
Space Weather Technical Forecast

Issued on Monday, 05 June 2023 at 13:21 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). Slight chance of a G1/Minor storm due to CME effects 07-08 June.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, but with frequent C-Class flares. There are currently eight sunspot regions on the visible disc. AR3323 nearing centre disk remains complex and this region contributing the bulk of current flare risk. The large region AR3319 is rotating over the southwestern limb. AR3327 near the southeast limb is still difficult to classify due to the viewing angle, but is starting to reveal some complexity. The other regions appear to be mostly smaller and/or simpler.

No Earth-directed CMEs were observed in available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds as observed by DSCOVR/ACE at L1 have shown some disturbance, likely from a weak transient, or perhaps weak coronal hole effects. Wind speeds were ambient to start, varying between 310-380 km/s, increasing to slightly elevated 400-450 km/s from 05/0530 UTC. Density has been at mostly average. Total IMF, Bt, has been at weak to moderate levels, with a peak of 12 nT at 04/1715 UTC. The north-south component, Bz, was moderately positive to start with a peak of +9.9 nT at 04/1250 UTC but fell after 04/1630 UTC to a minimum of -11.8 nT at 04/1714 UTC, before returning to weak levels by around 04/1900 UTC and remaining so since, fluctuating between +5/-5 nT. Phi angle was negative (towards the sun) to start but switched to positive (away from the sun) from 04/1900 UTC. Geomagnetic activity was mostly Quiet (Kp 1-2), with an Active (Kp 4) interval 04/1800-2100UTC.

Energetic 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 levels throughout. Associated 24-hour fluence has been below the Active threshold (1e8 integrated pfu) with a recent downward trend. Electron fluence observed at 05/0000UTC was 2.81e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain generally Low but there is a chance of isolated M-Class flares bringing Moderate activity, and a slight chance of isolated X-Class flares. These most likely from AR3323 or the developing AR3327.

Solar Wind / Geomagnetic Activity: A filament lift-off starting around 04/0900UTC from the southwest quadrant gave a CME. This is currently thought more likely to miss Earth, however a glancing blow is possible either late Day 3 or into Day 4 (07-08 June). Some potential transient CME and coronal hole activity has been observed in the past 24hrs and this may continue into the start of the period, in general however solar winds expected to remain generally slow-ambient to slightly elevated into the period with a slight chance of enhancement late Day 3 into

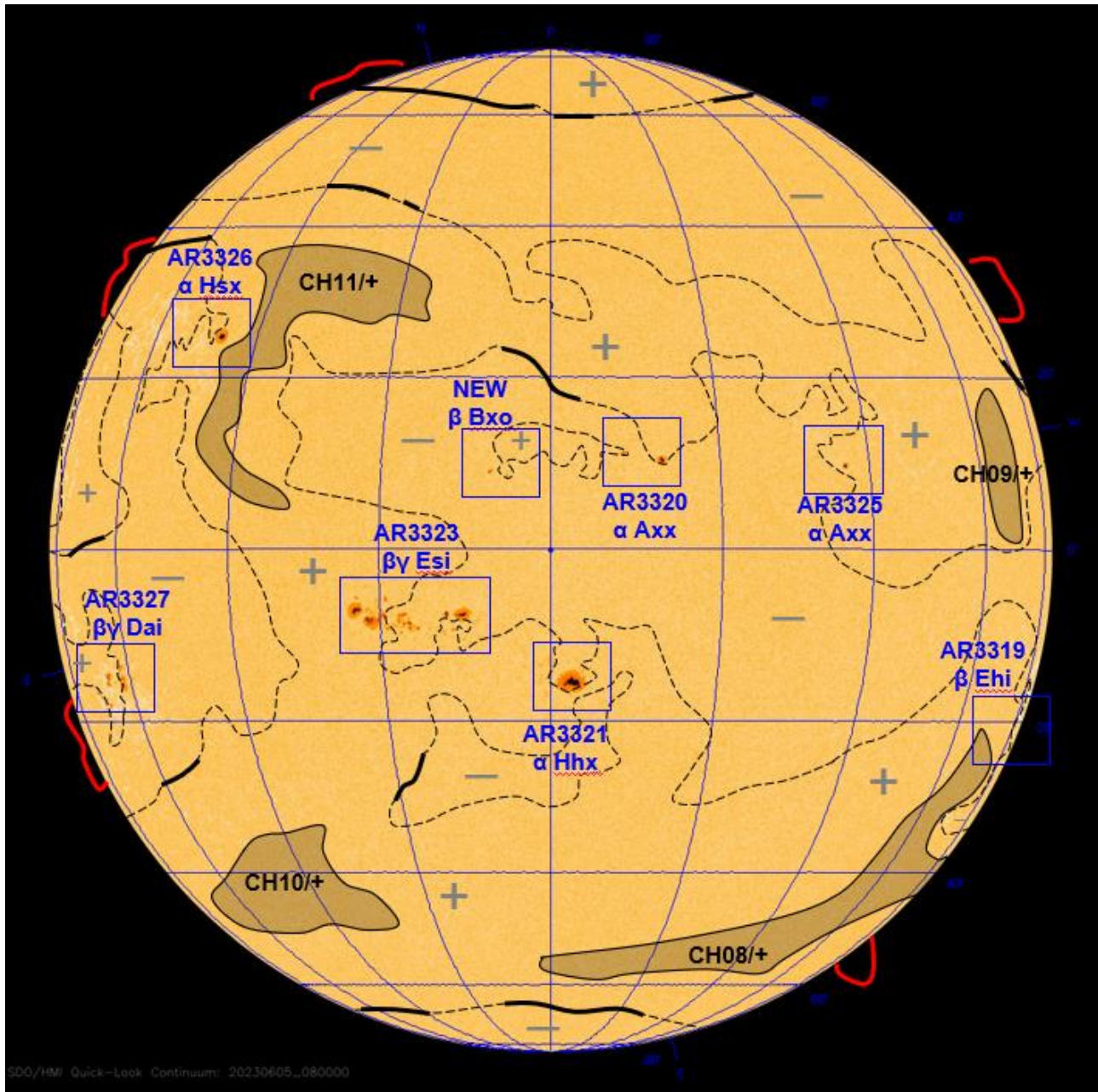
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Day 4 (07-08 June), should we see any CME effects.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled with a slight chance of Active intervals on Day 1 and Day 2 (05-06 June), should we continue to see any transitory enhancement. Activity possibly increasing late Day 3 into Day 4 (07-08 June) should we see any CME effects, becoming more Unsettled with a chance of Active intervals and a slight chance of isolated G1/Minor storm intervals.

