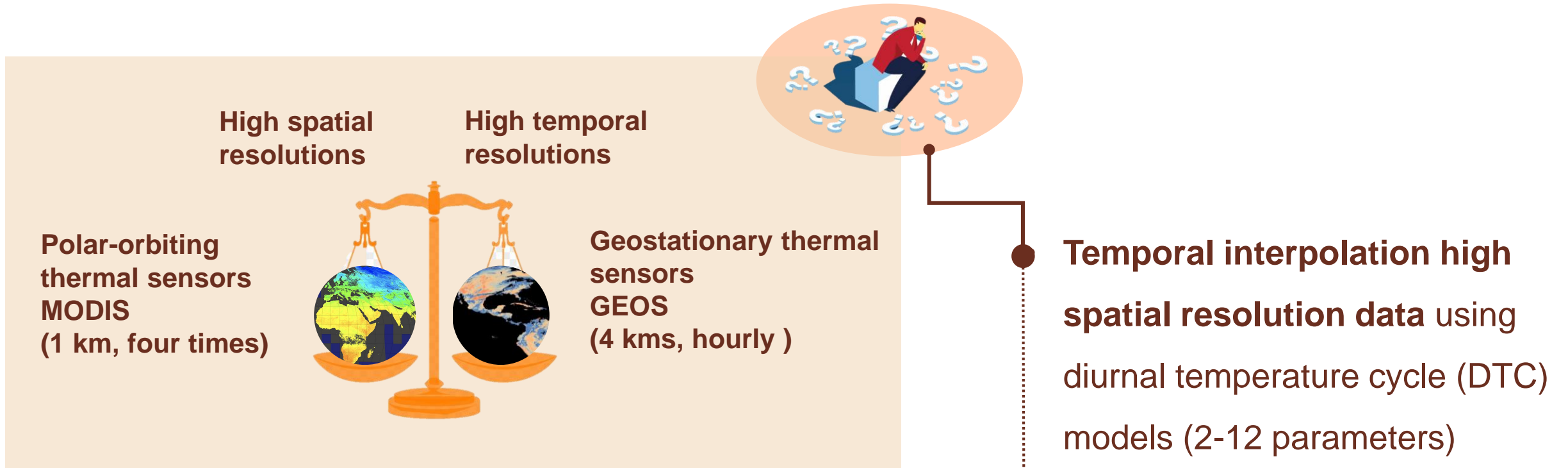


Daily LST





# LST Satellite Observations



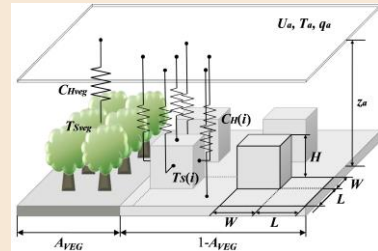
\* Moderate Resolution Imaging Spectroradiometer (MODIS)

\* Geostationary Operational Environmental Satellite (GOES)



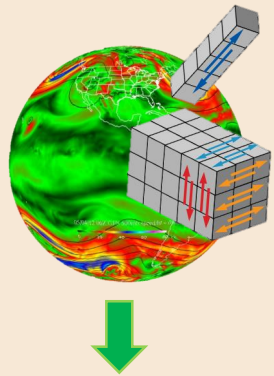
# LST from WRF model

Weather Research & Forecasting Model (WRF)



<http://www.ide.titech.ac.jp>

Physical parameterization schemes



Global weather modelling data

WRF



Land surface satellite data



● **Model calibration:**

tremendous computational power and professional knowledge



# Research Objective



## MODIS LST

- Accurate spatial pattern at 1km
- × Hourly pattern

## WRF model



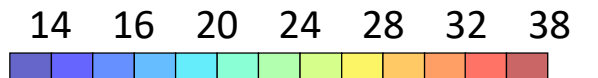
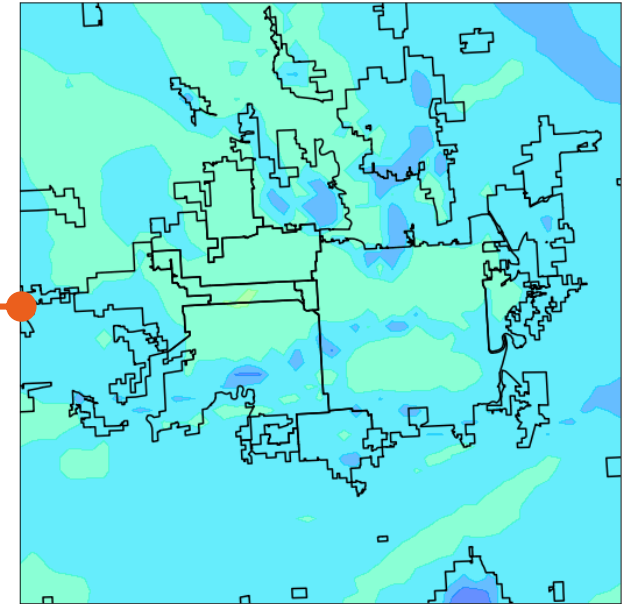
- Reliable hourly LST estimated by physical schemes
- Model bias



