**Twin Cities Land Surface Temperature 2022**

This page last updated: 09/20/2017

Metadata created using [Minnesota Geographic Metadata Guidelines](http://www.mngeo.state.mn.us/committee/standards/mgmg/metadata.htm)

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**Section 1: Overview**

**Originator:**Metropolitan Council

**Title:**Twin Cities Land Surface Temperature 2022

**Abstract:**A high resolution (10 meter) land surface temperature (LST) raster dataset shows temperatures in September 2022 for the seven-county metropolitan region of the Twin Cities. The LST layer was computed and downscaled to 10 meter resolution using satellite imagery from Landsat 9 and Copernicus Sentinel-2 along with ancillary water feature data from OpenStreetMap and [2020 Generalized Land Use](https://gisdata.mn.gov/dataset/us-mn-state-metc-plan-generl-lnduse2020) for the Twin Cities. These datasets were integrated using

First, Landsat 9 imagery taken at 11:59 am CDT on September 01, 2022 was processed into 30-meter resolution LST (based on Ermida et al. 2020). At this time, the air temperature was 88F at the Minneapolis-St. Paul International Airport (NOAA). A model predicting LST based on spectral indices of Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), and Normalized Difference Built-up Index (NDBI) was created, which was applied to 10-meter Sentenel-2 imagery resulting in a 10-meter downscaled LST image (based on Onačillová et al. 2022). Sentinel-2 also taken on September 1, 2022. To account for anomalies in NDVI on the primary image date of September 1 (e.g., recently harvested agricultural fields), maximum NDVI occurring between July 1, 2022 and September 1, 2022 was used for both Landsat and Sentinel image processing.

Sources:

Ermida, S.L., Soares, P., Mantas, V., Göttsche, F.-M., Trigo, I.F., 2020. Google Earth Engine open-source code for Land Surface Temperature estimation from the Landsat series. Remote Sensing, 12 (9), 1471; https://doi.org/10.3390/rs12091471.

NOAA, National Oceanic and Atmospheric Administration, National Centers for Environmental Information, station USW00014922. September 1, 2022.

The goals of this map **is not to show the maximum temperature that any specific area can reach, but rather to show the heat differences across the region.**

This script computes and downscales land surface temperature from remote sensing data.

// First, LST is computed from landsat using code developed by Ermida et al. 2020.

// Secondly, LST is downscaled using Sentinel 2 data using code from Onačillová et al. 2022.

// Finally, all code is modified to solve some site specific issues (water removed, clouds removed, mosaicing images)

// Onačillová, K., Gallay, M., Paluba, D., Péliová, A., Tokarčík, O., Laubertová, D. 2022:

// Combining Landsat 8 and Sentinel 2 data in Google Earth Engine

// to derive higher resolution land surface temperature maps in urban environment; https://doi.org/10.3390/rs14164076  
  
This Landsat 8 raster image was first used to create a NDVI raster dataset. Using that NDVI dataset with Bands 10 and 11 of the Landsat 8 raster dataset, a Land Surface Temperature raster can be derived. That raster is further processed from celsius to fahrenheit, then clipped to the 7-county metropolitan area, and all water bodies removed from the final image.  
  
The LST values without regional water bodies is the primary basis for the Metropolitan Council Climate Vulnerability Assessment Report. Part of this report specifically considers the urban heat island effect, or the effect of human activity and the built environment on increases in urban temperature on human life, and as water has different heat retention properties than most land surfaces, we chose to do our analysis without regional water bodies. It should be noted that the lowest original LST values were water bodies, and so by removing the water bodies from the map the minimum LST value raised 0.6F. This is not particularly significant, except that it would minimally affect which values would be highlighted in the third layer of this package.

**Purpose:**The 2022 Land Surface Temperature (LST) was developed as an update of the Metropolitan Council's Climate Vulnerability Assessment (CVA) project. **The goal of the updated map is not to show the maximum temperature that any specific area can reach, but rather to show the heat differences across the region.** An updated timestamp (2022 vs. 2016) and finer grained resolution (10m vs. 30m) improves the utility of the data for planning purposes.

**Time Period of Content Date:**09/01/2022

**Currentness Reference:**Land Surface Temperature raster dataset is based on the brightness temperature for a Landsat 8 image for 7/22/16 at 16:59 GMT

**Progress:**Complete

**Maintenance and Update Frequency:**None Planned

**Spatial Extent of Data:**7-county Twin Cities metro: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington counties, Minnesota

**Bounding Coordinates:**-94.012  
-92.732  
45.415  
44.471

**Place Keywords:**Minnesota, Anoka County, Carver County, Dakota County, Hennepin County, Ramsey County, Scott County, Washington County

**Theme Keywords:**land surface temperature, urban heat island, heat, climate vulnerability assessment

**Theme Keyword Thesaurus:**

**Access Constraints:**None. This dataset is public domain under the Minnesota Government Data Practices Act (Minnesota Statutes Chapter 13). If the dataset is not available from the Online Linkage in Section 6, please contact the Distribution Contact Person.

