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**Space Weather Technical Forecast**

Issued on Monday, 05 June 2023 at 01:13 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>**

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**Space Weather Forecast Headline: Chance of M-class flares (R1/Minor-R2/Moderate radio blackouts). Slight chance of G1/Minor storm due to CME effects 07-08 June.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Low, but with frequent C-Class flares and a peak impulsive flare of C8.8 at 04/0345UTC from AR3323. This is one of nine sunspot regions on the visible disc, and is the largest region, although it is relatively straightforward magnetically. AR3319 is rotating off the southwest limb but has not shown signs of significant activity in the last 24 hours. AR3327 is emerging on the southeast limb and is still difficult to classify due to the viewing angle, but is showing some signs of complexity. The remaining regions are all smaller and simpler, but there are signs of further regions to rotate onto the east limb in the near future. A large filament in the southwest quadrant lifted off around 04/0900UTC and gave a CME. Analysis is still ongoing, but it appears more likely to miss Earth, although a glancing blow is possible. No other Earth-directed CMEs were observed in available imagery during the period.

**Solar Wind / Geomagnetic Activity:** Solar winds as observed by DSCOVR at L1 have shown some disturbance, likely from a weak transient, or perhaps weak coronal hole effects. Wind speeds were ambient, varying between 310-380 km/s. Density has been at mostly average or above average levels, with a peak of 25 ppcc at 04/0607 UTC. Total IMF, Bt, has been at weak to moderate levels, with a peak of 12 nT at 04/1715 UTC. The north-south component, Bz, varied weakly at first but then varied moderately between +10/-12 nT after 04/1000 UTC. Phi angle has fluctuated in orientation. Geomagnetic activity was mostly Quiet (Kp 1-2), with an Active (Kp 4) interval 04/1800-2100UTC.

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV), as observed by GOES16, has remained at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, was initially at moderate levels but dropped to background levels after 04/0500 UTC. Associated 24-hour fluence has been below the Active threshold (1e8 integrated pfu) with a recent downward trend. Electron fluence observed at 05/0000UTC was 2.81e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is expected to be Low to Moderate, with a chance of M-class flares and a slight chance of X-class flares. Whilst AR3319 is rotating off the disc in the next 24 hours, it seems likely that further regions will rotate onto the east limb, keeping the flare probability flat through the next four days.

