# Himawari-8/ AHI hourly clear-sky land surface temperature and emissivity dataset (2016-2021) User Manual（V1.0）

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**Menu**

# 1. Dataset descriptions

Land surface temperature (LST) is a direct driving factor for land-atmosphere interaction has been recognized as one of the essential climate variables (ECVs). Land surface emissivity (LSE) is an inherent physical property of the land surface and is widely used for target detection and geological mapping based on the characteristics of emissivity spectra. The Advanced Himawari Imager (AHI) onboard Himawari-8 opens up new opportunities for the research of daily LST variations and the land surface energy balance, however, it does not yet provide an official LST product.

Zhou and Cheng (2020) proposed an improved temperature and emissivity separation (iTES) algorithm for simultaneously retrieving the LST and LSE from AHI data, including a modified water vapor scaling (WVS) method and a calibrated empirical relationship over vegetated surfaces. Based on the AHI iTES algorithm, the authors produced the clear-sky LST&E dataset (0.02°, hourly) using the AHI thermal infrared (TIR) data. A generic 8-13.5μm broadband emissivity (BBE) was also derived by a linear function of the AHI narrow band LSEs (Cheng et al. 2013). The in-situ validation results show that the bias and RMSE of the retrieved AHI LST are 0.19 and 2.93 K in the daytime, and −0.43 and 1.95 K in the nighttime, respectively. The retrieved LSE shows biases and RMSEs ≤ 0.005 and 0.014, respectively, compared with the latest MYD21 LSE. The time period of this dataset is 2016-2021, covering the AHI 0.02° nominal fixed grid (60°N~60°S, 80°E~160°W).

# 2. Algorithm description

The flowchart for generating the AHI hourly LST&E is shown in Figure 1. There are two key components: atmospheric correction and temperature and emissivity separation. The atmospheric correction is realized by feeding the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) atmospheric profiles into the fast RTM such as Radiative Transfer for TOVS (RTTOV). Besides, a modified WVS method was conducted for atmospheric correction, which is applicable for both high emissivity (graybody) and low emissivity (nongraybody) pixels. For LS&E retrieval, a new empirical function is established for vegetated surfaces that explicitly considers the multiple scattering between leaves and the underlying soil background.

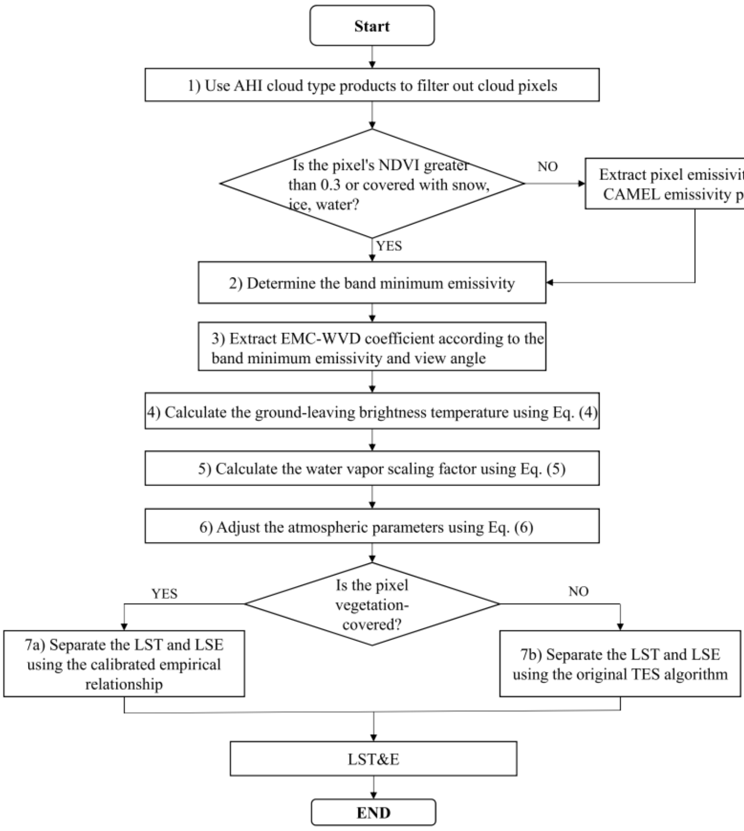


Figure 1. Flowchart of the proposed method for generating hourly LST&E.

