Contribution to High Asia Runoff from Ice and Snow (CHARIS) Melt Model Output, 2001 - 2014, Version 1

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Data Description

Summary

The Contributions to High Asia Runoff from Ice and Snow (CHARIS) project aimed to distinguish the specific contribution of seasonal-snow and glacier-ice melt in five major river basins of High Mountain Asia: Ganges, Brahmaputra, Indus, Amu Darya, and Syr Darya.

This data set contains input and output data for the temperature index (TI) melt model that was run for the CHARIS project at NSIDC. The model partitions contributions to stream flow from melt into volume coming from seasonal snow and volume coming from glacier ice. Input data consist of surface temperature along with the area of exposed glacier ice (EGI), snow on glacier ice (SOI), and snow on land (SOL). Output data are the volume of melt coming from each of those three surface types.

The model was run for 2001 through 2014 at a daily time step, for areas within 100-m elevation bands. Surface temperature came from downscaled reanalysis data. Daily maps of SOL, SOI, and EGI were generated from MODIS-derived remote sensing products. Model runs using these inputs to the model yielded melt water volumes contributing to river flow (Armstrong et al., 2018).

Table 1 lists the parameters for this data set. The first three are the output parameters from the model and the last four are the input parameters to the model.

Across High Mountain Asia, the amount, timing, and spatial patterns of snow and ice melt play key roles in providing water for downstream irrigation, hydropower generation, and general consumption. One of several CHARIS project goals was to use a simple TI model and readily available remote-sensing and reanalysis data to estimate the relative contributions of SOL, SOI, and EGI to river runoff over space and time. CHARIS was funded by the United States Agency for International Development (USAID). For more information and background on model details, please refer to Armstrong et al. (2018).

Parameters

Table 1. Parameter Descriptions

Parameter	Description
SOL melt	Volume of melt runoff (km^3) contributed by snow that is on land.
SOI melt	Volume of melt runoff (km^3) contributed by snow that is on ice.
EGI melt	Volume of melt runoff (km^3) that is contributed from exposed glacier ice.
SOL area	Area of snow on land (km^2)
SOI area	Area of snow on ice (km^2)
EGI area	Area of exposed glacier ice (km^2)
Temperature	Daily downscaled surface air temperature (°C), averaged over all grid cells in the given elevation band

File Information

Throughout this documentation, a 2-letter identifier is used for major basins as described in Table 2.

Table 2. Calibration Basin Abbreviation Descriptions

Basin Abbreviation	Basin Name
AM	Amu Darya
BR	Brahmaputra
GA	Ganges
IN	Indus
SY	Syr Darya

Format

The data files are in ASCII text (.txt) format. PNG (.png) browse images with graphs of the data and shapefiles (.shp) of the drainage outlines are also included.

File Contents

All the .txt files are formatted similarly, with standardized metadata data at the beginning of the file, followed by numerical data in a standard table. The .txt files use the following conventions:

1. Comments are any number of lines at the beginning of a file delimited by #.
2. Comments describe the contents and include relevant notes about inputs and units.
3. The first non-comment line is the number of elevation bands N.
    a. If N is 0 there will be no data in the file.
    b. If N is non-zero, the next line is the elevation in meters for each elevation band, designating the elevation of the bottom of the elevation band.
4. The remaining lines in a file have the white-space delimited form like the following:

    `yyyy mm dd doy {measurements at each of N elevation bands in km3}`

    where `yyyy` is the 4-digit year, `mm` is the 1- or 2-digit month, `dd` is the 1- or 2-digit day of month, `doy` is the 1-, 2-, or 3-digit day of year, then the measurements at the N bands begins.

    Note that the EGI/SOI/SOL files for a given basin and year will only include elevation bands where the respective area was non-zero. Data will only be saved for the set of elevation bands that have the specified type of area; so, in general, the lowest elevation band for EGI will likely be higher than the lowest elevation band for SOL.

The PNG figures are graphical representations of each of the four TI model inputs (temperature and area of EGI, SOI, and SOL). These are graphed by day and elevation band. PNGs of various inputs and outputs plotted by day or month and volume or area are also included.

The shapefiles contain polygons of the drainage basins to assist users in locating the drainages where modelling was performed.

Directory Structure

The data are organized into three main directories: `calibration_basins`, `snowy_basins`, and `partner_basins`. In each of the top three directories, there is a `shapefiles` sub-directory with ESRI-format drainage ID outline shapefiles.

