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Space Environment Services Center **Products and Services User Guide**

Space Environment Laboratory

Boulder, Colorado

January 1993

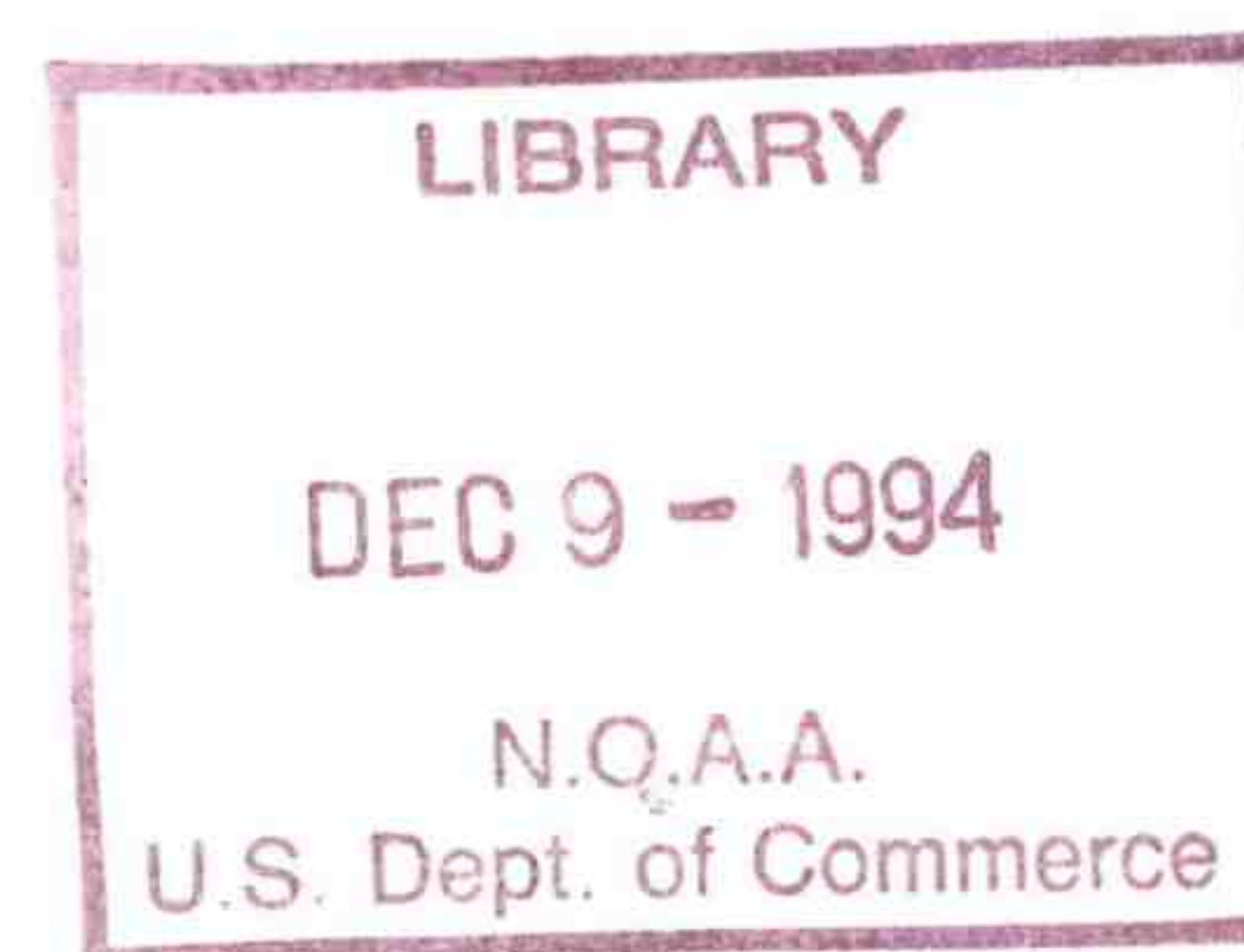
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Environmental Research Laboratories

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Appendix A – Acronyms and Abbreviations

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The entire staff of SESC contributes to providing the services described herein. Special thanks are due to Viola Raben, Ed Erwin, and Larry Combs.

MSgt Norm Cohen

I. Gayle Nelson

Introduction

The Space Environment Services Center (SESC) is a division within the U.S. Government:

Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
Environmental Research Laboratory (ERL)
Space Environment Laboratory (SEL)
Space Environment Services Center (SESC)

The Space Environment Services Center continuously monitors the Sun and the state of the near-Earth environment, acquiring data in real time from both ground-based and satellite-based sensors. Solar activity is monitored from satellites and observatories around the world on a 24-hour-a-day, 7-day-a-week basis. SESC forecasters issue alerts of significant solar and geomagnetic events. They also create products and provide services that summarize and predict space weather. Alerts and products are disseminated worldwide via a variety of delivery systems. The products and services are generally available to customers without cost.

SESC is operated jointly with the U.S. Air Force Space Forecast Center (AFSFC) in Colorado Springs, CO. Products are coordinated and issued jointly, with SESC serving the civilian community and AFSFC serving the Department of Defense customers.

This document describes products, services, and delivery systems available to our customers on a range of time scales. Our products include real-time alerts and warnings, daily products with summaries and forecasts, and a weekly publication of recent solar and geophysical activity. This publication is intended to allow customers already familiar with SESC to see at a glance the whole range of products and delivery systems. It does not address the needs of new customers who are not familiar with our data or how they might apply this information to their purposes. New customers are urged to contact SESC for more information.

SESC collects data, in real time, to create the most timely and extensive space-weather data base in the world. Because of the urgency in collecting the data they are preliminary. Final data are available from the National Geophysical Data Center. NGDC publishes monthly reports and maintains long-term data sets for a wide range of stations and observations. (See NGDC in Section 2).

Organization and Format

This document is divided into two sections. Section 1 describes the SESC products and shows a sample message of each; section 2 describes the delivery systems used to distribute products.

Two appendices present additional reference material. Appendix A is a short list of the abbreviations used in this document. Appendix B is a glossary of terms, excerpted from the *SESC Glossary of Solar-Terrestrial Terms*.

Contacting SESC

For further information or to arrange to receive products and services, please write or call:

Space Environment Services Center
NOAA R/E/SE2
325 Broadway
Boulder, CO 80303-3328

Telephone	(303)	497-5127
FAX	(303)	497-3137
Telex	888776	NOAA BLDR

Electronic mail	SELVAX::SESC or 34367::SESC	(SPAN)
	sesc@sel.blrdoc.gov	(Internet)

1. Products and Services

Products and Services

Delivery Systems

	Phone	Fax	Telephone Recording & Radio Bcst.	Satellite Broad- cast	COMEDS	SELDADS	Electronic File Transfer	Bulletin Board	Mail	NGDC
Alerts and Warnings	★	★	★	★	★					
Geophysical Alert Message			★							
Report of Solar and Geophysical Activity					★	★	★	★		
Solar Region Summary					★	★	★	★		
Solar and Geophysical Activity Summary					★	★	★	★		
Solar Coronal Disturbance Report					★	★	★	★		
High-Frequency Radio Propagation Report					★	★	★	★		
World Warning Agency GEOALERT					★	★	★	★		
Space Weather Data				★	★	★	★	★		★
Solar Images							★			
Solar-Synoptic Analysis Drawing		★							★	
“The Weekly”							★	★	★	★
Publications									★	
Short-term and special support arranged with the customer.										

Alerts and Warnings

The SESC forecaster issues real-time **alerts** on the occurrence, and **warnings** on the forecast, of a variety of solar-geophysical phenomena. See criteria for alerts and warnings on the facing page, and Appendix B or definitions.

Issue time: Alerts and warnings are issued 24 hours a day, 7 days a week. Direct telephone and fax customers can limit the time periods in which they are called by selecting a priority level:

Priority 1 — any day, any hour via telephone.

Priority 2 — any day, any hour via fax.

Priority 3 — any day, any hour to answering device.

Priority 4 — restricted days and hours.

Period Covered: Alerts cover conditions or events in progress. Warnings predict activity in the next 72 hours.

Delivery Systems: Customers for alerts can receive the messages directly by telephone and fax or indirectly on the COMEDS teletype network, the satellite broadcast, the recorded message at SESC, and WWV.

Note: Contact SESC to become a telephone- or fax-alert customer.

Sample: *List of one week's Alerts and Warnings*

Date and Time of Issue (UT)	Type of Alert or Warning	Date and Time of Event (UT)
04 January 0147	Type II Radio Emission	04 Jan 0057
04 January 0309	K = 4 observed	04 Jan 00-03
05 January 0530	K = 4 observed	05 Jan 03-06
06 January 0012	1 – 245 MHz burst	05 Jan
06 January 0552	K = 4 observed	06 Jan 03-06
07 January 0019	245 MHz Radio Noise Storm	06 Jan 0502
07 January 0912	Type II Radio Emission	07 Jan 0836
07 January 0913	Type IV Radio Emission	07 Jan 0843
07 January 1200	K = 5 observed	07 Jan 09-12
07 January 2225	Type IV Radio Emission	07 Jan 1237
07 January 2357	K = 4 observed	07 Jan 21-24
08 January 0028	245 MHz Radio Noise Storm	07 Jan 1013
08 January 0029	3 – 245 MHz bursts	07 Jan
09 January 0118	1 – 245 MHz burst	08 Jan
09 January 0119	245 MHz Radio Noise Storm	08 Jan 0635
10 January 0559	K = 4 observed	10 Jan 03-06
10 January 0906	K \geq 6 observed	10 Jan 06-09
10 January 0907	A \geq 20 observed	10 Jan 0900
10 January 1809	K = 4 observed	10 Jan 15-18

Alerts and Warnings – cont.

Alert Criteria

Conditions or events in progress:

Solar Flares

- X-ray flares of class \geq M5 or \geq X1.

Radio Bursts

- Sweep-frequency radio bursts of Type II or Type IV.
- Radio bursts \geq 100% of background at 2695 MHz.
- Radio bursts \geq 100 sfu at 245 MHz.
- Radio noise storms at 245 MHz.

Proton Events

- Proton event of \geq 10 pfu at $>$ 10MeV.
- Proton event of \geq 100 pfu at $>$ 100MeV.

Geomagnetic disturbances

- K index at Boulder of 4, 5, or \geq 6 .
- A index at Boulder of \geq 20, \geq 30, or \geq 50.

Stratwarms

- Wintertime stratospheric warming (start and end times) affecting polar high-frequency radio wave propagation.

Warning Criteria

Events predicted in the next 72 hours

- Proton event of \geq 10 pfu at $>$ 10 MeV.
- Proton event of \geq 100 pfu at $>$ 100 MeV.
- Geomagnetic A-indices at Fredericksburg, VA of \geq 20, \geq 30, or \geq 50.

Geophysical Alert Message

Every 3 hours SESC records a 40-second message containing the latest solar and geophysical indices, a summary of recent significant activity, and a forecast of activity in the next 24 hours. The significant activity includes solar flares, proton events, geomagnetic activity, and stratospheric warming alerts. This recording can be heard on WWV and WWVH radio broadcasts and on a telephone recording at SESC.

Issue time: Every 3 hours.

Period covered: The data are from the previous 24 hours, and the forecast is for the next 24 hours.

Delivery Systems: Telephone number in Boulder, CO:
(303) 497-3235

On WWV the message is broadcast at 18 minutes past each hour at
2.5, 5.0, 10.0, 15.0, and 20.0 MHz.

On WWVH it is broadcast at 45 minutes past each hour at
2.5, 5.0, 10.0, and 15.0 MHz.

Sample:

[Spoken]

Solar-terrestrial indices for 25 August follow:

Solar flux two-two-six, and estimated Boulder A-index one-seven.

Repeat. Solar flux two-two-six and estimated Boulder A-index one-seven.

The Boulder K-index at zero nine hundred UT on 25 August was four.

Repeat four.

Solar-terrestrial conditions for the last 24 hours follow:

Solar activity was high.

The geomagnetic field was active.

A major flare occurred at zero eight five zero UT on 25 August.

The forecast for the next 24 hours follows:

Solar activity will be moderate to high.

The geomagnetic field will be unsettled to active.

A proton event is expected to begin near twelve-hundred UT on 25 August.

Geophysical Alert Message – cont.

The Geophysical Alert Message is explained in the 19-page document *A Radio Frequency User's Guide to the SESC Geophysical Alert Broadcasts* available from SESC. This message contains three sections:

Latest indices:

The current UT day and month.

