
Space Weather Technical Forecast

Issued on Sunday, 11 June 2023 at 01:24 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-R2/Minor-Moderate radio blackouts) throughout. Very slight chance of G1/Minor Geomagnetic Storms 11-14 June.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the past 24 hours. The largest event was a C5.7 flare at 10/2116 UTC from AR3323 in the southwest quadrant. There are currently eight sunspot regions on the visible disc, although much of the flare risk can be attributed to three groups. AR3331 in the southeast the largest and most magnetically complex group on the disc, although only evolves slowly. AR3327 near the southern centre disc has generally weakened with a reduction in the size and number of its intermediate spots and loss of discernible penumbra on the leading portion of the group. AR3329 near centre disc in the northern hemisphere has also simplified, with the fading of penumbra from the trailing part of the group. The remaining regions all appear relatively small and/or stable and inactive. No CMEs that are likely to be Earth-directed have been observed on available coronagraph imagery. A filament that began to lift off of the northeast quadrant around 10/1020UTC appears to have been largely reabsorbed into the sun.

Solar Wind / Geomagnetic Activity: Solar wind at L1, has been at ambient levels varying between 290-340km/s. Density was largely on a steady upward trend, increasing from below average levels to above average, peaking at 27ppcc at 10/2250 UTC before abruptly dropping to average levels, likely associated with the arrival of a CME. Total magnetic field strength was largely weak, with the north-south component also varying weakly until the arrival of the CME late in the UTC day on 10 June, increasing the IMF to Moderate levels (peak 11nT at 10/2357 UTC) and with a moderately positive Bz. Phi angle was initially predominately negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2) 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 with a diurnal peak at moderate levels. The associated 24-hour fluence has remained well below the Active threshold (1e8 integrated pfu), with 1.46e6 integrated pfu observed at 10/2100 UTC.

Four-Day Space Weather Forecast Summary

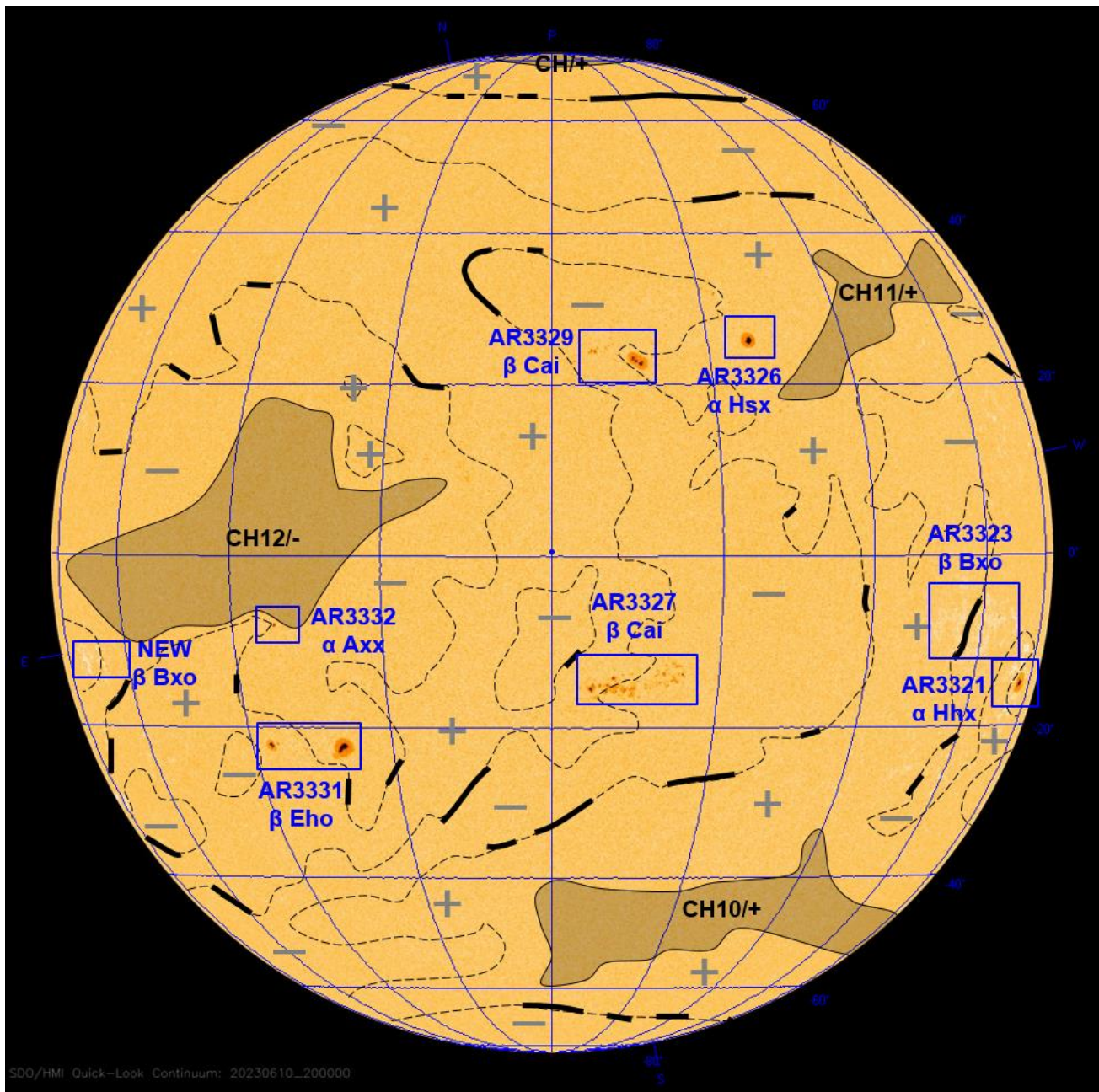
Solar Activity: Solar activity is expected to be generally Low, but with a chance for isolated Moderate flares. AR3327 and AR3329 near the central disc and AR3331 in the southeast pose the greatest risk of significant flaring.

