National Audit Office

REPORT

The UK's resilience to severe space weather

Department for Science, Innovation & Technology

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National Audit Office

The UK's resilience to severe space weather

Department for Science, Innovation & Technology

Report by the Comptroller and Auditor General

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Gareth Davies
Comptroller and Auditor General
National Audit Office

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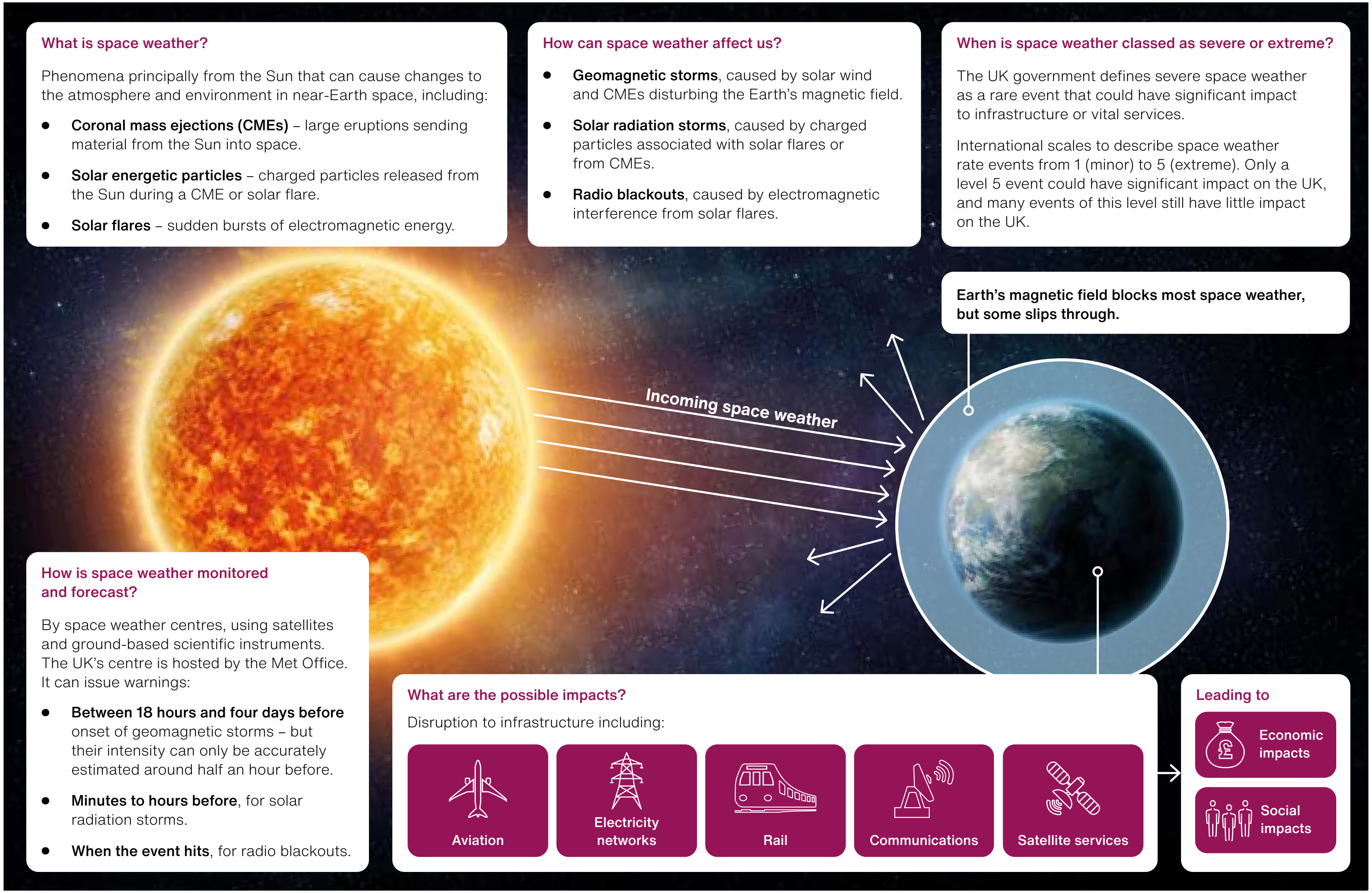
Figure 1

Introduction to space weather

Phenomena principally from the Sun can cause disruption to infrastructure on Earth



What is space weather?

Phenomena principally from the Sun that can cause changes to the atmosphere and environment in near-Earth space, including:

- **Coronal mass ejections (CMEs)** – large eruptions sending material from the Sun into space.
- **Solar energetic particles** – charged particles released from the Sun during a CME or solar flare.
- **Solar flares** – sudden bursts of electromagnetic energy.

How can space weather affect us?

- **Geomagnetic storms**, caused by solar wind and CMEs disturbing the Earth's magnetic field.
- **Solar radiation storms**, caused by charged particles associated with solar flares or from CMEs.
- **Radio blackouts**, caused by electromagnetic interference from solar flares.

When is space weather classed as severe or extreme?

The UK government defines severe space weather as a rare event that could have significant impact to infrastructure or vital services.

International scales to describe space weather rate events from 1 (minor) to 5 (extreme). Only a level 5 event could have significant impact on the UK, and many events of this level still have little impact on the UK.

Earth's magnetic field blocks most space weather, but some slips through.

How is space weather monitored and forecast?

By space weather centres, using satellites and ground-based scientific instruments. The UK's centre is hosted by the Met Office. It can issue warnings:

- **Between 18 hours and four days before** onset of geomagnetic storms – but their intensity can only be accurately estimated around half an hour before.
- **Minutes to hours before**, for solar radiation storms.
- **When the event hits**, for radio blackouts.

What are the possible impacts?

Disruption to infrastructure including:

- Aviation
- Electricity networks
- Rail
- Communications
- Satellite services

Leading to

- Economic impacts
- Social impacts

Source: National Audit Office analysis of publicly available information

Summary

1 The Cabinet Office sets out the most serious acute risks facing the UK in the government's classified National Security Risk Assessment (NSRA) and public-facing National Risk Register. Severe space weather has been on the National Risk Register since 2011 as one of the most serious natural and environmental hazards. In 2025, the government considered the likelihood of a severe space weather event occurring within the next five years to be 5–25%.

2 Space weather originates from solar activity (**Figure 1**) and mostly causes no tangible disruption. Severe space weather can, however, disrupt a range of technologies. The largest event on record (September 1859), known as the 'Carrington event', affected telegraph communications.[1] It is expected that a similar event today would have significant and wide-ranging impacts due to advancements in, and increasing dependence on, technologies. For example, an event could cause the widespread disruption of air travel for multiple weeks, localised power outages in the UK, and disruption to satellite services such as satellite navigation and timing services used by many sectors. The Cabinet Office assigns ownership of NSRA risks to lead government departments, covering the following: risk identification and assessment; prevention, resilience, preparation and emergency response; and recovery. The Department for Science, Innovation & Technology (DSIT) coordinates the government's work on severe space weather, having formally taken on this role in December 2025. It is the parent department for the Met Office and the policy owner for the UK civil space sector. The Met Office is responsible for risk identification and risk assessment.

3 In September 2021, the government published its *UK Severe Space Weather Preparedness Strategy* (the Strategy) setting an ambition to build the UK's resilience to the risk of severe space weather, while also collaborating with international partners and making science and technology integral to addressing this risk. DSIT told us it is planning to develop a new severe space weather preparedness strategy and is currently in the evidence-gathering phase.

1 A solar flare on 1 September 1859 triggered a geomagnetic storm that is broadly accepted to be the largest on record.

4 This report examines the government's work to increase the UK's resilience to the risk of severe space weather. It forms part of a broader programme of reviews examining preparedness for a range of risks on the NSRA and is intended to provide insights useful for the management of other risks. It covers:

- the extent to which the government understands the risks and potential cascading effects of severe space weather, and the adequacy of governance arrangements in place to oversee preparedness (Part One);
- the adequacy of the UK's forecasting capability (Part Two); and
- the adequacy and completeness of the government's response plans (Part Three).

5 The cross-cutting nature of the risk and its impacts requires coordinated action to be taken across government and beyond. This report sets out how central government coordinates, supports and assures local activity. It does not directly cover local response arrangements, nor is it a comprehensive assessment of whether the UK is prepared for a severe space weather event. This report also does not cover arrangements in the devolved nations or activities in the remit of the Ministry of Defence.

Key findings

Understanding the risk, and oversight arrangements

6 The government is improving its understanding of the UK's vulnerability to severe space weather but does not yet understand the full range of possible impacts and cascading effects well. The Met Office is responsible for assessing the risk of severe space weather on behalf of the government. It does so by drawing on the expertise of the Space Environment Impacts Expert Group and using a reasonable worst-case scenario (based on an event of approximately the same magnitude as the Carrington event), in line with Cabinet Office guidance. The government has a good understanding of some of the initial and knock-on impacts of this scenario. For example, it understands that an event could cause localised power outages in the UK, and the effects a loss of electricity could have on many services. However, limitations in scientific understanding and departmental planning mean the possible impacts and cascading effects on some sectors, such as the potential scale of impacts from space weather-induced errors in digital systems and how short disruptions to global navigation satellite systems would affect transport, are not well understood. The potential economic impact on the UK – estimated in 2022 at around £9 billion – is also uncertain. The government's understanding of the UK's vulnerability to severe space weather is improving as the science develops (paragraphs 1.3 to 1.8 and Figures 2 and 3).

