

Space Weather Technical Forecast

Issued on Saturday, 03 June 2023 at 13:26 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) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with a peak C6.3 flare at 02/2242UTC observed from AR3315 which has since rotated across the western limb. There are currently nine sunspot regions on the visible disc. AR3323 is the largest region, and although magnetically complex has remained relatively inactive. Mature region AR3319 in the southwest has also shown limited activity. AR3325 in the northeast quadrant of the disc has evolved quickly and based on current trends may become a significant region. The remaining regions appear relatively small, simple or stable. No Earth-directed CMEs have been observed on available imagery. However, several recent small CMEs and a filament lift-off from the southeastern quadrant around 03/1000UTC are yet to be analysed.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 have remained at ambient levels throughout, around 330-370 km/s. Earth does not appear to have connected to either of the high speed streams from CH08/+ or CH/09+. Density has mostly below average. Total magnetic field strength was weak at or below 6nT, with the north-south component varying weakly through the period. Phi angle was negative (towards the Sun) until 03/0105UTC, at which point it became predominantly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2) throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) has remained at background levels. 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) but on a slowly rising trend. Electron fluence observed at 03/0000UTC was 4.11e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain Low to Moderate through the period, with the greatest risk of M-class flares from the two largest regions, one in the southeast and one in the southwest of the disc. There is a low risk of High activity being reached, especially from AR3323.

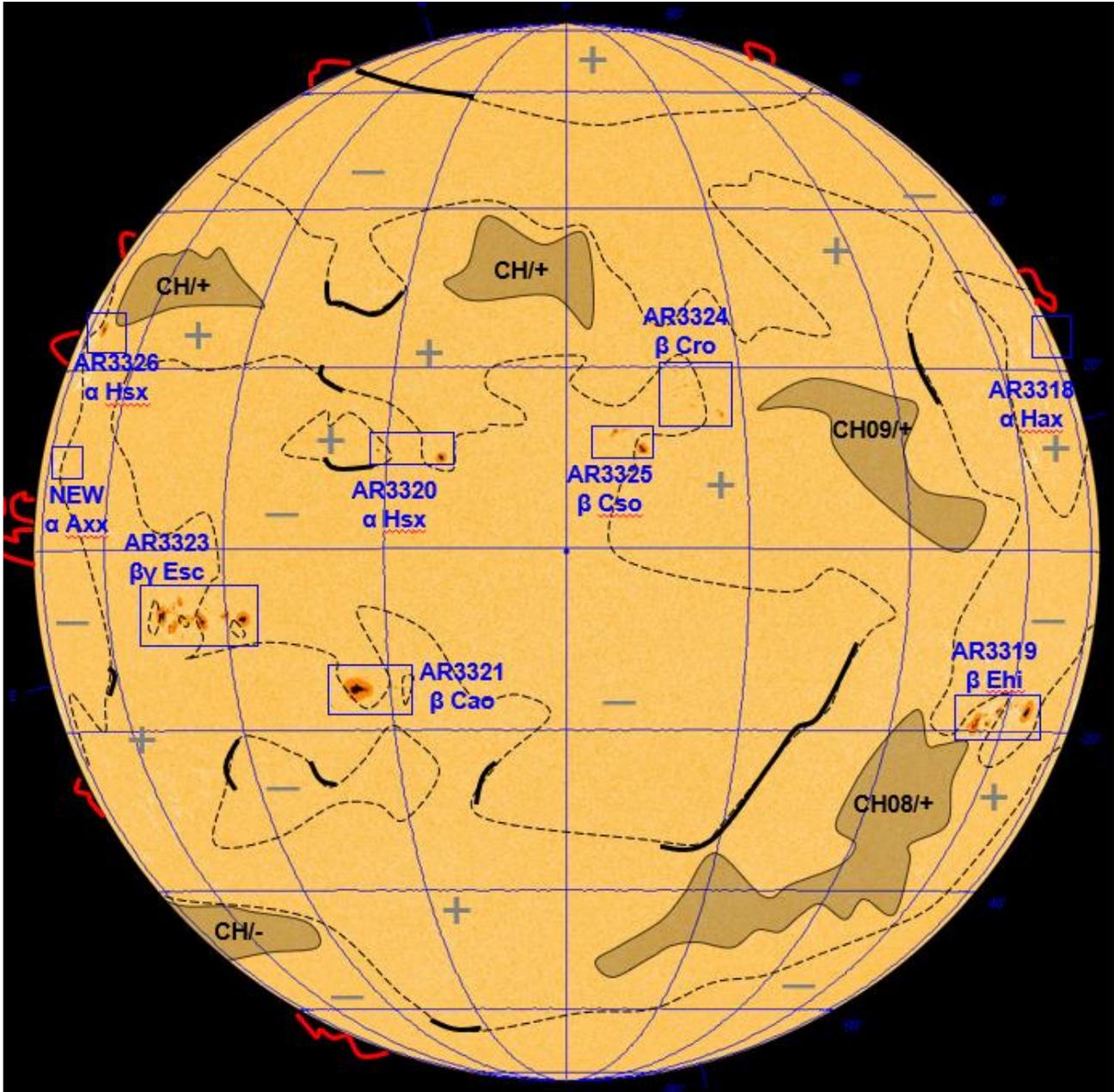
Solar Wind / Geomagnetic Activity: No Earth directed CMEs are currently in the forecast. Solar wind speeds are forecast to remain largely at slow-ambient levels, perhaps seeing some enhancement to 400-450 km/s Days 1-2 (03-04 June) should Earth connect to high speed streams from either CH08/+ or CH09/+. Mainly Quiet to Unsettled geomagnetic activity expected in the absence of any CME activity, with a very slight chance of Active or G1/Minor Storm intervals Days 1-2.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, however there is a slight chance of reaching the S1/Minor Storm threshold should any higher energy flares occur. High energy electron flux (greater than 2MeV) is expected to be at mainly background to moderate levels in the absence

