Greenland Climate Network (GC-Net) Radiation for Arctic System Reanalysis, Version 1

USER GUIDE

How to Cite These Data

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

Kindig, David 2010. *Greenland Climate Network (GC-Net) Radiation for Arctic System Reanalysis, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/6S7UHUH2K5RI. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0437

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION

1.1 Format

The data are in Network Common Data Form (NetCDF) format. NetCDF is a set of software libraries and self-describing machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data. The NetCDF project homepage is hosted by the Unidata program at the University Corporation for Atmospheric Research (UCAR). The format is an open standard.

1.2 File and Directory Structure

Data are available on the FTP site in the following directory:

`ftp://sidads.colorado.edu/pub/DATASETS/GCNet/`

1.3 File Naming Convention

Files are named according to the following convention and as described in Table 1:

`gcnet_XXX.nc`

Where:

Table 1. File Naming Convention

Variable	Description
gcnet	Greenland Climate Network incoming short wave radiation measurements
XXX	GC-Net station names: CP1 DYE_2 GITS HUMBOLDT_GLACIER JAR1 JAR2 NASA_SE NASA_U NGRIP PETERMANN_GLACIER SADDLE SOUTH_DOME SUMMIT SWISS_CAMP

Variable	Description
nc	indicates data are NetCDF format

Example: gcnet_HUMBOLDT_GLACIER.nc (GC-Net incoming short wave radiation readings recorded at the Humboldt Glacier station, in NetCDF file format).

1.4 File Size

The files range in size from 508 KB to 1.3 MB, and total about 15 MB.

1.5 Volume

The entire data set is approximately 15 MB.

The total distribution volume for the data set is listed in Table 2.

Table 2. GC-Net Radiation for Arctic System Reanalysis File Volume

File Name	Volume
gcnet_CP1.nc	1.30 MB
gcnet_DYE_2.nc	1.20 MB
gcnet_GITS.nc	1.20 MB
gcnet_HUMBOLDT_GLACIER.nc	1.29 MB
gcnet_JAR1.nc	1.19 MB
gcnet_JAR2.nc	0.90 MB
gcnet_NASA_SE.nc	0.89 MB
gcnet_NASA_U.nc	1.30 MB
gcnet_NGRIP.nc	0.85 MB
gcnet_PETERMANN_GLACIER.nc	0.50 MB
gcnet_SADDLE.nc	1.10 MB
gcnet_SOUTH_DOME.nc	1.01 MB
gcnet_SUMMIT.nc	1.20 MB
gcnet_SWISS_CAMP.nc	1.17 MB

1.6 Spatial Coverage

Southernmost Latitude: 63.15° N
Northernmost Latitude: 80.75° N
Westernmost Longitude: 61.04° W
Easternmost Longitude: 42.50° W

1.6 Temporal Coverage

The data in this data set span from 01 January 1995 through 09 May 2008.

1.6.1 Temporal Resolution

Hourly average data are transmitted via satellite link using Geostationary Operational Environmental Satellite (GOES) or Argos data collection relay system (ARGOS) throughout the year.

1.7 Parameter or Variable

Solar Radiation (incoming shortwave radiation).

1.7.1 Parameter Description

Solar radiation is Surface Downwelling Shortwave Radiation (RSDS) measured in W/m2.

2 SOFTWARE AND TOOLS

2.1 Software and Tools

The files in this data set are NetCDF format. The NetCDF files can be viewed using ncdump or any other tool capable of reading NetCDF files. The ncdump tool generates an ASCII representation of a NetCDF file. For more on ncdump, see the ncdump manual on the UCAR Web site.

2.2 Quality Assessment

Because up to 20 percent of GC-Net data are not transmitted via the satellite uplink, interpolation techniques are used to optimize the data record. When AWS station maintenance is performed in the field, the continuous data stream, including data not transmitted, can be retrieved (Box and Steffen 2000).

Statistical procedures are applied to the GC-Net data in effort to check data quality. First, impossible values are rejected. Second, a gradient threshold compares a measurement with the next sequential hourly measurement. If the change is greater than a threshold, the later point is rejected. Third, a moving statistics window scans the time series to identify and reject data beyond a variance threshold for a given window size. In some cases, a spectrum of window sizes is employed to reject outliers due to occasional transmission errors. In general, the data that are identified as bad by these filters represent less than a few percent of the total data volume. Missing

data are interpolated linearly if there are data available within an autocorrelation threshold of the flagged value. If there is a gap of greater than the autocorrelation threshold, then no interpolation is performed (Box and Steffen 2000).

