A High Spatio-temporal Resolution Land Surface Temperature (LST) Product for Urban Environments

Glynn Hulley¹, Panagiotis Sismanidis³, Jeffrey Luvall², Iphigenia Keramitsoglou³

1. NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
2. NASA Marshall Space Flight Center, Huntsville, AL
3. National Observatory of Athens, Athens, Greece

(c) 2020 California Institute of Technology. Government sponsorship acknowledged.
Heatwaves in urban regions are increasing at significant rates

- Need for data-driven recommendations to advise on policy decisions
- Heat mitigation, cooling, risk assessments, sustainability
- Requires: hourly, <100m fine scale surface/air temperature data

Source: Hulley et al. 2020, Earth’s Future
MuSLI Type 2 Prototype Product:

<table>
<thead>
<tr>
<th>Product</th>
<th>Data</th>
<th>Spatial</th>
<th>Temporal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Land Surface Temperature (LST)</td>
<td>Thermal: GOES-16, ECOSTRESS</td>
<td>100m</td>
<td>hourly</td>
</tr>
<tr>
<td></td>
<td>Optical: Landsat 8, Sentinel-2, HLS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Land Surface Temperature (LST) Downscaling

Statistical downscaling **disaggregates** coarse-scale LST to its components

Using higher spatial resolution data **statistically correlated** to the LST

**Vegetation index**  **Albedo**  **climatology**  **Topography**  **Emissivity**

LST predictors  
**or**  
LST disaggregation Kernels
Albedo/NDVI/LST Urban Statistical Relationships

HyTES LST plotted versus AVIRIS NDVI/Albedo

Vegetation
NPV
Roads, parking lots
Impervious surfaces
Soils
Reflective roofs

LST (K)
Random forest training

ECOSTRESS LST at 3-hourly intervals over diurnal cycle

\[ T(\text{time of day, city, season}) \]

100 trees = \(~3 \text{ K RMSE}\)
Data available in repository at https://ter.ps/lcluchulley
## Current Data Users

<table>
<thead>
<tr>
<th>Institution</th>
<th>PI/Contact</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Resolve, Los Angeles</td>
<td>Jonathan Parfrey</td>
<td>Used to inform optimal areas for cool pavements, bus shelters, tree planting in L.A.</td>
</tr>
<tr>
<td>University of Chicago</td>
<td>Dr. Kyoung Choe</td>
<td>Examining impacts of heat stress on cognitive functioning in Chicago neighborhood</td>
</tr>
<tr>
<td>Bloomberg Associates, NYC</td>
<td>Jacob Koch</td>
<td>Urban heat mapping to address heat issues for vulnerable population groups in NYC</td>
</tr>
<tr>
<td>UrbanCanopy/Hackathon</td>
<td>Katie Patrick</td>
<td>Mapping heat islands in major U.S. cities to help educate residents</td>
</tr>
<tr>
<td>Global Cool Cities</td>
<td>Kurt Shickman</td>
<td>Urban heat mapping for long-term climate sustainability in U.S. cities</td>
</tr>
<tr>
<td>LA County Sustainability Office, Bureau of Street Services</td>
<td>Rita Kampalath, Gregg Spotts</td>
<td>LA climate sustainability, heat mitigation efforts, cooling centers</td>
</tr>
</tbody>
</table>
May 2019: First Neighborhood-Level Cool Pavement Project
Winnetka, Cool Seal on 11 Residential Blocks

~12 F cooling

Images courtesy Greg Spotts, LA Bureau of Street Services
Effect of cool pavements:

~10-12% increase in albedo (Landsat 8) – *Arthur Elmes, UMass Boston*

~2 °F decrease in surface temperature (MuSLI Urban LST)
Panagiotis Sismanidis, NOA

The Diurnal DLST cycle for the point noted with the * symbol in the DLST image
Validation
ECOSTRESS comparison at 100m resolution – 4:30 am