OBSERVER REVIEW

ANALYZING THE MID JUNE 2025 SOLAR STORMS

BACKGROUND

Between June 15 and June 17, 2025, the Sun unleashed a pair of powerful solar flares that disrupted Earth's upper atmosphere and exposed vulnerabilities in our space weather monitoring systems. On June 15, an M8.46-class solar flare erupted from sunspot region AR4114, peaking between 17:45 and 18:07 UTC. This eruption was accompanied by a coronal mass ejection that partially impacted Earth's magnetic field, sparking elevated geomagnetic activity and setting the stage for further disturbances.

Just two days later, on June 17, a significantly stronger X1.3-class flare was released from the same volatile sunspot region at 21:49 UTC. This flare caused a high-frequency radio blackout across broad areas of the Pacific Ocean and the western United States, with disruptions confirmed through ionospheric absorption data.

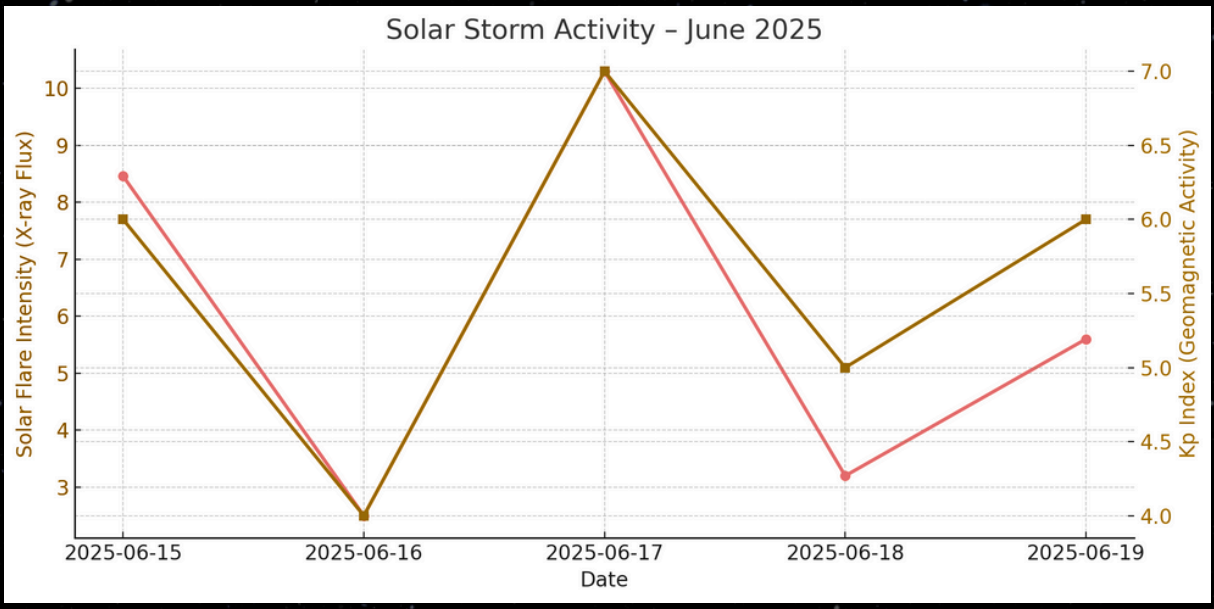
TIMELINE

JUNE 15

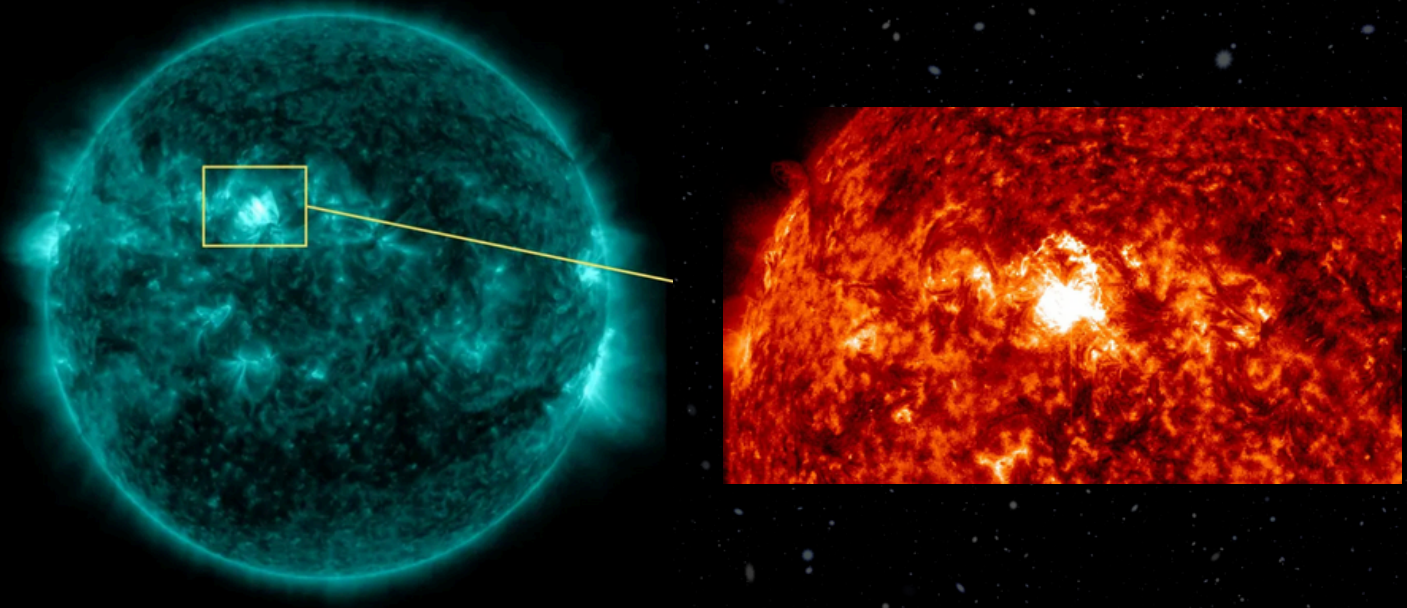
- **M8.46-CLASS SOLAR FLARE**
- **ORIGINATED FROM ACTIVE REGION 4114.**

JUNE 17

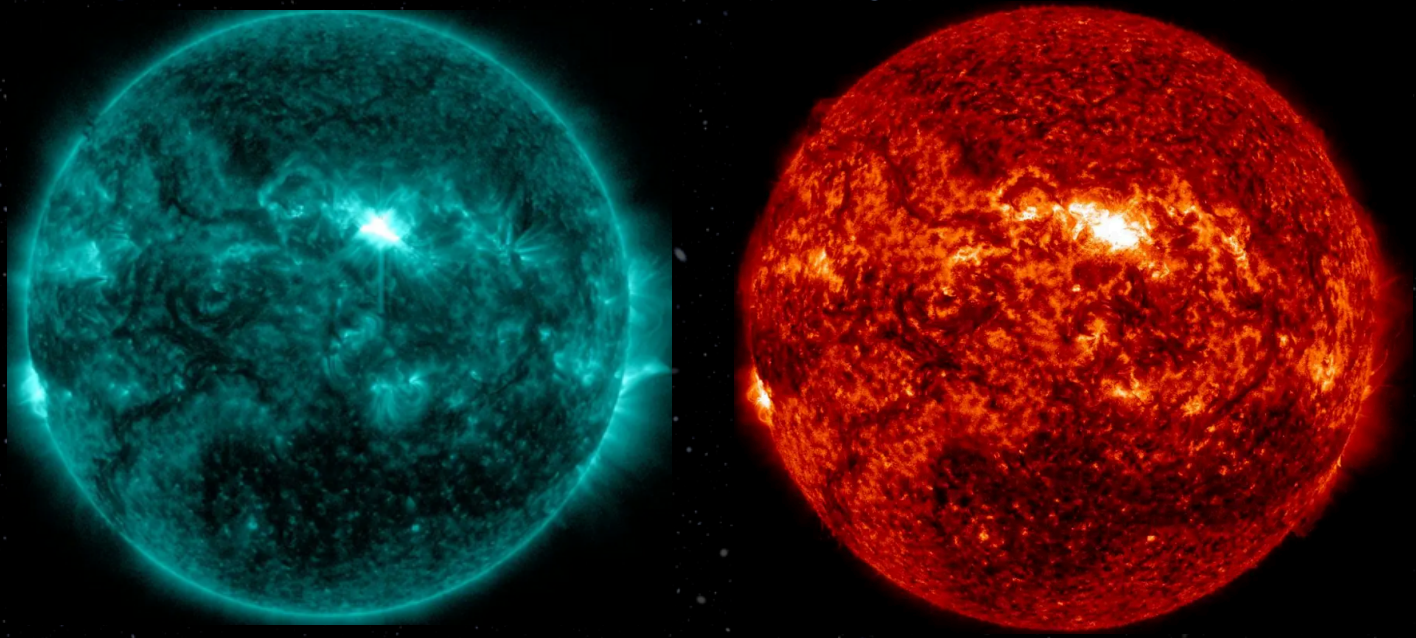
- **X1.3-CLASS SOLAR FLARE**
- **ORIGINATED FROM ACTIVE REGION 4114.**



