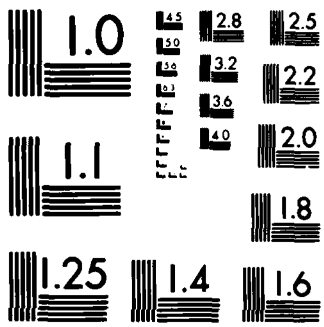
AD-A155 525 SEARCH FOR THE NORTH-SOUTH ASYMMETRY IN SOLAR ACTIVITY 1/1
(U) AIR FORCE GEOPHYSICS LAB HANSCOM AFB MA
M A SHEA ET AL. 03 JUN 85 AFGL-TR-85-0119

UNCLASSIFIED F/G 3/2 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Reprint from Joint U.S. - Japan Seminar "Recent Advances in the Understanding of Structure and Dynamics of the Heliomagnetosphere during the Current Maximum and Declining Phase of Solar Activity", Kyoto, Japan, November 5-9, 1984, 45-50, 1984.

AFGL-TR-85-0119

AD-A155 525

DTIC ELECTE JUN 25 1985 S A

SEARCH FOR THE NORTH-SOUTH ASYMMETRY IN SOLAR ACTIVITY

M. A. Shea and D. F. Smart
Air Force Geophysics Laboratory
Hanscom AFB, Bedford, Massachusetts 01731, U.S.A.

ABSTRACT

The use of the comprehensive flare index as a possible indicator of north-south asymmetry in solar activity is investigated. Using a data base extending from 1955 through 1980 we discuss several of the problems that were encountered in using this index as an indicator of possible north-south asymmetry in solar activity. Preliminary results indicate that even allowing for the large number of "major" flares for which the location on the sun was not observed, the northern hemisphere of the sun was decidedly more active than the southern hemisphere for the period 1959 through 1970. (Reprints)

1. Introduction

In studies of north-south asymmetry in solar activity, various researchers have used different phenomena as the measure of this asymmetry. For example, Dodson and Hedeman (1972) used the number of sunspots and the number of solar flares of importance >1 to show that the northern hemisphere of the sun was more active than the southern hemisphere during the early part of solar cycle 20. Waldmeier (1971) found similar results for 1959-1969 using sunspots, faculae, prominences, the brightness of the white light corona and the intensity of the green coronal line. In an attempt to relate geophysical perturbations with solar activity on either the northern or southern hemisphere of the sun, Bell (1961) and Harvey and Bell (1968) found a north-south solar asymmetry for major flares and microwave radio bursts they associated with geomagnetic activity and shortwave fadeouts, respectively. In a more recent study, Roy (1977) used the "major" flares as defined by the comprehensive flare index (Dodson and Hedeman, 1971) to show that, in general, between 1955 and 1970 there was a greater frequency of flares in the northern hemisphere of the sun than in the southern hemisphere, but this northern hemisphere asymmetry was not evident from 1971 to 1974. This paper extends the results of Roy through 1980 and relates problems encountered in both reproducing the earlier results of Roy and of using the comprehensive flare index as an indicator of north-south solar activity asymmetry.

DTIC FILE COPY

This document has been approved for public release and sale; its distribution is unlimited.

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: Unclassified

1b. RESTRICTIVE MARKINGS:

2a. SECURITY CLASSIFICATION AUTHORITY:

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE:

3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; Distribution unlimited.

