

Max Millennium Program: Evaluation of Cycle 23 Major Flare Watches

RHESSI Operations Meeting

Discussion

June 9, 2010

MM Chief Observers (MM_CO) MM Message of the Day (MOTD)

The MM_COs keep abreast of solar activity.

Each day, the MM_CO who is on duty selects the most appropriate Active Region and Observing Plan (if no pre-chosen plan is in place) using all available on-line data and their expertise at solar activity forecasting.

The MM_CO sends out the MOTD to over 200 solar scientists, planners, and observers worldwide via the self-subscribing MOTD e-mail system on a daily (or more frequent) basis.

The following team serves as MM_CO on a rotating basis:

- Shaun Bloomfield Trinity College Dublin
- William Marquette Helio Research
- James McAteer Trinity College Dublin
- Ryan Milligan Goddard Space Flight Center
- Clare Raftery Space Science Laboratory, Berkeley

Major Flare Watch Scientific Goals

The scientific goal of this program is to understand energy release, particle acceleration, and particle and energy transport in the largest flares, which afford unique opportunities for observations of gamma-ray lines.

Key questions are:

1. What is the partition of energy between ions and electrons?
2. Where are ions accelerated, and what are the physical conditions (temperature, density, velocity and magnetic fields) there?
3. What are the abundances of accelerated particles and the ambient atmosphere at the Sun?
4. What mechanisms accelerate both electrons and ions to high energies so rapidly and efficiently?
5. What mechanisms transport high-energy ions away from the acceleration site?
6. What are the characteristic signatures of flares that have potentially hazardous radiation effects?
7. What is the relationship between ion acceleration and CMEs?

Co-temporal data from ground and space-based observatories are crucial to answering these questions.

Current Criteria for Calling an MFW

- A major flare has occurred (if a region produced one big flare, it will probably produce at least one more)
- Large island delta - opposite polarity umbrae within 2 heliographic degrees within a common penumbra (delta configuration) and, in addition, the delta surrounded by opposite polarity flux - even better if the region is reversed polarity. Bright H-alpha will be present.
- Large delta configuration with bright H-alpha plage and better still if reversed polarity. Bright H-alpha along the neutral line is needed.
- Elongated umbrae in pairs of opposite polarity even if the umbrae are not a delta configuration. Transverse magnetograms will reveal strong shear.
- EFR within an existing active region, if the leader spots of the EFR are adjacent to the existing region's trailing spots or vice-versa.
- Rapidly moving sunspots - sunspot(s) moving towards and/or into an opposite polarity spot.

Typical Major Flare Watch MOTD

Date: Thu, 19 Jun 2003 08:57:04 -0700 (PDT)
From: Max Millennium Chief Observer <mm_co@bbso.njit.edu>
Subject: Major Flare Watch

Dear RHESSI collaborators,

Target region, NOAA 0386, was quiescent yesterday, but it continues to maintain its reversed polarity beta-gamma-delta magnetic configuration. As long as 0386 remains magnetically complex, it has the potential to produce another major flare.

The position of NOAA 0386 on June 19 at 15:00 UT:
S07E35 (Solar X = -539", Solar Y = -135")

See www.bbso.njit.edu/arm/latest/, www.lmsal.com/solarsoft/last_events and www.bbso.njit.edu/cgi-bin/LatestImages for images and additional information and for a description of the current Max Millennium Observing Plan go to solar.physics.montana.edu/max_millennium/ops/observing.shtml.