Solar Wind / Geomagnetic Activity: Several weak CME glancing blows are possible at Earth in the coming days, however each carries only low-moderate confidence in terms of timings and effects. Coronal hole high speed streams from either CH10/+ or CH11/+, may affect the Earth from Day 1 (11 June), possibly giving speeds of 400-450km/s but with low confidence given their relative latitudes on the sun. Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a chance of Active (Kp4) or very slight chance of a G1/Minor Storm intervals (Kp5) resulting from any CME or high-speed stream effects.

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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 remain at background to moderate levels, but may exceed the high threshold on diurnal peaks later in the period. Electron fluence is expected to persist below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 10/2000 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:

Several weak CME glancing blows are possible at Earth in the coming days. A filament eruption and associated CME that left the Sun on 07 June may be responsible for the currently elevated IMF conditions at L1, although this could also be the delayed CME from 06 June that was also mostly behind Earth-orbit.

A larger CME associated with the M2.5 flare from AR3331 on 09 June is directed mainly behind Earth-orbit, however, there may be some component that could glance Earth on Day 3 (13 June) given uncertainties in the fit to imagery when assessing the feature.

High speed streams from CH10/+ and CH11/+ are in favourable positions with respect to longitude to connect with Earth on Day 1 (11 June). However, their relative positions at high latitudes to the south and north of the solar equator respectively and also proximity to the solstice may result in only very minor enhancements at Earth, if at all. Indeed Enlil is modelling the high speed streams from these features as missing the Earth, which is considered reasonable guidance. Any connection to the HSS may see winds reach 400-450km/s but this is considered only a low-moderate probability.

Mainly Quiet to Unsettled geomagnetic 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 effects or a low confidence combination of both.