7 **The government has not yet set out how resilient it would like the UK to be to severe space weather nor what level of resilience its spending will provide.** The government's 2021 strategy included 12 high-level commitments aimed at improving resilience. It did not include target levels of preparedness or resilience, the outcomes it is seeking, or any cost estimates or additional specific public funding. It also did not consider the amount of risk the government is willing to accept (known as its risk appetite). We identified areas of existing spending including around £6.7 million in 2025-26 on the Met Office Space Weather Operations Centre, and around £300 million to date committed to the European Space Agency's (ESA's) Vigil space weather mission, although this is unlikely to be comprehensive. The government does not know its total spending on managing the risk of severe space weather. Many investments which increase resilience to severe space weather also increase resilience to other risks, so isolating funding for one particular risk is difficult. Private sector organisations also invest in resilience, and the government's regulation can encourage this. In the 2025 Spending Review, the Cabinet Office analysed resilience-related spending proposals across government and advised HM Treasury on which should be prioritised. Five packages of spending bids included resilience to severe space weather as a large part of their justification. The government has not, however, mapped out the totality of its requirement or reviewed whether the spending package meets its overall requirements (paragraphs 1.9 to 1.15).

8 **Roles in managing the risk of severe space weather are not clearly defined, and accountabilities and assurance arrangements could be stronger.** The Cabinet Office has assigned roles to four public bodies: the Met Office is responsible for risk identification and risk assessment; and DSIT, the Department for Energy Security & Net Zero (DESNZ) and the Department for Transport are responsible for prevention, resilience, preparation and emergency response depending on the policy areas. Although not formally assigned the role of overall lead government department, DESNZ coordinated the government's work on severe space weather across all areas until April 2025, when DSIT took over with a transition period running over the summer, and the transfer formalised in December 2025. The Cabinet Office's guidance for lead government departments does not explain what processes should be followed, nor does it set minimum standards. It told us it intends to publish new written expectations on the role by summer 2026. As the coordinators, DESNZ and DSIT have overseen cross-government work through a steering group. However, DESNZ told us it had difficulty getting senior officials to regularly attend and, in some instances, found it challenging to galvanise action from other government departments. We also found some confusion over what individual departments were responsible for. The government does not have an up-to-date assessment of progress against the aims of the 2021 strategy (paragraphs 1.16 to 1.23 and Figures 4 and 5).

The UK's forecasting capability

9 **The Met Office has played a vital role in establishing and enhancing the UK's forecasting capability.** In 2014, the Met Office opened its Space Weather Operations Centre (the Operations Centre), which it reports to be one of a handful of 24/7 space weather prediction centres globally. Forecasting continues to be a scientifically complex challenge, however, with a forecasting window of up to 96 hours depending on the type of space weather. The Operations Centre issues space weather alerts and specialist forecasts that can help sectors take preventative action, for example shutting down at-risk electricity transformers to prevent damage. We found the Operations Centre is well regarded internationally, with international forecasters drawing on its expertise, for example for training and technical advice (paragraphs 2.2 to 2.5 and 2.8 and 2.16, and Figure 6).

10 **The Met Office has built the UK's space weather monitoring and forecasting capability with limited resources, but the resilience of these services remains vulnerable.** Predicting space weather relies primarily on satellite data. The Operations Centre had a budget of around £6.7 million in 2025-26. As the UK does not have any of its own space weather satellites, the Met Office has an agreement with the United States' Space Weather Prediction Center to use data from satellites owned by the United States and to collaborate on forecasting. Some of the satellites the UK relies on have passed, or are nearing the end of, their predicted lifespan, and several are primarily scientific missions with scientific research taking priority over forecasting. To improve resilience, the Met Office uses data from multiple satellites in case one goes out of service, and it told us it is working with international partners to formalise its data-sharing arrangements; however, this will not fully ensure the resilience of the UK's capability (paragraphs 2.3, 2.9 and 2.10, and Figure 7).

11 **There is more to do to make forecasting information useful for government officials and industry.** Forecasting can only be effective if it is meaningful for those needing to take action. To describe conditions and their potential impacts, the UK uses the United States' National Oceanic and Atmospheric Administration's space weather scales, which are currently being revised to be more meaningful to users. We found the Met Office has worked collaboratively with some sectors, for example the electricity sector, to develop specialist forecasts. However, other sectors continue to find the technical information difficult to interpret. The Met Office is developing its communications, and during the May 2024 space weather event, it issued a new-format briefing with more specific details on the type and scale of likely impacts (paragraphs 2.15 to 2.17 and Figure 8).

12 The government is investing in programmes to advance the UK's future space weather forecasting capability. The UK is a member of ESA, which provides access to large-scale multi-national space programmes that are challenging to replicate nationally. This includes the government taking a leading role in supporting ESA's space weather mission, Vigil, which aims to improve the accuracy of forecasts of coronal mass ejection arrival times, giving more confident estimates of when impacts will be felt. To date, the UK has contributed just over half of the overall funding, with a total UK commitment to date in the region of £300 million. The Vigil satellite is currently expected to launch in 2031, with an operational life of five years. DSIT, with the Met Office, has begun to consider future programmes beyond this mission but has not yet initiated formal planning, creating uncertainty over how resilience will be maintained in future decades (paragraphs 2.11 to 2.14).

The government's response planning

13 The maturity and completeness of response plans across the government varies, with departments taking a variety of approaches. We would expect departments to assess the suitability for severe space weather of their generic response plans, fill in any gaps with risk-specific planning, and share their plan with the risk's lead government department. In 2023 and 2024, DESNZ requested information on sector response planning from relevant government departments and received limited replies. Plans in the electricity and aviation sectors were the most mature and specific.[2] Departments outlined a range of reasons for not producing plans, including the following: competing priorities; lack of resources; a lack of mechanisms to engage with a sector; and a lack of response and planning structures within some relevant organisations. Some sector teams we spoke to also described limitations in their understanding of the risk or the potential impacts. In February 2026, DSIT commissioned updated response plans from departments, but to date there has been no central assurance over the separate plans to ensure they are sufficient to enable an effective response (paragraphs 3.2 to 3.8).

14 The government has begun testing the effectiveness of response plans, but to date tests have been limited in number and scope. It is essential that the government gains assurance that response plans are fit-for-purpose for all relevant risks, many of which are managed by organisations outside the government's direct control. The government does this by reviewing and approving plans and testing them through discussion and simulation exercises. DESNZ ran three discussion exercises in 2024, and DSIT is in the process of applying the lessons learned and deciding its plans for future exercises. A full simulation exercise involving local responders has not yet been run. We found that other government departments have also carried out exercises and workshops, but there is no systematic learning from these. Past reviews of the NSRA process also argued that the government should avoid treating the reasonable worst-case scenario as a prediction and should consider a range of ways in which risks could manifest (paragraphs 3.2 and 3.14 to 3.19).

2 We have been told that Defence also has specific procedures, but these fell outside the scope of this review, and we have therefore not audited these plans.

15 The government has yet to define actions for businesses and citizens in the event of a severe space weather emergency. In the government's 2025 *Resilience Action Plan*, it set an objective to enable the whole of society to take action to increase their resilience. In May 2024, the government launched its *Prepare* public information website to help citizens prepare for emergencies and be more informed about hazards. For severe space weather, however, it has yet to identify any actions it would want individuals or businesses to take before or during an event. We found the Met Office has undertaken work seeking to raise public awareness of space weather and its potential impacts. The government has an outline communications plan for severe space weather events, which it plans to revise and expand, but it has not yet developed pre-agreed messages for the public in the event of a severe space weather emergency, risking an ineffective whole-of-society approach (paragraphs 3.20 to 3.22).

Concluding remarks

16 The government has identified severe space weather as a risk with potentially significant impacts that the UK must adequately prepare for and respond to. Since it first included it in the UK's National Risk Register in 2011, the government has invested in developing and enhancing the UK's forecasting capability and encouraged awareness of the risk it presents. The Met Office is well respected internationally, has built the UK's forecasting capability and is taking steps to increase its resilience while taking account of the developing science and user needs. The government has drawn on expertise in the scientific community to inform its assessment of the risk and has begun collating and exercising departmental response plans.

