
Space Weather Technical Forecast

Issued on Friday, 09 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). Slight chance of G1/Minor Geomagnetic Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Despite nine numbered sunspots on the visible disc solar activity has been Low over the past 24 hours, with the largest flare a C7 at 08/0459 UTC from AR3327. This region remains the most magnetically complex region on the disc, and one of the largest, currently classified as Eac/beta-gamma-delta. All remaining regions are magnetically simpler, and most smaller, with all regions showing little or no change through the period. No CME's that are likely to be Earth directed have been observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by ACE and DSCOVR at L1, started the period under the residual influence of a possible weak CME, which was observed around 07/2230UTC. This may have been the shock from the awaited glance from the 04 June CME. The solar wind speed peaked at 375km/s early in the period, then gradually declined to end the period around 330 km/s. The solar wind density started at average levels and then gradually decreased to below average levels. The IMF was predominantly at weak levels, only briefly reaching Moderate levels of 9 nT early in the period. The north-south component was weak throughout, and initially fluctuating between +6 and -5nT, with a gradual drift to a steady and largely positive position during the second half of the day. The phi angle was positive (away from the Sun) throughout. The resulting geomagnetic activity was Quiet (Kp 1-2).

Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, has remained at Background levels.

High energy electron flux (greater than 2MeV), as observed by GOES16 has been at Background to Moderate levels. The associated 24-hour fluence has remained well below the Active threshold (1e8 integrated pfu) on a very generally rising trend, with 1.73e6 integrated pfu observed at 09/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of Moderate solar activity. Any significant flares are most likely to originate from AR3327. The risk of flares remains steady throughout as no major new or returning regions are expected to arrive, or depart from, the visible disc.

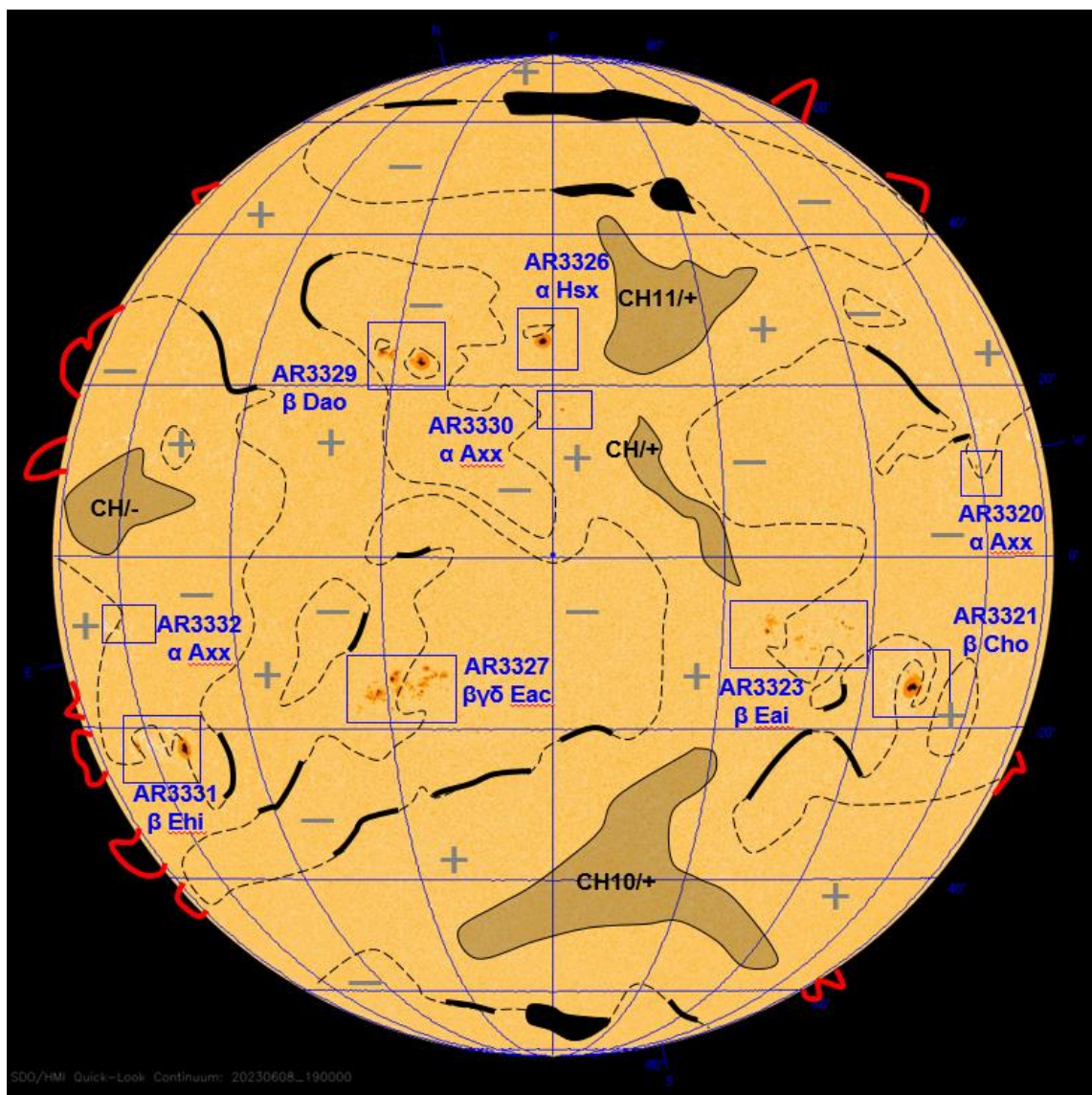
Solar Wind / Geomagnetic Activity: No Earth directed CME's are expected to arrive. Any increase in the current Quiet conditions of geomagnetic activity will be from coronal hole sources. Slight enhancements in the solar winds, from up to three positive coronal holes, are likely to arrive from late tomorrow (10th) onwards, with the solar winds becoming slightly elevated or elevated.

