

National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SET 9872 (DSI-9872)

**UNITED STATES SOLAR RADIATION BALANCE OBS
INTEGRATED SURFACE IRRADIANCE STUDY (ISIS) LEVEL 2**

April 8, 2003

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1. **Abstract:** The [Integrated Surface Irradiance Study](#) (ISIS) is a continuation of earlier NOAA surface-based solar monitoring programs, in the visible and ultra violet wavebands. ISIS provides basic surface radiation data with repeatability, consistency, and accuracy based on reference standards maintained at levels better than 1% to address questions of spatial distributions and time trends, at sites selected to be (1) regionally representative, (2) long-term continuous and (3) strategic foci for the research that is now needed.

The Air Resources Laboratory (ARL) operates the NOAA national broadband solar radiation network collecting data in both the visible and ultraviolet (UV-B) wavebands. ISIS operates at two levels: Level 1 monitors incoming radiation only, and Level 2 ([SURFRAD](#)) focuses on surface radiation balance. NCDC currently maintains data for the Level 2 set from 1995 and beyond.

Currently six SURFRAD stations are operating in climatologically diverse regions: Montana, Colorado, Illinois, Mississippi, Pennsylvania, and Nevada. Independent measures of upwelling and downwelling, solar and infrared are the primary measurements; ancillary observations include direct and diffuse solar, photosynthetically active radiation, UVB, spectral solar, and meteorological parameters.

Observations from SURFRAD have been used for evaluating satellite-based estimates of surface radiation, and for validating hydrologic, weather prediction, and climate models. Quality assurance built into the design and operation of the network, and good data quality control ensure that a continuous, high quality product is released.

2. **Element Names and Definitions:** - Solar radiation data are archived by station sort (WBAN number) then date.

A. RECORDS

There are two types of records in the database - header and data. Header records precede each station's monthly data. The header records contain information about the site (latitude, longitude, elevation, etc.) and the year and month of the data. The data records are hourly average values sorted by time. Data are archived on 3480 cartridges as described below:

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Record Length      : Fixed 100 characters
Blocked            : 15000 characters
Media              : ASCII 18-Track IBM-Type 3480 cartridge
Parity             : Odd
Label              : ANSI Standard Labeled
```

B. FORMAT

(1) The Header Record is a fixed 100 character string.

LABEL	FIELD	WIDTH	POSITION
WBAN	WBAN Number	5	1-5
YR	Year of reports	4	6-9
MN	Month of reports	2	10-11
ID	Station identifier	3	12-14
WMO	WMO number	5	15-19
LAT	Latitude	5	20-24
LATHEM	Latitude hemisphere	1	25-25
LONG	Longitude	6	26-31

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LONGHEM	Longitude hemisphere	1	32-32
ELEV	Elevation	5	33-37
TZSGN	Timezone Sign	1	38-38
TZ	Timezone	2	39-40
DV	Data version	1	41-41
RES	Reserved	55	42-96
SEQNUM	Sequence Number	4	97-100

Weather Bureau-Army-Navy Number (WBAN) - Site identification using WBAN. A unique five-digit number assigned to sites by NCDC.

Year (YR) - The year in which the data were observed. A four-digit number with values starting AT 1995.

Month (MN) - The month in which the data were observed. Range of values from 01 to 12.

Station identifier (ID) - Three letter FAA call sign of the site.

WMO number (WMO) - Five-digit World Meteorological Organization number.

Latitude (LAT) - The site's latitude in thousandths of degrees.

Latitude hemisphere (LATHEM) - The hemisphere of the latitude, either "N" or "S".

Longitude (LONG) - The site's longitude in thousandths of degrees.

Longitude hemisphere (LONGHEM) - The hemisphere of the longitude, either "E" or "W".

Elevation (ELEV) - Height of the site to the nearest tenth of a meter (MSL). A "-" in the left most position indicates site is below MSL.

Timezone sign (TZSGN) - Indicates whether to add or subtract the hour in the time zone field from UTC to determine the local standard time of the site. Value can be either "-" or "+".

Timezone (TZ) - The time zone correction in number of hours to Local Standard Time from Universal Time Coordinate (UTC).

Data version (DV) - Atmospheric Research Laboratory's processing version.

Reserved (RES) - Reserved blanks

Sequence Number (SEQNUM) - Sequence number is a 4-digit sort key. All header records have a sequence number of 0000.

FIELD	1	2	3	4	5	6
ELEMENT	WBAN NUMBER	YEAR	MONTH	SITE ID	WMO NUMBER	LAT

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#CHARAS	XXXXX	XXXX	XX	XXX	XXXXX	XXXXX
REC POS	1-5	6-9	10-11	12-14	15-19	20-24

FIELD	7	8	9	10	11	12
ELEMENT	LAT HEMIS	LONG	LONG HEMIS	ELEV	TIME SIGN	TIME ZONE
#CHARAS	X	XXXXXX	X	XXXXX	X	XX
REC POS	25-25	26-31	32-32	33-37	38-38	39-40

FIELD	13	14	15
ELEMENT	DATA VERSION	RESERVED	Sequence Number
RECORD POSITION	41	42-96	97-100

(2) The Data Records are a fixed length 100 character string. Fields are right justified and zero filled. Missing data is represented with all "9".

<u>LABEL</u>	<u>FIELD</u>	<u>WIDTH</u>	<u>POSITION</u>
WBAN	WBAN Number	5	1-5
YR	Year of report	4	6-9
MN	Month of report	2	10-11
DD	Day of Month of report	2	12-13
HR	Hour of report	2	14-15
GBL	Global irradiance	4	16-19
IfG	Global flag	2	20-21
NIP	Direct beam irradiance	4	22-25
IfN	Direct flag	2	26-27
Diff	Diffuse irradiance	4	28-31
IfD	Diffuse flag	2	32-33
UVB	UVB global irradiance	4	34-37
UPGBL	Upwelling global solar	4	38-41
IR	Downwelling thermal infrared	4	42-45
UPIR	Upwelling thermal infrared	4	46-49
PAR	Photosynthetically active rad	4	50-53
NETSOLAR	Net Solar (Global-UPGBL)	4	54-57
NETIR	Net infrared (IR-UPIR)	4	58-61
NET	Net radiation (NETSOLAR+NETIR)	4	62-65
TEMP	Temperature	5	66-70
RH	Relative Humidity	3	71-73
DIR	Wind Direction	3	74-76
SPD	Wind Speed	4	77-80
PRESS	Station Pressure	4	81-84
ZANGLE	Solar Zenith Angle	3	85-87
RES	Reserved	9	88-96
SEQNUM	Sequence Number	4	97-100

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Weather Bureau-Army-Navy Number (WBAN) - WBAN of the site. A unique five-digit number assigned to sites by NCDC.

Year (YR) - The year in which the data were observed. Range of values starting at 1994.

Month (MN) - The month in which the data were observed. Range of values is from 01 to 12.

Day of Month (DD) - The day of the month in which the data were observed. Range of values is from 01 to 31.

Hour (HR) - The hour in which the data were observed in Local Standard Time. Range of values is from 01 to 24.

