Documentation for the Global Summer Land Surface Temperature (LST) Grids, 2013

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Center for International Earth Science Information Network (CIESIN)
Columbia University

Abstract

This document presents the development of the Global Summer Land Surface Temperature (LST) Grids, 2013, which were produced as an input to the Global Urban Heat Island (UHI) Data Set, 2013. The Introduction describes the motivation for producing the UHI data set, and summarizes the approach taken to produce the Global Summer LST Grids, including brief descriptions of the input data and output grids. A thorough discussion of the input data, processing steps, and final distributed data set are covered in the Data and Methodology and Data Set Description sections. Additional sections of this documentation describe potential use cases, limitations, and use constraints.

Data set citation:

Center for International Earth Science Information Network (CIESIN), Columbia University. 2016. Global Summer Land Surface Temperature (LST) Grids, 2013. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H408638T. Accessed DAY MONTH YEAR.

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We appreciate feedback regarding this data set, such as suggestions, discovery of errors, difficulties in using the data, and format preferences. Please contact:

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I. Introduction

The Global Summer Land Surface Temperature (LST) Grids, 2013 data set serves as an input for the Global Urban Heat Island (UHI) Data Set, 2013 (CIESIN, 2016). The idea for a Global Urban Heat Island (UHI) Data Set arose from a joint Technical Interchange Meeting of the Socioeconomic Data and Applications Center (SEDAC) and Land Processes Distributed Active Archive Center (LP DAAC) in May 2013. The urban heat island (UHI) effect represents the relatively higher temperatures found in urban areas compared to surrounding rural areas due to higher proportions of impervious surfaces and the release of waste heat from vehicles and heating and cooling systems. Paved surfaces and built structures tend to absorb shortwave radiation from the sun and release long-wave radiation after a lag of a few hours. For this data set, UHI is defined as the temperature differential between an urban area and a buffer of 10km surrounding the urban area based on land surface temperature. The basic approach was to use LP DAAC's MODIS data on land surface temperature in conjunction with SEDAC's Global Rural-Urban Mapping Project (GRUMP) urban extents data (CIESIN, 2015) to measure the average daytime maximum and average nighttime minimum land surface temperatures within the urban extents during the highest temperature period of the northern and southern hemisphere summers. The same average was calculated for a 10km buffer surrounding the urban extents. Nighttime was included in addition to daytime because the health impacts of the urban heat island effect are often most pronounced at night.

We used the maximum daytime and minimum nighttime land surface temperatures (LSTs) extracted from MODIS LST 8-day composites (NASA LP DAAC, 2002b) acquired during a 40-day time-span in July-August 2013 in the northern hemisphere and January-February 2013 in the southern hemisphere to produce global grids of summer daytime maximum temperature and summer nighttime minimum temperature. These grids comprise the Global Summer Land Surface Temperature (LST) Grids, 2013 data set. The purpose of these time windows was to capture summer daytime maximum temperature and summer nighttime minimum temperature. All grids are in degrees Celsius at a spatial resolution of 30 arc-seconds (~1km). For most regions, the LST grids provide the daytime maximum (1:30 p.m. overpass) and nighttime minimum (1:30 a.m. overpass) LST values for each grid cell from the 40-day summer time periods previously mentioned. For cells with missing values resulting from high cloud cover in some tropical regions, the grids provide the daytime maximum and nighttime minimum LST values during April-May 2013 in the northern hemisphere and December 2013-January 2014 in the southern hemisphere, where available. Some data gaps remain in areas where data were insufficient (e.g., Central Africa).

II. Data and Methodology

Input data

The Global Summer Land Surface Temperature Grids, 2013 data set was produced using the Aqua Level-3 Moderate Resolution Imaging Spectroradiometer (MODIS) Version 5 global daytime and nighttime Land Surface Temperature (LST) 8-day composite data

(MYD11A2) (NASA LP DAAC, 2002b) distributed by NASA’s Land Processes Distributed Active Archive Center (LP DAAC), and acquired via MRTWeb 2.0 (NASA LP DAAC, 2009). The 8-day data are composed from the daily 1-kilometer LST product (MYD11A1) (NASA LP DAAC, 2002a) and represent the average values of clear-sky LSTs during an 8-day period.