2.3 Quality Control

After obtaining the incoming short wave radiation data from the GC-Net, the data were quality controlled. The following steps describe the quality control method.

1. A uniform time vector was created from the beginning (T=0) and ending (T=t_last) times in the data set. The time vector uses a uniform time step, such as three minutes.
2. Measurements that failed the following criteria were flagged:
    a. Missing data: missing data were given the missing value by the original data provider.
    b. Negative values: though incoming Shortwave radiation (SW) may go slightly negative in certain instances over ice sheets due to issues with the pyranometers, this was not allowed, and all negative values were set to zero.
    c. Duplicate time steps: some of the data contained duplicate time steps. Whenever a duplicate time step was found, all data for that time were flagged as bad.
    d. Persistent values: Two separate tests were conducted to search for regions in the data where persistent values exist. Persistent values were indicators of stuck sensors or other flaws in data collection. The first test looked for a flat line in the data where greater than two consecutive data values were unchanged. The second test looked for occurrences where the slope in the data was constant for greater than five consecutive data values. Data that did not pass these two tests were flagged as bad.
3. Flagged data were removed. This step prepared the data for running spline to fill in the missing and removed time steps.
4. A spline was run on the remaining data comparing the time steps to the actual time remaining. This comparison put the data on a uniform time step. The IDL function, SPLINE, was used to perform a cubic spline interpolation with sigma set to the default value of 1.0.
5. The splined data were compared to a model of shortwave radiation appropriate for the latitude of the station. Data were removed if they exceeded Top of Atmospheric (TOA) radiation levels. Using the model involved choosing the value for atmospheric transmissivity, as described below.
    a. Data that exceed a modeled value with atmospheric transmissivity set to 1 were removed.
    b. A minimum value of atmospheric transmissivity was set at 0.6, but values for the GC-Net were on the order of 0.86. Each year of data were compared to find the highest value for which atmospheric transmissivity works.
    c. Data were compared to an ideal (such as the optimum for the location) atmospheric transmissivity plus 2 standard deviations of the atmospheric transmissivity value for each year.
    d. A smooth array of hourly values was created using the maximum from each day.
    e. A diffuse radiation adjustment was applied to the modeled value. The default is 50 W/m2. This value may be too high.

f. Data that exceed the modeled value were removed.

3 DATA ACQUISITION AND PROCESSING

3.1 Theory of Measurements

The GC-Net AWS capture a range of weather data important to ice sheet conditions, including air temperature, wind speed, relative humidity, pressure, wind direction, solar radiation, net radiation, snow temperature, and surface height change. The GC-Net Radiation for Arctic System Reanalysis data set consists of only one of these data types: solar radiation. The data, which were quality assessed during GC-Net processing, were further quality controlled subsequent to acquisition from GC-Net. Refer to Section 2.3 Quality Control.

3.2 Data Acquisition Methods

Solar radiation data were acquired via the GC-Net stations distributed over the Greenland ice sheet. Solar radiation was recorded with a pyranometer. The GC-Net AWS are equipped with communication satellite transmitters that enable near-real time monitoring of weather conditions on the Greenland ice sheet. Transmission latency is as short as four minutes, typically one to two hours, and occasionally as long as 48 hours (Box and Steffen 2000). Table 4 provides a listing of Station Identification (ID) Numbers, station names, station latitude and longitude coordinates, the date when the station became operational, and the station's Site ID. Note: This data set does not include measurements from stations shaded in gray in Table 3.

Table 3. GC-Net Stations (June 03, 2002)

ID #	Name	Latitude	Longitude	Elev.[m]	Start Date	Site ID
1	Swiss Camp	69.5732° N	49.2952° W	1149	1995.00	fn_dkswcamp
2	CP1	69.8819° N	46.9736° W	2022	1995.39	fn_dkandcp1
3	NASA-U	73.8333° N	49.4953° W	2368	1995.41	fn_dkdnasau
4	GITS	77.1433° N	61.0950° W	1887	1995.43	fn_dkndgits
5	Humboldt Gl.	78.5266° N	56.8305° W	1995	1995.47	fn_dkhumbdt
6	Summit	72.5794° N	38.5042° W	3208	1996.37	fn_dksummit
7	Tunu-N	78.0168° N	33.9939° W	2020	1996.38	fn_dkdtunun
8	DYE-2	66.4810° N	46.2800° W	2165	1996.40	fn_dkdye2
9	JAR1	69.4984° N	49.6816° W	962	1996.47	fn_dkjar1
10	Saddle	66.0006° N	44.5014° W	2559	1997.30	fn_dksaddle
11	South Dome	63.1489° N	44.8167° W	2922	1997.31	fn_dksdome
12	NASA-E	75.0000° N	29.9997° W	2631	1997.34	fn_dkdnasae