17 However, there are a number of issues that could undermine the UK's ability to prepare for and respond effectively to a severe space weather emergency which the government needs to resolve. Roles and responsibilities for managing the risk remain unclear, accountabilities could be stronger, and the government has yet to set out what outcome it is looking to achieve and the level of residual impacts it is willing to accept (risk appetite). There is more the government can do to engage local responders and businesses in planning to ensure the effectiveness of its whole-of-society response. The centre of government has an incomplete understanding of how sectors plan to respond to a severe space weather emergency, including whether they plan to use risk-specific or generic response plans, and the testing of response plans through simulation exercises has been limited, constraining understanding of vulnerabilities. Now that responsibility for coordinating the risk sits with DSIT, as the parent department for the Met Office and policy owner for the UK civil space sector, it brings the opportunity to reinvigorate the government's ambition and address the gaps in its approach.

Recommendations

a The government is updating its severe space weather preparedness strategy. To invest efficiently and effectively in long-term resilience, it must define what outcomes it is seeking and the work required, and make informed decisions about prioritisation. It must also test plans against a range of plausible scenarios and embed knowledge from its past exercises and responses to space weather. In designing its new strategy, DSIT should consider and define:

- roles and responsibilities for severe space weather resilience across the public sector;
- what level of resilience to severe space weather's impacts the government is seeking for the UK to achieve, including agreeing expectations for different sectors;
- what public investment will be required to deliver its objectives; and
- which knowledge gaps on severe space weather's impact the government will prioritise and fill.

b Cross-government initiatives can often be more difficult to implement due to the large number of bodies involved in delivery and their existing individual governance and accountability structures. By the end of 2026, DSIT should review governance arrangements for overseeing the risk of severe space weather to strengthen leadership, accountability and assurance arrangements as required. This should include consulting with the Cabinet Office for guidance on governance arrangements for managing this cross-cutting risk.

c DSIT should, with the Met Office, decide what long-term forecasting capability, and at what level of resilience, the UK requires. Ahead of the next spending review, it should develop a delivery plan to secure the required capability.

d To strengthen response plans, DSIT should develop a continuous plan of learning and exercising by September 2026. This should include:

- collating, disseminating and applying lessons from past exercises, including those relevant to but not specifically on severe space weather;
- considering and testing multiple scenarios in addition to the reasonable worst-case scenario, and consider the compounding and cascading impacts and identify points of failure; and
- carrying out a command-post exercise on severe space weather, involving sectors and local responders, in the next three years.

e DSIT should add detail and precision to its plans to encompass a whole-of-society approach by March 2027. This should include:

- concluding its work developing a severe space weather communications plan for UK businesses and citizens in the event of an emergency;
- considering how it can best support local responders and civil society to participate in planning;
- identifying what specific preparedness work it needs the government to undertake as a result of its strategic analysis, and what risk-generic work it should rely on;
- working with other departments to ensure that all sectors understand how to interpret and use Met Office's notifications, and that the Met Office understands the information needs of those sectors; and
- working with other departments to map what actions sectors could take to prevent or reduce impacts prior to an event's arrival; this should include defining which actions would require direction from the government.

Part One

Understanding the risk, and oversight arrangements

1.1 Space weather originates from solar activity (Figure 1) and mostly causes no tangible disruption. However, severe space weather can cause disruptive impacts across a range of technologies and infrastructure.

1.2 In this part, we examine the government's understanding of the risk of severe space weather, and the adequacy of governance arrangements in place to oversee preparedness. We examine:

- the extent to which the government understands the risks and potential cascading effects of severe space weather;
- the government strategy and funding associated with the risk;
- roles and responsibilities for managing the risk; and
- the adequacy of governance arrangements in place to oversee preparedness.

Space weather

1.3 Space weather occurs every day. However, since the start of the space age in the late 1950s, there have been few space weather events with notable impacts, and consequently, understanding is limited. There have, however, been some 'near misses' and smaller events which have caused technological damage (see **Figure 2** overleaf). The largest event on record, the Carrington event of September 1859, caused widespread disruption to telegraph communications.[3] It is expected that a similar event today would have a significantly greater impact due to advancements in, and increasing dependence on, technologies.

3 A solar flare on 1 September 1859 triggered a geomagnetic storm that is broadly accepted to be the largest on record.

Figure 2
Examples of notable space weather events, 1859 to February 2026

Since the Carrington event of 1859, Earth has been affected by a number of smaller but still notable space weather events

Date	Event description
September 1859	The Carrington event is the most extreme solar storm on record. A solar flare on 1 September 1859 triggered a geomagnetic storm that is broadly accepted to be the largest on record. Telegraph machines reportedly shocked operators and caused small fires. Auroras were visible in tropical regions.
May 1967	A blackout of polar surveillance radars during the Cold War led to the mobilisation of US nuclear bomber squadrons for a strike on the USSR, until the Sun was identified as the source of the radio interference.
August 1972	This storm caused disruptions to the US electricity grid and detonated numerous magnetic sea mines off the coast of North Vietnam.
March 1989	A storm caused a power outage across the province of Quebec, Canada. Numerous radio communication blackouts and satellite anomalies were reported.
August 1989	A storm is thought to have caused the failure of the Toronto stock market’s computer systems, halting trading for three hours.
October and November 2003	This event caused a one-hour power outage in Malmö, Sweden. There were widespread disruptions to satellites and communication systems.
July 2012	A storm comparable in size to the 1859 Carrington event missed Earth.
November 2015	A solar radio burst caused interference to air traffic control radars in Europe. In southern Sweden, this caused the air traffic control system to shut down for several hours, severely disrupting flights.
May 2024	The largest storm since 2003, its impacts were minor. It moved thousands of satellites from their orbits.

Notes

1 All events in this timeline, except the 2015 event, reached the top category in the international space weather scale (see Figure 8). This does not mean they had severe impacts.

2 The examples above are illustrative, with an emphasis on events from recent decades. For a more complete set of notable space weather events, please see the timeline in the source.

3 For some of these events, pre-emptive mitigations and/or during-event actions were taken around the world that may have reduced the level of impacts experienced.

Source: National Audit Office summary of examples from timeline in Australian Government Bureau of Meteorology, *Australian Space Weather Alert System*, 2024, and other publicly available information

1.4 Severe space weather could potentially affect many services and infrastructures (see **Figure 3** overleaf). For example, it could cause regional power disruptions, loss or disruption of satellite services including Global Navigation Satellite Systems (GNSS) and some telecommunications such as satellite communications and high-frequency radio, disruption to aviation, an increase in background radiation doses at high altitudes and in space, and possible disruption to ground-based digital systems. Space weather can alter the density of the atmosphere, changing the orbits of satellites. The catalogue of tracked objects in orbit would be affected, raising the risk of in-orbit collisions. Our increasing reliance on satellites and other technologies also leads to an increase in the potential impacts from space weather.

Understanding risk and impact

The reasonable worst-case scenario

1.5 The Cabinet Office maintains the government's classified National Security Risk Assessment (NSRA) and public-facing National Risk Register, which set out the most serious acute risks facing the UK. Severe space weather has been on the National Risk Register since 2011 as one of the most serious natural and environmental hazards. In 2025, the government considered the likelihood of a severe space weather event occurring within the next five years to be 5–25%, with significant and wide-ranging impacts.

1.6 The Met Office is responsible for assessing potential scenarios on behalf of the government in line with Cabinet Office guidance, including developing a 'reasonable worst-case scenario', and assessing the impact and likelihood of these. Its main scenario uses a period of extreme solar activity lasting one to two weeks. It includes space weather events caused by several different solar phenomena including coronal mass ejections, solar flares, solar radiation storms and solar radio bursts. Each phenomenon would likely occur several times during the event period, with each varying in magnitude and temporal and spatial extent. One or more of the events would be of approximately the same magnitude as the most significant observed severe space weather event since modern measurements began – the Carrington event of 1859. The Met Office drew on the expertise of the Space Environment Impacts Expert Group (see paragraph 2.5) and a range of data sources to develop its risk assessment.[4]

4 M Hapgood, R Horne, M Angling and others, *Summary of space weather worst-case environments: (4th revised edition)*, Science and Technology Facilities Council, January 2026, accessed 5 March 2026.

