



Met Office

Space Weather in the UK

Mark Gibbs

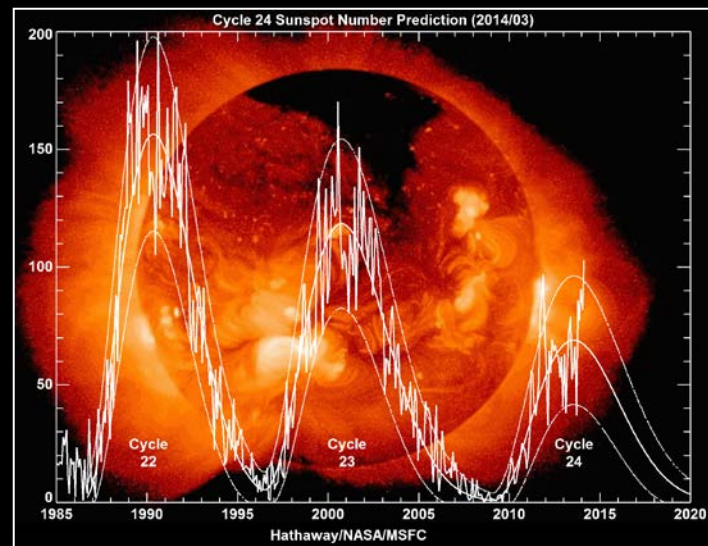
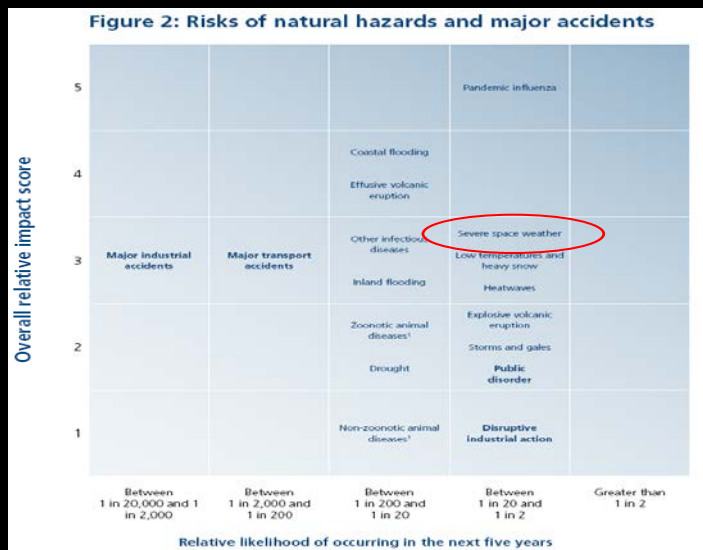
Head of Space Weather, Met Office

Space Weather as a Global Challenge

4th April 2016

What sparked the UK's interest?

- 2011 Space weather became a medium high risk on the UK NRR
- Vulnerability increasing with technology
- Extreme events don't necessarily cluster around solar max
- Royal Academy of Engineering report



Identifying the risk

- Extreme space weather – Carrington event
 - Electricity
 - ~13 transformers damaged in UK
 - 2 coastal nodes could experience disconnection
 - Satellites
 - ~10% experience temporary outages hours to days
 - Rapid ageing
 - GNSS – partial or complete loss 1-3 days
 - Loss of satcom & HF communications
- Voltage instability - outages of few hours in urban areas





Met Office Space Weather Operations Centre (MOSWOC)

- Fully integrated within Met Office Operations Centre (24/7/365 since April 2014)
- National capability supporting;
Government, military & critical sectors
- 14 forecasters (1 dedicated)





Met Office

Impact scales

Category	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
----------	--------	------------------	---

Category		UK Effect	US and Global Effect
----------	--	-----------	----------------------

Scale	Descriptor	Duration of event will influence severity of effects	
-------	------------	--	--