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Geomagnetic activity is expected to remain predominantly Quiet (Kp 0-2) until late tomorrow (10th). Geomagnetic activity is then expected to increase to become occasionally Unsettled (Kp 3) with isolated Active (Kp 4) intervals likely, these especially late tomorrow and through day 3.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, however there is a very slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to be Background to Moderate levels, but may rise late in the forecast period to become Moderate to High due to coronal hole high speed stream effects. Electron fluence is expected to persist below the Active (1e8 integrated pfu) threshold, but with an eventually increasing trend.

Figure 1. Solar Analysis Valid 08/1900 UTC.



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 CME's are expected to arrive, despite numerous weak CME's being visible in imagery. These all appear to be far sided in origin. Therefore any increase in the current Quiet conditions of geomagnetic activity will be as a result of coronal hole influence. There are currently up to three positive coronal holes in the western hemisphere if the sun, with CH10 and CH11 the largest. Slight enhancements in the solar winds are likely to arrive from late tomorrow (10th) onwards, with the solar winds becoming slightly elevated or elevated. During the previous rotation of the coronal holes mostly slightly elevated solar wind speeds were observed, but currently the coronal holes appear slightly larger and more defined. Therefore elevated wind speeds are possible during this forecast period, although geomagnetic impact will be muted by the close proximity of the summer solstice.

Geomagnetic activity is expected to remain predominantly Quiet (Kp 0-2) until late tomorrow (10th). Geomagnetic activity is then expected to increase to become occasionally Unsettled (Kp 3) with isolated Active (Kp 4) intervals likely, these especially from late tomorrow and through day 3 (11th).

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	5	20	20	10
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 images from previous rotation (left) and recently (right) showing coronal hole features.