Figure 3

Examples of sectoral impacts from severe space weather events

Severe space weather can affect many sectors and technologies

	Aviation	Electricity	Rail	Retail financial services
Possible impacts of a severe space weather event	• Navigation and communication systems, including satellite communications, and high-frequency radio communications, may be disrupted. • Aircraft components and systems may malfunction. • Air traffic control may see radar interference, and airports may be affected by power outages.	• Disruption to Earth's magnetic field may send unexpected currents through long-distance wires, including electricity transmission networks. The electricity system may trip out in some local areas due to voltage instability or distortions, and transformers may overheat. • Satellite services and specialised communications networks used by the electricity system may also be affected.	• Rail signalling systems may generate false signals during particularly strong events. • The rail network is vulnerable to knock-on effects from power outages. For example, it relies on the electricity network to run electric trains and to operate stations.	• Retail banking could be affected by short disruptions to satellite timing services and mobile communications, but the extent is uncertain. • Retail financial services are vulnerable to knock-on effects from power outages.
Scale of impact in the UK in a reasonable worst-case scenario[1]	Widespread disruption of air travel for multiple weeks. Potential for airport evacuations in the case of local power outages. Airlines have well-established procedures for loss of communications, and aircraft have redundant components to protect against malfunctions, but the safety impact of both issues potentially affecting many aircraft at once is less understood.	System protection can raise operational costs. Some local areas may experience outages of up to a day from system trips, or multi-month outages from transformer damage.	Rail services would be suspended in areas with power outages, and passengers evacuated from trains. The scale of any other impacts is unclear.	No disruption to core UK financial market infrastructure is expected. In some areas, mobile and face-to-face banking and cash machines could be affected by power outages. The UK has little understanding of the impacts on other financial markets around the World.
Impact examples from past severe space weather events	**November 2015:** A radar disturbance temporarily shut down Sweden's air traffic control system, affecting flights across the region. **November 2025:** After an aircraft lost altitude due to a computer malfunction, around 6,000 aircraft were grounded for repairs. The manufacturer reported that the malfunction was caused by solar radiation. Such effects can also be triggered by cosmic radiation.	**March 1989:** A geomagnetic storm led to a blackout in parts of Canada, affecting six million people for nine hours.	There are reports from the 1980s and the 2000s of red (safe) false signals on railways in Sweden and Russia coinciding with severe space weather events. There are no reported incidents of unsafe false green signals caused by severe space weather.	There are no direct examples.

Note

1 The National Risk Register sets out a 'reasonable worst-case scenario' for severe space weather risk. The scenario is not a prediction of what is most likely to happen, but instead represents the worst plausible manifestation of this particular risk once highly unlikely variations have been discounted.

Source: National Audit Office analysis of government and publicly available documentation and interviews

Understanding the impacts

1.7 Some of the initial and potential knock-on impacts of a Carrington event scenario are well understood by the government. For example, it understands that an event could cause localised power outages in the UK, and the effects a loss of electricity could have on many services. The government is also improving its understanding of the UK's vulnerability, particularly as the science develops. For example, initial findings from a recent reassessment of the electricity system's vulnerability to the direct effects of space weather suggest that, for certain elements, the risk may be lower than previously thought, whereas its vulnerability to outages of telecoms and data services is increasing. The Met Office is also working with a range of organisations to use weather balloons and instruments on aircraft to measure how space weather affects radiation levels in different parts of the atmosphere, which will help it to better predict impacts. The electricity transmission system operators are planning to increase the number of monitors on their network in Great Britain from four to over 100, to more reliably measure the impact of space weather.

1.8 However, limitations in scientific understanding and departmental planning, and uncertainty over possible cascading effects mean the potential impacts for some sectors, such as how short disruptions to GNSS would affect transport, are not well understood. As a consequence, the potential economic impact of a severe space weather event is also uncertain. The Met Office's 2022 risk assessment estimated it to be about £9 billion for the UK in a Carrington-level event. Examples of knowledge gaps include the following.

- **Errors in digital systems:** Solar energetic particles can damage micro-electronics, and smaller computer chips are generally considered more at risk. There are uncertainties over which infrastructure is more vulnerable, as well as over the potential scale of impacts.
- **Public reaction and behaviour:** This is considered difficult to predict due to the infrequency of events, meaning there is a lack of baseline.
- **The social and economic impact of satellites being disrupted intermittently:** Current economic impact estimates assume a complete loss of GNSS services regardless of the cause. However, during a severe space weather event, GNSS signals will be lost at times, and present but disrupted and unreliable at other points. There is therefore uncertainty over how this will impact different sectors.

Strategic aims and resilience levels

1.9 In September 2021, the government published its *UK Severe Space Weather Preparedness Strategy* (the Strategy).[5] It outlined the government's five-year vision and set an ambition to build the UK's resilience to the risk of severe space weather, while also collaborating with international partners and making science and technology integral to addressing this risk. It made 12 high-level commitments across three main categories.

- **Assess:** Focused on enhancing the UK's understanding of severe space weather, its impacts, and ability to forecast events.
- **Prepare:** Focused on increasing the resilience of infrastructure and services and minimising the impacts of a severe space weather event.
- **Respond and recover:** Focused on ensuring the UK can respond to events effectively and recover from them quickly.

1.10 The Strategy did not clearly state what level of resilience the government was aiming for or what outcomes it was looking to achieve, such as target levels of preparedness or resilience, or the amount of risk that it is willing to accept in pursuit of those outcomes (risk appetite). We found in discussions with sector leads that some sectors are required by legislation to be resilient within reason, but none had received a clear direction on what, specifically, they are expected to achieve on space weather resilience. Without these, it is challenging for the government to identify the actions needed and evaluate progress.

Funding

1.11 The government does not know its total spending on managing the risk of severe space weather. The Strategy did not include any cost estimates or additional specific funding, and no additional funding is automatically provided to lead government departments for NSRA risks.

1.12 We identified a number of government investments relevant to severe space weather, but this is unlikely to be comprehensive (see paragraphs 2.3, 2.6 and 2.12). Many investments which increase resilience to severe space weather also increase resilience to other risks, so isolating funding for one particular risk is difficult. For example, the Department for Science, Innovation & Technology (DSIT) is investing in a UK alternative to satellite position, navigation and timing services, which will reduce the impact of severe space weather but is mainly aimed at addressing other risks.

5 Department for Business, Energy & Industrial Strategy, *UK Severe Space Weather Preparedness Strategy*, September 2021 (viewed on 2 March 2026).

1.13 In Spending Review 2025, for the first time, the Cabinet Office asked departments to identify which of their spending bids would contribute to resilience to NSRA risks and used this to advise HM Treasury on which proposals from across government should be prioritised as the most effective ways to improve national resilience. This process identified five packages of spending bids, for which severe space weather was a large part of their case, all proposed by DSIT. DSIT told us that funding for these activities has since been approved.

- New funding for resilient Positioning, Navigation, and Timing (PNT).
- Continued funding for the European Space Agency's Vigil space weather mission (see paragraphs 2.11 to 2.13).
- Continued funding for other work on satellites' resilience.
- Continued funding for Met Office services directly addressing national resilience (see paragraphs 2.2 and 2.3).
- Extended funding for space weather research-to-operations work.

1.14 DSIT told us it is planning to develop a new severe space weather preparedness strategy and is currently in the evidence-gathering phase. The spending review did not assess the UK's overall needs for space weather resilience, or whether DSIT's funding is targeted at the most effective set of activities. During the spending review, DSIT did, however, assess the importance of its two main space weather-related investments (see Part Two), separately from each other. It identified the Vigil space weather mission as a priority within its space spending for national security and resilience reasons, and it included the budget for the Met Office Space Weather Operations Centre as part of the wider bid for core Met Office funding alongside weather services.

1.15 Private sector organisations also invest in resilience, and government regulation can encourage this, for example in the electricity sector and in the financial sector. In the electricity sector, from 2003, National Grid has applied design standards requiring new transformers to be highly resilient to geomagnetically induced currents. Other sectors require more investment. For example, in telecommunications, DSIT has assessed how much it would cost to achieve increased resilience but has not found a viable funding mechanism. The government has an ambition to deepen its understanding and engagement with private sector organisations on resilience.

Roles and responsibilities

1.16 The Cabinet Office assigns ownership of acute national risks to lead government departments, covering the following: risk identification and risk assessment; prevention, resilience, preparation and emergency response; and recovery. The response to each large-scale emergency is led by a lead government department and, in the most serious cases, is coordinated through the Cabinet Office Briefing Rooms (known as COBR) and its secretariat.[6]

1.17 Clear ownership is essential to ensure the UK is well prepared to anticipate, prepare for and respond to risks. The Amber Book sets out lead government departments' role in managing crises.[7] Outside of crises, the Cabinet Office's expectations of departments are set out in the *UK National Leadership for Risk Identification, Emergency Preparedness*, Response and Recovery.[8]

1.18 These documents do not explain what good performance of these responsibilities would look like and what processes to follow, nor do they set minimum standards. The guidance on best practices and the processes of carrying out the lead government department role was last updated in 2004. In July 2025, the government committed to publishing written expectations on the lead government department role, which it told us it expects to publish by Summer 2026. It intends that this document will:

- set out the role of the Cabinet Office and other UK government departments in planning, preparing, responding to and recovering for emergencies, including whole-system risks;
- set clear roles and responsibilities and articulate what 'good' looks like; and
- place a greater emphasis on ensuring the needs of vulnerable people are at the forefront of planning.

6 A national risk can have more than one lead government department for response.
7 Cabinet Office, *The Amber Book: Managing Crisis in Central Government,* April 2025.
8 Cabinet Office*, UK National Leadership for Risk Identification, Emergency Preparedness, Response and Recovery*, August 2023.