Regards,
Bill Marquette
BBSO/NJIT

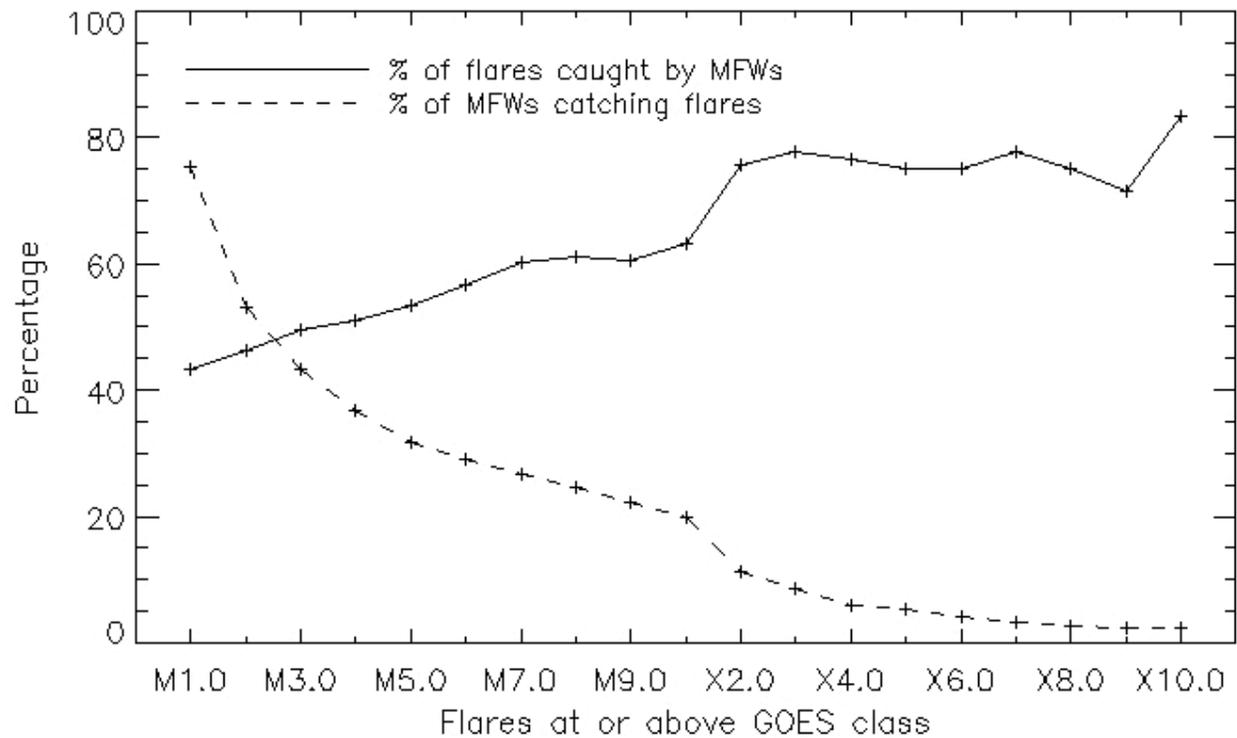
Statistics for Daily MFW Messages

Number of flares at or above a chosen GOES class within 24 hours of the Major Flare Watch UTC message issue times (24-hour MFW periods, MFWs below) during the period 26-Mar-2001 to 17-May-2010

Flare GOES class	Flares in all MFWs	Total flares	% flares in MFW	MFWs with flares	MFWs without flares	% MFWs with flares
M1.0	430	992	43	166	54	75
M2.0	216	466	46	117	103	53
M3.0	153	308	50	95	125	43
M4.0	119	233	51	81	139	37
M5.0	100	187	53	70	150	32
M6.0	86	152	57	64	156	29
M7.0	77	128	60	59	161	27
M8.0	69	113	61	54	166	25
M9.0	61	101	60	49	171	22
X1.0	55	87	63	44	176	20
X2.0	28	37	76	25	195	11
X3.0	21	27	78	19	201	9
X4.0	13	17	76	13	207	6
X5.0	12	16	75	12	208	5
X6.0	9	12	75	9	211	4
X7.0	7	9	78	7	213	3
X8.0	6	8	75	6	214	3
X9.0	5	7	71	5	215	2
X10.0	5	6	83	5	215	2

Major Flares Caught by MFWs

Percentage of flares at or above a chosen GOES class within 24 hours of the Major Flare Watch UTC message issue times (24-hour MFW periods, aka MFWs) for 26-Mar-2001 to 17-May-2010



Summary of MFW Effectiveness for Gamma-Ray Flares

Gamma-ray flares are a high-value target.

For reasons evident in the previous plot, let's identify them with GOES class $> X1$ (~ Shih 2009).

A criticism sometimes heard in the past has been that too many Major Flare Watches were called.

