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## Space Weather Technical Forecast

Issued on Friday, 30 June 2023 at 01:28 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: Moderate solar activity likely. Slight chance of G1/Minor Storm on 01 July.**

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

**Solar Activity:** Solar activity has been Moderate, with an M3.8 flare peaking at 29/1415 UTC from AR3354. This region, now in the western hemisphere, remains a very large region and magnetically complex, and has elongated slightly over the past 24 hours. Currently AR3354 is classified as a Fkc/beta-gamma-delta classification as a small delta region persists. AR3340 has a history of moderate solar activity, but is becoming difficult to assess as it is now close to the northwest limb. The remaining 3 numbered regions, and two new yet to be numbered regions, are small and magnetically simple, with no significant change.

No Earth directed CMEs were observed in the period.

**Solar Wind / Geomagnetic Activity:** The solar wind, as observed at L1, was slightly elevated or occasionally elevated with wind speeds between 440 and 510 km/s. Density was at average levels between approximately 29/0500-1300 UTC, and at below average levels before and after. The total magnetic field strength was weak, at 8 nT or below, with the north-south component was predominantly weakly negative, reaching a maximum southward deflection of -6nT. Phi angle was remained negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3), but with one Active (Kp 4) interval 29/1500-1800 UTC.

**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), has been reaching High levels at times, with a peak value of 2434pfu at 29/1710 UTC. The associated 24-hour fluence started above the Active threshold, then decreased below from 29/1800 UTC, with a peak of 1.15e8 integrated pfu at 29/0000UTC. The fluence continued to decline late in the day, with a fluence of 6.2e7 at 30/0000 UTC.

### Four-Day Space Weather Forecast Summary

**Solar Activity:** Solar activity is expected to be Low to Moderate, with a slight chance of X-class flares, mainly from AR3354 but also from new regions that are likely to rotate onto the disc.

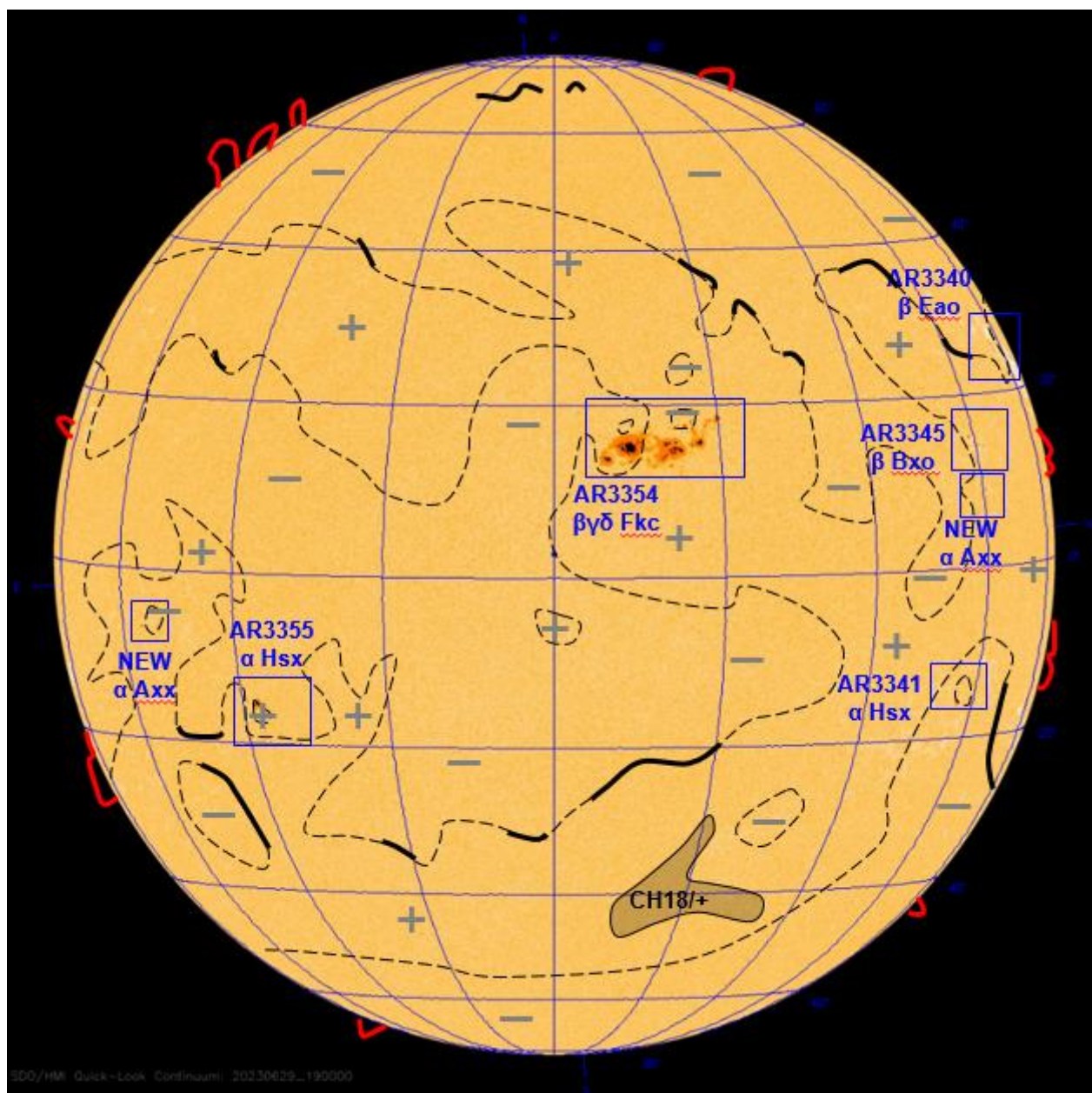
**Solar Wind / Geomagnetic Activity:** A CME which left the northeast quadrant of the Sun on 27 June may glance the Earth early on 01 July, but this is low confidence. In the absence of CME activity the solar wind speeds are expected to remain at predominantly slightly elevated levels today and tomorrow (30th and 1st), perhaps briefly reaching elevated speeds at times. During days 3 and 4 (2nd and 3rd) the solar winds are expected to decrease to background levels. Today and tomorrow geomagnetic activity is expected to be mostly Quiet to Unsettled (Kp 2-3) with isolated Active (Kp 4) intervals, and a slight chance of G1/Minor Storms (Kp 5), mainly tomorrow due to the potential CME glance.