Global irradiance (GBL) - Global horizontal irradiance measured using a precision spectral pyranometer. Unit is Watts per square meter (W/m^2) in whole values. Waveband ranges from 0.4 - 2.3 micrometers.

Global flag (IfG) - See "Data Quality"

Direct beam irradiance (NIP) - Direct beam irradiance measured using a precision pyr heliometer. Unit is Watts per square meter (W/m^2) in whole values. Waveband ranges from 0.4 - 2.3 micrometers. Instrument is mounted on a sun tracker.

Direct flag (IfN) - See "Data Quality"

Diffuse irradiance (Diff) - Diffuse irradiance measured using a precision spectral pyranometer. Unit is Watts per square meter (W/m^2) in whole values. Waveband ranges from 0.4 - 2.3 micrometers. Instrument is mounted under a shadowband.

Diffuse flag (IfD) - See "Data Quality"

UVB global irradiance (UVB) - Ultra Violet global irradiance measure using an Ultra Violet Biometer (Solar Light). Unit is milliWatts per square meter (mW/m^2) of erythema effective irradiance in whole values. Waveband ranges from 290-320 nanometers.

Upwelling Global Solar (UPGBL) - Global radiation measured using an Epply Precision Spectral Pyranometer mounted upside down ten meters above the surface on a meteorological tower. Unit is milliWatts per square meter (mW/m^2). Waveband ranges from 270 to 3000 nanometers.

Downwelling Thermal Infrared (IR) - Infrared radiation measured using an Epply Precision Infrared Radiometer mounted upright ten meters above the surface on a meteorological tower. Unit is milliWatts per square meter (mW/m^2). Waveband ranges from 3000 to 50,000 nanometers.

Upwelling Thermal Infrared (UPIR) - Infrared radiation measured using an Epply Precision Infrared Radiometer mounted upside-down ten meters above the surface on a meteorological tower. Unit is Watts per meter per meter (mW/m^2). Waveband ranges from 3000 to 50,000 nanometers.

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Photosynthetically active radiation (PAR) - The PAR sensor measures global solar radiation from 400 to 700 nm in Watts per square meter (mW/m^2), which approximates the spectral band active in photosynthesis.

Net Solar (NETSOLAR) - The difference between Global radiation and upwelling global radiation (Global-UPGBL) measured in Watts per square meter (W/m^2). If negative, left most position contains a "-" sign.

Net Infrared (NETIR) - The difference between downwelling infrared and upwelling infrared (IR-UPIR) measured in Watts per square meter (W/m^2). If negative, left most position contains a "-" sign.

Net Radiation (NET) - The total of Net Solar and Net Infrared (NETSOLAR+NETIR) radiation measured in Watts per square meter (W/m^2).

Temperature (TEMP) - The air temperature 10-meters above the surface in degrees and tenths Celsius. If negative, left most position contains a "-" sign.

Relative Humidity (RH) - The relative humidity to the nearest whole percent.

Wind Direction (DIR) - Direction of the wind in whole degrees. Range of values is 000-360.

Wind Speed (SPD) - Speed of the wind in meters per second to the nearest tenth.

Pressure (PRESS) - Atmospheric pressure in whole millibars.

Solar Zenith Angle (ZANGLE) - The Solar Zenith Angle is the angle in degrees between the sun and the perpendicular to the earth's surface. At sunrise it is 90 degrees, at noon it is a function of latitude, and at sunset it is again 90 degrees. Below the horizon value is 100. Values are to the nearest tenth of degree.

Reserved (RES) - Reserved.

Sequence Number (SEQNUM) - Sequence number is a 4-digit sort key. The header record in every file has a sequence number of 0000. The first data record has a SEQNUM of 0001 and the SEQNUM increases by one for each successful data record.

FIELD	1	2	3	4	5	6
ELEMENT	WBAN NUMBER	YEAR	MONTH	DAY	HOUR	GLOBAL IRRAD
#CHARAS	XXXXXX	XXXX	XX	XX	XX	XXXX
REC POS	1-5	6-9	10-11	12-13	14-15	16-19

FIELD	7	8	9	10	11	12
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ELEMENT	GLOBAL FLAG	DIRECT IRRAD	DIRECT FLAG	DIFFUSE IRRAD	DIFFUSE FLAG	UVB GBL IRRAD
#CHARAS	XX	XXXX	XX	XXXX	XX	XXXX
REC POS	20-21	22-25	26-27	28-31	32-33	34-37

FIELD	13	14	15	16	17	18
ELEMENT	UPWELL GLOBAL	DOWNWELL IR	UPWELL IR	PAR	NET SOLAR	NET IR
#CHARAS	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
REC POS	38-41	42-45	46-49	50-53	54-57	58-61

FIELD	19	20	21	22	23	24
ELEMENT	NET RAD	TEMP	REL HUM	WIND DIR	WIND SPEED	STATION PRESS
#CHARAS	XXXX	XXXXX	XXX	XXX	XXXX	XXXX
REC POS	62-65	66-70	71-73	74-76	77-80	81-84