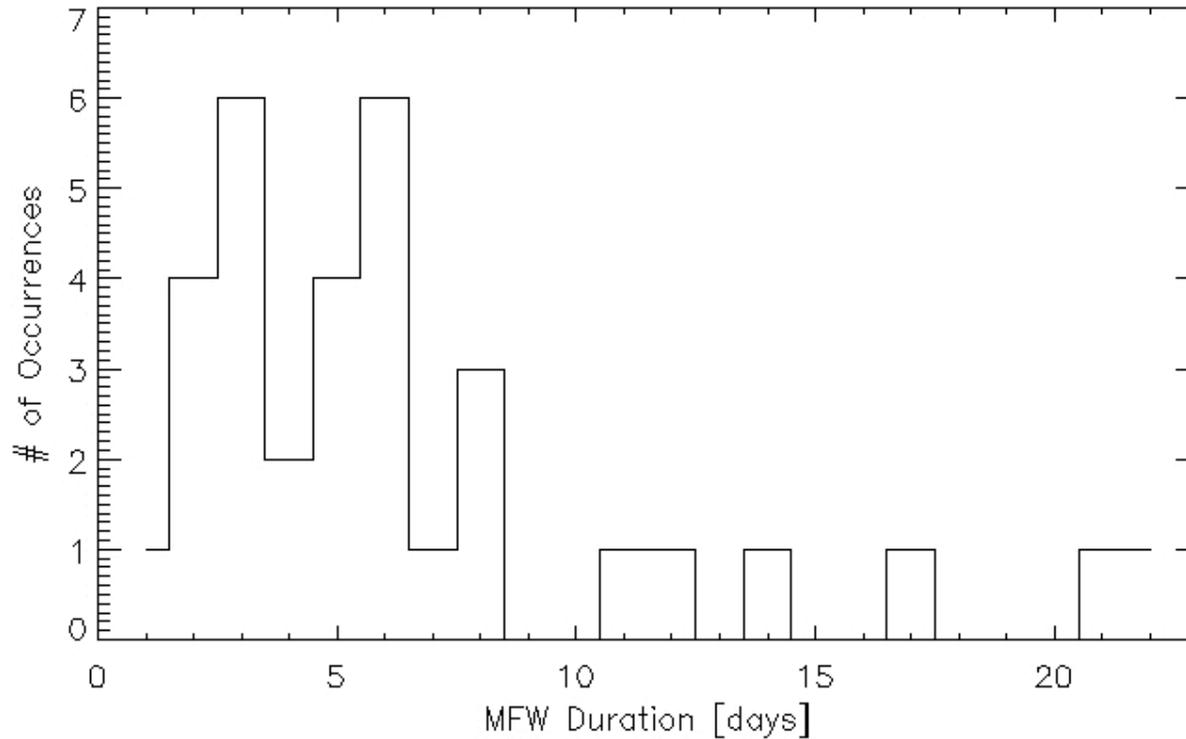
The data show that 220 MFW days were called over 9-plus years.

If we view this (as some do) as a cost that precludes non-flare science, the analysis shows that about 75% of all $> X1$ flares were caught at the cost of $< 7\%$ of all available observing days.

Pretty cost-effective, I'd say!

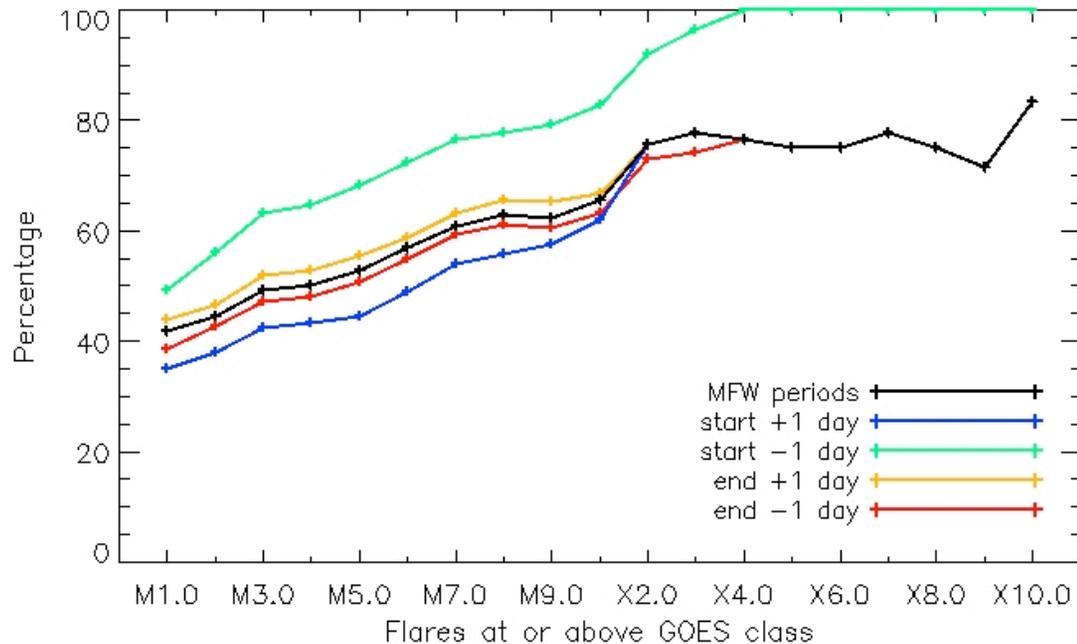
MFW Period Durations

- MFW durations measure periods of contiguous daily MFW messages.
- NB: there were 33 such MFW periods from 1-Feb-2001 to 31-May-2010



MFW “What-if” Study

- What if MFW periods started one day earlier/later or ended one day earlier/later?
- NB: Success catching > X1 flares is independent of 1-day delays in MFW period start dates [cf. Hinode MFW implementation]



Present Activities

- Draft “Ideal” Hinode MFW Observing Program from RHESSI Point of View (Milligan)
- Revisit Current Criteria for Calling MFWs (McAteer, Marquette)
- Develop RHESSI Nugget(s) on Max Millennium Program, MFWs (Bloomfield, McAteer, Raftery)

Acknowledgements

Thanks to MM_CO Shaun Bloomfield, Trinity College Dublin, for the analysis of the MFW statistics :)