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of significant contributing features producing an increase. Electron fluence is also expected to continue below the threshold.

Figure 1. Solar Analysis Valid 03/0800UTC.



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 currently in the forecast. Although a number of small CMEs are yet to be analysed, available imagery would suggest that these are far-sided eruptions. The lift-off of a small filament from the southeast around 03/1000UTC will be analysed when imagery becomes available.

Solar winds have remained at slow-ambient levels 330-370 km/s, with no observable influence from high speed streams from either CH08/+ or CH09/+. There is a slight chance that some enhancement to slightly elevated levels (400-450 km/s) is possible from CH08/+ during Days 1-2 (03-04 June), however, MOSWOC Enlil suggests that the bulk of the high speed stream may pass below the Earth and this is largely supported at this stage. However the hole is consistently evolving, along with CH09/+ to the north, so further connections are possible Days 1-2 as both coronal holes remain in potentially geoeffective locations.

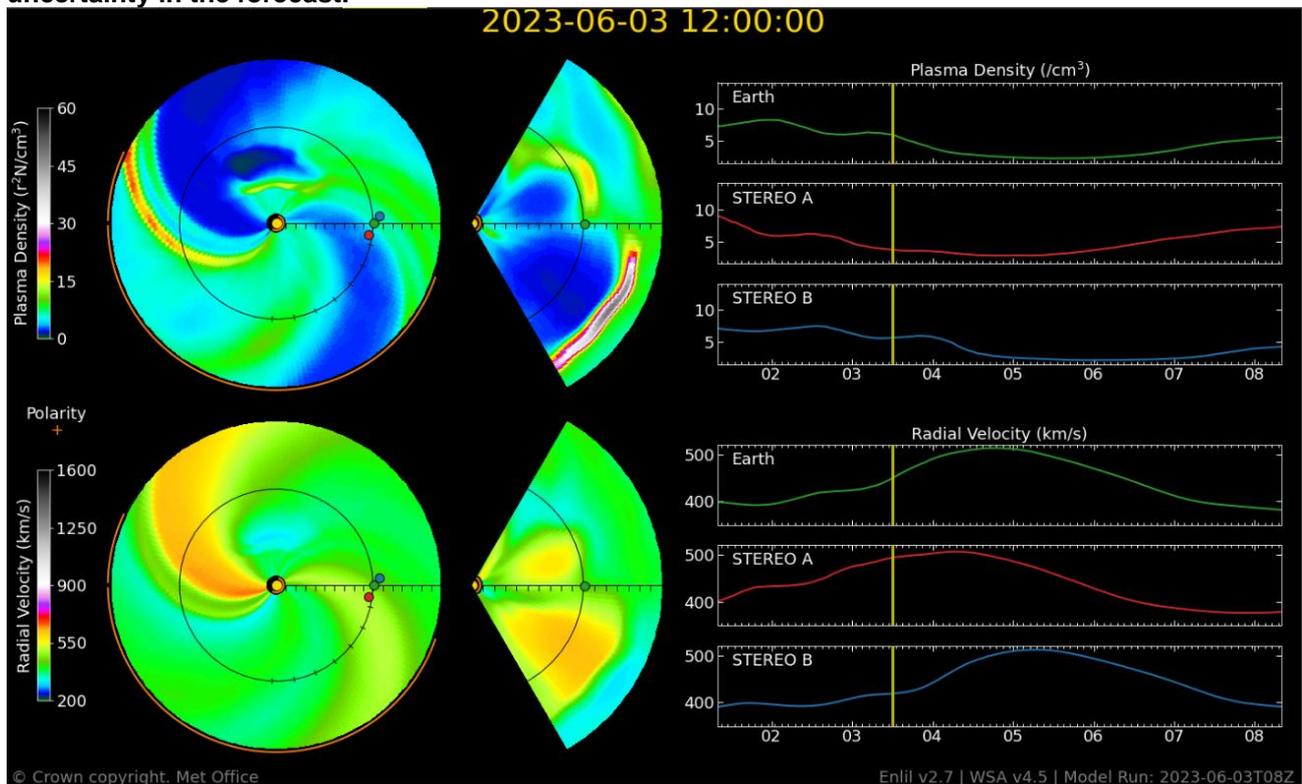
Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a slight chance of Active or G1/Minor Storm intervals, mainly on Days 1-2, should the Earth connect to either high speed stream.

