
Space Weather Technical Forecast

Issued on Thursday, 01 June 2023 at 13:23 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>

Space Weather Forecast Headline: Occasional R1/R2 radio blackouts likely throughout. Increasing chance of Active electron fluence into the period. Very slight chance of isolated G1/Minor storm intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, with the only significant flare a M4.2 from AR3323 (Eai/β) on the eastern limb at 31/2252UTC. This has been the most active region on the disc, and is revealing increasing complexity as it rotates further into view. AR3315 (Eko/βγδ) and AR3319 (Eki/βγ) in the southwestern quadrant are also complex but have slowed in terms of overall development. AR3315 appears to contain a weak delta spot, although this is becoming difficult to discern as the region moves closer to the western limb. The remaining regions out of a total of 11 sunspot groups are all 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 have shown a steadily increasing trend due to the onset of the high speed stream from coronal hole 08 in the southern quadrant, with speeds increasing from 375km/s to 450km/s over the 24 hour period. Density has also increased slightly, but is still in the average range. Total magnetic field strength has been mainly weak, but increased to moderate for a brief period at 01/0530UTC, 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, with one Active interval.

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) fell from moderate to background levels due to both diurnal variation and elevated geomagnetic activity. Associated 24 hour fluence has been below the Active threshold (1e8 integrated pfu) on a steady trend. Electron fluence observed at 01/0000UTC was 1.01e7 integrated pfu.

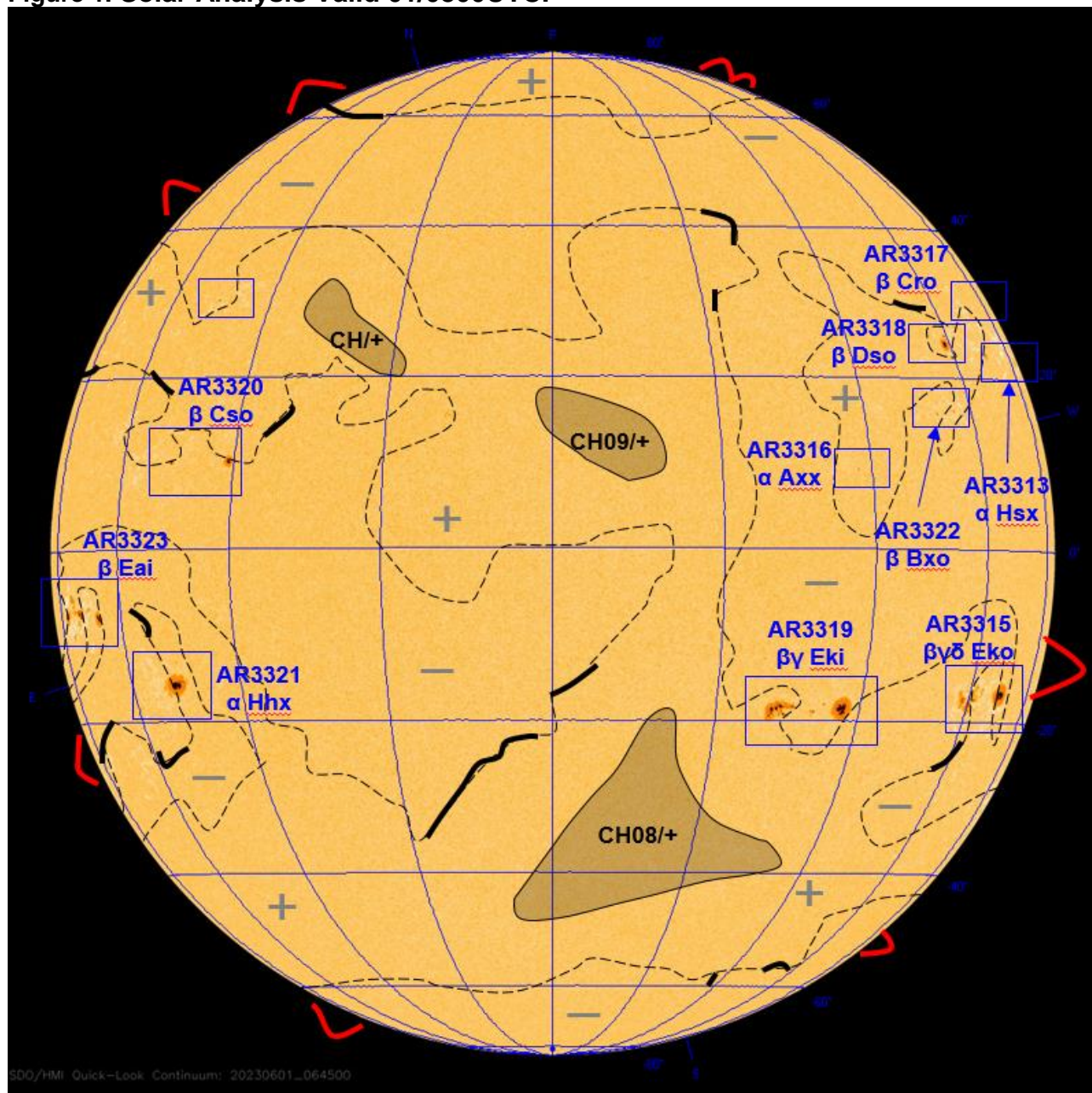
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be generally Moderate with a slight chance of High levels, due mainly to the activity from AR3323 on the eastern limb, with possible contributions from AR3315 and AR3319 in the southwest quadrant.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs currently feature in the forecast. A high speed stream from coronal hole 08 is currently affecting the Earth, with a further weak connection with coronal hole 09 possible by 02 June. Due to the relative speeds of the two coronal holes, which may reach 500-600km/s the connection to coronal hole 09 may not be observed at Earth. The high speed streams may then start to decline later on 04 June. Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a risk of Active and a very slight chance of G1/Minor storms.

