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**Space Weather Technical Forecast**

Issued on Wednesday, 07 June 2023 at 01:23 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/Minor Geomagnetic Storm 08/09 June.**

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

**Solar Activity:** Solar activity has been Low, with background X-ray flux at low C-class levels. Peak impulsive flare of C7.5 at 06/1900UTC from AR3327. There are currently twelve sunspot regions on the visible disc. AR3327 in the southeast is now the largest and most complex region, with a proliferation of many trailing spots and the emergence of a small delta spot. AR3323 in the centre disc in the southern hemisphere remains large and complex, although continues to decline with the lead group having significantly decayed. One new region continues to rotate across the southeastern limb. The other regions appear to be mostly small and/or simple, with only minor growth or decay.

No Earth-directed CMEs were observed in available imagery during the period. The most prominent CME on coronagraph imagery erupted from the Sun around 06/0300UTC but is expected to pass behind the Earth.

**Solar Wind / Geomagnetic Activity:** Solar wind parameters as observed by DSCOVR at L1 have shown some slight disturbance, thought to derive from one or more recent weak transients. Wind speeds were initially at slow-ambient levels around 350 km/s, rising to a peak of 407 km/s at 06/1009UTC. Winds subsequently returned to slow-ambient levels and have been on a general downward trend and are currently around 350 km/s. Density was initially average, falling to below average levels around 06/0830UTC where it has since largely remained. Total IMF, Bt, fluctuated between weak and moderate levels at first, with a peak of 9nT, but since 06/0920UTC erratically declined to become weak. The north-south component, Bz, although initially negative, has been largely positive, with a few generally short-lived periods of negative Bz, varying between +8/-7nT. Phi angle has been almost entirely positive (away from the Sun), with short-lived negative (towards the Sun) periods. Geomagnetic activity was mostly Quiet (Kp 0-2) with one Unsettled interval (Kp 3) 06/0000-0300UTC.

**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) on a generally steady trend with a peak of 1.68e6 integrated pfu at 06/1800UTC. Electron fluence observed at 07/0000UTC was 1.51e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is expected to remain generally Low with an ongoing, but steadily decreasing, chance of Moderate activity from M-class. There remains a very slight chance of isolated X-class flares. Any significant flares are most likely to originate from the two largest and most complex regions, both of which are located in the southern hemisphere.

**Solar Wind / Geomagnetic Activity:** A filament lift-off starting around 04/0900UTC from the southwest quadrant resulted in an observed CME. A glancing blow at Earth is possible from this feature, although not guaranteed, most likely Day 2 (08 June) but possibly Day 3 (09 June). A

