High Mountain Asia PyGEM Glacier Projections with RCP Scenarios, Version 1

USER GUIDE

How to Cite These Data

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

Rounce, D. R., R. Hock, and D. Shean. 2020. *High Mountain Asia PyGEM Glacier Projections with RCP Scenarios, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/190Y84IGLIQH. [Date Accessed].

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

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

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1 DATA DESCRIPTION

Glaciers in High Mountain Asia are an important freshwater resource for large populations living downstream, so projections of glacier mass change and runoff have important socioeconomic impacts.

This data set contains results from the Python Glacier Evolution Model (PyGEM), including projections of glacier mass balance, glacier runoff, and various components associated with these parameters. Results from 22 general circulation models (GCMs) and up to 4 representative concentration pathways (RCPs) for each GCM are provided. An RCP is an emission scenario named after the approximate increase in radiative forcing relative to pre-industrial levels that is reached before (RCP 2.6, RCP 4.5), after (RCP 6.0), or near (RCP 8.5) the end of the 21st century. In total, 81 combinations of GCMs and RCPs were used. The data files include modeled projections for every glacier in High Mountain Asia between 2000 and 2100 at a monthly or annual temporal resolution, depending on the parameter.

1.1 Parameters

The main parameters are listed in Table 1; Table 2 provides details on the coordinates defining each parameter. The standard deviation of each parameter was also computed and can be found in the data files.

Table 1. Parameter Details

Parameter	Description	Units
glac_acc_monthly	Monthly glacier-wide accumulation (solid precipitation; as water equivalent)	m
glac_area_annual	Annual glacier area at the start of the mass balance year	km^2
glac_ELA_annual	Annual equilibrium line altitude above mean sea level	m
glac_frontalablation_monthly	Monthly glacier-wide frontal ablation (as water equivalent)	m
glac_massbaltotal_monthly	Monthly glacier-wide total mass balance (as water equivalent)	m
glac_melt_monthly	Monthly glacier-wide melt (as water equivalent)	m
glac_prec_monthly	Monthly glacier-wide precipitation (liquid)	m
glac_refreeze_monthly	Monthly glacier-wide refreeze (as water equivalent)	m
glac_runoff_monthly	Monthly glacier-wide runoff from a moving-gauge station located at the glacier's terminus	m^3
glac_snowline_monthly	Monthly transient snowline altitude above mean sea level	m

Parameter	Description	Units
glac_temp_monthly	Monthly glacier-wide mean air temperature	K
glac_volume_annual	Annual glacier volume at the start of the mass balance year	km^3 (of ice)
offglac_melt_monthly	Monthly off-glacier_wide melt (as water equivalent)	m
offglac_prec_monthly	Monthly off-glacier-wide precipitation (liquid)	m
offglac_refreeze_monthly	Monthly off-glacier-wide refreeze (as water equivalent)	m
offglac_runoff_monthly	Off-glacier runoff from the area the glacier used to cover after it has retreated	m^3
offglac_snowpack_monthly	Monthly off-glacier-wide snowpack; i.e., the snow remaining after accounting for new accumulation, melt, and refreeze (as water equivalent)	m
RGIID	Randolph Glacier Inventory ID	-

Table 2. Coordinate Details

Coordinate	Description	Units
area	Glacier area	km^2
CenLat	Center latitude	° N
CenLon	Center longitude	° E
glac	Glacier index	-
O1Region	Randolph Glacier Inventory order 1 region	-
O2Region	Randolph Glacier Inventory order 2 region	-
time	Time since 1999-10-01 at 00:00:00	Days
year	Year (referring to the start of each year)	-
year_plus1	Year plus one additional year	-

1.2 File Information

1.2.1 Format

The data files are provided in netCDF-4 (.nc) format.

