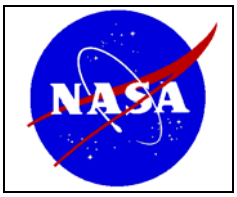

Future Solar Activity Estimates for Use in Prediction of Space Environmental Effects on Spacecraft Orbital Lifetime and Performance

Ronnie J. Suggs

Harold C. Euler Jr.

George C. Marshall Space Flight Center
Huntsville, Alabama

And

Steven W. Smith
Morgan Research Corporation
Huntsville, Alabama

APPROVAL:

Original Signed By

David L. Edwards
Natural Environments Branch

National Aeronautics and Space Administration
Marshall Space Flight Center • Huntsville, Alabama 35812

Spacecraft & Vehicle Systems Department
Systems Analysis & Integration Division
Natural Environments Branch

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Introduction

The main sources of uncertainty in spacecraft orbital lifetime prediction are estimated future solar radio flux and geomagnetic activity, modeled atmospheric density, and the ballistic factor. The major source of uncertainty in models estimating future atmospheric density at orbital altitude is the solar extreme ultraviolet heat input values. The observed 10.7-cm solar radio flux (not adjusted to 1 AU) is used as a proxy for this most significant input and is the basis for the development of most orbital altitude atmospheric density models in current use for spacecraft orbital lifetime and performance predictions**.**

Marshall Solar Activity Future Estimates (MSAFE) Model

Because no generally accepted physical solar model is available to accurately predict future solar activity, the NASA Marshall Space Flight Center (MSFC) developed a 13-month Zurich smoothed solar radio flux ($\overline{F}_{10.7}$) and geomagnetic ($\overline{A}_p$) index intermediate (months) and long-range (years) statistical estimation technique [Niehuss *et al.*, 1996; Vaughan *et al.*, 1999]. The technique is also applicable to the 13-month smoothed sunspot number ($\overline{R}$). The 13-month Zurich smoothing technique is a running average with a 13-month kernal size and the first and thirteenth months given half the weight of the others. This technique was developed by the Swiss Federal Observatory, Zurich, Switzerland [Waldmeier, 1961].

The primary reason for developing the MSFC Solar Activity Future Estimation (MSAFE) model, and for issuing intermediate and long-range solar radio flux and geomagnetic index future estimates, is the need for updated inputs to the upper atmosphere (thermosphere) density models used for spacecraft orbital lifetime predictions and performance requirement analyses [Dreher and Lyons, 1990]. Mission analysis and planning for future spacecraft launches and on-orbit operations require estimates of orbital lifetimes, altitudes, inclinations, and eccentricities as well as various space environment parameters important to selection of materials and parts and equipment design.

The MSFC Solar Activity Future Estimation (MSAFE) linear regression program is a modified McNish-Lincoln model [McNish and Lincoln, 1949; Boykin and Richards, 1966] based on the Lagrangian least-squares statistical technique of Holland and Vaughan [1984]. A detailed explanation of the MSAFE model, its computer program, and modifications that took place in 1995 and 1996 is given by Niehuss et al. [1996], copies of which are available on request. This model is built to provide the capability to provide monthly updates of future $\overline{F}_{10.7}$, $\overline{R}$, and $\overline{A}_p$ estimates with associated statistical confidence bounds, i.e. 95 Percentile, etc.

Observed Data

Generation of the information provided in this report begins each month with the acquisition of recently observed solar activity data. Table 1 contains recent monthly mean observed 10.7 cm solar radio flux, sunspot number, and planetary geomagnetic index values. The information in this table is based upon data from the National Research Council of Canada for the Series C 10.7-cm solar radio flux ($F_{10.7}$) data, the Sunspot Index Data Center Brussels, Belgium for the monthly mean relative

sunspot number (R), and the Institute for Geophysics in Gottingen, Germany for the monthly mean geomagnetic index (A_p) data as received from the U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) via their National Geophysical Data Center (NGDC) site. When there is insufficient data at the NGDC site to provide information through the most recently completed month, preliminary values are calculated using daily values from the NOAA Space Environment Center (SEC) and the Sunspot Index Data Center site.

The inputs used by the MSAFE model computer program are databases comprising Lagrangian interpolated $\overline{F}_{10.7}$ (cycles 1 through 23 converted and observed), $\overline{R}$ (cycles 1 through 23 observed), and $\overline{A}_p$ (cycles 13 through 23 converted and observed) and the smoothed values for cycle 24. Table 2 presents 13-month Zurich smoothed values for Cycle 23 and 24 of the observed 10.7 cm solar radio flux, sunspot number, and planetary geomagnetic index values assigned at the midpoint calculated from monthly values in Table 1 .

Future Estimates

Using these smoothed values as inputs, the MSAFE program estimates the intermediate-term (months) and long-term (years) behavior of $\overline{F}_{10.7}$, $\overline{R}$, and $\overline{A}_p$ for up to 132 months into the future, initialized from a cycle minimum or a cycle maximum. For reports starting with April 2004 and continuing through October 2007, MSAFE was initialized from the cycle 23 maximum determined to be April 2000 indicated by the 13-month smoothed sunspot values. This date was used for $\overline{F}_{10.7}$, $\overline{R}$, and $\overline{A}_p$ predictions. Beginning with the November 2007 report, MSAFE was re-initialized from the cycle 23 maximum using a date determined from a 27-month running mean. This was done to smooth the double peaks observed in the 13-month smoothed values in order to reduce the inconsistency in the dates of cycle maximum for $\overline{F}_{10.7}$, $\overline{R}$. The new date used for cycle 23 maximum of $\overline{F}_{10.7}$, $\overline{R}$ is April 2001. For reports starting with September 2009, MSAFE was initialize using the date of the beginning of cycle 24 determined to be Dec 2008 indicated by the 13-month smoothed sunspot values. This date was used for $\overline{F}_{10.7}$, $\overline{R}$, and $\overline{A}_p$ predictions.

The results of the MSAFE model calculations (i.e. the output data) for solar cycle 24 are reported in Tables 3, 4 and 5[1]. Table 3 contains the statistical estimates of future $\overline{F}_{10.7}$ and $\overline{A}_p$ 5, 50, and 95 Percentile values for cycle 24. Table 4 contains the statistical estimate of future $\overline{R}$ and $\overline{A}_p$ 5, 50, and 95 Percentile values for cycle 24. Table 5[1] contains the statistical estimates of 75 Percentile $\overline{F}_{10.7}$ and 95 Percentile $\overline{A}_p$ values for cycle 24. The extended statistical characteristics of cycle 25 are included to permit use of the information in long range spacecraft programs planning and analysis.

The computer program's input and output data are also depicted in graphical form. Figures 1 and 2 illustrate the inputs and application of the MSAFE model to the 10.7-cm solar radio flux. Figure 1 is a plot of monthly mean and 13-month Zurich smoothed observed 10.7-cm solar radio flux for solar cycle 23. Figure 2 is a plot of the statistical estimates of future13-month Zurich smoothed 10.7-cm solar radio flux for solar cycles 24 and 25. Similarly, Figures 3 and 4 demonstrate inputs and application of the MSAFE algorithm to sunspot number. Figure 3 is a plot of the monthly mean and 13-month Zurich smoothed observed sunspot number for solar cycle 23. Figure 4 is a plot of the statistical estimates of future13-month Zurich smoothed relative sunspot number for solar cycles 24 and 25. Figure 5[1] is a plot of monthly mean and 13-month Zurich smoothed observed 10.7-cm solar

[1] Table 5, Figure 5 and Figure 6 were added in June 2002 on the request of the NASA/JSC Vehicle Integration Performance and Resources (VIPeR) team.

radio flux for solar cycle 23. Figure 6 is a plot of the statistical estimates of future13-month Zurich smoothed 75 Percentile 10.7-cm solar radio flux for solar cycles 24 and 25.

It should be noted that the cycle 25, 5, 50, and 95 Percentile values are the statistical evaluation of the past 23 cycles and are not influenced by the MSAFE model's performance. Cycle 25 values are estimated using statistics for cycles 1 through 23 for $\bar{\bar{F}}_{10.7}$ and $\bar{R}$, and statistics for cycles 13 through 23 are used for $\bar{A}_p$. The 50 percentile values in Tables 3 and 4 and in Figures 3 and 4, at and beyond the beginning of cycle 25, are computed arithmetic means and are given with 95 Percentile and 5 Percentile values. Since the planetary geomagnetic data are only available for solar cycles 13 through 23 to produce the statistics, the small sample size requires that the 95 Percentile and 5 Percentile values for the $\bar{A}_p$ are only approximations. The mean solar cycle period of 11 years (132 months) is assumed for the period of cycles 24 and 25 based on the nominal solar cycle period from past records.

Applications

General. The observed and predicted solar activity information presented in this report is provided as input data for atmospheric and space environment models to ensure compatibility between calculations made for prediction of environmental effects on spacecraft orbital lifetime and performance, e.g. ambient density, ionosphere plasma density, cosmic ray flux, etc. The Marshall Engineering Thermosphere Model [Hickey, 1988a, 1988b], as well as the NASA/MSFC Global Reference Atmospheric Model-1999 Version [Justus et al., 1999], were developed on the basis of inputs of the daily 10.7-cm solar radio flux ($F_{10.7}$) and the 3-hourly planetary geomagnetic index (a_p) to compute atmospheric density. Some ionosphere models, such as the International Reference Ionosphere (IRI) and the Fully Analytical Ionospheric Model (FAIM), and newly emerging cosmic ray models utilize sunspot number (R) inputs. Therefore, the statistical estimates produced by the MSAFE model provide future 13-month smoothed values of the smoothed sunspot number ($\bar{R}$).

Changes of thermospheric and ionospheric density associated with short-term (days) variations in $F_{10.7}$, R, and A_p, required as inputs to the thermospheric and ionospheric models, are not represented by the 13-month Zurich smoothed statistical estimates of these parameters as provided by the MSAFE model and reported in this document. Future estimates of this dynamic component of the solar activity cannot be made with any acceptable degree of statistical confidence using existing techniques, so estimates from the MSAFE model represent the best information available for computing future orbital altitude atmospheric density and space environment parameters. Representative data sets, based on past $F_{10.7}$, R, and A_p values, may be utilized to compute the effects of the dynamic component on the ambient densities, etc. at orbital altitudes.

Design Requirements. Design requirements for solar activity and associated values of atmospheric space environment parameters are specified in the appropriate spacecraft and space vehicle project design requirements documentation. These documents should be consulted for this information. For spacecraft projects requiring minimum risk design for lifetime orbital altitude(s), re-boost activities, and control capability, the envelopes of 95 percentile estimates of future smoothed solar radio flux ($\bar{\bar{F}}_{10.7}$) and geomagnetic index ($\bar{A}_p$) that are recommended. These estimates permit statistically conservative spacecraft design and mission planning. Critical project considerations such as orbital lifetime predictions should be based on the most current MSAFE model intermediate and long-range statistical estimates of future solar and geophysical data that are

consistent with the critical project development and operational decision time points prior to the planned launch of the spacecraft.

Additional Information
Questions on the contents of this report may be addressed to Ron Suggs (ron.suggs@nasa.gov).

Customer Feedback
Marshall Space Flight Center's ISO 9000 process solicits customer feedback on all of our products. Please send an email to Dr. Rob Suggs (Rob.M.Suggs@nasa.gov) regarding the clarity and operational usefulness of this estimate.

References

Boykin, E. P. and T. J. Richards, Application of the Lincoln McNish Technique to the Prediction of the Remainder of the Twentieth Sunspot Cycle, Technical Memorandum 54/30-89, Lockheed Missiles and Space Company, Huntsville, Alabama, 1966.

Dreher, P. E. and A. T. Lyons, Long-Term Orbital Lifetime Predictions, NASA Technical Paper 3058, NASA Marshall Space Flight Center, Huntsville, Alabama (1990).

Hickey, M. P., The NASA Marshall Engineering Thermosphere Model, NASA CR-179359, 1988a.

Hickey, M. P., An Improvement in the Integration Procedure Used in the NASA Marshall Engineering Thermosphere Model, NASA CR-179389, 1988b.

Holland, R. L. and W. W. Vaughan, Lagrangian Least-Squares Prediction of Solar radio flux ($F_{10.7}$), *J. Geophys. Res.*, **89**, 11-16, 1984.

Justus, C. G. and D. L. Johnson, "The NASA/MSFC Global Reference Atmosphere Model – 1999 Version (GRAM-99)". NASA TM 1999-209630, May 1999.

McNish, A. G. and J. V. Lincoln, Prediction of Sunspot Numbers, *Trans. Am. Geophys. Union*, **30**, 673, 1949.

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Niehuss, K.O., H.C. Euler, and W.W. Vaughan, Statistical Technique for Intermediate and Long-Range Estimation of 13-Month Smoothed Solar radio flux and Geomagnetic Index, NASA TM-4759, 1996.

Vaughan, W.W., J.K. Owens, K.O. Niehuss, and M.A. Shea, The NASA Marshall Solar Activity Model for Use in Predicting Satellite Lifetime, *Adv. Space Res.*, **23**, (4)715-(4)719, 1999.

Waldmeier, M., *The Sunspot Activity in the Years 1610-1960*. Zurich Schulthess and Company, Switzerland, 1961.