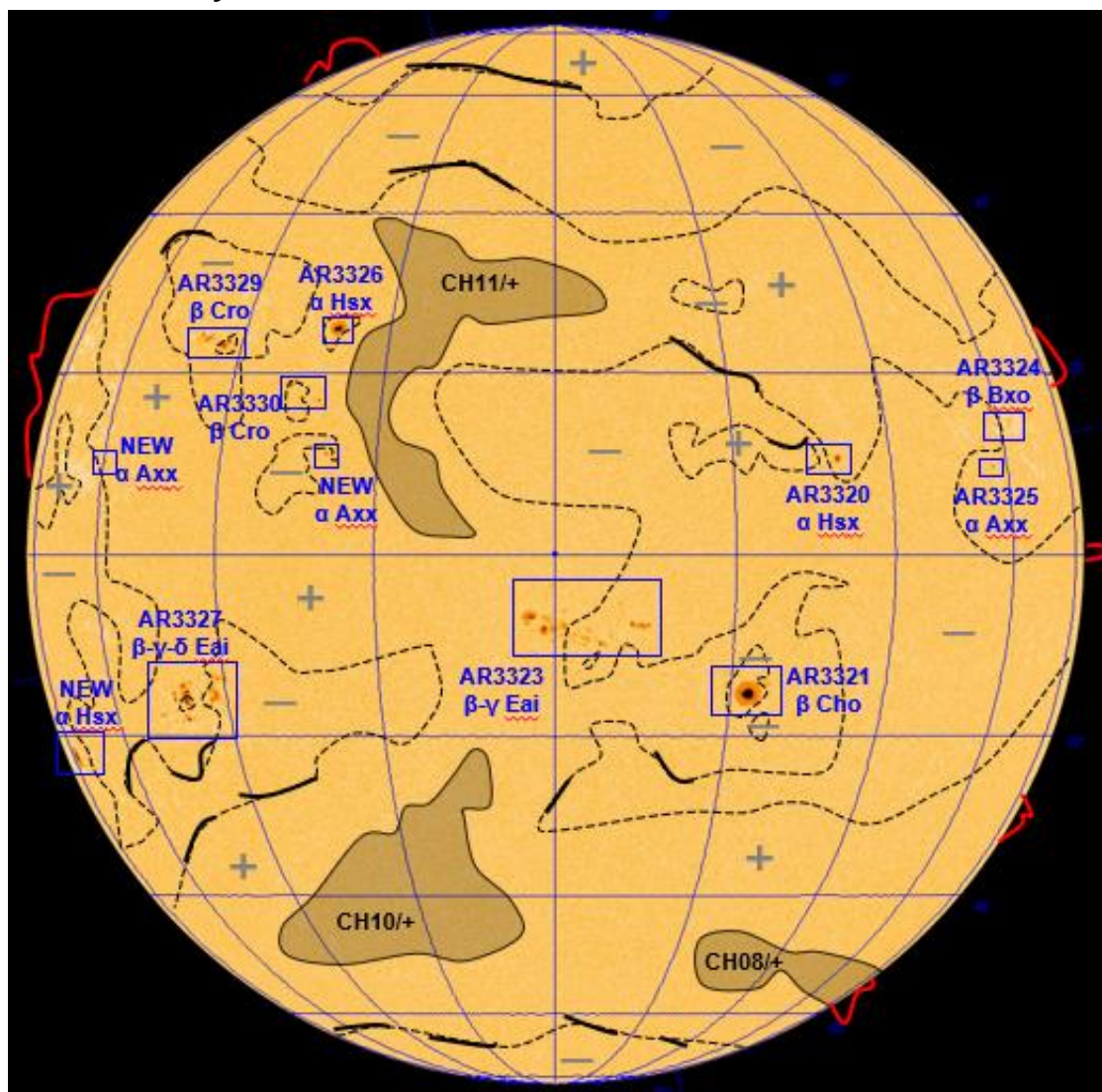
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second CME that left the Sun from near the eastern limb around 06/0300UTC is expected to miss, passing behind Earth on Day 4 (10 June). Solar winds expected to remain at slow-ambient to slightly elevated levels. Perhaps seeing a slight enhancement Days 2-4 given the potential for CME arrivals and a weak HSS from CH11/+.

Geomagnetic activity is forecast to be initially Quiet to Unsettled, with a slight chance of Active intervals on Day 1 (07 June). Activity may increase Days 2-3 with any CME effects, becoming more Unsettled with a chance of Active intervals and a slight chance of isolated G1/Minor 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 very slight 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, but may experience charging from a possible CME glancing blow. Electron fluence is also expected to continue below the Active ( $1e8$  integrated pfu) threshold, but likely see a gradual increase.

**Figure 1. Solar Analysis Valid 06/2000UTC.**



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

**Geomagnetic Storms:**

A filament lift-off starting around 04/0900UTC from the southwest quadrant resulted in an observed CME. A weak glancing blow is possible, most likely to arrive on Day 2 (08 June) or very possibly early Day 3 (09 June), although a small number of Enlil ensemble members have this feature missing Earth entirely. A CME erupted from close to the eastern limb around 06/0300UTC and is expected to pass behind Earth on Day 4 (10 June). Although the majority of Enlil members predict a miss, there remains a slight possibility of a glancing blow from this feature, or for some transient effects to be observed towards the end of the period. No other Earth-directed CMEs currently feature in the forecast.

CH08/+ in the southern hemisphere is considered to have largely transited beyond a geoeffective position on the visible disc with the next high-speed stream from CH11/+ in the northern hemisphere not forecast to become geo-effective until Day 4. Some potential transient CME activity has been observed in the past 24hrs, although this largely waned during 06 June. Solar winds are expected to continue to fluctuate between slow-ambient and slightly elevated levels, with an increased chance in enhancement to 450 km/s Days 2-4 (08-10 June) given the potential for CME arrivals and a weak HSS.

