High Mountain Asia 1 km MODIS-AIRS Gap-Filled Ground Temperatures and Permafrost Probability Maps, 2003-2016, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Kim, K. Y., V. Lakshmi, H. Rajaram, P. Kansara, and R. Haagenson. 2024. *High Mountain Asia 1 km MODIS-AIRS Gap-Filled Ground Temperatures and Permafrost Probability Maps, 2003-2016, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/ZSRHP8H3GGSK. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/HMA2_GFTP

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data set consists of 1 km resolution monthly land surface temperatures (MLSTs); mean annual ground temperatures (MAGTs); and estimates of permafrost extent (PE) in the High Mountain Asia region from 1 Jan 2003 – 31 Dec 2016.

The data were generated by gap-filling daily MODIS Terra/Aqua Land surface temperatures (LSTs) with downscaled Atmospheric Infra-Red Sounder (AIRS) skin surface temperatures.

1.1 Parameters

MLST (°C). Fill value = --9999.0

MAGT (°C).[1] Fill value = -9999.0. Four different estimates of MAGT are provided, computed with the following temperature-at-the-top-of-permafrost (TTOP) methods:

- Ia: TTOP calculated directly from MLSTs
- II: Method Ia, plus an insulating snow layer (HMA Daily Snow Depth)
- IIIa: Method II, plus soil moisture (GLDAS-Noah)
- IIIb: Method II, plus soil moisture (ERA5-Land)

PE (probability), 2003 – 2016, for each MAGT method above. Values range from 0 (no permafrost) to 1 (certain permafrost). Fill value = -9999.0.

1.2 File Information

1.2.1 Format

NetCDF-4

1.2.2 File Contents

MLSTs, MAGTs, and PEs are provided as separate files. All files contain latitude (lat) and longitude (lon) arrays, plus a string variable named “crs” with information about the coordinate reference system.

MLSTs are stored in a 168 × 2781 × 5232 (month × lat × lon) array, where “month” refers to the calendar month from January 2003 through December 2016. The file also contains a 168 × 1 “time” array which reports the number of days since 31 Jan 2003.

[1]The MAGT at a given lat/lon is the average of the annual ground temperatures at that location, i.e., a single value for 2003 – 2016 computed via one of the four TTOP methods described above.

MAGTs and PEs are stored in 4 × 2781 × 5232 (method × lat × lon) arrays, where “method” refers to the four TTOP methods described in “Section 1.1 | Parameters”. MAGT and PE files also contain a variable named “type” indicating which TTOP method/MAGT was used.

1.2.3 Naming Convention

This data set consists of the following three files:

HMA2_GFTP_MLST_MONTHLY_2003-2016_V01.0.nc
HMA2_GFTP_MAGT_2003-2016_V01.0.nc
HMA2_GFTP_PE_2003-2016_V01.0.nc

1.3 Spatial Information

1.3.1 Coverage

N: 45.0° N
S: 22.7° N
E: 106.7° E
W: 63.0° E

1.3.2 Resolution

1 km

1.3.3 Geolocation

The following table provides geolocation information about this data set. This information is also stored in the “crs” variable.

Table 1. Geolocation Details

Geographic coordinate system	WGS 84
Projected coordinate system	N/A
Longitude of Prime Meridian	Prime Meridian, Greenwich
Datum	World Geodetic System 1984
Ellipsoid/spheroid	WGS 84
Units	Degrees
False easting	N/A
False northing	N/A
EPSG code	4326
PROJ4 string	+proj=longlat +datum=WGS84 +no_defs +type=crs
OGC WKT	GEOGCS["WGS 84", DATUM["WGS_1984", SPHEROID["WGS 84",6378137,298.257223563, AUTHORITY["EPSG","7030"]], AUTHORITY["EPSG","6326"]], PRIMEM["Greenwich",0, AUTHORITY["EPSG","8901"]], UNIT["degree",0.0174532925199433, AUTHORITY["EPSG","9122"]], AUTHORITY["EPSG","4326"]]
Reference	https://epsg.org/crs_4326/WGS-84.html

1.4 Temporal Information

1.4.1 Coverage

1 January 2003 - 31 December 2016

1.4.2 Resolution

Monthly (MLST)

N/A (MAGT, PE)[2]

[2]MAGTs and PEs are computed as a single value for 1 January 2003 – 31 December 2016, using each of the four TTOP methods described in “Section 1.1| Parameters“.

