Global Seasonal-Snow Classification, Version 1

USER GUIDE

How to Cite These Data

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

Liston, G. E. and M. Sturm. 2021. *Global Seasonal-Snow Classification, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/99FTCYYYLAQ0. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0768

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data set consists of global, seasonal snow classifications determined from air temperature, precipitation, and wind speed climatologies. The classifications represent a climatological average for the 39 year period from 1981–2019.

1.1 Parameters

Data are provided on WGS 84 latitude-longitude grids with snow classified as tundra, boreal forest, maritime, ephemeral (includes no snow), prairie, montane forest, or ice (glaciers and ice sheets).

1.2 File Information

1.2.1 File Contents

Data are available as a single file with global coverage or as separate files for North America and Eurasia.

1.2.2 Formats

Data are available as NetCDF, GeoTIFF, and ASCII text files at the following resolutions:

- 10 arcsec (~300 m)
- 30 arcsec (~1 km)
- 2.5 arcmin (~5 km)
- 0.5° (~50 km)

The following sections describe each of the file formats.

1.2.2.1 NetCDF (.nc)

NetCDF files contain an array of snow classes named “SnowClass” plus geolocation arrays “lat” and “lon” that specify the latitude and longitude at the center of each grid cell. Details about the WGS 84 coordinate reference system can be found in the metadata attached to the string variable named “crs.”

Values in the snow class array correspond to the following snow classes:

1 = Tundra
2 = Boreal Forest
3 = Maritime
4 = Ephemeral (includes no snow)
5 = Prairie

6 = Montane Forest
7 = Ice (glaciers and ice sheets)
8 = Ocean
9 = Fill

1.2.2.2 GeoTIFF

GeoTIFF files (.tif) consist of a raster data array that utilizes the same snow class values described in the preceding section.

1.2.2.3 ASCII

ASCII text files begin with a five-line header which lists the following information:

- ncols
- nrows
- xllcorner (decimal degrees)[1]
- yllcorner (decimal degrees)[1]
- cellsize (decimal degrees)

For example, the global ASCII data file at 0.50° resolution begins with the following header:

```
ncols         720
nrows         360
xllcorner     -180.000000000000
yllcorner     -90.000000000000
cellsize      0.500000000000
```

The data array begins on the line immediately following the header and utilizes the same snow class values described in “Section 1.2.2.1 | NetCDF (.nc).”

[1]xllcorner and yllcorner together specify the coordinates of the lower left corner of the lower left cell.

1.2.3 Naming Convention

Data files utilize the following naming convention:

Example:

SnowClass_EA_01km_30.0arcsec_2021_v01.nc

SnowClass_[location]_[approx res]_[exact res]_[year]_v[nn].[ext]

Table 1 describes the variables used in the file naming convention.

Table 1. File Naming Convention

Variable	Description
SnowClass	Global Seasonal-Snow Classification (NSIDC-0768) data file
location	Location: GL (global) NA (North America) EA (Eurasia)
approx res	Approximate resolution: 300m (300 m) 01km (1 km) 05km (5 km) 50km (50 km)
exact res	Exact resolution: 10.0arcsec (10.0″) 30.0arcsec (30.0″) 2.50arcmin (2.50′) 0.50degree (0.50°)
year	Year data were published
nn	Data version (v01)
ext	File extension: asc (ASCII) tif (GeoTIFF) nc (NetCDF)

1.3 Spatial Information

1.3.1 Coverage

Coverage is global.

1.3.2 Resolution

Data are available at four different spatial resolutions:

- 10 arcsec × 10 arcsec (~300 m)
- 30 arcsec × 30 arcsec (~1 km)
- 2.5 arcmin × 2.5 arcmin (~5 km)
- 0.5° (~50 km)

1.3.3 Geolocation

The following table provides information for geolocating this data set:

Table 2. Geolocation Details

Geographic coordinate system	WGS 84
Projected coordinate system	N/A
Longitude of true origin	Prime Meridian, Greenwich
Latitude of true origin	N/A
Scale factor at longitude of true origin	N/A
Datum	World Geodetic System 1984
Ellipsoid/spheroid	WGS 84
Units	degree
False easting	N/A
False northing	N/A
EPSG code	4326
PROJ4 string	+proj=longlat +datum=WGS84 +no_defs
Reference	http://epsg.io/4326

1.4 Temporal Information

1.4.1 Coverage

Each snow classification represents a climatological average for the 39 year period from 1981–2019.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Sturm et al. (1995)* measured snow covers across large regions of North America and Europe and defined corresponding seasonal snow classes that could be derived from global data sets of air temperature, precipitation, and land cover. At that time, the highest resolution global data sets for these variables were provided on 0.5° × 0.5° latitude-longitude grids (approximately 50 km).