TABLE 1: RECENT MONTHLY MEAN SOLAR ACTIVITY VALUES				
Year	**Month**	**Solar Flux ($F_{10.7}$ (Series C))**	**Relative Sunspot Numbers (R)**	**Geomagnetic Index (A_P)**
2008	January	74.3	3.3	8.0
	February	71.1	2.1	11.0
	March	72.9	9.3	11.0
	April	70.2	2.9	9.0
	May	68.4	3.2	6.0
	June	65.9	3.4	7.0
	July	65.7	0.8	5.0
	August	66.3	0.5	5.0
	September	67.1	1.1	6.0
	October	68.3	2.9	7.0
	November	68.6	4.1	4.0
	December	69.2	0.8	4.0
2009	January	69.8	1.3	4.0
	February	70.0	1.4	5.0
	March	69.2	0.7	5.0
	April	69.7	0.8	4.0
	May	70.5	2.9	4.0
	June	68.6	2.9	4.0
	July	68.2	3.2	4.0
	August	67.4	0.0	5.0
	September	70.5	4.3	4.0
	October	72.3	4.6	3.0
	November	73.6	4.2	3.0
	December	76.8	10.6	2.0
2010	January	81.1	13.1	3.0
	February	84.7	18.6	5.0
	March	83.4	15.4	5.0
	April	75.9	7.9	10.0
	May	73.8	8.8	8.0
	June	72.5	13.5	7.0
	July	79.8	16.1	5.0
	August	79.5	19.6	8.0
	September	81.1	25.2	5.0
	October	81.7	23.5	6.0
	November	82.5	21.6	5.0
	December	84.2	14.5	4.0

Solar flux in units of 10^4 JANSKY (where one JANSKY equals 10^{-26} W m^{-2} Hz^{-1} Bandwidth)

* Preliminary Estimates

TABLE 1: RECENT MONTHLY MEAN SOLAR ACTIVITY VALUES				
Year	**Month**	**Solar Flux ($F_{10.7}$ (Series C))**	**Relative Sunspot Numbers (R)**	**Geomagnetic Index (A_P)**
2011	January	83.4*	19.0*	6.0*
	February			
	March			
	April			
	May			
	June			
	July			
	August			
	September			
	October			
	November			
	December			
2012	January			
	February			
	March			
	April			
	May			
	June			
	July			
	August			
	September			
	October			
	November			
	December			
2013	January			
	February			
	March			
	April			
	May			
	June			
	July			
	August			
	September			
	October			
	November			
	December			

* Preliminary Estimates

TABLE 2 : 13-MONTH ZURICH SMOOTHED VALUES

Year	Month	+10.7-cm Solar Flux ($\bar{F}_{10.7}$)	++Sunspot Numbers ($\bar{R}$)	+++Geomagnetic Index ($\bar{A}_p$)
1993	January	125.7	71.4	16.0
	February	123.1	69.3	15.9
	March	120.7	66.6	15.3
	April	118.1	63.6	14.9
	May	114.8	59.9	14.9
	June	111.3	56.1	15.0
	July	109.6	54.7	14.9
	August	107.6	52.3	15.4
	September	103.9	48.4	16.0
	October	100.4	44.9	16.4
	November	97.5	41.2	17.4
	December	94.8	38.4	18.1
1994	January	92.7	36.6	18.2
	February	91.2	34.8	18.1
	March	90.2	34.1	17.8
	April	89.3	33.7	18.0
	May	88.1	32.5	18.3
	June	86.7	30.8	18.2
	July	84.5	28.5	18.1
	August	82.5	26.8	17.5
	September	81.7	26.6	16.5
	October	81.4	26.5	15.5
	November	81.2	26.2	14.7
	December	81.0	25.6	14.3
1995	January	80.6	24.2	14.0
	February	80.2	23.0	14.0
	March	79.9	22.1	14.0
	April	79.2	20.6	13.8
	May	78.5	19.2	13.4
	June	77.7	18.2	13.0
	July	76.9	17.0	12.6
	August	76.0	15.4	12.2
	September	74.8	13.4	11.8
	October	73.8	12.1	11.5
	November	73.2	11.4	10.8
	December	72.8	10.8	10.0

* Preliminary Estimates

TABLE 2: 13-MONTH ZURICH SMOOTHED VALUES

Year	Month	+10.7-cm Solar Flux ($\bar{F}_{10.7}$)	++Sunspot Numbers ($\bar{R}$)	+++Geomagnetic Index ($\bar{A}_p$)
1996	January	72.4	10.4	9.7
	February	72.2	10.1	9.7
	March	72.1	9.7	9.8
	April	71.6	8.4	9.7
	May	71.4	8.0	9.5
	June	71.8	8.5	9.4
	July	72.0	8.4	9.3
	August	72.1	8.3	9.4
	September	72.3	8.4	9.3
	October	72.6	8.8	9.1
	November	73.0	9.8	9.1
	December	73.3	10.4	9.2
1997	January	73.4	10.5	9.3
	February	73.7	11.0	9.2
	March	75.1	13.5	8.9
	April	76.8	16.5	8.6
	May	78.4	18.3	8.6
	June	80.1	20.3	8.6
	July	81.8	22.6	8.5
	August	83.4	25.0	8.3
	September	85.7	28.3	8.4
	October	88.6	31.8	8.6
	November	91.3	35.0	9.0
	December	94.2	39.0	9.5
1998	January	97.5	43.7	9.9
	February	101.7	48.9	10.5
	March	105.8	53.4	11.1
	April	108.9	56.5	11.3
	May	112.0	59.4	11.6
	June	115.8	62.5	12.0
	July	120.0	65.5	12.2
	August	124.1	67.8	12.5
	September	126.8	69.5	12.7
	October	127.9	70.5	12.8
	November	130.0	73.0	12.5
	December	134.3	77.9	12.0

* Preliminary Estimates

TABLE 2: 13-MONTH ZURICH SMOOTHED VALUES

Year	Month	+10.7-cm Solar Flux ($\bar{F}_{10.7}$)	++Sunspot Numbers ($\bar{R}$)	+++Geomagnetic Index ($\bar{A}_p$)
1999	January	139.0	82.6	11.8
	February	142.6	84.6	11.6
	March	144.0	83.8	11.8
	April	145.8	85.5	12.2
	May	149.9	90.5	12.4
	June	152.9	93.1	12.4
	July	154.4	94.3	12.6
	August	156.3	97.5	12.9
	September	161.0	102.3	12.8
	October	167.2	107.8	12.7
	November	171.5	111.0	13.1
	December	173.4	111.1	13.8
2000	January	175.5	112.9	14.5
	February	176.8	116.8	15.0
	March	178.4	119.9	15.0
	April	180.5	120.8	14.9
	May	180.1	119.0	15.0
	June	179.7	118.7	15.0
	July	180.2	119.8	14.7
	August	179.4	118.6	14.2
	September	177.1	116.3	14.2
	October	175.5	114.5	15.0
	November	173.8	112.7	15.1
	December	172.0	112.0	14.7
2001	January	168.7	108.7	14.0
	February	165.6	104.0	13.3
	March	167.7	104.8	12.8
	April	171.6	107.5	12.5
	May	174.7	108.6	12.5
	June	178.7	109.8	12.4
	July	183.8	111.7	12.4
	August	188.7	113.6	13.0
	September	191.3	114.1	12.7
	October	191.9	114.0	12.1
	November	193.6	115.5	12.0
	December	193.8	114.6	12.4

* Preliminary Estimates

TABLE 2: 13-MONTH ZURICH SMOOTHED VALUES				
Year	**Month**	**+10.7-cm Solar Flux ($\bar{F}_{10.7}$)**	**++Sunspot Numbers ($\bar{R}$)**	**+++Geomagnetic Index ($\bar{A}_p$)**
2002	January	194.6	113.5	12.3
	February	197.2	114.6	13.1
	March	195.7	113.3	12.2
	April	191.5	110.5	12.5
	May	188.0	108.8	12.7
	June	182.9	106.2	12.9
	July	176.3	102.7	13.7
	August	169.5	98.7	14.2
	September	164.1	94.6	15.0
	October	159.4	90.5	15.6
	November	154.1	85.2	15.8
	December	150.7	82.0	17.1
2003	January	148.0	80.8	18.2
	February	143.6	78.3	18.9
	March	138.3	74.0	19.5
	April	135.0	70.1	20.1
	May	133.1	67.6	22.0
	June	130.2	65.0	21.5
	July	127.2	61.8	22.0
	August	125.2	60.0	22.2
	September	123.7	59.5	21.8
	October	121.8	58.2	21.1
	November	120.1	56.7	20.0
	December	118.0	54.8	18.6
2004	January	116.4	52.0	18.1
	February	115.5	49.3	17.7
	March	114.6	47.1	16.9
	April	112.3	45.6	15.5
	May	109.3	43.8	14.3
	June	107.3	41.6	14.0
	July	106.0	40.2	13.8
	August	105.1	39.2	13.8
	September	103.8	37.5	13.6
	October	102.2	35.9	13.5
	November	101.6	35.3	14.0
	December	101.4	35.2	14.7

* Preliminary Estimates

TABLE 2: 13-MONTH ZURICH SMOOTHED VALUES				
Year	**Month**	**+10.7-cm Solar Flux ($\bar{F}_{10.7}$)**	**++Sunspot Numbers ($\bar{R}$)**	**+++Geomagnetic Index ($\bar{A}_p$)**
2005	January	100.3	34.6	14.1
	February	98.6	33.9	13.9
	March	97.3	33.5	14.6
	April	95.5	31.6	15.1
	May	93.2	28.9	14.4
	June	91.8	28.8	13.6
	July	90.9	29.1	12.8
	August	89.2	27.4	11.8
	September	87.8	25.8	11.4
	October	87.3	25.5	11.3
	November	86.7	24.9	10.8
	December	85.2	23.0	10.1
2006	January	83.6	20.8	9.6
	February	82.3	18.6	9.1
	March	81.2	17.4	8.4
	April	80.6	17.1	7.9
	May	80.5	17.3	7.9
	June	80.3	16.3	8.3
	July	80.0	15.3	8.7
	August	80.1	15.6	8.9
	September	80.0	15.6	8.9
	October	79.1	14.2	8.8
	November	78.2	12.7	8.8
	December	77.8	12.1	8.8
2007	January	77.5	12.0	8.7
	February	76.9	11.6	8.5
	March	76.0	10.8	8.4
	April	75.3	9.9	8.4
	May	74.3	8.7	8.3
	June	73.4	7.7	7.8
	July	72.7	7.0	7.3
	August	72.1	6.1	7.4
	September	71.8	5.9	7.7
	October	71.8	6.1	7.8
	November	71.4	5.7	7.8
	December	70.8	5.0	7.7

* Preliminary Estimates

TABLE 2: 13-MONTH ZURICH SMOOTHED VALUES

Year	Month	+10.7-cm Solar Flux ($\overline{F}_{10.7}$)	++Sunspot Numbers ($\overline{R}$)	+++Geomagnetic Index ($\overline{A}_p$)
2008	January	70.3	4.2	7.7
	February	69.9	3.6	7.5
	March	69.8	3.3	7.4
	April	69.8	3.3	7.3
	May	69.8	3.5	7.2
	June	69.4	3.2	7.0
	July	68.8	2.7	6.8
	August	68.6	2.6	6.3
	September	68.4	2.2	5.8
	October	68.2	1.8	5.4
	November	68.3	1.7	5.1
	December	68.5	1.7	4.9
2009	January	68.7	1.8	4.7
	February	68.9	1.9	4.7
	March	69.0	2.0	4.6
	April	69.3	2.2	4.3
	May	69.7	2.3	4.1
	June	70.2	2.7	4.0
	July	71.0	3.6	3.8
	August	72.1	4.8	3.8
	September	73.3	6.1	3.8
	October	74.2	7.0	4.
	November	74.6	7.6	4.5
	December	74.9	8.3	4.8
2010	January	75.5	9.2	5.0
	February	76.5	10.6	5.1
	March	77.4	12.3	5.3
	April	78.3	13.9	5.5
	May	79.0	15.4	5.7
	June	79.7	16.3	5.8
	July	80.1	16.7	6.0*
	August			
	September			
	October			
	November			
	December			

NOTES:
+ computed and assigned at the mid-point from the National Research Council of Canada, Ottawa and Penticton Series C observed monthly values as received from the National Geophysical Data Center ftp site.
++ computed and assigned at the mid-point from the Sunspot Index Data Center Brussels, Belgium observed monthly values as received from the National Geophysical Data Center ftp site.
+++ computed and assigned at the mid-point from Institute for Geophysics in Gottingen, Germany observed monthly values as received from the National Geophysical Data Center ftp site.