## LST

- Hourly
- 1 km

2012-08-07 00:00:00



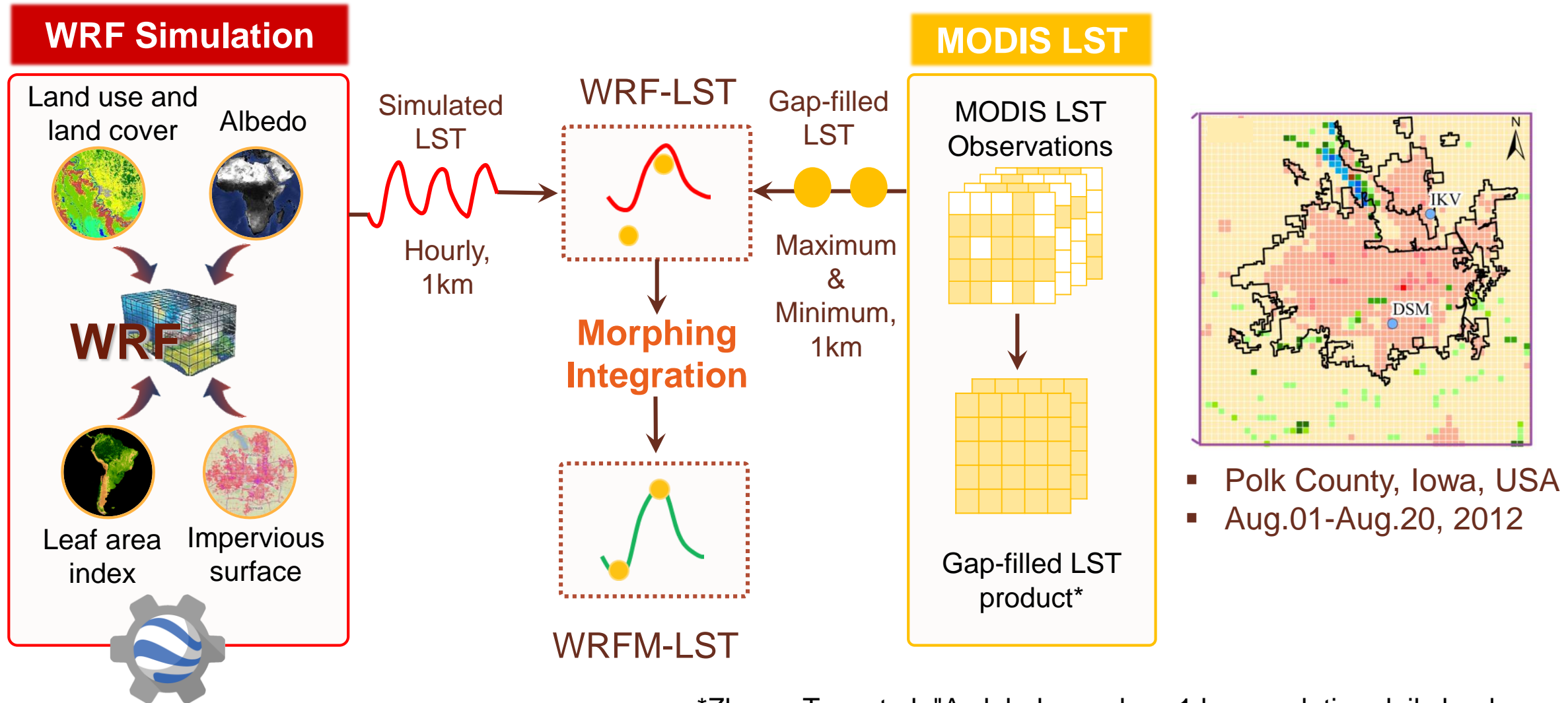
02



# METHODOLOGY



# Framework



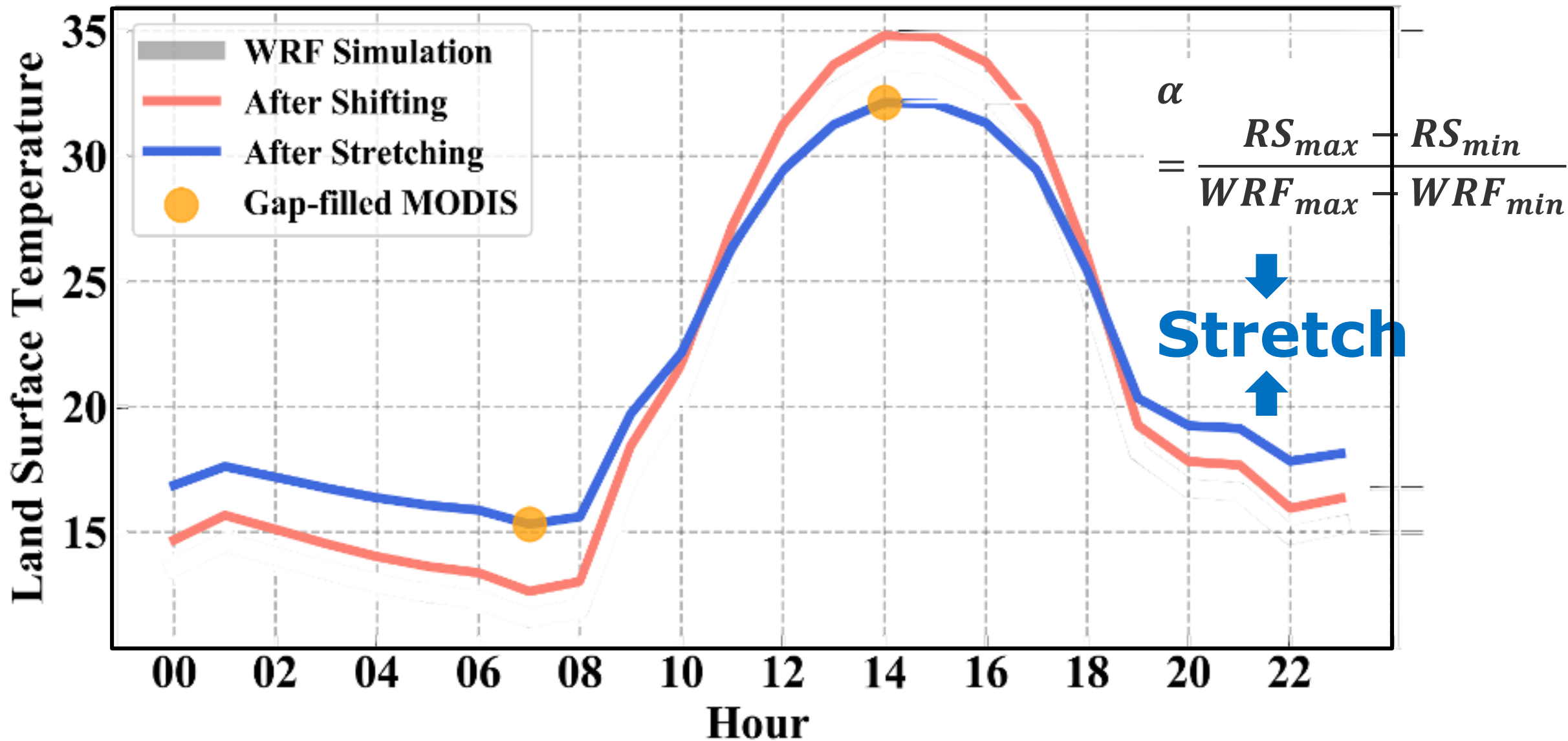
Google Earth Engine

\*Zhang, Tao, et al. "A global seamless 1 km resolution daily land surface temperature dataset (2003–2020)." Earth System Science Data 14.2 (2022): 651-664.