All data files, browse images, and shapefiles can be found within their respective directories on HTTPS: https://noaadata.apps.nsidc.org/NOAA/G10027/ , or the entire contents of the data set can be access by downloading one zip file called `G10027.zip`., also located in that same HTTPS directory.

Description of calibration_basins Directory

This directory contains the data from the five calibration basins used to derive model parameters and calibrated Degree Day Factors (DDFs) as described in Armstrong et al. (2018). As noted in the publication, calibration data required for a calibration basin in the Brahmaputra basin was not available. Therefore, for calibration in the BR basin, calibrated DDFs from calibration basin `GA_SaptaKosi_at_Chatara` were used. Each of the five calibration basins have their own subdirectory underneath `calibration_basins` and are listed in Table 3 along with the major basin they calibrated.

Table 3. Calibration Basins Sub-Directory Names
(See Tables 2 and 4 for naming conventions)

Calibration Basin Drainage ID/Directory name	Major basin for which calibrated DDFs were used
AM_Vakhsh_at_Komsomolabad	AM
GA_SaptaKosi_at_Chatara	BR
GA_Karnali_at_Benighat	GA
IN_Hunza_at_DainyorBridge	IN
SY_Naryn_at_NarynTown	SY

The calibration basin outlines were arrived at by analyzing elevations above specific river drainage outlets or *pour points*. The naming convention for the Drainage IDs for the calibration basins is as follows and as described in Table 4:

`XX_River_at_PourPoint`

Table 4. Calibration Basin Drainage ID Naming Convention

Variable	Description
XX	2-letter major drainage identifier; see Table 2 for a list of these
River	Name of river at pour point
PourPoint	Name of pour point (river drainage outlet)

Description of snowy_basins Directory

Each major basin drainage was partitioned into a set of mutually disjoint subbasins. Of these, basins with no history of snow cover from MODIS (2001-2014) were discarded. This left the set of "snowy basins" on which model calculations were performed. Melt volume output from these basins was aggregated for major basin drainages and reported in Armstrong et al. (2018). The `snowy_basin` naming convention is as follows and as described in Table 5:

`XX_[v01]_OBJECTIDYYY`

Table 5. Snowy Basins Directory Naming Convention

Variable	Description
XX	2-letter major drainage identifier; see Table 2 for a list of these
V01	Version indicator, only used for GA, IN, and SY, after errors were identified in the original snowy basin sets for these major basins
OBJECTID	Fixed text string
YYY	1- to 3- decimal unique numerical ID to distinguish basins

Description of partner_basins Directory

In the final year of the project, the CHARIS team solicited locations from their partners where the CHARIS TI model could be run for the use of these partners in their ongoing studies. This directory contains model outputs for these partner basin requests. Most partner basins follow the `XX_River_at_PourPoint` naming convention (see Table 4), except for a set of small basins on DudhKosi river, which were derived from shapefile boundaries rather than pour points.

Directory Contents

In each of the three top directories, there is one directory per drainage ID (Table 4 and Table 5). For each year from 2001 to 2014, each drainage ID sub-directory contains the following files:

4 input .txt files (1 each for temperature, and area of EGI, SOI, and SOL):

- `drainageID.yyyy.0100m.ERA_Interim_downscale_uncorrected_tsurf.v0.3_by_elev.txt`
- `drainageID.yyyy.0100m.modicev04_2strike.GRSIZE_SCAG.fromFile.exposed_glacier_ice_area_by_elev.txt`
- `drainageID.yyyy.0100m.modicev04_2strike.GRSIZE_SCAG.fromFile.snow_on_ice_area_by_elev.txt`
- `drainageID.yyyy.0100m.modicev04_2strike.snow_on_land_area_by_elev.txt`

3 output .txt files (1 each for melt volume from EGI, SOI, SOL areas):

- `drainageID.yyyy.0100m.modicev04_2strike.GRSIZE_SCAG.fromFile.exposed_glacier_ice_melt_by_elev.best_*_SA_model.txt`
- `drainageID.yyyy.0100m.modicev04_2strike.GRSIZE_SCAG.fromFile.snow_on_ice_melt_by_elev.best_*_SA_model.txt`
- `drainageID.yyyy.0100m.modicev04_2strike.snow_on_land_melt_by_elev.best_*_SA_model.txt`

2 output .png figures:

- `drainageID.yyyy.0100m.modicev04_2strike.GRSIZE_SCAG.fromFile.best_*_SA_model.melt_hyps.png`
- `drainageID.yyyy.0100m.modicev04_2strike.GRSIZE_SCAG.fromFile.best_*_SA_model.melt_tseries.png`