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For days 3 and 4 (2nd and 3rd) predominantly Quiet (Kp 0-2) geomagnetic activity is expected.

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is most likely to remain at background levels but with a slight chance of reaching the S1/Minor Storm level, mainly due to AR3354. High energy electron flux (greater than 2MeV) will be at Moderate to High levels for much of the period, although with a gradually declining trend. The corresponding fluence may show an increasing trend through today and tomorrow, but is likely to remain below the Active (1e8 integrated flux) threshold.

**Figure 1. Solar Analysis Valid 29/1900 UTC.**



**Key:** Filament ---, Prominence ---, Magnetic Field Line ---, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson  $\alpha$ - $\beta$ - $\gamma$ - $\beta\gamma\delta$  and Zurich-McIntosh Axx etc.

## Geomagnetic Storms:

A CME which left the northeast quadrant of the Sun on 27 June may glance the Earth early on 01 July, but this is low confidence, with a range of potential arrivals between today (30th June) and 02 July possible.

In the absence of CME activity the solar wind speeds are expected to remain at predominantly slightly elevated levels today and tomorrow (30th and 1st), perhaps briefly reaching elevated speeds at times, helped by the weak influence from coronal hole 18 in the southern hemisphere. This is a smaller feature compared to the previous rotation, when the coronal hole did not result in any significant geomagnetic activity. During days 3 and 4 (2nd and 3rd) the solar winds are expected to decrease to background levels.

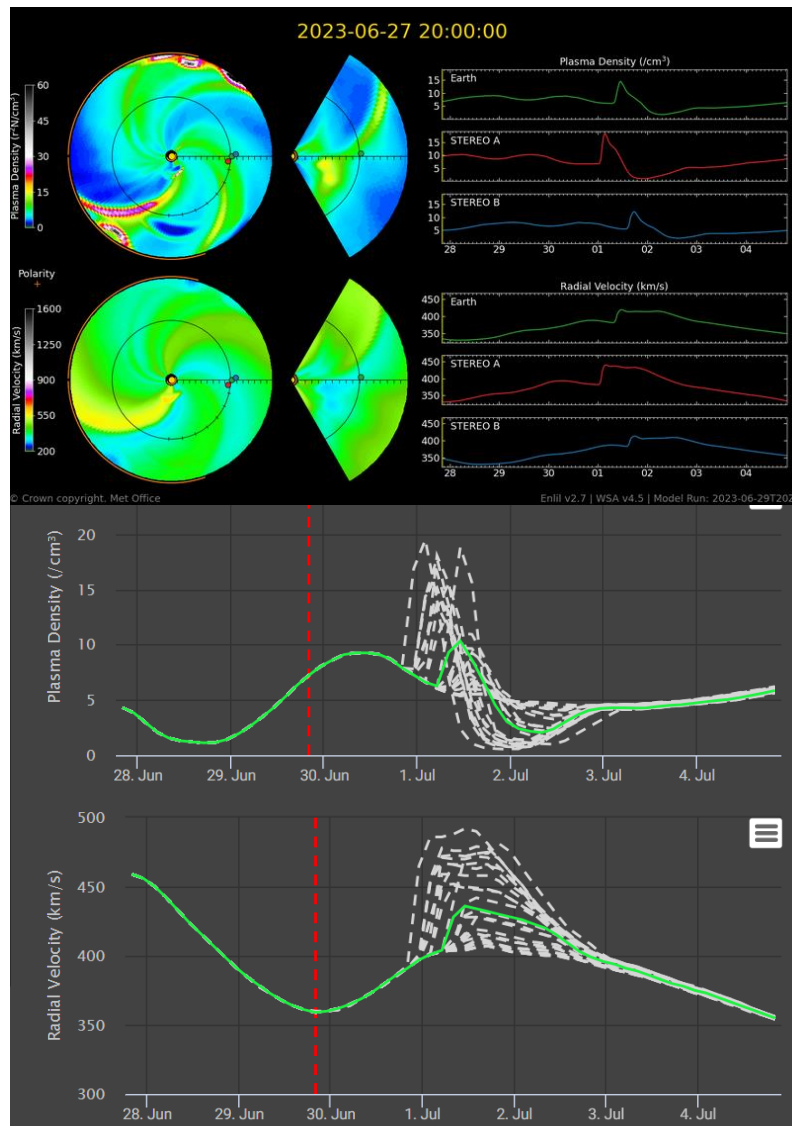
Today and tomorrow geomagnetic activity is expected to be Quiet to Unsettled (Kp 2-3) with isolated Active (Kp 4) intervals, and a slight chance of G1/Minor Storms (Kp 5), mainly tomorrow due to the potential CME glance. For days 3 and 4 (2nd and 3rd) predominantly Quiet (Kp 0-2) geomagnetic activity is expected.

