Space Weather Technical Forecast

Issued on Tuesday, 06 June 2023 at 01:24 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 a G1-G2/Minor-Moderate Geomagnetic 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. There are currently ten sunspot regions on the visible disc. AR3323 nearing centre disc remains the largest and most complex region. The other large region AR3319 has now rotated beyond the southwestern limb. AR3327 near the southeast limb is starting to reveal some complexity, however foreshortening still limits confidence. The other regions appear to be relatively small, simple or inactive.

No Earth-directed CMEs were observed in available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar wind parameters as observed by DSCOVR/ACE at L1 have shown some disturbance, thought to derive from a weak transient. Wind speeds were initially ambient around 350 km/s, increasing around 05/0500 UTC to become slightly elevated with a peak of 463 km/s at 05/0803 UTC. Winds later declined to ambient levels around 05/1245 UTC, where they have remained on a downwards trend and are currently around 360 km/s. Density has been largely below average, occasionally peaking at average levels. Total IMF, Bt, has been fairly steady at moderate levels, with a peak of 11 nT at 05/2218 UTC. The north-south component, Bz, was initially negative, becoming mostly positive from 05/0545 UTC fluctuating between +8/-4nT. Phi angle has been almost entirely positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

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 has been at largely background levels. Associated 24-hour fluence has been below the Active threshold (1e8 integrated pfu) with a recent downward trend, peaking at 2.81e6 integrated pfu at 05/0000UTC. Electron fluence observed at 06/0000UTC was 1.36e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain generally Low but there is a chance of isolated M-Class flares bringing Moderate activity, and a slight chance of isolated X-Class flares. These most likely from AR3323 or the developing AR3327.

Solar Wind / Geomagnetic Activity: 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 Day 2 or into Day 3 (07-08 June). Some potential transient CME has been observed in the past 24hrs and this may continue into the start of the Day 1. Generally solar winds expected to remain at slow-ambient or slightly elevated levels. Perhaps seeing enhancement Day 2-3 should Earth experience any CME effects.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled with a slight chance of Active