The latest daily 10.7 cm radio flux index from the Dominion Radio Astrophysical Observatory, Penticton, BC Canada (issued at 2000 UT daily).

The latest observed or estimated Boulder A-index.

The latest 3-hour K-index in Boulder.

Summary:

The level of solar activity and geomagnetic conditions during the last 24 hours. If appropriate, the time and size of recent major solar events (solar flares, proton events), geomagnetic storms, polar cap absorption events, and stratospheric warming alerts are noted.

Forecast:

A forecast of solar activity, geomagnetic conditions, and proton events expected in the next 24 hours.

Report and Forecast of Solar and Geophysical Activity

The Report and Forecast of Solar and Geophysical Activity is the primary daily report prepared by SESC. It provides a summary and analysis of solar and geomagnetic activity during the previous 24 hours as well as the most recent solar indices. It also provides a forecast of activity and indices for the next 3 days. In September 1992, SESC added a new probability forecast for geomagnetic activity, providing users with a quantitative measure of certainty in the forecast.

Issue time: Daily at 2200 UT.

Period Covered: Activity from 2100 UT the previous day to 2100 UT on the current day, and predicted activity for the next 3 days.

Delivery Systems: SELDADS, electronic file transfer, the Bulletin Board system, and the COMEDS teletype network.

Sample:

JOINT USAF/NOAA REPORT OF SOLAR AND GEOPHYSICAL ACTIVITY
SDF NUMBER 293 ISSUED AT 2200Z ON 19 OCT 1992

IA. ANALYSIS OF SOLAR ACTIVE REGIONS AND ACTIVITY FROM 18/2100Z TO 19/2100Z: SOLAR ACTIVITY WAS MODERATE DUE TO AN M1/1F FLARE AT 19/1759Z IN REGION 7315 (N05E19). THIS REGION ALSO PRODUCED SEVERAL C-CLASS FLARES, INCLUDING A C5/1F AT 19/0124Z, A C6/1F AT 19/0412Z, AND A C7/1N AT 19/0601Z. THIS REGION IS INCREASING IN COMPLEXITY AND MAY BE DEVELOPING A DELTA CONFIGURATION IN ITS CENTRAL SUN-SPOTS. THE OTHER DISK REGIONS WERE QUIET. NEW REGION 7318 (N11W63) WAS NUMBERED.

IB. SOLAR ACTIVITY FORECAST: SOLAR ACTIVITY IS EXPECTED TO BE LOW TO MODERATE. ANOTHER M-CLASS FLARE IS POSSIBLE IN REGION 7315.

IIA. GEOPHYSICAL ACTIVITY SUMMARY FROM 18/2100Z TO 19/2100Z: THE GEOMAGNETIC FIELD WAS QUIET TO UNSETTLED FOR MOST OF THE DAY. ISOLATED STORM CONDITIONS WERE OBSERVED AT SOME HIGH LATITUDE LOCATIONS FROM 19/1200-1800Z.

IIB. GEOPHYSICAL ACTIVITY FORECAST: THE GEOMAGNETIC FIELD IS EXPECTED TO BE QUIET TO UNSETTLED. ISOLATED HIGH-LATITUDE SUBSTORMS ARE POSSIBLE.

III. EVENT PROBABILITIES 20 OCT-22 OCT

CLASS M 30/20/20
CLASS X 05/01/01
PROTON 01/01/01
PCAF GREEN

IV. PENTICTON 10.7 CM FLUX

OBSERVED 19 OCT 125
PREDICTED 20 OCT-22 OCT 130/135/135
90 DAY MEAN 19 OCT 117

V. GEOMAGNETIC A INDICES

OBSERVED AFR/AP 18 OCT 009/009
ESTIMATED AFR/AP 19 OCT 012/015
PREDICTED AFR/AP 20 OCT-22 OCT 010/010-010/010-010/010

VI. GEOMAGNETIC ACTIVITY PROBABILITIES 20 OCT-22 OCT

A. MIDDLE LATITUDES

ACTIVE 10/10/10
MINOR STORM 01/01/01
MAJOR-SEVERE STORM 01/01/01

B. HIGH LATITUDES

ACTIVE 15/15/15
MINOR STORM 05/05/05
MAJOR-SEVERE STORM 01/01/01

Report and Forecast of Solar and Geophysical Activity – cont.

- Part IA** A summary of significant solar features and activity observed during the reporting period, including characteristics of sunspot groups, magnetic fields, flares, radio bursts, and active filaments associated with significant solar regions. Significant solar limb and disk features, including major filament disappearances, are also included.
- Part IB** A summary of the potential for solar activity during the next 3 days.
- Part IIA** A description of significant geophysical activity including geomagnetic activity and proton events, polar cap absorption (PCA) events, and satellite-level particle enhancements observed during the reporting period.
- Part IIB** A forecast of the level of geophysical activity during the next 3 days.
- Part III** **Class M and class X:** Probability forecast of the occurrence of one or more class-M or class-X x-ray flares for each of the next 3 days.
Proton flare: Probability forecast of a flare that will cause a significant proton event at satellite altitudes (at least 10 pfu at energies greater than 10 MeV) for each of the next 3 days.
PCAF: A 24-hour forecast of a polar cap absorption (PCA) event. The PCA forecasts are color coded:
 PCAF Green: No active sunspot region on the Sun is likely to produce a PCA event in the next 24 hours.
 PCAF Yellow: A sunspot region showing characteristics favorable for producing a PCA event is present on the Sun. If an energetic flare occurs in this region, the probability of a significant PCA event is very high.
 PCAF Red: An energetic solar event has occurred or a proton event has been observed at satellite altitudes, and there is a high probability that a significant PCA event will result within the next 24 hours.
 In Progress: A significant PCA event is in progress at forecast time.
- Part IV** **Observed:** The current day's 10.7 cm solar radio flux observed at 2000 UT from Penticton, British Columbia, Canada.
Predicted: Daily 3-day forecasts of the 10.7 cm flux.
90-Day Mean: The 90-day mean of the observed 10.7 cm flux.
- Part V** Observed, estimated, and predicted daily geomagnetic A_{Fr} -indices (A-indices from Fredericksburg, VA), and daily A_p -indices (planetary A-indices). A_p indices are estimated in near-real time using a network of up to 12 North American stations.
Observed A_{Fr} / A_p : The observed indices for the previous day.
Estimated A_{Fr} / A_p : The estimated indices for the current day.
Predicted A_{Fr} / A_p : 3-day predictions.
- Part VI** Probability forecast of geomagnetic conditions at middle and high latitudes—the probability of at least one 3-hour K index, at the indicated level, for each of the next 3 days.
Active: $K = 4$.
Minor storm: $K = 5$.
Major or Severe storm: $K \geq 6$.

Solar Region Summary

The Solar Region Summary is a daily report, written by SESC, describing the active solar regions observed during the preceding day. It provides a detailed description of all active regions currently visible on the solar disk.

Issue time: Daily at 0030 UT.

Period covered: Previous UT day.

Delivery Systems: SELDADS, electronic file transfer, the Bulletin Board system, and the COMEDS teletype network.

Sample:

JOINT USAF/NOAA SOLAR REGION SUMMARY

ISSUED AT 07/0030Z MARCH 1990

REPORT COMPILED FROM DATA RECEIVED AT SESC ON 06 MARCH

I. REGIONS WITH SUNSPOTS. LOCATIONS VALID AT 06/2400Z MARCH

NMBR	LOCATION	LO	AREA	Z	LL	NN	MAG	TYPE
5955	S17W73	267	0030	HSX	02	001	ALPHA	
5958	S21W47	241	0000	AXX	01	002	ALPHA	
5961	N30W39	233	0090	DAO	08	009	BETA	
5963	S13W26	220	0050	CAO	07	015	BETA	
5964	N28E11	183	0180	CAO	08	008	BETA	
5965	S10E17	177	0510	DHI	09	024	BETA	
5966	N12E51	143	0000	AXX	00	001	ALPHA	

IA. H-ALPHA PLAGES WITHOUT SPOTS. LOCATIONS VALID AT 06/2400Z

NMBR	LOCATION	LO	COMMENT
5959	N25W63	257	
5960	N16W68	262	

II. REGIONS DUE TO RETURN 07 MARCH TO 09 MARCH

NMBR	LAT	LO
5935	N19	098

Solar Region Summary – cont.

Part I Describes all active regions with sunspot groups:

- NMBR:** An SESC region number assigned to a sunspot group during its disk passage.
- LOCATION:** Sunspot group location, in heliographic degrees latitude and degrees east or west from central meridian, rotated to 2400 UT.
- LO:** Carrington longitude of the group.
- AREA:** Total corrected area of the group in millionths of the solar hemisphere.
- Z:** Modified Zurich classification of the group.
- LL:** Longitudinal extent of the group in heliographic degrees.
- NN:** Total number of visible sunspots in the group.
- MAG TYPE:** Magnetic classification of the group.

Part IA Describes previously numbered active regions which still contain plage but no visible sunspots.

- NMBR:** SESC region number.
- LOCATION:** Plage region location in heliographic degrees latitude and degrees east or west from central meridian rotated to 2400 UT.
- LO:** Carrington longitude of the region.

PART II Active regions that were observed on the previous solar rotation and are due to reappear on the East limb in the next 3 days.

- NMBR:** SESC region number.
- LAT:** Heliographic degrees latitude of the group on its last disk passage.
- LO:** Carrington longitude of the group on its last disk passage.

The characteristics for each active region are compiled from approximately half a dozen observatories that report to the SESC in near-real time. The sunspot counts are typically higher than those reported in non-real time by the Sunspot Index Data Center (SIDC), Brussels, Belgium, and the American Association of Variable Star Observers.

Solar and Geophysical Activity Summary

The Solar and Geophysical Activity Summary is a daily report that gives a brief list of solar and geophysical events and indices for the previous day, including energetic solar flares, proton events, geomagnetic activity, and stratospheric warming alerts.

Issue time: Daily at 0245 UT.

Period covered: Previous UT day.

Delivery Systems: SELDADS, electronic file transfer, the Bulletin Board system, and the COMEDS teletype network.

Sample:

JOINT USAF/NOAA SOLAR AND GEOPHYSICAL ACTIVITY SUMMARY
ISSUED AT 0245Z 07 MAR 1990.

THIS REPORT IS COMPILED FROM DATA RECEIVED AT SESC ON 06 MAR

A. ENERGETIC EVENTS:

BEGIN	MAX	END	RGN	LOC	XRAY	OP	245MHZ	10CM	SWEEP	SWF
1257	1302	1325	5961	N32W32	C1.8	SF				110

B. PROTON EVENTS:

NONE

C. GEOMAGNETIC ACTIVITY SUMMARY:

THE GEOMAGNETIC FIELD WAS QUIET TO ACTIVE.

D. STRATWARM:

NONE

E. DAILY INDICES:

10 CM 166 SSN 130 AFR/AP 015/021 X-RAY BACKGROUND B7.5
DAILY PROTON FLUENCE (FLUX ACCUMULATION OVER 24 HRS)
GT 1 MEV 1.2E+05 GT 10 MEV 1.1E+04 P/(CM2-STER-DAY)
(GOES SATELLITE SYNCHRONOUS ORBIT W108 DEGREES)

3 HOUR K-INDICES:

BOULDER 4 3 3 2 3 4 / 2 PLANETARY 5 4 3 3 4 4 2 2

F. COMMENTS:

THE BOULDER 18-21Z K-INDEX IS NOT AVAILABLE AND THE 21-24Z
BOULDER K-INDEX IS ESTIMATED DUE TO A POWER OUTAGE.

Solar and Geophysical Activity Summary – cont.

