
Space Weather Technical Forecast

Issued on Saturday, 17 June 2023 at 01:10 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 R1/R2 Radio Blackouts throughout. Reducing 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 UTC day of Friday 17 June, with three M-class flares observed at GOES16 on a low C-class background. These flares came from three different sources: in chronological order, an M1.0 at 16/0530UTC from AR3337; an M1.0 at 16/1036UTC from AR3338; and finally another M1.0 at 16/1939UTC from AR3331.

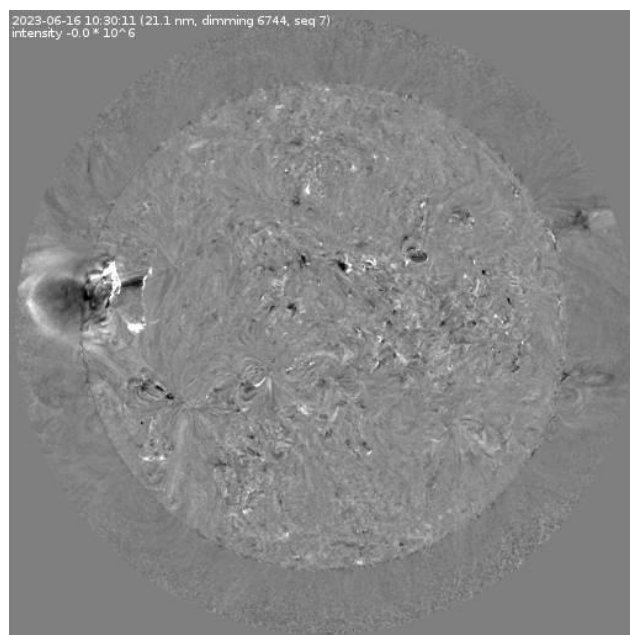


Figure 0: AIA211 time-integrated dimming of the CME immediately preceding the 16/1038UTC M1.0 flare from AR3338. This CME has been modelled and passes behind the track of the Earth's orbit to no effect. Image processing courtesy of SIDC ROB.

The population of front-sided groups fell overall in the 24 hours, with up to nine visible for a time, but only five surviving by the end of the UTC day. The casualties included one of the most active groups, AR3337, which returned to plage along with its near-neighbour AR3334, joined by up to three unnumbered groups in the northwestern quadrant.

Main trends in the remaining groups were a fading of intermediate spots in AR3333, while AR3335 developed some penumbral central spots that then migrated to the extremities of the group. There is now a tenuous candidate for a Mt Wilson delta spot in AR3335 as a result, and it is nominally the most complex as an Esc/Beta-Delta.

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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 northwestern 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 a Strong coronal hole: CH12/-. The solar wind speed rose to give occasional peaks in the low-700s of km/s from the UTC early hours, with a very gradual reducing trend that partially reversed into the UTC evening. The solar wind density was level in single figures ppcc throughout. The IMF peaked at the start of the reporting period near 13nT, with a step-wise reduction after 03UTC. The north-south component was mainly anti-aligned with Earth's field, with Bz ranging between +10 and -11nT, with this magnitude lessening with time. 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 Moderate Geomagnetic Storm G2, with Kp peaking at '6o' in the 03-06UTC interval, with all four UTC morning three-hour intervals at or above G1 Minor Storm. The UTC afternoon and evening then saw activity of between Active and Quiet.

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 Normal Background to Moderate levels in the period, with 417pfu recorded at 16/1505UTC. 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 carries a Chance of further M-class flares, with a very tentative increasing risk in the outlook as more regions are expected to arrive than leave.