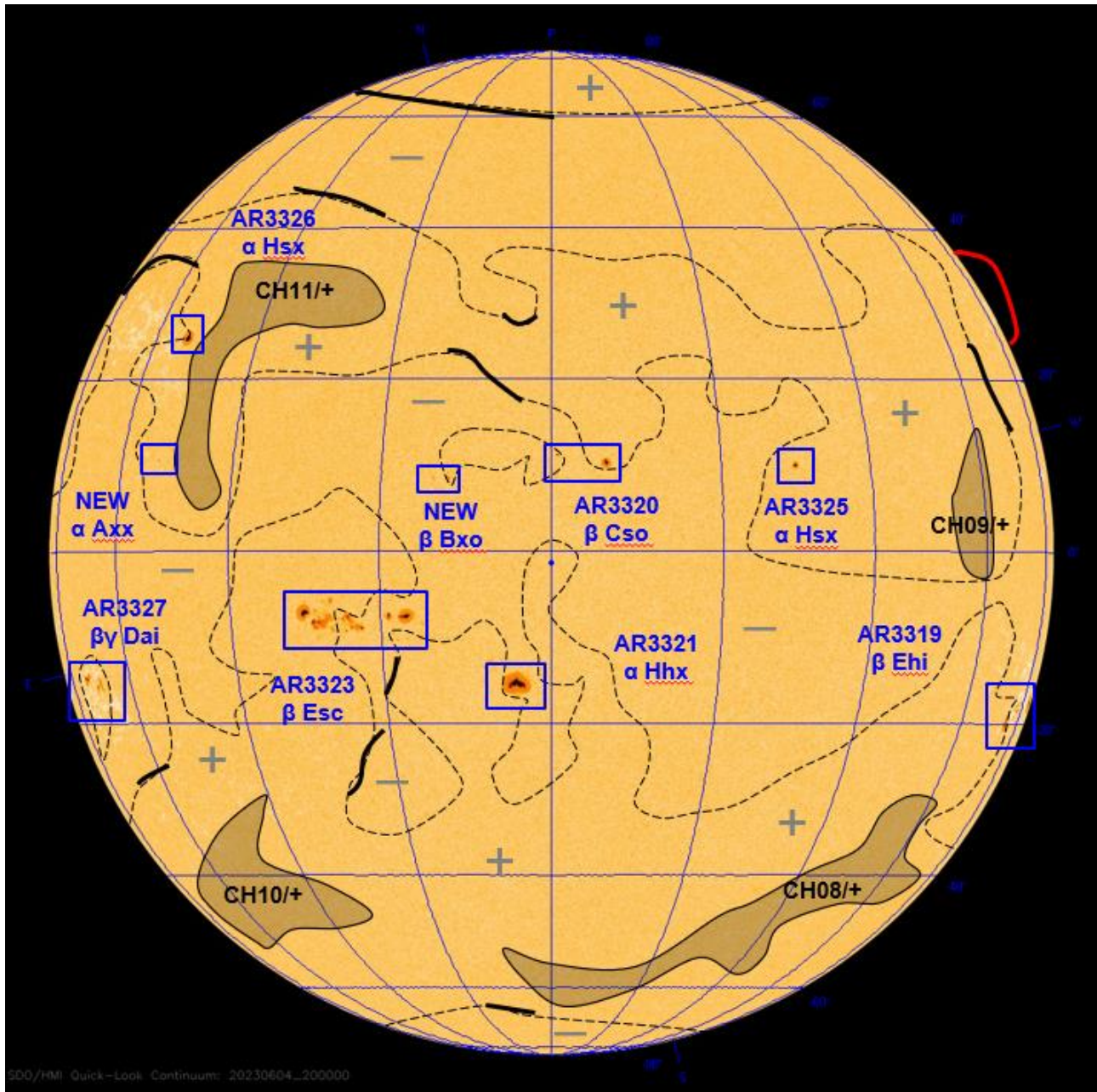
**Solar Wind / Geomagnetic Activity:** A CME erupted during the 04 June. This is currently thought more likely to miss Earth, however a glancing blow is possible either late on 07 June or early on 08 June. Coronal holes 08 and 09 both remain in potentially geoeffective positions on the visible disc, however, wind speeds remain at slow-ambient levels. There remains the possibility of an increase in wind speeds, perhaps to slightly elevated levels, through Day 1 (05

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June) although it now seems likely that any High Speed Stream (HSS) will be weak. Geomagnetic activity is forecast to be mainly Quiet to Unsettled with a chance of Active intervals on Day 1 should we see HSS effects. Activity then easing through Day 2 (06 June), with a possible increase late Day 3 into Day 4 (07-08 June) should we see any CME effects.

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, however there is a slight but declining chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to be at mostly background to moderate levels. Electron fluence is also expected to continue below the Active ( $1e8$  integrated pfu) threshold.

Figure 1. Solar Analysis Valid 04/2000UTC.



**Key:** Filament \_\_\_\_, Prominence \_\_\_\_, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson  $\alpha$ - $\beta$ - $\beta\gamma$ - $\beta\gamma\delta$  and Zurich-McIntosh Axx etc.

**Geomagnetic Storms:**

A filament lift-off starting around 04/0900UTC from the southwest quadrant gave a CME. This is currently thought more likely to miss Earth, however a glancing blow is possible either late on 07 June or early on 08 June.

Coronal holes 08 and 09 both remain in potentially geoeffective positions on the visible disc, however, wind speeds remain at slow-ambient levels. MOSWOC Enlil modelling suggests that the reason for this may be that the winds from CH08 are directed below the Earth, with winds from CH09 passing above the Earth. There remains the possibility of an increase in wind speeds, perhaps to slightly elevated levels, through Day 1 (05 June) although it now seems likely that any High Speed Stream (HSS) will be weak.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled with a chance of Active intervals on Day 1 should we see HSS effects. Activity then easing through Day 2 (06 June), with a possible increase late Day 3 into Day 4 (07-08 June) should we see any CME effects.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	1	10	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

