
Space Weather Technical Forecast

Issued on Sunday, 04 June 2023 at 13:28 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>

Space Weather Forecast Headline: M-class flares (R1/Minor-R2/Moderate radio blackouts) Likely 04 June, then Chance of 05-07 June.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, but tending towards Moderate with frequent C-Class flares and a peak impulsive flare of C8.8 at 04/0345UTC from AR3323. This is one of eight sunspot regions on the visible disc. AR3319 in the southwest is the only other notable region, but has not shown signs of significant activity in the last 24 hours. AR3324 has recently faded. One new region has started to emerge across the eastern limb but is as yet unnumbered. The remaining regions are all relatively stable with limited activity observed. A large filament in the southwest quadrant lifted off around 04/0900UTC and is awaiting coronagraph imagery for analysis, its position on the solar disc relative to Earth would suggest an Earth-directed component is possible. No other Earth-directed CMEs were observed in available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 have been at ambient levels throughout, after an initial decline from 350 km/s to 300 km/s, winds have been rising somewhat erratically since around 03/1830UTC and are currently around 360 km/s. Density was initially below average, but has followed a rising trend to mostly average levels by 03/1915UTC and rising to above average around 04/0500UTC where it has since remained fairly steady around 10-15ppcc. Total magnetic field strength was mainly weak, but rose relatively sharply to moderate levels around 03/2300UTC and has since weakly fluctuated. The north-south component varied weakly for much of the period, reaching a sharp positive peak of 8nT at around 03/2300UTC, a negative peak of -7nT at 04/0630 and another positive peak of 9nT at 04/1057UTC. Phi angle has fluctuated in orientation, initially mostly positive (away from the Sun) before transitioning to a predominantly negative (towards the Sun) orientation 03/1648-04/0120UTC and again from around 04/0800UTC. The combination of changes in wind parameters could be indicative of a connection to part of the high speed streams from either coronal holes 08 or 09. Geomagnetic activity was mostly Quiet (Kp0-2), with one Active KGBi interval.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) has remained at background levels. High energy electron flux (greater than 2MeV) oscillated between background and moderate levels. Associated 24-hour fluence has been below the Active threshold (1e8 integrated pfu) and after a slow rising trend appears to have stabilised. Electron fluence observed at 04/000UTC was 8.47e6 integrated pfu.

Four-Day Space Weather Forecast Summary

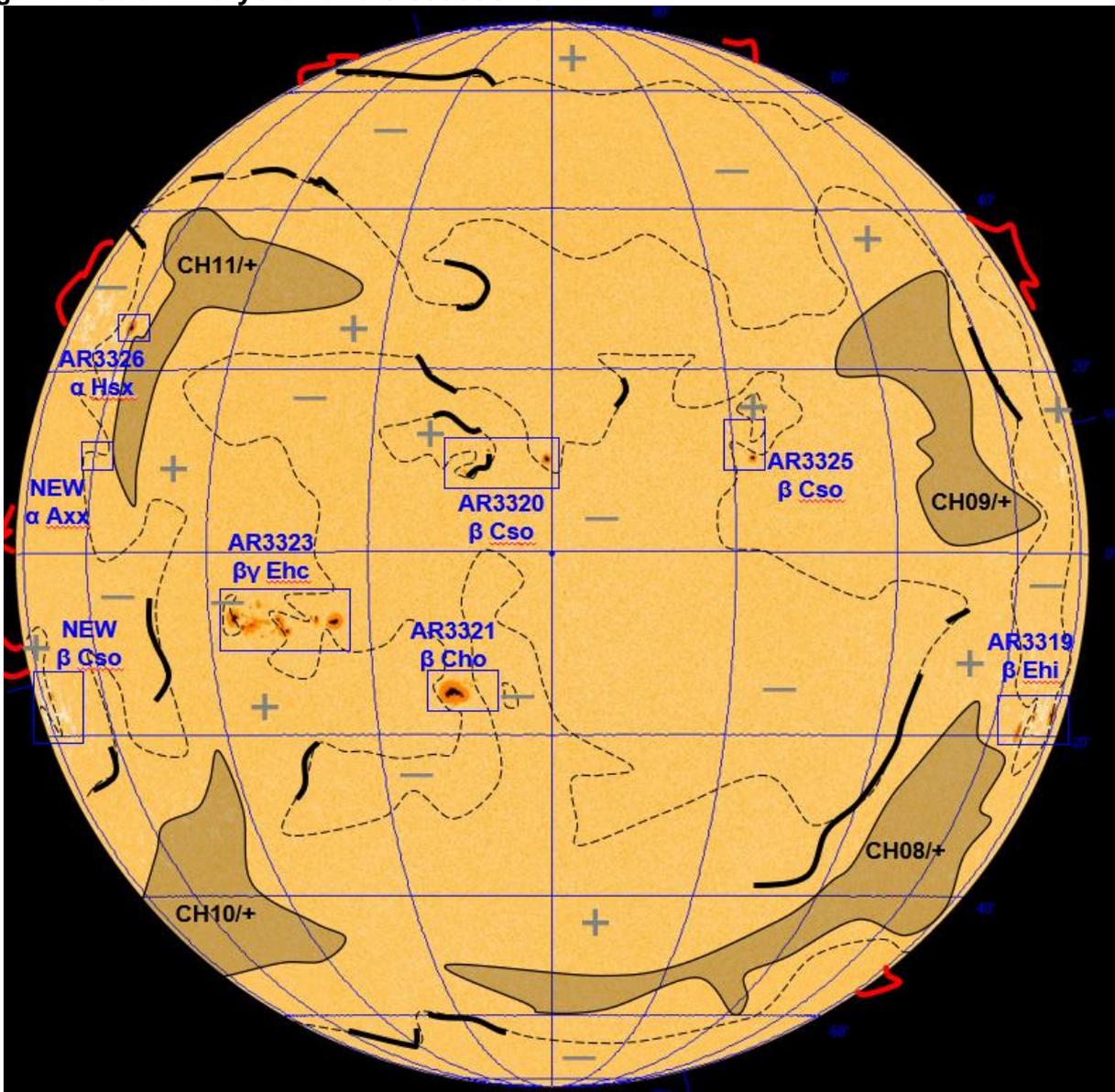
Solar Activity: Solar activity is likely to remain Low, with isolated M-class flares likely at times. However, there are only two significant regions contributing to the flare risk, one of which is set to rotate off the disc in the next two days. Further active regions are likely to rotate across the eastern limb during the same period. Based on this analysis there is a chance of Moderate activity and a low risk of High activity.

