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## Space Weather Technical Forecast

Issued on Thursday, 01 June 2023 at 01:18 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>**

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**Space Weather Forecast Headline: Occasional R1/R2 radio blackouts likely throughout. Increasing chance of Active electron fluence into the period. 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 three M-class flares observed. The largest a M4.2 from AR3323 on the south-eastern limb at 31/2252UTC, and this region was also the source of the proceeding smaller M-class flares. There are currently 10 numbered and 1 un-numbered active region on the visible disk. AR3315 remains a notable region, and retains a weak delta spot on the trailing portion. AR3319 also remains a complex region in the southwest disc with continued development in its central portion, now classified as Eki/Beta-Gamma. AR3323 continues to emerge around the eastern limb, displaying increased complexity and provisionally reclassified as Dso/Beta-Gamma though this may change as it continues to come into clearer view. The remaining regions are all weak, fading or stable. No Earth-directed CMEs were observed on available imagery during the period.

**Solar Wind / Geomagnetic Activity:** Solar winds observed at L1 have been at generally Slow-Ambient levels, below 400km/s with density average to below average. Total interplanetary magnetic field strength has been weak around 7nT, with the north-south component varying weakly between +7nT and -7nT. Phi angle was predominantly negative (towards the Sun), occasionally positive during the second half of the period. Geomagnetic activity was Quiet to Unsettled (2-3Kp).

**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 at GOES-16) has been diurnally varying between background and moderate levels. The associated 24 hour fluence has been below the Active threshold (1e8 integrated pfu), with 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 AR3315 and AR3319 in the southwest quadrant and a newly numbered, but increasingly active, region AR3323 on the southeast limb.

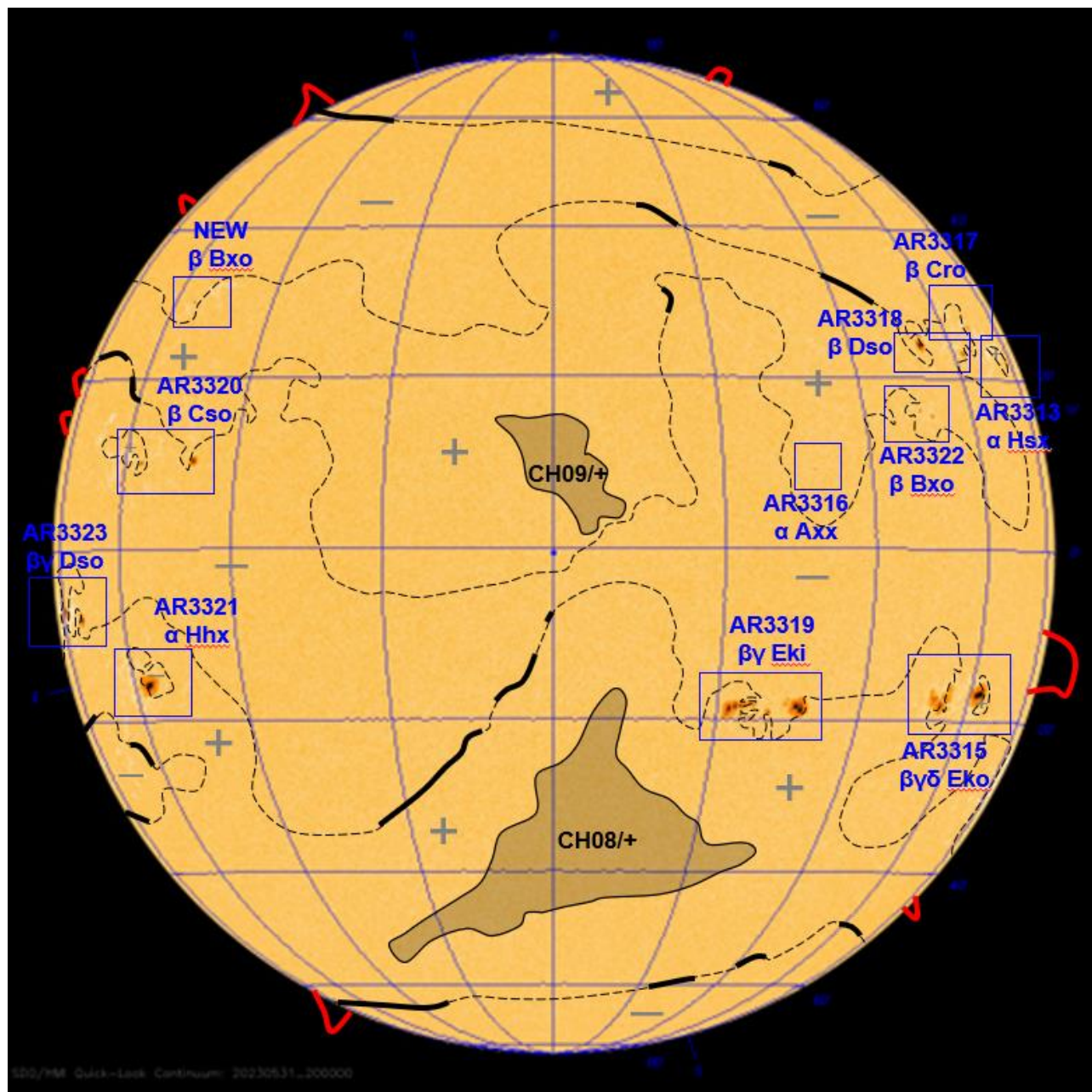
**Solar Wind / Geomagnetic Activity:** No Earth directed CMEs currently feature in the forecast. A high speed stream from coronal holes CH/08+ or CH/09+, or a combination of both, is forecast to connect with Earth either late on Day 1 (1 Jun) or more likely on Day 2 (2 Jun), giving estimated solar winds of 500-600km/s. Geomagnetic activity is expected to be mainly Quiet to Unsettled. Active intervals likely with a slight chance of G1/Minor Storm intervals due to the likely connection with coronal holes CH/08+ and CH/09+ and any associated CIR.