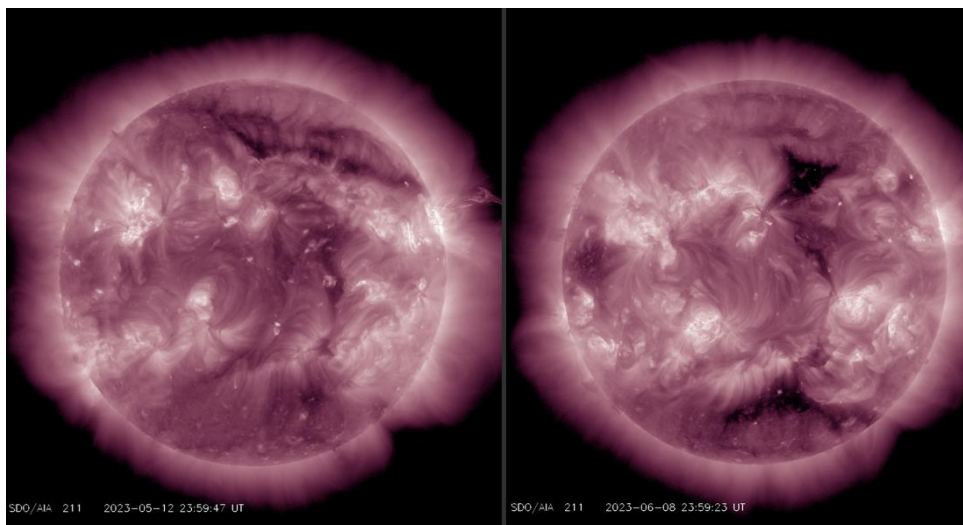
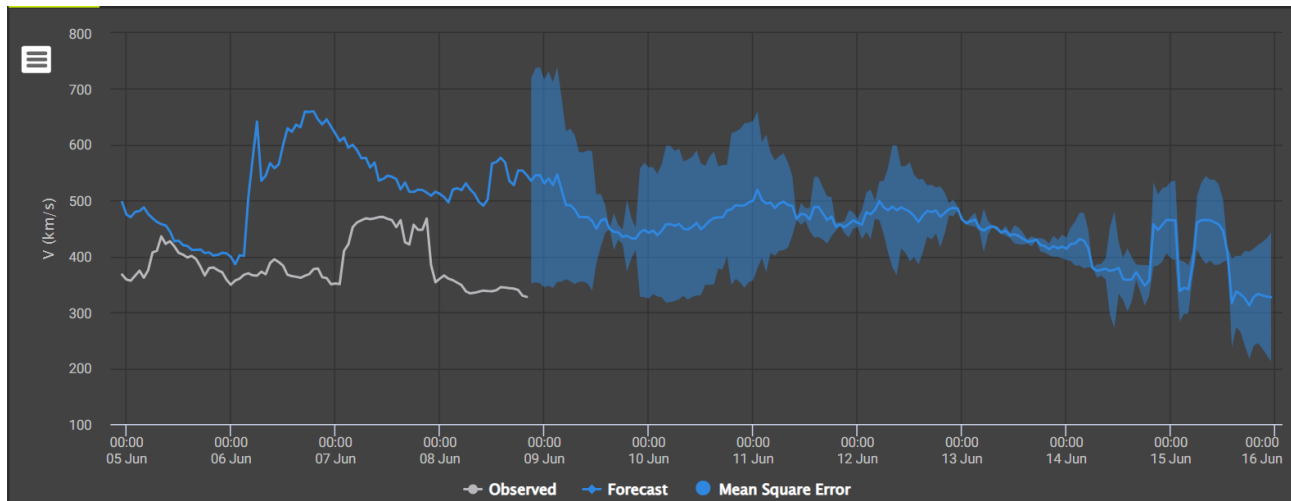


Figure 3: Met Office persistence model. The solar wind is expected to increase to similar or slightly stronger speeds on this rotation, becoming elevated at times, due to the slightly larger and more defined coronal hole features currently in the western hemisphere of the Sun.



Radio Blackouts - X-Ray Flares:

There are currently nine numbered sunspot groups on the disc, including recently numbered AR3332. No changes or only slight changes occurred during the period for all groups, with AR3329 losing its intermediate spots and is now a Dao/beta and AR3330 simplifying to an Axx/alpha. AR3327 remains the most magnetically complex group and one of the largest, with a small Mt Wilson delta spot in its trailing portion.

Despite the presence of nine regions, and one magnetically complex region, the solar activity has been Low over the past 24 hours. The largest flare of the period was a C7 at 08/0459 UTC from AR3327. Low to Moderate activity is expected to continue, with a slight chance of isolated X-class flares, these most likely from AR3327. The risk of flares remains steady throughout as no major new or returning regions are expected to arrive, or depart from, the visible 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	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

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The high energy (greater than 10MeV) proton flux is at Background levels, where it is expected to remain. There is a very slight chance of S1/Minor Radiation Storms should any larger flares occur, with the most likely culprit being the moderately large and complex region AR3327, which will be moving across the central portion of the disc over the coming days.

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	5	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) is expected to be Background to Moderate levels, but may rise late in the forecast period to become Moderate to High due to coronal hole high speed stream effects. Electron fluence is expected to persist below the Active ($1\text{e}8$ integrated pfu) threshold, but with an eventually increasing trend due to high speed stream influence from various coronal hole features.

The latest MOSWOC REFM appears to be giving good guidance, keeping the fluence well below the Active threshold over the next three days, although a slightly increasing trend for day 3 would be 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	1	10	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: Met Office REFM model.