- Part A** A profile of significant solar events including start, maximum, and end times, region number and location, x-ray and optical classification of flares, significant radio emission at 245 MHz, 10 cm (2695 MHz), and sweep frequencies, and significant short wave fades. All available data for an event are included in this section if one or more of the following thresholds are reached:
- Class-M or greater x-ray flare,
 - Optical flare of importance $\geq 2B$,
 - Radio burst of ≥ 100 sfu at 245 MHz,
 - Radio burst $\geq 100\%$ above background at 2695 MHz,
 - Type II or IV sweep frequency burst,
 - Shortwave fade of importance 2 or greater.
- Part B** Proton event data given whenever the flux of > 10 MeV protons reaches or exceeds 10 particle flux units (pfu). Data include start, maximum, and end times for events at > 10 , 50, and 100 MeV.
- Part C** A summary describing the geomagnetic field during the previous UT day.
- Part D** Stratospheric warming alerts when they are in effect.
- Part E** Indices about the previous UT day:
- Observed 2000 UT Penticton 10.7 cm flux,
 - SESC sunspot number (SSN),
 - Estimated geomagnetic A_F -index,
 - Estimated planetary A_P -index,
 - Daily x-ray background flux expressed in the B, C, M, X scale ($W m^{-2}$),
 - Daily proton fluence (flux accumulation over 24 hours) for > 1 MeV and > 10 MeV protons at geosynchronous altitudes,
 - 3-hourly K_B -indices and estimated K_P -indices.
- Part F** Reserved for additional comments as required.

Solar Coronal Disturbance Report

The Solar Coronal Disturbance Report describes coronal holes inferred from an image of the Sun in the Helium 1083 nm wavelength. This image is taken at the National Solar Observatory in Kitt Peak, Arizona, and sent to SESC daily. In addition, information on interplanetary disturbances and mass ejection reports are included when they are available. The report summarizes possible disturbances affecting the solar corona during the previous 24 hours.

Issue time: Daily at 0200 UT.

Period covered: Previous UT day.

Delivery Systems: SELDADS, electronic file transfer, the Bulletin Board system, and the COMEDS teletype network.

Sample:

JOINT USAF/NOAA SOLAR CORONAL DISTURBANCE REPORT
SCDR NUMBER 154 ISSUED AT 0200 UT ON 02 JUN 1992
REPORT COMPILED FROM DATA RECEIVED AT SESC ON 1 JUN 1992

PART I. POSSIBLE CORONAL MASS EJECTION EVENTS

UT TIME			OPTICAL	XRAY	RADIO
BEGIN	MAX	END	LOCATION	TYPE SIZE	DUR II IV
01/B0023		A1357	S13E02	DSF	

PART II. INFERRED CORONAL HOLES. LOCATIONS VALID AT 01/2400 UT

IIA. POLAR HOLES		CMP LATITUDE	POL	AREA	OBSN
NORTH POLE		N60	POS	025	10830A
SOUTH POLE		S60	NEG	027	10830A

IIB. ISOLATED HOLES AND POLAR EXTENSIONS

NMBR	HOLE BOUNDARIES				TYPE	POL	AREA	OBSN
	EAST	SOUTH	WEST	NORTH	CAR			
32	N46E49	N30E36	N40E28	N50E36	154	ISO	POS	007 10830A

PART III. INTERPLANETARY OBSERVATIONS – NONE

PART IV. COMMENTS

NONE

Solar Coronal Disturbance Report – cont.

- Part I** Reports of eruptive prominences, disappearing filaments, and long-duration x-ray flares that are suspected to be coronal mass ejection events. A long-duration x-ray flare has a decay time of > 30 minutes. Included in the report are flare times, heliographic location, type, associated x-ray size and duration, and associated sweep radio emission.
- Part II** Descriptions of inferred coronal holes, polar and isolated.
- Part IIA:** Polar Holes — contains the latitude of the equator-ward edge of a polar coronal hole at central meridian, magnetic polarity (positive or negative), area (in thousandths of the solar disk), and detector type (wavelength) of observation used to make the inference for both solar poles (North and South).
- Part IIB:** Isolated Holes and Polar Extensions — contains heliographic location of the outer boundary (East, South, West, and North extremes), magnetic polarity, type (extension of a polar hole or an isolated hole), area, and detector type of observation of all other inferred coronal holes.
- Part III** Reserved Solar Wind observations. At this time, SESC is not receiving interplanetary scintillation or other spacecraft observations.
- Part IV** Contains additional comments as required.

High Frequency Radio Propagation Forecast

The High Frequency Radio Propagation Forecast is prepared by the U.S. Air Force Space Forecast Center (AFSFC) and issued jointly with SESC. The primary daily forecast is issued at 0600 UT. Three secondary forecasts are issued at 0000, 1200, and 1800 UT. Secondary forecast contain Part I and, if conditions warrant, Part II.

Issue time: Four times a day, primary at 0600 UT and secondaries at 0000, 1200, and 1800 UT.

Period covered: Summary of the previous 6 and 24 hours and forecast for the next 24 hours and 3 days.

Delivery Systems: SELDADS, electronic file transfer, the Bulletin Board system, and the COMEDS teletype network.

Sample:

See facing page.

High Frequency Radio Propagation Forecast – cont.

JOINT USAF/NOAA BULLETIN PREPARED AT THE AIR FORCE SPACE
FORECAST CENTER, FALCON AFB, COLORADO.
PRIMARY HF RADIO PROPAGATION REPORT ISSUED AT 15/0540Z OCT 92.

PART I. SUMMARY 15/0000Z TO 15/0600Z OCT 92.
FORECAST 15/0600Z TO 15/1200Z OCT 92.

		QUADRANT			
		I	II	III	IV
		0 TO 90W	90W TO 180	180 TO 90E	90E TO 0
REGION	POLAR	N4	N4	N5	N5
	AURORA	N3	N3	N4	N4
	MIDDLE	N6	N6	N7	N7
	LOW	N7	N7	N7	N7
	EQUATORIAL	N7	N7	N7	N7

PART II. GENERAL DESCRIPTION OF HF RADIO PROPAGATION CONDITIONS
OBSERVED DURING THE 24 HOUR PERIOD ENDING 14/2400Z, AND FORECAST
CONDITIONS FOR THE NEXT 24 HOURS.

NO SIGNIFICANT DEGRADATIONS WERE OBSERVED DURING THE PERIOD DESPITE
THE INCREASE IN GEOMAGNETIC ACTIVITY SINCE 15/0000Z (MINOR STORMING).
FORECAST: EXPECT SOME DEGRADATION IN THE NIGHT TIME SECTORS OF THE
AURORAL AREAS.

PART III. SUMMARY OF SOLAR FLARE INDUCED IONOSPHERIC DISTURBANCES
WHICH MAY HAVE CAUSED SHORT WAVE FADES IN THE SUNLIT HEMISPHERE
DURING THE 24 HOUR PERIOD ENDING 14/2400Z OCT 92.

START(Z)	END(Z)	CONFIRMED	FREQUENCIES AFFECTED
1916	1950	NO	UP TO 12 MHZ

PROBABILITY FOR THE NEXT 24 HOURS SLIGHT

PART IV. OBSERVED/FORECAST 10.7 CM FLUX AND K/AP.
THE OBSERVED 10.7 CM FLUX FOR 14 OCT 92 WAS 106.
THE FORECAST 10.7 CM FLUX FOR 15, 16, AND 17 OCT 92
ARE 105, 105, AND 110.

THE OBSERVED K/AP VALUE FOR 14 OCT 92 WAS 03/16.
THE FORECAST K/AP VALUES FOR 15, 16, AND 17 OCT 92
ARE 04/25 03/20, AND 03/20.

SATELLITE X-RAY BACKGROUND: B2.5 (2.5 E MINUS 04 ERGS/CM SQ/SEC).
THE EFFECTIVE SUNSPOT NUMBER FOR 14 OCT 92 WAS 066.9.

World Warning Agency GEOALERT

The GEOALERT is a coded message containing a summary of sunspot characteristics, energetic solar-geophysical activity, and selected solar-geophysical indices for the previous day. It also contains a brief encoded forecast of solar-geophysical activity.

This message is a consensus of the Advices received from the seven Regional Warning Centers (RWCs) of the IUWDS (International Ursigrams and World Days Service). These centers are located in Paris, Beijing, Moscow, Darmstadt, Tokyo, Sydney, and Boulder. In addition to being one of the RWCs, Boulder is also the IUWDS World Warning Agency (WWA) responsible for collecting and coordinating daily forecasts, alerts, and encoded solar-terrestrial data.

The GEOALERT message, and other URSI coded messages transmitted on the COMEDS teletype network, are described in detail in the manual *I.U.W.D.S. Synoptic Codes For Solar And Geophysical Data*, written by SESC.

Issue time: Daily at 0330 UT.

Period covered: Previous UT day and forecast day.

Delivery Systems: SELDADS, electronic file transfer, the Bulletin Board system, and the COMEDS teletype network.

Sample:

```
GEOALERT WWA0152
UGEOA 20401 20531 0330/ 9930/
10311 20311 30311
99999
UGEOE 20401 20531 0330/ 30/00
99999
UGEOI 20401 20531 0330/ 30///
10059 20990 30140 49999 50000 61707 71004 80305 90060
99999
UGEOE 20401 20531 0330/ 30/24 31105
17179 20000 30000 42012 50000 60002 35807 02000
17180 20000 30000 41001 50000 60001 10817 01000
17183 20000 30100 47301 50060 60002 27326 02000
17184 20000 30000 41001 50000 60003 43810 00000
17185 20000 30100 41001 50000 60001 12512 01000
99999
```


World Warning Agency GEOALERT – cont.

The GEOALERT is a coded message. Codes begin with a five-letter code word (UGEOA, UGEOE, UGEOI, or UGEOR) indicating how the numbers that follow should be interpreted. Instructions for decoding the GEOALERT message are in the manual *I.U.W.D.S. Synoptic Codes For Solar And Geophysical Data*, written by SESC. In summary, the codes contain the following information:

UGEOA: The World Warning Agency (WWA) consensus forecast for 1- to 3-day forecasts of whole-disk flares, geomagnetic activity, and protons.

UGEOE: A summary of significant solar events for the previous day using the following criteria:

- M-class or greater x-ray flare
- Optical flares of importance 2B or greater
- Radio bursts ≥ 100 sfu at 245 MHz
- Radio bursts $\geq 100\%$ above background at 10 cm
- Type-II or Type-IV sweep-frequency burst

UGEOI: Observed solar-geophysical indices for the previous day, including:

- Daily SESC sunspot number and area
- A_B Index
- Ground-level cosmic ray intensity and events
- Daily 10.7 cm radio flux from Penticton, Canada
- Total M- and X-class x-ray flares
- X-ray background level
- Particle fluence (> 10 MeV)
- Total number of regions with sunspots
- Number of new regions with sunspots

UGEOR: Sunspot data for the previous day, and regional forecasts including:

- Region number and location
- Number of optical, M- and X-class x-ray flares for the region
- Sunspot classification and total sunspot area
- Number of spots in the region
- Flare probability forecast for the region

PLAIN: Plain-language remarks added as necessary; for example, it may describe international observing programs such as FLARES 22/Max'91.