* Preliminary Estimates

TABLE 3 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2010.5837	AUG	83.8	82.0	79.7	6.6	6.2	5.6
2010.6670	SEP	87.6	84.0	80.1	7.8	6.3	5.2
2010.7503	OCT	91.7	86.0	80.5	9.1	6.5	5.2
2010.8337	NOV	95.5	88.1	80.7	9.8	6.7	5.3
2010.9170	DEC	101.0	90.3	81.3	10.2	7.0	5.1
2011.0003	JAN	106.4	92.5	81.5	10.5	7.2	5.2
2011.0837	FEB	111.7	94.8	80.9	11.4	7.8	5.6
2011.1670	MAR	117.4	97.0	80.0	12.6	8.6	5.9
2011.2503	APR	124.0	99.4	78.1	13.6	9.2	6.2
2011.3337	MAY	131.0	101.9	77.8	14.5	9.7	6.6
2011.4170	JUN	137.5	104.3	78.0	14.9	10.1	7.0
2011.5003	JUL	143.6	106.8	77.3	14.5	10.1	7.1
2011.5837	AUG	148.7	108.7	78.0	14.7	10.2	7.1
2011.6670	SEP	152.8	110.5	77.9	14.5	10.4	6.9
2011.7503	OCT	158.7	112.7	76.5	13.8	10.5	6.6
2011.8337	NOV	166.7	115.1	74.5	14.5	10.7	6.4
2011.9170	DEC	174.4	117.7	71.6	14.9	10.9	6.1
2012.0003	JAN	179.6	119.8	68.6	14.9	11.2	5.8
2012.0837	FEB	183.1	121.6	66.8	15.3	11.4	5.5
2012.1670	MAR	186.6	123.5	66.8	15.5	11.4	5.4
2012.2503	APR	190.7	125.5	68.6	15.7	11.2	5.2
2012.3337	MAY	194.0	127.2	70.0	16.4	11.1	4.8
2012.4170	JUN	195.0	128.6	70.3	16.6	11.2	4.8
2012.5003	JUL	193.8	129.9	69.9	16.7	11.7	5.7
2012.5837	AUG	193.1	130.7	68.3	16.9	12.1	6.6
2012.6670	SEP	191.4	131.4	68.3	16.9	12.3	7.3
2012.7503	OCT	190.2	132.0	70.7	16.5	12.2	7.6
2012.8337	NOV	190.1	132.7	72.8	16.4	12.2	7.7
2012.9170	DEC	189.2	133.2	74.2	16.1	12.1	7.7
2013.0003	JAN	188.3	132.8	74.4	15.7	12.2	7.9
2013.0837	FEB	186.8	131.9	74.2	15.6	12.5	8.5
2013.1670	MAR	184.7	131.6	74.6	16.1	12.1	7.9
2013.2503	APR	182.8	132.0	74.8	16.5	11.7	7.1
2013.3337	MAY	182.1	132.6	74.3	17.2	11.6	7.3
2013.4170	JUN	182.1	133.1	72.7	18.6	11.6	7.7
2013.5003	JUL	181.7	133.4	70.7	19.8	11.8	7.6
2013.5837	AUG	181.0	133.6	68.3	20.5	12.0	7.7
2013.6670	SEP	180.2	133.4	66.4	21.7	12.3	7.9
2013.7503	OCT	180.4	133.2	64.3	22.0	12.3	7.9
2013.8337	NOV	181.2	133.2	63.4	21.4	12.4	8.3
2013.9170	DEC	181.6	133.2	62.3	21.4	12.6	8.8
2014.0003	JAN	180.6	132.5	60.6	20.8	12.7	8.7
2014.0837	FEB	178.3	131.3	59.8	18.8	12.5	8.2
2014.1670	MAR	176.1	130.1	58.9	17.1	12.6	8.0
2014.2503	APR	174.5	128.7	58.6	17.9	12.9	8.4
2014.3337	MAY	174.6	127.4	58.2	18.4	13.2	8.5
2014.4170	JUN	175.2	126.4	58.7	18.2	13.3	8.3
2014.5003	JUL	175.9	125.5	59.7	17.7	13.3	8.4
2014.5837	AUG	175.5	124.3	61.7	17.0	12.9	8.1
2014.6670	SEP	174.1	123.1	64.3	16.9	12.7	7.5
2014.7503	OCT	172.3	122.3	66.5	17.2	12.7	7.3
2014.8337	NOV	171.2	121.7	68.3	17.0	12.6	7.0
2014.9170	DEC	170.8	120.9	70.6	16.8	12.8	6.8

TABLE 3 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2015.0003	JAN	168.1	119.7	72.6	16.7	12.8	6.6
2015.0837	FEB	164.6	118.2	73.7	16.9	13.1	6.5
2015.1670	MAR	161.8	117.4	74.9	18.1	13.6	7.0
2015.2503	APR	159.2	116.8	76.2	18.9	13.9	7.5
2015.3337	MAY	157.6	115.9	75.7	19.6	14.2	8.4
2015.4170	JUN	156.3	114.7	75.2	20.0	14.6	9.0
2015.5003	JUL	153.3	113.5	75.7	19.8	14.9	9.3
2015.5837	AUG	148.3	112.3	76.4	19.5	15.2	9.9
2015.6670	SEP	143.0	110.9	76.3	20.3	15.4	10.4
2015.7503	OCT	140.1	109.3	75.7	21.0	15.6	11.0
2015.8337	NOV	138.7	107.6	75.5	21.2	15.7	12.2
2015.9170	DEC	137.4	106.1	75.7	20.8	15.8	11.8
2016.0003	JAN	134.8	104.8	75.9	20.2	15.8	11.5
2016.0837	FEB	132.0	103.4	76.0	19.8	15.5	10.9
2016.1670	MAR	129.3	102.3	76.9	19.5	15.0	10.2
2016.2503	APR	127.2	101.3	77.3	19.2	14.4	9.5
2016.3337	MAY	124.4	100.1	76.8	18.8	13.7	8.5
2016.4170	JUN	120.0	98.9	75.8	18.6	13.1	7.1
2016.5003	JUL	119.6	97.8	75.1	18.4	12.4	5.6
2016.5837	AUG	119.0	96.6	73.8	17.9	11.7	4.7
2016.6670	SEP	118.8	95.6	73.0	17.7	11.3	4.2
2016.7503	OCT	117.9	94.4	72.4	17.6	11.2	3.8
2016.8337	NOV	116.7	93.4	72.1	17.1	10.9	3.5
2016.9170	DEC	116.3	92.5	71.8	16.5	10.7	3.7
2017.0003	JAN	115.4	91.5	71.3	16.0	10.8	4.2
2017.0837	FEB	114.4	90.6	71.2	15.7	11.0	4.9
2017.1670	MAR	113.1	90.0	71.3	15.8	11.5	5.3
2017.2503	APR	109.9	89.2	71.5	15.8	11.8	5.7
2017.3337	MAY	105.9	88.2	71.1	16.5	12.3	6.4
2017.4170	JUN	103.0	87.2	70.7	17.0	12.7	7.2
2017.5003	JUL	101.5	86.4	70.4	17.4	12.9	7.7
2017.5837	AUG	100.2	85.8	70.4	18.0	13.0	8.2
2017.6670	SEP	97.9	85.0	70.0	18.4	13.1	9.0
2017.7503	OCT	96.3	83.9	69.6	18.7	13.0	9.4
2017.8337	NOV	94.4	82.8	69.5	18.6	13.1	9.0
2017.9170	DEC	93.3	82.0	69.5	18.5	13.2	8.8
2018.0003	JAN	93.1	81.3	69.4	18.4	13.6	8.6
2018.0837	FEB	92.3	80.5	69.3	18.0	13.8	8.4
2018.1670	MAR	91.0	79.8	69.1	17.3	13.9	7.9
2018.2503	APR	89.7	79.1	69.0	17.4	13.9	7.6
2018.3337	MAY	88.4	78.3	68.8	17.5	13.8	7.7
2018.4170	JUN	87.1	77.6	68.7	17.6	13.7	7.9
2018.5003	JUL	85.9	76.9	68.5	17.6	13.9	8.6
2018.5837	AUG	84.7	76.3	68.4	18.1	14.3	9.2
2018.6670	SEP	83.5	75.6	68.2	18.6	14.4	9.4
2018.7503	OCT	82.3	75.0	68.1	18.6	14.4	9.6
2018.8337	NOV	81.2	74.3	68.0	18.3	14.1	9.6
2018.9170	DEC	80.2	73.7	67.8	17.5	13.5	9.3
2019.0003	JAN	79.2	73.2	67.7	16.6	12.9	9.0
2019.0837	FEB	78.2	72.7	67.6	15.8	12.4	8.7
2019.1670	MAR	77.3	72.2	67.5	15.1	11.8	8.4
2019.2503	APR	76.5	71.7	67.4	14.3	11.3	8.1
2019.3337	MAY	75.8	71.3	67.3	13.6	10.8	7.9

TABLE 3 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2019.4170	JUN	75.2	70.9	67.2	13.0	10.4	7.7
2019.5003	JUL	74.6	70.6	67.2	12.5	10.0	7.5
2019.5837	AUG	74.1	70.4	67.1	12.0	9.6	7.3
2019.6670	SEP	73.7	70.1	67.1	11.6	9.3	7.1
2019.7503	OCT	73.4	70.0	67.0	11.3	9.1	7.0
2019.8337	NOV	73.3	69.9	67.0	11.1	9.0	7.0
2019.9170	DEC	73.2	69.9	67.0	11.1	9.0	6.9
2020.0003	JAN	73.3	70.0	67.0	11.3	9.0	6.9
2020.0837	FEB	74.0	70.3	67.1	11.6	9.2	7.1
2020.1670	MAR	74.8	70.7	67.2	11.7	9.3	7.4
2020.2503	APR	75.6	71.0	67.2	11.9	9.4	7.5
2020.3337	MAY	76.7	71.5	67.4	12.0	9.5	7.5
2020.4170	JUN	78.2	72.0	67.5	12.1	9.6	7.3
2020.5003	JUL	79.6	72.6	67.6	12.2	9.7	7.2
2020.5837	AUG	81.0	73.3	67.8	12.5	9.9	7.1
2020.6670	SEP	83.3	74.1	67.9	12.8	10.1	7.0
2020.7503	OCT	86.3	75.1	68.0	13.2	10.5	7.2
2020.8337	NOV	91.0	76.3	68.3	13.7	10.8	7.6
2020.9170	DEC	95.4	77.7	68.4	14.5	11.1	7.9
2021.0003	JAN	98.8	79.2	68.4	15.7	11.4	7.7
2021.0837	FEB	103.9	80.9	68.4	16.1	11.6	7.7
2021.1670	MAR	109.8	82.9	68.4	16.3	11.8	7.6
2021.2503	APR	115.6	85.1	68.3	16.8	12.0	7.6
2021.3337	MAY	122.9	87.3	68.6	18.0	12.3	7.6
2021.4170	JUN	131.3	89.9	68.7	18.9	12.6	7.7
2021.5003	JUL	137.8	92.6	68.9	19.1	12.7	7.7
2021.5837	AUG	142.5	95.4	69.2	19.2	12.9	7.8
2021.6670	SEP	146.9	98.2	69.2	19.0	13.1	7.7
2021.7503	OCT	151.3	101.0	69.5	18.6	13.1	7.7
2021.8337	NOV	156.2	103.9	69.9	18.5	13.2	7.8
2021.9170	DEC	161.5	107.0	70.6	18.9	13.4	8.0
2022.0003	JAN	166.8	110.1	70.9	18.8	13.5	8.2
2022.0837	FEB	171.3	113.2	71.3	17.8	13.5	8.6
2022.1670	MAR	177.2	116.5	71.5	17.9	13.7	8.7
2022.2503	APR	184.7	119.7	72.1	18.5	13.9	8.7
2022.3337	MAY	189.7	122.9	72.9	19.1	14.2	9.0
2022.4170	JUN	192.2	125.7	73.3	19.6	14.6	9.4
2022.5003	JUL	194.8	128.2	74.1	20.3	14.9	9.6
2022.5837	AUG	197.9	130.5	74.7	20.3	15.1	9.6
2022.6670	SEP	202.4	132.6	75.1	20.3	15.1	9.8
2022.7503	OCT	208.5	135.1	75.6	20.5	15.2	10.0
2022.8337	NOV	212.6	137.7	75.9	20.8	15.4	10.5
2022.9170	DEC	215.4	140.3	76.1	21.2	15.4	11.1
2023.0003	JAN	219.9	142.4	76.1	21.3	15.3	11.6
2023.0837	FEB	224.3	144.3	76.0	21.4	15.1	11.3
2023.1670	MAR	226.4	146.0	76.1	21.6	15.0	11.2
2023.2503	APR	227.3	147.7	76.6	22.0	15.0	10.7
2023.3337	MAY	229.2	149.0	76.9	22.8	14.9	10.2
2023.4170	JUN	231.4	149.9	77.6	22.5	14.7	9.9
2023.5003	JUL	234.2	150.8	78.9	21.3	14.5	10.1
2023.5837	AUG	237.3	151.2	79.7	20.6	14.3	10.1
2023.6670	SEP	238.6	151.4	80.6	20.1	14.2	10.3
2023.7503	OCT	236.8	151.7	82.2	19.6	14.1	10.6