Geomagnetic Storms

G5	Extreme	<p>Power systems: Localised voltage control and protective system problems may occur leading to potential for localised loss of power. Transformers may experience damage.</p> <p>Spacecraft operations: may experience extensive surface charging, drag may increase on low-Earth-orbit satellites, problems with orientation, uplink/downlink and tracking satellites.</p> <p>Other systems: HF (high frequency) radio communication may be impossible in many areas for one to two days, GNSS(GPS) satellite navigation may be degraded for days with possible effects on infrastructure reliant on GNSS (GPS) for positioning or timing, low-frequency radio navigation can be out for hours, and aurora may be seen across the whole of the UK.</p>	<p>Power systems:widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage.</p> <p>Spacecraft operations: may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites.</p> <p>Other systems: pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.)**.</p>
----	---------	---	--

G4	Severe	<p>Power systems: No significant impact on UK power grid likely.</p> <p>Spacecraft operations: may experience surface charging and tracking problems, drag may increase on low-Earth-orbit satellites, corrections may be needed for orientation problems.</p> <p>Other systems: HF radio propagation sporadic, GNSS(GPS) satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora may be seen across the whole of the UK.</p>	<p>Power systems: possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid.</p> <p>Spacecraft operations: may experience surface charging and tracking problems, corrections may be needed for orientation problems.</p> <p>Other systems: induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.)**.</p>
----	--------	--	--

		<p>Spacecraft operations: minor impact on satellite operations possible.</p> <p>Other systems: migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine)**.</p>	
--	--	--	--



Met Office Space

Energy

Sa

FORECASTER OVERVIEW

Moderate Radio Blackout
M-class flare likely over 1
ACE at 2130 UTC possibl

Solar activity is expected to
large sunspot groups AR205
become more geo-effective
start ACTIVE but then becor
equatorial small coronal ho
thought to be minimal. Wit
view a proton event seems
background values.

SOLAR TIMELAPSE



SDO/AIA 193 2014-05-20 07:45

Space Weather Energy

FORECASTER OVERVIEW

Moderate Radio Blackout observed this morning. Further M-class flare likely over the next few days. Sudden impulse at ACE at 2130 UTC possible CME from 3rd May.

Solar activity is expected to remain moderate over the coming days the large sunspot groups AR2055 and AR2056 rotate around the disc and become more geo-effective. Geomagnetic activity is expected to stay start ACTIVE but then become generally QUIET. There are a couple equatorial small coronal holes visible on the disc but their impact is thought to be minimal. With AR2051 now rotated completely out of view a proton event seems unlikely now and electrons should stay a background values.

Issued 8 May 2014 at 12:00

WARNINGS AND ALERTS

	Active alerts	Warnings
Geomagnetic	-	-
Radio blackout	-	R1 21:00 20/05 03:00 21/05
Proton flux > 100 MeV	S1 11:23-now	-
Proton flux > 10 MeV	-	-
Kp	-	-
Kuk	-	-
Electrons	-	-

GEOMAGNETIC STORM FORECAST

Probabilities of geomagnetic storms

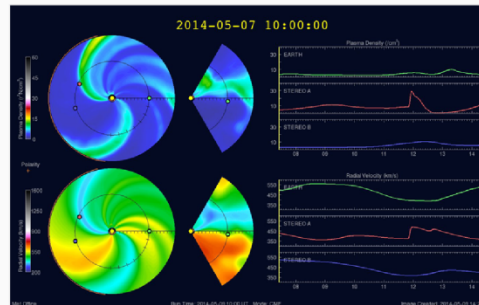
Probability	Level	Past 24 h.	Day 1	Day 2	Day 3	Day 4
Minor or moderate	G1 to G2	No	65	05	05	05
Strong	G3	No	45	01	01	01
Severe	G4	No	01	01	01	01
Extreme	G5	No	01	01	01	01
			%	%	%	%

Geomagnetic commentary

The largest flare over the last 24 hours was M1.2 flare at 16:29 UTC from AR2051 which has revolved around the western limb. With one beta-gamma spot (AR2055) and one beta-gamma-delta spot (AR2056) there is still a risk of further M-class flare activity over the next few days.

