
Space Weather Technical Forecast

Issued on Tuesday, 13 June 2023 at 01:16 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: A slight chance of M-class flares (R1-R2/Minor-Moderate radio blackouts) and isolated Minor (G1) Geomagnetic Storms during the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity Low with a number of low level C-flares, peaking at C5.2 at 12/0658 UTC from ex-AR3330, which has subsequently decayed. The six sunspot regions on the visible disc have generally been stable or declining, with AR3327 in the southwest and AR3331 in the southeast generally losing penumbral extent, although the latter did observe some slight flux emergence with its intermediate spots and is now the most likely visible group for notable flares. AR3329 and AR3326 both in the northwest are the other two numbered groups and these persist as mature unipolar regions. The two unnumbered regions are small. No Earth-directed CMEs were observed in the last 24 hours, however a large polar crown filament (PCF) eruption was observed from the northern disc. There are also a number of other large filaments on the Earth-facing Sun.

Solar Wind / Geomagnetic Activity: The solar wind at L1 showed an ongoing slightly-elevated environment, likely due to CH11/+ or CH10/+. Solar wind speeds as observed by DSCOVR were around 420-470km/s, whilst the density has remained around average. Total IMF strength, Bt has been at weak levels around 5-8nT. The north-south component also varying weakly between +6nT and -5nT. Phi angle has been positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

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 background. The associated 24-hour fluence remained below the Active threshold (1e8 integrated pfu), with 1.81e6 integrated pfu observed at 13/0000 UTC.

Four-Day Space Weather Forecast Summary

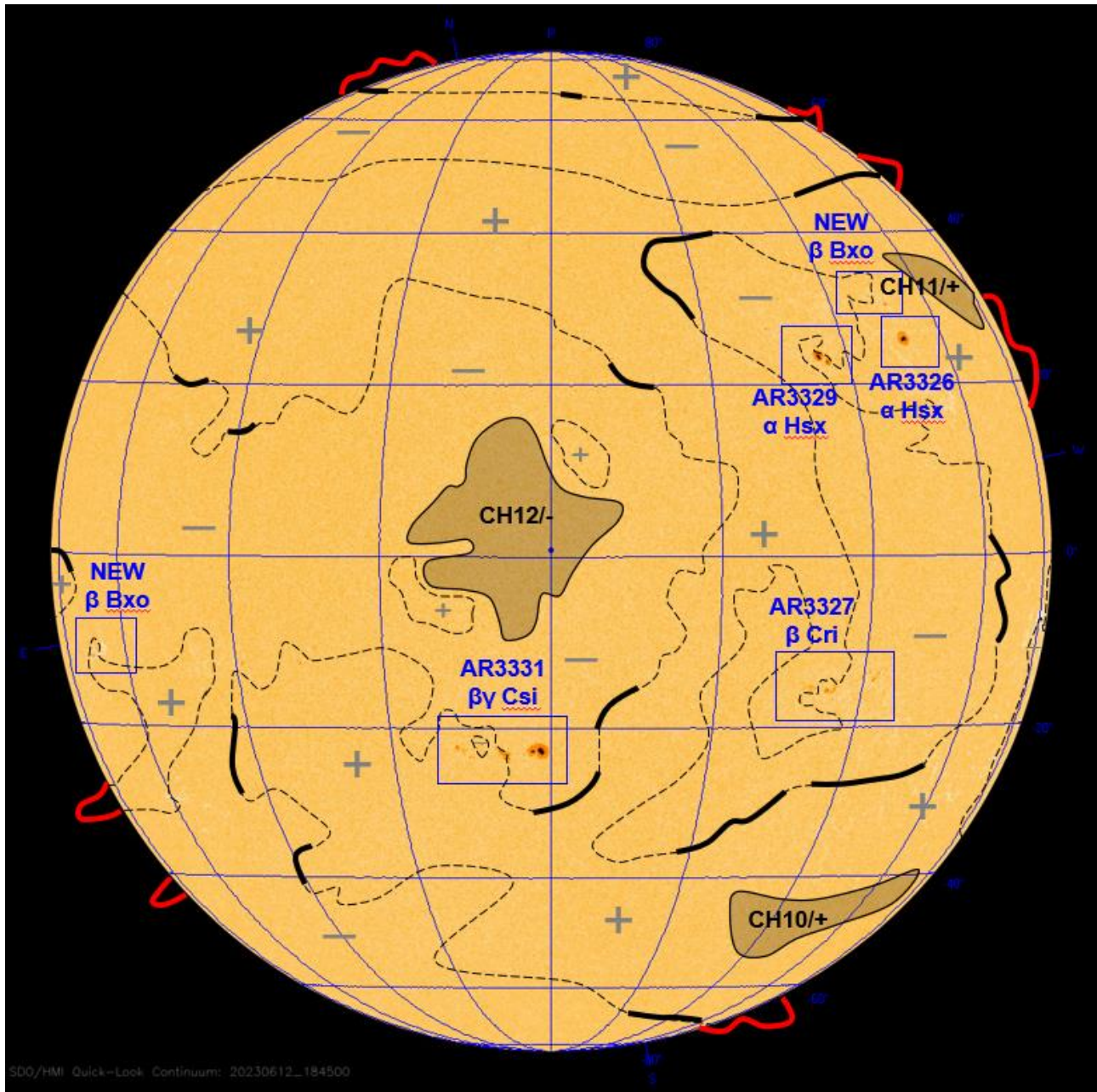
Solar Activity: Solar activity is expected to be mainly Low with a slight chance of rising to Moderate with isolated M-flares.