# Morphing Integration

$$X_h = WRF_h + \Delta + \alpha \times (WRF_h - RS_{mean})$$







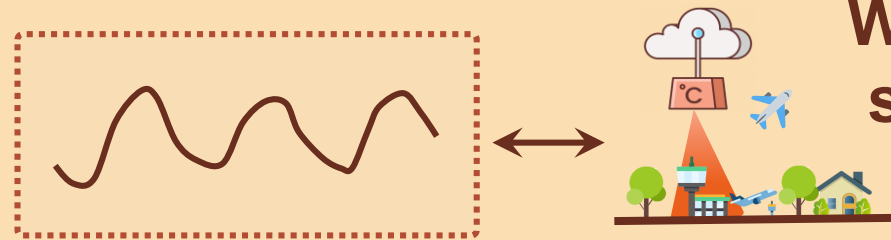
# 03 EVLUATION



# Q1: Can WRF simulation perform as good as other studies?



## WRF-Air temperature



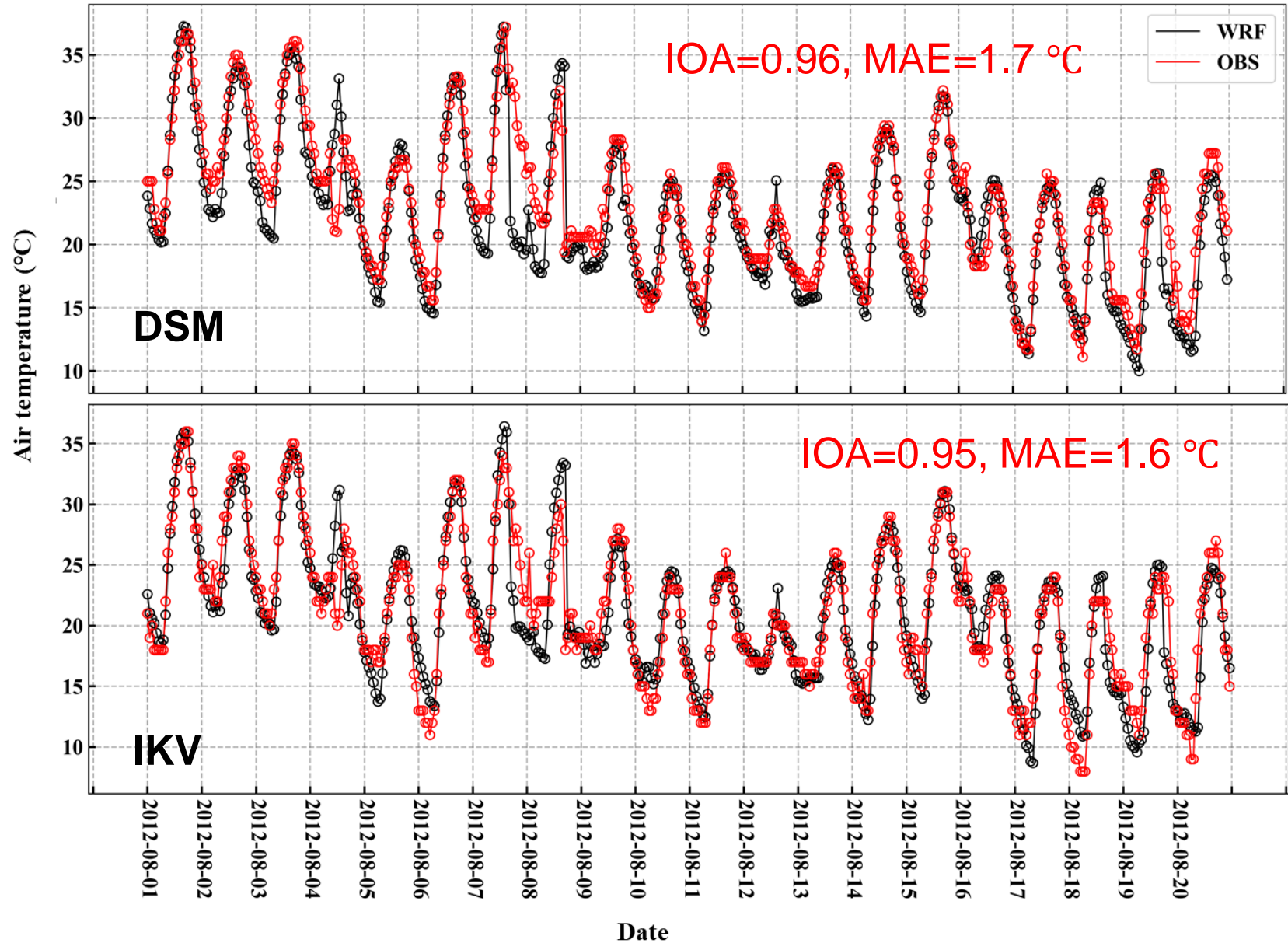
Index of agreement (IOA) > 0.8

Mean absolute error (MAE) < 2 °C



# WRF modeling performance

- WRF can well capture the hourly dynamic and magnitude of air temperatures.

