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:


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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>crs</td>
<td>Coordinate Reference System definition</td>
<td>N/A</td>
</tr>
<tr>
<td>LRad</td>
<td>Downscaled ECMWF surface incident longwave radiation</td>
<td>W/m²</td>
</tr>
<tr>
<td>P_CHP</td>
<td>Downscaled CHIRPS total precipitation</td>
<td>mm/h</td>
</tr>
<tr>
<td>P_ECMWF</td>
<td>Downscaled ECMWF total precipitation</td>
<td>mm/h</td>
</tr>
<tr>
<td>Pair</td>
<td>Downscaled ECMWF surface pressure</td>
<td>Pa</td>
</tr>
<tr>
<td>RHum</td>
<td>Downscaled ECMWF near-surface relative humidity</td>
<td>%</td>
</tr>
<tr>
<td>SHum</td>
<td>Downscaled ECMWF near-surface specific humidity</td>
<td>kg/kg</td>
</tr>
<tr>
<td>SRad</td>
<td>Downscaled ECMWF surface incident shortwave radiation</td>
<td>W/m²</td>
</tr>
<tr>
<td>Tair</td>
<td>Downscaled ECMWF near-surface temperature</td>
<td>K</td>
</tr>
<tr>
<td>Tdew</td>
<td>Downscaled ECMWF near-surface dew point temperature</td>
<td>K</td>
</tr>
<tr>
<td>time</td>
<td>Hours since 2003-09-09, 00:00 UTC</td>
<td>h</td>
</tr>
<tr>
<td>Wspd</td>
<td>Downscaled ECMWF near-surface total wind speed</td>
<td>m/s</td>
</tr>
<tr>
<td>x</td>
<td>x coordinates in Asia Lambert Conformal Conic projections</td>
<td>m</td>
</tr>
<tr>
<td>y</td>
<td>y coordinates in Asia Lambert Conformal Conic projections</td>
<td>m</td>
</tr>
</tbody>
</table>

1.2.3 Naming Convention

Data files use the following naming convention which is described in Table 2:
Table 2. File Naming Convention

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

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

<table>
<thead>
<tr>
<th>Geographic coordinate system</th>
<th>GCS_WGS_1984</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected coordinate system</td>
<td>Asia_Lambert_Conformal_Conic</td>
</tr>
<tr>
<td>Projection units</td>
<td>meters</td>
</tr>
<tr>
<td>Datum</td>
<td>WGS_1984</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Version</th>
<th>Release Date</th>
<th>Description of Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>V01</td>
<td>22 July 2021</td>
<td>Initial release</td>
</tr>
</tbody>
</table>

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
7 CONTACTS AND ACKNOWLEDGMENTS

Yuan Xue, Paul Houser, and Viviana Maggioni
George Mason University

Yiwen Mei
University of Michigan

8 REFERENCES


9 DOCUMENT INFORMATION

9.1 Publication Date

22 July 2021

9.2 Date Last Updated

23 July 2021