## 3. Data source

The AHI/Himawari-8 full disk data were used to retrieve the LST&E, in conjunction with the auxiliary data, such as the MERRA-2 atmospheric profiles, MODIS series products (including NDVI product, snow cover product and land cover product) and the Combined ASTER and MODIS Emissivity for Land (CAMEL) product. Detailed information was shown in Table 1.

Table 1 Data source

| Source | Dataset | Spatial Resolution | Temporal Resolution |
|---|---|---|---|
| Satellite Data | AHI full disk data | 0.02° × 0.02° | hourly |
| | AHI cloud product | 0.02° × 0.02° | hourly |

| | | |
|---|---|---|
| MERRA-2 | 0.5° × 0.625° | 6 h |
| MYD13A2 | 1 km × 1 km | 16 days |
| MOD10C1 | 0.05° × 0.05° | 1 day |
| MCD12Q1 | 0.05° × 0.05° | 1 year |
| CAMEL | 0.05° × 0.05° | 1 month |

# 4. Dataset details

## 4.1 Data format

NetCDF

## 4.2 Data file naming

filename：H08_YYYYMMDD_hhmm_LST&E.nc

- H08: product based on AHI LST；
- YYYY: Year;
- MM: Month;
- DD: Day;
- hhmm: Hour and minute (UTC);
- LST&E: LST and LSE product.

## 4.3 Scientific datasets

Table 2 Scientific datasets

| Datasets | Data type | Dimension | Scaling factor | Annotation |
|---|---|---|---|---|
| LST | int16 | 6001*6001 | 0.01 | LST |
| BBE | int16 | 6001*6001 | 0.001 | Broadband emissivity (8~13.5 μm) |
| LSE_band 11 | int16 | 6001*6001 | 0.001 | H08 band 11 LSE |
| LSE_band 13 | int16 | 6001*6001 | 0.001 | H08 band 13 LSE |
| LSE_band 14 | int16 | 6001*6001 | 0.001 | H08 band 14 LSE |
| LSE_band 15 | int16 | 6001*6001 | 0.001 | H08 band 15 LSE |
| QC | int8 | 6001*6001 | 1 | Quality control |

## 4.4 Quality control

Table 3 QC bit index

| Bits | Long name | Description |
|---|---|---|
| 0-1 | Mandatory flags | 00: Pixel produced, good quality<br>01：Pixel produced but unreliable quality (View zenith angle (VZA) > 55° or WVS failed with high water vapor loading)<br>11: Filled value |
| 2 | Cloud flag | 0: Clear sky<br>1: (Probable) Cloudy sky |
| 3 | Graybody flag | 0: Graybody pixel<br>1: Non-graybody pixel |
| 4 | VZA flag | 0: VZA≤55°<br>1: VZA>55° |
| 5 | WVS flag | 0: WVS conducted<br>1: WVS failed |
| 6 | Land surface flag | 0: Land surface<br>1: Ocean surface |

## 4.5 Data spatial range

AHI nominal fixed grid (60°N~60°S, 80°E~160°W)

## 4.6 Data temporal domain

2016 -2021

## 4.7 Data spatial resolution

0.02°

## 4.8 Data temporal resolution

1 hour

## 4.9 File size

About 50Mb per file.

### 4.10 Data reading method

This dataset can be read by MATLAB, Python and other programming languages, or it can be visualized in panoply and other software.

## references

Cheng, J., Liang, S., Yao, Y., & Zhang, X. (2013). Estimating the Optimal Broadband Emissivity Spectral Range for Calculating Surface Longwave Net Radiation. *IEEE Geoscience and Remote Sensing Letters, 10*, 401-405

Zhou, S., & Cheng, J. (2020). An Improved Temperature and Emissivity Separation Algorithm for the Advanced Himawari Imager. *IEEE Transactions on Geoscience and Remote Sensing, 58*, 7105-7124