PHOTOS



Satellite imagery shows the Sun erupting with an M8.46-class solar flare from Active Region 4114.
(Image credit: NASA SDO imagery)

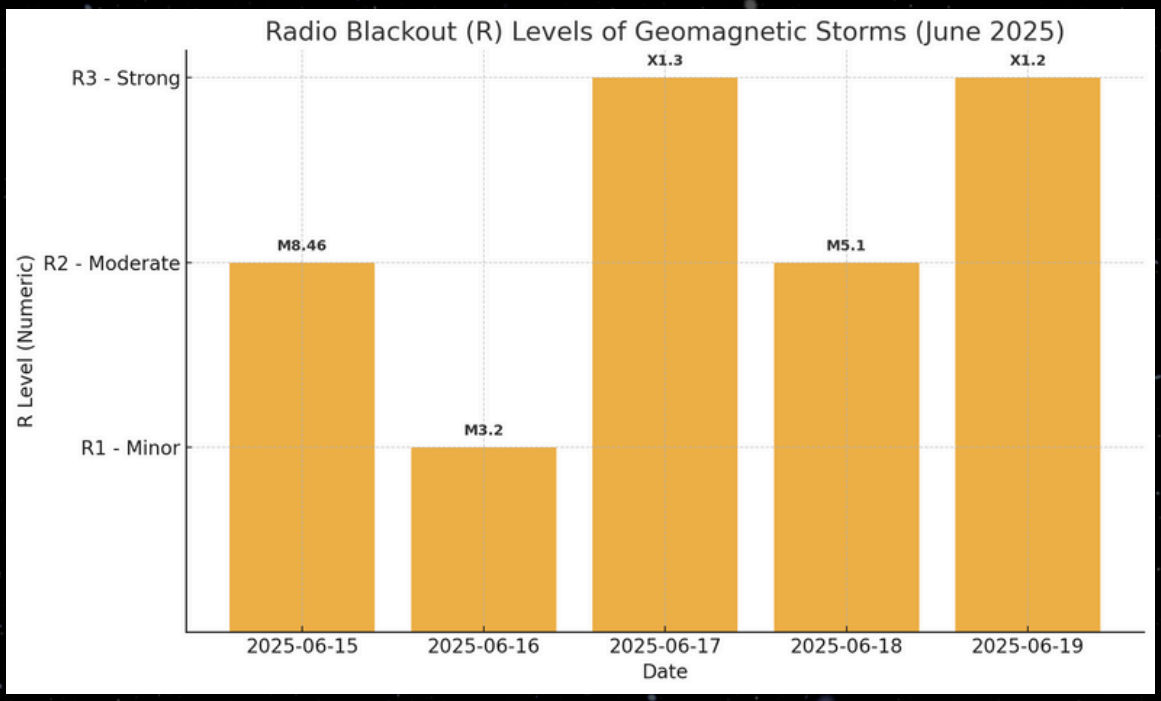


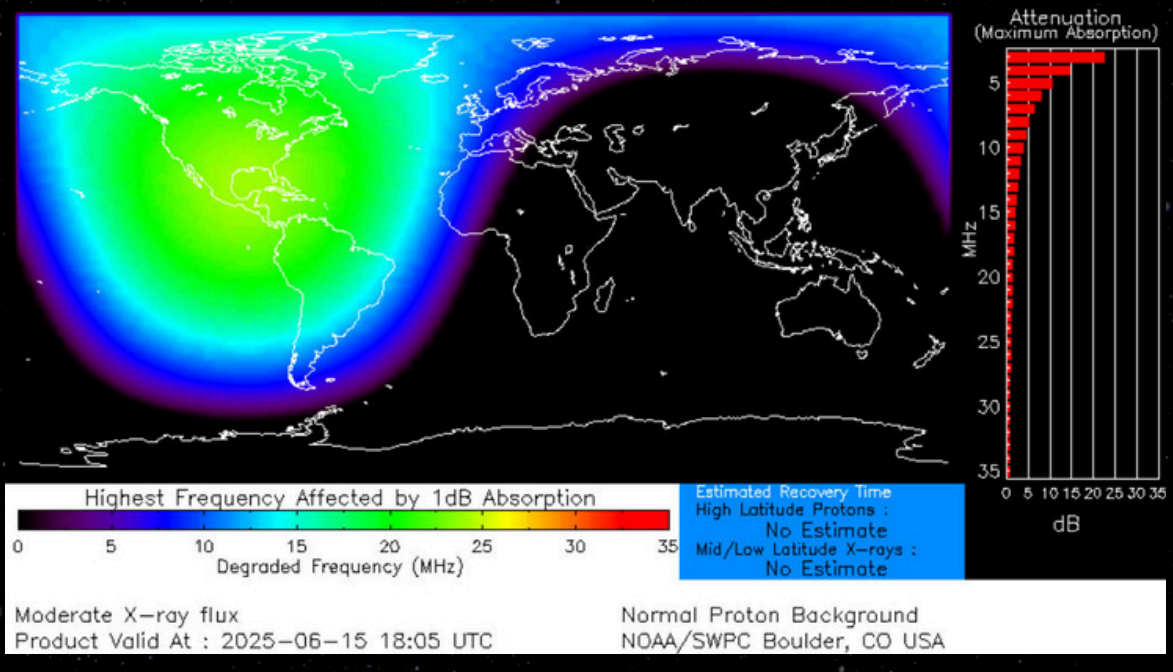
Satellite imagery shows the X1.2 solar flare on June 17, 2025 from Active Region 4114.
(Image credit: NASA SDO imagery)

RADIO BLACKOUTS

The flares caused an R2-level radio blackout that affected high-frequency (HF) communications below 30 megahertz across the Americas. These blackouts resulted from intense X-ray radiation that ionized the D-layer of Earth's atmosphere, leading to signal absorption and a temporary loss of HF radio propagation.

The X1.9-class flare was classified as an R3 blackout. It caused widespread HF signal loss across the sunlit side of Earth, particularly over the Pacific Ocean and western United States. Communications below 25 megahertz were severely degraded, affecting emergency response systems and long-range aviation transmissions.





IONOSPHERIC DISTURBANCES

The solar flares also induced sudden ionospheric disturbances, or SIDs. These events involved rapid spikes in D-layer ionization that triggered a phenomenon known as magnetic crochet. Magnetometers recorded short-lived perturbations in Earth's magnetic field, typically just a few nanoteslas in strength, lasting several minutes. These fluctuations were driven by the sudden arrival of X-ray photons, which accelerated ionospheric currents and altered local magnetic conditions.

GNSS AND NAVIGATION SYSTEMS