Table 6. File Naming Convention

Variable	Description
drainageID	Unique ID for the drainage basin. See Table 4 and Table 5 a description of these IDs.
yyyy	4-digit year of the data.
0100m	Magnitude of elevation bands, in meters.
ERA_Interim_downscal_uncorrected_tsurf	These files used the ERA-Interim Reanalysis surface temperatures, downscaled to the 500-m MODIS grids and averaged over the elevation band at a daily resolution.
V0.3	Version of the temperature data used.
by_elev	Indicates that the data are stored over many elevation bands.
modicev04_2strike	Indicates that glacier areas were derived from MODICE v0.4 data. Glacier areas were arrived at following a similar method as in Painter et al. (2012), using slightly less conservative criteria. “2strike” references the name of the method used here.
GRSIZE_SCAG	Indicates that EGI and SOI were discriminated using a threshold on grain size output from MODSCAG (Painter et al., 2009).
fromFile	Grainsize threshold varied by day and was retrieved from a lookup table in an external file.
exposed_glacier_ice_melt_by_elev	Indicates that the file contains EGI melt data.
best_*_SA_model	Indicates which calibration parameters were used. "SA" refers to "simulated annealing." Please refer to Armstrong et al. (2018) for calibration details.
snow_on_ice_area_by_elev	Indicates that the file contains SOI area data.
snow_on_land_area_by_elev	Indicates that the file contains SOL area data.
melt_hyps	Indicates that the file contains a melt hypsometry (date stored by date and elevation band).
melt_tseries	Indicates that the file contains a melt time series.

Spatial Information

This data set covers High Mountain Asia river basins of the Ganges, Brahmaputra, Indus, Amu Darya, and Syr Darya. Figure 1 shows these regions and Figures 2-4 show the snowy basins within these five regions for which the melt model was run. A high-resolution version of Figure 1 can be found in the directory `calibration_basins\shapefiles` and high-resolution versions of Figures 2-4 can be found in the directory `snowy_basins\shapefiles`.

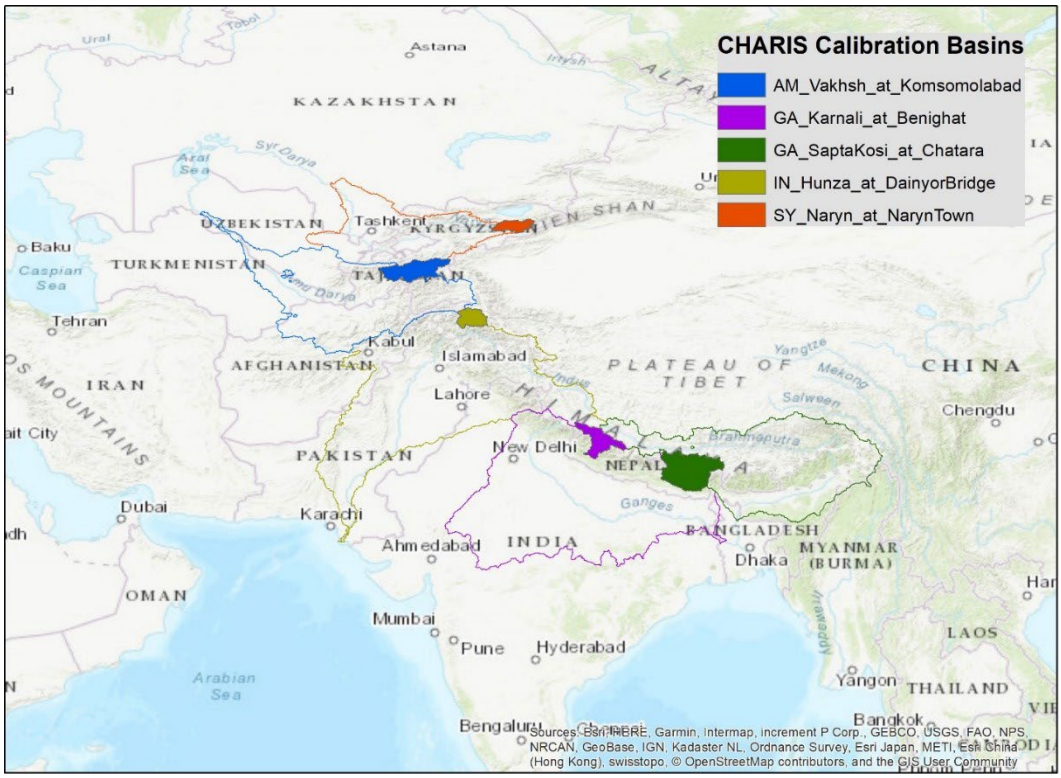

Figure 1. Calibration Basins with Outlines of the Major River Basins of High Mountain Asia