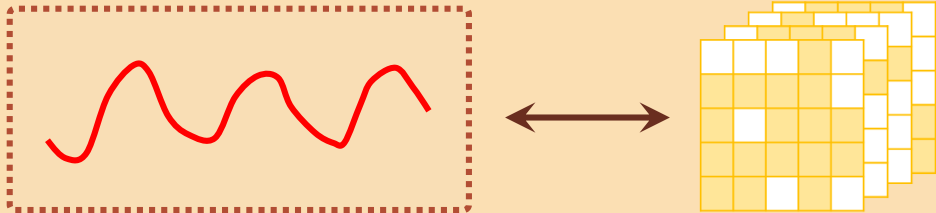


# Q2: To what extent, did WRF simulated-LST have model bias?

Spatial pattern, 1km, 4 obs.

WRF-LST

Original  
MODIS LST

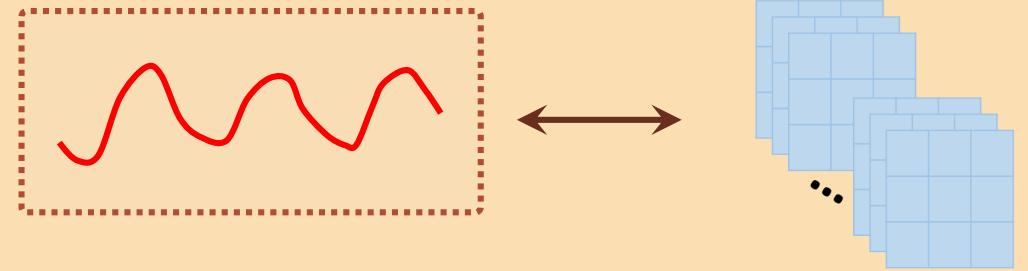


Root mean square error (RMSE)

Temporal pattern, hourly, 4km

WRF-LST

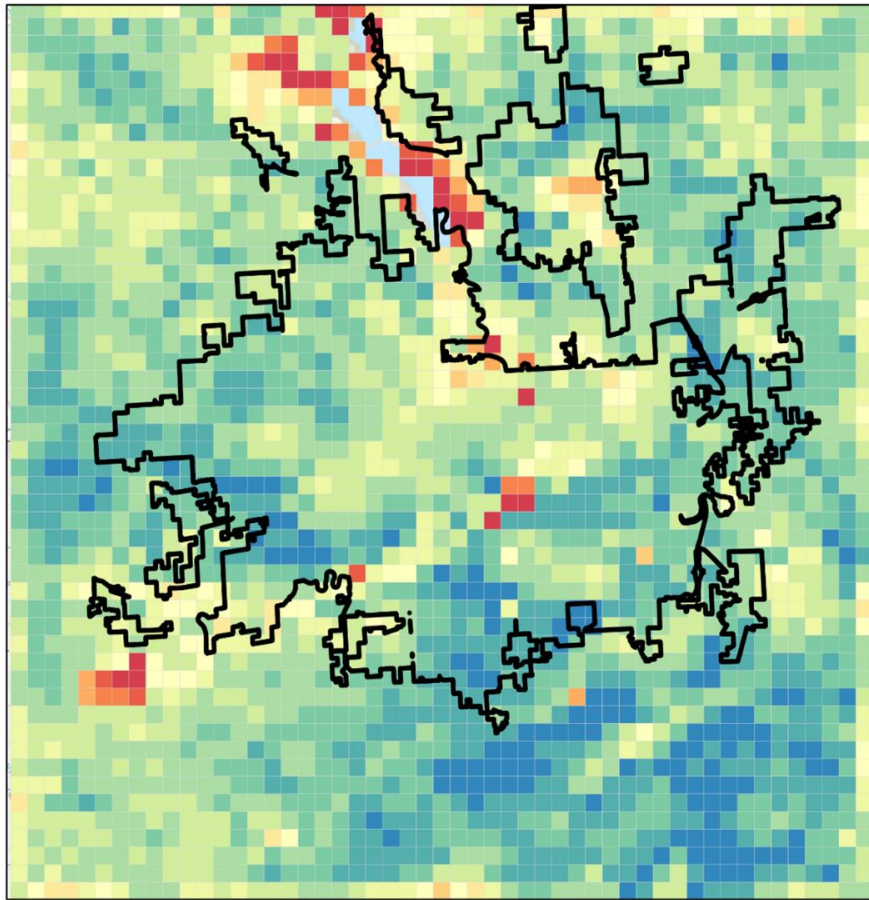
GEOS-LST



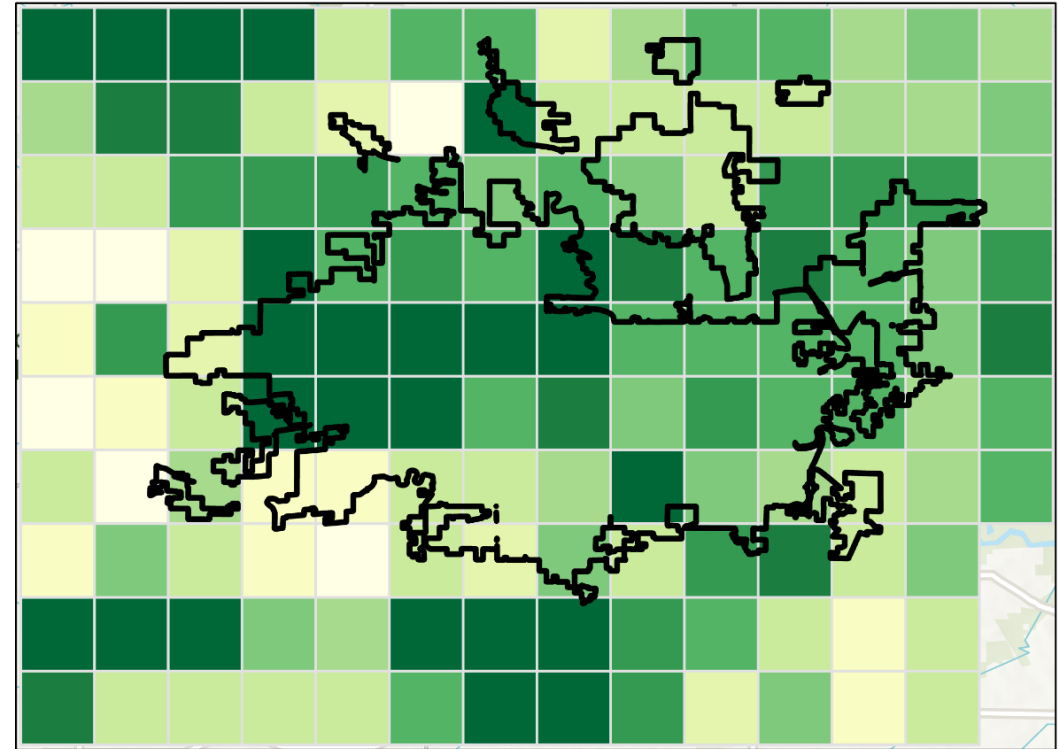
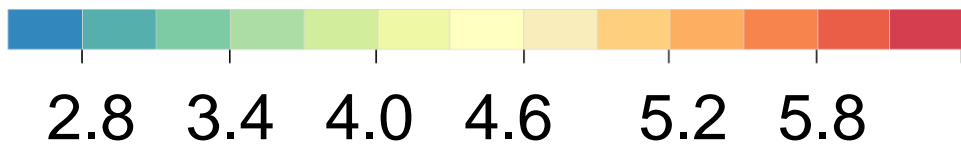
Spearman's rank correlation  
coefficient (R)