TABLE 3 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2023.8337	NOV	234.8	151.9	83.8	19.5	14.0	10.6
2023.9170	DEC	235.8	152.0	85.6	19.3	14.0	10.5
2024.0003	JAN	236.3	151.2	86.4	19.1	14.2	10.5
2024.0837	FEB	234.1	149.7	87.8	18.9	14.6	10.5
2024.1670	MAR	230.9	148.7	89.5	18.9	14.7	10.3
2024.2503	APR	227.3	148.4	90.7	19.5	14.6	9.8
2024.3337	MAY	225.6	148.5	93.0	20.4	14.7	10.2
2024.4170	JUN	226.0	148.9	94.2	22.0	15.0	10.7
2024.5003	JUL	226.2	149.0	95.5	23.4	15.3	10.7
2024.5837	AUG	225.0	148.7	95.8	24.0	15.4	10.9
2024.6670	SEP	223.5	148.1	95.4	25.1	15.7	11.1
2024.7503	OCT	223.0	147.5	95.4	25.6	15.9	11.3
2024.8337	NOV	223.0	147.3	96.9	24.9	15.9	11.5
2024.9170	DEC	222.6	147.2	97.7	24.8	15.9	11.7
2025.0003	JAN	221.7	146.4	97.2	23.9	15.8	11.9
2025.0837	FEB	219.4	145.1	96.4	22.1	15.8	11.8
2025.1670	MAR	216.2	143.5	96.3	22.4	15.9	12.0
2025.2503	APR	213.5	141.8	96.8	23.1	16.0	11.8
2025.3337	MAY	210.9	140.1	96.3	23.1	16.0	11.1
2025.4170	JUN	207.5	138.8	95.5	22.6	16.0	10.8
2025.5003	JUL	206.4	137.4	96.1	22.0	15.8	10.8
2025.5837	AUG	204.4	135.6	97.1	21.9	15.8	10.8
2025.6670	SEP	201.0	133.7	96.2	22.7	16.1	10.8
2025.7503	OCT	197.5	132.2	94.5	23.7	16.5	10.8
2025.8337	NOV	195.1	130.9	93.8	23.9	16.7	10.8
2025.9170	DEC	193.0	129.5	93.6	23.9	17.0	10.7
2026.0003	JAN	189.1	127.8	91.7	23.9	17.1	10.6
2026.0837	FEB	184.5	125.9	88.3	23.5	17.2	10.3
2026.1670	MAR	180.1	124.6	87.9	22.5	17.2	10.5
2026.2503	APR	176.3	123.5	88.7	22.7	17.2	10.7
2026.3337	MAY	174.0	122.3	87.3	23.0	17.4	11.4
2026.4170	JUN	172.1	121.0	86.3	23.1	17.6	11.9
2026.5003	JUL	167.8	119.3	85.7	22.5	17.8	12.0
2026.5837	AUG	161.4	117.4	84.8	21.7	17.6	12.1
2026.6670	SEP	155.5	115.6	83.6	21.2	17.4	12.3
2026.7503	OCT	151.9	113.7	82.5	21.7	17.0	12.5
2026.8337	NOV	149.6	111.7	82.1	21.7	16.9	13.3
2026.9170	DEC	147.1	110.0	82.1	22.1	16.9	13.1
2027.0003	JAN	144.1	108.6	82.0	22.6	17.0	12.8
2027.0837	FEB	141.1	107.0	80.9	22.3	16.8	13.1
2027.1670	MAR	137.5	105.5	80.5	22.4	16.5	12.7
2027.2503	APR	133.8	104.0	80.6	22.7	16.2	12.5
2027.3337	MAY	129.6	102.5	80.0	22.9	15.8	12.1
2027.4170	JUN	123.6	100.9	79.1	23.5	15.6	11.2
2027.5003	JUL	119.4	99.4	77.7	24.1	15.4	10.5
2027.5837	AUG	118.6	98.2	75.6	24.8	15.3	10.7
2027.6670	SEP	118.7	97.1	74.5	25.3	15.3	10.8
2027.7503	OCT	119.2	96.1	74.0	25.6	15.3	10.6
2027.8337	NOV	119.6	95.2	73.6	25.4	15.3	10.8
2027.9170	DEC	118.8	94.2	73.4	24.9	15.2	11.0
2028.0003	JAN	117.4	92.9	73.0	24.0	15.0	11.1
2028.0837	FEB	115.8	91.7	72.7	23.0	14.9	11.3
2028.1670	MAR	113.7	90.7	71.9	22.5	15.0	11.2

TABLE 3 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2028.2503	APR	110.2	89.6	71.4	22.1	15.1	11.1
2028.3337	MAY	105.8	88.4	71.0	21.8	15.2	11.2
2028.4170	JUN	103.2	87.3	70.7	21.4	15.3	11.4
2028.5003	JUL	101.6	86.5	70.4	20.7	15.2	11.5
2028.5837	AUG	100.2	85.6	70.5	19.9	14.9	11.3
2028.6670	SEP	98.1	84.7	70.3	20.0	14.7	11.1
2028.7503	OCT	96.6	83.5	69.8	20.1	14.6	10.8
2028.8337	NOV	94.6	82.4	69.6	19.9	14.3	10.1
2028.9170	DEC	93.5	81.7	69.5	19.5	14.2	9.6
2029.0003	JAN	93.2	81.0	69.4	19.0	14.1	9.1
2029.0837	FEB	92.3	80.3	69.3	18.3	14.1	8.6
2029.1670	MAR	91.3	79.6	69.1	17.3	14.0	8.0
2029.2503	APR	90.5	78.9	68.8	17.4	13.8	7.5
2029.3337	MAY	89.7	78.2	68.5	17.5	13.7	7.6
2029.4170	JUN	88.7	77.5	68.3	17.6	13.7	7.8
2029.5003	JUL	87.7	77.0	68.4	17.5	13.6	8.3
2029.5837	AUG	86.9	76.5	68.4	17.7	13.5	8.6
2029.6670	SEP	85.5	75.9	68.5	18.1	13.4	8.5
2029.7503	OCT	84.1	75.4	68.4	17.9	13.2	8.6
2029.8337	NOV	82.2	74.9	68.4	17.6	12.9	8.5
2029.9170	DEC	79.9	74.2	68.3	17.3	12.6	8.5
2030.0003	JAN	78.4	73.5	68.0	16.3	12.2	8.4
2030.0837	FEB	77.5	72.8	67.8	14.8	11.8	8.4
2030.1670	MAR	77.0	72.3	67.6	13.8	11.4	8.3
2030.2503	APR	76.9	72.0	67.6	13.9	11.0	8.2
2030.3337	MAY	76.6	71.6	67.5	13.6	10.6	8.2
2030.4170	JUN	76.5	71.2	67.2	13.2	10.3	7.9
2030.5003	JUL	76.1	70.9	67.1	12.9	9.9	7.4
2030.5837	AUG	75.1	70.6	67.1	12.6	9.7	7.1
2030.6670	SEP	74.2	70.3	67.0	11.9	9.5	7.3
2030.7503	OCT	74.0	70.1	67.0	11.4	9.4	7.1

TABLE 4 ESTIMATES OF 13-MONTH SMOOTHED R AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		SUNSPOT NUMBER ($\bar{R}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2010.5837	AUG	22.1	19.1	16.6	6.6	6.2	5.6
2010.6670	SEP	27.1	21.5	17.2	7.8	6.3	5.2
2010.7503	OCT	32.7	24.1	18.0	9.1	6.5	5.2
2010.8337	NOV	38.9	26.4	17.5	9.8	6.7	5.3
2010.9170	DEC	45.7	28.4	17.0	10.2	7.0	5.1
2011.0003	JAN	52.2	30.9	17.0	10.5	7.2	5.2
2011.0837	FEB	58.2	33.6	19.2	11.4	7.8	5.6
2011.1670	MAR	64.1	36.0	18.8	12.6	8.6	5.9
2011.2503	APR	70.6	38.5	17.1	13.6	9.2	6.2
2011.3337	MAY	74.7	41.1	17.8	14.5	9.7	6.6
2011.4170	JUN	80.1	43.9	18.3	14.9	10.1	7.0
2011.5003	JUL	86.2	46.6	17.4	14.5	10.1	7.1
2011.5837	AUG	91.0	48.3	18.1	14.7	10.2	7.1
2011.6670	SEP	95.4	50.0	18.2	14.5	10.4	6.9
2011.7503	OCT	101.5	52.0	16.3	13.8	10.5	6.6
2011.8337	NOV	109.1	54.3	14.4	14.5	10.7	6.4
2011.9170	DEC	115.6	57.1	12.5	14.9	10.9	6.1
2012.0003	JAN	120.6	59.7	11.0	14.9	11.2	5.8
2012.0837	FEB	124.3	61.8	10.6	15.3	11.4	5.5
2012.1670	MAR	127.7	64.1	10.9	15.5	11.4	5.4
2012.2503	APR	131.6	66.7	12.7	15.7	11.2	5.2
2012.3337	MAY	135.1	69.0	14.1	16.4	11.1	4.8
2012.4170	JUN	136.7	70.9	14.6	16.6	11.2	4.8
2012.5003	JUL	135.8	72.6	14.9	16.7	11.7	5.7
2012.5837	AUG	134.6	74.2	15.4	16.9	12.1	6.6
2012.6670	SEP	137.4	75.7	17.8	16.9	12.3	7.3
2012.7503	OCT	137.8	76.8	20.4	16.5	12.2	7.6
2012.8337	NOV	138.1	78.0	21.7	16.4	12.2	7.7
2012.9170	DEC	140.2	78.8	22.5	16.1	12.1	7.7
2013.0003	JAN	142.3	78.7	22.8	15.7	12.2	7.9
2013.0837	FEB	141.6	78.4	24.3	15.6	12.5	8.5
2013.1670	MAR	140.0	78.9	26.3	16.1	12.1	7.9
2013.2503	APR	138.8	79.9	28.0	16.5	11.7	7.1
2013.3337	MAY	138.4	80.6	28.2	17.2	11.6	7.3
2013.4170	JUN	138.4	80.6	27.0	18.6	11.6	7.7
2013.5003	JUL	138.1	80.5	24.9	19.8	11.8	7.6
2013.5837	AUG	138.6	80.8	23.4	20.5	12.0	7.7
2013.6670	SEP	139.5	81.2	22.8	21.7	12.3	7.9
2013.7503	OCT	140.0	81.3	21.2	22.0	12.3	7.9
2013.8337	NOV	139.2	80.8	19.8	21.4	12.4	8.3
2013.9170	DEC	139.4	80.5	19.2	21.4	12.6	8.8
2014.0003	JAN	138.7	80.0	19.4	20.8	12.7	8.7
2014.0837	FEB	136.5	79.1	19.2	18.8	12.5	8.2
2014.1670	MAR	133.7	77.7	18.7	17.1	12.6	8.0
2014.2503	APR	132.2	76.6	19.1	17.9	12.9	8.4
2014.3337	MAY	130.4	76.1	19.9	18.4	13.2	8.5
2014.4170	JUN	127.7	75.5	20.9	18.2	13.3	8.3
2014.5003	JUL	126.7	74.4	22.1	17.7	13.3	8.4
2014.5837	AUG	128.1	73.4	24.2	17.0	12.9	8.1
2014.6670	SEP	130.8	73.0	25.6	16.9	12.7	7.5
2014.7503	OCT	131.3	72.7	26.4	17.2	12.7	7.3
2014.8337	NOV	129.1	72.1	27.6	17.0	12.6	7.0
2014.9170	DEC	127.6	70.8	27.2	16.8	12.8	6.8
2015.0003	JAN	127.1	69.5	27.2	16.7	12.8	6.6

TABLE 4 ESTIMATES OF 13-MONTH SMOOTHED R AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		SUNSPOT NUMBER ($\bar{R}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2015.0837	FEB	125.0	68.5	27.6	16.9	13.1	6.5
2015.1670	MAR	122.2	67.6	26.6	18.1	13.6	7.0
2015.2503	APR	118.6	66.6	25.0	18.9	13.9	7.5
2015.3337	MAY	114.6	65.6	24.3	19.6	14.2	8.4
2015.4170	JUN	111.7	64.6	23.9	20.0	14.6	9.0
2015.5003	JUL	110.0	63.5	23.3	19.8	14.9	9.3
2015.5837	AUG	106.5	62.1	22.4	19.5	15.2	9.9
2015.6670	SEP	100.2	60.3	22.1	20.3	15.4	10.4
2015.7503	OCT	93.8	58.5	22.4	21.0	15.6	11.0
2015.8337	NOV	90.1	56.7	23.0	21.2	15.7	12.2
2015.9170	DEC	89.1	54.9	22.1	20.8	15.8	11.8
2016.0003	JAN	88.2	53.3	21.5	20.2	15.8	11.5
2016.0837	FEB	86.3	52.4	22.6	19.8	15.5	10.9
2016.1670	MAR	84.8	51.3	23.1	19.5	15.0	10.2
2016.2503	APR	81.9	50.2	23.1	19.2	14.4	9.5
2016.3337	MAY	79.1	49.1	21.7	18.8	13.7	8.5
2016.4170	JUN	75.9	47.9	20.2	18.6	13.1	7.1
2016.5003	JUL	70.7	46.0	18.6	18.4	12.4	5.6
2016.5837	AUG	69.6	44.4	16.6	17.9	11.7	4.7
2016.6670	SEP	70.0	43.2	14.7	17.7	11.3	4.2
2016.7503	OCT	69.2	41.7	13.4	17.6	11.2	3.8
2016.8337	NOV	69.0	40.4	12.0	17.1	10.9	3.5
2016.9170	DEC	68.2	39.1	10.5	16.5	10.7	3.7
2017.0003	JAN	66.7	38.1	9.5	16.0	10.8	4.2
2017.0837	FEB	64.6	37.3	8.7	15.7	11.0	4.9
2017.1670	MAR	61.7	36.3	8.0	15.8	11.5	5.3
2017.2503	APR	57.4	35.3	8.0	15.8	11.8	5.7
2017.3337	MAY	52.8	33.8	8.0	16.5	12.3	6.4
2017.4170	JUN	49.9	32.6	7.5	17.0	12.7	7.2
2017.5003	JUL	50.2	32.0	7.3	17.4	12.9	7.7
2017.5837	AUG	49.5	31.4	7.1	18.0	13.0	8.2
2017.6670	SEP	46.5	30.0	6.9	18.4	13.1	9.0
2017.7503	OCT	44.0	28.3	7.2	18.7	13.0	9.4
2017.8337	NOV	41.8	27.0	7.0	18.6	13.1	9.0
2017.9170	DEC	40.7	25.7	6.4	18.5	13.2	8.8
2018.0003	JAN	39.5	24.3	5.6	18.4	13.6	8.6
2018.0837	FEB	38.8	22.9	5.2	18.0	13.8	8.4
2018.1670	MAR	37.8	21.6	4.4	17.3	13.9	7.9
2018.2503	APR	36.0	20.5	4.1	17.4	13.9	7.6
2018.3337	MAY	34.1	19.4	3.8	17.5	13.8	7.7
2018.4170	JUN	32.4	18.3	3.5	17.6	13.7	7.9
2018.5003	JUL	30.6	17.2	3.2	17.6	13.9	8.6
2018.5837	AUG	28.8	16.2	2.9	18.1	14.3	9.2
2018.6670	SEP	27.1	15.1	2.6	18.6	14.4	9.4
2018.7503	OCT	25.5	14.1	2.3	18.6	14.4	9.6
2018.8337	NOV	23.9	13.2	2.0	18.3	14.1	9.6
2018.9170	DEC	22.4	12.2	1.8	17.5	13.5	9.3
2019.0003	JAN	20.9	11.4	1.5	16.6	12.9	9.0
2019.0837	FEB	19.6	10.5	1.3	15.8	12.4	8.7
2019.1670	MAR	18.3	9.7	1.1	15.1	11.8	8.4
2019.2503	APR	17.1	9.0	0.9	14.3	11.3	8.1
2019.3337	MAY	16.1	8.4	0.7	13.6	10.8	7.9
2019.4170	JUN	15.1	7.8	0.5	13.0	10.4	7.7
2019.5003	JUL	14.3	7.3	0.4	12.5	10.0	7.5