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 also forecast to rise through the period in response to increasing levels of electron flux.

Figure 1. Solar Analysis Valid 01/0800UTC.



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:

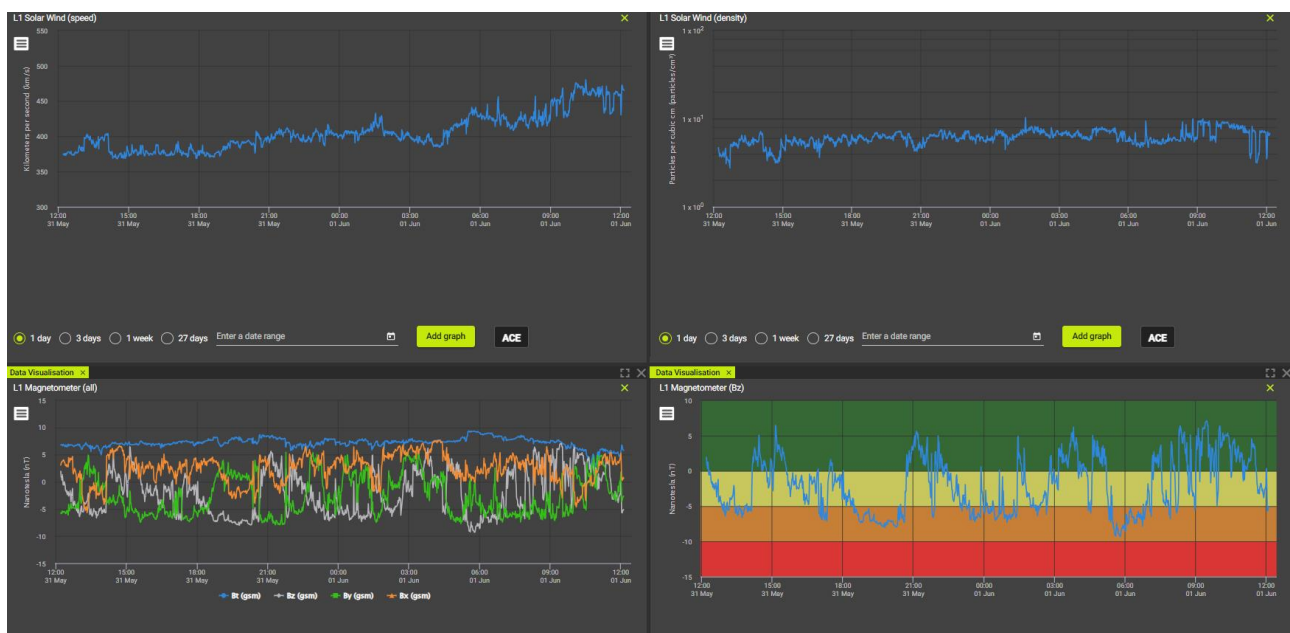
No Earth-directed CMEs are forecast through the next four days.