1.19 We found that roles and responsibilities for managing the risk of severe space weather are not clearly defined. For severe space weather, the Cabinet Office has assigned the lead government department role to four public bodies: the Met Office is responsible for risk identification and risk assessment, while responsibility for prevention, resilience, preparation and emergency response, as well as recovery, are shared across DSIT, the Department for Energy Security & Net Zero (DESNZ) and the Department for Transport, depending on which sectors are impacted by the event. The Cabinet Office also expects other government departments to support lead government departments and manage the risk to their policy areas. For example, the Ministry of Defence, the Ministry of Justice, and the Ministry of Housing, Communities & Local Government all have responsibilities for their respective sectors. We found some confusion among officials over what individual departments were responsible for, and ambiguity over the expectations for overarching coordination. In **Figure 4** overleaf, we summarise how roles and responsibilities are divided in practice.

1.20 Although not formally assigned the role of overall lead government department, DESNZ coordinated the government's work on severe space weather across all phases of emergency management until April 2025. DSIT then took over this overarching coordination role, with a transition period running over the summer, and the transfer formalised in December 2025.[9] DESNZ told us that, before handing over responsibility to DSIT, it had 0.5 full-time equivalent staff working on the coordination of the government's resilience to severe space weather. With the recruitment of one specialist in November 2025 and another in January 2026, DSIT told us it has increased the number of full-time equivalent staff on this to two.

Governance arrangements

1.21 Lead government departments do not take sole responsibility for acute national risks but must coordinate work and ensure there are clear roles and responsibilities. Lead government departments are expected to receive support from other departments and bodies, but in practice, this support is variable and not well defined. While the Cabinet Office can have a role in convening and coordinating work on risks, it is not responsible for ensuring that other departments comply with requests to work on preparedness.

9 DSIT is the parent department for the Met Office and the policy owner for the UK civil space sector.

Figure 4

Roles of UK government organisations involved in managing severe space weather risk

Several UK government orgnaisations have a role in managing the risk of severe space weather

Organisation	Day-to-day role	Role in response and recovery
The Department for Science, Innovation & Technology (DSIT)		
Space security and resilience team	Fulfils DSIT's duties as lead government department for severe space weather risk. Sets strategy and coordinates cross-government action.	Coordinates government activity during events, unless the response is escalated to the Cabinet Office Briefing Rooms (COBR).
Emergency response coordination secretariat	Develops DSIT's emergency response capabilities (for example through training and exercising) across all its risks.	Works with the space security and resilience team, as part of a temporary emergency response team.
Met Office		
Met Office Space Weather Operations Centre	Monitors and forecasts space weather. Carries out the government's risk assessment for severe space weather. Supports responders, the government and infrastructure operators to better understand space weather impacts and how to respond.	Provides severe space weather notifications to the government, the public, and its registered users.
Cabinet Office		
	Maintains the national security risk assessment. Monitors risks. Sets expectations of, and supports, lead government departments. Is responsible for the government's preparedness.	For events with whole-of-system impacts, the Cabinet Office leads the response, including the activation and operation of COBR, the mechanism for co-ordinating central government's acute response to crises.
Other government departments with day-to-day policy oversight of sectors that contain national infrastructure		
	Develop impact assessments for their sector. Ensure that the sector has appropriate mitigations and response plans.	Engage their sector to understand impacts and next steps. Keep DSIT informed. Respond to any disruption affecting their sector.
Ministry of Housing, Communities & Local Government		
	Works with local responders to increase their awareness of severe space weather and understand their role in the response.	Liaises between central government and emergency responders, escalating issues that require decisions from central government.
Local resilience forums (LRFs)		
	Most emergencies are handled locally. Emergency responders must work together through LRFs. LRFs develop risk assessments and multi-agency response plans for risks to their local area.	Local responders provide the meat of the government's operational response. The LRF coordinates during events.

Source: National Audit Office analysis of Cabinet Office, Department for Energy Security & Net Zero, and Department for Science, Innovation & Technology documents

1.22 The cross-cutting nature of the risk and its impacts requires coordinated action to be taken across government and beyond. DESNZ oversaw cross-government work through a steering group (see **Figure 5** overleaf). It told us it experienced difficulties leading collective action through this group, for example in securing regular attendees with sufficient seniority to make decisions and allocate resources to work plans, and commissioning complete response plans. DESNZ tracked progress against the 12 Strategy commitments through the steering group but stopped formally tracking these in August 2023. In 2024, it introduced a severe space weather working group, to discuss progress at a working level and allow the steering group to focus on strategic matters. DESNZ and DSIT have kept these groups informed about planned and achieved actions, but have not yet reassessed overall progress against the aims of the Strategy.

1.23 DESNZ found it challenging to galvanise action on some resilience issues, for example, one that did not fall neatly into the remit of an existing team. Severe space weather could potentially damage micro-electronics, but an impact assessment for this has yet to be completed. DESNZ began trying to define responsibilities for resilience to this impact in August 2023, but it – and now DSIT – has not yet found a policy team that would agree to take responsibility for assessment, contingency and response planning for this impact.

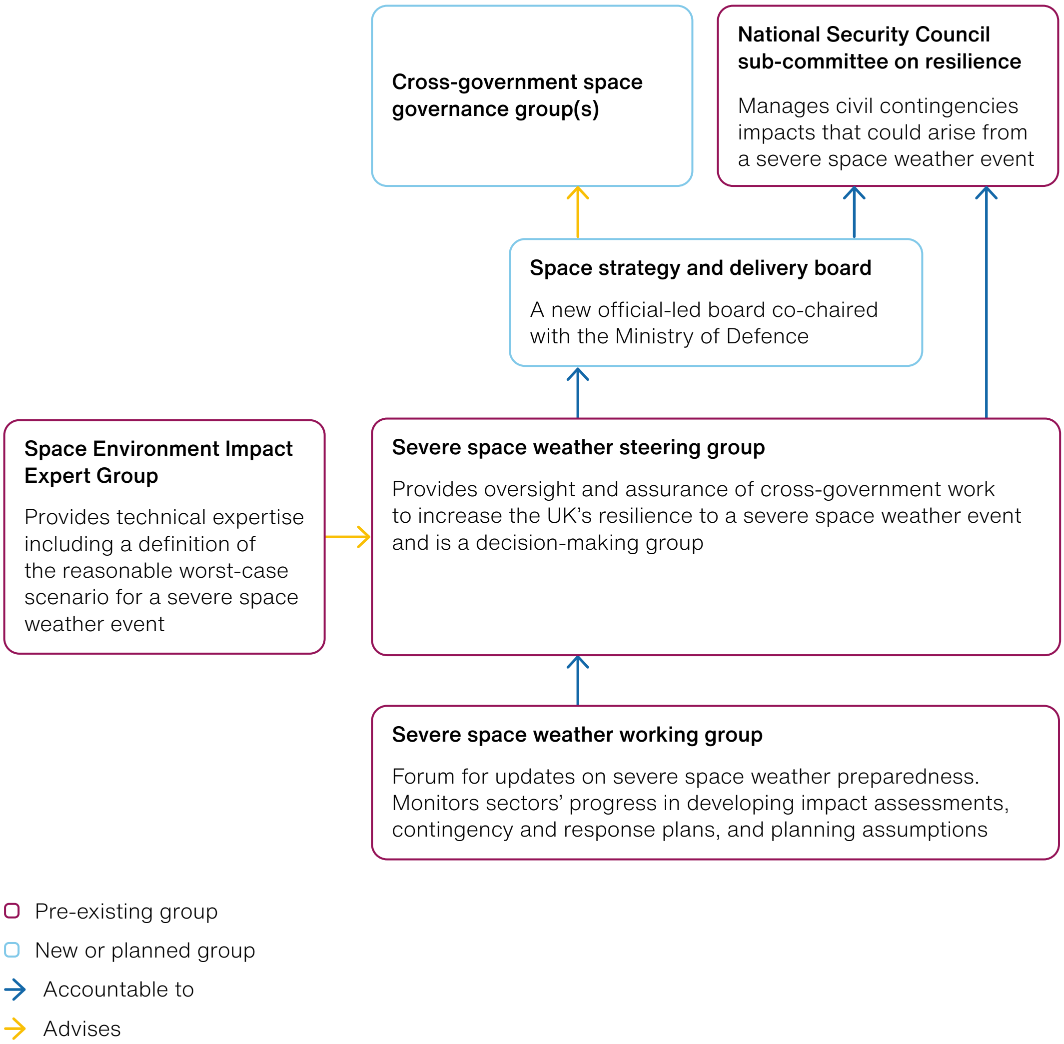
1.24 The transfer of responsibility for the risk from DESNZ to DSIT has led to short-term disruption. The steering group is meant to meet at least quarterly. We have seen no evidence of it meeting between December 2024 and November 2025. The working group is also meant to meet at least quarterly but was suspended from December 2024 to October 2025. The groups began to regularly meet again in autumn 2025: the working group in October and the steering group in November.

1.25 In August 2025, the government announced the UK Space Agency will be subsumed into DSIT's core department from April 2026, with the aim of improving the alignment of government space policy and delivery. The new unit will keep the UK Space Agency name and brand and will be staffed by experts from both organisations. Following this announcement, DSIT initiated a Space Transformation Programme to streamline its governance model and implement the merger. This programme is expected to be largely complete by 1 April 2026, with some final activities continuing to summer 2026. The new governance arrangements will oversee DSIT's management of the risk of severe space weather and the delivery of its new strategy.