Solar Synoptic Analysis Drawing

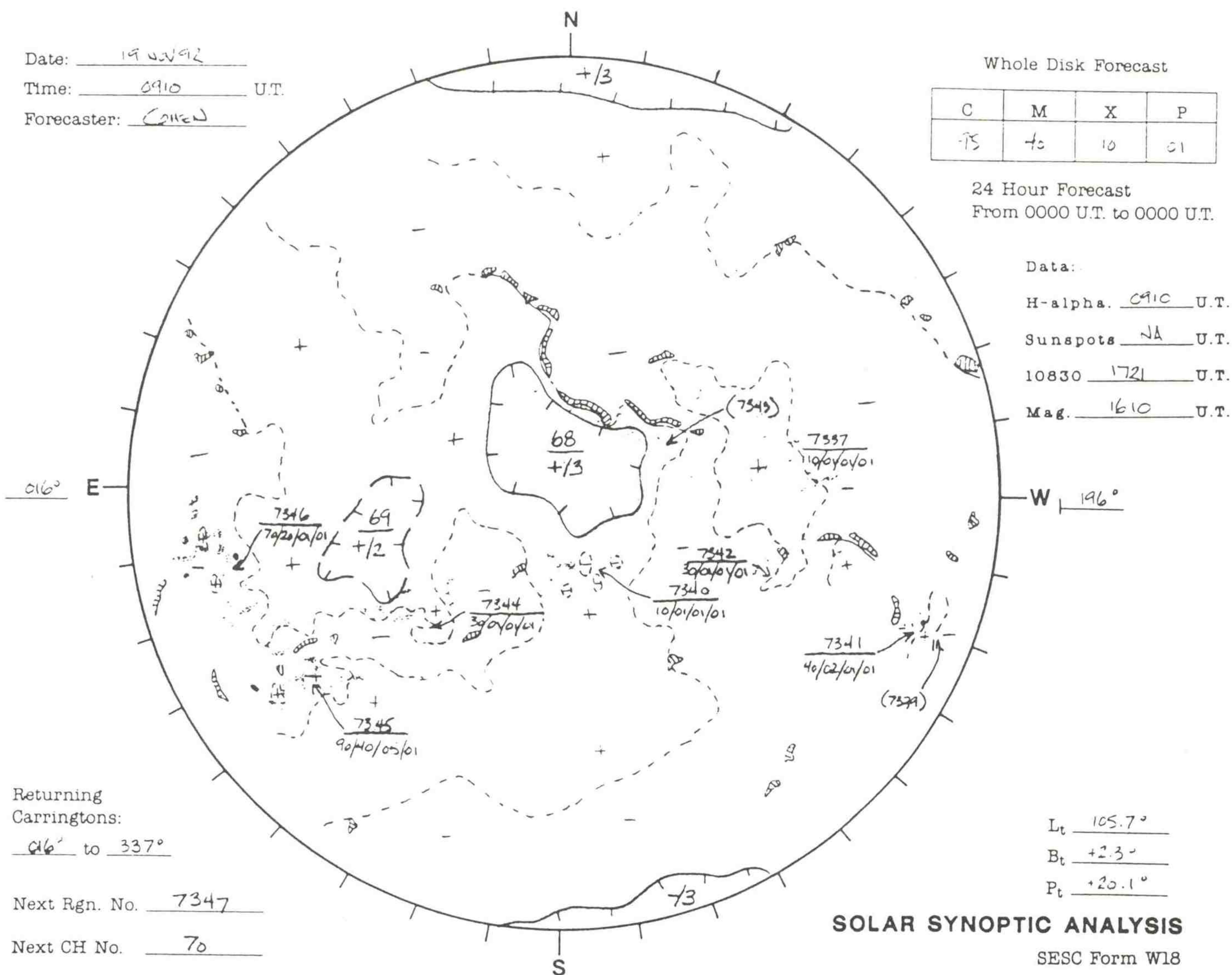
Each day, the SESC forecaster makes a composite drawing of the Sun, showing the solar features visible in various wavelengths. The best available H-alpha, magnetogram, sunspot and 1083 nm images are used.

Issue time: Usually available by 2200 UT daily.

Period covered: The current UT day.

Delivery Systems: An 8 1/2 x 11 inch worksheet with an 18-cm solar disk (available by fax and mail).

Sample:



Solar Synoptic Analysis Drawing – cont.

The drawing shows: Active regions, with the region number and 24-hour probability for class C, M, X, and proton flares
Coronal holes, with the assigned SESC number, polarity, and quality
Large scale solar magnetic fields with polarities, and limb features
Filaments

The legend shows: Date and time of analysis
Types of data used in analysis
Solar ephemeris information
Whole-disk, next-day flare forecast

Space Weather Data

SESC receives near-real-time space weather data from satellites and ground-based stations around the world. These data are generally available to SESC customers in computer formats as data values, listings, plots, and images. See the list of delivery systems below.

The data are calibrated and converted to engineering units; however, most are preliminary and should not be cited for reference purposes. Preliminary data are distributed rapidly from the observing stations and are subject to later revision or refinement.

Availability: Data are received at SESC in delayed real time; the delay varies from seconds for satellite data to as much as 24 hours for some international data.

Availability of the data varies among the different delivery systems. See Section 2 for a description of each delivery system and a listing of the particular data available on each system.

Period covered: The length of time for which data are retained is determined by the delivery system.

Delivery System: Satellite Broadcast system, SELDADS, electronic file transfer, the Bulletin Board system, and the COMEDS teletype network.

Space Weather Data – cont.

This is a sample of the Space Weather data available from SESC. See Section 2 for details on the data available from each delivery system.

Forecasts and Alerts

Solar and Geophysical Text

- SESC Alerts and Warnings
- Report of Solar and Geophysical Activity
- Solar Region Summary
- Solar and Geophysical Activity Summary
- Solar Coronal Disturbance Report
- World Warning Agency GEOALERT

Ionospheric Text

- High Frequency Radio Propagation Report
- 3-hourly Geomagnetic Events and Forecast Message

Data Summaries

X-ray Flare Display

Solar Radio Flux Summary

Magnetometer Analysis – 3- and 24-hour max nT, estimated K_P and A_P for 6 stations.

Solar Event Log

Limb/Disk Log

Particle Log

Geomagnetic Index Log – K and A indices from 26 stations

Data Plots

X-ray Plots GOES 6 & 7, 1- or 5-min data

Particle Plots GOES 6 & 7, Protons, Differential Flux, Integral Flux, Alpha Particles.

Geomagnetic Plots 1- or 5-min data by station, chain, or satellite

Data Listings

Critical Frequency Ionospheric data – foF₂, FOES, FMIN, and M3000 by stations

Total Electron Content (TEC)

Auroral Radar

Riometer and neutron monitor data

X-ray Lists GOES 6 & 7, 3-s, 1-min, 5-min, hourly, and daily data

Particle Lists GOES 6 & 7, Protons, Differential Flux, Integral Flux, Alpha Particles

Geomagnetic Lists 1- or 5-min data, by station, chain, or satellite

Radio Lists By station

SESC Stations: Contributing station name, country, geographic location, and 3-letter code.

Coded messages: Coded messages are data encoded into messages of 5-digit groups, in two internationally recognized formats: URSI codes and U.S. Air Force codes. The URSI-coded messages are described in the manual “*I.U.W.D.S. Synoptic Codes For Solar And Geophysical Data*,” written by SESC.

Solar Images

Each day SESC collects and processes solar images from several observing stations. Current images include full-disk and large-scale images: H-alpha, white-light(B2), Helium 1083 nm, Ca II, and magnetograms.

Observing stations

SESC Solar Observatory, Boulder, Colorado

Holloman Solar Observatory, Holloman Air Force Base, New Mexico

Kitt Peak National Observatory, Tucson, Arizona

Learmonth Solar Observatory, North Cape, Australia

Sacramento Peak Solar Observatory, Sunspot, New Mexico

Availability

Images are received at approximately these times. However, since the observations are made at a fixed local time, the times are 1 hour earlier during daylight savings:

Learmonth	1030 UT
Holloman	0300, 1530, & 2100 UT
Boulder H-alpha	1700 UT
Kitt Peak	2000 UT
Sacramento Peak	2000 UT

Period covered:

Compressed image files are retained for 10 days and un-compressed files for 4 days. SESC will begin using the FITS image format in the near future and will make FITS images available for longer than the current 10 days.

Delivery System:

Electronic file transfer over the Internet and SPAN networks.

Solar Images – cont.

SESC receives 15 to 20 images each day, depending on the seeing conditions at the sites and the level of solar activity. A maximum of 29 images could be received according to the limits shown in the table below.

SOLAR IMAGES			
Observatory		Maximum Images received per day	
Full-disk images			
Holloman	H-alpha		3
Learmonth	H-alpha		1
Boulder	H-alpha		2
Sacramento Peak	H-alpha		1
Sacramento Peak	Ca II		2
NSO/Kitt Peak	Mag		1
NSO/Kitt Peak	1083 nm		1
Large-scale images			
Holloman	H-alpha, B2, Mag		6
Learmonth	H-alpha, B2, Mag		2
Miscellaneous	special images		6
Spectrohelioscope			4
Maximum total number of images			29

Preliminary Report and Forecast of Solar and Geophysical Data “The Weekly”

The *Preliminary Report and Forecast of Solar and Geophysical Data*, referred to as “The Weekly,” is a weekly report published by SESC and mailed to customers. It contains summaries of significant solar and geophysical activity observed during the past week, an outlook for the next 27 days, detailed data listings, and data plots.

The Weekly provides prompt access for subscribers (current circulation is about 1100) to the most recent, although preliminary, activity reports. It serves users who do not need real-time information but cannot wait several months for the compilation of final data sets from NGDC.

The Weekly is a continuation of the weekly reports that began in 1951 and were issued jointly by the High Altitude Observatory and NOAA or its predecessors. The current series began on 09 September 1975.

- Issue time:** Composed each Tuesday, mailed on Wednesday.
- Period covered:** The 7 days up to and including the previous Sunday, plus forecasts for the next 27 days.
- Delivery Systems:** Available by mail. Back issues of The Weekly contact NGDC.
In addition, the Highlights of the week’s activity and Forecast of activity plus the 27-day Outlook table are available via electronic file transfer and the Public Bulletin Board.
- Data Quality:** The Weekly is based on the preliminary data available at the time of publication and should not be cited for reference purposes.
- Note:** To subscribe to the Weekly, contact SESC. *A Users Guide to The Preliminary Report and Forecast of Solar and Geophysical Data*, giving a detailed description of its contents, is published annually and sent to all new and current subscribers.

Preliminary Report and Forecast of Solar and Geophysical Data

“The Weekly” – cont.

Highlights of Solar and Geomagnetic Activity: Prose-style summary.

Daily Solar and Geophysical Indices: 10.7 cm radio flux; sunspot number and area; flare totals; x-ray background flux; proton and electron fluence; middle-latitude, high-latitude, and estimated planetary A and K indices.

Alerts and Warnings Issued: Listing.

Energetic Event Summary: Summary list of large solar events.

Flare List: Optical and x-ray flare list with times, size, location, and region number.

Region Summary: Description of active regions visible during the past week: location, sunspot area, extent, magnetic class, count of x-ray flares, and count of optical flares.

Geosynchronous Satellite Environment Summary: Plots of proton flux, electron flux, H-parallel, and estimated K_p-index.

GOES Satellite Proton Flux and x-ray Flux Plots: Proton flux at > 1, > 10, > 30 and > 100 MeV and x-rays at 0.05–0.4 and 0.1–0.8 nm.

Daily Middle- and High-Latitude A indices: Plots of the previous month’s A indices from Fredericksburg, Virginia, and Point Barrow, Alaska.

H-alpha Synoptic Chart: A preliminary map of the Sun, in absolute heliographic coordinates, for one solar rotation.

Recent Solar Indices: Preliminary observed and smoothed monthly mean values for sunspot numbers, 10.7 cm radio flux, and the estimated A_p index.

Forecast of activity for the next 27 days

Forecast of Solar and Geomagnetic Activity: Prose-style summary.

27-day Outlook: 10.7 cm solar radio flux, A_p index, and largest expected daily K_p index.

Monthly Activity Summary and Solar Cycle Outlook: A longer-term outlook, based on the general trend of the solar cycle, with previous solar-cycle comparison plots.

Month	Plot
Jan	Sunspot Number (RI)
Feb	Sudden Storm Commencements And Impulses
Mar	Solar Radio Flux (10.7 cm)
Apr	Quiet ($A_p \leq 7$) Geomagnetic Conditions
May	Cosmic Ray Ground Level Events
Jun	Severe Storm ($A_p \geq 100$) Geomagnetic Conditions
Jul	M5 or Greater X-ray Flares
Aug	Proton Events
Sep	Solar Terrestrial Indices
Oct	Optical Flares
Nov	Active Regions
Dec	Geomagnetic Activity (A _p)

Publications

SESC publishes a number of reference documents, which are sent free to interested customers.

Issue time: As requested by the customer.

Period covered: As requested by the customer.

Delivery Systems: As arranged between SESC and the customer.

SESC publications available on request

SESC Products and Services User Guide

This document.

Users Guide to The Preliminary Report and Forecast of Solar and Geophysical Data

An annual publication, describing the contents of the Weekly, sent to all new Weekly subscribers.

SESC Glossary of Solar-Terrestrial Terms

A glossary of solar terms used in SESC products.

A Radio Frequency User's Guide to the SESC Geophysical Alert Broadcasts

A 19 page document explaining of the terminology and format of the Geophysical Alert Message. NOAA Tech Memo ERL SEL-80.

IUWDS Synoptic Codes for Solar and Geophysical Data

The International URSI World Days Service organizations developed a set of 5-digit codes for encoding data in order to exchange data economically. Much of the data received from ground-based stations still arrive in coded form. SESC retransmits some coded data via electronic file transfer. This manual is the official description of the IUWDS codes.

TIROS/NOAA Satellites Space Environment Monitor Archive Tape Documentation, 1988 Update

SESC creates archive tapes of the Space Environment Monitor (SEM) data received from the TIROS/NOAA satellites. This NOAA Technical Memorandum describes the SEM instruments, the data obtained, and the tape format. NOAA Tech Memo ERL SEL-77.

Space Environment Laboratory Data Acquisition and Display System II

A historical and technical description of the SELDADS II computer system. NOAA Tech Memo ERL SEL-76.