4. PERFORMING ORGANIZATION REPORT NUMBER(S): AFGL-TR-85-0119

5. MONITORING ORGANIZATION REPORT NUMBER(S):

6a. NAME OF PERFORMING ORGANIZATION: Air Force Geophysics Laboratory

6b. OFFICE SYMBOL *(If applicable)*: PHP

7a. NAME OF MONITORING ORGANIZATION:

6c. ADDRESS *(City, State and ZIP Code)*: Hanscom AFB, Bedford, MA 01731

7b. ADDRESS *(City, State and ZIP Code)*:

JUN 2 6 198

8a. NAME OF FUNDING/SPONSORING ORGANIZATION:

8b. OFFICE SYMBOL *(If applicable)*:

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER:

8c. ADDRESS *(City, State and ZIP Code)*:

10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
61102F	2311	2311G1	2311G112

11. TITLE *(Include Security Classification)*: Search for the North-South Asymmetry in Solar Activity

12. PERSONAL AUTHOR(S): M.A. Shea, D.F. Smart

13a. TYPE OF REPORT: Reprint

13b. TIME COVERED: FROM Interim TO

14. DATE OF REPORT *(Yr., Mo., Day)*: 1985 June 3

15. PAGE COUNT: 4

16. SUPPLEMENTARY NOTATION: Reprinted from Joint US-Japan Seminar "Recent Advances in the Understanding of Structure & Dynamics of the Heliomagnetosphere During the Current Maximum & Declining Phase of Solar Activity" - Nov 5-9, 1984, Kyoto, Japan

17. COSATI CODES

FIELD	GROUP	SUB. GR.
03	01	
03	02	

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*: Solar activity; Solar flares; Heliosphere

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

The use of the comprehensive flare index as a possible indicator of north-south asymmetry in solar activity is investigated. Using a data base extending from 1955 through 1980 we discuss several of the problems that were encountered in using this index as an indicator of possible north-south asymmetry in solar activity. Preliminary results indicate that even allowing for the large number of "major" flares for which the location on the sun was not observed, the northern hemisphere of the sun was decidedly more active than the southern hemisphere for the period 1959 through 1970.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐

21. ABSTRACT SECURITY CLASSIFICATION: Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL: M. A. SHEA

22b. TELEPHONE NUMBER *(Include Area Code)*: 617-861-3977

22c. OFFICE SYMBOL: AFGL/PHP

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

2. Comprehensive Flare Index

The comprehensive flare index is the summation of five individual components as follows:

a. Importance of ionizing radiation as indicated by time-associated short wave fade or sudden ionospheric disturbance (scale 1-3);
b. Importance of H-alpha flare (scale 1-3);
c. Magnitude of ~10 cm radio flux; (characteristic of log of flux in units of $10^{-22} Wm^{-2} Hz^{-1}$);
d. Dynamic spectrum; (Type II = 1, Continuum = 2, Type IV with duration >10 minutes = 3); and
e. Magnitude of ~200 MHz flux; (characteristic of log of flux in units of $10^{-22} Wm^{-2} Hz^{-1}$).

These five components comprise the "profile" of the flare; the sum of these components gives the comprehensive flare index (CFI). A flare is considered "major" if it satisfies any one of the following criteria:

a. Short wave face (or sudden ionospheric disturbance) of importance ≥ 3;
b. H-alpha flare of importance ≥ 3;
c. 10 cm radio flux, $\geq 500 \times 10^{-22} Wm^{-2} Hz^{-1}$;
d. Type II radio burst;
e. Type IV radio emission with a duration >10 minutes.

3. Method

The comprehensive flare indices for "major" flares from 1955 through 1979 have been compiled by Dodson and Hedeman (1971, 1975, 1981). Unfortunately the indices published for the last four months of 1979 were estimates based upon preliminary summaries of flare data and on incomplete solar radio data. These estimated indices have since been re-evaluated and comprehensive flare indices have been derived through 1980 (Dodson and Hedeman, unpublished).

A computer file was generated containing these indices for the period 1955-1980. The file included the date and time of the flare, the flare profile, the H-alpha importance, the comprehensive flare index, the plage number in which the flare was observed, and the heliographic coordinates of the flare position. All events were numbered in consecutive order by year. The first problem was encountered in numbering the flares that are enclosed by brackets in the Dodson and

Hedeman lists. These are flares that overlap in time, making it impossible to determine an individual CFI for each flare. These flares were given the same number, indicating that two (or more as the case may be) were possibly responsible for the individual comprehensive flare index assigned to that particular "event".

