

**Space Weather Technical Forecast**

Issued on Saturday, 17 June 2023 at 13:17 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: Chance of R1/R2 Radio Blackouts throughout. Slight Chance of further G1 Minor Geomagnetic Storms this UTC weekend. Active electron fluence Likely by end of weekend.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Moderate over the past 24 hrs, with one M-class flares observed at GOES16 on a low C-class background, a M1.0 at 16/1939UTC from AR3331. There are now up to seven sunspot groups on the visible disc, with a new arrival near the south-eastern limb awaiting a number, this region hard to classify due to positions, with changes likely in the coming hours and days as it rotates. The larger bipolar groups, AR3333 and AR3335 (now Ehi/Beta-Gamma-Delta) continue to see some spot reconfiguration and slight development, with a delta spot still evident in the leading portion of AR3335. All other spots appear generally stable.

There remain a number of large filaments on the Earth-facing disc, not least one within 20 degrees of the sub-Earth point in the north-western quadrant. Peripheral CMEs observed in the period have been modelled and none carry an Earth-directed component.

**Solar Wind / Geomagnetic Activity:** The solar wind, as measured by ACE and DSCOVR and L1, was reflective of ongoing connection to coronal hole CH12/-. The solar wind speed saw a very gradual reducing trend from approximately 620km/s down to around 550km/s. The solar wind density was level in single figures ppcc throughout. The IMF peaked at the start of the reporting period at moderate levels near 8nT, with a slow reduction to weak levels. The north-south component has oscillated at weak levels, with Bz ranging between +5 and -7nT early in the period. The phi angle was negative (towards the Sun) throughout.

The net result of the above solar wind measures was provisionally an erratic and gradual decrease from Active to Quiet geomagnetic conditions (Kp4-2).

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

High energy electron flux (greater than 2MeV), as observed by GOES16, rose from generally Moderate levels, approaching High levels by the end of the period. The associated 24-hour fluence remained well below the Active threshold (1e8 integrated pfu), with an increasing trend, and 8.35e6 integrated pfu observed at 17/0001UTC.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity expected to be Low to Moderate, with a Chance of further M-Class flares, and a very Slight Chance of isolated X-Class flares.

**Solar Wind / Geomagnetic Activity:** No CMEs feature in the current forecast, which is

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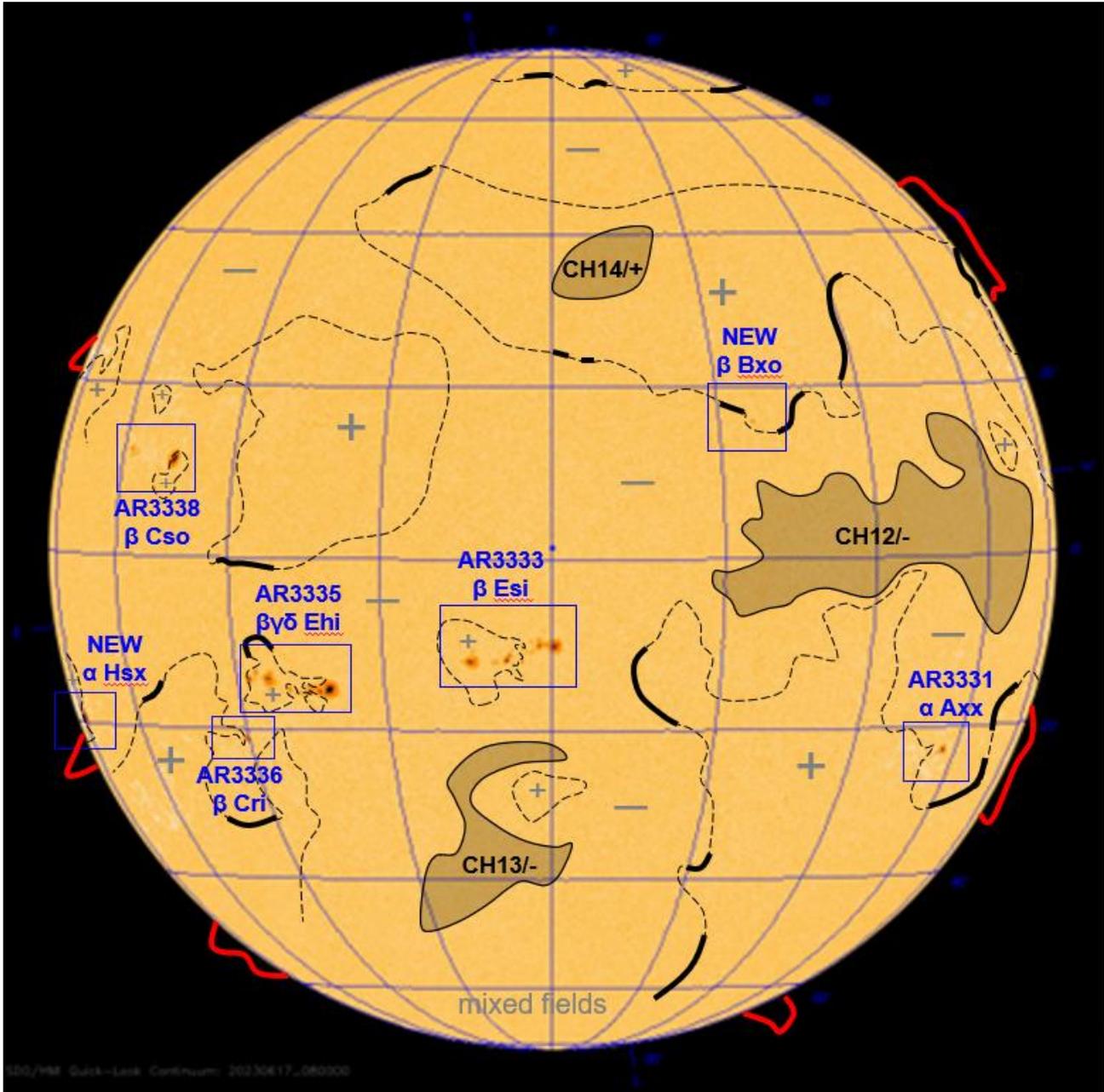
therefore an uncertain reduction in the current fast wind from CH12/- and perhaps a diffuse successor.