Short-term Support And Special Data Requests

SESC supports customers individually to meet special short-term data needs, provide individual forecasts, and develop specialized products.

Issue time: As requested by the customer.

Period covered: As requested by the customer.

Delivery Systems: As arranged between SESC and the customer.

Note: Contact SESC to arrange individual short-term support and special data requests.

Samples of special support and data provided by SESC:

- NASA Shuttle missions both before launch and during the mission.
- Special electronic file access to solar images, products, data listings, and data plots for Max'91 campaigns.
- Geomagnetic storm predictions for sounding rocket launches for MIT Lincoln Laboratories.
- Newspaper, magazine, radio, and TV interviews.
- Requests from individuals for information about the Sun or SESC.
- Requests for recent data sets that are not routinely distributed.
- Photographs and sunspot drawings from the local Boulder Observatory and other SELSIS Observatories.

2. Delivery Systems

Products and Services

Delivery Systems

	Phone	Fax	Telephone Recording & Radio Bcst.	Satellite Broad- cast	COMEDS	SELDADS	Electronic File Transfer	Bulletin Board	Mail	NGDC
Alerts and Warnings	★	★	★	★	★					
Geophysical Alert Message			★							
Report of Solar and Geophysical Activity					★	★	★	★		
Solar Region Summary					★	★	★	★		
Solar and Geophysical Activity Summary					★	★	★	★		
Solar Coronal Disturbance Report					★	★	★	★		
High-Frequency Radio Propagation Report					★	★	★	★		
World Warning Agency GEOALERT					★	★	★	★		
Space Weather Data				★	★	★	★	★		★
Solar Images							★			
Solar-Synoptic Analysis Drawing		★								★
“The Weekly”							★	★	★	★
Publications										★
Short-term and special support arranged with the customer.										

Telephone Call

SESC's customers with a need for immediate notification of solar-terrestrial events and predicted phenomena receive direct telephone calls. Customers are called on all alerts and warnings issued by SESC, as described in Section 1. Alerts and Warnings are issued 24 hours a day, 7 days a week. However, customers can limit the time periods when they are called by selecting a priority level:

- Priority 1 — any day, any hour via telephone.
- Priority 2 — any day, any hour via fax.
- Priority 3 — any day, any hour to answering device.
- Priority 4 — restricted days and hours via telephone or fax.

Update time: Alerts are issued as soon as an event is recognized, usually while it is still in progress. Warnings are issued when alerts conditions are predicted within the next 72 hours.

Maintenance: The telephone calls are made by the Forecaster and Soltech (Solar Technician). A Soltech is on duty 24 hours a day, 7 days a week. Customers are called according to priority levels.

Fax

SESC's customers who need quick notification of solar-terrestrial events, predicted phenomena, or the solar synoptic analysis drawings can receive them via fax.

Update time: Alerts are issued as soon as an event is recognized, usually while it is still in progress. Warnings are issued when alerts conditions are predicted within the next 72 hours. The drawings are sent when completed, about 2200 UT daily.

Maintenance: Faxes are sent by the duty Soltech.

Mail

SESC's customers can receive the solar synoptic drawing, The Weekly, or other publications via mail.

Update time: Solar synoptic drawings are mailed daily.
The Weekly is mailed every Wednesday.
Other publications are mailed on request.

Telephone Recording and Radio Broadcast (WWV & WWVH)

SESC's customers can hear a recorded message describing the latest solar and geophysical conditions in an hourly radio broadcast. The message is described in Section 1 under **Geophysical Alert Message**.

Telephone recording: (303) 497-3235

Radio Broadcast: WWV broadcasts the message at 18 minutes past the hour at 2.5, 5.0, 10.0, 15.0, and 20.0 MHz.
WWVH broadcasts the message at 45 minutes past the hour at 2.5, 5.0, 10.0, and 15.0 MHz.

Maintenance: The message is updated every 3 hours, beginning at 0000 UT.

COMEDS Teletype Networks

SESC uses the Continental Meteorological Data System (**COMEDS**), a U.S. Air Force (USAF) international weather network, to distribute alerts, warnings, products, and coded data messages. The coded messages include radio, optical, ionospheric, and geomagnetic data, plus event reports.

Update time: Products are put on the network at issue time and data are transmitted as received.

Maintenance: COMEDS is maintained by the U.S. Air Force 24 hours a day, 7 days a week.

Requirements: Customers are normally organizations with Department of Defense support requirements.

Satellite Broadcast

SESC broadcasts recent solar and geophysical data via a commercial satellite which can be monitored by customers with a small satellite receiving station. This enables customers to collect SESC data on a printer, video terminal or microcomputer for their individual use. The Satellite Broadcast provides real-time data on a continuing basis throughout the U.S. and Canada. SESC also has IBM-compatible PC software to display the data.

Update times: The Satellite Broadcast contains the most recent data from SELDADS. The data types and length of time the data are available vary.

Maintenance: This operational system is maintained 24 hours a day, 7 days a week.

Requirements: The customer needs a satellite receiving station: a micro-station consisting of a small (2-ft diameter) antenna and a portable controller. The controller can be connected to a printer, a video terminal, or a microcomputer of choice. Customers must purchase their own equipment, which is currently available for \$2,600.

The PC software is available at no charge.

Satellite Broadcast Menu on PC Software

1. Boulder and Planetary geomagnetic indices
2. Geosynchronous satellite geomagnetic data
3. Solar-geophysical forecasts, warnings, and alerts
4. Ionospheric data
5. Daily solar indices
6. (not currently in use)
7. GOES x-ray plot
8. Boulder magnetometer plot with quiet-day curve

Satellite Broadcast – cont.

Data transmitted over the Satellite Broadcast system:

Alert messages, as issued by SESC – updated at occurrence

Solar Flares

- x-ray flares of class \geq M5 or \geq X1 observed.

Radio Bursts

- Sweep-frequency radio bursts of Type II or Type IV observed.
- Radio Bursts greater than 100% of background at 2695 MHz observed.
- Radio Bursts greater than 100 sfc at 245 MHz observed.
- Radio noise storms at 245 MHz in progress.

Proton Events

- Proton Event of \geq 10 pfu at $>$ 10 MeV observed or predicted.
- Proton Event of \geq 100 pfu at $>$ 100 MeV observed or predicted.

Geomagnetic disturbances

- K_B -index of 4, 5, or \geq 6.
- A_B -index of $>$ 20, $>$ 30, or $>$ 50 observed or predicted.

Stratwarms – Stratwarm (stratospheric warming) alerts when they are in effect.

SESC 3-day Forecasts – updated daily

- Daily probability for M-, X-, and proton-class x-ray flares.
- Daily indices for 10.7 cm flux and geomagnetic A indices.
- 3-hourly geomagnetic K indices.

Solar Data – updated every minute

- Daily 10.7 cm flux index for the current day.
- 90-day mean 10.7 cm flux for the previous day.
- Daily SESC Sunspot number for the current day.
- X-rays—Latest GOES 6 & 7 1-min average expressed in the B, C, M, X scale (watts/meter²).
- Daily x-ray background flux expressed in the B, C, M, X scale (watts/meter²).
- Proton fluences—GOES 6 & 7 daily total proton fluence at $>$ 1 and $>$ 10 MeV.
- Protons—Latest GOES 6 & 7 5-min average number of protons at $>$ 1, $>$ 10, and $>$ 100 MeV.
- Polar Cap Absorption—Latest 15-min value, in dB, of absorption at 30 MHz from Thule.
- Neutrons—Latest Thule neutron monitor data in percent above or below background.

Ionospheric Data – updated every 3 minutes (one day for one station takes 3 minutes)

- foF2 hourly values from Churchill Canada and Eielson AK, in MHz.
- TEC—Total Electron Content hourly values from Boulder CO, Anchorage AK, Osan AFB Korea in electrons/square meter.

Geomagnetic Data – updated every minute

- K-indices—3 hourly K_B - and K_P -indices for previous and current day.
- A-indices—Daily Boulder A_B - and A_P -indices for previous and current day.
- Total field—1-min averages of three components, in nT, measured at Boulder.
- Geosynchronous—GOES 6 & 7, 1-min values for three components, in nT.

Special Support—Customer support and system status messages issued as required.

SELDADS Outside User System

SELDADS, the Space Environment Laboratory Data Acquisition and Display System, is the dedicated real-time computer system that supports SESC Operations. The SELDADS Outside User System provides customer access to the daily SESC products and near-real-time space weather data from around the world. SELDADS connections are via dial-up modem communications. The Outside User System is a menu-driven display, which lists and plots user selected data or products (see facing page).

- Update time:** The data are received in delayed real time. Delays vary from seconds for satellite data to as much as 24 hours for some international data.
- Period covered:** The length of time data are retained is determined by the amount of data received; i.e. daily data are retained much longer than 1 minute data.

Data Retention Limits

Data frequency	Retained for
1-min data	8 days
5- and 15-min data	32 days
3-hour data	1 year
Daily data	1 year up to 10 years
Monthly and Yearly	no set limit

- Maintenance:** SELDADS is an operational system and is maintained 24 hours per day, 7 days per week,.
- Requirements:** Users need a computer terminal and modem: 300- or 1200-baud connection, 8 bits/character, no parity, full duplex.
- Supported terminal types include 4010-compatible Tektronix, DEC-compatible VT100, Data General Dasher terminal, or teletype.
- Note:** To request a SELDADS Outside User account contact SESC. New users will receive a Users Manual, which explains the initial log-in process and how to navigate the menu system.

SELDADS Outside User System – cont.

Forecasts and Alerts Reports Menu

- Report of Solar and Geophysical Activity
- Solar Region Summary
- Solar and Geophysical Activity Summary
- Solar Coronal Disturbance Report
- WWA GEOALERT
- AFSFC 3-hourly Geomagnetic Events and Forecast Message
- AFSFC 27 day 10.7 cm Solar Radio Flux Forecast
- AFSFC HF Radio Propagation Report
- AFSFC 7-day A_p forecast
- AFSFC 27- & 45-day A_p and 10.7 cm flux forecast
- AFSFC Event Warning Report

Summaries Menu

- Solar and Geomagnetic Data
 - AFSFC Solar Flare Display
 - AFSFC Disk/limb Summary
 - AFSFC Solar Radio Bursts, Sweep, and Flux Summaries
 - AFSFC Mag. Analysis: 3-hour, 24-hour, and 1-day max nT, K_p & A_p , 6 stations
- Solar Event Log
- Limb/Disk Log
- Particle Log
- Geomagnetic Index Log: K and A indices from 26 stations

Data Lists Menu

- Ionospheric Lists
 - Critical Frequency: FoF2, FOES, FMIN, and M3000 by stations
 - Total Electron Content (TEC) data
 - Auroral Radar data
 - Riometer and Neutron Monitor data

- X-ray Lists – GOES 6 & 7, 3 sec, 1 min, 5 min, hourly, and daily data
- Particle Lists – GOES 6 & 7, Protons, Differential Flux, Integral Flux, Alpha Particles
- Geomagnetic Lists – 1- or 5-min data, by station, chain, or satellite
- Radio Lists – By station

Data Plots Menu (plots in Tektronix format)

- X-ray Plots: GOES 6 & 7, 1-min or 5-min data
- Particle Plots: GOES 6 & 7, Protons, Differential Flux, Integral Flux, Alpha Particles.
- Geomagnetic Plots: 1- or 5-min data by station, chain, or satellite; and k-index map
- Real-time plots and lists: X-ray, proton, and magnetometer

Utilities Menu

- TEC Satellites
- SELDADS Stations
- Brief Stations: Contributing station name, country, geographic location, and 3-letter code.

Electronic File Transfer for Products and Data

SESC maintains files of products, listings, and plots that are accessible through SEL's VAX computer system (SELVAX). SESC does not transmit data to users; rather, the user can log on to the SELVAX computer and get data via network file transfers. SELVAX contains READ.ME files, describing the system, that can be found in the SELVAX directories [sesc] and [max91].

Update time: Files are updated with the latest information every 6 hours beginning at 0030 UT.

Period covered: Files are kept on-line for 32 days.

Maintenance: The system is available 24 hours a day, 7 days a week, but SELVAX is maintained only during normal working hours.