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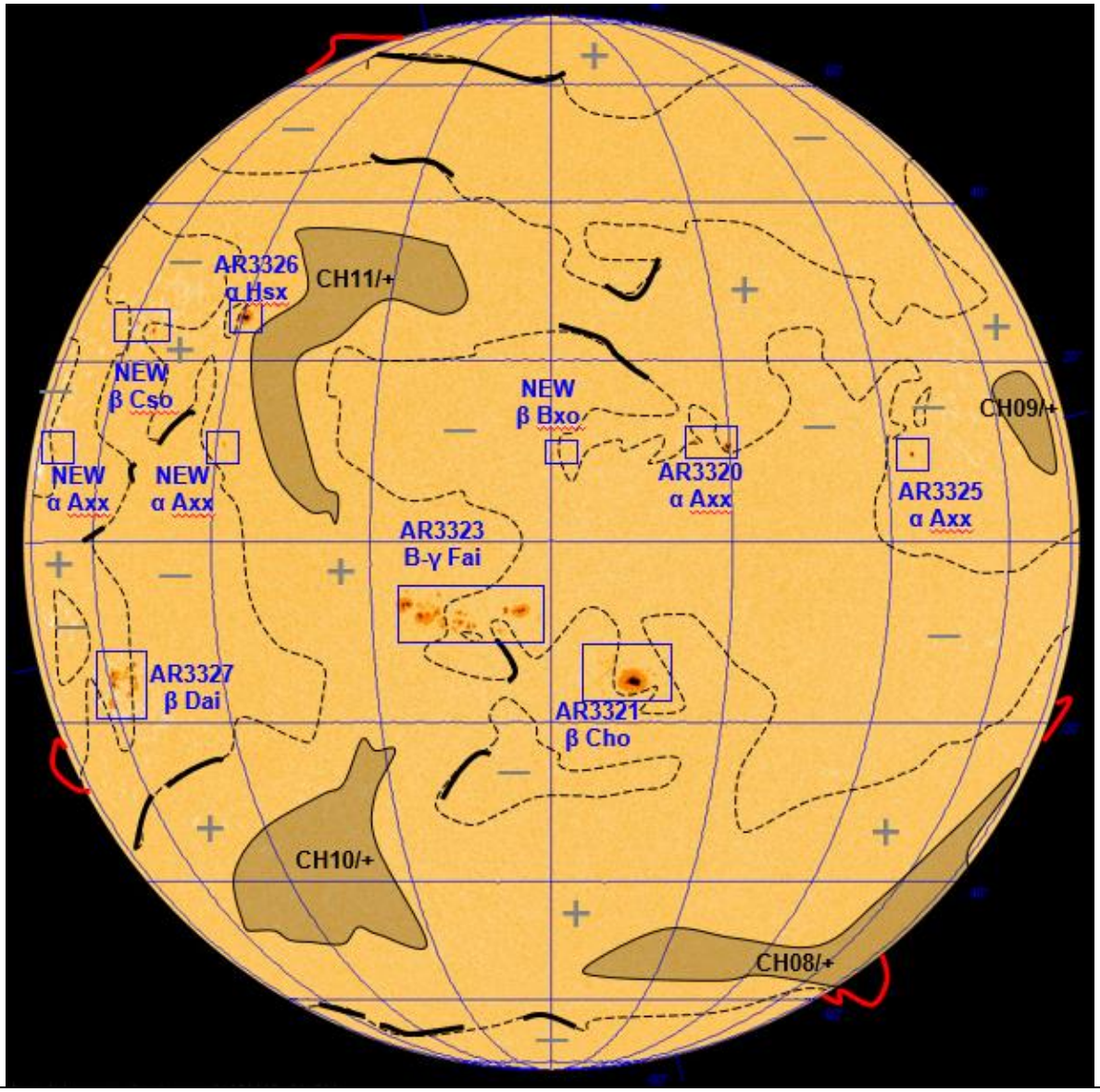
intervals on Day 1 (06 June) from weak transient enhancement. Activity possibly increasing late Day 2 into Day 3 (07-08 June) should we see any CME effects, becoming more Unsettled with a chance of Active intervals and a slight chance of isolated G1-G2/Minor to Moderate Geomagnetic Storm intervals.

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 or moderate levels. Electron fluence is also expected to continue below the Active (1e8 integrated pfu) threshold, but see a gradual increase.

Figure 1. Solar Analysis Valid 05/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament lift-off starting around 04/0900UTC from the southwest quadrant produced a CME. Although, this is currently thought more likely to miss Earth, a glancing blow is possible either late on Day 2 (07 June) or early Day 3 (08 June). No other potential Earth directed CMEs currently feature in the forecast.

Coronal holes 08 and 09 are considered to have largely transited beyond geoeffective positions on the visible disc, with the risk of any possible weak enhancement from the southernmost CH08/+ declining. Some potential transient CME activity has been observed in the past 24hrs, which is expected to wane through Day 1 (06 June). Generally solar winds expected to remain slow-ambient, perhaps at slightly elevated levels through the period with a slight chance of enhancement late Day 2 into Day 3 (07-08 June), should Earth experience any CME effects.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled with a slight chance of Active intervals on Day 1 (06 June), should we continue to see any transitory enhancement. Activity possibly increasing late Day 2 into Day 3 (07-08 June) should we see any CME effects, becoming more Unsettled with a chance of Active intervals and a slight chance of isolated G1-G2/Minor to Moderate Geomagnetic Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	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) (%)
Minor or Moderate	G1 to G2	No	5	15	20	10
Strong	G3	No	1	1	2	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 Lift-Off	SW	620 km/s	08/0000 UTC	Glancing blow possible. Moderate confidence