Solar wind speeds should gradually decrease to Elevated levels through Saturday 17 June, probably surviving at Slightly Elevated 18-19 June. Geomagnetic activity is forecast to see a Chance of Active intervals given appropriate Bz conditions, with a surviving Slight Chance of further G1/Minor Storm conditions at first. Geomagnetic activity is expected to further decline thereafter, likely becoming reliably Quiet by Tuesday 20 June.

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, though a very Slight Chance of enhancement throughout given the current configuration of front-sided sunspot groups.

High energy electron flux (greater than 2MeV) has been revised to show a likely sharper and greater increase in magnitude, probably odds-on for exceedance of Active 24-hour fluence by day 2 (18 June).

Figure 1. Solar Analysis Valid 17/0800 UTC.



**Key:** Filament      , Prominence      , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

**Geomagnetic Storms:**

No Earth-directed CMEs currently feature in the forecast.

The geomagnetic forecast comprises the current coronal hole 12, which is now a 'known' entity in terms of its effects, but less certain is the degree to which this fast wind will wane in the coming UTC weekend - given the presence of a possible tenuous continuation of the hole towards centre-disc. MOSWOC Enlil currently suggests that this is likely to be a multiple-day spanning event, with a gradual decrease in intensity through to UTC midweek, by which time a slow regime ought to have been restored. MOSWOC Enlil's handling of the current fast wind is reasonable, perhaps slightly underdone by 50km/s but improved versus recent runs, and the gradual decline from here is accepted as good guidance. No major impact currently signaled from the smaller northern coronal hole 13 or the southern coronal hole 13 both near centre disk.

Solar wind speeds should gradually decrease to Elevated levels through day 1 (17 June), probably surviving at Slightly Elevated levels days 2 and 3 (18-19 June). Geomagnetic activity is forecast to see a chance of Active intervals given appropriate Bz conditions at first, with a Slight Chance of further G1/Minor Storm conditions at first. Geomagnetic activity is expected to decline thereafter, likely becoming reliably Quiet by day 4 (20 June).