Both flares introduced significant disturbances to Global Navigation Satellite Systems. Users experienced signal jitter, carrier-phase errors, and momentary loss of positioning accuracy. These effects were especially problematic for pilots and surveyors conducting high-precision operations. The disruption was caused by phase and amplitude scintillation, a condition that arises when solar-induced turbulence in the ionosphere affects signal consistency.

The following geomagnetic storm, occurring on June 18 and 19, further worsened these conditions. GNSS reliability continued to fluctuate due to ionospheric irregularities. Real-time kinematic GPS operations were among the most affected.

POWER GRIDS

Although neither flare produced a significant Earth-directed coronal mass ejection, moderate geomagnetic storm activity followed. Conditions briefly reached G1 to G2 levels. Power grid operators in regions such as Quebec and Scandinavia activated standard protective protocols. These measures were designed to prevent damage from geomagnetically induced currents, and no power outages were reported during this period.

SPACECRAFT EFFECTS

Satellites and spacecraft in low-Earth orbit encountered elevated drag and background noise due to atmospheric heating and expansion. These changes posed risks to spacecraft attitude control and sensor calibration.

SOLAR STORM QUESTIONS

DO YOU HAVE ANY QUESTIONS ON THE TOPIC OF SOLAR STORMS?

IF SO, EMAIL THEM TO THE BELOW EMAIL ADDRESS:

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