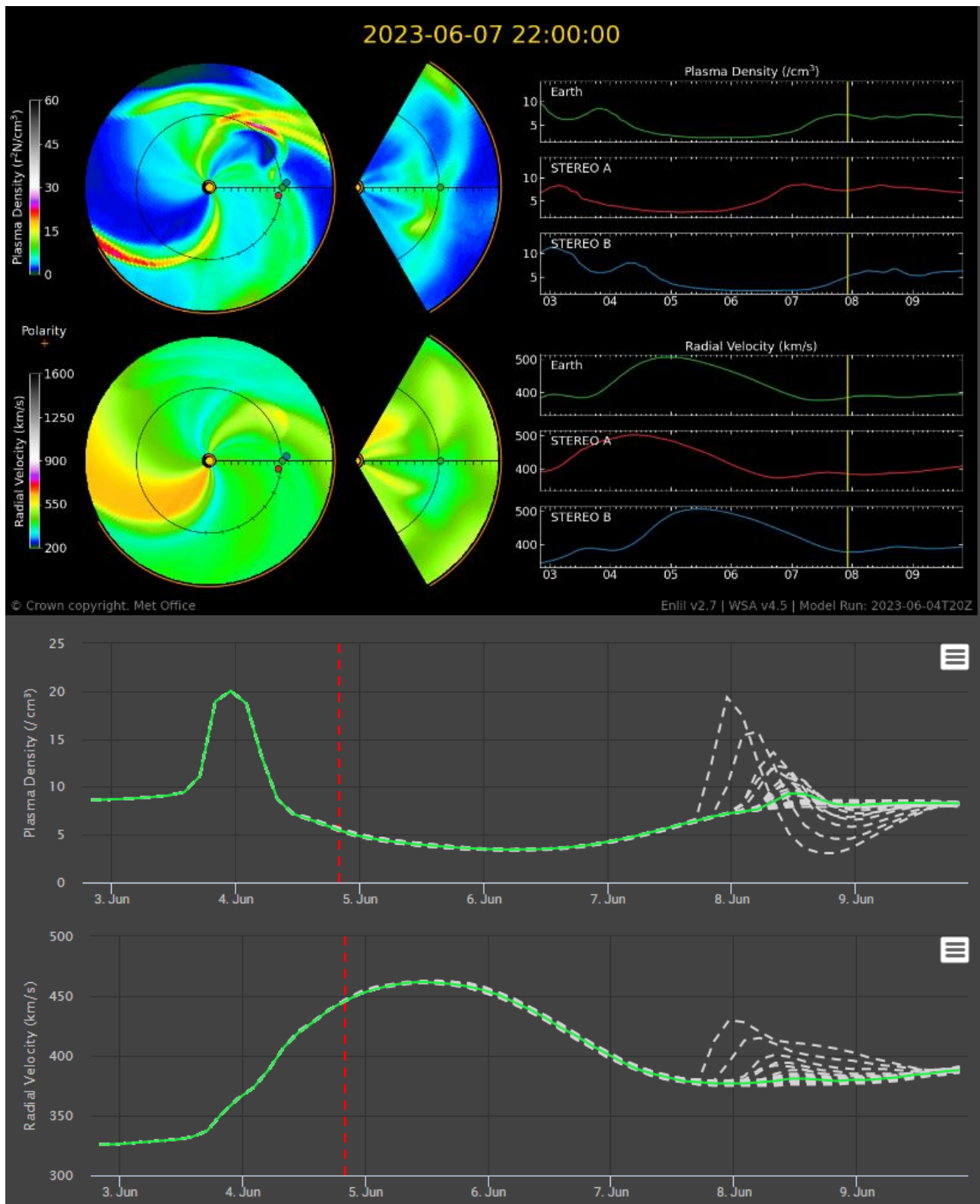
**Geomagnetic Activity - Earthbound Coronal Mass Ejections**

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1629	Partial	Filament	SW	620	08/0000 UTC	Glancing blow possible





Figure 2: MOSWOC Enlil and ensemble, showing a possible CME glancing blow late 07 June or on 08 June. Enlil is suggesting a weak HSS, which is still possible from CH08 or 09, although the strength varies from run to run.



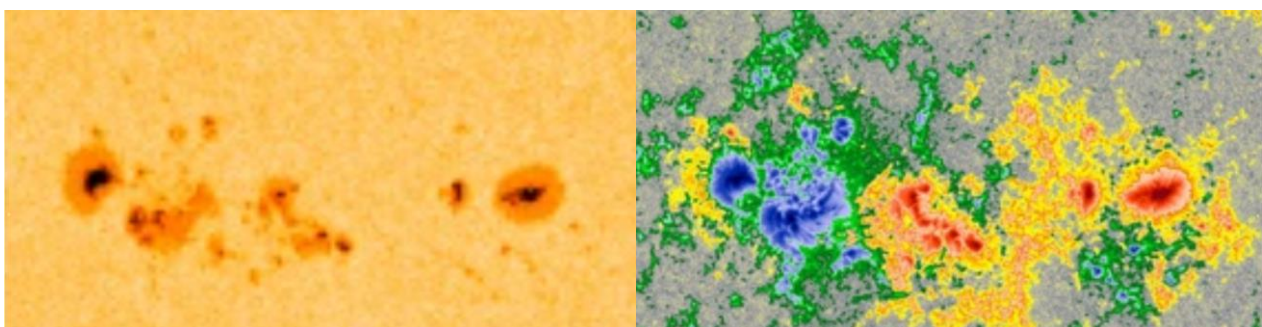
## Radio Blackouts - X-Ray Flares:

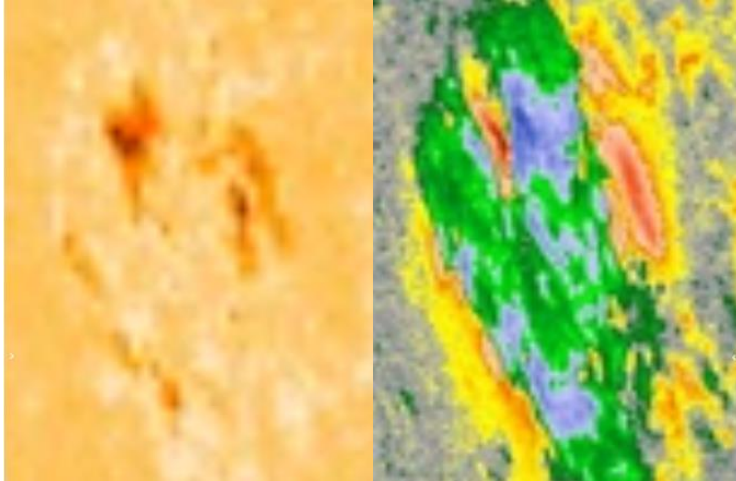
There are currently nine sunspot regions on the visible disc. AR3323 in the southeast remains the largest region, although the magnetic structure now appears relatively straightforward. It gave the largest flare of the last 24 hours, although this only peaked at C8.8. The other large region AR3319 is rotating off the disc over the southwestern limb, but as it is no longer fully visible it is difficult to assess. AR3327 has recently rotated onto the southeast limb and is also still difficult to classify due to the viewing angle, but is starting to reveal some complexity. The other regions appear to be mostly smaller and simpler, but there are signs of further regions to rotate onto the east limb in the near future.

Overall, solar activity is forecast to be Low to Moderate, with a slight chance of High activity. The flare probability has been kept flat through the four days - whilst AR3319 is rotating off so flare risk from this reduces, further regions look likely to rotate onto the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

**Figure 3: SDO intensitygram and magnetogram from AR3323 (top) and AR3327 (below). AR3323 now has a fairly straightforward magnetic structure, which AR3327 is starting to reveal some magnetic complexity, possibly with a hint of a delta region in the northern trailing spot. The viewing angle near the limb makes it difficult to be sure at this stage, however.**





## Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is at background levels and is most likely to remain at this level. There is a slight and declining chance of S1/Minor radiation storms should any larger flares occur. The main risk is from AR3319 and AR3323. AR3319 is rotating off and therefore the likelihood of proton storms from this location will diminish, hence the reduction in probability by Day 3 (07 June).

Radiation Storms	Level ( $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$ )	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$ . ( $\text{pfu} = \text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$ )						

## High Energy Electrons Event ( $\geq 2\text{MeV}$ ):

High energy electron flux (greater than  $2\text{MeV}$ ) is expected to remain at mainly background to moderate levels through the period. Although there remains the possibility of HSS effects early in this period from either coronal hole 08 or 09, this is likely to be weak and any electron charging minimal. The possibility of a CME glancing blow late Day 3 into Day 4 (07-08 June) would also keep electron levels suppressed in the initial wake of the CME, although could cause charging right at the end of the period. Confidence in the CME arrival is low, however as this is probably more likely to miss Earth.

Electron fluence is well below the Active ( $1\text{e}8$  integrated pfu) threshold and has been declining in recent hours. It is expected to stay below Active through this period, although a rise is possible later on Day 4, but this is low confidence. MOSWOC REFM is forecasting a below Active trend through the next three days which is reasonable.

GEO Electron Environment	Level ( $\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$ )	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM showing a below Active trend through the next three days.