The number of flares in each hemisphere were counted as a function of month and year. For overlapping flares, the plage number was examined. If the solar activity for these overlapping events was from the same plage region, the hemisphere of the location of the flare was counted only once; if different plages were involved, the hemisphere of the location of each plage was counted separately.

A second problem was encountered in handling the events for which no flare location was recorded. The heliographic coordinates of a flare are known for only those flares for which solar images are available (usually from H-alpha observations). Although observations from the worldwide network of solar optical patrol stations were utilized in the determination of the comprehensive flare indices, there is a significant percentage of time when optical measurements are simply not available primarily because of poor viewing conditions, equipment problems, or the fact that the flare may have occurred just behind the visible disk. Even through optical measurements may not be available, the electromagnetic emissions of the flare are often recorded thereby identifying that a solar event has occurred. In their various tables, Dodson and Hedeman have assigned a comprehensive flare index to those events having sufficient electromagnetic emission to satisfy the criteria of a "major" event (see Section 2). We have included these as "events" with no known location.

4. Results

We determined the percentage of flares that occurred in the northern hemisphere each year by dividing the number of events in the northern hemisphere by the sum of flares that occurred in the northern and southern hemisphere. These results, shown as solid circles in Figure 1, are similar, but not identical, to the results of Roy (1977) for the period 1955-1974.

We then assigned errors to these data points in order to account for the "no known location flares". These errors, shown by the error bars in Figure 1, were calculated in the following way. If we assume that all the unknown location flares were in the northern hemisphere, then we determined the absolute top limit of flares in the northern hemisphere by summing the known northern hemisphere flares with the unknown location flares and dividing this sum by the total of all flares on the sun for each year (i.e. northern, southern and unknown location flares). The absolute bottom limit was determined by assuming that all the unknown location flares were in the southern hemisphere. Thus the total of the northern hemisphere flares was divided by the total of all flares on the sun. Although it is unlikely that all the unassigned flare locations would be totally on one or the other hemisphere, this method does determine absolute limits of the maximum possible error. (Note that the location is known for all major flares that occurred in 1965; thus no error bars are shown.)