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Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs forecast, however a recent filament lift-off is yet to be analysed. Solar wind speeds are likely to remain at slow-ambient levels. High speed streams from coronal holes 08 or 09 may connect with the Earth Days 1-2 (04-05 June) to produce speeds of 450-500km/s. Geomagnetic activity is forecast to be mainly Quiet to Unsettled (Kp0-3), with a slight chance of Active (Kp4) intervals or a G1/Minor Storm (Kp5) Days 1-2.

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 chance of reaching the S1/Minor Storm threshold should any higher energy flares occur. High energy electron flux (greater than 2MeV) is expected to be at background to moderate levels in the absence of any high speed stream connections. Electron fluence is also expected to continue below the threshold.

Figure 1. Solar Analysis Valid 04/0800UTC.



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

Geomagnetic Storms:

No CMEs are currently forecast to affect the Earth through the next four days, however a recent filament lift-off around 04/0900UTC from the southwest quadrant is yet to be analysed. Given its position on the solar disc relative to Earth, an Earth-directed component is possible from this eruption.

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. L1 solar wind parameter observations suggest that high speed streams are sporadically affecting the near-earth environment without any sustained connection. Further connections are still possible through Days 1-2 (04-05 June) with speeds of 450-500km/s possible. Thereafter the risk diminishes.

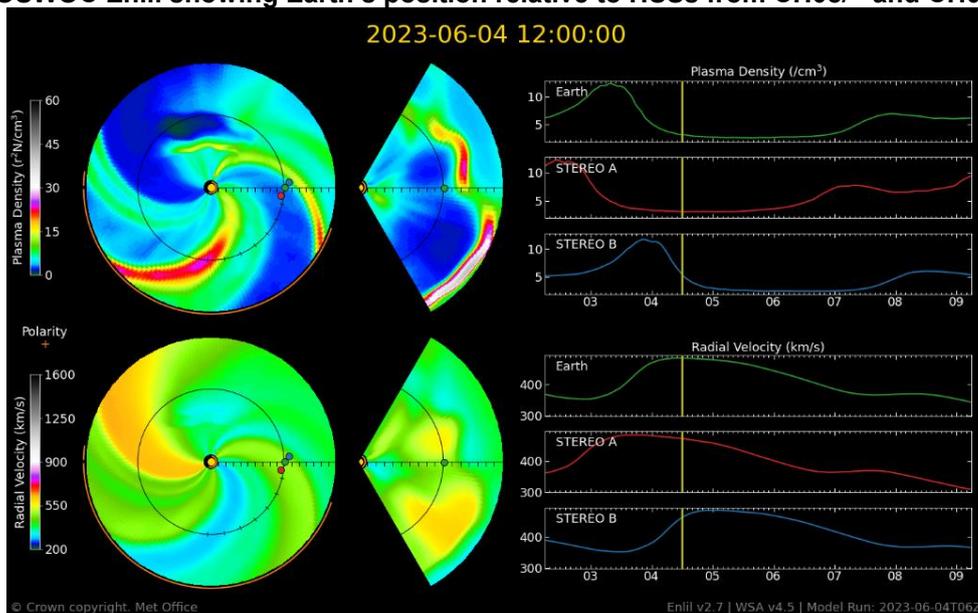
Geomagnetic activity is forecast to be mainly Quiet (Kp0-2) to Unsettled (Kp3), with a low risk of Active (Kp4) intervals or a G1/Minor Storm (Kp5) should a more sustained connections to a HSS occur.