The MODIS MYD11A2 data product uses a Sinusoidal grid tiling system with tiles covering an area 10 degrees by 10 degrees at the equator (Figure 1). The tile coordinate system starts at (0,0) (horizontal tile number *h*, vertical tile number *v*) in the upper left corner and proceeds right (horizontal) and downward (vertical). The tile in the bottom right corner is (35,17).

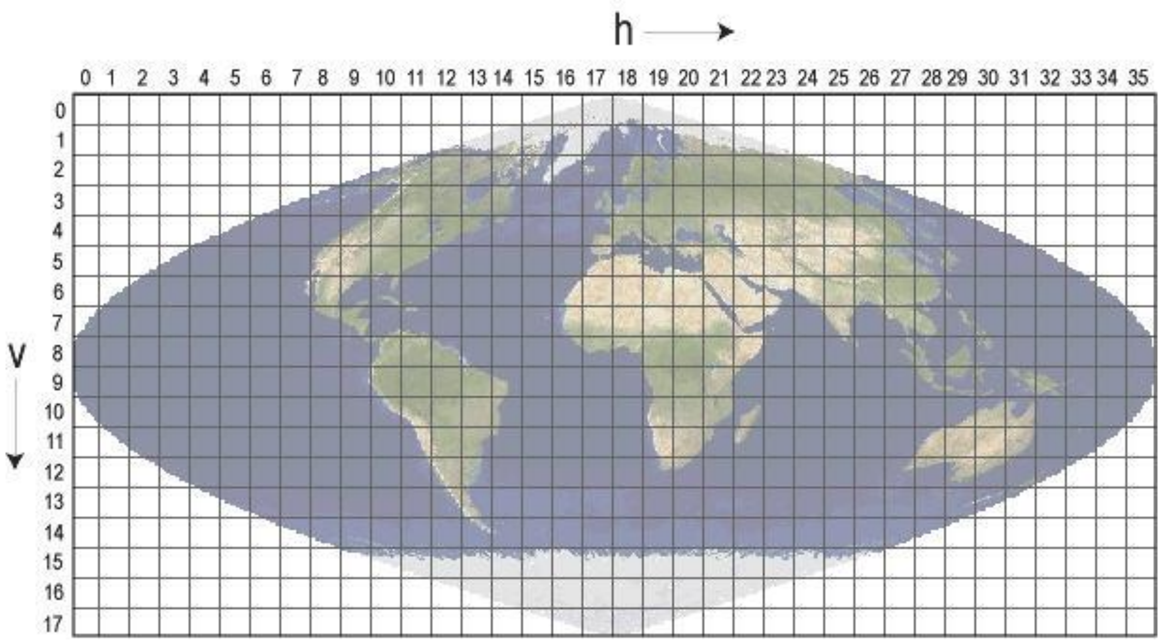

Figure 1. MODIS MYD11A2 Sinusoidal grid tiling system.
Source: https://lpdaac.usgs.gov/dataset_discovery/modis

Methods

We defined our time period of interest as the highest temperature period of the northern and southern hemisphere summers. In the northern hemisphere this roughly corresponds to the period from July to early August, while in the southern hemisphere it corresponds to the period from January to February. We identified five MODIS LST 8-day composites with Julian day acquisition dates in a 40-day time-span in July-August (Julian days 185-224) 2013 in the northern hemisphere (v = 1-8), and five 8-day composites with Julian day acquisition dates in a 40-day time-span in January-February (Julian days 001-040) 2013 in the southern hemisphere (v = 9-13). We then used MRTweb to select MODIS tiles by tile location (h,v). MRTweb will process up to 50 images per session, so we processed the data in batches, selecting 10 adjacent tiles to mosaic and processing all five 8-day composites for that selection. For each 8-day composite, both day and night image bands were selected, projected to WGS-84 and then mosaicked with the other selected tiles to create five daytime LST mosaics and five nighttime LST mosaics. To achieve global coverage (60 S latitude to 80 N latitude), approximately 200 tiles were selected to produce 80 MRTweb mosaics (40 each of daytime and nighttime LST) for each of five Julian dates. A total of 400 mosaics were downloaded.