Issued 8 May 2014 at 12:00

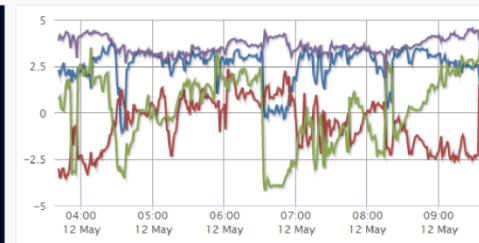
ENLIL



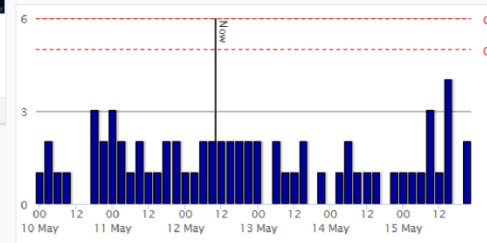
No Earth directed CMEs have been observed. Maximum solar wind speed is 500 km/s

Issued 8 May 2014 at 12:00

ACE MAGNETOMETER



BGS 3-HOURLY KP INDEX





Met Office

Public pages

Met Office | Email alerts | Contact us | Search

Weather | Climate | Learning | Research | Products | News | Holiday weather

Industry Multi-media A-Z | Transport Climate services | Public sector International development | Defence services DataPoint

Home > Products > Public sector > Weather and hazard management > Space weather > Forecast

Space Weather

Space Weather describes disturbances in the Earth's upper atmosphere and magnetic field which have a variety of impacts on mankind and our technology. For more details on the space weather alerts used in these forecasts see the [UK website](#).

Note: This page does not automatically update as if you have been viewing it for some time, please refresh to see the latest information.

Forecaster Overview

HEADLINE: No significant activity observed. Still a chance of M-class flares.

ANALYSIS OF SPACE WEATHER OVER PAST 24 HOURS:

Solar Activity: Solar activity has been at low levels with occasional C-class X-ray flares, the largest being a C4 at 01:00 UTC. There are currently 8 numbered sunspot regions on the visible disk. Regions 2172, 2173 and 2175 have been among the most complex over recent days and now nearing the west limb and have been showing signs of decay. Of the remaining regions 2177 and 2178 are the most complex, both having beta-gamma magnetic classifications, with 2178 showing signs of growth within its intermediate spots. A coronal mass ejection (CME) was observed in solar coronagraph imagery at around 01:00 UTC. This CME appears to have come from just around the east limb and is not expected to have an earthbound component.

Solar Wind / Geomagnetic Activity: The solar wind was an ambient level with its speed measured at between 350 and 400 km/s by the ACE spacecraft. The total interplanetary magnetic field was steady at around 5 or 6 nT. The Bz component was occasionally negative/southward reaching -3 nT at times. The data indicated a mainly positive (away from the sun) solar sector. Geomagnetic activity was mainly at quiet to unsettled levels but an active interval (Kp 4) was observed between 00:00 UTC due to a period of southward Bz in the solar wind.

Energetic Particles: High energy protons at geosynchronous orbit remained at background levels. The flux of high energy electrons was at normal to high levels with the flux measured by GOES-13 peaking at 1065 pfu at 01:17:00 UTC.

Issued on 2nd October 2014 00:10 UTC

Notifications

There are currently no active notifications.

Solar Imagery

SDO AIA-193 | SDO AIA-254

Met Office | Email alerts | Contact us | Search

Weather | Climate | Learning | Research | Products | News | Holiday weather

Industry Multi-media A-Z | Transport Climate services | Public sector International development | Defence services DataPoint

Home > Products > Public sector > Weather and hazard management > Space weather

Wind Review | Where are the windiest locations in Europe? | Find out more

UP TO 70% DISCOUNT | Find out more

latedeals.co.uk | last minute holidays

Space Weather

'Space weather' describes changing environmental conditions in near-Earth space.

Magnetic fields, radiation, particles and matter which have been ejected from the Sun can interact with the Earth's upper atmosphere and surrounding magnetic field to produce a variety of effects. Major impacts include possible interruptions to radio communications and GPS, disruption of power grids and damage to spacecraft.

The new Met Office Space Weather Operations Centre will provide the critical information to help build the resilience of UK infrastructure and impacted industries in the face of space weather events, thereby supporting continued economic growth.