To construct this data set, the data providers revisited and updated their 1995 methods to leverage the latest global data sets and meteorological modeling tools, resulting in a new snow classification system with substantially higher spatial resolution (Sturm and Liston 2021).

*The 1995 Sturm et al. snow classification data set is available from the Arctic Data Center.

2.2 Acquisition

The following data and tools were used to generate the snow classes in this data set:

- European Centre for Medium-Range Weather Forecasts (ECMWF) ReAnalysis, 5th Generation Land (ERA5-Land)
- 0.1° × 0.1° latitude-longitude (~10 km) gridded meteorological climatologies
- MicroMet (spatially distributed, high-resolution micro-meteorological model)
- European Space Agency (ESA) Climate Change Initiative (CCI) GlobCover land cover data
- Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010)

2.3 Processing

Like the 1995 classification system, this updated version utilizes air temperature, precipitation, and wind speed climatologies to drive the classification algorithm. However, in addition to higher resolution input data, the new algorithm incorporates a number of improvements, as summarized in the following paragraphs.

ⓘ Users interested in a more detailed description can consult "Section 2 | Snow classification update" of Sturm and Liston (2021).

The cooling degree month threshold used to delineate ephemeral snow from other seasonal snow classes was adjusted upward to address studies suggesting that the 1995 classification system underestimated the extent of ephemeral snow.

The threshold between high and low water-equivalent snowfall precipitation rates was changed to account for the higher resolution, input precipitation data.

The "Alpine" and "Taiga" classes from Sturm et al. (1995) are now called "Montane Forest" and "Boreal Forest." The reasons are detailed in "Section 4b | Snow classes based on physical properties" of Sturm and Liston (2021).

The updated classification system utilizes MicroMet, a quasi-physically based, high-resolution weather-data distribution model, to convert gridded, moderate-resolution, global air temperature and precipitation data into climatologies that were consistent with the resolution of the ESA CCI land cover data.

A new coastal mask encompassing all areas within ~500 km of a coastline has been added to prevent the algorithm from assigning the “Maritime” snow class to cells that lie outside the masked area.

2.4 Quality, Errors, and Limitations

The snow classifications in this data set represent the climatological average in a grid cell over a 39 year period. Interannual variability in response to variations in air temperature and precipitation can be large enough to modify a grid cell’s snow class in a given year.

In addition, a 39 year climatological record of land cover was not available at the required spatial resolution and, as such, snow classifications were derived using global 2018 land cover data. Because forests can evolve rapidly over time in response to e.g., insect disturbance and fire, the 2018 land cover data may register an area as nonforested when in fact it was forested for most of the 39-year period.

Lastly, because mountain snow covers can have high spatial variability, users may notice some oddities in the highest resolution map (i.e., ~300 m). For example, the data may not reflect the different snow conditions that commonly exist on the windward and lee sides of ridges above tree line, and some areas may be mapped as boreal or montane forest despite being predominantly grassland/meadow.

These snow distributions inherit any errors or biases that exist in the topography, land-cover, and meteorological forcing datasets that were used in the analysis.

For users interested in mountain snow covers, the “Discussion | Mountain Snow” section of Sturm and Liston (2021) lists coefficient of variation (CV) values for each snow class.

3 SOFTWARE AND TOOLS

NetCDF files can be accessed using freely available tools such as HDFView (the HDF Group) and Panoply (NASA Goddard Institute for Space Studies). GeoTIFF files can be viewed with a geographical information system such QGIS (Open Source) or Esri’s ArcGIS. ASCII text files can be accessed using spreadsheet software.

4 VERSION HISTORY

Version 1 (February 2022)

5 CONTACTS

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6 REFERENCES

Sturm, M., Holmgren, J., & Liston, G. E. (1995). A Seasonal Snow Cover Classification System for Local to Global Applications, *Journal of Climate*, *8*(5), 1261-1283. https://doi.org/10.1175/1520-0442(1995)008<1261:ASSCCS>2.0.CO;2

Sturm, M., & Liston, G. E. (2021). Revisiting the Global Seasonal Snow Classification: An Updated Dataset for Earth System Applications, *Journal of Hydrometeorology*, *22*(11), 2917-2938. https://doi.org/10.1175/JHM-D-21-0070.1

7 DOCUMENT INFORMATION

7.1 Publication Date

February 2022

7.2 Date Last Updated

February 2022