Figure 5

Governance arrangements for severe space weather risk, March 2026

The Department for Science, Innovation & Technology manages severe space weather risk using cross-government groups



Note

1 The government is establishing a new space policy governance structure, so the arrangements presented here are subject to change.

Source: National Audit Office analysis of Department for Science, Innovation & Technology information

Part Two

The UK's forecasting capability

2.1 In this part we examine the adequacy of the UK's forecasting capability, specifically:

- the Met Office Space Weather Operations Centre's funding, capability and resilience;
- the utility of space weather forecasts; and
- future investments.

The Met Office Space Weather Operations Centre

2.2 Forecasting space weather is scientifically complex. In 2014, the Met Office opened its Space Weather Operations Centre (the Operations Centre), which it reports to be one of a handful of 24/7 space weather prediction centres globally. It is responsible for notifying the government of severe space weather events and also issues alerts and specialist forecasts that can inform sectors on what impacts to expect. It has a range of products covering forecasts to inform planning and alerts relating to current solar activity.

2.3 The Operations Centre's budget is increasing, from £3.7 million in 2024-25, to £6.7 million in 2025-26, to an average of £11.2 million per year between 2026-27 and 2029-30. Almost all of its estimated future funding (94%) is from DSIT. Most of the remainder is provided by the European Space Agency (ESA) (for the Operations Centre's contributions to ESA space weather research, data and products), by the Ministry of Defence and by the Civil Aviation Authority.

Current forecasting capability

2.4 The Operations Centre forecasts space weather for the next four days but cannot confirm the size or timing of impacts until phenomena are close to Earth. The current forecasting time before the impact of a space weather event is experienced on Earth is between no notice and a few days, depending on the type of space weather (**Figure 6** overleaf).

Figure 6
Typical space weather forecasting windows by type of space weather

The forecasting window for space weather varies by phenomenon, ranging from no notice to days

Space weather phenomenon	Typical forecasting window
Solar flares	None. A solar flare is detected when the event reaches Earth, which can be as little as 8.5 minutes after it leaves the Sun.
Energetic particles/solar radiation	Minutes to hours.
Coronal mass ejections (CMEs)	The potential onset of a space weather event can be estimated 18–96 hours before the CME reaches Earth, but current capability only provides a reliable estimate of intensity up to 30 minutes before.

Source: National Audit Office analysis of Met Office documents

2.5 Space weather forecasting requires expert analysis and judgement. When assessing space weather, the Met Office space weather forecasters apply technical judgement to interpret its severity. The independent Space Environment Impacts Expert Group (SEIEG) is a committee of experts drawn from academia, research institutes, companies and agencies which assesses space weather science, reviews the impact to people and infrastructure, and provides support and advice to the government. During the May 2024 storm (see Figure 2), the Operations Centre consulted SEIEG to confirm the decision to issue a G5 warning and subsequent alert (see Figure 8).

Improving forecasting

2.6 The science and engineering needed to monitor and forecast space weather is still maturing, and there are limitations on what is currently possible. The government has therefore invested in developing its capability. UK Research and Innovation (UKRI) funded a £20-million programme (the Space Weather Instrumentation, Measurement, Modelling and Risk programme (the Programme)) aimed at developing and deploying new instruments, models and services to support the UK space weather community and the Operations Centre. Its three high-level objectives were to mitigate:

- the potential radiation hazards of space weather to satellites and aviation operations;
- potential space weather effects on communication and global positioning; and
- the potential risks of space weather to electricity networks.

2.7 The Programme completed in 2025. Implementation has been slower than expected, as the technical integration of some models with Met Office's systems has proven complex and taken longer than planned. In November 2025, a UKRI-commissioned independent evaluation reported that the Programme had substantially advanced UK space-weather capability, meeting or largely meeting most technical and operational objectives. The Operations Centre is now beginning to use the outputs in its modelling and forecasting. We were told that the models are now available to forecasters, but full integration of all models into Met Office's services is expected in the next two years.

2.8 We found the Operations Centre is well regarded internationally, with international forecasters seeking to draw upon its expertise. The Royal Netherlands Meteorological Institute (KNMI) has an operations agreement to use the Operations Centre's services, and the South African National Space Agency uses it to train its space weather forecasters. The Met Office also collaborates with academics and universities to conduct research. For example, it works with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), and in 2025 it partnered with KNMI and the University of Surrey to measure radiation from the Sun through Earth's lower atmosphere.

The resilience of forecasting capability

2.9 The Met Office relies on data from satellites mostly owned by the United States' National Oceanic and Atmospheric Administration (NOAA) and NASA, which is free and covered by data-sharing agreements. The UK also collaborates with the United States' Space Weather Prediction Center on forecasting. Some of the satellites used are nearing the end of their anticipated operational period, with some having already exceeded their predicted lifespan. Several of the satellites are primarily scientific missions, with scientific research prioritised over space weather prediction data (**Figure 7** overleaf).

2.10 To increase the resilience of its data sources, the Operations Centre uses data from multiple sources for the same task, in case one satellite goes out of service. The Met Office told us it is also working with its international partners to formalise the data-sharing agreements it has with the United States; however, this will not fully ensure the resilience of the UK's capability as it will continue to be reliant on international data-sharing arrangements.

2.11 The UK is a member of and participates in ESA, a non-European Union, inter-governmental agency that aims to shape the development of Europe's space capability and promotes cooperation and innovation. The UK chooses to invest in ESA as its technical knowledge, expertise and test facilities provide the opportunity to build national capabilities and grow the UK space sector. Working with ESA as a delivery partner also provides access to large-scale space programmes that would be challenging to replicate nationally.

Figure 7

Satellites used by the Met Office in space weather forecasting, February 2026

The Met Office mostly uses data from nine satellites to forecast space weather

Satellite	Owner	Launch year	Is it within its designed lifetime?[1]	Key use in space weather forecasting
SOHO	European Space Agency (ESA) and National Aeronautics and Space Administration (NASA)	1995	No	Located between the Sun and Earth, these satellites take measurements of space weather before it reaches Earth, enabling more accurate warnings.
ACE	NASA	1997	No	
DSCOVR	National Oceanic and Atmospheric Administration (NOAA)	2015	No	
STEREO-A	NASA	2006	No	From its orbit ahead of Earth, it monitors activity on parts of the Sun invisible from Earth.
SDO	NASA	2010	No	Provides exceptionally detailed data on changes in the Sun's atmosphere to improve space weather predictions.
GOES-18	NOAA	2022	Yes	Monitor the impact of arriving space weather on Earth's atmosphere.
GOES-19	NOAA	2024	Yes	
IMAP	NASA	2025	Yes	Provides data to improve the timeliness of energetic particle event warnings, alerts and forecasts.
SOLAR-1[2]	NOAA	2025	Yes	Will replace much of the capability provided by SOHO, ACE and DSCOVR.

Notes

1 All satellites above except the GOES series were designed with a required operational lifetime of five years or fewer. It is common for such satellites' actual lifetimes to be considerably longer than their designed ones. Since GOES-16, the GOES satellites have been designed for 15 years of operation.

2 SOLAR-1 was launched in September 2025 and is expected to enter operational service in Spring 2026.

3 The satellites launched before 2015, and IMAP, were built for scientific purposes. DSCOVR, SOLAR-1 and the GOES satellites were built for operational purposes, i.e. designed to meet the needs of monitoring and forecasting service providers.

Source: National Audit Office analysis of publicly available information

2.12 The UK government has taken a leading role in supporting ESA's space weather mission, Vigil. To date, the UK has contributed just over half of the overall funding for Vigil, alongside 16 other ESA member states and associate members. The United States will also provide two instruments for the mission. The UK has committed to contribute €70 million in 2019, €95 million in 2022, and €132 million in 2025. This adds up to in the region of £300 million in 2025 prices.[10] In 2025, ESA estimated the cost at completion for the Vigil mission would be around €800 million.[11] The UK's total contribution has yet to be determined. The UK also invests in other ESA programmes and missions relevant to severe space weather, including activities focused on developing European capability to provide accurate, timely and actionable space weather information.

2.13 Vigil will be Europe's first 24/7 operational space weather satellite and is expected to deliver faster, more accurate space weather warnings. It aims to improve the accuracy of forecasts of coronal mass ejection arrival times, giving more confident estimates of when impacts will be felt. It will also extend forecasts of some types of space weather such as the solar wind to up to five days ahead of an event (an increase from the current capability of up to four days). Planning for the Vigil mission was initiated in the early-to-mid 2010s, and the satellite is currently expected to launch in 2031 with an operational life of five years.

2.14 Complex programmes that are at the cutting edge of science with complicated technical requirements, like the ESA Vigil mission, often take a long time to deliver from their initial concept phase. DSIT, with the Met Office, has begun to consider future programmes beyond the Vigil mission but has not yet initiated formal planning, creating uncertainty over how resilience will be maintained in future decades.