TABLE 4 ESTIMATES OF 13-MONTH SMOOTHED R AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		SUNSPOT NUMBER ($\bar{R}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2019.5837	AUG	13.6	6.9	0.2	12.0	9.6	7.3
2019.6670	SEP	13.0	6.5	0.1	11.6	9.3	7.1
2019.7503	OCT	12.6	6.3	0.1	11.3	9.1	7.0
2019.8337	NOV	12.4	6.1	0.0	11.1	9.0	7.0
2019.9170	DEC	12.3	6.1	0.0	11.1	9.0	6.9
2020.0003	JAN	12.9	6.5	0.4	11.3	9.0	6.9
2020.0837	FEB	14.2	7.2	0.9	11.6	9.2	7.1
2020.1670	MAR	15.4	7.8	1.2	11.7	9.3	7.4
2020.2503	APR	16.6	8.5	1.7	11.9	9.4	7.5
2020.3337	MAY	18.1	9.3	1.8	12.0	9.5	7.5
2020.4170	JUN	20.6	10.2	2.3	12.1	9.6	7.3
2020.5003	JUL	23.0	11.2	2.9	12.2	9.7	7.2
2020.5837	AUG	25.1	12.3	3.1	12.5	9.9	7.1
2020.6670	SEP	28.3	13.6	3.2	12.8	10.1	7.0
2020.7503	OCT	32.2	15.1	3.5	13.2	10.5	7.2
2020.8337	NOV	38.2	16.9	3.5	13.7	10.8	7.6
2020.9170	DEC	43.7	19.0	3.5	14.5	11.1	7.9
2021.0003	JAN	47.9	21.0	4.2	15.7	11.4	7.7
2021.0837	FEB	54.1	23.4	4.3	16.1	11.6	7.7
2021.1670	MAR	60.7	25.9	4.3	16.3	11.8	7.6
2021.2503	APR	66.8	28.4	4.8	16.8	12.0	7.6
2021.3337	MAY	74.4	31.2	4.8	18.0	12.3	7.6
2021.4170	JUN	83.1	34.5	5.2	18.9	12.6	7.7
2021.5003	JUL	89.9	37.8	5.8	19.1	12.7	7.7
2021.5837	AUG	95.1	41.3	6.8	19.2	12.9	7.8
2021.6670	SEP	100.0	44.8	7.7	19.0	13.1	7.7
2021.7503	OCT	105.0	48.2	9.1	18.6	13.1	7.7
2021.8337	NOV	110.5	51.5	9.8	18.5	13.2	7.8
2021.9170	DEC	116.5	54.9	9.9	18.9	13.4	8.0
2022.0003	JAN	122.0	58.5	11.2	18.8	13.5	8.2
2022.0837	FEB	126.8	62.1	12.4	17.8	13.5	8.6
2022.1670	MAR	134.1	65.8	13.4	17.9	13.7	8.7
2022.2503	APR	141.4	69.4	14.6	18.5	13.9	8.7
2022.3337	MAY	146.1	72.7	15.1	19.1	14.2	9.0
2022.4170	JUN	147.9	75.6	15.6	19.6	14.6	9.4
2022.5003	JUL	151.0	78.5	16.2	20.3	14.9	9.6
2022.5837	AUG	154.7	80.9	16.7	20.3	15.1	9.6
2022.6670	SEP	158.4	83.0	17.1	20.3	15.1	9.8
2022.7503	OCT	163.8	85.3	17.1	20.5	15.2	10.0
2022.8337	NOV	167.3	87.7	16.7	20.8	15.4	10.5
2022.9170	DEC	169.1	90.1	16.4	21.2	15.4	11.1
2023.0003	JAN	172.9	92.3	16.8	21.3	15.3	11.6
2023.0837	FEB	177.6	94.2	17.5	21.4	15.1	11.3
2023.1670	MAR	180.4	96.2	18.7	21.6	15.0	11.2
2023.2503	APR	182.4	98.4	20.6	22.0	15.0	10.7
2023.3337	MAY	185.0	100.2	21.8	22.8	14.9	10.2
2023.4170	JUN	187.4	101.3	23.1	22.5	14.7	9.9
2023.5003	JUL	189.5	102.2	25.4	21.3	14.5	10.1
2023.5837	AUG	190.7	102.4	28.1	20.6	14.3	10.1
2023.6670	SEP	192.2	102.8	30.7	20.1	14.2	10.3
2023.7503	OCT	192.5	103.6	32.1	19.6	14.1	10.6
2023.8337	NOV	192.1	104.1	33.4	19.5	14.0	10.6
2023.9170	DEC	193.4	104.4	35.7	19.3	14.0	10.5
2024.0003	JAN	193.9	103.6	37.4	19.1	14.2	10.5

TABLE 4 ESTIMATES OF 13-MONTH SMOOTHED R AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		SUNSPOT NUMBER ($\bar{R}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2024.0837	FEB	190.8	102.1	39.6	18.9	14.6	10.5
2024.1670	MAR	186.3	101.2	41.2	18.9	14.7	10.3
2024.2503	APR	181.9	100.7	42.7	19.5	14.6	9.8
2024.3337	MAY	179.6	100.4	43.9	20.4	14.7	10.2
2024.4170	JUN	178.9	100.1	43.8	22.0	15.0	10.7
2024.5003	JUL	177.8	99.7	43.3	23.4	15.3	10.7
2024.5837	AUG	176.5	99.1	44.0	24.0	15.4	10.9
2024.6670	SEP	175.3	98.5	45.9	25.1	15.7	11.1
2024.7503	OCT	174.5	98.0	46.0	25.6	15.9	11.3
2024.8337	NOV	173.4	97.4	45.1	24.9	15.9	11.5
2024.9170	DEC	172.3	96.6	44.4	24.8	15.9	11.7
2025.0003	JAN	170.7	95.7	44.9	23.9	15.8	11.9
2025.0837	FEB	168.1	94.1	45.4	22.1	15.8	11.8
2025.1670	MAR	164.2	92.1	44.3	22.4	15.9	12.0
2025.2503	APR	161.0	90.3	43.7	23.1	16.0	11.8
2025.3337	MAY	157.9	89.1	44.7	23.1	16.0	11.1
2025.4170	JUN	153.9	87.8	45.7	22.6	16.0	10.8
2025.5003	JUL	150.5	86.2	44.6	22.0	15.8	10.8
2025.5837	AUG	146.4	84.3	42.6	21.9	15.8	10.8
2025.6670	SEP	142.9	82.9	41.6	22.7	16.1	10.8
2025.7503	OCT	142.0	81.8	41.3	23.7	16.5	10.8
2025.8337	NOV	138.7	80.3	39.3	23.9	16.7	10.8
2025.9170	DEC	136.4	78.4	35.0	23.9	17.0	10.7
2026.0003	JAN	135.3	76.6	34.1	23.9	17.1	10.6
2026.0837	FEB	132.3	74.9	35.4	23.5	17.2	10.3
2026.1670	MAR	128.8	73.5	34.6	22.5	17.2	10.5
2026.2503	APR	124.8	72.3	32.7	22.7	17.2	10.7
2026.3337	MAY	120.7	71.1	31.7	23.0	17.4	11.4
2026.4170	JUN	117.2	69.7	30.9	23.1	17.6	11.9
2026.5003	JUL	114.8	68.0	29.4	22.5	17.8	12.0
2026.5837	AUG	110.8	66.0	27.7	21.7	17.6	12.1
2026.6670	SEP	104.4	63.7	26.7	21.2	17.4	12.3
2026.7503	OCT	97.6	61.3	26.3	21.7	17.0	12.5
2026.8337	NOV	93.7	59.4	26.6	21.7	16.9	13.3
2026.9170	DEC	92.5	57.7	25.8	22.1	16.9	13.1
2027.0003	JAN	91.4	56.1	24.3	22.6	17.0	12.8
2027.0837	FEB	88.9	54.7	24.4	22.3	16.8	13.1
2027.1670	MAR	86.8	53.1	23.8	22.4	16.5	12.7
2027.2503	APR	83.1	51.4	22.7	22.7	16.2	12.5
2027.3337	MAY	79.8	49.8	21.9	22.9	15.8	12.1
2027.4170	JUN	76.3	48.2	20.4	23.5	15.6	11.2
2027.5003	JUL	71.0	46.4	18.9	24.1	15.4	10.5
2027.5837	AUG	69.8	44.7	16.7	24.8	15.3	10.7
2027.6670	SEP	70.1	43.5	14.9	25.3	15.3	10.8
2027.7503	OCT	69.7	42.3	13.7	25.6	15.3	10.6
2027.8337	NOV	69.6	41.1	11.9	25.4	15.3	10.8
2027.9170	DEC	68.8	39.7	10.4	24.9	15.2	11.0
2028.0003	JAN	66.8	38.2	9.5	24.0	15.0	11.1
2028.0837	FEB	64.1	36.8	8.7	23.0	14.9	11.3
2028.1670	MAR	60.9	35.5	7.9	22.5	15.0	11.2
2028.2503	APR	56.4	34.1	7.8	22.1	15.1	11.1
2028.3337	MAY	52.1	32.5	7.9	21.8	15.2	11.2
2028.4170	JUN	49.0	31.3	7.6	21.4	15.3	11.4
2028.5003	JUL	49.8	30.5	7.5	20.7	15.2	11.5

TABLE 4 ESTIMATES OF 13-MONTH SMOOTHED R AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		SUNSPOT NUMBER ($\bar{R}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		95.0%	50%	5.0%	95.0%	50%	5.0%
2028.5837	AUG	49.0	29.5	7.4	19.9	14.9	11.3
2028.6670	SEP	46.4	28.2	7.1	20.0	14.7	11.1
2028.7503	OCT	44.0	26.8	6.5	20.1	14.6	10.8
2028.8337	NOV	42.0	25.7	6.5	19.9	14.3	10.1
2028.9170	DEC	40.9	24.9	6.1	19.5	14.2	9.6
2029.0003	JAN	39.5	23.8	5.5	19.0	14.1	9.1
2029.0837	FEB	38.8	22.8	5.2	18.3	14.1	8.6
2029.1670	MAR	38.1	21.9	4.6	17.3	14.0	8.0
2029.2503	APR	37.7	21.0	3.8	17.4	13.8	7.5
2029.3337	MAY	36.9	20.0	3.6	17.5	13.7	7.6
2029.4170	JUN	35.9	19.2	3.5	17.6	13.7	7.8
2029.5003	JUL	34.7	18.3	3.3	17.5	13.6	8.3
2029.5837	AUG	33.3	17.4	3.2	17.7	13.5	8.6
2029.6670	SEP	31.6	16.5	2.6	18.1	13.4	8.5
2029.7503	OCT	29.7	15.5	2.0	17.9	13.2	8.6
2029.8337	NOV	27.1	14.8	1.6	17.6	12.9	8.5
2029.9170	DEC	24.5	13.8	1.6	17.3	12.6	8.5
2030.0003	JAN	22.1	12.6	1.3	16.3	12.2	8.4
2030.0837	FEB	20.3	11.5	0.9	14.8	11.8	8.4
2030.1670	MAR	19.2	10.5	0.6	13.8	11.4	8.3
2030.2503	APR	18.9	9.7	0.6	13.9	11.0	8.2
2030.3337	MAY	18.5	9.1	0.5	13.6	10.6	8.2
2030.4170	JUN	18.2	8.5	0.4	13.2	10.3	7.9
2030.5003	JUL	16.8	8.0	0.3	12.9	9.9	7.4
2030.5837	AUG	15.9	7.5	0.2	12.6	9.7	7.1
2030.6670	SEP	15.8	7.0	0.1	11.9	9.5	7.3
2030.7503	OCT	15.0	6.5	0.0	11.4	9.4	7.1

