High Mountain Asia 1 km 6-hourly Downscaled Meteorological Data 2003 to 2018, Version 1

USER GUIDE

How to Cite These Data

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

Xue, Y., P. Houser, V. Maggioni, and Y. Mei. 2021. *High Mountain Asia 1 km 6-hourly Downscaled Meteorological Data 2003 to 2018, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/CRN0E7YPPFGY. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/HMA_DM_6H

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

This data set contains 0.01 degree (nominally 1km) 6-hourly downscaled European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric forcings and Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) precipitation from 2003 to 2018 across the High Mountain Asia region. Table 1 lists all available parameters.

1.2 File Information

1.2.1 Format

Data are provided in NetCDF-4 (.nc4). In addition, a single GeoTIFF (.tif) file is available for detailed coordinates and projection information.

1.2.2 File Contents

Table 1. File Content

Parameter	Description	Unit
crs	Coordinate Reference System definition	N/A
LRad	Downscaled ECMWF surface incident longwave radiation	W/m^2
P_CHP	Downscaled CHIRPS total precipitation	mm/h
P_ECMWF	Downscaled ECMWF total precipitation	mm/h
Pair	Downscaled ECMWF surface pressure	Pa
RHum	Downscaled ECMWF near-surface relative humidity	%
SHum	Downscaled ECMWF near-surface specific humidity	kg/kg
SRad	Downscaled ECMWF surface incident shortwave radiation	W/m^2
Tair	Downscaled ECMWF near-surface temperature	K
Tdew	Downscaled ECMWF near-surface dew point temperature	K
time	Hours since 2003-09-09, 00:00 UTC	h
Wspd	Downscaled ECMWF near-surface total wind speed	m/s
x	x coordinates in Asia Lambert Conformal Conic projections	m
y	y coordinates in Asia Lambert Conformal Conic projections	m

1.2.3 Naming Convention

Data files use the following naming convention which is described in Table 2:

`HMA_DM_6H_v01_[YYYYMMDD].nc4`

Table 2. File Naming Convention

Variable	Description
HMA_DM_6H	High Mountain Asia 1 km 6-hourly Downscaled Meteorological Data 2003 to 2018.
v01	Data set version.
[YYYYMMDD]	8-digit date including year, month and day of data.
.nc4	file extension

Example:

`HMA_DM_6H_v01_20030909.nc4`

In addition to the .nc4 data files a single GeoTiff file (`HMA_DM_6H_v01_DEMe_1km.tif`) containing detailed coordinates and projection information is available for download.

Each data file has a corresponding XML file that contains additional file level metadata. XML metadata files have the same name as their corresponding .nc4/.tif file, but with .xml appended.

1.3 Spatial Information

1.3.1 Coverage

Northernmost latitude: 48.5° N
Southernmost latitude 12.95° N
Easternmost longitude: 102.59° E
Westernmost longitude: 56.94° E

1.3.2 Resolution

0.01 degree

1.3.3 Geolocation

The following table provides information for geolocating this data set

Table 3. Geolocation Details

Geographic coordinate system	GCS_WGS_1984
Projected coordinate system	Asia_Lambert_Conformal_Conic
Projection units	meters
Datum	WGS_1984

Ellipsoid/spheroid	WGS_1984
1st standard parallel	30 N
2nd standard parallel	62 N
Central meridian	105 E
Latitude of true origin	0
False easting	0
False northing	0
Scale factor at longitude of true origin	N/A
Reference	https://epsg.io/102012

1.4 Temporal Information

1.4.1 Coverage

The model simulations start on 01 January 2003 and run through 31 December 2018.

1.4.2 Resolution

6-hourly

2 DATA ACQUISITION AND PROCESSING

2.1 Background

In the High Mountain Asia (HMA) region, complex topography leads to localized precipitation gradients. The most common sources of hydrological surface measurements – including rain gauge observations, ground-based weather radar networks, satellite observations, and numerical prediction models – are scarce or unreliable in the HMA region due to the complex topography. However, clarifying local-scale precipitation variability is crucial to understanding the hydrological cycle and land-atmosphere dynamics of the region. To create high resolution precipitation data sets necessary for modeling, downscaling methods are required. This data set provides downscaled six-hourly atmospheric forcings from ECMWF and CHIRPS precipitation from 2003 to 2018 at a spatial resolution of ~1km across HMA.

2.2 Acquisition

Meteorological fields from ECMWF (Molteni et al., 1996) and CHIRPS Version 2 (Funk et al., 2015) were used. Forcing fields from ECMWF include air temperature, specific humidity, downward longwave flux, downward shortwave flux, wind speed, and surface pressure. The ECMWF product is on a TL511 triangular-truncation, linear-reduced, gaussian grid (0.25°) at four synoptic timestamps: 00:00, 06:00, 12:00, and 18:00 UTC.