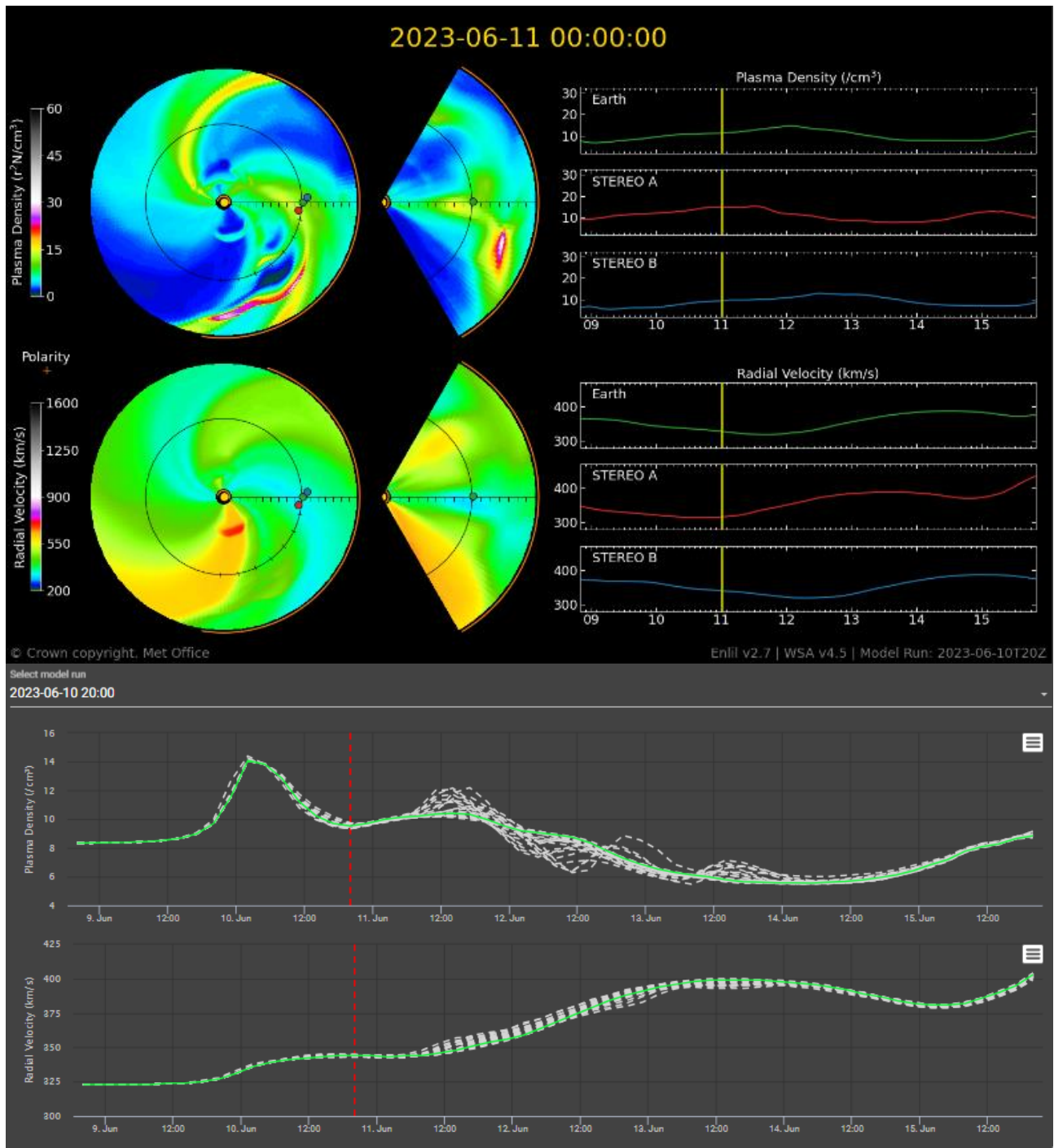
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMEs are expected in the forecast period. See 'Geomagnetic Storm' section for discussion surrounding potential glancing blows in the coming days.



Figure 2: MOSWOC Enlil and Enlil Ensemble.



