Daily Gridded North American Snow, Temperature, and Precipitation, 1959-2009

Mote, T. L., Estilow, T. W., Henderson, G. R., Leathers, D. J., Robinson, D. A., Suriano, Z. J. 2018. Daily Gridded North American Snow, Temperature, and Precipitation, 1959-2009, Version 1. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N5028PQ3.

Table of Contents

Data Description

Summary

This data set provides daily snow depth, snowfall, surface air temperature, and precipitation for North America on a 1-degree by 1-degree grid from 1959 to 2009. The data were obtained from U.S. National Weather Service Cooperative Observer Program (COOP) ground station network and daily surface observations from the Meteorological Service of Canada. The irregularly spaced ground station observations were interpolated to a 1-degree by 1-degree grid using Spheremap software from the University of Delaware.

Parameter

Table 1. Data Set Parameters

Parameter	Description
Snow Depth	Daily snow depth measured in meters.
Snowfall	Daily snowfall measured in meters (includes sleet). Hail occurring alone was not included with either snowfall or snow depth.
Temperature	Surface air temperature measured in °C. Both the maximum and minimum temperatures are presented for each day.
Precipitation	Daily precipitation measured in meters. Precipitation values are liquid equivalent of anything not defined as snowfall.

File Information

Format

All daily data from 01 September 1959 through 31 December 2009 are concatenated into one file in NetCDF format. The NetCDF file on FTP is tarred up in a single file with an MD5 checksum text file so users can verify that they have the complete NetCDF file.

Naming Convention

File Name: `G10021-noram-stp-1959-2009.v01r00.nc`

Where:

Table 2. File Naming Convention

File Name Variable	Description
G10021	Data set ID number.
noram	Identifies that this file covers North America.
stp	Identifies that this file contains snow, temperature, and precipitation data.
1959-2009	Identifies that this file contains data from 1959 through 2009.
V01r00	Identifies this as being version 1 revision 0.
.nc	Identifies this as a NetCDF file.

File Contents

The NetCDF file contains ten variables as described in Table 3.

Table 3. NetCDF File Variable Descriptions

NetCDF Variable	Description
latitude	Latitude of geographic grid cell center in degrees North.
longitude	Longitude of geographic grid cell center in degrees West.
precipitation	Interpolated daily precipitation in meters.
snow_depth	Interpolated daily snow depth in meters.
snow_depth_ds	Absolute value of percent change in the number of stations reporting between successive days stated as a fraction. For example, 0.8 = 80% and 1.0 = 100%.
snow_depth_qc	Snow depth quality flag with values of 0 or 1 (0 means it passed quality control; 1 means it was flagged by quality control because there was an unrealistic change in daily snow depth).
snowfall	Interpolated daily snowfall in meters.
temperature_max	Interpolated maximum daily surface air temperature in °C.
temperature_min	Interpolated minimum daily surface air temperature in °C.
time	Date of the measurement in days since 1959-08-31.

File Size

632 MB

Spatial Information

Spatial Coverage and Resolution

This data set covers the United States and Canada between 53.5° W to 166.5° W longitude and 25.5° N to 82.5° N latitude gridded at a 1-degree latitude by 1-degree longitude resolution to create a 114 x 58 grid for each day of data.

Geolocation

Grid Details

The coordinate reference system is the Geodetic CRS with an unspecified datum based upon the GRS 1980 Authalic Sphere. See Table 4 for specific details on this CRS.

Table 4. Projection and Grid Details

Grid Spacing	1-degree latitude by 1-degree longitude
Grid Size	114 x 58
Central Longitude (Meridian)	110° W
Central Latitude	54° N
Datum	Not specified (based on GRS 1980 Authalic Sphere)
Ellipsoid	GRS 1980 Authalic Sphere
Units	Degrees
EPSG Code	4047
PROJ4 String	+proj=longlat +a=6371007 +b=6371007 +no_defs

Temporal Coverage and Resolution

The data span 01 September 1959 to 31 December 2009 at a daily resolution.

Acquisition and Processing

Acquisition

The data were obtained from Daily Meteorological Data for U.S. Cooperative Stations from National Climatic Data Center (NCDC) TD3200 (NCDC 1981) and from daily observations from the Meteorological Service of Canada National Climate Data and Information Archive (Environment and Climate Change Canada 2012). Data were quality controlled using a modified version of the Robinson (1988) methodology. The data were interpolated to a regular grid using Spheremap software from the University of Delaware. Spheremap uses a modified version of Shepard's algorithm to interpolate irregularly spaced points onto a spherical lattice (Willmott et al., 1985). This data set is an update to the data set described by Dyer and Mote (2006) and Mote (2008).

Processing

The basic steps for processing these data are described below. Complete details on the creation of these data can be found in Kluver et al. (2016).