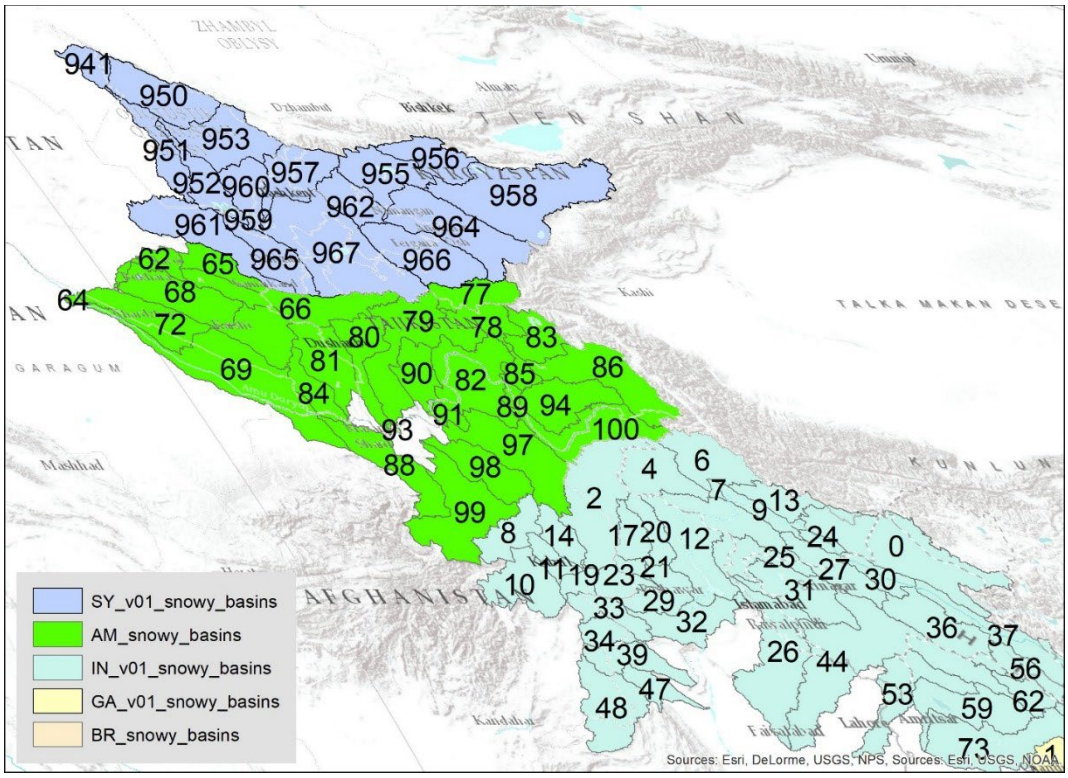

Figure 2. Snowy Basins of Syr Darya and Amu Darya

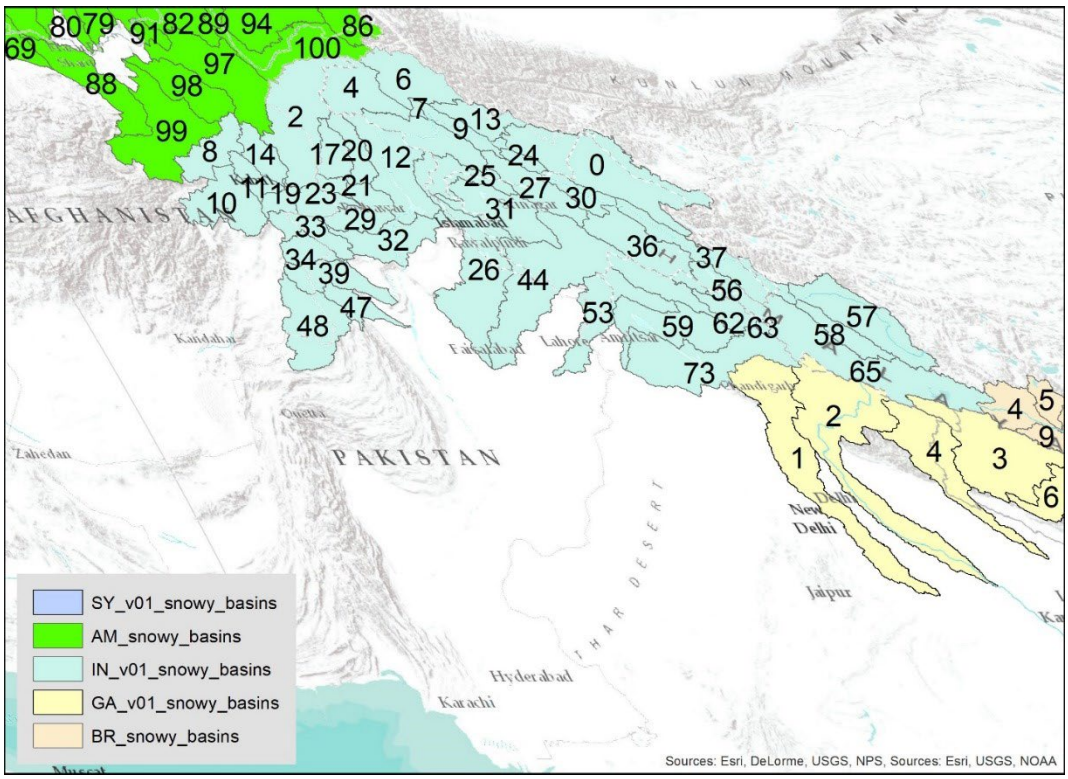

Figure 3. Snowy Basins of the Indus

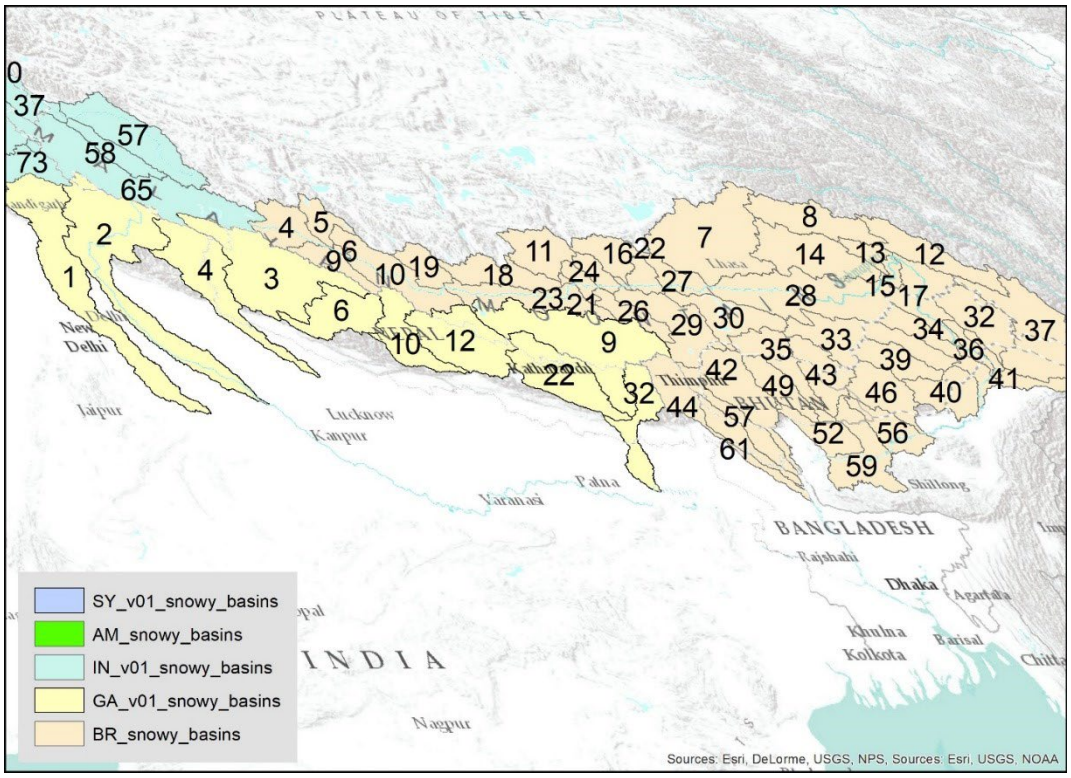

Figure 4. Snowy Basins of Ganges and Brahmaputra

Temporal Information

This data set covers 2001 to 2014 at a daily resolution.

Version History

Version	Date	Description
1	December 2019	Initial release of this data set.

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Document Information

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