Under Development: 31 July 2013 (WFD)

DAILY TOTAL SOLAR IRRADIANCE

Total solar irradiance describes the radiant energy emitted by the sun over all wavelengths that falls each second on 1 square meter outside the earth's atmosphere--a quantity proportional to the "solar constant" observed earlier in this century. It measures the solar energy flux in Watts/square meter. This disk contains six sets of original satellite observations: values from NIMBUS-7, from the Solar Maximum Mission (SMM) spacecraft, from the Earth Radiation Budget Satellite (ERBS), from the NOAA-9 and 10 platforms, and from the Upper Atmospheric Research Satellite (UARS).

Measurements span the periods:

NIMBUS-7	16 Nov 78-13 Dec 93;	SMM	16 Feb 80-01 Jun 89;
ERBS	25 Oct 84-28 Jun 00;	NOAA-9	23 Jan 85-20 Dec 89;
NOAA-10	22 Oct 86-01 Apr 87;	UARS	4 Oct 91-31 Dec 97.

Files:

READ.ME This file.

*.YY These files contain a table of daily values in Watts/sq meter for year indicated (YY) for each satellite.

*.PLT Files contain data in a form suitable for plotting. See each file's format information.

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Data format for the UARS97.PLT.

COL	FMT	DESCRIPTION
1- 4	I4	Year
5- 6	I2	Month
7- 8	I2	Day
9	1X	Blank
10-17	F8.3	Total Solar Irradiance (TSI) is reported on 'ACRIM II native scale' defined by operation of sensor 'B', the full-time monitoring sensor. Results are reconciled to a heliocentric rest frame at 1 A.U. and are fully corrected for sensor degradation.
18	1X	Blank
19-23	F5.3	Standard error of the daily means (W/M*2)
24	1X	Blank
25-32	F8.3	Acrim II data normalized to Acrim I UARS/ACRIMII results reported on scale defined by operation of SMM/ACRIMI instrumentation. Preliminary scaling factor is based on overlapping comparisons between the Nimbus7/ERB and both ACRIM experiments. The scale factor of 1.001689 is uncertain by less than 20 ppm of the total flux.

NOTE: The 1991 - 1997 UARS/ACRIM II database has been updated to make a small correction in the time base for 1996. It includes TSI reported on both the 'native scale' of the ACRIM II sensor and in terms of the

SMM/ACRIM I scale, as rekonned by mutual intercomparisons using the Nimbus7/ERB results. The ratio of ACRIM I/ACRIM II (native scale) is 1.001689.

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Total Solar Irradiance Results (TSI) from the Upper Atmosphere Research Satellite (UARS) Active Cavity Radiometer Irradiance Monitor II Experiment (ACRIM II)

The second Active Cavity Radiometer Irradiance Monitor experiment (ACRIM II)was launched in September 1991 as part of the science payload of the Upper Atmosphere Research Satellite (UARS). The variations on solar rotational and active region time scales are clearly seen. The large, short-term decreases are caused by the TSI blocking effect of sunspots in magnetically active regions as they rotate through our view from Earth. The peaks of TSI preceding and following these sunspot 'dips' are caused by the faculae of solar active regions whose larger areal extent causes them to be seen first as the region rotates onto our side of the sun and last as they rotate over the opposite solar limb. The downward trend through the 1991-1997 period is similar in slope and amplitude to that observed by ACRIM I during the declining activity phase of solar cycle 21. From the peak of solar cycle 21 to its minimum the TSI decreased by about 0.08 %. It appears likely from the ACRIM II results thus far that the cycle 22-23 minimum in TSI will occur during 1997, near the average solar cycle period of about 11 years after the cycle 21-22 minimum, and with a similar decrease relative to the maximum of cycle 22 in the 1990-1991 period.

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EARTH RADIATION BUDGET SATELLITE (ERBS) TOTAL SOLAR IRRADIANCE MEASUREMENTS

OCTOBER 1984 THROUGH JUNE 2000

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From 1984 to the present, total solar irradiance (TSI) values were obtained from the solar monitor on the Earth Radiation Budget Satellite (ERBS) nonscanner instrument. The ERBS solar monitor is an active cavity radiometer similar in design to the Active Cavity Radiometer Irradiance Monitors (ACRIM) which have flown on the NASA Solar Maximum Mission (SMM), Upper Atmosphere Research Satellite (UARS), and Atmospheric Laboratory for Applications and Science (ATLAS) spacecraft missions. The ERBS satellite was placed into orbit on October 5, 1984 and the solar monitor is still operating properly, after almost 15 years. The measurement precision is approximately 0.01 percent while the accuracy is 0.2 percent. The ERBS data reduction model is described in considerable detail in Reference 1. In Reference 2, analyses of the ERBS time series were presented as well as comparisons of the ERBS time series with those

of the ACRIM Solar Maximum Mission (SMM) and Nimbus 7 Earth Radiation Budget (ERB) Channel 10c pyrheliometers. Recently, Lee et al. (1999) and Lee et al. (2000) present analyses of the enclosed 1984-2000 ERBS TSI values, and comparisons among the ERBS values and those values from the Upper Atmosphere Research Satellite (UARS), Solar and Heliospheric Observatory (SOHO)/Variability of solar IRradiance and Gravity Oscillations (VIRGO), and Space Shuttle Atmospheric Laboratory for Applications and Science (ATLAS) Solar Constant (SOLCON) Spacecraft missions.

Format for ERBS.PLT

COL	FMT	DESCRIPTION
1- 4	I4	Year Calibration date - year/month/day
5	1X	Blank
6- 7	I2	Month
8	1X	Blank
9-10	I2	Day
11	1X	Blank
12-13	I2	Hour Measurement time(universal) - hour:min:sec
14	A1	:
15-16	I2	Minute
17	A1	:
18-19	I2	Second
20	1X	Blank
21-26	F6.1	Total solar irradiance (W/M*2) at 1 AU Corrected for Off-axis viewing and normalized to Astronomical Almanac Earth-Sun Distance tables
27	1X	Blank
28-30	F3.1	Standard Deviation of averaged samples (Watts/meters squared). 0.0 indicates 1 sample or very close instantaneous samples

References

[1] R.B. Lee, B. R. Barkstrom, and R. D. Cess, "Characteristics of the Earth Radiation Budget Experiment Solar Monitors", Appl. Optics, 26 (15) 3090-3096 1987.

