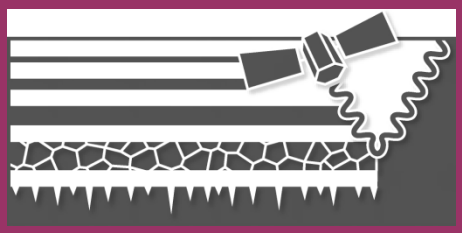
ESA DUE Permafrost



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Land Surface Temperature V2 product guide

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Contents

Abstract

The Land Surface Temperature Documentation – Version 2 contains an overview of the products, the different steps followed in order to produce LST products, a flow chart of the processing chain, known issues and some information on the data which will help the users to choose the most appropriate LST product to meet their needs.

1 UW-Level3LST product overview

Land surface temperature (LST) products and services identified by users for the pan-boreal/arctic scale include: weekly, monthly and annual averages with accompanying metadata information. For the pan-boreal/arctic scale, LST products with a grid size of 25 km have been identified as suitable by the user community. Both Regional (1-km) products for five regions of interest and the pan-Arctic products (25 km) are calculated from AATSR level2 data (ATS_NR_2P) and MODIS level 2 data (MYD11_L2.5) and (MOD11_L2.5).

2 Product specification

2.1 Product Description

2.1.1 Weekly

Weekly LST products available for each day based on a 7-day sliding time window, following the Globsnow convention. Weekly products includes level2 observations acquired by all satellite overpasses within a seven-day period. Weekly products are made of six files as follows: the weekly LST average, weekly maximum temperature, weekly minimum temperature and the number of level2 observations falling within each 1 km or 25 km pixel during that week.

2.1.2 Monthly

Monthly Averaged Land Surface Temperature follows the calendar months. Monthly products are made of six files as follows: the Monthly average, Monthly maximum temperature, Monthly minimum temperature and the number of level2 observations falling within each 1 km or 25 km pixel during that month.

2.2 Nomenclature Name

OOO="organisation",
<UW> University of Waterloo

SSSSS="sensor and mode",
The three first letters correspond to the sensor and the two last letters correspond to the mode with:

- *AV = Normal average*
- *SI = Average calculated from a sinusoidal equation fitted between existing LST values*

<MODAV> MODIS average
<ATSAV> AATSR average

PPP="product",
<LST> Land Surface Temperature

VVV="product/software version"
<1.1.4>*Version of the code written in IDL language used for calculations*

vvv="processing index" ,number of processing

YYYYMMDD_HHMMSS ="start date and time" ,

YYYYMMDD_HHMMSS="end date and time" ,

RRR="region of interest",
<100> for Pan-Arctic products
<001> for Kuparuk basin, Alaska
<002> for Mackenzie basin
<003> for Laptev Sea
<004> for Lena River delta
<005> for Ob Estuary

DDD="data type", set from 001 to 006

<001> for aggregation LST product based on equal weight average

<002> for counting the number of LSTs (all cloud free observations falling into each pixel).

<003> for average of LSTs (all cloud free observations falling into each pixel during (6AM - 6PM) local time)

<004> for counting the number of LSTs all cloud free observations falling into each pixel during (6AM - 6PM) local time

<005> for average of LSTs (all cloud free observations falling into each pixel during (6PM - 6AM of next day) local time

<006> for counting the number of LSTs(all cloud free observations falling into each pixel during (6PM - 6AM of next day) local time

Example of name:

UW_MODAV_LST_1.1.4_001_2007.1.1_0.0.0_2007.1.31_23.59.59_001_001.tif
(UW-Level3 LST product from MODIS Normal Average made with version 1.1.4 of the code, first processing, from1st to 31st January 2007 (monthly average), Kuparuk basin 1-km area, daily average data).

2.3 Available products as part of the 2nd version

Table 1: List of available UW-Level3 LST v1 products

Product	Unit	Data Format	Coverage	Time period	Temporal frequency	Coor-dinate system	Grid cell size
MODAV	K	Geotif NetCDF	Pan-Arctic	2007 - 2010	Weekly	Ease Grid	25 km
MODAV	K	Geotif NetCDF	Pan-Arctic	2000 - 2010	Monthly	Ease Grid	25 km
ATSAV	K	Geotif NetCDF	Pan-Arctic	2005 - 2009	Monthly	Ease Grid	25 km
ATSAV	K	Geotif NetCDF	Pan-Arctic	2008	Weekly	Ease Grid	25 km
MODAV	K	Geotif NetCDF	Kuparuk Basin, Alas-ka	2007 - 2010	Weekly & Monthly	Ease Grid	1 km
MODAV	K	Geotif NetCDF	Mackenzie Basin	2007 - 2010	Weekly & Monthly	Ease Grid	1 km
MODAV	K	Geotif NetCDF	Lena River	2007 - 2010	Weekly & Monthly	Ease Grid	1 km
MODAV	K	Geotif NetCDF	Laptev Sea	2007 - 2010	Weekly & Monthly	Ease Grid	1 km
MODAV	K	Geotif NetCDF	Ob Estuary	2007 - 2010	Weekly & Monthly	Ease Grid	1 km