The utility of space weather forecasts

2.15 Forecasting can only be effective if it is meaningful for those needing to take action. The UK uses NOAA's three space weather scales to describe conditions and their potential impacts. Since the scales' introduction in 1999, demand for forecasting has grown, and user needs have changed. The May 2024 storm was categorised as the highest category on the scale (G5); however, the observed impacts were relatively minor (see **Figure 8** overleaf).[12] This highlighted the scales' inadequacy and need for them to clearly communicate the levels of severity to enable the right response. NOAA, in consultation with the UK and other international partners, is currently revising the scales to make them more meaningful to users.

10 Based on an approximated conversion from euro to pound sterling and inflation to 2025 values. See methods appendix.
11 We have not audited this estimate.
12 Pre-emptive mitigations and/or during-event actions were taken around the world that may have reduced the impacts of the event.

Figure 8

The United States' National Oceanic and Atmospheric Administration (NOAA) space weather scales

The Met Office uses NOAA's three space weather scales to describe space weather conditions in its forecasts

	Space weather scale		
Level	**Geomagnetic storms**	**Radio blackouts**	**Solar radiation storms**
Extreme	G5	R5	S5
Severe	G4	R4	S4
Strong	G3	R3	S3
Moderate	G2	R2	S2
Minor	G1	R1	S1

Source: National Audit Office analysis of Met Office, *Space weather impacts*, available at: https://weather.metoffice.gov.uk/learn-about/space-weather/impacts, accessed 9 March 2026

2.16 The Operations Centre has worked with some sectors to develop sector-specific notifications and technical data that provide more actionable information than the current NOAA scales. For example, the Met Office has developed a specific forecast for the UK electricity sector to enable operators to take action to mitigate potential impacts. The Met Office has also worked with the Ministry of Defence to develop specialist forecasts that are more useful for the sector to plan for potential impacts and determine the causes of any outages.

2.17 A theme from our deep dive interviews and other audit work is that some responders find technical information on space weather difficult to interpret and use to make decisions. During a space weather event in May 2024, the Met Office issued a new-format briefing with more specific details on the type and scale of likely impacts.

Part Three

The government's response planning

3.1 This part assesses the adequacy and completeness of the government's response plans. It is not a comprehensive assessment of whether the UK is ready for a space weather event. It examines the government's:

- response plans;
- clarity of decision-making;
- approach to exercising; and
- communications strategy.

Response plans

3.2 The government's preferred approach to resilience is to focus its efforts on activity that is cross-cutting or applicable to large clusters of risks, complemented by some bespoke planning for risks with unique consequences or extreme impacts that generic planning cannot realistically cover. The impacts of severe space weather overlap with those of other risks but are not identical. For example, both space weather and terrestrial storms can cause simultaneous power outages and disruption to transport. However, terrestrial storms can be forecast further in advance, and the regions of the UK most likely to be affected can be predicted. Therefore, a response plan which is appropriate for storms may not be appropriate for space weather. It is essential that the government gains assurance that response plans are fit for purpose for all relevant risks, many of which are managed by organisations outside the government's direct control.

3.3 It is therefore important for the government to assess the extent to which its generic plans are suitable, without adaptations, to be used in a space weather event. We would expect departments to assess the suitability for severe space weather of their generic response plans, fill in any gaps with risk-specific planning, and share their plans with the risk's lead government department.

3.4 In 2023, the Department for Energy Security & Net Zero (DESNZ) asked relevant departments to provide summaries of the response plans for sectors that might be affected by severe space weather. It requested information on 14 sectors but only received six returns. One return (aviation) described some specific planning for severe space weather. The other five returns described the department's generic risk planning or their plans for responding to power outages. DESNZ also gathered information on the electricity sector's plans, which identified some specific planning in the sector for severe space weather.

3.5 In 2024, to enable it to run an exercise to test its cross-government response framework (see paragraph 3.10), DESNZ commissioned these departments to share their internal departmental response plans, providing them with guidance on how to review and adapt generic plans to be suitable for space weather. Again, it received few responses. Departments outlined a range of reasons for not producing plans including competing priorities; a lack of resources; a lack of mechanisms to engage with a sector; and a lack of response and planning structures within some relevant organisations. In February 2026, the Department for Science, Innovation & Technology (DSIT) commissioned updated response plans from departments.

3.6 We have not seen evidence that the departments which have chosen to use generic plans assessed whether their plans were suitable for a severe space weather event. DESNZ did not before handover, and DSIT has not since, gained assurance over other departments' plans. One effective way of testing a response plan is exercising. The evidence from exercises to date is that, overall, the government's response plans for severe space weather are not yet ready. An exercise organised by DESNZ in July 2024 identified that departments had not yet considered how a severe space weather event could affect their ability to staff and coordinate a response operation using their plans. The expectation is that local responders would use their generic plans and capabilities, but the exercise identified that there were no arrangements in place to notify local resilience forums (LRFs) of a severe space weather event.

3.7 The value of forecasting depends on key sectors having plans to use it. According to the assessments commissioned by DESNZ and the information gathered through our study, including deep dives into four areas, to the government's knowledge, only the electricity and aviation sectors have developed specific procedures to mitigate the impact of severe space weather. The electricity industry and government worked together in 2025 to develop and exercise a joint sector plan for severe space weather events. We have been told that Defence also has specific procedures, but have not audited this. Officials in the Cabinet Office, the Department for Health & Social Care, the Department for Transport, and DSIT have written space weather procedures which set out arrangements for internal coordination on receipt of a severe space weather alert. However, these do not include actions specifically by the departments to avoid or mitigate impacts ahead of an event. The government expects that organisations will have plans that enable them to respond to and recover from a wide range of emergencies. As many of the impacts of severe space weather are common consequences of other risks, it is likely that these plans will cover mitigations for at least some severe space weather impacts.

3.8 There is more to do to turn knowledge of space weather's theoretical effects into practical planning assumptions for different sectors. The Met Office engages with government departments, LRFs and industry to help enhance their understanding of the risk posed by space weather and of its potential impacts. Responsibility for developing the understanding of the risk to each sector and to develop response plans sits with the government department for the policy area. Some sector teams we spoke to had a less detailed understanding of how space weather may impact the sectors they are responsible for and described uncertainty around impacts being too high to develop response plans (see paragraph 1.7).

3.9 The 2021 *UK Severe Space Weather Preparedness Strategy* (the Strategy) highlighted that preparedness requires effective collaboration between the government, industry and LRFs, and set out as an aim that, by 2026, government departments, industry and LRFs "will ensure their response plans are clearly linked to space weather and match the latest understanding of the impacts". This is consistent with the government's ambition for a whole-of-society approach to resilience. Departments have also identified a range of specific support their sectors may need from LRFs during an event. The Met Office has run training, briefings and workshops for local responders to raise awareness of the risk. However, the government has not done any systematic work to involve local responders in national or sectoral planning for resilience to severe space weather.

Clarity of decision-making

3.10 In July 2024, DESNZ introduced a high-level cross-government framework to coordinate the government's response to severe space weather events (the Response Framework). This does not include operational-level plans and protocols that are expected to be held by individual departments. The Response Framework has since been adopted by DSIT, which told us it plans to update and revise it.

3.11 The solar cycle from 2008 to 2019 was the weakest in a century, with no severe space weather events. As a result, prior to 2024, the government's most recent experience of responding to a severe space weather event was in 2003. The current solar cycle (from 2019 to around 2030) has been more active but has not featured any truly severe space weather events. Events in 2024 and 2025 provided the Met Office Space Weather Operations Centre (the Operations Centre), DESNZ and DSIT with a live test of their forecasting, communication and coordination arrangements and of the electricity sector's response plans (see Figure 2). The government's overall assessment was that arrangements in 2024 worked well. In November 2025, there was a G4 space weather event which risked developing into a full-fledged severe space weather event (Figure 8). We found evidence indicating that DSIT and the Operations Centre worked together effectively during this period of heightened risk, but lessons were identified on streamlining decisions and better defining processes within DSIT. Both events were too mild to cause significant impacts, meaning decision-making on preventing or responding to a full range of potential impacts was not tested.

3.12 In the Response Framework, responsibility for enacting sectoral response plans, including decisions to encourage or compel sectors take pre-emptive action, rests solely with the departments leading policy for those sectors. The Response Framework describes how different government departments should share information during an event but does not include detail of what actions departments or sectors should take, and when. As the government is aware, sector partners that have severe space weather plans in place may be reluctant to take any response action until impacts are felt, due to the commercial nature of their operations and the potentially high cost of action.

3.13 If a severe space weather event reaches a threshold beyond which DSIT cannot reasonably coordinate the cross-government response, it is expected to ask the Cabinet Office to activate the Cabinet Office Briefing Rooms (COBR) response (see Figure 4). The Response Framework includes advice on when to do this. The threshold is judgement-based and flexible. However, it is likely to only be met after impacts have been felt, or after the time when pre-emptive action would have needed to be taken, for example restricting UK airspace.