Geomagnetic activity is forecast to be initially Quiet to Unsettled, with a slight chance of Active intervals on Day 1 (07 June) should Earth see any early CME enhancement. Activity possibly increasing Day 2 into Day 3 should we see any CME effects, becoming more Unsettled with a chance of Active intervals and a slight chance of isolated G1/Minor Geomagnetic Storm intervals.

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	10	20	15	5
Strong	G3	No	1	2	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

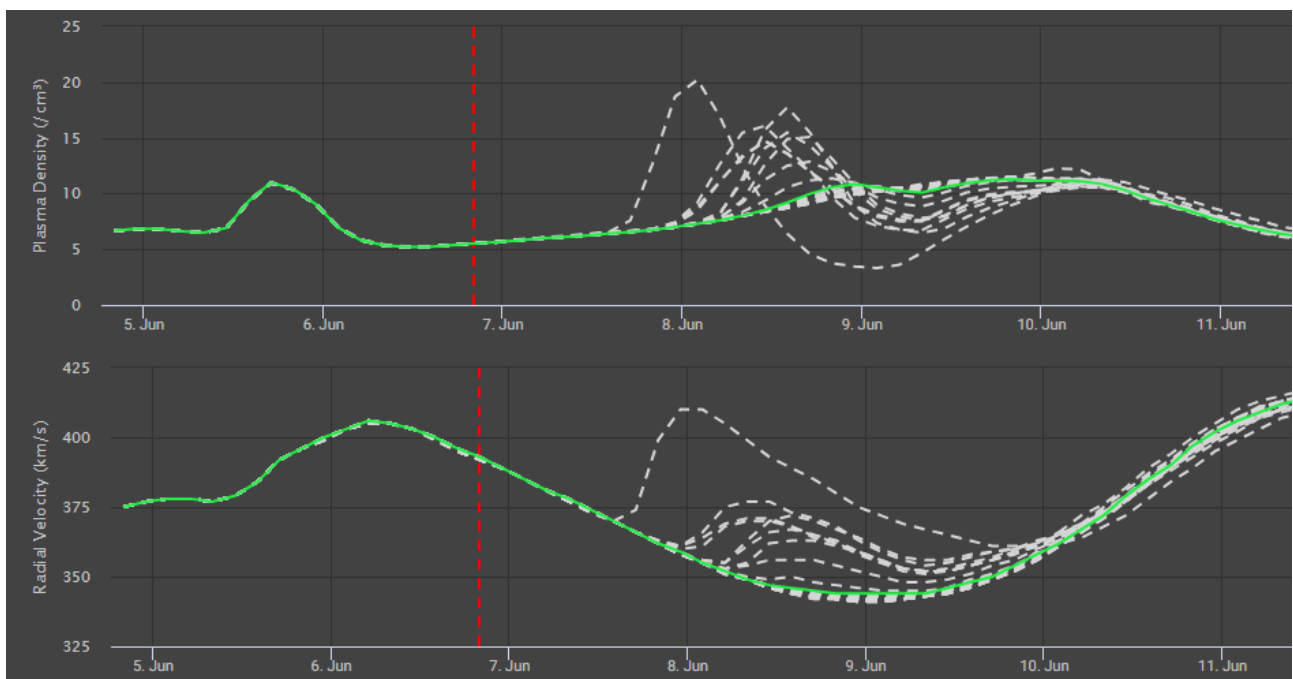
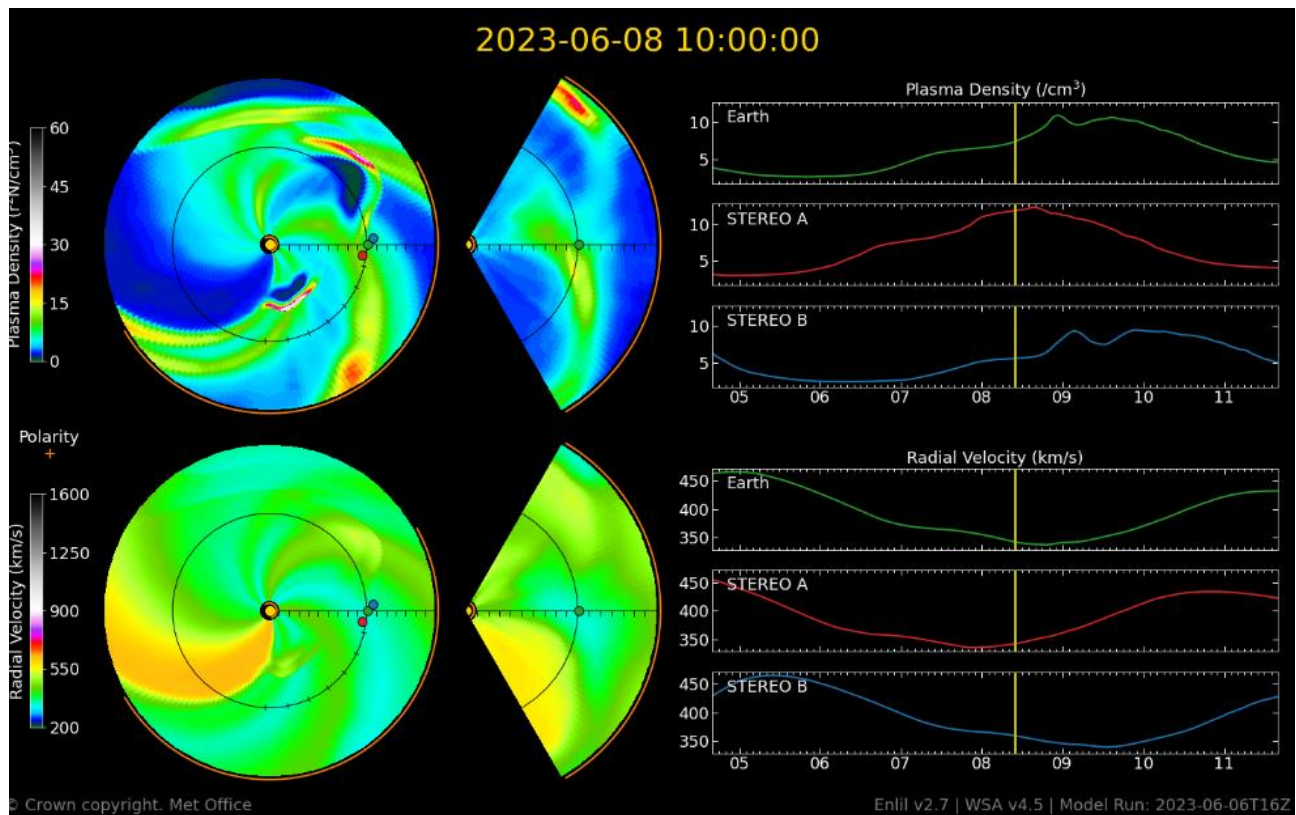
**Geomagnetic Activity - Earthbound Coronal Mass Ejections**