Solar wind parameters are indicative of a weak connection to coronal hole 08, with a modestly increasing speed and a slight rise in density. Magnetic field strength also demonstrated a slight shock. This connection is expected to continue through until at least 03 June, with a further connection to coronal hole 09 possible during 02 June. However due to the relative speeds of the high speed streams, this second connection may not be observed at Earth. Speeds may reach a peak of 500-600km/s based on persistence, with a steady decline then possible during 04 June.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, with a slight chance of Active intervals and a very slight chance of G1/Minor Storms in any notable periods of negative Bz.

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: Observations at L1. The slight shock due to the onset of the coronal hole high speed stream can be seen at around 01/0530UTC



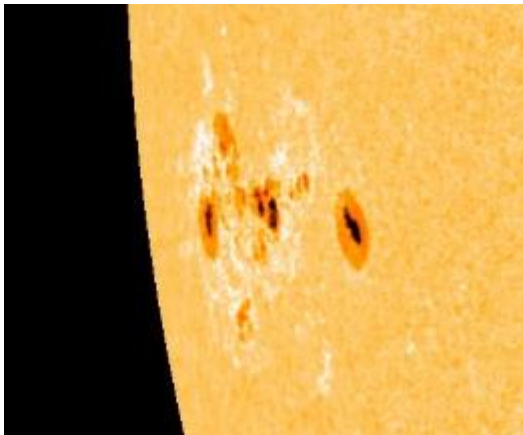
Radio Blackouts - X-Ray Flares:

There are 11 active regions on the visible disc, with AR3323 close to the eastern limb the most active region. This has only recently rotated onto the visible side of the Sun, but has a complex sunspot arrangement, and is revealing an increasingly complex magnetic structure. In addition to this, two further regions AR3315 and AR3319 have notable complexity and although relatively stable in development, carry a high risk of M-class flares. AR3315 may contain a weak delta spot, but this is becoming difficult to discern as it moves closer to the western limb. The remaining regions are either stable or weakening, but all are relatively benign, compared with the aforementioned regions.

Solar activity is likely to be Moderate with a risk of High activity, mainly from 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	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: SDO HMI intensitygram imagery of AR3323 (Eai/β) on the eastern limb. The magnetic field is not currently discernible, due to foreshortening effects.



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.

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	$\geq \text{S1}$	No	10	10	10	10
Very Active	$\geq \text{S3}$ *	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) has varied between moderate and background levels and is currently being suppressed by geomagnetic activity following a weak high speed stream onset. As the high speed stream becomes established, the electron flux is expected to oscillate and reach increasingly elevated levels on diurnal peaks. There is therefore a risk of exceeding the high threshold by the end of the period.

Electron fluence values are forecast to rise through the period, with an increasing risk of reaching the Active (1e8 integrated pfu) threshold by the end of the period.

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	40	60
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1