3 Processing chain

3.1 Product Development

3.1.1 Data sources and processing

Two sources of data will be used to develop the regional and pan-boreal/Arctic operational products:

a) AATSR geophysical level 2 product (**ATS_NR_2P**) above 50^{o}N available through the European Space Agency (ESA) online Archive MERCI, which has 1 km spatial resolution and is produced using a Nadir-only split window algorithm.

b) MODIS data level 2 product (**M*D11_L2 version 5**) available through LAP DAAC data tool online archive. LST version 5 is derived from MODIS sensor brightness temperature data using a nadir-only generalized split window algorithm.

3.1.2 Interpolation to a regular grid

Level2 LST observations is unprojected data with irregular distribution determined by the shape of satellite orbits. The Northern Hemisphere EASE - Grid Lambert Equal Area Azimuthal projection with a sphere datum (with a radius of 6371.228 km) was selected as the standard projection for the operational pan-boreal/Arctic and regional products. Original LST observations were projected using the EASE-Grid coordinates system and interpolated to the regular EASE-Grid using triangulation. The geographic coordinates were assigned to the centre point of each pixel of the EASE-Grid cells.

Local time for each observation was calculated using the acquisition time in UTC and the longitude of that observation. The acquisition time was extracted from ADS information in case of AATSR data and from the file name in case of MODIS level2 products. This method yielded a temporal accuracy of ± 15 minutes, which was sufficient for weekly and monthly products.

3.1.3 Spatiotemporal aggregation

Spatial Aggregation:

UW LST products at pan-boreal/Arctic product, with a spatial resolution of 25 km, were produced by spatial averaging of 1-km observations. Coarse resolution pixels, which were found to have less than 5 % of its total area (625 km^2) covered with 1 km observations, were discarded and considered missing data.

Temporal Aggregation:

Temporal aggregation was applied to both Regional (1 km) and Pan-Arctic (25 km) products to produce weekly and monthly LST averages. Equal weights are given to observations falling within a daytime bin (from 6a.m. to 6 p.m. local time) and nigh time bin (6p.m. to 6 a.m. of the next day) during the week or month of concern. the day and night average is done to avoid the daily heating cycle.