ID #	Name	Latitude	Longitude	Elev.[m]	Start Date	Site ID
13	CP2	69.9133° N	46.8547° W	1990	1997.36	fn_dkandcp2
14	NGRIP	75.0998° N	42.3326° W	2950	1997.52	fn_dkdngrip
15	NASA-SE	66.4797° N	42.5002° W	2579	1998.30	fn_dknasase
16	KAR	69.6995° N	32.9998° W	2400	1999.38	fn_dkandkar
17	JAR2	69.4200° N	50.0575° W	568	1999.41	fn_dkjar2
18	KULU	65.7584° N	39.6018° W	878	1999.46	fn_dkndkulu
19	JAR3	69.3954° N	50.3104° W	323	2000.41	fn_dkndjar3
20	Aurora	67.1352° N	47.2911° W	1798	2000.48	fn_dkaurora
22	Petermann Gl.	80.7500° N	54.0000° W	n/a	n/a	n/a

3.3 Error Sources

This section lists potential problems which may occur in GC-Net solar radiation measurements, as described in Box and Steffen 2000.

- When the sun is near the horizon, the values of upwelling solar radiation flux are occasionally larger than downwelling flux. This will not affect energy balance calculations much.
- During the polar day at midnight, the Automatic Weather Station (AWS) platform causes a shadow on the up-looking pyranometer and on the surface beneath the downward looking pyranometer. Radiometers are on an aluminum arm, which is directed due south. By having the measurement arm pointing south, direct solar beam shading is minimized, occurring at midnight when the sun is either below the horizon or when solar fluxes are the smallest for each day. Shading pollutes one or two hourly means near midnight.
- Reflections from the tower and solar panels can also lead to spurious measurements.
- Instrument level can drift through time, leading to errors.
- Frost can obscure the detectors, although due to the small size and thermal mass of our pyranometers, there are few cases where frost poses a problem.

3.4 Sensor or Instrument Description

The pyranometer contains a thermopile sensor with a black coating that absorbs solar radiation. The thermopile sensor generates a voltage output signal that is proportional to the solar radiation, measured in watts per square meter (W/m2). Refer to Table 4.

Table 4. Shortwave Radiation Parameter and Instrument

Parameter	Instrument	Instrument Accuracy	Sample Interval	No. per station
Shortwave radiation flux (W/m^2)	Li Cor Photodiode	5 - 15%	15 sec	1

4 REFERENCES AND RELATED PUBLICATIONS

Box, Jason E., and Konrad Steffen. 2000. Greenland Climate Network (GC-NET) Data Reference Version: November 19, 2000. University of Colorado, Boulder, http://cires.colorado.edu/science/groups/steffen/gcnet/Gc-net_documentation_Nov_10_2000.pdf, 893 KB.

Steffen Research Group, Greenland Climate Network (GC-Net), Cooperative Institute for Research in Environmental Sciences (CIRES), http://cires.colorado.edu/science/groups/steffen/gcnet/.

Table 5 lists related documents that are available on the NSIDC Web site.

Table 5. Related Documents

Document	Description	URL
NSIDC Education Center	Arctic Climatology and Meteorology: Solar Radiation	http://nsidc.org/arcticmet/factors/radiation.html
PARCA Data	Program for Arctic Regional Climate Assessment (PARCA)	http://nsidc.org/data/parca/

4.1 Related Data Collections

Automated Weather Station Data for Greenland Ice Core Locations

Barrow Alaska Climate Monitoring and Diagnostics: Meteorology and Radiation Data

North Pole Environmental Observatory (NPEO) Weather and Radiation Buoy Data

Arctic System Science (ARCSS) Atmospheric Radiation Data Sets

5 CONTACTS AND ACKNOWLEDGMENTS

David Kindig
National Snow and Ice Data Center
University of Colorado
Boulder, Colorado
USA

Acknowledgments:

This research was supported by the National Science Foundation Collaborative Research: IPY: Arctic System Reanalysis grant ARC 0732986.

Original data obtained for this data set were provided by the Greenland Climate Network (GC-Net) Project from Konrad Steffen, Cooperative Institute for Research in Environmental Sciences, University of Colorado; Jason E. Box, Atmospheric Sciences Program, Byrd Polar Research Center, The Ohio State University; and Waleed Abdalati, Cooperative Institute for Research in Environmental Sciences, University of Colorado.

6 DOCUMENT INFORMATION

6.1 Publication Date

December 2009

6.2 Date Last Updated

20 May 2021