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is

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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 31/2000 UTC.



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

**Geomagnetic Storms:**

No Earth directed CMEs currently feature in the forecast.

Solar winds at Slow-Ambient to Slightly elevated levels expected to continue to start the period. A high speed stream from coronal holes CH/08+ or CH/09+, or a likely combination of the two are forecast to increasingly connect with the Earth from late on Day 1 (1 Jun) into Day 2 (2 Jun), bringing estimated solar wind speed of 500-600km/s, perhaps preceded by a CIR feature. Both these hole are recurrent features with similar sizes and extents to the previous rotation. Recent STEREO data also lends support to this forecast, though the bulk of stronger winds associated with the leading CH/08+ are expected to pass below the Earths orbit in ENLIL output. Coronal hole influence expected to wane into Day 4 (4 Jun).

Geomagnetic activity is expected to be mainly Quiet to Unsettled. Active intervals likely with a slight chance of G1/Minor Storm intervals due to the likely connection with coronal holes CH/08+ and CH/09+ and any associated CIR.

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	20	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

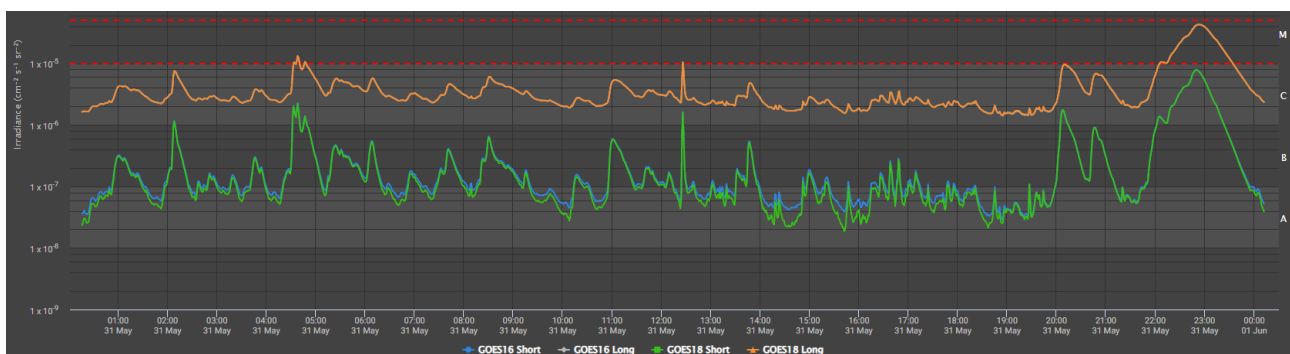
## Radio Blackouts - X-Ray Flares:

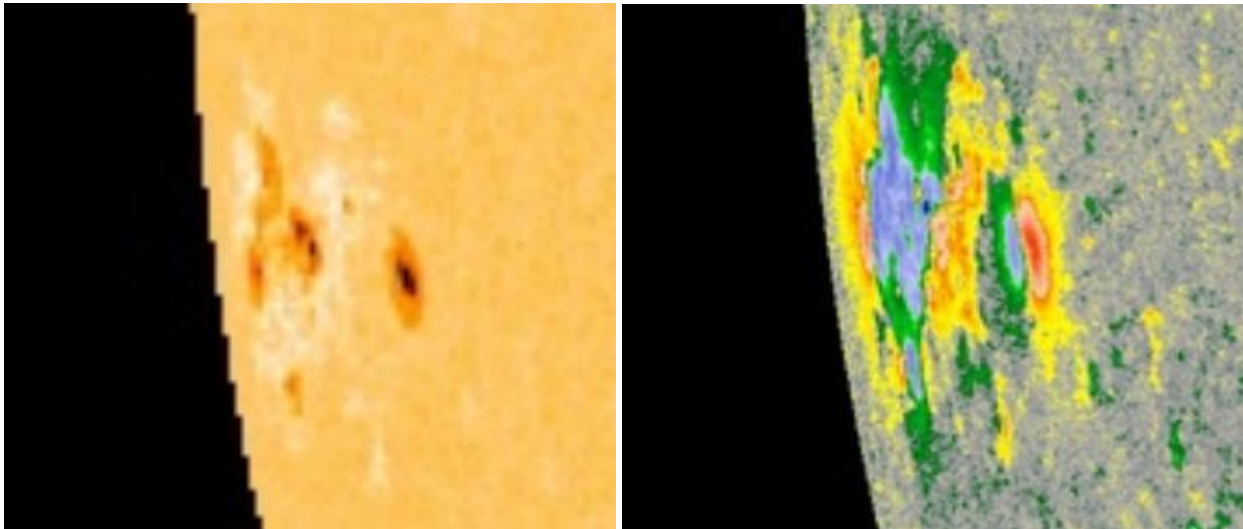
Although there are 10 numbered and 1 un-numbered sunspot regions currently on the visible disc. Three are currently considered to carry a significant flare risk. AR3315 in the southwest quadrant has declined slightly, but still contains a weak central delta spot. This was responsible for an M-class flare during 30 May, but has not produced significant activity since. AR3319 also remains a complex region in the southwest disc with continued development in its central portion. Newly numbered region AR3323 is producing a high level of flux, as observed on SDO imagery and is expected to reveal greater complexity as it rotates more fully onto the visible disc, having produced recent M-class flares.

Solar activity is expected to be mainly Moderate with occasional M-Class flares likely and a slight chance of X-Class flares giving High activity. This due mainly to the three regions mentioned above, though AR3315 will pass beyond the limb into the period persistence and sounding data suggest a number of active regions forecast to rotate across the eastern limb from the farside helping to maintain risk.

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 2: Latest 24hr GOES18 X-Ray trace, with Intensitygram and Colorized Magnetogram images showing AR3323 on the western limb.**







**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 the most likely source regions in the near term as they continue to transit the southwestern hemisphere.

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

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

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

High energy electron flux (greater than  $2\text{MeV}$ ) has varied between moderate and background levels, as the bulk of the recent electron accumulations in the radiation belts are modelled to be at a sub-GEO orbit. Initially on Day 1 (1 Jun) background to moderate levels are expected in the absence of any significant modifying factors. The likely onset high speed streams associated with coronal holes CH08/+ and CH09/+ from late on Day 1 or into Day 2 (1/2 Jun) may lead to an increasing risk of exceeding the high ( $1\text{e}3\text{pfu}$ ) threshold on diurnal peaks, with a rising trend expected into Days 3 and 4 (3/4 June).

Associated 24 hour fluence values are likely to show an increasing trend through the period, especially following the onset of the forecast high speed streams into Days 3 and 4 (3/4 Jun). Active ( $1\text{e}8$  integrated pfu) thresholds are increasingly likely to be exceeded by the end of the period. REFM model not currently viewed as providing good guidance.

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	10	20	40	60
Very Active	$\geq 2\text{MeV}$ $\geq 1\text{x}10^9$	No	1	1	1	1