
Space Weather Technical Forecast

Issued on Sunday, 04 June 2023 at 01:20 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/Minor-R2/Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with a peak flare of C4.1 at 04/0022UTC from AR3323 which has produced a number of low level C-class flares. This is one of nine sunspot regions on the visible disc, with AR3319 the only other notable region, but which has not evolved significantly in the last 24 hours, with limited activity. The remaining regions are all stable with limited activity observed. No Earth-directed CMEs have been observed on available imagery.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 have been at background throughout with no significant increases. Density has followed a rising trend from below average to average levels. Total magnetic field strength was mainly weak, but has recently risen relatively sharply towards moderate levels, which could be indicative of a connection to part of the high speed streams from either coronal holes 08 or 09. The north-south component varied weakly for much of the period, reaching a sharp positive peak of 8nT at around 03/2300UTC. Phi angle started positive, but moved into a negative (towards the Sun) orientation from around 03/1648UTC. Geomagnetic activity was mostly Quiet, with one Active 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) but on a slowly rising trend. Electron fluence observed at 04/000UTC was 7.48e6 integrated pfu.

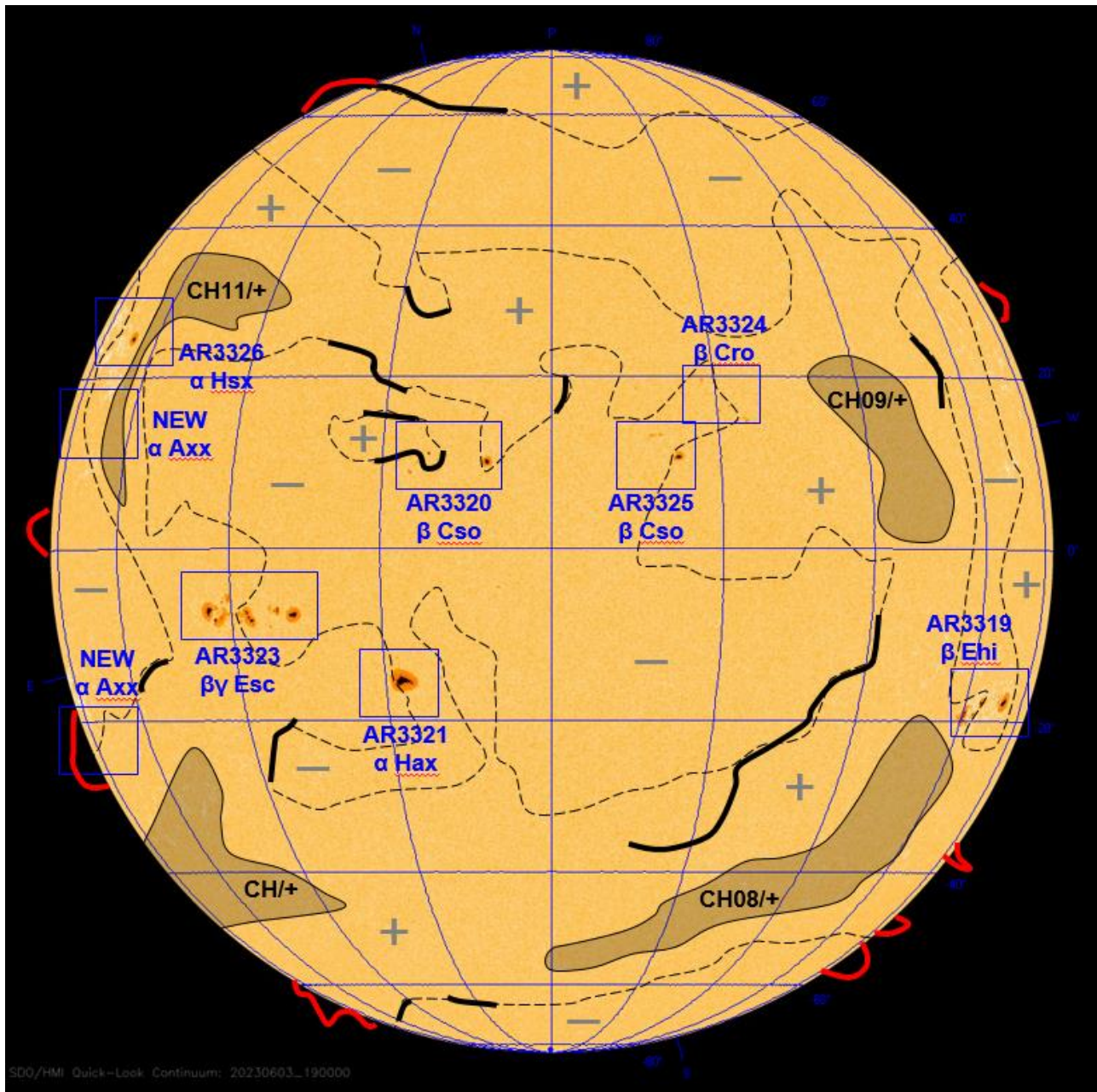
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain Low with only two high risk, but comparatively inactive regions on the visible disc. One of these regions is due to rotate off the disc in the next two days, but further active regions are likely to rotate onto 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.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs forecast. Solar wind speeds are likely to remain at background levels, with a decreasing risk of high speed streams from coronal holes 08 or 09 connecting with the Earth. If these connect they could produce speeds of around 500km/s through 04 and 05 June. No further coronal holes are forecast to connect on 06 or 07 June. Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a slight chance of Active or G1/Minor Storm intervals on 04 and 05 June.

