EARTH OBSERVATION CLIMATE INFORMATION SERVICE

Quick Start Guide

Land Surface Temperature Interim Climate Data Records

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1. Quick Start: Land Surface Temperature ICDRs

The following will provide you with sufficient information to quickly get to grips with the Land Surface Temperature (LST) dataset product(s) and to gain some familiarity with the information available.

1.1 What products are available?

Product name and acronym	Filename example	Version
SLSTR Land Surface Temperature ICDR	ESACCI-LST-L3C-LST-SLSTRA-0.01deg_1DAILY_DAY-20201231000000-fv3.00.nc	3.0
VIIRS Land Surface Temperature ICDR	ESACCI-LST-L3C-LST-VIIRS1-0.01deg_1DAILY_NIGHT-20201231000000-fv1.00.nc	1.0

Table 1 Dataset Products covered in this document

1.2 Summary information

Product Name	**SLSTR Land Surface Temperature ICDR**
Main observed variable(s)	Land surface temperature (LST)
Geographical range of dataset	Global
Temporal range of dataset	May 2016 - present
Spatial resolution / gridding	0.01˚
Temporal sampling characteristics	Day / Night composites
Level of processing	L3C gridded data
Main auxiliary content	Quality control flags; full uncertainty breakdown; auxiliary variables (biome)
Dataset citation	*Paper in preparation*
Dataset journal reference	*TBC*

Table 2 Summary Information for SLSTR Land Surface Temperature ICDR

Product Name	**VIIRS Land Surface Temperature ICDR**
Main observed variable(s)	Land surface temperature (LST)
Geographical range of dataset	Global
Temporal range of dataset	January 2012 – present
Spatial resolution / gridding	0.01˚
Temporal sampling characteristics	Day / Night composites
Level of processing	L3C gridded data

Main auxiliary content	Quality control flags; full uncertainty breakdown; auxiliary variables (biome, emissivity)
Dataset citation	*TBC*
Dataset journal reference	*TBC*

Table 3 Summary Information for VIIRS Land Surface Temperature ICDR

1.2.1 Variables summary information

Variable	Name	Description	Units
time	Reference time	Reference time of start of file in seconds since 1981-01-01 00:00:00	Seconds
dtime	Time difference from reference time	Pixel acquisition time in seconds since start of file	Seconds
lat	Latitude	Latitude of pixel centre	Degrees North
lon	Longitude	Longitude of pixel centre	Degrees East
satze	Satellite zenith angle	Satellite zenith angle	Degrees
sataz	Satellite azimuth angle	Satellite azimuth angle	Degrees
solze	Solar zenith angle	Solar zenith angle	Degrees
solaz	Solar azimuth angle	Solar azimuth angle	Degrees
lst	Land surface temperature	Radiative skin temperature of the land per pixel	Kelvin
lst_uncertainty	Total uncertainty	Total pixel uncertainty from components added in quadrature	Kelvin
lst_unc_ran	Random uncertainty	Pixel uncertainty component from uncorrelated errors	Kelvin
lst_unc_loc_atm	Locally correlated atmospheric uncertainty	Pixel uncertainty component from locally correlated errors on atmospheric scales	Kelvin
lst_unc_loc_sfc	Locally correlated surface uncertainty	Pixel uncertainty component from locally correlated errors on surface scales	Kelvin
lst_unc_sys	Large scale systematic uncertainty	Pixel uncertainty component from large scale systematic errors	Kelvin
lcc	Biome	Land cover classification according to modified Land Cover CCI classes	-
qual_flag	Quality flag	Flag to indicate if input pixel is nearest one to local solar time	-
emis	Emissivity	Land surface emissivity	-
N	Clear sky count	Number of native resolution clear sky pixels in gridded output pixel	-
ncld	Cloudy count	Number of native resolution cloudy pixels in gridded output pixel	-

Table 4 Summary information for each variable for SLSTR and VIIRS Land Surface Temperature ICDRs

1.3 What can these products be used for?

The Land Surface Temperature data are suitable for different uses such as:

- Land/atmosphere modelling: model validation and parameter constraint, study of temporal and spatial variability, initialisation of numerical models, trend analysis and anomalies, data assimilation for NWP, detection and consequences of land cover change
- Urban heat islands and urban planning to map and henceforth mitigate urban heat stress
- Agricultural / water management: irrigation, drought stress; evapotranspiration, soil moisture retrievals
- Fire monitoring users: burned area mapping, fuel moisture content
- Geological applications: geothermal anomalies, volcanic activity
- Cryosphere: monitoring of melt zones on glaciers and ice sheets

1.4 Where to find these products for download

To access the dataset products(s) navigate to the following locations using the links below:

- Data portal 1 – Not available yet

- Data portal 2 – Not available yet

1.5 Using downloaded data

Data will come in netCDF format. These files commonly have the extension '.nc'.

