

Space Weather Technical Forecast

Issued on Saturday, 10 June 2023 at 01:13 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 (Minor-Moderate radio blackouts). Slight chance of G1/Minor Geomagnetic Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours. The largest event was a M2.5 flare at 09/1711UTC originating from AR3331 located in the southeast quadrant. This produced a CME, which is currently under analysis for any potential Earth-directed component. There are currently eight sunspot regions on the visible disc, with AR3327 in the southeast the most complex region, although has shown very little activity, only minor C-class flares. The only other region of note is AR3323 in the southwest quadrant which has weakened markedly over the last 24 hours. The remaining regions are all relatively stable and inactive. No CMEs that are likely to be Earth-directed have been observed on available coronagraph imagery.

Solar Wind / Geomagnetic Activity: Solar wind at L1, has been at ambient levels, between 280-320km/s. Density has been below average. Total magnetic field strength has been weak, with the north-south component has been near neutral throughout, but became weakly negative towards the end of the period. Phi angle was predominately positive (away from the Sun), with some orientation to negative (towards the Sun) by end of period - probably due to a solar sector boundary crossing (SSBC). Geomagnetic activity was Quiet (Kp1-2) throughout.

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 mainly background levels. The associated 24-hour fluence has remained well below the Active threshold (1e8 integrated pfu) on a steadily rising trend, with 2.66e6 integrated pfu observed at 10/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Mainly Low to Moderate solar activity is forecast, with no significantly active regions on the solar disc. A potentially stronger region is due to rotate onto the disc during the next two days, although this is low confidence. Some evidence in latest imagery of plage emerging on the southeast limb. This will continue to be monitored for any sunspot development.

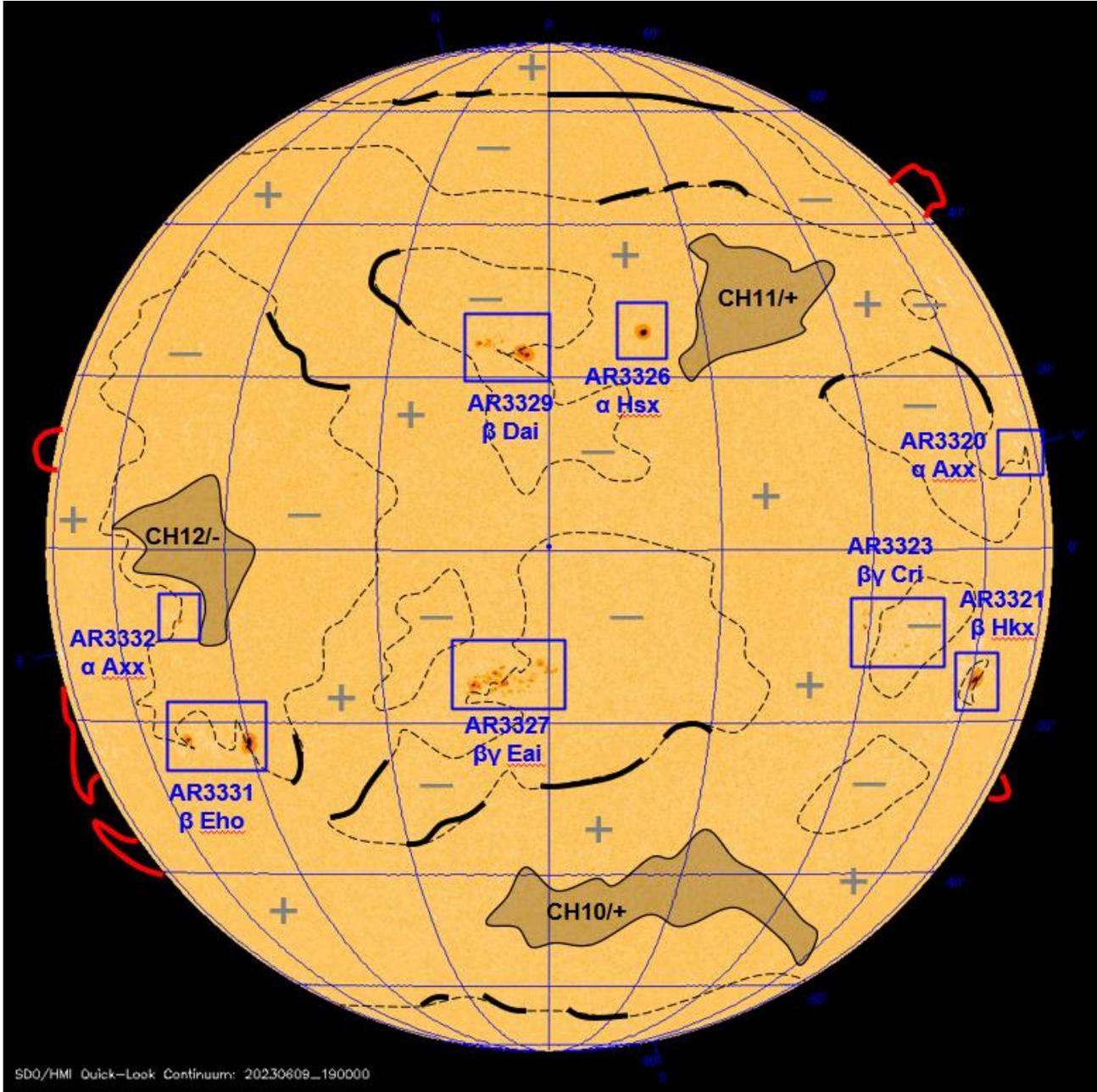
Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are expected to affect the Earth, with a low risk of a glancing blow on 11 or 12 June. Coronal hole high speed streams from either CH10 or 11, may affect the Earth from 10-11 June, possibly giving speeds of 500km/s but with low confidence. Geomagnetic activity is forecast to be mainly Quiet throughout, with a slight chance (10%) of Active or G1/Minor Storms on 10-12 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 very slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 10 MeV) is expected to remain at background levels. The associated 24-hour fluence has remained well below the Active threshold (1e8 integrated pfu) on a steadily rising trend, with 2.66e6 integrated pfu observed at 10/0001UTC.