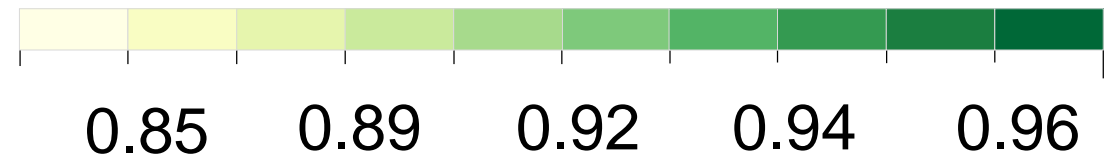
# Bias on WRF-simulated LST



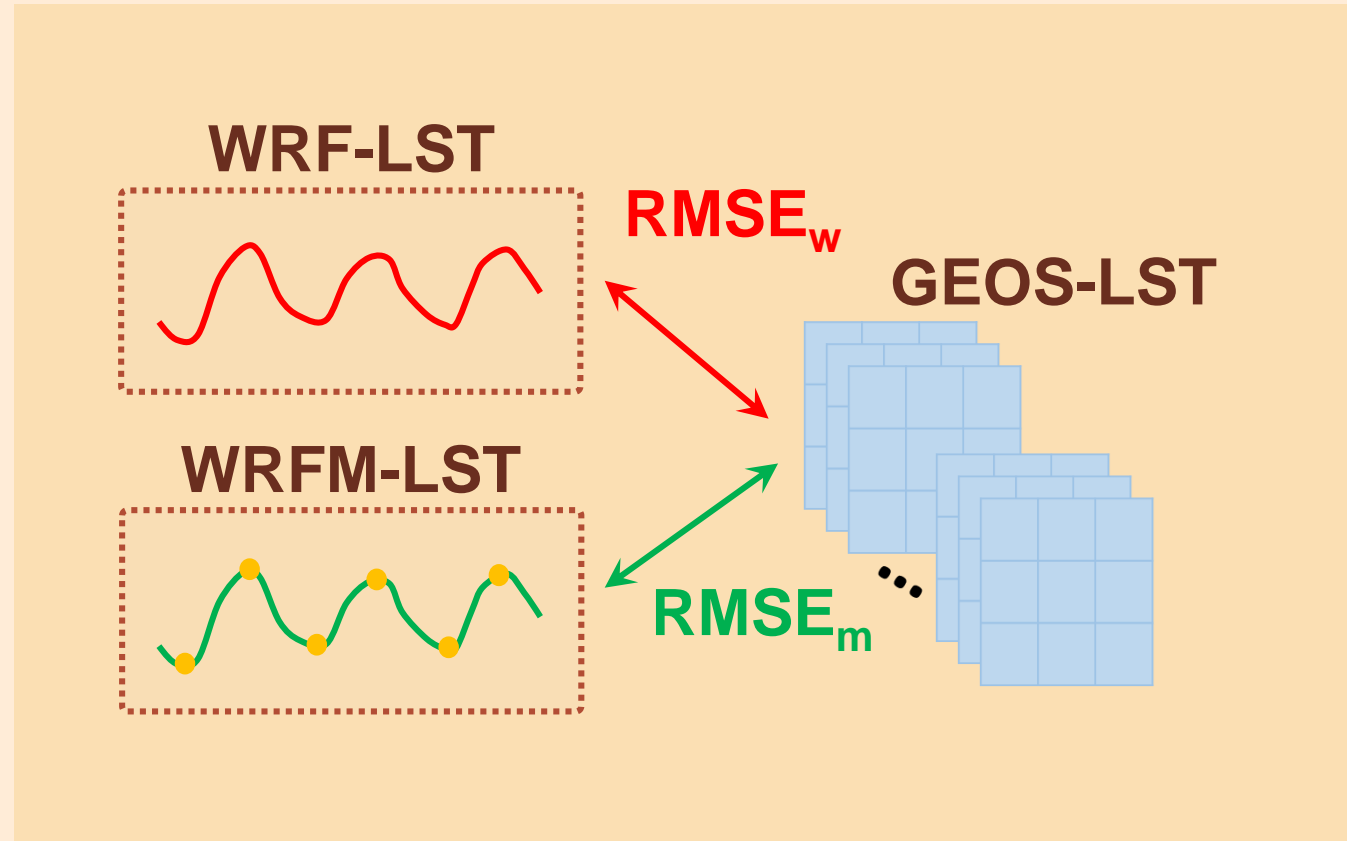
RMSE



R



# Q3: To what extent, can morphing integration improve LST estimation? – spatial pattern

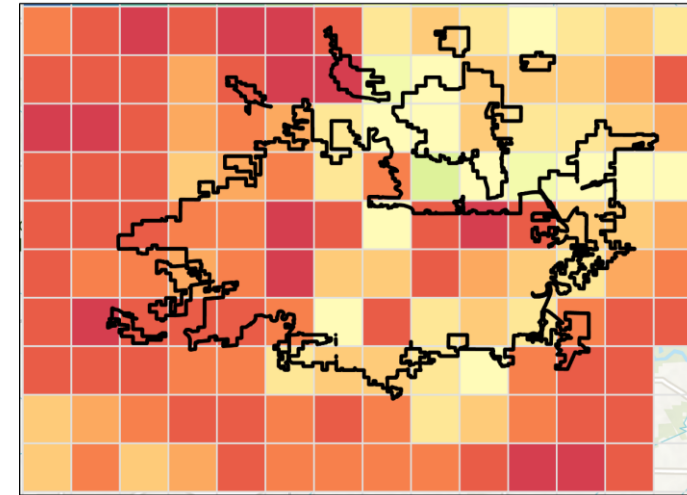




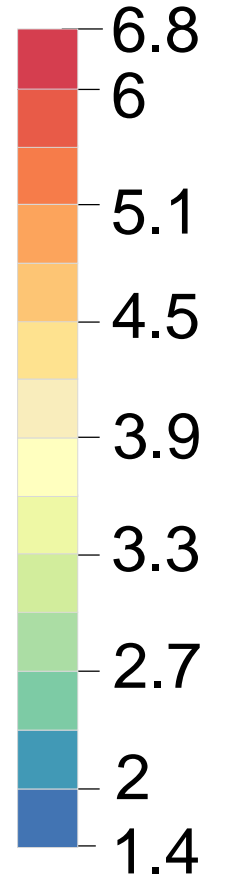
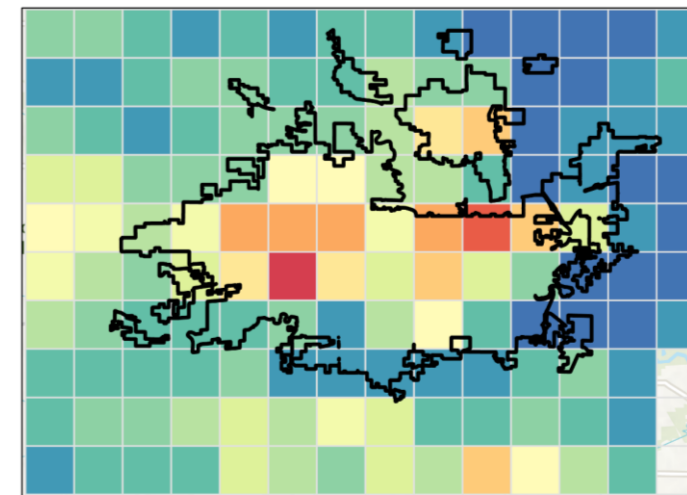
# WRFM-generated LST : spatial patterns

- WRFM framework can capture spatial variations and **reduce bias** in the magnitude of simulated LSTs.