[2] R.B. Lee III, M. A. Gibson, N. Shivakumar, R. S. Wilson, H L. Kyle, and A. T. Mecherikunnel, "Solar Irradiance Measurement: Minimum Through Maximum Solar Activity", Metrologia, Vol. 28, pp. 265-268, 1991.

[3] R.B. Lee III, B. R. Barkstrom, M. R. Luther, R.D. Cess, Solar Irradiance Measurements Using the Earth Radiation Budget Experiment Solar Monitors, Proceedings of the Sixth Conference on Atmospheric Radiation, American Meteorological Society, pp. J5-J8, 1986.

[4] R.B. Lee III, M. A. Gibson, R. S. Wilson, S. Thomas, "Long-term Total Solar Irradiance Variability During Sunspot Cycle 22", Journal of Geophysical Research, Vol. 100, No. A2, pp. 1667-1675, February 1, 1995.

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Format for NOAA09.PLT, AND NOAA10.PLT

COL	FMT	DESCRIPTION
1- 4	I4	Year
5	1X	Blank
6- 7	I2	Month
8	1X	Blank
9-10	I2	Day
11	1X	Blank
12-17	F6.1	Total solar irradiance (W/M*2)

Format for NIMBUS.PLT

COL	FMT	DESCRIPTION
1- 4	I4	Year
5	1X	Blank
6- 7	I2	Month
8	1X	Blank
9-10	I2	Day
11	1X	Blank
12-14	I3	Julian day
15-17	I3	Number of orbits with good data for the day
18-25	F8.2	Total solar irradiance (W/M*2)
26-30	F5.2	Standard deviation of the mean solar irradiance

In contrast to previous data releases, data for missing days are not filled, but rather omitted. Missing days are identified in the plot file and tables. Also, starting in 1990, a daily cycle appeared in the solar irradiances from unknown causes. This problem was corrected by excluding measurements from 0100-0600 UT in calculating the daily means from 1 Jan 90 to the end of the experiment. Daily averages are cosine-corrected for any off-axis positioning of the Sun in the telescope aperture. There will be no more total solar irradiance measurements made by NIMBUS-7.

In 1992 there are 2 data gaps: the first due to instrument problems (days 15-24) and the second (days 170-246) caused by the instrument not acquiring the Sun. Daily averages formed with 3 or less observations should be considered less reliable than other days; the user may wish to omit them or replace them with interpolated data.

The paper "The Nimbus-7 Solar Total Irradiance: A new Algorithm for its Deviation" by D.V. Hoyt, H.L. Kyle, J.R. Hickey, and R.H. Maschhoff (J.G.R., vol 97, pp.51-63) describes the methodology used to describe the data.

Format for SSM.PLT

COL	FMT	DESCRIPTION

1- 4	I4	Year
5	1X	Blank
6- 7	I2	Month
8	1X	Blank
9-10	I2	Day
11	1X	Blank
12-19	F8.3	Daily mean solar radiance (W/M*2)
20-25	F6.2	Standard deviation of the mean solar irradiance

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EARTH RADIATION BUDGET SATELLITE (ERBS) TOTAL SOLAR IRRADIANCE MEASUREMENTS

OCTOBER 1984 THROUGH JUNE 2000

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From 1984 to the present, total solar irradiance (TSI) values were obtained from the solar monitor on the Earth Radiation Budget Satellite (ERBS) nonscanner instrument. The ERBS solar monitor is an active cavity radiometer similar in design to the Active Cavity Radiometer Irradiance Monitors (ACRIM) which have flown on the NASA Solar Maximum Mission (SMM), Upper Atmosphere Research Satellite (UARS), and Atmospheric Laboratory for Applications and Science (ATLAS) spacecraft missions. The ERBS satellite was placed into orbit on October 5, 1984 and the solar monitor is still operating properly, after almost 15 years. In Figure 1 and in Table 1, the ERBS solar monitor time series covers the period from October 25, 1984 through June 28, 2000. The measurement precision is approximately 0.01 percent while the accuracy is 0.2 percent. The ERBS data reduction model is described in considerable detail in Reference 1. In Reference 2, analyses of the ERBS time series were presented as well as comparisons of the ERBS time series with those of the ACRIM Solar Maximum Mission (SMM) and Nimbus 7 Earth Radiation Budget (ERB) Channel 10c pyrheliometers. Recently, Lee et al. (1999) and Lee et al. (2000) present analyses of the enclosed 1984-2000 ERBS TSI values, and comparisons among the ERBS values and those values from the Upper Atmosphere Research Satellite (UARS), Solar and Heliospheric Observatory (SOHO)/Variability of solar IRradiance and Gravity Oscillations (VIRGO), and Space Shuttle Atmospheric Laboratory for Applications and Science (ATLAS) Solar Constant (SOLCON) Spacecraft missions.

In the attached Table 1, the format for the total solar irradiance (TSI) values is:

Column 1: Calibration date - year/month/day

Column 2: Measurement time (universal) - hour:min:sec
Column 3: Total Solar Irradiance (Watts/meters squared) at 1 AU Corrected for Off-axis viewing and normalized to Astronomical Almanac Earth-Sun Distance tables
Column 4: Standard Deviation of averaged samples (Watts/meters squared). 0.0 indicates 1 sample or very close instantaneous samples

In Figure 1, the individual total solar irradiance values represent orbital averages of the instantaneous measurements which are corrected for the angle between the instrument optical axis and the Sun and which are normalized to the mean Earth/Sun distance. At least once every 14 days, the Sun is observed by the monitor for several 64-second measurement intervals. Each interval is separated into two 32-second periods. During the first period, the Sun drifts across the 9.2-degree unocculted field of view, and its radiation field is measured. During the second period, a low-emittance shutter, representative of a near-zero irradiance source, is cycled into the field of view, and the low irradiance from the back of the shutter is measured. The resulting averaged measurements from the several 64-second time intervals are used to define the irradiance, using the algorithms which are described in Reference 1. Typically, two to eleven values of the irradiance are determined during an orbit. Considering that these irradiance values are derived typically during a single orbit for a few minutes, the averaged irradiance values represent an almost instantaneous level, and not a daily average.