The file contents of a netCDF file can quickly be viewed on Linux machines using the ncdump utility.

Libraries of routines for manipulating netCDF files exist in the commonly used languages.

The ESA SNAP toolbox and ESA CATE toolbox provide tools for visualization and processing of Earth Observation and ESA CCI climate data respectively and can also be used to open these netCDF files.

The following sub-sections give examples on how to ingest, display, subset, and reduce the resolution of the data using the Python xarray module.

1.5.1 Import Data

The data in netCDF files can be imported and manipulated using Python's xarray module. In the following code examples the python prompt is illustrated as >>> . Note, the global files at 0.01° resolution are large and require a large amount of memory to plot a full field, you may prefer to subset or reduce the spatial resolution of the data before plotting (see Sections 1.5.2 and 1.5.3 for example code for subsetting and reducing spatial resolution). The examples in this section plot the daytime LST for 15th June 2021 from SLSTR on Sentinel 3A.

```
# import the xarray module
>>>  import xarray as xr

# Open LST daily daytime dataset
>>>  filename = 'ESACCI-LST-L3C-LST-SLSTRA-0.01deg_1DAILY_DAY-20210615000000-
fv4.aa.nc'
>>>  d = xr.open_dataset(filename)
>>>  d
<xarray.Dataset>
Dimensions:          (time: 1, lat: 18000, lon: 36000, length_scale: 1,
                      channel: 2)
Coordinates:
  * time             (time) datetime64[ns] 2021-06-15
  * lat              (lat) float32 -90.0 -89.99 -89.98 ... 89.97 89.98 89.99
  * lon              (lon) float32 -180.0 -180.0 -180.0 ... 180.0 180.0 180.0
  * channel          (channel) float32 11.0 12.0
Dimensions without coordinates: length_scale
Data variables: (12/18)
    dtime            (time, lat, lon) timedelta64[ns] ...
    satze            (time, lat, lon) float32 ...
    sataz            (time, lat, lon) float32 ...
    solze            (time, lat, lon) float32 ...
    solaz            (time, lat, lon) float32 ...
    qual_flag        (time, lat, lon) float32 ...
    ...               ...
    lcc              (time, lat, lon) float32 ...
    ndvi             (time, lat, lon) float32 ...
    emis             (time, channel, lat, lon) float32 ...
    t2m              (time, lat, lon) float32 ...
    n                (time, lat, lon) float32 ...
    ncld             (time, lat, lon) float32 ...
Attributes: (12/41)
    title:                      ESA LST CCI land surface temperature data at
...
    institution:                University of Leicester
    source:                     ESA LST CCI SLSTRA L3U V4.a
    history:                    Created using software developed at
Universit...
    references:                 https://climate.esa.int/en/projects/land-
surf...
    Conventions:                CF-1.8
    ...                         ...
    geospatial_lon_resolution:  0.01
```

```
    geospatial_lat_resolution:  0.01
    key_variables:              land_surface_temperature
    format_version:             CCI Data Standards v2.2

# Plot the lst variable
# first import matplotlib module
>>>  import matplotlib.pyplot as plt
# make the plot
>>>  ax = d.lst[0,:,:].plot.imshow()
>>>  ax.axes.set_aspect('equal')
# display the plot
>>>  plt.show()
```

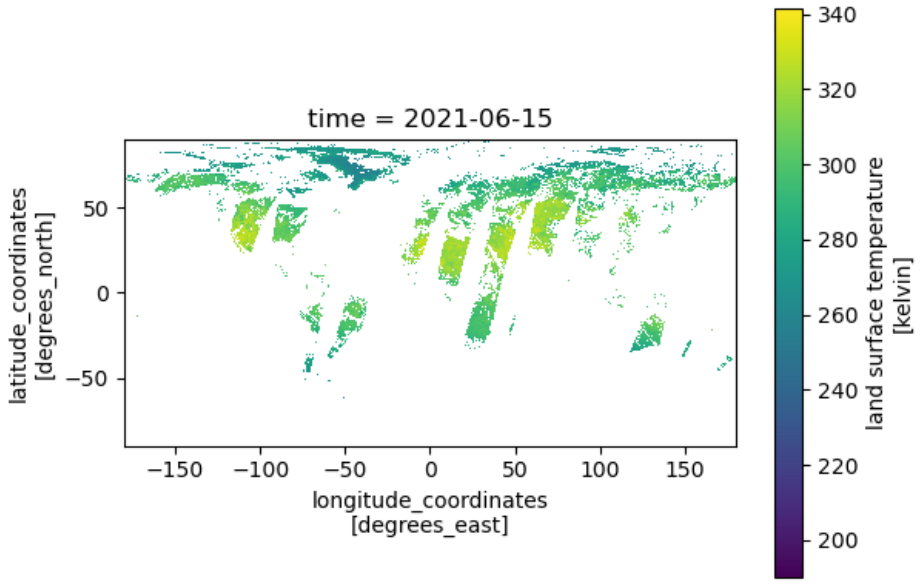

Figure 1 Plot of the LST field at full resolution made using the example code.