1.2.2 Naming Convention

Example file names:

```
HMA_GL_RCP_R15_multigcm_rcp45_c2_ba1_100sets_2000_2100.nc
HMA_GL_RCP_R15_multigcm_rcp45_c2_ba1_100sets_2000_2100.nc.xml
```

The data files are named according to the following convention, which is described in Table 3:

```
HMA_GL_RCP_RXX_multigcm_rcpNN_c2_ba1_100sets_2000_2100.ext
```

Table 3. File Naming Convention

File Designator	Description
HMA_GL_RCP	Data set ID
RXX	Randolph Glacier Inventory order 1 region number (R13, R14, or R15)
multigcm	Denotes that multiple general circulation models (GCMs) were used
rcpNN	Representative concentration pathway (RCP) used in the simulation (rcp26, rcp45, rcp60, or rcp85)
c2	Calibration method used (calibration 2 denotes the Markov chain Monte Carlo methods)
ba1	Bias adjustment method used (bias adjustment 1 denotes the new methods developed in this study)
100sets	Number of Monte Carlo simulations from which the statistics are derived
2000_2100	Start and end years of the simulation
.ext	File extension: netCDF-4 data file (`.nc`) or XML metadata file (`.nc.xml`)

1.3 Spatial Information

1.3.1 Coverage

Spatial coverage includes all glaciers within 25° N to 45° N and 65° E to 105° E.

1.3.2 Resolution

N/A

1.3.3 Geolocation

The center longitude and center latitude are derived from the Randolph Glacier Inventory, which is calculated in cartesian coordinates on a cylindrical equal-area projection of the authalic sphere of the WGS84 ellipsoid, or, for nominal glaciers, accepted from the source inventory.

Table 4 provides geolocation information for this data set.

Table 4. Geolocation Details

Geographic coordinate system	WGS 84
EPSG code	4326
PROJ4 string	+proj=longlat +datum=WGS84 +no_defs
Reference	https://epsg.io/4326

1.4 Temporal Information

1.4.1 Coverage

The model simulations start on 01 October 2000 and run through 30 September 2100.

1.4.2 Resolution

The temporal resolution is monthly or annually, depending on the parameter.

1.5 Instrumentation

The model results are derived from the Python Glacier Evolution Model (PyGEM). PyGEM is an open-source glacier evolution model coded in Python that estimates the transient evolution of glaciers. The model uses an elevation-dependent temperature index model for ablation, a threshold temperature to distinguish between snow and rain for accumulation and mean annual air temperature for refreezing. The glacier geometry is updated annually using parameterized elevation change curves. For more information on PyGEM, see Rounce et al. (2020).

2 DATA ACQUISITION AND PROCESSING

2.1 Processing Steps

The model output files are generated from PyGEM, as described in detail in Rounce et al. (2020).

2.2 Quality, Errors, and Limitations

To validate the model output, the following data quality assessments were undertaken by the data providers:

- Monte Carlo simulations were used to quantify the uncertainty associated with the model parameters. The data files contain information regarding the mean and standard deviation associated with each variable.

- Data quality was checked within PyGEM to ensure that the glacier area and ice thickness were internally consistent (i.e., that they were both greater than 0).
- Bias-adjusted precipitation did not exceed 10 m for any given month, which could occur from issues with the bias adjustment procedure.
- Changes in glacier volume and runoff, aggregated to various regions or watersheds, were plotted and visually inspected to ensure results were reasonable.

3 SOFTWARE AND TOOLS

The data files can be opened using netCDF-visualization software such as Panoply.

4 RELATED DATA SETS

High Mountain Asia at NSIDC | Data Sets

5 RELATED WEBSITES

High Mountain Asia at NSIDC | Overview

NASA High Mountain Asia Project

NASA Research Announcement: Understanding Changes in High Mountain Asia

6 CONTACTS

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8 REFERENCES

Rounce, D. R., Hock, R., & Shean, D. E. (2020). Glacier Mass Change in High Mountain Asia Through 2100 Using the Open-Source Python Glacier Evolution Model (PyGEM). Frontiers in Earth Science, 7. https://doi.org/10.3389/feart.2019.00331

9 DOCUMENT INFORMATION

9.1 Publication Date

10 March 2020

9.2 Date Last Updated

13 April 2020