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Flare Observation During Max'91 Balloon Campaigns

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Abstract

I present a brief overview of some of the large flare properties as observed during the prime SMM flare observation interval, 1980 - 1984. Two of these properties, namely their tendency to occur in groups and the strong effects of the 154 day periodicity, can be used to increase the probability of detecting large flares during the limited observing duration of Max'91 balloon campaigns provided the solar flaring characteristics of the 1991 Solar Cycle follows that observed in 1980-1984.

Observations

One of the major objectives of NASA's Max'91 Program will to observe solar flares with a new generation of instrumentation to be flown on high altitude balloons. These observations will be greatly enhanced if they can be made in coordination with those from improved ground based observations. It is a unfortunate fact that balloon flight experiments are limited both in the times that they can be launched and their total flight duration once they are launched. In the following I present the characteristics of flares observed in 1980-1984, having GOES soft X-Ray emission >M2.5, as a surrogate for the reasonably large flares which we hope to observe in 1981-1985.

I order to extrapolate to other flare sizes I note the following properties of flares having GOES emission >M2.5. Vestrand et al. (1987) showed that the solar positions of these events are consistent with isotropic emission. He also stated that 70% of the ~150 GRS flares detected at energies >300 keV (detection limit of F(>300 keV) >~4 photons/cm^2) had a GOES size >M2.5. There were 233 GOES >M2.5 events within the times that the SMM was in daylight and able to observe the sun. Bai (1987) has stated the relationship between GOES sizes and HXRBS events and Dennis (1985) has given a size-frequency relationship for HXRBS events.

During the 1500 days between March 1980 and the end of May 1984, the NOAA Solar-Geophysical Data reported 577 solar flares having a GOES size >M2.5. Figure 1 shows these events binned up into 15.4 day intervals. It is clear that these flares are not randomly distributed in time. It is this non-random distribution which can be used to increase the probability of flare observation during the Max'91 balloon campaigns.

There are two explanations for this observed non-random behavior. First is the presence of a relatively small number of Super-Active Regions which produce large numbers of flares during a single solar disk transient (Bai, 1987). The second is the well observed 154 day periodicity observed in the detection of solar flares (Rieger et al., 1984; Dennis, 1985; Bai and Sturrock, 1987). It is important to note that these two phenomena are not the same. Many Super-Active Regions occur outside of the 154 day preferred interval (Bai, 1987) and Bai and Sturrock (1987) have shown that the 154 day periodicity is not associated with increased flare production in a single active region but is a global effect.

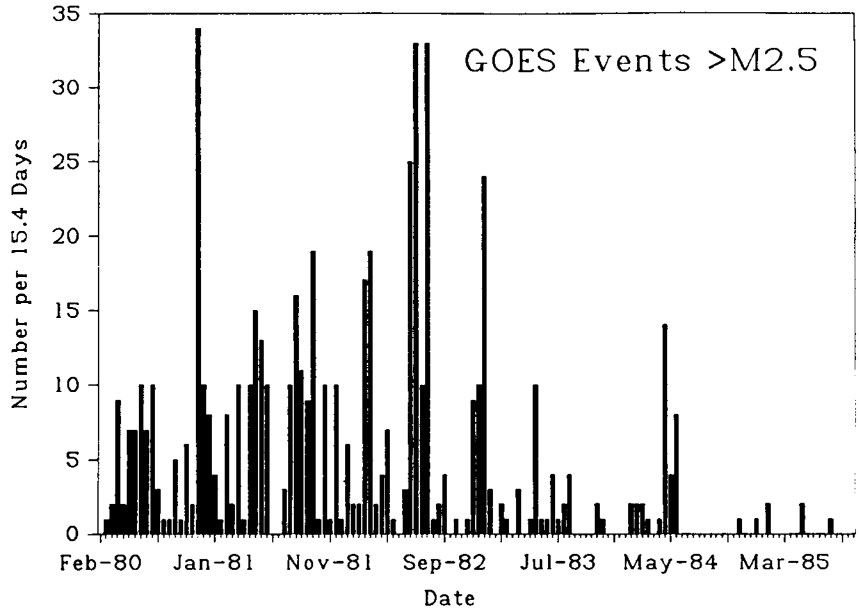

Figure 1. The time distribution of GOES >M2.5 flares reported in the Solar-Geophysical Data Reports from March 1980 to January 1986.

We illustrate the potential use of these phenomena as a flare predictor in the following two figures. Figure 2 shows the distribution of time intervals between successive flares. This data was obtained from the 577 flares shown in Fig. 1 between March 1980 and May 1984. It is clear that the detection of a >M2.5 event greatly increases the probability of another event over at least a 24 hour interval. Figure 3 shows the number of >M2.5 events binned up with the 154 day periodicity. Again this data shows the the flare detection probability can be increased by scheduling balloon campaigns within a given time.

Bai, T., Distribution of Flares on the Sun: Superactive Regions and Active Zones of 1980-1985, Ap. J., 314, 795, 1987.