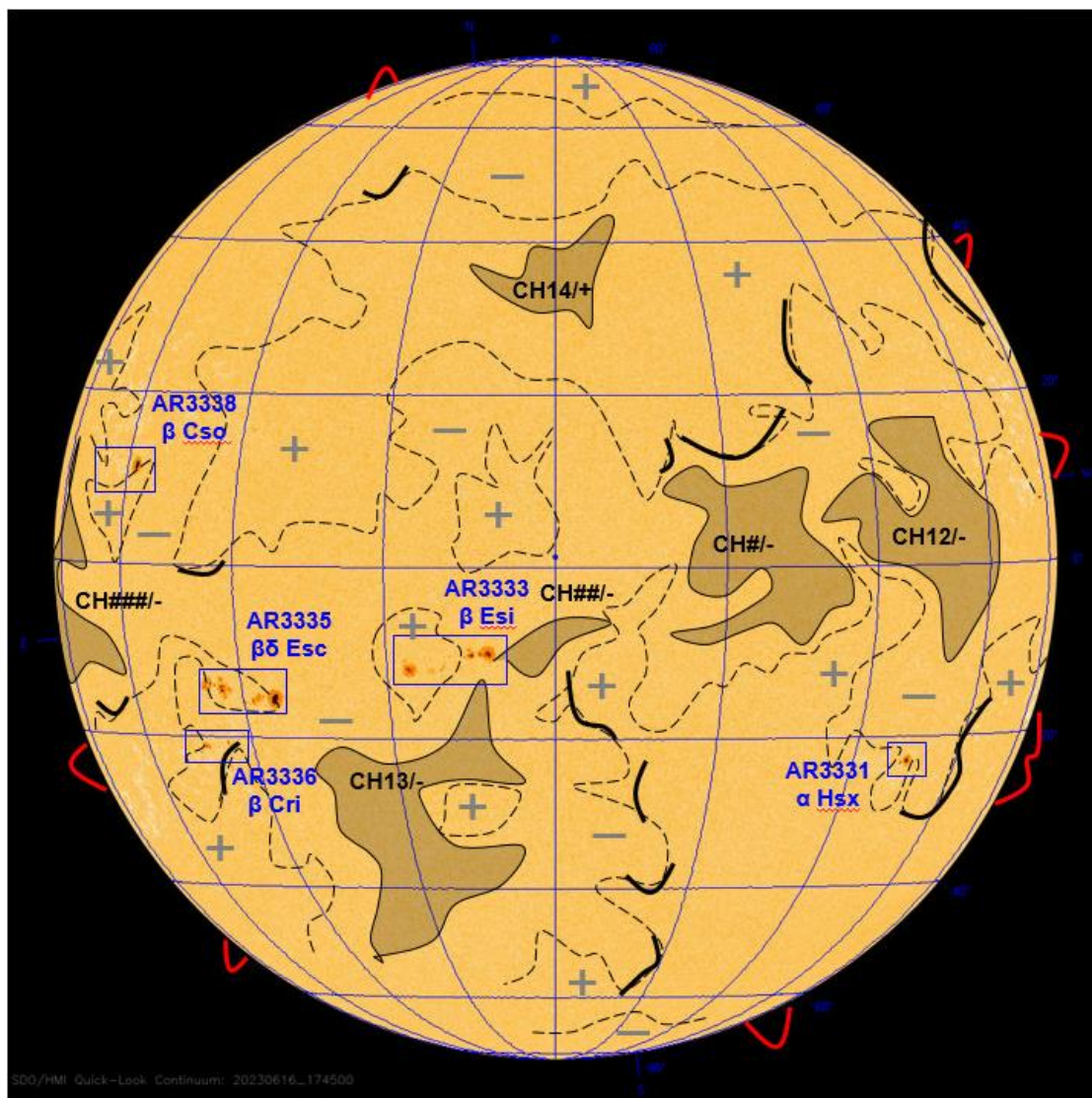
Solar Wind / Geomagnetic Activity: No CMEs feature in the current forecast, which is therefore an uncertain reduction in the current fast wind from CH12/- and perhaps a diffuse successor.

Initially Strong 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 Active intervals given appropriate Bz conditions at first, with a surviving 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, very gradually increasing with westward progress of 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 magnitude increase in magnitude, probably odds-on for exceedence of Active 24-hour fluence by day two, Sunday 18 June.

Figure 1. Solar Analysis Valid 16/1745UTC.



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 therefore comprises the current Strong 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 in AIA211 towards centre-disc as an unnumbered and diffuse coronal hole. 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.