2 DATA PROCESSING

AIRS AM and PM skin temperature retrievals were downscaled from their native 1° resolution to 1 km using a linear regression based on each scene's elevation, obtained by resampling the 90 m Multi-Error-Removed Improved-Terrain Digital Elevation Model (MERIT DEM) to 1 km and then 111 km (i.e., the resolution of AIRS), and atmospheric lapse rate coefficients based on the 111 km DEM and the scene's geographic latitude. The downscaled AIRS temperatures were used to fill gaps in daily 1 km resolution MODIS LST observations (MOD11 and MYD11, AM and PM overpasses).

The resulting MODIS-AIRS daily LSTs were then aggregated into monthly means (i.e., MLSTs), which were used to calculate MAGTs for 2003-2016 via the four TTOP methods described in "Section 1.1 | Parameters".

MAGTs were then transformed into permafrost probability maps with a complementary error function that uses the RMSE, climatological standard deviation, and estimated subsurface lapse rates.

Figure 1 below shows the workflow used to estimate the final permafrost probability maps. For a complete description of how this data set was generated, see Kim et al., 2024.

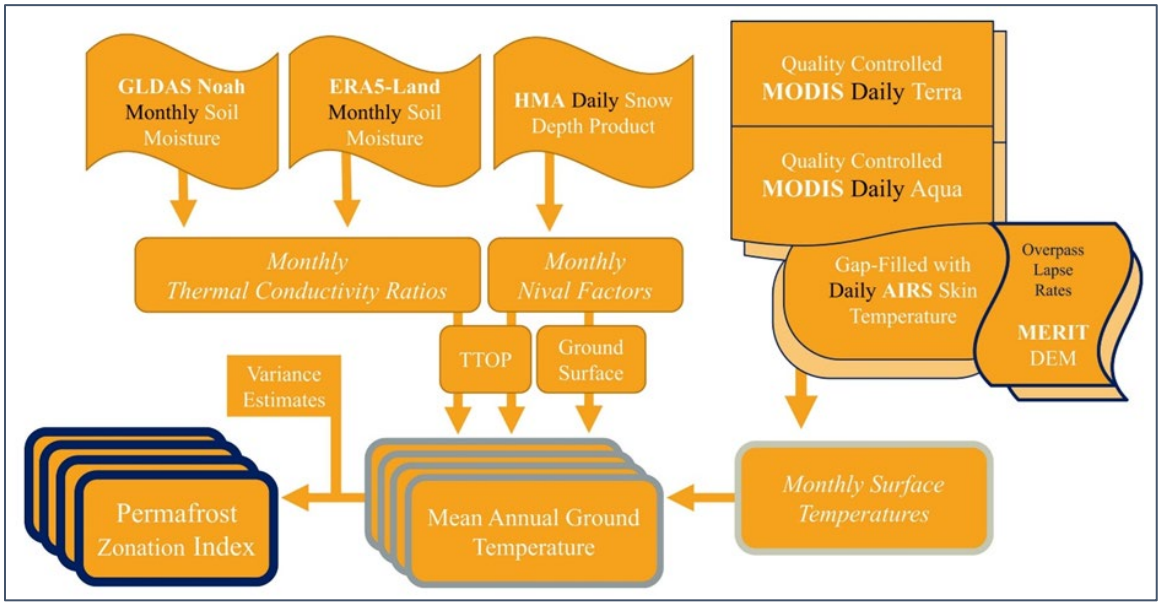

Figure 1. Workflow Used to Generate Final Permafrost Probability Maps (Kim et al., 2024)

3 VERSION HISTORY

Version 1 (initial release)

4 RELATED DATA SETS

- MODIS Land Surface Temperature and Emissivity (MOD11/MYD11)
- AIRS | Atmospheric Infrared Sounder
- High Mountain Asia UCLA Daily Snow Reanalysis, Version 1
- GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree V2.1
- ERA5-Land

5 RELATED WEBSITES

- High Mountain Asia (NSIDC)
- NASA's High Mountain Asia Team

6 REFERENCES

Kim, K. Y., Haagenson, R., Kansara, P., Rajaram, H., & Lakshmi, V. (2024). Augmenting daily MODIS LST with AIRS surface temperature retrievals to estimate ground temperature and permafrost extent in High Mountain Asia. In Remote Sensing of Environment (Vol. 305, p. 114075). Elsevier BV. https://doi.org/10.1016/j.rse.2024.114075

7 DOCUMENT INFORMATION

7.1 Publication Date

August 2024

7.2 Date Last Updated

August 2024