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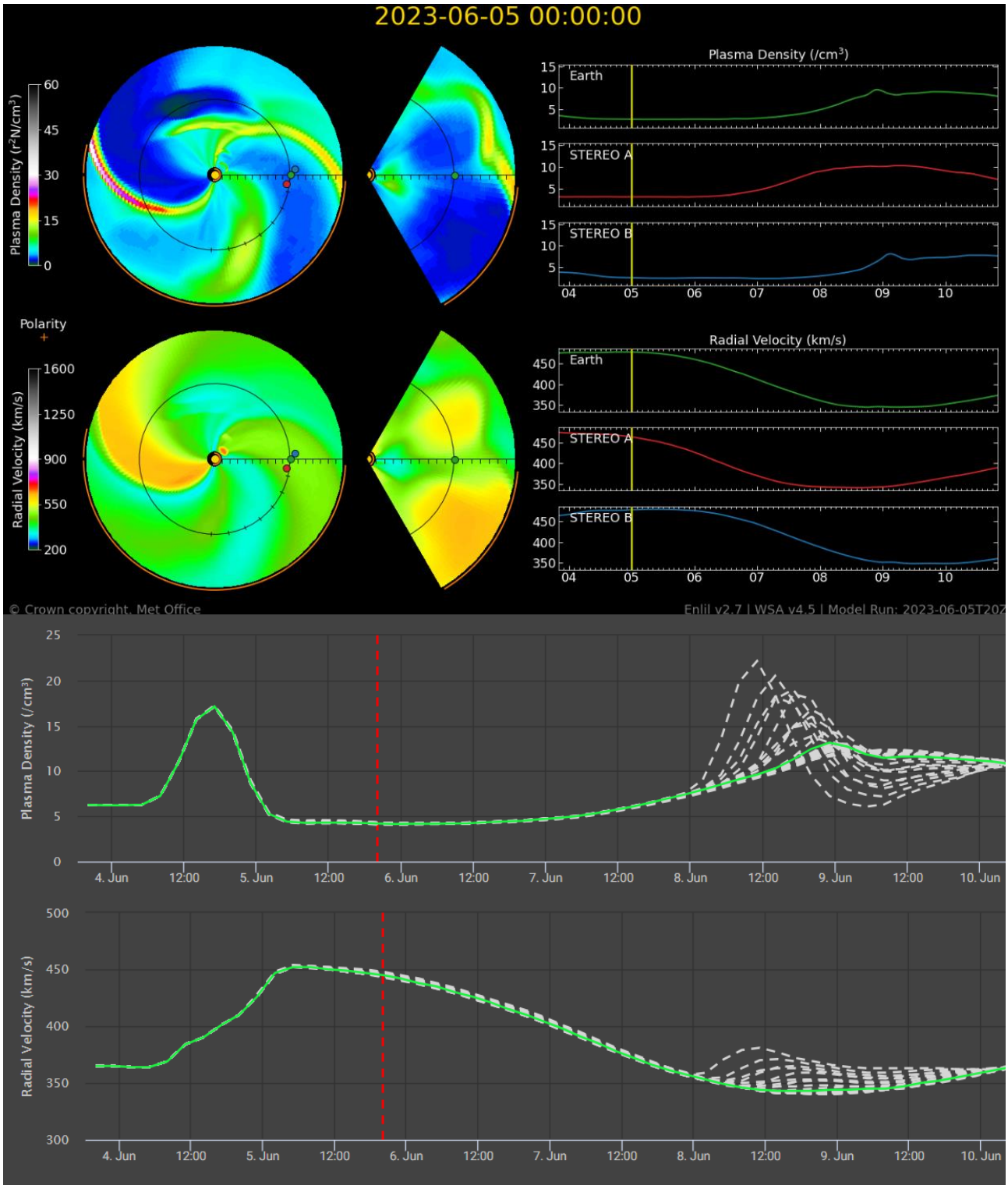
Figure 2: MOSWOC Enlil & Ensembles, showing potential timing of glancing blow CME



