

Space Weather Technical Forecast

Issued on Friday, 02 June 2023 at 01:17 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: Isolated R1/R2 radio blackouts likely. Increasing chance of Active electron fluence into the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours, with numerous C-class flares, the largest of which was a C8.2 from a region which has since rotated off behind the western limb. After this most of the C-class flares originated from AR3323, which is revealing increasing magnetic complexity as it rotates further into view. AR3315 (Eko/ $\beta\gamma$) and AR3319 (Ehi/ $\beta\gamma$) in the southwestern quadrant are also magnetically complex, although AR3315 has simplified a little by decreasing in size and penumbra and apparently losing its previous delta spot. However, this is difficult to discern as the region moves closer to the western limb. Most remaining regions out of the total of 9 numbered sunspot groups, and also the yet to be numbered region near centre disc, are small and weak, fading or stable. No Earth-directed CMEs were observed on available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 started at background levels, but then increased a little to reach slightly elevated levels, predominantly in the range 440-490 km/s but with a brief peak of 507 km/s at 01/1616 UTC, indicative of a weak connection to CH08. Density was mostly at average levels, but fell to below average later in the 24 hour period. Total magnetic field strength has been mainly weak, but increased to moderate for a brief period, peaking at 9nT at 01/0531 UTC, likely due to the connection with the high speed stream. The north-south component varied weakly for much of the period, but reached a negative peak of -9nT at 01/0544UTC. Phi angle has been mainly negative throughout. Geomagnetic activity was Quiet to Unsettled (Kp 2-3), after one early Active period (Kp 4).

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 steady then later decreasing 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 generally Low with isolated M-class flares likely, and a slight chance of X-ray flares. Later in the period new or returning regions are expected to rotate onto the visible disc, maintaining the risk of significant flares as by then AR3315 will have rotated onto the far side.

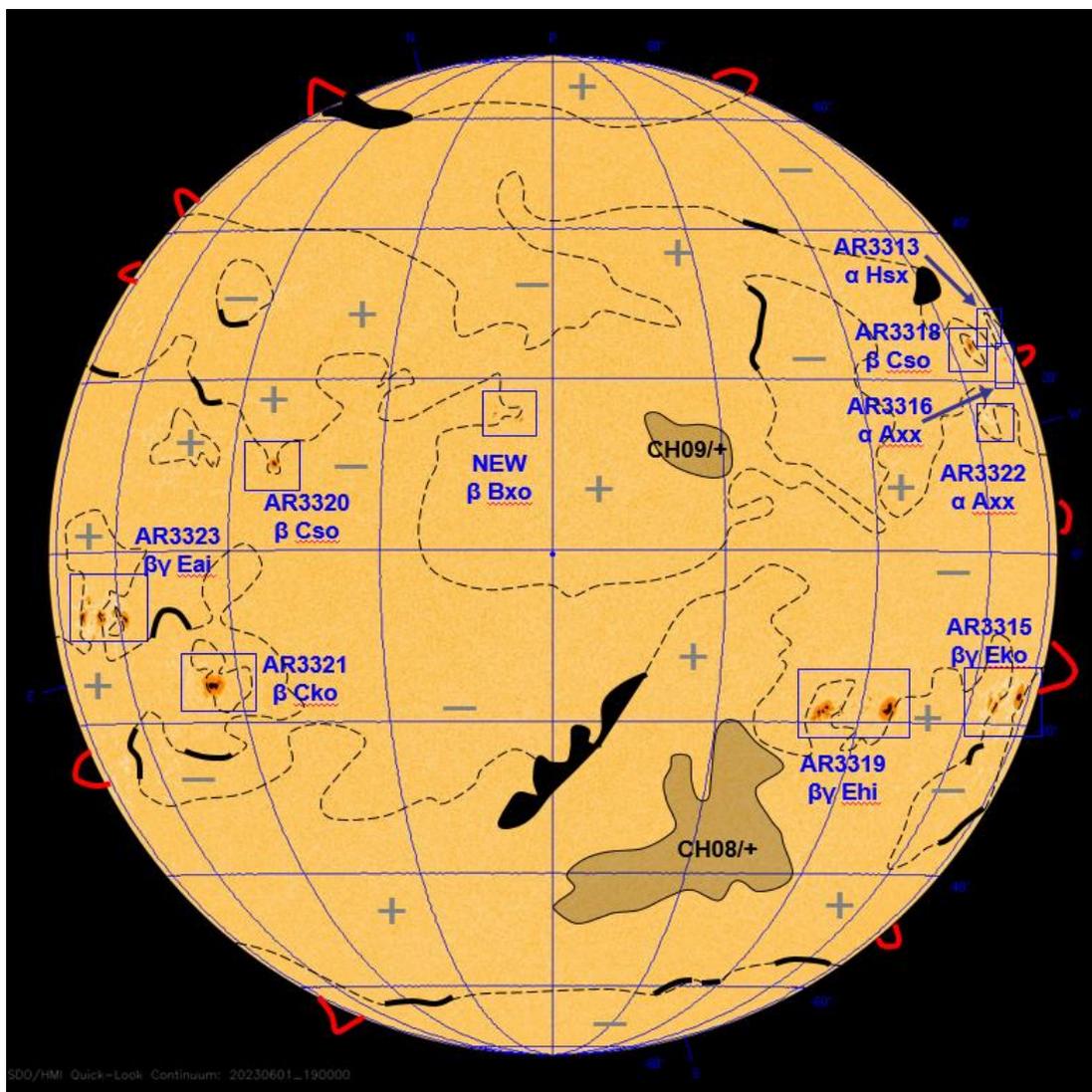
Solar Wind / Geomagnetic Activity: No Earth directed CMEs currently feature in the forecast. A weak high speed stream from coronal hole 08 is currently affecting the Earth, with a further weak connection with coronal hole 09 possibly arriving tomorrow, with both HSS potentially pushing the solar wind speeds to around 500 km/s.