Between 1984 and 1993, the solar monitor was operated continuously with the exception of the July 2-3, 1987, September 4-9, 1992, and July 2-3, 1993 when spacecraft attitude control or battery cell failure problems caused the monitor to be turned off. Between July 18, 1993 and November 21, 1993, the monitor was turned off because the spacecraft battery system and the flight operations procedures could not provide sufficient power to all of the spacecraft sensors. Therefore, there are no data available for this period. The 14-day measurement schedule was resumed after November 22, 1993 when flight procedures were revised to provide sufficient power to the monitor. Beyond Feb. 28, 1998, we have processed with the exception of a few days, all of the 1998 ERBS TSI measurements. During March 1998, no ERBS TSI measurements were obtained because the ERBS/ERBE telemetry dedicated to earth and solar radiation measurement failed. The April through December 1998, TSI measurements were relayed in a different format using the remaining ERBS/SAGE telemetry system. ERBS TSI measurements are also not available for later December 1998 and early January 1999 because the ERBS spacecraft had another battery cell failure. The TSI measurements started again on January 6, 1999. Also, between September 1999 and December 1999 no calibrations were done due to a failure in the elevation gimbal of the non-scanner instrument. Solar measurements were resumed for the solar monitor only December 22, 1999 using a different command sequence.

In Table 2, the solar monitor power-on days in 1993 through December 1999 are presented. In Table 1 and in Figure 1, the measurement standard deviations (STD) increased significantly when the power was turned off for 1 to 8 day [an average of 4 days] periods every 22 to 40 days [an average of 30 days].

In Figure 1, the ERBS irradiance values are compared with an empirical regression fit, which serves as a quality assurance diagnostic tool. The fit was derived from least squares analyses between the ERBS irradiances, photometric sunspot index (PSI), and 10.7-cm solar flux (F10), using March 1985 through August 1989 values. PSI is a proxy for irradiance decreases which are caused by the presence of large groups and numbers of sunspots. F10 is a proxy for irradiance brightening which is caused by the presence of faculae. Lee et al. (1995) describes the derivation of the regression fit.

Specialized irradiance measurement missions were conducted during March 23, 1992 through April 2, 1992, January 16, 1993 through January 30, 1993, April 6, 1993 through April 22, 1993, November 4, 1994 through December 13, 1994, August 8, 1997 through August 25, 1997 and October 29, 1998 through November 11, 1998. The specialized missions included increased measurement opportunities over three to nsix orbits each day compared to the typical single orbit measurements. The missions were extended to as much as 10 consecutive days of measurements.

References

[1] R. B. Lee III, B. R. Barkstrom, and R. D. Cess, "Characteristics of the Earth Radiation Budget Experiment Solar Monitors", Applied Optics, 26, No. 15, pp. 3090-3096, 1987.

[2] R. B. Lee III, M. A. Gibson, R. S. Wilson, S. Thomas, "Long-term Total Solar Irradiance Variability During Sunspot Cycle 22", Journal of Geophysical Research, 100, No. A2, pp. 1667-1675, February 1, 1995.

[3] Robert B. Lee III, Robert S. Wilson, K. J. Priestley, A. Al-Hajjah, J. Paden, D. K. Pandey, and S. Thomas, "1978-1998 Total Solar Irradiance Variability Trends," Proceedings of 10th Conference on Atmospheric Radiation [American Meteorological Society, Madison, WI, June 28 - July 2, 1999], pp. 84-287.

[4] Robert B. Lee III, Robert S. Wilson, K. J. Priestley, A. Al-Hajjah, J. Paden, D. K. Pandey, and S. Thomas, "1978-1998 Long-term Total Solar Irradiance (TSI) Variability Based Upon 1978-2000, spacecraft Measurements," Proceedings of International Radiation Symposium (IRS 2000), Session D. Earth Radiation Budget, Saint Petersburg, Russia, July 24-29, 2000, Paper D9.

TABLE 1. ERBS Solar Irradiance Values and Standard Deviations
[Watts per Square Meter]

YR/MO/DY HR:MN:SC	IRR	STD
84/10/25 15:24:45	1364.8	0.1
84/10/26 10:44:49	1365.4	0.2
84/10/29 11:21:05	1365.2	0.0
84/11/01 08:44:16	1366.0	0.0
84/11/05 06:21:26	1365.4	0.1

84/11/12 19:06:09	1365.3	0.5
84/11/20 11:00:49	1365.3	0.2
84/11/26 08:15:29	1364.8	0.4
84/12/03 09:37:37	1365.3	0.4
84/12/10 19:27:13	1365.4	0.4
84/12/17 11:21:05	1365.5	0.2
84/12/28 08:34:41	1364.9	0.0
85/01/09 10:00:33	1365.1	0.1
85/01/23 16:06:25	1365.1	0.0
85/02/06 13:20:33	1365.5	0.2
85/02/20 13:05:37	1364.8	0.3
85/03/06 11:09:53	1364.9	0.3
85/03/20 12:56:01	1364.9	0.3
85/04/03 17:30:13	1364.5	0.2
85/04/17 13:56:33	1364.9	0.1
85/05/01 12:48:33	1364.1	0.2
85/05/08 12:39:45	1364.2	0.5
85/05/29 12:38:25	1364.2	0.5
85/06/18 12:11:44	1364.8	0.1
85/06/26 12:11:13	1364.7	0.2
85/07/10 12:36:16	1363.7	0.2
85/07/24 12:15:12	1364.3	0.2
85/08/07 14:05:52	1365.1	0.1
85/08/21 12:01:36	1364.5	0.3
85/09/04 13:30:40	1364.5	0.0
85/09/18 12:18:40	1364.7	0.2
85/10/02 13:41:20	1364.6	0.1
85/10/16 13:16:16	1364.9	0.3
85/10/21 12:35:54	1365.3	0.2
85/10/31 12:05:20	1365.7	0.2
85/11/13 13:10:56	1365.1	0.1
85/11/27 13:36:00	1364.7	0.4
85/12/18 11:49:20	1364.6	0.2
85/12/25 14:44:48	1364.8	0.2
86/01/08 11:41:52	1365.1	0.3
86/01/22 12:57:36	1365.1	0.1
86/02/05 13:24:48	1364.2	0.2
86/02/15 12:12:47	1364.5	0.1
86/02/26 03:04:15	1364.8	0.2
86/03/05 12:49:35	1364.7	0.1
86/03/19 12:58:40	1364.4	0.3
86/04/02 12:41:36	1364.8	0.2
86/04/16 12:20:16	1364.2	0.1
86/04/30 12:48:32	1364.6	0.1
86/05/14 12:27:44	1364.7	0.2
86/05/28 12:37:52	1364.4	0.3
86/06/04 12:19:44	1364.4	0.3
86/06/19 12:34:08	1364.7	0.1
86/06/25 12:08:32	1364.3	0.2
86/07/09 12:33:04	1364.3	0.0
86/07/23 13:48:16	1365.3	0.1
86/08/17 12:56:32	1364.6	0.3
86/08/28 13:48:15	1364.4	0.4
86/09/03 13:26:24	1364.9	0.3