TABLE 5 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		75.0%	50%	5.0%	95.0%	50%	5.0%
2010.5837	AUG	83.4	82.0	79.7	6.6	6.2	5.6
2010.6670	SEP	85.9	84.0	80.1	7.8	6.3	5.2
2010.7503	OCT	88.7	86.0	80.5	9.1	6.5	5.2
2010.8337	NOV	91.6	88.1	80.7	9.8	6.7	5.3
2010.9170	DEC	94.8	90.3	81.3	10.2	7.0	5.1
2011.0003	JAN	97.6	92.5	81.5	10.5	7.2	5.2
2011.0837	FEB	99.3	94.8	80.9	11.4	7.8	5.6
2011.1670	MAR	102.3	97.0	80.0	12.6	8.6	5.9
2011.2503	APR	105.0	99.4	78.1	13.6	9.2	6.2
2011.3337	MAY	108.8	101.9	77.8	14.5	9.7	6.6
2011.4170	JUN	112.0	104.3	78.0	14.9	10.1	7.0
2011.5003	JUL	115.1	106.8	77.3	14.5	10.1	7.1
2011.5837	AUG	117.9	108.7	78.0	14.7	10.2	7.1
2011.6670	SEP	122.2	110.5	77.9	14.5	10.4	6.9
2011.7503	OCT	127.4	112.7	76.5	13.8	10.5	6.6
2011.8337	NOV	133.7	115.1	74.5	14.5	10.7	6.4
2011.9170	DEC	139.3	117.7	71.6	14.9	10.9	6.1
2012.0003	JAN	141.8	119.8	68.6	14.9	11.2	5.8
2012.0837	FEB	142.9	121.6	66.8	15.3	11.4	5.5
2012.1670	MAR	143.4	123.5	66.8	15.5	11.4	5.4
2012.2503	APR	144.8	125.5	68.6	15.7	11.2	5.2
2012.3337	MAY	149.2	127.2	70.0	16.4	11.1	4.8
2012.4170	JUN	152.5	128.6	70.3	16.6	11.2	4.8
2012.5003	JUL	153.6	129.9	69.9	16.7	11.7	5.7
2012.5837	AUG	152.2	130.7	68.3	16.9	12.1	6.6
2012.6670	SEP	150.5	131.4	68.3	16.9	12.3	7.3
2012.7503	OCT	153.5	132.0	70.7	16.5	12.2	7.6
2012.8337	NOV	157.2	132.7	72.8	16.4	12.2	7.7
2012.9170	DEC	162.5	133.2	74.2	16.1	12.1	7.7
2013.0003	JAN	160.3	132.8	74.4	15.7	12.2	7.9
2013.0837	FEB	159.2	131.9	74.2	15.6	12.5	8.5
2013.1670	MAR	157.3	131.6	74.6	16.1	12.1	7.9
2013.2503	APR	154.8	132.0	74.8	16.5	11.7	7.1
2013.3337	MAY	155.0	132.6	74.3	17.2	11.6	7.3
2013.4170	JUN	156.2	133.1	72.7	18.6	11.6	7.7
2013.5003	JUL	157.9	133.4	70.7	19.8	11.8	7.6
2013.5837	AUG	160.8	133.6	68.3	20.5	12.0	7.7
2013.6670	SEP	159.7	133.4	66.4	21.7	12.3	7.9
2013.7503	OCT	159.3	133.2	64.3	22.0	12.3	7.9
2013.8337	NOV	158.9	133.2	63.4	21.4	12.4	8.3
2013.9170	DEC	159.1	133.2	62.3	21.4	12.6	8.8
2014.0003	JAN	156.9	132.5	60.6	20.8	12.7	8.7
2014.0837	FEB	154.9	131.3	59.8	18.8	12.5	8.2
2014.1670	MAR	152.3	130.1	58.9	17.1	12.6	8.0
2014.2503	APR	151.3	128.7	58.6	17.9	12.9	8.4
2014.3337	MAY	148.4	127.4	58.2	18.4	13.2	8.5
2014.4170	JUN	144.2	126.4	58.7	18.2	13.3	8.3
2014.5003	JUL	142.5	125.5	59.7	17.7	13.3	8.4
2014.5837	AUG	141.1	124.3	61.7	17.0	12.9	8.1
2014.6670	SEP	139.0	123.1	64.3	16.9	12.7	7.5
2014.7503	OCT	136.0	122.3	66.5	17.2	12.7	7.3
2014.8337	NOV	133.3	121.7	68.3	17.0	12.6	7.0
2014.9170	DEC	136.1	120.9	70.6	16.8	12.8	6.8

TABLE 5 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		75.0%	50%	5.0%	95.0%	50%	5.0%
2015.0003	JAN	138.2	119.7	72.6	16.7	12.8	6.6
2015.0837	FEB	135.6	118.2	73.7	16.9	13.1	6.5
2015.1670	MAR	133.9	117.4	74.9	18.1	13.6	7.0
2015.2503	APR	133.7	116.8	76.2	18.9	13.9	7.5
2015.3337	MAY	131.8	115.9	75.7	19.6	14.2	8.4
2015.4170	JUN	129.2	114.7	75.2	20.0	14.6	9.0
2015.5003	JUL	125.7	113.5	75.7	19.8	14.9	9.3
2015.5837	AUG	124.6	112.3	76.4	19.5	15.2	9.9
2015.6670	SEP	124.4	110.9	76.3	20.3	15.4	10.4
2015.7503	OCT	122.4	109.3	75.7	21.0	15.6	11.0
2015.8337	NOV	120.9	107.6	75.5	21.2	15.7	12.2
2015.9170	DEC	119.6	106.1	75.7	20.8	15.8	11.8
2016.0003	JAN	117.2	104.8	75.9	20.2	15.8	11.5
2016.0837	FEB	116.6	103.4	76.0	19.8	15.5	10.9
2016.1670	MAR	115.1	102.3	76.9	19.5	15.0	10.2
2016.2503	APR	113.6	101.3	77.3	19.2	14.4	9.5
2016.3337	MAY	112.7	100.1	76.8	18.8	13.7	8.5
2016.4170	JUN	111.2	98.9	75.8	18.6	13.1	7.1
2016.5003	JUL	110.0	97.8	75.1	18.4	12.4	5.6
2016.5837	AUG	107.4	96.6	73.8	17.9	11.7	4.7
2016.6670	SEP	105.0	95.6	73.0	17.7	11.3	4.2
2016.7503	OCT	104.4	94.4	72.4	17.6	11.2	3.8
2016.8337	NOV	102.2	93.4	72.1	17.1	10.9	3.5
2016.9170	DEC	100.3	92.5	71.8	16.5	10.7	3.7
2017.0003	JAN	99.1	91.5	71.3	16.0	10.8	4.2
2017.0837	FEB	98.4	90.6	71.2	15.7	11.0	4.9
2017.1670	MAR	98.4	90.0	71.3	15.8	11.5	5.3
2017.2503	APR	98.3	89.2	71.5	15.8	11.8	5.7
2017.3337	MAY	97.9	88.2	71.1	16.5	12.3	6.4
2017.4170	JUN	97.0	87.2	70.7	17.0	12.7	7.2
2017.5003	JUL	95.7	86.4	70.4	17.4	12.9	7.7
2017.5837	AUG	95.0	85.8	70.4	18.0	13.0	8.2
2017.6670	SEP	93.5	85.0	70.0	18.4	13.1	9.0
2017.7503	OCT	91.6	83.9	69.6	18.7	13.0	9.4
2017.8337	NOV	89.8	82.8	69.5	18.6	13.1	9.0
2017.9170	DEC	88.6	82.0	69.5	18.5	13.2	8.8
2018.0003	JAN	87.1	81.3	69.4	18.4	13.6	8.6
2018.0837	FEB	86.0	80.5	69.3	18.0	13.8	8.4
2018.1670	MAR	85.0	79.8	69.1	17.3	13.9	7.9
2018.2503	APR	84.0	79.1	69.0	17.4	13.9	7.6
2018.3337	MAY	83.0	78.3	68.8	17.5	13.8	7.7
2018.4170	JUN	82.0	77.6	68.7	17.6	13.7	7.9
2018.5003	JUL	81.1	76.9	68.5	17.6	13.9	8.6
2018.5837	AUG	80.2	76.3	68.4	18.1	14.3	9.2
2018.6670	SEP	79.3	75.6	68.2	18.6	14.4	9.4
2018.7503	OCT	78.4	75.0	68.1	18.6	14.4	9.6
2018.8337	NOV	77.5	74.3	68.0	18.3	14.1	9.6
2018.9170	DEC	76.7	73.7	67.8	17.5	13.5	9.3
2019.0003	JAN	76.0	73.2	67.7	16.6	12.9	9.0
2019.0837	FEB	75.2	72.7	67.6	15.8	12.4	8.7
2019.1670	MAR	74.6	72.2	67.5	15.1	11.8	8.4
2019.2503	APR	73.9	71.7	67.4	14.3	11.3	8.1
2019.3337	MAY	73.4	71.3	67.3	13.6	10.8	7.9

TABLE 5 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		75.0%	50%	5.0%	95.0%	50%	5.0%
2019.4170	JUN	72.9	70.9	67.2	13.0	10.4	7.7
2019.5003	JUL	72.4	70.6	67.2	12.5	10.0	7.5
2019.5837	AUG	72.1	70.4	67.1	12.0	9.6	7.3
2019.6670	SEP	71.8	70.1	67.1	11.6	9.3	7.1
2019.7503	OCT	71.6	70.0	67.0	11.3	9.1	7.0
2019.8337	NOV	71.4	69.9	67.0	11.1	9.0	7.0
2019.9170	DEC	71.4	69.9	67.0	11.1	9.0	6.9
2020.0003	JAN	71.9	70.0	67.0	11.3	9.0	6.9
2020.0837	FEB	72.1	70.3	67.1	11.6	9.2	7.1
2020.1670	MAR	72.8	70.7	67.2	11.7	9.3	7.4
2020.2503	APR	72.5	71.0	67.2	11.9	9.4	7.5
2020.3337	MAY	72.9	71.5	67.4	12.0	9.5	7.5
2020.4170	JUN	73.3	72.0	67.5	12.1	9.6	7.3
2020.5003	JUL	73.8	72.6	67.6	12.2	9.7	7.2
2020.5837	AUG	75.1	73.3	67.8	12.5	9.9	7.1
2020.6670	SEP	76.7	74.1	67.9	12.8	10.1	7.0
2020.7503	OCT	78.1	75.1	68.0	13.2	10.5	7.2
2020.8337	NOV	79.9	76.3	68.3	13.7	10.8	7.6
2020.9170	DEC	82.0	77.7	68.4	14.5	11.1	7.9
2021.0003	JAN	85.2	79.2	68.4	15.7	11.4	7.7
2021.0837	FEB	88.2	80.9	68.4	16.1	11.6	7.7
2021.1670	MAR	90.2	82.9	68.4	16.3	11.8	7.6
2021.2503	APR	92.2	85.1	68.3	16.8	12.0	7.6
2021.3337	MAY	95.6	87.3	68.6	18.0	12.3	7.6
2021.4170	JUN	99.1	89.9	68.7	18.9	12.6	7.7
2021.5003	JUL	103.5	92.6	68.9	19.1	12.7	7.7
2021.5837	AUG	108.5	95.4	69.2	19.2	12.9	7.8
2021.6670	SEP	112.0	98.2	69.2	19.0	13.1	7.7
2021.7503	OCT	116.5	101.0	69.5	18.6	13.1	7.7
2021.8337	NOV	120.8	103.9	69.9	18.5	13.2	7.8
2021.9170	DEC	124.1	107.0	70.6	18.9	13.4	8.0
2022.0003	JAN	126.7	110.1	70.9	18.8	13.5	8.2
2022.0837	FEB	129.2	113.2	71.3	17.8	13.5	8.6
2022.1670	MAR	133.3	116.5	71.5	17.9	13.7	8.7
2022.2503	APR	138.2	119.7	72.1	18.5	13.9	8.7
2022.3337	MAY	142.8	122.9	72.9	19.1	14.2	9.0
2022.4170	JUN	148.3	125.7	73.3	19.6	14.6	9.4
2022.5003	JUL	152.9	128.2	74.1	20.3	14.9	9.6
2022.5837	AUG	157.7	130.5	74.7	20.3	15.1	9.6
2022.6670	SEP	163.7	132.6	75.1	20.3	15.1	9.8
2022.7503	OCT	169.4	135.1	75.6	20.5	15.2	10.0
2022.8337	NOV	174.6	137.7	75.9	20.8	15.4	10.5
2022.9170	DEC	180.2	140.3	76.1	21.2	15.4	11.1
2023.0003	JAN	183.5	142.4	76.1	21.3	15.3	11.6
2023.0837	FEB	185.6	144.3	76.0	21.4	15.1	11.3
2023.1670	MAR	185.7	146.0	76.1	21.6	15.0	11.2
2023.2503	APR	185.2	147.7	76.6	22.0	15.0	10.7
2023.3337	MAY	184.2	149.0	76.9	22.8	14.9	10.2
2023.4170	JUN	184.6	149.9	77.6	22.5	14.7	9.9
2023.5003	JUL	187.3	150.8	78.9	21.3	14.5	10.1
2023.5837	AUG	190.1	151.2	79.7	20.6	14.3	10.1
2023.6670	SEP	191.7	151.4	80.6	20.1	14.2	10.3
2023.7503	OCT	191.8	151.7	82.2	19.6	14.1	10.6