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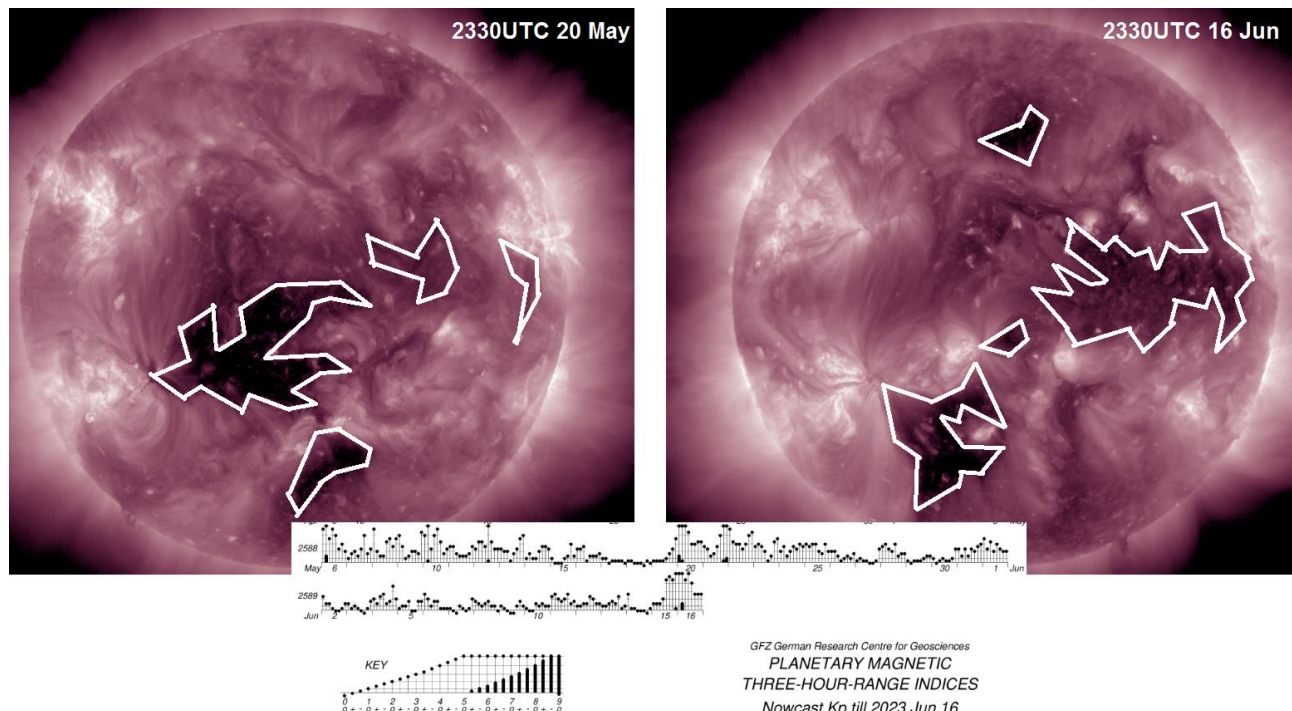
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Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	25	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: SDO AIA211 imagery from the previous and current rotations, showing geometry differences in CH12 and its neighbours. The Bartels music plot for the relevant passes is also shown below. Although the detail is very likely to differ, the general trend of a reduction from current activity levels is expected into the forthcoming new working week (UTC).



Radio Blackouts - X-Ray Flares:

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There are now just five numbered 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 Penticton 10.7cm flux has performed a volte-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).