Bai, T. and Sturrock, P.A., The 152-day Periodicity of the Solar Flare Occurrence Rate, Nature, 327, 601, 1987.

Dennis, B.R., Solar Hard X-Ray Bursts, Solar Phy., 100, 465, 1985.

Rieger, E. et al., Evidence for a 154 Day Periodicity in the Occurrence of Hard Solar Flares (Time Period 1980-1983), Nature, 312, 623, 1984.

Vestrand, W.T. et al., The Directivity of High-Energy Emission from Solar flares: Solar Maximum Mission Observations, Ap. J., 322, 1010, 1987.

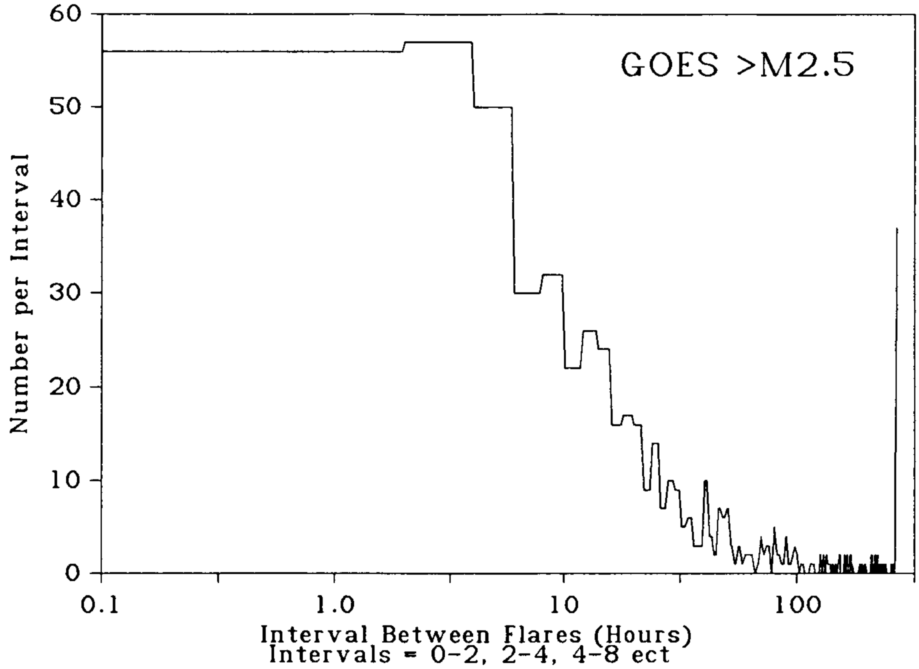

Figure 2. The distribution of time intervals between successive GOES >M2.5 flares measured in hours. The 1st interval is 0-2 hours, the 2nd 2-4, the third 4-8, ect. The high point at the end of the trace shows that there were 37 intervals larger than 256 hours.

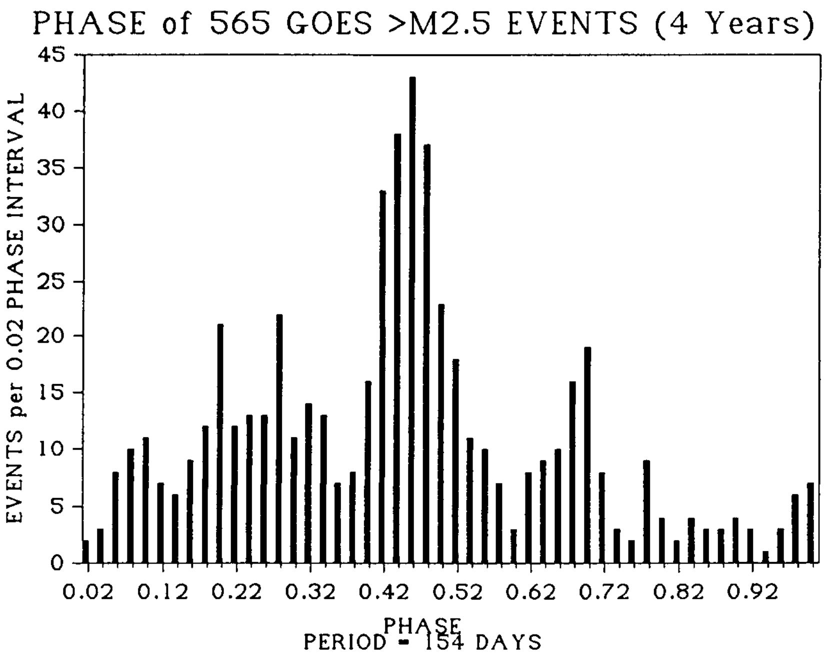

Figure 3. The epoch folded distribution of GOES >M2.5 flares within the 154 day period. These events occurred over a 4 year interval representing about 10 periods. The flares have been binned up in intervals, each 3.08 days long, so that each data point represents about 31 days of observation.