1.5.2 Subsetting

The python xarray module can be used to subset the data by selecting a latitude-longitude slice. Assuming the xarray and matplotlib.pyplot modules have been imported as shown in Section 1.5.1 the following code will select a subset of the global data with latitudes between 30 °N and 65 °N and longitudes between 10 °W and 30 °E and plot the selected data.

```
# Form the spatial subset of the lst variable
>>>  subset = d.lst.sel(lat=slice(30,65), lon=slice(-10,30))
>>>  subset
<xarray.DataArray 'lst' (time: 1, lat: 3500, lon: 4000)>
[14000000 values with dtype=float32]
```

```
Coordinates:
  * time     (time) datetime64[ns] 2021-06-15
  * lat      (lat) float32 30.0 30.01 30.02 30.03 ... 64.96 64.97 64.98 64.99
  * lon      (lon) float32 -9.995 -9.985 -9.975 -9.965 ... 29.98 29.98 29.99
Attributes:
    long_name:     land surface temperature
    units:         kelvin
    valid_min:     -8315
    valid_max:     7685
    actual_range:  [190.01999 341.66   ]
>>> subset = d.lst.sel(lat=slice(30,65), lon=slice(-10,30))
# Plot the lst variable spatial subset
>>>  bx = subset[0].plot.imshow()
>>>  bx.axes.set_aspect('equal')
>>>  plt.show()
```

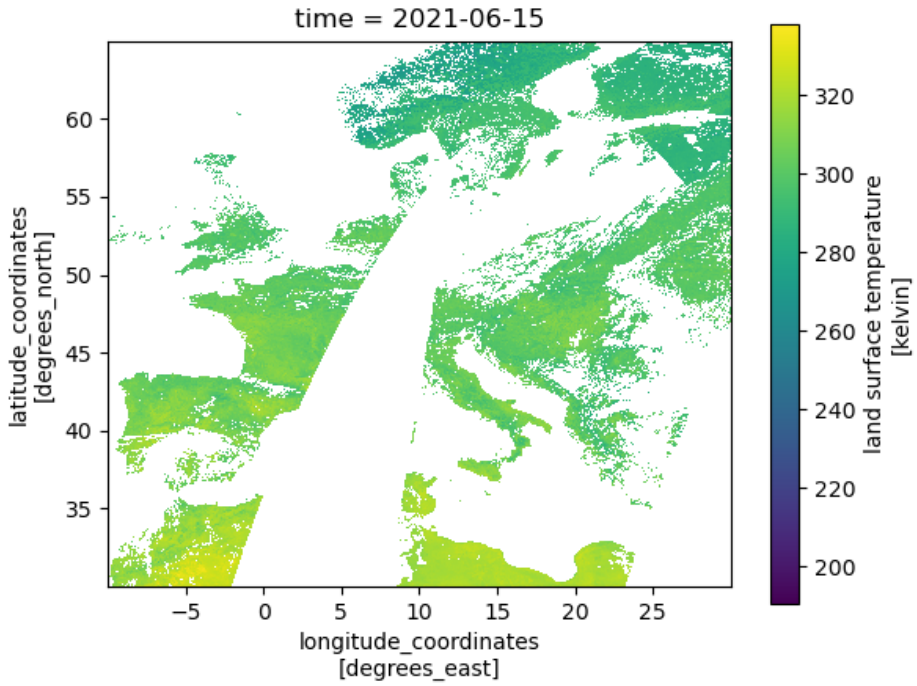

Figure 2 Plot of the LST for a subset over Western Europe.