Solar Wind / Geomagnetic Activity: A CME associated with the M2.5 flare from AR3331 on the 9 June is directed mainly behind Earth but has the potential to give a glancing influence, most likely early day 1 (13 Jun). There are no other Earth-directed CMEs. Ongoing slightly elevated solar winds are expected day 1 (13 Jun), before easing day 2 (14 Jun). The next fast wind enhancement is expected to be from the arrival of the HSS of equatorial CH12/- into days 3 and 4 (15-16 Jun). Geomagnetic conditions are forecast to be mainly Quiet with Unsettled spells through the period. There is a slight chance of Active to G1 Minor Storm intervals early day 1 (13 Jun) from any CME glance that may occur. An increased chance of Active interval and a slight chance of G1 Minor Storms returns into days 3 and 4 (15-16 June) from the interaction with any CIR and likely HSS associated with CH12/-.

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Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux (greater than 2MeV) is expected to continue at generally background levels. Electron fluence is expected to remain below the Active ($1e8$ integrated pfu) threshold.

Figure 1. Solar Analysis Valid 12/1850 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:

A CME from the 09 June, associated with the M2.5 flare from AR3331 is forecast to miss, likely passing just behind Earth early day 1 (13 Jun), but bringing just the chance of a glancing impact. No other Earth-directed CMEs have been observed.

Solar winds are currently slightly elevated, likely due to a weak connection to the fast wind associated with the high speed stream (HSS) of CH11/+ or CH10/+. Solar winds are expected to continue at around 450km/s day 1 (13 Jun), before likely easing somewhat day 2 (14 Jun).

Equatorial CH12/- is currently near center disk, with the fast wind enhancement from the arrival of its HSS expected later on day 3 into day 4 (15-16 Jun). This feature was apparent on the previous rotation, but is a larger and more distinct region on this occasion. A G2 Moderate Storm was observed on 20 May, however this was likely due to a CME which was embedded into the HSS arrival, reducing the value of persistence.

Geomagnetic conditions are forecast to be mainly Quiet with Unsettled spells through the period. There is a slight chance of Active to G1 Minor Storm intervals early day 1 (13 Jun) from any CME glance that may occur. An increased chance of Active interval and a slight chance of G1 Minor Storms returns into days 3 and 4 (15-16 June) from the interaction with any CIR and likely HSS associated with CH12/-.

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	1	20	20
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

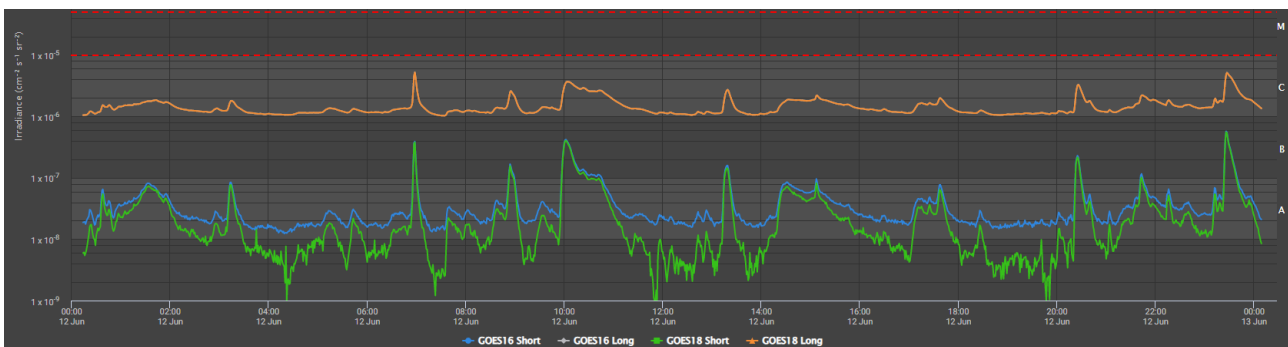
Radio Blackouts - X-Ray Flares:

Low activity is expected to continue through the period, although with a slight chance rising to Moderate at times.

Sunspot activity on the Earth-facing disc has been in a declining trend with most spots decreasing in areal extent and complexity, including AR3326 and AR3329 in the north east which are now mature unipolar regions. AR3327 has also continued to fade, with penumbra dispersing from its component small spots. AR3331 has also seen the penumbra on its trailer spot fade, although this has had some small development of a reverse polarity spot within its intermediate region, and is now perhaps the most likely source of any notable flares. There are also potential far-sided sunspots rotating onto the disc during the coming days, as indicated by far-sided products, perhaps ex-AR3314 and ex-AR3310 from the last rotation. This is supported by C-flare activity that has been observed over the NE and SE limbs, with along with looping visible on SDO aia-94, STEREO A-euvi and other similar imagery.

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	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 2: Latest 24hr GOES18 X-ray Flux.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is at Background and currently expected to persist at this level.

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	1	1	1	1
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 ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) is expected to be at mainly background levels through the period, with any glancing CME arrival day 1 (13 Jun) likely to continue to suppress electron flux, as will the likely onset of the HSS from CH12/- into days 3 and 4 (15-16 Jun). Electron flux perhaps beginning to rise by day 4 (16 June).

Electron fluence is not expected to exceed the Active ($1\text{e}8$ integrated pfu) threshold during the period, with the REFM model currently providing generally good guidance.

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

Figure 3: Latest MOSWOC REFM model output