86/09/17 12:12:48	1364.7	0.0
86/10/01 11:57:52	1364.6	0.3
86/10/15 13:10:24	1364.6	0.1
86/10/29 11:46:40	1364.8	0.3
86/11/12 13:03:28	1364.7	0.4
86/11/26 13:28:32	1364.5	0.3
86/12/04 06:58:39	1364.8	0.2
86/12/18 11:50:55	1364.5	0.9
86/12/24 12:58:08	1364.5	0.3
87/01/07 13:19:20	1365.0	0.4
87/01/21 12:46:56	1365.9	0.2
87/02/15 12:13:20	1364.7	0.3
87/02/26 13:05:04	1364.7	0.4
87/03/04 12:37:52	1364.7	0.4
87/03/18 12:47:28	1365.0	0.2
87/04/01 14:05:20	1364.6	0.2
87/04/29 12:34:40	1364.6	0.2
87/05/13 12:13:52	1365.4	0.1
87/05/27 12:24:32	1364.9	0.2
87/06/03 12:06:07	1364.9	0.1
87/06/18 12:18:39	1364.9	0.4
87/06/24 13:31:12	1364.4	0.3
87/07/08 12:18:40	1365.3	0.5
87/07/22 13:36:00	1365.0	0.1
87/08/05 12:13:20	1364.9	0.1
87/08/12 08:44:00	1364.8	0.0
87/08/28 13:52:00	1365.1	0.1
87/09/02 13:17:20	1364.9	0.0
87/09/09 13:02:56	1364.9	0.0
87/09/16 13:42:56	1365.4	0.1
87/09/30 11:52:00	1364.6	0.2
87/10/14 13:06:40	1364.4	0.3
87/10/28 11:44:00	1364.9	0.2
87/11/11 13:01:20	1365.4	1.1
87/11/25 11:50:51	1365.3	1.3
87/12/18 12:04:48	1365.4	1.1
87/12/23 13:01:20	1365.8	1.0
88/01/06 13:13:34	1365.7	0.1
88/01/20 12:52:14	1364.6	0.6
88/02/03 16:34:06	1365.2	0.0
88/02/14 02:38:54	1364.9	0.1
88/02/25 11:35:58	1365.4	0.3
88/03/02 12:46:22	1365.0	0.1
88/03/16 11:19:26	1365.2	0.3
88/03/29 14:13:50	1365.0	0.3
88/04/13 12:18:38	1365.2	0.1
88/04/27 12:45:50	1365.1	0.1
88/05/11 12:25:02	1365.8	0.0
88/05/25 14:13:18	1364.8	0.1
88/06/02 06:01:34	1365.4	0.4
88/06/17 12:43:10	1365.8	0.2
88/06/22 13:42:22	1365.2	0.2
88/07/06 12:29:34	1365.7	0.1
88/07/20 13:43:58	1365.3	0.1

88/08/03 13:56:46	1365.4	0.2
88/08/15 06:34:06	1365.0	0.0
88/08/26 09:02:54	1365.7	0.2
88/08/31 13:17:50	1364.8	0.1
88/09/14 13:40:14	1365.9	0.2
88/09/28 13:23:10	1365.5	0.1
88/10/12 12:57:02	1365.5	0.1
88/10/26 13:07:10	1365.2	0.3
88/11/09 13:44:14	1365.2	0.4
88/11/23 13:05:34	1365.7	0.3
88/12/02 06:45:50	1365.4	0.5
88/12/16 08:20:14	1365.1	0.1
88/12/21 12:28:14	1364.5	0.1
89/01/05 12:43:42	1366.4	0.3
89/01/18 12:03:42	1366.0	0.4
89/02/01 12:23:58	1366.1	0.3
89/02/12 06:26:38	1365.6	0.2
89/02/24 05:47:42	1365.5	0.2
89/03/01 13:09:18	1365.8	0.2
89/03/22 12:48:30	1365.3	0.2
89/03/29 12:36:46	1365.9	0.1
89/04/12 12:05:18	1366.8	0.1
89/04/26 12:19:42	1365.9	0.0
89/05/10 11:45:34	1366.7	0.0
89/05/24 11:41:50	1365.9	0.2
89/06/02 06:36:14	1365.6	0.1
89/06/15 08:10:06	1363.3	0.4
89/06/22 13:54:38	1366.1	0.1
89/07/06 12:24:30	1365.9	0.2
89/07/20 13:21:02	1366.1	0.1
89/08/03 13:17:18	1365.5	0.2
89/08/15 05:40:14	1365.7	0.1
89/08/25 07:55:10	1366.6	0.3
89/08/30 12:02:38	1366.2	0.2
89/09/13 12:07:58	1365.9	0.1
89/09/27 11:30:38	1366.3	0.3
89/10/11 12:21:50	1367.0	0.5
89/10/25 13:48:46	1366.6	0.1
89/11/08 13:05:34	1366.5	0.0
89/11/23 13:05:34	1365.7	0.4
89/11/30 07:58:22	1365.5	0.2
89/12/15 07:43:26	1366.4	0.1
89/12/20 13:19:58	1365.9	1.0
90/01/03 13:02:21	1366.1	0.4
90/01/17 12:10:05	1366.0	0.4
90/01/31 13:44:29	1366.3	0.3
90/02/11 07:30:05	1365.6	0.2
90/02/22 08:08:29	1365.5	0.2
90/02/28 13:45:01	1365.7	0.2
90/03/14 11:45:01	1366.2	0.2
90/03/28 12:29:17	1366.4	0.3
90/04/11 13:12:29	1365.9	0.0
90/04/25 13:04:29	1366.3	0.2
90/05/09 12:08:29	1365.9	0.2