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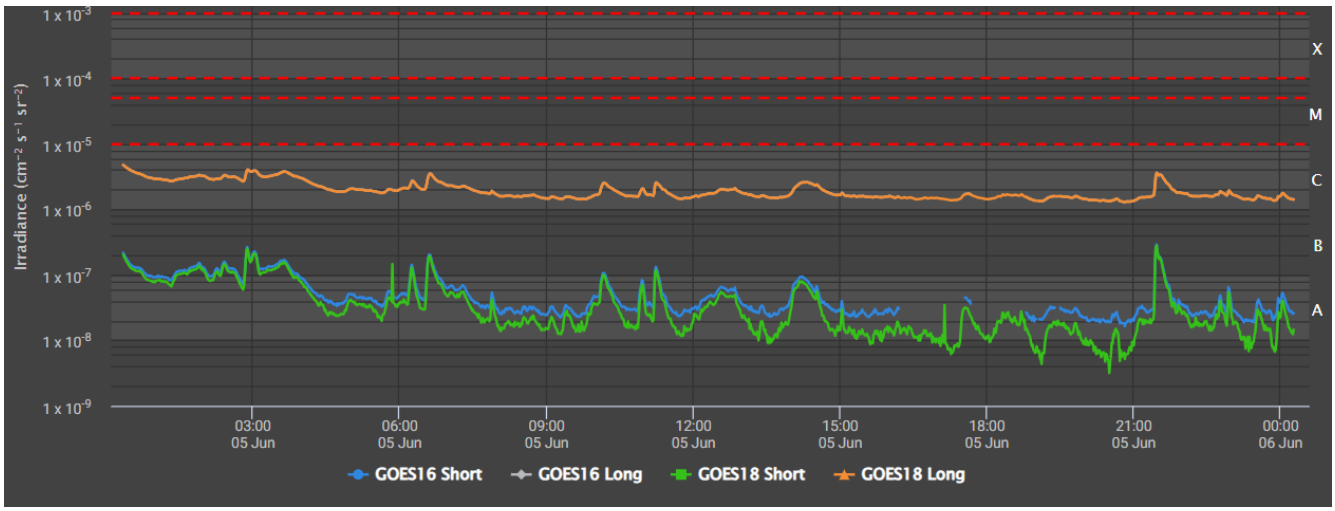
Radio Blackouts - X-Ray Flares:
There are currently ten sunspot regions on the visible disc. AR3323 nearing centre disk remains the largest and most magnetically complex region on the disc, contributing the bulk of current flare risk accordingly. The large region Ex-AR3319 has now rotated over the southwestern limb. AR3327 near the southeast limb is developing quite quickly and is showing some complexity and the possibility of a faint delta spot in its trailing portion, however, the viewing angle still limits accurate assessment. The new region to the east of AR3326 is developing fairly rapidly. The remaining regions appear to be mostly small and/or simple. A number of new and returning regions are expected to rotate across the eastern limb Days 1 (06 June), supported by STEREO EUVI imagery.

Overall, solar activity is expected to remain generally Low but there remains a chance of isolated M-flares producing Moderate activity, and a very slight chance of isolated X-flares. These most likely from AR3323 or the developing AR3327. The flare probability has been kept flat through the forecast with the reduced risk from departed AR3319 counteracted by the emergence or development of further regions.

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	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES16 & GOES18 X-Ray Trace



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is at background levels, where it is expected to remain. There is a slight but diminishing chance of S1/Minor Radiation Storms should any larger flares occur. The main contributors to risk are from Ex-AR3319, which has just passed beyond the western limb and AR3323. The likelihood of proton storms from Ex-AR3319 will continue to decline through Days 1-2 (06-07 June) as the region rotates away. The recently emerged region in the southeast, AR3327, has developed quickly and may pose an elevated risk of significant flares, however, any associated radiation storm risk lies mainly beyond the scope of the current forecast.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} 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) (%)
Active	≥ S1	No	10	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is expected to remain at mainly background to moderate levels through the period. The possibility of a CME glancing blow late Day 2 into Day 3 (07-08 June) would also keep electron levels suppressed, although could cause charging right at the end of the period. Confidence in the CME arrival is low, with the majority of material passing ahead of the Earth.