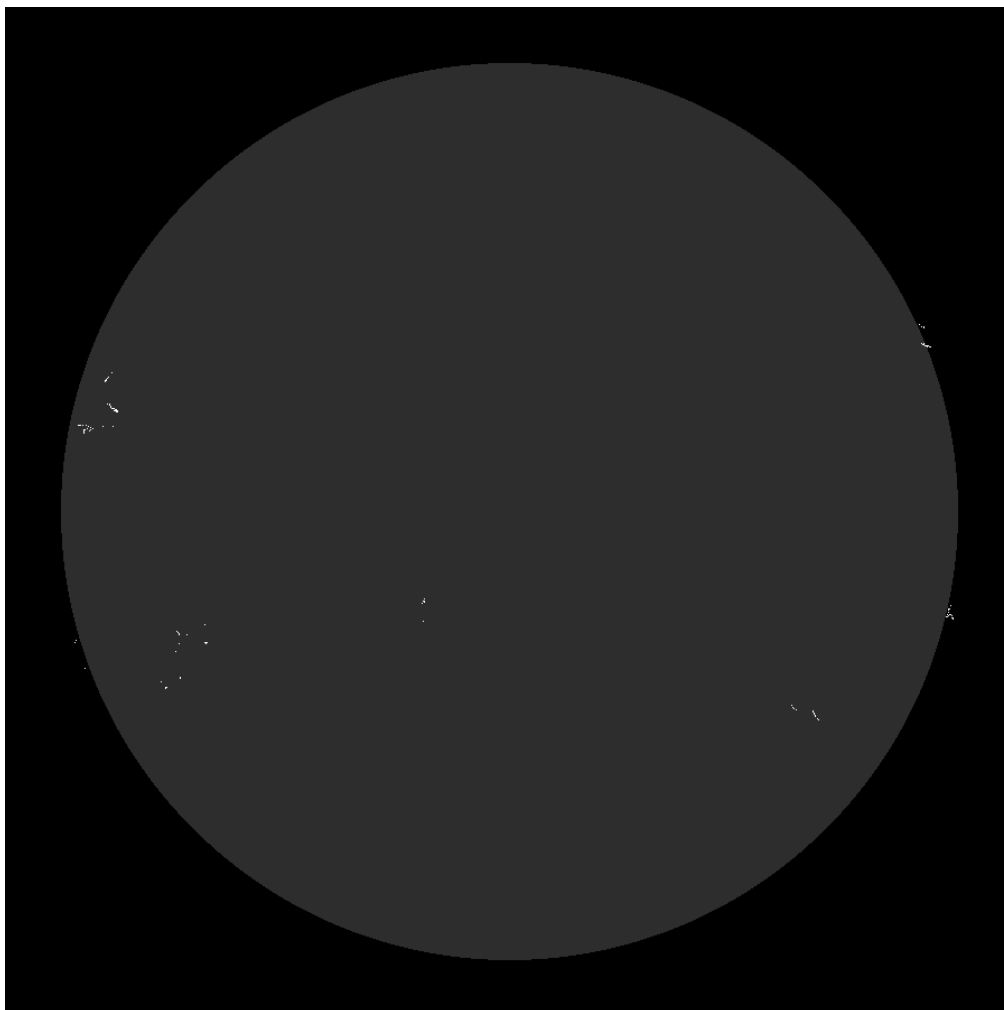
One feature of recent solar activity has been that it is well-distributed across the disc, which helps lend credence to not adjusting the suggested raw daily risk value of 50% for M-class based on any one quiescent spot group. Some of the more active in the past 24 hours have in fact been (apparently) visually very simple regions, including AR3337 which gave an M1 flare despite barely distinguishing itself from a spotless plage, perhaps peaking at an Axx/Alpha before fading. This may be partly a product of the narrow viewing angle to this group.

No significant regions are due to leave the disc in the coming four days, however further regions are potentially approaching the east limb as inferred by brighter flux regions in STEREO A and SDO imagery. 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 tentative increasing risk in the outlook as more regions are expected to arrive than leave.

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	1	1	1	1

Figure 3: Locations of C-class flares and above (white dots) on the current disc (past 24 hours to 16/2330UTC), showing the well-spread nature of activity. Image courtesy of SIDC ROB.



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 than previously stated, with a further slightly rising trend with their westward advance.

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	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 largely be at Background levels to start. The unexpectedly potent fast wind emanating from CH12 is now thought Likely to be able to provide the impetus for at least diurnal peaks within High flux. This may mean that Active 24-hour integrated fluence could come as early as day one, Saturday 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 revised forecast now proposes a significant upturn in flux and fluence through the coming UTC weekend, with exceedance of Active odds-on by Sunday 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	40	70	70	70
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	5	5	5



Figure 4: Top: Latest MOSWOC REFM, showing rising observed fluence trend as well as forecast and persistence traces. The general idea of the forecast tracking above the past rotation's levels is accepted, with the extent perhaps slightly underdone. Bottom: Past 24 hours in GOES16 high energy electron flux, showing a rising tendency that is expected to increase in magnitude in the next 36 hours or so.