The CHIRPS precipitation product has a native spatial resolution of 0.05° at a daily timescale. Using physically-based and statistically-based algorithms, ECMWF and CHIRPS meteorological inputs were downscaled onto the 0.01° grid for model estimates.

2.3 Processing

A random forest (RF) classification and an RF regression make up the kernel of the precipitation downscaling framework. A procedure based on recursive feature elimination was used to determine an optimal number of predictors that balances model performance and computation cost. ECMWF meteorological forcings were spatially downscaled from their original resolutions of 0.25° onto the 0.01° model grid. The original 0.05°/daily CHIRPS precipitation was spatially and temporally downscaled to 0.01°/6-hours using weighting factors.

To avoid distortions of the rain effect that may arise with simple statistical interpolations in coarse resolutions, this downscaling framework generates 1 km binary precipitation masks and applies the mask to the 1 km precipitation fields. This allows for clearer inference of whether or not the pixels are rainy.

More details on the downscaling framework implemented by functions and codes can be found in Yiwen Mei's (i.e., HMA-1 member) Github repositories at https://github.com/YiwenMei/AtmDS and https://github.com/YiwenMei/PrecipDS. See Mei et al. (2020), Rouf et al. (2020), and Xue et al. (2021) for more information on the downscaling algorithms used for processing data.

2.4 Quality, Errors, and Limitations

The Normalized Mutual Information (NMI) value, which can be derived as a proxy for spatial similarity, was computed between before and after for each downscaled meteorological forcing field. The computed values range from 0.82 to 0.96, indicating strong similarities between the compared forcing fields. The evaluation of incident shortwave radiation produced the lowest NMI, which is likely attributable to multiple correction factors involved in the shortwave radiation downscaling procedure.

When compared to ground-based measurements, hyper-resolution modeling generally improves the skill in the meteorological forcing estimates (excluding precipitation) by 9% relative to coarse-resolution estimates. The downscaled precipitation estimate developed by the George Mason

University team improves the skill by 3% when compared to the 0.25° aggregated precipitation across the region's complex terrain.

For further information on the error assessments performed on this data set, please see Xue et al. (2021).

3 SOFTWARE AND TOOLS

The .nc4 data files can be opened using NetCDF-visualization software such as Panoply. The .tif data files can be opened with GIS software.

The following software was developed by scientists to produce High Mountain Asia products from satellite data or reanalysis (climate model) data. These software products are not designed for non-specialist users in general, but may be useful to other scientists, and may facilitate learning the details of the algorithms behind some of the High Mountain Asia data products.

Atmospheric variable downscaling framework
Author(s): Yiwen Mei
Reference(s)/documentation:
Mei et al. 2020 at https://doi.org/10.1002/essoar.10502607.1
Rouf et al. 2020 at https://doi.org/10.1175/JHM-D-19-0109.1

MODIS processing for emissivity, land cover type, normalized-difference snow index, other parameters
Author(s): Yiwen Mei

4 VERSION HISTORY

Table 4. Version History Summary

Version	Release Date	Description of Changes
V01	22 July 2021	Initial release

5 RELATED DATA SETS

High Mountain Asia at NSIDC | Data Sets

6 RELATED WEBSITES

High Mountain Asia at NSIDC | Overview
NASA High Mountain Asia Project
ECMWF

CHIRPS

7 CONTACTS AND ACKNOWLEDGMENTS

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8 REFERENCES

Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., et al. (2015). The climate hazards infrared precipitation with stations—A new environmental record for monitoring extremes. Scientific Data, 2, 150066. https://doi.org/10.1038/sdata.2015.66.

Mei, Y., Maggioni, V., Houser, P., Xue, Y., & Rouf, T. (2020). A nonparametric statistical technique for spatial downscaling of precipitation over High Mountain Asia. Water Resources Research, 56, e2020WR027472. https://doi.org/10.1029/2020WR027472.

Molteni, F., Buizza, R., Palmer, T. N., & Petroliagis, T. (1996). The ECMWF ensemble prediction system: Methodology and validation. Quarterly Journal of the Royal Meteorological Society, 122(529), 73–119. https://doi.org/10.1002/qj.49712252905.

Rouf, T., Mei, Y., Maggioni, V., Houser, P., & Noonan, M. (2020). A Physically Based Atmospheric Variables Downscaling Technique, Journal of Hydrometeorology, 21(1), 93-108. https://doi.org/10.1175/JHM-D-19-0109.1.

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9 DOCUMENT INFORMATION

9.1 Publication Date

22 July 2021

9.2 Date Last Updated

23 July 2021