AUTOGRAPIPER | The world's first intelligent, wearable camera is here. | Find out more

Downloads

- [The Met Office and Space Weather](#) (PDF, 201 KB) | Find out more about how we forecast space weather
- [What is space weather](#) (PDF, 1 MB) | All you need to know about space weather and its impacts
- [Space Weather frequently asked questions](#) | Got a question about Space Weather, take a look here first
- [Space Weather Impacts](#) | Low level space weather events occur on a regular basis and whilst they can be of concern for specific industries, in the majority of instances they have little impact on our daily lives.
- [Measuring the Impact](#) | Different aspects of space weather have a variety of impacts on mankind and our technology.

Last updated: 6 May 2014

Share this page



Met Office

Met office

'Owns' NRA space weather risk. Monitors space weather and provides forecasts and alerts to departments, agencies and industry bodies that have signed up for them. Met Office would be in regular contact with CCS, SAGE, BIS and others. Leads on comms pre-event

Assess national risk and co-ordinate central response

Co-ordinate scientific advice to central Government

Co-ordinate Government severe space weather work (March 2015)

Departments responsible for own sectors

Industry and operators and responders



Space Weather Preparedness Strategy

Version 2.1
July 2015

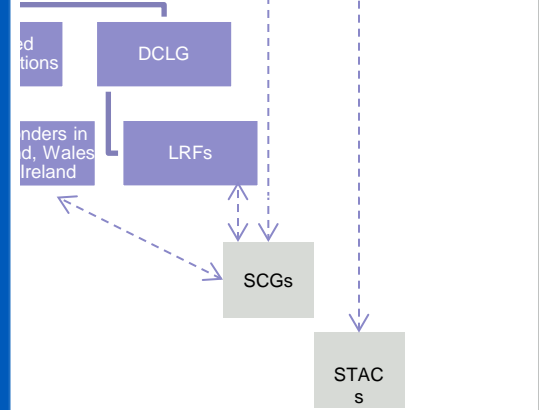
COBR

COBR

SAGE

Scientific community

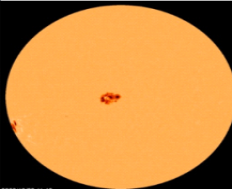
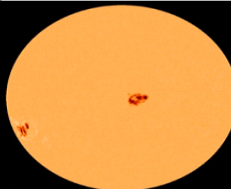
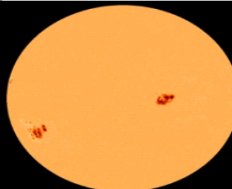
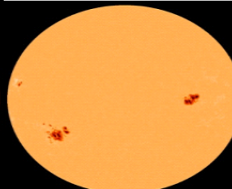
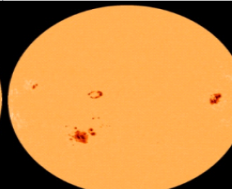
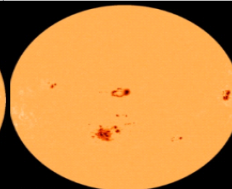
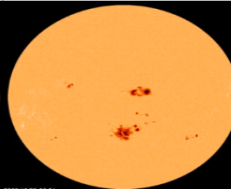
SAGE



- BIS- Depart. Business, Innovation & Skills
- DECC- Depart. Energy & Climate Change
- DfT- Depart. Transport
- UKSA- UK Space Agency
- DAs- Devolved Administrations
- DCLG- Depart. Communities and Local Govern

- SCGs- Strategic Coordination Groups
- STACs- Scientific & Technical Advice Cells
- Scientific Community- British Geological Society, Science & Technology Facilities Council etc.

Understand requirements through exercises

	14-Mar	15-Mar	16-Mar	17-Mar	18-Mar	19-Mar	20-Mar
Sunspot							
Flaring	Some low X class	X15	X1	M	X4	X5	X1
CME	slow not Earth directed	slow not Earth directed	slow partial halo	1390 kms-1 partial halo (18:00)	slow partial halo	slow full halo	1300 kms-1 1620 kms-1 (10.00 & 23.00) full halos
Geomag	-	-	-	-	G1	G3	G2
Protons	None	slow rise	S2	S3	S4	S3	S3
Electrons			low	low	low	low	moderate
Impacts UK	No Sig	2-3 hour HF comms blackout over UK & some degradation of satellite comms & GNSS positioning	2-3 hour HF comms blackout over UK & some degradation of satellite comms & GNSS positioning	No Sig	Airlines avoiding near-polar tracks. Intermittent satellite service outages. Minor HF comms outages	Airlines avoiding near-polar tracks. Minor HF comms outages	Airlines avoiding near-polar tracks. Minor HF comms outages
Impacts Global	Minor HF comms blackouts	2-3 hour HF comms blackout over Africa, Europe & Eastern Atlantic. Some degradation of satellite comms & GNSS positioning	Minor HF comms blackouts	US airlines avoiding polar routes, minor HF comms blackouts	Avoiding polar & North Atlantic routes. Loss of HF in polar regions. Intermittent satellite service outages	G2 to G3 geomagnetic storm. Avoiding polar & North Atlantic routes. Loss of HF in polar regions. Intermittent satellite service outages waning	G1 to G2 geomagnetic storm. Avoiding polar & North Atlantic routes. Loss of HF in polar regions.