Accessing the SELVAX computer:

Internet

telnet selvax.sel.bldrdoc.gov	or	telnet 132.163.224.10
login with username SEL		(no password required)
TYPE <i>filename</i>		(VMS commands must be used)

OR

ftp selvax.sel.bldrdoc.gov	or	ftp 132.163.224.10
login with username ftp		(password is your email address)
cd [sesc]	or	cd [max91]
get <i>filename</i>		

SPAN

SET HOST SELVAX	or	SET HOST 34367::
login with username SEL		(no password required)
TYPE <i>filename</i>		

OR

COPY SELVAX::SEL\$SEL: <i>filename</i> *.*	or	
COPY 34367::SEL\$SEL: <i>filename</i> *.*		

Telephone

(303) 497-3215	(1200 or 2400 baud)
login with username SEL	(no password required)
TYPE <i>filename</i>	

Electronic File Transfer for Products and Data – cont.

There are two directories, [sesc] and [max91]. Both have a **README** file, which describes the data files and the file-naming convention.

Daily and Weekly Text Products

- Solar and Geophysical Activity Report and Forecast (SGARF)
- Solar Region Summary (SRS)
- Solar Geophysical Activity Summary (SGAS)
- Solar Coronal Disturbance Report (SCDR)
- Geophysical Alert Reports (GEOALERT)
- High-Frequency Radio Propagation Reports (PROPRPT)
- Geomagnetic Reports

6-hour plots of 5-min data, as Textronix plot 10 files (binary file transfers are required)

- GOES X-ray flux, 0.05–0.4 and 0.1–0.8 nm.
- GOES X-ray flux tagged with optical flare information.
- GOES–7 particle and electron channels (P1–P11 and E1)
- GOES–7 differential protons (P@5 to P@50)
- GOES–7 proton integral flux (P > 1 to P > 60)
- Mid-latitude ground-based magnetometer station chain
- East-West ground-based magnetometer station chain
- Alaskan ground-based magnetometer station chain

Data listings

- Magnetic Index Summary
- Total Electron Count, hourly data, east or west hemisphere
- Solar flares
- SESC contributing stations:
 - name, abbreviation, IUWDS#, WHO#, contributions, and location

Forecasts

- 27-Day Outlook of daily 10.7 cm solar flux, planetary A_p indices, and largest daily K_p indices. Updated weekly on Wednesday
- Daily 10.7 cm, A_p and K_p values and 3-day forecasts

Electronic File Transfer for Solar Images

SESC maintains files of solar images, in digital format, that are accessible through SEL's VAX computer system (SELVAX). SESC does not transmit data to users; rather, the user can log on and transfer data via network file transfers. Images are available in compressed and uncompressed format, and soon will be available in FITS format.

- Update time:** Images are transferred to SELVAX throughout the day as they are received.
- Period covered:** Compressed files are retained for about 10 days, uncompressed files for 4 days. SESC will begin using the FITS image format in the near future and will make images available for longer than the current 10 days.
- Maintenance:** The system is available 24 hours a day, 7 days a week, but SELVAX is maintained only during normal working hours.

Accessing the SELVAX computer:

Internet –

ftp selvax.sel.bldrdoc.gov	or	ftp 132.163.224.10
login – username IMAGE		(no password required)
get <i>filename</i>		

SPAN –

COPY SELVAX::SEL\$IMAGE:*filename* *.* or
 COPY 34367::SEL\$IMAGE:*filename* *.*

Electronic File Transfer for Solar Images – cont.

The IMAGE account has a text file, **directory.lis**, which lists the currently available images.

Compressed and Uncompressed files

The files are 513×512 bytes; the first line is 128 bytes of ASCII header information plus 384 bytes of blank fill.

The *filename* is made up of the image's date/time, a station code, and a format extension:

	iyymmddhhmmssob.span	or	iyymmddhhmmssob.span_z
i	1 letter, always "i," means image file.		
yy	2-digit year		
mm	2-digit month		
dd	2-digit day		
hh	2-digit hour		
mm	2-digit minute		
ss	2-digit second		
ob	2-digit observatory code:		
	01 = Boulder		04 = Learmonth
	02 = Holloman		05 = Sac Peak
	03 = Kitt Peak		
.span	uncompressed file, 513×512 bytes.		
.span_z	compressed file. Contact Jim Winkelman (SELVAX::SYSTEM) for the VAX decompression algorithm.		

FITS format files

The *filename* is made up of the image's date, wavelength, station, resolution, processing, and sequence number through the day:

	yymmddws.rpnn	
yy	2-digit year	
mm	2-digit month	
dd	2-digit day	
w	1 letter for wavelength:	h = h-alpha, w = white light, m = magnetogram, l = 1083nm, s = spectrohelioscope
s	1 letter for station:	b = Boulder, h = Holloman, k = Kitt Peak, l = Learmonth, s = Sac Peak
r	1 letter for resolution:	l = low, m = medium, h = high
p	1 letter for processing:	r = raw, o = oriented, s = synoptic
nn	2-digit sequence number:	begins at 01 and increases incrementally for each new image throughout the day.

Public Bulletin Board System

SESC maintains a PC-based Public Bulletin Board System (PBBS) through which customers can access the last 24 hours of SESC products and data.

Update times: The PBBS contains the most recent products and data, but the retention lengths vary (see the descriptions on the facing page).

Maintenance: The system is available 24 hours a day, 7 days a week, but it is maintained only during normal working hours. Therefore, if the system goes down during off-hours it is not restarted until the next regular work day.

Accessing the Public Bulletin Board System:

Contact SESC for more information about the bulletin board, or access the PBBS directly.

The data are obtained via modem from a dial-up PC in SESC.

Protocol is 8-bit data with 1 stop bit and no parity.

The PBBS prompts you for the required initial information and then leads you to the main menu.

Phone number: (303) 497-5000 for 300-, 1200- or 2400-baud.

SEL/ERL Space Environment Laboratory BBS

P)ropagation Report	C)oronal Data Report
S)olar Report	G)eoalert Message
R)egion Report	L)og of Magnetic Data
A)ctivity Summary	D)ata Listing Menu
O)utlook for 27 days	W)eekly Summary
Q)uick Look Data	M)UF Predictions
N)ews of Services	F)eedback to Sysop
H)elp Menu	B)ye (Leave System)

(P, S, R, A, O, Q, N, H, C, G, L, D, W, M, F, B) Choice ? __

Public Bulletin Board System – cont.

Material available on the PBBS

Activity Summary – The daily report of significant x-ray flares, proton events, or geomagnetic storms. Available at 0330 UT.

Bye – The command to exit the PBBS system.

Coronal Data Report – The daily report of coronal holes, interplanetary disturbances, and mass-ejection reports. Available at 0230 UT.

Data Listings – 30-day listings of sunspot numbers, solar radio flux values, and geomagnetic A and K indices.

Feedback to Sysop – A routine that PBBS users can use to send their comments to the system operator at SESC.

Geoalert Message – A coded message of sunspot locations, flare activity, and energetic solar-geophysical activity for the previous day, a brief forecast of solar-geophysical activity. Available at 0430 UT.

Help – A help menu.

Log of Magnetic Data – A tabular display of the latest 24-hour UT day A and K indices for a selection of geomagnetic stations.

MUF Predictions – A routine that users can run to obtain real-time Maximum Usable Frequency predictions for propagation paths of their choice.

News of Services – A description of new products and services.

Outlook for 27 days – 27-day forecast of 10.7 cm solar radio flux, A_p index, and largest expected daily K_p index (from The Weekly). Available each Wednesday after 0100 UT.

Propagation Report – A simple summary and forecast of HF radio propagation conditions for the Northern Hemisphere. This product is refreshed every 6 hours and posted on the PBBS.

Quick-Look Data – A tabular display of the latest 24-hour UT day values for a selection of key solar-geophysical parameters.

Region Report – The daily report of sunspot regions for the most recent 24-hour UT day. Available at 0100 UT.

Solar Report – The daily report of solar and geophysical activity (such as solar flares, proton events, PCAs, geomagnetic storms) and forecasts for the subsequent 3 days. Available at 2230 UT.

Weekly Summary – Text portion of The Weekly containing highlights of solar and geophysical activity during the past week and a forecast for the next 27 days. Available each Wednesday after 0100 UT.

NGDC

SESC collects data in near-real time for quick dissemination. Some data are later revised or enhanced; other data are not available in the quick time-scale needed (less than 3 days). SESC also only retains data for 30 days. The National Geophysical Data Center (NGDC) is the data archive center for solar-terrestrial physics. NGDC archives the same data collected by SESC, but it collects final and corrected data. Data for research use should be obtained from NGDC.

NGDC is the focal point for archived data pertaining to solar-terrestrial physics, including solar activity, the ionosphere, and geomagnetic variations. NGDC is a part of the NOAA National Environmental Satellite, Data, and Information Service (NESDIS) that has responsibility for the collection, management, and dissemination of data produced by scientific observations of the Earth, the Sun, and the interplanetary medium.

Update time: SESC data are sent to NGDC yearly.

Period covered: NGDC has extensive data holdings, some dating back to the 1800s.

Medium: NGDC provides data in a wide variety of media from paper to CD-ROM. NGDC also correlates and reorganizes data into new formats such as publications and archive data sets.

Note: For information on the data, media, and associated costs, please contact NGDC at the following address:
National Geophysical Data Center
NESDIS, NOAA, E/GC2
325 Broadway
Boulder, CO 80303-3328

Phone (303) 497-6133
FAX (303) 497-6513

SPAN: 34367::HCOFFEY

NGDC – cont.

NGDC Data Categories

- Airglow
- Aurora
- Cosmic rays
- Flare-associated events
- Geomagnetic variations
- Ionospheric phenomena
- Satellite anomalies
- Solar and interplanetary phenomena

SESC products and data archived by NGDC

- Solar Coronal Disturbance Report
- Edited Regions: a daily listing describing all visible active sunspot regions
- Edited Events: a daily listing of energetic solar and geophysical events
- H-alpha prints from the Boulder Observatory
- GOES satellite archive tapes

Appendix A – Acronyms and Abbreviations

AFB	U. S. Air Force Base.
AFSFC	Air Force Space Forecast Center, U. S. Air Force. SEL operates SESC jointly with AFSFC (sometimes referred to as SFC).
B2	Observations in magnesium B2.
Ca II	Calcium II emission wavelength.
FAX	Facsimile machine.
FITS	Flexible Image Transfer System. A NASA Science Data Systems Standards Office format for transferring astronomical data.
GEOALERT	Geophysical alert.
GOES	Geostationary Operational Environmental Satellites.
HF	High Frequency.
IUWDS	International URSIgram and World Days Service.
Mag	Magnetogram solar image (and sometimes geomagnetic).
MeV	Megaelectronvolts, million electron volts.
MHz	Megahertz, million hertz.
MUF	Maximum Usable Frequency.
MV	Data General MV10000 computer, running the SELDADS.
NESDIS	National Environmental Satellite, Data, and Information Service.
NGDC	National Geophysical Data Center, in Boulder, CO.
NOAA	National Oceanic and Atmospheric Administration, also used to denote a satellite in the TIROS/NOAA satellite series
NSO	National Solar Observatory.
nT	nanotesla. A unit of magnetic flux equivalent to 1×10^{-5} gauss.
NWS	National Weather Service.
PBBS	SESC's Public Bulletin Board System.
PC	IBM-compatible personal computer.
PCA	Polar Cap Absorption.
pfu	particle flux unit. $1 \text{ p cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1}$.
QDC	Quiet Day Curve.
RI	International Relative Sunspot Number.
SEL	Space Environment Laboratory.
SELDADS	Space Environment Laboratory Data Acquisition and Display System, SESC's operational database and computer system.
SELVAX	The SPAN address of SEL's VAX computer.

SESC	Space Environment Services Center, Boulder, CO.
SFC	Space Forecast Center, U. S. Air Force (sometimes referred to as AFSFC). SEL operates SESC jointly with AFSFC .
sfu	solar flux units. $10^{-22} \text{ W m}^{-2} \text{ Hz}^{-1}$.
SID	Sudden Ionospheric Disturbance.
SOON	Solar Optical Observing Network.
SPAN	Space Physics Analysis Network, a computer network.
TEC	Total Ionospheric Electron Content.
UT	Universal Time, for example 2200 UT. See Coordinated Universal Time in the glossary, Appendix B.
VAX	Digital Equipment Corporation (DEC) computer.
W m^{-2}	watts per square meter
WWA	World Warning Agency.
WWV	Call letters of the standard time and frequency radio station broadcast from Ft. Collins, CO.
WWVH	Call letters of the standard time and frequency radio station broadcast from Hawaii.
Z	Zulu time, for example 2200Z. See Coordinated Universal Time in the glossary, Appendix B. In one product Z is used to indicate Modified Zurich Sunspot Classification (see page 9).