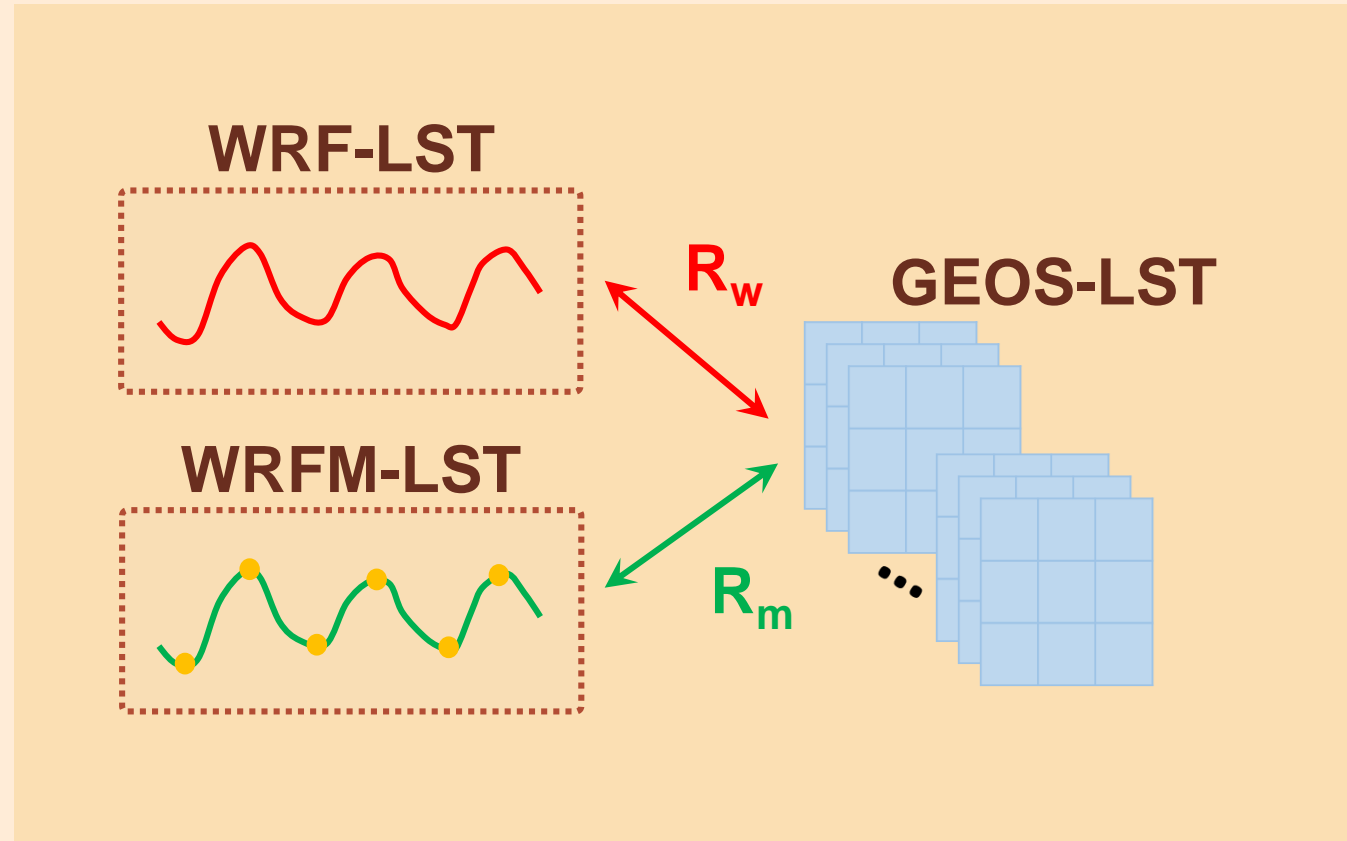
$RMSE_w$



$RMSE_m$



# Q3: To what extent, can morphing integration improve LST estimation? – temporal pattern

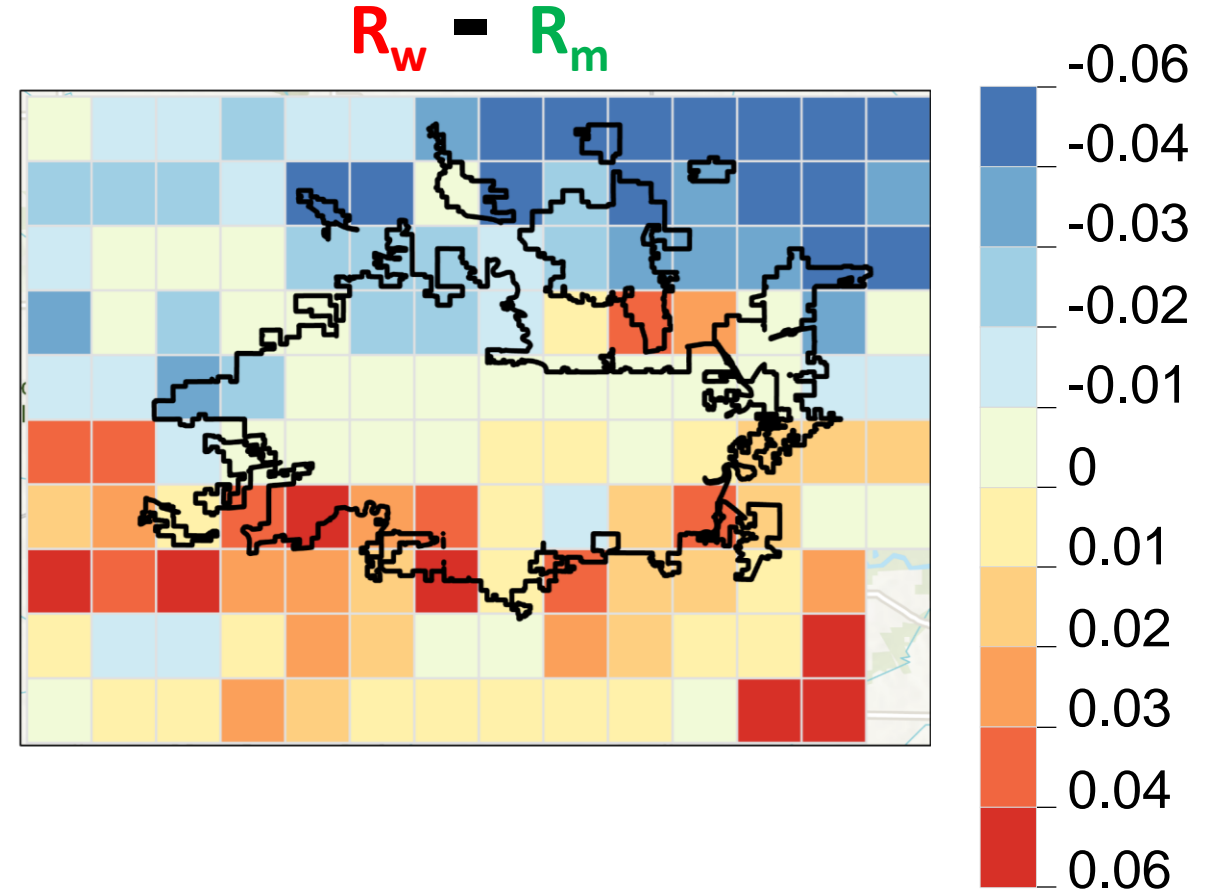