Met Office

Complete the evidence chain

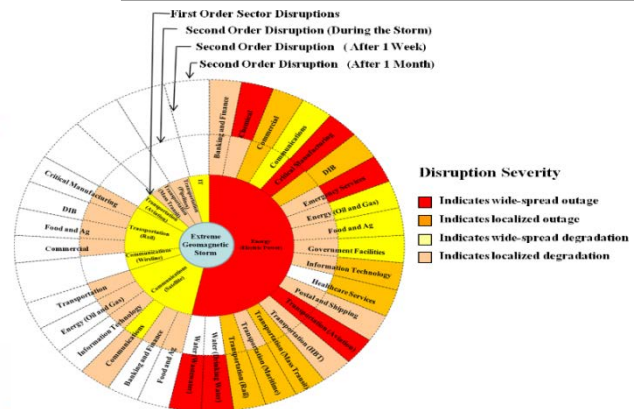
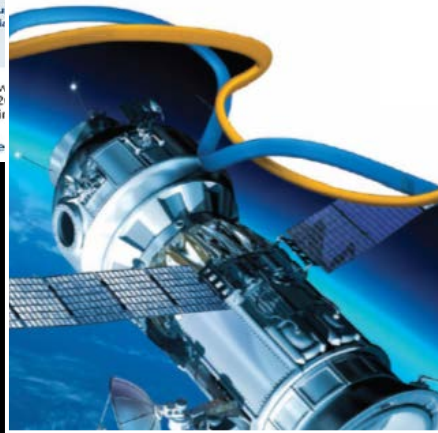
Figure 2: Risks of natural hazards and major accidents



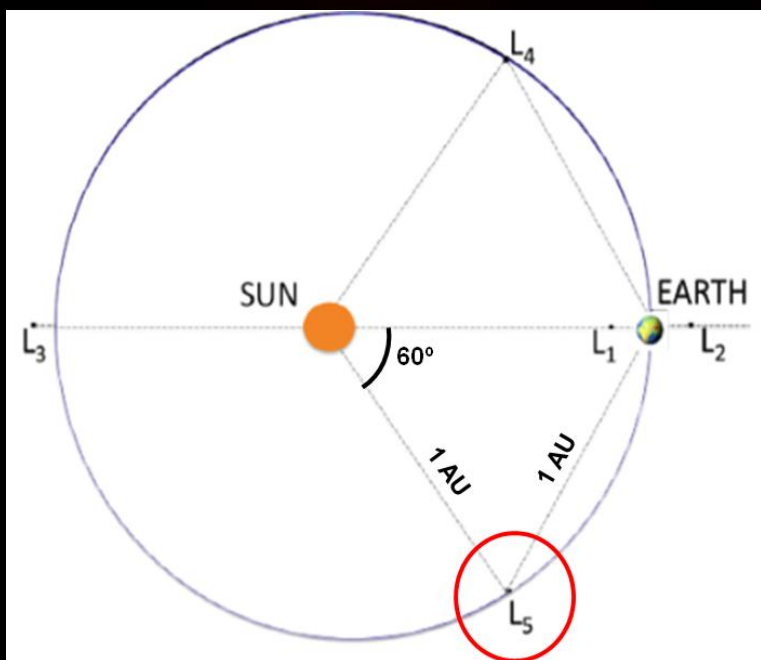
Study due for completion June 2016



Extreme space weather: impacts on engineered systems and infrastructure



Carrington mission to L5





Met Office

Thank you