90/05/24 11:51:25	1366.4	0.3
90/05/30 07:53:01	1365.6	0.4
90/06/14 09:03:25	1366.6	0.3
90/06/20 13:11:57	1366.3	0.6
90/07/04 12:58:37	1364.5	0.2
90/07/18 13:35:25	1366.6	0.1
90/08/01 13:09:17	1366.0	0.0
90/08/11 06:42:37	1366.7	0.3
90/08/23 07:15:41	1364.4	0.3
90/08/29 12:52:45	1366.5	0.2
90/09/12 12:36:13	1366.0	0.5
90/09/26 13:16:13	1365.8	0.1
90/10/10 12:09:01	1365.0	0.5
90/10/24 11:39:41	1365.7	0.3
90/11/07 13:50:53	1366.1	0.1
90/11/21 13:31:41	1363.6	0.2
90/11/28 08:06:21	1365.4	0.3
90/12/13 07:32:13	1365.9	0.0
90/12/19 13:09:49	1364.4	0.4
91/01/02 07:45:00	1366.3	0.2
91/01/16 13:03:24	1364.8	0.2
91/01/30 12:43:08	1363.1	0.0
91/02/09 09:20:28	1365.6	0.2
91/02/20 09:35:56	1365.8	0.1
91/02/27 09:35:56	1365.6	0.1
91/03/13 13:04:28	1365.7	0.3
91/03/27 11:55:08	1365.0	0.1
91/04/10 12:17:00	1367.6	0.2
91/04/24 13:27:24	1366.3	0.1
91/05/08 12:11:08	1365.0	0.4
91/05/22 13:00:12	1365.6	0.0
91/05/28 07:17:48	1364.5	0.0
91/06/12 09:42:20	1364.8	0.1
91/06/19 12:13:32	1365.7	0.1
91/07/03 11:39:40	1366.9	0.1
91/07/17 11:55:08	1366.3	0.0
91/07/31 12:44:12	1366.9	0.2
91/08/09 07:23:08	1366.5	0.3
91/08/21 07:37:00	1364.5	0.2
91/08/28 11:45:32	1366.2	0.0
91/09/11 12:44:12	1365.8	0.3
91/09/25 11:26:52	1365.9	0.4
91/10/09 11:33:16	1366.5	0.1
91/10/23 12:19:08	1365.4	0.0
91/11/06 12:31:24	1365.8	0.3
91/11/20 11:49:48	1366.3	0.2
91/11/26 07:42:20	1365.6	0.1
91/12/10 08:13:16	1364.4	0.3
91/12/18 12:17:00	1366.1	0.0
92/01/01 11:20:28	1365.6	0.4
92/01/15 11:24:44	1366.2	0.3
92/01/29 12:17:00	1364.8	0.2
92/02/06 08:23:56	1365.7	0.2
92/02/18 08:28:12	1365.9	0.4

92/02/26 12:31:24	1365.1	0.3
92/03/11 13:03:24	1366.2	0.1
92/03/23 16:06:52	1366.3	0.2
92/03/24 16:14:20	1365.8	0.3
92/03/25 13:08:44	1366.2	0.1
92/03/26 16:29:16	1365.6	0.2
92/03/27 03:44:28	1365.8	0.4
92/03/28 03:51:56	1365.2	0.2
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92/04/02 14:03:40	1366.0	0.1
92/04/08 12:22:52	1365.7	0.1
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92/05/24 08:16:28	1365.3	0.2
92/06/08 08:42:36	1365.2	0.1
92/06/17 12:50:36	1365.6	0.3
92/07/01 11:58:19	1365.7	0.4
92/07/15 11:54:03	1365.9	0.2
92/08/05 06:37:47	1365.6	0.2
92/08/18 08:20:43	1364.3	0.1
92/08/26 12:23:55	1366.2	0.1
92/09/12 10:13:15	1365.2	0.1
92/10/07 12:02:35	1365.5	0.2
92/10/21 11:52:59	1364.5	0.1
92/11/04 11:49:47	1365.3	0.3
92/11/18 12:29:47	1365.7	0.4
92/11/22 08:05:47	1365.2	0.3
92/12/06 09:58:51	1365.3	0.2
92/12/16 12:29:47	1365.8	0.2
92/12/30 12:58:03	1365.8	0.0
93/01/13 11:14:03	1365.3	0.3
93/01/16 21:10:19	1365.8	0.3
93/01/17 19:39:39	1365.6	0.2
93/01/18 14:56:27	1366.0	0.2
93/01/19 07:00:11	1365.8	0.1
93/01/20 16:02:35	1365.9	0.4
93/01/21 12:55:23	1365.9	0.3
93/01/22 09:48:11	1365.6	0.2
93/01/23 06:41:31	1365.9	0.1
93/01/24 03:34:19	1366.1	0.2
93/01/25 00:27:39	1365.6	0.2
93/01/26 02:03:39	1365.3	0.4
93/01/27 11:54:03	1365.2	0.2
93/01/28 18:25:31	1365.6	0.1
93/01/29 13:43:23	1365.8	0.4
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93/02/01 07:35:55	1365.3	0.1
93/02/14 07:39:39	1365.4	0.5
93/02/24 11:47:39	1365.1	0.0
93/03/10 12:12:11	1364.8	0.5

93/03/24 12:11:07	1365.7	0.3
93/04/06 14:22:19	1365.7	0.2
93/04/07 09:38:35	1365.1	0.0
93/04/08 12:57:31	1365.6	0.3
93/04/09 13:03:23	1365.7	0.4
93/04/10 13:09:15	1365.7	0.4
93/04/11 13:15:07	1365.8	0.3
93/04/12 13:20:59	1365.8	0.4
93/04/13 16:39:55	1365.7	0.4
93/04/14 13:33:15	1365.6	0.4
93/04/15 13:39:39	1365.5	0.1
93/04/16 13:46:03	1365.1	0.3
93/04/17 13:52:27	1365.5	0.2
93/04/18 13:58:51	1365.3	0.2
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93/04/21 12:42:35	1365.3	0.3
93/04/22 14:25:31	1365.1	0.1
93/05/05 12:30:51	1366.2	0.0
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93/05/21 09:48:11	1365.5	0.2
93/06/05 08:30:52	1365.2	0.5
93/06/16 11:09:48	1365.3	0.0
93/06/30 11:49:16	1366.1	0.0
93/07/16 05:23:07	1365.6	0.0
93/07/17 07:47:07	1366.1	0.0
93/11/22 21:38:35	1365.4	0.3
93/11/23 12:07:55	1365.4	0.3
93/11/24 09:07:07	1365.4	0.1
93/11/25 12:35:39	1365.2	0.1
93/11/26 04:43:39	1365.3	0.3
93/11/27 06:26:03	1365.4	0.3
93/11/28 08:07:55	1365.6	0.2
93/11/29 03:23:39	1365.9	0.3
93/11/30 03:28:59	1365.9	0.3
93/12/01 05:10:19	1365.0	0.2
93/12/02 03:39:07	1365.2	0.1
93/12/03 03:44:27	1365.0	0.3
93/12/04 02:13:15	1365.3	0.1
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93/12/13 11:01:15	1364.9	0.3
93/12/20 23:36:27	1365.8	0.2
93/12/22 12:32:59	1365.8	0.0
94/01/05 10:44:43	1365.2	0.3
94/01/11 09:43:23	1365.5	0.1
94/01/20 05:01:47	1365.2	0.1
94/02/11 13:56:43	1364.5	0.3
94/02/21 03:34:19	1365.4	0.3
94/02/27 20:51:07	1366.0	0.4
94/03/17 19:28:27	1365.0	0.6
94/04/04 22:26:19	1364.6	0.0
94/04/13 10:08:59	1364.7	0.4