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 but declining chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to be at mostly background to moderate levels. Electron fluence is also expected to continue below the Active ($1e8$ integrated pfu) threshold.

Figure 1. Solar Analysis Valid 05/0800 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:

A filament lift-off starting around 04/0900UTC from the southwest quadrant gave a CME. This is currently thought more likely to miss Earth, however a glancing blow is possible either late on 07 June or early on 08 June. No other potential Earth directed CMEs currently feature in the forecast.

Coronal holes 08 and 09 both continue to transit past potentially geoeffective positions on the visible disc, however, wind speeds have remained at slow-ambient to slightly elevated levels suggesting any High Speed Stream (HSS) connection has been weak. Some potential transient CME activity has been observed in the past 24hrs and this may continue into the start of the period, in general however solar winds expected to remain generally slow-ambient to slightly elevated into the period with a slight chance of enhancement late Day 3 into Day 4 (07-08 June), should we see any CME effects.

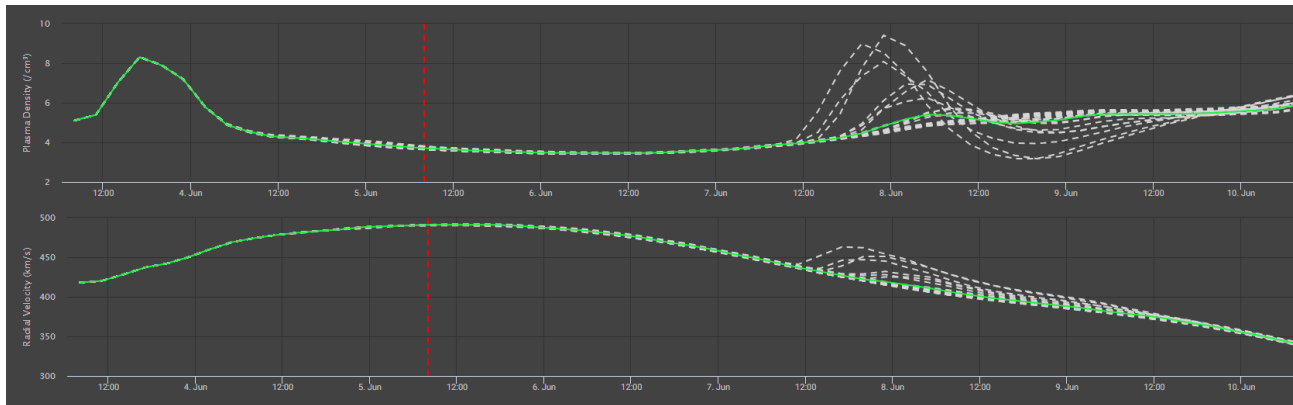
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Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	10	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1629	Partial	Filament lift off	SW	620 km/s	08/0000 UTC	Glancing blow possible

Figure 2: Latest MOSWOC ENLIL Ensemble output, showing potential for some CME influence. (Note current ENLIL expectations for HSS influence which have not been realized)



Radio Blackouts - X-Ray Flares:

There are currently eight sunspot regions on the visible disc. AR3323 nearing centre disk remains complex with slight continued development, and this region contributing the bulk of current flare risk. The large region AR3319 is rotating over the southwestern limb, though the flare risk will be maintained for a period of time as it rotates off. AR3327 near the southeast limb is still difficult to classify due to the viewing angle, but is starting to reveal some complexity. The other regions appear to be mostly smaller and/or simpler, but there are signs of further regions to rotate onto the east limb in the near future.

Overall, solar activity is expected to remain generally Low but there remains a chance of isolated M-flares bringing Moderate activity, and a slight chance of isolated X-flares. These most likely from AR3323 or the developing AR3327. The flare probability has been kept flat through the four days - whilst AR3319 is rotating off so flare risk from this reduces, further regions look likely to rotate onto 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	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is at background levels and is most likely to remain at this level. There is a slight but declining chance of S1/Minor radiation storms should any larger flares occur. The main risk is from AR3319 and AR3323. AR3319 is rotating off the visible disk and therefore the likelihood of proton storms from this location will diminish, hence the reduction in probability by Day 3 (07 June).

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	10	10	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ 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 remain at mainly background to moderate levels through the period. Although there remains the possibility of HSS effects early in this period, this is likely to be weak and any electron charging minimal. The possibility of a CME glancing blow late Day 3 into Day 4 (07-08 June) would also keep electron levels suppressed in the initial wake of the CME, although could cause charging right at the end of the period. Confidence in the CME arrival is low, however as this is probably more likely to miss Earth.

Electron fluence is well below the Active ($1\text{e}8$ integrated pfu) threshold and has been declining in recent hours. It is expected to stay below Active through this period, although a rise is possible later on Day 4, but this is low confidence. MOSWOC REFM is forecasting a below Active trend through the next three days which is reasonable.

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