# WRFM-generated LST : temporal patterns

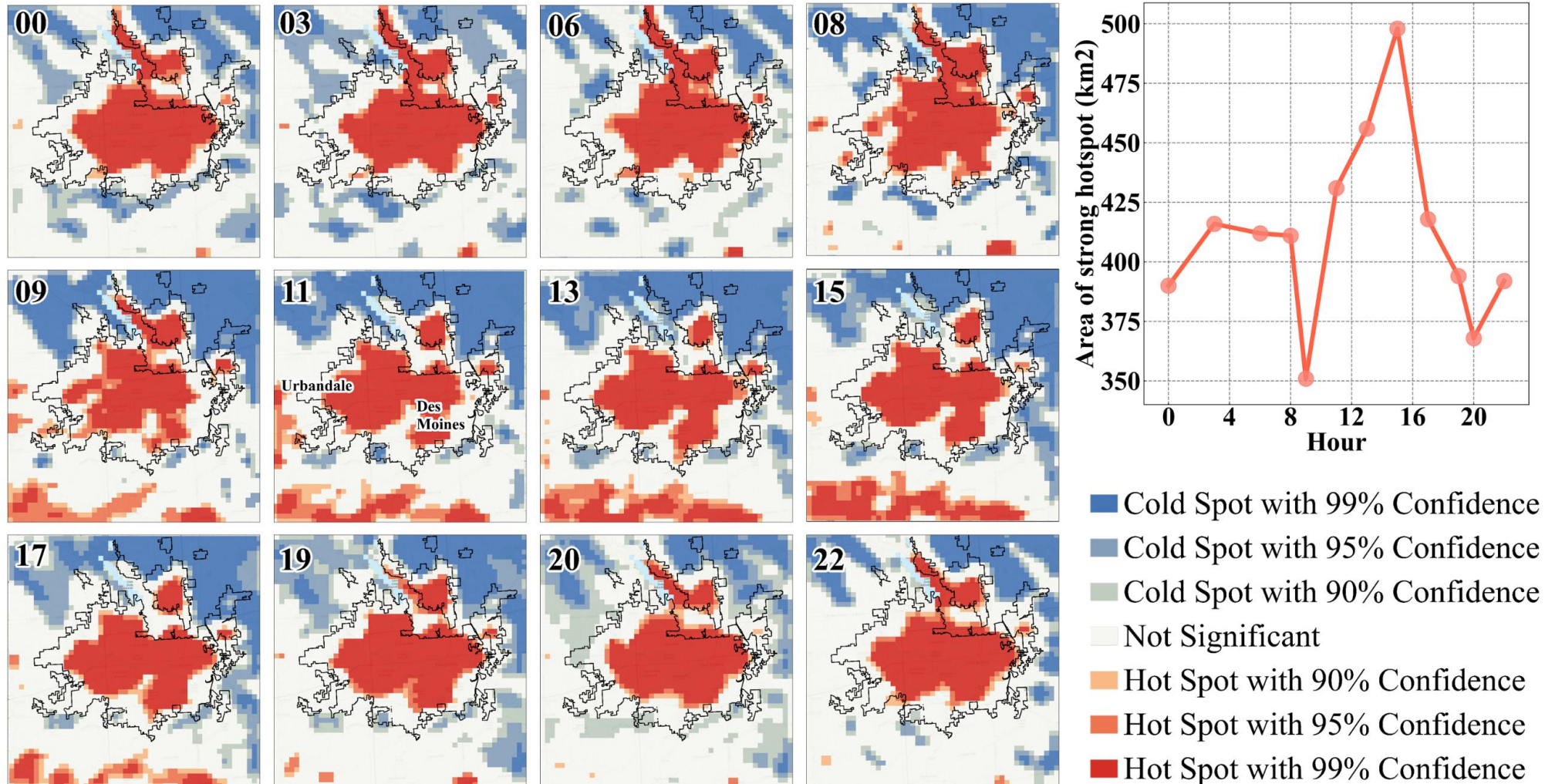
- LSTs from the WRFM framework can **still capture** the diurnal dynamic compared to GOES observations.



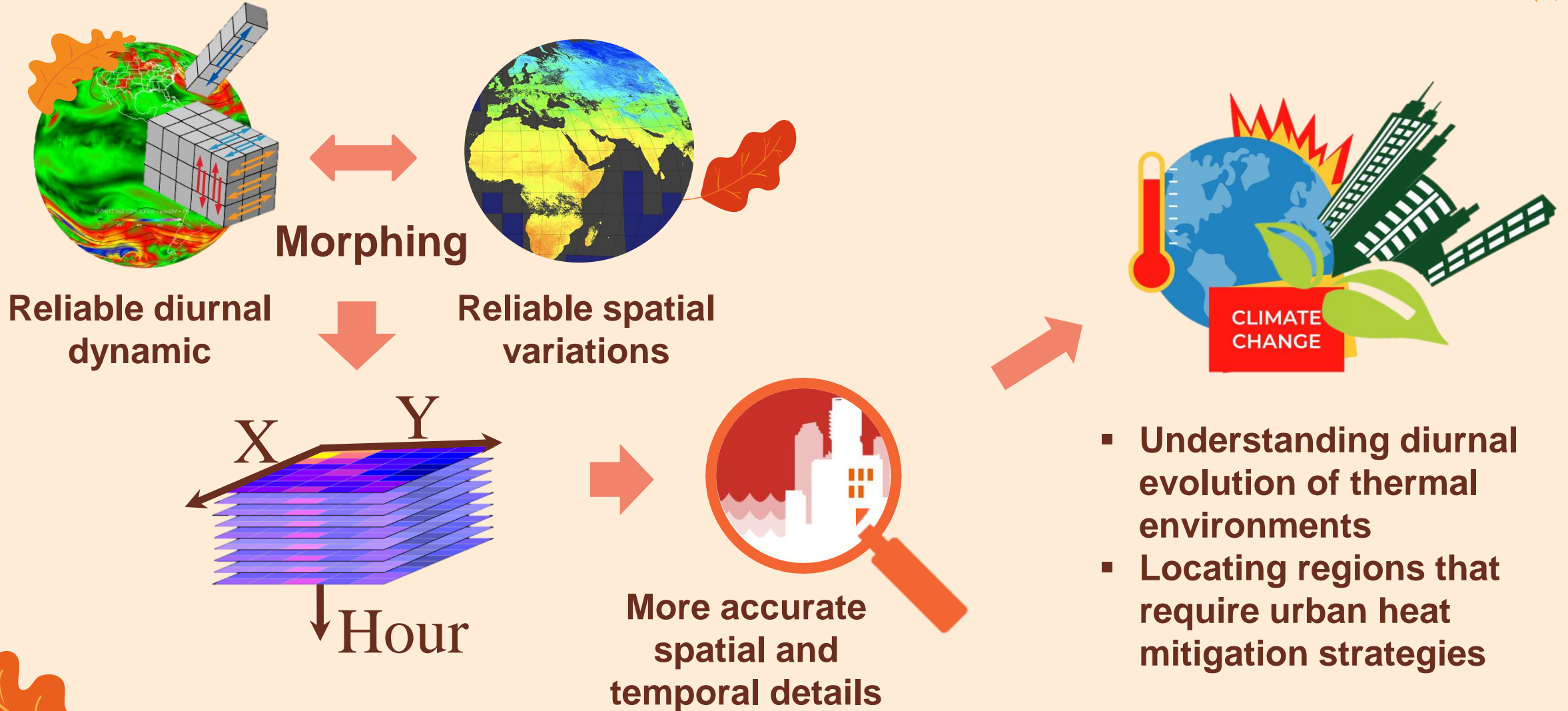


# Spatiotemporal pattern of thermal condition

- Hourly patterns of LST hotspots can be examined at a 1 km resolution



# Take home message





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# THANK YOU!



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