Electron fluence is well below the Active (1e8 integrated pfu) threshold. It is expected to stay below Active through this period, although a rise is possible Days 3-4 (09-09), but this is low confidence. MOSWOC REFM is forecasting an increasing trend, but remaining below Active levels, this is considered to be reasonable guidance at this stage.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} 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) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	8
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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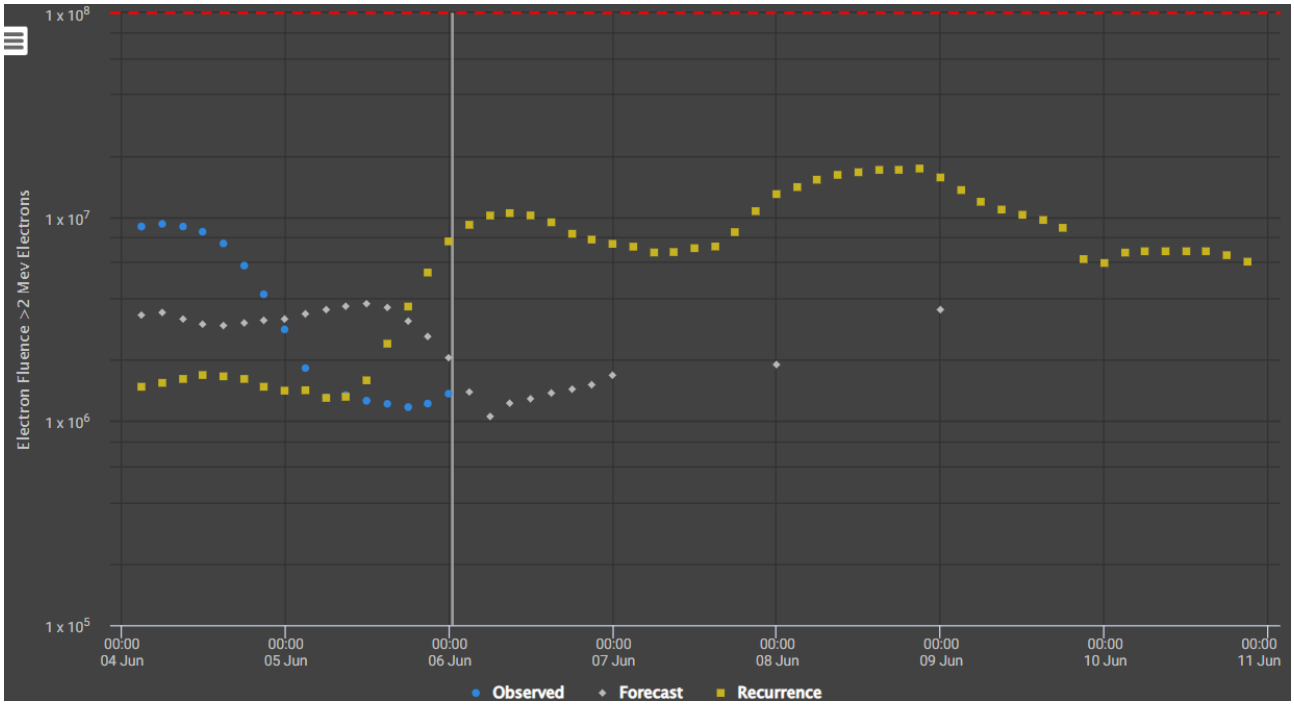
Figure 5: MOSWOC REFM showing rising trend projected in fluence values.



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