FIELD	25	26	27
ELEMENT	SOLAR Z ANGLE	RESERVED	SEQ NUMBER
#CHARAS	XXX	X.....X	XXXX
REC POS	85-87	88-96	97-100

C. INSTRUMENTS AND MEASUREMENTS REPORTED

Instrument	Measurement	Waveband	Units	Accuracy Uncrtnty	Comments
Precision spectral pyranometer	Global horizontal irradiance	0.4 - 2.3 micrometer	W/m ²	< 5%	Usually < 3%
Precision pyrhelimeter (Eppley)	Normal incident irradiance	0.4 - 2.3 micrometer	W/m ²	< 2%	Mounted on sun tracker
Precision spectral pyranometer	Diffuse horizontal irradiance	0.4 - 2.3 micrometer	W/m ²	< 5%	mounted under shadowband
Ultra Violet Biometer (Solar Light)	UVB Global irradiance	290-320 nanometer	mW/m ²	< 5%	erythema effective radiation
Pyranometer (LicOR)	Global horizontal	0.4-1.1 micrometer	W/m ²	< = 5%	silicon solid

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	irradiance				state detector
Photosynthetic active radiation (LiCOR)	Global horizontal irradiance	0.4-0.7 micrometer , RSR .2RPM	micro-Einstein /s/m ²	< = 5%	under rotating shadowband
Pyranometer (LiCOR)	Global horizontal irradiance	0.4-1.1 micrometer	W/m ²	< = 5%	under rotating shadowband
REDS Q*7.1 net radiometer	Net allwave radiation	0.25-60.0 micrometer	W/m ²	< = 5%	measured at 33m at ORT

C. Sort - 15 minute solar radiation records are sorted by station sort (WBAN number) and date.

3. **Start Date:** 19950199

4. **Stop Date:** Ongoing.

5. **Coverage:** Continental United States

- a. Southernmost Latitude: 18N
- b. Northernmost Latitude: 65N
- c. Westernmost Longitude: 160W
- d. Easternmost Longitude: 65W

6. **How to Order Data:**

Ask NCDC's Climate Services about the cost of obtaining this data set.
 Phone: 828-271-4800
 FAX: 828-271-4876
 E-mail: NCDC.Orders@noaa.gov

7. **Archiving Data Center:**

National Climatic Data Center
 Federal Building
 151 Patton Avenue
 Asheville, NC 28801-5001
 Phone: (828) 271-4800.

8. **Technical Contact:**

National Climatic Data Center
 Federal Building
 151 Patton Avenue
 Asheville, NC 28801-5001
 Phone: (828) 271-4800.

9. **Known Uncorrected Problems:** None.

10. **Quality Statement:** At NOAA's Atmospheric Research Laboratory in Oak Ridge, Tennessee, the data processes through a quality control procedure and daily plotting of time series. The passed 15-minute mean values are also

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tested against the Solar Energy Research Institute (SERI, but now National Renewable Energy Laboratory) Quality Control (SERI QC) software. The SERI QC generates flags for global, normal incident, and diffuse global radiation. This quality control primarily flags data that departs from expected limits and boundaries. Flagging convention follows:

<u>Flag</u>	<u>Description</u>
00	Untested (raw data)
01	Passed one-component test; data fall within max-min limits of K_t , K_n , or K_d
02	Passed two-component test; data fall within 0.03 of the Gompertz boundaries
03	Passed three-component test; data come within ± 0.03 of satisfying $K_t = K_n + K_d$
04	Passed visual inspection: not used by SERI_QC1
05	Failed visual inspection: not used by SERI_QC1
06	Value estimated; passes all pertinent SERI_QC tests
07	Failed one-component test; lower than allowed minimum
08	Failed one-component test; higher than allowed maximum
09	Passed three-component test but failed two-component test by 0.05
10-93	Failed two- or three- component tests in one of four ways.

To determine the test failed and the manner of failure (high or low), examine the remainder of the calculation $(\text{flag}+2)/4$.

<u>Rem</u>	<u>Failure</u>
0	Parameter too low by three-component test ($K_t = K_n + K_d$)
1	Parameter too high by three component test ($K_t = K_n + K_d$)
2	Parameter too low by two-component test (Gompertz boundary)
3	Parameter too high by two-component test (Gompertz boundary)

The magnitude of the test failure (distance in K-units) us determined from: $d = (\text{INT}(\text{flag} + 2)/4)100$.

<u>Flag</u>	<u>Description</u>
94-97	Data fails into physically impossible region where $K_n > K_t$ by K-space distances of 0.05 to 0.10 (94), 0.10 to 0.15 (95), 0.15 to 0.20 (96), and ≥ 0.20 (97).
98	Not used
99	Missing data

11. **Essential Companion Datasets:** None.

12. **References:**

National Solar Radiation Database (1961-1990), User's Manual, National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden CO 80401.

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