TABLE 5 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		75.0%	50%	5.0%	95.0%	50%	5.0%
2023.8337	NOV	191.4	151.9	83.8	19.5	14.0	10.6
2023.9170	DEC	189.8	152.0	85.6	19.3	14.0	10.5
2024.0003	JAN	186.5	151.2	86.4	19.1	14.2	10.5
2024.0837	FEB	182.2	149.7	87.8	18.9	14.6	10.5
2024.1670	MAR	177.4	148.7	89.5	18.9	14.7	10.3
2024.2503	APR	173.9	148.4	90.7	19.5	14.6	9.8
2024.3337	MAY	177.0	148.5	93.0	20.4	14.7	10.2
2024.4170	JUN	176.6	148.9	94.2	22.0	15.0	10.7
2024.5003	JUL	173.8	149.0	95.5	23.4	15.3	10.7
2024.5837	AUG	172.7	148.7	95.8	24.0	15.4	10.9
2024.6670	SEP	171.7	148.1	95.4	25.1	15.7	11.1
2024.7503	OCT	170.6	147.5	95.4	25.6	15.9	11.3
2024.8337	NOV	167.1	147.3	96.9	24.9	15.9	11.5
2024.9170	DEC	163.8	147.2	97.7	24.8	15.9	11.7
2025.0003	JAN	161.2	146.4	97.2	23.9	15.8	11.9
2025.0837	FEB	158.7	145.1	96.4	22.1	15.8	11.8
2025.1670	MAR	155.9	143.5	96.3	22.4	15.9	12.0
2025.2503	APR	155.7	141.8	96.8	23.1	16.0	11.8
2025.3337	MAY	156.4	140.1	96.3	23.1	16.0	11.1
2025.4170	JUN	154.9	138.8	95.5	22.6	16.0	10.8
2025.5003	JUL	151.2	137.4	96.1	22.0	15.8	10.8
2025.5837	AUG	147.1	135.6	97.1	21.9	15.8	10.8
2025.6670	SEP	144.2	133.7	96.2	22.7	16.1	10.8
2025.7503	OCT	144.9	132.2	94.5	23.7	16.5	10.8
2025.8337	NOV	142.3	130.9	93.8	23.9	16.7	10.8
2025.9170	DEC	137.0	129.5	93.6	23.9	17.0	10.7
2026.0003	JAN	134.3	127.8	91.7	23.9	17.1	10.6
2026.0837	FEB	134.9	125.9	88.3	23.5	17.2	10.3
2026.1670	MAR	134.0	124.6	87.9	22.5	17.2	10.5
2026.2503	APR	134.3	123.5	88.7	22.7	17.2	10.7
2026.3337	MAY	132.9	122.3	87.3	23.0	17.4	11.4
2026.4170	JUN	131.5	121.0	86.3	23.1	17.6	11.9
2026.5003	JUL	130.4	119.3	85.7	22.5	17.8	12.0
2026.5837	AUG	129.7	117.4	84.8	21.7	17.6	12.1
2026.6670	SEP	126.8	115.6	83.6	21.2	17.4	12.3
2026.7503	OCT	125.7	113.7	82.5	21.7	17.0	12.5
2026.8337	NOV	125.9	111.7	82.1	21.7	16.9	13.3
2026.9170	DEC	124.1	110.0	82.1	22.1	16.9	13.1
2027.0003	JAN	122.4	108.6	82.0	22.6	17.0	12.8
2027.0837	FEB	120.8	107.0	80.9	22.3	16.8	13.1
2027.1670	MAR	118.9	105.5	80.5	22.4	16.5	12.7
2027.2503	APR	116.4	104.0	80.6	22.7	16.2	12.5
2027.3337	MAY	115.2	102.5	80.0	22.9	15.8	12.1
2027.4170	JUN	114.2	100.9	79.1	23.5	15.6	11.2
2027.5003	JUL	111.9	99.4	77.7	24.1	15.4	10.5
2027.5837	AUG	108.1	98.2	75.6	24.8	15.3	10.7
2027.6670	SEP	106.6	97.1	74.5	25.3	15.3	10.8
2027.7503	OCT	105.0	96.1	74.0	25.6	15.3	10.6
2027.8337	NOV	104.3	95.2	73.6	25.4	15.3	10.8
2027.9170	DEC	102.5	94.2	73.4	24.9	15.2	11.0
2028.0003	JAN	100.8	92.9	73.0	24.0	15.0	11.1
2028.0837	FEB	99.1	91.7	72.7	23.0	14.9	11.3
2028.1670	MAR	98.3	90.7	71.9	22.5	15.0	11.2

TABLE 5 ESTIMATES OF 13-MONTH SMOOTHED $F_{10.7}$ AND A_p FOR CYCLE 24 AND CYCLE 25

TIME		10.7-CM SOLAR FLUX ($\bar{F}_{10.7}$) PERCENTILE			GEOMAGNETIC INDEX ($\bar{A}_p$) PERCENTILE		
		75.0%	50%	5.0%	95.0%	50%	5.0%
2028.2503	APR	98.3	89.6	71.4	22.1	15.1	11.1
2028.3337	MAY	97.9	88.4	71.0	21.8	15.2	11.2
2028.4170	JUN	97.0	87.3	70.7	21.4	15.3	11.4
2028.5003	JUL	95.7	86.5	70.4	20.7	15.2	11.5
2028.5837	AUG	95.0	85.6	70.5	19.9	14.9	11.3
2028.6670	SEP	93.3	84.7	70.3	20.0	14.7	11.1
2028.7503	OCT	91.0	83.5	69.8	20.1	14.6	10.8
2028.8337	NOV	89.6	82.4	69.6	19.9	14.3	10.1
2028.9170	DEC	88.2	81.7	69.5	19.5	14.2	9.6
2029.0003	JAN	86.7	81.0	69.4	19.0	14.1	9.1
2029.0837	FEB	86.0	80.3	69.3	18.3	14.1	8.6
2029.1670	MAR	85.4	79.6	69.1	17.3	14.0	8.0
2029.2503	APR	84.3	78.9	68.8	17.4	13.8	7.5
2029.3337	MAY	82.9	78.2	68.5	17.5	13.7	7.6
2029.4170	JUN	81.8	77.5	68.3	17.6	13.7	7.8
2029.5003	JUL	81.3	77.0	68.4	17.5	13.6	8.3
2029.5837	AUG	81.0	76.5	68.4	17.7	13.5	8.6
2029.6670	SEP	80.8	75.9	68.5	18.1	13.4	8.5
2029.7503	OCT	79.4	75.4	68.4	17.9	13.2	8.6
2029.8337	NOV	78.0	74.9	68.4	17.6	12.9	8.5
2029.9170	DEC	77.4	74.2	68.3	17.3	12.6	8.5
2030.0003	JAN	76.8	73.5	68.0	16.3	12.2	8.4
2030.0837	FEB	75.8	72.8	67.8	14.8	11.8	8.4
2030.1670	MAR	75.6	72.3	67.6	13.8	11.4	8.3
2030.2503	APR	74.6	72.0	67.6	13.9	11.0	8.2
2030.3337	MAY	73.4	71.6	67.5	13.6	10.6	8.2
2030.4170	JUN	73.5	71.2	67.2	13.2	10.3	7.9
2030.5003	JUL	72.6	70.9	67.1	12.9	9.9	7.4
2030.5837	AUG	72.3	70.6	67.1	12.6	9.7	7.1
2030.6670	SEP	72.2	70.3	67.0	11.9	9.5	7.3
2030.7503	OCT	71.9	70.1	67.0	11.4	9.4	7.1

