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Readme: Solar Flares in H-Alpha and X-rays

Solar Flares

A solar flare is a short-lived sudden increase in the intensity of radiation emitted in the neighborhood of sunspots. For many years it was best monitored in the H-alpha wavelength and occurs in the chromosphere, though occasionally white light flares are seen in the photosphere. In modern times the solar X-ray wavelengths are monitored via satellite for solar flares. Flares are characterized by a rise time of the order of minutes and a decay time of the order of tens of minutes. The total energy expended in a typical flare is about 10^{30} ergs; the magnetic field is extraordinarily high reaching values of 100 to 10,000 gauss. Optical flares in H-alpha are usually accompanied by radio and X-ray bursts and occasionally by high-energy particle emissions.

The optical brightness and size of the flare are indicated by a two-character code called "importance." The first character, a number from 1 to 4, indicates the apparent area. For areas of less than 1, an "S" is used to designate a subflare. The second character indicates relative brilliance: B for bright, N for normal and F for faint. A general discussion of solar flares is found in Svestka [1976]. The National Geophysical Data Center (NGDC) holds archives for about 80 stations, covering the period 1938 to the present. Currently 5 stations send their data to NGDC Boulder on a routine monthly basis -- the current main observing emphasis for Space Weather has transitioned to Coronal Mass Ejections (CMEs) which directly impact the Earth's geomagnetic field. Solar flares impact the Earth's upper atmosphere and can eject high energy particles that can cause satellite failures. The flare reports were processed and published in the monthly report "Solar-Geophysical Data" and in a different format in the IAU "Quarterly Bulletin on Solar Activity."

AVAILABLE DATASETS

Dataset: Solar Features – Solar Flares – H-alpha (1980-present; earlier data 1938 - 2010)

Description: The basic reports sent monthly from the observatories (as soon as possible after the end of the month) consist of data for each flare or subflare and a day-by-day table of times when the sun was under observation by photographic, electronic or visual patrol. The table gives as many of the following measurements as possible: time of beginning; time of maximum brightness; time of any prominent secondary maxima; time of end (all times in UT); area at time of maximum brightness (square degrees of solar disk correct for foreshortening); importance class of flare (IAU 1964 report, updated in 1975); heliographic coordinates of center of gravity of flare at maximum brightness; whether the above information is taken from photographic, electronic or visual data; also, where available, give maximum width, and end of every observing period of each day, distinguishing any gaps of 5 minutes or more. Photographic patrols indicate the normal interval between exposures; visual patrols (without photographic patrol) indicate whether continuous or intermittent and specify the normal interval.

Dataset Status: This dataset is no longer active.

Dataset: Solar Features – Solar Flares – Flare Patrol (1955 - 2010)

Description: Solar H-alpha Flare patrol observations from a worldwide network

Dataset Status: This dataset is no longer active.

Dataset: Solar Features – Solar Flares – X-ray (1975 – Present)

Description: This dataset consists of Solar X-ray Flares observations from the SOLRAD satellites (1968-1974) and from the GOES satellites (1975 to present). For GOES x-ray events the event starts when 4 consecutive 1-minute Xray values have met all three of the following conditions -- a.) All 4 values are above the B1 threshold and b.) All 4 values are strictly increasing and c.) The last value is greater than 1.4 times the value which occurred 3 minutes earlier. The maximum is the time when the flux value reaches maximum. The maximum flux value (the event size) is the flux, as defined by the C-M-X scale, at the time of maximum. The event ends when the current flux reading returns to 1/2 the 'peak' (peak is the sum of the flux at maximum plus the flux value at the start of the event).

Dataset Status: Under review

Solar Features – Solar Flares – Flare Index (1966-2008)

Description: This datasets consists of calculations of the "Comprehensive Flare Index" (1955-2008) and Kandilli "Flare Index" (1976-2010). The Comprehensive Flare Index was developed by Helen W. Dodson and E. Ruth Hedeman from the McMath-Hulbert Solar Observatory. A detailed description of the Comprehensive Flare Index is contained in UAG-14 report, *An Experimental, Comprehensive Flare Index and Its Derivation for 'Major' Flares, 1955-1969* with subsequent updates included in UAG-52 (1970-1974) and UAG-80 (1975-1979). Five measures of flare importance are added to obtain the Comprehensive Flare Index:

1. Sudden Ionospheric Disturbance importance (scale 0 - 3);
2. H-alpha flare importance (scale 0-3);
3. 10.7 cm solar radio flux magnitude (characteristic of log of flux);
4. Solar radio spectral type (Type II=1, Continuum=2, and Type IV with duration greater than 10 minutes=3
5. Magnitude of 200 MHz flux (characteristic of log of flux).

The "Flare Index" was introduced by Kleczek [1952] who derived the quantity "Q = i x t" to quantify the daily flare activity over 24 hours per day. He assumed that this relationship gives roughly the total energy emitted by the flares. In this relation, "i" represents the intensity scale or optical importance of the flare and "t" is the flare duration in minutes. Some reviews of flare activity using Kleczek's method are given for each day from 1936 to 1997 by Kleczek [1952], Knoska and Petrasek [1984], Atac [1987] and Atac and Ozguc [1986; 2000]. The daily flare index for the 21, 22, and 23 st Solar Cycles were determined by using the final grouped solar flares which are compiled by the NOAANational Geophysical Data Center.

Dataset Status: Under review

Dataset: Solar Features – Solar Flares - Sudden Ionospheric Disturbances (1943 – 2010)

Description: A sudden ionospheric disturbance (SID) is an abnormally high ionization/plasma density in the D region of the ionosphere caused by a solar flare. The SID results in a sudden increase in radio-wave absorption that is most severe in the upper medium frequency (MF) and lower high frequency (HF) ranges, and as a result often interrupts or interferes with telecommunications systems (Wikipedia).

Dataset Status: Relocate this dataset to a more appropriate location.

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