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	10	1	1
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

Nil CMEs expected during the period. See '*Geomagnetic Storms*' section for more information

Figure 2: MOSWOC Enlil showing Earth's position relative to HSSs from CH08/+ and CH09/+



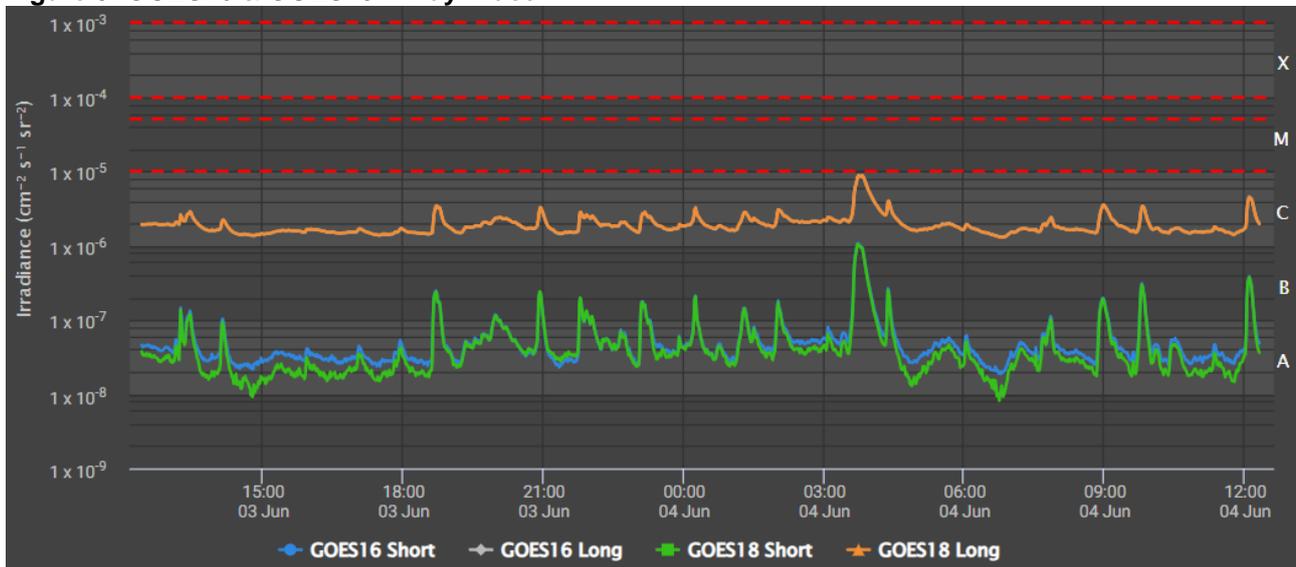
Radio Blackouts - X-Ray Flares:

There are currently eight sunspot regions on the visible disc, but only two of these contribute significantly to the overall flare risk. AR3323 in the southeast remains the most active and dominant region and produced a C8.8 flare at 04/0345UTC. AR3319 in the southwest is mature but relatively inactive and is expected to rotate across the western limb through Days 1-2 (04-05 June). The remaining regions are mostly simple or relatively inactive, only evolving slowly. As the new region in the southeast emerges further from the eastern limb, improved viewing angle will give increased confidence in analysis. Bright flux on the eastern limb and visible on STEREO-EUVI suggests that a number of active regions are due to rotate onto the visible disc through the next four days.

Overall, solar activity is forecast to be Low. However, isolated M-class flares are likely at times. There is a very slight chance of High activity.

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	60	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES16 & GOES18 X-Ray Trace



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, is at background levels and expected to remain at this level. The slight chance of S1/Minor Radiation Storms is maintained should any larger flares occur. Initial risk is slightly elevated due to the possibility of Earth-directed component of a recent filament eruption. Otherwise, the greatest contributors to the radiation storm risk during the period are AR3319 and AR3323. By Day 3 (06 June), AR3319 will have rotated sufficiently beyond the western limb to no longer pose a significant risk.

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	$\geq S1$	No	15	10	10	10
Very Active	$\geq S3$ *	No	1	1	1	1

* $S3 \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

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

High energy electron flux (greater than 2MeV) is expected to remain at mainly background to moderate levels through the period with only a low confidence of connecting with a high speed stream Days 1-2 (04-05 June). Should a connection occur, there is a slight chance of reaching the high ($1\text{e}3\text{pfu}$) threshold on diurnal peaks.

Electron fluence values are currently steady. There is a very low chance of reaching the electron fluence Active ($1\text{e}8$ integrated pfu) threshold later in the period, largely based on low confidence effects of any HSS.

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	5	10	10
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM. The overall trend is considered to be good guidance for forecast fluence