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The high speed streams may then start to decline later on 04 June. Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3), with a chance of isolated Active (Kp 4) intervals and a slight chance of G1/Minor Storms i(Kp 5) in any notable periods of negative Bz. Day 4 (5th June) predominantly Quiet (Kp 0-2) geomagnetic activity is expected.

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 01/1900 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.

Geomagnetic Storms:

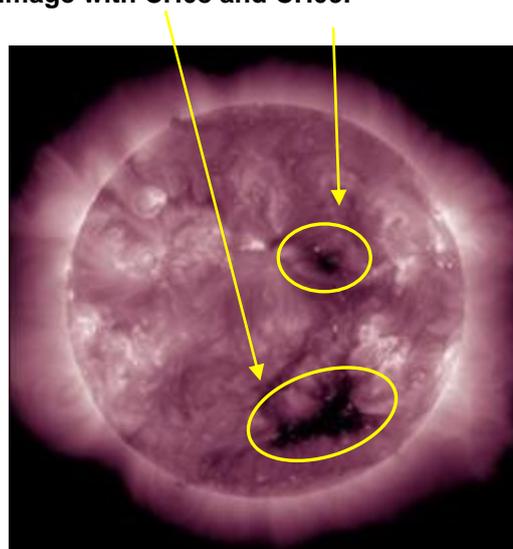
No Earth-directed CMEs are forecast through the next four days.

Solar wind parameters are indicative of a weak connection to coronal hole 08, having a modest increase in speed and a temporary slight rise in density over the past 24 hours. The magnetic field strength also demonstrated a weak slight shock. This connection is expected to continue through until at least 03 June, with a further connection to coronal hole 09 possible tomorrow. Based on persistence speeds may reach a peak of 500-600km/s, with a steady decline then likely during 04 June.

Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3), with a chance of isolated Active (Kp 4) intervals and a slight chance of G1/Minor Storms i(Kp 5) in any notable periods of negative Bz. Day 4 (5th June) predominantly Quiet (Kp 0-2) geomagnetic activity is 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

Figure 2: Latest SDO/AIA 211 image with CH08 and CH09.



Radio Blackouts - X-Ray Flares:

There are 9 numbered sunspot groups on the visible disc, as AR3317 has now faded to plage. The majority of the regions are in the western hemisphere. The spots in the northwest all appear to be stable and weak or fading as they rotate towards the western limb, with an accurate analysis is becoming increasingly difficult. AR3315 in the southwest is now too close to the western limb for visual confirmation of a delta spot, and the region has definitely reduced in size of penumbra over recent hours. Therefore the delta spot has been dropped from the current classification. AR3319 remains magnetically complex but relatively inactive. AR3323, which continues to rotate into the southeastern quadrant also continues to reveal greater complexity, although a full magnetic analysis is not yet possible, due to the effects of foreshortening. A newly developed region, currently unnumbered, remains small, weak and stable towards the north-centre disc.

Solar activity is likely to be generally Low with isolated M-class flares likely, and a slight chance of X-class flares. Over the next two days significant flares are most likely to originate from AR3323 in the southeast, although with possible contributions from AR3315 and AR3319 in the southwest quadrant, before AR3315 rotates behind the western limb. As this occurs new or returning regions are likely to rotate onto the visible disc, these potentially active regions, and therefore the chance of significant flares does not diminish over the forecast period.

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

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. AR3315 and AR3319 are most likely source regions in the near term as they continue to transit the southwestern quadrant, although later in the period AR3315 will have rotated off behind the western limb.

Radiation Storms	Level (cm ⁻²)	Past 24 Hours	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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Probability (Exceedance)	sr ⁻¹ s ⁻¹	(Yes/No)	(%)	(%)	(%)	(%)
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 (≥ 2MeV):

High energy electron flux (greater than 2MeV) has varied between moderate and background levels. Under the influence of one or two weak high speed streams a gradual rising trend in the flux is expected, with a chance of the flux reaching high levels later in the period at the peaks of the diurnal cycle.

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. Therefore the Met Office REFM model is offering good guidance, with keeping the fluence below the Active threshold, although a gradually rising trend is preferred.

GEO Electron Environment	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)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	1	10	20	30
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

Figure 3: Met Office REFM.

