

Space Weather Technical Forecast

Issued on Friday, 02 June 2023 at 13:10 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: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, following an impulsive M1.5 flare at 02/0241UTC from AR3324. There are seven numbered sunspot groups on the visible disc. The bulk of the regions are in the southern hemisphere. AR3318 in the northwest appears stable and weak as it rotates towards the western limb. AR3315 in the southwest has changed little in recent hours as it is about to cross the western limb. AR3319 remains magnetically complex but relatively inactive in the southwest. AR3323 appears to have some magnetic complexity, and has continued to slightly increase in complexity. The newly numbered region AR3324 continues to develop with magnetic complexity in evidence, including a reverse polarity leading spot and is positioned north-centre disc. No Earth-directed CMEs were observed on available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 have declined from slightly elevated levels at around 470 km/s to slow-ambient at 390 km/s. Density started at mostly average levels with a declining trend to below average levels. Total magnetic field strength has been weak, as has the north-south component Bz which varied weakly through the period (-7/+5nT). Phi angle has been steadfastly negative throughout. Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV) was at background to moderate levels. The associated 24 hour fluence has been below the Active threshold (1e8 integrated pfu) on a mostly steady trend. Electron fluence observed at 02/0000UTC was 3.68e6 integrated pfu.

Four-Day Space Weather Forecast Summary

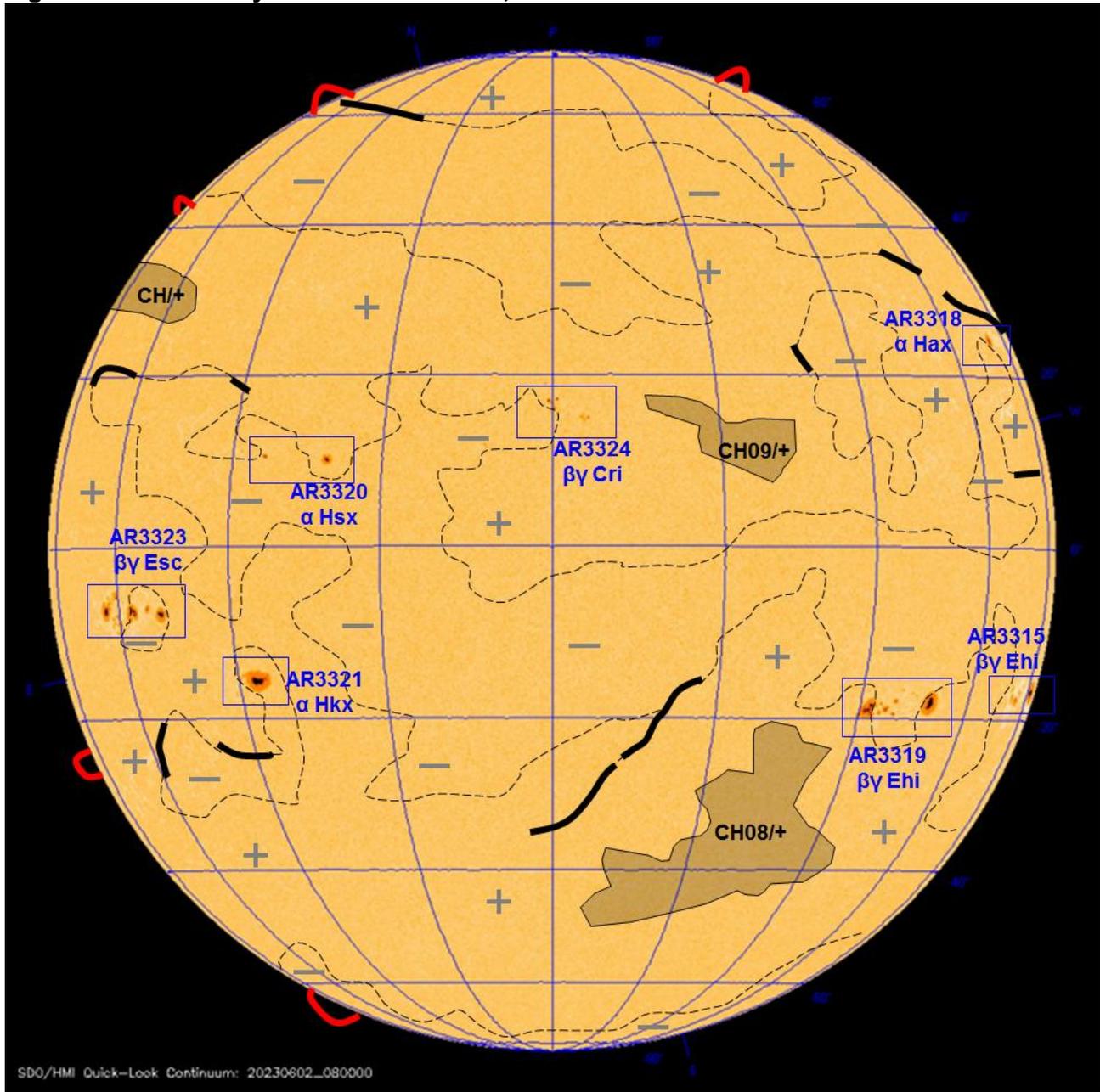
Solar Activity: Solar activity is likely to be Low with a chance of isolated M-class flares, and a slight chance of X-class flares. Significant flares are most likely to originate from AR3323 in the southeast and AR3324 near centre-disc. During the period new or returning regions are expected to rotate onto the visible disc, maintaining the risk of significant flares.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs currently feature in the forecast. Solar winds may be enhanced by a connection to a high speed stream in the next 24 hours, related to a couple of coronal holes and potentially pushing solar winds to slightly elevated to elevated levels of around 500 km/s. Solar winds then probably declining later on Day 3 (04 June). Geomagnetic activity is expected to be Quiet to Unsettled (Kp0-3), with a chance of isolated Active (Kp4) intervals. By Day 4 (5th June) predominantly Quiet geomagnetic activity are expected.