1.5.3 Reducing resolution

The python xarray module coarsen function can be used to reduce the resolution of the data. Assuming the xarray and matplotlib.pyplot modules have been imported as shown in Section 1.5.1, the code in the following example takes a subset of the data over Europe and reduces the resolution from 0.01° to 0.5°. See the next section for example code which can be used to form a spatial subset.

```
# Regridding to a coarser spatial resolution (50x coarser)
>>>  subset_coarse=subset.coarsen(lon=50,lat=50,boundary='pad').mean()
>>>  subset_coarse
<xarray.DataArray 'lst' (time: 1, lat: 70, lon: 80)>
array([[[311.27936, 314.74875, 315.66098, ...,       nan,       nan,
               nan],
        [311.7403 , 314.49863, 313.10748, ...,       nan,       nan,
               nan],
        [313.0768 , 314.68176, 314.2865 , ...,       nan,       nan,
               nan],
        ...,
        [      nan,       nan,       nan, ..., 280.22687, 280.9955 ,
         281.6391 ],
        [      nan,       nan,       nan, ..., 282.17215, 282.61194,
         283.09814],
        [      nan,       nan,       nan, ..., 283.02817, 281.6329 ,
         279.50558]]], dtype=float32)
Coordinates:
  * time     (time) datetime64[ns] 2021-06-15
  * lat      (lat) float32 30.25 30.75 31.25 31.75 ... 63.25 63.75 64.25 64.75
  * lon      (lon) float32 -9.75 -9.25 -8.75 -8.25 ... 28.25 28.75 29.25 29.75
Attributes:
    long_name:     land surface temperature
    units:         kelvin
    valid_min:     -8315
    valid_max:     7685
    actual_range:  [190.01999 341.66   ]

# plot the reduced resolution data
>>>  cx = subset_coarse[0].plot(edgecolor='k')
>>>  cx.axes.set_aspect('equal')
>>>  plt.show()
```

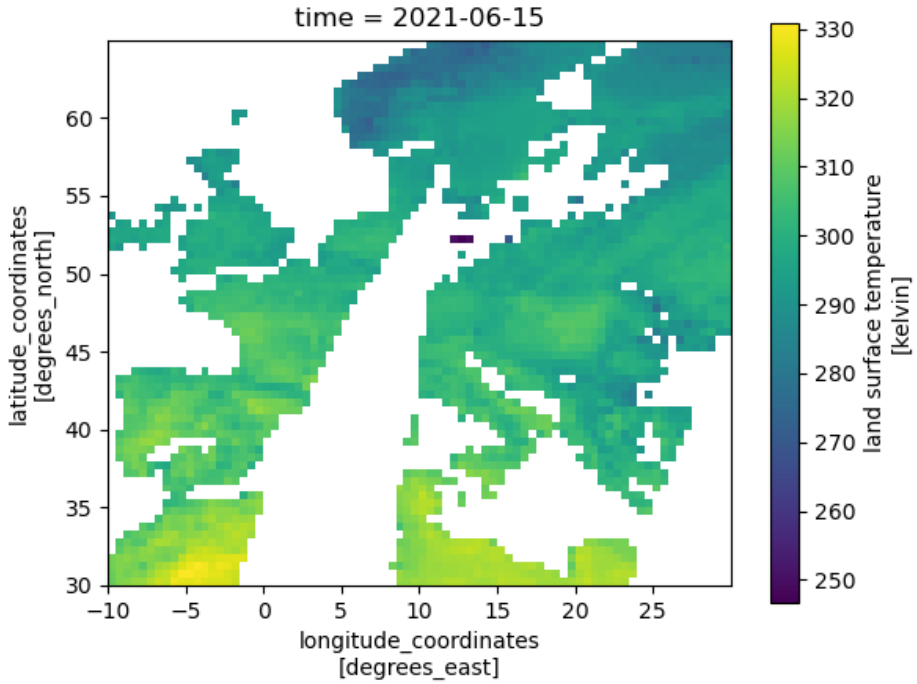

Figure 3 Plot of the LST over Western Europe at reduced spatial resolution (0.5°) made using the example code.

1.6 Interactive visualisation / data access

Linux based online regridding and subsetting tool for ESA CCI LST products which is compatible with the EOCIS LST ICDRs.
The tool can be accessed at https://climate.esa.int/en/projects/land-surface-temperature/data/

1.7 Your obligations when using these products

By accessing the Land Surface Temperature ICDRs, you agree to cite the dataset digital object identifier (doi) and corresponding journal article describing the dataset every time you publish results obtained in whole or in part by use of UK EOCIS products. These citations are given under Summary Information.

The reference to the dataset should mention "created by the UK Earth Observation Climate Information Service". The product name and acronym in Table 1 and should be used to avoid confusion and enable traceability.

1.8 Further Information

The products will be available with a timeliness of 5 days from real time. They will start from the beginning of the routine production of the input Level-1 data and production will be ongoing.

History of modifications / Change Log

Version	Date	Changes	Person
0.1	24/04/2023	Initial Draft	DG

Related Documents / Reference Documents

Document	Author	Reference

Acronyms and/or Abbreviations

Acronym / Abbreviation	Definition

General definitions

Term	Definition