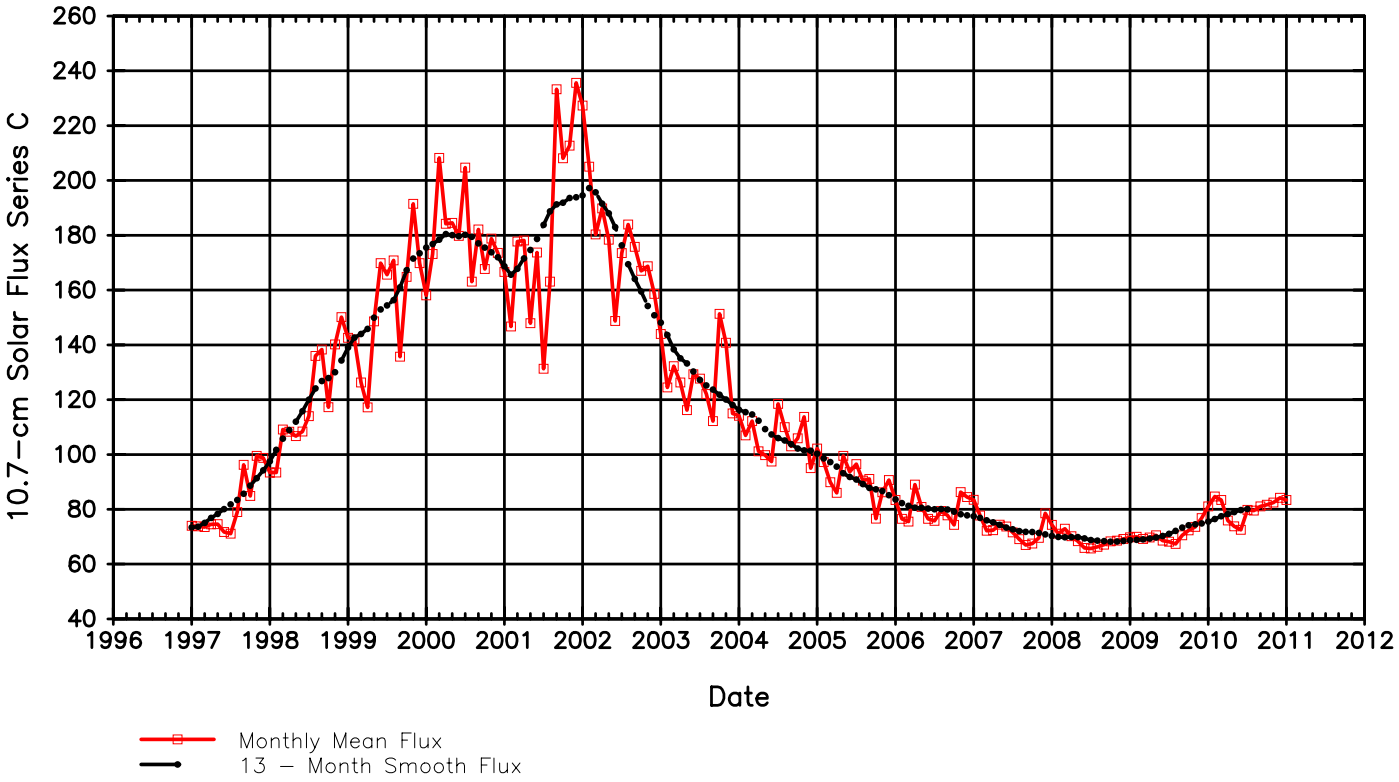

Figure 1. Plot of Recent Monthly Mean and 13-Month Smoothed Solar Flux

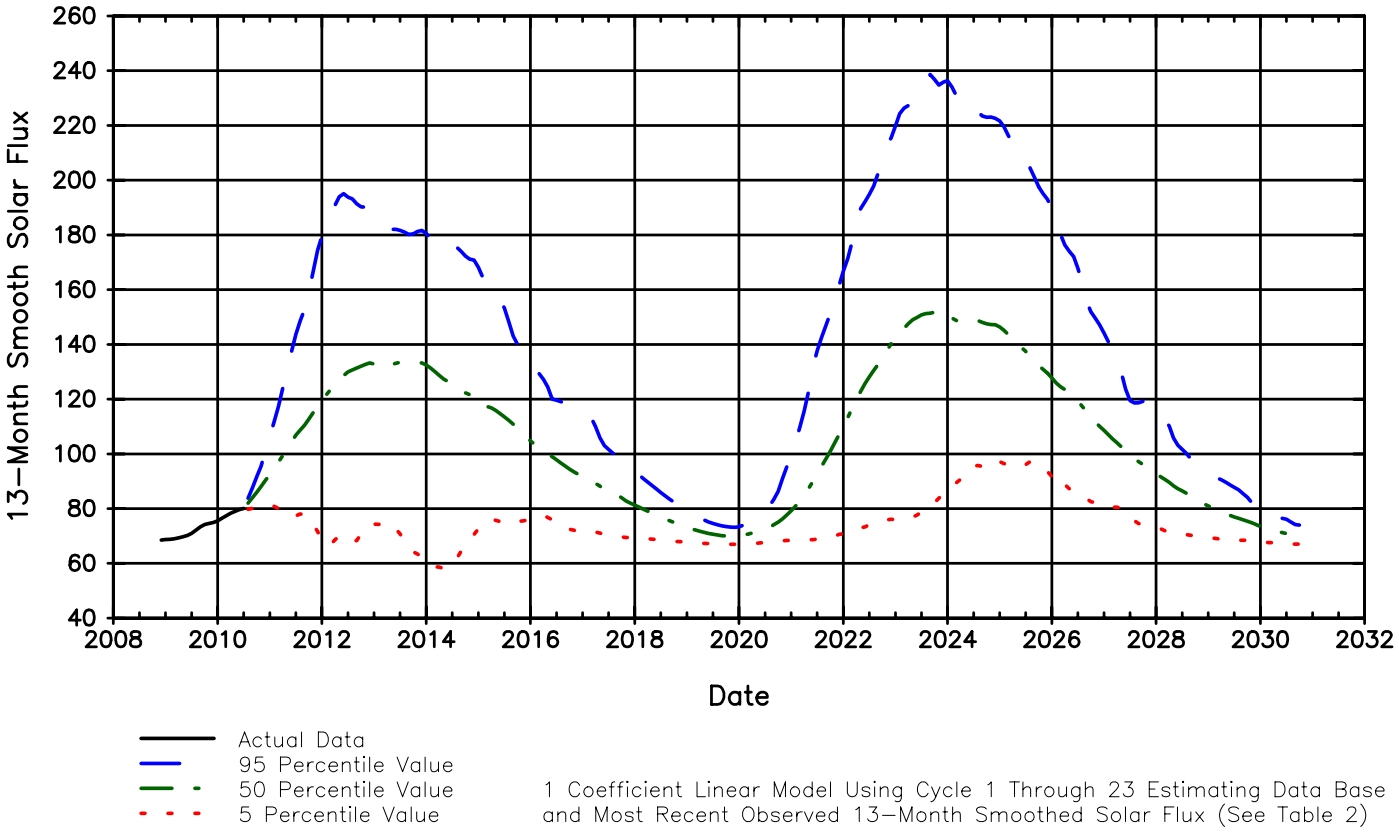

Figure 2. Estimate of 13-Month Smoothed Solar Flux For Cycle 23* and Cycle 24

* Program initialized from the start of Cycle 24

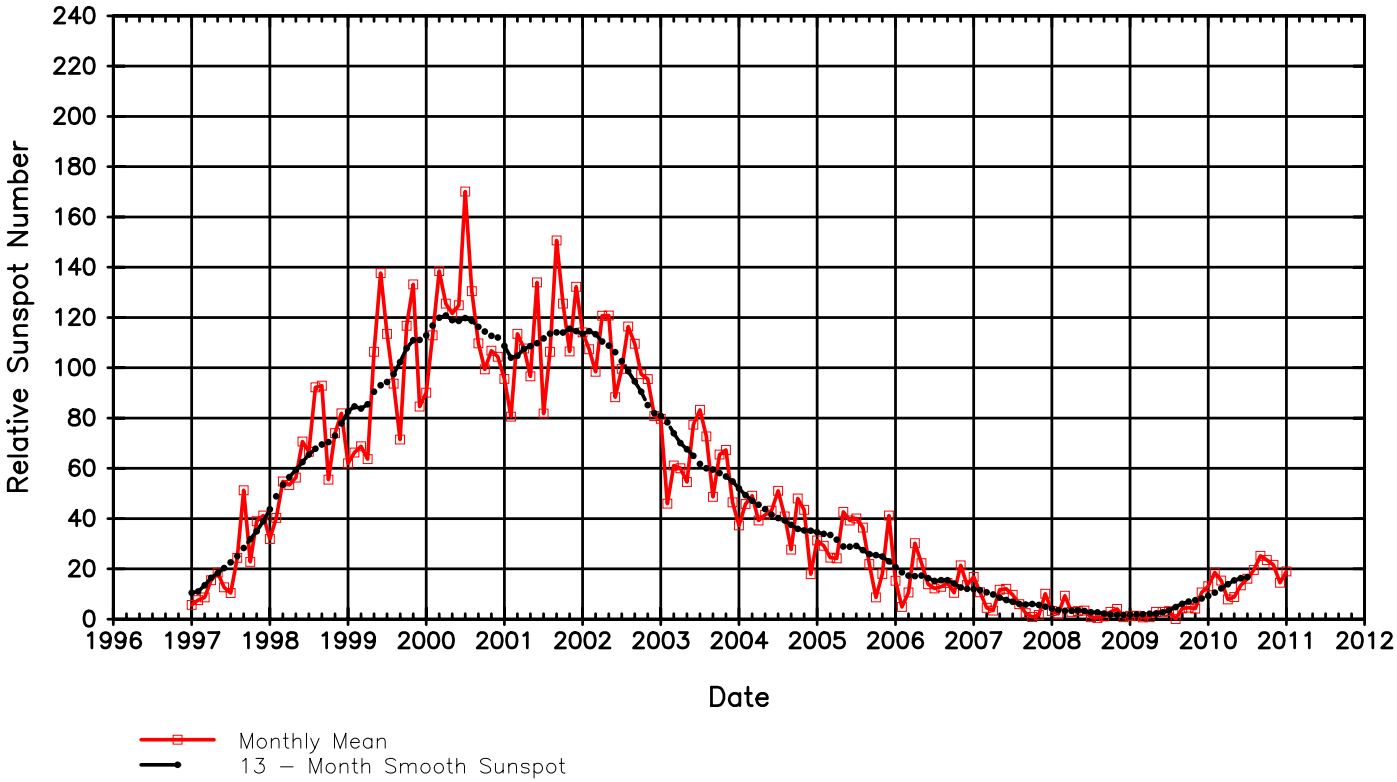

Figure 3. Plot of Recent Monthly Mean and 13-Month Smoothed Relative Sunspot Number

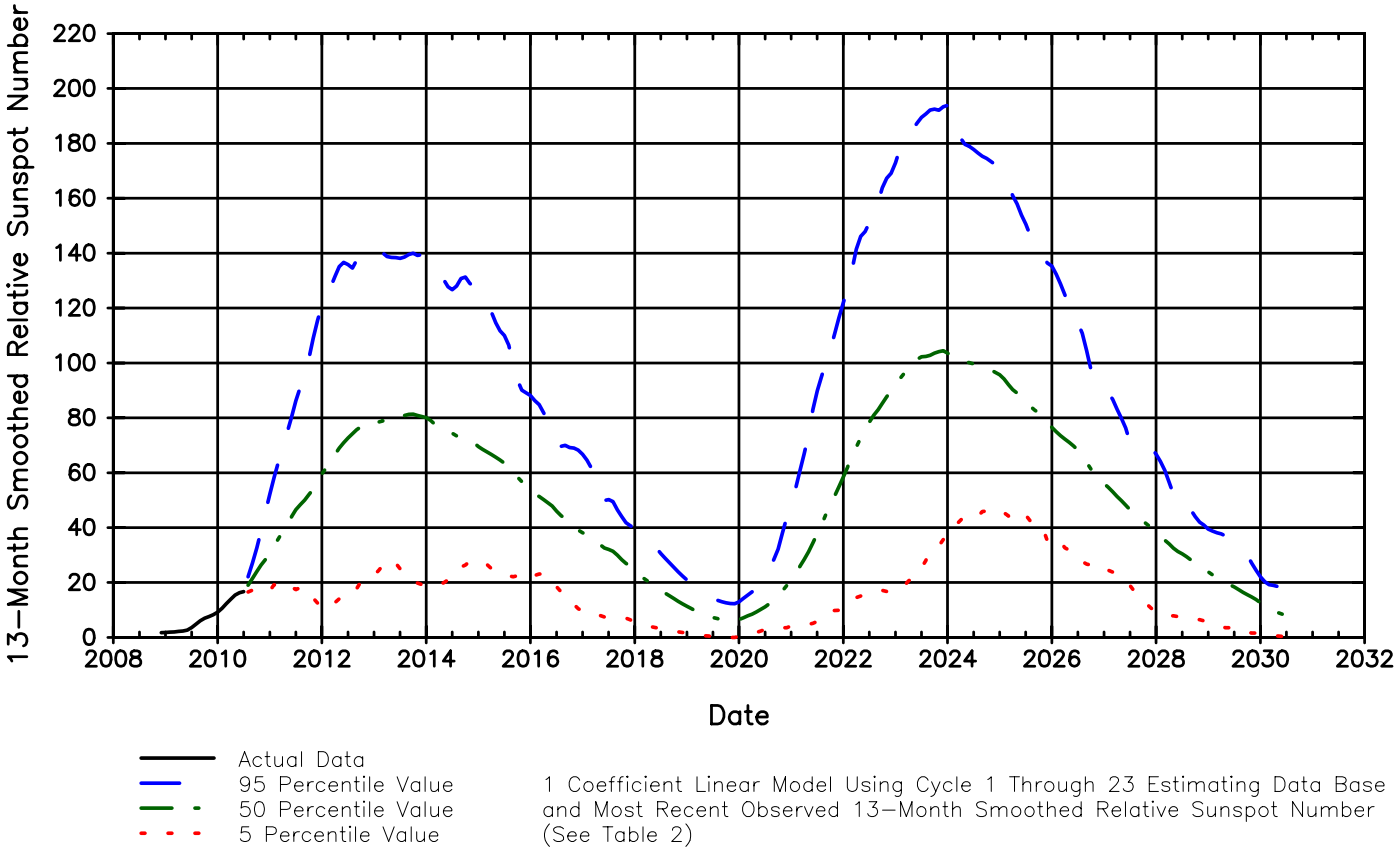

Figure 4. Estimate of 13-Month Smoothed Sunspot Number For Cycle 23* and Cycle 24

* Program initialized from the start of Cycle 24

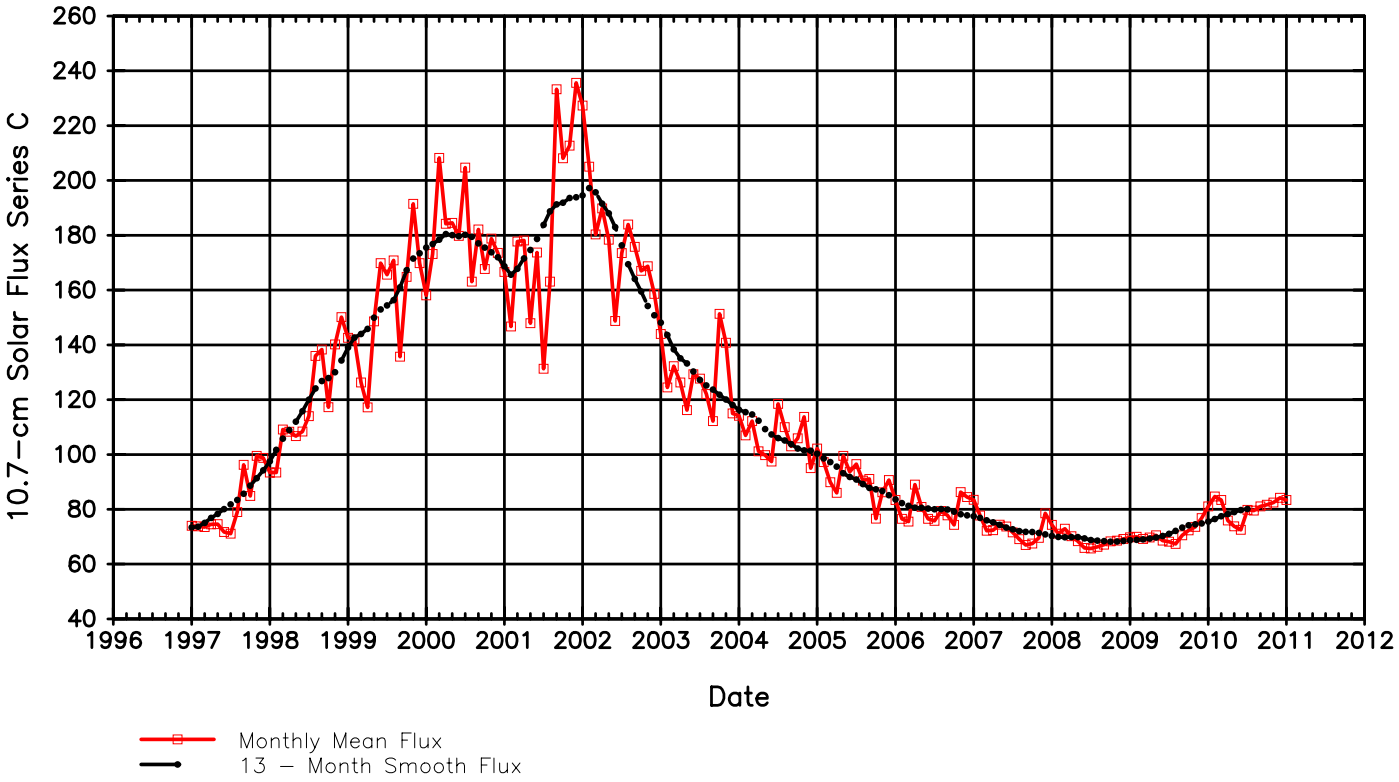

Figure 5. Plot of Recent Monthly Mean and 13-Month Smoothed Solar Flux

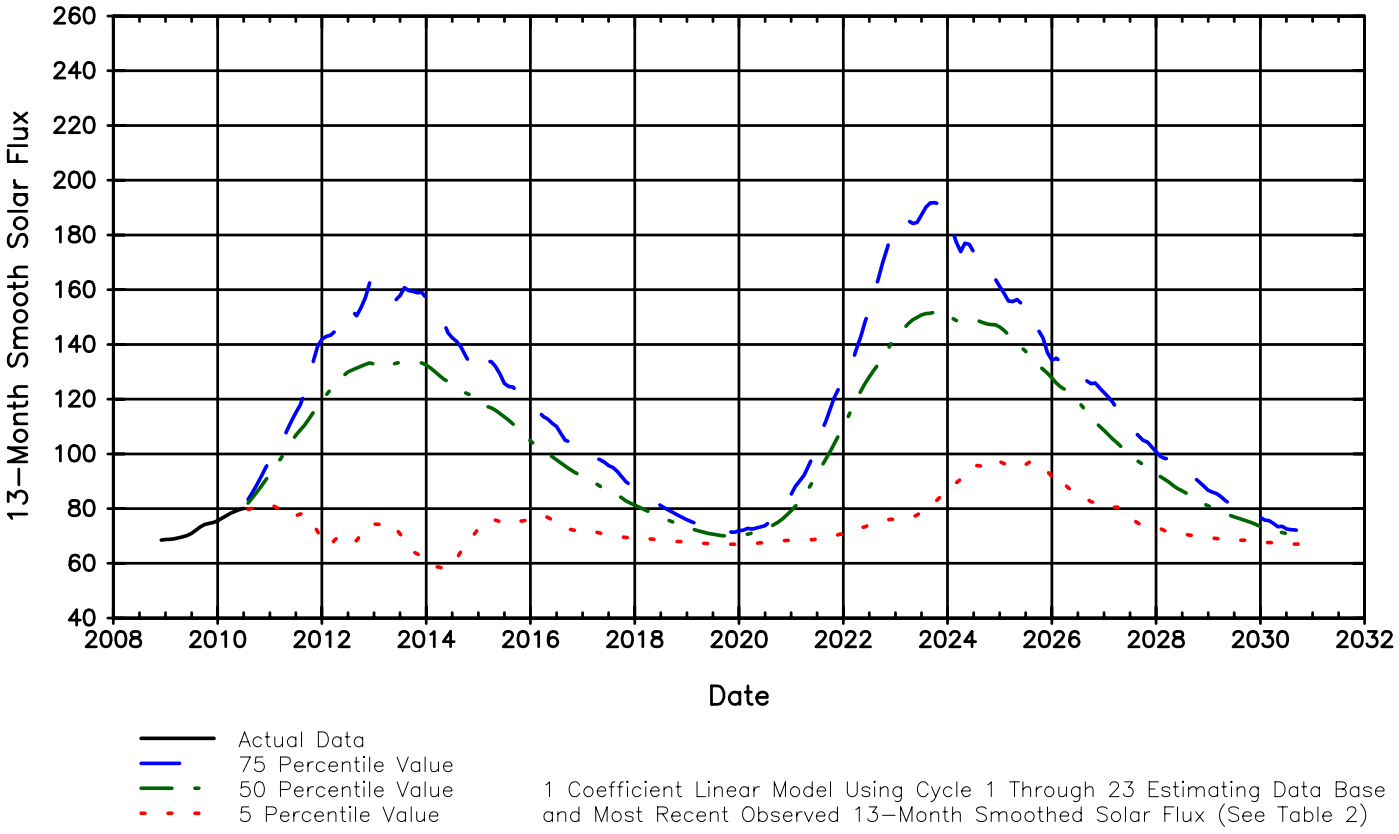

Figure 6. Estimate of 75th Percentile 13-Month Smoothed Solar Flux For Cycle 23* and Cycle 24

* Program initialized from the start of Cycle 24