94/04/27 11:35:23	1365.0	0.9
94/05/01 15:09:47	1364.4	0.0
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94/05/11 11:54:35	1365.3	0.3
94/05/18 12:28:43	1365.2	0.1
94/06/01 12:39:23	1364.7	0.2
94/06/08 11:42:51	1364.5	0.0
94/06/17 05:23:07	1365.7	0.0
94/06/22 12:15:55	1364.8	0.4
94/07/11 09:18:50	1364.5	0.3
94/07/20 12:23:54	1364.8	0.3
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94/08/17 18:34:34	1365.0	0.5
94/08/21 15:43:54	1364.5	0.0
94/08/26 15:27:22	1365.0	0.0
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94/09/26 12:06:18	1364.6	0.5
94/10/01 05:12:58	1365.8	0.1
94/10/12 09:27:22	1365.2	0.0
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94/11/04 22:14:50	1365.7	0.8
94/11/05 22:20:10	1365.4	0.2
94/11/06 06:21:46	1365.6	0.4
94/11/07 08:03:06	1365.9	0.5
94/11/08 22:35:38	1364.8	0.2
94/11/09 00:12:10	1365.3	0.2
94/11/10 00:17:30	1365.5	0.6
94/11/11 01:59:22	1365.2	0.0
94/11/12 16:31:54	1365.2	0.2
94/11/13 16:37:46	1365.3	0.2
94/11/16 08:54:50	1365.1	0.2
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94/12/07 09:36:58	1364.6	0.3
94/12/11 00:19:06	1365.1	0.5
94/12/16 09:55:38	1364.8	0.2
94/12/21 09:56:42	1365.1	0.0
95/01/04 11:19:22	1365.7	0.2
95/01/09 00:32:26	1365.3	0.0
95/01/14 05:05:30	1365.0	0.0
95/01/18 10:16:58	1364.2	0.2
95/01/25 23:47:38	1364.9	0.2
95/02/08 01:23:38	1364.0	1.0
95/02/18 19:53:30	1364.5	0.0
95/02/23 06:34:02	1364.8	0.0
95/03/15 14:58:34	1365.0	0.8
95/03/30 14:04:10	1365.4	0.6
95/04/12 16:55:54	1364.9	0.1
95/04/26 21:31:06	1365.4	0.5
95/04/29 20:10:34	1364.6	0.2
95/05/03 22:48:58	1365.5	0.0
95/05/10 16:57:30	1365.0	0.4
95/05/15 10:57:30	1364.9	0.2

95/06/07 21:32:42	1365.3	0.2
95/06/09 21:42:50	1365.3	0.0
95/06/13 21:22:02	1365.2	0.3
95/06/21 18:53:14	1364.7	0.6
95/07/05 10:36:42	1364.4	0.8
95/07/09 07:45:30	1364.6	0.0
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95/08/16 10:37:46	1365.8	0.3
95/08/20 14:11:06	1365.0	0.6
95/08/23 00:53:46	1365.1	0.6
95/08/30 11:09:14	1365.1	0.4
95/09/13 11:00:10	1364.7	0.3
95/09/23 15:07:38	1365.0	0.3
95/09/27 06:32:26	1364.8	0.6
95/10/11 22:18:34	1364.8	0.4
95/10/25 17:16:42	1365.8	0.3
95/10/28 06:18:02	1365.8	0.1
95/10/31 23:30:31	1365.2	0.5
95/11/12 18:11:38	1364.8	0.5
95/11/25 11:46:02	1364.9	0.4
95/12/07 19:10:50	1365.2	0.2
95/12/12 18:42:34	1364.6	0.7
95/12/20 11:24:42	1364.8	0.5
96/01/03 11:09:13	1364.9	0.6
96/01/06 01:47:05	1365.2	0.1
96/01/12 16:02:33	1364.6	0.0
96/01/17 16:29:45	1364.9	0.0
96/01/22 23:24:41	1364.9	0.3
96/02/04 18:34:01	1365.5	0.5
96/02/15 16:15:21	1365.5	0.4
96/02/20 17:22:33	1365.4	0.2
96/02/28 14:51:37	1364.9	0.3
96/03/21 13:50:17	1365.9	0.2
96/03/27 13:40:09	1364.7	0.4
96/04/10 16:39:21	1365.1	0.4
96/04/24 21:10:17	1365.1	0.2
96/04/30 12:44:09	1365.3	0.3
96/05/08 11:47:05	1365.0	0.2
96/05/10 23:10:49	1364.5	0.3
96/05/23 11:56:09	1364.5	0.1
96/05/24 15:15:05	1364.7	0.3
96/06/05 01:51:53	1365.5	0.2
96/06/09 01:30:01	1364.8	0.0
96/06/19 08:51:05	1364.7	0.2
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96/07/08 22:32:25	1364.4	0.2
96/07/17 12:01:29	1364.8	0.2
96/07/21 05:56:41	1364.6	0.2
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96/08/28 12:16:57	1364.6	0.2
96/09/11 12:05:45	1365.0	0.2