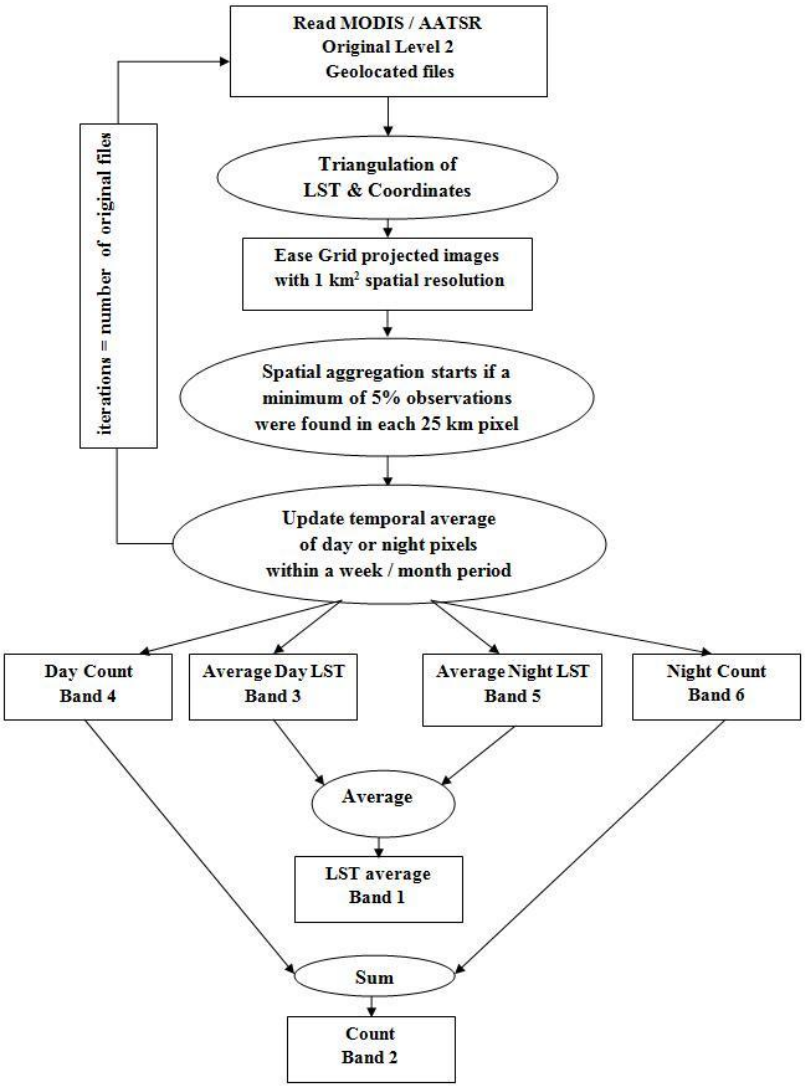

Figure 1: Processing flowchart for UW pan-arctic LST products

3.2 Technical Metadata of 2nd version

Metadata available to users – post processing, will include:

References to algorithm documentation
References to auxiliary data documentation
References to products documentation
References to validation documentation

Size of each geotif-file
(following are general estimates, file size varies)

Regional – depending on the size of the region:
Kuparuk basin, Alaska = 4.44 MB
Mackenzie Basin = 20.3 MB
Lena River = 832 KB
Laptev Sea = 14.8 MB
Ob Estuary = 6.48 MB
Pan-Arctic = 482 KB

3.3 NetCDF files

Files were produced in both Geotiff and netcdf formats. the netcdf files contains either a singles LST band or a single LST count band. auxiliary fields contains a longitude field with a short name 'LON' and a latitude field with a short named 'LAT' , an Ease Grid X-coordinates field named 'GRIDX' and an Ease grid Y-coordinates named 'GRIDY'. All pixel values are assigned to the canter of the EASE-Grid cells. LST field were packed using :

unpacked data value = add offset + packed data value * scale factor

Information about the variables properties (e.g., the scale factor and add offset values), EASE grid projection parameters and dimensions are stored under the variables attributes, general information about the LST product are stored under the Global attributes.

3.4 Known Issues

3.4.1 Density of Level2 observations

LST products driven from MODIS level2 observations are more complete compared to products driven from AATSR observations. The high density of observations obtained from MODIS sensors on both AQUA and TERRA satellites increased the chances of recording clear sky observations 10-folds compared to AATSR.

3.4.2 Artefacts

LST products were found free of artefacts with exception to an artefact found on pan-Arctic maps derived from MODIS level2 at 60°N over Siberia and northern Québec (Canada) during the months of January and December. This problem, however, is not affecting the five regions for the 1-km product where the temperatures are all consistent.

3.4.3 Bias toward clear-sky observations

The LST data correspond to land surface temperatures under clear-sky conditions only. Therefore, LST products is warmer during winter and colder during summer compared to the true LST average, which include LST of clear and cloudy skies. That is because, cloud cover increases LST during winter by re-emitting long wave radiation to earth, while decreasing LST during summer by blocking direct sun radiation.

3.4.4 Contamination with top-cloud temperature

Difference between monthly MODIS / AATSR and reanalysis or air temperature measured at weather stations were found to oscillates with a one year cycle. For example, during the warm period from June to August bias reached a minimum difference (around 2K). The observed while during the cold months (snow on ground season) bias reached a maximum negative, which support a possible admixing with top clouds temperature. for further details about the validation, refer to the DUE permafrost Validation report.

4 Data access and contact information

The UW MODIS L3 Land Surface Temperature (LST) version 2 product can be accessed via PANGAEA (http://doi.pangaea.de/10.1594/PANGAEA.780111) and should be cited as:

Duguay, Claude; Hachem, Sonia; Soliman, Aiman; Saunders Williams (2012): Circumpolar and regional Land Surface Temperature (LST) with links to geotiff images and netCDF files, University of Waterloo, CA, doi:10.1594/PANGAEA. 775962
In: DUE Permafrost Project Consortium (2012): ESA Data User Element (DUE) Permafrost: Circumpolar Remote Sensing Service for Permafrost (Full Product Set) with links to datasets. doi:10.1594/PANGAEA.780111

The product is alternatively stored on the Institute of Photogrammetry and Remote Sensing (TU Wien) FTP server which can be accessed via the DUE Permafrost data portal (www.ipf.tuwien.ac.at/permafrost). The dataportal includes a WebGIS for visualization. Login information is available on request.

For login access to the dataportal, contact Annett.Bartsch@tuwien.ac.at.
For questions about the product, contact Claude Duguay crduguay@uwaterloo.ca or Aiman Soliman a2solima@uwaterloo.ca.
For ESA's technical officer, contact Frank.Martin.Seifert@esa.int.

Additional information on the ESA DUE Permafrost project can be found at the web - site: http://www.ipf.tuwien.ac.at/permafrost

5 References

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