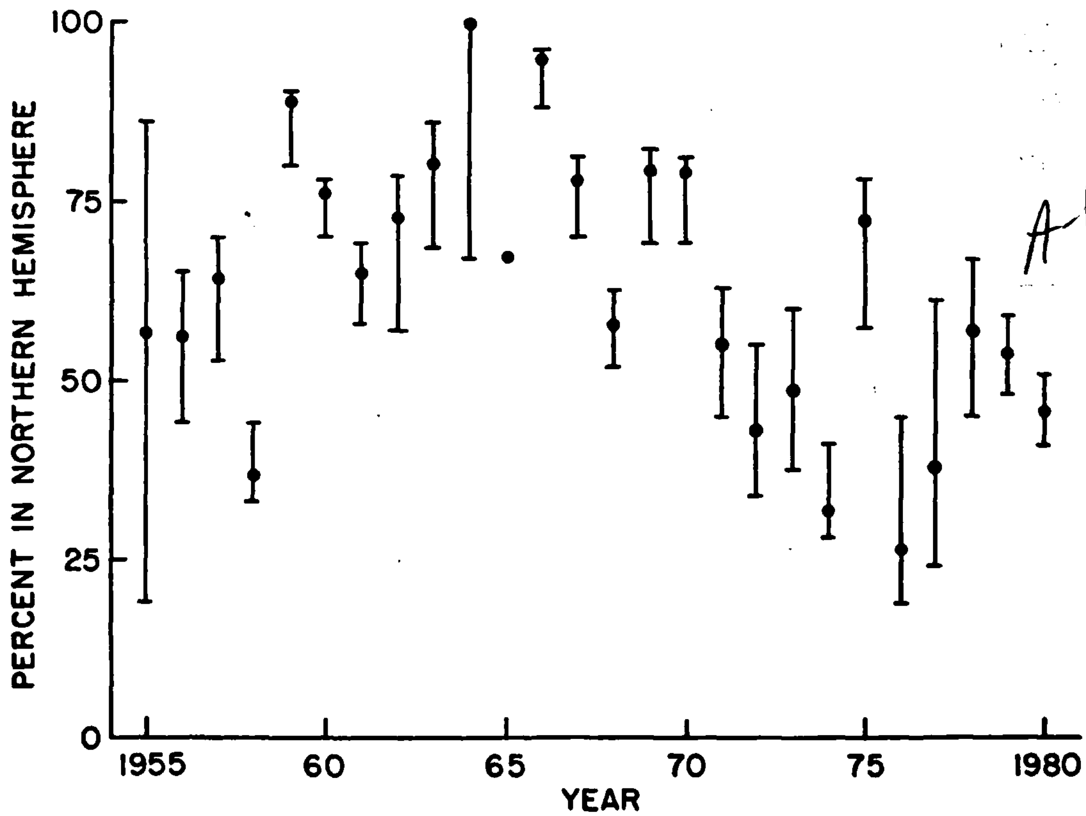


Figure 1. The percentage of "major" flares, as defined by the comprehensive flare index, that occurred in the northern hemisphere of the sun from 1955 through 1980. See text for explanation of the error shown.

Since there is a large difference between the number of flares that occur throughout the solar cycle Figure 2 shows the total number of events that occurred each year of this study. The shaded section of each bar represents the number of flares for which we have a known solar location; the open section of each bar indicates the number of flares for which no location was identified.