GLOSSARY OF SOLAR-TERRESTRIAL TERMS

A

A_B. The A index observed at Boulder, Colorado.

A_{Fr}. The A index observed at Fredericksburg, Virginia.

a_k index. A 3-hourly “equivalent amplitude” index of geomagnetic activity for a specific station or network of stations (represented generically here by k) expressing the range of disturbance in the horizontal magnetic field; “a_k” is scaled from the 3-hourly K index according to the following table:

K	0	1	2	3	4	5	6	7	8	9
a _k	0	3	7	15	27	48	80	140	240	400

At SESC these values are used directly for operational purposes. But to convert the a_k values to nanotesla (nT), a local (station-dependent) conversion factor must be found by dividing the station’s lower limit for k = 9 by 250. For example, at Boulder and Fredericksburg the lower limit for k = 9 is 500 nT so the factor is 2; therefore the a_k for these stations are in units of 2 nT. (To obtain an equivalent amplitude in nT for Boulder or Fredericksburg, the index value must be doubled.)

A_k index. A daily index of geomagnetic activity for a specific station or network of stations (represented here by k), derived as the average of the eight 3-hourly a_k indices in a Universal Time day.

a_p index. A mean, 3-hourly “equivalent amplitude” of magnetic activity based on **K index** data from a planetary network of 11 Northern and 2 Southern Hemisphere magnetic observatories between the geomagnetic latitudes of 46° and 63° by the Institut für Geophysik at Gottingen, F.R. Germany; a_p values are given in units of 2 nT.

A_p index. Formally the daily A_k index, determined from the eight daily a_p indices. However, for daily operational uses (since several weeks are required to collect the data and calculate the index), Air Force Space Forecast Center estimates the value of the Gottingen A_p index by measuring the geomagnetic field in near real time at several Western Hemisphere magnetometer stations. The value of this estimated A_p index is reported in SESC daily and weekly summaries of geophysical activity.

C

Carrington longitude. A real system of fixed solar longitudes rotating at a uniform synodic period of 27.2753 days (a sidereal period of 25.38 days). Carrington selected the meridian that passed through the ascending node of the Sun’s equator at 1200UTC on 01 January 1854 as the original prime meridian. The daily Carrington longitude of the central point of the apparent solar disk is listed (with other solar coordinates) in *The Astronomical Almanac* published annually by the U.S. Naval Observatory. Compare Bartel’s rotation number.

Coordinated Universal Time (UTC). By international agreement, the local time at the prime meridian, which passes through Greenwich, England. It was formerly known as Greenwich Mean Time, or sometimes simply Universal Time. There are 24 time zones around the world, labeled alphabetically. The time zone centered at Greenwich has the double designation of A and Z. Especially in the military community, Coordinated Universal Time is often referenced as Z or Zulu time.

coronal hole. An extended region of the corona, exceptionally low in density and associated with unipolar photospheric regions having “open” magnetic field topology. Coronal holes are largest and most stable at or near the solar poles, and are a source of high speed solar wind. Coronal holes are visible in several wavelengths, most notably solar x-rays; but at SESC, coronal holes are determined from solar images in H_e 1083 nm provided by the Kitt Peak National Solar Observatory.

coronal mass ejection (CME). A transient outflow of plasma from or through the solar corona. CME’s are often but not always associated with erupting prominences, disappearing solar filaments and flares.

D

disappearing solar filament (DSF). A solar filament (prominence) that disappears suddenly (on a time scale of minutes to hours). The prominence material is often seen to ascend but is also seen to fall into the sun or just fade. (Historically, DSF’s have been called disparition brusques because they were first studied by French astronomers.) DSF’s are a possible indicator of coronal mass ejections.

E

eruptive prominence on limb (EPL). A solar prominence that becomes activated and is seen to ascend from the sun; sometimes associated with a coronal mass ejection. (See also disappearing solar filament).

F

filament. A mass of gas suspended over the chromosphere by magnetic fields and seen as dark ribbons threaded over the solar disk. A filament on the limb of the sun seen in emission against the dark sky is called a prominence. Filaments occur directly over magnetic polarity inversion lines, unless they are active.

flare. A sudden eruption of energy in the solar atmosphere lasting minutes to hours, from which radiation and particles are emitted. Flares are classified on the basis of area at the time of maximum brightness in H-alpha:

Importance 0 (Subflare): ≤ 2.0 hemispheric square degrees.

Importance 1: 2.1–5.1 square degrees.

Importance 2: 5.2–12.4 square degrees.

Importance 3: 12.5–24.7 square degrees.

Importance 4: ≥ 24.8 square degrees.

[One square degree is equal to $(1.214 \times 10^4 \text{ km})^2 = 48.5$ millionths of the visible solar hemisphere.] A brightness qualifier, F, N, or B, is generally appended to the importance character to indicate faint, normal, or brilliant (for example, 2B).

fluence. Time integrated flux; in SESC use, a specified particle flux accumulation over 24 hours.

flux. The rate of flow of a physical quantity through a reference surface.

fmin. The lowest frequency at which echo traces are observed on an ionogram. It increases with increasing D region absorption.

foEs. The maximum ordinary mode radio wave frequency capable of vertical reflection from the sporadic E layer of the ionosphere.

foF2. The maximum ordinary mode radio wave frequency capable of vertical reflection from the F2 layer of the ionosphere.

G

gamma. A unit of magnetic flux equivalent to 1×10^{-5} gauss; equal to 1 nanotesla (nT), which is the preferred unit of measure.

geomagnetic activity. Natural variations in the geomagnetic field, classified quantitatively into quiet, unsettled, active, and geomagnetic storm levels according to the observed a_k index:

Category	Range of a_k index
quiet	0–7
unsettled	8–15
active	16–29
minor storm	30–49
major storm	50–99
severe storm	100–400

geomagnetic elements. The components of the geomagnetic field at the surface of Earth. These elements are usually denoted thus in the literature:

- X geographic northward component.
- Y geographic eastward component.
- Z vertical component, reckoned positive downward.
- H horizontal intensity, of magnitude $(X^2 + Y^2)^{1/2}$.
- F total intensity $(H^2 + Z^2)^{1/2}$.
- I inclination (or dip) angle, $\tan^{-1} (Z/H)$.
- D declination angle, measured from the geographic north direction to the H component direction, positive in an eastward direction. $D = \tan^{-1} (Y/X)$.

However, in SESC use, the geomagnetic northward and geomagnetic eastward components are called the H and D components. The H axis direction is defined by the mean direction of the horizontal component of the field; the D component is expressed in nT and is related to the direction of the horizontal component relative to geomagnetic north by using small-angle approximation. Thus the D component equals H (the horizontal intensity) multiplied by $\Delta\theta$ (the declination angle relative to geomagnetic north, expressed in radians).

geomagnetic field. The magnetic field in and around the earth. The intensity of the magnetic field at Earth's surface is approximately 32,000 nT at the equator and 62,000 nT at the north pole (the place where a compass needle points vertically downward). The geomagnetic field is dynamic and undergoes continual slow secular changes as well as short-term disturbances (see geomagnetic activity). The geomagnetic field can be approximated by a centered dipole field, with the axis of the dipole inclined to Earth's rotational axis by about 11.5°. Geomagnetic dipole north is near geographic coordinate 78.3° N 69° W (Thule, Greenland), and dipole south is near 79°S 110°E. The observed or dip poles, where the magnetic field is vertical to the earth's surface, are near 76°N 101°W, and 66°S 141°E. The adopted origin of geomagnetic longitude is the meridian passing through the geomagnetic poles (dipole model) and the geographic south pole. (See also corrected geomagnetic coordinates).

geomagnetic storm. A worldwide disturbance of Earth's magnetic field, distinct from regular diurnal variations. For operational purposes, a storm is defined as occurring when the daily A_p index exceeds 29 (see geomagnetic activity).

Initial phase: Of a geomagnetic storm, that period when there may be an increase of the middle-latitude horizontal intensity (H) (see geomagnetic elements) at the surface of Earth. The initial phase can last for hours (up to a day), but some storms proceed directly into the main phase without showing an initial phase.

Main phase: Of a geomagnetic storm, that period when the horizontal magnetic field at middle latitudes is generally decreasing, due to the effects of an increasing westward-flowing magnetospheric ring current. The northward component can be depressed as much as several hundred nT in intense storms. The main phase can last for hours, but typically lasts less than a day.

Recovery Phase: Of a geomagnetic storm, that period when the depressed northward field component returns to normal levels. Recovery is typically complete in 1 to 2 days, but can take longer.

GLE. See ground level event.

ground level event (GLE). A sharp increase in ground-level cosmic ray count to at least 10% above background, associated with solar protons of energies greater than 500 MeV. GLEs are relatively rare, occurring only a few times each solar cycle. When they occur, GLEs begin a few minutes after flare maximum and last for a few tens of minutes to hours. Intense particle fluxes at lower energies can be expected to follow this initial burst of relativistic particles. GLE's are detected by neutron monitors, e.g., the monitor at Thule, Greenland.

H

H-alpha. The first atomic transition in the hydrogen Balmer series; wavelength = 656.3 nm. This **absorption line** of neutral hydrogen falls in the red part of the visible spectrum and is convenient for solar observations. The H-alpha line is universally used for patrol observations of solar **flares, filaments, prominences**, and the fine structure of **active regions**.

heliographic. Referring to coordinates on the solar surface, referenced to the solar rotational axis.

high frequency (HF). That portion of the radio spectrum between 3 and 30 MHz.

high latitude. With reference to zones of geomagnetic activity, 50 to 80 degrees geomagnetic latitude. The other zones are equatorial, polar, and middle latitudes.

I

integrated particle flux. The integral directional particle flux, $J(E,W)$, is literally the mathematical integral, with respect to the energy, E , of the differential particle flux, $J(E,W)$. It denotes the number of particles of energy equal to or greater than E , per unit area, per solid angle, per unit time, passing through an area perpendicular to the viewing direction.

ionosphere. The region of the earth's upper atmosphere containing free electrons and ions produced by ionization of the constituents of the atmosphere by solar ultraviolet radiation at very short wavelengths (< 100 nm) and energetic precipitating particles. The ionosphere influences radio wave propagation of frequencies less than about 300 MHz.

K

K index. A 3-hourly quasi-logarithmic local index of geomagnetic activity relative to an assumed quiet day curve for the recording site. Range is from 0 to 9. The K index measures the deviation of the most disturbed horizontal component.

K_B index. A 3-hourly quasi-logarithmic local index of geomagnetic activity calculated for Boulder, Colorado.

K_p index. A 3-hourly planetary index of geomagnetic activity calculated by the Institut für Geophysik der Gottingen Universität, F.R. Germany, from the K indices observed at 13 stations primarily in the Northern Hemisphere. The K_p indices, which date from 1932, are used to determine the ap indices.

L

long duration (or decay) event (LDE). With references to x-ray events, those events that are not impulsive in appearance. The exact time threshold separating impulsive from long-duration events is not well defined. Operationally, any event requiring 30 minutes or more to return to half the maximum amplitude would probably be regarded as an LDE. It has been shown that the likelihood of a coronal mass ejection increases with the duration of an x-ray event, and becomes virtually certain for durations of 6 hours or more.

M

magstorm. A telegraphic abbreviation used to denote a geomagnetic storm.

maximum usable frequency (MUF). The highest frequency that allows reliable HF radio communication over a given ground range by ionospheric refraction. Frequencies higher than the MUF penetrate the ionosphere and become useful for extraterrestrial communications.

middle latitude. With reference to zones of geomagnetic activity, 20 to 50 degrees geomagnetic latitude. Other zones are equatorial, polar, and high latitude.

Mount Wilson magnetic classification. Classification of the magnetic characteristics of sunspots according to rules set forth by Mount Wilson Observatory in California.

alpha. A unipolar sunspot group.

beta. A sunspot group having both positive and negative magnetic polarities (bipolar), with a simple and distinct division between the polarities.

gamma. A complex region in which the positive and negative polarities are so irregularly distributed as to prevent classification as a bipolar group.

beta-gamma. A sunspot group that is bipolar but is sufficiently complex that no single, continuous line can be drawn between spots of opposite polarities.

delta. A qualifier to magnetic class (see below), indicating that umbrae separated by less than 2 degrees within one penumbra have opposite polarity.

beta-delta. A sunspot group of general beta magnetic classification but containing one (or more) delta spot(s).

beta-gamma-delta. A sunspot group of general beta-gamma magnetic classification but containing one (or more) delta spot(s).

gamma-delta. A sunspot group of gamma magnetic classification but containing one (or more) delta spot(s).