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Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, however there remains a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to remain largely below the high threshold but with an increasing chance of reaching High levels during diurnal maximums, especially later in the period. Election fluence is forecast to remain below the Active threshold (1e8 integrated flux) despite an eventually rising trend in response to increasing levels of electron flux.

Figure 1. Solar Analysis Valid 0800UTC, 02 June 2023.



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:

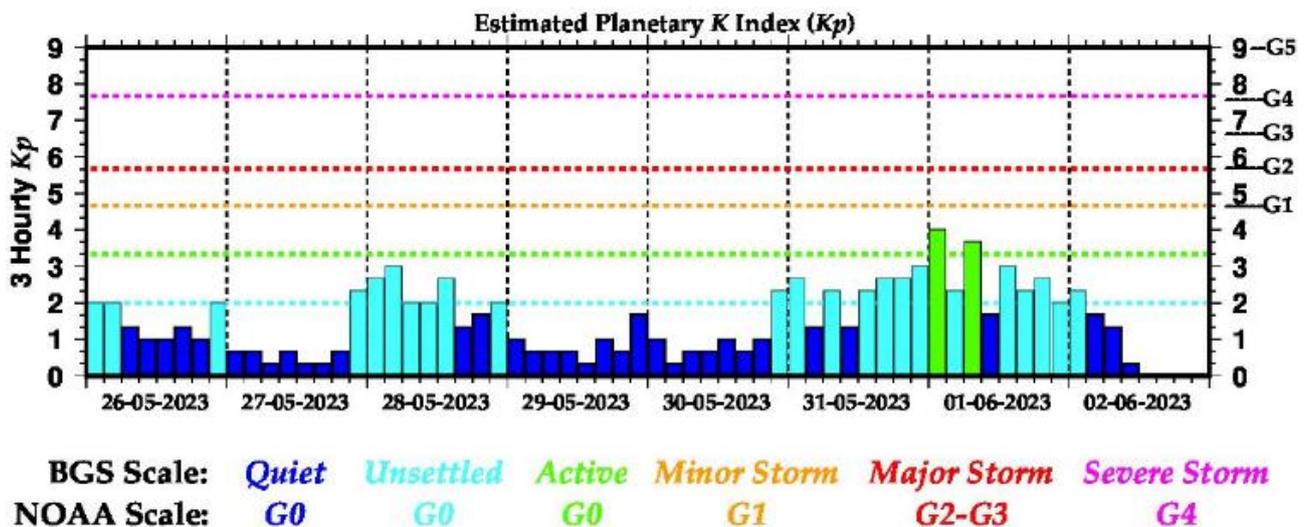
No Earth-directed CMEs are forecast through the next four days. Solar wind parameters are likely to become increasingly indicative of a connection to coronal hole 08 which is positioned in the southwest, with a modest increase in solar winds. This connection will probably continue through until at least 03 June, with a further connection to coronal hole 09 which is in the northwest. Based on persistence solar winds may reach a peak of 500-600km/s, with a steady decline then likely during 04 June. This is the current forecast as displayed by Met Office ENLIL. Geomagnetic activity is likely to be Quiet to Unsettled (Kp 0-3), with a chance of isolated Active (Kp 4) intervals in any notable periods of negative Bz. By Day 4 (5 June) predominantly Quiet (Kp 0-2) geomagnetic activity are expected.