Radio Blackouts - X-Ray Flares:

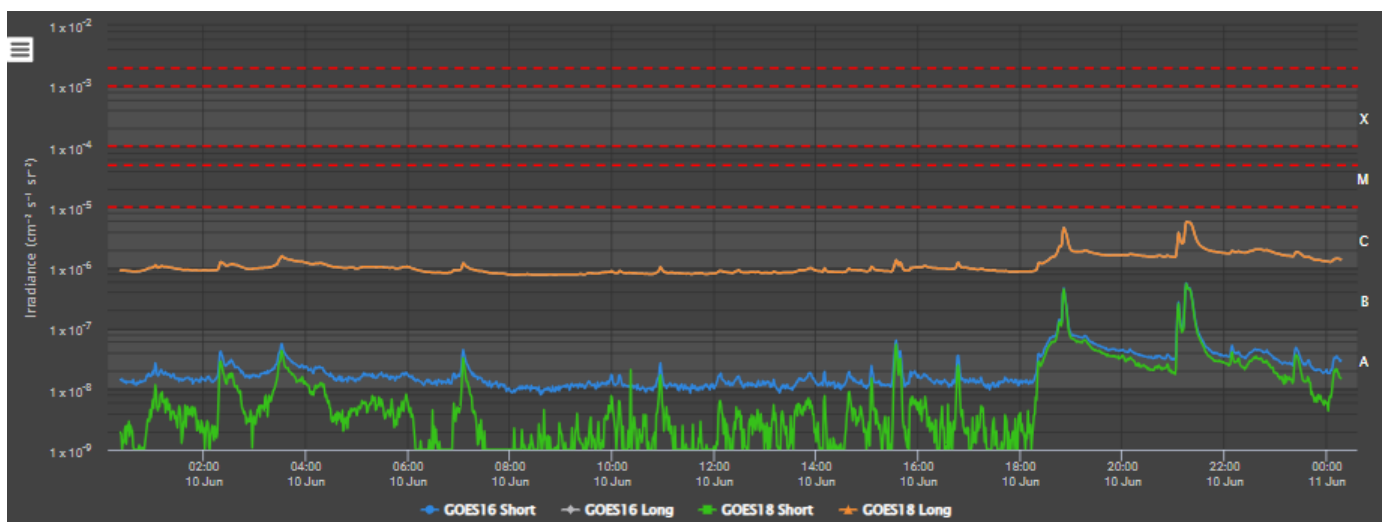
There are currently eight sunspot regions on the visible disc with AR3331 (Eho/Beta) in the southeast the largest and most magnetically complex group on the disc, although it appears stable at this time. AR3327 (Cai/Beta) near the southern centre disc has generally weakened with a reduction in the size and number of its intermediate spots and loss of discernible penumbra on the leading portion of the group. AR3329 (Cai/Beta) near centre disc in the northern hemisphere has also simplified, with the fading of penumbra from the trailing part of the group. The remaining regions all appear relatively small and/or stable and inactive.

Helioseismology is forecasting a minor region to rotate over the northeast limb early on Day 1 (11 June), otherwise no significant regions are expected to arrive onto the visible disc during the period.

Solar activity is expected to be generally Low, but with a chance for isolated Moderate flares.

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	35	35	35	35
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16 and GOES-18 X-ray flux trace



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 either of the two moderately large and complex regions AR3327 or AR3329. These regions will be transiting further into the western hemisphere and into a more geoeffective position during the forecast period.

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	5	5	5	5
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 be at mainly background levels through the period. Should connection to high speed streams from either CH10/+ or CH11/+ occur, then flux levels may increase to moderate to high (1e3 pfu) levels, with the high threshold being increasingly exceeded on diurnal peaks. This is low confidence however.

Electron fluence is not expected to exceed the Active (1e8 integrated pfu) threshold with any high speed stream that connects to Earth expected to be relatively muted. The MOSWOC REFM model suggests that any fluence levels will remain well below the Active threshold, and the British Antarctic Survey Radiation Belt Model (BAS-RBM) supports the idea that the greatest populations of electrons will be below GEO.

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	5	10
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

Figure 4: Latest MOSWOC REFM forecast