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2MeV) is expected to be background to Moderate levels, but may increasingly exceed the high threshold on diurnal peaks later in the period. Electron fluence is expected to persist below the Active ($1e8$ integrated pfu) threshold, but with an eventually increasing trend.

Figure 1. Solar Analysis Valid 09/1900UTC.



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 expected in the forecast period, although Enlil is indicating a very slight risk a CME from an eruption in the southeast on 07 June, glancing the Earth on 11 or 12 June. Low confidence.

Coronal holes 10 and 11 are otherwise forecast to connect with Earth either on 10 or 11 June as they move into geoeffective locations north and south of the solar equator, with a further coronal hole apparently developing between the two of these in west centre disc. Enlil is modelling the high speed streams from these features as missing the Earth, despite them appearing to be stronger and more distinct than previous rotations, when speeds of around 500km/s were observed. If the coronal holes connect then similar speeds are possible on this occasion, although this is an estimate as no high speed streams have been observed connecting with STEREO A.

Mainly Quiet conditions are forecast through the period, with a slight chance of Active or G1/Minor Storms due to the connection to the high speed streams, glancing CME or a low confidence combination of both.

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)
			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	10	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil forecasts shows a possible glancing blow from a CME (which left the Sun on the 7th) on either the 11-12th June, with combination of fast wind from CH influence – low confidence.