**Use Constraints:**None. This dataset is public domain under the Minnesota Government Data Practices Act (Minnesota Statutes Chapter 13).

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**Browse Graphic:**[Click to view a data sample](https://resources.gisdata.mn.gov/pub/gdrs/data/pub/us_mn_state_metc/env_cva_lst2016/metadata/preview.jpg).

**Associated Data Sets:**Landsat 8 image for 7/22/16 at 16:59 GMT

**Section 2: Data Quality**

**Attribute Accuracy:**N/A

**Logical Consistency:**N/A

**Completeness:**See LST\_Data\_Processing\_Steps.pdf

**Horizontal Positional Accuracy:**Equivalent to the source Landsat 8 Horizontal Positional Accuracy:  
-12 meter circular error, 90% confidence global accuracy for OLI  
-41 meter circular error, 90% confidence global accuracy for TIRS  
source: <https://lta.cr.usgs.gov/L8>

**Vertical Positional Accuracy:**N/A

**Lineage:**The final data is in UTM NAD83 (WGS\_1984) Zone 15 projection.  
  
For full processing step details, see [LandSurfaceTemperature2016\_Data\_Processing\_Steps.pdf](https://resources.gisdata.mn.gov/pub/gdrs/data/pub/us_mn_state_metc/env_cva_lst2016/metadata/LandSurfaceTemperature2016_Data_Processing_Steps.pdf) document.  
  
Overview of Processing Steps in ArcGIS 10.3.1:  
1) NDVI from: Landsat8\_07222016 (July 22, 2016 Landsat8 imagery - LC80270292016204LGN00.tar):  
....a. Composite Bands tool (all bands) to create 1 composite Landsat8 image  
....b. Use Composite Landsat8 Image to create the NDVI using the Image Analysis tool  
........i. Image Analysis Options NDVI tab settings  
........ii. Select the Composite Image and click the NDVI button to calculate the NDVI scores  
........iii. export the temporary raster NDVI to a new NDVI raster file  
....c. Use the extract by mask tool to create the NDVI of just the 7-county metro area  
2) Create the Land Surface Temperature raster  
....a. Download the Land Surface Temperature Model from ESRI: <https://www.arcgis.com/home/item.html?id=bd13c860a9b14c7bab0dca6ee2100cb6>  
....b. modify the tool's 8 local variables (as described in the detailed steps)  
....c. run the model using:  
........- NDVI of the 7-county metro area  
........- Landsat 8 Bands 10 and 11  
........- all the parameter settings described in the detailed steps (from the Landsat 8 metadata record)  
....d. convert the LST output from Celsius to Fahrenheit using the raster caclulator ("LSTCelsius"\*9/5+32)  
....e. Use the extract by mask tool on the LST Fahrenheit raster to create a final LST raster without open water

**Section 3: Spatial Data Organization (not used in this metadata)**

**Section 4: Coordinate System**

**Horizontal Coordinate Scheme:**Universal Transverse Mercator

**UTM Zone Number:**15

**Horizontal Datum:**NAD83

**Horizontal Units:**meters

**Vertical Datum:**

**Vertical Units:**

**Depth Datum:**

**Depth Units:**

**Cell Width:**30

**Cell Height:**30

**Section 5: Attributes**

**Overview:**Cell data values are calculated temperature in degrees Fahrenheit derived from the Landsat 8 raster imagery from July 22, 2016.  
Floating Point, 32-Bit Raster

**Detailed Citation:**See [LandSurfaceTemperature2016\_Data\_Processing\_Steps.pdf](https://resources.gisdata.mn.gov/pub/gdrs/data/pub/us_mn_state_metc/env_cva_lst2016/metadata/LandSurfaceTemperature2016_Data_Processing_Steps.pdf) document.

**Table Detail:**

**Section 6: Distribution**

**Publisher:**Metropolitan Council

**Publication Date:**09/20/2017

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**Distributor's Data Set Identifier:**Land Surface Temperature 2016

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**Ordering Instructions:**See Online Linkage Below

**Online Linkage:**[Download Page](https://gisdata.mn.gov/dataset/us-mn-state-metc-env-cva-lst2016)

**Section 7: Metadata Reference**

**Metadata Date:**09/20/2017

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**Metadata Standard Name:**Minnesota Geographic Metadata Guidelines

**Metadata Standard Version:**1.2

**Metadata Standard Online Linkage:**<http://www.mngeo.state.mn.us/committee/standards/mgmg/metadata.htm>

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