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96/10/25 07:13:29	1366.3	0.5
96/10/28 11:35:53	1365.2	0.4
96/11/06 12:22:49	1365.0	0.4
96/11/08 07:46:01	1365.0	0.6
96/11/20 10:51:05	1365.0	0.5
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96/12/07 11:22:01	1365.3	0.3
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97/03/26 11:16:09	1364.7	0.0
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97/04/22 10:37:13	1364.5	0.1
97/04/24 11:28:57	1365.1	0.2
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97/08/12 04:14:16	1365.0	0.4
97/08/13 16:27:36	1365.8	0.8
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97/08/16 21:31:36	1365.4	0.3
97/08/17 00:44:08	1365.3	0.0
97/08/18 10:27:36	1365.7	0.3
97/08/19 10:32:56	1365.3	0.3
97/08/20 10:38:16	1365.3	0.3
97/08/21 12:20:08	1365.2	0.3
97/08/22 10:49:28	1365.3	0.2
97/08/23 14:07:52	1365.2	0.6
97/08/24 11:01:12	1365.1	0.2
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97/12/31 11:45:28	1365.3	0.3
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98/01/28 11:24:08	1365.2	0.3
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98/05/28 11:43:51	1365.0	0.0
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98/06/17 11:10:47	1365.3	0.2
98/06/27 10:26:31	1364.9	0.4
98/06/30 11:23:03	1365.6	0.3
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98/09/13 13:21:27	1365.6	0.4
98/09/23 10:57:27	1365.1	0.2
98/09/30 21:16:07	1365.8	0.3
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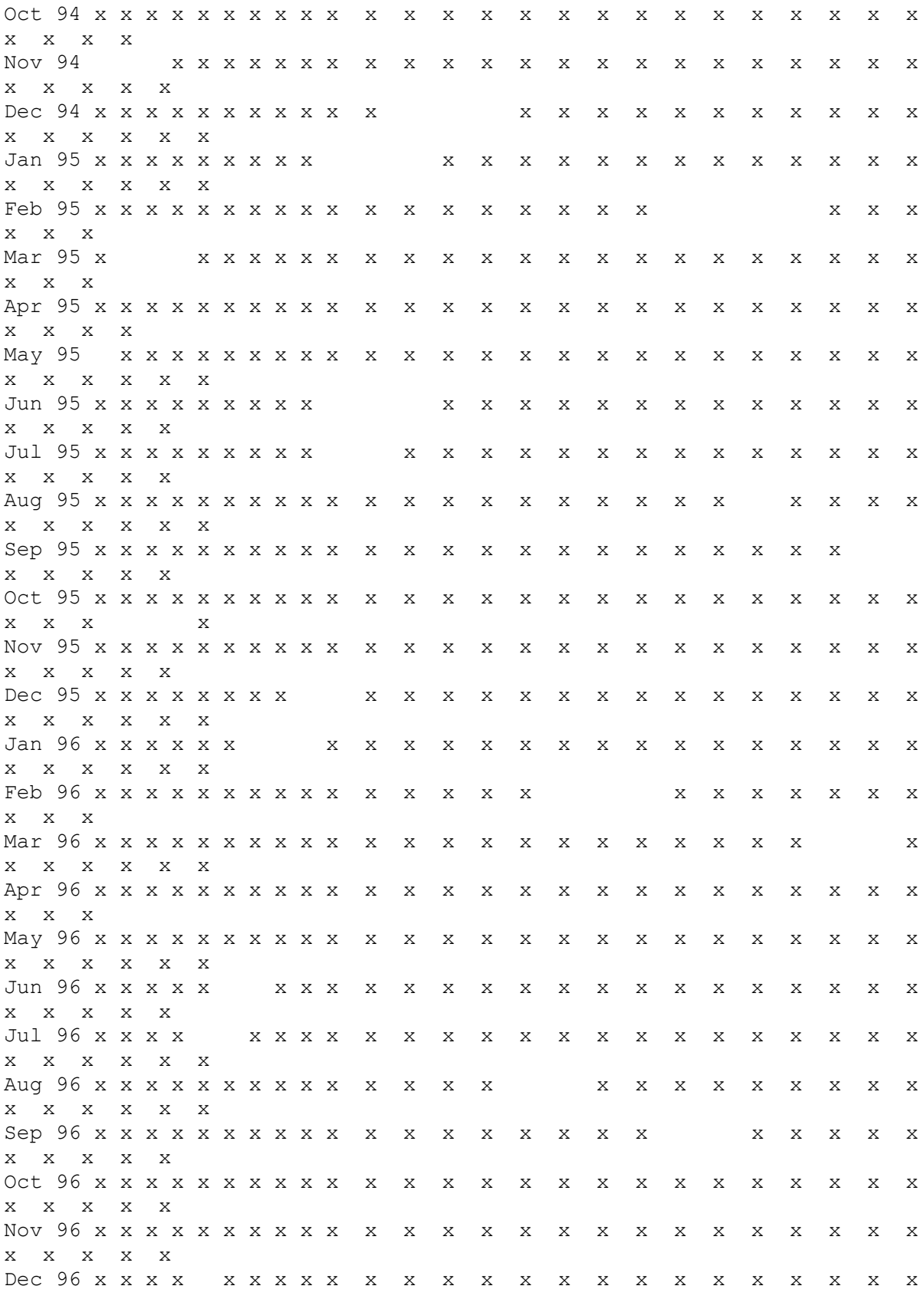
98/11/19 12:19:03	1365.6	0.8
98/11/25 11:09:11	1365.8	0.1
98/11/29 10:33:59	1366.5	0.1
98/12/02 22:02:31	1366.0	0.0
99/01/06 11:23:02	1366.2	0.4
99/01/09 11:39:02	1365.5	0.4
99/01/11 11:51:19	1365.8	0.3
99/01/13 12:07:19	1366.1	0.3
99/02/06 11:43:50	1366.4	0.0
99/02/10 12:01:58	1366.1	0.0
99/02/24 13:15:34	1366.3	0.1
99/02/28 12:00:22	1365.6	0.4
99/03/10 12:48:54	1365.9	0.2
99/03/11 12:11:34	1365.5	0.7
99/03/24 13:15:34	1365.8	0.5
99/03/31 10:43:34	1365.6	0.3
99/04/07 12:55:18	1365.6	0.5
99/04/21 13:01:10	1365.6	0.3
99/04/29 10:22:14	1364.7	0.2
99/05/11 13:17:10	1365.7	0.2
99/05/19 12:20:06	1365.1	0.4
99/05/31 10:55:18	1365.0	0.0
99/06/02 12:40:54	1365.3	0.3
99/06/16 10:37:42	1365.2	0.6
99/06/30 12:20:06	1366.4	0.2
99/07/09 11:19:50	1365.9	0.5
99/07/23 11:15:02	1365.0	0.2
99/07/28 11:37:58	1366.1	0.0
99/07/31 11:50:46	1365.8	0.2
99/08/11 13:31:02	1365.4	0.4
99/08/25 11:29:26	1365.9	0.3
99/08/31 11:57:42	1365.6	0.3
99/09/08 11:36:54	1366.9	0.0
99/09/22 20:39:50	1366.1	0.4
99/09/30 11:45:58	1365.6	0.3
99/12/22 18:54:46	1365.7	0.0
99/12/29 19:21:26	1366.0	0.8
00/01/05 19:51:18	1366.1	0.4
00/01/19 19:38:30	1365.6	0.3
00/01/26 20:02:30	1365.4	0.2
00/02/02 19:33:10	1366.2	0.0
00/02/09 19:59:50	1366.6	0.0
00/02/16 20:30:15	1366.0	0.2
00/02/23 19:26:47	1365.6	1.0
00/03/01 19:55:35	1364.9	0.0