N

nanotesla (nT). A unit of magnetic flux density. 1×10^{-9} weber per meter squared (Wb/m^2).

neutral line. The line that separates solar magnetic fields of opposite polarity, typically determined from solar magnetograms recording the longitudinal magnetic component. (Neutral lines are, more properly, inversion lines).

neutron monitor. A ground-based detector that counts secondary neutrons generated by processes originating with the impact of atmospheric molecules and atoms by very energetic particles (galactic or solar cosmic rays).

P

PCA. See polar cap absorption.

particle flux unit (p.f.u.). $1 \text{ p cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1}$. One particle per centimeter squared per second per steradian.

penumbra. The sunspot area that may surround the darker umbra or umbrae. In its mature form it consists of linear bright and dark elements that radiate from the sunspot umbra.

plage. On the Sun, an extended emission feature of an active region that is seen from the time of emergence of the first magnetic flux until the widely scattered remnant magnetic fields merge with the background. Magnetic fields are more intense in plage, and temperatures are higher than in surrounding quiescent regions.

polar cap absorption (PCA). An anomalous condition of the polar ionosphere whereby HF and VHF (3–300 MHz) radiowaves are absorbed, and LF and VLF (3–300kHz) radiowaves are reflected at lower altitudes than normal. PCAs generally originate with major solar flares, beginning within a few hours of the event and maximizing within a day or two of onset. As measured by a riometer, the PCA event threshold is 2 db of absorption at 30 MHz for daytime and 0.5 db at night. In practice, the absorption is inferred from the proton flux at energies greater than 10 MeV, so that PCAs and proton events are simultaneous. However, the transpolar radio paths may still be disturbed, up to weeks, following the end of a proton event, and there is some ambiguity about the operational use of the term PCA.

proton event. The measurement of proton flux reaching and sustaining ≥ 10 p.f.u. for at least 15 minutes at energies > 10 MeV by the primary SESC geosynchronous satellite (see polar cap absorption). The start time of the event is defined as the earliest time at which event thresholds have been reached. There are two event thresholds, namely p10 and p100.

proton flare. Any flare producing significant counts of protons with energies exceeding 10 MeV in the vicinity of Earth.

Q

quiet. A descriptive word specifically meaning that geomagnetic activity levels are such that $A_k < 8$.

quiet day curve (QDC). Especially in connection with the components of the geomagnetic field, the trace expected in the absence of activity. The K index is measured from deviations relative to a QDC. Riometer and neutron monitor deviations are also measured relative to a QDC.

R

radio emission. Emission of the Sun in radio wavelengths from centimeters to dekameters, under both quiet and disturbed conditions. Some patterns, known variously as noise storms, bursts and sweeps, are identified as described below. These types of emission are subjectively rated on an importance scale of one to three, three representing the most intense.

Type I. A noise storm composed of many short, narrow-band bursts in the meter-wavelength range (300–50 MHz), of extremely variable intensity. The storm may last from several hours to several days.

Type II. Narrow-band emission (sweep) that begins in the meter range (300 MHz) and sweeps slowly (tens of minutes) toward dekameter wavelengths (10 MHz). Type II emissions occur in loose association with major flares and are indicative of a shock wave moving through the solar atmosphere.

Type III. Narrow-band bursts that sweep rapidly (seconds) from decimeter to dekameter wavelengths (500–0.5 MHz). They often occur in groups and are an occasional feature of complex solar active regions.

Type IV. A smooth continuum of broad-band bursts primarily in the meter range (300–30 MHz). These bursts occur with some major flare events; they begin 10 to 20 minutes after the flare maximum and can last for hours.

Type V. Short duration (a few minutes) continuum noise in the dekameter range, usually associated with Type III bursts.

recurrence. Used especially to express a tendency of some solar and geophysical parameters to repeat a trend, and sometimes the actual value of the parameter itself every 27 days (the approximate rotation period of the Sun.)

region number. A number assigned by SESC to a plage region or sunspot group if one of the following conditions exists: (1) the region is a group of at least sunspot classification C, (2) two or more separated optical reports confirm the presence of smaller spots, (3) the region produces a solar flare, or (4) the region is clearly evident in H-alpha and exceeds 5 heliographic degrees in either latitude or longitude.

riometer (Relative Ionospheric Opacity meter). A specially designed ground-level radio receiver for continuous monitoring of cosmic noise. The absorption of cosmic noise in the polar regions is very sensitive to the solar low-energy cosmic ray flux. Absorption events are known as polar cap absorption (PCA) events and are primarily associated with major solar flares.

S

shock. A discontinuity in pressure, density, and particle velocity, propagating through a compressible fluid or plasma.

short wave fade (SWF). An abrupt decrease of HF radio signal strength, lasting from minutes to hours, caused by increased day-side ionization from some solar flares. A SWF is one effect under the broad category of sudden ionospheric disturbances (SIDs).

smoothed sunspot number. An average of 13 monthly RI numbers, centered on the month of concern. The first and thirteenth months are given a weight of 0.5.

solar activity. Transient perturbations of the solar atmosphere as measured by enhanced x-ray emission (see x-ray flare class), typically associated with flares. Five standard terms are used to describe the activity observed or expected within a 24 hour period:

Very low – x-ray events less than C-class.

Low – C-class x-ray events.

Moderate – isolated (one to four) M-class x-ray events.

High – several (five or more) M-class x-ray events, or isolated (one to four) M5 or greater x-ray events.

Very high – several (five or more) M5 or greater x-ray events.

solar flux unit. $10^{-22} \text{ W m}^{-2} \text{ Hz}^{-1} = 10,000 \text{ jansky}$.

solar maximum. The month(s) during the sunspot cycle when the smoothed sunspot number reaches a maximum. A recent solar maximum occurred in July 1989.

solar minimum. The month(s) during the sunspot cycle when the smoothed sunspot number reaches a minimum. A recent solar minimum occurred in September 1986.

solar wind. The outward flow of solar particles and magnetic fields from the Sun. Typically at 1 AU, solar wind velocities are near 375 km s^{-1} and proton and electron densities are near 5 cm^{-3} . The total intensity of the interplanetary magnetic field is nominally 5 nT.

STRATWARM. A code word designating a major disturbance of the winter, polar middle atmosphere from the tropopause to the ionosphere, lasting for several days at a time and characterized by a warming of the stratospheric temperature by some tens of degrees. There is no evidence that stratwarms are caused by solar events, or that they affect the lower atmosphere. (In fact, the disturbance may be generated by tropospheric conditions.)

sudden commencement (SC or SSC for storm sudden commencement). An abrupt increase or decrease in the northward component (see geomagnetic elements) of the geomagnetic field, which marks the beginning of a geomagnetic storm. SCs occur almost simultaneously worldwide, but magnitudes vary locally.

sudden impulse (SI+ or SI-). A sudden perturbation, positive or negative of several nT in the northward component of the low-latitude geomagnetic field, not associated with a subsequent geomagnetic storm. (An SI becomes an SC if a storm follows.)

sunspot. An area seen as a dark spot, in contrast with its surroundings, on the photosphere of the Sun. Sunspots are concentrations of magnetic flux, typically occurring in bipolar clusters or groups. They appear dark because they are cooler than the surrounding photosphere. Larger and darker sunspots sometimes are surrounded (completely or partially) by penumbrae. The dark centers are umbrae. The smallest, immature spots are sometimes called pores.

sunspot classification (modified Zurich sunspot classification). As devised by McIntosh, a three-letter designation of the optical, white-light characteristics of a sunspot group. The general form of the designation is Zpc. One letter is chosen from each of the following three categories.

Z (the modified Zurich class of the group).

- A A small single sunspot or very small group of spots with the same magnetic polarity, without penumbra.
- B Bipolar sunspot group with no penumbra.
- C An elongated bipolar sunspot group. One sunspot must have penumbra, and the group does not exceed 5° in longitudinal extent.
- D An elongated bipolar sunspot group with penumbra on both ends of the group; longitudinal extent of the group is more than 5° but does not exceed 10° .

- E An elongated bipolar sunspot group with penumbra on both ends. The longitudinal extent of the group exceeds 10° but not 15° .
- F An elongated bipolar sunspot group with penumbra on both ends. The longitudinal extent of penumbra exceeds 15° .
- H A unipolar sunspot group with penumbra. A class H sunspot group becomes a compact Class D or larger when the group exceeds 5° in longitudinal extent.

p (the penumbra type of the largest spot in the group):

- x no penumbra.
- r rudimentary.
- s small ($\leq 2\frac{1}{2}^\circ$ north-south diameter), symmetric.
- a small, asymmetric.
- h large ($\geq 2\frac{1}{2}^\circ$ north-south diameter), symmetric.
- k large, asymmetric.

c (the compactness of the group):

- x a single spot.
- o open.
- i intermediate.
- c compact.

Sunspot cycle. The approximately 11-year, quasi-periodic variation in the sunspot number. The polarity pattern of the magnetic field reverses with each cycle. Other solar phenomena, such as the 10.7 cm solar radio emission, exhibit similar cyclical behavior.

sunspot number. A daily index of sunspot activity (R), defined as $R = k(10g + s)$ where s = number of individual spots, g = the number of sunspot groups, and k is an observatory factor (equal to 1 for Zurich Observatory and adjusted for all other observatories to obtain approximately the same R number). The standard number, RI , once derived at Zurich, is now being derived at Brussels and is denoted RI . Often, the term “sunspot number” is used in reference to the widely distributed smoothed sunspot number.

synoptic chart. A map of the whole Sun in absolute heliographic coordinates, displaying an integrated view of solar features observed during a Carrington rotation.

T

tenflare. A solar flare accompanied by a 10-cm radio noise burst of intensity greater than 100% of the pre-event 10-cm flux value.

total electron content (TEC). The number of electrons along a ray path between a transmitter and a receiver adjusted to vertical incidence. Units are electrons per square meter. This number is significant in determining ionospheric effects such as refraction, dispersion, and group delay on radio waves, and can be used to estimate critical frequencies. The TEC is strongly affected by solar activity and geomagnetic activity.

U

ultraviolet (UV). That part of the electromagnetic spectrum between 5 and 400 nm.

umbra. The dark core or cores (umbrae) in an sunspot with penumbra, or a sunspot lacking penumbra.

UT or UTC. See **Coordinated Universal Time**.

W

white light (WL). The sum of all visible wavelengths of light (400–700 nm), in which all colors are blended to appear white to the eye. No pronounced contribution from any one spectral line (or light-emitting element) is implied.

WWV. Call letters of the radio station over which National Institute of Standards and Technology broadcasts time-standard signals at 2.5, 5, 10, 15, and 20 MHz. Solar-terrestrial conditions and forecasts are broadcast at 18 minutes past the hour.

X

x-ray. Radiation of extremely short wavelength (generally less than 1 nm).

x-ray background. A daily average background x-ray flux in the 0.1 to 0.8 nm range. It is a midday minimum given in terms of x-ray flare class.

x-ray burst. A temporary enhancement of the x-ray emission of the Sun. The time-intensity profile of soft x-ray bursts is similar to that of the H-alpha profile of an associated flare. Soft x-rays are those of energies less than 20 keV, or wavelengths longer than 0.05 nm.

x-ray flare class. Rank of a flare based on its x-ray energy output. Flares are classified by the Space Environment Services Center according to the order of magnitude of the peak burst intensity (I) measured at Earth in the 0.1 to 0.8 nm band as follows:

Classification	Peak, 0.1-0.8 nm	
	(Wm ⁻²)	(ergs cm ⁻² s ⁻¹)
B	I < 10 ⁻⁶	I < 10 ⁻³
C	10 ⁻⁶ ≤ I < 10 ⁻⁵	10 ⁻³ ≤ I < 10 ⁻²
M	10 ⁻⁵ ≤ I < 10 ⁻⁴	10 ⁻² ≤ I < 10 ⁻¹
X	I ≥ 10 ⁻⁴	I ≥ 10 ⁻¹

x-ray flare termination. SESC terminates x-ray events when the flux has declined to half the maximum amplitude.

Z. Zulu Time. (See **Coordinated Universal Time**.)