Exercising

3.14 Exercises are an essential part of resilience and preparedness. The government carries out exercises at many different sizes and levels of intensity to validate its planning for risks.

3.15 As part of the National Exercising Programme, the Cabinet Office oversees one national-level 'Tier 1' exercise per year. 'Tier 1' exercises are scalable national exercises involving devolved governments, regional and local responders, and relevant industry engagement, and they are complex to run. As there are over 60 risks on the National Security Risk Assessment (NSRA), not all risks will be the subject of a 'Tier 1' exercise. Recent ones have simulated events the government classes as potentially catastrophic (such as a pandemic and a national power outage). We have been told that severe space weather, which has a lower potential impact in a reasonable worst-case scenario, is not on the forward programme of 'Tier 1' exercises, but that some scheduled 'Tier 1' exercises are expected to cover common consequences and impacts.

3.16 In 2024, DESNZ ran an exercising programme for the risk of severe space weather, starting with a small internal exercise, and working up to two 'table-top' discussion exercises involving a range of government departments. It originally intended to follow these in late 2024 and 2025 with 'command-post' simulation exercises involving industry partners, and graduate to holding international exercises every two years. In December 2024, the working group (see paragraph 1.22) agreed to put these plans on hold as insufficient progress had been made on other actions, such as the development of response plans with sector-specific actions, and updates to fill gaps identified in the Response Framework. This means that a full simulation exercise involving local responders has not yet been run: the government response plan's ability to deal effectively with the cascading impacts of severe space weather has not yet been tested with local responders or with the sectors. This is in contrast to recent exercises held in Australia and the United States.

3.17 DSIT told us that it is planning to restart the severe space weather exercising programme, starting with a small internal exercise in 2026. Past reviews of the NSRA process argued that the government should avoid treating the reasonable worst-case scenario as a prediction and should consider a range of ways in which risks could manifest. Our previous work has shown that planning based on a single scenario can limit the government's ability to anticipate the full range of impacts, with some real events exceeding the planning assumptions used. Considering and testing multiple scenarios, including variations and more extreme manifestations, can help identify where systems may be vulnerable and strengthen preparedness for a broader range of severe yet plausible impacts.

3.18 We found the exercises run by DESNZ were of good quality and identified useful findings. However, the government has not yet implemented all of the recommendations from the exercises. This mirrors findings of the COVID-19 inquiry, which criticised the government for not acting upon some warnings about the UK's lack of preparedness from its past pandemic simulations prior to the pandemic.[13]

3.19 We found examples of other parts of the government using exercises and workshops to understand and develop their area's readiness for severe space weather events, but no systematic learning from these. Since the start of 2022, the Met Office has run at least 12 exercises and 17 workshops on severe space weather for different organisations. The Government Office for Science also ran an exercise in 2025 simulating its response to a severe space weather event. Officials working on resilience described learning from exercises on other risks also applying to severe space weather.

The government's communications strategy

3.20 In 2015, research identified that the public would expect the government to provide simple and consistent answers to the questions: "what is space weather?"; "what would the likely impacts be as a result?"; "what can we do about it?"; and "how vulnerable is the UK?".[14] In the Strategy, the government committed that the Met Office would "develop a cross-government space weather communication strategy, which identifies public communications lines to be disseminated in a severe space weather event by 2022".

3.21 The Met Office is responsible for the government's communications about space weather events. It regularly communicates events like aurora sightings to the public and media and has a strategy, briefing materials and experienced spokespeople. It is not prepared or responsible for communicating with the public about specific impacts on infrastructure or services. In May 2024, the government launched its Prepare public information website to help citizens prepare for emergencies and be more informed about hazards.[15]

3.22 We found that the government has completed some work to clarify roles and responsibilities for communicating with the public during an event, and that an outline plan exists for how government would run communications around a severe space weather event. DSIT and the Met Office have not yet developed pre-agreed media lines for if impacts are being felt in the UK. They have not identified any actions they would want individuals or businesses to take before or during an event. Without a complete communications plan, the government is at risk of taking an ineffective whole-of-society approach. DSIT and the Met Office plan to revise and expand the outline communications plan.

13 Comptroller and Auditor General, *The government's preparedness for the COVID-19 pandemic: lessons for government on risk management*, Session 2021-22, HC 735, National Audit Office, November 2021.
14 Science and Technology Facilities Council, Department for Business, Innovation & Skills, *Space weather public dialogue*, February 2015 (viewed on 9 March 2026).
15 See prepare.campaign.gov.uk (viewed on 2 March 2026).

Appendix One

Our audit approach

Our scope

1 This report examines the government's work to increase the UK's resilience to the risk of severe space weather. It forms part of a broader programme of reviews examining preparedness for a range of risks on the National Security Risk Assessment and is intended to provide insights useful for the management of other risks. It covers:

- the extent to which the government understands the risks and potential cascading effects of severe space weather;
- the adequacy of governance arrangements in place to oversee preparedness;
- the adequacy of the UK's observational and forecasting capability; and
- the adequacy and completeness of the government's response plans and exercising.

Our evidence base

Interviews

2 Throughout our fieldwork, we held regular discussions with the Met Office's Space Weather Operations Centre and with officials in teams working on resilience issues in the Department for Science, Innovation & Technology (DSIT) and the Department for Energy Security & Net Zero (DESNZ). We used these discussions to cover issues across our scope, including to understand the government's impact assessments, current and future forecasting ability, progress on implementation of the 2021 *UK* Severe Space Weather Preparedness Strategy, and their roles in coordinating cross-government activity on severe space weather risk.

3 In September 2025, we visited the Met Office Space Weather Operations Centre, to build a deeper understanding of how its services work in practice. We also observed meetings of the Space Environment Impacts Expert Group, the severe space weather working group and the severe space weather steering group.

4 Between June and December 2025, we conducted around 40 semi-structured interviews with key bodies. Prior to each interview, we set agendas based on our scope. Most of our interviews were conducted virtually using Microsoft Teams, with a small number taking place in person. We did not record any of these interviews but instead took notes.

5 The key areas of inquiry were as follows.

- To understand the cross-government systems in place to manage risks on the National Security Risk Assessment and respond to events with significant impacts, we spoke to organisations including the Cabinet Office, the Government Office for Science, and DSIT.
- To understand the state of research on severe space weather and developments in monitoring and forecasting capability, we spoke to UK Research and Innovation, Frazer-Nash Consultancy, the Met Office, the UK Space Agency, and some of the government’s expert advisers on space weather.
- To understand how different sectors have approached developing their resilience to severe space weather, we undertook deep dives in the following sectors.
  - Electricity.
  - Transport (aviation and rail).
  - Financial services (retail banking and payment services).

6 For each sector, we examined the approach taken by the relevant government departments and arm’s-length bodies, and the level of activity on severe space weather within the relevant sector. We chose a sample covering several government departments, types and causes of likely impact, and degrees of engagement with DESNZ-led activity on severe space weather.

7 For our deep dives, we spoke to DSIT, DESNZ, the UK Space Agency, the Department for Transport, HM Treasury, Ofcom, the Bank of England, the National Physical Laboratory, Network Rail, EDF, the National Energy System Operator, the UK Health and Security Agency, NATS (national air traffic services), and the Civil Aviation Authority.

Document review

8 To understand what work had been done to date, we reviewed more than 400 government documents, pre- and post-interview. This included a review of the following key documents.

- The 2021 *UK Severe Space Weather Preparedness Strategy*.
- Cabinet Office guidance, including the *Amber Book*.

- The government's impact assessments and draft plans for responding to severe space weather.
- Papers on exercising, its findings, and implementation of recommendations.
- Documents outlining the planned communications for severe space weather.
- The government's reasonable worst-case scenario and overall planning assumptions for severe space weather.
- Documents describing the government's case for investment in the Vigil space weather mission.
- The Met Office's performance reporting relating to its space weather services.

Presentation of figures

9 To estimate the value of the UK's commitments to the Vigil programme, we first converted the euro values into pound sterling using HM Revenue & Customs' published annual average exchange rates. We then adjusted the nominal figures for inflation to 2025 values using GDP deflators published by the Office for National Statistics (series MNF2) and the Office for Budget Responsibility (November 2025 *Economic and fiscal outlook*).

Use of experts

10 To gather feedback on our thinking and ensure that we sufficiently understood the area we are reporting on, we held remote discussions with the following experts.

- Space weather resilience: The chair of the Space Environment Impacts Expert Group (SEIEG), and experts at the Defence Science and Technology Laboratory (DSTL), University of Birmingham, University College London, and Imperial College London.
- Emergency preparedness: Bruce Mann and Kathy Settle (strategic advisers on resilience and preparedness), and Dr Fabian Steinmann (Lecturer in Organisational Resilience and Change, Cranfield University).
- Infrastructure resilience: The National Infrastructure and Service Transformation Authority (NISTA).

11 In September 2025, we also virtually attended the UK Space Weather and Space Environment Meeting III, the third meeting in the conference series.

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