
Space Weather Technical Forecast

Issued on Tuesday, 13 June 2023 at 13:22 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: Slight Chance of R1 throughout. Peak Slight Chance of G1 Thursday into Friday (UTC).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional low-level C-class flares recorded at GOES16. These peaked with an impulsive C5.1 at 12/23:27UTC.

All but the first six hours of this reporting period suffered an SDO imagery outage which has hampered the immediacy of monitoring. The resolution of some of the alternative sources for imagery is also lower, and this includes visible sunspot analyses which were gleaned from ground-based observatories rather than SDO. At present then, there appear to be five sunspot regions of sufficient size to manifest on available imagery. AR3327 and AR3331 both showed decay in their trailing regions especially, while a new sunspot region in the southeast showed a weak growth tendency, else remaining spots appeared stable. The mantle of the most complex active region on the disc has now passed from AR3327 to AR3331, with the latter a Csi/Beta, while the former is now a Cri/Beta as of 13/1200UTC.

Coronagraph imagery for the period showed a west-directed narrow Coronal Mass Ejection (CME) through the UTC afternoon of Monday 12 June. This has been modelled as a miss and plays no part in the forecast. A large filament and prominence eruption circumscribing the western part of the northern crown (from an Earth-viewpoint) also lifted off in the period around 13/0200UTC. Preliminary modelling results suggest that this is directed north and west of the Sun-Earth line, but with confirmatory results awaited. No definitive Earth-directed CMEs were therefore observed in the last 24 hours.

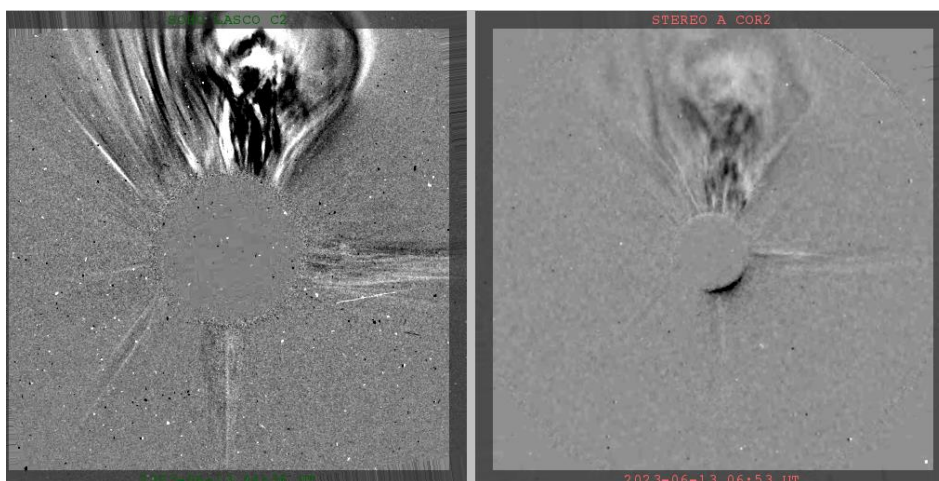


Figure 0: Coronagraph difference imagery (Lasco C3 and STEREO A COR2) of a high latitude northwest-directed filament and prominence eruption peaking 13/0200UTC. While modelling results are awaited, this feature is thought most likely to bypass Earth to no effect.

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Solar Wind / Geomagnetic Activity: The solar wind at L1 showed an ongoing Slightly Elevated fast wind environment, likely due to CH11/+ or CH10/+. Solar wind speeds, as observed by DSCOVR, showed an erratic tendency between 425 and 475km/s, with the density at Background levels in single figures ppcc. The IMF was at or below 8nT throughout with a smooth tendency, with the north-south component erratic between +6 and -5nT. The phi angle was stably positive (away from the Sun).

The net result of the above solar wind measures was for provisionally Quiet geomagnetic activity throughout, with a peak Kp of '2o' in the 12-15UTC interval.

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 Normal Background levels. The associated 24-hour fluence remained below the Active threshold ($1e8$ integrated pfu), with $1.81e6$ integrated pfu observed at 13/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low. A net increase in the number of sunspots on the disc appears likely in the four days, however the degree to which this increases the flare risk will be assessed with each sunspot that presents on the limb for analysis.

Solar Wind / Geomagnetic Activity: A CME associated with the M2.5 flare from AR3331 on the 9 June is now thought most likely to have passed 1AU to no effect at Earth (angled mainly behind). There are no other Earth-directed CMEs.