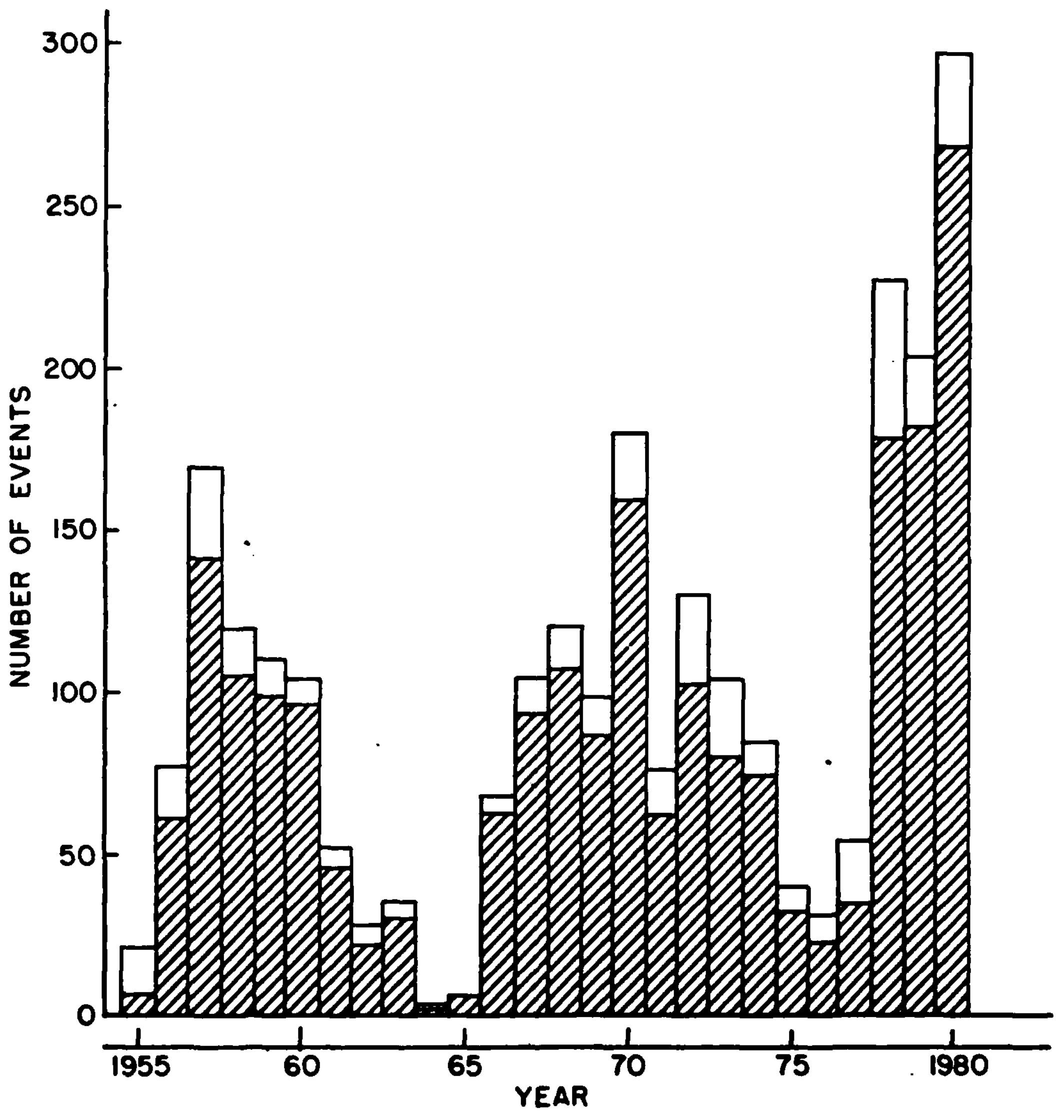


Figure 2. The number of "major" solar events, as defined by the comprehensive flare index, from 1955 through 1980. The shaded area represent events for which the location on the sun is known; the open portion of each bar represents the number of events for which the solar location is unknown.

5. Discussion and Summary

As mentioned previously these results for 1955-1974 are similar, but not identical to those of Roy (1977). The differences are in the manner in which the simultaneous events and the unknown location events are considered. The results illustrated in Figure 1 show that more "major" flares occurred on the northern hemisphere of the sun than the southern hemisphere for the period 1959-1970. The extent of the asymmetry can be determined by summing all the flares for the period 1959-1970. For this 12-year period 77% of the flares occurred in the northern hemisphere; the maximum range of uncertainity is 69-79%. The results for the years 1955 through 1958 and 1971 through 1980 are mixed with no clearly defined preference for solar hemisphere.

REFERENCES

Bell, B., Smithsonian Contr. Astrophys., 5, 69, 1961.

Dodson, H. W., and E. R. Hedeman, An Experimental, Comprehensive Flare Index and Its Derivation for "Major" Flares, 1955-1969, UAG-14, World Data Center A, NOAA, U.S. Department of Commerce, Boulder, Colorado, 1971.

Dodson, H. W., and E. R. Hedeman, in Solar-Terrestrial Physics/1970, E. R. Dyer, Ed., Part I, p. 151, 1972.

Dodson, H. W., and E. R. Hedeman, Experimental Comprehensive Solar Flare Indices for Certain Flares, 1970-1974, UAG-52, World Data Center A for Solar-Terrestrial Physics, NOAA, U. S. Dept. of Commerce, Boulder, Colorado, 1975.

Dodson, H. W., and E. R. Hedeman, Experimental Comprehensive Solar Flare Indices for "Major" and Certain Lesser Flares 1975-1979, UAG-80, EDIS, NOAA, U. S. Dept. of Commerce, Boulder, Colorado, 1981.

Harvey, G., and B. Bell, Smithsonian Contr. Astrophys., 10, 197, 1968.

Roy, J.-R., Solar Phys., 52, 53, 1977.

Waldmeier, M., Solar Phys., 20, 332, 1971.

END

FILMED

8-85

DTIC