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 03/2000UTC.



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.

Geomagnetic Storms:

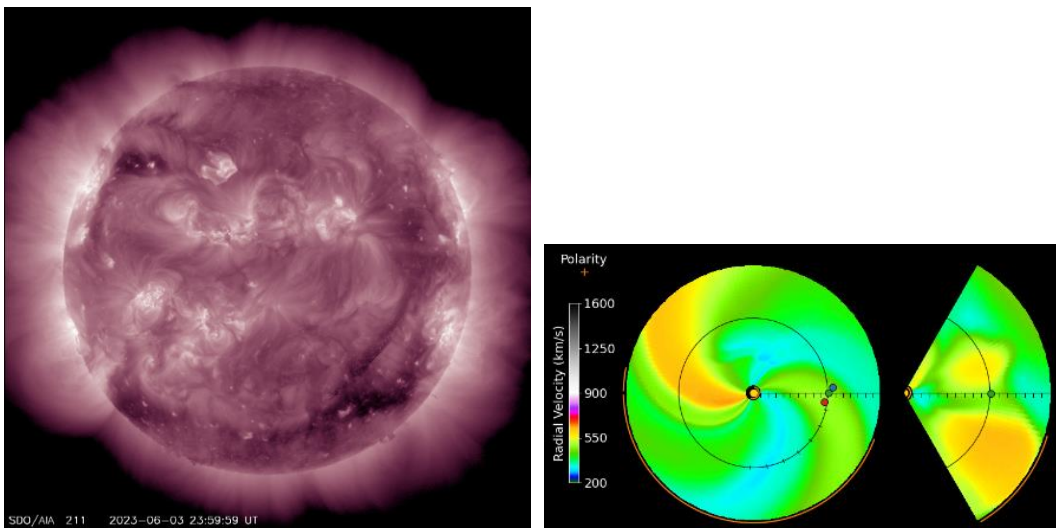
No CMEs are forecast to affect the Earth through the next four days.

Coronal holes 08 and 09 are both in potential geoeffective positions on the visible disc but after a brief onset around 01 June, solar wind speeds have declined to background. MOSWOC Enlil modelling suggests that the reason for this may be that the winds from coronal hole 08 are directed to the south of the Earth, with winds from coronal hole 09 to the north. L1 observations suggests that faster winds are sporadically affecting the near-earth environment without any sustained connection. Further connections are still possible through 04 June with speeds of 500km/s possible, but with a declining probability.

Geomagnetic activity is forecast to be mainly Quiet to unsettled, with a low risk of Active intervals of G1/Minor Storms.

| 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 |

Figure 2: SDO AIA 211 showing the position of the two dominant coronal holes in the western hemisphere. MOSWOC Enlil modelling suggests that the high speed stream from these is likely to over and undershoot the Earth. As both coronal holes are persistent features, there is higher than average confidence in this aspect of the MOSWOC Enlil forecast.



Radio Blackouts - X-Ray Flares:

There are nine sunspot regions on the visible disc, but only two of these contribute significantly to the overall flare risk. AR3319 in the southwest is mature but relatively inactive. AR3323 has been active and initially developed quickly, but has slowed in development and activity. The remaining regions are all simple or relatively inactive, only evolving slowly. Bright flux on the eastern limb 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, with a risk of Moderate activity, below the level expected from the complexity of sunspots on the visible disc. 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 | 50 | 50 | 50 | 50 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

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. The greatest risk for 04 June appears to be from either recently departed region AR3315 or from AR3319 located in the southwest. From 05 to 07 June the main region contributing to the risk being AR3319.

| 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)

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 modest solar wind speeds and only a low confidence of connecting with a high speed stream. 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 following a slight upward trend, but this is probably reflective of the diurnal variation in the electron flux, rather than the start of sustained increase. There is a very low chance of reaching the electron fluence Active ($1\text{e}8$ integrated pfu) threshold later in the period, based mainly on low confidence in any high speed stream effects.

| 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 | $\geq 2\text{MeV}$ $\geq 1\text{x}10^8$ | No | 1 | 10 | 10 | 10 |
| Very Active | $\geq 2\text{MeV}$ $\geq 1\text{x}10^9$ | No | 1 | 1 | 1 | 1 |