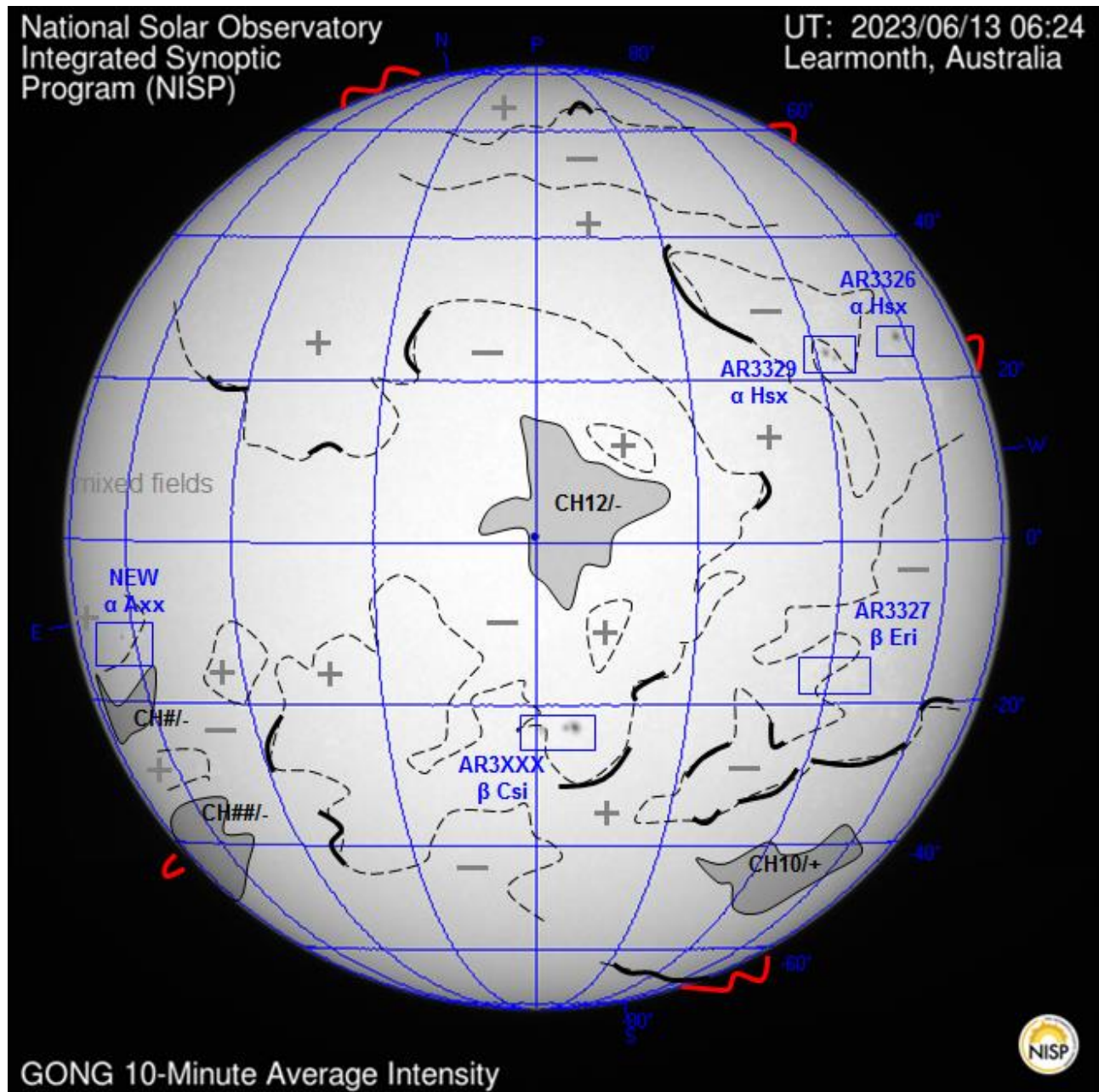
The forecast otherwise comprises the current weak fast wind further weakening though midweek, replaced by a stronger but still modest fast wind from CH12/- from Thursday 15 June.

Current Quiet geomagnetic conditions are now thought more likely to persist in the near-term given the now likely 09 June CME miss. Activity should increase to a peak of Slight Chance of G1 on Thursday 15 June, perhaps continuing into the start of Friday 16 June.

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 Normal Background levels. Electron fluence is expected to remain below the Active ($1e8$ integrated pfu) threshold.

Figure 1. Solar Analysis Valid 13/0625UTC.



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

Geomagnetic Storms:

A CME from the 09 June, associated with the M2.5 flare from AR3331 is now thought most likely to have passed 1AU to no effect, and the Slight Chance of G1 has been reduced accordingly relative to earlier guidance. No other Earth-directed CMEs feature in the forecast.