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	10	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

Figure 2: BGS geomagnetic data over the UK showing current Quiet conditions.



Radio Blackouts - X-Ray Flares:

There are seven numbered sunspot groups on the visible disc. The bulk of the regions are in the southern hemisphere. AR3318 in the northwest appears stable and weak as it rotates towards the western limb. AR3315 in the southwest has changed little in recent hours as it is about to cross the western limb. AR3319 remains magnetically complex but relatively inactive in the southwest. AR3323 appears to have some magnetic complexity, and has continued to slightly increase in complexity. A newly numbered region continues to develop with magnetic complexity in evidence, including a reverse polarity leading spot and is positioned north-centre disc. Solar activity is Moderate following an impulsive M1.5 flare at 02/0241UTC from AR3324. Solar activity is likely to be Low with a chance of isolated M-class flares, and a slight chance of X-class flares. Significant flares are most likely to originate from AR3323 in the southeast and AR3324 near centre-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: X-ray flare flux at GEO with several C-class flares and impulsive M-class (M1.5) at 02/0241UTC.



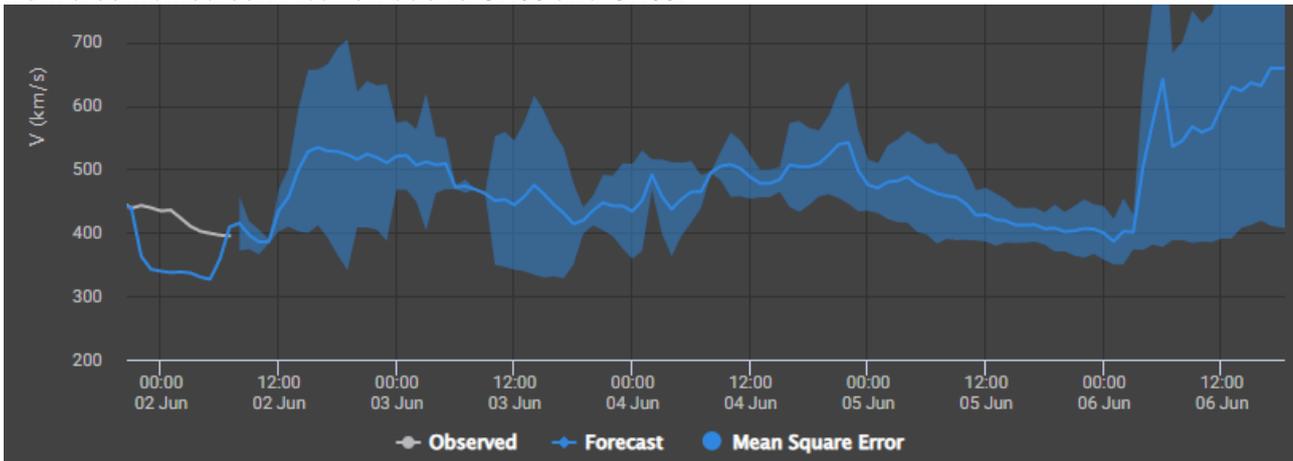
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and expected to remain so. A slight chance of S1/Minor Radiation Storms is maintained should any larger flares occur. The greatest risk currently appears to be from AR3319 located in the southwest and is becoming increasingly favourably positioned

Radiation Storms	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)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 [*]	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

Figure 4: Met Office Solar Winds Prediction Model (SWPM) showing anticipated HSS in next 24 hours from a combined contribution due to CH08 and CH09.



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

High energy electron flux (greater than 2MeV) has varied between moderate and background levels. Under the influence of anticipated high speed streams a gradual rising trend in the flux is expected, with a chance of the flux reaching high levels, at diurnal maximum, later in the period. Election fluence is forecast to remain below the Active threshold ($1\text{e}8$ integrated flux), despite an eventually rising trend in response to increasing levels of electron flux. Met Office REFM output appears to offer good and sensible guidance, and maintains the fluence below the Active threshold, although a gradually rising trend is preferred.

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	10	20	30
Very Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output over past week.