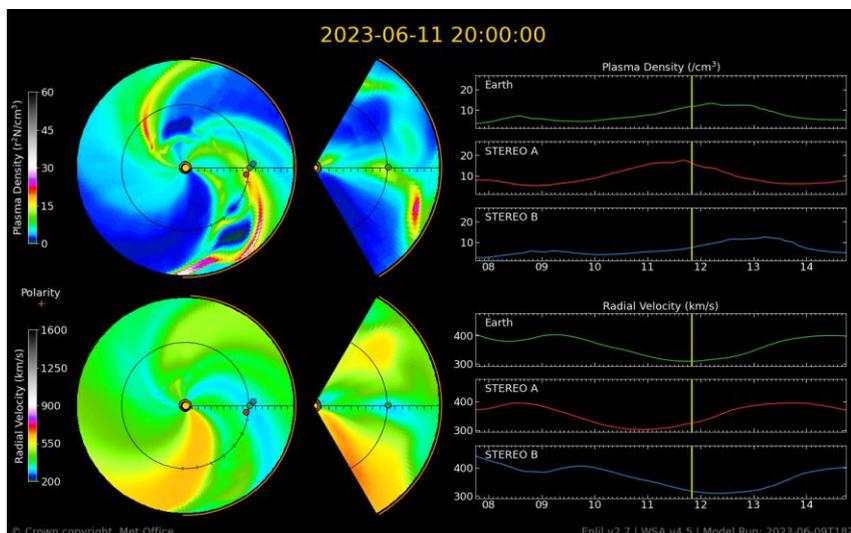
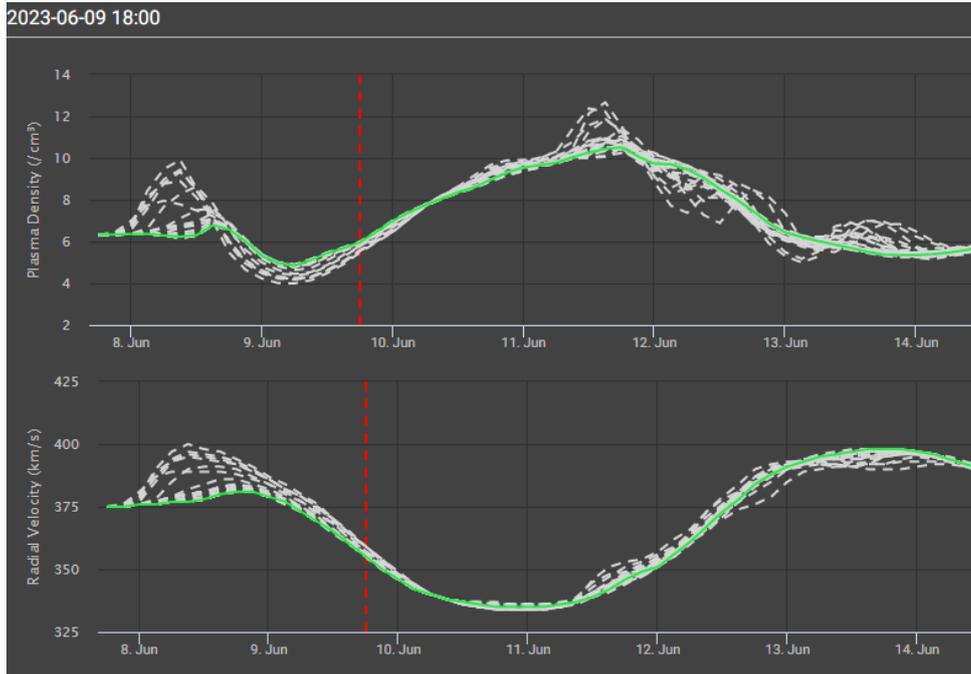


Figure 3: MOSWOC Enlil ensemble model shows limited number of ‘members’ suggesting a possible glance from a CME on 11-12 June.