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	20	5	1	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:

There are now five numbered and two unnumbered sunspot regions on the disc, with a significant number of groups losing their identity in the past 24 hours. These fading groups included AR3337, AR3334, and up to three embryonic groups in the northwestern quadrant. Despite the apparent minor collapse in the front-side sunspot population, the larger bipolar groups, AR3333 and AR3335 (now Ehi/Beta-Gamma-Delta) continue to see some slight development, with a delta spot still evident in the leading portion of AR3335. The Pentiction 10.7cm flux has performed an about-face since its middle of the UTC week low, and is now rivalling levels at which it entered the week (161sfu on 10 June, falling to 144 on 14 June, then reaching 157 on 16 June).

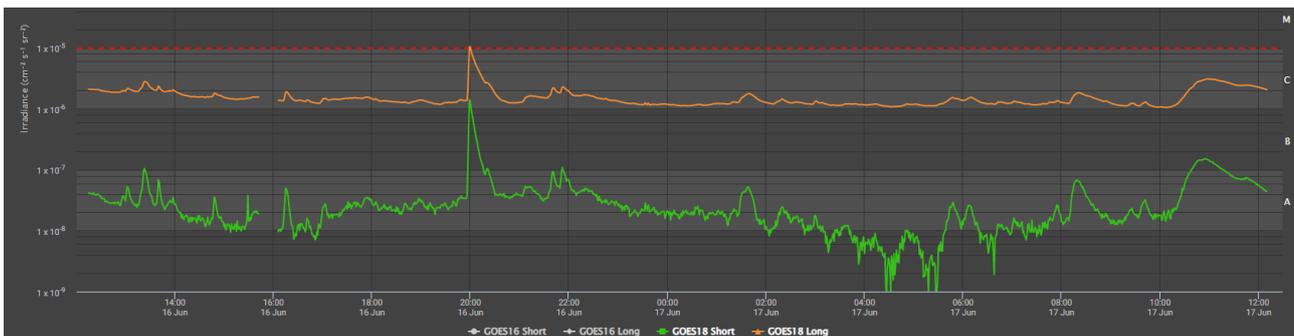
One feature of recent solar activity has been that it is well-distributed across the disc, which helps lend credence to suggested raw daily risk value of approximately 50% for M-class flares. Some of the more active flares in the past 24 hours have been seen from (apparently) visually very simple regions, including Ex-AR3337 which gave an M1 flare despite barely distinguishing itself from a spotless plage, perhaps peaking at an Axx/Alpha before fading.

No significant regions are due to leave the disc in the coming four days, however further regions potentially approaching the east limb as inferred by brighter flux regions in STEREO A and SDO imagery and the as yet unnumbered spot on the southeast limb. As there is not yet significant activity from over the east limb, flare probabilities are kept flat until these regions become visible and can be analysed.

All considered, solar activity carries a Chance of further M-class flares, with a very slight chance of isolated X-Class flare activity, with this risk mostly presented by AR3335 in the near term.

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 2: Latest 24hr GOES18 X-Ray flux trace



**Solar Radiation Storms - (High Energy Protons):**

The high energy (greater than 10MeV) proton flux is at Background levels at present. While it remains true that the larger sunspot regions currently occupy the eastern solar hemisphere, the fact that recent M-class activity has been well-spread across three sunspot regions means that the chances of S1 or greater are now judged to be slightly higher..

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	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

\* S3  $\geq 10$  MeV  $\geq 1000$  pfu and / or  $\geq 50$  MeV  $\geq 10$  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 Moderate to High levels to start. The unexpectedly potent fast wind emanating from CH12 likely to provide the impetus for at least diurnal peaks within High flux. This may mean that 24-hour integrated fluence could rise above active levels as early as the end of day 1 (17 June), although this is dependent on the brakes of recent Moderate geomagnetic activity lifting, allowing the charged Van Allen belt to recover to register fully at GOES16.

The forecast is now for a significant upturn in flux and fluence through the coming UTC weekend, with exceedance of Active likely by day 2 (18 June). The trend thereafter depends on the uncertain contribution from a more diffuse trailing portion of CH12, which may extend its tenure on the disc and perhaps prolong geomagnetic activity and delay any eventual crossing of Active. The current forecast assumes that any contribution from this unnumbered feature is low. MOSWOC REFM is showing a forecast trend in excess of that proposed by persistence, and this appears realistic, even if the exact timings are lower confidence.

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	60	70	70	70
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	5	5	5

**Figures 3 and 4: Latest 24hr GOES16 electron flux trace and MOSWOC REFM model output**