1. Obtain the ground station data from the Daily Meteorological Data for U.S. Cooperative Stations from NCDC TD3200 (NCDC 1981) ground station network and daily surface observations from the Meteorological Service of Canada (Environment and Climate Change Canada 2012).
2. Do quality control using modified version of the Robinson (1988) methodology.
3. Merge the U.S. and Canadian data.
4. Regrid the irregularly spaced ground station data to a 1-degree by 1-degree grid using Spheremap software from the University of Delaware (Willmott et al., 1985).
5. Set the two quality control flags. Create the snow depth quality control flags (snow_depth_qc) using a six-step process to compare values between adjacent days for each grid cell (Suriano 2017). The number of stations reporting within each grid cell was used to calculate the percent change in stations (snow_depth_ds) reporting day-to-day within each cell.
6. Write the resulting ASCII text files to NetCDF.

Quality, Errors, and Limitations

A comprehensive error and quality assessment was carried out on these data and described in Kluver et al. (2016). Although that publication covers a time period from 1900 to 2009, where this data set ranges from 1959 to 2009, Kluver et al. (2016) still provide applicable information on the quality of this data set. Data were quality controlled using a

modified version of the Robinson (1988) methodology. In the southeastern United States, reported errors are less than 0.01 cm. The Great Lakes region and the Intermountain West have higher values with reported errors ranging from 1.0–2.5 cm, with a few stations reporting errors on the order of 5.0 cm. On average, the error is approximately 0.5 cm of snowfall (Kluver et al. 2016).

Instrumentation

First order U.S. National Weather Service stations used a variety of equipment to measure temperature; liquid and glass thermometers until the 1960s, then a series of electronic thermistors leading up to Automated Surface Observing Systems (ASOS) units in the 1990s. Until the implementation of ASOS, various units were used to measure precipitation, including the 8-inch non-recording Standard Rain Gage (SRG).

Stations in the U.S. Cooperative Observer Program (COOP) measured temperature using liquid in glass until the 1980s, then electronically using Maximum/Minimum Temperature Systems (MMTS) units. Most COOP stations measure precipitation using the SRG, with some using electronic equipment such as the Fischer-Porter Recording Rain Gage (FPR). Snowfall and snow depth across both station networks are recorded using rulers and snowboards throughout the data record.

Environment Canada uses similar equipment at staffed and automated land-based sites to collect weather observations, including FPR units for precipitation measurement.

Software and Tools

There are a number of NetCDF file readers available to read/view NetCDF files. For a list of some of these tools, please see the NetCDF Resources at NSIDC: Software and Tools web page.

Version History

Table 5. Version History

Version	Description
V1.0	Initial release of data.

Related NSIDC Data Sets

- Snow Data Assimilation System (SNODAS)
- IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions
- Snowfall and Snow Depth for Canada 1943-1982
- Reconstructed North American Snow Extent, 1900-1993
- Reconstructed North American, Eurasian, and Northern Hemisphere Snow Cover Extent, 1915-1997

- Rand Corporation Mean Monthly Global Snow Depth

Related Websites

- Toward Improved Understanding of Extreme Snow Melt Runoff Events Under Past, Present, and Future Climate

Acknowledgments

Documentation, maintenance, and distribution of the data set is supported by NOAA@NSIDC with funding from NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) and the National Centers for Environmental Information.

References

Dyer, J., and T. L. Mote. 2006. Spatial variability and trends in observed snow depth over North America. *Geophys. Res. Lett.* 33(L16503). doi: http://dx.doi.org/10.1029/2006GL027258.

Environment and Climate Change Canada. 2012. National Climatic Data and Information Archive. Accessed 1 January 2012.

Kluver, D., T. L. Mote, D. Leathers, G. Henderson, W. Chan, and D. Robinson. 2016. Creation and validation of a comprehensive 1 degree by 1 degree gridded North American dataset: Snowfall. *J. Atmos. Oceanic Tech* 33: 857-871. doi: http://dx.doi.org/10.1175/JTECH-D-15-0027.1.

Mote, T. L. 2008. On the role of snow cover in depressing air temperature. *J. Appl. Meteor. Climatology* 47: 2008-2022. doi: http://dx.doi.org/10.1175/2007JAMC1823.1.

NCDC. 1981. Daily meteorological data for U.S. cooperative stations from NCDC TD3200. Research Data Archive at the National Center for Atmospheric Research Computational and Information Systems Laboratory, updated monthly, accessed 1 January 2012.

Robinson, D. A. 1988. Construction of a United States historical snow data base. *Proc. 45th Eastern Snow Conf.*, Lake Placid, NY, Eastern Snow Conference: 50–59. https://climate.rutgers.edu/stateclim_v1/robinson_pubs/refereed/Robinson_1988.pdf.

Suriano, Z. J. and D. J. Leathers. 2017. Spatio-temporal variability of Great Lakes basin snow cover ablation events. Hydrological Processes 31: 4229-4237. doi: http://dx.doi.org/10.1002/hyp.11364.

Willmott, C. J., C. M. Rowe, and W. D. Philpot. 1985. Small-scale climate maps: a sensitivity analysis of some common assumptions associated with grid-point interpolation and contouring. *Amer. Cartographer* 12: 5-16. doi: http://dx.doi.org/10.1559/152304085783914686.

Document Information

Author

This document was prepared by Ann Windnagel using text and correspondence from Thomas Estilow.

Publication Date

June 2018