00/03/08 19:39:35	1365.5	0.1
00/03/15 20:07:19	1365.3	0.3
00/03/22 20:40:23	1365.3	0.2
00/03/29 19:36:54	1365.8	0.1
00/04/05 20:02:31	1366.1	0.4
00/04/12 19:30:31	1366.2	0.1
00/04/19 19:52:55	1366.5	0.2
00/04/26 20:16:23	1364.5	0.3
00/05/03 19:21:59	1366.6	0.2
00/05/10 19:53:27	1365.5	0.3
00/05/17 20:17:59	1364.4	0.2
00/05/24 19:58:15	1365.2	0.8
00/05/31 20:23:51	1365.4	0.2
00/06/07 19:15:03	1365.8	0.2
00/06/14 19:39:35	1366.7	0.0
00/06/22 20:46:15	1365.9	0.1
00/06/28 19:27:19	1364.9	0.2

TABLE 2 ERBS Nonscanner Instrument Days of Operation up to Dec. 29, 1999

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jun 93	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Jul 93	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									
Aug 93																															
Sep 93																															
Oct 93																															
Nov 93																						x	x	x	x	x	x	x	x		
Dec 93	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Jan 94	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							x		x	x	x	x	x	x		
Feb 94	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x				
Mar 94	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Apr 94			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
May 94	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Jun 94	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x	x	x	x	x	x	x	x			
Jul 94	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Aug 94	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x											
Sep 94	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						


Oct 94
Nov 94
Dec 94
Jan 95
Feb 95
Mar 95
Apr 95
May 95
Jun 95
Jul 95
Aug 95
Sep 95
Oct 95
Nov 95
Dec 95
Jan 96
Feb 96
Mar 96
Apr 96
May 96
Jun 96
Jul 96
Aug 96
Sep 96
Oct 96
Nov 96
Dec 96

Under Development: 31 July 2013 (WFD)

```
Jan 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Feb 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x
Mar 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Apr 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x
May 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Jun 97 x x   x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x
Jul 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Aug 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Sep 97 x x x x x x x x x x  x  x  x  x     x  x  x  x  x  x  x  x  x  x
x  x  x  x  x
Oct 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Nov 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x
Dec 97 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Jan 98 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Feb 98 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x
Mar 98 x x x x x
Apr 98                   x  x  x  x  x  x  x  x        x  x  x  x  x  x
x  x  x  x  x
May 98 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x        x
Jun 98 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x     x  x
Jul 98 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Aug 98 x x x x x x x     x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Sep 98 x x x x x x x x x x     x  x  x     x  x  x  x  x  x  x  x  x  x
x  x  x  x  x
Oct 98 x x x x x x x x x x  x  x  x  x  x  x     x  x  x  x  x  x  x  x
x  x  x  x  x  x
Nov 98 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x
Dec 98 x x x x x x x
Jan 99         x x x x x x  x  x  x  x  x  x
Feb 99         x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x
Mar 99 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x  x
Apr 99 x x x x x x x x x x  x  x  x  x  x  x  x  x  x  x  x  x  x  x  x
x  x  x  x  x
```

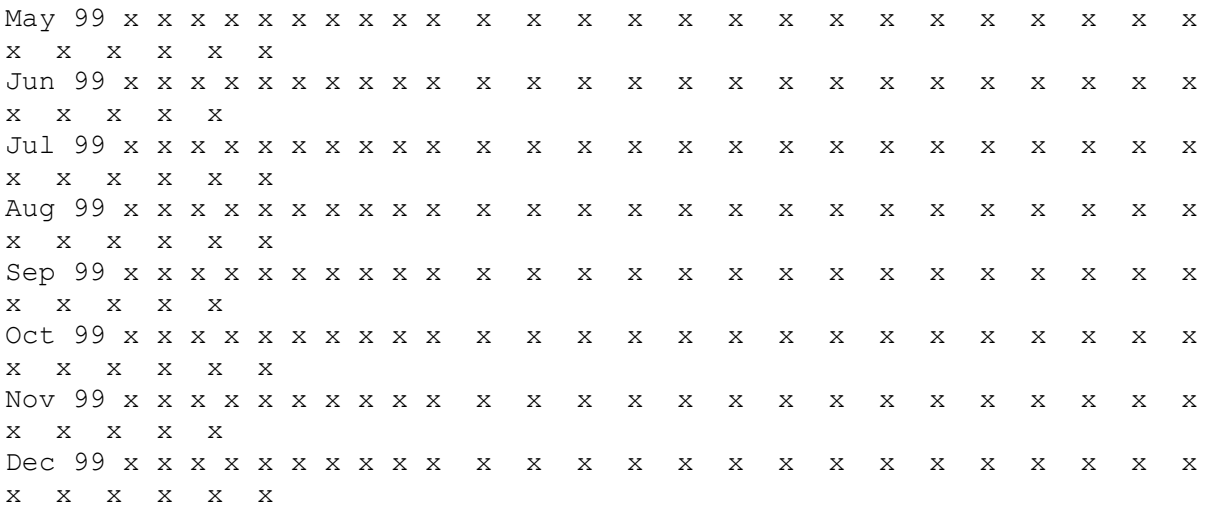


Figure 1. Earth Radiation Budget Satellite (ERBS) total solar irradiance values and the standard deviations for each value with an empirical model fit represented by solid line.