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1629	Partial	Filament Eruption	SW	620km/s	08/1000UTC	Glancing blow possible. Moderate confidence in arrival time.





Figure 2: MOSWOC Enlil and Ensemble forecast, indicating possible glancing blows from CMEs 08-10 June.



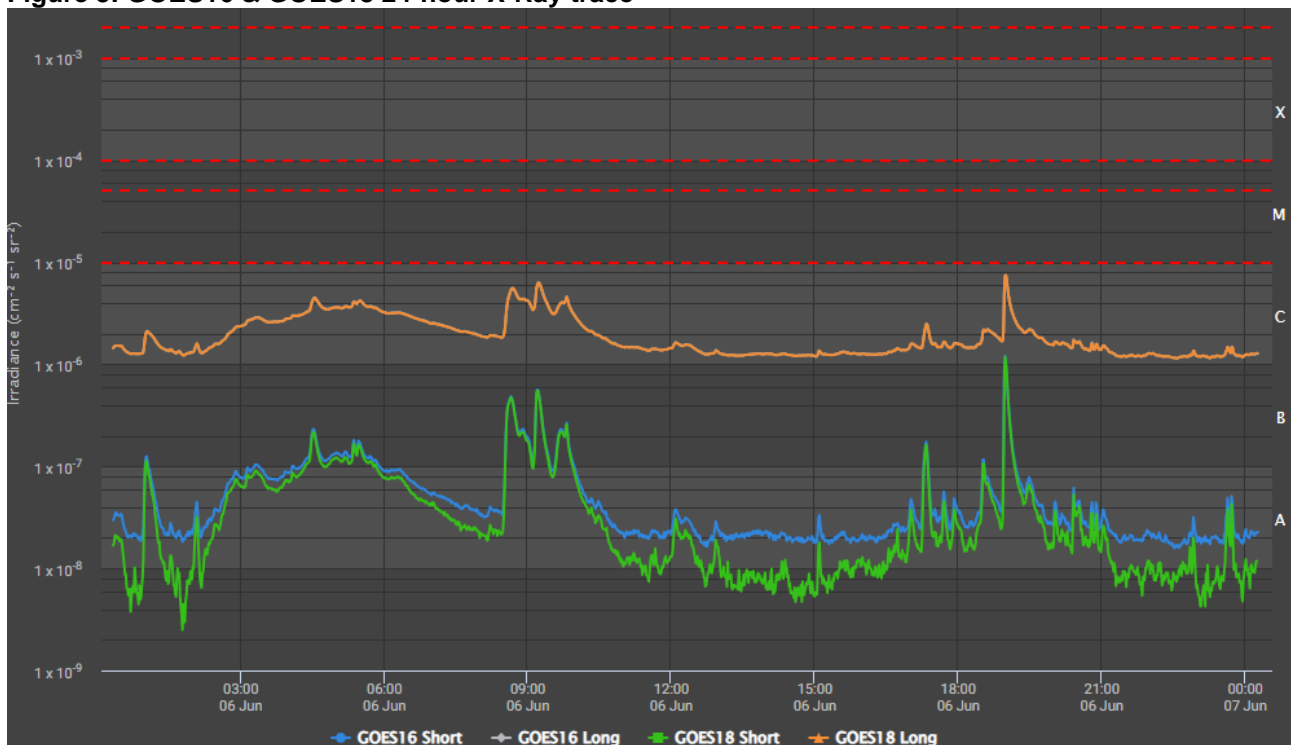
## Radio Blackouts - X-Ray Flares:

There are currently twelve sunspot regions on the visible disc. AR3327 (Eai/Beta-Gamma-Delta) in the southeast quadrant is now the largest and most complex region on the disc, having seen a recent proliferation of trailing spots and the emergence of a small delta configuration. AR3323 (Eai/Beta-Gamma) in the central disc, although still large and magnetically complex, has shown gradual signs of decay, with the leading group greatly diminished. A new region continues to emerge across the southeast limb, although it remains too foreshortened in available imagery to make a confident assessment. The other regions appear to be mostly small and/or simple, with minimal growth or decay since the last assessment.

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 AR3327, with the risk diminishing in line with expected decay of AR3323.

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	45	40	30	30
Very Active	R3 to R5 X Class	No	5	5	3	3

**Figure 3: GOES16 & GOES18 24-hour X-Ray trace**



## 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 very slight chance of S1/Minor Radiation Storms should any larger flares occur from AR3327 or AR3323. There appears to be a decreasing risk from AR3323 near the southern central disc as it is showing a decaying trend, reflected in the decline in probabilities through the period.

Radiation Storms	Level (cm <sup>-2</sup> sr <sup>-1</sup> s <sup>-1</sup> )	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	≥ S1	No	10	5	5	5
Very Active	≥ S3 <sub>*</sub>	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm <sup>-2</sup> sr <sup>-1</sup> s <sup>-1</sup> )						

## 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 Days 2-3 (08-09 June) may also keep electron levels suppressed, although could produce charging towards the end of the forecast period. Confidence in any CME arrivals is low, with a chance they may miss Earth entirely.

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 (09-10 June), but this is low confidence. MOSWOC REFM is forecasting an increasing trend, but remaining well below Active levels. This is considered to be reasonable guidance at this stage.

GEO Electron Environment	Level (cm <sup>-2</sup> sr <sup>-1</sup> day <sup>-1</sup> )	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	≥ 2 MeV ≥ 1x10 <sup>8</sup>	No	1	1	5	5
Very Active	≥ 2 MeV ≥ 1x10 <sup>9</sup>	No	1	1	1	1

**Figure 4: MOSWOC REFM showing gradual recovery in fluence levels.**