We then used ENVI software version 4.8 (Exelis Visual Information Solutions, 2011) to create layer stacks of the daytime and nighttime mosaic imagery for a given mosaicked MRTweb selection. This reduced the number of files we were working with from 400 mosaics for individual dates to 80 layer stacks of daytime and nighttime imagery. We prepared an *R* script (R Development Core Team, 2013) to process each layer stack. The first part of the *R* script converted the data from Kelvin to degrees Celsius and recoded unrealistic values to NoData. Then we mosaicked the scenes into global files in Esri ArcMap version 10.2.2 (Esri, 2014), and ran the second part of the *R* script to extract the maximum LST value in the global layer stack of five daytime images and the minimum LST value in the global layer stack of five nighttime images, for each pixel location.

While conducting quality assurance during processing, we noticed that some tropical locations, especially in India and Indonesia, were missing data due to cloud cover related to monsoon periods. We decided to patch these data gaps with scenes from April-May (Julian days: 97-129) for the northern hemisphere, and from December 2013-January 2014 (Julian days: 337-001) for the southern hemisphere. We re-ran the script on these files, and the outputs were then mosaicked to the global files such that only the pixels with missing values were updated with values from the supplementary files. Some data gaps remain in areas where data were insufficient (e.g., Central Africa).

The final outputs prepared for distribution as the Global Summer Land Surface Temperature (LST) Grids, 2013 data set are global grids of summer daytime maximum temperature and summer nighttime minimum temperature and regional subsets of the global grids, all in GeoTIFF format. All grids are in degrees Celsius at a spatial resolution of 30 arc-seconds (~1km).

III. Data Set Description

The Global Summer Land Surface Temperature (LST) Grids, 2013, represent daytime maximum temperature and nighttime minimum temperature in degree Celsius at a spatial resolution of 30 arc-seconds (~1km) during summer months of the northern and southern hemisphere for the year 2013.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/sdei-global-summer-lst-2013

Data set format:
The data set is available as global and regional rasters in GeoTIFF format. The data are stored in geographic coordinates of decimal degrees based on the World Geodetic System

spheroid of 1984 (WGS84). Each downloadable is a compressed zip file which contains: 1) the GeoTIFF and 2) PDF documentation. Downloaded zipfiles need to be uncompressed in a single folder using either WinZip (Windows file compression utility) or a similar application before the file can be accessed by your GIS software package.

Data set downloads:
sdei-global-summer-lst-2013-global.zip
sdei-global-summer-lst-2013-africa.zip
sdei-global-summer-lst-2013-americas.zip
sdei-global-summer-lst-2013-asia.zip
sdei-global-summer-lst-2013-europe.zip
sdei-global-summer-lst-2013-oceania.zip

IV. Potential Use Cases

The Global LST data set could be used in a number of ways to assess surface temperature differentials as they relate to different land cover types, ecosystems, and health impacts. Integration of this data set with population data could help to quantify populations exposed to extreme heat during the summer months. The global temperature grid may also serve as a baseline that will allow comparisons of urban temperatures in future years.

V. Acknowledgments

The MODIS MYD11A2 data were retrieved from MRTWeb 2.0, courtesy of the NASA EOSDIS Land Processes Distributed Active Archive Center (LP DAAC), USGS/Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota (https://lpdaac.usgs.gov/data_access).

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VIII. Recommended Citation(s)

Data set:

Center for International Earth Science Information Network (CIESIN), Columbia University. 2016. Global Summer Land Surface Temperature (LST) Grids, 2013. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H408638T. Accessed DAY MONTH YEAR.

IX. Source Code

The *R* script used in processing the MODIS MYD11A2 dataset to produce the Global Summer Land Surface Temperature (LST) Grids, 2013 has been archived with the data set and is available upon request. Please contact SEDAC User Services at ciesin.info@ciesin.columbia.edu to request the code.

X. References

Center for International Earth Science Information Network (CIESIN), Columbia University. 2016. *Global Urban Heat Island (UHI) Data Set, 2013*. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4H70CRF.

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NASA Land Processes Distributed Active Archive Center (LP DAAC). 2002b. *MODIS MYD11A2 Version 5*. NASA EOSDIS Land Processes DAAC, USGS Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota (https://lpdaac.usgs.gov), accessed June 2014, at https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/myd11a2

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