CLASSIFICATION AND INVESTIGATION OF SOLAR FLARE SITUATIONS CONFORMABLY TO INTERPLANETARY AND MAGNETOSPHERIC DISTURBANCES

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1. CLASSIFICATION

A new classification of large solar flares is presented. If the time spacings between the flares are over 2.5 days, the flares and the corresponding interplanetary streams are classified as isolated ones. The concepts of the nearest, intermediate and distant flare zones (N, I and D zones) are introduced. The limits of the zones are determined at 30° longitude intervals and at 15° latitude ones. The classification is applied to the flares of 1966-1974 (Ivanov et al., 1979). It allows one to study the interplanetary and the magnetospherical disturbances more systematically.

2. OCCURRENCES OF SSC'S AFTER THE ISOLATED FLARES

Table 1 gives the number of isolated flares N and the number of SSC's: N_{ssc}. One can see that the occurrences of SSC's are nearly independent of the flare positions.

TABLE 1

Zones	N	N_{ssc}	$N_{ssc}/N, \%$
N	13	8	60
I	54	36	65
D	50	25	50
Total	117	69	60

It is especially strange that, in the N zone, 40% of the flares did not generate an SSC.

3.   RELATION OF OCCURRENCES OF SSC'S AFTER ISOLATED FLARES WITH
     MAGNETIC AXES OF BIPOLAR GROUPS OF SOLAR SPOTS

     Figure 1 shows the flares of the nearest zone (the asterisks) and
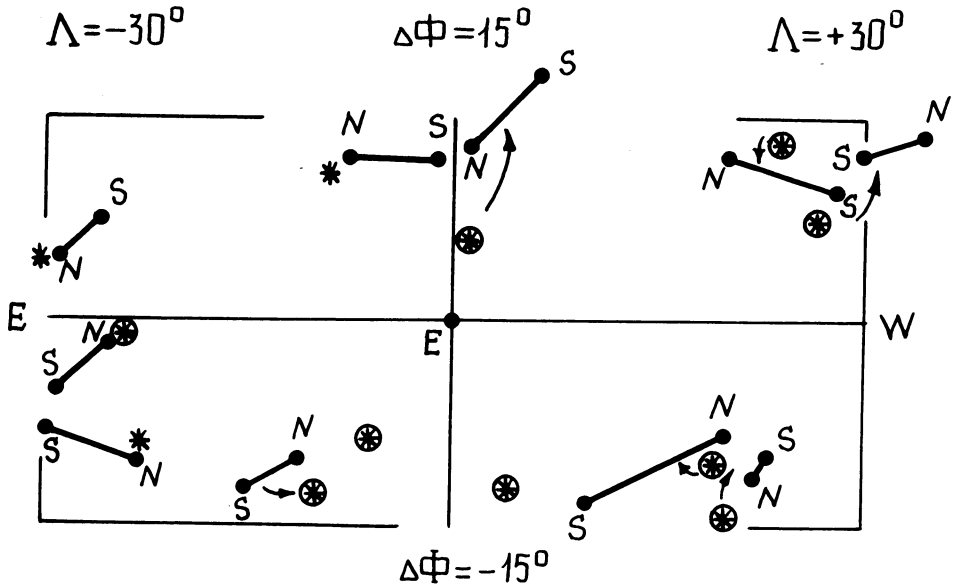the magnetic axes NS of the bipolar groups.

Figure 1.   Flares and magnetic axes of N zone. Note the helioprojec-
            tion of the Earth onto the solar disk, E.

     We now establish the following rule: If a straight line, passing
through a flare in parallel to the corresponding NS, cuts the parallel
of helioprojection of the Earth E at a point which is removed from the
E less than 30°, then the flare generates a SSC. The rule is
statistically performed on the Sun (Table II).

TABLE II

Zones	$|\Lambda^*| \leqslant 30^O$			$|\Lambda^*| > 30^O$		
	N	N_{ssc}	$\dfrac{N_{ssc}}{N}$,%	N	N_{ssc}	$\dfrac{N_{ssc}}{N}$,%
N	5	5	100	5	5	100
I	10	9	90	15	10	65
D	2	2	100	14	11	80
Total	17	16	95	34	26	75

The relation can be interpreted in the following manner. Let an
isolated stream be strongly flattened to the plane of a large circle
which passes through the flare and is parallel to the NS. Then the

favourable positions of the NS occur when the angle $\Lambda^* \lesssim 30^O$, and the forward shock wave envelops the Earth and generates a SSC.

4.   SOLAR PROTON EVENTS IN CONNECTION WITH MAGNETIC AXES OF BIPOLAR
      GROUPS

      According to Tverskoy, acceleration of solar protons takes place in the forward shock layer. The strongly flattened shock wave must have an effect on the solar proton events (SPE) near the Earth. The favourable positions of NS (in this case) cut the parallel of Earth's helioprojection at the points of $0^O \div 60^O W$. The consequence of the model is confirmed by data (Table III).

TABLE III

$\Lambda = 0^O - 60^O W$			$\Lambda \neq 0^O - 60^O W$		
N	N_{SPE}	$N_{SPE}/N,\%$	N	N_{no}	$N_{no}/N,\%$
15	10	65	42	36	85

Table III gives the numbers of isolated flares N, the number of SPE, and the number of flares without SPE - N_{no}.

REFERENCES

Ivanov, K. G., Mikerina, N. V., Zovoykina, A. I., and Treschotkina,
     V. M., Catalogue of Flare Situations of 1966-1974, IZMIRAN,
     Moscow, 1979.

DISCUSSION

   McIntosh: Your result is very interesting and will be tested immediately at the NOAA Space Environment Services Center in Boulder. Can you relate your classification to the production of a B_z interplanetary field favorable for geomagnetic disturbance (i.e., strong southward component)?
   Ivanov: Yes. If, after an isolated flare and for the favourable position of the magnetic axis of a bipolar group, the Earth was enveloped by flare ejecta, then the sign of B_z-component of IMF was in a strong accordance with the point of view with the direction of NS. However, we have analysed only the flares of nearest zone.

   Simon: Could you describe more in detail the criteria used to select the "active" and "unactive" flares?
   Ivanov: Let us consider the following situation. There are a bipolar

group of solar spots and a large flare near the group. The line
connecting the spots is the magnetic axis - NS. There is also the
projection of the Earth onto the solar disk for the time of the flare,
E. We draw a line passing through the flare in parallel to the NS.
The line crosses the heliographical parallel of E in a point P. If
the angle distance $|PE|$ is less than 30° of longitude, then SSC is
generated by the flare. In the other case, SSC is absent.

  Tandon: Have you also considered flares associated with complex
groups in your analysis?
  Ivanov: No, we have analysed only isolated flares in bipolar groups.