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

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMEs currently expected.

Figure 2: MOSWOC Enlil showing Earth's position between high speed streams, the cause of uncertainty in the forecast.

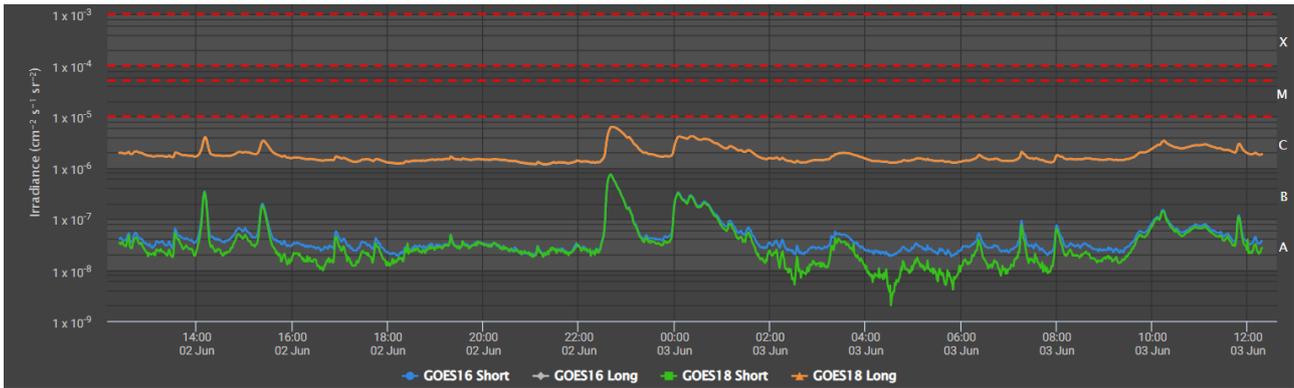


Radio Blackouts - X-Ray Flares:

There are currently nine sunspot regions on the visible disc, one of which is unnumbered. AR3323 (Esc/ $\beta\gamma$) is the largest and most complex region, which although magnetically complex, has remained relatively inactive. AR3319 (Ehi/ β) in the southwest is the second largest region and other than a recent proliferation of intermediate spots has been recently inactive. Ex-3315 just beyond the western limb sees a decreasing potential for visible flares. AR3325, in the northwest quadrant, evolved quickly and may continue to develop further should current trends continue. A number of new or returning regions are due to rotate onto the disc from the eastern horizon, including one large region on Days 2-3 (04-05 June) which could likely affect the flare risk later in the period.

Solar activity is currently Low and is expected to remain either Low or Moderate with a slight chance of High activity due to the complex regions on the 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	55	55	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES16 & GOES18 24-hour X-Ray trace


Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, is at background levels and expected to remain so. The slight chance of S1/Minor Radiation Storms is maintained should any larger flares occur. The greatest risk for Days 1-2 (03-04 June) appear to be from either recently departed region AR3315 or from AR3319 located in the southwest. Through Days 3-4 (05-06 June), AR3315 will have rotated beyond influence, with the main region contributing to the risk being AR3319.

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 electron flux (greater than 2MeV) is expected to remain at mainly background to moderate levels through the period, in the absence of significant modification from solar wind effects. There is a slight chance Days 1-2 (03-04 June) of reconnecting to a HSS from either CH08/+ or CH09/+, however, in the absence of this, and with no CMEs currently expected within the forecast period, there is no clear source for flux levels to increase.

Electron fluence is following a slowly rising trend, with this expected to continue in the absence of an increase of flux values. However, fluence is expected to remain below the Active (1e8 integrated pfu) threshold throughout.

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	1	10	10
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

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Figure 4: MOSWOC REFM showing forecast increase in fluence later in period.