| 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                | 30                | 10                | 5                 |
| 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                                     |
|-----------------------|-----------------------|-------------------|--------------------------|-----------------|------------------------|--|
| 28/0336               | Partial               | Filament eruption | NE quadrant, near AR3354 | 600 km/s        | 01/0600 UTC            | Glancing impact possible but low confidence. |

**Figure 2: MOSWOC ENLIL (top) and ensemble runs (bottom)**



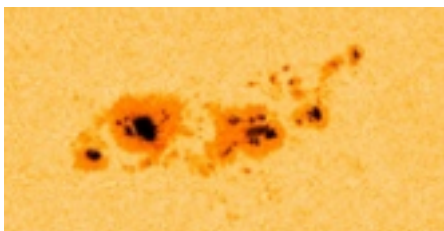
## Radio Blackouts - X-Ray Flares:

There are currently five numbered sunspot regions on the visible disc, and two small, simple and weak new regions. AR3354 remains a very large region and magnetically complex, now in the western hemisphere, having rapidly developed over previous days. The region has recently elongated slightly, while penumbra around the large intermediate spots has decreased a little but at the same time penumbra has increased slightly around some leading spots. A small and weak delta spot still survives. AR3340 in the northwest had also been noteworthy, being previously being moderately sized and complex. Currently AR3340 appears to be decreasing in size, although this is likely to be partly due to its position as it approaches the west limb. The other regions on the disc are small or simple with no significant change observed.

Solar activity has been Moderate, with an M3.8 flare peaking at 29/1415 from AR3354. Low to Moderate activity is expected to continue, with a slight chance of X-flares, these most likely from AR3354 but also from potential new regions that are likely to rotate onto the visible disc today and tomorrow.

| 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                     | 10                | 10                | 10                | 10                |

**Figure 3: AR3354 from latest SDO/AIA imagery**





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

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and is most likely to remain so throughout the period. However, there is a slight chance of reaching the S1/Minor Storm threshold, mainly due to AR3354 as it is now a very large and a magnetically complex region in the western hemisphere.

| Radiation Storms  | Level<br>(cm <sup>-2</sup> sr <sup>-1</sup> s <sup>-1</sup> ) | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|---|---|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance)   |   |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active  | ≥ S1  | No                        | 10                   | 10                   | 10                   | 10                   |
| Very Active   | ≥ S3<br>*   | No                        | 1                    | 1                    | 1                    | 1                    |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm <sup>-2</sup> sr <sup>-1</sup> s <sup>-1</sup> ) |   |                           |                      |                      |                      |                      |

## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has oscillated between moderate and high levels through the last 24 hours. The high energy electron flux (greater than 2MeV) will be at Moderate to occasionally High levels for much of the period, partly due to the expected weak influence of CH18, although with a gradually declining trend.

The corresponding fluence may show a slight increasing trend through today and tomorrow, but is likely to remain below the Active (1e8 integrated flux) threshold. The MOSWOC REFM therefore appears to be offering good guidance.

| GEO Electron Environment    | Level<br>(cm <sup>-2</sup> sr <sup>-1</sup> day <sup>-1</sup> ) | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|-----------------------------|---|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance) |   |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active                      | ≥ 2 MeV<br>≥ 1x10 <sup>8</sup>                                  | Yes                       | 50                   | 40                   | 30                   | 20                   |
| Very Active                 | ≥ 2 MeV<br>≥ 1x10 <sup>9</sup>                                  | No                        | 1                    | 1                    | 1                    | 1                    |

## Figure 4: MOSWOC REFM model

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