Solar winds are currently Slightly Elevated, likely due to a weak connection to the fast wind associated with the high speed stream of either CH11/+ or CH10/+, both relatively high latitude features, visually very tenuous in the most recently available AIA211 and 193 imagery (12/1800UTC). Solar winds are expected to continue at this level for the remainder of day one (Tuesday 13 June) before likely easing somewhat through day two (Wednesday 14 June). Their successort, equatorial CH12/- is currently near centre- disc, with the fast wind enhancement from the arrival of its HSS expected later on day three and into day four (15-16 June), with the risk of G1 partitioned between these two UTC days. 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 in this case.

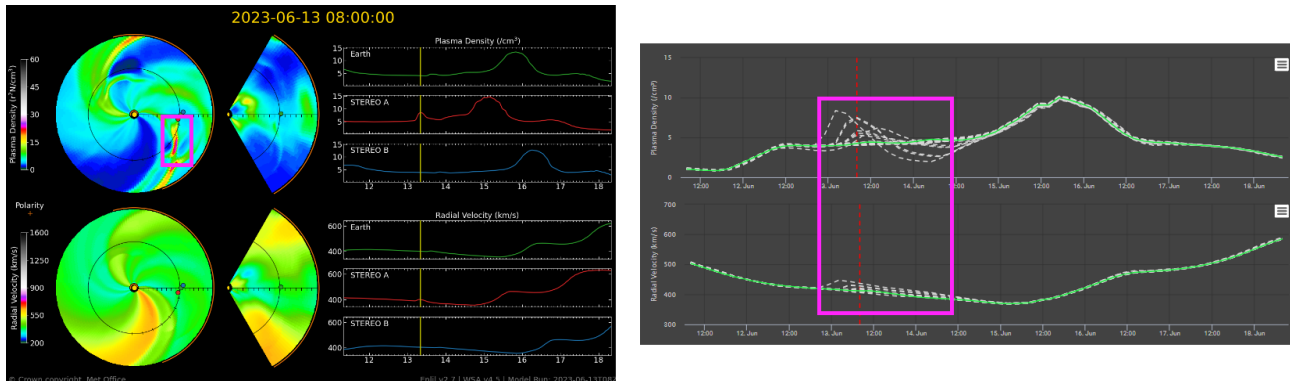
Geomagnetic conditions are forecast to be mainly Quiet with Unsettled spells through midweek. There is then a Chance of Active interval and a Slight Chance of G1 Minor Storms on days three and four (15-16 June) from the interaction with any CIR and likely HSS associated with CH12/-.

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	1	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

Now nil.

Figure 2: Latest MOSWOC Enlil ruin and ensemble, showing the 09 June CME as a miss in the deterministic run in recent hours. While some members of the ensemble have varying degrees of ‘hit’ shown, the peak disturbances are now passed, and the CME is judged to have passed 1AU in all likelihood to no effect at Earth.



Radio Blackouts - X-Ray Flares:

Low activity is expected to continue through the period, although with a continuing daily Slight Chance rising to Moderate at times. The Penticton 10.7cm flux has been in decline for some time since its 06 June 172sfu peak, and now stands at 146sfu as of 12 June.

Sunspot activity on the Earth-facing disc has been in a declining trend, with most spots apparently continuing to decrease in areal extent and complexity, although analysis of these trends has been somewhat hampered by the availability of relevant satellite imagery beyond 12/1800UTC.

There remains the potential for far-sided sunspot regions rotating onto the disc during the coming days, as indicated by far-sided products, perhaps ex-AR3314 and ex-AR3310 from the last rotation. The latest available AIA171 for example has significant EUV looping in both solar 'tropics', while STEREO A EUVI 195 also suggests some surviving regions here may be imminent onto the front side.

A net increase in the number of sunspots on the disc appears likely in the four days, however the degree to which this increases the flare risk will be assessed with each sunspot that presents on the limb for analysis.

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)
			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is at Background levels and is currently expected to persist at this level given the dearth of significant front-side sunspots.

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 (≥ 2MeV):

High energy electron flux (greater than 2MeV) is expected to be at mainly Normal Background levels through the period. Current conditions are suggestive of a steady state for levels in the wake of CH11 or CH10, and there is no feature likely to cause these levels to deviate beyond CH12/- into days 3 and 4 (15-16 Jun). This may result in an eventual rise of electron flux on day four (16 June).

Electron fluence is not expected to exceed the Active (1e8 integrated pfu) threshold during the period, with the REFM model currently providing generally good guidance for the full scope of its range, i.e. 72 hours. A slight uptick is thought probable on day four, but probably well below Active.

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