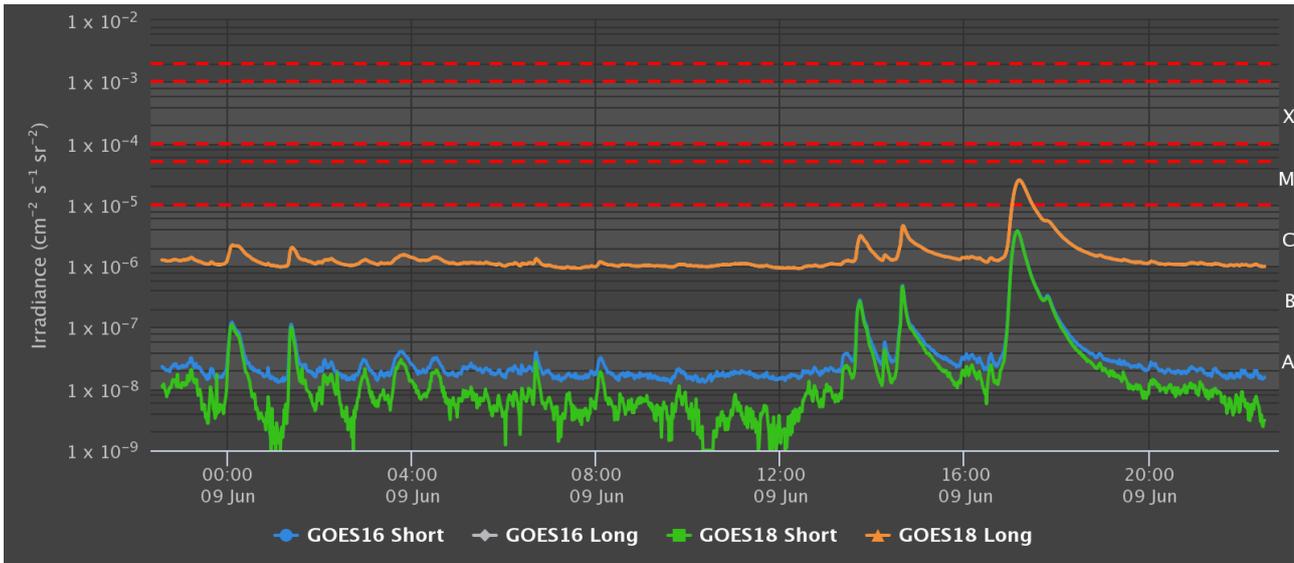


Radio Blackouts - X-Ray Flares:

There are currently eight sunspot groups on the visible disc. AR3331 has surprisingly been the most active region in the past 24 hours, producing a M2.5 flare at 09/1711 UTC. This also produced a resultant CME, which is yet to be analysed for any potential Earth-directed components - awaiting further imagery. Otherwise, AR3327 has been the most complex on the disc, although has shown signs of weakening, after losing its delta spot. This spot has only produced minor C-class flares in the past 24 hours. AR3323 in the southwest quadrant has weakened significantly, with only one prominent penumbra visible. Helioseismology is forecasting a strong region to rotate onto the southeast limb during 10 June, which may just be showing signs of emerging on the southeast limb as a plage area. Mainly Low to Moderate solar activity is forecast, with a slight chance of Strong flaring.

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	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: GOES X-Ray flares – shows the recent M2.5 flare from AR3331 in the SE quadrant



Solar Radiation Storms - (High Energy Protons):

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 source 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 (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 (≥ 2MeV):

High energy flux (greater than 2MeV) is expected to be at mainly background levels through the period, with lower than normal confidence in any high speed stream connection from coronal holes 10 or 11 June. Presuming that the high speed streams connect with Earth, flux levels are likely to increase to moderate to high (1e3 pfu) levels, with the high threshold being increasingly exceeded on diurnal peaks.

Electron fluence is not expected to exceed the Active (1e8 integrated pfu) threshold with any high speed stream expected to be relatively muted. The MOSWOC REFM model is not providing good guidance in this respect, with the British Antarctic Survey Radiation Belt Model (BAS-RBM) suggesting that the greatest populations of electrons will be below GEO.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹)	Past 24 Hours	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

Probability (Exceedance)	day ⁻¹	(Yes/No)	(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	5	10	10
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: REFM electron fluence – observations and forecast

